

Health and Safety Plan

Note: This health and safety plan has been updated from the plan developed by the 2016 rocket avionics project team. For future launches, any additional information will be included in the corresponding launch sheet.

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The Rocket

The rocket to be launched has a maximum weight of 100 grams and a maximum length of 12 centimetres. It will use a Quest C6-5 motor which has 12.5 grams of black powder propellant (containing potassium nitrate, sulphur and charcoal, see Appendix A4), and 8.8 Newton seconds of impulse. With this motor, the rocket will can reach an estimated maximum height of 30 metres (100 feet), based on simulations of flight under ideal conditions (conditions most facilitating to a straight, undiverted, upward trajectory). The maximum landing radius based on simulations of the worst case launching conditions is approximately 40 metres. In accordance with the NZ Model Rocketry Safety Code, the rocket exterior contains no metal parts, and the ignition system includes two safety interlocks. In addition, as a recovery charge is not needed for this flight it will be deactivated by the client, André Geldenhuis, who is experienced with this operation. This will greatly reduce the potential damage risk from fire or debris, as a non-deactivated charge could go off after the rocket has already landed. The rocket is designed to tumble after burnout, preventing a dangerous ballistic fall.

Launch Plan Outline

Location

The launch will take place in Trentham Park, Upper Hutt. Figure 1 below shows the proposed launch site. It can be seen that the nearest building or tree cover is over 80 m from the proposed launch point, whereas the worst case simulated landing point of the rocket is 40 m from the proposed launch point. It is therefore highly unlikely that the rocket will interfere with or cause damage to any buildings or tree cover. Should the rocket land in nearby bush, it is highly unlikely that a fire will be caused as the rocket motor will likely not be ignited upon landing. To ensure any outstanding risk of damage due to a fire is minimised, a water-based fire extinguisher will be brought to the launch. The designated primary persons of contact will have on their person one working mobile phone each, should emergency services need to be called (see Appendix A1, risk #3). As per CAA regulations Part 101.155 (see Appendix A2), this location is greater than 4km from any aerodrome, and the maximum simulated height of the rocket is well below the CAA maximum ceiling of 400 feet for a flight between 4 and 8km from an aerodrome.



Figure 1: Proposed launch point in Trentham Park, Upper Hutt. Each 'arm' on the aerial view is 80m from the launch site.

Travel Plan

Three independently-owned vehicles will be used to transport participants and equipment to the launch site. These vehicles each have full registration and warrant of fitness and will only be driven by the designated, fully-licensed drivers. The participants will travel to the launch site from Victoria University Kelburn Campus via State Highway 2. The heat needed to ignite the motor is approximately 288°C (550°F), thus the rocket will be kept far from any source of heat greater than 50°C during transportation to minimise the risk that the motor ignites (see Appendix A1, risk #2). One of the three primary persons of contact will ride in each car; should an issue occur, such as getting lost or the vehicle breaking down, the mobile phone(s) can thus be used to resolve the issue appropriately (see Appendix A1, risks #13, #14).

The two vehicles transporting the participants of the launch to the launch site will depart Victoria University Kelburn Campus at 10:00am and return to Victoria University Kelburn Campus no later than 2:00pm. A designated member of university staff who is well informed of the excursion will be contacted upon return to confirm that all participants have safely returned from the launch.

If the staff member has not been contacted to confirm this by 6:00pm, emergency action should be taken.

Environment

As required by CAA regulations Part 101.157 and Part 101.159 (see Appendix A2), the launch will take place during daylight hours and will be cancelled under the following weather conditions:

- Conditions which limit horizontal visibility to less than 8km
- Heavy precipitation
- High wind (speeds exceeding 32kmph)

Furthermore, the rocket will not be launched into cloud, as per CAA regulations Part 101.157 (b).

To ensure no harm is caused to any members of the general public who may be using the park at the time of the launch, each member will be notified of the launch and any safety precautions they will need to take for the duration of the launch. If they indicate prior to the launch that they will not comply with these precautions, the launch will be postponed until the members leave the park (if possible), or simply cancelled (if not possible).

Throughout the duration of the launch itself, three members of the team will be stationed around the launch site at the maximum landing radius. They will ensure that any nearby users of the park are kept aware of the launch and remain outside the safe radius of 5m from the launch point.

Participants

The potential participants in the launches are as follows:

- | | |
|--------------------------|-----------------------------|
| • André Geldenhuis | [client, launch supervisor] |
| • Luke Davia | [team member] |
| • David Dobbie | [team member] |
| • Jonathan Elliot | [team member] |
| • Nathaniel Fallow | [team member] |
| • Grayson Solomon Hughes | [team member] |
| • Tyaan Singh | [team member] |
| • Harrison Jones | [project champion] |
| • Chelsea Miller | [project champion] |
| • Jamie Sanson | [project champion] |

Communications

The primary persons of contact are:

- Nathaniel Fallow, Mob: 021 280 4843
- David Dobbie, Mob: 022 412 8153
- Jonathan Elliot, Mob: 0210 841 9447

Equipment

The equipment to be taken on the launch is summarised in the table below.

Equipment	Owner
Rocket and ignition switch	André
Fire extinguisher	School of Engineering and Computer Science, VUW
First aid kit	School of Engineering and Computer Science, VUW
Safety goggles x11	School of Engineering and Computer Science, VUW
Hi-Vis vests	School of Engineering and Computer Science, VUW
Ammo bag	School of Engineering and Computer Science, VUW
Glad wrap (for burns)	Participants
Launch rail and pad	School of Engineering and Computer Science, VUW
Laptop computers	Participants
Digital camera	School of Engineering and Computer Science, VUW
Mobile phones	Participants

A checklist based on this list will be used to ensure all equipment is packed before departure to and from the site.

Supervision

The launch will be supervised by André Geldenhuis. André is a very experienced expert in model rocketry and is a member of the NZ Model Rocketry Association. André is the only member of the off campus party authorized to launch the rocket, and it is his decision upon reaching the launch site whether conditions are safe for launch. He will abide by the NZMRA rules as laid out in appendix A3.

Launch

As per CAA regulations Part 101.161, Airways NZ (Air Traffic Control) will be notified of the launch and given all necessary details pertaining to it. A NOTAM will be raised by Airways NZ to ensure any traffic using this airspace is informed of the necessary details of the launch. As stated above, the maximum height of the rocket is estimated at 30m; well under the minimum flying height of manned air traffic in this airspace. Due to these practices, any potential risk to manned air traffic presented by the launch is negligible.

Upon arrival at the site, a safety inspection will be conducted to identify any hazards in the area and mitigate risks pertaining to those hazards. A safety induction will be given to all participants by Nathaniel Fallow to ensure all are aware and participating in necessary precautionary measures throughout the duration of the operation. At this point, any hazards relating to members of the general public present in the park will be assessed as has been described above.

The safe radius of 5m from the launch point, as determined by the NZ Model Rocketry association (see Appendix A3), will be marked out to ensure all participants are aware of it at all times. A countdown will be used to provide plenty of notice to all participants and ensure they are prepared for the launch. This countdown can be stopped upon request from any of the participants at any time to ensure the launch does not commence until all are prepared for it. Should the rocket motor fail to ignite, the safety interlocks will be put back in place and all participants will wait at least one minute before approaching the rocket.

The rocket will be launched from the launch rail and pad provided by André Geldenhuis, which will be directed as close to vertical as possible. All participants will wear protective eye goggles or glasses during the launch and when handling the rocket or launch rod/pad.

The rocket will tumble rather than fall ballistically after motor burnout, slowing the descent of the rocket. Participants will not attempt to recover the rocket from dangerous areas (very high-up places, deep holes, etc.).

Appendix

A1: Risk register for launches

Ref. Number	Risk	Likelihood	Impact	Risk Rating (%)	Status	Mitigation Strategy	Stakeholders to contact if risk materialises
1	Rocket falls onto one or more persons during launch causing mild to serious injury	3	5	60	Current	All participants will remain at a safe distance of 5m from the launch point for the duration of the launch. This radius has been defined by the NZ Model Rocketry Association as a safe observation distance from rockets using D motors or smaller.	Roger Cliffe
2	Rocket thrust ignites prematurely causing burns or other serious injury, or damage to property	3	5	60	Current	The rocket will be kept far from any heat or fire. There are two safety interlocks on the launch trigger, dramatically reducing the possibility of accidental ignition.	Roger Cliffe

3	Ignited engine lands in a flammable area resulting in a fire	2	5	40	Current	The launch site chosen (Trentham Park, Upper Hutt) is a large, open space with very little flammable material. The fire risk for Upper Hutt as listed by the National Rural Fire Authority will be checked before the launch date and the launch cancelled if it is too high. At least two group members will have a working mobile phone during the launch, should emergency services be needed.	Roger Cliffe
4	Aircraft flight is disturbed or interfered with by the rocket during a launch	2	5	40	Current	obtained from the CAA. Airways NZ (Air Traffic Control) will issue a NOTAM on our behalf to ensure any air traffic which may use that airspace is notified of potential hazards. In addition to this, the maximum height of the rocket is approximately 30m - below the minimum altitude of aircraft.	CAA, Air Traffic Control, Roger, James, André
5	Rocket falls sideways and launches into trees	2	5	40	Current	The rocket's shallow cone-shaped body will not tip over. The passive rocket will utilize a launch rail as an added measure.	Roger Cliffe, Hutt City Council
6	Heat, light, or small particles from motor hit participants causing injury to the eye, face, or skin	2	4	32	Current	All participants will stand a safe distance of at least 5m away from the launch point as advised by the NZ Model Rocketry Association (when using a D motor or lower)	Roger Cliffe

7	One or more participant is surprised by launch and is thus unprepared and unable to follow safety precautions	1	3	12	Current	A countdown will be used to ensure all participants are aware and prepared for launch	Roger Cliffe
8	Rocket motor fails to ignite, then ignites unexpectedly at a later time causing injury, fire, or other damage	2	5	40	Current	If the rocket fails to ignite when required, the ignition system will be disabled and all participants will wait a minimum of one minute before approaching the rocket to disable.	Roger Cliffe, Hutt City Council
9	Rocket is diverted by high winds during flight and lands on person, animal, or property causing damage or injury	2	5	40	Current	The launch will be cancelled in the event of high wind. Airways will be notified so that the NOTAM can be rescheduled.	Roger Cliffe, Hutt City Council
10	Rocket chassis (containing metal weights) falls apart during flight, causing weights to fall and cause serious injury	2	5	40	Current	The nose cone will be secured with several layers of strong duct tape. This will not only prevent the pieces from separating, but will prevent significant amounts of air from entering the gap between the two pieces which would cause them to separate.	Roger Cliffe
13	Vehicle breaks down during transport	1	3	12	Current	One of the two primary persons of contact will ride in each of the transport vehicles; should the vehicle break down, emergency services such as AA can be contacted via mobile.	

14	Drivers get lost during transport	2	2	16	Current	One of the two primary persons of contact will ride in each of the transport vehicles; maps on mobile phones can be used to navigate and prevent drivers from getting lost.	
15	Participant becomes ill during operation	2	3	24	Current	A first aid kit will be brought on the excursion. Two members of the team have training in basic first aid (CPR, burns, Heimlich, etc.). Mobile phones carried by the designated primary persons of contact will be used to contact emergency services if needed.	Roger Cliffe

A2: CAA Regulations

CAA: Part 101, Subpart D — Rockets

101.151 Applicability

This Subpart prescribes rules governing the operation of rockets.

101.153 Large model rockets

A person shall not operate a large model rocket except in accordance with the Model Rocketry Safety Code.

101.155 Aerodromes

(a) Except as provided in paragraph (b), a person shall not operate a rocket on or within 4 km of an aerodrome boundary.

(b) A person may operate a rocket within 4 km of an aerodrome boundary providing—

- (1) the rocket does not fly above 400 feet AGL; and
 - (2) at uncontrolled aerodromes, it is operated in accordance with an agreement with the aerodrome operator; and
 - (3) at controlled aerodromes, it is operated in accordance with an authorisation from ATC; and
 - (4) it is not operated on or over any active aircraft movement area of an aerodrome; and
 - (5) it is not operated on or over any active runway strip area.
- (c) A person shall not operate a rocket between 4 and 8 km of an aerodrome boundary above 400 feet AGL.

101.157 Meteorological limitations

(a) A person shall not operate a rocket at any altitude where—

- (1) there are clouds or obscuring phenomena of more than four- eighths coverage; and
- (2) the horizontal visibility is less than 8 km.

(b) A person shall not operate a rocket into cloud.

101.159 Night operations

Except for a large model rocket, a person shall not operate a rocket at night.

101.161 Pre-launch notice

Except for a large model rocket, a person shall not launch a rocket unless they provide the following information to the New Zealand NOTAM office at least 24 hours prior to launch:

- (1) their name, address, and telephone number or, where there are multiple participants at a single event, the name, address, and telephone number of the person whose duties include co- ordination of the launch data estimates required by paragraphs (2), (3), and (4) of this rule and co-ordinating the launch event:
- (2) the estimated number of rockets to be operated:
- (3) the estimated size and the estimated weight of each rocket:
- (4) the estimated highest altitude or flight level to which each rocket will be operated:

(5) the location of the operation:

(6) the date, time, and duration of the operation:

(7) any other relevant information requested by the person to whom notification is given.

A3: NZ Model Rocketry Association 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 5 metres away when I launch rockets with D motors or smaller, and 10 metres away 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 1,500 grammes at liftoff and will not contain more than 125 grammes of propellant nor produce more than 320 N-secs 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 table below, 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 wadding in my rocket.

11. RECOVERY SAFETY

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

Bibliography

B1: Fire Risk Maps

<http://fireweather.nrfa.org.nz/>

B2: Airspace Maps

<https://www.airshare.co.nz/maps>