Flight Readiness Review

Trail Blazers

BLAZING A TRAIL INTO THE FUTURE

SLI 2017

Cedar Park Homeschoolers
715 Discovery Blvd. Ste. 101
Cedar Park, TX 78613

NASA Student Launch Flight Readiness Review

CEDAR PARK Home School

c/o Capstone Works, Inc.

715 Discovery Blvd., Ste 101

Cedar Park, TX 78613

Submitted: 3/6/17

Adult Educators

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Our Website: http://cedarparkrocketry.com/download.html

Safety Officer

Ryan Raglin, 8th Grade, Home Schooled

Alex Adams, NAR Mentor Safety Oversight

Team Lead/Project Manager

Josh Thayer, 11th Grade, Home Schooled

4 students will be participating - their names, duties and responsibilities are included in the Team Member Info section.

Changes made since CDR:

We have made several changes to the CDR including the overall length, placement of the payload, overall weight, main parachute size, And attachment method of the fins. We have changed the avionics bay to make it more structurally sound. We extended both the top and bottom half of the rocket there for changing the weight. We decided to place our payload in the nose cone due to how we have made the motor retainer set up. We have also more securely attached the fins to the rocket to reduce the “wobble” of the fins. Our parachute has been made larger to reduce the falling.

Launch Vehicle Criteria:

Body tube: we have a 4 inch diameter fiberglass body tube that was 5 feet long total that we are using for our top and bottom body tubes, they are secured together by a 9in length coupler that is connected by 3 #2 shear pins, the top body tube is 711.2 millimeters (2 feet 4 inches) in length and the bottom body tube is 914.4 millimeters (3 feet) in length.

Nosecone. Our nose cone is made out of G10 with a fiberglass shoulder and aluminium tip. It has a wooden centering ring with a bulk plate that is attached with 8 screws and holds the payload inside. The shoulder is 4 inches (101.6 millimeters) in length.

Fins: we have 4 G10 Fiberglass clipped right triangular fins with a thickness of 2.1mm, root chord and sweep chord lengths are 203.0mm, they are surface mounted and held on with west epoxy 105 and 206 fillets, the fins have a layer of carbon fiber over them to help strengthen them.

Centering rings: The centering rings are made out of G10 and we had them custom made to fit our tube. They are 2.1 millimeters in thickness and are the width of a coupler and the inside diameter is 54 millimeters to fit our motor mount.

Bulkheads: we have Bulkheads made of G10 fiberglass that have a diameter of just under 101.6mm so that they can fit inside our body tubes and a width of 2.1mm, there are 2 of them close to the top of the bottom body tube about 3 inches from each other, there is a U-ring on the one closer to the top tube facing up with a quick link on it so we can connect it to the parachutes, they are also securing the motor tube by putting a kevlar cord through a hole in both bulkheads and on the edge of one of the centering rings around the motor tube then securely tying off both ends.

Rail buttons: We have two 10/10 rail buttons 8 inches apart from each other attached to the bottom section. The first rail button is ¾ of an inch (19.05 millimeters) from the underside of the bottom section of the rocket. And the second rail button is 10 inches and ¾ of an inch (273.05 millimeters) from the underside of the bottom section of the rocket.

Motor mount: The motor mount is a 7 inch (177.8 millimeters) section of a 54 millimeter tube. There is a centering ring attached to both ends of the tube the size of a 98 millimeter coupler and a centering ring fastened to one end of the tube the size of the inside diameter of the 98 millimeter tube and it rests up against a piece of coupler glued to the inside of the very bottom of the rocket. There is a piece of Kevlar fastened to the top centering ring the we then thread through the entire bottom section of the rocket and tie to the U-bolt at the top of the bottom section of the rocket. And twist the motor mount till it is held tight to the bottom of the rocket.

Piston:The piston is 4 and ½ inches (114.3 millimeters) in length and is made out of a section of coupler for the 98 millimeter tube. There is a bulk head glued inside the piston with a 44 inch (1117.6 millimeters) section of 11/32 kevlar running through the middle of the bulkhead.

Redundant Systems

We have two Stratologger altimeters both connected to two separate 9 volt batteries. Each altimeter has two electronic matches the run to two black powder charges giving us four black powder charges total. If the first black powder charge fails to go off the second one will be triggered one hundred feet lower in altitude. The drogue charge consists of 2.5 grams of black powder and the main charge consists of 2 grams of black powder.

Test Launch Results

We Launched our rocket in an approximately 1 square mile field in hutto on 3/3/17 at 5:53pm, the rocket flew 2793 ft into the air and landed in 79.5 seconds, Jim Jarvis was our NAR certified person ensuring that the launch was safe, the drogue parachute deployed right after apogee then the main and pilot deployed at 700 ft above the ground.

Recovery System

Main Parachute: we have a 96 inch diameter Spherachute that is deployed using a piston and a pilot chute when the nose cone is sheared off the top body tube , deploys at 1000 feet.

Drogue Parachute: our drogue parachute is a 24 inch PML that is deployed at apogee by the two body tubes coming apart.

Pilot Parachute: The Pilot Parachute we are using is a PML 30 inch

Altimeter Bay

Our altimeter bay is a 5.5 in length fiberglass tube that fits well inside of our 4 in diameter body tube, it has a 5 inch long wooden sled inside of it that holds our 2 9-volt batteries, 2 stratologger altimeters, and 2 switches, on the outside of the altimeter bay there are two G10 Fiberglass bulkheads, one on each end, then there are 2 pieces of PVC pipe for holding black powder on each bulkhead

safety plan

Facility Risks

Workshop Unavailable

- Tools and facility available at Adams,Thayer, And Raglin households

Launch Site

- Hutto could be only available site
- Weather dependent

Project risks

Personal arguments

- If the students can’t reach a solution their current progress in the project will be protected and, if necessary, the students will be separated
- Mentors will aid conflict resolution

Payload Risks

- The only thing that could go wrong with the payload we selected- using magnets to lower the G-forces effect on astronauts in a rocket - is if someone with a pacemaker, insulin pump, or something else nearby was susceptible to magnetic interference.

Personnel Risks

- Injury

· PPE (personal protection equipment) is required during all construction tasks and during prepping the rocket for flight

· Adult supervision at all times

Rocket Recovery Failures

Possible part failures	**Chance of occurrence/amount of damage done**	**Failures effect**	**How to prevent this**
Parachute tears apart	Low/medium	Rocket falls at high speed and breaks on impact with the ground	Check if the parachute is damaged pre-launch and tape over sharp edges in the rocket near the parachute
Rocket sections don't separate	Low/medium	Rocket falls at high speed and breaks on impact with the ground	Make sure the parts fit together smoothly, use the correct amount of black powder, use redundant charges.
Shock cord melt or combust	Low/medium	Rocket falls at high speed and breaks on impact with the ground	Wrap heat resistant material around nylon cords, develop a consistent procedure for

			packing
Parachute melt or combust	Low-Medium/medium	Rocket falls at high speed and breaks on impact with the ground	Heat resistant blanket, develop a consistent procedure for packing
Parachute tangles	Low/medium	Rocket falls at high speed and breaks on impact with the ground	Check lines before launch, develop a consistent procedure for packing

Construction Failures

Fin failure	Low/low-medium	Rocket becomes unstable and crashes	Do static tests on the fins, mount them well with good fillets
Body tube bent	Low/low-medium	Rocket becomes unstable and crashes	Do static tests on the body tube, put square joints at the couplers
Damage from	Medium/low	Broken fins, body tube ends, or nose	Drop test the body tube, overbuild it, confirm that

landing		cone	the parachute deploys
Motor mount failure	Low/high	The motor shoots through the body tube destroying the rocket	Check motor and mount before use, static test the motor mount

Payload Failures

Payload mounted wrong	Low/low-medium	Payload destroyed, rocket made unstable	Develop a consistent procedure for packing payload
Magnets attached wrong	Low-Medium/low	Payload inside and outside bounce around/stick together strangely	Carefully place each magnet in its correct position, double check every one of them
Batteries not charged/incorrectly installed	Low-Medium/low	G-forces levels sensors failure, rocket tracking failure	Develop a consistent procedure for packing batteries, always charge them fully and inspect them prior to launch
Magnetically floating	Low/low	Payload tests being	Make sure that the inside

inside pod breaks		done fail, inside pod could bust through and harm other parts of the rocket	and outside pods are set correctly, develop a consistent procedure for packing them

Management failures

Too much time and effort is required for the project	Low/high	too many team members quit to continue the project	Keep team large enough and split the work evenly so no one is overworked
Parts arrive late	Medium/low-medium	Rocket cannot be constructed until later on and we get to conduct less test flights	Order parts as early as possible and be ready to use the parts as soon as they arrive

Environmental Failures

Rocket cannot be Found after landing	Low/low-medium	Wild animals could attempt to eat part of the rocket, harming themselves	Use GPS location in the rocket and look closely for any parts that may have come off
Rocket lands in tree	Medium/low	Difficult to retrieve, members are hurt attempting to recover the rocket	Make sure area near launch site has few trees
Parachute tears on something during landing	Low/medium	Have to replace or repair the parachute	Make sure area is open so this is less likely to happen, buy a stronger parachute that won't tear much
Motor and fins malfunction and the rocket shoots into a group of trees	Minimal-low/medium-high	Could cause a small fire and destroy the rocket	Make sure that all the fins and the motor are correctly set

Launching Failures

Rocket is too highly powered	Medium/low	Rocket flies higher than what our goal is	Select a motor that will better fit our rockets goal height
Rocket is to underpowered	Medium/low	Rocket flies lower than what our goal	Select a motor that will better fit our rockets goal height
Motor failures	Low/medium	Rocket cannot launch, motor can burn through casing, Rocket could become unstable or be destroyed	Bring spare ignitors, check that the motor is good, develop a consistent method for inserting motor

NAR/TRA

Range Safety

A range safety inspection will be performed on each rocket before it’s flown, our team will abide by the ruling of the range safety inspection.

RSO ruling

The range Safety Officer has the last say on all rocket issues and has the right to stop the launch of any safety reason.

Team Compliance

If our team does not comply with the safety requirements they will not be allowed to fly.

Purchase, Storing, Transporting, and usage of Energetics

Only one of our mentors: Alex Adams, Chuck Adams, or James Duffy are permitted to purchase or handle the energetics (motors, igniters, and ejection charges)

NAR Mentors

Our Mentors, Chuck Adams and Alex Adams:

- are NAR Members HPR and certified level 1 almost level 2
- teach the team, keep us on track, and attend all our meetings
- will be at the launches and help the safety officer check that everything is ready and safe for launch

Vehicle

The Rocket will:

- Be constructed only with reliable materials made by trusted manufacturers
- Be constructed with supervision by at least one of our mentors

· Only methods for recovery that are known to work well will be used during retrieval of the rocket

· Be propelled by motors within the NAR HPR level 2 power limits and restrictions stated by the SL program

· Will only be flown with permission from the FAA and will follow all instructions we receive from them

· Strict adherence to NAR and NFPA safety codes for model rockets and high power rockets will be followed at all launches

Team Members Safety

· Mentors and more experienced team members will teach new members rocket safety

· All team members will be taught about the hazards that rocketry presents and how to deal with them ex: fires, ballistic rockets, and environmental dangers

· Written Safety Statement

· Team members will read emails sent out to the team Google group

· During a launch, mentors/adult supervisors will make sure the launch area is clear and that all team members are watching carefully

· All hazardous materials like motors and black powder will be put into the rocket by a mentor

· Each launch will have a countdown as instructed by NAR safety codes

· Each launch will have a way to extinguish fire near a team member during pre-launch prep and at launch

Safety Documentation

Proper usage of hazardous materials will be used always when they are being handled including wearing the needed PPE (Personal Protective Equipment) like goggles, gloves, and long pants.

While cutting fiberglass the dust that comes off can imbed itself in your skin, or can be breathed in, which isn’t fun, it also has a chance to cause cancer, so make sure that we are wearing long clothes and goggles during cutting.

All construction of the rocket will be closely watched over by a mentor who will make sure that the team member building it is using the proper protection and tools.

Checklist of Final Assembly and Launch Procedures

Final assembly

ü Ensure PPE is worn as necessary. Face masks, gloves, and other skin protection while handling launch equipment.

ü Check redundancy of safety systems, i.e. parachute deployment charges, motor ignition.

ü Check structural integrity of fins, cone, and body.

ü Check motor integrity and charge delay.

ü Ensure payload is properly situated in rocket and ready for launch.

ü Ensure parachutes are properly attached.

ü Check fireproof wadding and adjust as needed.

Launch

ü Pick a launch site as far away from power lines, trees, and buildings as possible so it is easier to recover the rocket

ü Place the launch pad in the center of the area on firm stable ground and keep spectators at least 30 feet back

ü Make sure that the launch pad, controller, and rocket engine have no defects or damages

ü Insert the wadding and the recovery system into the rocket from the top, install the igniter into the engine then put the engine in the engine mount

ü Get back a safe distance and use the launch key then start a countdown, when you say zero hit the button

ü If the rocket does not launch when pressed wait at least a minute before going up to it

MSDS Information

Many materials solvents and adhesives will be use in the construction of our rocket. The MSDS Sheets will be compiled and maintained in a Safety Binder by the Safety Officer for each material used in the construction of our rocket. This Safety Binder will be present at each construction event and each launch. The MSDS for relevant items are included here for reference only and are not deemed to be the complete MSDS sheet as will be maintained in our Safety Binder.

Aerotech MSDS

https://www.apogeerockets.com/downloads/MSDS/Aerotech/Motors.pdf

Epoxy MSDS

http://www.westsystem.com/ss/assets/MSDS/MSDS105.pdf

http://www.westsystem.com/ss/assets/MSDS/MSDS206.pdf

http://www.westsystem.com/ss/assets/MSDS/MSDS404.pdf

http://www.westsystem.com/ss/assets/MSDS/MSDS406.pdf

http://www.westsystem.com/ss/assets/MSDS/MSDS410.pdf

Acetone MSDS

http://www.sciencelab.com/msds.php?msdsId=9927062

Cesaroni MOTORS MSDs

https://www.apogeerockets.com/downloads/MSDS/Cesaroni/Cesaroni_Propellant_SDS.pdf

Fiberglass MSDS

http://web.mit.edu/rocketteam/www/usli/MSDS/Fiberglass%20(differnt%20supplier).pdf

Magnets MSDS

http://www.homedepot.com/catalog/pdfImages/ca/cab540e6-26b4-44f8-bb25-767d1eb428c9.pdf

Black Powder MSDS

https://www.epa.gov/sites/production/files/2015-05/documents/9530608.pdf

Batteries MSDS

http://www.omega.com/msds/msdspdf/MSDS0375.pdf

Obeying Federal, State, and Local Laws

All team members and mentors will act responsibly and will build the rocket and payload following all applicable laws.

All team members and mentors will also make sure to minimize any disturbances to the environment

All waste that we can recover will be disposed of properly and we will try our hardest to locate and safely recover any parts of the rocket that drifted away

Each team member will agree, by signature and date, to adhere to the following safety codes in Team Safety and Procedure Adherence Contract.

High Power Rocket Safety Code, Effective August 2012

1. 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.
2. Materials. I will use only lightweight materials such as paper, wood, rubber, plastic, fiberglass, or when necessary ductile metal, for the construction of my rocket.
3. 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.

4. 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.

5. 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.

6. 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 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.

7. 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.

8. 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.

9. 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 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.

10. 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 1000 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).

11. 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.

12. 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

13. Recovery Safety. I will not attempt to recover my rocket from power lines, tall trees, or other dangerous 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.

Minimum Distance from Launch

Installed Total Impulse (Newton-Seconds)	Equivalent High Power Motor Type	Minimum Diameter of Cleared Area (ft.)	Minimum Personnel Distance (ft.)	Minimum Personnel Distance (Complex Rocket) (ft.)
0 — 320.00	H or smaller	50	100	200
320.01 — 640.00	I	50	100	200
640.01 — 1,280.00	J	50	100	200
1,280.01 — 2,560.00	K	75	200	300

2,560.01 — 5,120.00	L	100	300	500
5,120.01 — 10,240.00	M	125	500	1000
10,240.01 — 20,480.00	N	125	1000	1500
20,480.01 — 40,960.00	O	125	1500	2000

FAA 101, Subpart C— Amateur Rockets

§101.21 - Applicability.

(a) This subpart applies to operating unmanned rockets. However, a person operating an unmanned rocket within a restricted area must comply with §101.25(b)(7)(ii) and with any additional limitations imposed by the using or controlling agency.

(b) A person operating an unmanned rocket other than an amateur rocket as defined in §1.1 of this chapter must comply with 14 CFR Chapter III.

From: http://www.ecfr.gov/cgi-bin/text-idx?rgn=div5&node=14:2.0.1.3.15#sp14.2.101.c

[Doc. No. FAA-2007-27390, 73 FR 73781, Dec. 4, 2008]

§101.22 - Definitions.

The following definitions apply to this subpart:

(a) *Class 1—Model Rocket* means an amateur rocket that:

(1) Uses no more than 125 grams (4.4 ounces) of propellant;

(2) Uses a slow-burning propellant;

(3) Is made of paper, wood, or breakable plastic;

(4) Contains no substantial metal parts; and

(5) Weighs no more than 1,500 grams (53 ounces), including the propellant.

(b) *Class 2—High-Power Rocket* means an amateur rocket other than a model rocket that is propelled by a motor or motors having a combined total impulse of 40,960 Newton-seconds (9,208 pound-seconds) or less.

(c) *Class 3—Advanced High-Power Rocket* means an amateur rocket other than a model rocket or high-power rocket.

§101.23 - General operating limitations.

(a) You must operate an amateur rocket in such a manner that it:

(1) Is launched on a suborbital trajectory;

(2) When launched, must not cross into the territory of a foreign country unless an agreement is in place between the United States and the country of concern;

(3) Is unmanned; and

(4) Does not create a hazard to persons, property, or other aircraft.

(b) The FAA may specify additional operating limitations necessary to ensure that air traffic is not adversely affected, and public safety is not jeopardized.

[Doc. No. FAA-2007-27390, 73 FR 73781, Dec. 4, 2008]

§101.25 - Operating limitations for Class 2-High Power Rockets and Class 3-Advanced High Power Rockets.

When operating *Class 2-High Power Rockets* or *Class 3-Advanced High Power* Rockets, you must comply with the General Operating Limitations of §101.23. In addition, you must not operate *Class 2-High Power Rockets* or *Class 3-Advanced High Power* Rockets—

(a) At any altitude where clouds or obscuring phenomena of more than five-tenths coverage prevails;

(b) At any altitude where the horizontal visibility is less than five miles;

(c) Into any cloud;

(d) Between sunset and sunrise without prior authorization from the FAA;

(e) Within 9.26 kilometers (5 nautical miles) of any airport boundary without prior authorization from the FAA;

(f) In controlled airspace without prior authorization from the FAA;

(g) Unless you observe the greater of the following separation distances from any person or property that is not associated with the operations:

(1) Not less than one-quarter the maximum expected altitude;

(2) 457 meters (1,500 ft.);

(h) Unless a person at least eighteen years old is present, is charged with ensuring the safety of the operation, and has final approval authority for initiating high-power rocket flight; and

(i) Unless reasonable precautions are provided to report and control a fire caused by rocket activities.

[74 FR 38092, July 31, 2009, as amended by Amdt. 101-8, 74 FR 47435, Sept. 16, 2009]

§101.27 - ATC notification for all launches.

No person may operate an unmanned rocket other than a Class 1—Model Rocket unless that person gives the following information to the FAA ATC facility nearest to the place of intended operation no less than 24 hours before and no more than three days before beginning the operation:

(a) The name and address of the operator; except when there are multiple participants at a single event, the name and address of the person so designated as the event launch coordinator, whose duties include coordination of the required launch data estimates and coordinating the launch event;

(b) Date and time the activity will begin;

(c) Radius of the affected area on the ground in nautical miles;

(d) Location of the center of the affected area in latitude and longitude coordinates;

(e) Highest affected altitude;

(f) Duration of the activity;

(g) Any other pertinent information requested by the ATC facility.

[Doc. No. FAA-2007-27390, 73 FR 73781, Dec. 4, 2008, as amended at Doc. No. FAA-2007-27390, 74 FR 31843, July 6, 2009]

§101.29 - Information requirements.

(a) *Class 2—High-Power Rockets.* When a Class 2—High-Power Rocket requires a certificate of waiver or authorization, the person planning the operation must provide the information below on each type of rocket to the FAA at least 45 days before the proposed operation. The FAA may request additional information if necessary to ensure the proposed operations can be safely conducted. The information shall include for each type of Class 2 rocket expected to be flown:

(1) Estimated number of rockets,

(2) Type of propulsion (liquid or solid), fuel(s) and oxidizer(s),

(3) Description of the launcher(s) planned to be used, including any airborne platform(s),

(4) Description of recovery system,

(5) Highest altitude, above ground level, expected to be reached,

(6) Launch site latitude, longitude, and elevation, and

(7) Any additional safety procedures that will be followed.

(b) *Class 3—Advanced High-Power Rockets.* When a Class 3—Advanced High-Power Rocket requires a certificate of waiver or authorization the person planning the operation must provide the information below for each type of rocket to the FAA at least 45 days before the proposed operation. The FAA may request additional information if necessary to ensure the proposed operations can be safely conducted. The information shall include for each type of Class 3 rocket expected to be flown:

(1) The information requirements of paragraph (a) of this section,

(2) Maximum possible range,

(3) The dynamic stability characteristics for the entire flight profile,

(4) A description of all major rocket systems, including structural, pneumatic, propellant, propulsion, ignition, electrical, avionics, recovery, wind-weighting, flight control, and tracking,

(5) A description of other support equipment necessary for a safe operation,

(6) The planned flight profile and sequence of events,

(7) All nominal impact areas, including those for any spent motors and other discarded hardware, within three standard deviations of the mean impact point,

(8) Launch commit criteria,

(9) Countdown procedures, and

(10) Mishap procedures.

[Doc. No. FAA-2007-27390, 73 FR 73781, Dec. 4, 2008, as amended at Doc. No. FAA-2007-27390, 74 FR 31843, July 6, 2009]

Payload: Exploration of the use of Magnetic Levitation to dampen g-Forces experienced during launch

The payload we chose focuses on a futuristic technology: using magnetic levitation for G-force damping. G-force damping is useful in that manned and unmanned space vehicles can only go at a speed which is safe for astronauts and equipment. With g-force damping technology called Magnetic Levitation, rockets in the future can reach greater speeds, allowing for inter-planetary travel faster than ever before. Magnetic levitation is a method by which an object is suspended with no support other than magnetic fields. Magnetic forces are used to counteract the effects of the G-forces and shocks. The two primary issues involved in magnetic levitation are lifting forces - providing magnetic repulsion sufficient to successfully oppose gravity, and stability - ensuring that the system does not spontaneously slide or flip into a position where the levitation is rendered impossible. Another way to do it is to use diamagnetism. Diamagnetism is the property of an object which causes it to create a magnetic field in opposition to an outer magnetic field, thus causing the material to be repelled by magnetism. Diamagnetic materials cause magnetic fields to curve away from the material. Specifically, an outer magnetic field changes the orbital speed of electrons around their nuclei, thus changing the magnetic dipole moment. Diamagnetism is a form of magnetism that is only exhibited by a substance in the area of an outer magnetic field. It is generally quite weak in most materials, although bismuth and superconductors exhibit a strong effect.

The idea is that magnets on an object being used as a payload will repel each other, thereby causing that object to float in midair inside the payload bay, which, we hope, will dampen sudden accelerations in that given object.

Payload Design

The payload will be a hollow 11.25 in length Fiberglass tube with a circular neodymium magnet attached to the bottom and top of it, the tube is outside of a 8.5 in length PVC tube with caps on each end and circular neodymium magnets secured inside each cap, the payload pod will be placed in the top of the nose cone through a centering ring then the centering ring will be cover with a wood bulkhead that has 6 screws going through it, There will be two accelerometers, one in the middle of the interior tube to measure the supposedly dampened forces and another accelerometer mounted outside the tubes to measure the undamped forces.

Backup Payload

Just in case there is some unforeseen problem with the magnetic levitation experiment, we have come up with a backup experiment. The experiment would be the impact of high g-forces on a slime mold's growth pattern and rate. The first step of the experiment would be to send the slime mold sclerotium up in a rocket, and letting them experience high g-forces. Next would be to take the sclerotium from the rocket and grow it next to a control, both in the exact same conditions and time. The final step would be to measure growth rates and observe growth patterns to see if there are any differences between the two slime molds. The slime molds would be grown in separate petri dishes with food placed in the same locations for each. The slime molds' behavior would then be compared to see if there is any difference between the two. Comparing the growth rate would be as simple as using a ruler to measure the distance traveled over a certain time interval, like one day. The slime mold used will be *Physarum polycephalum*, a slime mold that likes wet, cool, and shady areas.

One of the reasons to test the effects of a rocket launch on slime mold is possible infection of extraterrestrial objects. If a rocket launch stops growth then there will be less to worry about, but if it doesn't affect or if it even speeds up growth then that would be something to be much more concerned about. The slime mold could hitch a ride to Mars in a manned capsule, and if it does, it is important to know how to prevent it from infecting Mars and ruining many possible experiments having to do with life on Mars.

Slime molds can also solve complex problems like the shortest path problem, transportation problems, and even the Euclidean Steiner tree problem. Problems that computers have trouble solving, because of the sheer amount of information that has to be processed. Because of this, slime molds could be used to compute resource allocation on the ISS and on spacecraft, or in satellites to find the most efficient communication network. If the launch of the slime mold changed its properties, then these bio computers wouldn't work as intended.

If the large amount of acceleration somehow changed the slime mold's behavior, it could also shed some light on the inner workings of this organism, and perhaps enable researchers to create a complete computer model of slime mold's logic systems, which would enable scientists to create computers that could solve complex problems, or even, in the distant future, emulate the human brain.