

SHAPED CHARGE JET ATTACKS

WHAT SHAPED CHARGE ?

WHICH TEST SET-UP ?

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' viewpoint with regards to relevant transnational regulations and requirements.

Expert Working Groups

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

- **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.

Three large, faded yellow stars are arranged vertically on the left side of the slide.

CURRENT SITUATION

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- **STANAG 4439 & AOP 39**
- **TEST PROCEDURE STANAG**
- **IMPLEMENTATION DIFFICULTIES**
- **FEED-BACK FROM FRANCE**
- **FEED-BACK FROM GERMANY**
- **FEED-BACK FROM UNITED KINGDOM**
- **COMPARISON OF IM SIGNATURES**

STANAG 4439 Ed3 & AOP 39 Ed3

- **STANAG 4439**

- 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 V²d 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 Rocketeye (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 (to come) **much too high** by at least a factor of **> 2**

IMPLEMENTATION DIFFICULTIES

- For example RPG-7

- typical measured values for the Shaped Charge Jet tip:

- $V \sim 7.5 \text{ mm}/\mu\text{s}$ and $d \sim 3 \text{ mm}$ gives a V^2d value of $\sim 170 \text{ mm}^3/\mu\text{s}^2$**

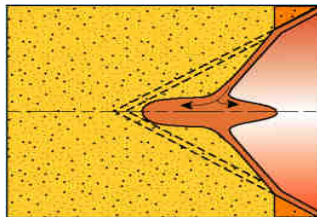
- **different from $430 \text{ mm}^3/\mu\text{s}^2$ as noted in the table (i.e. $430/170 = 2.5$ too large)**

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

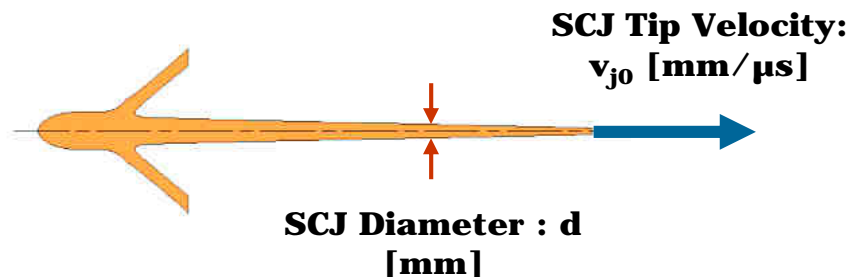
IMPLEMENTATION DIFFICULTIES

- 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.

Shaped Charge

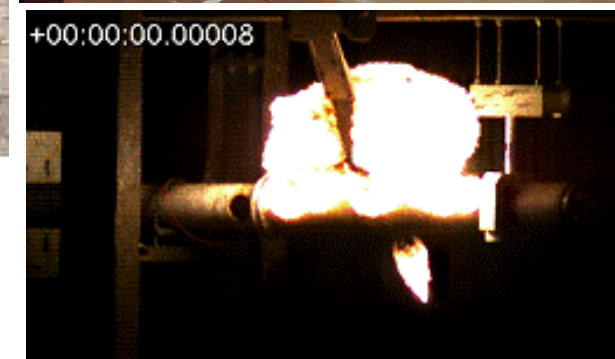


Shaped Charge Jet Formation



FEED-BACK FRANCE

- French test centers to use different Shaped Charges:
 - MILAN K115, MILAN 2, ACL 89 (mm), PG-7, CCEB 62 (mm),...
 - Test conditions vary: target nose, stand-off, conditioning plate...



**ACL 89
with target nose**

**45 mm
Bomblet**

**CCEB 62
with conditioning plate**

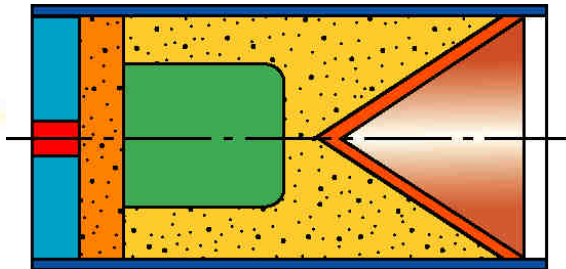
RPG-7

RPG-7

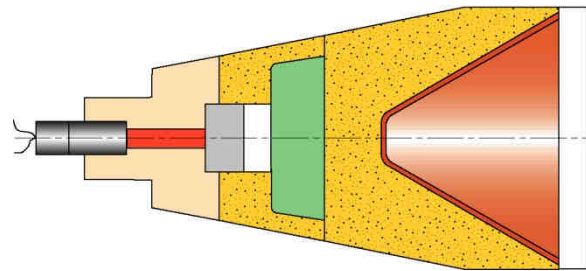
FEED-BACK GERMANY

- Some Shaped Charges:
 - DM1244 (44 mm diameter)
 - PG-7 replica (75 mm)

Bomblet
Caliber 44 mm



PG-7 Replica
Caliber 75 mm



- **Shaped Charges used:**
 - **IBL 755 (50 mm diameter),**
 - **MLRS Bomblet : M42 (34 mm diameter),**
 - **Standard DERA Fort Halstead K4 (63.5 mm diameter).**
- **EMTAP test method define K4 Shaped Charge:**
 - **Conditioning plate can be used.**

FEED-BACK UK

- **The SCJ test is only carried out**
 - » when required by Threat Hazard Assessment of the relevant environments for the munition,
 - » However frequently used for assessing the IM response for Large Calibre Gun Propellant Charges,
 - » **Validity considered by IMAP (IM Assessment Panel),**
IMAP also review the testing conducted.

COMPARISON OF IM SIGNATURES

- Difficult to understand when listed in a table with colors-coded boxes (AOP39 Ed3)

	FH	SH	BI	FI	SR	SCJI
Configuration 1	V		NR	IV	N/A	III

Colour Coding	IM Compliance					
Green	IM requirement fulfilled.		Pass (P)	N/A	N/A	I
Yellow	IM requirement not fulfilled. One response level difference between the assessed response level and the IM requirement		Fail (F)	V Main Charge	P	F
Red	IM requirement not fulfilled. Two and plus response levels difference between the assessed response level and the IM requirement			III Booster		
White	Not Assessed (N/A)		Not Assessed	N/A	N/A	(P)

				7.62 Ball		
	Full-up Round	(I)	V	IV	III	P

COMPARISON OF IM SIGNATURES

- Difficult to understand when listed in a table with colors-coded boxes (AOP39 Ed3)

Colour Coding	
Green	IM r
Yellow	IM rec One response level differenc th
Red	IM rec Two and plus response level: level a
White	Nc

		FH	SH	BI	FI	SR	SCJI
Configuration 1		V		NR	IV	N/A	III
Configuration 2		III		IV	N/A	N/A	I
Configu- ration 3	Warhead	(I)	N/A	NR	V Main Charge III Booster	P	F
	Propulsion Unit	IV	V	V 0.50 AP	N/A	N/A	(P)
				IV 7.62 Ball			
Full-up Round	(I)	V	IV	III	P	F	

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**

FUTURE CHANGES

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COMMENTS...

- **NEW TRENDS IN THREAT DEFINITION**
- **FRANCE**
- **GERMANY**
- **USA**

NEW TRENDS IN 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 $141 \text{ mm}^3/\mu\text{s}^2$
 - » Due to lack of RPG-7 reliability across various manufacturers, it is necessary to develop RPG-7 surrogate,

.../...

NEW TRENDS IN THREAT DEFINITION

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

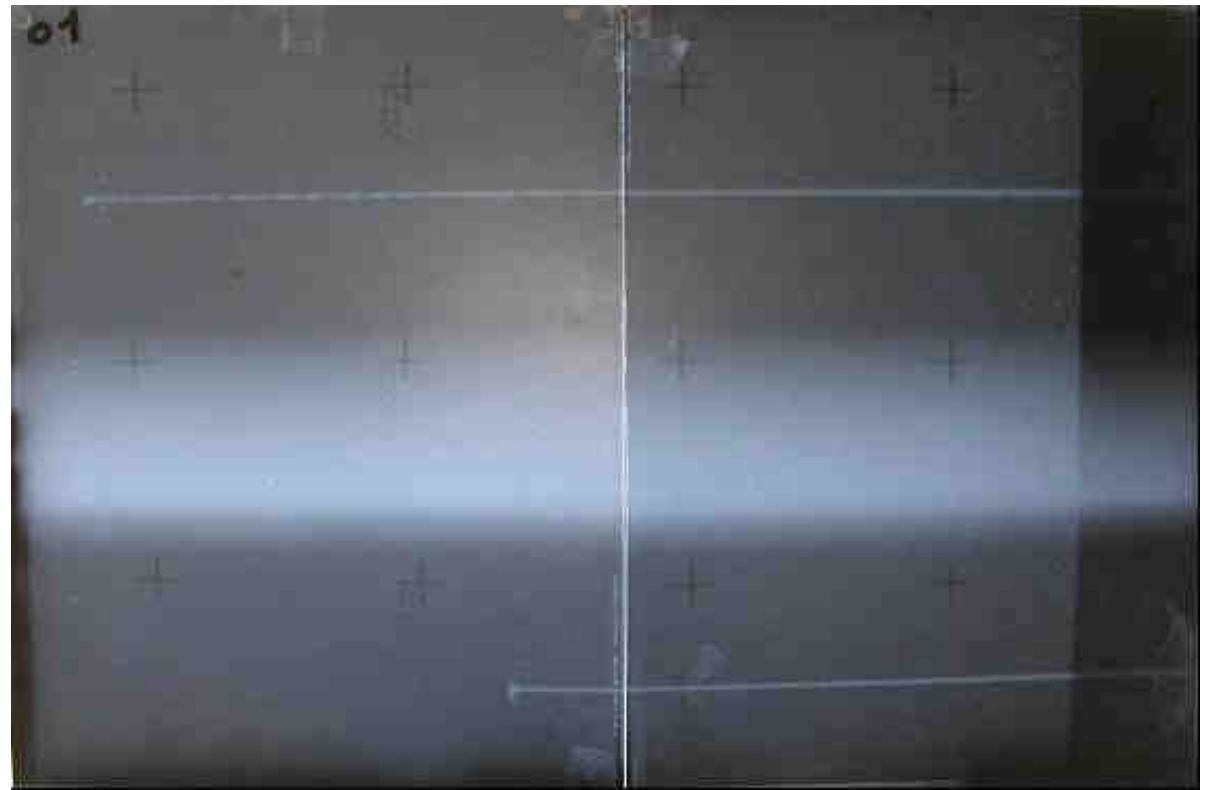
- **CCEB 62 » the French Standardized Shaped Charge for IM Signature assessment**
 - **MoD Instruction N° 211893/DEF/DGA/INSP/IPE July 21, 2011**
 - **STANAG 4526 implemented with CCEB62**
 - **Test Procedure defined in French Standard: NF T70-511**
 - **CCEB62 performances characteristics (i.e. V^2d) are available**
- **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 ($\text{mm}^3/\mu\text{s}^2$)	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

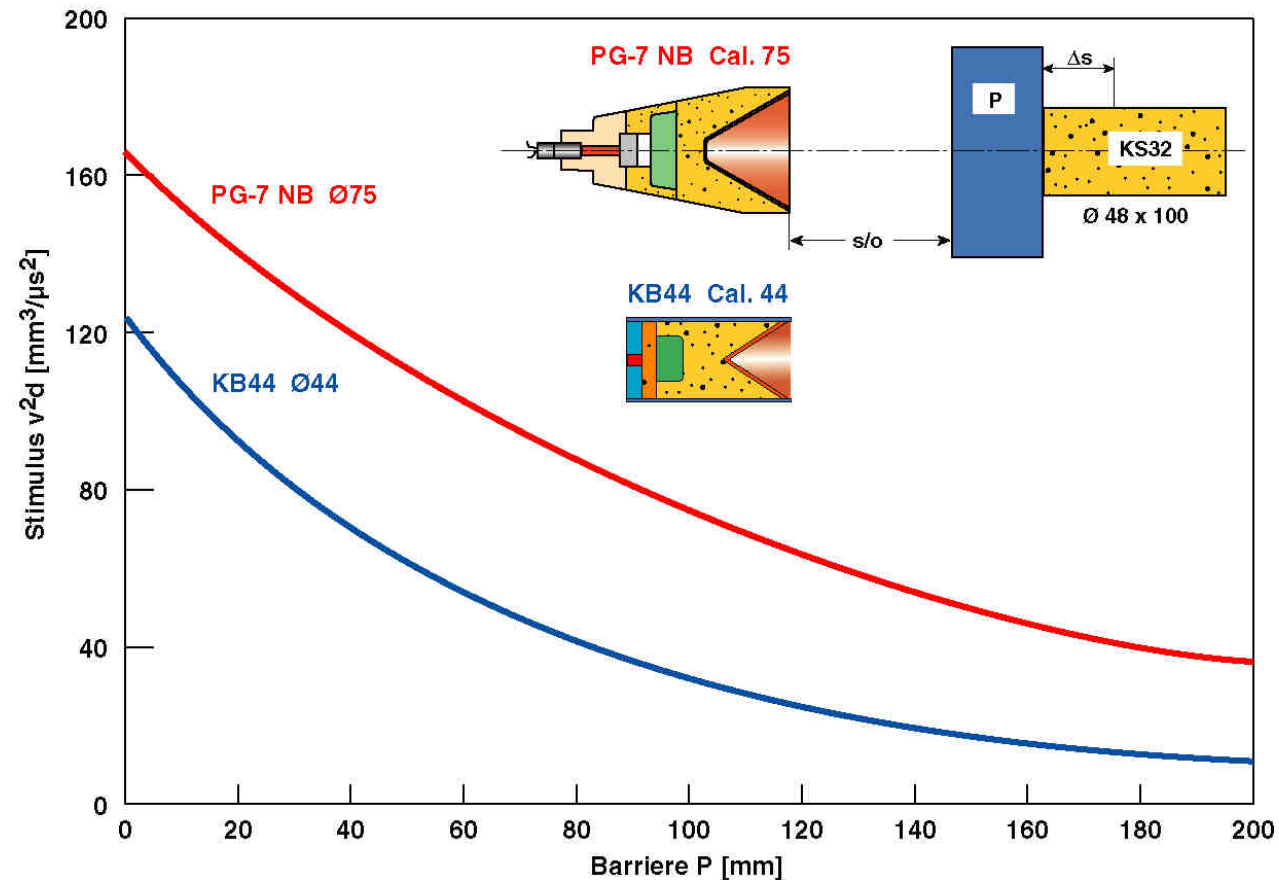
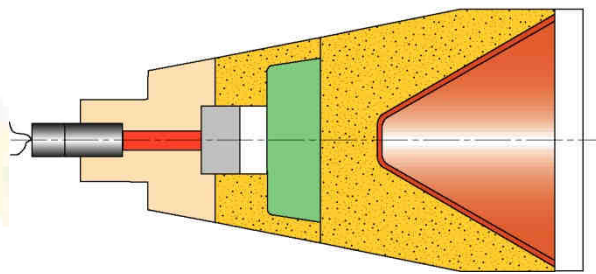
- **CCEB 62 : Example of Free Jet X-Ray pictures (at two successive times)**
 - **Note straightness diameter**



**CCEB62 manufactured
by NEXTER Munitions**



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



- **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 $V^2d = 141 \text{ mm}^3/\mu\text{s}^2$,**
 - » **tolerance about this value not given**

- **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 manufactured by different producers will have the same performance
 - » **real performance would be checked**



IMEMG CONCERNS & COMMENTS

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- **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.

IMEMG CONCERNS & COMMENTS

- 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 $141 \text{ mm}^3/\mu\text{s}^2$
- Each Shaped Charge referred to should have an **available and comprehensive technical data pack.**

IMEMG CONCERNS & COMMENTS

B U T ...

IMEMG CONCERNS & COMMENTS

- **V^2d is not the sole parameter for munition response:**
 - same stimulus of V^2d can outcome Type I and Type V on the same tested item
 - » future standard STANAG Shaped Charges **should not vary** too much in caliber,
- **V^2d level tolerance would be specified**
 - » that means $\pm 10\%$ or $\pm 14 \text{ mm}^3/\mu\text{s}^2$
(for the standard value $141 \text{ mm}^3/\mu\text{s}^2$)

IMEMG CONCERNS & COMMENTS

- **V2d stimulus of $141 \text{ mm}^3/\mu\text{s}^2$ 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:
V2d is $141 \text{ mm}^3/\mu\text{s}^2$ then,
alternative procedure could consider stimulus around 60 to $70 \text{ mm}^3/\mu\text{s}^2$.*

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