XP®: A cost effective approach for medium calibre insensitive munitions

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C. Coulouarn, R. Boulanger, D. Bouchaud

NEXTER Munitions
Etablissement de Bourges
7, route de Guerry
18023 Bourges cedex
c.coulouarn@nexter-group.fr

GROUPE NEXTER

nexter MUNITIONS

Contents

- Context of the study and objectives
- Low vulnerability and energetic material formulations
  - Hazard characterizations
  - Detonic performances
- Industrial transfers
- IM tests
- Dynamic and static firings
- Summary and conclusions

Context of the study (1)

Objectives of this study

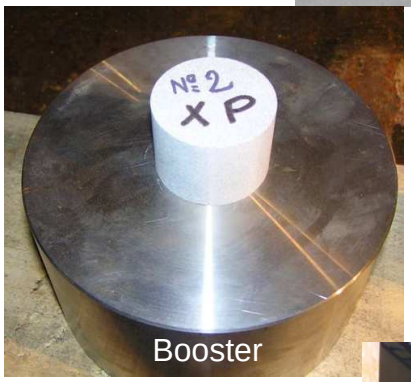
- To develop an explosive composition
  - Pressable at room temperature
  - Best cost-effectiveness

- To meet required performances
  - Explosive composition compatible with wide range of munitions:
    - Medium calibre, warhead, booster,...
  - Compliant with the STANAG 4439 with respect to the munitions

Context of the study (2)

- **Applications**
  - **DGA project: Anti Aircraft Warhead**

  - **Booster applications**

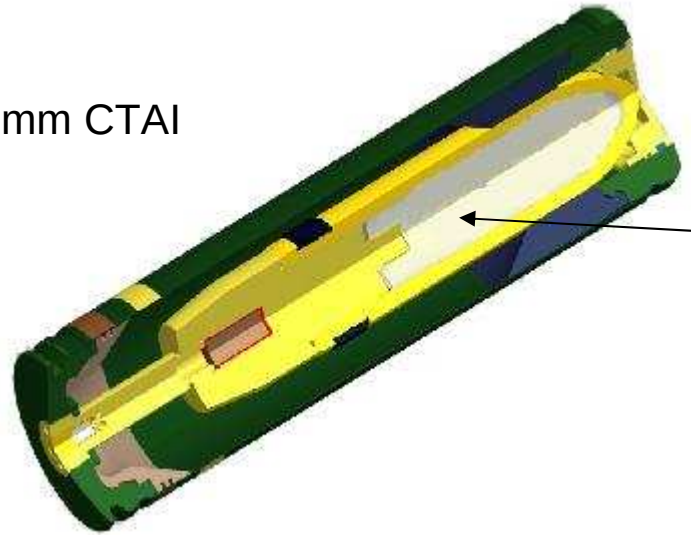


  - **Medium calibre applications**
    - **25 x137 HEI Airburst**
    - **30 x113 Supersafe**
    - **40 CTA: GPR-PD and GPR-AB**

Case study: CTAI cased telescoped ammunition

- **40 mm ammunition developed by CTAI**
  - **CTAI JV is dedicated to developing and promoting the 40 mm Cased Telescoped Armament System.**
  - **Development of the GPR round: NEXTER munitions in charge of explosive filling**

40 mm CTAI



Explosive composition

NEXTER Munitions' responsibility

Low vulnerability explosive composition approach

Objectives: explosive composition intended for medium calibre ammunition

State of the art existing explosive compositions

<u>No explosive</u> composition with :

- ✓ High production capability
- ✓ Uniaxial compression at room temperature
- ✓ Cost objectives
- ✓ IM requirements

new vulnerability composition development

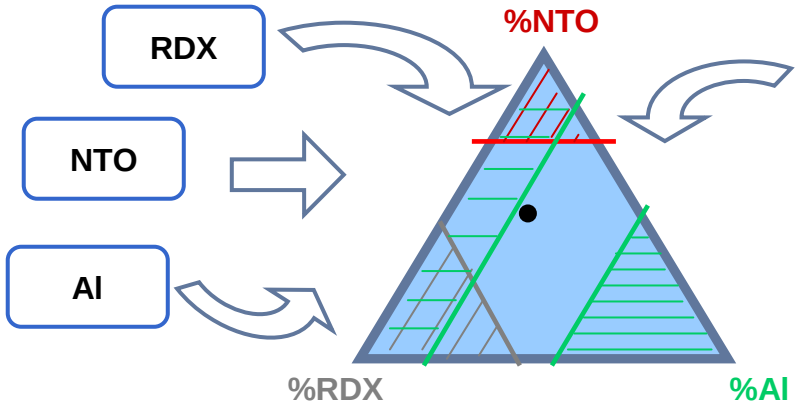
Targeted performances

	Detonics Properties				Mechanical properties	
Targeted performances	Density ρ	VoD	Unconfined Critical diameter	Gap Test LSGT	Stress max	Young's Modulus
	> 1.8 $g.cm^{-3}$	> 7800 $m.s^{-1}$	< 10 mm	Between 200 and 275 cards	< 10 MPa	< 2000 MPa

Energetic material formulation

- NTO/RDX based compositions
  - Developed and optimized with the help of experimental designs
  - Compromise between NTO/RDX/Aluminium: optimal conditions

Laboratory scale



Using calculation tools
- VOD
- Density & CJ pressure
- Sensitivity criterion

Experimental tests
- initiation tests
- VOD

1 composition

Safety characterization, detonic performances evaluation

Energetic material characterization

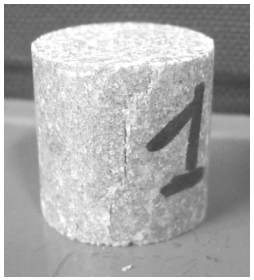
Hazards characterization: basic safety tests

	50% Go results	AFNOR standard
Friction sensitivity	0% at 353 N	NF T 70 503
Electrostatic discharges	367 mJ	NF T 70 539
Impact sensitivity	30% at 50 J	NF T 70 500

↳ Low sensitivity to basic stimuli

Mechanical properties evaluation

XP3264®

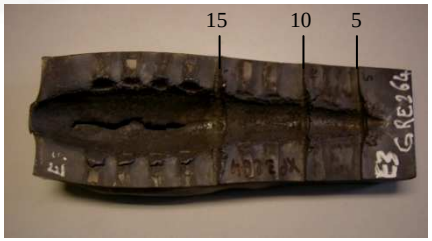


	Mechanical properties	
XP3264® at 20°C	Stress max	Young's Modulus
	9,8 MPa	607 MPa

Energetic material characterization

Detonation velocity and unconfined critical diameter

> 7900 m.s^{-1}



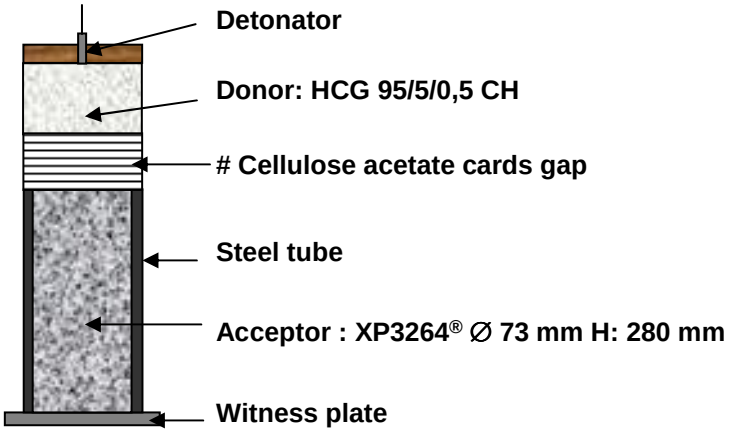
Less than 5 mm

XP3264®

Gap Test ISGT

iSGT result: 230 cards

Pressure in acetate: 22,8 kbar



STANAG 4488

Energetic material characterization

Summary of properties for XP3264® explosive

	Detonics Properties					Mechanical properties	
	Density ρ	VoD	Detonation pressure	Unconfined Critical diameter	Gap Test iSGT	Stress max	Young's Modulus
Targeted performances	> 1.8 g.cm^{-3}	> 7800 m.s^{-1}		< 10 mm	Between 200 and 275 cards	< 10 MPa	< 2000 MPa
Recorded perfomances XP3264®	**1.82 g.cm^{-3}**	**7921 m.s^{-1}**	**285 kBar**	**< 5 mm**	**230 cards**	**9,8 MPa**	**607 MPa**

French MoD (DGA) certification

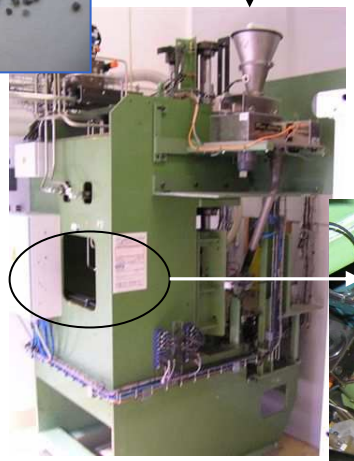
XP3264® homologation according to STANAG 4170 will be delivered at the end of 2010.

Transfer and qualification to industrial process

Industrial scale

Coated process

XP3264® agglomerates



Multi-pressed positions

Dedicated workshop

Explosive composition XP3264®

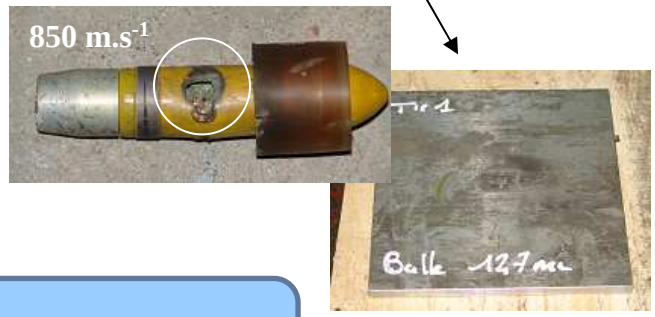
40 mm CTAI ammunition

IM tests (STANAG 4439) – Results (cartridge)

Bullet Impact test

12.7 mm AP type M2

Witness plate



Type V

Shaped Charge Jet Impact: CCEB 62

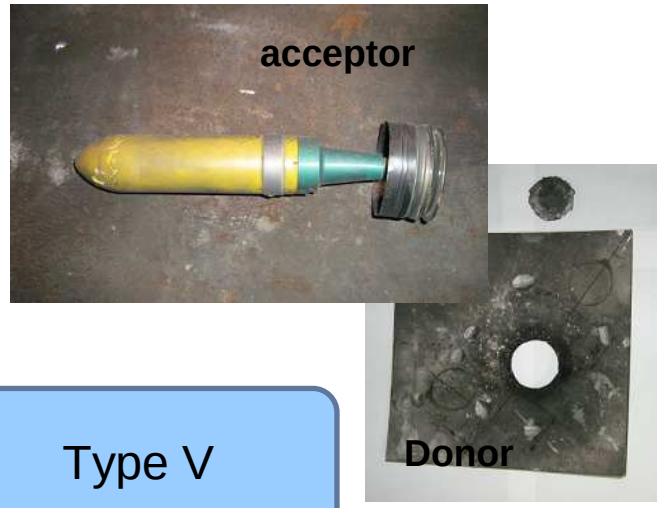
Type III

IM tests (STANAG 4439) – Results (cartridge)

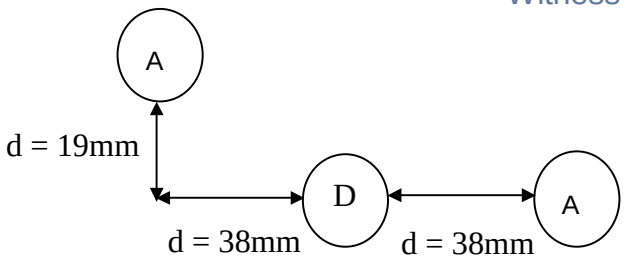
Sympathetic reaction: 2 configurations tested

Witness plate

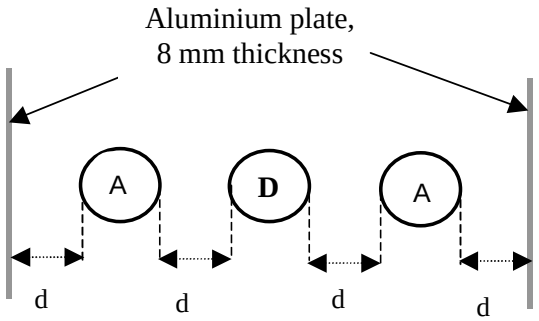
Type V



Witness plate



① 40 mm configuration without any packaging



d= 7 mm

② Feed slot ammunition configuration

IM tests (STANAG 4439) – Results (cartridge)

Slow Cook Off: 2 configurations (slope 3.3°C/h)

Type IV

Cartridge opening

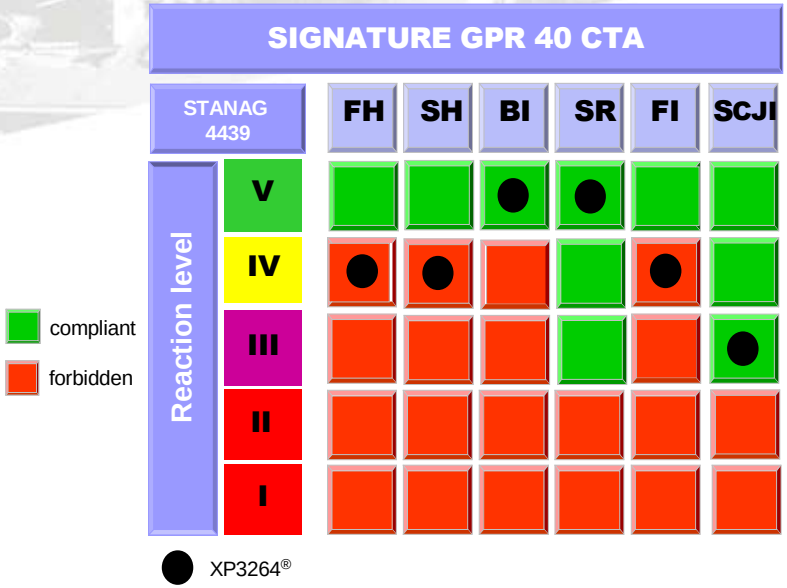
Fast Cook Off

Type V

Cartridge opening

40 MM GPR IM signature

Reaction level	
I	Detonation
II	Partial detonation
III	Explosion
IV	Deflagration
V	Burning



Threat	
FH	Fast Heating
SH	Slow Heating
BI	Bullet Impact
SR	Sympathetic Reaction
FI	Fragment Impact
SCJI	Shaped Charge Jet Impact

- Increase the safety level during storage, transport and handling phases
- Increase the safety level for the vehicle's crew during combat phase

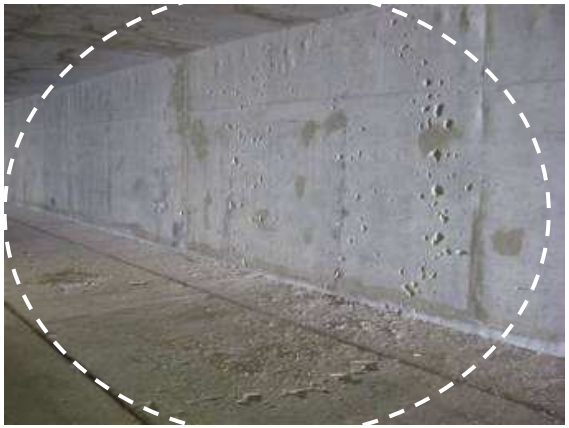
40 MM: static and dynamic firings

Static firing: fragmentation test

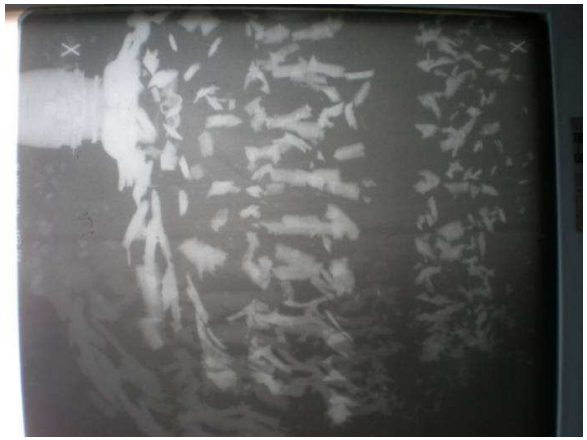
Water recovery

Fragment distribution

Example of dynamic firing



Fragment impacts in the wall



X-Ray visualisation

Conclusion

- R&T activities
  - Researching explosive formulations
  - Explosive composition compliant with customer's requirements
- XP3264® characterization
  - Low sensitivity (safety tests), detonation properties compliant with requirements
  - XP homologation (STANAG 4170) in progress
- Industrial transfer:
  - Laboratory to industrial scale production qualified
  - Process robustness assessed in parallel
  - A dedicated workshop built for mass production
- Terminal efficiency
  - Good fragmentation level observed with 40 mm recovery tests
  - Confirmation with dynamic firing tests
- IM signature (STANAG 4439)
  - Significant increase of safety level,
  - Full IM signature coming with qualification programme

40 mm CTA GPR are now filled with XP3264®

Acknowledgements

Many thanks to the DGA who are supporting the homologation

Thank you for your attention

QUESTIONS ?

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Annex

	XP 3264	Hexal	STANAG
Friction sensitivity	41,7 J	21,7 J	4489
Impact sensitivity	0% at 353 N	263,1 N	4487
Electrostatic discharge	367 mJ	242 mJ	4490
Intermediate Scale Gap Test	230 Cards ~23,8 kPa	275 Cards ~15 kPa	4488
Unconfied critical Diameter	< 5 mm	2 < < 3 mm	AOP7
Velocity of detonation	> 7900 m/s at ρ=1,82 g/cm^3	8230 m/s at ρ=1,81 g/cm^3	AOP 7

Annex