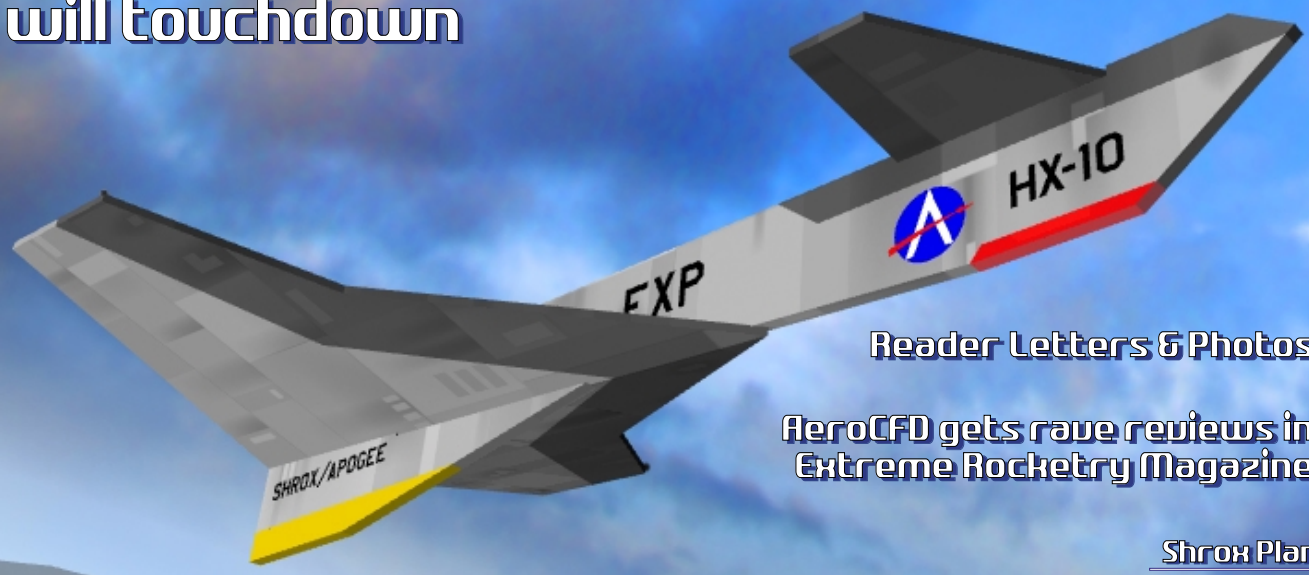
ISSUE 86 - AUGUST 1, 2002

APOGEE PEAK OF FLIGHT NEWSLETTER

splash

New 6 Degree-of-freedom determines where your suborbital flights will touchdown



Reader Letters & Photos

AeroCFD gets rave reviews in Extreme Rocketry Magazine

Shrox Plan

HX-10 Glider- Futuristic glider to recover stranded space explorers

Stability of Short Rockets

What tools and equations should you use when designing short, squat rockets?

Apogee Components
1130 Elkton Drive, Suite A
Colorado Springs, CO 80907 USA
www.ApogeeRockets.com
orders @ApogeeRockets.com
phone 719-535-9335 fax 719-534-9050

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APOGEE

PEAK OF FLIGHT

NEW SOFTWARE HELPS YOU PLAN FOR HIGH ALTITUDE SUBORBITAL LAUNCHES

Splash™ is a new six degree-of-freedom launch simulation software designed to find the landing location of your rocket.

Why do you need it?

Extreme high-altitude launches require more than just a high-power-rocketry waiver. When you approach the FAA, they will tell you that you need a "launch license." And you can't get that license unless you present paperwork that is compliant with Federal Regulations.

One biggie, as far as the Feds are concerned, they need to see a plot showing where the stages of the rocket will land or splash down. To them, that is difference between a hpr waiver and a sub-orbital trajectory; the rocket may not land within the boundary of the launch site. The rocket just flies too high, and the winds aloft can easily push the rocket tens of miles (or further) downrange.

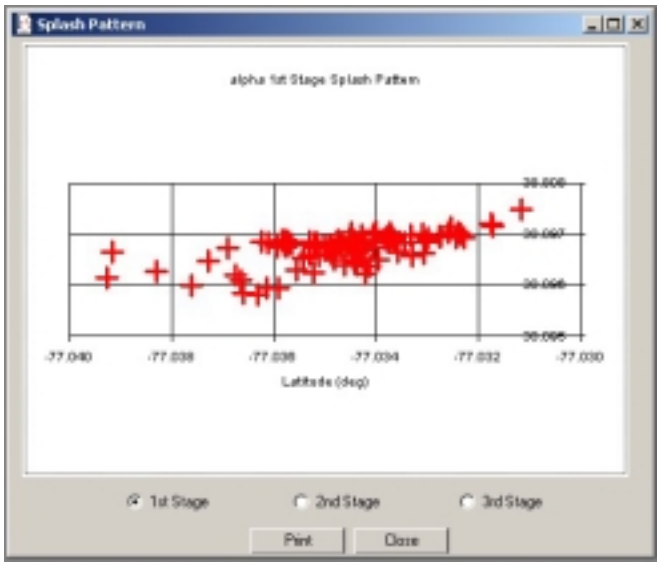
That is where the new Splash™ software becomes indispensable. It creates the plots (called splash patterns) that the FAA will want to see as part of your proposal for your launch license.

Constructing these "splash pattern" plots is not easy due to various uncertainties that can occur during the launch, or due to changing wind conditions.

What Splash™ does is to inject 18 constantly shifting variables into the launch simulation, and then predicts how these will affect the landing location of the rocket. It is Splash's™ ability to insert these "uncertainties" into the scenario that makes it different from any other simulation software.

For example, any margin of error in any of these parameters will change the flight trajectory of your high altitude rocket and where it may land:

- Mass Of The Rocket
- Moment Of Inertia
- Product of Inertia
- Center Of Gravity Location
- Axial Force Coefficient
- Normal Force Coefficient
- Center of Pressure Location



- Fin Cant Angle
- Total Impulse Of The Motor
- Propellant Mass
- Thrust Axis
- Wind Direction
- Wind Velocity
- Launch Rail Azimuth Angle
- Launch Rail Elevation Angle
- Ignition Failure Likelihood
- CATO Of The Rocket Motor Likelihood
- Deployment Failure Likelihood
- Chute Failure Likelihood

Splash™ takes all eighteen of these variables into account at the same time! Based on these uncertainties, it create a likely landing zone where the rocket will touch down. Yes, you can even put something into orbit.

The figure on the right is a plot listing 250 potential impact points of a particular rocket. The distribution of the impact points illustrates not just a nominal impact point, but provides a level of confidence to the likelihood of an impact in any given region. Such data is indispensable in prelaunch safety analysis and is also of use in determining possible locations for wayward rockets. It is this capability that sets Splash apart.

cont. on pg. 3

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cont. from pg. 2

As you can see from the plot, Splash™ displays the results in Latitude/Longitude format. There are two reasons this benefits you. First, you can overlay the grid right onto a map and quickly find out what structures lie in the landing zone. And second, you can take a GPS handheld receiver out the launch site, and walk toward the general landing zone. So it helps you find your rocket quicker.

Other features of Splash™ include:

- Wind effects (weather cocking).
- Earth modeled as a rotating oblate spheroid. Yes, the earth rotates under the flying rocket!
- Gravitational effects that vary with altitude and latitude.
- Models the atmosphere up to 632 km above sea level (ASL).
- Clustering of up to 5 motors per vehicle stage.
- Up to 3 stages per vehicle.
- Ability to export flight data to a spread sheet program for further study.
- Uncertainty analysis for 18 different vehicle/ scenario parameters.

Splash™ is a full 6-Degree-of-Freedom (6 DOF) simulation program. What this means is that it computes all six coordinates of the rocket during the entire flight: downrange distance (X), cross wind distance (Y), altitude (Z), pitch, yaw, and roll. By comparison, RockSim is 3 DOF: X, Z, and pitch. This is what allows Splash™ to create a true profile of the rocket's flight, and why it is so valuable in high altitude flights. It is really impossible to predict where the rocket will land if you don't know how it is oriented throughout the entire flight.

Who Wrote the Software, and Why?

Splash™ was written by David Hall. He is an engineer working in the Ordnance Test Support Branch of the Naval Air Warfare Center. In the past, he worked in the Weapons Engineering and Analysis Branch of the Naval Air Warfare Center, and authored various 3 and 6 DOF codes to simulate military weapon systems ranging from shoulder-fired rockets to IRBMs for both design and range safety purposes.

David was contacted by a team competing for the C.A.T.S. prize to help them develop range safety procedures. Through this experience, he quickly realized that there was no "inexpensive" software available to the general public to predict the splash patterns of high altitude research rockets. He decided to write the software so that other research teams would have a safety analysis tool available to meet the requirements of the various government agencies.

To sum it up, he wants to promote the advancement of safe (and sane) rocketry by offering up a software tool at an inexpensive price. Now, there is no excuse for rockets that are launched without regard to safety.

Do You Still Need RockSim if You Buy Splash?

I do recommend you own both, because Splash™ is not a rocket design program. It only runs launch simulations.

Splash™ needs some specific data about the physical characteristics of the rocket, like size, weight, and fin area. While you can compute these parameters separately, they are easily displayed using RockSim. So you'll save time running your Splash™ simulations if you own RockSim.

I also recommend using the AeroCFD software, and HyperCFD in conjunction with Splash™. The software needs a Cd for the rocket, and the more accurate you can make this number, the better your simulations will be.

It's Not For Everyone

For most model rocket and hpr flights, the capability of the Splash™ software is massive overkill. If your rocket is not going to exceed 20,000 feet, it is likely that it will land within the confines of your launch area. In that case, the RockSim software is what you need.

Finally, because of the accuracy of Splash™ software and that it could potentially be used by terrorists to lob bombs across vast distances, at this time we can only offer it to citizens of the United States of America. Please be aware that you may be contacted by a representative of the US Government concerning your intentions for using the software.

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READER LETTERS:

In the last issue of the e-zine, I mentioned the quicktime video of the LDRS helicopter built and flown by Dave Leininger. There were a few people that offered to post the video on there web sites; and I'm thankful for all the offers.

The video has a home on the web site of Frank Terhaar-Yonders. If you have a good internet connection, check it out. The URL is:

http://www.employees.org/~fty/apogee/video/helicopter.mov

The video doesn't really do the actual flight justice. The helicopter is actually spinning at a rate of about 5 revolutions per second. But during the process of converting it to web video, the number of frames is reduce by half. Therefore, the model appears to spin slower.

Paul Bauer sent a couple of pictures of his Apogee Components' 1/70th scale Saturn V rocket. Paul modified the rocket to take a bigger motor, and as you can see by the lift-off shot, it appears to have been a spectactular launch. I forgot, but I think that is a J motor in the rocket. Thanks for sharing the photos Paul!

Tim, I just read the ezine, and your article about why we love rockets was great. When my friend and I both flew our first F reloads we both felt like we had done something great,too.

Steve Corban

If you have a letter, comment, or suggestion for our newsletter, please send it to tvm@apogeerockets.com

Archives of this Newsletter

All the articles that have appeared in this newsletter are archived at http://www.apogeerockets.com/education/newsletter_archive.asp

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APOGEE

PEAK OF FLIGHT

STABILITY OF SHORT, SQUAT ROCKETS

By Tim Van Milligan

"Hi Tim,

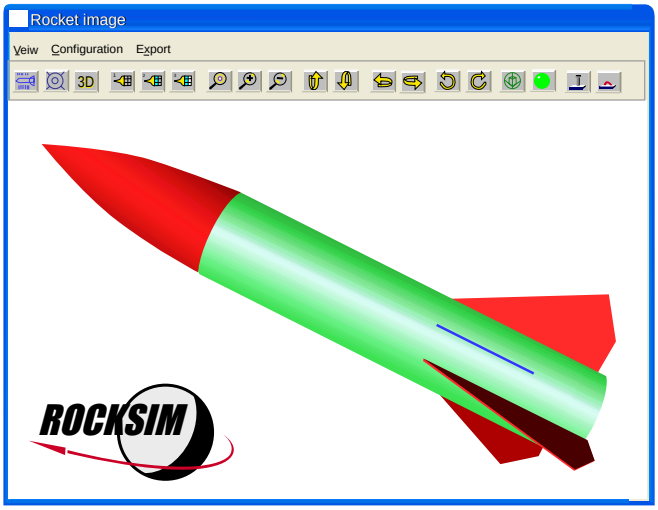
I have a question reguarding RockSim and the Loc Minie-Magg rocket. I input all the information on the rocket in RockSim and looked at the stability and RockSim said it was marginially stable. I then proceeded to post the question to RMR and got responses that shorter rockets are inheriently more stable. I then read an article that gave reason's why shorter rockets are stable with less than 1 caliber and that the calculation's for stability don't necessarily apply to short fat rockets.

The article I was pointed to is "Wind Instability, What Barrowman Left Out," by Robert Galejs. It can be found at:

http://www.cmass.org/member/Robert.Galejs/sentinel39-galejs.pdf

Can you tell me if this is true and why or why not RockSim does or does not do the math for such a rocket. Any help with this would be most appreciated. Thanks."

-- Mark K.



Let's start with some basics, and work forward from there.

The basic rule of rocket stability says that in order for the rocket to be stable, the Center-of-Gravity (CG) must be located forward of the Center-of-Pressure (CP) on the rocket.

This is true for short rockets, as well as long rockets. So I'm not sure what the person who told you that "shorter rockets are inherently more stable" was trying to say. When you launch your rockets, always be sure the CG is forward of the CP.

Next, we get to the question about RockSim. Your question is probably "what does it mean when it says the rocket is "marginally" stable?"

What RockSim is telling us is that the distance (length) between the CP and the CG is less than the diameter (length) of the rocket. A good rule-of-thumb that we've all been taught is that the ratios of CG-to-CP divided by the body tube diameter should be greater than "1.0."

For more information about the terms "Overstable," "Unstable," and "Marginally stable", see the article in the Apogee E-zine newsletter number 5 at:

http://www.apogeerockets.com/education/newsletter05.asp

Why do we have that rule of thumb about the ratios? Because it allows for some margin of error when designing and constructing the rocket.

Short, squat rockets, like the LOC Mini-Magg are probably always going to be indicated as marginally stable in RockSim, because the CG is hard to move sufficiently forward. If they could be made longer, they would say "Stable" in RockSim.

"Marginally stable" still means that the CG is forward of the CP on the rocket—it just that the ratio isn't greater than +1.0. Because it is greater than zero, technically, if the model is build with some degree of quality, it will be stable when flown.

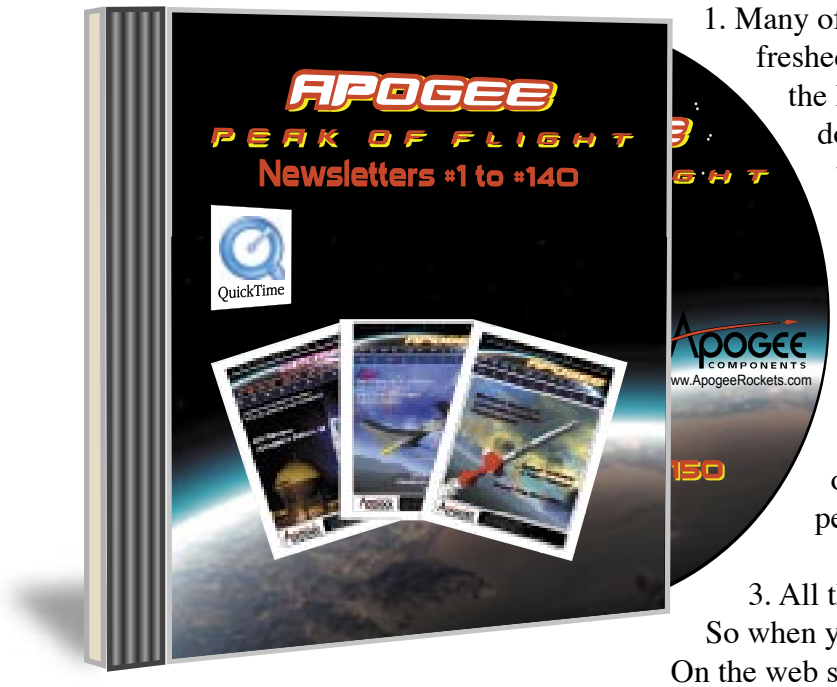
The problem that occurs is when the rocket is launched in windy conditions. This is because the rocket will be leaving the launch rod with some angle-of-attack.

The real CP location of the, is not static. It constantly shifts forward and backward. If it is windy and the rocket flies at an angle-of-attack, it shifts forward, making the rocket less stable.

Notice I said "less" stable. It does not become "unstable" unless the the shift in location puts the CP position forward of

Read the rest of this article on the Peak-of-Flight Newsletter CD-ROM!

Why get the CD-ROM?



1. Many of the older articles were re-written and re-freshed to make the information up-to-date. During the last few years, technology has allowed us to do things faster and cheaper. So I wanted to update the older articles for you to reflect the advances that have occured.

2. All the issues are in pdf format, so you can easily print out the issues that interest you most. Compare this to the old "web site" files. They are wide format, so they always seem to get cut-off on the right side of the paper. In the CD-ROM version, you get perfect printouts every single time.

3. All the images are in "high-resolution" format. So when you print them out, they are sharp and crisp. On the web site, we always have to worry about download size, so the images were set to a measly 72 dpi (low resolution). That makes them relatively easy to download, but the photos and especially the screen-shot pictures looks like they were drawn with a crayon. On the CD, you'll get perfect images that you can actually read!

4. Each of the files contains links, just like a web page. So when you see a link to another article, you can just click on it, and it will open the file from the CD automatically. Not only that, but most of the non-newsletter files are also contained on the CD-ROM. The 49 other files on the CD are made up of:

* RockSim design files
* QuickTime movie clips
* Excel spreadsheets
* other PDF rocketry reports
* Sample software
* Posters you can print out
* Shrox rocket plans and decals

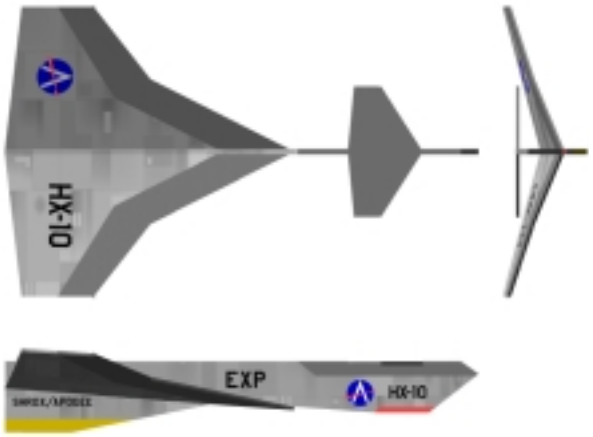
5. Additional web links to other rocketry web sites that are referenced in the newsletters. Just click on the link, and your web browser will automatically take you to the web site. That makes it fast and convenient.

To Order, Visit:

www.ApogeeRockets.com/Newsletter_CD.asp

HX-10 GLIDER BY SHROX

DOWNLOAD THE ROCKSIM PLANS AND DECALS

The data file you will need is at: http://www.ApogeeRockets.com/shrox/HX-10Glider.asp

All you will need is 16in. Balsa or thick cardboard.