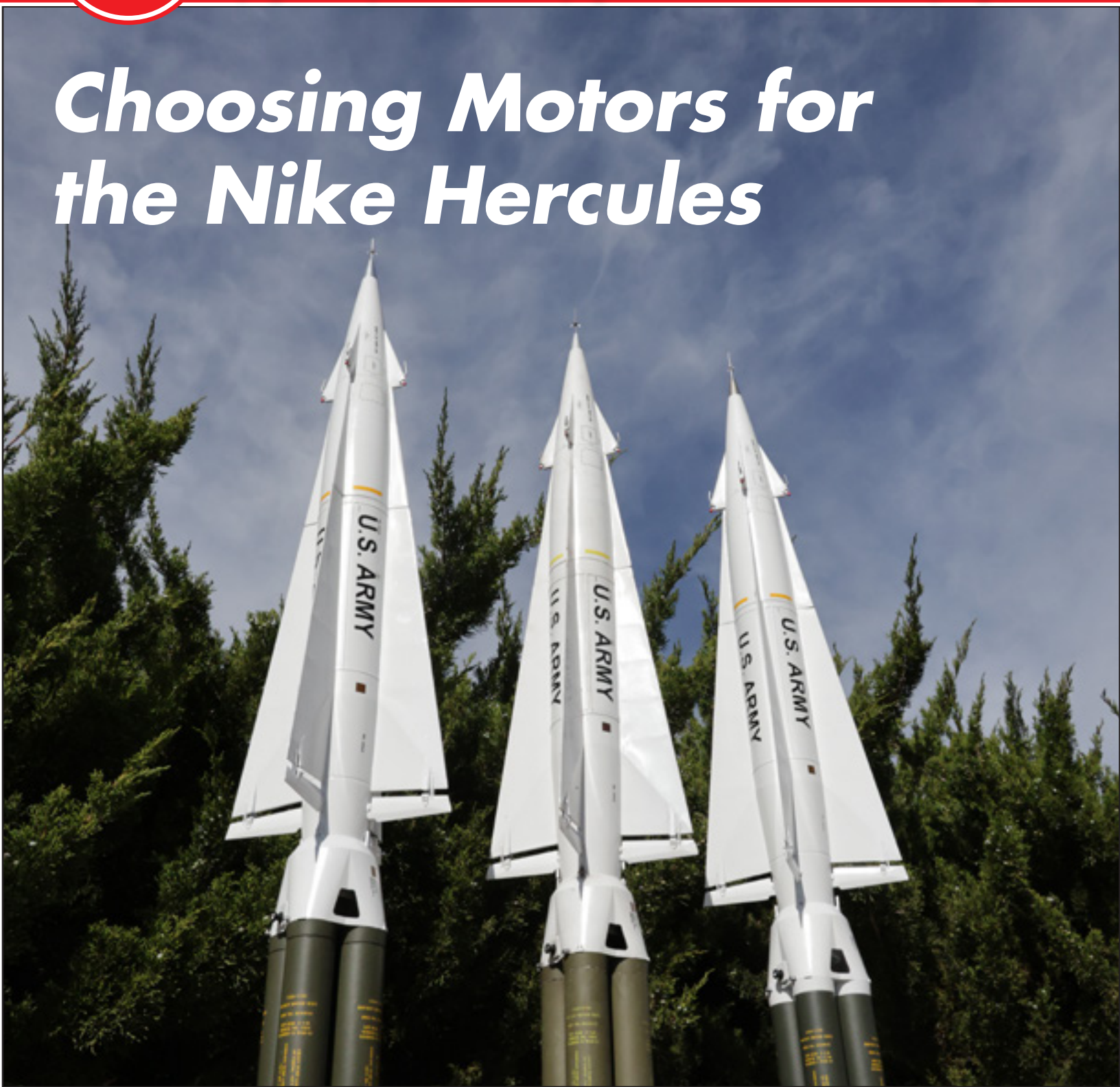
Issue 637 / October 22nd, 2024

PEAK OF FLIGHT NEWSLETTER

Apogee Components, Inc. / ApogeeRockets.com / Colorado Springs, CO

Choosing Motors for the Nike Hercules



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COVER PHOTO

Apogee Nike Hercules Rocket Kit

The Nike Hercules is our up-and-coming rocket kit that pushes the limits on what a 2-stage scale hercules rocket can do. It's been in the making for a long time, and will be making its public debut in Late 2024.

FEATURED ARTICLE

Choosing Motors for the Nike Hercules

by Tim Van Milligan

In this article, we will explore the considerations you might make when selecting rocket motors for Apogee Components' 1/10th scale model of the Nike-Hercules.

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About this Newsletter

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Aerobee 150A Rocket being set-up for launch Pueblo, CO

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Choosing Motors for the Nike Hercules

by Tim Van Milligan

Figure 1: A collection of Apogee Nike Hercules Model Rockets, ranging from early prototypes to the final design

In this article, we will explore the considerations you might make when selecting rocket motors for Apogee Components' 1/10th scale model of the Nike-Hercules (https://www.apogeerockets.com/nike-hercules). This large model rocket presents several challenges, including a clustered first stage with four engines, an electronically ignited second stage, and the need to balance performance with safety and spectator appeal. We'll delve into the various factors that influence motor selection, from propellant types to thrust-to-weight ratios, and provide guidance on achieving a successful and impressive launch.

Introduction

The Nike-Hercules, a surface-to-air missile used by the US Army in the 1960s and 70s, presents a unique opportunity for model rocket enthusiasts to build and launch a complex, two-stage rocket. As I was going through the instruction manual for the Nike-Hercules rocket, it struck me that the section on selecting rocket motors had a lot of really great information, not just for the Nike-Hercules, but for other cluster-engine rockets as well, such as the Apogee Quick Draw (https://www.apogeerockets.com/Model-Rocket-Kits/Skill-Level-4-Model-Rocket-Kits/Quick-Draw).

But before we dive into motor selection, let's review the specifications of our 1/10th scale Nike-Hercules model rocket:

Nike Hercules Specifications

- Weight: 910 Grams (empty, w/parachutes)
- Length: 47.83 inches (121.5cm)
- Diameter: ~4 inches (10.16cm)
- First Stage: Cluster of 4 Rocket Engines
- Second Stage: Single motor w/onboard electronic ignition system
- Both stages are configured for 29mm diameter motors, but with motor adapters, they can use 24mm diameter motors

This model is a complex rocket due to its two-stage design and the use of multiple motors in the first stage. The main goals we have for our motor selection are:

Goals for Motor Selection

- A safe and stable launch trajectory
- Reliable ignition of ALL 4 motors in the booster stage
- Successful ignition of the upper stage motor
- Impressive Launch with ample smoke and sound
- Maintain a reasonale altitude for spectator visibility
- Keeping the total propellant weight under 125 grams (if possible), to avoid high power classification, or the need for a waiver

With these goals in mind, let's explore the various types of rocket motors available and their characteristics.

Figure 2: Nike Hercules Pictured next to Estes E16-6 Motors

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Rocket Motor Types

In model rocketry, two main types of solid propellant motors are commonly used: Black Powder and Composite. Each type has its own characteristics, advantages, and disadvantages that need to be considered when selecting motors for the Nike-Hercules model.

Black Powder motors are the traditional choice for beginner model rocketeers and have been used since the early days of the hobby. They offer several advantages:

Black Powder Motors

Advantages

- **Easy ignition, making them exceptionally suitable for clustered configurations**
- **Usually a little less expensive than composite motors**
- **Produce distinct white smoke, and an orange flame**
- **Produces sound akin to a "scratchy hiss"**

Disadvantages

- **Lower impulse compared to composite motors**
- **Lower peak thrust compared to composite motors**
  - **On the flip side, this gives you slower take off speeds, that are more visually appealing to many**
- **Higher propellant weight for the same total impulse**
- **Limited variety in flame and smoke colors**
- **Big black powder motors are a little less reliable, and have been known to fail spectacularly.**

Black Powder motors are known for their reliable ignition in cluster configurations, which is an important consideration for the Nike-Hercules model's first stage. They ignite easily and consistently, reducing the risk of a partial cluster ignition.

Composite propellant motors represent a more advanced propellant technology. These motors offer higher performance, but they also come with some trade-offs:

Composite Propellant Motors

Advantages

- **Variety of choices for thrust levels and burn times**
- **Higher Specific Impulse, resulting in a more efficient propellant use**
- **Lower propellant weight for the same total impulse**
- **Higher peak thrust, for a faster lift-off speed**
  - **This can Improve flight safetyand stability**
- **Wider variety of flame colors and smoke effects**

Disadvantages

- **Harder to ignite, req. both heat and internal pressure**
- **Slightly more expensive than Black Powder Motors**
- **Might require special igniters for reliable ignition**

Composite motors can provide impressive visual and auditory effects, making them attractive for a spectacular launch. The "White Lightning" formulation, for example, is one of my favorites because it produces a huge white flame and gray smoke. In my opinion, it is particularly impressive for the Nike-Hercules model.

Propellant Weight Considerations

An important factor in motor selection for this model is the total propellant weight. If the combined propellant weight of all five motors (four in the bottom and one in the top) exceeds 125 grams, the rocket is classified as a Class 2 rocket (defined in 14 CFR 101.22, also known as a high-power rocket with NAR and

Tripoli), which requires additional safety certifications for the modeler. See also: "Do you need a permit to fly a model rocket?" in POF Newsletter #516 (https://www.apogeerockets.com/education/downloads/Newsletter516.pdf).

This is one kit that you really have to think about whether you want to fly it as a high-power rocket, or instead go for a mid-power rocket that doesn't require certification. If the Safety-Check person at your launch site is on the ball, they should ask you this question when you check it in. The Nike Hercules can be flown in either configuration, depending on which motors you select for the flight.

Black Powder motors typically contain about twice as much propellant weight as composite motors for the same total impulse. This makes it harder to keep the total propellant weight under the 125-gram limit when using 29mm diameter Black Powder motors.

Let's take an example, the 29mm diameter Estes E16 motor. It has a propellant weight of 40 grams. You can find propellant weights of all the motors we sell on our website; just search for the specific motor you're interested in. For example, the E16 can be found at: https://www.apogeerockets.com/Rocket_Motors/Estes_Motors/29mm_Motors/Estes_Motors_E16-4.

Since there are four motors in the booster stage, we take the 40 grams of propellant and multiply it by 4, which is a total of 160 grams. This is already over the limit of 125 grams. It would be a high-power rocket with this selection.

Composite motors, with their higher efficiency, make it easier to stay within this limit. So even though the composite motors are going to take off faster and fly higher, the rocket might actually be a mid-power class rocket that doesn't require any certification.

Aerotech has the 29mm diameter single-use E24C motor (https://www.apogeerockets.com/Rocket-Motors/AeroTech-Motors/29mm-Motors-Single-Use/Aerotech-29mm-Enerjet-Motor-E24-4C) that has more total impulse than the Estes E16 (36.3 N-s versus 33.4 N-s), and it's propellant weight is just 18 grams.

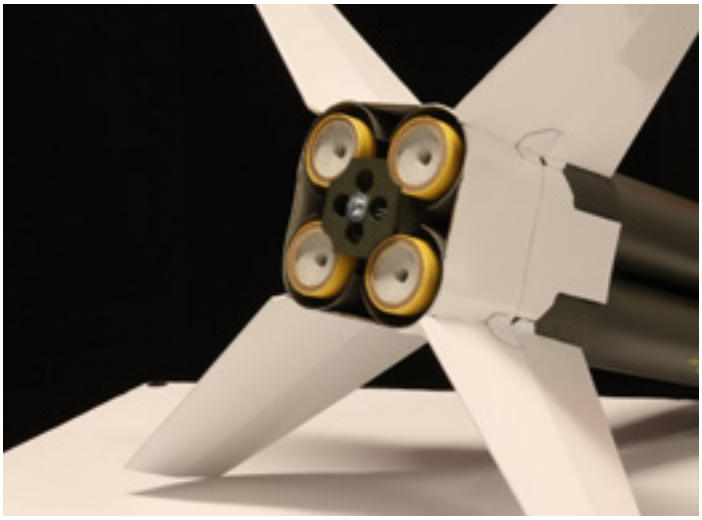

Figure 3: Nike Hercules loaded with 4 booster stage motors

Figure 4: A pair of Aerotech 29mm E24C Motors

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Figure 5: Motor Mount Adapters allow the use of 24mm motors for the Nike Hercules in the upper or lower stages

Multiply the 18 grams of propellant weight times four motors, and you get a total of 72 grams. We're under the 125-gram limit, and we can still have up to 53 grams of propellant for the upper-stage motor and still not require a high-power certification to fly the rocket. That is almost a G-size motor that we could put into the upper stage if we wanted to use that big of a motor.

If you want to keep the rocket as a mid-power rocket (under 125 grams of total propellant) with black powder motors, you'll need to use 24mm diameter motors. This will require the purchase of motor mount adapters, but it may well be worth it.

If you wanted to use the Estes D12, look up its propellant weight on the Apogee website (https://www.apogeerockets.com/Rocket_Motors/Estes_Motors/24mm_Motors/Estes_Motors_D12-3) and you'll find that it has 21.1 grams of propellant. Multiply by four, yields a mass of 84.4 grams of propellant for the booster stage. So now the biggest motor you can use in the upper stage can have a maximum of 40.6 grams (125g - 84.4g = 40.6g) of propellant.

Initial Lift-off Speed & Thrust-to-Weight Ratio

The other issue we have to consider when selecting motors is the lift-off thrust. If the rocket doesn't come off the pad fast enough, the fins won't be effective in providing stability for the rocket. We'd like to see a lift off speed of around 30 miles per hour (mph) for the fins to be effective. A higher velocity is always better.

Some people prefer to use the Thrust-to-Weight Ratio (TWR) of the motors compared to the lift-off weight of the rocket. So if you don't want to use the lift-off speed of 30 mph, then the minimum TWR for the motors should be 5:1.

Fortunately for us, clustering motors is a really effective way of dramatically increasing the TWR of the rocket. In our Nike-Hercules, we have four motors in the booster. But before we simply multiply the max thrust of the motor by 4, we have to consider what would happen if all the motors didn't ignite.This is a major concern in clustering. You'll often hear people ask "Did you get all the motors to ignite?" as your rocket is taking off.

In this case, we want to lean on the side of caution and assume that one motor doesn't ignite. The rocket will have the weight of four engines, but the thrust of three. In that situation, will it leave the launch pad at a sufficient speed for the fins to be effective?

Since we're aiming for a minimum TWR of 5:1 based on the fully loaded rocket weight, and assuming only three out of four motors ignite, this means each motor should provide at least 1.7x the weight of the loaded rocket in thrust (5/3 = 1.667). Let's do some calculations:

- **The rocket has an empty mass of 910 grams without motors**
- **Estes D12-3 motor: Mass = 41.4 grams**
- **Total rocket lift-off mass = 910 + (41.4*5) = 1117.5g (1.1175kg)**
  - Note: we multiplied times five instead of four because I assumed there would be a 5th motor in the upper stage to account for the extra mass)

We need to convert the total mass to weight in Newtons:

Weight in Newtons = Mass x Gravity

- **1.1175kg x 9.81m/s² = 10.95N**

Now to reach a 5:1 TWR, our combined lift-off thrust must be 54.75 N, which is the same as 10.95 x 5.

From this point, we need to divide the lift-off thrust by 3 motors, which is 18.25 N. What this tells us is that the Maximum Thrust of the motor we pick must be at least 18.25 N.

If we dig up information on the D12 from the Apogee Components website, we see it has a peak thrust of 29.7 Newtons. Since this is greater than the 18.25 N minimum allowable thrust from our calculations above, we can conclude that the D12 does have a big enough kick to successfully lift the Nike-Hercules off the pad, even if only three of the four motors ignite.

Is there an Easier Way To Pick Motors?

Does doing the math for motor options seem tedious and are you looking for a faster and easier way? Me too. So I just use RockSim.

Figure 6: Loading motors in RockSim. Leave one motor out of a booster motor mount tube to account for an engine that doesn't ignite.

RockSim calculates both the Lift-off speed and the Thrust-to-Weight Ratio. I prefer to use Lift-off Speed (30mph minimum) because of the ambiguity of where during the burn the Maximum Thrust occurs. Everyone assumes that max thrust happens near the ignition point of the rocket. That isn't always the case. In some extreme situations, the maximum thrust can occur at engine burnout, far too late for a successful lift-off.

RockSim accounts for this by actually looking at the thrust curve, and finding the total thrust of the motors right when it reaches the end of the launch rod. It is more accurate, and I feel it. For more information on this, see the article "What Happened to Maximum Lift-off Weight" in POF Newsletter #625 (https://www.apogeerockets.com/education/downloads/Newsletter625.pdf)

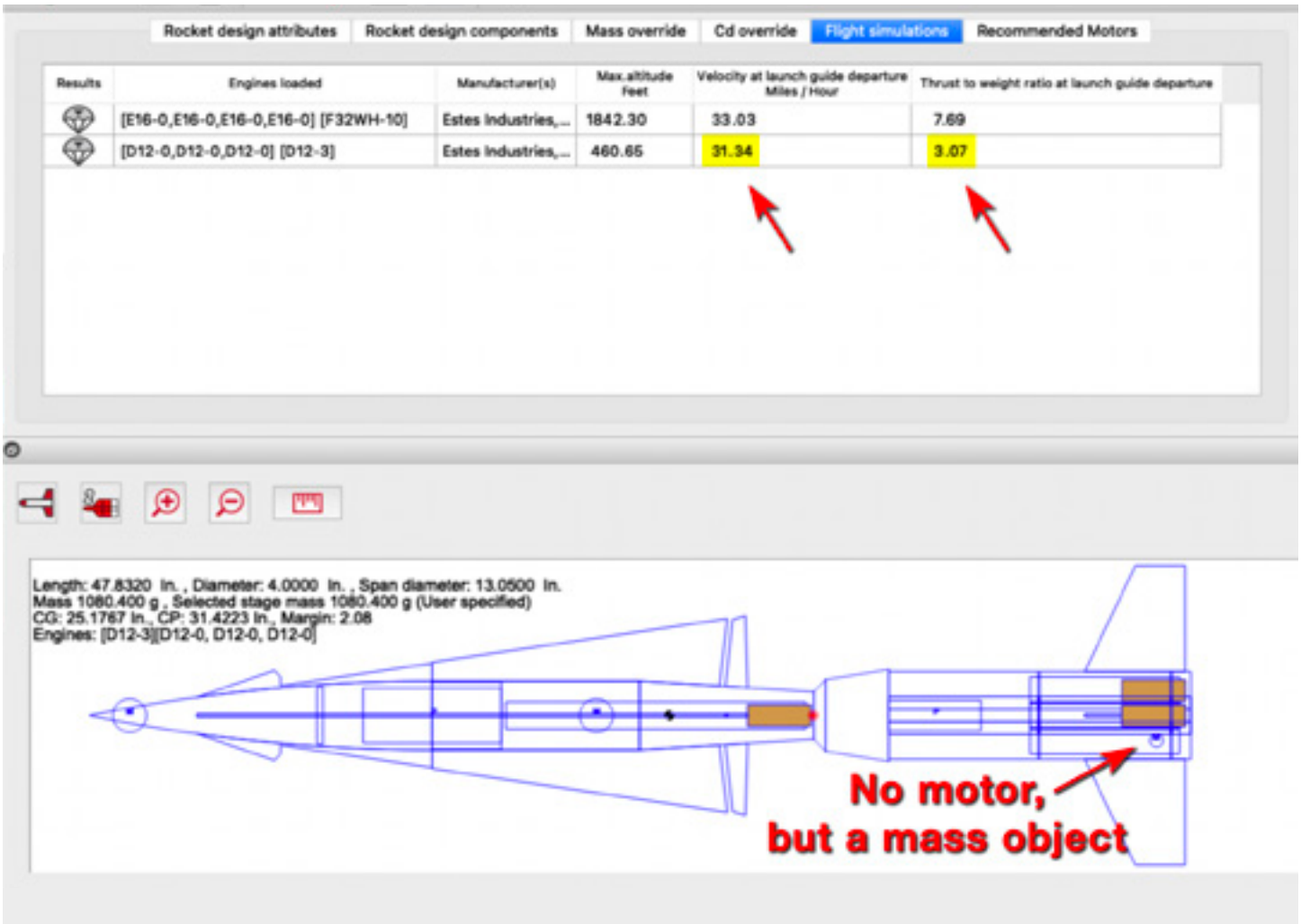

Figure 7: RockSim will quickly tell you both the lift-off speed and the Thrust-to-Weight Ratio.

If you run RockSim for this situation of five D12 motors in the Nike-Hercules, and one motor doesn't ignite, you will see that the thrust-to-weight ratio is 3.07. This is below our minimum allowable of 5:1. However, if you look at the lift-off speed of the rocket, we're still at 31.34 mph, which is totally acceptable.

In this configuration of five D12 motors, the rocket only gets to 460 feet, and it does weathercock a little more than I'd like to see if you look at RockSim's flight profile of the launch. I'd probably only use this configuration if the wind was dead calm, and the launch site was not capable of handling high-power rockets. It is probably the lowest power I'd ever use, and I'd do so with lots of trepidation. What makes it attractive to a lot of modelers is that the motors are widely available in local stores. Hopefully, you'll order online from us at ApogeeRockets.com, because you'll have more options and they'll still get to you quickly.

I think a better choice for a first flight of the Nike-Hercules if you want to keep it as a low-power option is the Quest D22 for the booster stage motors. With four motors, this gives a TWR of 7:1, and a lift-off speed of 41mph, even with only three motors igniting.

My personal preference is that I'd use "E" size motors in the booster stage of the Nike-Hercules, which provide around 40 Newton-seconds (Ns) of total impulse each. This extra power is a bit more impressive because second-stage ignition will be at a higher point in the sky, but not so high that it is hard to see.

The "2-motor Option" for the Booster Stage

The Nike-Hercules from Apogee does not have to use four motors in the booster stage. It can also be successfully flown with just two! This could save you money if you're on a tight budget.

The other empty tubes do not even need to have motors installed in them for a successful launch. The rocket was designed so that it only needs to take a single motor's ejection charge to push out the parachute. Honestly, It's rather ingenious the way that Martin Jay McKee designed it.

The transition of the model acts like a nose cone for the four tubes that make up the booster stage. This connects four individual "shoulders" into the tubes. The dilemma this created was that you need even pressure from the ejection charges to push that transition off the tubes. If one tube blows early, it will try to rotate the transition and cease up the shoulders in the other tubes. So Martin designed it in a way that two motor tubes just vent their ejection charges to the atmosphere and are not used to push the nose out. The other two tubes are connected by a duct tube **(Figure 8).** This equalizes the air pressure in each tube so that any gas in one tube will travel to the other tube and, they both push the transition off with equal pressure. This prevents the transition from rotating, and it comes out nice and straight without ceasing up.

When (or if) you decide to just use two motors in the booster stage, they do have to be installed in the tubes that are used to push the nose cone off. They are diagonal from each other in the stage, and one of the tubes has the parachute in it, which makes it easy to tell which tubes have to be loaded.

If you use two motors in the booster stage, when it comes to motor selection, we still need a 5:1 TWR. But for safety reasons, we still have to assume that one motor may not ignite. This means that the other motor has to have enough thrust to safely lift the rocket into the sky, and It has to have enough thrust to do all the work of getting the rocket off the pad.

In this case, you're going to need a high-thrust motor. If you look back at the calculations we did above, the rocket needs to have a motor that produces at least a 54.75N Max thrust in order to give us the 5:1 TWR.

Figure 8:The booster stage with some tubes removed to show the "duct" tube allowing the transition to pop off straight.

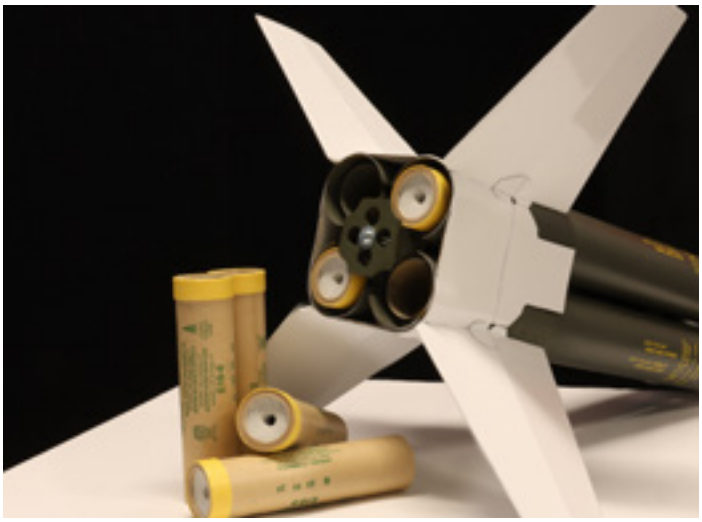

Figure 9: When using 2 motors in the booster stage, they must be installed diagonally, w/one of the tubes having the parachute.

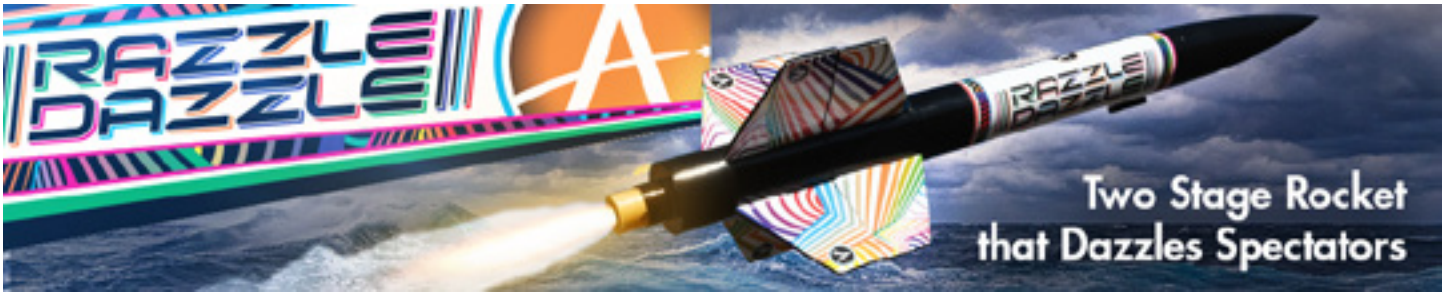

Figure 10: An Estes E16-6 loaded into the upper stage of the Nike Hercules Rocket kit.

Digging for this information on the Apogee website, I found that the 29mm diameter F42T motor has a max thrust of 62.3N. This is a little more kick than we need, but it was the smallest "single" motor that could safely lift the rocket if we don't achieve successful ignition of two motors. It also has a measly 27 grams of propellant in it, so you can actually use a G-size motor in the upper stage and still not require high-power certification to fly the model.

However, I kinda doubt that people will fly the rocket with just two motors in the booster stage. What fun is that? The real missile had four motors, so that is how I personally fly it.

Conclusion on Booster Stage Motor Selection

For the booster stage, any motor larger than the Estes D12 will probably work since it has a high enough initial thrust to lift the rocket safely into the air. This means that you have lots of choices that will work when you consider both 24mm and 29mm diameter motors that are available from the various manufacturers.

If you want to keep it under the 125-gram propellant limit so it is not considered a high-power rocket, then you'll be mostly looking at composite propellant E-size motors for the booster stage. They come in at around 20 grams of propellant, which means that you can put something a little bigger in the upper stage and still be under that 125g propellant limit.

If you are already high power certified, then the size and variety of the motors you put in the booster stage is almost unlimited because you don't have to worry about the amount of propellant contained in the rocket. This also opens you up to using the 29mm Estes E's and F's in the booster stage which will always make the combined propellant total greater than 125 grams.

As far as the booster stage is concerned, you'll probably want to stick with single-use motors, because buying 4 reload casings could be expensive. But there are many options to choose from.

Sustainer Stage Motor Selection

The sustainer stage, or upper stage, of the Nike-Hercules model is easier to pick motors for sinceyou only need one instead of four.

Normally, with a two-stage rocket, you have the option of just flying the upper stage alone, without any booster stage. We considered this too, even though as a real missile, the upper stage was never flown alone. And we did fly it on a couple of occasions as a single stage. It looked funny on the pad and flew kinda funny too. It is on the hairy edge of stability because it actually has fins on the nose cone called “destabilizing fins.” On the real missile, you want it to be highly maneuverable, so fins up front are desirable. But for us, we just want it to fly straight and be stable.

To get that upper stage to fly straight when launched from the ground, you need a lot of weight in the nose. Even then, we discourage flying the upper stage by itself.

But when flying it as an upper stage on a two-stage rocket, we have something going for us that really helps the trajectory. We have the speed and the stability that the lower stage contributes to the flight. The fins on the booster stage are absolutely huge, and when the two stages are connected together, it is overstable. So we know that just prior to stage separation, the rocket is going to be flying straight and with some velocity.

That initial velocity also helps the upper stage stay stable. It isn’t starting out at zero velocity when the motor ignites, so the fins are already generating some lifting forces to keep the rocket stabilized. We also did a small trick in the rocket, in that we canted the small elevon fins (the ones at the back end of the 2nd stage) by

Figure 11: You can use smaller diameter motors in the upper stage by using these motor adapters

a couple of degrees. The purpose of this is to impart a slow spin to the model. It's like rifling a bullet, which helps keep it flying straight.

Therefore, if you are flying as a two-stage rocket, the upper stage can have a lower TWR than the booster stage. We recommend a Thrust-to-Weight Ratio anywhere between 2 to 10, and we actually lean toward recommending motors with thrust levels toward the lower end of the spectrum.

The reason is that the upper stage is fairly short and therefore has a low moment of inertia, which means it can turn quickly (see also https://www.apogeerockets.com/education/downloads/Newsletter192.pdf). So any thrust misalignment of the motor mount can cause quick deviations to the flight path. This is another reason we chose to spin the rocket with canted elevon fins in the upper stage.

In general though, you'll have lots of options for motors in the upper stage because it is easy to keep the TWR under 10. Besides, it's got a lot of nose weight in it, so it is already a weighty rocket that needs a good push from the motor. If you want to use high-thrust level motors, our recommendation is to work up to it by launching it with some lower thrust motors flown first. As with any new rocket, get to know the flight characteristics of the model to see if it has any tendencies to fly in directions that you didn't intend by using smaller motors on the initial launches. If it is obvious, you'll see it and the walk to recover it will be a lot longer than you expected. That's all we look for on the initial flights of rockets.

The other thing we must consider when selecting motors for the upper stage is getting successful ignition with onboard electronics.

In general, black powder motors are the easiest to ignite, because any small igniter will start them burning. Composite propellant motors take a lot of heat and internal pressure to get started. You notice this a lot on the launch range when you see a lot of misfires with composite propellant motors.

Misfires are a bigger problem in an upper-stage rocket. If the motor doesn't ignite, then there won't be an ejection charge to push the parachute out at apogee. Meaning the upper stage of the rocket will crash hard into the ground.

To be prepared for a misfire, you'll have to use electronics that have a backup apogee deployment charge to push the parachute out. All the "staging" electronics that we currently sell at Apogee Components have this as a standard feature.

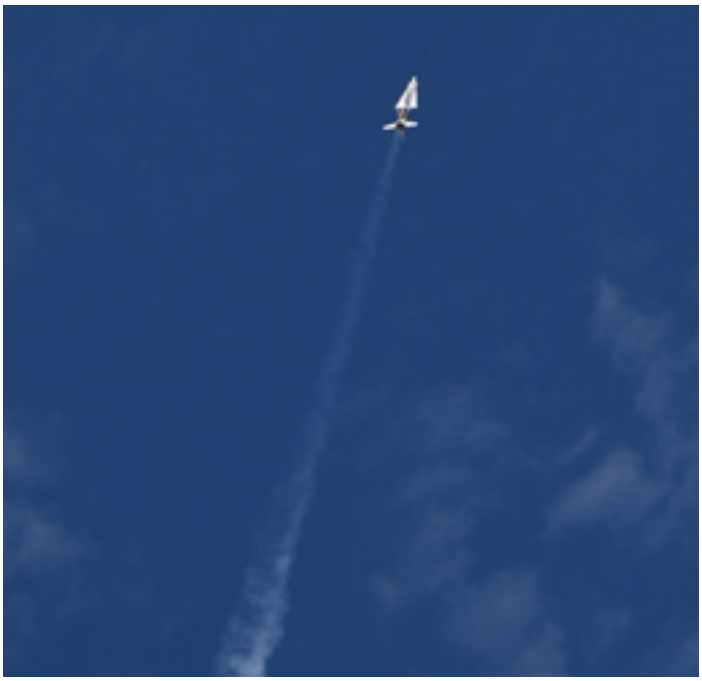

Figure 12: Multi-Stage Nike Hercules coasting upwards

Given the complexity of the Nike-Hercules, we recommend that you have experience with electronically staged rockets before flying the Nike-Hercules for the first time. We have other rockets, particularly the Timer Test Vehicle (https://www.apogeerockets.com/Model-Rocket-Kits/Skill-Level-4-Model-Rocket-Kits/TTV) that will give you a low-cost option to learn how to use your electronics for successful staging.

When it comes to composite motors, it is generally agreed that the Cesaroni brand motors are easier to ignite compared to the Aerotech motors. The reason is that they all have a special igni-

Figure 13: Preparing the Nike Hercules for launch

tion nugget of black powder built into them to make ignition more reliable. Even a wimpy igniter can start the black powder nugget burning, which then ignites the composite propellant.

Aerotech motors don't have that ignition nugget, so they need more care when installing the igniter to make sure it is located at the very top of the propellant so that it has the best chance of igniting the motor. Also, small Aerotech motors generally have smaller nozzles that require a smaller igniter to slip into them. You can't slip an Ematch (https://www.apogeerockets.com/Rocket-Motors/Motor-Starters/Firewire-Mini-Initiator-6-pk) into them like you could into a Cesaroni motor.

We'd all prefer to use an Ematch because they are very reliable and take only a whiff of electricity to set them off. Even a tiny battery can do the trick, which is perfect for on-board electronic devices. However since the Aerotech and Quest composite motors require a different igniter that is smaller to fit through the nozzle, they need a bigger battery with higher voltage.

For igniting Aerotech motors with the First-Fire Jr. (https://www.apogeerockets.com/Rocket-Motors/Motor-Starters/FirstFire-Mini-8in-long) or First-Fire Mini igniter, you'll need to use a 2-cell Li-Po battery (7.4volts). They are widely available, and we sell them too (https://www.apogeerockets.com/Electronics-Payloads/Electronics-Accessories/7-4v-260mAh-2-Cell-LiPo-Battery-1-pk). But they are not as common as the single-cell Li-Po battery that outputs 3.7volts of electricity.

We have videos that will help you learn all the tricks for ensuring successful ignition of the motor on our web site at: https://www.apogeerockets.com/Advanced_Construction_Videos/Rocketry_Video_297

Conclusion on Sustainer Motor Selection

Picking the motor for the sustainer stage has fewer considerations than the booster stage. If you want to stay below the high-power level, you must sum the total amount of propellant in all the motors in the rocket. That total must be below 125 grams, or otherwise you'll have to fly the rocket as a Class 2 (High power) rocket.

Unless the average thrust of the motor is pretty high (greater than 70N), you shouldn't have to worry about exceeding our recommendation of a thrust-to-weight ratio below 10 for the first flight. Most E and F-size motors are well under that thrust level, which means that most of the rocket engines available will work just fine.

There is concern about having a misfire in the upper stage, but with electronics and batteries that are commonly available, we don't think that should have any effect on the motors you choose.

Motor Chart

Nike (Booster) Motors	Hercules (Sustainer) Motor	Total Propellant Mass (g)	Class	Altitude (ft)	Altitude (m)
4 x Quest D22-4	Quest E25-4	66.3	MPR	1113	339
4 x Quest D22-4	Quest F41-5	78	MPR	1427	435
4 x Quest D22-4	Estes F15-6	108	MPR	1359	414
4 x Quest D22-4	Aerotech F20-7	78	MPR	1700	518
4 x Quest D22-4	Aerotech F25-6	84	MPR	1973	602
4 x Quest E26-4	Aerotech F20-7	103.2	MPR	2078	634
4 x Quest E26-4	Aerotech F25-7	109.2	MPR	2221	677
4 x Quest E26-4	Cesaroni F29-6	104.1	MPR	1917	584
4 x Aerotech E20-4	Estes F15-6	124.8	MPR	2205	672
4 x Aerotech E20-4	Aerotech F20-7	94.8	MPR	2437	743
4 x Aerotech E20-4	Aerotech F25-7	100.8	MPR	2577	786
4 x Aerotech E20-4	Cesaroni F32-6	94.7	MPR	2249	686
4 x Aerotech E20-4	Aerotech G40-10	118	MPR	2986	910
4 x Estes E16-4	Estes F15-6	220	HPR	1945	593
4 x Estes E16-4	Aerotech F20-7	190	HPR	2186	667
4 x Estes E16-4	Cesaroni F32-7	189.9	HPR	2001	610
4 x Quest E26-4	Estes F15-6	133.2	HPR	1836	560
4 x Aerotech F20-4	Aerotech F25-7	156	HPR	3677	1121
4 x Aerotech F20-4	Cesaroni F31-6	145.7	HPR	3425	1044
4 x Aerotech F20-4	Aerotech G40-10	174	HPR	4063	1239
4 x Aerotech G74-4	Aerotech G40-10	211.2	HPR	5300	1395

Figure 14: Example Motors you might use in the Nike Hercules

Final Parting Words

Remember that success comes not just from the power of the motors, but from the careful planning, preparation, and execution of the entire Nike Hercules build project.

As you embark on this challenging but rewarding build, take the time to thoroughly test each component and system. The complexity of this model provides an excellent opportunity to expand your skills in model rocketry and gain a deeper understanding of the principles behind multi-stage and clustered motor configurations.

With the right approach and attention to detail, your Nike-Hercules model rocket can serve as a testament to the fascinating history of rocketry while providing an awe-inspiring demonstration of the principles of flight and propulsion.

I personally believe in challenging modelers like you to take on projects like the Nike-Hercules that push your limits.The rewards of such endeavors far outweigh the effort required. I am your biggest cheerleader, always rooting for your success.

My and our team's commitment to your success extends beyond just providing high-quality products. We also strive to create a supportive community where modelers can learn, share their experiences, and inspire each other. Our community groups, workshops, and instructional videos are all designed to help you achieve your modeling goals.

We understand that taking on a challenging project can be daunting, but we want to assure you that you're not alone. Our team of experienced modelers is always here to help. Whether you need advice on motor selection, construction techniques, or launch preparation, we're here to guide you every step of the way.

So, don't be afraid to dream big and take on a challenging project like the Nike-Hercules kit. Apogee Components is committed to helping you achieve success. Together, let's push the boundaries of model rocketry and reach new heights.

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 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.

PEAK OF FLIGHT NEWSLETTER
Article Submission Guidelines
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SUBMITTING ARTICLES TO APOGEE

We are always looking for quality articles to publish in the *Peak-of-Flight* newsletter. Please submit the "idea" first before you write your article. It will need to be approved first.

When you have an idea for an article you'd like to submit, please use our contact form at **https://www.apogeerockets.com/Contact**. After review, we will be able to tell you if your article idea will be appropriate for our publication.

Always include your name, address, and contact information with all submissions. Including best contact information allows us to conduct correspondence faster. If you have questions about the current disposition of a submission, contact the editor via email or phone.

CONTENT WE ARE LOOKING FOR

We prefer articles that have at least one photo or diagram for every 500 words of text. Total article length should be between 2000-4000 words and no shorter than 1750 words. Articles of a "how-to" nature are preferred (though other types of articles will be considered) and can be on any rocketry topic: design, construction, manufacture, decoration, contest organization, etc. Both model rocket and high-power rocket articles are accepted.

CONTENT WE ARE NOT LOOKING FOR

We don't publish articles like "launch reports." They are nice to read, but if you don't learn anything new from them, then they can get boring pretty quick... Example: "Bob flew a blue rocket on a H120 motor for his certification flight." As mentioned above, we're looking for articles that have an educational component to them, which is why we like "how-to" articles.

You can see what articles and topics we've published before at: **https://www.apogeerockets.com/Peak-of-Flight?pof_list=archives&m=education**. You might use this list to give you an idea or two for your topic.

Here are some of the common articles that we reject all the time, because we've published on these topics before:

- How to get a L1, L2, or L3 Cert
- Building cheap rockets and equipment (pads & controllers)
- How to 3D print parts, or a Rocket Kit
- How to Build a cheap Rocket Kit
- Getting Back Into Rocketry After a Long Hiatus

ARTICLE & IMAGES SUBMISSION

Articles may be submitted by emailing them to the editor. Article text can be provided in any standard word processor format (MS Word, Libre Office, etc.) or as plain-text. Graphics, meanwhile, should be provided in either a vector format (Adobe Illustrator, SVG, etc.) or a raster format (such as jpg or png) with a width of at least 600 pixels for single column images or a width of 1200 pixels for two-column images. If possible, it is generally preferable for images to be simple enough to be readable in a two-column layout, but special layouts can use the whole page width if required.

Send the images separately via email as well as show where they go by placing them in the word processor document.

ACCEPTANCE

Submitted articles will be evaluated against a rubric (available here on our website). All articles will be evaluated and the results will be sent to the author. In the evaluation process, our goal is to ensure the quality of the content in *Peak-of-Flight*, but we want to publish your article! Resubmission of articles that do not meet the required standard are heavily encouraged.

ORIGINALITY

All articles submitted to Peak-of-Flight must not run in another publication before inclusion in the *POF* newsletter, but it may be based on another work such as a prior article, R&D report, etc. After we have published and paid for an article, you are free to submit them to other publications.

RATES

Apogee Components offers **$300** for a quality-written article over 2,000 words in length. Payment is pro-rated for shorter articles.

WHERE WILL IT APPEAR?

These articles will mainly be published in our free newsletter, *Peak-of-Flight*. Occasionally some of the higher-quality articles could potentially appear in one of Tim Van Milligan's books that he publishes from time to time.

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