Bulldog Rocketry

Post-Flight Performance Report

2016-2017 NASA Space Grant Midwest High-Power Rocket Competition

Faculty Advisor
Jose Carrillo
jcarrill@

Level Two Mentor
John Christopherson

University of Minnesota Duluth

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Executive Summary

The Minnesota Space Grant Consortium operates and organizes the Space Grant Midwest High-Power Rocket Competition, of which draws teams throughout the Midwest United States to test and display their engineering abilities in the form of rocket science. The University of Minnesota-Duluth team, Bulldog Rocketry, attended and competed with a fully designed and thoroughly tested high-power rocket. The team consists of 50 active members, some of whom are outlined in the team summary.

The purpose of the competition was to develop a high-power rocket with an adaptable motor system which allows a J-class and K-class motor to reach the same altitude. Bulldog Rocketry launched with an Aerotech J-135 and was planning on using a Cesaroni K-2045 to prove the adaptable motor design, along with an active drag system. The avionics package included a custom-built pitot tube which acted as an active data recording device that directly recorded velocity. The rocket was fitted with an on-board, downward and upward facing camera, that provided visual data of deployment events. The launch scoring focused primarily upon the accuracy and precision of the rocket's ability to reach similar altitudes with different rocket motors.

A full recovery package, consisting of a dual deployment parachute mechanisms (integrated with on-board avionics) would in theory allow the rocket to safely descend from its peak flight altitude to land and be collected. The recovery altimeter was commercially made and has documented performance characteristics.

The combination of manual calculations and computer aided simulations on SolidWorks, and OpenRocket were used by Bulldog Rocketry to design the best possible rocket. By using analytical engineering methods, the team was able to determine the rocket's most essential dimensions including body length, nose cone design, and fin length.

Throughout the design and testing phase, team and public safety has been, and always will be, of the utmost concern.

Unfortunately, on the 22nd of May during competition, the rocket was lost on the first flight, and the team was not able to properly recover the rocket. With the rocket, we lost all of the data that we would have received to make key findings and conclusions as well as tables and graphs for this report.

Bulldog Rocketry Team Summary

The Bulldog Rocketry Team is a registered student organization at the University of Minnesota Duluth that includes students from the mechanical engineering, industrial engineering, electrical engineering, computer science, graphic design, civil engineering, and physics departments. Only the team leads are included in this report since there are so many active members.

Air-Brake: Chet Peterson (Lead)
Video: David Ries (Lead)
Simulation: Evan Boncher (Lead) Aesthetics: Paul Cerar (Lead)
Financial: Kalli Anderson (Lead)

Rocket Design Objective

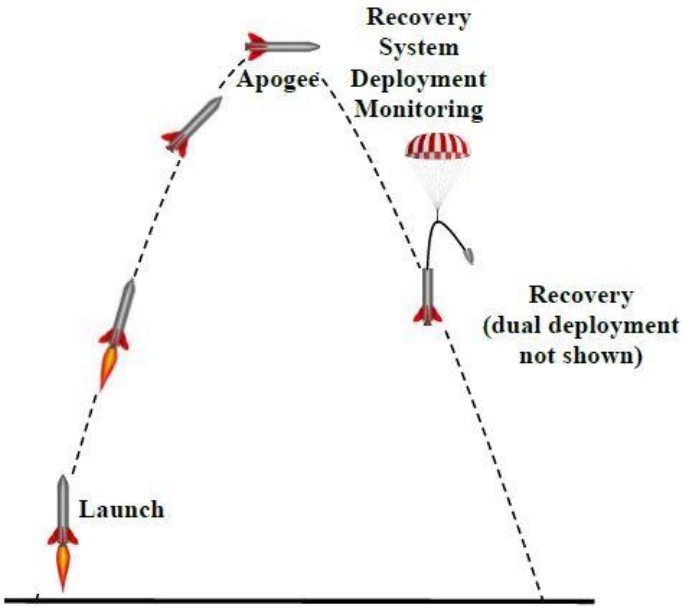

Figure: Events during rocket flight.

Flight Performance Characteristics

Since the rocket was lost, we cannot present any of the data for the rocket flight and we cannot make any conclusions for the launch analysis or coast analysis for this report.

Rocket Operational Assessment

During the competition, the Bulldog Rocketry team did have anomalies that significantly impacted the performance, but not the safety, of the flight. When the rocket reached apogee, the main parachute deployed, causing the rocket to drift farther than expected. Coupled with the fact that we couldn't get a radio beacon from the radio tracker, the rocket was lost. Bulldog Rocketry hopes that one day we will get our rocket back.

Drag System Analysis

Since we could not recover the rocket to launch after our first flight, we could not launch for a second time. The second launch was the flight where the drag system would have been enabled. Due to this fact, we have no data or observations for the drag system analysis.

Recovery System Analysis

Unfortunately, since we never recovered the rocket, we cannot make conclusive findings from the recovery system and how it worked. The team can however make the conclusion that somewhere during the morning of the competition, either during assembly or during the flight itself, something caused the main parachute to open at apogee instead of the expected 600 feet above ground level. This failure could have been caused by many things, including the chute release failing by early release, and a failure in the deployment of the recovery system. All this is speculative, so hopefully the team will get the rocket back so more conclusive findings can be made.

Data and Video Collection Analysis

As stated throughout this report we could not recover any data or video. We had live telemetry capabilities, but due to the fact the launch got postponed the member of the team that is HAM Radio certified and runs the live telemetry could not make it. This caused us to only record to the onboard SD card and since the team couldn't recover the rocket we have no data. This is true for the video as well. Since the video files are stored onboard the rocket, specifically inside the cameras themselves we have no video or visual data of the launch.

Team Performance

The UMD Bulldog Rocketry team had five members in attendance at the competition. Each had a specific task assigned to them to streamline the process of preparing the rocket for each launch. Because the pre-launch and post-launch procedures were practiced prior to the competition, each member could perform their tasks quickly to then assist those who required multiple hands for their portion. In this way, Bulldog Rocketry was able to setup and launch the rocket for the first time in under an hour.

Overall, the members of Bulldog Rocketry operated as a professional and efficient team in preparing the rocket for the first launch. This is attributed to preparation, practice, and the elevated level of responsibility that each member of the team took to ensure that everything was done properly.

Key Findings/Potential Design Improvements

Given the chance to perform the flights again, only a few minor changes would have been made. A more thorough inspection of the recovery system would have been done, on top of a possible recovery system design change. This design change would include replacing the Chute Release on the main parachute with an alternative deployment method. The Team would have also made sure that the radio tracker was in proper working condition, and tested the tracking system with the equipment at the competition.

Conclusion

Overall, Bulldog Rocketry spent nine months designing, manufacturing, and testing a high-powered rocket for the NASA Midwest High-Powered Rocketry Competition. This lead to some minor failures that caused the rocket to be lost but all the leaders of Bulldog Rocketry are very pleased with the team performance over these last nine months. In which every hour of tedious design, precision construction, and rigorous testing, as well as rebuilding the rocket twice, culminated in a design that the whole team can be proud of.

The team worked together efficiently and performed well overall. This was due the clear launch procedures and how the team practiced and prepared. The team takes immense pride in how it operated throughout the competition. The team's hard work ethic and dedication was something to witness after every setback seen this year. The team is very proud of itself, even though there was not a successful launch and recovery. As is generally true, you can learn more from failure than success. The Team will take all it has learned from this year and apply it to future rocket designs.