

# The delicate m of lifetime

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## VITAL EXPERTISE FOR MUNITIONS AND MISSILE SYSTEMS

**You know whether you can still drink your milk – check the ‘consume by’ date on the carton. However, that’s not the case for munitions and missile systems. Certainly not when munitions are exposed to hot climates like Afghanistan or Iraq. TNO has developed a new way of monitoring the quality of munitions and missile systems. Developed for the Dutch armed forces, the TNO methods are also being used by other NATO countries and, for example, the Brazilian army.**

You don’t too quickly associate car tyres or children’s toys with missile systems and munitions, but they have one thing in common: they contain ingredients to resist degradation. ‘Many products contain antioxidants which ensure that the material remains stable and doesn’t degrade.’ That is the analogy drawn by business development manager Huub Keizers of TNO. But with munitions, long-term durability, the lifetime, is a much more delicate matter. In recent years, the Dutch armed forces have been much more involved in expeditionary missions, resulting in munitions being transported to countries like Afghanistan and Iraq. Keizers: ‘The use of munitions is significantly different from twenty years ago, when it was ready for a possible strike from the other side of the Iron Curtain. Storage at temperatures of up to 60 or 70 degrees Celsius in the desert has a different effect than storage in a bunker at a constant 15 degrees.’

In addition to heat, shocks and vibrations as

well as humidity (think of frigates for example) can accelerate the effect of degradation of energetic materials. It is literally vital to know whether the life expectancy of munitions is shorter or longer than the manufacturer’s ‘consume by’ date.

### Maintenance

Maintenance is essential. Munitions and missiles have to be periodically checked and inspected in terms of safety, reliability, performance and operational status. ‘Certain energetic materials in munitions are subject to the problem of instability,’ Keizers explains. ‘If the stabiliser is depleted, you can get internal heating which, in extreme cases, could lead to ignition. Complete munition bunkers have gone up in smoke in this way.’ And that is undesirable not only from a safety point of view but also for economical, operational and logistic reasons.

TNO has a long tradition of munitions management. TNO in Rijswijk holds a permanent store of samples of the gun propellants of the Ministry of Defence. Keizers: ‘That goes back to 1900. This surveillance of gun propellants forms the origin of our activities.’

### HFC, the new test method

The HPLC method of analysis is widely used for propellant testing. HPLC – High Pressure Liquid Chromatography – enables you to see how much stabiliser is still present in the propellant and you can identify decomposition products. Depending on NATO or national limits, munitions are approved or rejected. ‘But HPLC is only an indirect method,’ Keizers says. ‘Rejection can be all too easy.’ For this reason, TNO developed the HFC or the Heat Flow Calorimeter. Heat flow measurement reveals the amount of energy that is released during decomposition (the energy production), in other words, the real ageing of the propellant. Keizers: ‘You are measuring the actual safety, since you are able to translate the measurements within a certain bandwidth into the life expectancy.’ For

## MISSILE SURVEILLANCE PROGRAMMES OF NATO/NAMSA

TNO has become somewhat indispensable at NATO’s Maintenance & Supply Agency (NAMSA) in Luxembourg, being so closely involved in test programmes and monitoring of missile systems. The relationship stems from 2000. TNO performs chemical and mechanical tests on propellants for AMRAAM and STINGER rocket motors as well as verifies the test results from a scientific and engineering perspective. ‘TNO

is even involved in analysing the results of tests by other research institutes that work for NAMSA, like WTD 91 in Germany,’ says Miguel Ramos, head of the Engineering & Configuration Control Section of the Land Combat Missiles department at NATO/NAMSA: ‘The thorough knowledge of TNO in rocket motor technology helps us monitor the safety of missile systems, cost effectively. What’s more, it is good to work

with TNO experts and the TNO management always responds quickly to the customer’s specific requirements.’ TNO also works as a consultant for NAMSA in selecting research institutes for rocket motor test programmes, like the new MAVERICK programme.

## TNO-HFC FOR THE BRAZILIAN ARMY

The Brazilian army has been using two TNO HFC munitions test systems since the end of 2005. And to its satisfaction, says Col Brasiliano of D Log, the logistics unit of the Brazilian army. 'The HFC systems have been of great help to our munitions surveillance programme. We save a lot of money and the safety in our central munitions depot in Rio de Janeiro is better safeguarded, which was our primary goal.' Brasiliano also praises the practical benefits of the HFC units: 'The system is simple and user friendly as well as being safe to use. You can test all kind of propellants, including multiple base propellants, quickly and cheaply. We have also tested propellants from our missile systems and, together with researchers at the Brazilian army's technology centre CTeX, we use the TNO-HFC to develop new propellants.' What is also important, Brasiliano points out, is that HFC provides not only 'right' or 'wrong' but also the determines how long the munitions can still be used.

validation of the method and models, munitions returning from a mission are being investigated. 'We compare predictions with what we observe,' Keizers says.

The HFC method has been around for thirty years but the TNO-HFC, a robust blue box, has made it more straightforward and practical. The propellant to be analysed is brought to the required temperature in a sturdy, insulated block. The containers used to test the munitions samples vary in volume from 15 to 530 ml, enabling munition-like testing of charges from, for example, artillery shells, mortars and handgrenades.

'What we do for the Dutch government is, in principle, necessary for all governments,' Keizers argues. 'But not every country is adequately concerned about munitions safety.' The Brazilian armed forces is a launching customer (see box) together with the Dutch Ministry of Defence, and other NATO and non-NATO countries are interested.

### Missile systems

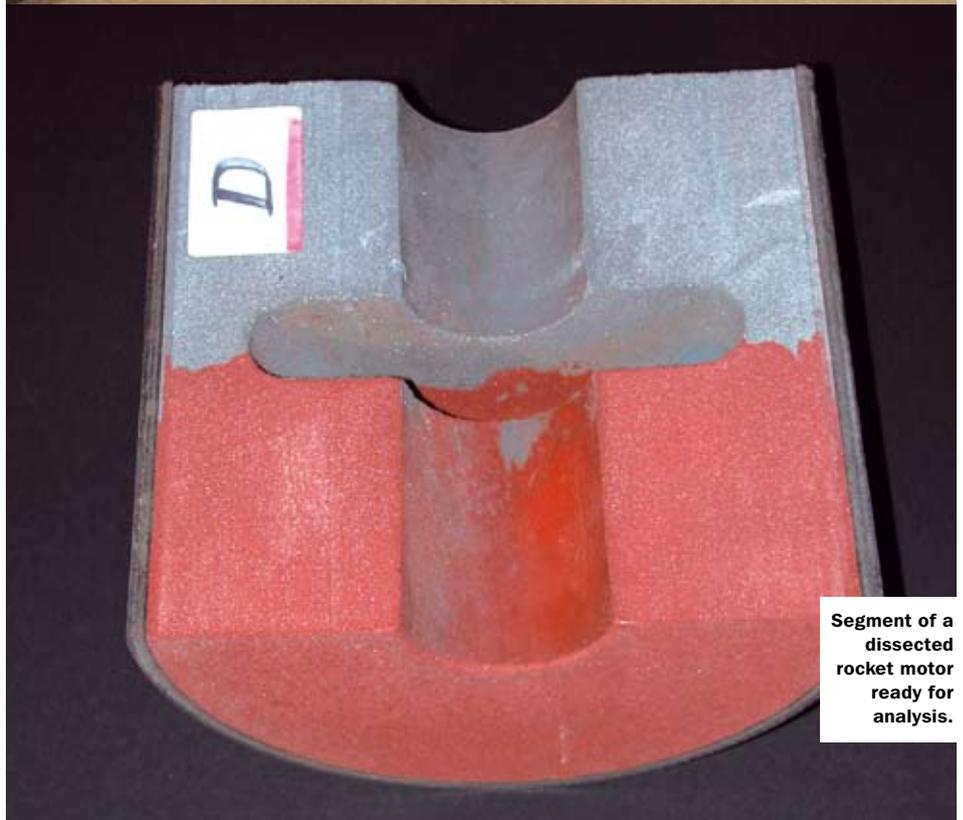
In monitoring the quality of missile systems, other aspects become relevant. 'The propellant in the rocket motor tends to be intrinsically stable. Propellants comprise a polymeric binder with a high amount of solid filling, oxidisers and fuels,' Keizers explains. Mechanical and thermal influences can cause cracks that may lead to an undesired explosion. The strength of TNO is the knowledge that has been accumulated through the very detailed analysis of rocket motors. Keizers runs through the procedure. 'We dissect rocket motors using a saw bench, test the material properties under various conditions, and analyse the data obtained. The properties measured are being translated into what occurs in the motor when it is ignited. This is combined with our knowledge on the ageing behaviour'. In addition, motors are fired on a test bench and tested non-destructively through visual, X-ray and ultrasonic inspection.

Thanks to this knowledge and experience TNO is closely involved in the missile surveillance programmes of NAMSA, the NATO Maintenance and Supply Agency (see box). Keizers: 'We are able to make well founded statements about the safety of missile systems and advise intelligently on our own programmes or the test programmes the Americans are carrying out.'

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Tests are now performed using the TNO-HFC.



Segment of a disassembled rocket motor ready for analysis.

Photo: H.J. Siemer