Inherent Impact Response Behavior of Explosive Charge in Confinement

Hu Haibo[1], Li Tao[1], Fu Hua[1], Dai Xiaogan[2], Qiu Tian[2], Yao Kuiguang[2]

1 Laboratory for Shock Wave and Detonation Physics Research, Institute of Fluid Physics, CAEP, Mianyang, Sichuan, China, 621900

2 Institute of Chemical Materials, CAEP, Mianyang, Sichuan, China, 621900

In safety tests simulating accident impact insults to explosive charge in metal case, the inherent characteristic response behavior of explosive can be observed with help of carefully designed diagnostics. As for Susan test [1], full scenario of typical accident response shows non-prompt reaction behavior in following steps:

1. large deformation and fracture of nose-cap with explosive damage which may last hundreds microseconds even beyond milliseconds before ignition event;

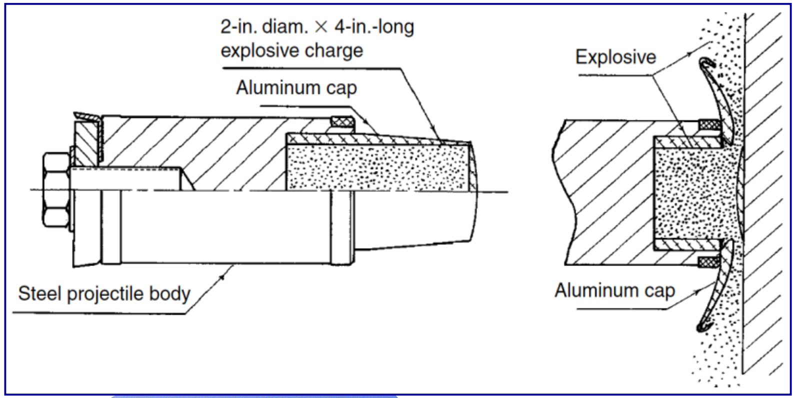
2. non-shock initiation inside the damaged explosive;

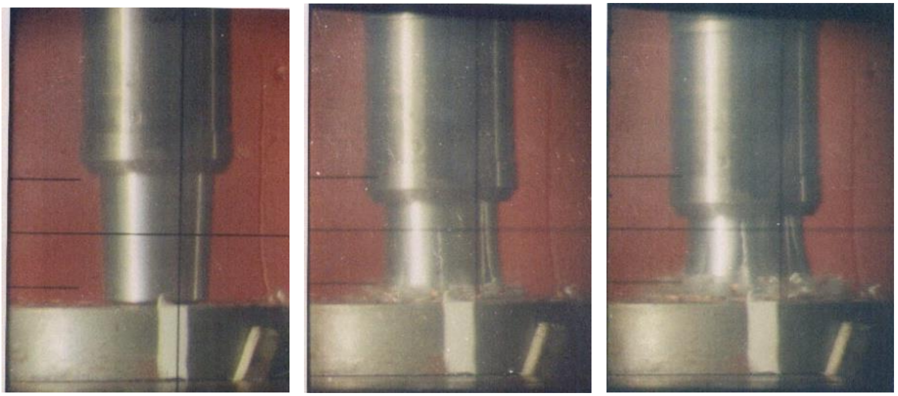
3. the propagation of combustion throng cracks in damaged explosive bulk and evolution of reaction violence inside damaged explosive without tightly case confinement.

Key words: accident response sequence; non-prompt ignition; reaction violence; transition into explosion/detonation; OPS

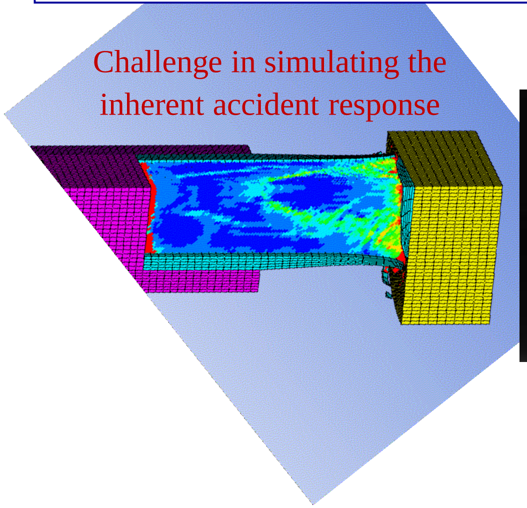
Accident response sequence of HMX-based explosive charge @≈100m/s:

—deformation & fracture, deeply delayed ignition, intensive blast wave but low debris velocity





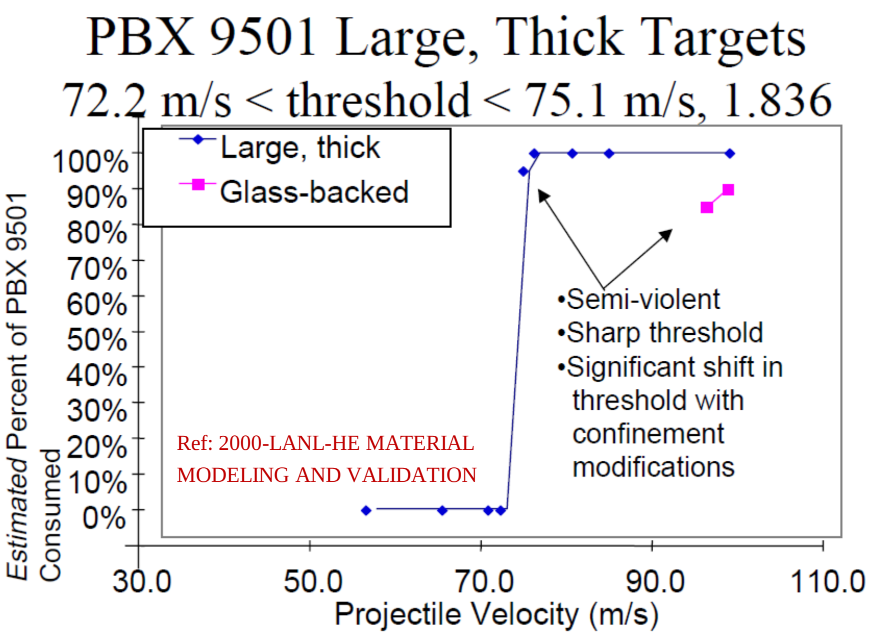
Typical pre-ignition deformation of a Susan test projectile

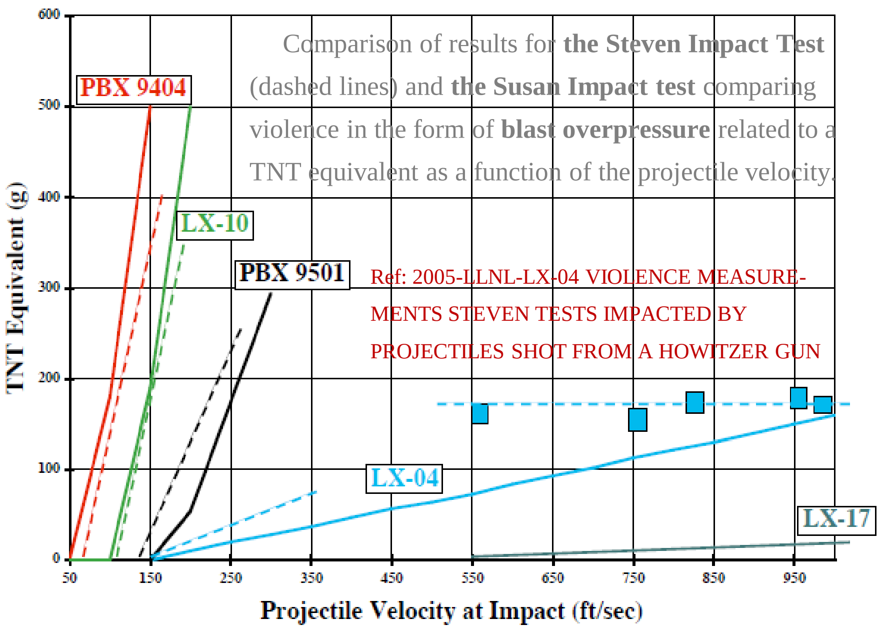


Recovery fragments of projectile scattered nearby after violent explosion

Reaction violence evolution: transition into explosion vs immune to DDT

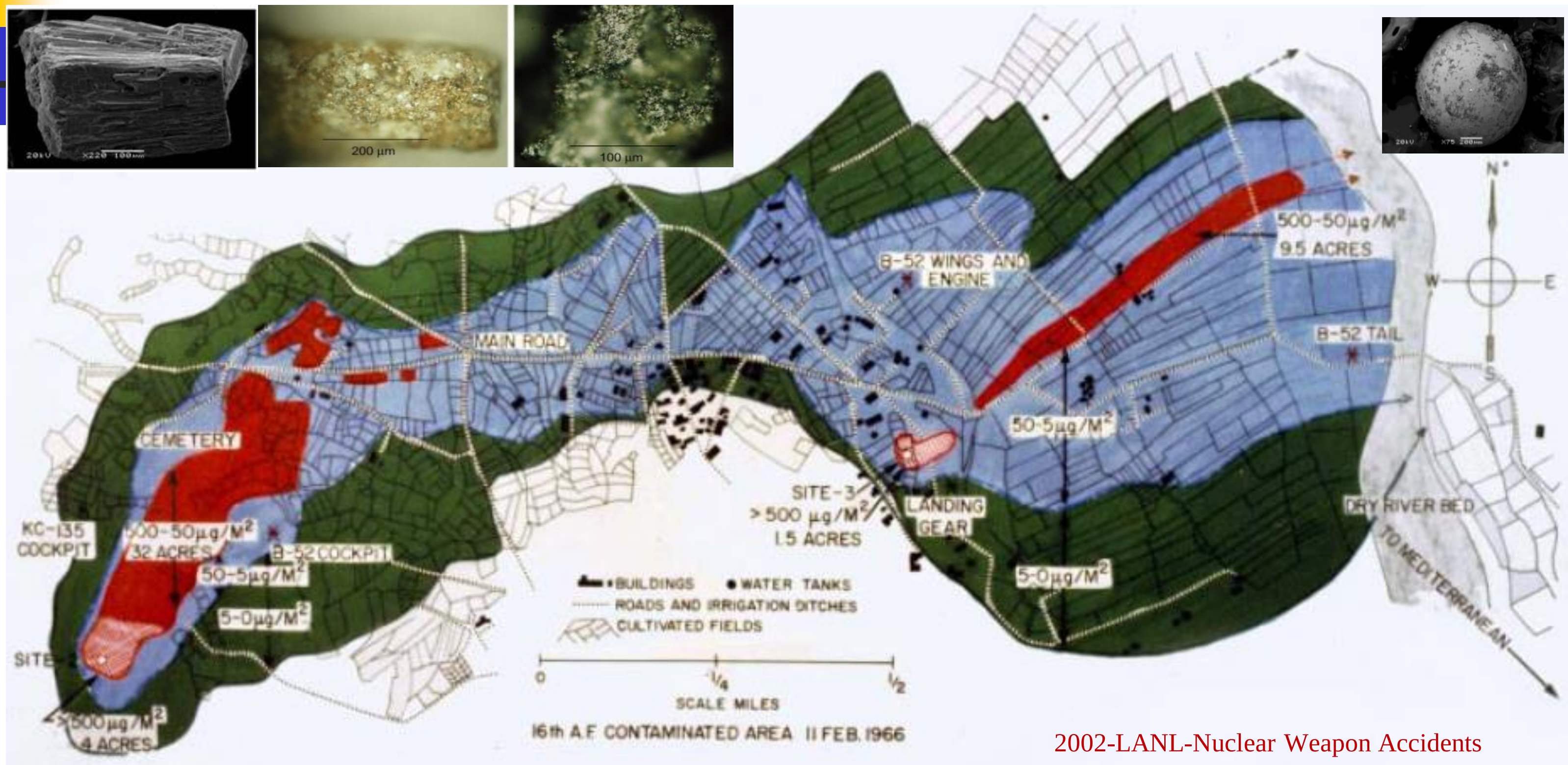
—What about local pressure profile inside reaction zone: ≈100MPa@ms





Intensive blast wave comparable to that of full detonation of explosive charge might be recorded at some distance away from the explosion locus, while the on-site reaction pressure goes up merely to hundreds MPa with a duration of hundreds microseconds to several milliseconds. The nose-cap fragments are scattered in nearby range showing no sign of high strain rate shear fracture and high velocity driven by detonation.

2004-LANL: In fact, no detonation of PBX 9404 has occurred in Broken Arrow accidents involving this explosive.



2002-LANL-Nuclear Weapon Accidents

Such kind of high violence explosions do not necessarily correspond to real detonation event [2], it should be interpreted as multi-stage deflagration taking into account of the reaction of explosive particles dispersed inside the fire ball of the ongoing explosion. The blast wave intensity, e.g. equivalent energy release level does not present on-site reaction violence of explosive. Terms like transition into explosion, partial detonation or low order detonation should be redefined and used very carefully in this case.

An Explosion can be supersonic**—a Detonation–** or subsonic**—a Deflagration**

The multi-stage inherent behavior of accident response should be taken into account in physics models study and numerical codes validation on strict process aware logic base along with the real events sequence including pre-ignition deformation and confinement fracture, non-prompt ignition of combustion, reaction spreading through explosive cracks, violence evolution inside a partial fractured structure with mass confinement of damaged explosive and late stage massive combustion of explosive particles inside explosion fire ball [3,4].

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