Battle of the Rockets™ Competition 2025-2026

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Introduction

The Battle of the Rockets™ is a program of the Federation of Galaxy Explorers. The program is a series of competitive events focusing on the engineering design cycle. The events within the competition are designed to inspire student's interest in engineering and science with an exciting hands-on competition. The competition provides multiple levels of difficulty of engineering design challenges. These challenges are meant to continuously increase as the competitor's skill level grows. Each year, Galaxy Explorers will introduce new and more complex event challenges for the competition.

Dates

Registration for the competition is due by Oct 30, 2024.
The launch will be held in April 2025 and will be for two days.

The Competition

The competition comprises multiple events. Each event has unique challenges and complexities. The events are judged separately.

Contact Information

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Competition Operation

The competition starts when the competition guide is posted online in August. Teams can start designing before registration. Registration starts when the competition guide is posted and ends October 30.

All Target Altitude teams are required to submit rocket safety documents by the end of Dec 15. Documents will be reviewed and teams will receive comments about their designs. The purpose is to identify any potential safety or operation issues so teams will have a better chance of success. The safety document template will be made available. Teams must include an email address for comments in the document and use the file name format as follows:

Safety_xxxx.pdf where xxxx is the team number.

The sounding rocket event and rover event teams are required to submit PDR documents in December and have a review with judges. The PDR documents are scored. Teams will get score results after PDR.

March 1, sounding rocket event and rover event teams submit CDR documents and have a review with judges. The CDR documents are scored. Teams will get score results after CDR.

Templates for the PDR and CDR are provided. Use them and do not change the order of the slides. Scoring is based on the templates.

All rockets are to be flown before the competition weekend. Some documentation of a flight attempt should be submitted to the contest email. An example of documentation is a picture of the signed flight card.

PDR and CDR schedules are created by having volunteer judges sign up for time slots over a one week period indicating their availability for reviews. Time slots are in one hour increments from 7am until 8pm eastern. When two or three judges sign up for the same time slot, the time slot becomes available for teams to select. At least one week before reviews start, the calendar of available time slots will be sent to the teams for selection. Each team is to submit 3 time slots and will be given the first available selected time slot. Reviews are to last a half hour.

In April, the competition launch will take place on Saturday and Sunday. This allows dealing with weather issues and gives teams time to perform up to 3 qualifying launches and any test launches. There is no launch schedule for the two days. It is up to the teams to manage their time and get enough qualifying launches completed. The competition launch period starts 10 am Saturday and ends 4 pm Sunday. Launch times for Friday and Saturday are 10 am to 4 pm.

An awards ceremony will be held on the field. Teams are encouraged to attend the awards ceremony. For teams who cannot attend, their award will be mailed.

Weather can affect launching. NAR and Tripoli rules do not allow for launching into clouds or with winds over 20 mph. If the cloud ceiling is too low or the weather is affecting the performance of the rockets in any adverse way, the range will be shut down until the weather improves. The competition must follow all safety rules. It is possible the weather can affect the whole weekend. If rover and sounding rocket teams are not allowed to launch the whole weekend, awards will be given based on PDR and CDR scores. Target altitude teams will not be able to fly and will not receive any awards. Target altitude competition requirements will be kept the same for the next year.

Launch Procedures

All teams are to prepare their rockets and payloads in the team area. Teams must follow all safety procedures for handling rocket motors and ejection charges. When teams are ready to launch, they must bring their rocket up to the Range Safety Officer (RSO) table for a safety check. If performing a test flight, a club flight card needs to be filled out. For high power motors, a member of the team or mentor or any person over 18 and certified by NAR or Tripoli at the correct level must fill out the flight card. The RSO will check the rocket for flight worthiness and verify the rocket motor meets the 5:1 thrust to weight ratio.

Once approved by the RSO, the team with the certified motor handler will move on to the Launch Control Officer (LCO) at the flight line and hand off the flight card. The LCO will assign a launch pad and the team with the certified motor handler can proceed to load the rocket on the launch pad.

At the launch pad, the team can load the rocket and prepare the payload if the rocket has a payload. When it is time to arm the altimeter and insert the igniter, non-certified team members must back away from the rocket. Only the minimal number of people should be near the rocket during the arming process and igniter insertion. Per range safety rules, no more than five people are allowed with a certified adult. All team members must return to the flight line after the rocket is ready for launch.

After all rockets have been launched, the LCO will announce the range is safe and at that time, teams can go into the field to recover their rockets and payloads.

Specific instructions for each event for recovery and judging are in each event section.

Awards

Each event will have a set of awards. The top three teams will receive a plaque reflecting their ranking. If teams are not present during the award ceremony at the end of Sunday, the teams will be contacted and awards shipped.

All team members will receive certificates of participation. A member of the team must be present at the launch to receive the certificates.

Launch Systems

Launch pads will be provided and have six feet long 1 inch (1010) aluminum rails. 8 foot 1.5 inch (1515) aluminum rails will be provided. The rails are to be vertical. They cannot be angled at all. Teams can substitute with their own launch equipment. For safety, student launch equipment will be inspected by the launch LCO and or RSO.

The following table is the rail requirements.

Rail	Max Motor Size	Rail Buttons	On Pad Max Weight (lb)	Max Rocket Diameter (in)	Rail Length (feet)
1010	J	1010	15	6.0	6
1515	L	1515	25	7.5	8
Unistrut	O	Unistrut/1515	100	18	20

Practice Flights

Teams can perform test flights any time during the year up to the competition. The teams must perform test flights at sanctioned rocket launches supported by NAR or Tripoli. If testing with high power rocket motors, a team member must be certified or the team must find a person at the launch with proper certification to purchase and assemble the rocket motor for the team. Teams must follow all regulations when flying with high power rocket motors.

Disqualifications

A team will be disqualified for any of the following reasons:

1. Recovery system does not deploy and the rocket free falls or goes ballistic.
2. One or more parts of the rocket free fall from the rest of the rocket.
3. Rocket motor separates from the rocket during any part of flight.
4. The rocket is damaged beyond field repair after flight.
5. Team acts in a dangerous manner.
6. Team misbehaves and or interferes with other team's progress.
7. Team does not launch before the end of the window.
8. Team attempts an unsafe recovery. An unsafe recovery is defined as attempting to remove any part of a rocket out of power lines or trees that require climbing. Rockets

can be pulled out of trees or other vegetation if the team member can reach any part while standing on the ground.

9. The team argues with the contest director.

Rocket Test Flight

Teams are to complete one test flight and submit a flight document, such as a signed flight card, before the competition. Due to the complexity of some of the rockets, test flights must be completed before the competition.

Test flight information can be submitted electronically via email.

Common Rules for All Events

Item	Rule
1	All competitors must follow the Tripoli High Power Safety Code. The code can be found on the Tripoli website. www.tripoli.org
2	The rocket must have been flown before. First flight rockets are allowed Friday if the rocket passes RSO inspection.
3	All rockets shall use a single motor: Clustering and staging are NOT allowed.
4	The airframe, fins, nose cone, bulk plates, centering rings, and motor mount cannot be made of any metals.
5	Metal fasteners and small metal components are allowed.
6	Composite materials are allowed.
7	Launch lugs are not allowed except for in the Target Altitude event.
8	Competitors can provide their own launch pad and controller.
9	A positive motor retention is required. Motor retention must pass RSO approval before the flight will be allowed.
10	Friction fit of motors is not allowed.
11	No modifications are allowed to any of the currently certified commercial motors. Manufacturers that allow modifications to the delay charge as part of standard assembly is allowed.
12	Only currently certified NAR/Tripoli commercial motors are allowed.
13	Average thrust to weight ratio must be at least 5:1. Rockets will not be allowed to fly if their thrust to weight ratio is less than 5:1.

14	Any of the commercially available altimeters are allowed.
15	Electronic deployment devices are allowed. (dual deployment altimeters, Jolly Logic Chute release, etc.)
16	Electronic deployment devices must be disarmed until the rocket is placed on the launch pad.
17	Recovery aids such as radio beacons/trackers and audible beacons are allowed.
18	Maximum descent rate must not exceed 20 feet/sec.
19	A recovery system is required so that the rocket lands and is immediately flyable without the need for any repairs or alterations. Rockets not meeting this definition will be disqualified.
20	Any structural part of the rocket recovery system, or motor that free falls will result in a disqualification. Pop off rail guides are considered part of the ground support equipment. Any components that are supposed to be released or discarded for launch purposes are allowed. The competitor must specify what gets released or discarded for launch purposes before the launch.
21	The word of the safety committee and range safety officer is final. The safety team and/or RSO are the ultimate judges in determining a safe or unsafe flight.
22	Rockets are not to exceed 10,000 feet due to waiver limits.
23	Up to three attempts per competitor per event is allowed. Exceptions are due to malfunctioning launch equipment or faulty rocket motor due to manufacturer defects. Launch attempts stop at 4pm. It is up to the competitor to manage their time.
24	Rockets may not use any externally-generated signals such as radio or computer control for any purpose, including flight termination, after liftoff. Autonomous on-board control systems can be used.
25	No guidance systems are allowed.
26	Boosted darts are not allowed.
27	Recovery electronics must be turned on before the igniter is inserted.
28	The igniter is to be installed at the launch pad when the rocket is in the vertical position.
29	Competitors attempting unsafe recovery from trees or power lines will be disqualified. If a rocket lands in a tree or power line, a contest or launch official must be notified in order to make a safe recovery.
30	The altimeter used for altitude measurement must not be removed from the rocket or turned off until in the presence of a judge.

31	If a team chooses to use a hybrid rocket motor, the team must provide all ground support equipment.
32	No Li-PO batteries allowed.
33	All electronics power must support up to an hour delay on the launch pad.
34	Sparky motors or any type of motor that can generate sparks are not allowed
35	If the rocket uses a level 1 or level 2 motor, at least one team member with the appropriate certification level must be present at the launch, handle the rocket and motor and insert the igniter into the motor
36	The range safety officer has the right to refuse any rocket deemed not safe.
37	If using a VMAX rocket motor, an electronic altimeter is required per manufacturer requirements.
38	All parts of rockets must land safely.

Event 1: Mars Rover Delivery

Event 1: Mars Rover Delivery

The event shall simulate the prepositioning of assets at various locations on Mars for future astronauts to use. The asset the team will provide is a small rover to assist astronauts in exploring areas of interest. Since the landing location can have vegetation that will inhibit the rovers maneuvering abilities, a designated bare area will be used. Assets and materials prepositioned are usually delivered packaged in a container of some sort to protect the asset from the environment and landing.

Design a Mars Rover with the ability to collect a soil sample that is packaged in a container to be launched on a rocket to at least 1000 feet and less than 2000 feet. At peak altitude, deploy the rover in its container to descend at less than 25 feet/sec. The container shall transmit telemetry at a 1 Hz rate containing altitude, acceleration, rover temperature and battery voltage from launch to landing.

Once landed, the team will locate the rover in its container and rocket and return both to the judge for inspection. The rover container must remain closed. The team shall then carry the container to the judges station and remove the rover.

The rover must be fully assembled. It can include parts that fold but must be attached to the rover and not require tools to unfold or require any assembly. This simulates an astronaut in a space suit handling the rover. The container that the rover is enclosed must be easily opened without the use of tools. All container and rover handling activities must be able to be done with gloved hands and no tools.

Teams will place their rover in an arena at some position specified by the judge. The team will send a sequence of multiple commands to navigate to a sandy area and collect a sample of the sand. There will be obstacles to maneuver around. The fewer number of navigation commands, the higher the score. Sensors are allowed in supporting the navigation except for GPS.

Payload Requirements

Req #	Requirement
1	The container and rover shall not weigh more than 2 Kg.
2	The container and rocket shall ascend to at least 1000 feet and less than 2000 feet.
3	Upon being deployed, the container shall descend at a rate of less than 25 feet/sec.
4	During ascent and descent, the payload shall transmit telemetry once per second.

5	The telemetry shall consist of altitude, acceleration, payload temperature, and battery voltage.
6	The payload shall use an XBEE radio operating at 2.4 GHz or 900 MHz.
7	The payload XBEE radio shall have its NETID set to the team number.
8	The rover shall transmit video of where it travels in real time to the ground station.
9	The rover video link and command link can be any wireless connection.
10	When commanded, the payload shall perform the specified maneuvers in the sequence given.
11	All commands shall be sent at the same time for the rover to sequence through.
12	The types of maneuvers shall be limited to moving forward and reverse and turning left and right.
13	Maneuver distance shall be in meters.
14	Turn angle shall be in degrees.
15	The container shall enclose the rover and provide flight protection.
16	The container shall be opened without using any tools.
17	The rover shall be removed from the container and prepared without using any tools and be performed using gloves.

Ground Station Requirements

Req#	Requirement
1	A ground station shall capture telemetry from the payload during ascent and descent.
2	The ground station radio shall be an XBEE radio operating at 2.4 GHz of 900 MHz.
3	The ground station radio shall have its NETID set to the team number.
4	The ground station shall display the telemetry in real time.
5	The ground station shall plot the altitude data in real time.
6	The ground station shall be portable.
7	The ground station shall command the payload to perform a specified sequence of maneuvers to reach a sandy area.

8	The ground station shall receive real time video from the rover.
9	The rover shall collect at minimum TBD grams of sand.

Rocket requirements

Req #	Requirement
1	Motor clusters are not allowed.
2	Staging is not allowed.
3	Total installed impulse shall not exceed 2,560 Newton-seconds or a K motor.
4	All parts of the rocket must safely return under a recovery system.
5	The rocket airframe, nose cone, fins, bulk plates, and centering rings cannot be made of any types of metal. Composite materials are allowed.
6	If the rocket with the rover exceeds 12 pounds, rail buttons for 1515 and extreme rails must be used.
7	If the rocket is more than 6 inches in diameter, rail buttons for 1515 and extreme rails must be used.
8	If the rocket is over 35 pounds or greater than 8 inches in diameter, unistrut rail buttons must be used and will be launched at the away cell.
9	The rocket must reach an apogee of at least 1000 feet.
10	The rocket must use a commercial altimeter for measuring the peak altitude.
11	The average thrust to weight ratio must be greater than 5:1.
12	Average thrust is per the motor designation. For example, a J240 has an average thrust of 240 newton-seconds.
13	The rocket must use a motor retainer. Friction fit is not allowed.
14	All common rules must be followed.

Documentation Requirements

Teams must submit a preliminary design review document and a critical design review document.

PDRs are due by December 1.
CDRs are due by March 1.
Documentation should be submitted via email to battleoftherockets@gmail.com.
Templates will be provided for both PDR and CDR. Design review will be scheduled after each submission date. Teams will present via teleconference.

All documents must be in PDF format.
PDR file name format shall be robot_xxxx_pdr.pdf where xxxx is the team number.
CDR file name format shall be robot_xxxx_cdr.pdf where xxxx is the team number.
The file name formats must be followed.

Judging and Scoring

Before launch, teams must secure a judge. The judge must go out with the team during recovery to review the lander and rover deployment. No team member is allowed to touch the lander until the judge says it is OK or if the team decides the lander is nonfunctional. Any team member touching the payload forfeits all points toward the lander.

The judge must be at the site of the payload to score the event.

The team must bring the rocket to the judge with the altimeter so the judge can get the altitude reading for scoring. The altimeter must not be turned off before the judge gets the reading. Once the judge has completed scoring, the team may recover all parts of the rocket and payload.

Flight Scoring

Teams will receive a score for each level successfully completed. Certain levels require previous levels and must be completed in order to gain current level points. The scores will be added to the PDR and CDR scores.

Requirement	Score	Function
1	5	Rover and container does not exceed 2 Kg.
2	10	Rocket apogee is between 1000 and 2000 feet.
3	5	Rover and container shall be deployed from the rocket after reaching apogee
4	10	The Rover shall descend at less than 25 feet/sec.

5	10	Rover and container lands intact. No broken pieces.
6	30	Telemetry is received by the ground station.
7	30	Telemetry is plotted in real time.
8	20	The payload is opened without the use of tools or destructively.
9	20	Rover is removed and prepared without the use of tools.
10	40	Rover reached sandy area.
11	30	Rover collects TBD grams of sand.
12	50 - (5 * cmd)	The number of commands sent. Less is better.
13	40	The rover video is received and displayed in real time.

Event 2: Deployable Sensor Payload, Tethered Sensor

Design a payload and rocket to launch, using a commercial G rocket engine, to at least 700 feet and no more than 1200 feet and have the payload deploy from the rocket at peak altitude. The payload shall descend on a parachute at no more than 15 feet/sec. At 75% maximum altitude, the payload shall release the nose cone so it will fall gently at a rate of less than 15 feet/sec. With the nose cone released, the payload shall expose a camera and capture video of the ground as it descends. The payload shall transmit telemetry consisting of air pressure, altitude, acceleration, payload temperature, and rotation rate starting when placed on the launch pad until landing.

The ground station shall capture the data transmitted from the payload and display the sensor data in real time. The ground station shall calculate the descent rate based on the telemetry received. The video shall be played back for the judge after retrieving the payload and rocket.

Payload Requirements

Req #	Requirement
1	Payload must be deployed at apogee.
2	The descent rate shall be less than 15 feet/sec after parachute release.
3	The payload shall measure altitude, air temperature, and acceleration from launch to landing.
4	The payload shall transmit the sensor measurements at a minimum of 2 Hz rate.
5	Sensor measurements shall include air pressure, altitude, acceleration, payload temperature, and payload rotation rate.
6	The payload electronics shall be custom designed. No commercial systems are allowed.
7	The payload shall release the nose cone at 75% peak altitude.
8	The nose cone shall fall gently to the ground at less than 15 feet/sec. Tumbling is allowed.
9	The payload shall include the nose cone as part of the payload.
10	The camera shall capture video of the ground as it descends until it lands.

Rocket requirements

Req #	Requirement
1	The rocket shall use a commercial G motor.
2	The rocket must reach at least 700 feet and not exceed 1200 feet.
3	The rocket must use a motor retainer. Friction fit is not allowed.
4	The rocket shall include a commercial altimeter to verify its peak altitude.
5	The rocket shall be returned to the judges area for altitude verification.
6	All common rules must be followed.

Ground Station Requirements

Req #	Requirement
1	The ground station shall be portable.
2	The ground station antenna shall be handheld.
3	The ground station shall operate on battery for at least 2 hours.
4	The ground station shall display the telemetry in real time.
5	The ground station shall calculate the descent rate of the payload in real time.

Documentation Requirements

Teams must submit a preliminary design review document and a critical design review document.
PDRs are due by December 1.
CDRs are due by March 1.
Documentation should be submitted via email to battleoftherockets@gmail.com.
Templates will be provided for both PDR and CDR. Design review will be scheduled after each submission date. Teams will present via teleconference.

All documents must be in PDF format.
PDR file name format shall be ds_XXXX_pdr.pdf where xxxx is the team number.
CDR file name format shall be ds_XXX_cdr.pdf where xxxx is the team number.
The file name formats must be followed.

Judging and Scoring

Before launch, teams must secure a judge to be at the ground station. The judge will review the ground station and indicate when ready for launch. The team must also determine when they are ready for launch. One member of the team must be designated the mission control officer and must be positioned at the launch control officer and verify with their team they are ready for launch. The rocket will not be launched until the mission control officer gives word to launch.

After all parts of the rocket have been recovered, the team shall return the payload to the ground station and download the video with a judge present.

For altitude verification, the team must return the rocket with the altimeter still on. Do not turn off the altimeter before the judge records the altitude.

Flight Scoring

The flight scores will be added to the PDR and CDR scores.

Requirement	Points	Function
1	10	The rocket reaches at least 700 feet and does not exceed 1200 feet.
2	5	Payload deploys from the rocket at peak altitude.
3	20	The nose cone is released at 75% peak altitude.
4	30	Ground station receives telemetry and displays it in real time. At least 10 packets must be received after liftoff.
5	20	Altitude is plotted in real time.
6	20	Acceleration is plotted in real time.
7	20	Gyro rotation rates are plotted in real time.
8	20	Payload temperature is plotted in real time.
9	0.1	Per foot beyond 700 feet, not exceeding 1200 feet.
10	50	The camera captures video of the ground after the nose cone is released until landing.
11	20	Descent rate is calculated and displayed in real time.

Event 3: Target Altitude

Event 3: Target Altitude, Tubular

Design and build a rocket to reach 801 feet using a commercial F motor. The vehicle must carry a commercial altimeter. The rocket shall use only tube fins.

The vehicle must safely recover and be in condition to be flown again. The team must perform two successful flights of the same rocket meeting all the requirements out of three attempts. At least two attempts must meet the requirements or be disqualified. The team with the closest altitude to 801 feet wins.

The rocket must be test flown before any qualification attempts. 3D printing is allowed.

Requirements

Item	Requirement
1	Two successful flights must be completed out of three attempts.
2	Any commercial certified F motor is allowed.
3	Only a commercial altimeter may be used.
4	The fins must be tubes.
5	The rocket must use a launch rail. Rods are not allowed.
6	The rocket must be designed and built from scratch. Cannot use kits or existing design files from the internet.

Documentation Requirements

Teams are required to submit a design document describing the design of the target altitude rocket by December 15. A document template will be provided. Documentation should be submitted via email to battleoftherockets@gmail.com.

Judging and Scoring

The flight score is the absolute value of 801 - altitude in feet. The two lowest flight scores will be summed up and become the final score. The lowest combined flight score wins.

After teams complete a qualification flight attempt, the team must take their rocket with the altimeter to the judge's tent to record the altitude. Do not turn off the altimeter until after the altitude has been recorded. The altitude must be recorded at the judge's tent.

Application

Teams must submit an application form and identify each event to be attempted. The application form requires student information and a signed release form. No information will be released or sold. All applications are to be destroyed after the competition. The information requested is for administrative and insurance purposes only. The application fee for the Target Altitude event is $50 and $75 for the Deployable Sensor Payload and Rover events. The application fee is nonrefundable. Teams can compete in more than one event.

Team Requirements

Teams shall have at minimum 2 members and no more than 10 members per event. Teams can consist of university, college, or trade school students currently enrolled in a university, college, community college, high school, non-profit organizations such as boy scouts, girl scouts, 4-H club, etc or trade school. Each team must have a faculty advisor assigned to the team. The faculty advisor may support multiple teams. Teams can have a Tripoli or NAR certified mentor to review and guide teams in rocket design and motor handling.

At least one team member or mentor must have a membership in Tripoli or NAR and be certified at the proper level to use the selected high power rocket motors. The certified team member or mentor must attend the contest with the team.

Only team members can work on any aspect of the competition including the design, simulation, construction, repair, and launching. Adults, companies, and any non-team members cannot help. Mentors cannot design the rocket but can provide guidance in the design of the rocket and help with test launches.

Team List Management

Each team must fill out an application which comprises a spreadsheet that includes a list of team members. After submission and payment, the team members will receive their spreadsheet with team numbers for each event the team is participating in. The teams must maintain the list of team members and will resubmit the spreadsheet three weeks before the launch with the final list of team members. The final list will be used for generating certificates and verifying submission of release forms.