Melt-cast process applied to develop based IM ammunition

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Nexter Munitions

- Melt-cast process
- Major detonics performances of XF®11585
- Recent IM results on ammunition loaded with XF®11585
- New challenges for Energetics Materials
- Conclusion

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Objectives of the R&D studies

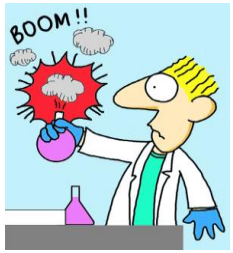
Leadership for « IM » munitions and low sensitivity Energetic Materials

Artillery shell — XF® Family — **155 mm HE-IM LU211** — Fully compliant with STANAG 4439

Tank

Mortars

Navy



Searched for new explosive compositions

XF®11585 is a solution for this range of ammunition

Medium caliber — XP® Family

90's — 2000 — 2006

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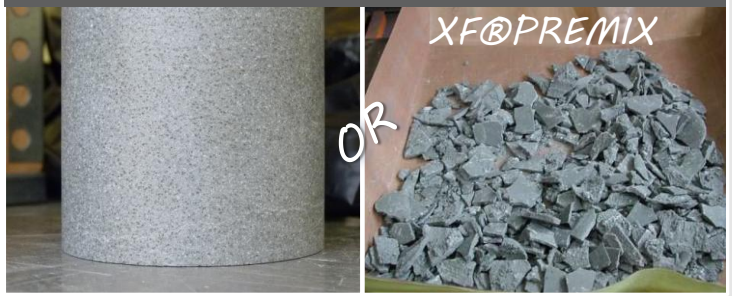
Melt-cast process

REUSE
REDUCE
RECYCLE

Reversibility
(demilitarisation)

Mixing phase

Cooling phase



Gravitational casting phase

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Major detonics performances of XF®11585

Detonics performances

	Unconfined critical diameter	VoD Unconfined ∅ 30 mm	VoD Unconfined ∅ 50 mm	VoD Confined ∅ 73 mm
XF®11585	~10 mm	7070 m/s @ 1,73 g/cm^3	7300 m/s @ 1,73 g/cm^3	7468 m/s @ 1,73 g/cm^3
Comp B	< 4 mm	7920 m/s @ 1,72 g.cm^{-3}		7920 [illegible] @ 1,71 g/cm^3

Mechanical properties

	Density	Stress, max (MPa)	Young Modulus (MPa)	Deformation max (%)	Sample porosity
XF®11585	1,73 g/cm^3	20,8	1986	1,18	< 0,8
Comp B	1,73 g/cm^3	16,1	1877	0,94	ND

Similar to Comp B

Gap test STANAG 4488

	Density	PMMA	Equivalent pressure
XF®11585	1,73 g/cm^3	70 mm	~50 kbar
Comp B	1,69 g/cm^3	130 mm	19,2 kbar

a low sensitivity EM With Comp B performances

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IM performances already recorded

- Ammunition filled with XF®11585

STANAG 4439	STANAG	GEMO-Mock up	120 mm Tank ammunition	100 mm Navy Ammunition
Fast heating	4240	IV	V	
Slow heating	4382	V		
Bullet impact	4241	VI	VI	
Sympathetic reaction	4396		IV	VI
Fragment impact	4496	V		
Shaped charge impact	4526	III		

Screwed cover

Shell body
1 cm thickness

Bottom

French Standard NF T 70-500

GEMO Mock up represents an artillery shell

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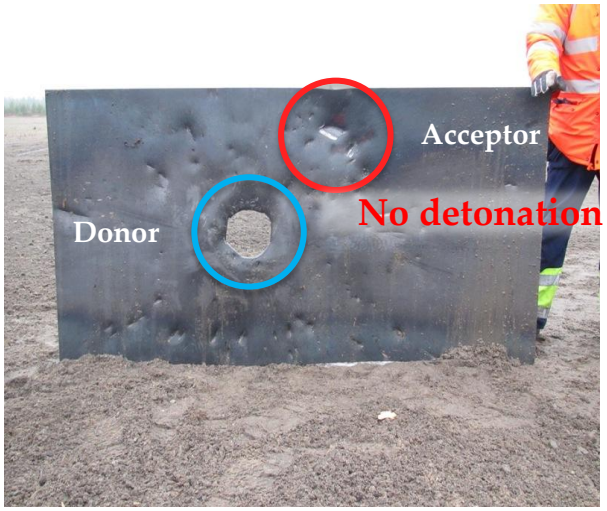
Recent results in ammunition

- 155 mm Artillery shell: LU107 modernized version of M107
  - Sympathetic reaction: STANAG 4396

Logistical configuration



Distance between donor and acceptor 12 cm

Recent results in ammunition

- 120 mm Tank ammunition
  - Sympathetic reaction: logistic packaging (live HE shell only without “empennage”)

  - Shaped charge Jet Impact with CCEB62 (Caliber 62 mm / HMX based)

Compliant with STANAG 4526

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Recent results in ammunition

- 76 mm Navy ammunition
  - Bullet Impact according to the STANAG 4241

Works in cooperation with DIEHL BGT Defence

1st: in fuze 2nd: in main charge

  - Sympathetic reaction according to the STANAG 4396 (turret configuration)

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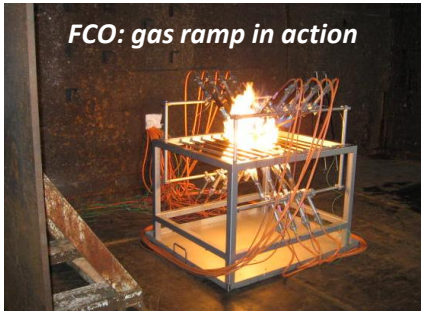
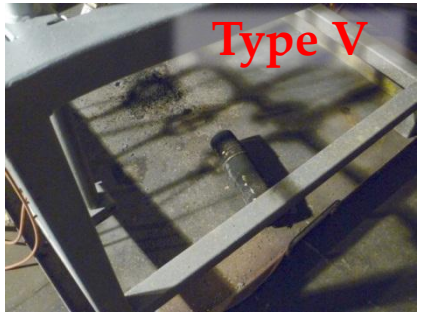
Recent results in ammunition

- 76 mm Navy ammunition
  - Thermal Threat: Slow heating according to STANAG 4382

Works in cooperation with DIEHL BGT Defence

  - Thermal Threat: Fast heating according to STANAG 4240 (reviewed in progress)





IM performances

- Overview on ammunition filled with XF®11585

STANAG 4439	Result expected		155 mm LU107	120 mm Tank ammunition	100 mm Navy Ammunition	76 mm Navy Ammunition
Fast heating	4240	V	V	V		V*
Slow heating	4382	V	V**			V
Bullet impact	4241	V	VI**	VI		VI
Sympathetic reaction	4396	III	III	IV	VI	VI
Fragment impact	4496	V	V**			
Shaped charge impact	4526	III	III**	III		

STANAG 4439 compliant

*: ramp gas
**: Gemo-mock up

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Energetic materials available for Insensitive Munitions

- Energetic materials described in open literature for “IM” for the 60 mm up to 120 mm

	Technology process	Key ingredient	Applications
XF®11585	TNT melt cast	TNT + RDX + NTO + Al	60 mm up to 120 mm
IMX-104 (OSX-7)	DNAN melt cast	DNAN + NTO + RDX	60 mm up to 120 mm
CLX-663	Composite		120 mm
HBU-88A	Composite	HTPB + RDX	76 mm
OSX-12	DNAN melt cast	DNAN + NTO + HMX	
PAX-21	DNAN melt cast	DNAN + RDX + AP + MNA	120 mm
PAX-48 (OSX-8)	DNAN melt cast	DNAN + NTO + RDX + AL	120 mm
PAX-195	Wax melt cast	RDX + Wax	60 and 81 mm
PAX-41	DNAN melt cast	DNAN + RDX + MNA	

- XF11585 is a solution for this range of ammunition

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PAX-41	DNAN melt cast

- The challenge is now to propose the best trade-off according the secondary criteria

Energetic materials available for Insensitive Ammuntion

- Basic hypothesis: Explosive composition must be efficient in terms of
  - Detonics performances ✓
  - Insensitivity ✓

➔ Essential but **not discriminant** between solutions

- What do we need to provide the best trade-off “IM” ammunition for the 60mm up to 120 mm?
  - Low investment in terms of filling equipment 
  - Compliant with a simple method of demilitarisation 
  - Ageing compliance 
  - Best cost efficiency 

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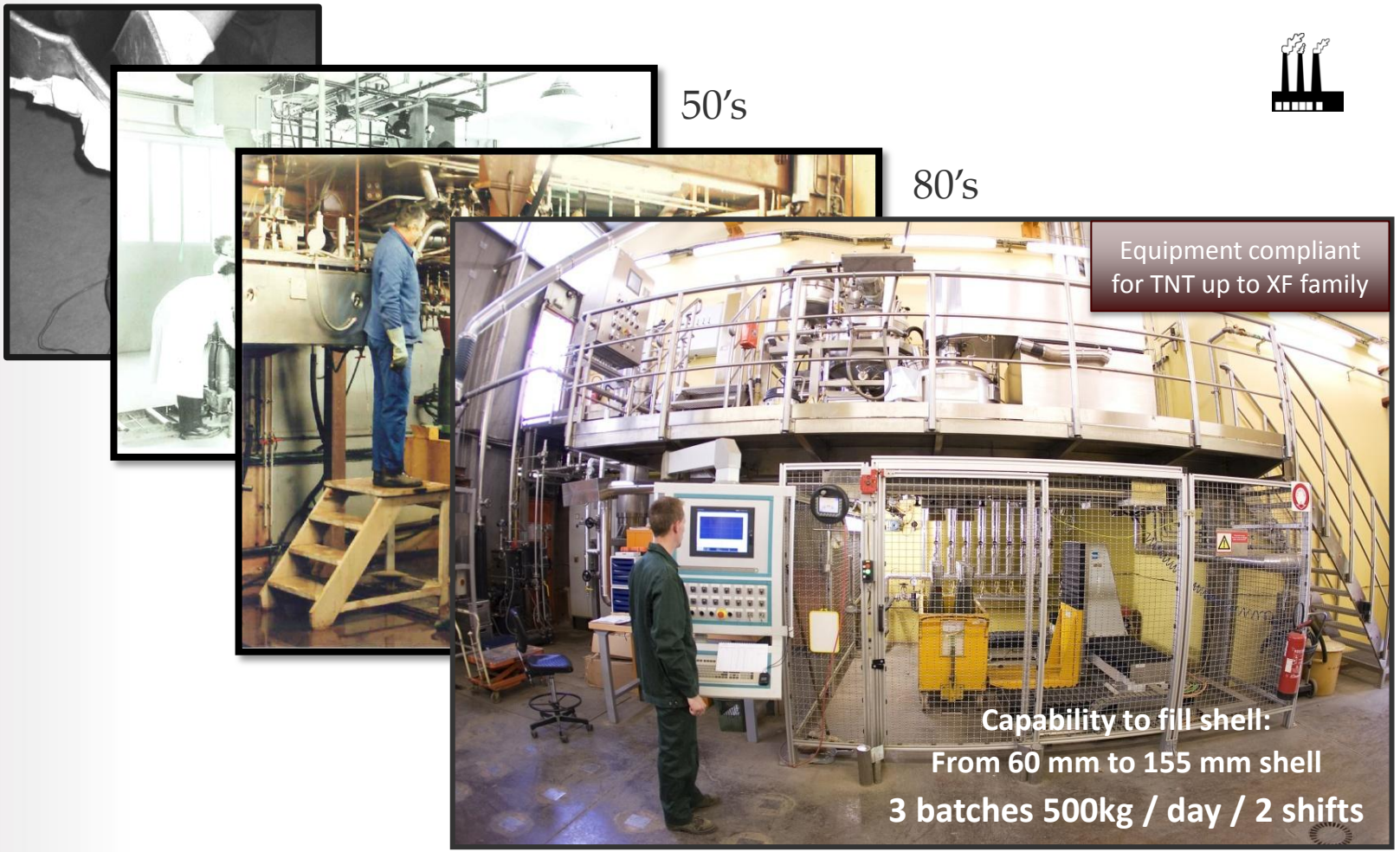
New challenges: low investment in terms of filling equipment

- Melt-cast process : simple, no-specific equipment and worldwide widespread



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New challenges: Demilitarization

- Simple method…

No additional booster:

Easy to dismantle

1st: Re-melt phase

2nd: Recycling EM

3rd: Re-use phase

Recycling Steel

Re-use of ammunition shell

Re-use of explosive composition

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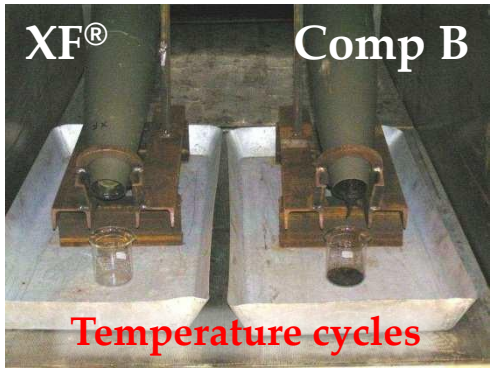
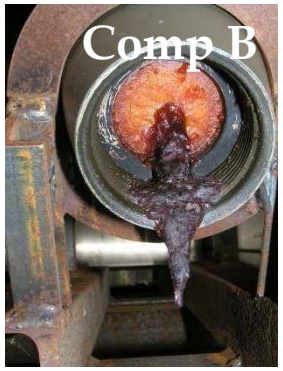
New challenges: performances after ageing

- TNT binder:
  - Worldwide used by the military forces for **more** than **50** years in TNT shells or NTO/TNT warheads: **excellent background!**
- Exsudation:
  - Problem solved by Nexter Munitions many years ago by using XF® Family





- **XF®11585:**
  - **French ministry of Defense is going to evaluate XF11585 by applying complete set of tests according to the STANAG 4170**
  - **Results are expected for mid Y2014**

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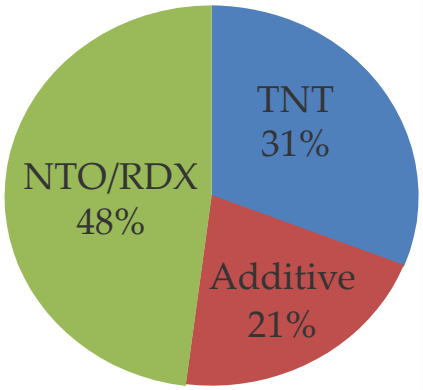
New challenges: Better cost efficiency

- Economic performances

  Of course, the last key of choice for the non-technical people

- 3 main axes to obtain the best economics performances
  - (1/3) Simple industrial plant
    - XF®11585 allows us to use standard filling plant for TNT or Comp B
  - (2/3) Use of cheap raw materials
    - TNT as powerful energetic binder : still the best choice in terms of economic performances in comparison with DNAN or plastic binder
    - TNT is 6900 m/s @ for less than **3,5€/kg**

XF®11585 formulation

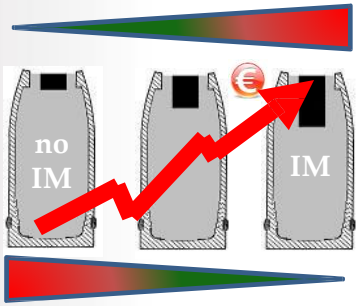


New challenges: Better cost efficiency

Economic performances:

- (3/3) Simple pyrotechnic train

Size or / and performances of additional Booster



Sensitivity of main charge

155 mm

120 mm

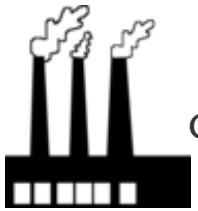
100 mm

~76 mm config.

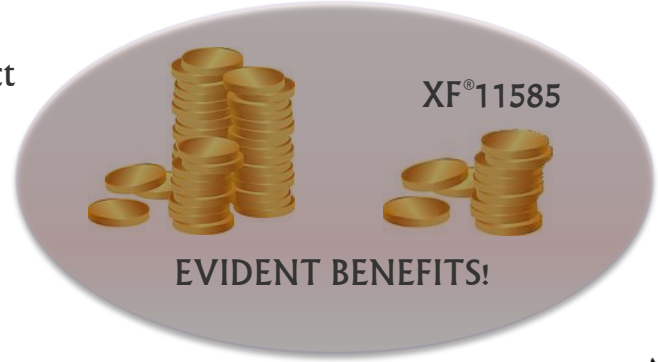
Conclusion

Demilitarization aspect

Studying board:
No additional booster



Simple industrial plant
Current TNT equipment



IM use

Storage 1.6 HD
Reduced area

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XF®11585 presents numerous advantages:

- ✓ Standard filling plants
- ✓ Compatible with caliber from 60 mm up to 120 mm
- ✓ Stable and ages well …
- ✓ Economic benefits

Thank you for your attention

Contact

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