

NZ Rocketry Challenge 2016

The Challenge

The NZ Rocketry Challenge is designed to provide Year 7 and 8 Students* a realistic experience in designing a flying aerospace vehicle that meets a specified set of mission and performance requirements.

* But students from Year 5-9 are welcome to participate.

Students work together in teams the same way Aerospace Engineers do. The task is intended to be challenging but within the capabilities of students of these ages with a good background in science and mathematics, and some craftsmanship skills.

Objective:

The objective of the Challenge is to design and build a safe and stable model rocket flight vehicle and use it to safely lift a fragile payload (one raw hen's egg) to an altitude of exactly 250 feet (76.2m), then to return the rocket and payload safely and undamaged. Closest to the target altitude, wins.

Fly at your school:

To make the competition accessible to students everywhere in New Zealand -- you can fly at your own school, or a nearby field. Simply register undertake two competition flights (you must be registered in advance), under some pre-defined conditions, and then submit your results to be in to win.

Contest Rules

A summary of the basic conditions that entrants must adhere to are as follows:

Your team:

- Teams can be between 2 and 6 members in size
- Entrants can be from anywhere in New Zealand.
- Team members must be students in Years 5 - 9
- Teams must be formally supervised throughout all training, testing and launching by an adult (normally a teacher).
- Community organisations (such as Girl Guides, Scouts, etc) can facilitate and supervise teams - but team members must fit the age-eligibility criteria.

Your rocket:

- Must have no metal structural parts, and must comply with the "Model Rocket Safety Code" (see below).
- May be any size, but must not exceed 180 grams gross weight at liftoff including the egg & altimeter.
- You may use commercially made parts or modify a commercially-made kitset.
For this inaugural competition, given time constraints -- it may be based on a kit designed to carry egg payloads, provided it has been modified in some way beyond simply the addition of an altimeter.
- May have only one stage.
- Must be powered by either ONE commercially-made C-power model rocket motor, which will be provided to you on launch day.
- Must not contain any pyrotechnic charges except that provided as part of the basic commercially-made rocket motor used for the flight, and this must be used in the manner prescribed in the instructions for that motor.
- Must contain and completely enclose one raw hen's egg of 62 to 67 grams weight and no more than 46 millimeters in diameter (approximately a size 7 egg). Your contest flight egg will be provided on the day. Eggs may be decorated, but in a way that alters their physical strength.
- Must contain the provided AltimeterOne altitude recording device, reset to zero before flight.
- Parts must contain a recovery device designed to return the rocket vehicle to earth at a velocity that presents no hazard.
- May not use an externally-generated signal such as radio or computer control for any purpose after liftoff.
- Must be allowed to land at the end of flight without human intervention (catching).

Your flight:

- The portion of the rocket containing the egg and the altimeter must return to the ground using a parachute recovery system.
- The rest of the rocket may be attached to the portion of the rocket containing the egg, altimeter, and this parachute, or may return separately with a different recovery device of any size as long as it does so safely.
- Your egg payload must return from the flight without any cracks or other external damage.



Model Rocket Safety Code

1. **Materials:** I will use only lightweight, non-metal parts for the nose, body, and fins of my rocket.
2. **Motors:** I will use only certified, commercially made model rocket motors, and will not tamper with these motors or use them for any purposes except those recommended by the manufacturer.
3. **Ignition System:** I will launch my rockets with an electrical launch system and electrical motor igniters. My launch system will have a safety interlock in series with the launch switch, and will use a launch switch that returns to the "off" position when released.
4. **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.
5. **Launch Safety:** I will use a countdown before launch, and will ensure that everyone is paying attention and is a safe distance of at least 5 metres away when I launch rockets with D motors or smaller, and 10 metres when I launch larger rockets. If I am uncertain about the safety or stability of an untested rocket, I will check the stability before flight and will fly it only after warning spectators and clearing them away to a safe distance.
6. **Launcher:** I will launch my rocket from a launch rod, tower, or rail that is pointed to within 30 degrees of the vertical to ensure that the rocket flies nearly straight up, and I will use a blast deflector to prevent the motor's exhaust from hitting the ground. To prevent accidental eye injury, I will place launchers so that the end of the launch rod is above eye level or will cap the end of the rod when it is not in use.
7. **Size:** My model rocket will not weigh more than 1500 grams at liftoff and will not contain more than 125 grams of propellant or 320 N-sec of total impulse.
8. **Flight Safety:** I will not launch my rocket at targets, into clouds, or near airplanes, and will not put any flammable or explosive payload in my rocket.
9. **Launch Site:** I will launch my rocket outdoors, in an open area at least as large as shown in the accompanying table, and in safe weather conditions with wind speeds no greater than 32 kilometres per hour. I will ensure that there is no dry grass close to the launch pad, and that the launch site does not present risk of grass fires.
10. **Recovery System:** I will use a recovery system such as a streamer or parachute in my rocket so that it returns safely and undamaged and can be flown again, and I will use only flame-resistant or fireproof recovery system wadding in my rocket.
11. **Recovery Safety:** I will not attempt to recover my rocket from power lines, tall trees, or other dangerous places.



Model Rocket Safety Code (continued)

Launch Site Dimensions

Installed Total Impulse (N-sec)	Equivalent Motor Type	Minimum Site Width (m) <i>(Diameter if circular area, or shortest side if rectangular)</i>
0.00 -- 1.25	1/4A, 1/2A	15
1.26 -- 2.50	A	31
2.51 -- 5.00	B	61
5.01 -- 10.00	C	122
10.01 -- 20.00	D (or 2 x C)	152
20.01 -- 40.00	E	305
40.01 -- 80.00	F	305
80.01 -- 160.00	G	305
160.01 -- 320.00	Two Gs	457

Qualification Flights

Once you have completed your rocket design and any test flights you choose to undertake, you must then undertake the contest 'qualification flights' - under appropriate test conditions.

Flight Criteria

The two test flights must:

- Be sequential -- e.g. flown directly after each other
- Be declared in advance of liftoff -- e.g. not cherry-picked from a selection of past flights
- Must occur within 60 minutes of each other
- Be observed by an appropriate witness (see below)

The rocket must:

- Comply with the "Contest Rules" criteria
- Have a properly affixed digital altimeter -- Jolly Logic AltimeterOne-Three (which can be rented/purchased via NZ Rocketry Challenge website)

The payload ("egg") must:

- Meet the size and weight criteria specified in "Contest Rules"
- Cannot be modified in any way
 - No adhesive coating can be used to strengthen the egg/etc.
 - *Can* be wrapped in bubble-wrap, etc - provided can be removed easily from the egg.
 - Must be certified as having no cracks or damage prior to being flown.

Other criteria:

- The team needs to have registered at the competition website in-advance of undertaking their flights.
- Flight can take place at any day or time up until the contest deadline.
- You can launch in any weather condition (e.g. windy or still, overcast or sunny) -- provided the Model Rocketry Safety Code is adhered to (notably range safety and launch-site dimensions).

Photo/Video Evidence Required

Use of a camera-phone is acceptable - but try to get the best quality images and video you can.

Date and time of each launch must be supplied.

Current weather conditions (approximation) must be supplied (not part of the judging criteria, unless exceeds safety limits).

Photographs must be provided of (for each launch):

1. The complete rocket assembly, prior to flight, laying on a flat surface with booster and payload sections pulled apart
2. Altimeter (closeup) - showing the zeroed ground-level reading



3. Rocket (both booster and payload section), after flight - **as it was found** on the ground / landing surface (e.g. **unopened**)
4. Egg (closeup) - showing both sides
5. Altimeter (closeup) - showing reading for the flight

Videos of each launch should be provided:

- Showing launch, as much of flight as possible, and if possible - landing
- Approaching the rocket as it landed
- Opening the rocket
- Examining the Egg (with full 360 rotation over both axis)

Launch Witness

The launch and recovery should be witnessed by:

- Teacher; or
- An adult who is not related to any of the team members.

Certification

The final results being submitted to NZ Rocketry Challenge must be certified by:

- In the case of a school team, the Principal or Deputy Principal of the School; or
- In the case of a community group; a senior leader/manager from that group; or
- In the case of homeschool; the Parent/Guardian of the student AND an independent witness

The person certifying the results must not have been involved in the coaching of the teams.

Competition Judging Criteria

Failures

- A rocket that leaves the launch pad under power is considered to have made a flight.
- If a rocket misfires and does not leave the launch pad or experiences a rare 'catastrophic malfunction' of the rocket motor as determined by launch supervisors, then a replacement flight may be made.
- If a launched rocket cannot be recovered (e.g. flies out of the recovery area or into hazards) a replacement flight may also be made.
- Only one repeat launch attempt is allowed (even if the first two launches failed).

Judging Criteria

- Your egg must be recovered without any cracks or other external damage, or the flight will be disqualified.
- All parts of the rocket must have landed in a safe manner, and still be attached to the parachute recovery system.
- The achieved altitude will be based on the readings from the digital altimeter in *feet* (the most fine-grained value provided by the altimeter) by contest officials.
- If altitude data is not returned from a flight, then the achieved altitude will be recorded as 0m.
- The distance away from the target competition altitude (250 ft) for each flight will be recorded for each of the two flights, to create a combined "Total Delta".
e.g. If two flight results were 245m and 262m, then the Total Delta would $5\text{m} + 12\text{m} = 17\text{m}$.
- The winning team will be that with the lowest Total Delta.
- In the event of a tie, for teams not attending the contest day, the winner will be the team who submitted their certified flight results first.

Launch Protocols

The following is a broad summary of the launching protocols used for formally organised rocketry events, which you may choose to adopt if doing multiple-team competition flights at your school; or adapt for a standalone flight.

General

- Teams will be randomly assigned a launch order
- Teams will be given two launch opportunities
- Teams are permitted to bring up to two rocket bodies, in case one is damaged in flight - and to bring spare parts for repairs.
- The following items will be provided by the organisers:
 - Launch pads and rod (3.25mm diameter rod, 900mm high)
 - A centralised launch controller (motor ignition device), managed by the Range Controller
 - 2 x C Flight motors (provided at team check-in)
 - 2 x Labelled Flight Eggs
 - 1 x Digital Altimeter

Launching Protocol

- Rockets are certified as safe for flight in a pre-launch check by a Range Safety Officer (RSO).
- Teams will be given a 5-minute window to set up their rocket, starting from when teams are admitted to the launch area.
- Teams must then install their rocket on the launch rod and connect the igniters to the centralised launch controller cable.
- Your rocket and installation will then be approved as safe by the Pad Controller.

- When the launching range is ready, the Range Controller will arm your rocket on the launch controller.
- For each team in sequence, the Range Controller will initiate the countdown and a team representative will depress the launch button.
- Using their experience and expertise, the Range Controller will make best judgement with respect to avoiding wind gusts, etc - but any weather/timing differences will not be considered in the judging criteria.
- If the rocket motor does not ignite, then the controller will disarm your rocket and you will be permitted back to your rocket to remedy the issue.

- Once your rocket has launched, you must wait for approval before entering the range to recover your rocket.
- You will be accompanied by a contest official who will record the altimeter reading and verify the condition of your egg. The official's decision is final.