Issue 646 / February 25th, 2025

PEAK OF FLIGHT NEWSLETTER

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

Modifying the Apogee Nike-Hercules for Single-Stage Flight



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Issue 646/ February 25th, 2025

COVER PHOTO



Close-Up of the Single Stage Motor Modification on the Nike Hercules

FEATURED ARTICLES



Modifying the Apogee Nike-Hercules for Single Stage Flight

by Martin Jay McKee

Interested in converting your Nike Hercules Rocket into a single stager flyer? Here's how!

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Pueblo, CO



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Modifying the Apogee Nike-Hercules for Single Stage Flight

by Martin Jay McKee

The Nike-Hercules from Apogee Components is a 1:10.25 scale rocket, capable of being flown under both class 1 (mid-power) and class 2 (high-power) rules. It's an extremely flexible rocket that can be flown on a huge variety of motor combinations from a low flight with 4 x Quest D22s staging to an Aerotech E20. At the same time, the rocket is capable of flying on four Aerotech G74s in the booster up to an Aerotech G40 in the sustainer. The massive flexibility is, I believe, part of the rocket's charm and (I hope) part of its appeal. When designing the rocket, we focused on making it as true to the full-scale Nike-Hercules as possible, both in external dimensions and in flight. That necessitated the clustered and staged nature of the rocket. Also, because it was a primary goal to make flight on composite motors possible, electronics are required for staging and highly recommended for deployment. Now, while all this leads to absolutely amazing flights, it does mean that the Nike-Hercules is a complicated rocket to prep and fly.



Tim Holding the Nike Hercules Model Rocket, Fully Built

As a result of this overall complexity, there have been many requests for information on ways to simplify the flight of the Nike-Hercules. One of those—gap staging the booster motors to sustainer motors—is a suggestion that, while possible, isn't really something we're too interested in figuring out. After all, this is an expensive rocket. If the upper stage does not light and there is no electronic backup, the sustainer (at the very least) is as good as gone. Other ideas, however, are certainly something that is interesting. One of the ideas we'll explore in this article is one I toyed around with early in the design stages of the rocket; that is, a central, single, motor mount instead of having a 4-engine cluster. The other idea we'll explore in this article is modifying the rocket into a single-stage configuration.

Before continuing with these more invasive modifications, however, it is worth mentioning that it's possible to fly the Nike-Hercules in a more "budget" configuration than it would first appear. The cluster mount on the booster allows for flights with either two or four motors. So, that makes a flight with something like two F67 or G74 motors possible. Since these Economax motors come in packs of two, this ends up being a fairly frugal flight for a rocket the size of the Nike-Hercules. In addition, there is no need to fly a motor in the sustainer as long as electronic deployment is provided. This need not be an unimpressive flight either, the aforementioned flight on two Aerotech G74s will boost the Nike-Hercules to 2000'. Simply flying the Nike-Hercules with a reduced engine loadout and the stock configuration means that the rocket continues to have all the same capabilities it is designed with while being easier and cheaper to prepare and fly. Obviously when flying the sustainer (Hercules missile) as a dart, it is necessary to plug the motor mount tube so that the electronic deployment system will not simply vent out the back. Carry a small 29mm motor as a payload or drop a bit of epoxy in the end of a spent 29mm motor and use it as a plug. Either will work fine.

But, let's say you still want to modify the Nike-Hercules to make it a dedicated single-stage rocket. We can do that. It won't cost much at all, and that's what the remainder of this article is about.





Nike Hercules Flying on a 2-Motor Cluster, Rather than 4

Motor Options:

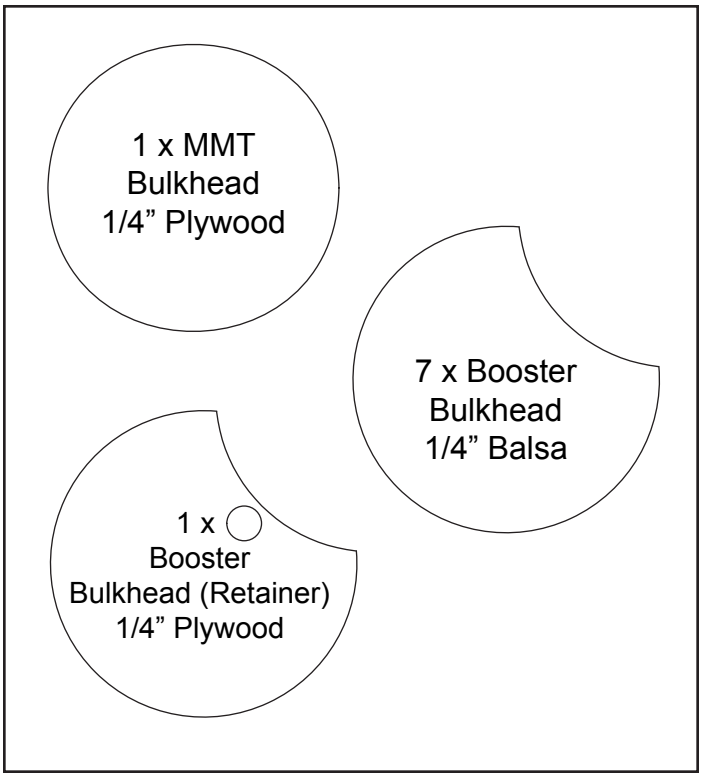
To begin, let's look at the two options we have for the motor configuration in a single-stage Nike-Hercules. I think my preferred option is to simply keep and use the standard cluster mount. As mentioned, that provides the option of flying with either two or four motors and it provides the most realistic smoke trail. Using the cluster for a single-stage Nike-Hercules also means that the only additional parts required are a larger parachute and a bit of clay for nose weight, making the conversion quite inexpensive. To make it even easier to fly, however, it is also possible to build the booster with a single 38mm motor mount. For the cluster option, the booster should be built exactly as described in the instructions (freely available on the Apogee Components web site) except for the modifications to the interstage. As such, building that option will not be considered in this article.

Quantity	Description	Apogee Part #
1	AT-38/11" Motor Mount Tube	10205
n/a	1/4" Balsa (for Support Bulkheads)	14095
n/a	1/8" or 1/4" Plywood (for Retainer Bulkheads and Motor Mount Bulkhead)	n/a
1	1/8" or 1/4" Plywood Bulkhead TBD-38	12215



Stock Parts Used in this Modification

1. The central 38mm motor mount requires the creation of several bulkheads, and modification to the laser-cut booster tubes. Six support bulkheads need to be cut from 1/4" thick Balsa wood. These bulkheads are mostly used for alignment and holding the shape of the booster tubes so balsa wood should suffice. Two additional Retainer Bulkheads are required and should be cut out of 1/8" or 1/4" plywood. These bulkheads are used to hold the weld nuts which help to retain the motor. Finally, the motor mount is capped by a bulkhead, and the exhaust gasses are directed out the side of the tube. The motor mount bulkhead can either be cut out custom or an **Apogee TBD-38 (P/N 12215)** may be used.



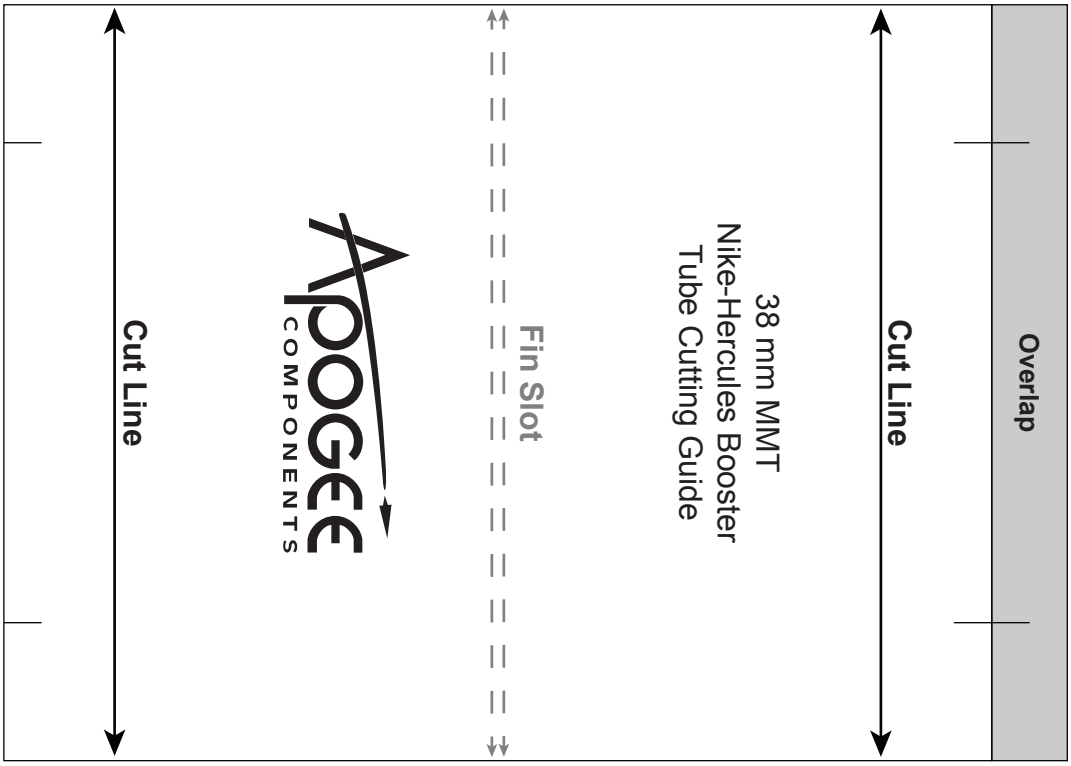
1. Print These Bulkhead Cut Guides AT FULL SCALE

2. To begin, modify the booster tubes by wrapping them with the **booster tube marking guide**, lining up the dashed arrows with the laser cut fin slot and marking the cut lines onto the tube. Also, use the forward edge of the guide to draw lines around the tube at 1-1/8" (29 mm) and 3-1/4" (83 mm) from the forward (non-notched) end of the booster tubes. After marking the tubes, use an aluminum angle or door frame to extend the cut lines the length of the tubes. Then, use a sharp hobby knife to cut out the rectangle of tube opposite the fin slot, from the 1-1/8" (29 mm) tube aft. Cut the tube using multiple light passes to ensure the cuts are as straight as possible. It is worth noting that the laser cutting overlaps the removed rectangle on the two **P/N 10155 (Nike-Hercules Booster Tube A)**. These tubes will be the 2nd set of tubes to be installed.





2. Booster Tube Cutting Guide, Inner and Outer Tube Sides



Booster Tube Cutting Guide

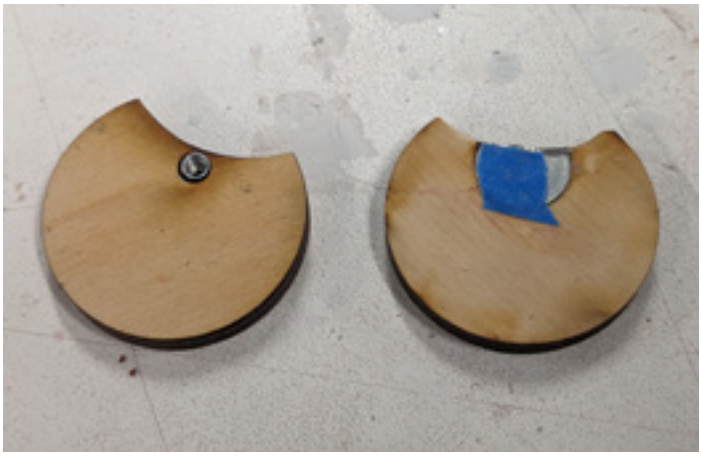
PLEASE PRINT THIS OUT AT FULL SCALE FOR ACCURATE MEASUREMENTS!

3. Mark the new motor mount tube using the **motor tube cutting guide**. Align the side marked “Forward Edge” against the end of the tube and use a pencil to trace the oval cutouts onto the tube. These cutouts fall opposite one another and are used to transfer the ejection charge into the interstage and, thus, into the sustainer. Use a sharp knife & many light passes to remove the oval cutouts.

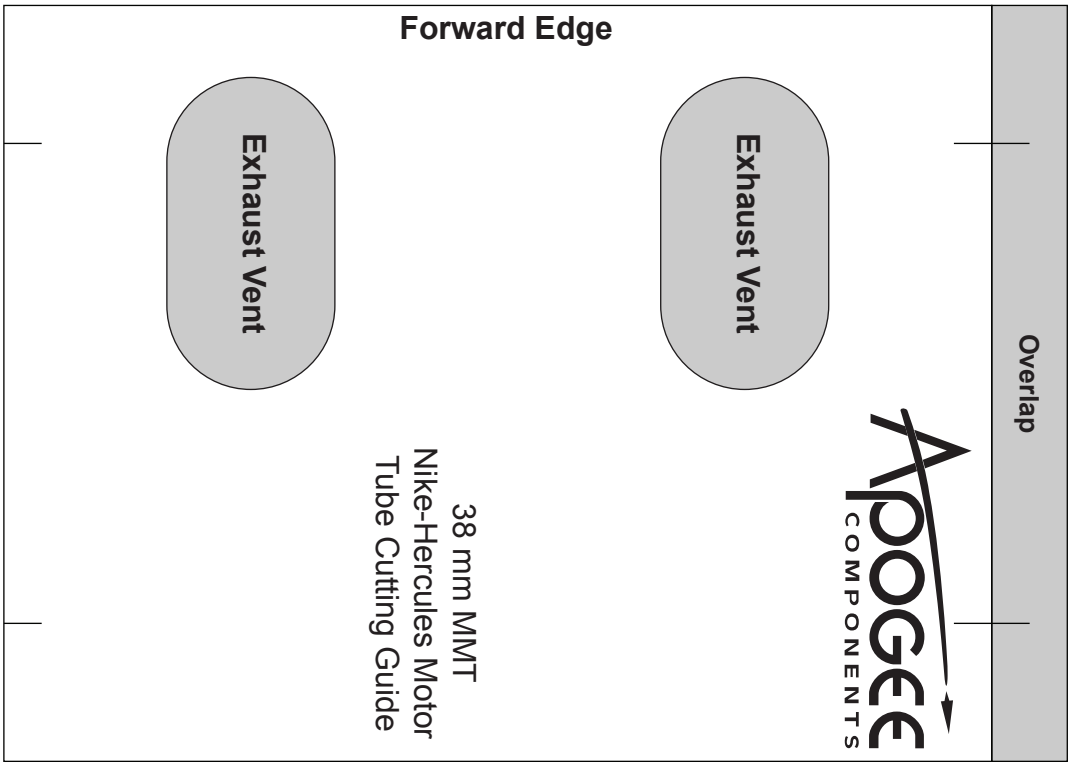


3. Attach the Motor Mount Cutting Jig and Trace the Cut-Outs

4. Install the weld nuts into the two retainer bulkheads with thick CyA adhesive and then grind the flange of the weld nut so that it follows the curve of the motor mount tube. This is easily done with an abrasive wheel on a rotary tool.



4. Retainer Bulkheads with Installed Weld Nuts



Motor Tube Cutting Guide

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Reference Image for all the Cut Tubes

5. Use the two cutdown **Booster Tube B (P/N 10156)** that do not have the slight incursion of the laser cutting beyond the rectangular section that was removed. Glue the two retainer bulkheads flush with the step on the aft end of the tube using epoxy. Align the rounded notch on the bulkheads with the cut edges of the tubes. Similarly, install two of the support bulkheads (balsa) just behind the second mark 3-1/4" (83 mm) from the front of the tube.

6. Install the remaining support bulkheads (balsa) in the two cut-down **Booster Tube A (P/N 10155).** Use epoxy to install one set of the bulkheads flush with the notch & the other set just behind the marked location 3-1/4" (83 mm) from the front of the tubes.



5. Install the 2 Retainer Bulkheads into Booster Tubes B



6. Install the 2 Retainer Bulkheads into Booster Tubes B

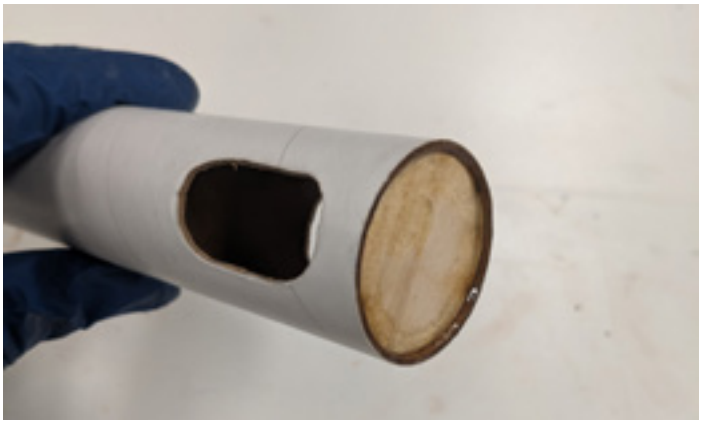
7. Install the bulkhead at the front of the motor mount tube adjacent to the oval vent holes using epoxy. Ensure that there are fillets on both sides of the bulkhead to keep it in place despite its proximity to the ejection charge.

8. Create a **booster alignment jig** by gluing the full-size template (found on the next page) to a piece of cardboard or foam-core board and cutting it out. Spray glue is ideal for this purpose but rubber cement works well also.

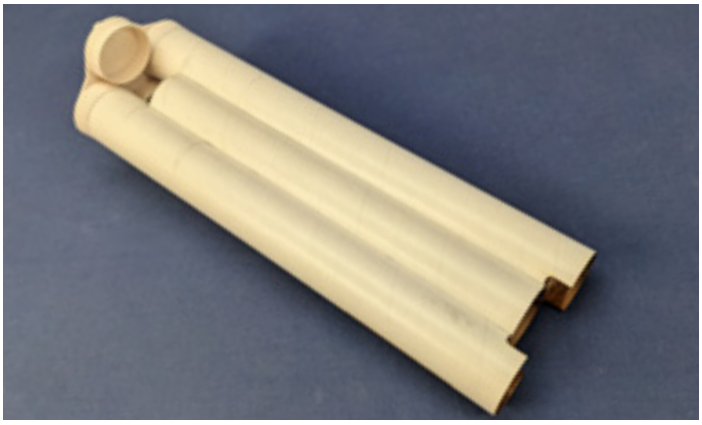
9. The next step is to attach the two cut-down B-style tubes – those with the cleaner of the cuts – to the motor mount tube. The booster alignment jig is used together with the interstage base and the coupler tubes to ensure alignment. Insert two coupler sections into the front ends of the booster tubes, apply a small amount of 5-minute epoxy to the inner surface of the bulkheads, and assemble the two booster tubes and motor mount. Press the interstage base onto the couplers at the front and slide the alignment jig over the back while the epoxy sets.

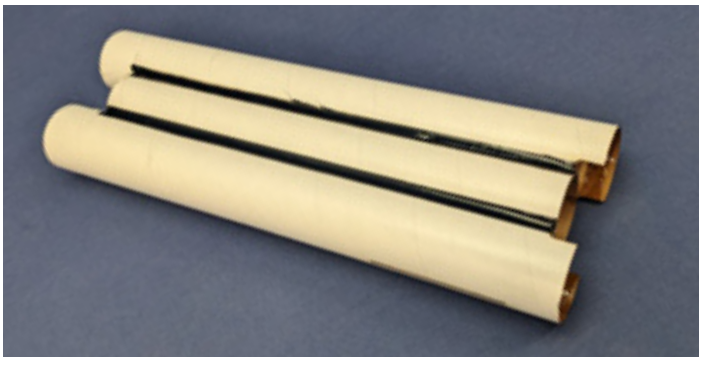
10. Once the first two booster tubes are attached, remove the alignment guides and mask the joints for epoxy fillets. A thickened epoxy (llike our **G-Flex 655**, or the original RocketPoxy) is recommended here. Once the fillets reach the green stage (soft but no longer tacky), pull the tape off & allow the fillets to cure entirely.





7. Install the bulkhead at the Front of the Motor Mount Tube



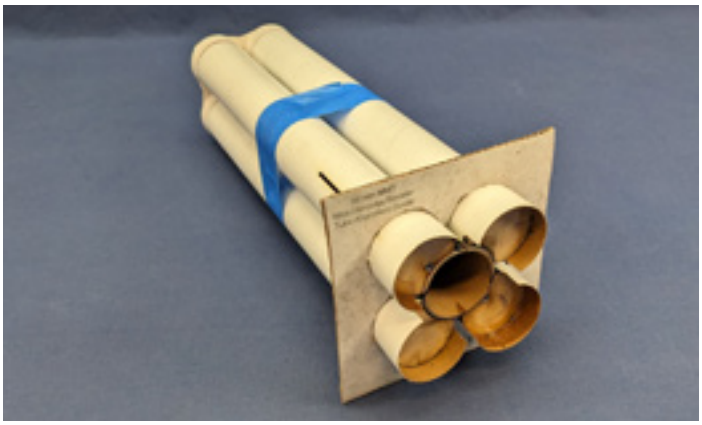


8-10. Align the Motor Tubes with the B Style Tubes, then use the Interstage Base to Align. Then, Fill Cracks with Epoxy.

11. Apply the second set of booster tubes (the remaining A-style tubes) with 5-minute epoxy. Use the interstage base at the front and the booster alignment guide at the back to ensure alignment.

12. This completes the modification of the booster from the standard quad cluster. The remainder of the booster construction can be completed using steps 31-62 and 74-85 from the Nike Hercules standard instruction book.





11. After Applying Epoxy, Use the Interstage Base and the Booster Alignment Guide to Ensure Proper Alignment

38 mm MMT
Nike-Hercules Booster
Tube Alignment Guide

Transfer Cutout To Cardboard

Apogee Components

Booster Tube Alignment Guide

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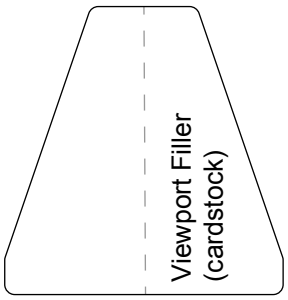
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Interstage Modifications:

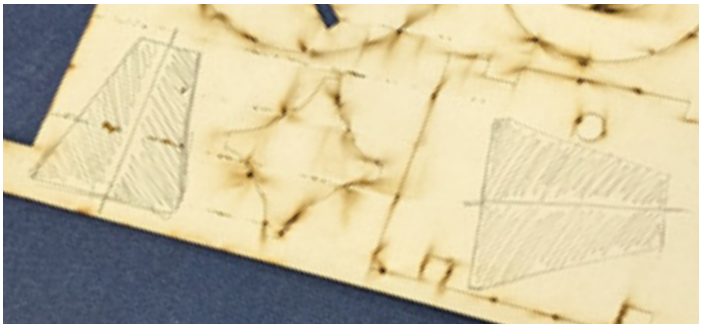
Two primary modifications need to be made to the interstage to allow the single-stage operation of the rocket. The viewing ports on the sides of the interstage need to be sealed in order to retain the ejection charge, and holes need to be added to the interstage base to provide a path for the same.

1. Use the included template to trace the filler pieces onto the **heavy cardstock sheet (P/N 40097)**. These can be fit within the open area and the center of the launch guide alignment template, so that no additional material needs to be purchased. Use a sharp hobby knife to cut out the parts and score down the center section so that the cardstock can be easily creased.



VIEWPORT FILL TEMPLATE

PLEASE PRINT THIS OUT AT FULL SCALE FOR ACCURATE MEASUREMENTS!



1. Trace Filler Pieces onto Heavy Cardstock; Cut with Knife





2. Glue the two filler pieces inside the interstage using epoxy. Ensure that the viewports are entirely filled and that the epoxy covers the entire edge so that there are no potential gas leaks.

3. Complete the interstage assembly steps 66-71 from the Nike Hercules kit instruction manual.

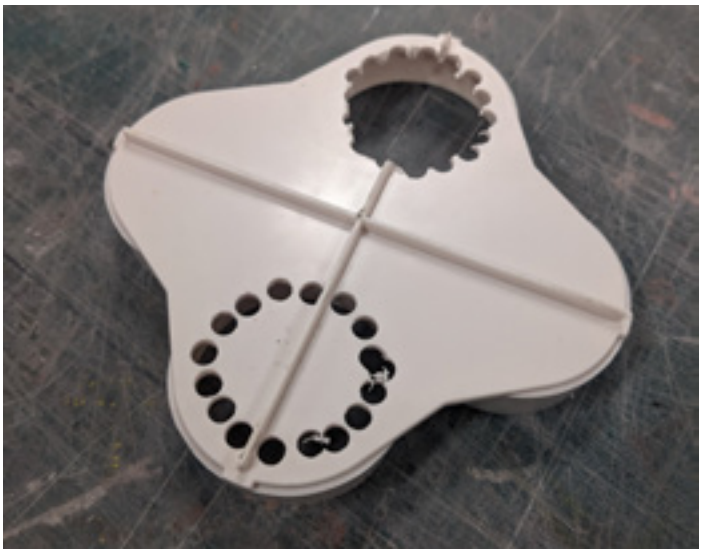


2. Glue the Filler Pieces onto the Interstage with Epoxy

4. Use a small drill (1/8”-3/16”) to produce a row of holes around two opposing booster mounts in the interstage base.

5. Use diagonal cutters in order to remove the scrap material from the middle of the booster mounts.

6. Use a sanding disk on a rotary tool (such as a Dremel) to clean up the booster mount hole.



4. Drill Holes on Opposing Sides of the Booster Mounts



5-6. Clean up the Holes with Cutters & a Rotary Sanding Disk

Sustainer Modifications:

The Hercules missile sustainer should be built according to the instructions except for four small changes. First, the motor retention weld nut need not be modified and installed in the aft centering ring CR5 (step 87). Similarly, the 4mm straw need not be installed in step as shown in step 93. In place of these two parts, however, the holes in the aft centering ring should be plugged using a thickened epoxy. I ended up using Bond-Aid epoxy clay for my test build. Many other options are available. Most importantly, make sure to seal the path of exhaust gasses in order to allow the deployment of the upper stage.

The final modification is that it is recommended to add 60g - 120g (2oz - 4oz) nose weight to account for the absence of the sustainer motor and the potentially greater weight of a 38mm motor in the modified booster. Ideally, the weight should be added in step 161 at the same time as the base nose weight.

Otherwise, the sustainer should be built as per the instructions and can be completed before the entire rocket needs to be assembled in the final steps.

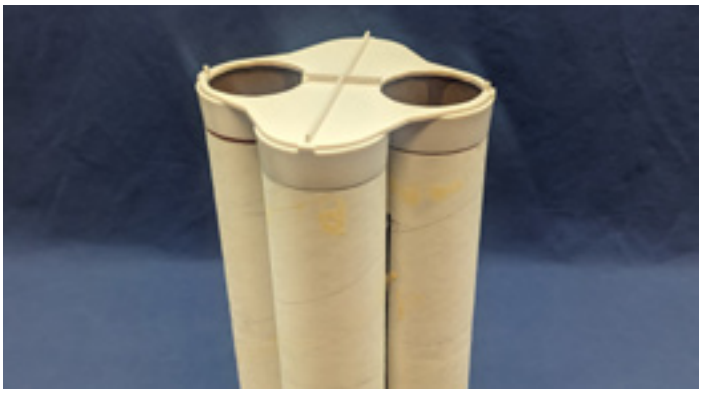


Seal the Holes in the Aft Centering Ring with a Thick Epoxy

Assembling the final rocket:

1. Mount the interstage base onto the booster tubes using the included couplers and epoxy. Apply epoxy into the booster tubes and the pockets on the interstage base, then align the passthru holes in the interstage base with the two booster tubes connected to the motor charges. On a standard four-motor Nike-Hercules build, the A-style tubes with the small coupler tube are the tubes which should be vented to the interstage. In contrast, on the single-38 mm booster version, it is the two booster tubes into which the 38 mm motor mount is vented.

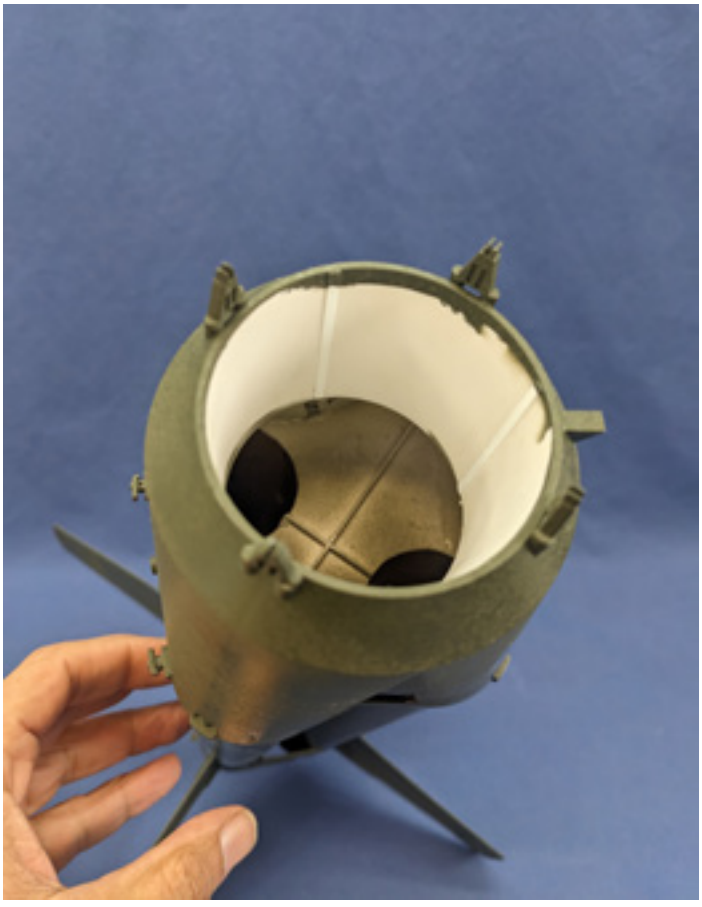
2. Once the interstage base is secured, use epoxy to glue the interstage body onto the base. Ensure that the rail buttons are aligned, apply epoxy to the edge of the interstage base, and mount the interstage body into place. For strength, also apply a fillet of epoxy around the internal joint between the base and body.



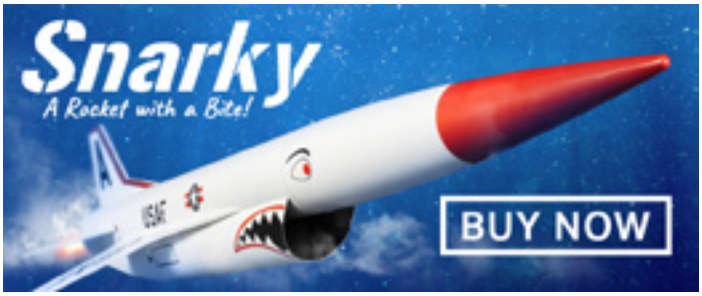
1. Mount Interstage Base using Couplers and Epoxy; Align.



2. The Interstage Base is Fully Installed into the Body



Assembled View of the Interstage



3. If the aft end of the sustainer boat tail has been painted, mark the depth that the sustainer sits within the interstage. Then sand off any paint aft of that line.

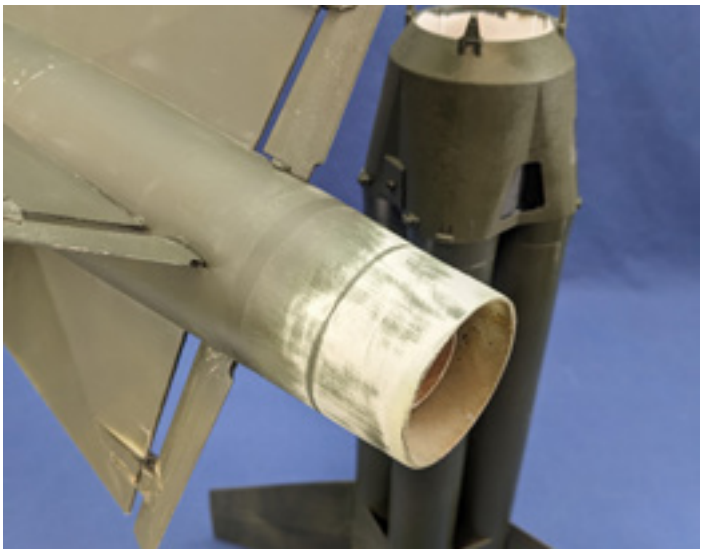


3. Mark the Depth the Sustainer Sits and Sand off any Paint

4. Use epoxy to glue the sustainer into position on the booster and allow the joint to dry with the rocket in a vertical orientation to ensure the best alignment possible.

5. Once all epoxy is set, install a large 48" parachute into the to ensure safe recovery

6. The single-stage Nike-Hercules is ready for flight!



3. Sustainer is Prepped and Ready for Assembly

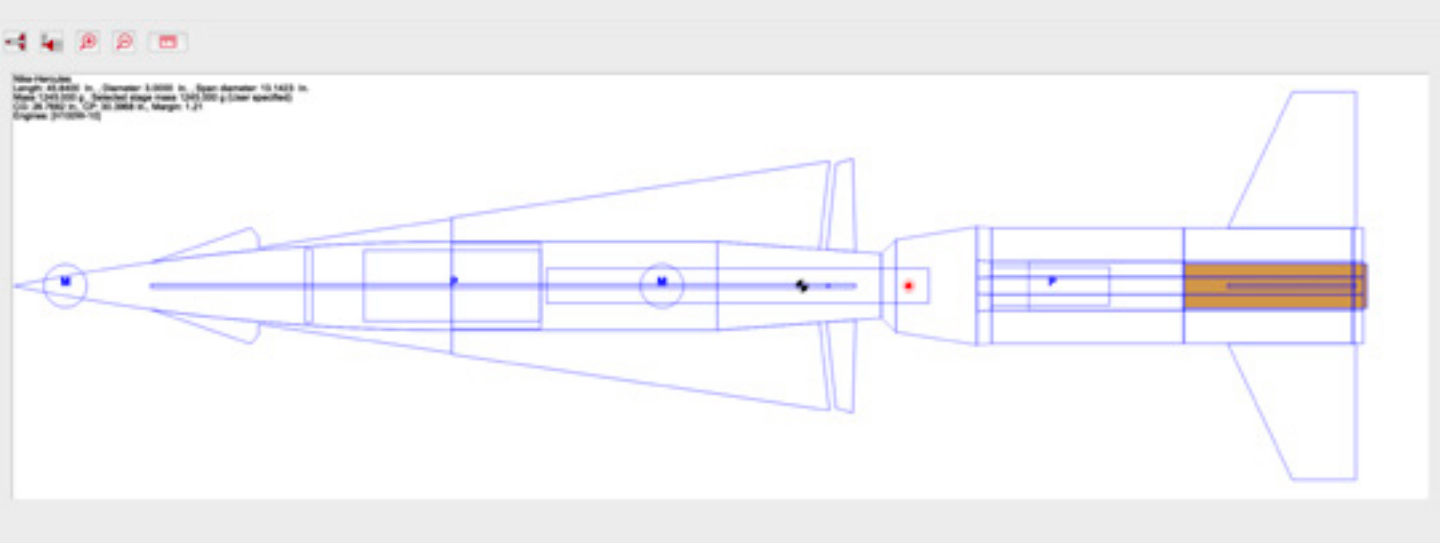
Flying the Single-Stage Nike-Hercules:

Obviously, flying a rocket with a cluster of four motors will be different than flying one with a single motor. The more important thing for us, however, is the safest way to ensure reliable recovery of the single-stage Nike-Hercules. We'll just assume that a single 38mm booster has been chosen and that is what we will be flying. Despite the fact that the modified Nike-Hercules would be capable of being recovered using motor deployment, it is still highly recommended that electronic deployment be used when available.



The flight of the modified Nike-Hercules can be simulated using one of the modified RockSim files (in this case, with a central 38mm). For the test flight, an Aerotech H100W was chosen as the flight motor. Given the final build weight, this gives a stability margin of 1.21 calibers, and a velocity off the rail of slightly over 38 miles-per-hour. I would expect that to be a lovely mellow liftoff and a straight boost. For backup deployment, it is being flown with a tiny Featherweight Blue Jay Plus altimeter.

The optimal motor delay is 9.5 seconds, so 4 seconds will be drilled from the 14 second maximum. The Blue Jay, conversely, will be configured for deployment right at the point of apogee. If the rocket flies perfectly straight, there is a small chance that the charges could happen at the same time; that's highly unlikely, however. It would be much more likely that the rocket will have some small amount of arc which will lead to a lower apogee and an earlier electronic deployment, leaving the motor ejection charge to act as a safe backup. This would be my preferred flight configuration, where the motor ejection charge is used as a backup to electronic deployment, in case anything goes wrong.



Setting up the Rocket for Flight in RockSim

Conclusion:

Whether anyone actually decides to build and fly their Apogee Nike-Hercules as a one-piece, single-stage, rocket, I hope that this article has scratched some of the itch for other ways to fly the Nike-Hercules (both simpler and cheaper) as well as given enough guidance for others to give it a try if they so desire.

Let's be honest, Nike-Hercules was never intended to be a simple rocket to build and fly. It was designed to be an accurate representation of a complex historic nuclear weapons system. I believe the kit does that well. That said, I do understand the discomfort that comes from spending all the time and money to build a complicated rocket, to only be met by an equally complicated launch. Flying the Nike-Hercules as intended requires five motors and electronics. That's nothing to sniff at. While the flight is an absolutely amazing experience, I would prefer people to simplify the prospect rather than lose the opportunity to witness a flight.

This article has shown that there are many ways to make flying an Apogee Nike-Hercules simpler (and cheaper). Building it exactly as recommended in the instructions, it can be flown with two motors in the booster, a plug in the sustainer, and standard recovery electronics in the sustainer. Or, one can modify the rocket to fly on two or four motors and use motor ejection. Or, if really desired, the booster can be redesigned for a single 38mm mount to fly high-power flights with motor eject. There are endless options.

Have fun!

About the Author:

Martin has been designing and building rockets for as long as he can remember. After originally toying with the idea of pursuing a career in Aerospace Engineering, he decided to double major in Computer Science and Fine Arts, spending a decade working in K-12 math & science education. He joined Apogee Components as the Product Designer in 2022.



PEAK OF FLIGHT NEWSLETTER

Article Submission Guidelines

Issue 646 / February 25th, 2025

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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, or as plain-text. Graphics should be sent 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 1200 pixels for two-column images. It is preferable for images to be simple enough to be readable in a two-column layout, but special layouts can be used.

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.

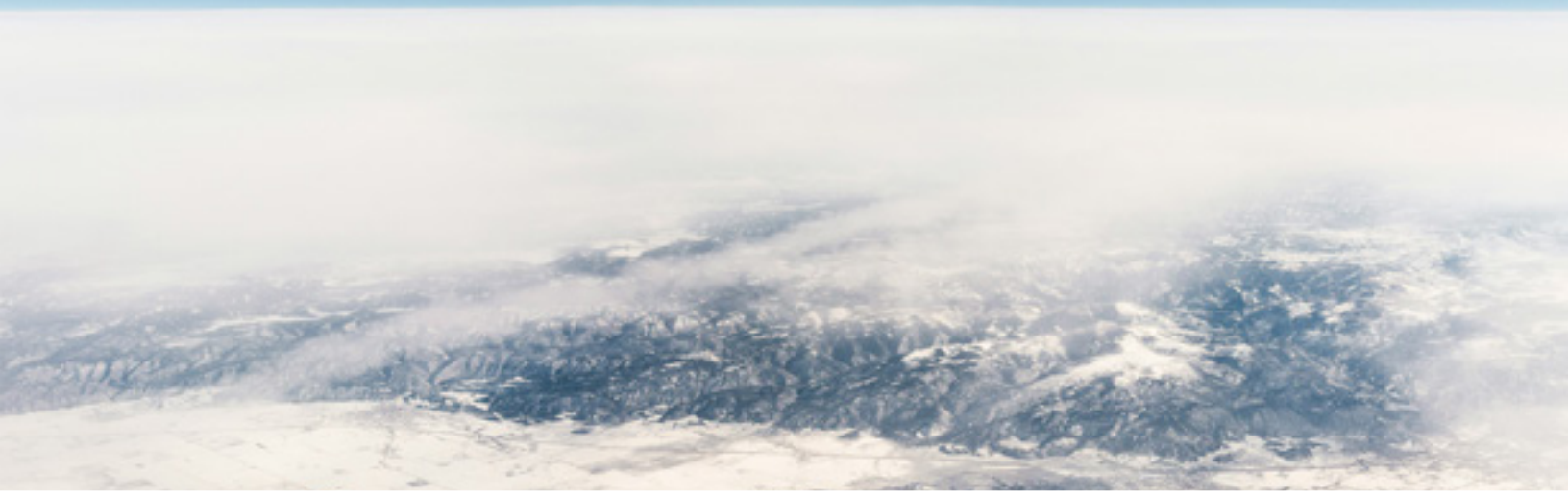



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