The UK Military Perception of Electromagnetic Technology

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Abstract - This paper discusses the operational context and advantages of electromagnetic (EM) technology associated with fielding future generations of the main battle tank (MBT). There are several technical risks associated with the military objectives of the "Electro Tank". A multi-national collaborative program is required to aggressively pursue these technical complexities and associated cost.

I. Introduction

A. Threat Statement

The extraordinary events in Europe of the last 2 years has ensured that the risk of conflict is seen by many as having reduced, although this is perhaps more a reflection of intent rather than capability. Furthermore, the potential capability of the tank fleets of other countries outside the European theater, many of which could be subject to extensive improvement programs using both Western and CIS technology, cannot be ignored.

B. Operational Context of EM Weapon

The less dense battlefield of the future is a concept which is principally predicated on the reduction in the size of the forces facing each other in Europe. Within this less dense battlefield, there will be no lesser role for the tank than there is today. Despite the increased emphasis on maneuver, the point of resolution will remain the close combat battle. All operational analysis to date, as well as recent experience in the Gulf War, has shown that despite the capabilities of other weapon systems such as the attack helicopter or artillery-launched precision guided munitions, the tank is the only weapon system which can maneuver effectively under fire, retake ground and maintain its presence in all weather conditions in sustained high intensity operations. These unique capabilities will continue to be required, and so in any future conflict tanks can be expected to fight a close combat battle of undiminished intensity, within an overall concept which places greater emphasis on maneuver.

II. EM Advantages and Other Novel Technology

It is a widely held view that after the first decade of the next century, current tank guns will be ineffective in the face of the evolving threat. It is also a shared view that EM technology is a strong contender to succeed powder technology in this timeframe. Electromagnetic and electrothermal (ET) technologies are perceived to be competing novel options for a future tank gun. At present, the EM approach is considered more attractive for the tank. EM does not require a means of metering or injecting plasma, the storage of propellant liquid, or a chamber for mixing them. Moreover, the ET gun is potentially less consistent because the interaction between plasma and liquid propellant is difficult to control. Although EM guns require prodigious amounts of electrical energy, and highly demanding energy transfer arrangements, there have recently been significant advances in these areas. The technical feasibility of hypervelocity ballistics is virtually established, even if very complex engineering problems remain. There are significant advantages which the military believe will accrue from the exploitation of EM technology which are outlined below:

1) Higher launch velocities which give substantially increased range.
2) High rates of fire can be maintained.
3) The tank's overall signature, including that of firing, can be reduced.
4) Vulnerability can be lowered by the elimination of propellant within the turret.
5) A greater payload can be achieved.
6) The logistic and manpower burden, both major considerations in the future, will almost certainly be reduced.
7) And finally, advantage can be taken of the electric power source to provide both turret and automotive power, and possibly even advanced armor.

III. Military Perceptions and Objectives

A. Military Perceptions of Technical Risk

Most of the key technologies associated with fielding an EM gun have now been identified, although the necessary technological advances have not been fully quantified. Although it is accepted that there are some important technological challenges associated with EM, it is considered possible that if enough money and effort are invested, a fieldable system might be available sometime during the second decade of the next century. The military perceptions of technical risk associated with these key technologies are assessed to be as follows:

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1) Energy management is perceived to be a major risk area. It will be difficult to minimize stray magnetic field effects resulting from the transfer of electrical energy around the turret, which will clearly be a prerequisite for a manned vehicle solution. Related to this are the problems associated with the likely physiological effects on crews.

2) Thermal management is also an important issue as not only will the engine be generating significant heat energy, but in addition when the gun fires the majority of the surplus energy will be rejected in the form of heat.

3) Power generation is also a concern. The power required to drive an MBT would be in the order of 1 MW, whereas that required for the EM gun would be in the order of 3-4 MW, depending on the gun's electrical power characteristics, projectile muzzle energy and rate of fire. In effect, what must be achieved is a power output some three times the capability of current MBT power packs, while minimizing the engine's physical volume to allow for integration into the smallest vehicle design.

4) One of the major factors which will determine if an EM gun system can actually be integrated into a vehicle is the energy density associated with pulsed power storage. Currently the energy density of capacitors has been experimentally demonstrated at about 3 kJ/kg and this will have to improve by a factor of 10 before integration into a vehicle can be considered. Other types of electrical power storage equipments such as compulsators, high speed alternators and homopolar generators require improvements in energy density of the same order, although it is accepted that they may offer greater potential for vehicle applications.

5) Finally, there are other related technologies, including electric armor, electric drives, vetronics, and robotics, which are likely to be available in the same timeframe. Although not essential for an EM gun installation, they will need to be addressed as they also carry risk.

B. Military Objectives for the Future "Electro Tank"

Key attributes of an Electro Tank are summarized below:

1) 2 man crew.
2) An external gun.
3) A lower and smaller silhouette.
4) Greatly reduced weight.
5) Sustained rates of fire at least as high as current MBTs.
6) Burst rate of fire of 3 rounds in approximately 5 seconds.
7) Much higher projectile velocities giving higher hit probabilities at greater range.
8) Increased terminal effects.

IV. Collaboration and Standardization

A. UK Efforts

The UK is currently engaged in a bilateral research and development program with the U.S., under the umbrella of an MOU, to prove the principle of EM technology for incorporation into a future MBT. A critically important element of this program is the instrumented EM range at the UK Defence Research Agency's Kirkcudbright site in Scotland. This project will enable analysis to be conducted into the major aspects of hypervelocity technology in a single open range facility; this will include the launch mechanism, power supply, projectile aeroballistics and accuracy, as well as projectile/target interaction. The facility should be complete in March 1993 and the subsequent 18 months of accuracy and terminal ballistics firing trails are scheduled to finish in 1995.

B. Multi-national Efforts

As a result of the Gulf War, increasing emphasis is being placed on interoperability in military procurement. As a start in the tank area, agreement has been reached between the UK, the U.S., FR and GE on harmonized parameters for a 140 mm powder gun, should that option ever be required. Furthermore, looking to the next generation tank it is firmly believed that it will have to be a collaborative effort, if only because the R&D costs alone are likely to force us in that direction. It is the UK view, again supported quadrilaterally, that the technical complexity and associated costs are such that if an EM weapon system is ever to be fielded, a multi-national collaborative program will be essential.