ISSUE 58

APOGEE PEAK OF FLIGHT NEWSLETTER

Saturn 1B and V Test-Launch Report

By Tim Van Milligan

Time for something completely different...

I thought I'd write a report about the first launches of the Apogee Saturn 1B and the Saturn V rockets (which I flew on Saturday, July 21). I don't usually write launch reports because I know that they can sometimes get a little boring to read. But for historical reasons, I thought I'd better document these flights.

Another reason I had for writing this article is that I hope to teach younger modelers how to test launch new designs. This is an important skill to acquire; especially once you progress beyond Skill Level 1 model rockets.

Getting Ready For the First Launch

This past week, I found a little time to complete the construction of the flight test vehicles of the Saturn 1B and the Saturn V. Most of the production parts I now have in stock: tubes, plastic nose cones, transitions, and centering rings. But I don't have all the final wraps and the fins yet. However, I was able to cobble together some prototype parts that were "close-enough" to the final production pieces that will be in the kit.

For example, for the vacuum form wraps that I didn't have, I used parts of wraps that are used on other areas of the rocket. While they didn't have the correct scale appearance, they would provide the same mass and aerodynamic drag effects as the final parts.

The same went for the fins. I made a simple urethane casting of the prototype fins. While these didn't have the surface detail as the production parts, they would be close to the actual weight and size. A objective of the flight program was to use "scale" fins, and not to make them larger if at all possible.

Overall, I wanted the flight vehicle to match -- as close as possible --- the final production vehicle. I am reasonably assured that I was/am pretty close.

For the Saturn V, I did have time to put down a coat of primer, and the white base color paint. So it's final weight should be pretty close to the actual production kit. I ran out of time on the Saturn 1B, and I didn't have a chance to paint it.

Even though the models were built, I knew I wasn't able to test fly them yet. The reason is that I didn't know the Center-of-Pressure location for them. Without this, I didn't know how much nose weight to add to them, so that they'll fly straight.

To find out the CP location, I used a great software program called "RockSim." You may have heard of it...

When I enter a rocket design into RockSim, I don't try to match the picture with the actual appearance of the rocket. I try to match the aerodynamic qualities. So, if you looked at my RockSim files, the first thing you'd notice is that there is no escape tower on the models. The reason is that this part would throw off the CP calculations.

In the Barrowman equations, the reference area used to calculate the CP is chosen as the base area of the nose cone. If the area is very small compared to the rest of the diameter of the rocket (like the escape tower nose cone), then the CP location will be way off. I wouldn't trust those numbers. That is why in my RockSim files, the escape tower is missing. There are other differences too. I'll be posting the files to my web site later, and you can see them for yourself and note the differences.

The RockSim files were very enlightening. It told me that the Saturn 1B was going to need a whole lot of nose weight. Yikes! Even so, the size of the parachutes I had selected were adequate to bring it down at a nice slow rate.

Being that I have been around rocketry for a while, I had a pretty good idea what motors would be good for the models. I selected a F20-4 Econojet from Aerotech as the first motor for the Saturn 1B. I have a hunch that most people will eventually fly the model on the F20; because it is a inexpensive launch with lots of smoke and noise.

For the Saturn V, I chose the G80-4 rocket motor; also from Aerotech. The delays were selected based on that I knew that, despite the low weight for the rockets, they would be

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very draggy. They would slow down real quick after motor burnout.

I used a high fixed drag coefficient of 0.9 for both models. With this selected, RockSim told me that my choice of motors would be reasonable -- with good take-off speeds, and ejection within a second of the apogee point.

Note: for those of you needing extra assistance in selecting rocket motors, please see the series of articles beginning in Newsletter 38.

With my RockSim simulations completed, I was able to put the final touches on the rockets and prep them for flight. The hardest part was figuring out how to add the significant amount of nose weight to the Saturn 1B. But these types of things out is why we do test flights.

The last thing that I prepped was the harness for the capsule section of the models. I'm playing around with several different ways of making it descend horizontally. What I'm looking for is something that is quick and easy; and doesn't detract from the appearance of the rockets.

For the first launches, I did choose not to add the escape tower to the capsule. From a flight perspective, it wouldn't really affect the trajectory or altitude of the models. I'll wait until later in the test program to add them to the flight models.

Launch Day

It was luck that the day of the first launch was also the 32nd anniversary of the First Men On The Moon. I took that as a good omen.

I found out about a launch that was occurring in Pueblo, Colorado. It was being hosted by Jason Unwin; who volunteers at the Weisbrod Aircraft Museum at the Pueblo Airport. Jason is organizing a new N.A.R. section in Pueblo, and has found a very nice field to fly from. It is always good for the hobby when a club secures a big flying field. So I thought I'd take advantage of the field, and at the same time show support for the budding club.

The launch site is on a 20,000 acre military reservation known as the Pueblo Chemical Depot. This military installation would have been closed down years ago; except for one thing. It is a storage location for chemical weapons (like mustard gas). These weapons are going to be destroyed in the next decade; but until they are -- it is safer to leave them alone in their storage bunkers than to transport them to another military base.

The storage bunkers were off limits, but being that the place was 20,000 acres, there is still had miles and miles of room to roam.

The day started out around 9 a.m. with a rocket building session for the new members of the Pueblo club. There were probably at least a dozen kids that showed up -- each dragging along their parents. It was nice to see the next generation of rocketeers getting hands-on instruction from Jason and a few of the club members that came down from the Colorado Springs Rocket Society.

The building session lasted until around 11 a.m., at which time Jason gave everyone a safety briefing. I found this very worthwhile for the kids. The only thing that I would have done different is to tell the kids what to expect when they headed to the launch site. Every club runs things a little different, so it is good to know the procedures on how the range operates. This would reduce the initial confusion when everyone wanted to load the rockets onto the launch rack at the same time.

I also need to make a mental note to remember to include a discussion about retrieving someone else's rocket. I don't mind people chasing down my rockets -- it saves me the trek. But I would like people to collapse the parachute and stuff it into the tube. This would prevent damage to the model and keep the chute from getting too tangled. And at large launches; where there is usually some type of "lost and found" box, it also prevents the contents of the box from looking like a huge plastic mess. Getting your rocket out of the box can be more damaging than the flight and landing.

Parachutes failure would play a large role in the kid's flights. The instructions given to them during the building session were a little too brief in this respect. More care should be given to parachute folding instructions; and then there would have been less "plastic wad" recovery.

Launch Conditions

Summer launches in Colorado are usually guaranteed to be sunny. This day was no exception. The sky was crisp and clear. Since the Pueblo Chemical Depot is mostly flat with only a few small trees, we had great views in all directions. I could easily see mountains on the horizon that were well over 70 miles away.

The day started out warm, and got toaster-oven hot by middle afternoon. I think it reached about 97 or 98 degrees.

About this Newsletter

You can subscribe "FREE" to receive this e-zine at the Apogee Components web site (www.ApogeeRockets.com), or sending an email to: ezine@apogeerockets.com with "SUBSCRIBE" as the subject line of the message.

To stifle the heat, a breeze would have felt welcome. Occasionally there was a variable breeze, but it couldn't make up its mind on which direction it was going to blow. Sometimes it blew to the east, sometimes to the west. A lot of the time, it was dead calm. On a scale of 1 to 10, only the heat index would have kept this from being a perfect launch day. I would have given it a "9."

The humidity was very low, about 30 percent, so all the glue on those newly built rockets was dry by the time the rockets got out to the launch area. I worry about that type of thing when the models are built the same day they are launched.

The launches got underway by around 11:30 with rack upon rack of the kids' newly built models. All the kits flew nice and straight, and the kids had lots of fun chasing them down (along with my dog Lacey). Even the occasional plastic-wad recovery device didn't dampen their enthusiasm.

I got as much enjoyment out of watching them squeal with delight over their own rockets as I did with my own squeals of joy with my rocket projects. I have to say that if you're not launching with a club, you're missing out on one heck of a parade of excitement.

I had the Saturn rockets prepped by 12 noon, but held back to let the kids launch first. I had my Easy-Up canopy with me, so I became quite popular with all those seeking some shade. So while I waited to launch my rockets, I had a chance to sell a few of the Apogee products: books and rocket kits.

The launch of the Saturn 1B

About 1 o'clock, I took the Saturn 1B to the launch pad. The 1/4 inch launch rod supplied at the range was a mounted on a tripod; which was weighted down with an old wooden pallet. It would have taken a hurricane force wind to blow that pad over. But since there was no wind, it was a bit overkill.

The excitement of the small crowd was beginning to grow as the other rockets on the rack were launched first. Most of the kids had never seen such a big rocket before -- let alone an "F" motor. So when the countdown ended at zero; and the rocket still sat on the pad, they were mildly disappointed. You probably guessed it; igniter failure.

I was using the Aerotech supplied copperhead igniter with the F20 motor. It came tightly folded in the little shipping tube, so my guess is that there was a short somewhere on the strip.

I grabbed one of my own copperheads, and loaded up the model on the launch pad. Again, the other models were cleared from the rack before the countdown of the Saturn 1B could begin.

After a brief announcement of the significance of the Saturn 1B, the LCO began the countdown: "Going in: 5, 4, 3, 2, 1, LAUNCH!"

This time, the copperhead did its job, and after the chamber pressure built up, the rocket motor roared to life. Full throttle...

The model seemed to take off like a bullet. But I noticed that it was arching downwind a little bit after clearing the rod because of the slight breeze blowing at lift-off. This indicates that it was definitely not overstable. Had it been overstable, it would have turned slightly into the wind.

Secretly, I was hoping that is was overstable, so that I could remove some of the nose weight on future launches. Because it wasn't, I'll have to give it some deep reflection before I decide to try that.

At about 30 feet into the air, the rocket had already accelerated to a goodly amount of speed, and the fins were finally

Saturn_1B_launch.mov

Instructions: Click on the box above to start the movie playing.

producing the forces needed to counteract the crosswind. Because of this, it stopped arching with the wind and had attained a straight vector -- like it was following a taut rope into the sky. My calibrated eyeball says it was maybe 5 degrees from vertical. I didn't notice any spinning of the rocket as it ascended either.

The sound of liftoff was echoing off a nearby building, and it really added to the effect of the launch. The kids and the parents that had never seen a composite propellant motor launched before were going spasmatic. I was just happy it didn't cato on the rod...

By now, the rocket was coasting high into the air (RockSim predicted about 700 feet). I was videotaping the launch at the time, so I was searching through the viewfinder to find the rocket in the sky. The blasted camera has auto focus, and was trying to focus on the wispy high clouds in the sky. Because of this, I didn't get to see if the ejection was right at apogee or not. But from the PA system in the background, I heard the LCO say "All Rigggght!" That told me the chutes were out and had blossomed fully.

Then I heard him say, "looks like the upper part is catching a thermal..." That would have meant a long chase to recover the rocket. I started out after the model; and then I noticed that about six other folks were helping me out too. They were moving a lot faster than I was, since I was carrying the video camera and at the same time trying not to step in any holes where a rattlesnake might be hiding. So I turned the video camera back on to record the descent of the two parts.

Even at a launch elevation of 4000 feet, the sections came down nice and slow. Through the eye of the video camera, I managed to just catch the last 20 feet of the upper portion of the rocket, and the final 50 feet of the descent of the bottom part. The capsule made it to the ground before one of the chasers got to it, but the bottom section hung up just enough for someone to catch it mid-air. It was a cool sight to see.

The two parts had drifted maybe 300 yards downwind to the west. Both parts came down close together, so I didn't have far to go to retrieve them.

The flight lasted about a minute, but the memories will last me a lifetime.

After I returned back to the shade of my canopy, I looked the rocket over: no damage at all. Hence, I was a very happy camper.

First Flight of the Saturn V

The Saturn V was nearly completely prepped while I was out launching the Saturn 1B. The only remaining thing I had to do was take the bigger parachute from the smaller model and attach it to the capsule portion of the Saturn V. So within a few minutes, the Saturn V was ready to go.

But I wasn't... I was hot and thirsty from the launch of the Saturn 1B. So I cooled my heels for a while; and talked to the people that wanted to learn more about the Saturn 1B flight. So it was probably a half hour before I took the Saturn V out to the launch pad.

After loading the Saturn V on the pad, I snapped a quick photograph of it. I at least wanted one picture of it; just in case it had a early demise.

As previously, there was a rack full of other models that were launched prior to the Saturn V. This allowed the anticipation of the small crowd to build to heightened levels. I was hoping that I wouldn't suffer another igniter failure. That would have been a huge let-down for the spectators.

But they wouldn't be disappointed on this attempt.

When the LCO said: "Ready in -- 5, 4, 3, 2, 1, LAUNCH," the popping sound that a copperhead igniter makes when burning was immediately drowned out by the loud rumble of the motor coming up to full power.

I had placed the model as low on the launch rod as possible, because I wanted to allow the rocket to get up to flight velocity before it reached the end of the launch rod. This meant that the base of the rocket was nearly touching the blast deflector. Those of you familiar with this type of situation know that distinctive sound the motor makes at it fills the void beneath the rocket with exhaust gases. It has sort of a sucking sound. This is known as the "Lovelace Effect."

But once the cavity is filled with gasses and the rocket starts to move upward on the rod, the sound of the motor is free to escape. And then you hear the very loud blast and roar of the motor. Because of this, the motor seams to be a lot louder than its actual size says it should make. The spectators, who were overwhelmed by the sound of the F20 motor in the Saturn 1B where now completely orgasmic from the roar of G80 rocket motor.

The trajectory of this flight was slightly upwind of the launch rod, indicating a slight over stability condition. But it was very close to being a near vertical launch. As before, I didn't notice any spinning of the model. I am completely satisfied with the flight aspects of the rocket so far.

I was able to keep the video camera on the rocket all the way to deployment, which occurred very close to apogee. The chute of the capsule section blossomed almost immediately on ejection; while there was a slight hesitation for the bottom portion's chute to fully open. Again, the both fell at a nice slow rate. Fortunately, they stayed close together for me while I was video taping; so I was able to keep them both in the picture for a significant portion of the descent.

The breeze had swung around by this time, and was blowing to the southeast. This was in the complete opposite direction as the launch of the Saturn 1B. The two portions of the

model both landed about 300 yards away, and were easily picked up by the people helping me chase them down.

This time, I didn't try to recover them myself. I immediately headed toward the shade of the canopy. A few minutes later, Jason Unwin showed up with the rocket. He seemed to be heading right passed me to his own vehicle. I had to remind him that I wasn't donating it to the museum (not yet anyway).

I did an inspection of the model. This time, the bottom portion suffered a slight crack in the plastic of one of the fin fairings. I had somewhat expected this to happen. I think I have a way to stop that from happening, but I'll need to test it out on a future test flight.

The upper portion of the rocket had zero damage. So all in all, I was very pleased with the flight. The spectators were far more enthusiastic; and they begged me to fly it again.

Saturn_5_launch.mov

Instructions: Click on the box above to start the movie playing.

I had planned on making several test flights, and had taken a stash of motors with me just for this reason. While I was getting ready to put in another motor, the rocket fell over and snapped a fin. Wouldn't you know it... Murphy's Law said I was done for the day. The fin was repairable, but it was getting a bit hot, and people were starting to call it a day. I didn't want to force anyone to sit in the hot sun while I fixed the fin, so I packed it in too.

There is video of both of the launches. I'll be posting them to the Apogee Components web site as soon as I can edit them down and convert them to Quicktime format. It shouldn't be more than a couple of days.

In conclusion, what did we learn?

I'm not talking about the flights of the models. But in general terms, what did you learn about how to proceed with test flights?

Here are some key things that I did and that you should too:

1. Input the rocket into RockSim to determine it's CP location.

2. Adjust the CG of the rocket as necessary using nose weight. You can use RockSim to find out how much you'll need for adequate stability.

3. Use RockSim to select the proper rocket motor.

4. Be prepared at the launch for unplanned events that force you to alter your plans.

5. Pay attention to the flight characteristics of the rocket. That way, you can make modifications to the model or the motor used. You can't fix a problem until you know it exists; and even though the flight may appear 100% successful, there is always something you can learn from it.

Your eyeballs and your ears are excellent tools. In this regard, I strongly recommend using the Apogee Flight Record form: http://www.apogeerockets.com/flight_record_sheet.asp

You can get a sample of the Apogee Flight Record by clicking here.

It will remind you of the important things that you should be looking at when the model takes to the sky.

6. Learn, learn, learn. You may have noticed that I knew the limitations of the Barrowman equations when I input the design into RockSim. I wouldn't have known these limitations unless I did a lot of reading from other modelers. Use their knowledge to your advantage. You can start by looking at the previous newsletters from Apogee Components, and also reading the other free articles on our web site.

My test flights of these two rockets could be classified as

100% successful. But they did leave me with a lot of other things that I want to try; because I think the flights can be improved upon even further.

Doing these test flights makes you feel a part of the real space program. I hope that you get the same feeling when you launch your rockets.

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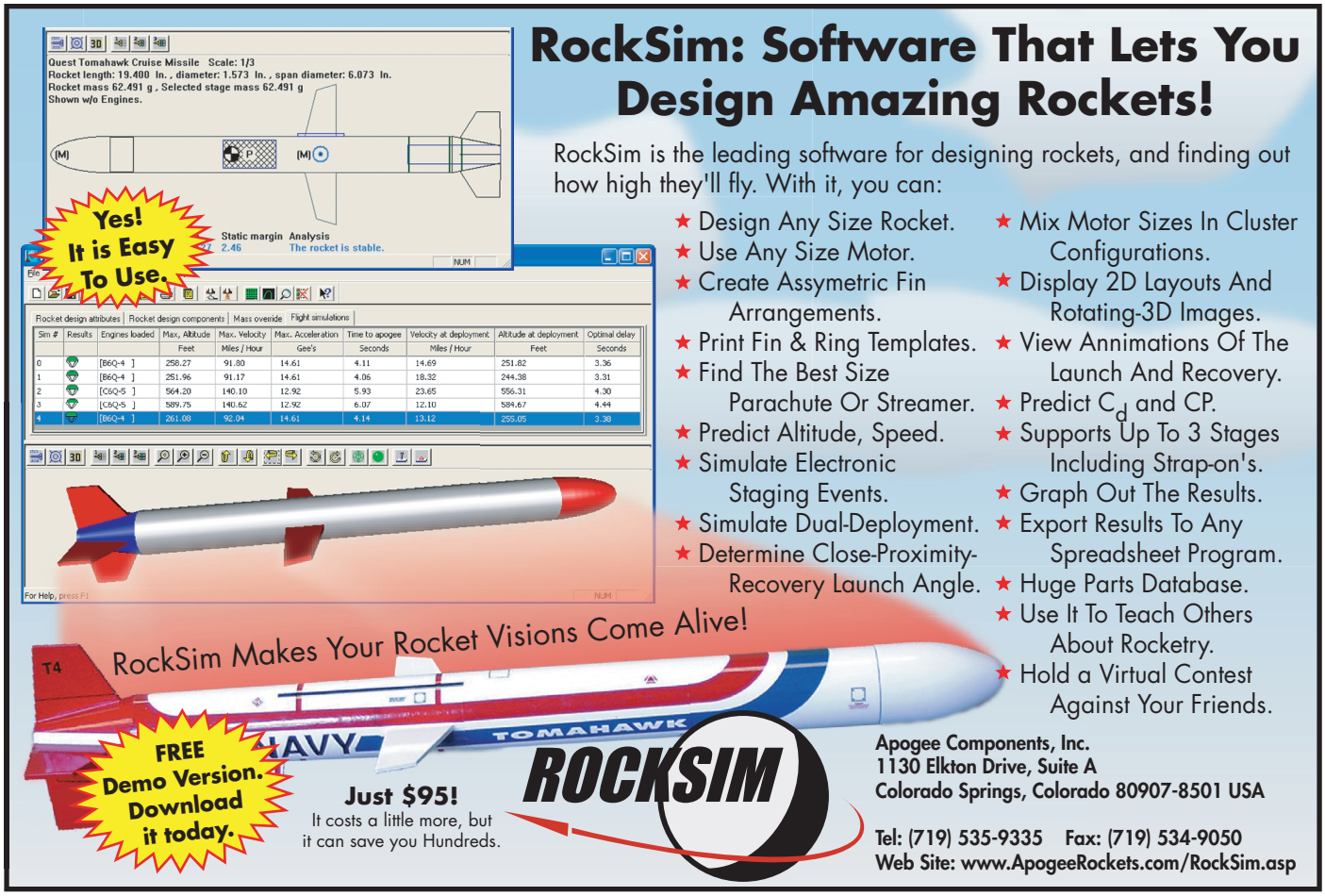
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