

PEAK_{OF} FLIGHT

NEWSLETTER

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IN THIS ISSUE

***VENTING EJECTION
CHARGES***

***SELECTING
EJECTION DELAYS***



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Venting Ejection Charges

By Bobby Potter

What does it mean to vent an ejection charge?

In model rockets, an ejection charge is the primary method used to deploy a recovery system when your rocket hits apogee. The ejection charge is a part of the motor filled with loose black powder that fires after the motor is spent and the delay has burnt through. This creates a pressure in the body tube that ejects the nose cone and the recovery system from the front of the rocket.

There can be times when this method is not optimal, an acceptable solution would be to vent the ejection charge.

By vent we basically mean “let out”. When the ejection charge fires and the pressure quickly fills the body tube it can either push out the nose cone OR the pressure can escape through a hole on the side of the tube (the vent) - see Figure 1.



FIGURE 1: VENTING OF THE SIDE BOOSTER PODS THAT ARE PERMANENTLY ATTACHED TO THE CENTRAL CORE TUBE

Venting Clustered Motors

Clustered motors typically create the primary situation you would want to vent an ejection charge. In set-ups like this, the auxiliary motors are there to produce thrust, but only the main motor is needed to deploy the ejection charge. You can prevent the pressure from building inside

the main tube, or side tubes, by venting these auxiliary motors out the side of the tube.

The “way” to do this depends on whether the motors of the rocket are placed internally in the body tube such as shown in Figure 2, or if the motor mounts are externally placed on the rocket with only the main motor housed in the body tube like shown in Figure 1.

Internally, this is all about airflow. You want the ejection charge for your recovery system to pressurize your main tube without escaping. Conversely, you want all the other motors to push their air pressure outside the vehicle, without affecting the main tube.

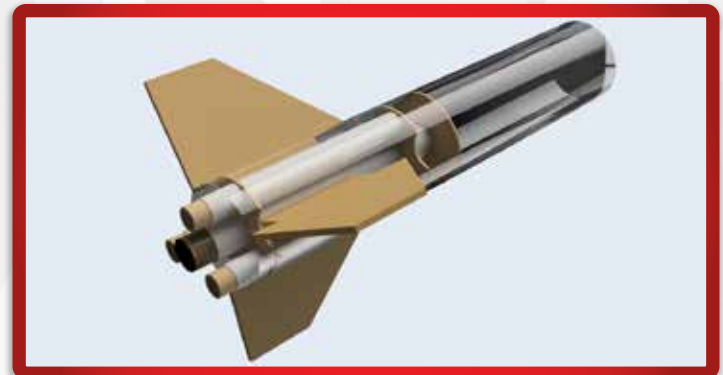


FIGURE 2: THE EJECTION CHARGE GASES FOR THE THREE OUTER TUBES IN THIS EXAMPLE GO FORWARD, BUT THEN HAVE TO TURN AROUND AND EXIT OUT THE REAR OF THE ROCKET.

When using clustered motors, you can consider deploying your recovery system electronically. This would work around the potential failure of your ejection charge and separate the recovery system from the motors. When using electronic ejection, you could also use a main motor with an ejection charge that would deploy your recovery system shortly after apogee. This would work as a redundancy and pretty much eliminate any fears that your rocket would return ballistically.

Staggered Ejection Charges

One of the safest options when flying a clustered motor set without electronic recovery deployment is to use all of the ejection charges to fire the recovery system. This

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Continued on page 3

PEAK^{OF}FLIGHT

Venting Ejection Charges

Continued from page 2

prevents a failed recovery system because the main motor didn't fire, as the other motors in the cluster fire off as a redundancy.

We would still want our first delay to be timed for apogee, but if we were doing a cluster of 5 motors, with a time to apogee of 5 seconds, we could cluster our motor with two C6-5's, an E9-6 for the main motor and two C6-7's. This way we have ejection charges firing at 5 seconds, 6 seconds, and 7 seconds. If any of the motors fail to ignite, we can safely rely on the other motors to deploy the parachute (see Figure 3).



FIGURE 3: IN A CLUSTER MOUNT LIKE THIS, YOU COULD HAVE SEVERAL DELAYS. THE FIRST ONE TO GO OFF PUSHES OUT THE PARACHUTE. THOSE EJECTION CHARGES THAT FIRE LATER SIMPLY VENT OUT THE FRONT OF THE TUBE INTO THE ATMOSPHERE. BUT THEY DO GIVE REDUNDANCY IN CASE THE FIRST MOTOR'S EJECTION CHARGE DOESN'T GO OFF AT ALL.

In a case like this, we want all the auxiliary motors to have roughly the same power, in this example they are all C6's. With a staggered set-up like this, we don't want to block or vent any of the ejection charges. Assuming all the

engines fire, then the C6-5's will deploy the parachute with their ejection charge. By the time the next ejection charge fires on the E9-6, the chute should already be out of the body tube, and all the heat and pressure created by the E9-6 will just vent out the top of the body tube. This would also occur with the C6-7 ejection charges.

Damage and Discoloration

Any time you vent an ejection charge out the sidewall of a tube, the heat and exhaust will affect the area surrounding the vent. A majority of this will occur just below the vent, where the exhaust travels over the most during the ascent.



FIGURE 4: A GLIDER WITH DISCOLORATION AROUND ITS VENTS.

This damage is more of a discoloration, the structural integrity of the body tube is not altered. Without cleaning it adds a tiny bit of surface friction in flight, but these markings buff out smooth with very little effort. The discoloration does not go away and continued flights will add to the

Continued on page 4

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PEAK^{OF} FLIGHT

Venting Ejection Charges

Continued from page 3

exhaust discoloration.

That being said, this has no negative impacts on flight and most rocketeers see these markings more as battle scars. A rocket with plenty of exhaust damage has seen its share of the sky.

In some cluster set-ups, you can vent the charge in between motor mounts, hiding the vent and the discoloration. This would also prevent your vents from creating much drag in flight, but a warning to all you would be warriors: Venting too many ejection charges into a small cavity between motor mounts, especially at the same time, could create its own issues, such as intense heat that damages your tubes in that small area.

How Big Should My Vents Be?

There's some debate here, but a good rule of thumb to follow would be to make sure your vent is the same diameter as the bore of your ejection charge. For most 13mm and 18mm motors, a 1/4 inch vent should suffice.

Larger motors will likely need larger vent holes, or perhaps multiple vents. If you stick to the rule of thumb where your minimum size vent hole needs to be as large as the bore on the ejection charge, a quick measurement of any new motor will tell you exactly what you need. A half inch diameter vent should be sufficient for almost any size of motor.



FIGURE 5: MEASURING THE BORE OF A G74-6

Problems come into play when your vent is far smaller than the ejection charge as this allows pressure to build up as it is trying to force air through the small hole. You will then see your vent hole really char around the edges and weaken the tube.

You may want to consider vents that are slightly larger than the bore on the ejection charge when you are using larger motors with relatively weaker materials like cardboard. It will allow the pressure to flow out more easily and reduce the stress on the chamber.



FIGURE 6: THE POTENTIAL CONSEQUENCES OF UNVENTED TUBES (CLUSTER DUCK)

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Selecting Ejection Delays

By Tim Van Milligan

Selecting Ejection Delays

What is the best delay for your rocket? We get a lot of questions about that, particularly from modelers who are new to the hobby. In this article, I'll go over my current thinking on this important topic. It is a safety issue, so understanding how to pick delays is important.

With the release of RockSim 10, people are already seeing how it is great at picking motors, as it automatically sorts through all the possible motors that could fit into your rocket. Now I'm spending a lot more time answering questions about how RockSim is picking delays.

I didn't think the new feature of recommending motors would be as important as it has turned out. The more I consider what RockSim v10 is doing as it chugs through possible motor combinations, the more value I can see it offers rocketeers. To be honest, I'm second guessing my decision to give away a free upgrade to v9 users. This is one powerful tool that is going to be indispensable.

The basis for what it does was written up in a report I wrote more than 15 years ago in 2004 in Apogee Technical Publication #28 (https://www.apogeerockets.com/downloads/PDFs/Tech_Pub_28.pdf). What has changed

since that report first came out is that we finally automated the step-by-step process in RockSim v10. It loads each motor that will fit the diameter of the motor mount tube, and runs a simulation to find out how the rocket flies.

In the past, people would come to us, and ask us to pick rocket motors for the designs that they came up with, or the kits they bought from other manufacturers. But we always turned them down (we still do). The big reason is that it takes time to pick rocket motors - there are 22 steps in the process documented in the report. Multiply that by how many different motors you want to simulate, and you can just guess at how much time it takes. And that assumes that you have a RockSim file to start with. If I had to create a new design file for the program, you could add a lot of time to the task.

Unfortunately, people aren't willing to pay a consulting fee for our time. They assume that since we give away so much information for free on our website, that everything we have is free. That includes our time. They assume that we must have hours-and-hours of time available to run simulations for them in order to pick motors for their design.

As an aside, the reason we give away so much information on our website, isn't because the information isn't valuable. It is because we don't have enough time to help everyone out. We make information available so that modelers can learn to do many of the tasks themselves, so that we free up time for our employees to work on other projects. I wrote about this in Peak-of-Flight Newsletter #519 (<https://www.apogeerockets.com/Peak-of-Flight/Newsletter519>) in the topic about picking screw-on retainers. Like rocket motor selection, we just don't have time to pick retainers for every obscure project that people are working on. The line of modelers waiting for our attention is too long, because they just can't get help anywhere else in the industry.

Continued on page 6



PEAK^{of} FLIGHT

Selecting Ejection Delays

Continued from page 5

The second reason we don't pick motors for people is that the launch conditions have a major impact on what motors would be OK for the flight. And I just don't know what those conditions are going to be on the launch day when they fly their rocket. Ideally, you want to run the simulations right before the launch, so you have as accurate as possible weather conditions and launch angles.

Since we don't know them, then we either have to ask the modeler a series of questions (which they probably don't know either), or we have to guess.

That same problem exists for us today with RockSim v10. I still don't know the launch conditions. So when the software runs the simulations, it has to make some assumptions for the launch conditions.

The "recommended" launch conditions we have in RockSim v10 are basically a springtime day in the mid-western USA. The temperature is a nice 59°F, and the launch elevation is 700 feet above sea level. If you want, visualize a nice flat field somewhere in Illinois or Iowa, and that is pretty close to what RockSim is using when it recommends motor choices. It is a slightly breezy day, where the wind is blowing at a constant 8 miles per hour.

As I said previously, you should ideally run the recommended motor chart the day of the launch where you know the actual weather conditions. That would be ideal.

When you run the software to pick recommended motors, you'll end up with a chart showing all the motors that were simulated. It still needs to be sorted, which you can do by clicking on the column called "RockSim Recommended." This will group together the motors that are recommended and the ones that are not recommended.

The two columns that you'll notice right away are "recommended delay" and the "Optimal delay." Here is the difference between the two. The optimal delay is that delay time for the motor that would eject the rocket right at apogee. This is the highest point in the flight, and more importantly, it is where the rocket will be travelling at its slowest speed.

Since the simulations have wind in them (remember, it is 8 mph), the rocket will not go perfectly straight up. It will always have some horizontal velocity because of the wind, and therefore the speed of the rocket will not be zero at apogee. But it will always be the slowest speed of the flight.

In an ideal world, we'd like a delay for the motor that is as close to optimum as possible. Say you run your simulations with the Estes C6 motor, and the optimum delay is 3.3 seconds. The choices of rocket engines with the C6 designation are C6-0, C6-3, C6-5, or C6-7. The last digit in the name, as you know, is the delay time of the motor.



FIGURE 7: THE FOUR DIFFERENT DELAYS AVAILABLE FOR THE C6 MOTORS FROM ESTES: 0, 3, 5, AND 7 SECONDS.

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Continued on page 7

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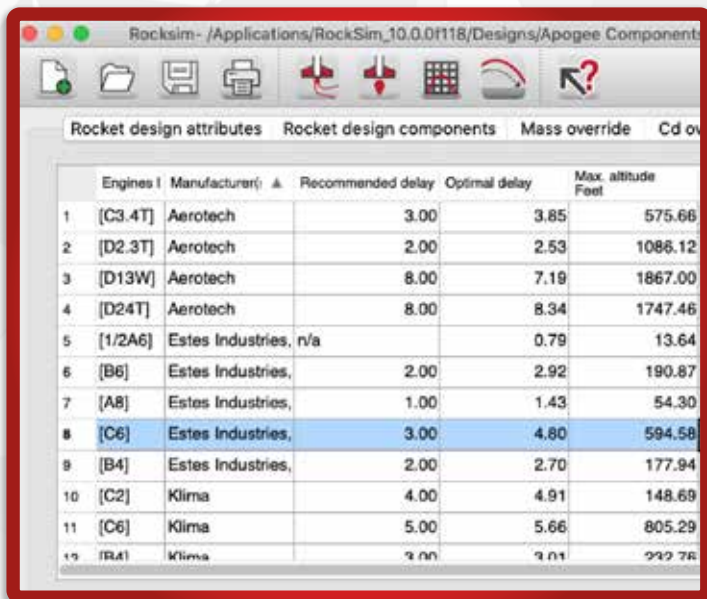
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PEAK_{OF}FLIGHT

Selecting Ejection Delays

Continued from page 6

In this case, since the optimum delay is 3.3 seconds, the one motor that is closest to that is the C6-3. Pretty easy, right? What if the optimum delay comes back at 4.8 seconds. This is where I am also recommending that beginners go with the C6-3 motor. And if you look in the new version of RockSim, it is also going to recommend the 3-second delay. Why? Clearly, the 5 second delay is closer to the 4.8 seconds for the optimum delay than 3 seconds.



Engines	Manufacturer(s)	Recommended delay	Optimal delay	Max. altitude Feet
1 [C3.4T]	Aerotech	3.00	3.85	575.66
2 [D2.3T]	Aerotech	2.00	2.53	1086.12
3 [D13W]	Aerotech	8.00	7.19	1867.00
4 [D24T]	Aerotech	8.00	8.34	1747.46
5 [1/2A6]	Estes Industries, n/a		0.79	13.64
6 [B6]	Estes Industries,	2.00	2.92	190.87
7 [A8]	Estes Industries,	1.00	1.43	54.30
8 [C6]	Estes Industries,	3.00	4.80	594.58
9 [B4]	Estes Industries,	2.00	2.70	177.94
10 [C2]	Klima	4.00	4.91	148.69
11 [C6]	Klima	5.00	5.66	805.29
12 [B4]	Klima	3.00	3.01	222.76

FIGURE 8: EVEN THOUGH THE OPTIMAL DELAY IS CLOSER TO 5 SECONDS, THE RECOMMENDED MOTOR IS ACTUALLY 3.0 SECONDS.

Why? What's changed? I tricked you here. If you noticed the conditions of the situation, I said that I was talking to "beginner" rocketeers. Those of you who are experts, I accept your argument that the 5 second delay may be the better choice.

But if someone asks me to recommend a delay for them, or if they are using RockSim to recommend a delay, I'm going to err on the side of caution, and assume they are a beginner.

This is strictly my opinion, and you can argue against this too. But my history with beginners is that the quality of their completed rockets is less than optimal, and their flying skills are also lacking. They just are deficient in wisdom and judgement that comes with the experience of launching a lot of rockets.

Why does this matter when selecting a motor delay? Because there is a much higher probability that a beginner's rocket is not going to fly straight and predictable like an expert's rocket. (Author's note: Of course, if you watch my personal rocket flights, you could argue that my flight skills are still lacking - even after almost 40 years of experience. I've already crashed more rockets than most people will ever fly in their lifetime.)

If the rocket does not fly straight-and-true, like RockSim predicts, it is going to reach apogee long before the "optimal delay" says it should.

The easiest example to show this would be a rocket that completely goes unstable. It is zipping-and-zagging back-and-forth across the sky, and never comes even close to the predicted apogee. That rocket clearly needs a shorter delay if there is any chance that the chute comes out before it impacts the ground.

That is why from this point on, here at Apogee Components, we are going to recommend that when rounding the optimal delay value to the nearest integer, you always

Continued on page 8



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PEAK^{of} FLIGHT

Venting Ejection Charges

Continued from page 7

round downward. In other words, the optimal delay of 4.8 seconds would be rounded down to a 3-seconds - which is the next available motor.

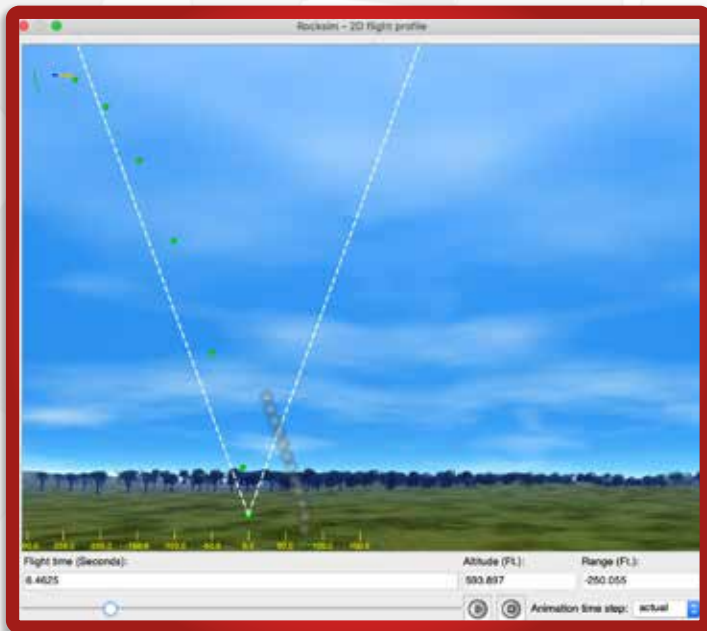


FIGURE 9: ALWAYS LOOK AT THE 2D FLIGHT PROFILE WHEN RUNNING A SIMULATION, TO MAKE SURE THE ROCKET STILL FLIES STRAIGHT.

That is why you will see the recommended delay in RockSim as always being lower than the optimal delay. I know this will be a common question, which is why I'm answering it here. In fact, it has already come up even though RockSim 10 has only been available for less than a week.

To sum up, here are the assumptions I'm making:

1. If you have to ask which delay to use - I'm assuming you're a beginner.
2. Beginner rockets are generally of lower quality, and the modeler definitely lacks experience that comes from flying lots of rockets. They take greater risks than experienced modelers do.
3. Lower quality rockets generally do not fly as straight, and they will reach their apogee before the predicted time in the flight.
4. I therefore would recommend a shorter ejection delay for their rocket.

Now if you're an experienced modeler, I have greater trust in your ability to build better rockets and fly them straight. In that case, your own experience will allow you to override Rocksim's recommendations, and you can use the longer delay. I will stand behind your decision 100%. But if you come to me and ask me which delay to use -- I'm going to assume you're a beginner... And I'm still not picking the delay for you; I'll point you to RockSim so you can pick your own motors with just a click of your mouse.

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Continued on page 9

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Continued from page 8

About the Author:

Tim Van Milligan (a.k.a. "Mr. Rocket") is a real rocket scientist who likes helping out other rocketeers. He is an avid rocketry competitor and is Level 3 high power certified. He is often asked what is the biggest rocket he's ever launched. His answer is that before he started writing articles and books about rocketry, he worked on the Delta II rocket that launched satellites into orbit. He has a B.S. in Aeronautical Engineering from Embry-Riddle Aeronautical University in Daytona Beach, Florida, and has worked toward an M.S. in Space Technology from the Florida Institute of Technology in Melbourne, Florida. Currently, he is the owner of Apogee Components (<http://www.apogeerockets.com>) and also the author of the books: Model Rocket Design and Construction, 69 Simple Science Fair Projects with Model Rockets: Aeronautics and publisher of the "Peak-of-Flight" newsletter, a FREE ezine newsletter about model rockets. You can email him by using the contact form at <https://www.apogeerockets.com/Contact>.



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