EURENCO France

SYMPATHETIC DETONATION TESTS WITH CONCEPTS OF UNITARY WARHEADS FOR A ROCKET SYSTEM

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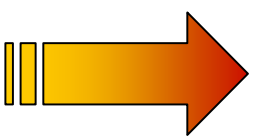
CONTENTS

OBJECTIVE

- Modern munitions/warheads are designed according to IM Standards
- Performances and costs must fulfill specific program requirements
- Development phase has to be as short as possible



→ *Necessity to adapt existing concepts and materials*
→ *Simple methods are required*

Increasing performances while preserving the IMness

METHODOLOGY

Framework : *Preliminary study for the development of a new generation of explosive payload (rocket launch system)*

The idea : *to develop a synergy with :*

- the use of insensitive grains (NTO, …) in Plastic Bonded Explosives (PBXs)

- an adapted payload concept (dual composition architecture and Pre Determined Fragmented envelop (PDF)

The Work :

- Evaluation of the performances (velocity, fragment)

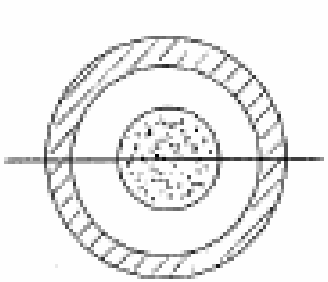
- Assesment of the vulnerability response (Sympathetic detonation test)

Other vulnerability tests : calculation responses (internal database, existing experimental results,…)

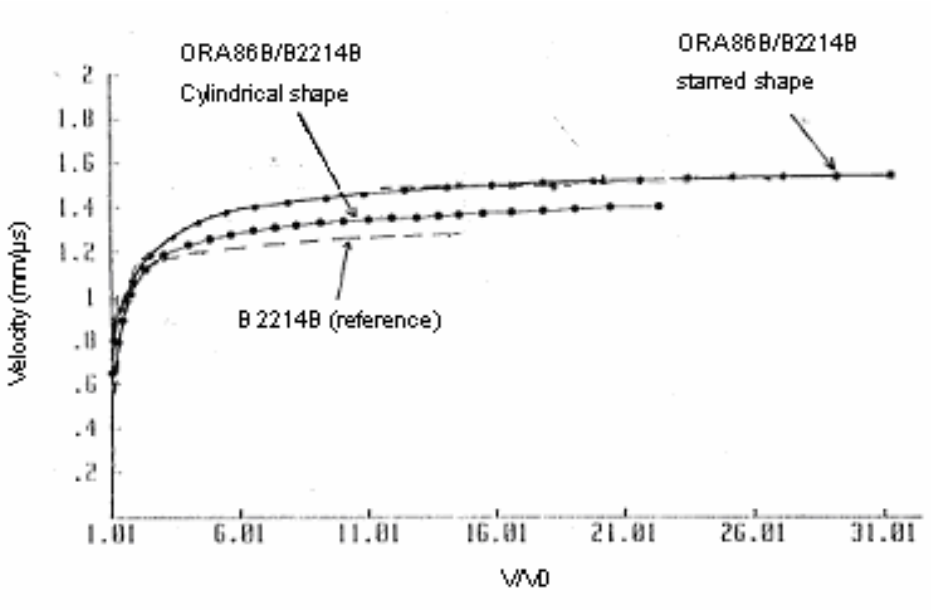
DUAL CHARGE FORMULATION (EURENCO PATENTS)

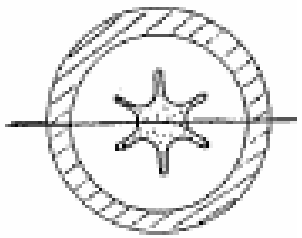
Inner formulation : HMX

Outer formulation : NTO

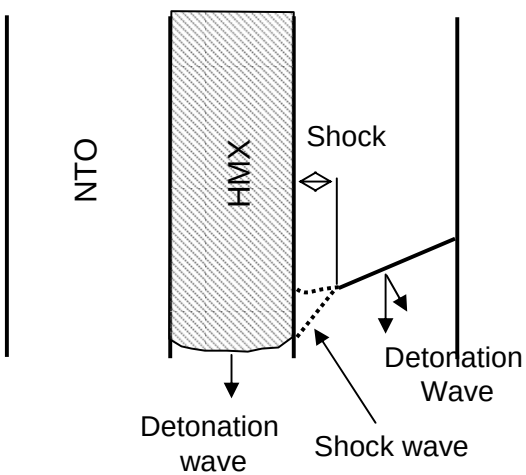


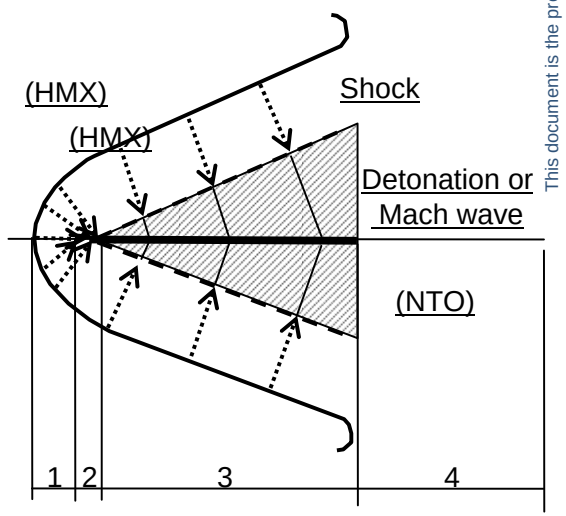
CYLINDRICAL DUAL CHARGE





STARRED DUAL CHARGE

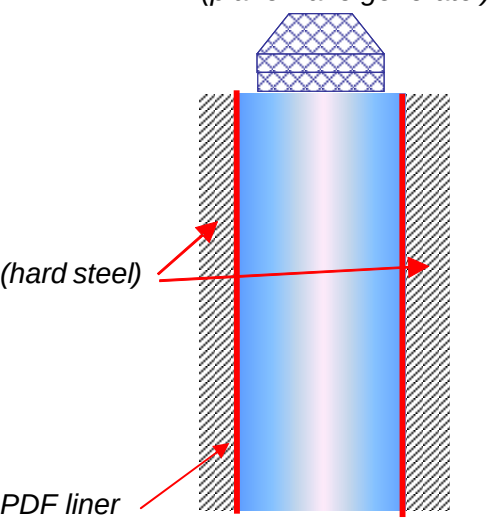


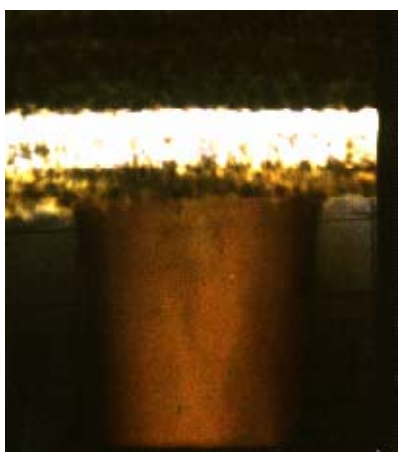


PRE DETERMINED FRAGMENTATION ENVELOP

Several functions :

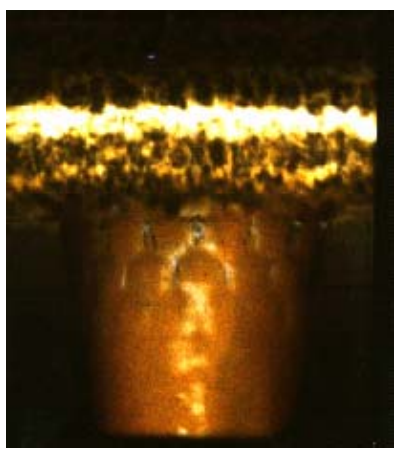
- Protection against friction (HE/casing)
- Thermal insulation
- Controlled fragmentation without degrading mechanical properties of the casing
- Internal drain of decomposition gases





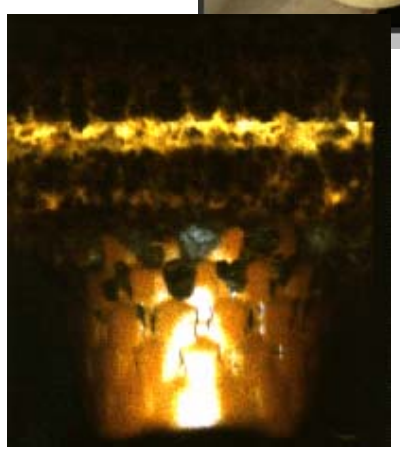
Casing Expansion

17,5 µs



Fragments shaping

30 µs



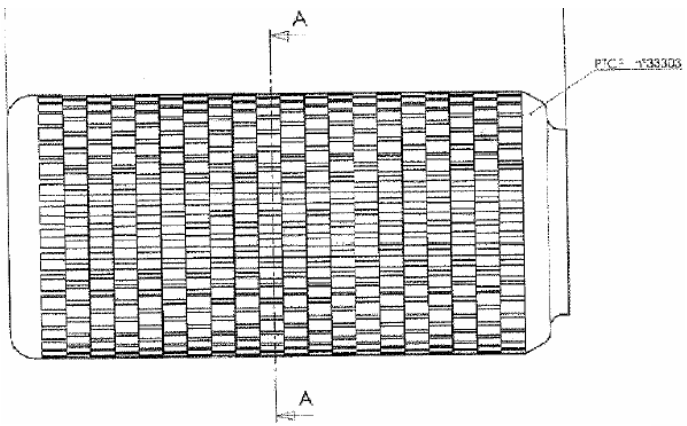
longitudinal fractures and leakage of Detonation products

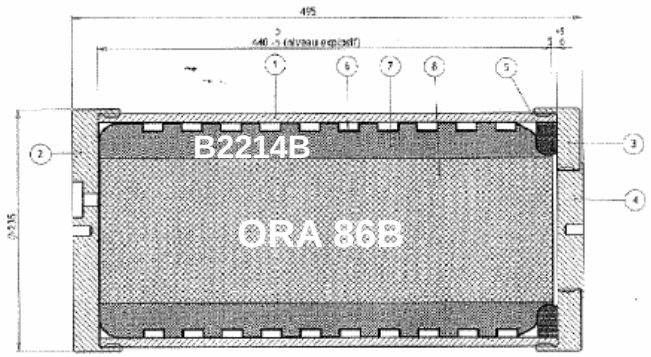
42,5 µs

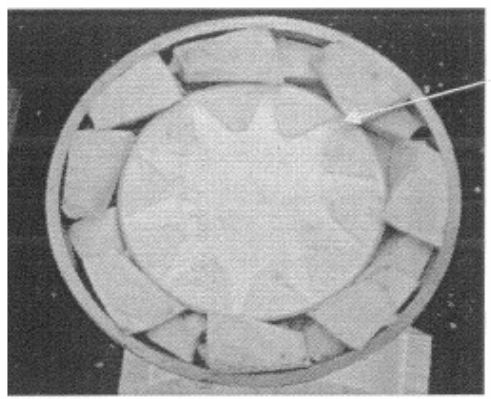
PROTOTYPE PRESENTATION

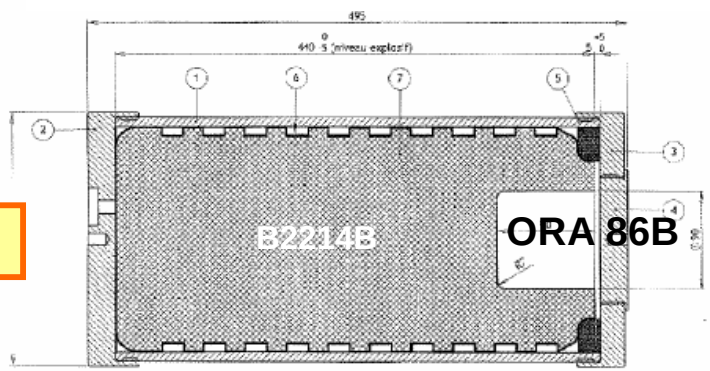
- Casing : steel tube Øext. 226 mm, length 445 mm, thickness 8 mm

- Total payload mass ≈ 22 kg







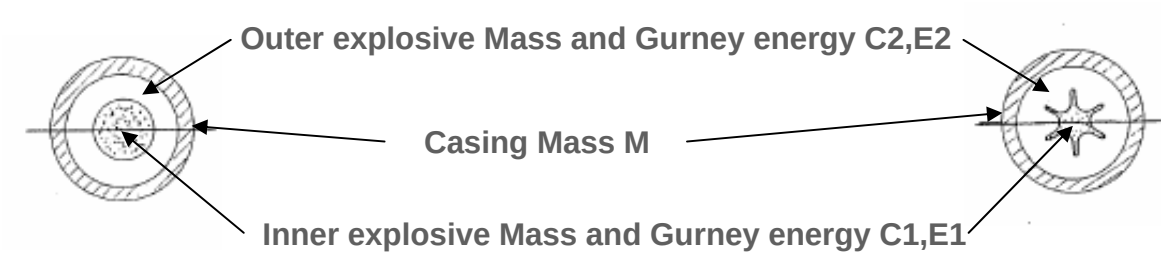


B2214B (HMX/NTO/HTPB 12/72/16)

ORA 86B (HMX/PU 86/14)

PERFORMANCE TEST ASSESSMENTS

Extented Gurney model for dual charge architectures



- Total Mass M12 = M+(1-λ)C2
- Efficient explosive mass C12 = C1+λC2
- Dual composition Gurney energy E12 = (C1E1+λC2E2)/C12

Envelop velocity: $V_{12} = \sqrt{2E_{12}} \cdot f\left(\frac{M_{12}}{C_{12}}\right)$

λ Fitted on cylinder tests

Diameter effect: $\frac{V}{V_0} = 1.0146 + 2.4351 * \frac{R - R_o}{R_o} + 0.99645 * \left(\frac{R - R_o}{R_o}\right)^2$

	Reference	Cylindrical dual charge	Starred dual charge
Fragment velocity (m/s)	1770	1865 (+5%)	2037 (+15%)

PERFORMANCE TEST CONFIGURATION

Performed on reference and starred dual charges

Fragment velocity determination

(high speed camera and shock sensors)

Fragments collector

Efficiency assesment (steel plates)

PERFORMANCE TEST RESULTS

Fragment velocity

Shot	Prototype	Velocity by high speed camera (m/s)	Analytical calculations (m/s)
N°1	Reference B2214B	1540	1770
N°2	Starred dual composition	1750	2037

different absolute values but
Same relative gap 14 / 15%

Collected fragments

Total	Reference	Starred dual composition
Mass (g)	3810	3905
Number = 0.2 g	849	885
Number = 1 g	231	230

Efficiency

Plate N°	Reference	Starred dual composition
	Number of open holes	Number of open holes
1	21	20
2	20	22
3	21	25
4	25	23
5	20	24
6	25	25
7	16	21
TOTAL	**148**	**160**

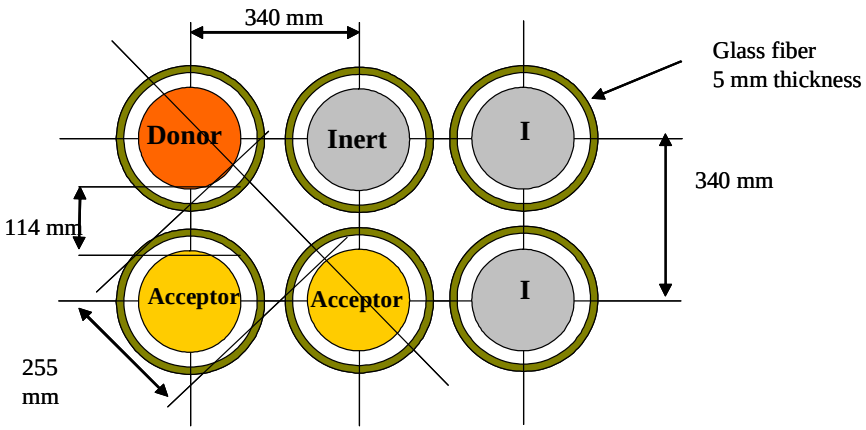
+ 8%

Cylindrical dual composition (analytical assessment) :
+ 5% on fragments velocity

Starred dual composition (Experimental/analytical) :
+ 14% on fragments velocity
+ 8% on efficiency
Equal for collected fragments (PDF liner)

SYMPATHETIC DETONATION TEST ASSESSMENTS

Logisitc pallet configuration



Assumptions for analytical calculations:

- Unitary Fragment agression
- Glass fiber screen negligible
- Fragments mean mass and mean surface are defined (PDF)
- Detonation criterion based on Card Gap Test results:
  ELSGT-1 Ø 75mm B2214B : 105 kBar
  ISGT Ø 40mm ORA86B : 53kBar

- Critical diameter dimensions are taken into account
- Pressure attenuation in the outer explosive : Green formula

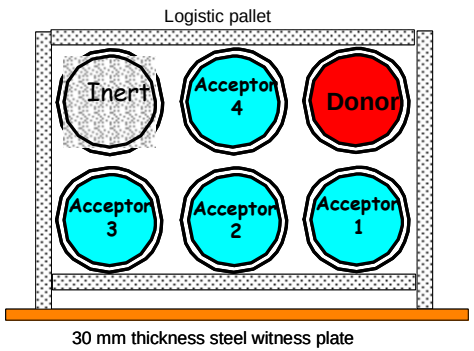
Prototype	*Impact velocity (m/s)*	*B2214B Pressure (kBar)*	*ORA86B Pressure (kBar)*
Reference	*1770*	*98*	*41*
Cylindrical dual	*1865*	*107*	*44*
Starred dual	*2037*	*122*	*49*

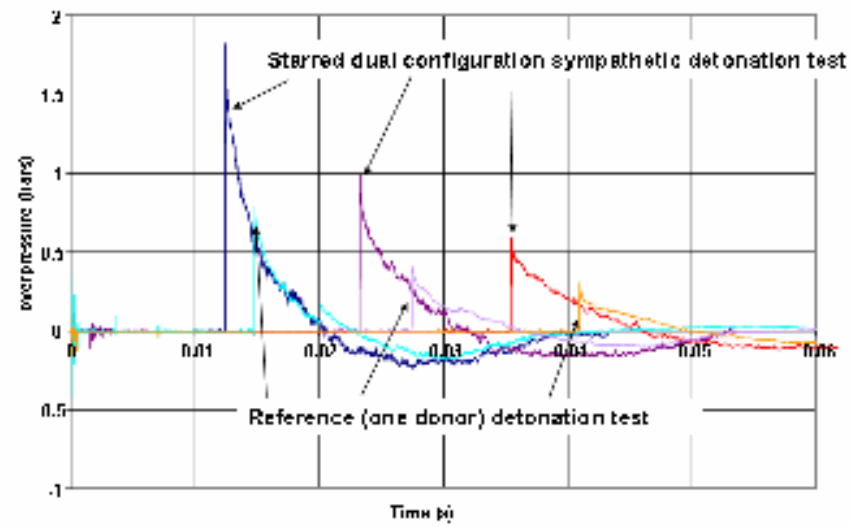
CRITICAL DIAMETER > FRAGMENT DIAMETER:
NO DETONATION

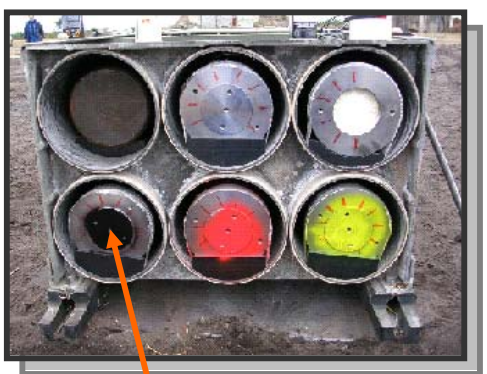
DETONATION HAZARD CAN NOT BE AVOIDED
(STARRED CONFIGURATION)

SYMPATHETIC DETONATION TEST RESULTS

Shot n°1 : Starred dual composition architecture





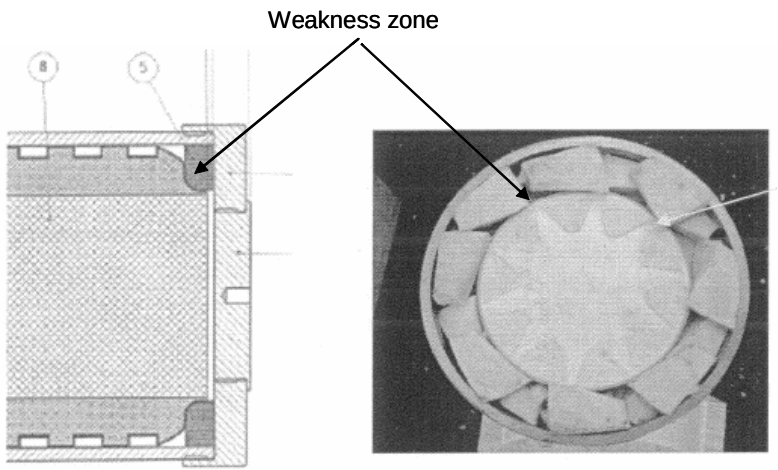


First acceptor to detonate

DETONATION

ASSUMPTIONS

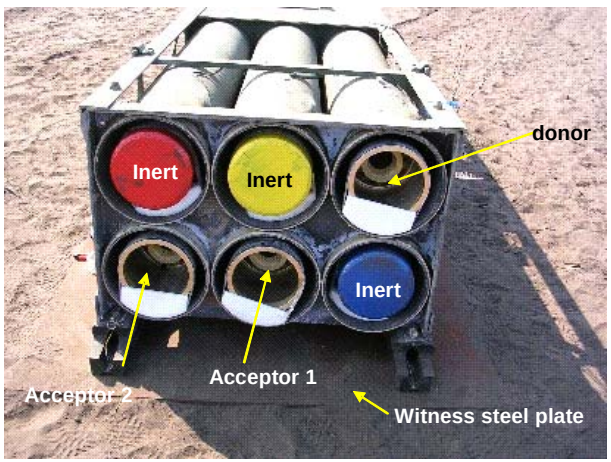
- High fragments velocity
- ORA86B pressure underestimated
- Prototype non representative:
  Presence of a weakness zone

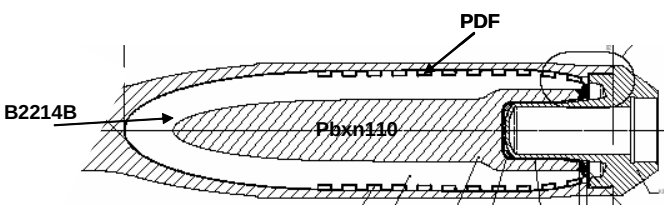


SYMPATHETIC DETONATION TEST RESULTS

Shot n°2 : Cylindrical dual composition architecture

Logistic pallet





Differences with shot n°1 :

- More representative : real warhead
- Approximately the same geometries and mass
- Inner explosive PBXN110 (88% HMX / 12% HTPB) (sligtly more shock sensitive)
- Pallet arrangement

NO DETONATION
TYPE III

Total recovery of acceptor n°2

Witness plate + one inert

Partial recovery of acceptor n°1

CONCLUSIONS

This preliminary study allows us :

- To define a new architecture concept which an increase efficiency : dual charge composition + PFD liner

- To keep a low vulnerability level (type III sympathetic detonation test) for the cylindrical dual charge

Explosive formulations match
other IM requirements for the STANAG 4439

READY TO BE INTEGRATED IN A DEVELOPMENT PHASE

Development and use of simple analytical methods and tools

POSSIBLE IMPROVEMENT:

Sympathetic detonation test with the performing starred configuration
To be tested in a real warhead

THANK YOU FOR YOUR ATTENTION