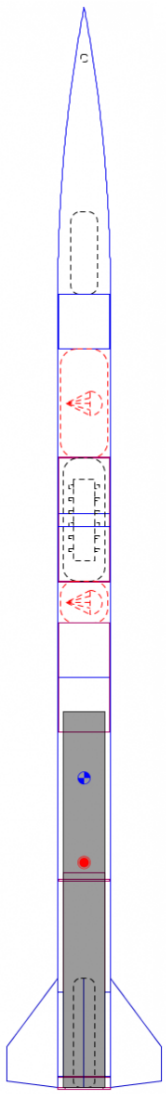
127 Days Till Launch

Purchasing



Rocket schematic

As the university returns to life after winter break, we have been pressing forward completing the majority of of our orders for airframe components with USG. Kenny at Performance Hobbies is sourcing in our G-10 fiberglass body tubes, and we should have our hands on the parts by the end of the month.

Mike at Binder Designs is doing some custom fiberglass CNC work for us, cutting out the fins and profiling the leading and trailing edges. He is also cutting out the centering rings and bulkheads used to align the sections of the rocket.

Mark, a senior here at UCONN and a second year member of the rocketry team, has lead a group of undergraduate students in designing the thrust plate for the rocket. After spending last semester designing, modeling, and validating the design, he will be spending this month turning his design into reality. Produced from an 8” diameter disk of 6061 aluminum alloy, the thrust plate transfers the nearly 1600 pounds of thrust from the motor to the airframe. Expect to see the progress of his handiwork in upcoming newsletters.

Recovery hardware has been ordered, and should be expected in the upcoming month. Teddy at One Bad Hawk is producing a set of high quality Kevlar recovery harnesses for the rocket. While Kevlar is heavier than nylon, it does have the advantage of being fire-resistant. This mitigates the risk of melting harnesses with the ejection charges used to separate the rocket and deploy the parachutes. Rocketman Parachutes is also supplying a high quality drogue chute to slow the descent from 30,000’, which should be in this month.

Propulsion

Over break, we were able to characterize our propellant thanks to help from our local Tripoli Rocketry Association mentor and the Upstate Rocketry Research Group in Penn Yan, NY. After identifying the burn rate and sensitivity of our selected propellant to pressure, we designed a flight motor based on the lessons learned last year.

Last year’s static fire and flight statistics showed that our motor ran significantly over the design pressure for the first second of flight. This phenomena, called erosive burning, is due to the excessive mass flux through the lower cores of the motor. This causes the burn rate in the lower cores to be higher than predicted by Saint-Robert’s Law ($r = aP^n$), which increases the mass flux through the nozzle, increasing total pressure in the motor, further increasing the burning rate. While both the static and flight motor’s were successful last year, erosive burning can easily cause the pressure in the motor to exceed the design pressure in the case, posing a serious safety concern.

Over break we tasked ourselves with identifying the cause of the erosive burning and finding a way to mitigate the risk. Thorough simulation and analysis of the previous motor revealed that while the mass flux through the bottom grain of the 2019 motor was reasonable, the mass flux through the second to last grain exceeded what was recommended to avoid erosive burning. To mitigate this, we redesigned the grain geometry to optimize the mass flux through each core to avoid problems with erosive burning.

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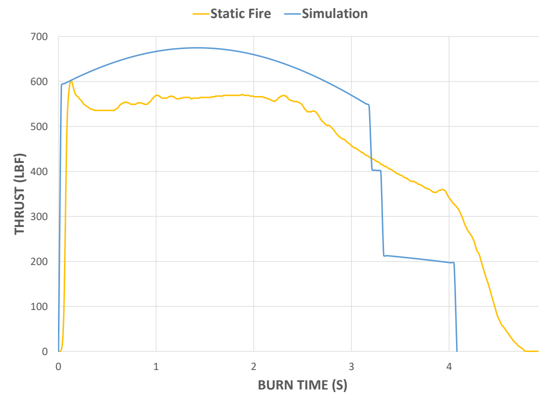
Static fire of scale M motor

With the new grain geometry designed, we set to designing and static firing a scaled down version of the flight motor for testing. The 98 mm M class motor was selected as a reasonable scale model. Previous tests had shown that 98 mm motors had enough residence time for the chosen propellant to perform similarly to the flight motor. The size also gave a reasonable 5 second burn time, allowing us to see how the motor would respond as the lower grains burnt out before the upper grains.



Thrust profile from simulation(blue) and static fire test(yellow)

Test results were nominal, with a very minor erosive peak at ignition. Delivered ISP for the static fire was 183.8 s, with the simulation predicting an ISP of 188.5 s, a 2.5% reduction in ISP. Analysis of the thrust and pressure curves indicate the motor ran about 5% below design pressure for the test, resulting in the reduced burn rate and reduction in ISP. It is possible some of the variance is the result of nozzle erosion. The nozzle was designed to be reusable, and had been fired on a number of prior occasions. It is possible the throat had opened slightly, resulting in the reduction of chamber pressure. Future work will analyze the sensitivity of the simulation to nozzle diameter variance resulting from nozzle erosion.

The static fire was a success, and we are going forward mixing a full scale motor for static fire before the end of January. Expect to see results from the full scale motor in the next newsletter.

Thank you to everyone involved for your continued support. Without your help, none of this would be possible.

AIAA SHAPING THE FUTURE OF AEROSPACE

UCONN SCHOOL OF ENGINEERING

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