# Rocketeers on the hunt for European altitude record

## With a two-stage rocket to more than 132 thousand feet (40 km)

The H10a being launched on the Artillery Shooting Range

**Amateur rocketeers of the Dutch federation for Rocket Research (NERO) are committed to a project to break the European altitude record for amateur rockets. A project team of nine people is developing and building a two-stage rocket, which will have to make this come true in 2010. The goal is to get the English record, which is set at over ten kilometers, to the Netherlands and to beat it by almost 30 kilometers. For this purpose, a launch program is set up with three qualification launches before the final attempt. In order to break this record, NERO is looking for enthusiastic people to strengthen the project team and for companies, which are willing to support the project with material and otherwise.**

NERO-members are designing, building and launching amateur rockets since 1959. In the past, NERO already broke a number of records: the highest amateur rocket flight in the Netherlands, the first European flight with a hybrid motor and the first Dutch two-stage rocket flight.

The rocket, called H10, which will be built for the record attempt, has two motors with a total impulse of over 28,000 Ns. These motors give the rocket an initial acceleration of 23 g and a maximum velocity of Mach 3.

Furthermore, the rocket is subjected to extreme temperatures: aerodynamic heating of the nose cone up to 300 °C, environment temperatures of –60 °C and air pressure of just 1.6% of the air pressure at sea level. Two parachutes, a drogue and a main parachute ensure a soft landing. The first stage separation and the deployment of the parachutes is initiated using pyrotechnic devices. Consider this to be a mechanical part that transfers expanding gasses in motion.

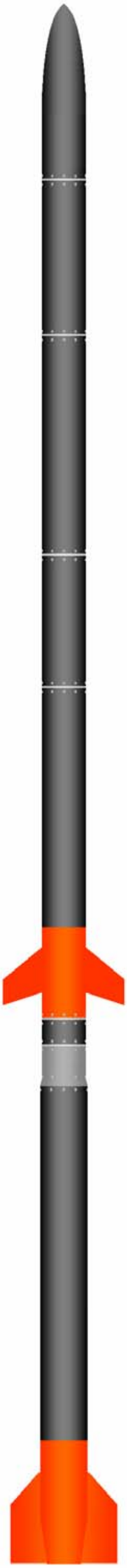
Remarkable about this record attempt is that the rocket will fly to this altitude with a full set of instruments. Amongst others a GPS module, a video camera and a transmitter will be carried on-board. What will make this flight also a very special one is that the H10 rocket will be one of the first amateur rockets in the world to be equipped with a full-blown situational awareness system. Situational awareness means that the on-board computer knows the position and the velocity of the rocket in all six degrees of freedom and based on this, is able to control the flight. In order to realize this, the rocket will have extensive avionics with a large number of sensors, namely three gyroscopes, a GPS, an accelerometer and a pressure sensor. The used sensors are smart sensors, which means that the sensor data is being checked and – if necessary – being altered by the accompanying micro controller. The main flight processor will compare the sensor information of several sensors, in order to increase reliability. The video images as well as the data are collected by the on-board computers and transmitted to the ground station using a transmitter.

The ground station receives the video and data signal and splits this up over three screens. On the first screen, a real-time video image from the rocket will be displayed, on the second screen shows a map of the surrounding area and a projected position of the rocket and on the third screen vital information about the functioning of the on-board systems is available and, of course the actual height will be shown!

Several qualification flights will be made in the Netherlands, to test the developed hard- and software. More than 350 mechanical parts need to be machined in order to make this qualifying possible. Especially for the qualifying, a cheap – easy to mount – motor has been developed: the Thrust-18. When the testing is complete, the high-performance motors will replace both Thrust-motors and the rocket will be ready to go for the altitude record.

For more information about NERO, please visit www.nerorockets.org.

# High Tech H10
## A top-down overview



**Nosecone**
Calculations have shown that the nosecone will reach temperatures of up to 300° Celsius due to the aerodynamic friction. Additionally, the nosecone will also have to be permeable to electromagnetic radiation as the GPS antenna will be located inside the nosecone. To satisfy these not easily reconcilable demands, a new material will be used for the nosecone called Vubonite. This unique material, developed at the University of Brussels (Belgium) can be machined like an epoxy yet when dried results in a material with ceramic-like properties. The nosecone itself has a Von Karman characteristic, as this is the most efficient aerodynamically.

**Pay-load module**
We decided early on to allow for a small experimental payload to be carried on-board. A small compartment has been reserved for this purpose. At the time of this writing, no decision has been reached on what experimental payload will be flown during the attempt.

**Electronics module**
The advanced electronics module will take up a sizeable amount of the volume of the rocket. Because these electronics will be exposed to an air pressure of just 0,016 bar, all electronics will have to be tested in a vacuum chamber. To test the complex electronics a test electronics package will be designed and built with which a full-system test of an actual flight can be performed. To prevent the powerful RF transmitter causing interference, the electronics package will be extensively shielded.

**Parachute module**
The H10 contains two parachutes: a pilot parachute which stabilizes the rockets as it falls down through the jet-stream and a main parachute which deploys at 800m (2400 ft) altitude and guides the H10 down to a gentle touchdown. When the on-board computer fires the pyrotechnical bolt with which the hatch is ejected, the pilot chute is deployed immediately. Another pyrotechnical device severs a securing line, which allows the pilot chute to pull out and deploy the main parachute. The upper half of the globe shaped parachute consists of waterproof parachute fabric, the lower half of gas-permeable gauze. The main advantage of using a ballute is that it cannot get tangled up since at apogee the air pressure is so low that a normal parachute could get entangled with the rocket itself!

**Camera module**
Contains a small window through which the camera peeks outside at an angle. The camera is positioned in such a way that the horizon can be clearly seen. Within the team wagers have been struck whether the curving of the Earth will be visible in the video pictures.

**Transmitter module**
The design and development of an antenna, which has a smooth radiating pattern and can be placed inside a rocket is no small feat. Ultimately, we decided upon a toroidal-type antenna, which is mounted around the fuselage (circular path antenna). The compartment also contains several lithium-ion cells to fulfill the energy needs of the rocket. The H10 will be powered by external batteries up until the moment of launch, in order to maximize the battery capacity during flight. The 10W radio transmitter is the biggest consumer of electrical power in the H10. The battery pack will be thermally isolated to enable it to withstand the freezing temperatures of -50 to -60 C (-32 to -50 F) occurring at such high altitudes.

**Engines**
The engines are the workhorses of the rocket and are completely designed in-house. Years of development have been spent on getting them to their current performance level. The engines are even tuned for maximum performance at the altitude at which they will be operating

**Separation module**
The mechanically most complex part on-board the H10 is the separation module, which must eject the first stage. This part must be strong enough to withstand the high g-forces during launch yet reliable enough to guarantee successful separation.

**Launch rail**
Launching the rocket in the Netherlands is not an option because of space and safety constraints. We therefore had to develop a portable, 8 meter (20 ft) long launch tower. The lightweight and modular structure has to be strong enough to withstand the launch and light enough to be easily transported.