# EXPLORER POST 1010
# STUDENT LAUNCH INITIATIVE
# PROPOSAL


**September 19, 2022**

Institution: Explorer Post 1010

Mailing Address:
Rockville Science Center
PO Box 1084
Rockville, MD 20849

Email Address:
post1010@gmail.com

# General Information

Our team is sponsored by the Rockville Science Center. They help us find qualified adults to mentor our teams and work with the library to provide meeting space. We help the Center with

staffing their outreach events which allows our student members to earn Student Service Learning hours. Post families financially support the Center and participate in other Center programs.

We are organized under the national Learning-for-Life Exploring Program (http://exploring.learningforlife.org), and supported by the National Capital Area Council of the Boy Scouts of America.

Explorer Post 1010 ("Post") contact information:

- Meeting Location:
  Rockville Science Center,
  36C Maryland Ave,
  Rockville, MD 20850
- Mailing Address:
  Rockville Science Center,
  PO Box 1084,
  Rockville, MD 20849
- Shipping Address:
  Rockville Science Center,
  524 Carr Ave,
  Rockville, MD 20850
- Email Address: post1010@gmail.com

Mentor contact information:

- Bob Ekman (Post Advisor)
  - bob.ekman@att.net
  - phone: 301-512-1278
- Jonathan Rains (NAR L2 Member)
  - jrains@comcast.net
- Vince Camobreco (Payload Advisor)
  - vincent.camobreco@gmail.com

Student Team Leader Name: Sam Troost

- Email: samueltroost20816@gmail.com
- Phone Number: 301-310-7351

Safety Officer: Peter Camobreco

- Email: camopd10@gmail.com
- Phone Number: 301-651-2120

- Number of Students Committed: 9
    - Sean Russell
    - Peter Camobreco
    - Sam Troost
    - Alex Emami (new in 2022)
    - Michael Guardado
    - Ethan Goldberg
    - Daniel Greynolds (new in 2022)
    - Conrad Randall (new in 2022)
    - Jason Termini (new in 2022)

*This list may change some, since we are still recruiting.*

Name of the NAR/TRA sections the team is planning to work with:

- NAR Headquarters Astromodeling Rocket Section (NARHAMS), Section 139 - NARHAMS model rocket club serves Maryland and the Washington Metropolitan Area. The club is an official chapter section of the National Association of Rocketry (NAR).
- Northern Virginia Association of Rocketry (NOVAAR), Section 205 of the National Association of Rocketry (NAR)
- Tripoli Central Virginia, (TCV), Culpeper, Virginia.
- Maryland Delaware Rocketry Association, (MRDA), Eastern Shore, Maryland. They have two launch sites - Central Sod Farm, Centreville, MD and Higgs Farm, Price, MD.

Hours Spent on Proposal: 15 hours

Available time slots for presentations include
Wednesday 3-4
Wednesday 4-5
Friday 3-4

Explorer post 1010 is not affiliated with a school and our members go to many different schools we can only meet for presentations after school.

# Facilities and Equipment

We will be using the Rockville Science Center Storefront (open evenings and Saturdays) and the Rockville Library Makerspace (open 10am-8pm) to design and construct our rocket.

The Explorer Post has had teams in the American Rocketry Challenge (TARC) since 2005. We have had several teams make it into the TARC finals. In 2022, one of our teams came in 23. In 2022 we completed the NASA SLI program. We have institutional experience and equipment that can be put to use in this project.

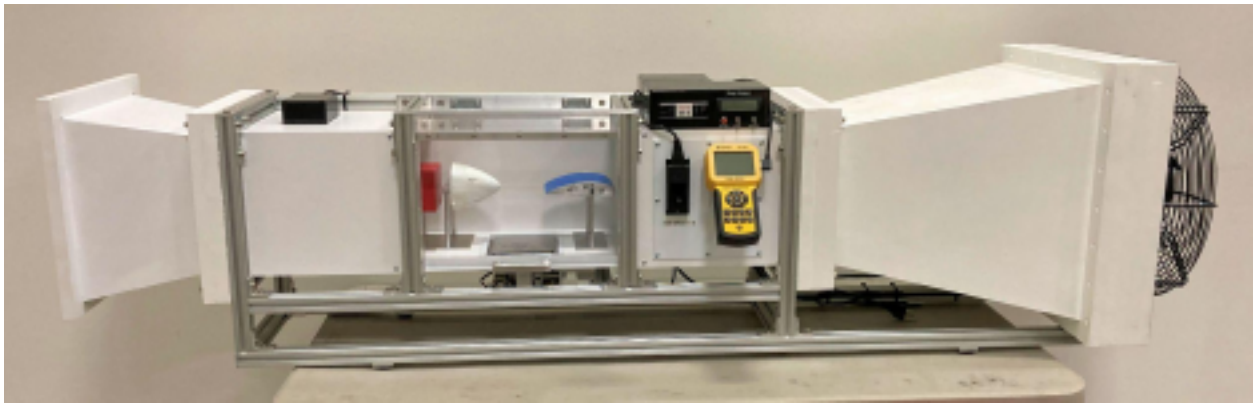
The tools available that we use to build our rocket include a laser cutter, 3D printers, a CNC machine, power tools, and a wind tunnel. There are Center staff available to assist with the use of equipment.

The team has access to soldering equipment, microcontrollers, computers and programming software, wires and connectors, and power supplies (including lithium batteries).

We have mid power parts that we use from TARC that can be used for the subscale. We also have some high power rocket parts (motor mounts, altimeters, GPS trackers, etc) but we will need to acquire most major pieces encoding the airframe.

For rocket design and flight simulation, we use OpenRocket. We have used it for many years successfully in TARC.

The Explorer Post also hosts a drone team. The drone team and their equipment are available to use and help with development. The drone team is registered in the AMA UAS4STEM competition (https://amablog.modelaircraft.org/uas4stem/ ). In 2022 our team came in 3rd place at the national competition held at the annual International AirVenture Aviation Festival.



# Safety

## Safety Plan

Safety is the number one priority of the team at all times. Our team follows tried and true guidelines on maintaining proper safety; Team members will not be permitted to use power tools until they receive necessary training on how to operate them from the Safety Officer. A fire extinguisher is always easily accessible inside the lab and team members will be briefed on how to operate it. A qualified adult will always be present and supervising the lab while work is being done. All energetics and high power motors will be handled by the certified team NAR representative.

## NAR/TRA Compliance

As said previously all energetics and high power motors will only be handled by the certified team NAR representative, Jonathan Rains.
The team will comply with the following guidelines outlined by NAR at all times during launch.

1. The team will only fly motors available to the NAR representative's current certification.
2. The team will only use lightweight materials in vehicle construction.
3. The team will only use certified and commercially available rocket motors, and will never tamper with said motors. No open flames or heat sources will be allowed within 25 feet of these motors.
4. The team will only launch with an electrical ignition system.
5. No team members will approach the rocket while the controller is armed and will wait at least 60 seconds after a misfire.
6. The rocket will launch with a five second countdown and ample warning to the audience. Only absolutely necessary personnel will be present during arming of the energetics at the pad. The stability of the rocket will be verified before flight.

7. The rocket will launch from a sufficiently long and stable launch rail that will be pointed within 20 degrees of vertical. The launch pad will have a blast deflector and will not be situated near dry grass.
8. The rocket will not contain any combination of motors that total more than 40,960 N-sec (9208 pound-seconds) of total impulse. The rocket will not weigh more at liftoff than one-third of the certified average thrust of the high power rocket motor(s) intended to be ignited at launch.
9. The rocket will not be launched into clouds or at any sort of targets. It will not launch in winds exceeding 20 miles per hour. It will comply with all relevant FAA airspace regulations in effect.
10. The rocket will not be launched near trees, powerlines, occupied buildings, or persons not involved with the launch.
11. The rocket will be launched at least 1500 feet from any occupied building or public highway.
12. The rocket will have a parachute recovery system and flame protection for the parachute.
13. The team will not attempt to recover the rocket from power lines, tall trees, or other dangerous locations.

**Risk Analysis**

We consider the following risks to be the most significant throughout the project.

| Risk | Risk/Likelihood | Mitigation |
|---|---|---|
| Cuts, burns, and scrapes from tools | Medium-High | Proper tool usage and supervision from an adult when using heavy machinery |
| Fires from electrical sources or tool usage | Low | Proper procedures around electronics and power tools, training on usage of fire extinguishers and fire blankets |
| Accidental discharge of motor and energetics | Low | Strict safety precautions around motors and energetics, no flames or heat sources within 25ft of motors |
| Damage to property or personnel from rocket launch | Medium | Rocket will be launched minimum of 1500ft away from vehicles and structures, all launch attendees will be alerted to the launch |

**Caution Statements**

Caution statements will be employed on any activities where risk is present, including instructions on proper use of Personal Protective Equipment. All procedures pertaining to power tools will have caution statements present.

**Compliance with laws**

In compliance with laws outlined by the Federal Aviation Administration the team will not launch:

1. At any altitude where clouds or obscuring phenomena of more than five tenths coverage prevails;
2. At any altitude where the horizontal visibility is less than five miles;
3. Into any cloud;
4. Between sunset and sunrise without prior authorization from the FAA;
5. Located within 9.26 kilometers (5 nautical miles) of any airport boundary without prior authorization from the FAA
6. In controlled airspace without prior authorization from the FAA;
7. Unless you observe the greater of the following separation distances from any person or property that is not associated with the operations applies:
    - (1) Not less than one quarter the maximum expected altitude;
    - (2) 457 meters (1,500 ft.);
8. Unless a person at least eighteen years old is present, is charged with ensuring the safety of the operation, and has final approval authority for initiating high-power rocket flight; and
9. Unless reasonable precautions are provided to report and control a fire caused by rocket activities.

**Hazard Briefing**

All team members will be briefed on potential hazards in the lab and on launch day. A pre-launch briefing will occur each launch day to remind the team of the necessary safety guidelines.

**Safety Agreement**

All team members will agree, understand, and abide to the following guidelines;

1. Range safety inspections will be conducted on each rocket before it is flown. Each team shall comply with the determination of the safety inspection or may be removed from the program.
2. The Range Safety Officer has the final say on all rocket safety issues. Therefore, the Range Safety Officer has the right to deny the launch of any rocket for safety reasons.
3. The team mentor is ultimately responsible for the safe flight and recovery of the team's rocket. Therefore, a team will not fly a rocket until the mentor has reviewed the design, examined the build and is satisfied the rocket meets established amateur rocketry design and safety guidelines.
4. Any team that does not comply with the safety requirements will not be allowed to launch their rocket.

**Plan for NAR mentor purchase, storage, transportation, and use of rocket motors and energetic devices**

Our motors and energetics will be purchased by our NAR mentor Jonathan Rains; they will be delivered to and stored in his house. He will pre assemble the motors and he will transport them to the launch. At the launch he will prep the ejection charges and load the motor into the rocket.

# Technical Design

## Vehicle

The outer diameter of the rocket is 4 inches and the combined length of the airframe will be 58 inches long. The total height will be 75 in.

**Airframe**

We plan to make the rocket airframe out of MAC Performance canvas phenolic tubes because of their mass, cost, and ease of construction. We will get the airframe pre-cut to length and custom slotted.

**Nose cone**

The rocket will use a Wildman 4 to 1 FWFG-VK nose cone. We chose this nose cone because of its strength, removable coupler, and aluminum tip.

**Fins, centering rings, and bulkheads.**

The fins will be made out of 1/8 G10 fiberglass sheet because of strength. We will use our CNC router to cut the fins, centering rings, and bulkheads.

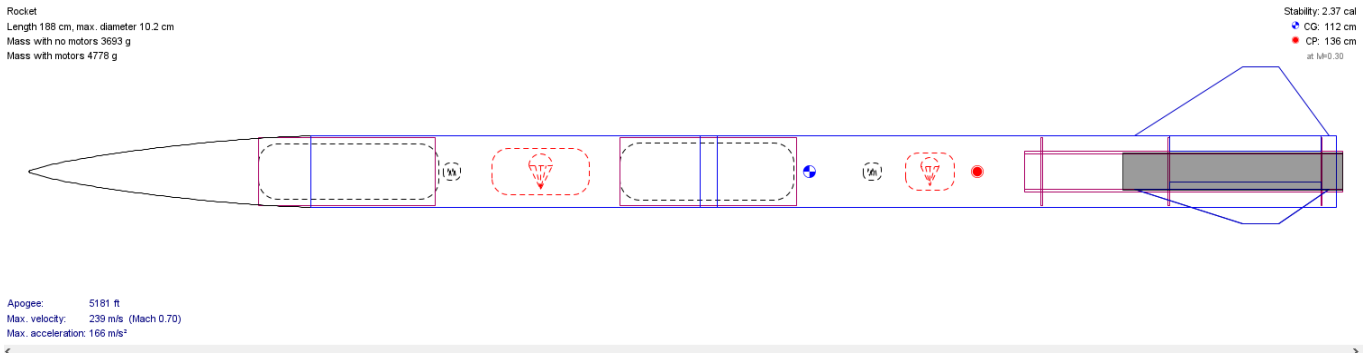
**Altimeter bay**

The altimeter bay will be a MAC Performance 4” Altimeter Bay Kit. We will use an altimeter bay kit to save time and reduce the number of parts we need to buy.

**Motor mount**

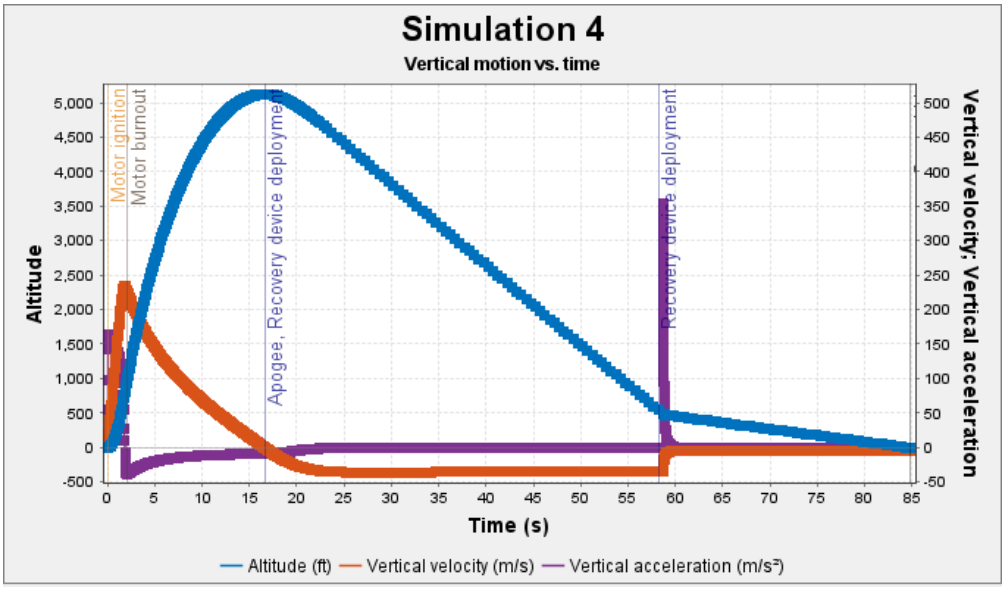
The motor mount will be made out of PML phenolic due to its heat resistance and cost.

**Design**




**Simulation**.

The projected altitude is 5000 ft using simulations from OpenRocket, flying on an Aerotech J800T motor.




**Recovery**

Our rocket will use a traditional dual deploy system with two Missile Works RRC3 sport altimeters. A 12 inch Fruity Chutes elliptical parachute will deploy at apogee with backup at apogee + 1 second using BP charges. At 600 feet (Backup at 500), the

altimeters will light black powder charges to eject the main chute. The main chute will be a 6 ft Rocketman parachute. The rocket will use a Featherweight GPS for tracking. For redundancy, our rocket will contain independent altimeters in case one fails.

**Payload**

The payload will test the air for microplastics. Microplastic pollution has become an emerging environmental concern. In recent years, there have been a number of studies considering microplastics pollution in different ecosystems. Microplastics can be released from a number of everyday materials and can contaminate the air.

Microplastic testing is an emerging field and there are not many standard methods of sampling. Based on a review of past studies of testing the air for microplastics there are usually two methods for sampling the air:

- Passive atmospheric deposition where a system is set up to measure particles that deposit out of the air over a period of time.
- Active sampling where air is pumped over a filter to collect particles in the air

Once the samples are collected there are ways to test for microplastics including:

- Visual observation - using a microscope to view and classify any particles that are collected, there are also software programs that can help with image analysis.
- Infrared spectroscopy where infrared is used to detect the spectra of samples, different polymers give off different spectral images.

The primary approach we are considering for taking samples is a collection system that will use vacuum tubes connected to holes in the rocket. At a preprogrammed altitude a valve controlled by a servo will open to allow air into the vacuum tube. The valves will then close to keep the air inside the tubes. There will be two vacuum tube systems that will collect samples on descent at 5000 ft and 2500ft. The servos will be controlled by a microcontroller with an altimeter. A third sample will be taken on the ground. After the flight all the samples will be tested for microplastics and compared likely through visual inspection to determine if there is a difference in microplastic concentrations at different altitudes.

As it is unclear if the vacuum tube collection approach will collect enough air volume of sample to determine any concentration of microplastics we are also considering an active collection method where we would draw a volume of air over a filter through the use of a fan or pump in order to sample a larger volume of air.

There are also existing sample methods, kits and samplers for measuring Particulate Matter

(PM) in the air. Microplastics are a form of airborne PM so we are also looking into using existing PM approaches for measuring microplastics. Methods include sticky collection strips and high volume air samplers.

While our primary goal of the payload will be to determine if there are detectable and different concentrations of microplastics in the air at different altitudes, our secondary goal will be to construct and demonstrate a system for collecting air samples at different altitudes for follow on analysis.

## Technical Requirements

Our team safety officer, Peter Camobreco, will ensure all team members are aware of the requirements outlined in the handbook and that the team will adhere to all general, vehicle, recovery, payload, safety, and flight requirements. All work will be done by the team members except for handling the energetics and motors. He will also ensure that all NAR and FAA rules are adhered to. Peter will work with our mentor Jonathan Rains to ensure that the vehicle is constructed safely and properly.

## Challenges

### Rocket

Based on results from last year's project, the greatest challenge presented with the launch vehicle is keeping the weight low enough to hit the altitude targets while still strong enough to remain undamaged throughout multiple flights. We will be using strong, but lightweight components, including an aluminum tipped nose cone and G10 fins. We will also be using techniques such as having an airfoil fin-profile and a very smooth finish to achieve the best performance.

### Payload

The most difficult aspect of the payload will be the sample intake. Actuating the valve to open the intake will be simple to construct as our team has experience with a similar system from a previous project. Other considerations are ensuring there is no sample contamination including from the rocket exhaust. Unlike our previous year SLI project, the avionics and software will be fairly simple.

### Miscellaneous

Securing enough funding throughout the project is always a challenge. This year our team will conduct a more rigorous fundraising plan to raise sufficient money for the project. We will also schedule more STEM Engagement events as outlined in the section below.

# STEM Engagement

We will use the Rockville Science Center as a hub for our in-person STEM Engagement activities. We will also do video conferencing. Some of the topics that will be focused on include programming, aerospace engineering, and mathematics.

We run a monthly science day where we have tables that cover many science topics.

We run classes on how to build a model rocket where we teach kids about model rockets and we conduct Alpha III build sessions where they learn rocket construction techniques.

We visit local schools and run exhibits on rocketry for their STEM festivals.

We help with rocket building and launches at the annual Rockville Science Day held at the Rockville campus of Montgomery College. NARHAMS runs an exhibit at the annual event and we support their exhibit. They work with 36 elementary students to build Alpha III rockets and launch them in the late afternoon on the athletic field.

# Project Plan

**Timeline**

| Date(s) | Description |
|---|---|
| Aug. 15-Sep. 19 | Develop Preliminary Design and work on Proposal |
| Sep. 19 | Submit Proposal |
| Oct. 4 | Begin working on PDR and ordering parts |
| Oct . 26 | Submit Preliminary Design Review |
| Nov.- Jan. 9 | Build and launch Sub-scale Rocket |
| Jan. 9 | Submit Critical Design Review |
| Jan. - Feb. | Build vehicle and payload |
| Feb. | Vehicle demonstration flight |
| Mar. 6 | Submit Flight Readiness Review |
| Mar. | Payload demonstration flight |
| Apr. 3 | FRR addendum |
| Apr. 12 | Huntsville Launch Week |
| May. 1 | Submit Post-Launch Assessment Review |

**Budget**

| **Item** | **Description (if applicable)** | **Cost (USD)** |
|---|---|---|
| Payload electronics | Microcontrollers, servos, etc. | 100 |
| Payload misc. | Vacuum tubes, Valves, tubes, etc. | 100 |
| Payload bay | Mounting sled, hardware, etc. | 25 |
| Motors | 2 J800T | 250 |

| | | |
|---|---|---|
| Rocket Body Tubes | Four-inch diameter canvas phenolic | 93.95 |
| Nose cone | Wildman 4" 4:1 filament wound fiberglass Von Karman nosecones | 69.00 |
| Motor retainer | AeroPack Motor retainer | 40 |
| Parachutes | Rocketman 6ft Main | 55 |
| Altimeter Bay Kit | MAC Performance 4 in Altimeter Bay Kit | 44.95 |
| Motor casing | AT 54 1280 | 160 |
| motor mount | Phenolic motor mount | 10.65 |
| Centering rings | Plywood centering rings | 9.90 |
| Epoxy | Rocketpoxy 1 cup set | 30 |
| Team travel | paid for by team members family | 0 |
| Other | Building supplies, tools, etc. | 200 |
| **TOTAL** | **TOTAL** | 1188.45 |

**Funding Plan:**

Membership Fees: $2250 ($250/member)
- Donations and contributions ~$400
- Fundraising events ~$400

**Sustainability**

- **Recruitment**
  - The Post enrolls about 40 teens every fall and runs the program through the next summer. Most members are involved for three or four years. This Post has been

active since 1997. We were at Lockheed Martin for 17 years, then spent five years at Johns Hopkins University in Montgomery County, and recently moved to the Rockville Memorial Library and the Science Center storefront. We have had over 500 students participate through the years.

- ○ Meetings and open-houses
- ○ School word-of-mouth marketing
- ○ We utilize the Center's storefront's location to spread the word to foot traffic

- **Funding**
  - ○ Membership fees from new members
  - ○ Grants, donations and contributions
  - ○ Some travel costs may be covered by members and their families
  - ○ Fundraising activities as needed
- **STEM Engagement**
  - ○ The Post supports the Science Center with their camps and classes to foster STEM engagement. We will support and continue these programs.
    - Exhibits at local school STEM nights.
    - Bottle rocket build/launch at local Cub Scout Packs.
    - Rocket build/launch at Rockville Science Day.
    - Model rocketry display at Center.