Recommendations
For Shaped Charge Jet, Munitions Test Procedure

Part 2 : Gun Propellant

Dr Frédéric PEUGEOT, March 2003
# Introduction

## Influencing factors

<table>
<thead>
<tr>
<th>Shaped Charge Jet</th>
<th>Propellant Ballistics Properties</th>
<th>Propellant Physical Properties</th>
<th>Propellant Shock Sensitivity</th>
<th>Propellant Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velocity</td>
<td>Impetus</td>
<td>Composition</td>
<td>CJ parameters</td>
<td>Shape</td>
</tr>
<tr>
<td>Diameter</td>
<td>Burn rate</td>
<td>Particle sizes</td>
<td>Hugoniot</td>
<td>Perforations</td>
</tr>
<tr>
<td>Composition</td>
<td>Ignition</td>
<td>Bed loading density %</td>
<td>Critical energy</td>
<td>(number, size, …)</td>
</tr>
<tr>
<td></td>
<td>Temperature</td>
<td>TMD (voidage)</td>
<td>Critical Diameter</td>
<td>Web Size</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Homogeneity</td>
<td></td>
<td>Outer diameter</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Glass transition temp.</td>
<td></td>
<td>Mass</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Binder/Filler interaction</td>
<td></td>
<td>Confinement</td>
</tr>
</tbody>
</table>

GB 19T - 120mm
GB Bp - 120mm
GB Se - 12.7mm

GB 19T - 120mm
GB Bp - 120mm
GB Se - 12.7mm
Shortcomings
Scaling effects

NOL Large Scale Gap test

The greater, the less shock sensitive

Reaction level

The thicker, the more shock sensitive

U shape?
Resolving Shortcomings

Scaling effects

The response is driven by the bed properties

The response is driven by the grains properties

Actual Size
Reaction Mechanisms (1/2)

Macroscale

**AREA 1**
Jet tip / Grains interaction
Mechanism: Shock Detonation Transition

**AREA 2**
Grains / Grains interaction
Mechanism: ?
Area 1 Protocol
Interaction Jet-Grain(s)

Type IV-V

NO

YES

Interaction Jet-Grain(s)

Compressed Propellant

Cavity

Jet

Bow Shock

Confinement

SDT?

NO

Type IV-V

Confinement
Area 1 Protocol
Interaction Jet-Grain(s)

Energy provided by the jet impact
> Formulation Critical energy?

YES

Grains dimensions
> Grains critical dimensions?

YES

NO

Type IV-V
What is the influence of a perforation or several perforations on the critical diameter?

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Formulation Critical Diameter (mm)</th>
<th>Slotted Tube Critical Web (mm)</th>
<th>Slotted Tube Critical Outer Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2.9-4.1</td>
<td>1.7-2.0</td>
<td>4.5-5.3</td>
</tr>
<tr>
<td>B</td>
<td>3.8-4.7</td>
<td>2.5-3.2</td>
<td>8.3-10.7</td>
</tr>
<tr>
<td>C</td>
<td>2.7-3.8</td>
<td>2.1-2.5</td>
<td>7-8.3</td>
</tr>
</tbody>
</table>

But, Debenham obtained a high order response even with a web lower than the critical web....
Reaction Mechanisms (2/2)

Area 2 - Macroscale

WATSON (1992)

X rays

ZIMMERMANN (1996)

X rays

Sympathetic detonation

PEUGEOT (1996)

43.9 µs

49.2 µs
Sympathetic Detonation
Area 2 - Mesoscale Mechanisms

- IDT
- XDT I
- XDT II
Area 2 Protocol
Interaction Grain(s)-Grain(s)

Sympathetic Detonation of the grains?

- Yes → Type I
- No → Type II-III

Propsellant Bed

Area 1

Area 2

Jet

Bow Shock +Cavity
Test conditions

- No jet particulation
- No inverted gradient effect
- No spall
- Longest credible path

Test configuration

- Represent the life cycle configuration

Test instrumentation

- Threat & Reaction level

Testing Recommendations

- Stand off
- X-Ray
- Min attenuator thickness
- Stripper plate
- Representative casing
- Representative shielding
- Representative dimensions
- Sufficient amount of prop.
- No additional Confinement
- Witness plate
Conclusions
The best LOVA propellant

- The lowest Hugoniot
- The highest pressure dependent critical energy curve
- The highest critical diameter

Gun propellant vulnerability to SCJI is driven by 2 mechanisms:
- the sensitivity to shock of the gun propellant
- the mechanical behavior of the gun propellant

- Dimensional characteristics that reduce the risk of Sympathetic Detonation
- The best mechanical properties (XDT issues)
- The lowest bed loading density (opposite to ballistics properties) not to favour SD
Any Questions?

f.peugeot@hq.nato.int