F.L.A.M.E.

Fire Locator and Arial Monitoring Equipment

Animas High School

NASA Student Launch Preliminary Design Review

High School/Middle School Division

October 28, 2024

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Summary Of PDR Report

Team Summary

- Mailing Address
    - 22 Osprey Way, Durango, CO 81301
    - 90 Florid Place, Durango, CO 81303
- Mentor Contact Info
    - Scot Davis, Adult NAR Mentor, - durangoscot@gmail.com
- Mentor Certifications
    - Scot Davis
        i. TRIPOLI #: 25112
        ii. Certification level: 2
    - Section - Tripoli Southwest Colorado/Durango
- Launch Week Plans
    - Our team is not planning on launching in Huntsville during launch week. We will instead launch locally near Durango, Colorado during the time window between April 5th-May 4th
- Time spent working on the PDR milestone: 50 hours
- Social media handles

Instgram:	@ahsflamerocketry
TikTok	@ahs.rocketry

Launch Vehicle Summary

- Official Target Altitude (ft.): 5,500
- Primary Motor choice: J1799N
- Secondary Motor choice: J401FJ

- Size and Mass:
    - Length: 72.68 In
    - Diameter: 4.08 In
    - Span Diameter: 8.13 In
    - Mass(lbs):
        - Loaded(full rocket): 9.67lb
        - Unloaded(full rocket): 7.23lb
        - Sustainer: 0.14lb
        - Payload section: 0.19 lb
    - Main Parachute:

        - Material: Rip-stop Nylon
        - Diameter: 61in
    - Drogue Parachute
        - Material: Rip-stop Nylon
        - Diameter: 18.5in

Payload Summary

Title: WingBat UAV

Our payload is a plane equipped with an Infrared camera and standard camera for fire monitoring with a focus on identifying moisture content in trees. The plane will be released from the side of the rocket after the main parachute is released and we have RSO clearance. The released plane will unfold and stabilize its flight before starting its autonomous path around the flight area. After stabilizing, the plane will start recording images from both cameras, saving the data to independent SD cards. The plane will land, and the data will be collected and converted into usable information.

Changes Made Since Proposal

Changes Made to Vehicle

Change	Reason	Initial
Apogee altitude: 5,500ft	With modifications to our payload, we can reach a higher altitude. Aiming for a high altitude will give us room if our rocket's mass increases beyond the expected values.	4,000ft
Body tube diameter 4 in	It was deemed not necessary to have the initial diameter body tube(s) with our current payload	6in diameter
Length: 72.6 in	Adjusted to contain payload with more precise measurements	

Changes Made to Payload

Change	Reason	Initial
Payload Deployment after main shute	To ensure that the rocket is safe before releasing another payload. This will also follow NASA SL guidelines.	During ascent

Changes Made to Project Plan

No major changes have been made to our plan or mission. The only small changes are needed to make our project succeed.

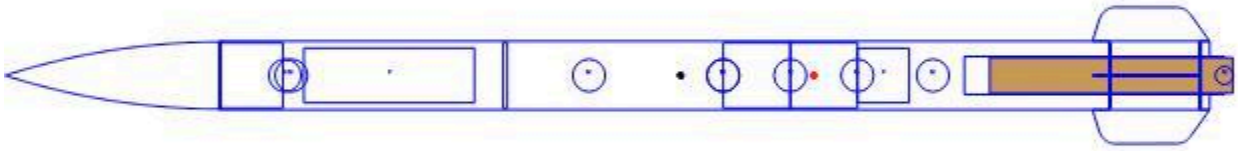
Launch Vehicle

Mission Statement

Our mission is to design, build, and launch a rocket that can carry a working prototype of a wildfire scanning device. The device will scan its surroundings for potential wildfires, demonstrating its potential effectiveness. Our goal is to provide a trial run for technology that could improve early wildfire detection in the future.

Vehicle Design

F.L.A.M.E
Length: 72.6750 In. , Diameter: 4.0800 In. , Span diameter: 8.1311 In.
Mass 4385.223 g , Selected stage mass 4385.223 g
CG: 40.2639 In., CP: 48.1979 In., Margin: 1.98
Engines: [J1799N-0]



Rocket Dimensions:

Length: 72.7in

Body tube Diameter: 4.08

Sustainer length: 25in (fiberglass)

Payload tube length: 34in (fiberglass)
Nose cone length: 12.8in (Ogive shaped)

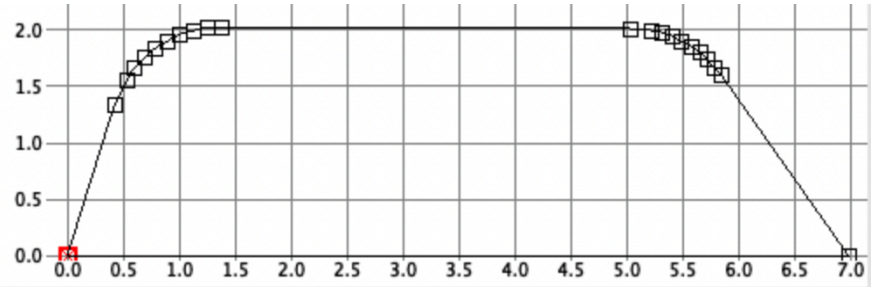
Fin Dimensions:

Fin count: 4 (fiberglass)
Fin thickness: .1181in (3mm)

Root chord: 7in

Tip chord: 3.5in

Semi Span: 2in



Points of separation:

We have two points of separation. One at the coupler for the drogue parachute and the other at the noes cone for the main parachute. More information about the separation is located in the Recovery Subsystem section. We will be using black power as our charges, one located above the rocket motor and the other located above the payload storage compartment.

Leading Alternative Design

Our alternative for this rocket design is a 3.5-inch body tube rocket with a longer body tube. This would make the plane harder to release but decrease the amount of black powder, engine size, and body tube cost.

Motor choices

	J1799N	J401FJ
Total Impulse	1,214.8 Ns	1115.4 Ns
Average thrust	1,963.4 N	408.9N
Peak thrust	2,965.9 N	480.0 N
Initial thrust	1,881.3 N	447.4 N
Total mass	1,111g	1267g
Mass propellant	506g	730g
Burn time	.6sec	2.8 sec

Recovery Subsystems

Recovery Design and Alternatives

We will be using a dual deploy system to safely recover our rocket while staying inside the flight zone.

Drogue parachute

Deploy at:	0.5 sec after apogee	This, according to Rocksim, will place very few gees on our rocket, minimizing any structural issues
Backup Deply at:	1.5 sec after apogee	This is not the optimal time for deployment, but the forces are still within acceptable ranges in our simulations.
Parachute size:	18.5 in Diameter	This parachute is smaller than we would like, but to complete our mission inside the apogee to touch down while releasing our payload at a high enough altitude, it is the largest we can use.
Charge size:	1.2g black powder	Calculated using our rocket simulator
Shock cord length	5ft	Low forces at apogee
kevlar	15ft	This is our current estimate

Main parachute

Deploy at:	750ft	It is as high as we could release the parachute and stay within the 90-second apogee to landing maximum. This should be high enough to release our payload without issue.
Backup Deploy at:	700ft	This backup isn't perfect, but it will still meet all of the guidelines.

Parachute size:	61 in Diameter	Keeps our kinetic energy below the maximum listed in the NASA student launch handbook
Charge size:	1.8g black powder	Calculated using our rocket simulator
Shock cord length	15ft	Higher forces so a long shock cord will be used. This is our current estimate, but will likely be changed
kevlar	25ft	This is our current estimate

Alternative for parachute:

With our system, the only alternative that would lead to success is switching our drogue parachute with a streamer. This would have to be extremely long, and the only benefit is the decrease in the likelihood of tangle. The two parachute methods are what our mentor is most comfortable with, and as we have limited experience with them we will try to avoid this system.

Safety for parachute:

The rocket simulations show kinetic energy just under the maximum of 75 ft-lbs at landing. With sturdy construction, no damage should accrue to the rocket.

Our altimeters are fully disconnected, running separated batteries and black powder igniters. They are both held in the same coupler, which will be designed to handle higher forces than the rest of the rocket contest to force failures on less critical systems.

The payload will not deploy without ground clearance from the RSO and our team's safety officer. Our rocket will not launch without following all pre-launch checklists and approval from the RSO and our team's safety officer. The team safety officer will watch all pre-launch checklists related to activities and ensure proper operation of all components. Pre-launch checklists will be made primarily with safety in mind to ensure that all systems are running.

Batteries for all critical systems will be charged until they are placed into the rocket to ensure full charge. They will also be sized to last 3 hours on the launch pad before launch in an idling state with enough charge remaining to carry out necessary operations.

Success Criteria

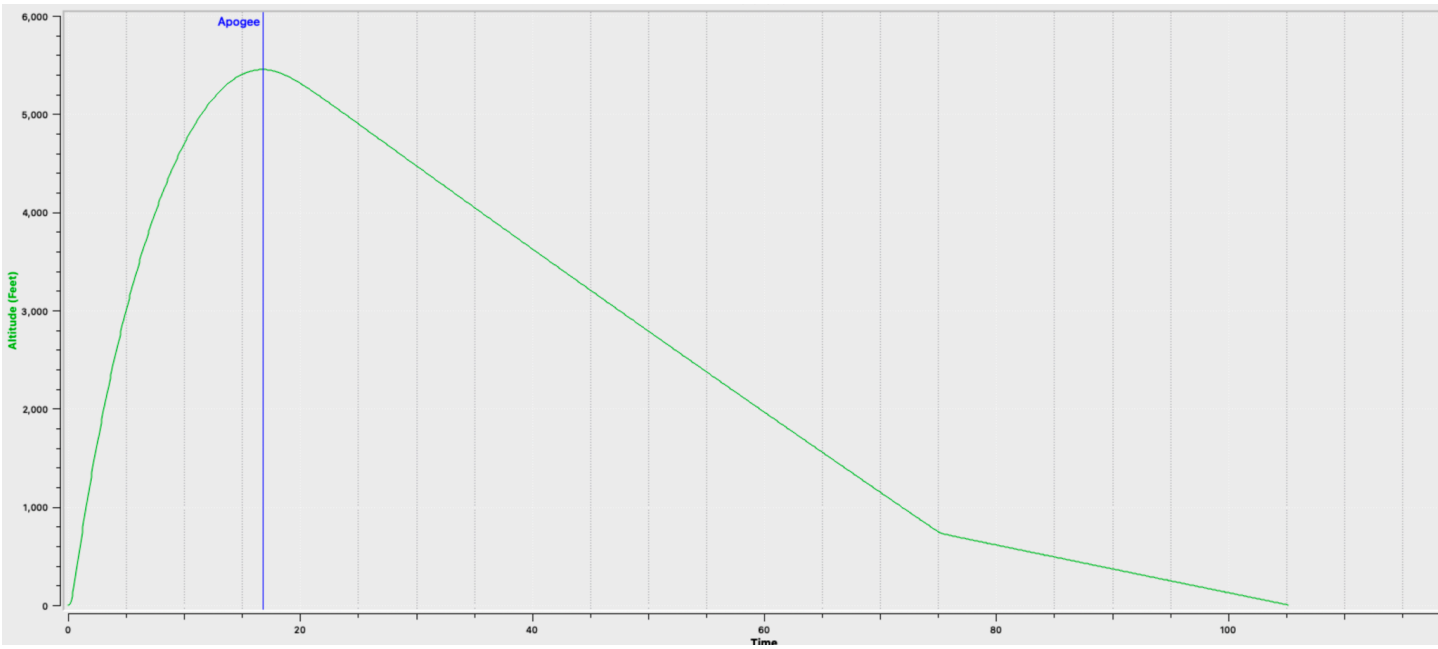
- The plane will achieve autonomous flight, maintaining stable and controlled operation throughout the mission.

- There will be no unwanted structural failures or malfunctions during the flight.
- The onboard wildfire scanning payload will successfully activate, collect data, and operate continuously during the flight.
- The plane will maintain a safe altitude and speed, ensuring optimal coverage of the target area for fire detection.
- The payload will gather environmental data within a specific range of accuracy and transmit the information in real-time to the ground team.
- The plane will safely return to its designated landing zone, meeting all recovery requirements.

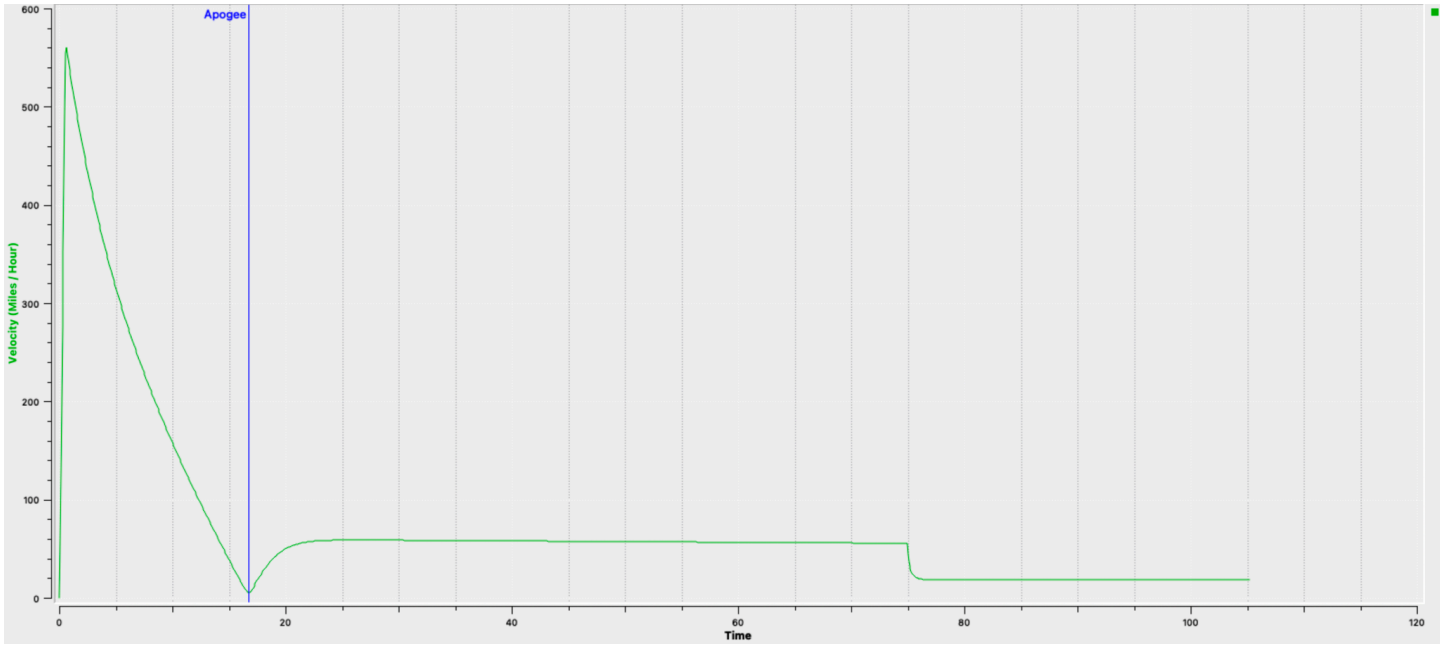
Mission Performance Predictions

Target altitude: 5,500

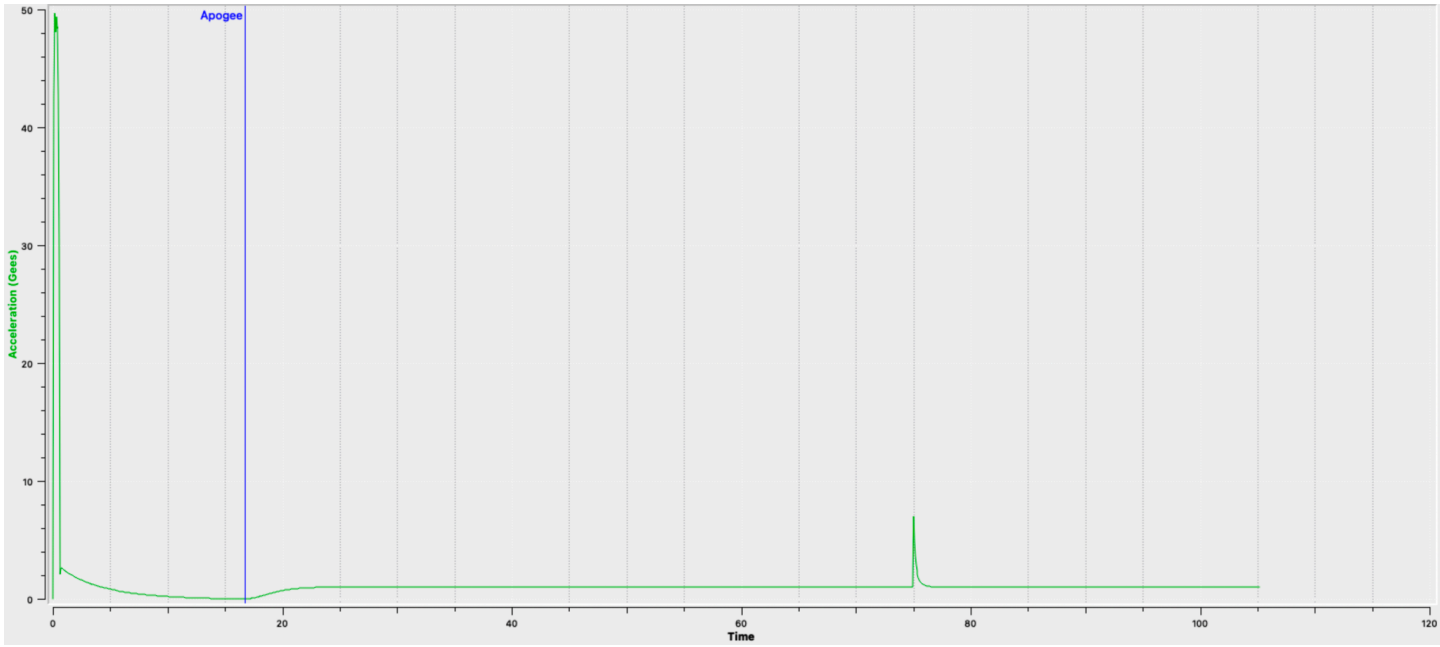
Altitude over time:



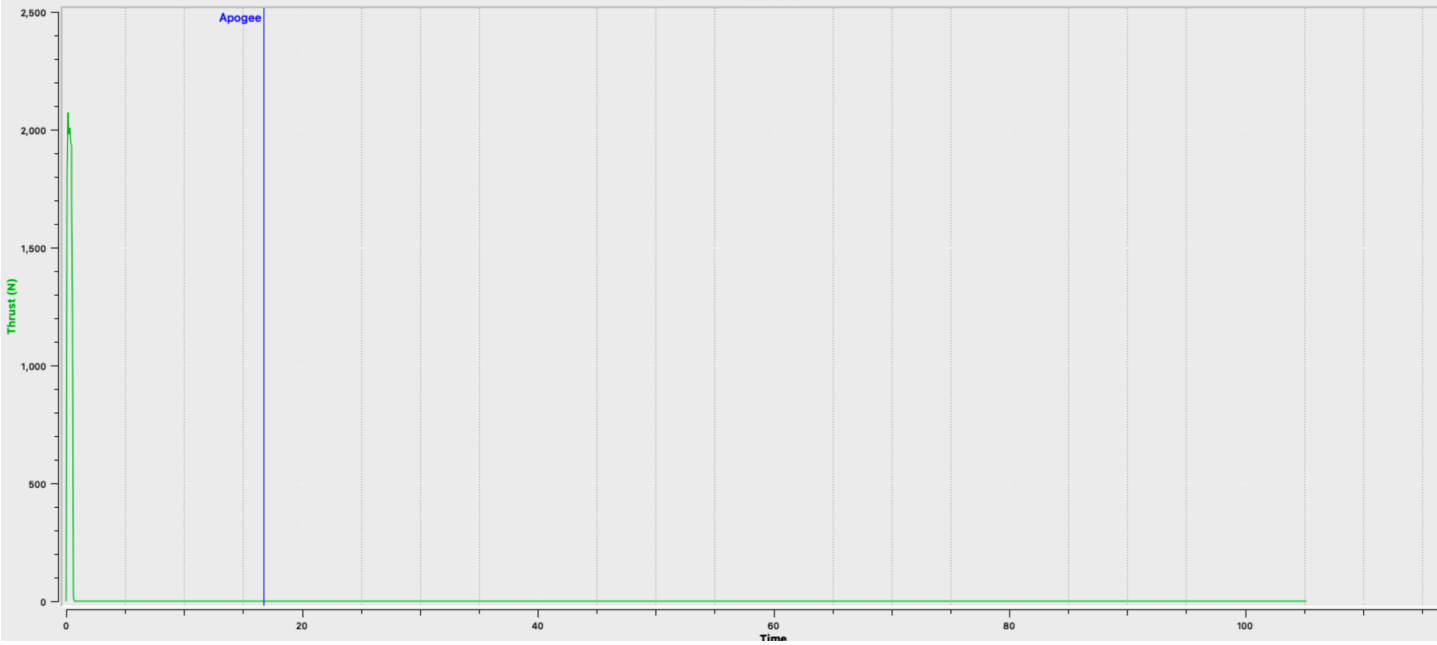
Velocity over time:



Acceleration over time:



Thrust over time:



Stability:
Margin with motor: 2.01
CG: 40.1, CP: 48.2

Time of flight: 107 sec
Time Apogee to landing: 89 sec
Payload flight time: Undecided

Kinetic energy at landing for each part:

Drift of parts:
The drift at 20mph wind speed is 1188ft, according to our simulator.
As this is inside our designated fly zone there is no need to test at other wind speeds we have GPS tracking and will be launching with winds under 20mph. We will run simulations on launch days with current weather conditions to ensure safety and that regulations are followed.

Payload

Objective

- To record inferred images and normal images
- To have a stable, safe, decent
    - Full deployment of a plane
    - Successful autonomous navigation
    - Successful motor start-up
- Landing without damage

Success Criteria:

- Data being intact on landing
- Plane being repairable after landing within 2 hours
- It leaves the rocket and unfolds fully

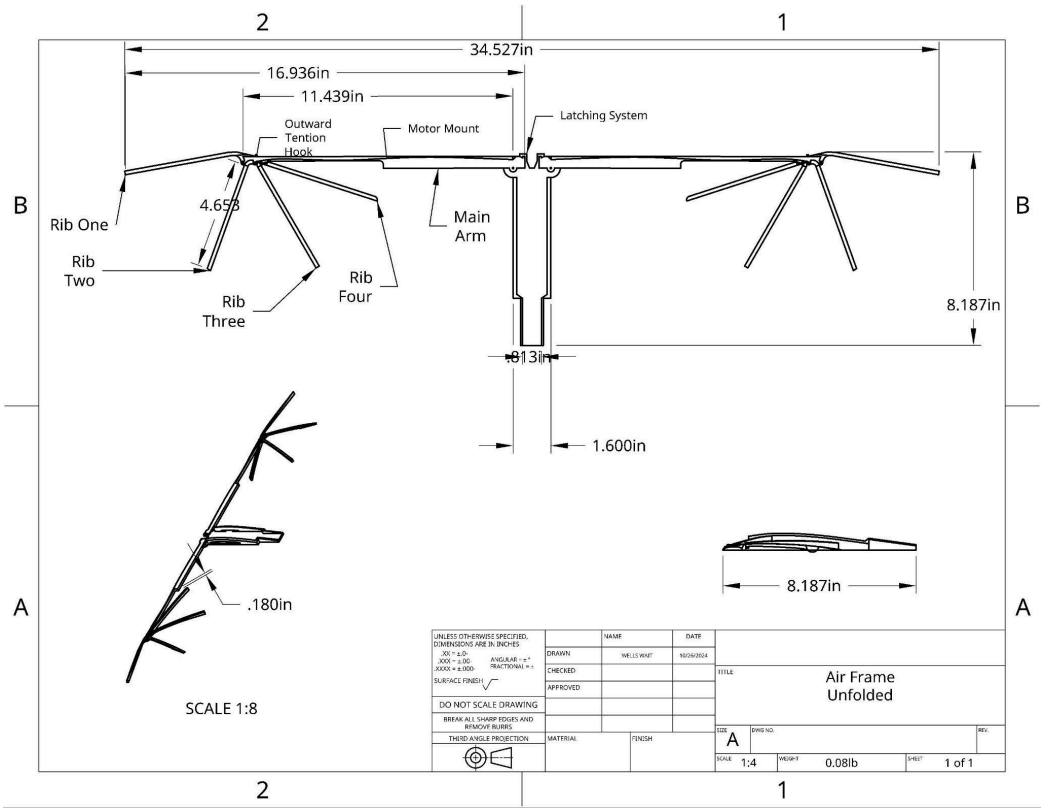
Design

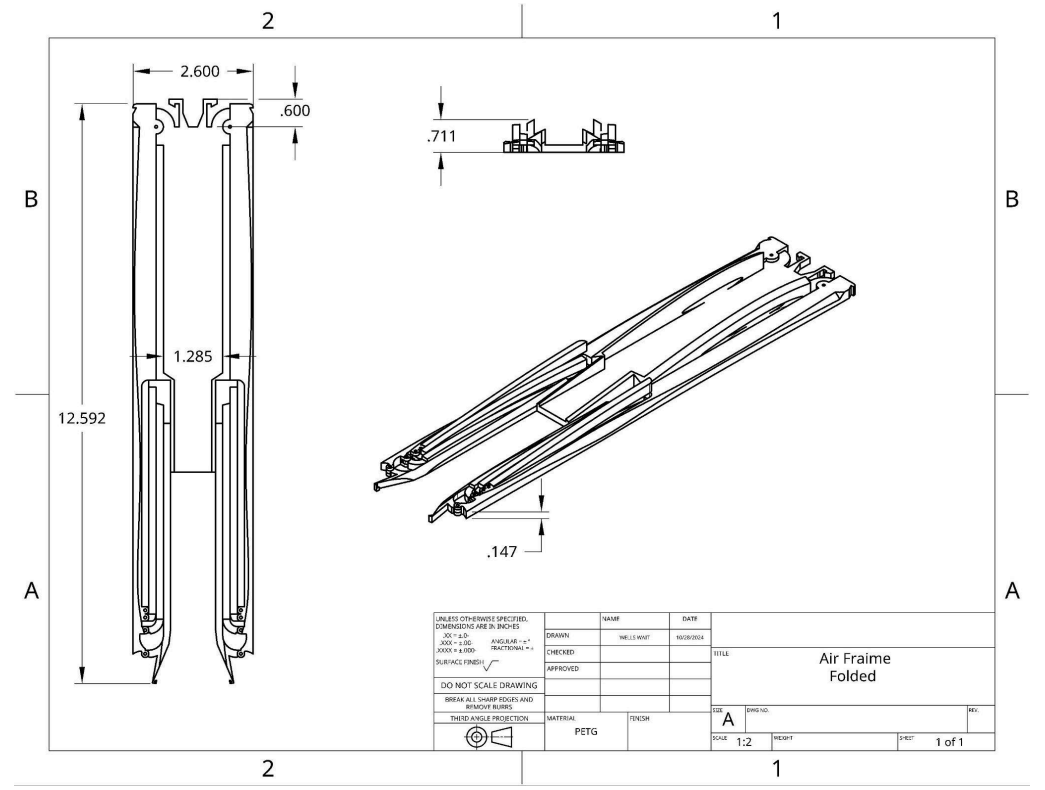
We are using a folding plane for our payload to allow for more positional control over our Infrared images while being power-efficient, unlike most drones.

Mechanical Design

Our wings are mechanically deployed and locked into place as soon as they exit the confines of the rocket. The wing is similar to tube and fabric wings, with a plastic film covering ribs to give the material a wing shape. This wing system allows for the wing to collapse far beyond what a solid wing can manage while still being light.

Payload fig 1





Payload Fig 1 shows the unfolded wing design with some basic measurements. These wings use the tension of the fabric to space ribs two through four to create the desired wing shape. Rib one uses a tension cord to

open, pulling the rest of the ribs out in the process. The tension cord is linked from the Outward Tension Hook to the plane body. When the Main Arm is fully extended, this core is under tension, holding Rib One in its proper location. When not under tension, it allows Rib One to rotate to a folded position, which in turn allows Ribs two through four to fold. In practice, if the main arm is extended, all the rips are extended, and the wing is in its proper airfoil shape. When the main arm is folded, the ribs can be rotated to be parallel with the main body.

Payload Fig 2

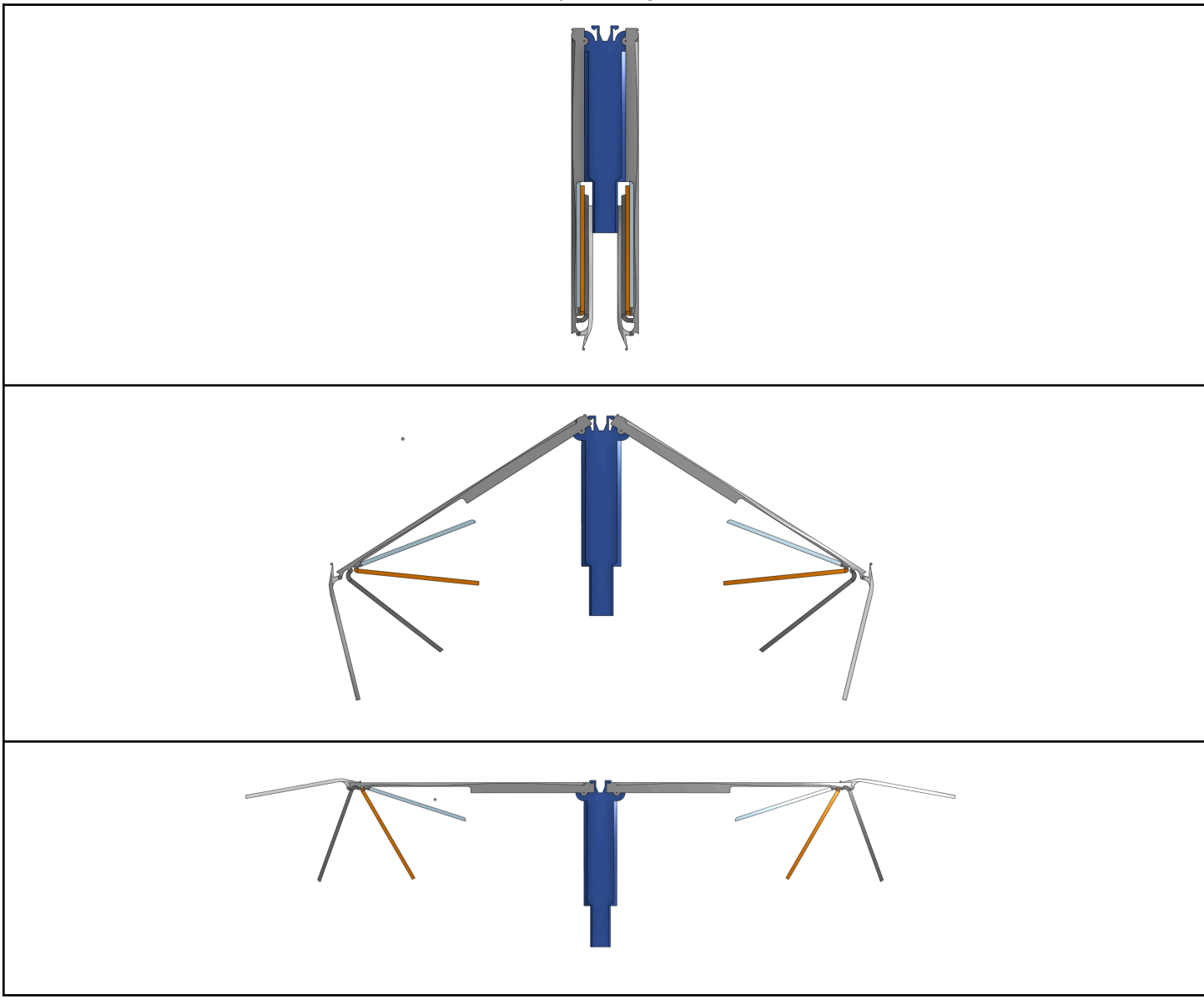
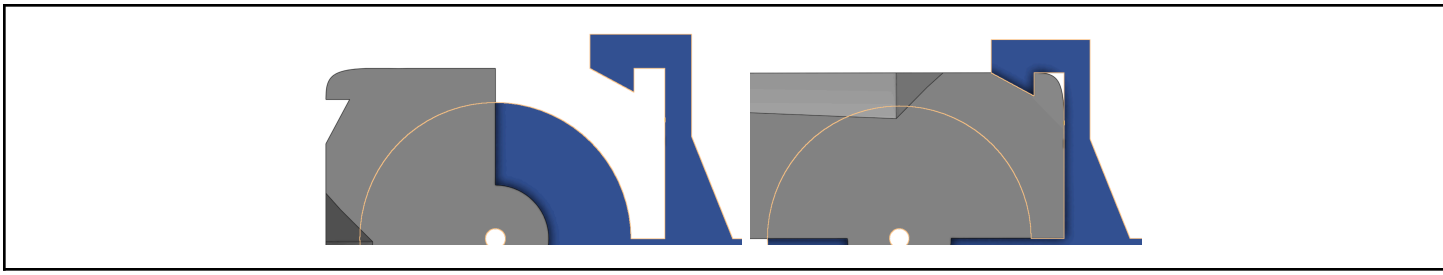


Figure 2 shows how the wings progress through the unfolding process. The Main Arm is pulled out with a tension component and is latched into place, as seen in Figure 3. The tension components' mounting points have not yet been tested, but minimal force is required to latch the main arm into place. There are currently two ideas for how to route the tension component one is of a lever arm on the main arm to a corresponding arm off the plain body near the latching mechanism. This would hinder aro dynamics but would provide plenty of

mechanical advantage. The second idea is to attach the tension component to the section of the Main Arm that is latched onto and connect it below the plains latching mechanism. This method would have less force but would be more durable and more aerodynamic. Work is currently being done to resolve this issue.

Payload fig 3



The latching system will hold out the entire wing and is a critical component of the design. Currently 3d printed in PETG, the arm in blue can handle an angle of up to 45 degrees before permanent deformation. The act of latching pushes the arm in blue to around 10 degrees. As such, the latching of the wing will not damage this critical component. The load on the wing in flight without thrust would pull this blue arm away from the plane. This has not yet been tested to the extreme, but preliminary testing shows admirable strength in this component. Once the brushless motors are on, the latching mechanism should experience no strain. The motors are located on the wings, pulling the Main Arm forward. This, as a result, will cause the gray part of the locking mechanism to push against the plain's stronger arias.

This plane will be using two brushless motors mounted on the wings for thrust. They are located on the wings so that when folded a two-blade prop goes along the length of the plane, not adding much size. We are using two brushless motors to remove the need for flaps. Increasing thrust to various motors gives full staring of the plane as well as control over the amount of lift. If we can’t control the pitch well enough with this system a flap with servo control will be added to the back of the plane fuselage. As the motors are on the Main Arm, a rod to stiffen will be added to ensure the wing is not bent out of shape.

The plain fuselage will be a minimalist body section easily detachable from the wings, just large enough to hold the electrical components. This will be made out of foam and replace the body that is seen in the CAD designs except for the front and a real for the wing material to attach two. The fuselage will be very thin at mack half an inch below the plain wing. The alternative to this design is similar to the wing with fabric or plastic stretched over a frame, but unlike the wing, a resin will be used to stiffen the fuselage.

Electrical Design

This pain will have two microcontrollers. The Main Controller will handle all systems relating to flight and the infrared camera. The second microcontroller is the Camera Controller and its primary job is to handle the saving of the images. The only link between these systems is the GPS which will allow time to sink.

The Main Controller is linked with the below devices

Part	Reason	Communication protocol
Infrared Camera	This will be how we detect ground moisture for fire monitoring	I2C
SD card and Reader	We will be saving all relevant flight data as well as the data from the IR sensor. This will help us refine our system and map IR image locations with GPS credits.	spi
Brushless ESC 2x	These two lightweight ESCs will allow for control over the brushless motors and, thus all steering.	PWM
GY-87	This board has our gyroscope, accelerometer, compass, altimeter, and ambient temperature sensor. And is critical for a stable flight.	I2C
Mercury tilt sensor	This will tell us if the plane is upside down, which the altimeter unfortunately can't do.	Binary
GPS	For our autonomous navigation and time syncing with the camera module.	Serial
Radio using LoRa comunication	This will allow us to kill motors in an emergency as well as track our payload.	Serial

The Camera Controller is linked with the below devices(the plane can fly without this system and will be if overweight)

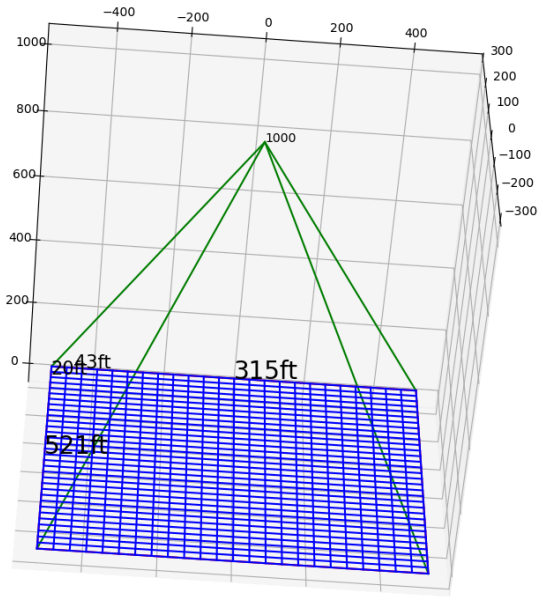
Part	Reason	Communication protocol
Camera	To allow for spatial comparisons with the inferred camera	
GPS(same as for Main Controller)	To time and GPS since the images are from the IR camera and the RGB camera.	Serial

SD card and Reader	We will be saving all relevant flight data as well as the data from the IR sensor. This will help us refine our system and map IR image locations with GPS credits.	spi

IR Camera

Our inferred camera is critical to our mission, which is why we are deploying a plane. As this is a prototype for a bigger system, we are using a lower image resolution camera to test feasibility. The IR camera we selected uses a small field of view of 55 degrees, but as it is being flown around, this will not impact the area of image coverage. The camera has 32X24 pixels, and the second axis field of view is 35 degrees.

Payload fig 4



20ft by 43ft per pixel when at 1000 ft

Area covered: 521ft X 315ft

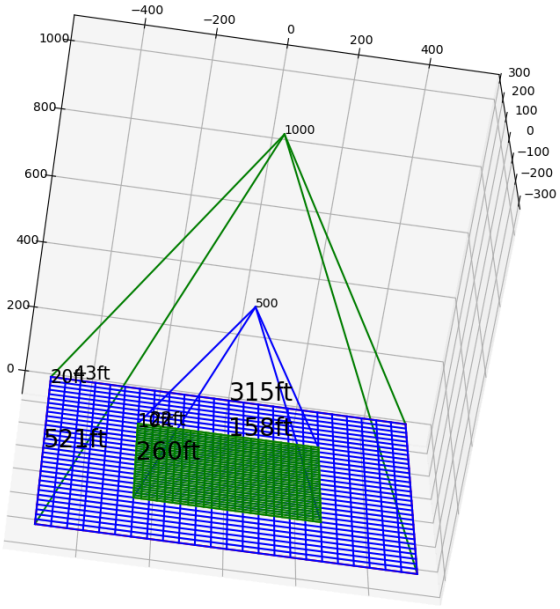
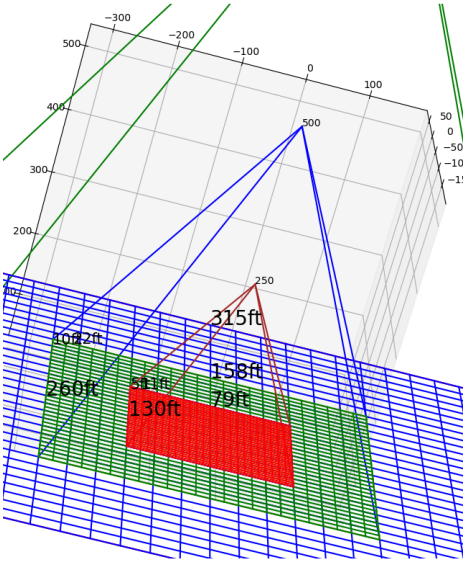
	10ft X 22ft per pixel when at 500ft Area covered: 260ft X 158ft
	5ft X 11ft per pixel at 250ft Aria covered: 130ft X 79ft

Figure 4 is a visualization of how different heights will affect our image quality and area of each image. Currently, we have not decided on what height would be best for image capturing. Currently, we are planning on flying between 400 and 500 feet as this is a probable height at which we will be releasing our payload. Adding a rotating camera to this plane would be a good idea for future designs to limit flying distance but for this model, we will keep the camera most likely mounting it straight down. The alternative mounting is off one side of the plane to allow for one circle of flight aria to scan outside the flight area.

Flight Control Software

There are several elements to this part of the system, such as guidance, controlled flight, and data recording. Currently, this is still in the planning stage, as it is heavily dependent on how the plane performs and the GPS unit accuracy.

Payload fig 5

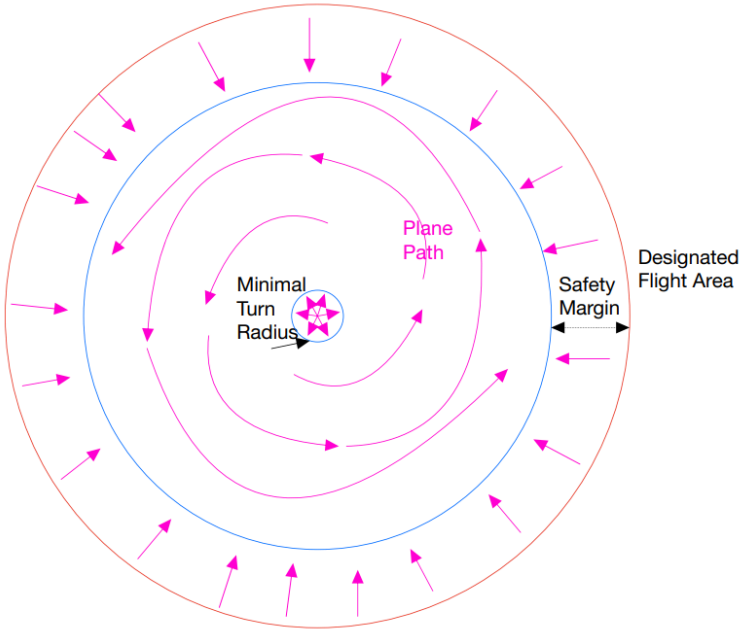


Figure 5 shows the version of the flight path we would use. A simple spiraling flight path out from the center. The cons of this method are that there would be a central region based on the turn radius, not included in the path, and as the flight path is not a loop, if the plane is released away from the center, it would miss a large region as there is no reason to go back toward the center. This problem can be resolved by checking if near the outside and flying inward.

Payload fig 6

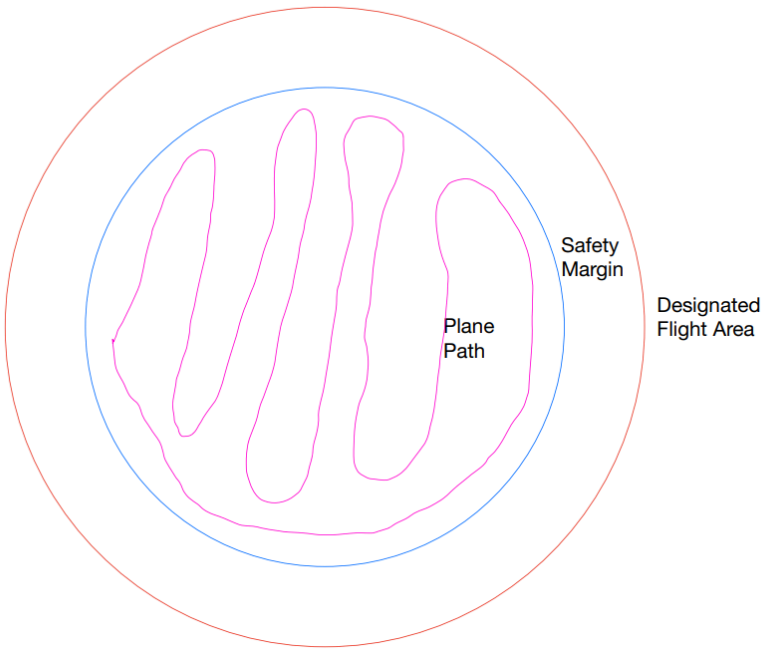


Fig 6 shows another flight path. This is simply a systematic grid-style flight path with a loop around the perimeter to create a full loop. This would allow the plane to cover the entire area of the flight zone given enough time. The con of this style of the light path is that if the plane gets off course it would have to do a 180-degree turn to match the new flight path.

Both fig 5 and 6 use a system where each coordinate is assigned a direction. This could be done with a series of if commands and math equations. This would be computationally efficient and simple to implement. The other type of autonomous system would look at the areas it has been in and attempt to avoid them. This is

computationally intensive as it has to store all GPS coordinates in RAM and scroll through them each second multiple times. Part of this can be solved by using arrays with indexes of GPS coordinates but the other method is generally better.

Flight logic to keep the plane stable will be based on the Gyroscope. The GPS navigation system will add a bias to the angle of the wings to enact steering based on the desired location. This will keep the plane's stability a foremost priority to ensure a safe flight. This program will be dependent on how responsive the plane is and thus there is not much information that can be given.

Recovery Design and Alternatives

The payload, once released from the rocket, will use the lift generated by two wings to maintain a slow descent. It will be designed to glide if powered flight fails, but under standard operation, two brushless motors will control and power flight through differential thrust.

If at all possible, the plane will have a small backup parachute in case of critical error and assist in landing. This would be deployed at the back of the plane, away from the two propellers.

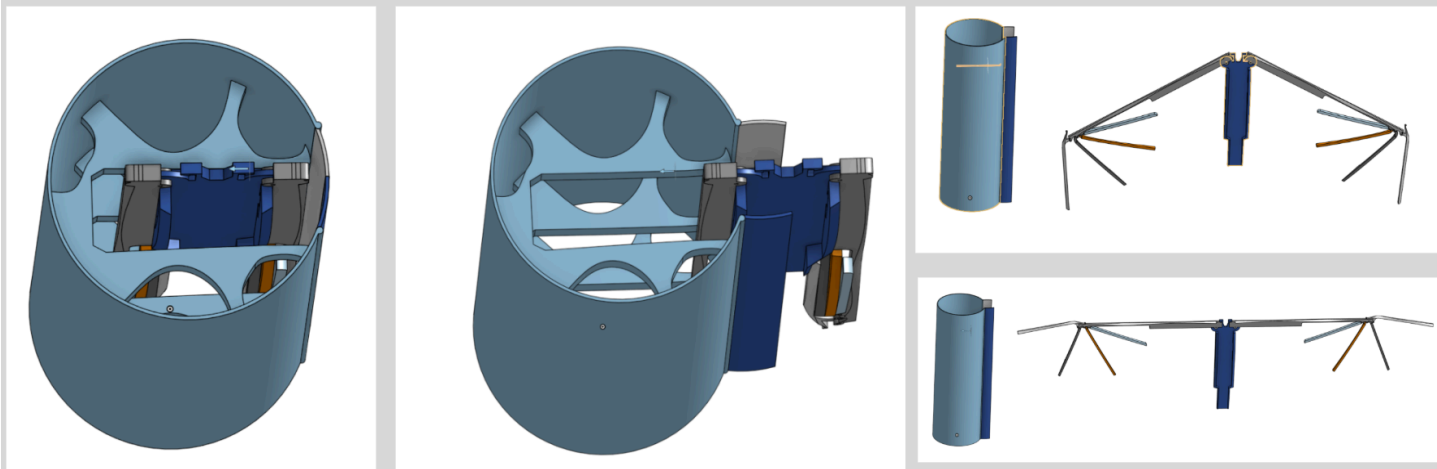
Alternatives:

Most of the subsystems of our payloads have alternative designs except for the plane. At this point, we will have a plan to carry out our scientific mission but we do have some alternative designs.

Design	Pro	Con
Rotating folding Wing	Simple and reliable	Smaller wings will take up more room in the rocket possibly requiring a larger body tube.
Non-differential thrust	More standard and would be able to steer without forward thrust	This would involve adding more rotating parts and servos. These are fragile during deployment
Delta wing high speed decent with flap contra	No motors and minimal wings with a parachute for safe landing	This will be moving too fast to get good images and if a failed parachute is released it is a dart-like object.

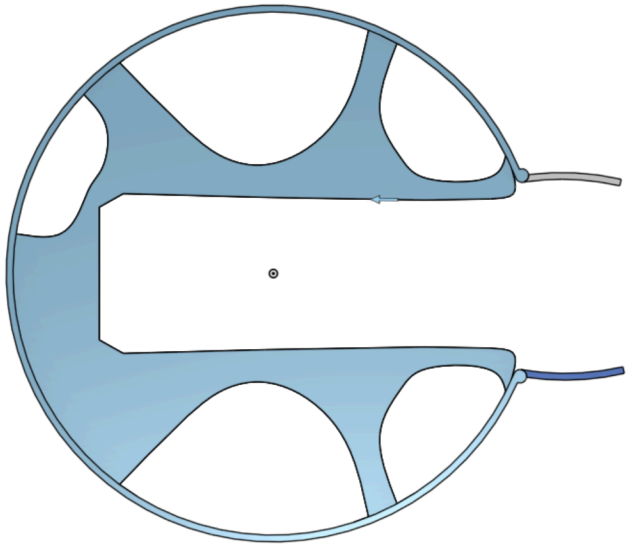
Payload Release

Hatch Release:



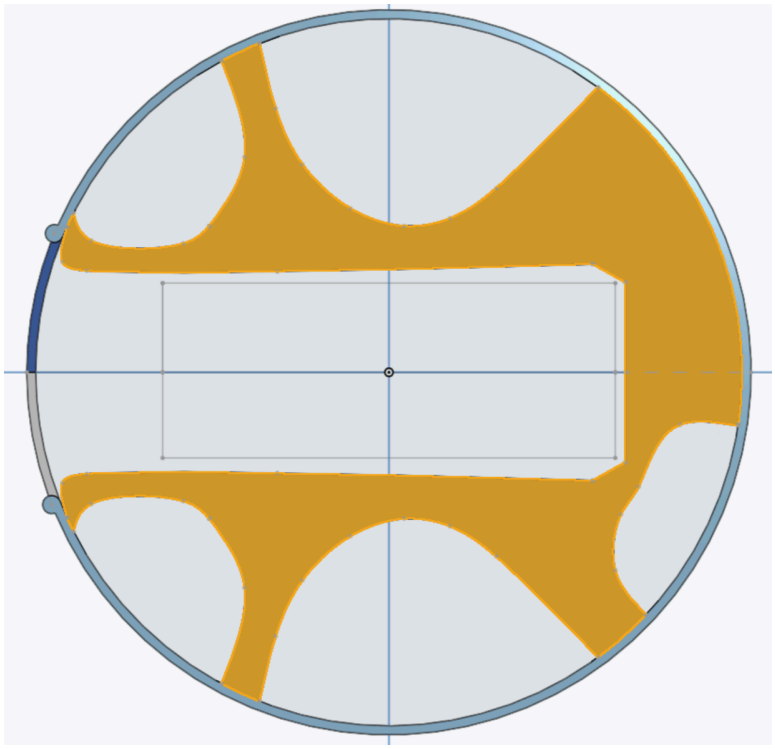
We will use a double-door hatch system to hold the plane inside the rocket. The doors will be latched on the top and bottom by a crossbar controlled by two servos. An alternative to this is a hatch that is pushed off the rocket with a tether to prevent dropping without a parachute.

Slingshot launcher:



We will be using a slingshot-style launcher for our payload to get our plane away from the rocket and its parachute. The elastic material will be stretched across the opening of the rocket to ensure the plane can't get stuck on anything. The plane, when slotted in, will tension the elastic material, so when the double door opens, it is flung out of our rocket path. Alternatives to this system include a gravity-dropping system, which would Raleigh on the proper orientation of the rocket during descent, or using compressed air but ensuring the safety of pressurized containers during increases in altitude would be difficult.

Internal Frame



The internal frame in orange ensures that the plane maintains proper positioning during the rocket launch and payload release. There is also a bulkhead at the bottom of the payload release chamber to keep the payload from moving during the initial gee forces of launch. An alternative to this is a rail system that the payload slides along during release. This would get in the way of the elastic material but could help the plane recover from getting launched from the rocket.

Safety

FMEA Key

Rating	Severity
1	No effect
2	Moderate environmental Impact

3	Mild damage to components
4	Moderate Damage to components
5	Severe damage to components
6	Superficial Injuries
7	Short-term mild injury
8	Short-term moderate injury
9	Short-term severe injury
10	Long term injury

Preliminary Personnel Hazard Analysis

NAR Saftey Code

NAR Saftey Code	Team Compliance
Certification. I will only fly high-power rockets or possess high-power rocket motors that are within the scope of my user certification and required licensing.	We comply that our L1 certified team members and only those team members are permitted to handle/pack motors of H and I class. We also comply that Scott Davis our mentor and only Scott will handle/pack motors above that of which an L1 Certification allows
Materials. I will use only lightweight materials such as paper, wood, rubber, plastic, fiberglass, or when necessary ductile metal, for the construction of my	We comply that all engineering teams will only select appropriate materials for the construction of our

rocket.	rocket while keeping in mind weight and structural integrity.
Motors. I will use only certified, commercially made rocket motors, and will not tamper with these motors or use them for any purposes except those recommended by the manufacturer. I will not allow smoking, open flames, nor heat sources within 25 feet of these motors.	Our team will only utilize motors purchased from sources trusted by our mentor, Scott. These motors will only be stored by Scott. All team members are aware of the proper safety measures involved with motor usage.
Ignition System. I will launch my rockets with an electrical launch system, and with electrical motor igniters that are installed in the motor only after my rocket is at the launch pad or in a designated prepping area. My launch system will have a safety interlock that is in series with the launch switch that is not installed until my rocket is ready for launch, and will use a launch switch that returns to the “off” position when released. The function of onboard energetics and firing circuits will be inhibited except when my rocket is in the launching position.	All launches will be performed at official events, always with an acting safety officer. The Safety Officer will ensure that electrical motor igniters are installed properly. Along with this, our team understands that we have to install a safety interlock that is in series with the launch switch. We also comply with using a launch switch that returns to the off position after release and that energetics and firing circuits will be inhibited except when the rocket is in the launching position.
Misfires. If my rocket does not launch when I press the button of my electrical launch system, I will remove the launcher’s safety interlock or disconnect its battery, and will wait 60 seconds after the last launch attempt before allowing anyone to approach the rocket.	Our team complies with having a knowledge of proper safety measures to take if a misfire occurs. This includes the role of our safety officer to remind us of the safety measures before the countdown.
Launch Safety. I will use a 5-second countdown before launch. I will ensure that a means is available to warn participants and spectators in the event of a	We comply with the launching procedure outlined, including ensuring the stability of our rocket before

problem. I will ensure that no person is closer to the launch pad than allowed by the accompanying Minimum Distance Table. When arming onboard energetics and firing circuits I will ensure that no person is at the pad except safety personnel and those required for arming and disarming operations. I will check the stability of my rocket before flight and will not fly it if it cannot be determined to be stable. When conducting a simultaneous launch of more than one high power rocket I will observe the additional requirements of NFPA 1127.	launch, and ensuring that any event participants and spectators are not closer than the Minimum Distance Table is to the launch pad. We also understand that only the safety officer and 2 trained team members, one from the rocket subteam, and one from the payload subteam, will approach the launch pad in order to arm the rocket.
Launcher. I will launch my rocket from a stable device that provides rigid guidance until the rocket has attained a speed that ensures a stable flight, and that is pointed to within 20 degrees of vertical. If the wind speed exceeds 5 miles per hour I will use a launcher length that permits the rocket to attain a safe velocity before separation from the launcher. I will use a blast deflector to prevent the motor's exhaust from hitting the ground. I will ensure that dry grass is cleared around each launch pad in accordance with the accompanying Minimum Distance table, and will increase this distance by a factor of 1.5 and clear that area of all combustible material if the rocket motor being launched uses titanium sponge in the propellant.	Our team complies with using a reliable and sturdy launcher that allows our rocket to reach stable flight speeds, accounting for winds. We comply with the outlined safety measures involving the launcher.
Size. My rocket will not contain any combination of motors that total more than 40,960 N-sec (9208 pound-seconds) of total impulse. My 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.	Our team will follow these rules using our chosen motor, J1799. This motor has a total impulse of 1,214.8 Ns, which adheres to this constriction. Our rocket's current weight is 8.3 pounds which also adheres to this rule.
Flight Safety. I will not launch my rocket at targets, into clouds, near airplanes, nor on trajectories that take it directly over the heads of spectators or beyond	Launch sites with have confirmed conformations with the FAA, and a weather assessment will be done by

the boundaries of the launch site, and will not put any flammable or explosive payload in my rocket. I will not launch my rockets if wind speeds exceed 20 miles per hour. I will comply with Federal Aviation Administration airspace regulations when flying, and will ensure that my rocket will not exceed any applicable altitude limit in effect at that launch site.	the team and mentor. Our team complies with the rules outlined to ensure proper flight safety of others,
Launch Site. I will launch my rocket outdoors, in an open area where trees, power lines, occupied buildings, and persons not involved in the launch do not present a hazard, and that is at least as large on its smallest dimension as one-half of the maximum altitude to which rockets are allowed to be flown at that site or 1500 feet, whichever is greater, or 100 feet for rockets with a combined total impulse of less than 160 N-sec, a total liftoff weight of less than 1500 grams, and a maximum expected altitude of less than 610 meters (2000 feet).	Our team will only launch at designated launch sites that are approved by the FAA, and proper calculations with be done to ensure our rocket performs under these restrictions.
Launcher Location. My launcher will be 1500 feet from any occupied building or from any public highway on which traffic flow exceeds 10 vehicles per hour, not including traffic flow related to the launch. It will also be no closer than the appropriate Minimum Personnel Distance from the accompanying table from any boundary of the launch site, **100 ft.**	Launch locations are chosen in consideration of this code and will follow all safety measures, enforced by an onsite Safety Officer.
Recovery System. I will use a recovery system such as a parachute in my rocket so that all parts of my rocket return safely and undamaged and can be flown again, and I will use only flame-resistant or fireproof recovery system wadding in my rocket.	Our rocket consists of two parachutes in order to achieve a safe and efficient landing that returns all parts back to the team. Our team makes use of Kevlar clothes for fire-resistant wadding in our rocket.
Recovery Safety. I will not attempt to recover my rocket from power lines, tall trees, or other dangerous	Our team complies to not attempt to recover our rocket

places, fly it under conditions where it is likely to recover in spectator areas or outside the launch site, nor attempt to catch it as it approaches the ground.	from any high or dangerous place it lands. Our team will do our best to prevent this by taking proper precautions when launching.

General workplace rules team members will follow:

1. Wear Personal Protective Equipment (PPE)\
2. Maintain a Clean Workspace
3. Use Tools Properly and Carefully
4. Work in a Well-Ventilated Area
5. Inspect Materials and Equipment
6. Avoid Working Alone
7. Practice Proper Lifting Techniques
8. Keep Flammable Materials Away from Heat Sources
9. Label and Store Hazardous Materials Safely
10. Wash Hands Frequently
11. Stay Focused and Take Breaks
12. Have a First-Aid Kit and Emergency Plan

FMEA

Hazard Analysis: Construction

Hazard	Cause	Effect	Lik	Sev	Mitigation
Exposure to harmful fumes	Epoxy resin, super glue, 3D printing filaments, spray paint, soldering.	Irritation of eyes, skin, and/or lungs, allergic reactions, headache, nausea, dizziness.	2	6-8	Work in a well-ventilated area; use a mask if needed
Harmful chemical contact on skin	Working with epoxy/adhesives, paint,	Irritation of skin and/or eyes, chemical burns, allergic reaction.	4	7	Wear gloves and protective eyewear; have a first-aid kit readily

	batteries, solid rocket propellant.				available
Lacerations	Working with fiberglass, fiberglass fabric, drills, drill press, miter saw, dremel, hand sander.	Cuts, splinters, loss of limb extremities, abrasion to skin, infection.	2	6-10	Use gloves, handle sharp tools carefully, and keep the first-aid kit accessible
Exposure to electricity	Misuse or damage of batteries or wires	Shocks, burns, equipment damage	4	6	Use insulated tools; inspect wires before use; turn off power when not needed
Common workplace accidents	Not clean/ organized workplace	Sliping, tripping, dropping heavy materials	7	7	Keep workspace clean and organized; clean up spills immediately

Hazard Analysis: Components - Rocket

Parts	Hazard	Causes	Effects	Lik	Sev	Mitigation
Sustainer	Structural Failure	High stress during flight	Loss of control, rocket crash	1	5	Conduct stress tests and use high-quality materials
Electronics Bay Coupler	Electrical shock	Improper handling of power connections	Burn damage	7	4	Use insulated tools, follow proper wiring protocols

Nose Cone	Impact injury	Detachment during launch or landing	Injury to nearby personnel	2	3	Secure attachment, verify connections
Motor Mount	Fire hazard	Motor overheating or ignition issues	Fire, total rocket failure,	2	5	Use fire-resistant materials, and inspect the motor for faults
Motor	Fire hazard	Accidental ignition, motor meltdown	Fire damage to workplace, rocket, personnel	4	6	Ensure proper storage of motor
Drogue Parachute	Deployment failure	Tangling, packing error, mechanical malfunction	High descent speed, damage to the rocket	3	5	Pack carefully, use high-quality materials
Main Parachute	Deployment failure	Tangling, packing error, mechanical malfunction	High descent speed, damage to rocket	3	5	Conduct deployment tests, ensure secure packing
Fins (in flight)	Structural damage	Impact with debris or ground	Altered trajectory, loss of stability, rocket failure	1	5	Use durable materials, inspect for cracks, and ensure proper transportation of the rocket
Fins (on landing)	Structural damage	Abrupted impact with the ground	Un-flyable rocket	4	5	Use durable materials, inspect for cracks, and ensure proper transportation of the rocket
Payload	Pressure	Overheating	Risk of rupture,	1	4	Ensure proper

Body Tube	build-up	or improper venting	potential injury			venting, monitor temperature
Parachute Release Charges	Chemical Burns	Handling explosive charges	Burns to hands, risk of fire	2	8	Wear gloves and eye protection, handle carefully
Shock Cords	Tension snap	Excessive tension during deployment	Potential injury or damage to components	3	4	Use high-tensile materials, test under load
Eye-bolts	Structural failure	Excessive force on attachment points	Loss of attached components, possible injury	2	4	Use rated hardware, test under expected loads
GPS	Signal loss	Insufficient power, poor antenna placement	Loss of tracking data	4	3	Ensure full battery, position antenna properly

Hazard Analysis: Components - Payload

Parts	Hazard	Causes	Effects	Lik	Sev	Mitigation
Inner electronics	Short circuits	Exposure to moisture, incorrect wiring, and impact	Malfunction, UAV control failure, information link disconnection	2	5	Use moisture resistant enclosures, inspect wiring frequently, and after each test
Brushless motors	Overheating	Extended use	Reduced motor lifespan, risk of failure	3	4	Avoid extended high-thrust operation

Propellers	Breaking, deforming, chipping	Impact with objects or wear, most likely when testing	Loss of thrust and instability	9	3	Inspect propellers for deformations or cracks before and after each flight test
Main arms	Structural failure	High stress on wings from impact, flight, and/or rough handling	Loss of control, potential crash	6	4	Test wing stress tolerance. Inspect for damage before and after each test flight
Ribs	Warping or deformation	Environmental exposures, impacts	Reduced lift, aerodynamic instability	2	3	Conduct tests modeling environmental impacts, test for durability
Main body	Structural damage	Rough handling, impacts	Compromised payload integrity, increased drag	4	3	Use impact-resistant materials; secure during transportation
Latching system	Structural damage, deformation	Flight test impacts, improper unlatching	Unstable wings resulting in unstable flight	6	4	Refrain from bending plastic past 45° to prevent plastic deformation

Hazard Analysis: Project Impact On the Environment

Hazards	Causes	Effects	Lik	Sev	Mitigation
Soil contaminations	Chemical spills from propellants or adhesives	Pollution of soil and potential harm to wildlife	7	2	Use spill trays; dispose of chemicals properly; train team in spill response

Air pollution	Emissions from rocket launch or exhaust fumes	Release of pollutants, potential respiratory harm	10	2	Limit launch frequency
Rocket debris	Detached parts during flight or failed recovery	Litter, potential harm to wildlife and the environment	5	2	Ensure all rocket parts are recovered after launch
Wildlife disturbance	The presence of people, loud noises, or smoke	Stress or harm to local wildlife	8	2	Select remote launch sites; limit foot traffic; avoid sensitive habitats
Water pollution	Rocket debris or accidental chemical runoff into water	Contamination of water bodies	1	2	Keep the launch site clear of nearby water sources; ensure proper waste disposal
Fire hazard	Use of flammable materials near dry vegetation	Wildfire risk	7	10	Clear launch area of vegetation; monitor weather conditions; have fire precautionary equipment ready
Erosion and soil compaction	Frequent activity at the launch site	Damage to vegetation, habitat degradation	9	2	Use defined paths; limit heavy foot traffic; minimize area usage, avoid stepping on cryptobiotic soil crust
Hazardous waste	Disposal of batteries, e-waste, or chemical	Environmental contamination	3	2	Follow local hazardous waste disposal regulations;

	residues				recycle electronics responsibly

Hazard Analysis: Environment Impact On Project

Hazards	Causes	Effects	Lik	Severity to project	Mitigation
Wind	High winds during launch or recovery	Difficulty estimating vehicle trajectory; risk of drift or crash	7	Medium	Monitor weather conditions; delay launches if winds exceed safe limits
Rain	Precipitation during launch or recovery	Damage to electronics	6	High	Use waterproof enclosures for sensitive components; reschedule launches if heavy rain is forecasted
Extreme Temperatures	High heat or cold during operation	Potential failure of materials or components	8	Medium	Test components at expected temperature ranges; insulate sensitive areas
Lightning	Launching during thunderstorms	Risk of electrical damage, safety hazards	2	Medium	Monitor local forecasts; establish lightning safety protocols, including

					delays

Hazard Analysis: Risks to Project

Hazards	Causes	Effects	Lik	Severity to project	Mitigation
Time overrun	Delays in component delivery, testing failures, or team availability	Missed milestones, reduced testing time	6	Medium	Set realistic timelines; establish contingency plans; track progress weekly
Budget overrun	Unexpected costs in materials, travel, or repairs	Reduced funds for later project stages	3	High	Create detailed budget forecasts; prioritize spending; maintain a buffer
Resource shortage	Limited access to required tools, materials, or skilled team members	Delayed or limited project capabilities	2	Medium	Identify key resources early; secure backup suppliers; cross-train team members
Scope creep	Expanding project goals beyond the initial scope	Overuse of time and budget, dilution of core objectives	7	Medium	Clearly define project scope; document any changes and their impacts
Functionality risk	Malfunctioning or incomplete components	Reduced system performance, increased test failures	10	Low	Conduct component testing upon receipt; have backup options ready
Technical	Design or	Increased	10	Low	Break down

complexity	integration challenges	time in development, possible redesigns			tasks; assign skilled team members; seek guidance if necessary
Safety risks	Lack of adherence to safety protocols or unexpected hazards	Potential injury, loss of credibility	7	High	Strict adherence to safety protocols; conduct safety training; regular safety audits
Testing failures	Unexpected issues in the testing phases	Need for redesign, additional materials, delays	10	Low	Plan multiple testing rounds; troubleshoot and document each failure; allocate extra testing time
Communication issues	Poor communication within the team or with mentors	Misalignment of tasks, duplicated efforts, or missed details	10	Medium	Schedule regular meetings; use collaborative tools; ensure clear documentation
Regulatory compliance	Failure to meet NASA or local guidelines	Project suspension, penalties	2	Very High	Review and follow all regulatory guidelines; consult with advisors as needed
Data loss	Software failure	Loss of critical data, delay in analysis	4	High	Regularly back up data; use cloud storage; create physical backups if possible
Launch permissions	Delays in securing permits for launch	Inability to conduct launch, timeline impact	2	High	Apply for permits early; establish relationships with regulatory authorities

Team fatigue	High workload leading to burnout or fatigue	Reduced productivity, risk of errors	9	Medium	Encourage balanced workloads; allow breaks; monitor for signs of burnout

MSDS Data Sheets

Epoxy Resin

SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT IDENTIFIER: WEST SYSTEM® 105 Epoxy Resin
APPLICABLE PRODUCT CODES: 105, 105-A, 105-B, 105-C, 105-E, C 105-A, C 105-B, C 105-C, C 105-E
CHEMICAL FAMILY: Epoxy resin mixture.
INTENDED PRODUCT USES: Resin for coatings or adhesives.
PRODUCT USE RESTRICTIONS: None identified.
SDS VERSION: 105-2022a

MANUFACTURER:
Gougeon Brothers, Inc.
100 Patterson Ave.
Bay City, MI 48706, U.S.A.
Phone: 866-937-8797 or 989-684-7286
www.westsystem.com

EMERGENCY TELEPHONE NUMBERS (24 HRS):
Transportation
CHEMTREC: 800-424-9300 (U.S.)
703-527-3887 (International)
Non-transportation
Poison Hotline: 800-222-1222

2. HAZARDS IDENTIFICATION

Classification of Substance or Mixture

Skin corrosion/irritation, Category 2
Skin sensitizer, Category 1
Eye damage/irritation, Category 2A
Chronic aquatic toxicity, Category 2

Label Elements

Hazard Pictogram(s):

Signal Word
WARNING

Hazard Statements
H315 Causes skin irritation.
H317 May cause an allergic skin reaction.
H319 Causes serious eye irritation.
H411 Toxic to aquatic life with long lasting effects.

Precautionary Statements
Prevention
P261 Avoid breathing dust/fume/gas/mist/vapors/spray.
P264 Wash hands thoroughly after handling.
P272 Contaminated work clothing should not be allowed out of the workplace.
P273 Avoid release to the environment.
P 280 Wear protective gloves/protective clothing/eye protection.
Response
P302 + P352 IF ON SKIN: Wash with plenty of soap and water.
P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P333 + P313 If skin irritation or rash occurs: Get medical attention/advice.
P337 + P313 If eye irritation persists: Get medical attention/advice.
P362 + P364 Take off contaminated clothing and wash it before re-use.
P391 Collect spillage.
Disposal
P501 Dispose of contents/container in accordance with local, regional and international regulations.

Other Hazards Not Resulting In Classification
None known.

3. COMPOSITION/INFORMATION ON HAZARDOUS INGREDIENTS

INGREDIENT NAME	CAS #	CONCENTRATION (%)
Propane, 2,2-bis[p-(2,3-epoxypropoxy)phenyl]-, polymers	25085-99-8	60-80
Benzyl alcohol	100-51-6	10-30

Last Revised: 03JAN22

Phenol-formaldehyde polymer glycidyl ether	28064-14-4	5-10

The exact chemical identity and/or exact percentage (concentration) of each ingredient may be held as confidential business information (CBI). Any ingredient not disclosed in this section may have been determined not to be hazardous to health or the environment, or it may be present at a level below its disclosure threshold.

4. FIRST AID MEASURES

FIRST AID FOR EYES..... SYMPTOMS: Causes serious irritation and redness. RESPONSE: Flush immediately with water for at least 15 minutes. Remove contact lenses if present and easy to do. Consult a physician as precautionary measure.

FIRST AID FOR SKIN..... SYMPTOMS: Causes skin irritation. May cause allergic skin reaction and sensitization. RESPONSE: Remove contaminated clothing. Wipe excess from skin. Apply waterless skin cleaner and then wash with soap and water. Consult a physician if effects occur.

FIRST AID FOR INHALATION..... SYMPTOMS: Not a likely route of exposure under normal conditions of use. RESPONSE: Remove to fresh air if respiratory irritation occurs and keep comfortable for breathing.

FIRST AID FOR INGESTION..... SYMPTOMS: No acute adverse health effects expected from amounts ingested under normal conditions of use. RESPONSE: Seek medical attention if a significant amount is ingested.

5. FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA: ..... SUITABLE: Foam, carbon dioxide (CO_2), dry chemical. NON-SUITABLE: Direct water stream.

FIRE AND EXPLOSION HAZARDS: ..... During a fire, smoke may contain the original materials in addition to combustion products of varying composition which may be toxic and/or irritating. Combustion products may include, but are not limited to: phenolics, carbon monoxide, and carbon dioxide.

SPECIAL FIRE FIGHTING PROCEDURES: ..... Wear a self-contained breathing apparatus and complete full-body personal protective equipment. Closed containers may rupture (due to buildup of pressure) when exposed to extreme heat.

6. ACCIDENTAL RELEASE MEASURES

EMERGENCY PROCEDURES: ..... Keep unnecessary and unprotected personnel from entering area. Use appropriate safety and personal protective equipment as indicated in Section 8.

MITIGATION AND CLEAN UP PROCEDURES: ..... Stop leak without additional risk. Isolate area. Dike and absorb with inert material (*e.g.*, sand) and collect in a suitable, closed container. Warm, soapy water or non-flammable, safe solvent may be used to clean residual.

ENVIRONMENTAL PRECAUTIONS:..... Prevent from entering into soil, ditches, sewers, waterways and groundwater. See Section 12 for environmental impact information.

7. HANDLING AND STORAGE

STORAGE TEMPERATURE (min./max.): ..... 40°F (4°C) / 120°F (49°C)

STORAGE:..... Store in cool, dry place. Store in tightly sealed containers to prevent moisture absorption and loss of volatiles. Excessive heat over long periods of time will degrade the resin.

HANDLING PRECAUTIONS: ..... Avoid all skin and eye contact. Wash thoroughly after handling. Launder contaminated clothing before reuse. Avoid inhalation of vapors from heated product. Precautionary steps should be taken when curing product in large quantities. When mixed with epoxy curing agents this product causes an exothermic, which in large masses, can produce enough heat to damage or ignite surrounding materials and emit fumes and vapors that vary widely in composition and toxicity.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

ENGINEERING CONTROLS: ..... Use with adequate general ventilation and/or local ventilation to keep exposures below established limits.

EYE PROTECTION GUIDELINES: ..... Safety glasses with side shields or chemical splash goggles.

SKIN PROTECTION GUIDELINES:..... Wear liquid-proof, chemical resistant gloves (nitrile-butyl rubber, neoprene, butyl rubber or natural rubber) and full body-covering clothing.

RESPIRATORY PROTECTION GUIDELINES:..... When ventilation cannot be made adequate enough to keep exposures below established limits, use a NIOSH approved respirator with an organic vapor cartridge, or organic vapor cartridge + P100 particulate filter, depending on specific workplace conditions. Consult with your respirator and cartridge supplier to ensure proper selection of respirator and cartridge based on ingredients listed in Section 3 and specific workplace conditions. Use and select a respirator according the guidelines established in OSHA 1910.134 or other applicable respiratory protection standard.

ADDITIONAL PROTECTIVE MEASURES: ..... Practice good caution and personal cleanliness to avoid skin and eye contact. Avoid skin contact when removing gloves and other protective equipment. Wash thoroughly after handling. Generally speaking, working cleanly and following basic precautionary measures will greatly minimize the potential for harmful exposure to this product under normal use conditions.

OCCUPATIONAL EXPOSURE LIMITS: ..... Exposure limits may not be established for this product as a whole. For established exposure limits of specific ingredients in this product, or other available exposure limit information, refer to the table below.

Ingredient Name	CAS#	Exposure Limit Information
Propane, 2,2-bis[p-(2,3-epoxypropoxy)phenyl]-, polymers	25085-99-8	No data available
Benzyl alcohol	100-51-6	10 ppm (AIHA-WEEL)
Phenol-formaldehyde polymer glycidyl ether	28064-14-4	No data available

9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL FORM: ..... Viscous liquid.
COLOR: ..... Colorless.
ODOR: ..... Mild.
ODOR THRESHOLD: ..... No data available
pH ..... No data available
MELTING POINT / FREEZING POINT ..... No data available
BOILING POINT (760mm/Hg): ..... > 400°F (204°C).
FLASH POINT: ..... >200°F (93°C). Estimated based on ingredient data.
FLAMMABILITY (solids or gasses) ..... No data available
AUTO IGNITION TEMPERATURE ..... No data available
LOWER EXPLOSIVE LIMIT (LEL) ..... No data available
UPPER EXPLOSIVE LIMIT (UEL) ..... No data available
VAPOR PRESSURE ..... No data available
SPECIFIC GRAVITY/DENSITY (water = 1) 1.15
BULK DENSITY ..... 9.6 lb./gal. (1.15 kg/L)
VAPOR DENSITY (air = 1) ..... Heavier than air. Estimated based on ingredient data.
EVAPORATIOIN RATE (Butyl Acetate = 1) ..... No data available
WATER SOLUBILITY (% BY WT.) ..... No data available
PARTITION COEFFICIENT, n-OCTANOL/WATER (log Pow) ..... No data available
KINEMATIC VISCOSITY: ..... 869.5 mm^2/s @ 20°C
DECOMPOSITION TEMPERATURE: ..... No data available.
% VOLATILE BY WEIGHT: ..... ASTM D 2369-07 was used to determine the Volatile Content of mixed epoxy resin and hardener. Refer to the hardener SDS for information about the total volatile content of the resin/hardener system.

10. STABILITY AND REACTIVITY

STABILITY: ..... Product is stable at normal temperatures and pressures.

REACTIVITY/HAZARDOUS REACTIONS: ..... Product will not react by itself. A mass of more than one pound of product mixed with an aliphatic amine will cause irreversible polymerization with significant heat buildup. Strong acids, bases, amines and mercaptans can cause polymerization.

INCOMPATIBILITIES: ..... Strong acids, bases, amines and mercaptans can cause polymerization. External heating or self-heating could result in rapid temperature increase and pressure build up. If such a condition were to occur in a drum, the drum could expand and rupture violently.

CONDITIONS TO AVOID: ..... Avoid excessive heat.

DECOMPOSITION PRODUCTS: ..... Carbon monoxide, carbon dioxide and phenolics may be produced during uncontrolled exothermic reactions or when otherwise heated to decomposition.

11. TOXICOLOGICAL AND HAZARD ENDPOINT INFORMATION

Component Name	CAS#	LD_{50} Oral	LD_{50} Dermal	LC_{50} Inhalation
Propane, 2,2-bis[p-(2,3-epoxypropoxy)phenyl]-, polymers	25085-99-8	>15,000 mg/kg (rat)	>23,000 mg/kg (rabbit)	No data
Benzyl alcohol	100-51-6	1620 mg/kg	No data	>4.18 mg/l 4 h aerosol
Phenol-formaldehyde polymer glycidyl ether	28064-14-4	>2,000 mg/kg (rat)	2,000 mg/kg (rat)	No data

ACUTE TOXICITY: ..... No specific toxicity data exists for this mixture. Classification is based on acute toxicity estimation methods using ingredient data.

Oral: ..... Not classified. Does not meet acute oral toxicity criteria.
Dermal: ..... Not classified. Does not meet acute dermal toxicity criteria.
Inhalation: ..... Not classified. Does not meet acute inhalation toxicity criteria. If product is heated, vapors generated can cause headache, nausea, dizziness and possible respiratory irritation if inhaled in high concentrations.

SKIN CORROSION / IRRITATION:..... Causes skin irritation – Category 2.

SERIOUS EYE DAMAGE / IRRITATION:..... Causes serious eye irritation. Category 2A.

RESPIRATORY SENSITIZATION:..... Not classified. Does not meet criteria for respiratory sensitizer. Repeated exposure to high vapor concentrations may cause irritation of pre-existing lung allergies and increase the chance of developing allergy symptoms to this product.

SKIN SENSITIZATION:..... May cause allergic skin reaction. Category 1.

REPRODUCTIVE TOXICITY:..... Not classified. Diglycidyl ether bisphenol-A, in animal studies, has been shown not to interfere with reproduction. Diglycidyl ether bisphenol-A did not cause birth defects or other adverse effects on the fetus when pregnant rabbits were exposed by skin contact, the most likely route of exposure, or when pregnant rats or rabbits were exposed orally.

MUTAGENICITY:..... Not classified. Diglycidyl ether bisphenol-A in animal mutagenicity studies were negative. In vitro mutagenicity tests were negative in some cases and positive in others.

CARCINOGENICITY:..... Not classified. No ingredient of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA, NTP or IARC.

Many studies have been conducted to assess the potential carcinogenicity of diglycidyl ether of bisphenol-A. Although some weak evidence of carcinogenicity has been reported in animals, when all of the data are considered, the weight of evidence does not show that Diglycidyl ether bisphenol-A is carcinogenic. Indeed, the most recent review of the available data by the International Agency for Research on Cancer (IARC) has concluded that Diglycidyl ether bisphenol-A is not classified as a carcinogen.

Epichlorohydrin, an impurity in this product (<5 ppm) has been reported to produce cancer in laboratory animals and to produce mutagenic changes in bacteria and cultured human cells. It has been established by the International Agency for Research on Cancer (IARC) as a probable human carcinogen (Group 2A) based on the following conclusions: human evidence – inadequate; animal evidence – sufficient. It has been classified as an anticipated human carcinogen by the National Toxicology Program (NTP). Note: It is unlikely that normal use of this product would result in measurable exposure concentrations to this substance.

STOT (Single Exposure): ..... Not classified. Does not meet STOT SE criteria.

STOT (Repeated Exposure): ..... Not classified. Does not meet STOT RE criteria.

ASPIRATION HAZARD: ..... Not classified. Does not meet aspiration toxicity criteria.

OTHER HEALTH HAZARD INFORMATION:..... None known.

12. ECOLOGICAL INFORMATION

ACUTE AQUATIC TOXICITY:..... No specific test data available for the mixture. Calculated Estimate: Not classified. Does not meet acute aquatic classification criteria.

CHRONIC AQUATIC TOXICITY: ..... No specific test data available for the mixture. Calculated Estimate: Aquatic Chronic Category 2.

PERSISTANCE AND BIODEGRADABILITY: ..... No specific test data available for the mixture.

MOBILITY IN SOIL: ..... No specific test data available for the mixture.

ADDITIONAL ECOTOXICITY INFORMATION:..... In the liquid, uncured state, this product may be harmful to aquatic life long lasting effects. Prevent release to the environment, sewers and natural waters.

Ingredient	CAS#	Ecotoxicity Classification Information
Propane, 2,2-bis[p-(2,3-epoxypropoxy)phenyl]-, polymers	25085-99-8	Aquatic Chronic Cat. 2
Benzyl alcohol	100-51-6	Not Classified
Phenol-formaldehyde polymer glycidyl ether	28064-14-4	Aquatic Chronic Cat. 2

13. DISPOSAL CONSIDERATIONS

WASTE DISPOSAL METHOD:..... Evaluation of this product using RCRA criteria shows that it is not a hazardous waste, either by listing or characteristics, in its purchased form. It is the responsibility of the user to determine proper disposal methods.

Incinerate, recycle (fuel blending) or reclaim may be preferred methods when conducted in accordance with federal, state and local regulations.

14. TRANSPORTATION INFORMATION

US DOT
U.N./N.A. NUMBER:..... Not regulated.

SHIPPING NAME:..... Not applicable.
TECHNICAL SHIPPING NAME:..... Not applicable.
HAZARD CLASS:..... Not applicable.
PACKING GROUP:..... Not applicable.

CANADA TDG
U.N./N.A. NUMBER:..... Not regulated.
SHIPPING NAME:..... Not applicable.
TECHNICAL SHIPPING NAME:..... Not applicable.
HAZARD CLASS:..... Not applicable.
PACKING GROUP:..... Not applicable.

IMDG
U.N. NUMBER: ..... UN3082.
SHIPPING NAME:..... Environmentally hazardous substance, liquid, n.o.s.
TECHNICAL SHIPPING NAME:..... Epoxy Resin.
HAZARD CLASS:..... Class 9.
PACKING GROUP:..... PG III.
EmS Number: ..... F-A, S-F
MARINE POLLUTANT ..... Yes

ICAO/IATA
U.N. NUMBER: ..... UN3082.
SHIPPING NAME:..... Environmentally hazardous substance, liquid, n.o.s.
TECHNICAL SHIPPING NAME:..... Epoxy Resin.
HAZARD CLASS:..... Class 9.
PACKING GROUP:..... PG III.
MARINE POLLUTANT: ..... Yes

15. REGULATORY INFORMATION

COUNTRY	INVENTORY LIST	STATUS
United States	TSCA	All ingredients are listed or otherwise compliant.
Europe	EINECS or ELINCS	All ingredients are listed or otherwise compliant.
Canada	CEPA (DSL/NDSL)	All ingredients are listed or otherwise compliant.
Australia	AICS	All ingredients are listed or otherwise compliant.
Japan	ENCS	All ingredients are listed or otherwise compliant.
South Korea	KECI	All ingredients are listed or otherwise compliant.
China	IECSC	All ingredients are listed or otherwise compliant.
Philippines	PICCS	All ingredients are listed or otherwise compliant.

US EPA TSCA Requirements:..... No data available.

Canada WHMIS Confidential Business Information (CBI):..... No data available.

US EPA SARA TITLE III Reporting and Notification Requirements:
Subject to Section 302 (TPQ) ..... No data available.
Subject to Section 304 (RQ)..... No data available.
Subject to Section 311 or 312 ..... Refer to the health and physical classifications in section 2.
Subject to Section 313 ..... No data available.

STATE REGULATORY INFORMATION:
Chemicals listed below may be specifically regulated by individual states. For details on state regulatory requirements you should contact the appropriate state agency.

COMPONENT NAME /CAS NUMBER		**STATE CODE**
Epichlorohydrin 106-89-8	< 5ppm	[1]CA

[1] These substances are known to the state of California to cause cancer or reproductive harm, or both.

16. OTHER INFORMATION

REASON FOR ISSUE:..... Approval date change.
PREPARED BY:..... Gougeon Brothers, Inc.
SDS CONTACT:..... safety@gougeon.com
TITLE: ..... Health, Safety & Environmental Manager
APPROVAL DATE: ..... January 03, 2022
SUPERSEDES DATE:..... January 15, 2019

SDS VERSION: 105-2022a

OTHER HAZARD INFORMATION AND RATING SYSTEMS:

HMIS® RATING

HEALTH:	**2**
FLAMMABILITY:	**1**
PHYSICAL HAZARD:	**1**
PERSONAL PROTECTION:	

NFPA® 704 CODES

Approximate HMIS and NFPA Risk Ratings Legend:
0 = Low or None; 1 = Slight; 2 = Moderate; 3 = Serious; 4 = Severe

Information in this document is furnished without warranty, expressed or implied, except that it is accurate to the best knowledge of Gougeon Brothers, Inc. The data on this sheet is related only to the specific material designated herein. Gougeon Brothers, Inc. assumes no legal responsibility for use or reliance upon these data.

Mercury

ThermoFisher SCIENTIFIC

SAFETY DATA SHEET

Creation Date 20-Aug-2014 **Revision Date** 09-Feb-2024 **Revision Number** 5

1. Identification

Product Name **Mercury (Certified ACS)**

Cat No. : **M141-1LB; M141-6LB**

Synonyms Colloidal mercury; Hydrargyrum; Metallic mercury

Recommended Use Laboratory chemicals.
Uses advised against Food, drug, pesticide or biocidal product use.

Details of the supplier of the safety data sheet

Company
Fisher Scientific Company
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

2. Hazard(s) identification

Classification
This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Acute Inhalation Toxicity - Vapors	Category 2
Reproductive Toxicity	Category 1B
Specific target organ toxicity - (repeated exposure)	Category 1
Target Organs - Central nervous system (CNS), Kidney.	

Label Elements

Signal Word
Danger

Hazard Statements
Fatal if inhaled
May damage the unborn child
Causes damage to organs through prolonged or repeated exposure

Precautionary Statements
Prevention
Obtain special instructions before use
Do not handle until all safety precautions have been read and understood
Use personal protective equipment as required
Do not breathe dust/fume/gas/mist/vapors/spray
Use only outdoors or in a well-ventilated area
Wear respiratory protection
Wash face, hands and any exposed skin thoroughly after handling
Do not eat, drink or smoke when using this product
Response
IF exposed or concerned: Get medical attention/advice
Inhalation
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Immediately call a POISON CENTER or doctor/physician
Storage
Store locked up
Store in a well-ventilated place. Keep container tightly closed
Disposal
Dispose of contents/container to an approved waste disposal plant
Hazards not otherwise classified (HNOC)
Very toxic to aquatic life with long lasting effects
WARNING. Reproductive Harm - https://www.p65warnings.ca.gov/.

3. Composition/Information on Ingredients

Component	CAS No	Weight %
Mercury	7439-97-6	100

4. First-aid measures

General Advice Show this safety data sheet to the doctor in attendance. Immediate medical attention is required.

Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. In the case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

Skin Contact Wash off immediately with plenty of water for at least 15 minutes. Immediate medical attention is required.

Inhalation Remove to fresh air. If not breathing, give artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Immediate medical attention is required.

Ingestion Do NOT induce vomiting. Call a physician or poison control center immediately.

Most important symptoms and effects None reasonably foreseeable.

Notes to Physician Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media Substance is nonflammable; use agent most appropriate to extinguish surrounding fire. approved class D extinguishers.

Unsuitable Extinguishing Media Water may be ineffective

Flash Point Not applicable
Method - No information available

Autoignition Temperature No information available
Explosion Limits
Upper No data available
Lower No data available
Sensitivity to Mechanical Impact No information available
Sensitivity to Static Discharge No information available

Specific Hazards Arising from the Chemical
Very toxic. Non-combustible, substance itself does not burn but may decompose upon heating to produce corrosive and/or toxic fumes. Keep product and empty container away from heat and sources of ignition. Do not allow run-off from fire-fighting to enter drains or water courses.

Hazardous Combustion Products
Mercury oxide. Toxic fumes.
Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

NFPA

Health	Flammability	Instability	Physical hazards
4	0	0	N/A

6. Accidental release measures

Personal Precautions Ensure adequate ventilation. Use personal protective equipment as required. No special precautions required. Keep people away from and upwind of spill/leak. Evacuate personnel to safe areas.

Environmental Precautions Do not flush into surface water or sanitary sewer system. Do not allow material to contaminate ground water system. Prevent product from entering drains. Should not be released into the environment. Local authorities should be advised if significant spillages cannot be contained.

Methods for Containment and Clean Up Soak up with inert absorbent material. Keep in suitable, closed containers for disposal. Pick up and transfer to properly labelled containers.

7. Handling and storage

Handling Wear personal protective equipment/face protection. Do not get in eyes, on skin, or on clothing. Use only under a chemical fume hood. Do not breathe mist/vapors/spray. Do not ingest. If swallowed then seek immediate medical assistance.

Storage. Keep containers tightly closed in a dry, cool and well-ventilated place. Corrosives area. Keep in a dry place. Keep away from acids. Incompatible Materials. Strong oxidizing agents. Ammonia. Metals. Halogens.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH	Mexico OEL (TWA)
Mercury	TWA: 0.025 mg/m³ Skin	(Vacated) TWA: 0.05 mg/m³ Ceiling: 0.1 mg/m³ (Vacated) STEL: 0.03 mg/m³ Skin (Vacated) Ceiling: 0.1 mg/m³	IDLH: 10 mg/m³ TWA: 0.05 mg/m³ Ceiling: 0.1 mg/m³	TWA: 0.025 mg/m³

Legend

ACGIH *- American Conference of Governmental Industrial Hygienists*
OSHA *- Occupational Safety and Health Administration*
NIOSH: *NIOSH - National Institute for Occupational Safety and Health*

Engineering Measures Use only under a chemical fume hood. Ensure adequate ventilation, especially in confined areas. Ensure that eyewash stations and safety showers are close to the workstation location. None under normal use conditions.

Personal Protective Equipment

Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection Wear appropriate protective gloves and clothing to prevent skin exposure.

Respiratory Protection No special protective equipment required.

Hygiene Measures Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Silver
Odor	Odorless
Odor Threshold	No information available
pH	No information available
Melting Point/Range	-38.87 °C / -38 °F
Boiling Point/Range	356.72 °C / 674.1 °F
Flash Point	Not applicable
Evaporation Rate	No information available
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	0.002 mmHg @ 25 °C
Vapor Density	7.0
Specific Gravity	13.59 (H2O=1)
Solubility	Insoluble in water
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	No information available
Decomposition Temperature	No information available
Viscosity	No information available
Molecular Formula	Hg
Molecular Weight	200.59

10. Stability and reactivity

Reactive Hazard None known, based on information available

Stability Stable under normal conditions.

Conditions to Avoid Incompatible products. Excess heat.

Incompatible Materials Strong oxidizing agents, Ammonia, Metals, Halogens

Hazardous Decomposition Products Mercury oxide, Toxic fumes

Hazardous Polymerization Hazardous polymerization does not occur.

Hazardous Reactions None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information
Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Mercury	Not listed	Not listed	LC50 < 27 mg/m³ (Rat) 2 h

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation No information available

Sensitization No information available

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS No	IARC	NTP	ACGIH	OSHA	Mexico
Mercury	7439-97-6	Not listed	Not listed	Not listed	Not listed	Not listed

Mutagenic Effects No information available

Reproductive Effects No information available.

Developmental Effects May cause harm to the unborn child.

Teratogenicity No information available.

STOT - single exposure None known
STOT - repeated exposure Central nervous system (CNS) Kidney

Aspiration hazard No information available

Symptoms / effects,both acute and delayed No information available

Endocrine Disruptor Information No information available

Other Adverse Effects The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

The product contains following substances which are hazardous for the environment. Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. May cause long-term adverse effects in the environment. Do not allow material to contaminate ground water system.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Mercury	Not listed	0.9 mg/L LC50 96h	Not listed	Not listed

		0.18 mg/L LC50 96h 0.16 mg/L LC50 96h 0.5 mg/L LC50 96h		

Persistence and Degradability Insoluble in water May persist

Bioaccumulation/ Accumulation No information available.

Mobility Is not likely mobile in the environment due its low water solubility.

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

Component	RCRA - U Series Wastes	RCRA - P Series Wastes
Mercury - 7439-97-6	U151	-

14. Transport information

DOT

UN-No	UN2809
Proper Shipping Name	Mercury
Hazard Class	8
Subsidiary Hazard Class	6.1
Packing Group	III

TDG

UN-No	UN2809
Proper Shipping Name	Mercury
Hazard Class	8
Subsidiary Hazard Class	6.1
Packing Group	III

IATA

UN-No	UN2809
Proper Shipping Name	Mercury
Hazard Class	8
Subsidiary Hazard Class	6.1
Packing Group	III

IMDG/IMO

UN-No	UN2809
Proper Shipping Name	Mercury
Hazard Class	8
Packing Group	III

15. Regulatory information

United States of America Inventory

Component	CAS No	TSCA	TSCA Inventory notification - Active-Inactive	TSCA - EPA Regulatory Flags
Mercury	7439-97-6	X	ACTIVE	S;12C

Legend:
TSCA US EPA (TSCA) - Toxic Substances Control Act, (40 CFR Part 710)
X - Listed
'-' - Not Listed
S - Indicates a substance that is identified in a proposed or final Significant New Use Rule.

TSCA - Per 40 CFR 751, Regulation of Certain Chemical Substances & Mixtures, Under TSCA Section 6(h) (PBT) Not applicable

TSCA 12(b) - Notices of Export

Component	CAS No	TSCA 12(b) - Notices of Export
Mercury	7439-97-6	Section 5

International Inventories

Canada (DSL/NDSL), Europe (EINECS/ELINCS/NLP), Philippines (PICCS), Japan (ENCS), Japan (ISHL), Australia (AICS), China (IECSC), Korea (KECL).

Component	CAS No	DSL	NDSL	EINECS	PICCS	ENCS	ISHL	AICS	IECSC	KECL
Mercury	7439-97-6	X	-	231-106-7	X	X		X	X	KE-23117

KECL - NIER number or KE number (http://ncis.nier.go.kr/en/main.do)

U.S. Federal Regulations

SARA 313

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product contains a chemical or chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372. Note that PBT chemicals are not eligible for the de minimis exemption. For these chemicals, supplier notification limits are provided.

> 0 % = no low concentration cut-off set, supplier notification limit applies.

Component	CAS No	Weight %	SARA 313 - Threshold Values %	SARA 313 - Reporting threasholds
Mercury	7439-97-6	100	> 0 %	RT = 10 lb

SARA 311/312 Hazard Categories

Should this product meet EPCRA 311/312 Tier reporting criteria at 40 CFR 370, refer to Section 2 of this SDS for appropriate classifications.

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Mercury	-	-	X	X

Clean Air Act

OSHA - Occupational Safety and Health Administration — Not applicable

CERCLA

This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355).

Component	Hazardous Substances RQs	CERCLA Extremely Hazardous Substances RQs	SARA Reportable Quantity (RQ)
Mercury	1 lb	-	1 lb 0.454 kg

California Proposition 65 This product contains the following Proposition 65 chemicals.

Component	CAS No	California Prop. 65	Prop 65 NSRL	Category
Mercury	7439-97-6	Developmental	-	Developmental

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Mercury	X	X	X	X	X

U.S. Department of Transportation
Reportable Quantity (RQ): Y
DOT Marine Pollutant N
DOT Severe Marine Pollutant N

U.S. Department of Homeland Security This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade No information available

Authorisation/Restrictions according to EU REACH

Component	CAS No	REACH (1907/2006) - Annex XIV - Substances Subject to Authorization	REACH (1907/2006) - Annex XVII - Restrictions on Certain Dangerous Substances	REACH Regulation (EC 1907/2006) article 59 - Candidate List of Substances of Very High Concern (SVHC)
Mercury	7439-97-6	-	Use restricted. See item 18[a]. (see link for restriction details) Use restricted. See item 30. (see link for restriction details) Use restricted. See item 75. (see link for restriction details)	-

REACH links
https://echa.europa.eu/substances-restricted-under-reach

Safety, health and environmental regulations/legislation specific for the substance or mixture

Component	CAS No	OECD HPV	Persistent Organic Pollutant	Ozone Depletion Potential	Restriction of Hazardous Substances (RoHS)
Mercury	7439-97-6	Listed	Not applicable	Not applicable	0.1% (Max. Conc.)

Contains component(s) that meet a 'definition' of per & poly fluoroalkyl substance (PFAS)?
Not applicable

Other International Regulations

Component	CAS No	Seveso III Directive (2012/18/EC) - Qualifying Quantities for Major Accident Notification	Seveso III Directive (2012/18/EC) - Qualifying Quantities for Safety Report Requirements	Rotterdam Convention (PIC)	Basel Convention (Hazardous Waste)
Mercury	7439-97-6	Not applicable	Not applicable	X	Annex I - Y29

16. Other information

Prepared By Regulatory Affairs

Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

Creation Date	20-Aug-2014
Revision Date	09-Feb-2024
Print Date	09-Feb-2024
Revision Summary	This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS

Fiber Glass

Fiberglass Safety Data Sheet

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifier

- Fiberglass

1.2 Relevant identified uses of the substance or mixture and uses advised against

- Structural reinforcement for thermoset resin products.

1.3 Details of the supplier of the safety data sheet

- NOV Fiber Glass Systems

  17115 San Pedro Avenue, Suite 200
  San Antonio, Texas 78232 USA

  Tel: 1-210-477-7500
  Fax: 1-210-231-5915

  E-mail: Mike.Thayer@nov.com

1.4 Emergency telephone number(s)

- 3E Company, 24-Hour Support (Access Code/Contract Number: 333386)
  - USA, Canada 1-888-298-2344
  - Asia, Pacific 1-760-476-3960
  - Europe, Middle East, Africa 1-760-476-3961
  - Americas 1-760-476-3962

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

Physical

- Not classified

Health

- Skin irritation, Category 2
- Eye irritation – Category 2
- Specific target organ systemic toxicity – single exposure, Category 3 (respiratory tract irritation)

Environmental

- Not classified

2.2 Label elements

Signal Word(s)

- WARNING

Pictogram(s)

Hazard Statements

- Physical
  - Not classified
- Health
  - H315: Causes skin irritation.
  - H319: Causes serious eye irritation.
  - H335: May cause respiratory irritation.
- Environmental
  - Not classified.

Precautionary Statements

- Prevention
  - P271: Use only outdoors or in well-ventilated area.
  - P280: Wear protective gloves/protective clothing/eye protection/face protection.
- Response
  - P305+P351+P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
- Storage
  - No special instructions.
- Disposal
  - P501: Dispose of contents/container in accordance with regulatory requirements.

2.3 Other Hazards

- PBT and vPvB assessment
  - None of the ingredients are considered to be either PBT or vPvB.

SECTION 3: Composition/information on Ingredients

3.1 Substances

- Not applicable

3.2 Mixtures

Chemical Identity	CAS No.	EC No.	Concentration Range (weight %)
Fibrous glass, continuous filament	065997-17-3	266-046-0	> 95
Organic surface binder/sizing	Not available	Not available	< 5

SECTION 4. First-aid measures

4.1 Description of first-aid measures

Inhalation

- Move to fresh air.
- If difficulty in breathing or respiratory irritation; seek immediate medical attention.
- If breathing has stopped; seek immediate medical attention, perform artificial respiration.

Skin contact

- Remove contaminated clothing.
- Gently wash with plenty of soap and water.
- If irritation develops or persists or if product becomes imbedded in skinn; seek medical attention.

Eye contact

- Remove contact lenses, if present.
- Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open.
- If irritation develops or persists, seek medical attention.

Ingestion

- If swallowed and conscious, rinse mouth with water (never give anything by mouth to an unconscious person).
- If symptoms persist, seek immediate medical attention.

4.2 Most Important symptoms and effects, both acute and delayed

Acute

- Dusts may cause temporary mechanical irritation to the eyes, skin, and respiratory tract. Accidental ingestion may cause illness or irritation to the mouth and gastrointestinal tract.

Delayed

- No specific data available.

4.3 Indication of any immediate medical attention and special treatment needed

- Treat symptomatically.

SECTION 5: Firefighting measures

5.1 Extinguishing media

- Use an extinguishing media suitable for the surrounding fire.

5.2 Specific hazards arising from the substance or mixture

- No specific fire or explosion hazards.

5.3 Advice for firefighters

- Wear self-contained breathing apparatus and protective clothing, as necessary.

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

- Wear appropriate personal protective equipment and clothing to reduce or eliminate contact.

6.2 Environmental precautions

- Fiberglass is generally considered to be an inert solid; no special precautions identified.

6.3 Methods and materials for containment and cleaning up

- Collect spilled material by vacuum or sweeping and place into suitable container for disposal

6.4 Reference to other sections

- See also, *SECTION 8: Control parameters* and *SECTION 13: Disposal considerations*.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

- Wear appropriate personal protective equipment.
- Avoid eating, drinking, and smoking in areas where this material is handled, stored, and processed.
- Wash face and hands before eating, drinking, and smoking after handling this product.

7.2 Conditions for safe storage, including any incompatibilities

- No specific data available.

7.3 Specific end use(s)

- No additional data available.

SECTION 8: Exposure controls/personal protection

8.1 Control parameters

Glass Fiber (continuous filament glass fibers)
CAS No. 065997-17-3

Country	Occupational Exposure Limit (OEL) Values		Legal Basis
	Eight Hour TWA	Fifteen Minute STEL	
Australia	2 mg/m^3 (inhalable dust)	None established	Workplace Exposure Standards for Airborne Contaminants
Canada – British Columbia	1 fiber/cc	None established	Occupational Health and Safety Regulation, Table of Exposure Limits for Chemical and Biological Substances
Canada - Ontario	1 fiber/cc	None established	Regulation 883, Control of Exposure to Biological or Chemical Agents
Canada - Manitoba	1 fiber/cc	None established	Workplace Safety and Health Act, Part 36
Canada - Quebec	1 fiber/cc	None established	Regulation respecting occupational safety and health
Canada - Saskatchewan	1 fiber/cc (respirable fibers) 5 mg/m^3 (inhalable fraction)	3 fibers/cc (respirable fibers) 10 mg/m^3 (inhalable fraction)	The Occupational Safety and Health Regulations
New Zealand	1 fiber/cc	None established	Workplace Exposure Standards and Biological Exposure Indices
Singapore	10 mg/m^3 (fibrous glass dust)	None established	Workplace Safety and Health (General Provisions) Regulations
USA (ACGIH)	1 fiber/cc	None established	None
USA (NIOSH)	3 fiber/cc	None established	NIOSH Pocket Guide to Chemical Hazards (Recommendations Only)

Particulates not otherwise classified/regulated (PNOC / PNOR) (may be generated if cured product is subjected to sanding, grinding, cutting, etc.)
CAS No. – Not applicable

Country	Occupational Exposure Limit (OEL) Values		Legal Basis
	Eight Hour TWA	Fifteen Minute STEL	
Austria	10 mg/m^3 (inhalable)	None established	Workplace Exposure Standards for Airborne Contaminants
Belgium	10 mg/m^3	None established	limites d'exposition professionnelle – VLEP/ Grenswaarden voor beroepsmatige blootstelling – GWBB
Canada - Alberta	10 mg/m^3 (total) 3 mg/m^3 (respirable)	None established	Occupational Safety and Health Code
Canada – British Columbia	10 mg/m^3 (total dust) 3 mg/m^3 (respirable)	None established	Occupational Health and Safety Regulation, Table of Exposure Limits for Chemical and Biological Substances
Canada - Manitoba	10 mg/m^3 (inhalable) 3 mg/m^3 (respirable)	None established	Workplace Safety and Health Act, Part 36
Canada - Ontario	10 mg/m^3 (inhalable) 3 mg/m^3 (respirable)	None established	Regulation 883, Control of Exposure to Biological or Chemical Agents

Canada - Quebec	10 mg/m^3 (total dust)	None established	Regulation respecting occupational safety and health
China	3 mg/m^3 (fiberglass reinforced plastic dust)	None established	GBZ 2.1-2007, Occupational exposure limits for hazardous agents in the workplace
Ireland	10 mg/m^3 (inhalable) 4 mg/m^3 (respirable)	None established	Code of Practice for the Safety, Health and Welfare at Work (Chemical Agents) Regulations
Malaysia	10 mg/m^3 (inhalable) 3 mg/m^3 (respirable)	None established	Occupational Safety and Health (Use and Standards of Exposure of Chemicals Hazardous to Health) Regulations
New Zealand	10 mg/m^3 (inhalable) 3 mg/m^3 (respirable)	None established	Workplace Exposure Standards and Biological Exposure Indices
Singapore	10 mg/m^3 (nuisance)	None established	Workplace Safety and Health (General Provisions) Regulations
South Korea	10 mg/m^3	None established	[Need reference]
USA (ACGIH)	10 mg/m^3 (inhalable) 3 mg/m^3 (respirable)	None established	None
USA (OSHA)	15 mg/m^3 (total dust) 5 mg/m^3 (respirable)	None established	29 CFR 1910 Subpart Z, Toxic and Hazardous Substances
United Kingdom	10 mg/m^3 (inhalable) 4 mg/m^3 (respirable)	None established	EH40 Workplace exposure limits

8.2 Exposure controls

Appropriate engineering controls

- Provide adequate general and local exhaust ventilation to control airborne concentrations to below the occupational exposure limit values.

Personal protective equipment

- Eye and face protection
  - Approved safety glasses with side shields (e.g., ANSI Z87, EN166)
- Skin protection
  - Hand protection: Butyl rubber, Nitrile rubber or Neoprene gloves. Different glove materials, thicknesses, and from different glove manufacturers may provide varying degrees of protection. Temperature and specific use can impact glove effectiveness. Some gloves may be intended to be used only once and then discarded, while others may be used for longer periods of time. The glove supplier should provide the user with information regarding permeability and breakthrough time. Gloves should be discarded and replaced if there is any indication of degradation or chemical breakthrough.
  - Other skin protection: Such clothing as to minimize or eliminate the chance of skin contact.
- Respiratory protection
  - If ventilation is insufficient to keep airborne concentrations below the occupation exposure limit levels, full or half-mask respirator fitted with particulate filters. Filter masks may be of limited use in cases of high or unknown exposure.

Environmental exposure controls

- Do not flush into surface water or sanitary sewer system.
- Do not place directly onto ground.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

-	Appearance	White to yellowish solid
-	Odor	None
-	Odor threshold	No data available
-	pH	No data available
-	Melting point/freezing point	> 800°C (1472°F) / No data available
-	Initial boiling point and boiling range	No data available
-	Flash point	Not applicable
-	Evaporation rate	No data available
-	Flammability (solid, gas)	No data available
-	Upper/lower flammability or explosive limits	Not applicable
-	Vapor pressure	No data available
-	Vapor density (air = 1)	No data available
-	Relative density	2.4 – 2.7
-	Solubility(ies)	Insoluble
-	Partition coefficient: n-octanol/water	No data available
-	Auto-ignition temperature	No data available
-	Decomposition temperature	No data available
-	Viscosity	Not applicable
-	Explosive properties	No data available
-	Oxidizing properties	No data available

9.2 Other information

- No data available.

SECTION 10: Stability and reactivity

10.1 Reactivity

- No data avaialble.

10.2 Chemical stability

- Product is stable.

10.3 Possibility of hazardous reactions

- Under normal conditions of storage and use, hazardous reactions will not occur..

10.4 Conditions to avoid

- Excessive heat and flames.

10.5 Incompatible materials

- None known.

10.6 Hazardous decomposition products

- Fiberglass products may release small amounts of acetic acid and other organic materials at elevated temperatures.

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity

- Data for ingredients were not found or not sufficient for classification.

Skin corrosion/irritation

- Data for ingredients were not found or not sufficient for classification.

Serious eye damage/irritation

- Data for ingredients were not found or not sufficient for classification.

Respiratory or skin sensitization

- Data for ingredients were not found or not sufficient for classification.

Germ cell mutagenicity

- Data for ingredients were not found or not sufficient for classification.

Carcinogenicity

- Data for ingredients were not found or not sufficient for classification.

Reproductive toxicity

- Data for ingredients were not found or not sufficient for classification.

STOT-single exposures

- Respiratory system Irritation

STOT-repeated exposures

- Data for ingredients were not found or not sufficient for classification.

Aspiration hazard

- Data for ingredients were not found or not sufficient for classification.

SECTION 12: Ecological information

12.1 Toxicity

Acute toxicity

- Data for ingredients were not found or not sufficient for classification.

Chronic toxicity

- Data for ingredients were not found or not sufficient for classification.

12.2 Persistence and degradability

- Data for ingredients were not found or not sufficient for classification.

12.3 Bioaccumulative potential

- Data for ingredients were not found or not sufficient for classification.

12.4 Mobility in soil

- Data for ingredients were not found or insufficient for classification.

12.5 Results of PBT and vPvB assessment

- None of the ingredients are listed.

12.6 Other adverse effects

- No additional data is available.

SECTION 13: Disposal considerations

13.1 Waste treatment methods

- Must be disposed of in accordance with local regulatory requirements.

SECTION 14: Transport information

- The transport information provided below conforms to the following:

  - UN Model Regulations
  - International Carriage of Dangerous Goods by Road (ADR)
  - International Carriage of Dangerous Goods by Rail (RID)
  - International Carriage of Dangerous Goods by Inland Waterways (ADN)
  - International Maritime Dangerous Goods (IMDG) Code
  - International Civil Aviation Organization (ICAO)Technical Instructions for the Safe Transport of Dangerous Goods by Air

		If offered alone, the classification is as described below
14.1	**UN number**	None
14.2	**UN proper shipping name**	Not regulated
14.3	**Transport hazard class(es)**	None
14.4	**Packing group**	None
14.5	**Environmental hazards**	None
14.6	**Special precautions for user**	None
14.7	**Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code**	Product is not offered nor intended to be transported in bulk quantities.

SECTION 15: Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

The regulatory information provided below may not be comprehensive.

Canada

Controlled Products Regulation (CPR)

- This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.

Ingredient Disclosure List (IDL)

- All components of this mixture that are on the IDL above their specified concentration are disclosed in this SDS.

United States

EPCRA			CERCLA	RCRA	CAA	OSHA
Section 302 (EHS) TPQ (LB/KG)	Section 304 RQ (LB/KG)	Section 313	RQ (LB/KG)	P/U Codes	112(r) TQ (LB/KG)	Highly Hazardous Chemical
None of the ingredients are listed						

15.2 Chemical safety assessment

- No chemical safety assessment has been carried out for this mixture by the supplier.

SECTION 16: Other information

Revision history

Revision Number	Revision Date	Revision Description
1	25-AUG-2013	Initial SDS creation in conformance with OSHA hazard communication standard (29 CFR 1910.1200), Regulation (EC) No. 1907/2006 (REACH), and UN Globally Harmonized System (GHS).

Legend to abbreviations and acronyms used

- ACGIH American Conference of Governmental Industrial Hygienists
- ANSI American National Standards Institute
- CAA Clean Air Act
- cP centipoise
- CFR Code of Federal Regulations (US)
- EPCRA Emergency Planning and Community Right-to-Know Act
- IARC International Agency for Research on Cancer
- IBC Code International Bulk Chemical Code
- MARPOL Marine Pollution
- NIOSH National Institute for Occupational Safety and Health
- NTP National Toxicological Program
- OSHA Occupational Safety and Health Administration (US)
- PBT Persistent Bioaccumulative and Toxic
- RCRA Resource Conservation and Recovery Act
- vPvB very Persistent and very Bioaccumulative

Key literature references and sources for data

- ESIS. European chemical Substances Information System. http://esis.jrc.ec.europa.eu/.
- USEPA. 2006. List of Lists, Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-To-Know Act (EPCRA) and Section 112(r) of the Clean Air Act. EPA 550-B-01-003. October 2006.

Project Plan

Requirements Verification

Derived Requirements are requirements set by our team. On top of the NSL handbook guidelines, these requirements are the team's unique criteria for success in our project:

Team Requirments	Justification
Vehicle	
Body tube minimum size is 4in in diameter	In order to fit folded payload, the body tube must be equal to or greater than this dimension
Recovery	
At 750ft above ground on the descent, the main parachute must deploy	To allow enough time to receive permission to release the payload. The payload needs to be released at a high enough altitude to effectively monitor the area. In order for payload success, this requirement must be met.
Payload	
Take both visible light and infrared images.	In order to be applied in a practical setting, the fire detection UAV needs to capture RGB/visible light footage along with infrared scanning. This will allow the users to be aware of where each infrared image is taken from in the flight range without complete reliance on the GPS system.
Autonomous guidance	Since the UAV will be at high altitudes, using a remote control and receiver system to fly the plane isn't practical. In order to be efficient, the plane also needs to scan the surrounding area methodically by never flying in the same place twice. In order to have an efficient flight path, the UAV must be autonomously flown.
Be able to fold into a 4-in-diameter body tube	In order to fit into the rocket, the compact form of the

	UAV must fit in this dimension.

Budgeting

Rocket:

Item:	Cost:	Quantity:	Total:	$3,456.77
Motor: AeroTech J1799N	$149.00	4	$596.00	
Motor Case: RMS-54/1280	$141.99	1	$141.99	
4in G10 Fiberglass	$30.00	3	$90.00	
Epoxy Resin	$379.63	1	$379.63	
Fiberglass cloth (10yd by 38in)	$161	1	$161.12	
Filament	$50	5	$250.00	
NAR Cert Supplies/Fees	$150	5	$750.00	
Motor Mount	$11	1	$11.00	
Parachutes	$175	1	$175.00	
Miscellaneous Supplies	$200	1	$200.00	
Kevlar string	$20	1	$20.00	
Shock Cord	$25	3	$75.00	
Nomex	$45	1	$45.00	
Electronics	$300	1	$300.00	
15/15/12 Launch Rail	$12.03	1	$12.03	
Shipping+Tax Estimate	$250			

Payload:

Item:	Cost:	Quantity:	Total:	$411.97
Motor	$29.99	2	$59.98	
ESC	$12.99	2	$25.98	
Infared Camera	$60.50	1	$60.50	

Cam Brain + Cam	$19.95	1	$19.95	
Flight Brain	$7.13	1	$7.13	
SD card mount	$0.80	2	$1.60	
Mercury Switch	$6.88	1	$6.88	
PETG Filament	$15	2	$30	
Carbon Fiber Filament	$30	1	$30	
GPS	$69.95	1		
Miscellaneous	$50	1	$50.00	
Shipping+Tax Estimate	$50			

Fundraising

Even though our team has received no fundraising so far, we have reached out to our school, Animas High School, and our in communication with the school board. Our team has also recently gained a fundraising sub-team which will greatly increase our fundraising efficiency. The following table outlines the companies we aim to reach out to in order to raise a goal of $10,000 and fund our project.

Name of Business/ Institution/ Foundation	Contacted	Donated Before	Responded	Donation Goal
Animas High School	Y	N	Y	$5000
LPEA	N	Y	n/a	$3000
National Science Foundation	N	N	n/a	$1000
Amgen Foundation	N	N	n/a	$1000
Best Western Plus Rio Grande Inn	N	N	n/a	$500

Project Timeline:

Initial planning and design – (Completed)

Design Refinement and accomplish ability check – (Completed)

Decision to submit to NASA – (Completed)

Submit Proposal Sep 11 - (Completed)

Find interested people- Early Sep - (Completed)

Awarded Proposals Known- Oct 3 - (Completed)

Conduct final team interviews and finish assigning roles in Early Oct - (Completed)

Have basic models of payload and CAD rocket models Mid-Oct - (Completed)

Start emailing potential sponsors Mid-Oct - (Completed)

PDR video teleconferences - Nov 8

Send initial emails to schools for community outreach lessons - Early Nov

Start Middle School and High School Curriculum - Early Nov

Gateway Registration Deadline - Nov 29

Start finalizing dates to give lessons for high school and middle school - Mid-Nov

First launch (no payload) - Early Dec
Have first school lessons complete - Early Dec(Schedules Permitting)

CDR Q&A - Dec 3

Subscale Flight deadline - Jan 8

Second launch - Early February

Vehicle Demonstration Flight deadline & FRR report - March 17

Final Launch Mid-April