National Defense Industrial Association Insensitive Munitions & Energetic Materials
10564
Technology Symposium
Initiation Trials of the IMX-101 Explosive in the M795 projectile

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The CLIMEx Explosive replacement effort has developed very insensitive candidate explosives. Due to the insensitivity of the new explosive fill, the initiation train requires a re-design to ensure that the new, IM projectile meets the reliability requirement of the legacy round. In order to initiate the IMX 101 main fill, an extremely powerful explosive charge must be used to augment the output of the Fuze Booster. This charge, called the Supplementary Charge (Supp Charge) is pressed TNT in the legacy round. This TNT charge does not have the energy to initiate IMX-101. A full suite of explosive candidates was investigated to determine which would be the new Supp Charge in the M795, as well as the rest of PM-CAS's Artillery rounds. A series of tests were designed to evaluate multiple candidates for both applications. These tests were conducted in two series to determine if (1) the reliability of the fuze booster to initiate the supplementary charge and (2) the reliability of the supplementary charge to initiate the main fill have been compromised as a result of the new supplementary charge and main charge. The Neyer analysis (D-Optimal test) was used to analyze the data of these tests. Like other sensitivity tests, the Neyer method requires varying a parameter in order to acquire pass/fail responses for the booster to supplementary charge test; the variable parameter was the gap between the booster and supplementary charge. For the supplementary change to IMX-101 main fill test, the variable parameter was the density of the PBXN-9 supplementary charge.

For the first experiment, a baseline test was conducted with the M739A1 fuze booster pellet (22 grams of Comp A5) in contact with the PBXN-9 supplementary charge, and the supplementary charge in contact with the witness plate. The variable in subsequent tests was the gap between the fuze booster pellet and the supplementary charge (figure 1). With the fuze booster pellet in contact with the supplementary charge, the initiation of the supplementary charge will produce a baseline dent depth in the witness plate. Twenty tests were conducted with variable gaps in addition to the three tests with zero gap to define the baseline witness plate dent. Eighty percent (80%) of the average dent depth of three successful detonations was the success criteria for detonation. A dent less than 80% of the baseline was deemed an unsuccessful detonation.

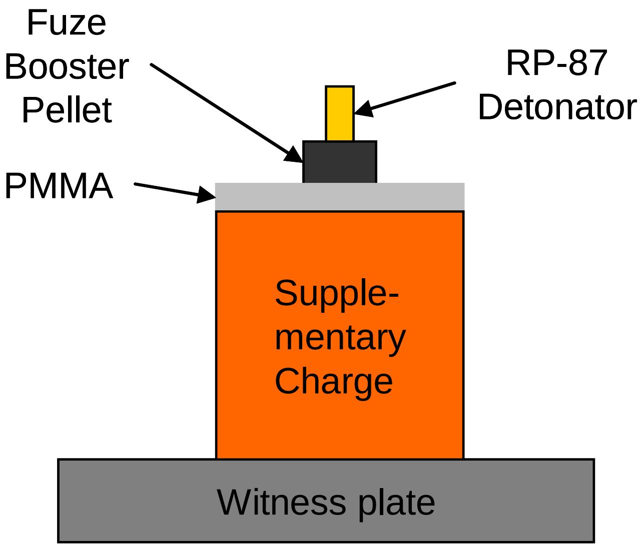

Figure 1 – Test Series 1 Configuration

The 50% point resulted in a shock attenuator thickness of 0.604 inches with a sigma of 0.013 inches. At 90% confidence, the Neyer program could not provide quantitative data for reliability due to the extremely high number generated. Analysis produces a figure that at zero gap, there is 99.5% confidence that there would be less than 1 failure per approximately 1 trillion shots. The gap corresponding to a 0.99995 reliability with a 90% confidence level is about 0.5" (figure 2).

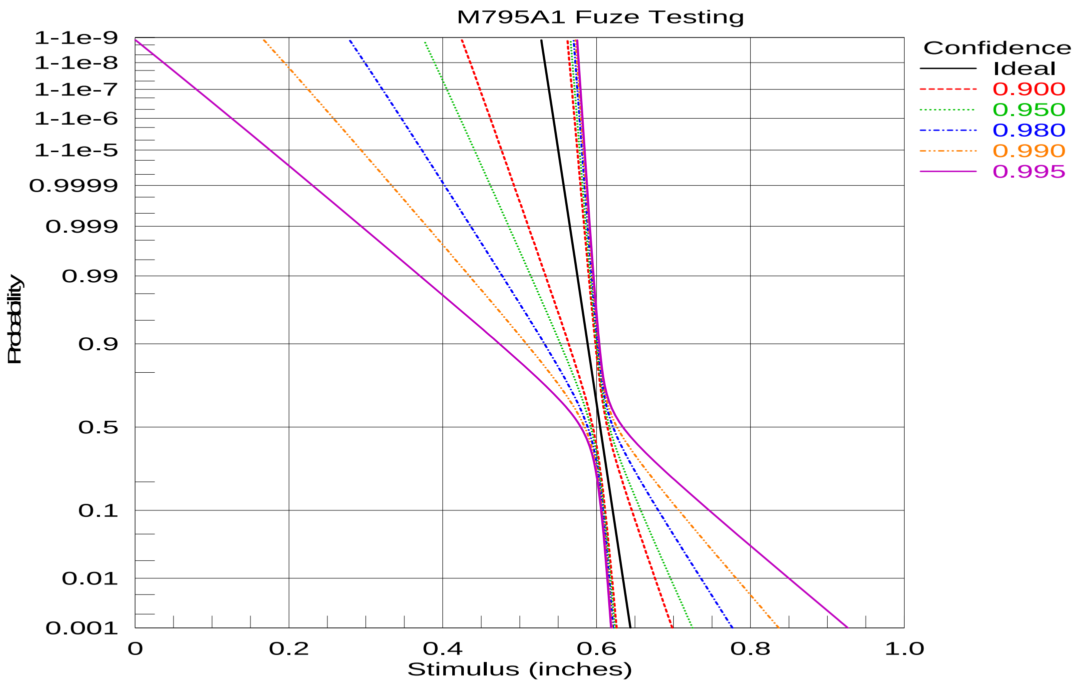

Figure 2 – Test Series M739A1 Results

The second test series was conducted to determine the reliability between the MK399 fuze (which has the smallest booster pellet of all current fuzes; 6 grams of CH-6) and the PBXN-9 Supp charge. There were twelve total tests conducted; two shots were done at zero gap to determine the baseline dent and the remaining 10 were used to perform the Neyer analysis (again, 80% of the baseline dent was considered a "go"). The 50% go/no-go point was determined to be 0.574" (compared to the A5 booster being 0.604").

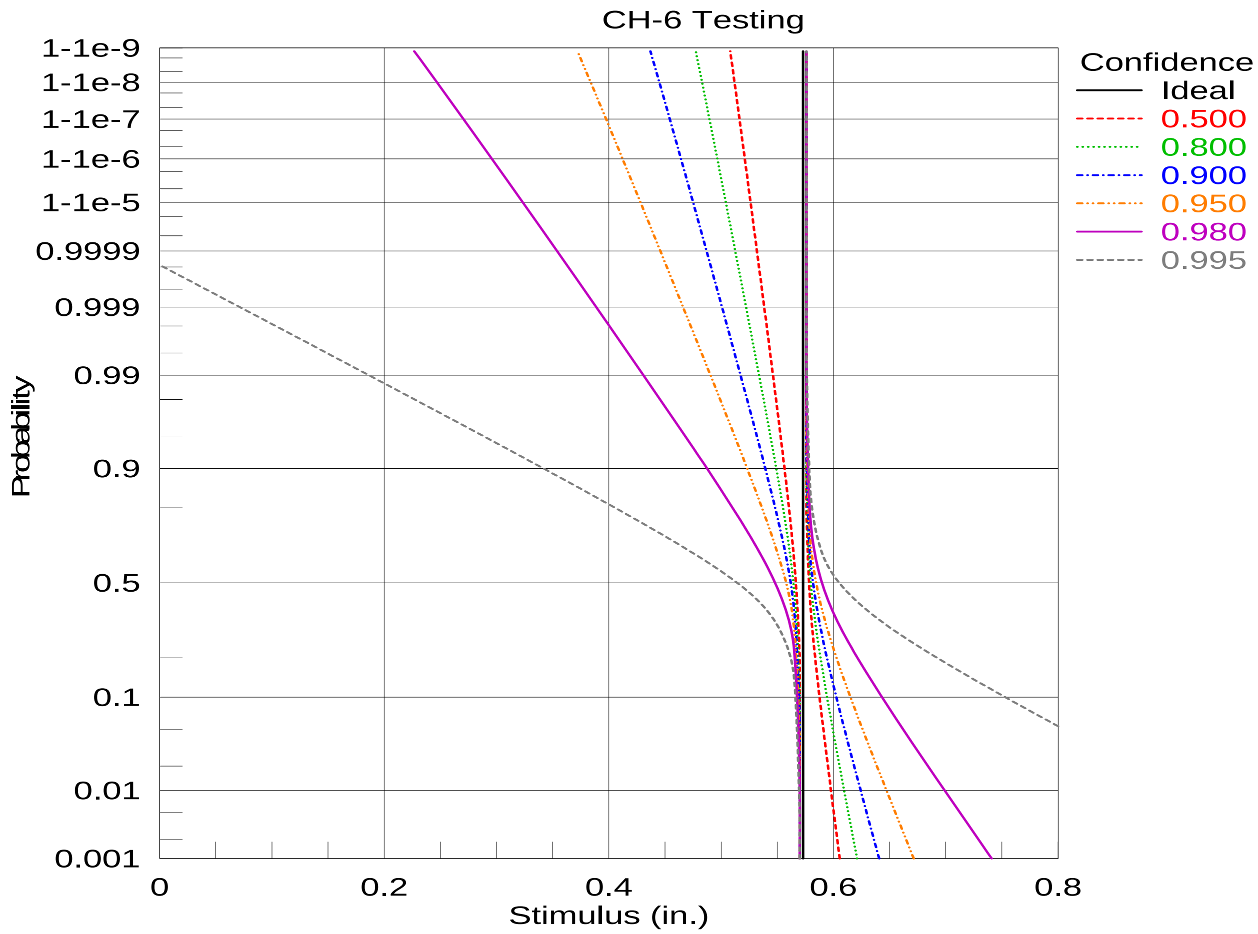

Figure 2 – Test Series MK399 Results

Thus, at a 99.5% confidence level, there would be approximately one failure per 3000 shots at zero gap (significantly less reliability than A5, but only half the shots were available). Using a typical 90% confidence, that number is far beyond one failure per trillion.

An additional test series was conducted to determine the reliability of the PBXN-9 Supp charge to initiate the IMX-101 main charge. This time the variable was the density of PBXN-9 in the supp charge. The baseline supp charge has 150.4 grams of PBXN-9 with a density of 1.70 g/cc. A series of supp charges were assembled ranging from a low of 1.35 g/cc (the lowest density achievable on the production line) up to 1.75 g/cc or 118g – 154.7g. There were 5/5 go's at 1.35 g/cc; 4/4 go's at 1.40 g/cc; 2/2 go's at 1.50 g/cc. At this point the test was stopped due to a lack of no-go reactions. Because there were no failures, the Neyer program cannot predict the reliability. In addition to the reliability tests there have been 332/332 successful (detonations) gun firings (which includes tests at hot, cold and ambient; temperature and vibration cycled projectiles) of the M795 projectile loaded with IMX-101 via the PBXN-9 Supp charge at a density of 1.70 g/cc.

In summary, through this series of three penalty tests and gun performance data, although highly insensitive, the M795 projectile loaded with IMX-101 matched the initiation reliability of the legacy M795 round.