

# MUNITIONS AND GUIDED WEAPONS

HEALTH MANAGEMENT

RISK ANALYSIS

QUALIFICATION

EFFECT

RANGE

FLEXIBILITY

PRECISION

YOUR PARTNER IN CO-DEVELOPMENT  
AND SUPPORT FOR INNOVATIONS IN  
MUNITIONS AND GUIDED WEAPONS

# MUNITIONS AND GUIDED WEAPONS

**TNO** innovation  
for life

**TNO.NL**

#### 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

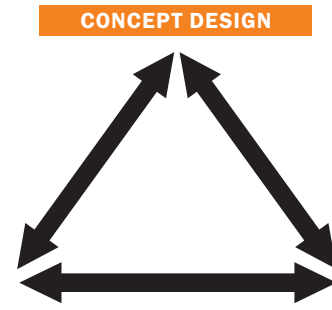
TNO focuses its efforts on seven themes including Defence, Safety and Security: TNO works on a safe and secure society by creating innovations for people working in defence organisations, the police, emergency services and industry.

#### CONTACT

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**VERIFICATION**  
Effect assessment needs modelling tools, for example by using TNO's TARVAC software for lethality assessment.

**VALIDATION**  
Our facilities offer excellent validation testing opportunities.

### CO-DEVELOPMENT AND SUPPORT

TNO is a not-for-profit independent R&D organisation. TNO has close cooperation with both Governments and Defence industry. In the field of munitions and guided weapons we combine and further develop our knowledge from different areas of expertise. These areas range from the functioning of energetic materials for propulsion and warhead lethality to the behaviour of target sensors. Our capability to bring together these areas of expertise in agile teams

allows for an integral system approach. We use this integral approach to design and optimise munitions and guided weapons concepts and products. This is done with and for industry or for armed forces, for whom we test and evaluate their products. Our activities cover munitions of all calibers and all guided weapon systems. Evolving operational needs call for flexibility and precise effects, which is why we focus our activities on:

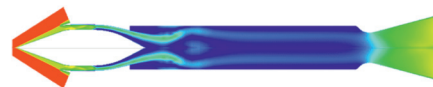
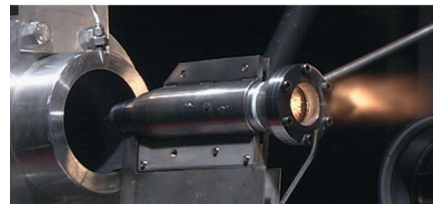
- Range
- Effect
- Flexibility
- Precision

### EVOLVING OPERATIONAL NEEDS CALL FOR PRECISE EFFECTS AND FLEXIBILITY



#### CASE: NON-LETHAL WEAPON EFFECTIVENESS ASSESSMENT

The scientific assessment of non-lethal weapon effects is largely uncharted territory, since internationally agreed standards and procedures are lacking. TNO develops a range of effectiveness tools to determine and qualify effects ranging from physical impacts up to behavioural changes as an effect of non-lethal weapons. Currently available capabilities include assessment of non-penetrating projectiles, acoustic performance of hailing devices, optical effects of lasers and other light sources, stopping power of vehicle arresting devices, and the range of capabilities is still expanding. The ability to appraise these effects is also applied for manufacturing requirements and verification during less lethal munition development.

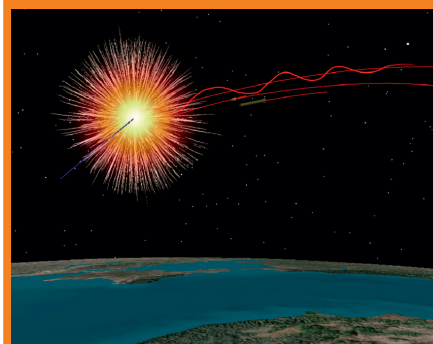


#### CASE: CO-DEVELOPMENT OF 35 MM SOLID FUEL RAMJET PROJECTILE

TNO successfully co-developed a prototype 35 mm solid fuel ramjet air defence projectile that demonstrated a sustained flight speed of 1400 m/s. The solid fuel ramjet technology offers the simplicity and robustness compatible with the harsh gun-launch environment. Meanwhile, its high fuel efficiency allows for a longer range, shorter time-to-target and increased kinetic energy, resulting in a higher kill probability. What's next? Currently TNO is in contact with industry for the implementation of the solid fuel ramjet technology in different calibres and applications, which can contribute to the fighting power of both naval and ground artillery forces.

## THE INTEGRAL SYSTEM APPROACH

To achieve superior effect, range, flexibility and precision in guided weapons and munitions, an integral perspective has an added value. Furthermore, whether it concerns a round for line-of-sight weapon systems, an artillery shell or a smart missile, the system design is always the result of a trade-off between performance, safety and cost, taking into account numerous other aspects related to the expected operational life cycle. TNO supports munitions and guided weapon system manufacturers and future users to define the best functional requirements based on operational needs.



#### RANGE

Advanced gun and in-flight propulsion is a key enabling technology to provide range extension. TNO has unique facilities to develop and test gun and rocket propellants. Also TNO can perform direct-connect and free jet tests such as ramjet air breathing propulsion systems.



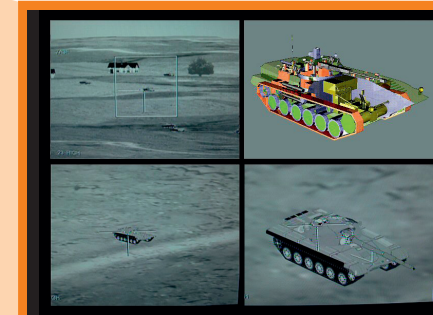
#### EFFECT

The effect based approach of military forces in modern conflicts demands more scalability in (non-) lethal effects and minimising collateral damage. This involves knowledge of conventional mechanisms but also the integration of new technologies and mechanisms. TNO offers expertise and facilities to assess and optimise effects in all phases of product development.



#### FLEXIBILITY

Multi-role weapons and munitions are essential in modern day military operations: adjustability in lethal effect is necessary. TNO cooperates with industry and armed forces to develop the capability for controlled detonation before, during or after target penetration with effects adjusted to the target that has to be defeated. Advanced fuse concepts, ignition trains, warhead designs and explosive compositions are evaluated, taking into account munition safety aspects as a precondition.



#### PRECISION

For performance evaluation of guided missiles and for optimising effects, TNO has developed integral simulation models containing detailed guidance, navigation and control laws. These models are used to further develop existing advanced guidance concepts. Some examples: developing guidance laws for the intercept of spiralling targets and online dynamic flight path optimisation for an airbreathing missile.