

Smart Munitions

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ABSTRACT

In modern land warfare, munitions are considered as highly effective means of the defence against an invading force, especially armoured fighting vehicles. In recent decades, new technologies have transformed the dumb land munitions, into sophisticated smart munitions that can be used for offensive purposes. The evolution in the munitions technology was marked by the introduction of sensed smart munitions. Armament Research and Development Establishment (ARDE) has achieved a technological breakthrough by developing world class sensor-based influence land munitions Adrushy MK-I and subsequently Adrushy MK-II. Successful development of these smart influence munitions has made India proud and at par with the world market.

Keywords: Smart munitions, sensed munitions, influence land munition

1. INTRODUCTION

Munitions are intended to protect troops, military bases, key installations, to delay the advance of enemy troops, to deny them access to certain areas and resources, and to burden them with injured soldiers. Munitions, in general cover a larger range of weapons, but here the focus is primarily on land munitions. Land munitions are basically explosive devices that are designed to explode when triggered by pressure, a tripwire or by influence. These devices are typically found on or just below the surface of the ground. The purpose of munitions when used by armed forces is to disable any person or vehicle that comes into contact with it by an explosion or through fragments released at high speeds. In modern land warfare, land munitions are considered as highly effective means

of the defence against an invading force, especially armoured fighting vehicles. Technological leaps have enabled the land munitions designers to transform traditionally used dumb land munitions into technologically advanced land munitions called smart munitions that can be used for offensive purposes. These include remotely delivery systems and munitions with low metal content, electronic sensors, self-destruct (SD)/self neutralising (SN) mechanisms and remote-controlled activation and actuation.

2. CATEGORIES OF MUNITIONS

Munitions are classified according to their delivery/laying method, the position they assume below the ground, their method of actuation, their use, technology involved, and desired functionality. When classified by delivery method, these are referred to as: (a) aircraft-laid munitions, (b) Vehicle-based system-laid munitions, or (c) mechanically-laid munitions. When classified according to the position they assume with respect to the ground, these are either: (a) underground munitions, (b) claymore munitions, or (c) drifting munitions. When classified by their method of actuation, these are divided into three types: (a) contact, (b) influence, and (c) controlled. When classified by use, they are referred to as: (a) service munitions and (b) exercise and training munitions. When classified according to the technology involved and desired functionality, these are referred to as: (a) dumb, (b) smart and (c) precision munitions.

Smart munitions refer to a number of next-generation land munitions designs being developed around the world with the state-of-the-art-technology. Munitions are said to be smart in context with following:

- *Sensor technology:* Detects targets at a distance or in proximity. Sensed munitions are equipped with



Figure 1. Land munitions.



Figure 2. Target emissions used by sensed land munitions.

numerous sensors like infrared, seismic, audio, magnetic, and even electromagnetic that gives the munition a target-selection capability in its proximity.

- *Discrimination capability:* Distinguishes between targets types and non-targets. This capability would allow the munitions to attack a roller or plough/ trawl and tank before it could breach the munitions field. In addition, munitions could be programmed to only attack the specific targets, while allowing others to pass.
- *Surface munitions counter counter measures:* Survival against breaching techniques by incorporation of intelligent algorithms and combination of sensors.
- *Control of Munitions:* Through SD and SN features: SN is for sophisticated and high value munitions. This allows recovery and re-use; SD is used for those difficult to detect or clear and used for offensive purposes.
- *Engage targets at greater distances*—Therefore less munitions required.
- *Remote delivery system:* Deploy large numbers of scatterable munitions from the air, which automatically activate as these hit the ground
- *Remote communication:* SN and SD periods are set remotely. It also allows the remote activation/ actuation of the munitions.

3. DEVELOPMENTS AT ARDE

3.1 Adrushy MK-I

Adrushy MK-I is first indigenously developed anti-tank influence munition, which is India's answer to the increasing threat caused by the MBTs of the nineties. With the introduction of this munition with shaped-charge and magnetic-cum-seismic influence fuze, a new dimension has been given to the munition warfare. This is simple in handling and is user-friendly. This munition provides full-width attack capability against the moving tanks unlike the conventional pressure-actuated munitions, hence more lethal. This munition consists of a magnetic sensor to detect the vehicle in the proximity. To make the munition more difficult to breach by the magnetic signature duplicator, seismic-cum-magnetic mode of operation is provided. Tank-trawl discrimination has been incorporated. Being a

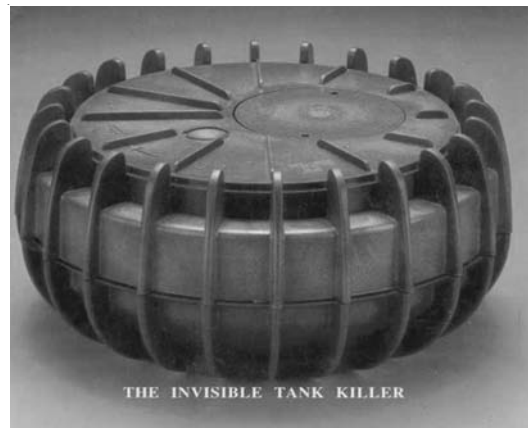


Figure 3. Adrushy MK-I.

sophisticated munition, self-neutralisation has been incorporated with reusable feature. Flexibility has been provided for selection of the self-neutralisation period depending on the tactical requirement of the munition field. This munition is safe to handle and also during laying, as it consists of electro-mechanical safety device with 1 h arming delay. This munition is both waterproof and shockproof. This munition is indomitable with capability of armour penetration—90 mm causing 'K' kill.

Technologies established during the development of the store are passive magnetic sensor—to provide full-width attack capability; smart fuze—with field-settable SN period up to 160 days; and tank trawl discrimination capability, safety and arming device (electromechanical timer), anti-tilt device, armour penetration up to 90 mm through shaped-charge warhead. It has undergone users trial successfully and 5500 numbers were productionised. Munitions were used during operation Parakram in 2002 successfully and commendation from Army HQ.

3.2 Adrushy MK-II

Another good example of the sensed smart munition is antitank *Adrushy* MK-II. Technology breakthrough has been achieved by developing active sensor based on the smart fuze which is brain of the *Adrushy* munition MK-

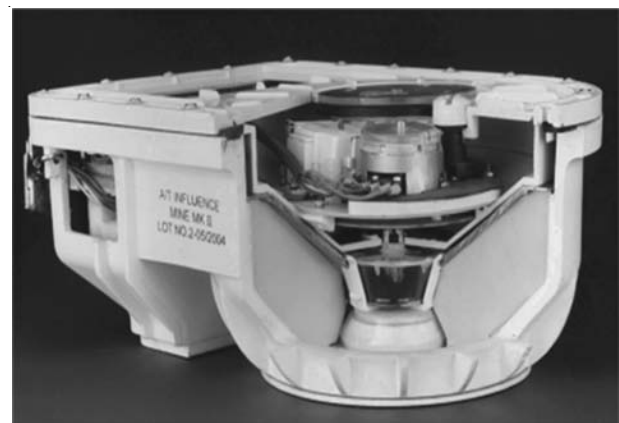


Figure 4. Adrushy MK-II.



Figure 5. Functioning under tank.

II for the first time in India. This has added feather in the cap of India Army. The productionisation of these munitions will make us self-reliant and will save foreign currency to the extent of more than 100 crore.

This munition discriminates the tank-trawl/ plough, track and wheeled vehicles, also has survival capability against blast of CLMC (V) and 100 per cent performance against tanks. The state-of-the-art fuze has been developed consisting of active sensor and microcontroller-based signal processor. The active sensor consists of a set of transmitter and receiver coils, initially in balanced condition. When tank passes over it, the balance gets disturbed and in turn generates voltage across the receiver coil. This signal forms the signature of the target. The signature collection was done through the field trials. The software has been developed for analysing the signature and for taking appropriate decision for firing the munition. This makes the fuze smart. Successful development of this smart influence Aadrushy munition MK-II by ARDE has made India proud and at par with the world market.

Technologies established during the development of the store are: (a) active sensor based on induction balance principle, and (b) smart fuze microcontroller-based software to determine the exact instant of firing under tank, to provide discrimination between track and wheeled vehicles, and survival against CLMC(V). Users trial work done successfully and inducted into Services. Order quantity of 20,000 has been placed by the Army.

4. ANTITANK SCATTERABLE MUNITIONS

Remote delivery systems deploy large number of scatterable munitions from the air, which automatically activate as these hit the ground. Even these smart munitions are indispensable weapons of war. Under this category of antitank remotely delivered sub-munitions for 122 mm rocket and Pinaka rocket have been developed and are under evaluation phase. This sub-munition consists of miniature passive magnetic sensor for detection of the vehicle which provides full-width attack capabilities. Electronic timer generates the set SD period. As per Geneva protocol, a self-deactivation facility has also been provided as a backup. Vertical landing is ensured with the help of pyrocutter device and 6 legs arrangement. Handling and operational safety has been provided through safety arming device.



Figure 6. Remote delivery of submunitions.

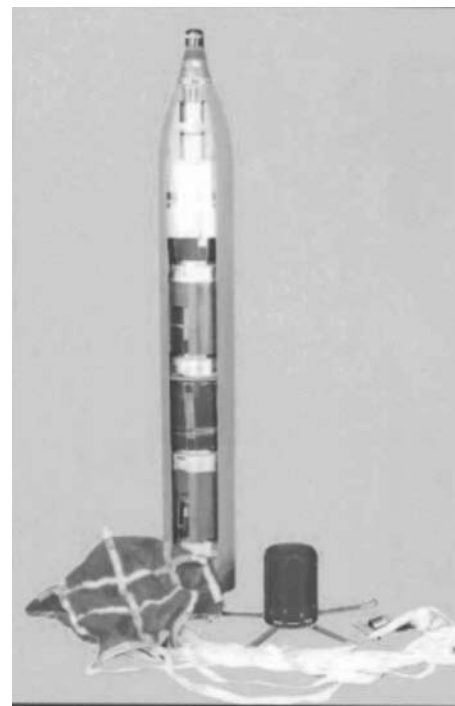


Figure 7. Submunitions.

5. INDIAN SCENARIO

Very few countries have successfully developed such types (Adrushy (MK-I & II), scatterable) of munitions and are part of their Army's inventory. Similar type of munitions have been developed by France (HPDF1 and HPDF2), Austria (ATM 200E), Sweden (FFV028), and Italy (SBMV1, BAT/7, VS-HCT). Basically, three types of technologies which have been used worldwide for influence munitions are: (a) passive magnetic sensor, (b) active sensor, and (c) seismic sensor. ARDE has also established all these technologies and munitions developed and is at par with those available in the world market.

6. GLOBAL SCENARIO FOR FUTURISTIC SMART MUNITIONS

6.1 Self-healing Munitions Field

The most recent, and perhaps the most interesting evolution in munitions technology is the autonomous, or self healing munitions (SHM). The SHM, currently under development by the US Defence Advanced Research Projects Agency (DARPA) consists of a number of sensed smart munitions that communicate with one another via radio frequencies. In addition to possessing a standoff attack capability, these munitions, through their internal communications network, are capable of reacting to enemy breaching efforts also.

6.2 Wide Area Munitions

The wide area munitions (WAM) (e.g., M93 Hornet) is a smart autonomous top-attack antitank/anti-vehicle munitions, designed to defeat armoured combat vehicles from a stand-off distance. The WAM utilizes acoustic and a seismic sensors in its ground platform to detect, track, and classify potential targets and then launches infrared detecting sub-munitions over the top of the selected target. Once the sublet detects the target, it fires an explosively formed penetrator (EFP) to defeat the target. The WAM consists of three major subsystems a communications module, a ground platform module, and a smart submunitions/warhead module. Once deployed, the WAM uprights itself and autonomously searches for a target vehicle. In addition, the WAM has a command destruct capability for easy battlefield cleanup. Then WAM's explosively formed penetrator has demonstrated the ability to perforate substantial areas

of potential threat armour targets and to cause loss of mobility or firepower after perforation. There are concerns about the hit point distribution and WAM's ability to function properly under windy conditions. This munition has been developed by US army and is in service with US Force.

6.3 Spider

Is an advanced, man-in-the-loop, area-denial munition. It protects the war fighter by laying down either a lethal or non-lethal field of fire, yet puts complete command and control in the hands of the soldier. Spider offers remotely-controlled force protection while enhancing the operational and tactical flexibility of forces in the field. Not only is a soldier in complete control of the munitions at all the times, the soldier can also select to engage the enemy with individual munitions rather than the entire system and can choose lethal or non-lethal options. The man-in-the-loop feature requires the soldier to determine whether a target is friendly or hostile, visually or using sensor input, before activating the response element. This type of munitions is under development by US Force.

6.4 Modular Pack Munitions System

Modular pack munitions system (MOPMS) is a human-portable system used by the soldier for dispersing a total of 21 antitank and other land munitions. This system has been developed by US Army. The system was specially created to employ a short-term (temporary) protective, tactical, or nuisance munitions field. The unit weights ~75 kg so can easily be put in place (even in battle conditions) by four men, and can later be activated by wired remote or wireless radio control. Though the system can be activated by wire, it is most commonly and most safely activated by a hand-held remote control unit (RCU). This RCU allows a single operator to control upto 15 groups of MOPMS by a click. The radio units use coded frequencies to stop electronic countermeasures against the system. After activation, the system discharges four munitions. The anti-tank munitions are magnetically activated, so can be triggered without direct contact, while the other munitions automatically disperse four trip wires by default. All munitions self-destruct after 4 h, but a timer can be reset up to three times for a total of 16 h. In addition, all land munitions can be set to detonate on command by remote control if needed.



Figure 8. Hornets.

7. OPPORTUNITIES IN SMART LAND MUNITION TECHNOLOGY

The application of new, high-end computer chips, and sophisticated electronics will be creating an electronic battlefield, filled with small, powerful new munitions which are intelligent, mobile, communicate with each other through network and plan strategy. Futuristic munitions will call for incorporation of following features:

- Munition mobility
- Munition-to-munition communication network



Figure 9. Modular pack munition system.

- Miniature warhead with ‘K’ kills capabilities.
This future munitions field concept will assure a robust obstacle to disrupt enemy vehicles and will prevent a successful breach of an antitank munitions field
- Smart land munitions are a part of defensive and offensive strategy of every Nation as these provide protective cover to Nation’s border and strategic location against enemy. Therefore, it is required to give prime importance and top-most priority to the development of smart munitions.
- To venture into the development of futuristic smart munitions, development of core expertise in the following technologies is needed:
 - Miniaturisation of the magnetic sensors
 - Development of the acoustic and seismic sensors
 - Development of the miniature warhead with ‘K’ kill
 - Development of remote control system for the munitions
 - MMIC-based RF transceiver system
 - Development of MEMs-based sensed munition
 - Power harvesting system for passive wireless communication system
 - Development of the MML(mechanical munitions layer) compatible safety arming mechanism
 - Individual impulse-based munitions mobility with self-righting
 - Low power munition-to-munition communication (resistant to enemy countermeasures methods) that can determine each munition location
 - Non-GPS-based geolocation
 - Healing algorithms/ behaviors that are robust against a variety of enemy breaching tactics and autonomously identify and respond to an enemy attack within few seconds
 - Compact multi-hopping system

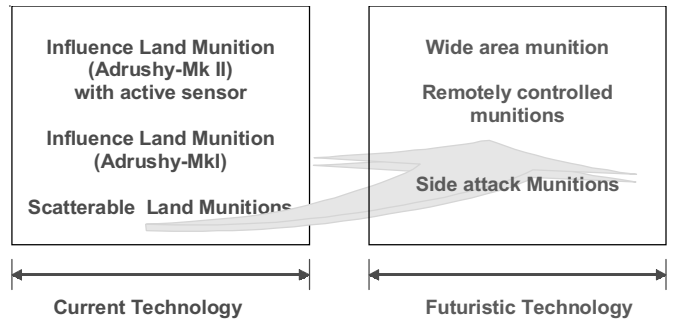


Figure 10. Evolution of smart land munitions.

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