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KINETIC ENERGY KE AMMUNITION FOR MEDIUM CALIBRE WEAPON SYSTEMS

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Medium calibre weapon systems have been widely deployed by armies throughout the world as the main armament for Armoured Fighting Vehicles AFVs for many years now but the current trend, especially within Western Europe and NATO, is towards the application of 30 mm systems. Presently, this calibre represents the optimal solution between logistical/tactical considerations and ammunition performance.
Today's battlefield demands higher dynamics and greater firepower, as well as optimised armour protection for AFVs (Battle Tanks, Infantry Fighting Vehicles and Attack Helicopters).
A modern ammunition family must offer the following characteristics:
– High first round hit probability
– Short time of flight
– Devastating target effects
– Good low vulnerability LOVA
– No "blinds"
The exterior and terminal ballistic performance of the 30 mm ammunition family will be explained and the various influencing parameters quantified.

REQUIREMENTS OF A MODERN FAMILY OF AMMUNITION

In addition to a good performance against the widest possible mission (target) spectrum, a high reliability and handling safety is also expected, whereby the latter mitigates ageinst the risk of blinds.

PARAMETERS DEFINING PERFORMANCE

Clearly, in order to be truly effective, the ammunition must hit the target and, so, hit probability becomes the dominate factor affecting performance. This is explained briefly below.

Ammunition Characteristics which Enhance Hit Probability

Hit probability will be enhanced by the following characteristics:

1. High functional reliability – Today, this point is taken for granted and is often overlooked. It probably requires no further explanation in order to demonstrate the importance of this Parameter.
2. Optimized dispersion – Optimized does not necessarily mean the smallest possible. In reality, larger or smaller deviations between the target and centre of impact may exist due to, for example, atmospheric conditions, barrel wear and ranging errors. To define the optimum ammunition dispersion, the complete weapon system must be taken into account, as well as the deployment doctrine and the target scenario.
3. Short time of flight – The shorter the time of flight, the smaller is the required lead angle. In addition, with a short time of flight the projectile is less affected by disturbing influences such as side wind.
4. Flat trajectory – The flatter the trajectory, the smaller is the influence of ranging errors and tilting of the weapon.

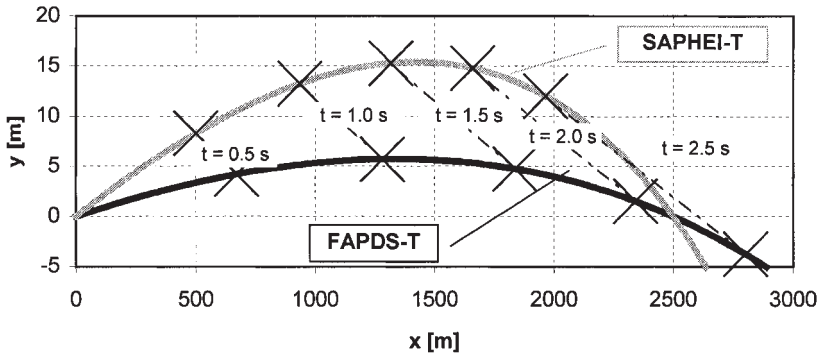

Figure 1: Trajectory Comparison.

QUANTIFICATION OF SOME INFLUENCE PARAMETERS

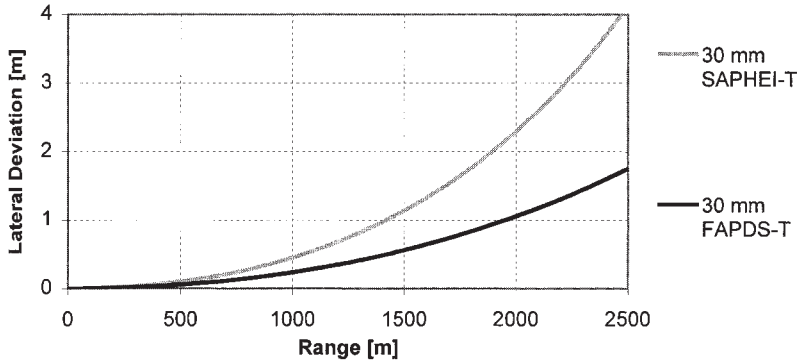

Figure 2. Lateral deviation due to a tilt of 5°.

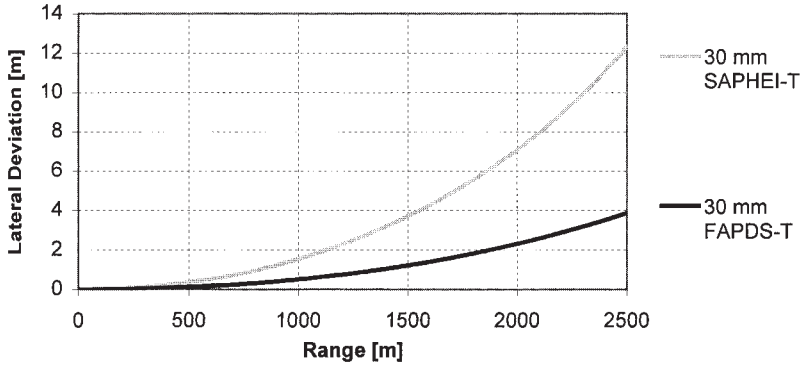

Figure 3: Lateral deviation due to a crosswind of 10 m/s.

ENDBALLISTIC PERFORMANCE

On the one hand the requirements for effective endballistic performance vary target (depth of penetration, lateral dimensions or their combination) whilst, on the other hand, most weapons have, at the most, two feed systems, resulting in only two ammunition types being available to cover the whole target spectrum.

DEFEAT OF HARD TARGET

In order to defeat hard targets such as AFVs, 30 x 173 mm long rod ammunition with a high penetration performance was developed. This is fired at full spin, which, in this caliber, brings benefits rather than disadvantages, as listed below:

– Precise and reproducible firing conditions (Vo & ω0) during the entire barrel life cycle and also after long storage of the ammunition.
– Large centrifugal energy provides a trouble free symmetrical, radial separation.
– Reproducible and rapid spin reduction through aerodynamic damping.
– Spin decay occurs asymptotically to a constant rate, where it remains above the critical natural frequency of the penetrator.
– Firing with full spin and subsequent rapid spin reduction, does not measurably influence the velocity decay.

Figure 4. 30 mm APFSDS-T full penetrations into a M-60 tank-turret @ 1500 m.

Defeat of Remaining Targets

For all other targets, such as vehicles, helicopters and Urban targets, the subcalibre Frangible ammunition has clearly proven to be more effective than full calibre high-explosive ammunition (Figure 5 & 6). The effect of this new 30 x 173 ammunition is based on specialised tungsten material technology. As this ammunition does not contain any high explosive, the hazard potential falls into the category of inert training ammunition (insensitive ammunition) and the risk caused by duds is reduced to zero.

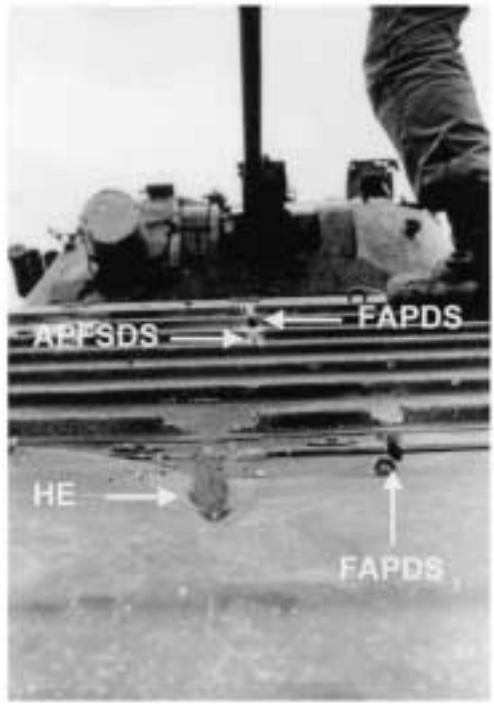

Figure 5. Firing trials against BMP 2/ HEI no penetration / FAPDS and APFSDS full penetration [1].

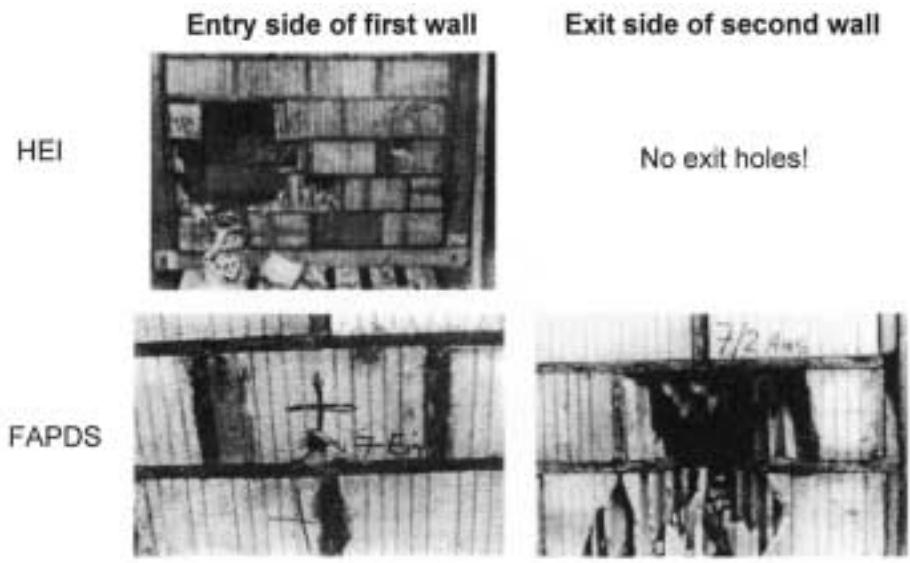

Figure 6: Comparison of effectivnes at an urban target [1].

Figure 7: FAPDS against an helicopter cockpit [1].

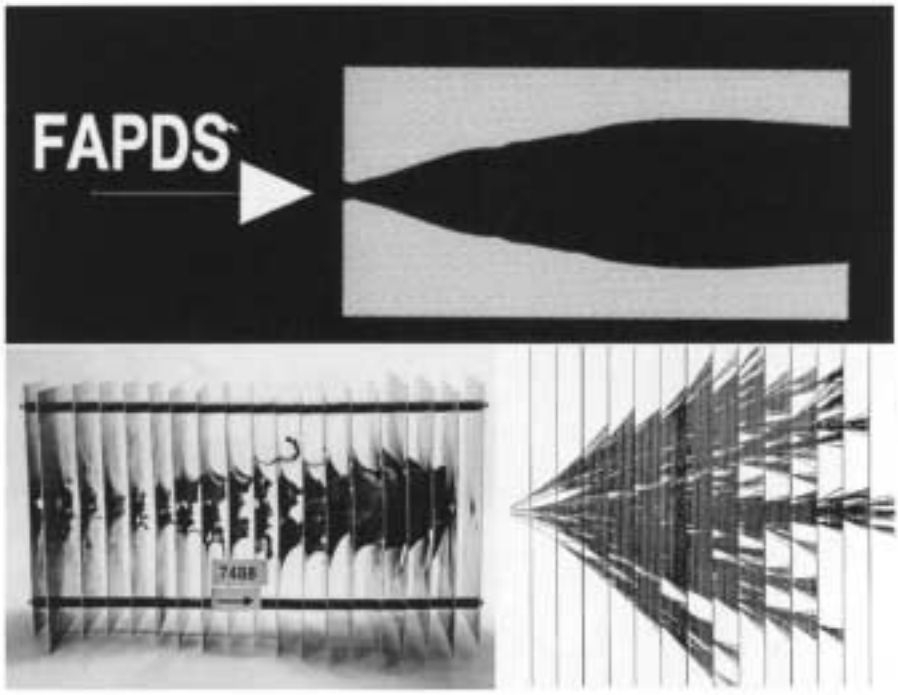

Figure 8: Terminal ballistics of the FAPDS the principle (top), in reality (left) and as simulated (right) [1].

Practice Ammunition

Practice ammunition must meet the following demands: It should be as similar to combat ammunition as possible (handling, flight path, hit probability etc.) however, it must have a smaller maximum range than the combat ammunition (Figure 10) and the danger of Ricochets should be reduced as far as possible. The practice projectiles of the new 3 0mm ammunition essentially fulfil these demands by use of following design features:

– The subcalibre projectile has a higher muzzle velocity but a smaller cross sectional area than the combat ammunition, which ensures a good trajectory match.
– By careful dimensioning of the break points and choice of material characteristics, the projectile breaks up even at very small impact angles (Figure 9).

Figure 9. TPFDS-T after hitting ground.

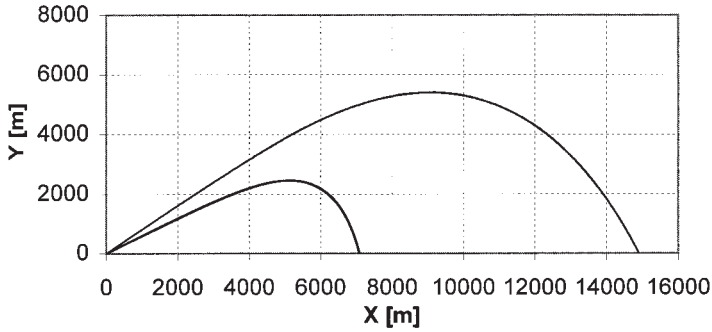

Figure 10: Trajectories of maximal range 30 mm TPFDS-T and FAPDS.

SUMMARY

Thanks to the unique combination of the ballistic properties of the new 30 mm x 173 ammunition family, the requirements for AFVs, from training to combat, can be satisfactorily met for the foreseeable future.

REFERENCES

1. TNO Prins Maurits Laboratory NL