

# AMMUNITION SAFETY

## LIFE CYCLE MANAGEMENT

- Lifetime prediction of ammunition
- Missile service life support
- Thermal stability
- Stability research of gun propellants
- Munition lifetime during expeditionary operations

## INSENSITIVE MUNITIONS

- Insensitive Munitions testing
- Safe functioning and IM aspects of ammunition

## QUALIFICATION OF ENERGETIC MATERIALS

- Functioning, safety and IM aspects of munition
- Qualification of energetic materials
- Mechanical characterization testing

## ENVIRONMENTAL IMPACT

- Health risks from munitions
- Munitions in the environment
- Study into the transfer and impact of noise

## EXPLOSIVES SAFETY

- Safe field storage
- Quantitative risk analysis of stored explosives
- Blast research
- Experimental capabilities
- Protection and survivability of compounds
- Protection against enhanced blast

## UNEXPLODED ORDNANCE

- Unexploded explosives
- Enhancing the efficiency and safety of EOD activities against IEDs and UXOs

## DEMILITARIZATION

- Disposal of munitions and explosive substances

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### TNO

TNO is an independent innovation organisation that connects people and knowledge in order to create the innovations that sustainably boost the competitiveness of industry and wellbeing of society

TNO focuses its efforts on seven themes including Defence, Safety and Security: TNO works on a safe and secure society by creating innovations for people working in defence organisations, the police, emergency services and industry.

# AMMU- NITION SAFETY

**TNO** innovation  
for life



# AMMUNITION SAFETY

“The mission of the product group is to assist stakeholders in achieving the required level of ammunition safety to result in an as safe as reasonably affordable environment for now and in the future”

## SAFETY, SECURITY AND DEFENCE

Safety and our sense of safety are more than ever being subjected to threats that emanate from the distribution of prosperity, conflicting opinions and the increasing scarcity of raw materials. All over the world defence organizations, emergency services and industry are helping to protect us against less and less obvious and visible threats. TNO uses technological innovation to help this work become smarter, more efficient and more protective.

The combined capabilities of TNO include state-of-the-art theoretical knowledge, powerful simulation tools and unique experimental facilities. One of the R&D areas TNO is focusing on is Ammunition Safety.



Are these fumes toxic?  
(source: DoD, US Air Force)

## PRODUCT GROUP AMMUNITION SAFETY

The product group Ammunition Safety is addressing R&D activities, which make the safe use of weapon and munition systems, including missiles, possible. These activities include:

- Qualification of Energetic Materials
- Insensitive Munitions (IM)
- Life Cycle Management
- Environmental Impact
- Explosives Safety
- Demilitarization
- Unexploded Ordnance (UXOs)

The research activities range from safety of the energetic material itself to safety of the complete article, and bulk quantities. The activities cover the complete life cycle of ammunition from cradle to grave.



The ammunition life cycle



High velocity impact gun

The product group Ammunition Safety consists of a team of experts with long time experience in:

- Risk analysis in relation to accidents
- Characterization of energetic materials, including ageing effects
- Impact on the environment
- Sensitivity of ammunition
- Characterization of energetic materials
- Experimental Analysis

The mission of TNO is guided by the changing world of expeditionary operations, which requires a new approach in ammunition safety. The mission of the product group is to assist stakeholders in achieving the required level of ammunition safety to result in an as safe as reasonably affordable environment for now and in the future. We believe that an integral approach in ammunition safety throughout its life cycle is beneficial for stakeholders enabling a reduction in safety related costs. E.g. implementing IM will not only result in safer end-use of ammunition, but also will lead to smaller safety distances in relation to storage resulting in a cost reduction for storage and transport.

Support is provided to the Dutch Ministry of Defense, industry and foreign governments to adapt to today's changing world.

## QUALIFICATION OF ENERGETIC MATERIALS

TNO has a variety of facilities to perform the experimental qualification of energetic materials, contributes actively to the update and maintenance of NATO standards through participation in AC/326 SG1, and

develops new or improves equipment and methods. As such TNO is able to support MODs to set up realistic safety requirements and industries to realize these requirements.



(source: Ministry of Defence)

## LIFE CYCLE MANAGEMENT

During expeditionary operations ammunition is subjected to a wide range of harsh conditions. To ensure a safe use while maintaining the required performance characteristics, it is necessary to monitor the health status of ammunition throughout its entire life cycle. TNO has developed in-house prediction models and hardware (HFC), which are capable to predict the end lifetime, given operational conditions. These conditions can be simulated by accelerated ageing based on by real-life data collected by sensors.



## ENVIRONMENTAL IMPACT

TNO has developed reliable and accurate research methods to detect and measure ammunition-related substances in the environment. Harmful substances may kill species, which reduces the biodiversity. Contamination of soil, water and air may cause reactions to the human body by e.g. skin irritation or inflammation of the eyes. TNO investigates the propagation of noise, its impact on the environment, and gives advice on noise reduction measures.



## INSENSITIVE MUNITIONS

TNO has contributed to the establishment of standardized IM-criteria and has the capability to perform IM-tests according to STANAG requirements, including high velocity (2750 m/s) fragment impact tests. With our analysis capabilities, TNO is able to quantify the pros and cons of IM during the entire life cycle (safe transport, transfer, storage and end use) of ammunition. As such, TNO can support in costs and benefits analyses.



## UNEXPLODED ORDNANCE (UXOs)

TNO supports stakeholders with its expertise on detection techniques, methods and safety measures to secure (safe removal and temporary storage) and dispose UXOs in a safe and environmental-friendly way.



(source: ANP)

## EXPLOSIVES SAFETY

Based on our knowledge of explosion effects and consequences to the environment, TNO has in-house-developed software to perform quantitative risk analyses of transport, transfer and storage of ammunition. With this software TNO supports stakeholders regarding internal and external safety issues in the home country, during training or expeditionary operations.

## DEMILITARIZATION

TNO supports demil stakeholders with knowhow and technology for safe and environmentalfriendly disposal of ammunition. E.g. TNO has technology to convert high explosives into chemical waste which

can be processed in standard incinerators. It should be emphasized that this is logistically beneficial since the chemical waste is transport classified at a lower Hazard Classification.

