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DUAL MODE WARHEAD TECHNOLOGY FOR FUTURE SMART MUNITIONS

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The U.S. is developing Multi-Mode Explosively Formed Penetrator (EFP) warhead technology to increase the effectiveness of a single warhead design against a wide range of threat targets. A warhead can be detonated with different initiation schemes and/or mechanical attachments to produce difference EFP shapes and lengths. Such a warhead can form multiple compact ball-shaped EFPs for lightly Armored targets, a fin stabilized EFP for extended range engagements or a very long stretched EFP for thick armor defeat. A multi-mode warhead will reduce the logistical burden of carrying multiple munitions needed to complete a mission in which multiple targets will be engaged.

BACKGROUND

Over the last few years, with the advances in sensor and electronic technology, new Smart Munitions that utilize Explosively Formed Penetrator (EFP) technology are being fielded. EFP warheads in munitions being fielded will form a single long rod penetrator that has been optimized to defeat a fixed target set at long standoff. Although the EFP will defeat targets outside of its target set, it may not be as effective nor have the same on-target hit accuracy. There is an effort to develop new multi-purpose EFP Warheads with long standoff defeat capability, as well as wide area coverage with multiple EFPs or thick armor penetration at closer standoff. Since sensor technology may now be capable of not only detecting threat targets but also categorizing them, this data will enable a smart munition to select the most effective EFP firing configuration to defeat the target identified.

APPROACH

There is interest in two types of Dual Mode EFP Warheads; the first type can form a aerostable EFP for long standoff defeat capability or a stretched non-aerostable EFP for deep armor penetration; the second type will form an aerostable EFP or multiple compact

EFPs for wide area coverage. The first Dual Mode warhead design can be achieved by using two initiation schemes. In the aerostable EFP mode a single detonator in the rear of the warhead is initiated and in the long stretched EFP mode a ring of multiple detonators will be detonated. In the second type of Dual Mode warhead, a single detonator is again used to form the single EFP with a mechanical device, that the liner will fired through, used to produce multiple EFPs.

AEROSTABLE AND STRETCHED EFP

The effects of arranging multiple detonators in different patterns to change the shape of an EFP in a fixed Warhead geometry has been studied in other International Ballistic Symposium Paper[1,2]. Dyna2D simulations in Figure 1 below show the effects of changing the location of a ring of detonators. When the ring of detonators are moved away from the centerline, the EFP collapses harder due to the shape of the detonation wave.

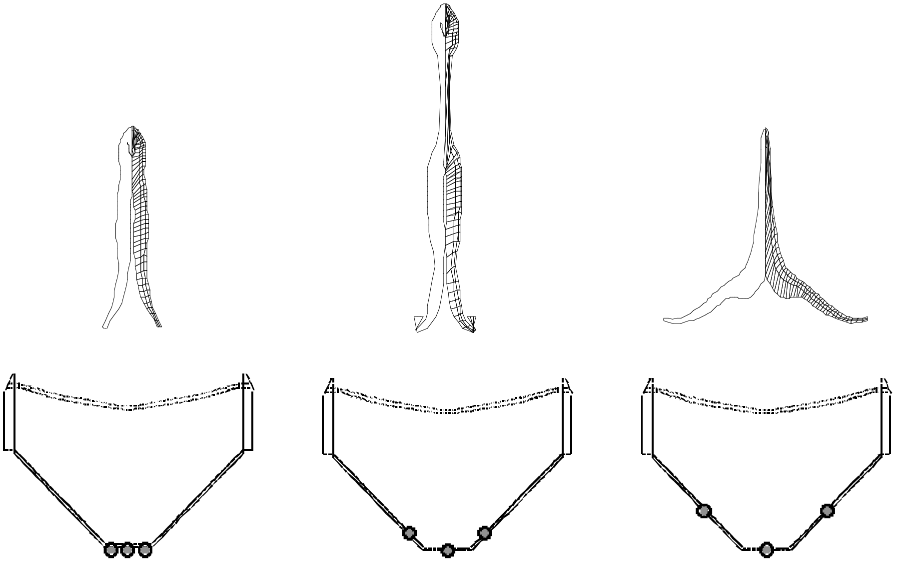


Figure 1: Dual Mode warhead design approach.

A series of three designs were generated and tested, as summarized in Figure 2 below. In the first design, the EFP had no fin or flare features and was not fired in the stretched EFP mode. A flare was added in the second iteration to help improve the aerostability of the EFP, but when tested in the stretched EFP mode, the EFP collapsed too hard and broke up too early to be effective. The design approach to this point was to optimize the liner geometry to form an aerostable EFP, and just insert the ring initiator to form the stretched EFP. It is clear from the data that the liner curvature must be designed for both initiation schemes. This resulted in a liner design that was flatter that the previous design, and performed well in both modes. When tested in the aerostable mode, the EFP met all requirements at 100 m. and in the stretched EFP mode, the EFP penetrated significantly more armor that conventional aerostable EFPs. Figure 3 shows the test data for the 100 m test. The 8 yaw screens indicate the maximum miss distance of the EFP throughout the 100 m flight to be less than 12 inches radially.

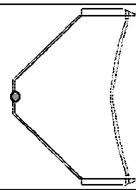
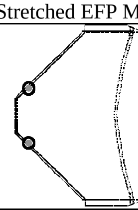
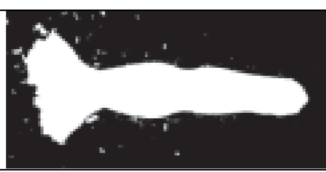
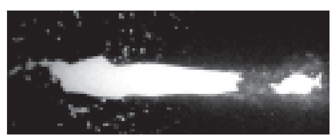
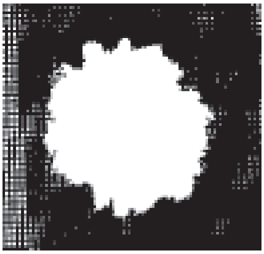
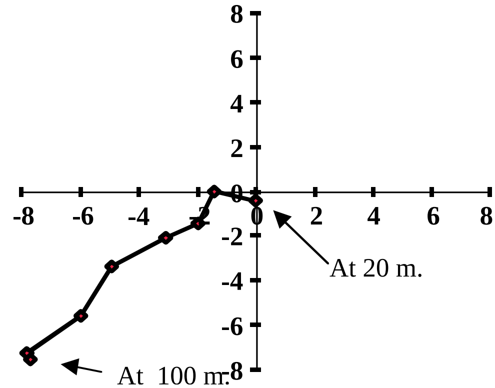
	Aerostable Mode	Stretched EFP Mode
Design		
1		Not tested
2		
3		

Figure 2: Dual Mode EFP warhead test results (° Detonator location).



Representative Yaw Screen



Yaw Screen data

Figure 3: Test data for long standoff test.

SINGLE AND MULTIPLE EFP WARHEAD

An initiation system, similar to the one described above, could be used for a Dual Mode warhead with a Single EFP and Multiple EFP (MEFP) mode. In the single EFP mode, only one detonator would be detonated and in the MEFP mode, multiple detonators laid in an array would be detonated. Using the multiple detonators approach, it is relatively easy to break up the liner to form the MEFPs, but very difficult to form compact penetrators and to control the MEFP spray angle and pattern. A simple method was developed using an ejectable mechanical device. This device is attached to the front of warhead. When used in the single EFP mode, this device would be ejected prior to detonating the EFP warhead. In the MEFP mode, the EFP liner is fired through the device. The device is designed not only to break up the liner, but to form compact MEFPs and to achieve the desired spray angle and pattern. This approach was first demonstrated using small test charges to control the pattern (see Figure 4 & 5). Then with the design was scaled up to a tactical size warhead similar pattern control was demonstrated (see Figure 6). In one tactical warhead test, some of the compact MEFPs were recovered for examination (see Figure 7).

Figure 4: Subscale test warhead.

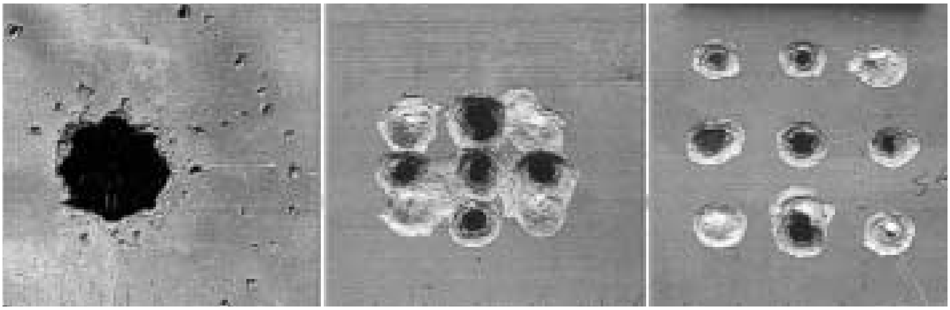


Figure 5: Pattern control demonstration with subscale warhead.

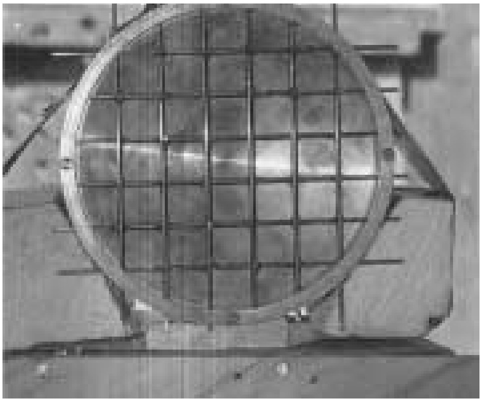


Figure 6: Full size tactical warhead.

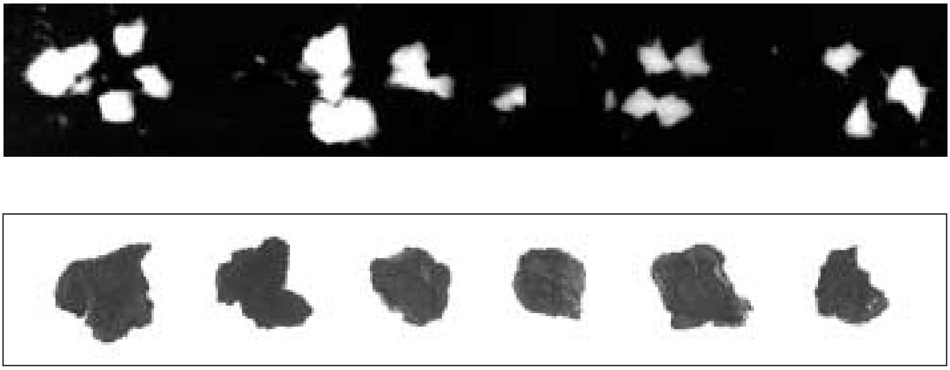


Figure 7: X-rays of MEFPs and recovered MEFPs.

CONCLUSIONS

Two successful Dual Mode Warhead concepts have been demonstrated for integration into munition systems. Using a multi-point initiation device, a Dual Mode Warhead design that can form either a aerostable EFP for long standoff or a stretched EFP for short standoff was demonstrated. An ejectable mechanical device was designed to demonstrate a Dual Mode warhead with a Single EFP mode for Main Battle Tanks and a MEFP mode for thinner armor targets. Both concepts can be combined to develop a warhead with three modes, long standoff Aerostable EFP, shorter standoff deep penetration EFP, and wide area MEFP.

REFERENCE

1. 14th International Symposium on Ballistics, Flight Stability of EFP with Star Shaped Tail, Dr. Klaus Weimann, Quebec City, Canada, 26–29 September 1993
2. 15th International Symposium on Ballistics, Study of a Multi-point Ignition EF, Dr. Th. Bouet, P. Tarayre, J.P. Guillon, Jerusalem, Israel, 21–24 May 1995