Dutch Federation for Rocket Research
1959 – 2005

Information bulletin for participants of the NERO Launch Campaigns at the Artillery Range (ASK) at 't Harde in the Netherlands
Version July 2005

1. General

All NERO Launching Campaigns are held on a Friday at the Artillery Range (ASK) at 't Harde, the Netherlands. Rocket inspection will be at Thursday in the afternoon.

This Information Bulletin is intended for *participants*, i.e. clubs or rocket teams that have the intention to launch an experimental rocket on the Launch Campaign. The bulletin starts in the next chapter by stating the obligations of participants to the organisation. The third chapter specifies the available infrastructure and services during the Launch Campaign. The fourth chapter states operational restrictions of the launching site at the Artillery Range (ASK) at 't Harde and lists rocket design requirements. Finally, the fifth chapter lists the people of the organisation and the way they can be contacted if you need additional information.
Last minute information on the Launch Campaign is given on the NERO website http://www.nerorockets.org.

2. Obligations of participants

2.1 Insurance and Launch Fee.

The military authorities of the Artillery Range (ASK) at 't Harde demand that the liability risk, for rockets that cause personal injury and/or damage to third parties, is insured. NERO has effected an insurance policy which covers liability for third party damages inflicted by NERO rockets launched at events organised by NERO. For this reason, all experimental rockets proposed to be launched on the NLC will formally be handed over to NERO. The launch will than take place on behalf of and under responsibility of NERO. Any participating party must make use of the NERO insurance policy.

For every rocket to be launched a launch fee of 20 euro will have to be paid. This includes the cost of insurance. Participants can pay their contribution in cash upon arrival at the Launch Campaign.

2.2 Data Requirements

To aid in the organization and safe execution of the Launch Campaign, the organization has drawn up a Questionnaire that must be filled out by all participating teams and returned at least 2 weeks before the launching day. The Questionnaire can be downloaded from the NERO web site (**Basic** Rocket Safety Data Sheet). For every rocket that meet one or more of the following conditions the **Full** Rocket Safety Data Sheet replaces the Basic Sheet:

- the rocket contains more than one rocket motor (clusters or multiple stage rockets)
- the rocket motor will burn more than 3 seconds;
- the rocket will reach an altitude of more than 1500 meters
- the rocket does not solely contain soft materials
- the rocket does not have a standard geometry with a cylindrical body and three or four fins.

NOTE:
Often, a considerable amount of the work needed to finalise a project is done in the months before the launching date. As a result many of the specific questions in the Questionnaire cannot be answered until very close before the date of launch simply because some rocket subsystems are not completed. This however should not delay the timely return of the Questionnaire. If the answers to some specific questions cannot be given, just write down why, and go on with the next

question, but do send in the Questionnaire in time. Then provide the remaining information by email at a later date.

2.3 Financial Contributions

The following financial contributions have to be paid in cash to the organisation upon arrival at the launch site:

- An admission fee of 10 Euro per person. This fee is only for visitors who are not NERO member (or member of NERO clubs), not an invited guest of NERO, not a NERO sponsor.
- A launch fee of 20 Euro per launch (or statical test).
- All costs that are made by the organization for their benefit exclusively. Examples are the costs of sleeping arrangements on the ASK, meals and the costs of dinner and social event (if applicable).

2.4 Subscription of project team members and guests

In order to attend the Launch Campaign all team members and team guests must subscribe to the organisation of the Launch Campaign by signing a form stating that they accept the risks associated with attending the NERO launch activities and will not claim compensation in case of damage and/or injury. This subscription form is combined with the application form and can also be found on the website. It has to be mailed to NERO secretary Maarten Tromp as soon as possible but at least two weaks in advance.

2.5 Contributions to the NERO-Bulletin

The participants are supposed to write a report in Dutch or English about the results of their experiments for publication in the NERO-Bulletin, within two months after the NLC. It must be sent to the editor-in-chief John Koster.

3. Infrastructural facilities available at the Launch Area

3.1 Launch towers

The NERO launch rail is the main launch tower for experimental rockets on the Launch Campaign. It has the following specifications:

Item	Specification
length	7.5 meter
rocket diameter supported	4 to 14 cm
maximum weight	40 kg
attachment	standard 8mm (large type) HPR launch lug for C-rail two lugs to be placed at lower end of rocket and in center of gravity, but at least separated by 30% of rocket length
rail contour	see drawing Appendix B
fin geometry	3 or 4 fins supported
launch tower frame material	anodized aluminium
elevation angle	85 degrees or less, depending on actual wind conditions.

Rocket access to the launch rail is from below. Tower orientation is fixed during access (i.e. tower can not be tilted). A breakwire might be attached to the rail to trigger rocket timers and/or automatic camera(s).

3.2 Pyrocontrol

Connecting a high pulse 12 V battery to the igniter will do ignition of the rocket motor. This device is capable of generating a DC current of 4 A during 4 seconds. Actual current is limited by the series resistance of the igniter and the primary fire line. It is remotely operated from Launch

Control, via a relay box near the Launch Tower. The primary fire line and the igniter are remotely checked for continuity. Use of high energy U-class igniters is recommended for motor ignition.

3.3 Telemetry ground equipment.

The organization does not provide standard facilities for telemetry reception and recording. The rule is that each rocket team shall bring its own telemetry ground equipment to the launch campaign. Upon request, the organization will provide suitable accomodation for the equipment, such as mains power connections and a communication link with launch control. Requests for facilities have to be made on the Questionnaire (Appendix A).

Operation of 2 meter band RF transmitters is allowed provided that the owner has a radio amateur licence. In practice however, license and message contents are not checked as long as transmissions are short duration and low power (order 100 mW). Transmissions in broadcast band (FM 89-104 MHz) are formally prohibited. Information to be provided on the questionnaire (appendix A).

Operation of commercial-of-the-shelf LPD 433 MHz (10 mW) or PMR 446 MHz (0.5W) band devices is allowed without license, provided the antenna interface on the modules is not modified. Interference with the datalink of the meteo station, which is operating in the 433 MHz band, is possible. Should this occur, the rocket transmitter has to be switched off, unless wind conditions near the tower are uncritical.
In order to reduce RF interference with the datalink, wireless communications including rocket ground testing shall not be performed during the flight of rockets carrying telemetry equipment.

3.4 Recovery and recovery aids

Recovery of the rocket will be co-ordinated by the military, using military vehicles. In principle each rocket will be recovered immediately after its flight. For practical purposes however, it might be decided to combine the recovery of several rockets together.

In order to make recovery easier all rockets shall carry a simple radio beacon and/or an acoustic beacon. The organisation supports the use of 433 MHz radio beacons which can be obtained free of charge on request. A dedicated receiver with Yagi antenna is available for direction finding (no downlink data storage).

If the rocket can only survive a short time in the field, for example if data will be lost due to battery depletion, this should be communicated to the organization via the Questionnaire (Appendix A).

3.5 Meteo

The weather forecast and wind profiles will be available for the organization. Wind profiles are measured every six hour on a nearby military basis. Actual meteorological conditions (wind speed and direction, temperature, pressure, humidity) near the launch tower platform are measured in real time and stored electronically. Although a lot of information about launch conditions is available all over the place, launch practice points out that one should not expect that transfer of this information to rocket teams is automatic. Therefore this information can only be transferred to the rocket team **upon request**.

3.6 Trajectory calculation

Several personal computer systems with Windows and Excel spreadsheet programs are installed at or nearby launch control. These systems will be used by the organization, amongst others, for checking the flight trajectory calculations of the rockets to be flown. Simulations of all rockets will be performed as part of the rocket design review on the basis of information provided in the questionnaire. If necessary, and time/manpower permits, the calculations will be repeated using actual weather data.

3.7 Rocket preparations area

An indoor motor storage and rocket flight preparations area is provided. The available space for each rocket is practically limited to one table of 2,5 m^2. Each rocket team is supposed to carry its own tool set. The flight preparations area is open during the night hours and will otherwise be locked. It has lighting and mains supply. In the rocket preparations area smoking is prohibited.
Mixing of fuel and filling of ZnS motors shall be done early in the morning of the Launch Campaign on a dedicated location near the launch tower area. This shall be discussed well in advance with the organization. The need for such fuel handling shall be indicated on the questionnaire.

4. Limitations and Regulations

4.1 Altitude and Range Restrictions

The military authorities have imposed a maximum ceiling for amateur rocket launches of 2000 meters. Preflight verification of expected ceiling is done by:

- Evaluation of expected nominal flight on the basis of information from the questionnaire, actual weather conditions (especially wind profile) and inspection of the hardware.
- Simulation of expected nominal flight using the 'Flight3' or equivalent computer programs
- Simulation of non-nominal (ballistic) flight
- Verification that rocket stability is OK.

A map of the military range showing contours of the launch area is attached in appendix D. The launch tower is always oriented such that the risk that rockets land outside the military area is minimized, taking into account actual wind profile. It is not allowed that rockets land outside the borders of the launch area, neither after nominal flight nor after ballistic flight. As a result and because of the stretched shape of the terrain, there are altitude and parachute descent-time restrictions that depend on wind speed and wind direction. In order to build an understanding, the next table lists the operational consequences of the wind directions for a common wind speed of 8-12 m/s.

Wind Direction	Tower azimuth and elevation settings	Remarks
North / North-West **(Worst-Case)**	The objective is to position the apogee of the rocket trajectory as far north the south border of the terrain <u>and</u> as low as possible. Roughly this means that the launch direction is as north as is permitted by the rocket ballistic range.	If the parachute-descent time is too large, it may not be possible to determine a launch direction and launch angle for which both the ballistic impact point and the parachute touchdown point are within the militairy area.
North-East	The objective is to position the apogee of the rocket trajectory as far east as possible. This means that the rocket is launched in east direction with a launch angle which decreases with increasing parachute decent time.	After parachute deployment, the rocket floats back towards the public and military buildings. If the parachute descent-time is too large, it may not be possible to determine a launch angle for which the apogee is sufficiently far away and for which the parachute deployment speed is still acceptable.
South-East	The rocket is launched roughly in parallel with the south border of the military terrain. In case the parachute descent-time is very large, the altitude of parachute deployment may be reduced in order to limit the altitude of parachute deployment.	Because of the south position of the launching site, this wind direction is not as critical as the North / North-West direction.
West South-West	The launch direction can be freely chosen between North to North East.	

Wind Direction	Tower azimuth and elevation settings	Remarks
(Best Case)	The launch angle can be chosen between 85 and 70 deg.	

Table 4-1 Consequences of wind direction on launching angle and launching direction for wind speeds between 8-12 m/s

Due to military regulations as stated in a letter from the head of the ASK to the NERO, the rockets to be launched on the ASK need to fulfil the following requirements:

The rocket must have a working radio and/or acoustic bacon

The rocket must be (partially) painted in bright colours such as yellow, orange or red in order to improve the recoverability in the field.

4.2 Requirements on the rocket system design and construction

A reduction of launch angle below the nominal 85 degrees will increase the rocket velocity at which the parachute is deployed. If this is not taken into account for the design of the deployment system, the parachute line could be overstretched at deployment resulting into a crash of the rocket.
It is recognized that a ballistic impact of a rocket is in itself not a safety problem. However, a ballistic impact severely reduces the chance of a successful recovery. Given the fact that the Military only allow *incidental* losses of rockets on the ASK, the following requirement is adopted:

The parachute system must be designed such that it can withstand, with a safety factor of 2, the aerodynamic forces during parachute deployment for a launch angle of 70 degrees. The moment of parachute deployment is thereby defined as the intended or programmed time of deployment for a launch at 85 degrees.

It is well known that there are two effects of atmosferic wind on the rocket trajectory. Firstly, the rocket will exhibit damped pitching and yawing motions directly after leaving the tower. This effectively results in a deviation of the azimuth and elevation from the launch tower values. Secondly, the rocket will tend to be pushed aside and drift with the wind. The result is that the position of ballistic impact and parachute touch down have to be compensated for effects of wind and wind uncertainties. In order to minimize the effect of wind, the following limitation is applicable:

The stability margin shall have a value, at lift-off, between 1 and 2 (refer to appendix A).

The derivative of the normal force coefficient CNα of the rocket fins shall have a value of at least 12 rad^{-1}

Both CP And CG must be marked visible on the outside of the rocket..

Note: It is recommended to use the Barrowman method for velocities well below Mach 1. Equations are given in appendix A. However, any other proven method may be used. Nevertheless the organization will check the CoP calculations using the Barrowman method and in case of conflict conclusions on rocket stability will be based on this method. For velocities being transsonic (M=0,8 – 1,2) or supersonic, more advanced calculations methods are required. In this case the rocket team shall provide reference to literature used for the calculations.

Note: To reduce the sensitivity to cross-winds during the initial part of the flight, rockets shall have a stability margin, at lift-off, between 1 and 2. This will be verified by the organization using the Barrowman method for the calculation of the CoP. Verification of the CoG is done by a balance test, to be performed as part of the rocket inspection.

Exceptions to the stability margin requirement have to be motivated by the rocket team. The organization may decide to waiver the requirements on a case-by-case basis.

The organization adopts a tower exit velocity to cross-wind ratio of at least 3:1. Since a practical limit to wind speed is approximately 7 m/s, this means that the rocket shall be preferable designed to leave the launch tower with a velocity of at least 21 m/s.
During previous Launch Campaigns it has occurred that the weather situation in terms of wind speed and direction was worst case as outlined above, while at the same time the parachute descent-time for many rockets was quite large. As a result, there were many discussions and evaluations going on between (a) the organization and the military with respect to the launching angle and launching direction for each individual rocket and (b) between the organization and participants on how to reduce the parachute descent-time. As a consequence, considerable delays were introduced in the launching schedule. To limit these situations in the future, the following requirement is adopted:

> *The parachute descent-time for rockets to be launched at the ASK is limited to 120 seconds for a launch at 85 degrees. In this context, the parachute descent time is defined as the time from first parachute deployment to touch down.*

For safety reasons during rocket assembly and rocket handling in and around the tower, is following is required:

> *The rocket must have a device that allows to perform the SAFE and ARM function without having to disassemble or open the rocket. This function must physically disconnect all igniters from their ignition systems. It shall be possible to externally switch on and off on-board transmitters, inclusive radio beacons. Unsafe conditions shall be externally monitorable (by audible and/or visible alarm).*

To facilitate the recovery of the rocket the military demand that the rocket is designed, as much as practically possible, to be easily located after landing. This could be achieved by building in complex on-board systems such as GPS, RF beacons etc, but the most simple, cheap and effective measure is to have the rocket painted in bright colours:

> *The rocket shall be painted in bright colours to improve visibility after landing.*

> *The rocket shall contain a sticker with the name, address and telephone number of the owner.*

The following mechanical construction guidelines are based on requirements from the ANSTJ "Cahier des charges pour fusees experimentales". They will not be tested by the organization. However sound rocket construction will be verified by other suitable methods. Construction that complies with these requirements will pass the verification.

> *The rocket shall be constructed to withstand the forces of handling and flight without significant bending. This will be tested by balancing the rocket in horizontal position centered on the center of gravity. The sum of bending of left and right parts shall be less than 1% of the rocket body lenght.*

> *The rocket shall be constructed to withstand the maximum static axial loads of acceleration during flight with a margin of factor 2. The center of mass at lift-off shall be indicated by a mark on the rocket body.*

The rocket fin mounting shall be constructed to withstand the peak bending moments exerted during flight. This will be tested by applying a force F on the center of gravity of each fin, which shall cause a fin bending less than 10 degrees. The force $F = 0{,}052xAxV^2$ [N], where A = area of one fin [m^2] and V = maximum velocity during flight [m/s].

4.3 Flightworthyness check.

All rockets proposed to be launched will be subjected to a general *flightworthyness check*. The purpose of the check is to verify that the rocket does not create an unacceptable extra risk to its environment, in terms of personal injury and damage.
The check consists of two parts: (1) Review of the information provided via the Questionnaire and (2) Inspection of the rocket hardware. Both design and construction but also operational and handling aspects will be considered.

Aspect to be verified	Way of verification
General status of the rocket	Comparison of data on questionnaire with the flight hardware. Discussion of problems (if any).
Rocket pyrosystems, safe/arm devices and control circuitry	Demonstration of normal operation (timing, transmitter interference). Testing of response to not nominal situations, especially of microcontroller operated devices.
Mechanical strength and stiffness	Engineering judgement and assessment
Aerodynamics, stability margin	Checking geometry, (Barrowman) calculations and center of mass.
Rocket motor qualification status	Review of data on questionnaire and comparison with flight motor.
Recovery system	Verification of recovery system and dimensions of the parachute.

The inspection of the rocket will take place at the accomodations of the launch area on the evening before the Launch Campaign, i.e. on Thursday. Therefore all participants are supposed to check in at the ASK the day before the launch day not later than 20.00 hour.

4.4 Launch operation and schedule

The launch order will be planned in advance by the organization based on a variety of information such as:

- complexity of the rocket (required infrastructure)
- size (diameter, settings launch tower)
- performance (altitude, speed, sensitivity to wind)
- recovery specifics
- rocket general status (for example readiness or general condition)
- risk of failure and possible effect on schedule

It is intended that rockets requiring the same launch tower settings, will be launched sequentially. The 'final' launch order will be determined early in the morning of the Launch Campaign at the kick-off meeting, using latest available information. However, in the course of the day it can be decided to deviate from this order depending on the actual situation.
If it is expected that a rocket is likely to exceed the limits of the area (by range and/or altitude) taking one or more of the following ad hoc measures can be considered by the rocket team:

- adjusting the launch angle and direction for the rocket (refer to section 4.1)
- adjust the parachute ejection time(s)
- modify the parachute hardware (reefing)
- increase the mass of the rocket (by adding dummy weight), if motor peak thrust allows
- disable the parachute system (i.e. accept a ballistic flight)

If these measures are found to be insufficiently effective (or considered unacceptable by the rocket team) the rocket will in principal *not* be launched. The military authorities may request the launch angle and elevation to be adjusted.

4.5 Launch window.

A general launch window is applicable between 10.00 and 14.00 hr. It is expected that launchings begin not earlier than 10.00 hr. Decisions concerning scheduling of individual rockets are made by the organization but the rocket teams will be consulted whenever necessary.

5. Range rules

At this moment only the enduring hospitality of the ASK makes it possible to launch rockets in the Neterlands. Due to the fact that we are guests on a military shooting range, the following rules apply:

- Instructions of military personnel and NERO officials must be obeyed.
- For entrance of the ASK Shooting Range a passport can be asked for. The badges provided by the NERO to visitors must be worn visible.
- Parking is allowed between the fence and the tents. Cars are not allowed on the parking terrain before the building or places where they block passage. Military Police is permitted to write parking tickets.
- Smoking is prohibited near rockets and/or motors
- Walking on the moors of the ASK areas **strictly forbidden**. This because unexploded ammunition can be found there. Access is only permitted when accompanied by military personnel. Since we have had some bad experiences, **offenders will be denied access for the next two launch campaigns.**

6. Launch protocol

6.1 Key personnel

The following officials are in charge on the launch campaign.

The **Launch Director (LD)** has the final responsibility for the launch day. He is the person that decides the launch schedule and is co-ordinating the rockets and sends them to the tower. However he is not allowed to overrule the LCO or RSO. Finally he is the formal contact person and represents NERO to the military. The LD wears a bright yellow vest.

The **Facility Manager (FM)** arranges the following:

- Subscription of visitors and participants
- Time-of-arrival
- Sleeping arrangements
- Special food arrangements, if any
- Payment of spectator and insurance fees

The FM wears a bright yellow vest.

The **Range Safety Officer (RSO)** is responsible for the fact that only safe rockets are being launched and therefore carries the final responsibility for safety issues and rocket inspection. He has to give his approval to all launches. The RSO wears a bright red vest.

The **Launch Control Officer (LCO)** is responsible for the operations around the launch tower and –area. He installs pyrotechnical charges, supervises arming of the rocket motor, connects the primary fireline to the igniter and is the last person to leave the launch area. He conducts the final count down. The LCO wears a bright red vest.

6.1 Launch procedures

The following procedures are followed to launch a rocket or conduct a static test.

- Before every launch the actual wind conditions are measured, to look if it is within limits. When the wind speed is unfavourable, we await a wind dip and count down starts at 5.
- After the launch, strict silence is requested, since sounds may provide valuable information about the flight.
- During the launch of one or more rockets it is forbidden to leave the visitors terrain.
- The visiting of the launch tower is only permitted after the approval of the RSO.
- All rockets are recovered in a military vehicle with military assistance. Please spot and remember the landing place, since this will shorten search time. Use a compass to take the bearing.

Appendix A - Calculation of rocket stability using the Barrowman method

Notations.

d	Diameter of the rocket (assuming one diameter)	(mm)
d_1	Largest Diameter of the boattail	(mm)
d_2	Smallest Diameter of the boattail	(mm)
L_b	Length of the boattail	(mm)
L_n	Length of the nose cone	(mm)
X_b	Distance of the largest cross-section of the boattail to the tip of the nose cone:	(mm)
X_{cp}	Position of centre of gravity (from tip of nose cone)	(mm)
X_{cp}	Position of centre of pressure (from tip of nose cone)	(mm)
X_f	Distance of leading edge to tip of nose cone	(mm)
R	Radius of rocket fuselage at fin attachment	(mm)

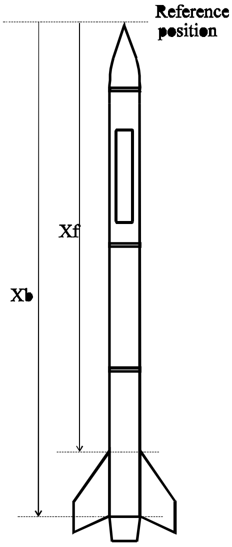


Figure A.2 Reference Frame.

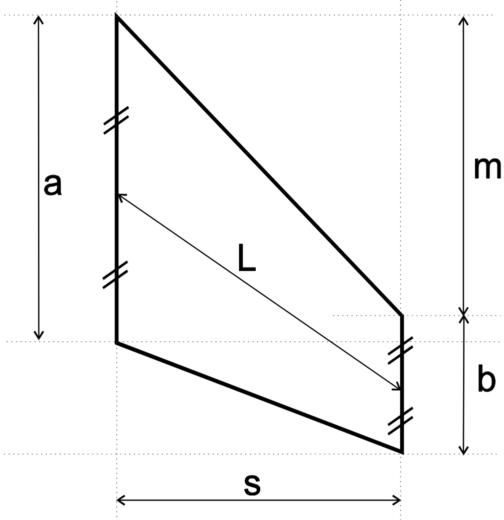


Figure A.1 Dimensions of rocket fins.

A.1 Margin of stability

The margin of stability MS is defined as:

$$MS = \frac{(X_{cp} - X_{cg})}{d}$$

Note: *The rocket shall be constructed to have a margin of stability, at lift-off, between 1 and 2.*
The position of the centre of gravity is determined by the distribution of mass in the rocket which we assume known.

A.2 Center of Pressure

The center of pressure is determined using:

$$X_{cp} = \frac{\sum_i (X_{cp})_i \cdot (C_{n\alpha})_i}{\sum_i (C_{n\alpha})_i}$$

in which $C_{n\alpha}$ denotes the coefficient of the normal force derivative with respect to the angle of attack and $\sum_i$ denotes summing the contributions of nose cone, boattail and fins of the rocket, respectively. The contribution of the fuselage is ignored, i.e.:

$$X_{cp} = \frac{(X_{cp})_n \cdot (C_{n\alpha})_n + (X_{cp})_b \cdot (C_{n\alpha})_b + (X_{cp})_f \cdot (C_{n\alpha})_f}{(C_{n\alpha})_n + (C_{n\alpha})_b + (C_{n\alpha})_f}$$

The various terms in this equation will be worked-out in the next sections.

A.2.1. Nose cone

The contribution of the nose cone $(C_{n\alpha})_n$ to the total derivative of the normal force with respect to the angle of attack, is approximated by:

$$(C_{n\alpha})_n = 2$$

The dependence of the centre of pressure of the shape of the nose cone, however, is such that a difference is made for various shapes of nose cones. For conical nose $(X_{cp})_n$ is given by:

$$(X_{cp})_n = \frac{2}{3} \cdot L_n$$

while for ogive nose cones the following holds:

$$(X_{cp})_n = 0.4666 \cdot L_n$$

Finally, for parabolic nose cones $(X_{cp})_n$ is approximated by:

$$(X_{cp})_n = \frac{1}{2} \cdot L_n$$

A.2.2. Boattail

The contribution of the boattail $(C_{n\alpha})_b$ to the total derivative of the normal force with respect to the angle of attack is approximated by:

$$(C_{n\alpha})_b = 2 \cdot \left[\left(\frac{d_2}{d} \right)^2 - \left(\frac{d_1}{d} \right)^2 \right]$$

$(C_{n\alpha})_b$ is always smaller or equal to zero. The centre of pressure of the boattail is approximated by:

$$(X_{cp})_b = X_b + \frac{L_b}{3} \cdot \left[1 + \frac{1 - \frac{d_1}{d_2}}{1 - \left(\frac{d_1}{d_2} \right)^2} \right]$$

A.2.3. Fins

The contribution of the fins $(C_{na})_f$ to the total derivative of the normal force with respect to the angle of attack is approximated by:

$$(C_{n\alpha})_f = \left(1 + \frac{R}{S + R} \right) \cdot \left(\frac{16 \cdot \left(\frac{S}{d} \right)^2}{1 + \sqrt{1 + \left(\frac{2 \cdot L}{a + b} \right)^2}} \right)$$

The centre of pressure for fins described by figure A.1 is approximated by:

$$(X_{cp})_f = X_f + \frac{m \cdot (a + 2 \cdot b)}{3 \cdot (a + b)} + \frac{1}{6} \cdot \left(a + b - \frac{a \cdot b}{a + b} \right)$$

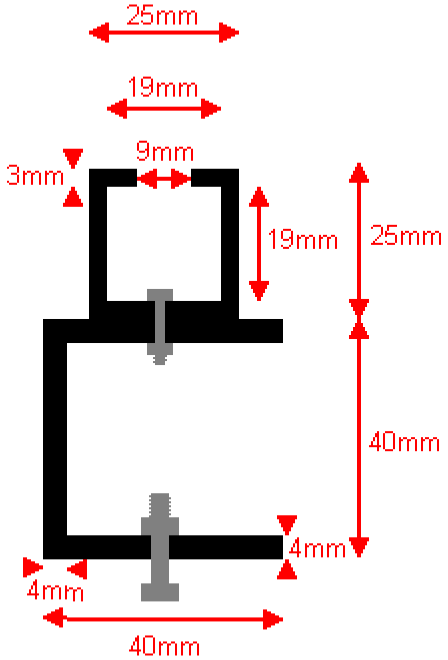
Note that these equations are only valid for rockets with 4 fins.

Details of the Barrowman calculation method can be found in:

Technical Information Report 33 "Calculating the center of pressure of a model rocket", by J. Barrowman. 1970, published by the Centuri Engineering Company.

Appendix B - Geometry of launch rail interface and stand-off

Launch lug (on rocket body) guided by 9 mm slot.
Insertion on open end of rail.



This side connected to support frame (tri-angular, sides of 30 cm, 7.5 m long)