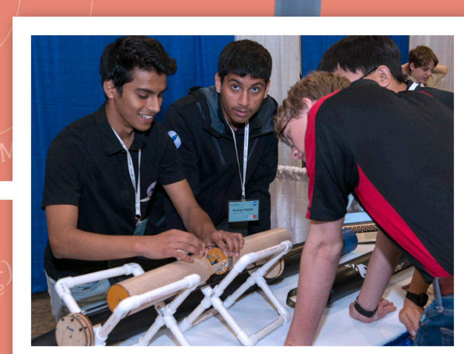
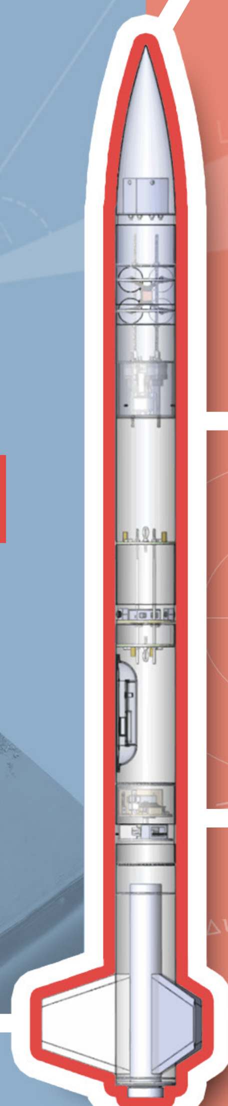
National Aeronautics and Space Administration

2020 NASA SL Student Launch

Handbook and Request for Proposal





Note: For your convenience, this document identifies Web links when available. These links are correct as of this publishing; however, since Web links can be moved or disconnected at any time, we have also provided source information as available to assist you in locating the information.

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Project Milestones: Criteria and Expectations

Safety

Awards

Timeline for NASA Student Launch

(Dates are subject to change.)

August 2019

22	Request for Proposal (RFP) released.

September 2019

18	Electronic copy of completed proposal due to project office by 3 p.m. CDT to

Katie Wallace: **katie.v.wallace@nasa.gov**
Fred Kepner: **fred.kepner@nasa.gov**

Receipt of all submissions will be confirmed via an email response. If you have attached a large file to your submission email and not received an email confirmation, it may not have been received.

October 2019

03	Awarded proposals announced
09	Kickoff and PDR Q&A
25	Team social media presence established, social media handle list sent to project office by 8 a.m. CDT.

November 2019

01	Preliminary Design Review (PDR) report, presentation slides, and flysheet submitted to NASA project management team by 8:00 a.m. CDT.
04–20	PDR video teleconferences
25	CDR Q&A

January 2020

10	Critical Design Review (CDR) report, presentation slides, and flysheet submitted to NASA project management team by 8:00 a.m. CST.
13–28	CDR video teleconferences
31	FRR Q&A

March 2020

02	Vehicle Demonstration Flight deadline
02	Flight Readiness Review (FRR) report, presentation slides, and flysheet submitted to NASA project management team by 8:00 a.m. CST.
06–19	FRR video teleconferences
23	Payload Demonstration Flight and Vehicle Demonstration Re-flight deadlines
23	FRR Addendum submitted to NASA project management team by 8:00 a.m. CDT. (Teams completing additional Payload Demonstration Flights and Vehicle Demonstration Re-flights only)
26	Launch Week Q&A

April 2020

01	Teams travel to Huntsville, AL
01	OPTIONAL – Launch Readiness Reviews (LRR) for teams arriving early.
02	Official Launch Week Kickoff, LRRs, Launch Week Activities
03	Launch Week Activities
04	Launch Day
04	Awards Ceremony
05	Backup launch day
27	Post-Launch Assessment Review (PLAR) submitted to NASA project management team by 8:00 a.m. CDT.

Acronym Dictionary

AGL = Above Ground Level

APCP = Ammonium Perchlorate Composite Propellant

CDR = Critical Design Review

CG = Center of Gravity

CP = Center of Pressure

FAA = Federal Aviation Administration

FN = Foreign National

FRR = Flight Readiness Review

HEO = Human Exploration and Operations

LCO = Launch Control Officer

LRR = Launch Readiness Review

MSDS = Material Safety Data Sheet

MSFC = Marshall Space Flight Center

NAR = National Association of Rocketry

PDR = Preliminary Design Review

PLAR = Post Launch Assessment Review

PPE = Personal Protective Equipment

RFP = Request for Proposal

RSO = Range Safety Officer

SLI = Student Launch Initiative

SLS = Space Launch System

SME = Subject Matter Expert

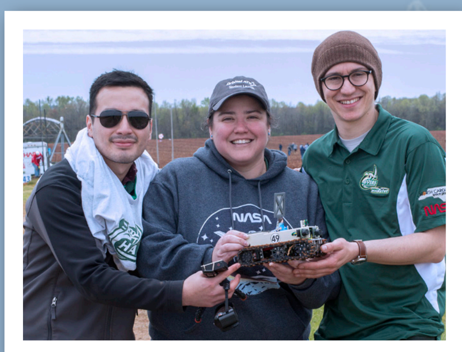
SOW = Statement of Work

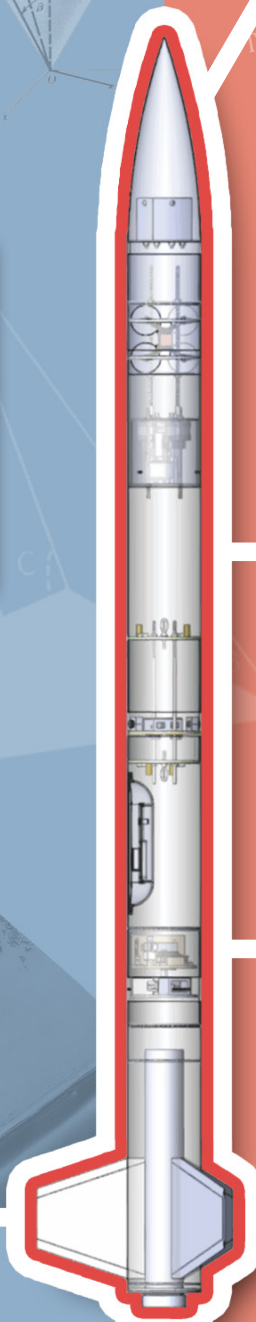
STEM = Science, Technology, Engineering, and Mathematics

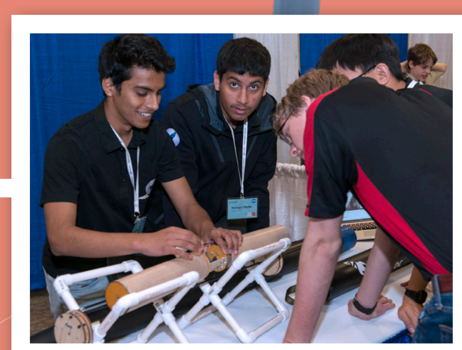
TRA = Tripoli Rocketry Association

USLI = University Student Launch Initiative

Proposal/ Statement of Work







Design, Development, and Launch of a Reusable Rocket and Payload Statement of Work (SOW)

1. **Activity Name: NASA Student Launch**

2. **Governing Office: NASA Marshall Space Flight Center Office of STEM Engagement**

3. **Period of Performance: Eight (8) calendar months.**

4. **Introduction**

The Office of STEM Engagement at NASA Marshall Space Flight Center (MSFC) seeks proposals from colleges and universities to conduct the NASA University Student Launch Initiative (USLI) and qualified high schools and middle schools to conduct the NASA Student Launch Initiative (SLI) during the 2019-2020 academic year. The NASA Student Launch (SL) is a research-based, competitive, and experiential learning project that provides relevant and cost-effective research and development to help solve problems critical to NASA's missions. SL connects learners, educators, and communities in NASA-unique opportunities that align with Science, Technology, Engineering, and Mathematics (STEM) Challenges. The activity is supported by the Human Exploration and Operations (HEO) Mission Directorate and commercial industry.

Student Launch reaches a broad audience of colleges, universities, and secondary institutions across the nation in an 8-month commitment to design, build, launch, and fly a payload(s) and vehicle components that support NASA research on high-power rockets. The College/University Division teams are challenged to develop a system capable of collecting a simulated lunar ice sample. Teams may incorporate additional research through the use of a separate payload if desired. Secondary experiments must be approved by NASA. In addition, the team must provide documentation on additional components and systems in all reports and reviews. High School/Middle School division teams may elect to tackle the College/University Division challenge, or they may design their own science or engineering experiment. Awards are presented to teams in both divisions at an awards ceremony during Launch Week. More information on awards is on pages 43 and 44.

Proposals to participate in the NASA Student Launch Projects College/University Division will be accepted from any US college or university. Proposals to participate in the High School/Middle School Division will only be accepted from teams who: 1) have qualified at the Team America Rocketry Competition (Top 25) or Rockets for Schools (Top 3) in either 2018 or 2019 and have completed the Advanced Rocketry Workshop (ARW) or 2) have qualified for Student Launch Journeyman status. Journeyman status shall be given to High School/Middle School Division teams who meet the following requirements: 1) have participated in Student Launch for four or more consecutive years, 2) satisfactorily completed Student Launch during the previous academic year, and 3) the team educator has completed the NASA Student Launch Advanced Rocketry Workshop. Student Launch proposals and participation are limited to one team per school.

After the competitive proposal selection process, teams will complete a series of design reviews that mirror the NASA engineering design lifecycle. Teams must successfully complete a Preliminary Design Review (PDR), Critical Design Review (CDR), Flight Readiness Review (FRR), and Launch Readiness Review (LRR) which include safety briefings, analysis of vehicle and payload systems, and flight test data. Each team must pass a review in order to move to a subsequent review. Teams will present their PDR, CDR, and FRR to a review panel of scientists, engineers, technicians, and educators via video teleconference. Review panel members, the Range Safety Officer (RSO), and Subject Matter Experts (SME) provide feedback and ask questions in order to increase the fidelity between the team's work and research objectives, and will score each College/University Division team according to a standard scoring rubric. High School/Middle School Division teams complete the same milestones but are not in competition and are not scored.

The requirements for NASA Student Launch are as follows:

1. General Requirements

1.1. Students on the team will do 100% of the project, including design, construction, written reports, presentations, and flight preparation with the exception of assembling the motors and handling black powder or any variant of ejection charges, or preparing and installing electric matches (to be done by the team's mentor). Teams will submit new work. Excessive use of past work will merit penalties.

1.2. The team will provide and maintain a project plan to include, but not limited to the following items: project milestones, budget and community support, checklists, personnel assignments, STEM engagement events, and risks and mitigations.

1.3. Foreign National (FN) team members must be identified by the Preliminary Design Review (PDR) and may or may not have access to certain activities during launch week due to security restrictions. In addition, FN's may be separated from their team during certain activities on site at Marshall Space Flight Center.

1.4. The team must identify all team members attending launch week activities by the Critical Design Review (CDR). Team members will include:

1.4.1. Students actively engaged in the project throughout the entire year.

1.4.2. One mentor (see requirement 1.13).

1.4.3. No more than two adult educators.

1.5. The team will engage a minimum of 200 participants in educational, hands-on science, technology, engineering, and mathematics (STEM) activities, as defined in the STEM Engagement Activity Report, by FRR. To satisfy this requirement, all events must occur between project acceptance and the FRR due date and the STEM Engagement Activity Report must be submitted via email within two weeks of the completion of the event. A sample of the STEM Engagement Activity Report is on page 35.

1.6. The team will establish a social media presence to inform the public about team activities.

1.7. Teams will email all deliverables to the NASA project management team by the deadline specified in the handbook for each milestone. In the event that a deliverable is too large to attach to an email, inclusion of a link to download the file will be sufficient.

1.8. All deliverables must be in PDF format.

1.9. In every report, teams will provide a table of contents including major sections and their respective sub-sections.

1.10. In every report, the team will include the page number at the bottom of the page.

1.11. The team will provide any computer equipment necessary to perform a video teleconference with the review panel. This includes, but is not limited to, a computer system, video camera, speaker telephone, and a sufficient Internet connection. Cellular phones should be used for speakerphone capability only as a last resort.

1.12. All teams will be required to use the launch pads provided by Student Launch's launch services provider. No custom pads will be permitted on the launch field. At launch, 8-foot 1010 rails and 12-foot 1515 rails will be provided. The launch rails will be canted 5 to 10 degrees away from the crowd on launch day. The exact cant will depend on launch day wind conditions.

1.13. Each team must identify a "mentor." A mentor is defined as an adult who is included as a team member, who will be supporting the team (or multiple teams) throughout the project year, and may or may not be affiliated with the school, institution, or organization. The mentor must maintain a current certification, and be in good standing, through the National Association of Rocketry (NAR) or Tripoli Rocketry Association (TRA) for the motor impulse of the launch vehicle and must have flown and successfully recovered (using electronic, staged recovery) a minimum of 2 flights in this or a higher impulse class, prior to PDR. The mentor is designated as the individual owner of the rocket for liability purposes and must travel with the team to launch week. One travel stipend will be provided per mentor regardless of the number of teams he or she supports. The stipend will only be provided if the team passes FRR and the team and mentor attend launch week in April.

2. Vehicle Requirements

2.1. The vehicle will deliver the payload to an apogee altitude between 3,500 and 5,500 feet above ground level (AGL). Teams flying below 3,000 feet or above 6,000 feet on Launch Day will be disqualified and receive zero altitude points towards their overall project score.

2.2. Teams shall identify their target altitude goal at the PDR milestone. The declared target altitude will be used to determine the team's altitude score during Launch Week.

2.3. The vehicle will carry one commercially available, barometric altimeter for recording the official altitude used in determining the Altitude Award winner. The Altitude Award will be given to the team with the smallest difference between their measured apogee and their official target altitude on launch day. This altimeter may also be used for deployment purposes (see Requirement 3.4)

2.4. The launch vehicle will be designed to be recoverable and reusable. Reusable is defined as being able to launch again on the same day without repairs or modifications.

2.5. The launch vehicle will have a maximum of four (4) independent sections. An independent section is defined as a section that is either tethered to the main vehicle or is recovered separately from the main vehicle using its own parachute.

2.5.1. Coupler/airframe shoulders which are located at in-flight separation points will be at least 1 body diameter in length.

2.5.2. Nosecone shoulders which are located at in-flight separation points will be at least ½ body diameter in length.

2.6. The launch vehicle will be capable of being prepared for flight at the launch site within 2 hours of the time the Federal Aviation Administration flight waiver opens.

2.7. The launch vehicle and payload will be capable of remaining in launch-ready configuration on the pad for a **minimum** of 2 hours without losing the functionality of any critical on-board components, although the capability to withstand longer delays is highly encouraged.

2.8. The launch vehicle will be capable of being launched by a standard 12-volt direct current firing system. The firing system will be provided by the NASA-designated launch services provider.

2.9. The launch vehicle will require no external circuitry or special ground support equipment to initiate launch (other than what is provided by the launch services provider).

2.10. The launch vehicle will use a commercially available solid motor propulsion system using ammonium perchlorate composite propellant (APCP) which is approved and certified by the National Association of Rocketry (NAR), Tripoli Rocketry Association (TRA), and/or the Canadian Association of Rocketry (CAR).

- 2.10.1. Final motor choices will be declared by the Critical Design Review (CDR) milestone.
- 2.10.2. Any motor change after CDR must be approved by the NASA Range Safety Officer (RSO) and will only be approved if the change is for the sole purpose of increasing the safety margin. A penalty against the team's overall score will be incurred when a motor change is made after the CDR milestone, regardless of the reason.

2.11. The launch vehicle will be limited to a single stage.

2.12. The total impulse provided by a College or University launch vehicle will not exceed 5,120 Newton-seconds (L-class). The total impulse provided by a High School or Middle School launch vehicle will not exceed 2,560 Newton-seconds (K-class).

2.13. Pressure vessels on the vehicle will be approved by the RSO and will meet the following criteria:

- 2.13.1. The minimum factor of safety (Burst or Ultimate pressure versus Max Expected Operating Pressure) will be 4:1 with supporting design documentation included in all milestone reviews.
- 2.13.2. Each pressure vessel will include a pressure relief valve that sees the full pressure of the tank and is capable of withstanding the maximum pressure and flow rate of the tank.
- 2.13.3. The full pedigree of the tank will be described, including the application for which the tank was designed and the history of the tank. This will include the number of pressure cycles put on the tank, the dates of pressurization/depressurization, and the name of the person or entity administering each pressure event.

2.14. The launch vehicle will have a minimum static stability margin of 2.0 at the point of rail exit. Rail exit is defined at the point where the forward rail button loses contact with the rail.

2.15. Any structural protuberance on the rocket will be located aft of the burnout center of gravity.

2.16. The launch vehicle will accelerate to a minimum velocity of 52 fps at rail exit.

2.17. All teams will successfully launch and recover a subscale model of their rocket prior to CDR. Subscales are not required to be high power rockets.

- 2.17.1. The subscale model should resemble and perform as similarly as possible to the full-scale model, however, the full-scale will not be used as the subscale model.
- 2.17.2. The subscale model will carry an altimeter capable of recording the model's apogee altitude.
- 2.17.3. The subscale rocket must be a newly constructed rocket, designed and built specifically for this year's project.
- 2.17.4. Proof of a successful flight shall be supplied in the CDR report. Altimeter data output may be used to meet this requirement.

2.18. All teams will complete demonstration flights as outlined below.

- 2.18.1. Vehicle Demonstration Flight - All teams will successfully launch and recover their full-scale rocket prior to FRR in its final flight configuration. The rocket flown must be the same rocket to be flown on launch day. The purpose of the Vehicle Demonstration Flight is to validate the launch vehicle's stability, structural integrity, recovery systems, and the team's ability to prepare the launch vehicle for flight. A successful flight is defined as a launch in which all hardware is functioning properly (i.e. drogue chute at apogee, main chute at the intended lower altitude, functioning tracking devices, etc.). The following criteria must be met during the full-scale demonstration flight:

2.18.1.1. The vehicle and recovery system will have functioned as designed.

2.18.1.2. The full-scale rocket must be a newly constructed rocket, designed and built specifically for this year's project.

2.18.1.3. The payload does not have to be flown during the full-scale Vehicle Demonstration Flight. The following requirements still apply:

2.18.1.3.1. If the payload is not flown, mass simulators will be used to simulate the payload mass.

2.18.1.3.2. The mass simulators will be located in the same approximate location on the rocket as the missing payload mass.

2.18.1.4. If the payload changes the external surfaces of the rocket (such as with camera housings or external probes) or manages the total energy of the vehicle, those systems will be active during the full-scale Vehicle Demonstration Flight.

2.18.1.5. Teams shall fly the launch day motor for the Vehicle Demonstration Flight. The team may request a waiver for the use of an alternative motor in advance if the home launch field cannot support the full impulse of the launch day motor or in other extenuating circumstances (such as weather).

2.18.1.6. The vehicle must be flown in its fully ballasted configuration during the full-scale test flight. Fully ballasted refers to the same amount of ballast that will be flown during the launch day flight. Additional ballast may not be added without a re-flight of the full-scale launch vehicle.

2.18.1.7. After successfully completing the full-scale demonstration flight, the launch vehicle or any of its components will not be modified without the concurrence of the NASA Range Safety Officer (RSO).

2.18.1.8. Proof of a successful flight shall be supplied in the FRR report. Altimeter data output is required to meet this requirement.

2.18.1.9. Vehicle Demonstration flights must be completed by the FRR submission deadline. No exceptions will be made. If the Student Launch office determines that a Vehicle Demonstration Re-flight is necessary, then an extension may be granted. THIS EXTENSION IS ONLY VALID FOR RE-FLIGHTS, NOT FIRST TIME FLIGHTS. Teams completing a required re-flight must submit an FRR Addendum by the FRR Addendum deadline.

2.18.2. Payload Demonstration Flight - All teams will successfully launch and recover their full-scale rocket containing the completed payload prior to the Payload Demonstration Flight deadline. The rocket flown must be the same rocket to be flown on launch day. The purpose of the Payload Demonstration Flight is to prove the launch vehicle's ability to safely retain the constructed payload during flight and to show that all aspects of the payload perform as designed. A successful flight is defined as a launch in which the rocket experiences stable ascent and the payload is fully retained until it is deployed (if applicable) as designed. The following criteria must be met during the Payload Demonstration Flight:

2.18.2.1. The payload must be fully retained until the intended point of deployment (if applicable), all retention mechanisms must function as designed, and the retention mechanism must not sustain damage requiring repair.

2.18.2.2. The payload flown must be the final, active version.

2.18.2.3. If the above criteria are met during the original Vehicle Demonstration Flight, occurring prior to the FRR deadline and the information is included in the FRR package, the additional flight and FRR Addendum are not required.

2.18.2.4. Payload Demonstration Flights must be completed by the FRR Addendum deadline. NO EXTENSIONS WILL BE GRANTED.

2.19. An FRR Addendum will be required for any team completing a Payload Demonstration Flight or NASA-required Vehicle Demonstration Re-flight after the submission of the FRR Report.

2.19.1. Teams required to complete a Vehicle Demonstration Re-Flight and failing to submit the FRR Addendum by the deadline will not be permitted to fly the vehicle at launch week.

2.19.2. Teams who successfully complete a Vehicle Demonstration Flight but fail to qualify the payload by satisfactorily completing the Payload Demonstration Flight requirement will not be permitted to fly the payload at launch week.

2.19.3. Teams who complete a Payload Demonstration Flight which is not fully successful may petition the NASA RSO for permission to fly the payload at launch week. Permission will not be granted if the RSO or the Review Panel have any safety concerns.

2.20. The team's name and launch day contact information shall be in or on the rocket airframe as well as in or on any section of the vehicle that separates during flight and is not tethered to the main airframe. This information shall be included in a manner that allows the information to be retrieved without the need to open or separate the vehicle.

2.21. All Lithium Polymer batteries will be sufficiently protected from impact with the ground and will be brightly colored, clearly marked as a fire hazard, and easily distinguishable from other payload hardware.

2.22. Vehicle Prohibitions

2.22.1. The launch vehicle will not utilize forward canards. Camera housings will be exempted, provided the team can show that the housing(s) causes minimal aerodynamic effect on the rocket's stability.

2.22.2. The launch vehicle will not utilize forward firing motors.

2.22.3. The launch vehicle will not utilize motors that expel titanium sponges (Sparky, Skidmark, Metal-Storm, etc.)

2.22.4. The launch vehicle will not utilize hybrid motors.

2.22.5. The launch vehicle will not utilize a cluster of motors.

2.22.6. The launch vehicle will not utilize friction fitting for motors.

2.22.7. The launch vehicle will not exceed Mach 1 at any point during flight.

2.22.8. Vehicle ballast will not exceed 10% of the total unballasted weight of the rocket as it would sit on the pad (i.e. a rocket with an unballasted weight of 40 lbs. on the pad may contain a maximum of 4 lbs. of ballast).

2.22.9. Transmissions from onboard transmitters will not exceed 250 mW of power (per transmitter).

2.22.10 Transmitters will not create excessive interference. Teams will utilize unique frequencies, handshake/passcode systems, or other means to mitigate interference caused to or received from other teams.

2.22.11. Excessive and/or dense metal will not be utilized in the construction of the vehicle. Use of lightweight metal will be permitted but limited to the amount necessary to ensure structural integrity of the airframe under the expected operating stresses.

3. Recovery System Requirements

3.1. The launch vehicle will stage the deployment of its recovery devices, where a drogue parachute is deployed at apogee, and a main parachute is deployed at a lower altitude. Tumble or streamer recovery from apogee to main parachute deployment is also permissible, provided that kinetic energy during drogue stage descent is reasonable, as deemed by the RSO.

3.1.1. The main parachute shall be deployed no lower than 500 feet.
3.1.2. The apogee event may contain a delay of no more than 2 seconds.
3.1.3. Motor ejection is not a permissible form of primary or secondary deployment.

3.2. Each team must perform a successful ground ejection test for both the drogue and main parachutes. This must be done prior to the initial subscale and full-scale launches.

3.3. Each independent section of the launch vehicle will have a maximum kinetic energy of 75 ft-lbf at landing.

3.4. The recovery system will contain redundant, commercially available altimeters. The term "altimeters" includes both simple altimeters and more sophisticated flight computers.

3.5. Each altimeter will have a dedicated power supply, and all recovery electronics will be powered by commercially available batteries.

3.6. Each altimeter will be armed by a dedicated mechanical arming switch that is accessible from the exterior of the rocket airframe when the rocket is in the launch configuration on the launch pad.

3.7. Each arming switch will be capable of being locked in the ON position for launch (i.e. cannot be disarmed due to flight forces).

3.8. The recovery system electrical circuits will be completely independent of any payload electrical circuits.

3.9. Removable shear pins will be used for both the main parachute compartment and the drogue parachute compartment.

3.10. The recovery area will be limited to a 2,500 ft. radius from the launch pads.

3.11. Descent time will be limited to 90 seconds (apogee to touch down).

3.12. An electronic tracking device will be installed in the launch vehicle and will transmit the position of the tethered vehicle or any independent section to a ground receiver.

3.12.1. Any rocket section or payload component, which lands untethered to the launch vehicle, will contain an active electronic tracking device.
3.12.2. The electronic tracking device(s) will be fully functional during the official flight on launch day.

3.13. The recovery system electronics will not be adversely affected by any other on-board electronic devices during flight (from launch until landing).

3.13.1. The recovery system altimeters will be physically located in a separate compartment within the vehicle from any other radio frequency transmitting device and/or magnetic wave producing device.
3.13.2. The recovery system electronics will be shielded from all onboard transmitting devices to avoid inadvertent excitation of the recovery system electronics.
3.13.3. The recovery system electronics will be shielded from all onboard devices which may generate magnetic waves (such as generators, solenoid valves, and Tesla coils) to avoid inadvertent excitation of the recovery system.
3.13.4. The recovery system electronics will be shielded from any other onboard devices which may adversely affect the proper operation of the recovery system electronics.

4. Payload Experiment Requirements

All payload designs must be approved by NASA. NASA reserves the authority to require a team to modify or change a payload, as deemed necessary by the Review Panel, even after a proposal has been awarded.

4.1. High School/Middle School Division – Teams may design their own science or engineering experiment or may choose to complete the College/University Division mission. Data from the science or engineering experiment will be collected, analyzed, and reported by the team following the scientific method.

4.2. College/University Division – Teams will design a system capable of being launched in a high power rocket, landing safely, and recovering simulated lunar ice from one of several locations on the surface of the launch field. The method(s)/design(s) utilized will be at the teams' discretion and will be permitted so long as the designs are deemed safe, obey FAA and legal requirements, and adhere to the intent of the challenge.

An additional experiment (limit of 1) is allowed, and may be flown, but will not contribute to scoring. If the team chooses to fly an additional experiment, they will provide the appropriate documentation in all design reports so the experiment may be reviewed for flight safety.

4.3. Lunar Ice Sample Recovery Mission Requirements

4.3.1. The launch vehicle will be launched from the NASA-designated launch area using the provided Launch pad. All hardware utilized at the recovery site must launch on or within the launch vehicle.

4.3.2. Five recovery areas will be located on the surface of the launch field. Teams may recover a sample from any of the recovery areas. Each recovery site will be at least 3 feet in diameter and contain sample material extending from ground level to at least 2 inches below the surface.

4.3.3. The recovered ice sample will be a minimum of 10 milliliters (mL).

4.3.4. Once the sample is recovered, it must be stored and transported at least 10 linear feet from the recovery area.

4.3.5. Teams must abide by all FAA and NAR rules and regulations.

4.3.6. Black Powder and/or similar energetics are only permitted for deployment of in-flight recovery systems. Any ground deployments must utilize mechanical systems.

4.3.7. Any part of the payload or vehicle that is designed to be deployed, whether on the ground or in the air, must be fully retained until it is deployed as designed.

4.3.7.1. A mechanical retention system will be designed to prohibit premature deployment.

4.3.7.2. The retention system will be robust enough to successfully endure flight forces experienced during both typical and atypical flights.

4.3.7.3. The designed system will be fail-safe.

4.3.7.4. Exclusive use of shear pins will not meet this requirement.

4.4. Special Requirements for UAVs and Jettisoned Payloads

4.4.1. Any experiment element that is jettisoned during the recovery phase will receive real-time RSO permission prior to initiating the jettison event.

4.4.2. Unmanned aerial vehicle (UAV) payloads, if designed to be deployed during descent, will be tethered to the vehicle with a remotely controlled release mechanism until the RSO has given permission to release the UAV.

4.4.3. Teams flying UAVs will abide by all applicable FAA regulations, including the FAA's Special Rule for Model Aircraft (Public Law 112-95 Section 336; see **https://www.faa.gov/uas/faqs**).

4.4.4. Any UAV weighing more than .55 lbs. will be registered with the FAA and the registration number marked on the vehicle.

5. Safety Requirements

5.1. Each team will use a launch and safety checklist. The final checklists will be included in the FRR report and used during the Launch Readiness Review (LRR) and any launch day operations.

5.2. Each team must identify a student safety officer who will be responsible for all items in section 5.3.

5.3. The role and responsibilities of the safety officer will include, but are not limited to:

5.3.1. Monitor team activities with an emphasis on safety during:

5.3.1.1. Design of vehicle and payload

5.3.1.2. Construction of vehicle and payload components

5.3.1.3. Assembly of vehicle and payload

5.3.1.4. Ground testing of vehicle and payload

5.3.1.5. Subscale launch test(s)

5.3.1.6. Full-scale launch test(s)

5.3.1.7. Launch day

5.3.1.8. Recovery activities

5.3.1.9. STEM Engagement Activities

5.3.2. Implement procedures developed by the team for construction, assembly, launch, and recovery activities.

5.3.3. Manage and maintain current revisions of the team's hazard analyses, failure modes analyses, procedures, and MSDS/chemical inventory data.

5.3.4. Assist in the writing and development of the team's hazard analyses, failure modes analyses, and procedures.

5.4. During test flights, teams will abide by the rules and guidance of the local rocketry club's RSO. The allowance of certain vehicle configurations and/or payloads at the NASA Student Launch does not give explicit or implicit authority for teams to fly those vehicle configurations and/or payloads at other club launches. Teams should communicate their intentions to the local club's President or Prefect and RSO before attending any NAR or TRA launch.

5.5. Teams will abide by all rules set forth by the FAA.

NASA will maintain a Frequently Asked Questions (FAQ) list on the Student Launch Website (**www.nasa.gov/studentlaunch**). This list will include important changes and/or clarifications to project requirements. Changes and clarifications appearing in the FAQ supersede what is written in this handbook. It is the team's responsibility to check the FAQ and be aware of any changes to the challenge.

Proposal Requirements

At a minimum, the proposing team shall identify the following in a written proposal due to NASA MSFC by the dates specified in the project timeline.

General Information

1. A cover page that includes the name of the college/university or secondary education institution, mailing address, title of the project, and the date.

2. Name, title, and contact information (including email address and phone number) for up to two adult educators. (minimum of one required)

3. Name, title, and contact information for the student team leader.

4. Name and title of the student team member who will take responsibility for implementation of the safety plan. (Safety Officer)

5. Approximate number of student participants who will be committed to the project and their proposed duties. Include an outline of the project organization that identifies the key managers and technical personnel.

6. Name of the NAR/TRA section(s) the team is planning to work with for purposes of mentoring, review of designs and documentation, and launch assistance.

Facilities/Equipment

1. Description of facilities and hours of accessibility, necessary personnel, equipment, and supplies that are required to design and build the rocket and payload(s). Specify what is on hand and what will need to be acquired.

Safety

The Federal Aviation Administration (FAA) [**www.faa.gov**] has specific laws governing the use of airspace. A demonstration of the understanding and intent to abide by the applicable federal laws (especially as related to the use of airspace at the launch sites and the use of combustible/flammable material), safety codes, guidelines, and procedures for building, testing, and flying large model rockets is crucial. The procedures and safety regulations of the NAR [**www.nar.org/safety-information/**] shall be used for flight design and operations. The NAR/TRA mentor and Safety Officer shall oversee launch operations and motor handling.

1. Provide a written safety plan addressing the safety of the materials used, facilities involved, and student responsible, i.e. Safety Officer, for ensuring that the plan is followed. A risk assessment should be done for all these aspects in addition to proposed mitigations. Identification of risks to the successful completion of the project should be included.

   1.1. Provide a description of the procedures for NAR/TRA personnel to perform. Ensure the following:
   - Compliance with NAR High Power Safety Code requirements [**http://www.nar.org/safety-information/high-power-rocket-safety-code/**].
   - Performance of all hazardous materials handling and hazardous operations.

   1.2. Describe the plan for briefing students on hazard recognition and accident avoidance as well as for conducting pre-launch briefings.

1.3. Describe methods to include necessary caution statements in plans, procedures, and other working documents, including the use of proper Personal Protective Equipment (PPE).

1.4. Each team shall provide a plan for complying with federal, state, and local laws regarding unmanned rocket launches and motor handling. Specifically, regarding the use of airspace, Federal Aviation Regulations 14 CFR, Subchapter F, Part 101, Subpart C; Amateur Rockets, Code of Federal Regulation 27 Part 55: Commerce in Explosives; and fire prevention, NFPA 1127 "Code for High Power Rocket Motors."

1.5. Provide a plan for NRA/TRA mentor purchase, storage, transportation, and use of rocket motors and energetic devices.

1.6. Include a written statement that all team members understand and will abide by the following safety regulations:
   1.6.1. Range safety inspections will be conducted on each rocket before it is flown. Each team shall comply with the determination of the safety inspection or may be removed from the program.
   1.6.2. The Range Safety Officer has the final say on all rocket safety issues. Therefore, the Range Safety Officer has the right to deny the launch of any rocket for safety reasons.
   1.6.3. The team mentor is ultimately responsible for the safe flight and recovery of the team's rocket. Therefore, a team will not fly a rocket until the mentor has reviewed the design, examined the build and is satisfied the rocket meets established amateur rocketry design and safety guidelines.
   1.6.4. Any team that does not comply with the safety requirements will not be allowed to launch their rocket.

Technical Design

1. A proposed and detailed approach to rocket and payload design.
   a. Include general vehicle dimensions, preliminary material selection and justification, and construction methods.
   b. Include projected altitude and describe how it was calculated.
   c. Include planned recovery system design.
   d. Include projected motor brand and designation.
   e. Include detailed description of the team's projected payload.
   f. Address the General, Vehicle, Recovery, Payload, and Safety requirements outlined on pages 5-12 of this handbook.
   g. Address major technical challenges and solutions.

STEM Engagement

1. Include plans and evaluation criteria for required STEM engagement activities. (See project requirement 1.5 on page 5)

Project Plan

1. Provide a detailed development schedule/timeline covering all aspects necessary to complete the project successfully.

2. Provide a detailed budget to cover all aspects necessary to complete the project successfully, including team travel to the launch.

3. Provide a detailed funding plan.

4. Develop a clear plan for sustainability of the rocket project in the local area. This plan should include how to provide and maintain established partnerships and regularly engage successive classes of students in rocketry. It should also include partners (industry/community), recruitment of team members, funding sustainability, and STEM engagement activities.

Deliverables required for successful participation are listed below. More details are provided in the Project Milestones: Criteria and Expectations section.

1. A reusable rocket with required payload system ready for official launch.

2. A scale model of the rocket design must be flown before CDR and the flight data reported in the CDR.

3. A full-scale Vehicle Demonstration Flight and Payload Demonstration Flight must be flown and flight data reported in the FRR and/or FRR Addendum.

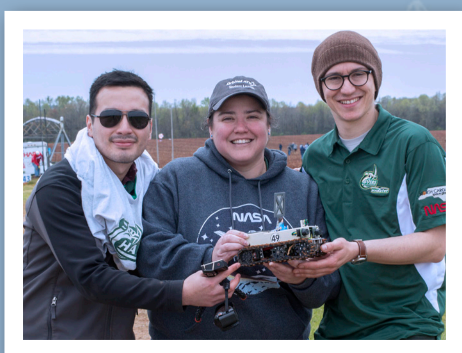
4. A team social media presence established and maintained/updated throughout the project year.

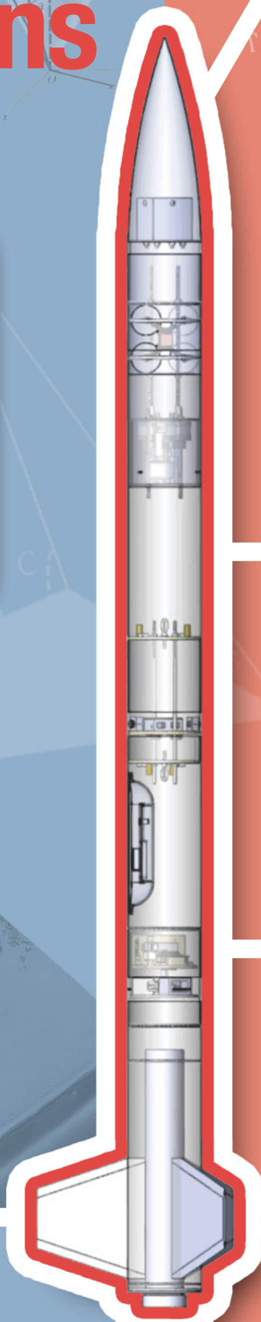
5. Reports, PDF slideshows, and Milestone Review Flysheets completed and submitted to the Student Launch Projects management team by due dates.

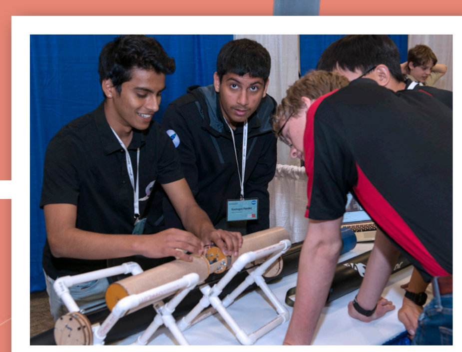
6. Electronic copies of the STEM Engagement form(s) submitted after proposal acceptance, prior to FRR, and within two weeks of the STEM engagement event.

7. Participation in PDR, CDR, FRR, LRR, and PLAR.

Project Milestones: Criteria and Expectations







Preliminary Design Review (PDR)

The PDR demonstrates that the overall preliminary design meets all requirements with acceptable risk, within the cost and schedule constraints, and establishes the basis for proceeding with detailed design. It shows that the correct design options have been selected, interfaces have been identified, and verification methods have been described. Full baseline cost and schedules, as well as all risk assessment, management systems, and metrics, are presented.

The panel will be expecting a professional and polished report that follows the order of sections as they appear below.

Preliminary Design Review Report

All information contained in the general information section of the project proposal shall also be included in the PDR Report.

Page Limit: PDRs will only be scored using the first 250 pages of the report (not including title page). Any additional content will not be considered while scoring.

I) Summary of PDR report (1 page maximum)

Team Summary

- Team name and mailing address
- Name of mentor, NAR/TRA number and certification level, and contact information

Launch Vehicle Summary

- Size and mass
- Preliminary motor choice(s)
- Official target altitude (ft.)
- Recovery system

Payload Summary

- Payload title
- Summarize payload experiment

II) Changes made since Proposal (1-2 pages maximum)

Highlight all changes made since the proposal and the reason for those changes.

- Changes made to vehicle criteria
- Changes made to payload criteria
- Changes made to project plan

III) Vehicle Criteria

Selection, Design, and Rationale of Launch Vehicle

- Include unique mission statement and mission success criteria.
- Review the design at a system level, going through each system's alternative designs, and evaluating the pros and cons of each alternative.
- For each alternative, present research on why that alternative should or should not be chosen.
- After evaluating all alternatives, present a vehicle design with the current leading alternatives, and explain why they are the leading choices.
    - Describe each subsystem and the components within those subsystems
    - Provide a dimensional drawing using the leading design
    - Provide estimated masses for each subsystem
    - Provide sufficient justification for design selections
- Review different motor alternatives and present data on each alternative.

Recovery Subsystem

- Review the design at a component level, going through each components' alternative designs, and evaluating the pros and cons of each alternative.
- For each alternative, present research on why that alternative should or should not be chosen.
- Using the estimated mass of the launch vehicle, perform a preliminary analysis on parachute sizing, and determine what size is required for a safe descent.
- Choose leading components amongst the alternatives, present them, and explain why they are the current leaders.
- Prove that redundancy exists within the system.

Mission Performance Predictions

- Declare the team's official launch day target altitude (ft.).
- Show flight profile simulations, altitude predictions with simulated vehicle data, component weights, and simulated motor thrust curve. Verify that the vehicle is robust enough to withstand the expected loads.
- Show stability margin and simulated Center of Pressure (CP)/Center of Gravity (CG) relationship and locations.
- Calculate the kinetic energy at landing for each independent and tethered section of the launch vehicle.
- Calculate the expected descent time for the rocket and any section that descends untethered from the rest of the vehicle.
- Calculate the drift for each independent section of the launch vehicle from the launch pad for five different cases: no wind, 5-mph wind, 10-mph wind, 15-mph wind, and 20-mph wind. The drift calculations should be performed with the assumption that apogee is reached directly above the launch pad.
- Present data from a different calculation method to verify that original results are accurate.
- Discuss any differences between the different calculations.
- Perform multiple simulations to verify that results are precise.

IV) Payload Criteria

Selection, Design, and Rationale of Payload

- Describe what the objective of the payload is and what experiment it will perform. What results will qualify as a successful experiment?
- Review the design at a system level, going through each system's alternative designs, and evaluating the pros and cons of each alternative.
- For each alternative, present research on why that alternative should or should not be chosen.
- After evaluating all alternatives, present a payload design with the current leading alternatives and explain why they are the leading choices.
- Include drawings and electrical schematics for all elements of the preliminary payload. List estimated masses for components.
- Describe the justification used when making design selections.
- Describe the preliminary interfaces between the payload and launch vehicle.
- Describe the preliminary design of the payload retention system.

V) Safety

- Demonstrate an understanding of all components needed to complete the project and how risks/delays impact the project.
- Provide a preliminary Personnel Hazard Analysis. The focus of the Hazard Analysis at PDR is identification of hazards, their causes, and the resulting effects. Preliminary mitigations and controls can be identified, but do not need to be implemented at this point unless they are specific to the construction and launching of the sub-scale rocket or are hazards to the success of the SL program (i.e. cost, schedule, personnel availability). Rank the risk of each hazard for both likelihood and severity.
    - Include data indicating that the hazards have been researched (especially personnel). Examples: NAR regulations, operator's manuals, MSDS, etc.
- Provide preliminary Failure Modes and Effects Analysis (FMEA) of the proposed design of the rocket, payload, payload integration, launch support equipment, and launch operations. Again, the focus for PDR is identification of hazards, causes, effects, and proposed mitigations. Rank the risk of each hazard for both likelihood and severity.
- Discuss any environmental concerns using the same format as the Personnel Hazard Analysis and FMEA.
    - This should include how the vehicle affects the environment and how the environment can affect the vehicle.
- Define the risks (time, resource, budget, scope/functionality, etc.) associated with the project. Assign a likelihood and impact value to each risk. Keep this part simple (i.e. low, medium, high likelihood, and low, medium, high impact). Develop mitigation techniques for each risk. Start with the risks with higher likelihood and impact, and work down from there. If possible, quantify the mitigation and impact. For example, including extra hardware to increase safety will have a quantifiable impact on budget. Including this information in a table is highly encouraged.

VI) Project Plan

Requirements Verification

- Create a verification plan for every requirement from sections 1-5 of the project requirements listed in this handbook. Identify if test, analysis, demonstration, or inspection are required to verify the requirement. After identification, describe the associated plan needed for verification.

- Create team derived requirements in the following categories: Vehicle, Recovery, and Payload. These are requirements for mission success that are beyond the minimum success requirements presented in this handbook. Create a verification plan for each team derived requirement identifying whether test, analysis, demonstration, or inspection is required and describe the associated verification plan. Demonstrate that the requirements are not arbitrary and are required for the team's unique project.

Budgeting and Timeline

- Provide a line item budget with market values for individual components, material vendors, and applicable taxes or shipping/handling fees.
- Provide a funding plan describing sources of funding, allocation of funds, and material acquisition plan.
- Provide a timeline including all team activities and expected activity durations. The schedule should be complete and encompass the full term of the project. Deliverables should be defined with reasonable activity duration. GANTT charts are encouraged.

Preliminary Design Review Presentation

Please include the following in your presentation:

Vehicle dimensions, materials, and justifications

- Static stability margin and CP/CG locations
- Preliminary motor selection and justification
- Thrust-to-weight ratio and rail exit velocity
- Discussion of alternative designs and why each should or should not be chosen
- Drawing/discussion of each major component and subsystem, especially the recovery subsystem
- Discussion of current Mission Performance Predictions
- Preliminary payload design
- Preliminary payload retention system design
- Requirements compliance plan

The PDR will be presented to a panel that may be comprised of scientists, engineers, safety experts, education specialists and industry partners. The purpose of this review is to convince the NASA Review Panel that the preliminary design will meet all requirements, has a high probability of meeting the mission objectives, and can be safely constructed, tested, launched, and recovered. Upon successful completion of the PDR, the team is given the authority to proceed into the final design phase of the life cycle that will culminate in the Critical Design Review.

It is expected that the **team participants** deliver the report and answer all questions. The mentor shall not participate in the presentation.

The presentation of the PDR shall be well prepared with an overall professional appearance. This includes, but is not limited to, the following: easy-to-read slides; appropriate placement of pictures, graphs, and videos; professional appearance of the presenters; speaking clearly and loudly; looking into the camera; referring to the slides rather than reading them; and communicating to the panel in an appropriate and professional manner. The slides should use dark text on a light background.

Critical Design Review (CDR)

The CDR demonstrates that the maturity of the design is appropriate to support proceeding to full-scale fabrication, assembly, and integration; showing that the technical effort is on track to complete the flight and ground system development and mission operations in order to meet overall performance requirements within the identified cost schedule constraints. Progress against management plans, budget, and schedule, as well as risk assessment, are presented. The CDR is a review of the final design of the launch vehicle and payload system.

All analyses should be complete, and some critical testing should be complete. The CDR Report and Presentation should be independent of the PDR Report and Presentation. However, the CDR Report and Presentation may have the same basic content and structure as the PDR documents, but with final design information that may or may not have changed since PDR. Although there should be discussion of subscale models, the CDR documents are to primarily discuss the final design of the full-scale launch vehicle and subsystems.

The panel expects a professional and polished report that follows the order of sections as they appear below.

Critical Design Review Report

Page Limit: CDRs will only be scored using the first 250 pages of the report (not including title page). Any additional content will not be considered while scoring.

I) Summary of CDR report (1 page maximum)

Team Summary
- Team name and mailing address
- Name of mentor, NAR/TRA number and certification level, and contact information

Launch Vehicle Summary
- Size and mass
- Final motor choice
- Target altitude (ft.)
- Recovery system
- Rail size

Payload Summary
- Payload title
- Summarize payload experiment

II) Changes made since PDR (1-2 pages maximum)

Highlight all changes made since PDR and the reason for those changes.
- Changes made to vehicle criteria
- Changes made to payload criteria
- Changes made to project plan

III) Vehicle Criteria

Design and Verification of Launch Vehicle

Flight Reliability and Confidence

- Include unique mission statement and mission success criteria
- Identify which of the design alternatives from PDR were chosen as the final components for the launch vehicle. Describe why those alternatives are the best choices.
- Using the final designs, create dimensional and computer-aided design (CAD) drawings to illustrate the final launch vehicle, its subsystems, and its components.
- Demonstrate that the designs are complete and ready to manufacture.
- Discuss the integrity of design.
  - Suitability of shape and fin style for mission
  - Proper use of materials in fins, bulkheads, and structural elements
  - Sufficient motor mounting and retention
  - Estimate the final mass of the launch vehicle as well as the individual subsystems.
- Provide justification for material selection, dimensioning, component placement, and other unique design aspects.

Subscale Flight Results

- At least one data gathering device must be onboard the launch vehicle during the test launch. At a minimum, this device must record the apogee of the rocket. If the device can record more than apogee, please include the actual flight data in the report.
- Describe the scaling factors used when scaling the rocket. What variables were kept constant and why? What variables do not need to be constant and why?
- Describe launch day conditions and perform a simulation using those conditions.
- Perform an analysis of the subscale flight.
  - Compare the predicted flight model to the actual flight data. Discuss the results.
  - Discuss any error between actual and predicted flight data.
  - Estimate the drag coefficient of the full-scale rocket with subscale data.
- Discuss how the subscale flight data has impacted the design of the full-scale launch vehicle.

Recovery Subsystem

- Identify which of the design alternatives from PDR were chosen as the final components for the recovery subsystem. Describe why those alternatives are the best choices.
- Describe the parachutes, harnesses, bulkheads, and attachment hardware.
- Discuss the electrical components and prove that redundancy exists within the system.
- Include drawings/sketches, block diagrams, and electrical schematics.
- Provide the operating frequency of the locating tracker(s).

Mission Performance Predictions (Using the most up to date model)

- Show flight profile simulations, altitude predictions with simulated vehicle data, component weights, and simulated motor thrust curve. Verify that the vehicle design is robust enough to withstand the expected loads.
- Show stability margin and simulated Center of Pressure (CP)/Center of Gravity (CG) relationship and locations.
- Calculate the kinetic energy at landing for each independent and tethered section of the launch vehicle.
- Calculate the expected descent time for the rocket and any section that descends untethered from the rest of the vehicle.
- Calculate the drift for each independent section of the launch vehicle from the launch pad for five different cases: no wind, 5-mph wind, 10-mph wind, 15-mph wind, and 20-mph wind. The drift calculations should be performed with the assumption that apogee is reached directly above the launch pad.

- Present data from a different calculation method to verify that original results are accurate.
- Discuss any differences between the different calculations.
- Perform multiple simulations to verify that results are precise.

IV) Payload Criteria

Design of Payload Equipment

- Identify which of the design alternatives from PDR was chosen for the payload. Describe why that alternative and its components were chosen.
- Review the design at a system level.
    - Include drawings and specifications for each component of the payload, as well as the entire payload assembly.
    - Describe how the payload components interact with each other.
    - Describe how the payload integrates within the launch vehicle.
    - Describe the payload retention system.
- Demonstrate that the design is complete.
- Discuss the payload electronics with special attention given to safety switches and indicators. Include the following:
    - Drawings and schematics
    - Block diagrams
    - Batteries/power
    - Switch and indicator wattages and locations
- Provide justification for all unique aspects of your payload (like materials, dimensions, placement, etc.)

V) Safety

Launch concerns and operation procedures

- Submit a draft of final assembly and launch procedures including:
    - Recovery preparation
    - Motor preparation
    - Setup on the launch pad
    - Igniter installation
    - Troubleshooting
    - Post-flight inspection
- These procedures/checklists should include specially demarcated steps related to safety. Examples include:
    - Warnings of hazards that can result from missing a step
    - PPE required for a step in the procedure (identified BEFORE the step)
    - Required personnel to complete a step or to witness and sign off verification of a step

Safety and Environment (Vehicle and Payload)

- Update the Personnel Hazard Analysis, the Failure Modes and Effects Analysis, and the Environmental Hazard Analysis to include:
    - Finalized hazard descriptions, causes, and effects. These should specifically identify the mechanisms for the hazards, and uniquely identify them from other hazards. Ambiguity is not useful in safety work.
    - A near-complete list of mitigations, addressing the hazards and/or their causes

    - A preliminary list of verifications for the identified mitigations. These should include methods of verifying the mitigations and controls are (or will be) in place, and how they will serve to ensure the mitigation. These do not need to be finalized at this time, but they will be required for FRR. Example verifications include: test data, written procedures and checklists, design analysis, as-built configuration drawings, and Personal Protective Equipment.

VI) Project Plan

Testing

- Identify all tests required to prove the integrity of the design.
- For each test, present the test objective and success criteria, as well as testing variable and methodology.
- Justify why each test is necessary to validate the design of the launch vehicle and payload.
- Discuss how the results of a test can cause any necessary changes to the launch vehicle and payload.
- Present results of any completed tests.
    - Describe the test plan and whether or not the test was a success.
    - How do the results drive the design of the launch vehicle and/or payload?

Requirements Compliance

- Create a verification plan for every requirement from sections 1-5 of the project requirements listed in this handbook. Identify if test, analysis, demonstration, or inspection are required to verify the requirement. After identification, describe the associated plan needed for verification.
- Create a set of team derived requirements in the following categories: Vehicle, Recovery, and Payload. These are a set of requirements for mission success that are beyond the minimum success requirements presented in this handbook. Create a verification plan for each team derived requirement identifying whether test, analysis, demonstration, or inspection is required with an associated plan.

Budgeting and Timeline

- Provide an updated line item budget with market values for individual components, material vendors, and applicable taxes or shipping/handling fees.
- Provide an updated funding plan describing sources of funding, allocation of funds, and material acquisition plan.
- Provide an updated timeline, including all team activities and expected activity durations. The schedule should be complete and encompass the full term of the project. Deliverables should be defined with reasonable activity duration. GANTT charts are encouraged.

Critical Design Review Presentation

Please include the following information in your presentation:

- Final launch vehicle and payload dimensions
- Discuss key design features
- Final motor choice
- Rocket flight stability in static margin diagram
- Thrust-to-weight ratio and rail exit velocity
- Mass Statement and mass margin
- Parachute sizes, recovery harness type, size, length, and descent rates
- Kinetic energy at key phases of the mission, especially landing
- Predicted drift from the launch pad with 5-, 10-, 15-, and 20-mph wind
- Test plans and procedures
- Scale model flight test data
- Tests of the staged recovery system
- Final payload design overview
- Payload integration plans
- Payload retention system
- Interfaces (internal within the launch vehicle and external to the ground)
- Status of requirements verification

The CDR will be presented to a panel that may be comprised of scientists, engineers, safety experts, education specialists and industry partners. The team is expected to present and defend the final design of the launch vehicle and payload, proving the design meets the mission objectives and requirements and can be safely constructed, tested, launched, and recovered. Upon successful completion of the CDR, the team is given the authority to proceed into the construction and verification phase of the life cycle that will culminate in a Flight Readiness Review.

It is expected that the **team participants** deliver the report and answer all questions. The mentor shall not participate in the presentation.

The presentation of the CDR shall be well prepared with an overall professional appearance. This includes, but is not limited to, the following: easy-to-read slides; appropriate placement of pictures, graphs, and videos; professional appearance of the presenters; speaking clearly and loudly; looking into the camera; referring to the slides rather than reading them; and communicating to the panel in an appropriate and professional manner. The slides should be made with dark text on a light background.

Flight Readiness Review (FRR)

The FRR examines tests, demonstrations, analyses, and audits that determine the overall system (all projects working together) readiness for a safe and successful flight/launch and for subsequent flight operations of the as-built rocket and payload system. It also ensures that all flight hardware, software, personnel, and procedures are operationally ready.

The panel will be expecting a professional and polished report that follows the order of sections as they appear below.

Flight Readiness Review Report

Page Limit: FRRs will only be scored using the first 250 pages of the report (not including title page). Any additional content will not be considered while scoring.

I) Summary of FRR report (1 page maximum)

Team Summary

- Team name and mailing address
- Name of mentor, NAR/TRA number and certification level, and contact information

Launch Vehicle Summary

- Size and mass
- Launch Day Motor
- Target altitude (ft.)
- Recovery system
- Rail size

Payload Summary

- Payload title
- Summarize payload experiment

II) Changes made since CDR (1-2 pages maximum)

Highlight all changes made since CDR and the reason for those changes.

- Changes made to vehicle criteria
- Changes made to payload criteria
- Changes made to project plan

III) Vehicle Criteria

Design and Construction of Vehicle

- Describe any changes in the launch vehicle design from CDR and explain why those changes are necessary.
- Describe features that will enable the vehicle to be launched and recovered safely.
    - Structural elements (such as airframe, fins, bulkheads, attachment hardware, etc.)
    - Electrical elements (wiring, switches, battery retention, retention of avionics boards, etc.)
- Discuss flight reliability confidence. Demonstrate that the design can meet mission success criteria.
- Prove that the vehicle is fully constructed and fully document the construction process.
- Include schematics of the AS-BUILT rocket. There is a good chance dimensions have changed slightly due to the construction process.
- Discuss how and why the constructed rocket differs from earlier models.

Recovery Subsystem

- Describe and defend the robustness of the as-built and as-tested recovery system.
  - Structural elements (such as bulkheads, harnesses, attachment hardware, etc.)
  - Electrical elements (such as altimeters/computers, switches, connectors)
  - Redundancy features
  - As-built parachute sizes and descent rates
  - Drawings and schematics of the as-built electrical and structural assemblies
  - Rocket-locating transmitters with a discussion of frequency, wattage, and range
  - Discuss the sensitivity of the recovery system to onboard devices that generate electromagnetic fields (such as transmitters). This topic should also be included in the Safety and Failure Analysis section.

Mission Performance Predictions

- Show flight profile simulations, altitude predictions with simulated vehicle data, component weights, and simulated motor thrust curve. Verify that the vehicle is robust enough to withstand the expected loads.
- Show stability margin and as-built Center of Pressure (CP)/Center of Gravity (CG) relationship and locations.
- Calculate the kinetic energy at landing for each independent and tethered section of the launch vehicle.
- Calculate the expected descent time for the rocket and any section that descends untethered from the rest of the vehicle.
- Calculate the drift for each independent section of the launch vehicle from the launch pad for five different cases: no wind, 5-mph wind, 10-mph wind, 15-mph wind, and 20-mph wind. The drift calculations should be performed with the assumption that apogee is reached directly above the launch pad.
- Present data from a different calculation method to verify that original results are accurate.
- Discuss any differences between the different calculations.
- Perform multiple simulations to verify that results are precise.

IV) Payload Criteria

Payload Design and Testing

- Describe any changes in the payload design from CDR and explain why those changes are necessary.
- Describe unique features of the payload. Include the following:
  - Structural elements
  - Electrical elements
- Discuss flight reliability confidence. Demonstrate that the design can meet mission success criteria.
- Prove that the payload is fully constructed and fully document the construction process.
- Include schematics of the AS-BUILT payload. There is a good chance dimensions have changed slightly due to the construction process.
- Discuss how and why the constructed payload differs from earlier models.
- Discuss the planned or completed Payload Demonstration Flight. Include the following:
  - Date of flight or planned future flight
  - Success criteria
  - Results of flight
  - Analysis of payload retention system performance (if applicable)

V) Demonstration Flights

Provide for all flights:

- Identify whether the flight was conducted to fulfill the requirements for the Vehicle Demonstration Flight, Payload Demonstration Flight, or both.
- Date of flight
- Location of flight
- Launch conditions
- Motor flown (brand and designation)
- Ballast flown (lbs.)
- Final payload flown (Y/N)
- Air brake system status during test flight (if design incorporates airbrakes)
- Official target altitude (ft.)
- Predicted altitude from simulations (ft.)
- Measured altitude (ft.)
- Provide altimeter flight profile data.
- Identify all vehicle and recovery systems that functioned as intended.
- Identify and discuss any vehicle or recovery hardware or software that failed to function as intended.
- If the payload was not present, describe how the payload was simulated during the flight.
- Perform an analysis of the Vehicle Demonstration Flight. Update your simulated flight model with launch day condition data and compare the predicted flight performance to the actual flight data. Discuss the results.
- Estimate the drag coefficient of the full-scale rocket utilizing launch data. Use this value to run a post-flight simulation.
- Discuss any error between actual and predicted flight data.
- Discuss the similarities and differences between the full-scale and subscale flight results.
- Identify any hardware that was damaged and required repair or replacement and discuss the plan of action.
- Discuss lessons learned, if any, from the flight.
- Identify any off-nominal events during mission execution.

If the final, active payload was flown (i.e. the flight qualified as a Payload Demonstration Flight), also provide:

- Identify all retention systems that functioned as intended.
- Identify and discuss any retention hardware or software that failed to function as intended.
- Identify any retention hardware that was damaged and required repair or replacement and discuss the plan of action.
- Discuss retention system lessons learned, if any, from the flight.
- Summarize the designed payload mission sequence, from activation or deployment through mission completion.
- Identify all payload systems that functioned as intended.
- Identify and discuss any payload hardware or software that failed to function as intended.
- Identify any payload hardware that was damaged and required repair or replacement and discuss the plan of action.
- Discuss payload lessons learned, if any, from the flight.

Provide a list of any planned future demonstration flights. Include a summary of the team's objectives for each launch.

VI) Safety and Procedures

Safety and Environment (Vehicle and Payload)

- Update the Personnel Hazard Analysis, the Failure Modes and Effects Analysis, and the Environmental Hazard Analysis to include:
    - Finalized hazard descriptions, causes, and effects for the rocket and payload the team has built. **Note:** These sections can change from CDR to FRR if there are design related changes made as a result of subscale and full-scale test flights, and refined modeling and analysis. These should specify the mechanisms for the hazards and uniquely identify them from other hazards. Ambiguity is not useful in safety work.
    - A completed list of mitigations addressing the hazards and/or their causes.
    - A completed list of verifications for the identified mitigations. This should include methods of verifying the mitigations and controls are (or will be) in place, and how they will serve to ensure the mitigation.
- Be sure to discuss any concerns that remain as the project moves into the operational phase of the life cycle. Emphasize concerns related to your procedures as well as the environment.

Launch Operations Procedures

Provide detailed procedures and checklists for the following (at a minimum):

- Recovery preparation
- Motor preparation
- Setup on launch pad
- Igniter installation
- Launch procedure
- Troubleshooting
- Post-flight inspection

These procedures and checklists should include specially demarcated steps related to safety. Examples include:

- Warnings of hazards that can result from missing a step
- PPE required for a step in the procedure (identified BEFORE the step)
- Required personnel to complete a step or to witness and sign off verification of a step

VII) Project Plan

Testing

- Prove that all testing is complete and provide test methodology and discussion of results.
- Discuss whether each test was successful or not.
- Discuss lessons learned from the tests conducted.
- Discuss any differences between predicted and actual results of the tests conducted.

Requirements Compliance

- Review and update the verification plan. Describe how each handbook requirement was verified using testing, analysis, demonstration, or inspection.
- Review and update the team derived requirements for the vehicle, recovery system, and payload. Describe how each team derived requirement was verified using testing, analysis, demonstration, or inspection.

Budgeting and Timeline

- Provide an updated line item budget with market values for individual components, material vendors, and applicable taxes or shipping/handling fees.
- Provide an updated funding plan describing sources of funding, allocation of funds, and a material acquisition plan for any items that have not yet been obtained.

Flight Readiness Review Presentation

Please include the following information in your presentation:

- Launch vehicle design and dimensions
- Discuss key design features of the launch vehicle
- Motor description
- Rocket flight stability in static margin diagram
- Launch thrust-to-weight ratio and rail exit velocity
- Mass statement
- Parachute sizes and descent rates
- Kinetic energy at key phases of the mission, especially at landing
- Predicted altitude of the launch vehicle with a 5-, 10-, 15-, and 20-mph wind
- Predicted drift from the launch pad with a 5-, 10-, 15-, and 20-mph wind
- Test plans and procedures
- Vehicle Demonstration Flight results. Present and discuss the actual flight test data as well as any issues or failures encountered.
- Recovery system tests
- Summary of requirements verification (launch vehicle)
- Payload design and dimensions
- Key design features of the payload
- Payload integration into the vehicle
- Payload retention system design
- Payload Demonstration Flight plans. If complete, discuss the actual flight test results as well as any issues or failures encountered.
- Summary of requirements verification (payload)
- Interfaces with ground systems (vehicle and payload)

The FRR will be presented to a panel that may be comprised of scientists, engineers, safety experts, education specialists, and industry partners. The team is expected to present and defend the as-built launch vehicle and payload, showing that the launch vehicle and payload meet all requirements and mission objectives and that the design can be safely launched and recovered. Upon successful completion of the FRR, the team is given the authority to proceed into the Launch and Operational phases of the life cycle.

It is expected that the **team participants** deliver the report and answer all questions. The mentor shall not participate in the presentation.

The presentation of the FRR shall be well prepared with an overall professional appearance. This includes, but is not limited to, the following: easy to see slides; appropriate placement of pictures, graphs, and videos; professional appearance of the presenters; speaking clearly and loudly; looking into the camera; referring to the slides, not reading them; and communicating to the panel in an appropriate and professional manner. The slides should be made with dark text on a light background.

Flight Readiness Review Addendum

The FRR Addendum is a required submission for any team completing a Payload Demonstration Flight (PDF) or NASA-required Vehicle Demonstration Re-flight after the submission of the FRR Report. It is expected to be a brief but informative document highlighting the success or failure of the new flight(s) and any updates or changes to the vehicle or payload design. The information reported in the FRR Addendum will be reviewed by NASA to determine whether each submitting team is eligible to fly at the official launch during NASA Student Launch Week.

Flight Readiness Review Addendum Document Outline

Page Limit: The FRR Addendum is not scored and does not have a specific minimum or maximum page count, but each requested item listed below must be sufficiently addressed.

I) Summary of FRR Addendum

Team Summary

Team name, mailing address, and contact information.

Purpose of Flight(s)

Identify whether the flights conducted were conducted to fulfill the requirements for the Payload Demonstration Flight, Vehicle Demonstration Re-flight, or both.

Flight Summary Information (for each flight)

- Date of flight
- Location of flight
- Launch conditions
- Motor flown (brand and designation)
- Ballast flown (lbs.)
- Final payload flown (Y/N)
- Air brake system status during test flight (list N/A if your vehicle does not contain an air brake system)
- Official target altitude (ft.)
- Predicted altitude from simulations (ft.)
- Measured altitude (ft.)
- Identify any off-nominal events during mission execution.

Changes made since FRR

- Describe changes made to the vehicle design and explain why those changes are necessary.
- Describe changes made to the payload design and explain why those changes are necessary.

II) Payload Demonstration Flight Results (if applicable)

Summarize the payload retention system design and discuss its successes and failures.

- Summarize the design of the payload retention system.
- Identify all systems that functioned as intended.
- Identify and discuss any hardware or software that failed to function as intended.
- Identify any hardware that was damaged and required repair or replacement and discuss the plan of action.
- Discuss retention system lessons learned, if any, from the flight.

Summarize the payload mission and discuss its successes and failures.

- Summarize the designed payload mission sequence, from activation or deployment through mission completion.
- Identify all systems that functioned as intended.
- Identify and discuss any hardware or software that failed to function as intended.
- Identify any hardware that was damaged and required repair or replacement and discuss the plan of action.
- Discuss payload lessons learned, if any, from the flight.

Summarize the flight of the rocket and discuss its successes and failures.

- Identify all systems that functioned as intended.
- Identify and discuss any hardware or software that failed to function as intended.
- Provide altimeter flight profile data.
- Identify any hardware that was damaged and required repair or replacement and discuss the plan of action.
- Discuss vehicle-related lessons learned, if any, from the flight.

III) Vehicle Demonstration Re-flight (if applicable)

Summarize the flight of the rocket and discuss its successes and failures.

- Identify all systems that functioned as intended.
- Identify and discuss any hardware or software that failed to function as intended.
- If the payload was not present, describe how the payload was simulated during the flight.
- Provide altimeter flight profile data.
- Perform an analysis of the Vehicle Demonstration Flight. Update your simulated flight model with launch day condition data and compare the predicted flight performance to the actual flight data. Discuss the results.
- Estimate the drag coefficient of the full-scale rocket utilizing launch data. Use this value to run a post-flight simulation.
- Identify any hardware that was damaged and required repair or replacement and discuss the plan of action.
- Discuss lessons learned, if any, from the flight.

Launch Readiness Review (LRR)

The Launch Readiness Review (LRR) will be held by NASA and the National Association of Rocketry (NAR), our launch services provider. These inspections are only open to team members and mentors. These names were submitted as part of your team list. All rockets/payloads will undergo a detailed, deconstructive, hands-on inspection. Your team should bring all components of the rocket and payload except for the motor, black powder, and e-matches. Be able to present: anchored flight predictions, anchored drift predictions (15 mph crosswind), procedures and checklists, and CP and CG with loaded motor marked on the airframe. The rockets will be assessed for structural and electrical integrity, as well as safety concerns. At a minimum, all teams should have:

- An airframe prepared for flight with the exception of energetic materials
- Data from the previous flight(s)
- A list of any flight anomalies that occurred on the previous full-scale flight(s) and the mitigation actions
- A list of any changes to the airframe since the last flight
- Flight simulations
- Pre-flight check list and Fly Sheet
- Team name and contact info in/on the airframe and any untethered section of the vehicle

Each team will demonstrate these tasks to the NAR Review Team. The RSO has final word on whether the rocket and/or payload may be flown on Launch Day.

A "punch list" will be generated for each team. Items identified on the punch list should be corrected and verified by NAR/NASA prior to launch day. A flight card will be provided to teams and is to be completed and provided at the RSO booth on launch day.

Post-Launch Assessment Review (PLAR)

The PLAR is an assessment of system in-flight performance.

The PLAR should include the following items at a minimum and be about 4-15 pages in length.

- Team name
- Motor used
- Brief payload description
- Vehicle dimensions
- Altitude reached (ft.)
- Official target altitude (ft.)
- Launch Day altimeter flight profile data
- Vehicle summary
- Data analysis & results of the vehicle
- Payload summary
- Data analysis & results of the payload
- Scientific value achieved
- Visual data observed
- Lessons learned
- Summary of overall experience (what you attempted to do versus the results; how valuable you felt the experience was)
- Estimate of the number of man-hours that were necessary for the team to complete the project.
- STEM Engagement summary
- Final Budget Summary

STEM Engagement Activity Report

Please complete and submit this form each time you host a STEM engagement event. For numerous NASA STEM engagement ideas, educational resources, games, videos, and PowerPoint presentations visit **www.nasa.gov/stem/resources**. NASA educational resources can be searched and filtered by subject (e.g. space science, NASA history, technology, etc.), type (e.g. lesson plan/activity, lithograph, multimedia, etc.), and grade level (e.g. K-4, 5-8, 9-12, higher education, and informal education).

(Return within 2 weeks of the event end date)

School/Organization name:

Date(s) of event:

Location of event:

Instructions for participant count

Education/Direct Interactions: A count of participants in instructional, hands-on activities where participants engage in learning a STEM topic by actively participating in an activity. This includes instructor-led facilitation around an activity regardless of media (e.g. face-to-face, Vidyo, etc.). Example: Students learn about Newton's Laws through building and flying a rocket. ***This type of interaction will count towards your requirement for the project.***

Education/Indirect Interactions: A count of participants engaged in learning a STEM topic through instructor-led facilitation or presentation. Example: Students learn about Newton's Laws through a PowerPoint presentation, or students learn about the Space Launch System (SLS) through a SLS activity/material provided on ***www.NASA.gov/SLS*** *(under SLS Public Engagement).*

Outreach/Direct Interactions: A count of participants who do not necessarily learn a STEM topic, but are able to get a hands-on look at STEM hardware. For example, the team does a presentation to students about their Student Launch project, brings their rocket and components to the event, and flies a rocket at the end of the presentation.

Outreach/Indirect Interactions: A count of participants that interact with the team. For example: The team sets up a display at the local museum during Science Night. Students come by and talk to the team about their project.

Grade level and number of participants: (It is helpful if you are able to break down the participants into grade levels: Preschool-4, 5-9, 10-12, and University.)

Participant's Grade Level	Education		Outreach	
	Direct Interactions	**Indirect** Interactions	**Direct** Interactions	**Indirect** Interactions
Preschool-4				
5-9				
10-12				
University students				
Educators				
Adult non-students				

Are the participants with a special group/organization (i.e. Girl Scouts, 4-H, school)? Y N

If yes, what group/organization?

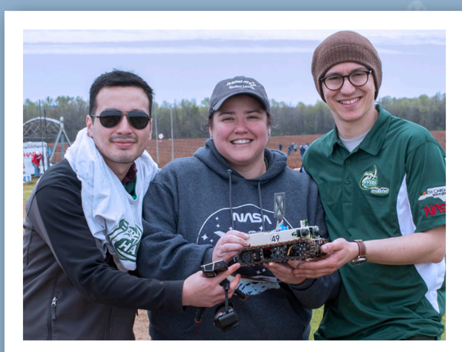
Briefly describe your activities with this group.

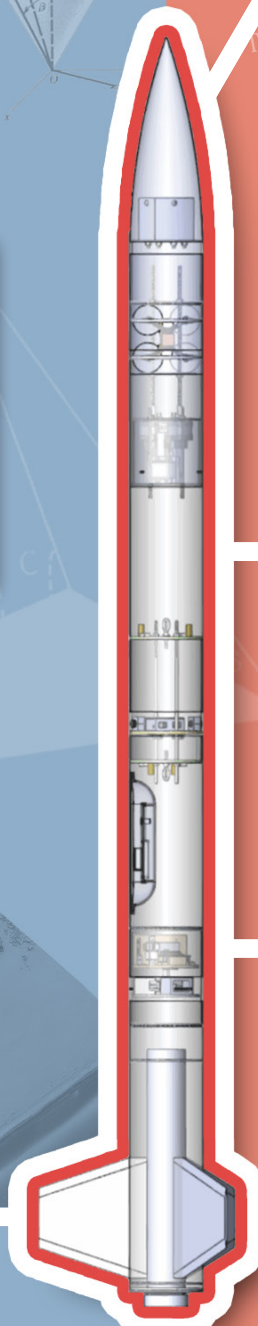
How does this activity connect to your team's overall mission, goals, objectives, and NASA's mission statement?

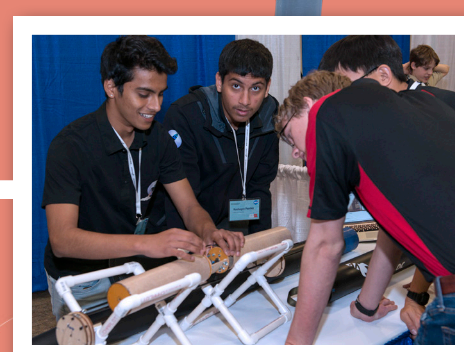
Did you conduct an evaluation? If so, what were the results?

Describe the comprehensive feedback received.

Safety







High Power Rocket Safety Code

Provided by the National Association of Rocketry

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 (9,208 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 1,500 feet, whichever is greater, or 1,000 feet for rockets with a combined total impulse of less than 160 N-sec, a total liftoff weight of less than 1,500 grams, and a maximum expected altitude of less than 610 meters (2000 feet).

11. **Launcher Location.** My launcher will be 1,500 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 only flame-resistant or fireproof recovery system wadding in my rocket.

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.

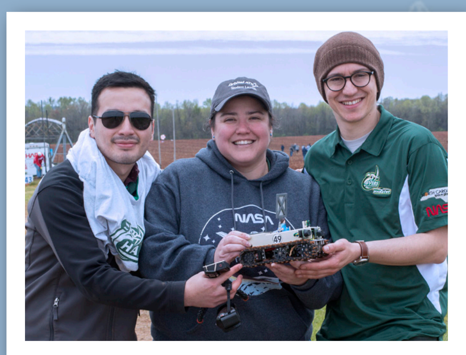
Minimum Distance Table

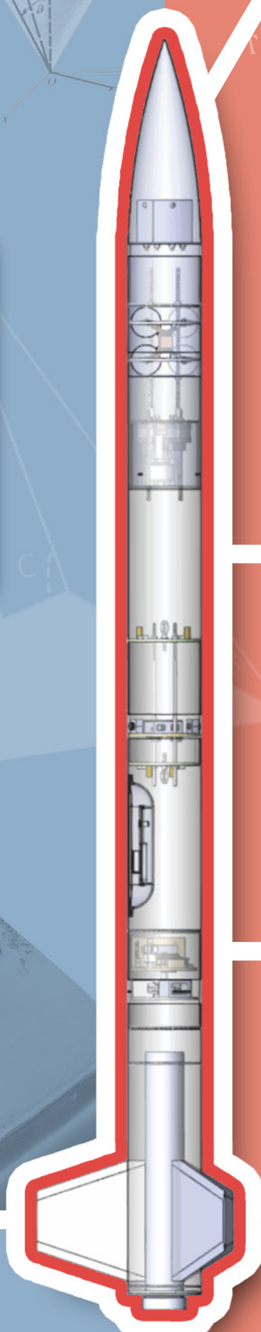
Installed Total Impulse (Newton-Seconds)	Equivalent High Power Motor Type	Minimum Diameter of Cleared Area (ft.)	Minimum Personnel Distance (ft.)	Minimum Personnel Distance (Complex Rocket) (ft.)
0 – 320.00	H or smaller	50	100	200
320.01 – 640.00	I	50	100	200
640.01 – 1,280.00	J	50	100	200
1,280.01 – 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	1,000
10,240.01 – 20,480.00	N	125	1,000	1,500
20,480.01 – 40,960.00	O	125	1,500	2,000

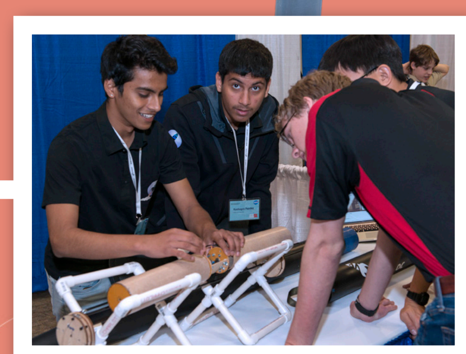
Note: A Complex rocket is one that is multi-staged or that is propelled by two or more rocket motors
Revision of August 2012

Provided by the National Association of Rocketry (**www.nar.org**)

Awards







College and University Division Awards

Award:	Award Description:	Determined by:	When awarded:
Vehicle Design Award	Awarded to the team with the most creative and innovative overall vehicle design for their intended payload while still maximizing safety and efficiency.	NASA Panel	Awards Ceremony
Experiment Design Award	Awarded to the team with the most creative and innovative payload design while maximizing safety and science value.	NASA Panel	Awards Ceremony
Safety Award	Awarded to the team that demonstrates the highest level of safety according to the scoring rubric.	NASA Panel	Awards Ceremony
Project Review (PDR/CDR/FRR) Award	Awarded to the team that is viewed to have the best combination of written reviews and formal presentations.	NASA Panel	Awards Ceremony
STEM Engagement Award	Awarded to the team that is determined to have best inspired the study of rocketry and other science, technology, engineering, and math (STEM) related topics in their community. This team not only presented a high number of activities to a large number of people, but also delivered quality activities to a wide range of audiences.	NASA Panel	Awards Ceremony
Social Media Award	Awarded to the team that has the most active and creative social media presence throughout the project year.	NASA Panel	Awards Ceremony
Altitude Award	Awarded to the team that comes closest to their declared target altitude on Launch Day.	NASA Panel	Launch Day
Best Looking Rocket	Awarded to the team that is judged by their peers to have the “Best Looking Rocket”.	Peers	Awards Ceremony
Best Team Spirit Award	Awarded to the team that is judged by their peers to display the “Best Team Spirit” during launch week.	Peers	Awards Ceremony
Best Rocket Fair Display Award	Awarded to the team that is judged by their peers to have the “Best Display” at the Rocket Fair.	Peers	Awards Ceremony
Rookie Award	Awarded to the top overall rookie team using the same criteria as the Overall Winner Award. If a rookie team is the Overall Winner, this award will go to the 2nd place Rookie Team.	NASA Panel	After PLAR Milestone
Overall Winner	Awarded to the top overall team. Design reviews, outreach, safety, and a successful flight will all factor into the Overall Winner.	NASA Panel	After PLAR Milestone

Middle and High School Division Awards

Award:	Award Description:	Determined by:	When awarded:
STEM Engagement Award	Awarded to the team that is determined to have best inspired the study of rocketry and other science, technology, engineering, and math (STEM) related topics in their community. This team not only presented a high number of activities to a large number of people, but also delivered quality activities to a wide range of audiences.	NASA Panel	Awards Ceremony
Social Media Award	Awarded to the team that has the most active and creative social media presence throughout the project year.	NASA Panel	Awards Ceremony
Altitude Award	Awarded to the team that comes closest to their declared target altitude on Launch Day.	NASA Panel	Launch Day
Best Looking Rocket	Awarded to the team that is judged by their peers to have the “Best Looking Rocket”.	Peers	Awards Ceremony
Best Team Spirit Award	Awarded to the team that is judged by their peers to display the “Best Team Spirit” during launch week.	Peers	Awards Ceremony
Best Rocket Fair Display Award	Awarded to the team that is judged by their peers to have the “Best Display” at the Rocket Fair.	Peers	Awards Ceremony
Judges’ Choice Award	Selected during Launch Week by a panel of guest judges and awarded for the best combination of payload innovation, vehicle design and construction, and public engagement.	VIP Panel	Awards Ceremony

National Aeronautics and Space Administration

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www.nasa.gov/marshall

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