Ministry of Defence

de&s

Heavy Fragment Impact of PBX Materials

DOSG Science & Technology

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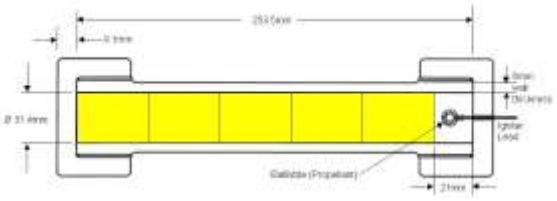
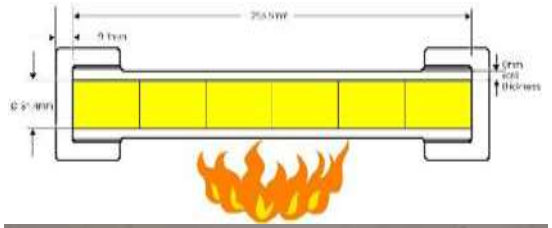
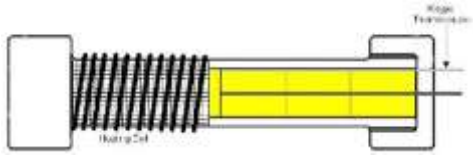
Weapons Operating Centre

Introduction

- **Motivation:**
  - Is it possible to induce Deflagration to Detonation Transition in cast cured PBX formulations?
- **Review of:**
  - Charge scale Fragment Attack testing of cast cured PBX formulations
  - All Up Round testing to assess susceptibility to DDT

Explosiveness Testing and DDT

- An extensive database held in the UK on material explosiveness properties
- UK uses EMTAP 35, 41 & 42 – the “Tube Tests”
- Materials that have passed the tube tests have not caused issues in IM tests


Explosiveness Testing and DDT

- Materials that have passed the tube tests have not caused issues in IM tests

- Number of 1000lb (500kg) & 540lb (250kg) ROWANEX bombs subjected to Fast Heating Tests

Fragment Impact

- The UK has undertaken extensive fragment impact testing
  - Experimental & Qualification

- Flat Faced Cylinder
  - 13.15mm & 20mm 27g fragment

- 18.6g NATO IM Fragment
  - 160° projectile – 1850m/s or 2530m/s

- 30mm 100g Fragment (Experimental)
  - Used for thick barriers or IM materials

- 20mm (50g) & 30mm (200g) Chisel Nose Fragment
  - UK Generic Naval Environment

Fragment Attack - EMTAP 36

Test Purpose:

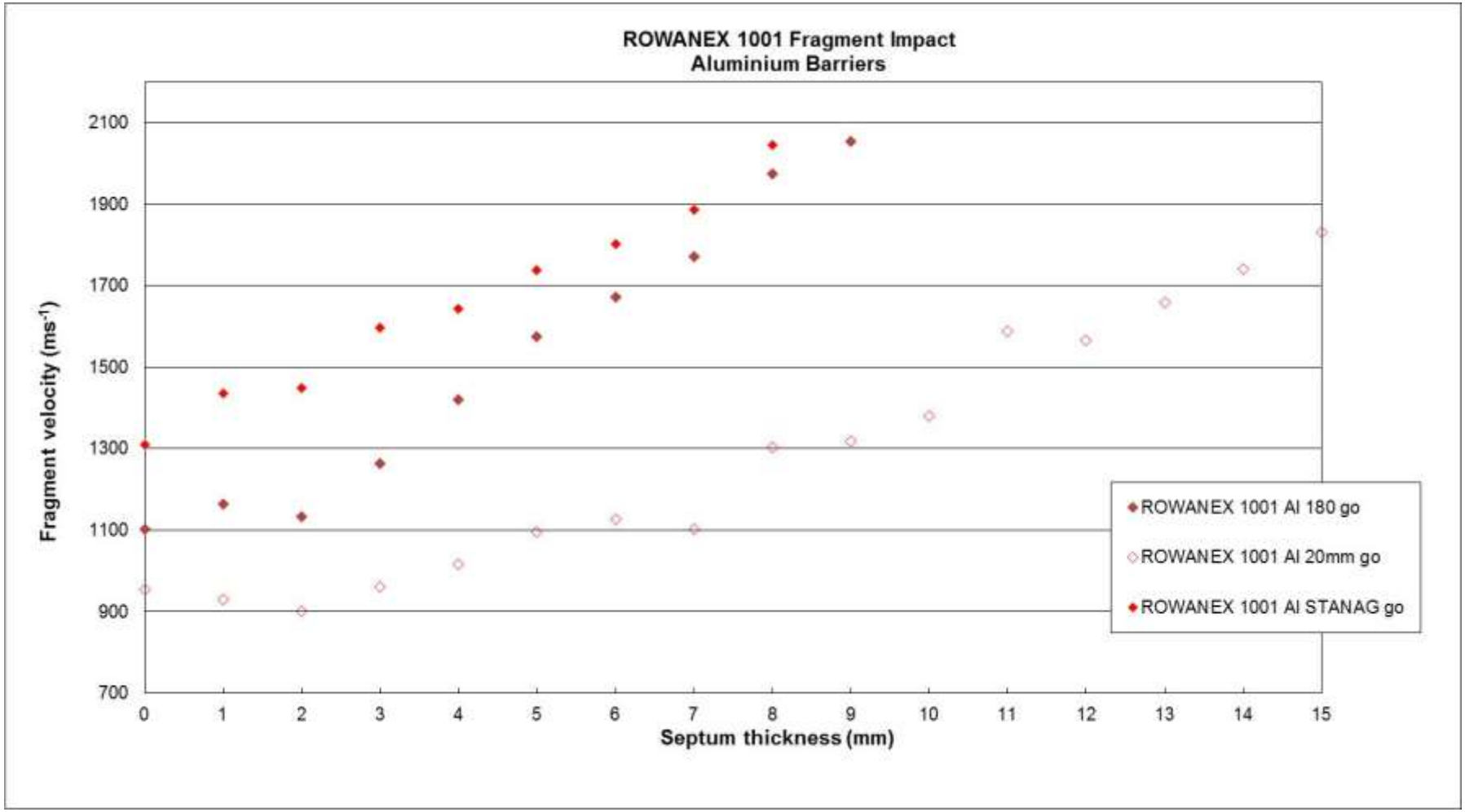
"To determine the SDT velocity threshold of an energetic material.."

–Steel and aluminium barriers

–Allows prediction of response to IM Fragment impact

- Select Standard or Alternative velocity

SDT Threshold Curves:



Initial Experimental Findings - Charge Scale

- What happens with heavy fragment damage into a confined PBX?
  - Tube Test does not inflict severe mechanical damage
  - NATO IM Fragment causes burning

- High confinement vessel
  - 25mm barrier to prevent SDT ≈ 2,200m/s
  - At 2,213m/s – evidence of partial detonation
  - Suggests DDT within a cast cured PBX

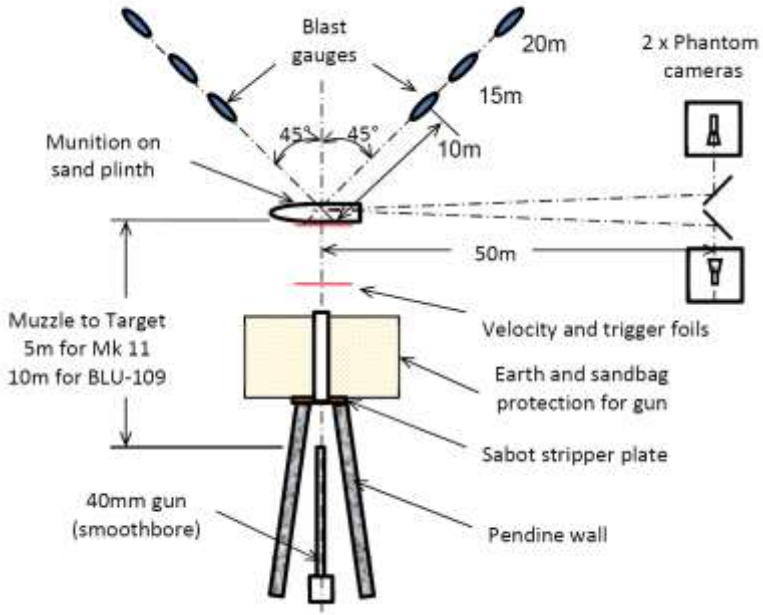
Initial Experimental Findings - Charge Scale

- What happens with heavy fragment damage into a PBX?
  - Tube Test does not inflict severe mechanical damage
  - NATO IM Fragment causes burning

- High confinement vessel
  - Inconclusive
  - Required larger scale testing

High Velocity Fragment Impact Set Up

- 40mm, 10m Long Gun
- 3-Stage Powder gun
- Requires Protection!



ROWANEX 1400 Filled 540lb & 1000lb Bombs

- 200g, 30mm fragment used in trials

ROWANEX 1400 - 540lb Filled Bombs

- Shot No 1 – 200g, 30 mm fragment at 540lb
  - 1,590m/s. 100m/s below calculated SDT velocity

ROWANEX 1400 - 540lb Filled Bombs

- Shot No 2 – 200g, 30 mm fragment at 540lb
  - 1,669m/s





ROWANEX 1400 -1000lb Filled Bombs

- Shot No 3 – 200g, 30mm fragment at 1000lb
  - 1,860m/s

PBXN-109 2000lb (1000 kg) - Filled Bombs

- Shot No 1 – 50g, 20 mm fragment (video 7)

PBXN-109 2000lb (1000 kg) - Filled Bombs

- Shot No 1 – 50g, 20 mm fragment

PBXN-109 2000lb Filled Bombs

- Shot No 2 – 200g, 30 mm fragment (video 8)

PBXN-109 2000lb Filled Bombs



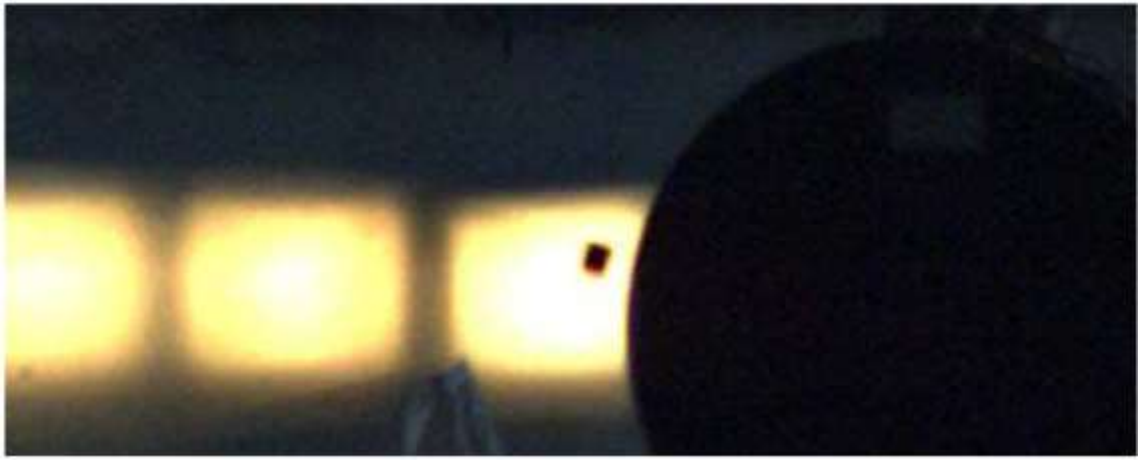



PBXN-109 2000lb Filled Bombs

- Shot No 3 – 200g, 30mm fragment (video 9)

PBXN-109 2000lb Filled Bombs

- Shot No 3 – 200g, 30mm fragment



Conclusions to Date

- PBXs - ROWANEX 1400 & PBXN-109 resistant to SDT & DDT in NATO Fragment Impact Tests
  - Predictable behaviour

- Large Cast cured PBX bombs show different reactions with larger fragments
  - Show more violent tendencies with larger fragment impacts

- Extreme mechanical damage and breakup of PBX leads to high surface area and flame front

- No detonations observed to date, but on the fringe of DDT?

Acknowledgements

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