SHAPED CHARGE JET STANAG
Propositions for an updated edition

IMEMG's Expert Working Group on
Hazard Assessment & Classification

Presented by Yves GUENGANT

www.imemg.org

INTRODUCTION

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- European Organisation assembling twenty leading armament groups working with Insensitive Munitions technologies

INTRODUCTION

Express the armament industry's viewpoint with regards to relevant transnational regulations and requirements.

Expert Working Groups:

- Computer Models for IM Performance,
- Cost & Benefit Analysis,
- Effects of Ageing,
- Fast Cook-off Test Procedure,
- Hazard Assessment & Classification.

Hazard Assessment & Classification Expert Working Group to present this analysis

CONTEXT

STANAG 4526 ed2

"SHAPED CHARGE JET – MUNITIONS TEST PROCEDURE"

➔ not a real standardized reference:

- not ratified by all Nations,
- 50 mm Rockeye Shaped Charge not readily available,
- Performance not correctly defined for determination of an equivalent Shaped Charge,
- test set-up not clearly defined (conditioning plate, target nose, ...),
- each test center to use own Shaped Charge and test procedure.

CONTEXT

- *Recent feedback from Afghanistan and Iraq*

➔ Threat Hazard Analysis review :

Standard Shaped Charges design which would be representative of numerous RPG7 types:

- **USA** MIL-STD-2105(D) specifies a standardised LX-14 81mm Shaped Charge.
- **France** has designed CCEB 62,
- **Germany** is developing PG-7 replica;

➢ ***Presentation to introduce industrial experts points-of-view to the IM community.***

➢ ***This paper could feed discussions for the 2014 MSIAC Workshop dedicated to SCJ STANAG.***

CURRENT SITUATION

STANAG 4439 Ed3 & AOP 39 Ed3

- STANAG 4439 ed3
  - Threat : Shaped Charge weapon attack ➔ Requirement: **Type III**,
  - Shaped Charge Jet, Munitions Test Procedure ➔ **STANAG 4526 Ed2.**

STANAG 4439 Ed3 & AOP 39 Ed3

- AOP 39
  - The *Baseline Threat Range*
  - » shaped charge caliber up to 85 mm diameter (AOP39 table 1).
  - For the purpose of IM:
  - » shaped charge to be **"broadly representative of Rocket Propelled Grenades and top attacks bomblets"** (AOP39 annex F)
  - *Test conditions* (AOP39 annex H):
    - » 50mm Rockeye or equivalent v^2d charge,
    - » Use of conditioning plate not defined.

TEST PROCEDURE STANAG

- STANAG 4526 ed2

SHAPED CHARGE JET – MUNITIONS TEST PROCEDURE

» designed for "*determining the degree of reaction of a munition when hit by typical top attack bomblet shaped charge jet*"

» **not ratified** by all NATO nations

» specified charge (50mm Rockeye) not readily available in many countries, therefore **not used** in IMEMG's Nations

TEST PROCEDURE STANAG

- STANAG 4526 (Ed2)

SHAPED CHARGE JET – MUNITION TEST PROCEDURES (cont'd)

» test set-up **not precisely defined** (potential use of conditioning plate)

» **inconsistent values** about 50mm Rockeye (confirmed during MSIAC IM Technology Gaps Workshop - June 2011)

» paper: "*Rocket Propelled Grenade Shaped Charge Initiation Test Configuration for IM Threat Testing*" by Ernest L. Baker and al.

IMPLEMENTATION DIFFICULTIES

- The v^2d values is the link between different shaped charges
  - various shaped charges allowed, if same v^2d
  - values noted in STANAG 4526 Table 1 **much too high** by at least a factor of **> 2**

Threat	Representative V^2D ($mm^3/\mu s^2$)
Top Attack Bomblet	200
SCJ with characteristics of 50mm Rockeye	360
Rocket Propelled Grenade	430
Anti-Tank Guided Missile	800

IMPLEMENTATION DIFFICULTIES

- For example RPG-7
  - typical measured values for the Shaped Charge Jet tip:

    v ~ 7.5 mm/µs and d ~ 3 mm gives a v^2d value of ~ 170 $mm^3/\mu s^2$
  - **different from** 430 $mm^3/\mu s^2$ as noted in the table
  - ➢ 430/170 = 2.5 too large

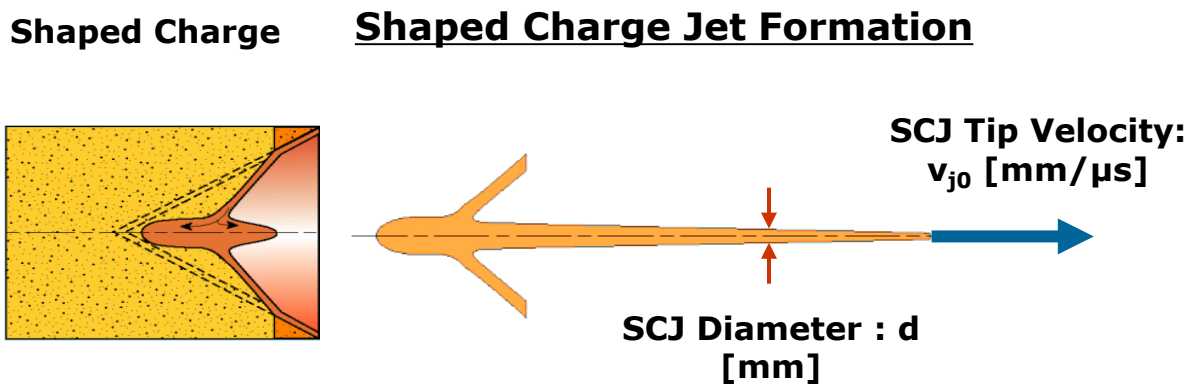
IMPLEMENTATION DIFFICULTIES

- As v^2d is the link between different shaped charges

  » very important to **define exactly** how **v** and **d** should be measured as below;

  » Both numbers **v** and **d** are **not constant but variably** over the Shaped Charge Jet length;

  » the **scattering** within the measurements should be taken into account.



COMPARISON OF IM SIGNATURES

- Conditioning plate often use to :
  - adjust v^2d value according to specific Threat Hazard Analysis,
  - avoid the rear slug effect discrepancies.

» a munition to pass the STANAG 4526 but which is the **real stimulus** ?

- In-service Shaped Charge are equipped with target nose

» i.e. for RPG7, target nose can **reduce significantly** the v^2d with the "same" charge

COMPARISON OF IM SIGNATURES

- *Main parameters to be known*
  - **Shaped Charges**
    - » Diameter from 45 mm to 120 mm,
    - » In-service charge: with or without target nose,
    - » High performance (tapered & fast) jet /// un-optimized and cheap serial charge,
  - **Conditioning plate use,**
  - **Stand-off value,**
  - **Break-up time,**
  - **Penetration capability.**

COMMENTS ON CURRENT CHANGES

NEW THREAT DEFINITION

- Recent feedback from Afghanistan and Iraq led to a Threat Hazard Analysis review

  - » RPG-7 is now the sole considered Shaped Charge Threat,
  - » RPG7-V has been measured at 141 $mm^3/\mu s^2$

  - » Due to lack of RPG-7 reliability across various manufacturers, it is necessary to develop RPG-7 surrogate,

NEW THREAT DEFINITION

Many nations are designing their own RPG-7 surrogate and/or Standardised Shaped Charge

- **USA** : LX-14 81mm Shaped Charge (MIL-STD-2105(D) requirement)
- **France** : CCEB 62
- **Germany** : 75 mm Shaped Charge "PG-7 German replica"

FRANCE

- CCEB 62 » the French Standardized Shaped Charge for IM Signature assessment
  - MoD Instruction N°211893/DEF/DGA/INSP/IPE **July 21, 2011**
  - **STANAG 4526 implemented** with CCEB62
  - **Test Procedure defined** in French Standard: NF T70-511
  - CCEB62 performances characteristics **are available**
  - But these are currently re-checked for new production phase validation

CCEB62 manufectured by NEXTER Munitions

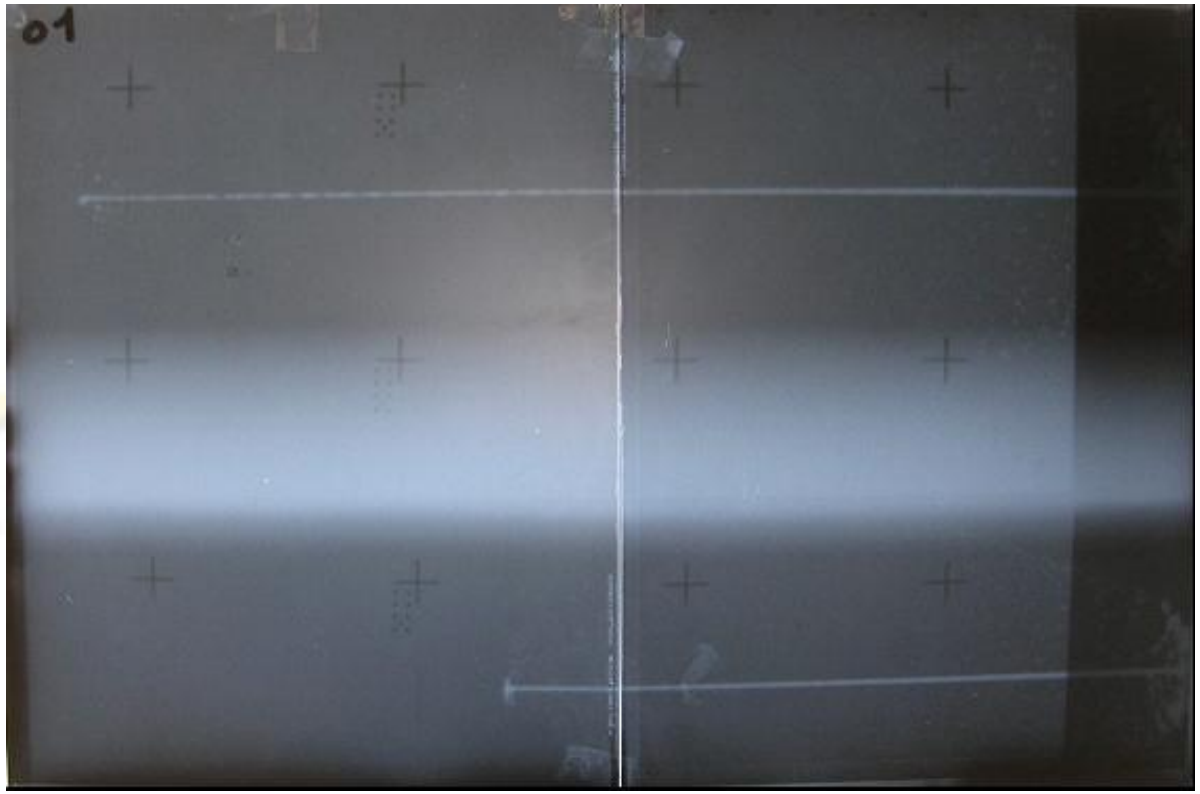
FRANCE

- Conditioning mild steel plates can be used
  - Critical V^2d determination: detonation/no detonation for PBXs characterization
  - Adjust V^2d to specified value (customer requirements)

V^2d ($mm^3/\mu s^2$)	203	103	93	82.5	72	62	41.5	52	31	21
Steel Plate thickness (mm)	0	20	25	40	60	80	110	150	200	280

FRANCE

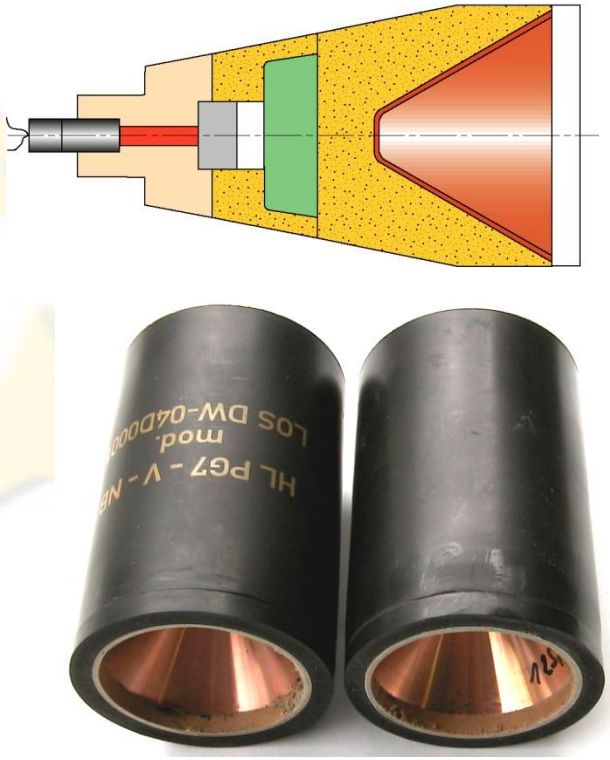
- CCEB 62 : Example of Free Jet X-Ray pictures (at two successive times)
  - Note straightness diameter

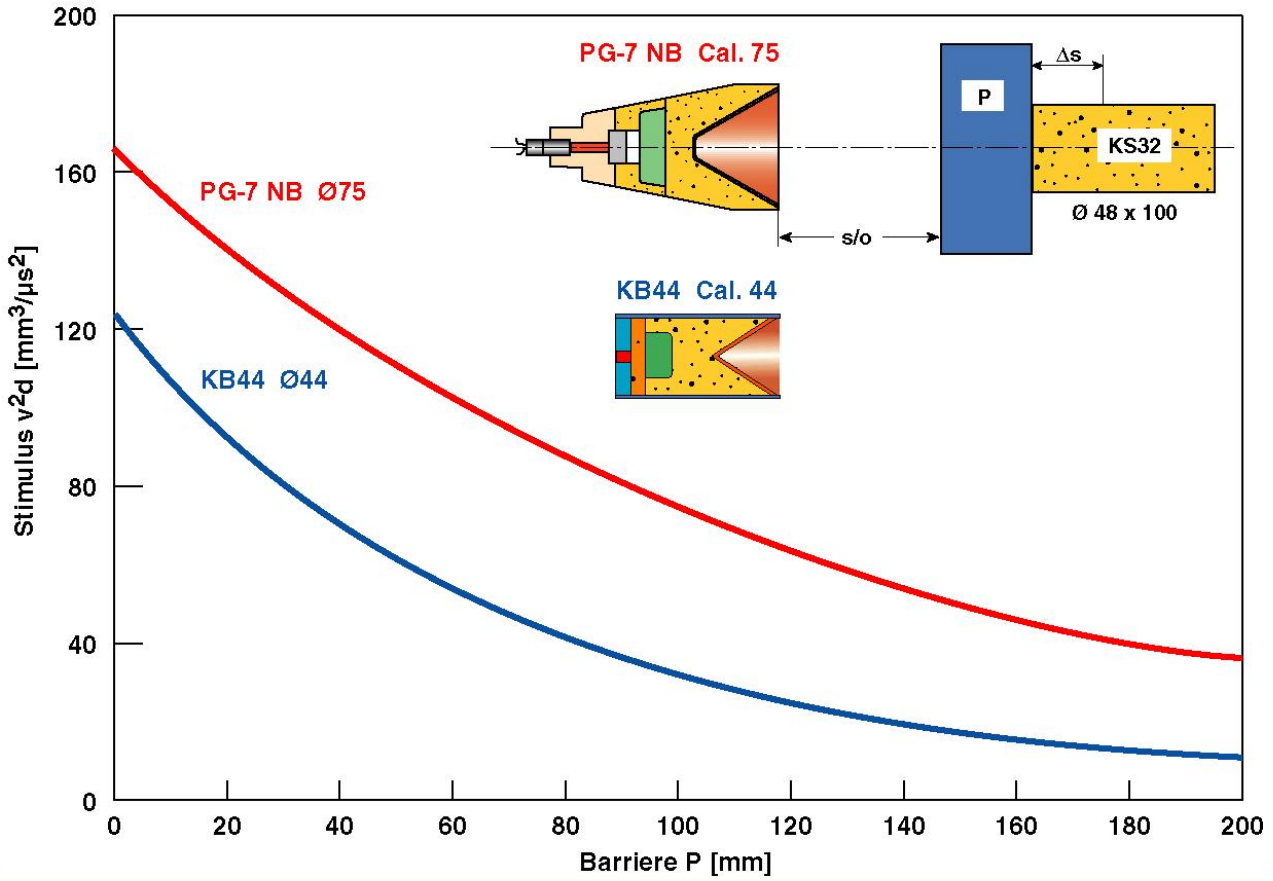


X-Ray picture
by SAFRAN Herakles

GERMANY

- PG-7 replica would become German standard
  - PG-7 replica (75 mm) manufactured by Dynamit Nobel.





USA

- LX-14 81mm appears as US Standard Shaped Charge
  - MIL-STD-2105(D) **requirement**
  - Charge design and performances **are available** (E. L. Baker's Paper)
  - Tests seem to be **always carried out** with a 4" aluminum conditioning block, in that situation
    - » the $v^2d = 141\ mm^3/\mu s^2$,
    - » tolerance about this value **not given**

USA

- LX-14 81mm appears as US Standard Shaped Charge (cont'd)
  - the LX14 explosive charge characteristics are not precisely defined:
    - » **no real guarantee** that various LX14 batches **if** manufactured by different producers will have the same performance,
    - » real performance of each producer would be checked.

IMEMG CONCERNS & COMMENTS

HARMONISATION NEEDS

- **Concerned** by the lack of consistency in various test procedures.
- **Difficult** to compare munitions responses to Shaped Charge Jet attack.
- NATO standards **should be agreed** and practicable with reproducibility by all member countries.
- IMEMG experts intend to **support** current harmonization efforts and wish to highlight the fact that next STANAG 4526 should list a very **limited number of approved** Shaped Charges types and test set-up to each nation.

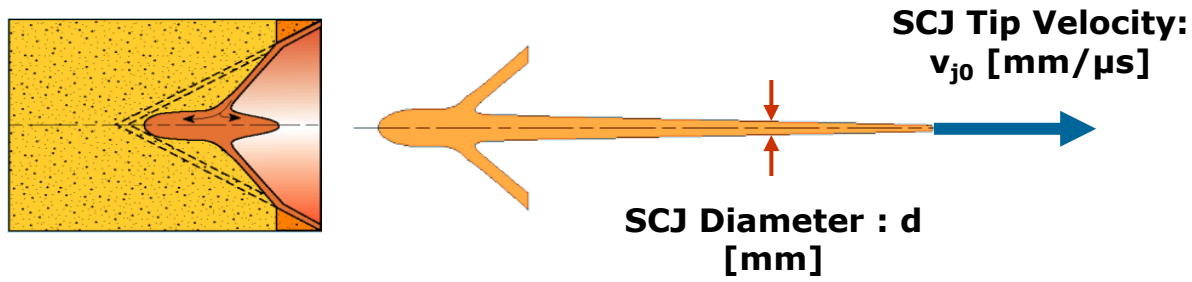
STANDARDIZED SHAPED CHARGES

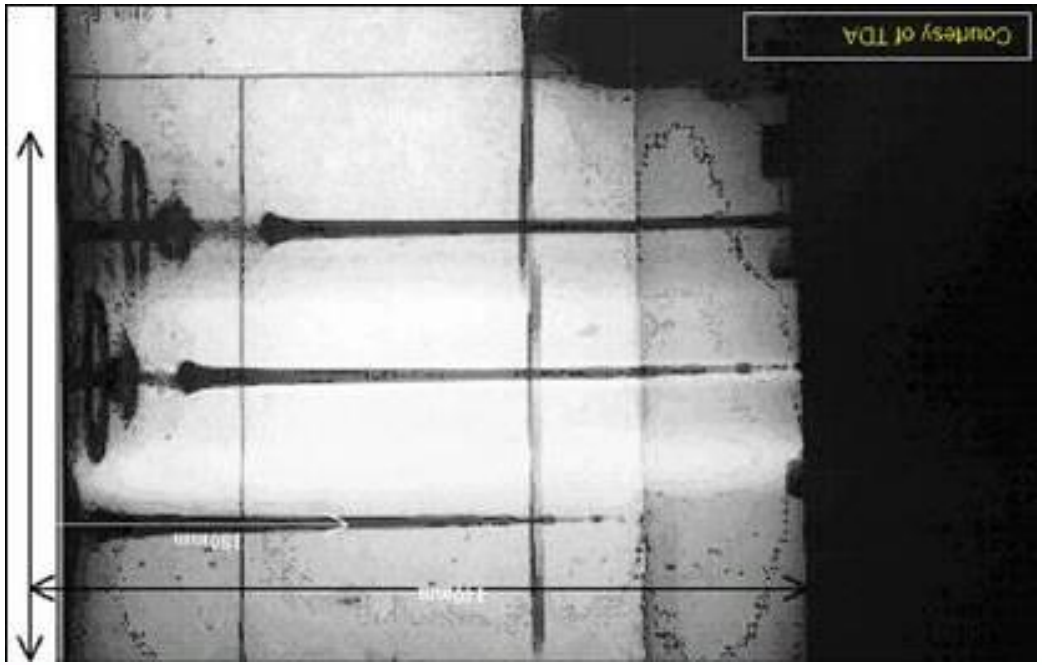
- Shaped charge jet harmonization has really begun, even if charges are different for each nation:
  - LX-14 81 mm, CCEB 62, PG-7 Replica
  - with v^2d that could be closed to 141 $mm^3/\mu s^2$
- Each Shaped Charge referred to should have an **available and comprehensive technical data pack.**

SHAPED CHARGES PERFORMANCES CARACTERISATION

Shaped Charge

Shaped Charge Jet Formation





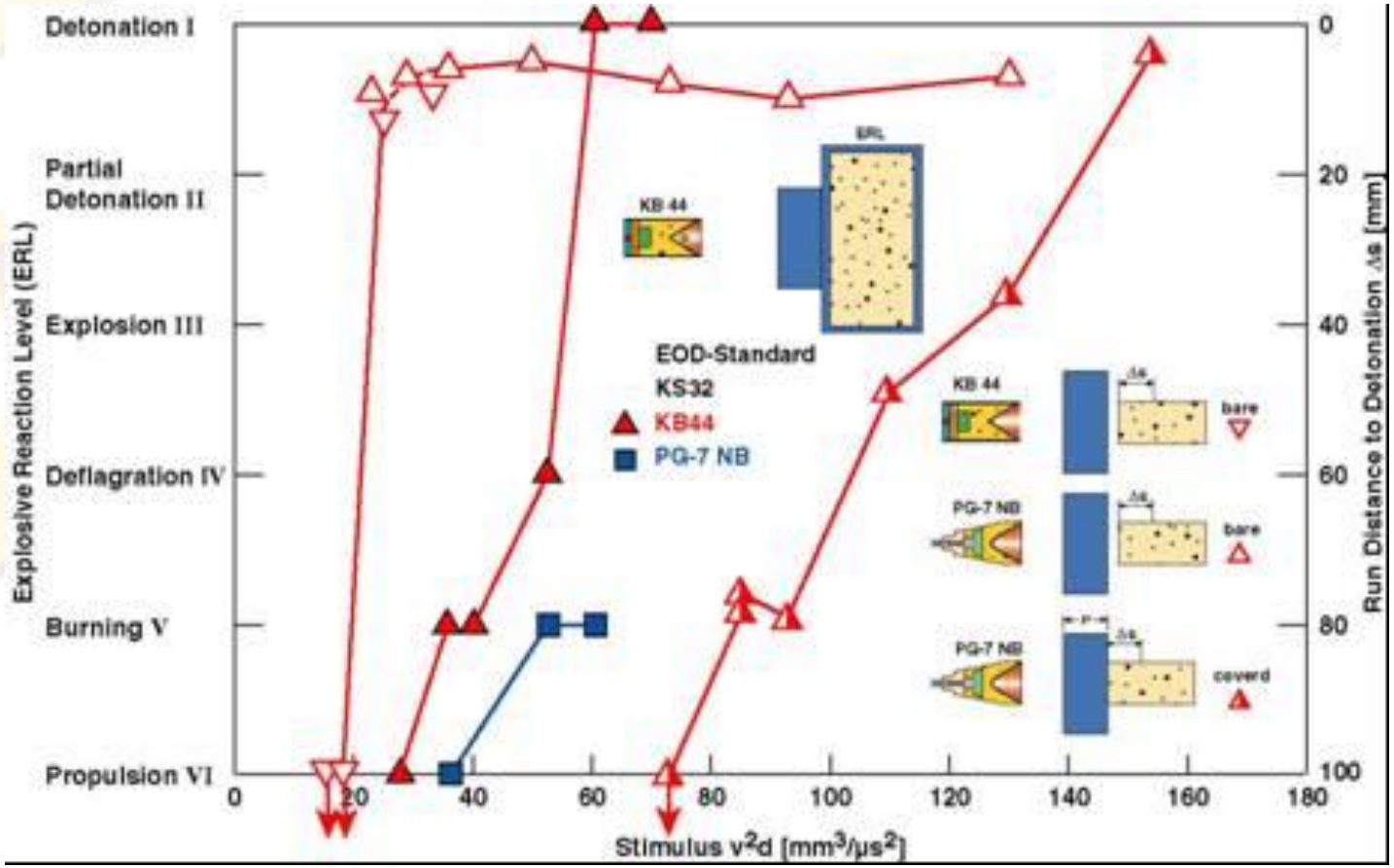
X-Ray picture by TDA Armaments

SHAPED CHARGES PERFORMANCES CARACTERISATION

- Measuring v^2d not easy or trivial :
  - Diameter to be considered
    - » Tip diameter ?
    - » Average diameter between fixed positions ?
  - Velocity to be considered
  - Stand-off value
  - V2d tolerance +/- 10 % ?

STANDARDISED TEST PROCEDURES

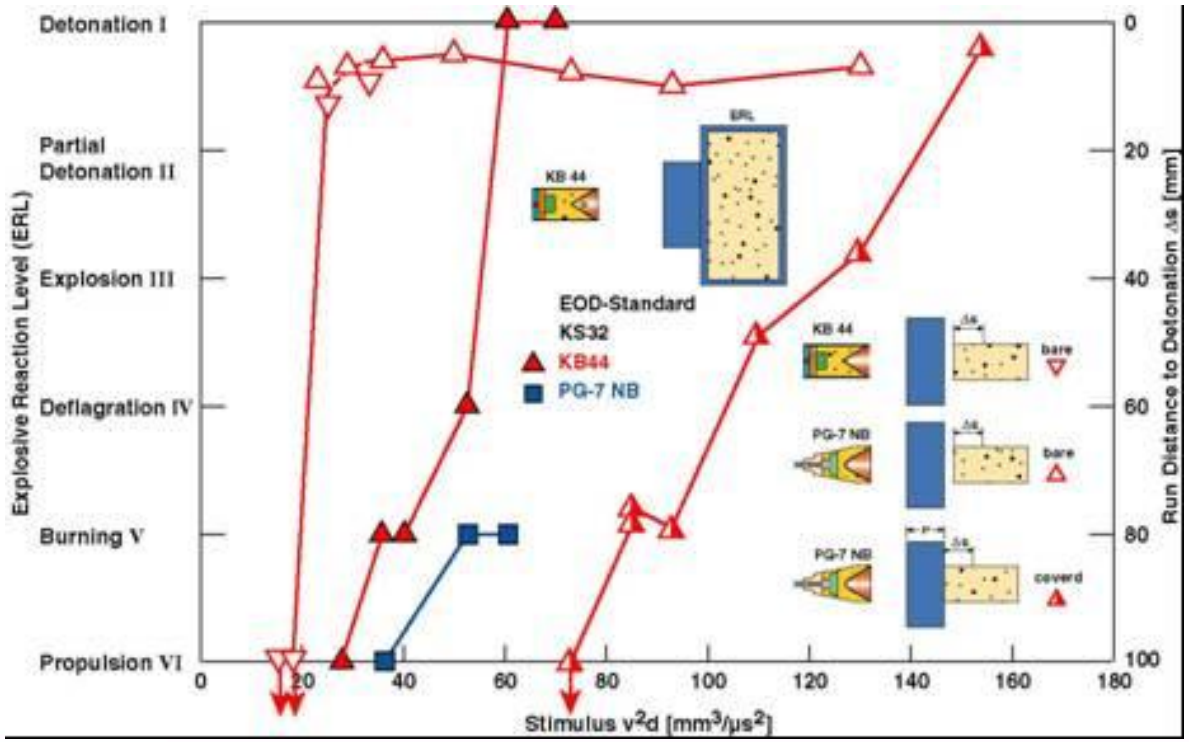
- Test set-up may have a real influence on tested munition response :



Experiments by MBDA-TDW Gmbh

STANDARDISED TEST PROCEDURES

- Same stimulus of v2d around 55 / 60 mm3/µs2
- low order “burning” or "Propulsion" (Explosive Reaction Level ERL = V r VI) is observed if the shoot is done with PG-7 (blue squares),
- full detonation (ERL = I) is observed if the KB44 (red triangles) is used.



Experiments by MBDA-TDW Gmbh

STANDARDISED TEST PROCEDURES

- Similar observations were done on propellants.
- not only v^2d is important for the reaction level but also v and d themselves.
- Future standard STANAG Shaped Charge should not vary too much in caliber.
- Reason why it is necessary to standardize the STANAG shaped charge and also the test set-up in the next STANAG 4526 edition.

- *kind of Round Robin tests should be organized under NATO or MSIAC authority, in order to compare the three described shaped charges against the same target / explosive arrangement.*
- *to prove that there is no bias, depending on a given shaped charge and thus would give more reliability in data comparisons.*

ALTERNATE v^2d VALUE

- v^2d stimulus of 141 $mm^3/\mu s^2$ would be much too high:

  » most charges (including insensitive PBX) would detonate,

  only few EIS would survive (Extremely Insensitive Substance in accordance with UN HD 1.6).

» STANAG to **define different stimuli** according to Life Cycle and Threat Hazard Assessment

If standard procedure is defined with the stimulus:

v^2d is 141 $mm^3/\mu s^2$ then,

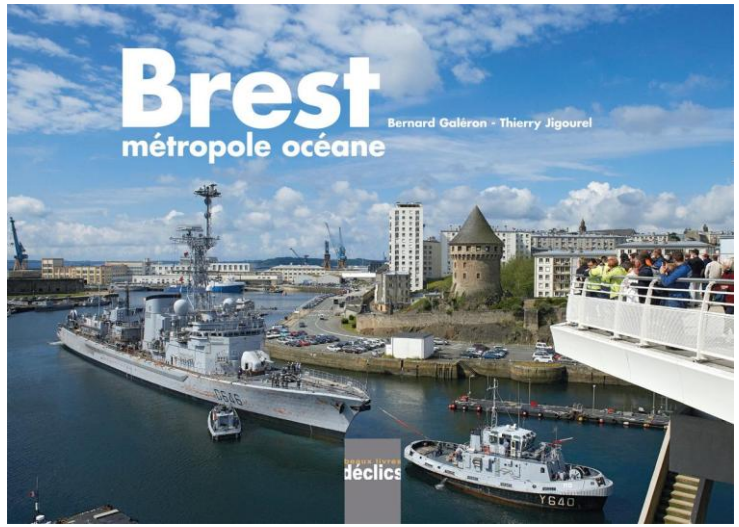
alternative procedure could consider stimulus around 60 to 70 $mm^3/\mu s^2$.

CONCLUSIONS

CONCLUSION

See you in Brest, France,
12-16 May 2014

- MSIAC Workshop !!!



AUTHORS

FRANCE

- CEA – DAM
  Frank DAVID-QUILLOT
- EURENCO
  Yves GUENGANT
- MBDA-F
  Michel VIVES
- NEXTER Munitions
  Frederic NOZERES
- ROXEL
  Raymond COLENO
- TDA Armements
  Carole FOURNIER

GERMANY

- MBDA TDW
  Dr Werner ARNOLD
- RHEINMETALL WM GmbH
  Dr Gerhard HUBRICHT

ITALY

- RWM Italia SpA
  Massimo CASTIGLIA

UK

- AWE Plc.
  Helen FLOWER
- BAE Systems GCSM
  Charles MARSHALL
- CHEMRING ENERGETICS
  John HAND
- MBDA-UK
  Sean RANDALL