PHYSICAL EFFECTS AND CONSEQUENCES FROM DETONATIONS AND LESS VIOLENT MUNITION RESPONSES

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An increasing number of warhead designs shows a less violent response than Detonation (type I) in cook off or impact scenarios. In order to quantify the safety benefits, MSIAC is working on improvements in the risk management of such munitions. For Deflagration (type IV) and Explosion (type III) reactions, only limited quantitative information exists about the physical effects and consequences. This includes primary fragmentation, internal pressure loads and projection of debris from storage structures, as well as external blast (or pressure) waves and thermal effects. In storage conditions, the larger scale and confinement introduces additional complexities. This paper discusses relevant data and presents a first step towards the development of models.

Due to the reduced reaction rate, fragmentation typically leads to larger strip-like fragments, but with a smaller velocity. Trajectory calculations have been carried out to illustrate the influence on impact distances. Tests have shown that impact distances can even increase due to a smaller deceleration by airdrag. The occurrence of a small number of fragments with a large impact distance raises questions about appropriate definitions for safety distances. Break-up of storage structures will occur at higher loading density (NEQ per volume) for less violent munition responses. Detailed knowledge about the storage construction and in particular vent areas, is essential to determine the overall response. As for primary fragments, structural debris will increase in size and reduce in velocity, however the debris throw may also become more directional. A number of adaptions to the Debris Launch Velocity (DLV) equation are discussed to account for sub-detonative behavior. These are a reduction in either the available energy for acceleration or a reduction of the effective acceleration path length. External blast will reduce in strength, which can be represented with reduced TNT equivalencies, but more appropriate are models that account for a lower reaction rate and lower explosion overpressures. The potential of the Multi-Energy method (originally developed for gas-explosions) has been investigated.
We recommend that standardized IM tests are extended with a more detailed measurement of fragmentation and blast for the purpose of model validation. The IM test standards could also specify more quantitative measures to help define the munition response in terms of reaction rate. It is also recommended that the international community focus on full scale testing of IM. CFD and engineering models could focus more on internal pressure development and structural response for limited reactions rate. We hope that the findings in this paper will aid the development of Quantity Distances (QD) and risk management of future munitions for a range of responses.