Tube Testing For IM Assessment Of The Booster Explosives PBXN-5 And ITEX-07

Dr Helmut Zöllner

A Presentation to: IM/EM Technology Symposium 2012

16th May 2012

QinetiQ | de&S | dyniTEC Ignition Technology Energetic Compounds

Contents

1 Introduction

2 Testing

3 Results

4 Summary

5 Recommendations

1 Introduction

1 Introduction

This presentation reports the results from a collaborative study funded by Defence Equipment and Support, MOD, UK supported and performed by DynITEC and QinetiQ.

It is a follow-up to a paper presented at the last symposium in 2010 and includes the complete results for both explosives.

The study was instigated in response to a question from the Defence Ordnance Safety Group, DE&S, MOD, UK:
“How small does a booster have to be before the current suite of EMTAP tube tests becomes a gross over-test?”

In order to gather relevant data QinetiQ has designed four sets of reduced confinement tubes capable of subjecting two diameters of explosive materials to thermal stimuli.

1 Introduction

These tubes have been used to test two booster explosives over a two year programme.

Details of the explosives:

Characteristic	PBXN-5	ITEX-07
Composition	HMX (95 %)	TATB (60%) RDX (35%)
Binder	5%	5%
Density	1.75 g/cm³	1.74 g/cm³
Friction (BAM)	160 N	130 N
Impact (BAM)	5.5 J	20 J

1 Introduction

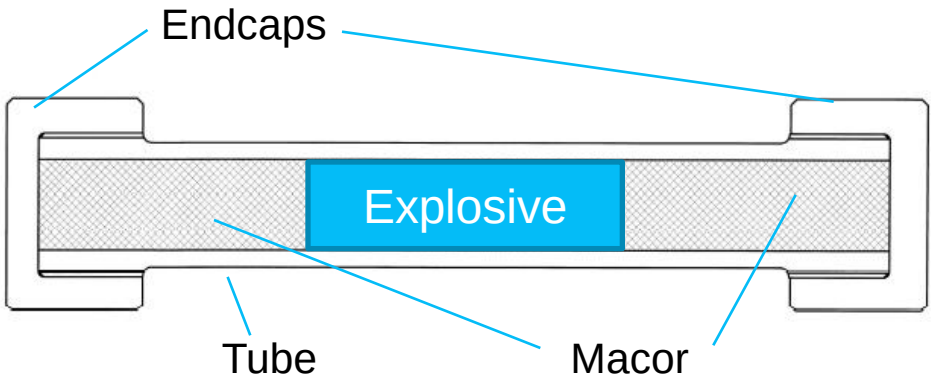
Design data		Test conditions				
Major dimension (mm)	Confinement level (MPa)	Tube material	Internal diameter (mm)	Wall thickness (mm)	Test explosive length (mm)	Comments
Large ≥ 50	Any	Steel	31.4	6	Full 254	Same test as main charge explosives
50 > Medium ≥ 15	High > 110	Steel	31.4	6	100	Two 50mm pellets
50 > Medium ≥ 15	110 ≥ Medium ≥ 40	Steel	31.4	3	100	Two 50mm pellets
50 > Medium ≥ 15	Low < 40	Aluminium	31.4	3	100	Two 50mm pellets
Small < 15	High or medium > 80	Steel	15	3	30	Two 15mm pellets
Small < 15	Low ≤ 80	Aluminium	15	3	30	Two 15mm pellets

2 Testing

2 Testing

Fast heating (Fuel Fire)

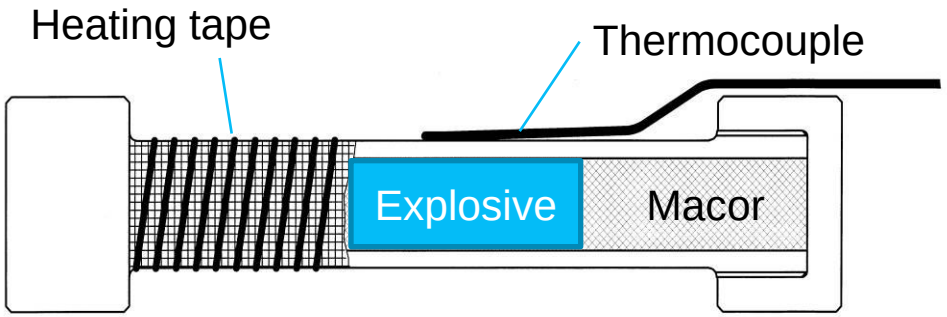
- The test vehicle is placed over a tray containing 2 litres of petrol.
- The petrol is ignited by a suitable remote method and the time from ignition to the event(s) is recorded.
- The total number of fragments are recorded.



2 Testing

Electrically Heated

- Woven glass fibre is attached to the tube.
- Nichrome heating tape is spiral-wound onto the glass fibre.
- Each tube has a thermocouple to its surface position half way along the tube
- The total number of fragments are recorded.



2 Testing

Category	Reaction Description	Observation
0	No reaction	From weighing
(0/1)	Burning / decomposition	No disruption of tube
1	Pressure burst due to burning / decomposition	Assembly ruptured but in one fragment
2	Deflagration	2 - 9 body fragments
3	Explosion	10 - 100 body fragments
4	Detonation	> 100 body fragments showing evidence of detonation

3 Results

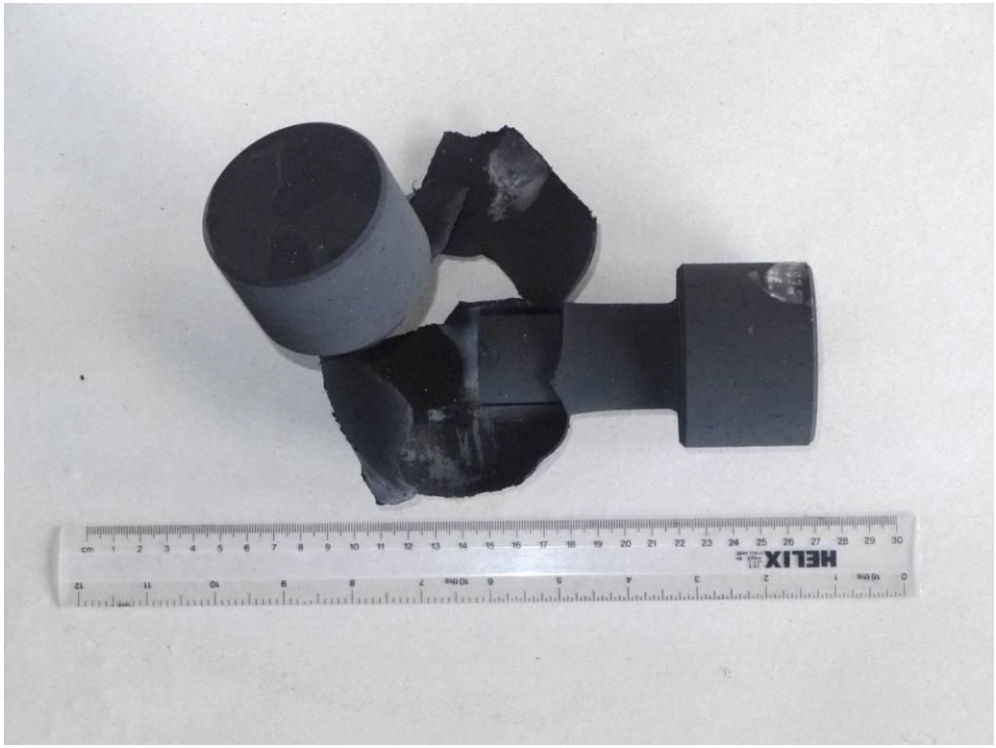
3 Results – Fast Heating (Fuel Fire)

Confinement	Size	ITEX-07					PBXN-5				
		Results expressed in number of tests out of 10 falling in category ...									
		0	1	2	3	4	0	1	2	3	4
H	L	0	0	10	0	0	0	0	0	0	10
H	M	0	3	7	0	0	0	0	0	0	10
M	M	0	9	1	0	0	0	0	0	6	4
H or M	S	0	1	9	0	0	0	0	0	10	0

3 Results – Electrically Heated

Confinement	Size	ITEX-07					PBXN-5				
		Results expressed in category for different heating rates (°C/min)									
		100	10	5	1	0.16	100	10	5	1	0.16
H	L	2	2	2	3	2	4	4	4	4	4
H	M	2	2	2	2	1	4	4	3	4	4
M	M	2	4	2	2	1	3	4	3	2	4
L	M	1	1	3	4	1	2	3	4	1	2
H or M	S	2	3	2	3	2	3	3	3	3	3
L	S	1	2	3	3	2	2	3	3	3	3

4
Summary and Recommendations



4 Summary (1)

- Reduced scale testing has shown that even for the high explosiveness PBXN-5, no detonation responses have occurred with 15 mm Diameter Pellets (S). This demonstrates that results from the standard test are a gross over test when applied to small pellets.
- PBXN-5 shows results that are broadly confinement dependent with some variation in response across the different heating rates for some confinement levels. 36 from 70 trials resulted in Cat 4 failures.
- ITEX-07 shows results that overall demonstrate significantly lower explosiveness than PBXN-5, but some Cat 3 and 4 results occurred over a wide range of confinement at intermediate heating rates. 2 from 70 trials resulted in Cat 4 failures.

4 Summary (2)

- No trial involving the smallest pellets of ITEX-07 or PBXN-5 resulted in a Cat 4 failure.
- The results confirm concerns raised by the standard version of the tube test over the response of munitions containing large or medium sized PBXN-5 booster pellets.
- However, they also raise some concerns over munitions containing large or medium sized confined booster pellets of ITEX-07.
- When considering the overall set of results from this range of tube testing it is evident that ITEX-07 is a lower vulnerability booster candidate to PBXN-5.

5 Recommendations

- The reproducibility of the electrically heated tube test needs further examination. Some of the trials at intermediate heating rates need to be repeated i.e. 5 times to establish a better understanding of reproducibility and any possible gas leakage.
- The unique behaviour of ITEX-07, where failures occurred at intermediate heating rates, is not fully understood. Information on the decomposition chemistry kinetics of this formulation should be investigated and used to model its thermal response as pellet size and heating rate are varied.
- For assessing the results from smaller pellets, it is suggested that steel tubes are used throughout with wall thicknesses of 6, 3 and 1.5 mm for the 31.4 mm pellets and 3, 1.5 and 1 mm for the 15 mm pellets.
- The ceramic inserts have performed well and no one ended results have occurred. These should be adopted in the standard heated versions of the tube test.

Acknowledgment

Mr Martin Sloan
Mr Adrian Carp
DOSG UK MOD

Mr Jason Fitzgerald-Smith
Dr Rainer Schirra
DynITEC GmbH

Mr David Mullenger
Mr Stephen Rodrigues
QinetiQ

Any Questions?

.

Contact:

Dr Helmut Zöllner
DynITEC GmbH
Kaiserstrasse 3
D-40670 Troisdorf
Germany
phone: ++49 2241 208 1206
e-mail: helmut.zoellner@dynitec.com