UCLA Rocket Project

Vehicle: Prometheus (Hybrid) | Cycle: 25–26

Test Summary Report

Static Fire Campaign #2

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Test Campaign:	Student Researched and Developed (SRAD)
Test Location:	Reaction Research Society
Test Date:	2026-04-11
Team:	Propulsion Test Engineering
Leads:	Blas Kozicki; Ignacio García Pereña

Revision History

Rev.	Date	Description	Prepared By
A	2026-04-15	Initial release.	Aidan Yu; Manav Patel; Kyle Lactaoen

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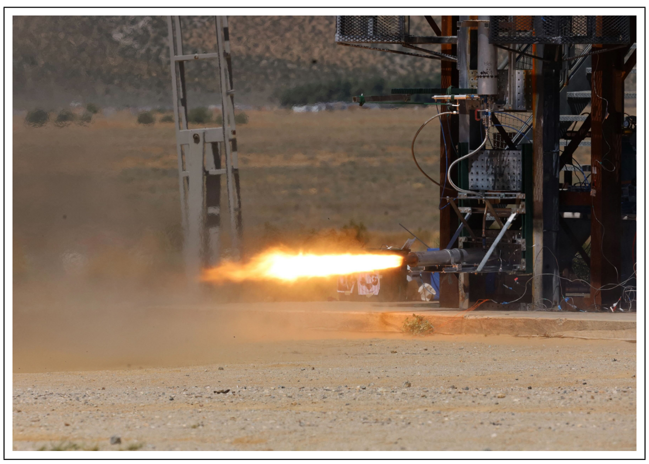
1 Summary

The first SRAD engine, “Amber,” performed nominally with no burn-throughs or large visual anomalies. The secondary engine, “Particularity,” was not fired due to fuel grain mold release issues. Setup began with preparing for high press at around 11 PM. The fill table was low-pressed early, but due to electronics issues, high press was not started until 7 am. High press failed twice due to leaking fittings, and passed with a narrow margin (9.4psi/min). We successfully filled and fired at around 12:25 PM. Due to a significantly lower tank pressure at ignition (600 psi vs. 750), we had a longer burn time (14s vs 12s) and lower peak thrust (521 lbf vs. 586 lbf). The engine exhaust plume jumped to 1ft in length around 1s, then stayed relatively constant. Mach diamonds were seen clearly around 2-5s into the burn. The engine experienced significant chugging in the latter half of the burn, which was observed visually (flickering exhaust plume) and heard as a deep rumble. The exhaust visually stabilized immediately at blow-down, which continued until T+00:25 s when large black plumes of smoke started coming out of the nozzle.



(a) Thrust plume

(b) Idle test engineer before integration

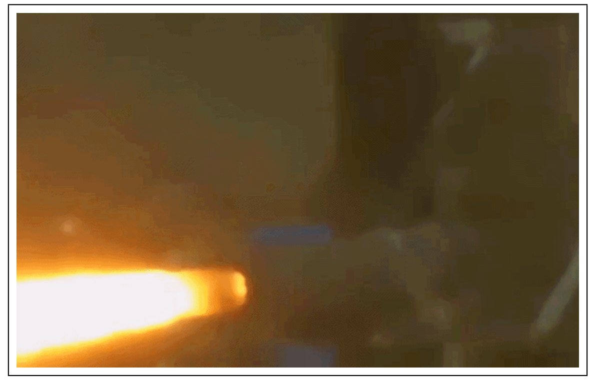
Figure 1

2 Issues Encountered

2.1 Engine Restrain

The load cell was not bolted to the structure's back plate, allowing the engine to lift within the clamps during the burn. The vertical displacement reduced the load cell readings, lessening the thrust measurement.

(a) Engine at rest, pre-ignition



(b) Axial lift-off during steady-state burn

Figure 2

2.2 Chamber Pressure

The top plate was installed 180 degrees out of clock, which connected the chamber PT port to an un-drilled hole left behind by a broken drill bit. No chamber pressure data was captured for the static fire, a critical loss.

2.3 Oxidizer

The tank was underfilled at 27.2 lbs vs. 30 lbs due to a mis-sized or possibly bent dip tube. This produced a fuel-rich flow at the end of the burn, visible as black plumes in the exhaust as O/F ratio shifted.

2.4 Leaks

A swivel T fitting nut on the MPV line leaked during fill, and there was leaking ball valves on the GSE fill table. These leaks contributed to the underfill and reduced margin on the run pressure.

2.5 Flex Hose

The flex hose from the MPV to the injector was run too long with sharp bends and loops, introducing pressure losses. Flex hose choice needs to be particular.

Figure 3: Non-optimal flex hose with excessive bends

2.6 Nitrogen

Nitrogen ran low because the bottles were not labeled correctly, leading to uncertainty about actual capacity. Bottle labeling and inventory need improvement.

3 Statistics and Anomalies

During fill, the nitrous bottle read approximately 860 psi on the pressure gauge. Despite this, the tank was only filled to around 600 psi, 150 psi below the target firing pressure of 750 psi. As a result, peak thrust reached only 520 lbf, below the 586 lbf target required for minimum off-the-rail speed.

During firing, significant engine chugging was observed both visually and audibly. At approximately $t = 10\,\text{s}$, noticeable flickering appeared in the exhaust plume and progressively worsened until blowdown at $t = 14\,\text{s}$, at which point the plume immediately stabilized.

Table 1: Statistics.

Parameter	**Measured**	**Delta vs. Target**
Tank pressure	601 psi	−149 psi
Peak thrust	521 lbf	−65 lbf
Burn time (to blowdown)	14 s	+2 s
Total impulse	5628 lbf·s	+233 lbf·s
Specific impulse (I_{sp})	204.3 s	−43.7 s
Oxidizer mass consumed	24 lb	−2.45 lb
Fuel grain mass consumed	3.6 lb	−0.53 lb
O/F ratio	6.65	+0.25
Average oxidizer mass flow rate	1.71 lb/s	−0.94 lb/s
Throat diameter erosion	0.090 in	—
Throat area increase	17.49%	—
Average feed system pressure loss	24%	—
Average injector pressure differential	11%	−2.3%

4 Post-Hotfire Inspection

4.1 Manifold O-Ring

While the manifold o-ring was still sealed, it appears to have ruptured, possibly due to manufacturing errors. We'd see large leaks if the manifold O-ring tore before or during the fire (propellant would be all over the place), which did not occur.

Figure 4: Manifold.

4.2 Nozzle-to-RR Seal

The sealing method uses a thin layer of RTV between supersonic exhaust gases and the chamber walls, and there was damage to the RTV near the chamber walls. However, the temperature and pressure are a lot lower there, so it's less likely to burn through in that area.

Figure 5: Nozzle.

4.3 Ablation

Throat ablated about 90 thousandths of an inch, and highest ablation on the fuel grain is about 1.68 inches in diameter, leaving about 0.35 inches of thickness left to the grain. This is quite excessive, but with issues with tank pressure there's no guarantee that we will have this amount of buffer left with optimal chamber pressures. Post and pre CC performed nominally.

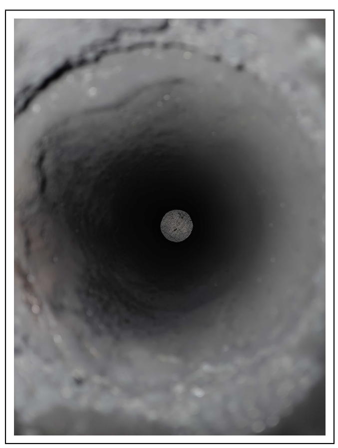


Figure 6: Combustion chamber.

4.4 Liner Scarring

The black is the result of a sealing issue, though it appears to be on the injector side, which doesn't really make sense since our O-rings sealed on the injector pretty well. The chamber inside showed no deformation. The seal broke at the nozzle to RR or the phenolic to nozzle. It is worth slathering RTV in that seal even more next time, since it may have been a miracle we didn't burn through.

Figure 7: Liner.

4.5 Fuel Grain

Grain looks homogenous with little to no bubbles. It also seems to have hardened quite a bit, meaning it definitely wasn't cured when fired. It could take a week with the same cure index to get a satisfactory stiffness. Comparing our pieces to last year's, last year's is significantly cleaner than ours; we either didn't apply enough RTV or did not compress our grain enough for a compressive seal on the steps. Cure index might be good if we just cure further in advance.

5 Thrust Data Analysis

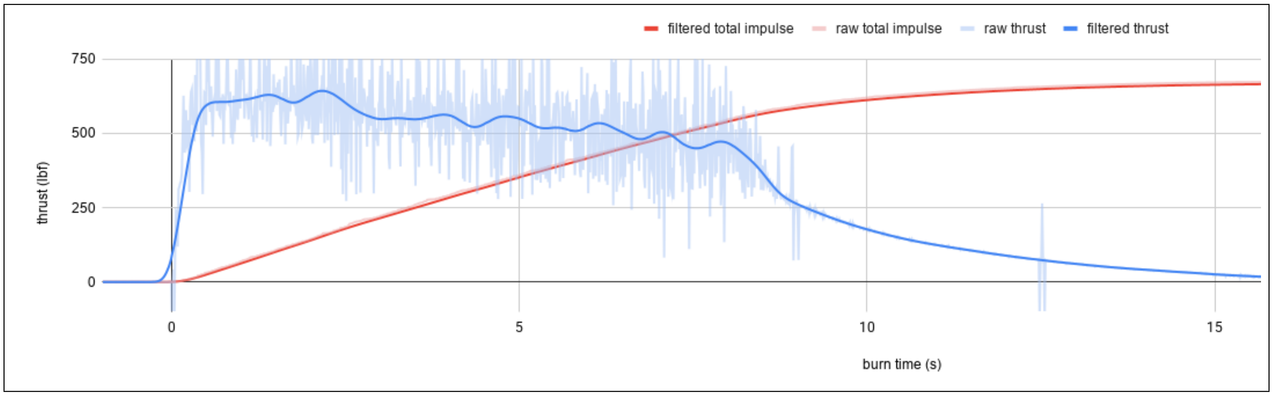


Figure 8: Thrust vs. Time

Data shows that the initial peak is not correlated with the tank pressure. There is an early thrust spike. This is an anomaly as these two should be proportional to each other and be on trend. Possible causes include a load cell issue correlated with a connection issue, where the connectors weren't connected properly and were incorrectly recording data. Another possible issue can be an overfilled oxidizer tank. If this were the case, it would explain why we have an early thrust spike and a longer total burn time.

As said, in the thrust curve, we have a lengthened burn time, which is another anomaly. This was likely caused by an overfilled oxidizer tank, as explained earlier. We could also have a lower empirical mass flow rate than the theoretical value, which would increase the burn time and extend the propellant's duration. Therefore, some of our feed losses or assumptions were likely off. Thrust and impulse are conservative, meaning that we only accounted for the dry mass and calculated our performance based on this, which is why impulse is lower than the actual value.

6 Pressure Data Analysis

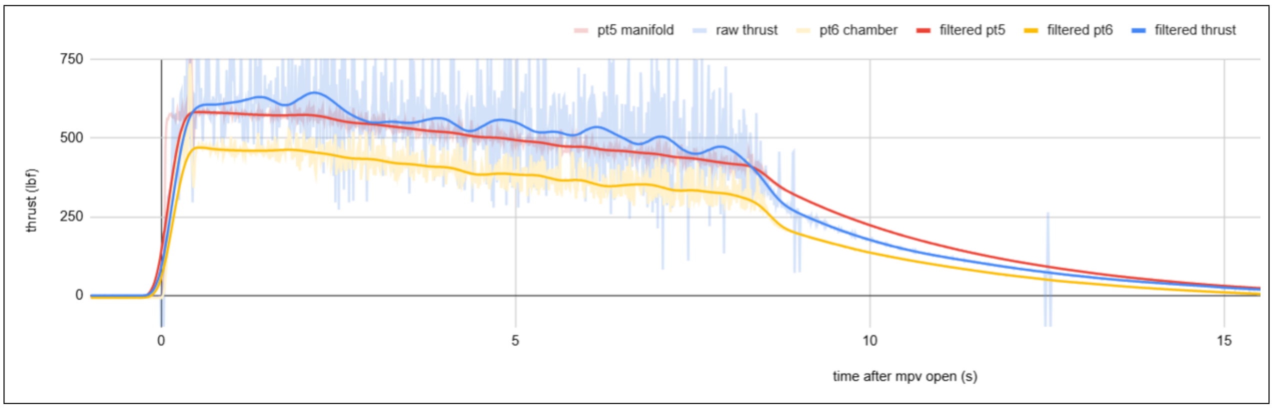


Figure 9: Pressures vs. Time

The pressure-time data is in many respects the cleaner of the two datasets, and provides a useful counterpoint against which the thrust curve anomalies can be better contextualized.

The bottle pressure (blue) remains essentially constant at approximately 710–720 psi across the entire duration of the test. This flatness confirms that the pressurant supply was not a limiting factor at any point during the burn and that the regulator or high-pressure bottle was delivering a consistent driving pressure to the system throughout. No meaningful degradation in bottle pressure is visible, which rules out pressurant starvation as a contributor to any of the thrust irregularities observed in the thrust-time data.

The fill line pressure (yellow) behaves as expected. It begins near tank pressure (670 psi), briefly spikes to approximately 760 psi around t = 0.3 s, a pressure transient associated with valve actuation at ignition, and then depressurizes rapidly to near zero by approximately t = 0.7 s, where it remains for the rest of the test. This behavior confirms that the fill valve closed properly and that the fill line was successfully isolated from the system at the onset of the burn. The slight negative offset visible in the fill line after depressurization is almost certainly a sensor zeroing artifact rather than a physical phenomenon, and is consistent with the similar pre-ignition offset seen in the static fire thrust trace.

The oxidizer tank pressure (red) is perhaps the most informative channel. It opens at approximately 670 psi, dips briefly during the ignition transient, then stabilizes at roughly 600–610 psi for the first 1.5 seconds before beginning a smooth, continuous decline to near zero by t = 7 s. The smoothness of this decay is a meaningful positive result: it indicates that the feed system was functioning without flow instabilities, injector flooding, or sudden vapor lock events. Critically, there is no sudden collapse in tank pressure at any point, which would have been the signature of a catastrophic flow disruption or injector choking event.

7 Future Improvements

7.1 Pre-Test Load Cell Verification Protocol

Before any future static fire, the load cell should be tested and calibrated at the test site after all wiring is connected. Electrical interference from the igniter is a known risk and shielding or rerouting the load cell cables away from igniter wiring should be standard practice going forward.

7.2 Repeatable Fill Procedure

The fill process should be codified into a step-by-step procedure with explicit stop points and measurements rather than relying on operator judgment. This includes a target fill volume, a method to verify it, and a sign-off before proceeding to pressurization.