# The melt-cast XF®11585: a low vulnerability composition Ammunition application from 60 to 155 mm

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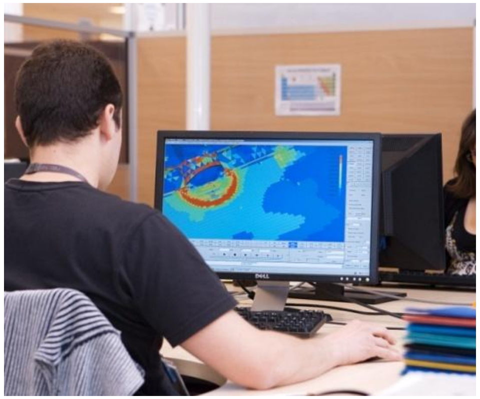
# Outline

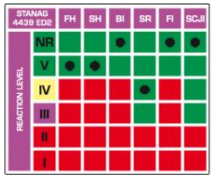
- Explosive Composition XF®11585
  - Context of the study
  - Melt cast process based on TNT
  - Energetic material: XF®11585
    - Pyrotechnic properties
    - Detonics properties
  - Ammunition examples filled with XF®11585
    - Vulnerability performances
    - Ammunition performances
  - Potential IM munitions using XF®11585
  - Conclusion



# Context of the study (1/4)

- "IM" technology at Nexter Munitions

LU211-IM




Filled with XF®13333


A reality

155 mm LU211 IM artillery shell is the first French IM Field Artillery ammunition under mass production

- Researching explosive compositions to extend the Nexter Munitions ammunition offers to 120 mm and below.

# Context of the study (2/4)

- The next challenges have been followed for developing an explosive composition

Best cost effectiveness

Compatible with a large range of calibers from tank ammunition to mortar bombs


Insensitivity,
detonics performances
and terminal efficiency

Searching for


new explosive compositions

Compliant with standard filling plant


Simple way of demilitarization

# Context of the study (3/4)

- Melt cast process: Strategy developed by Nexter Munitions for 20 years.

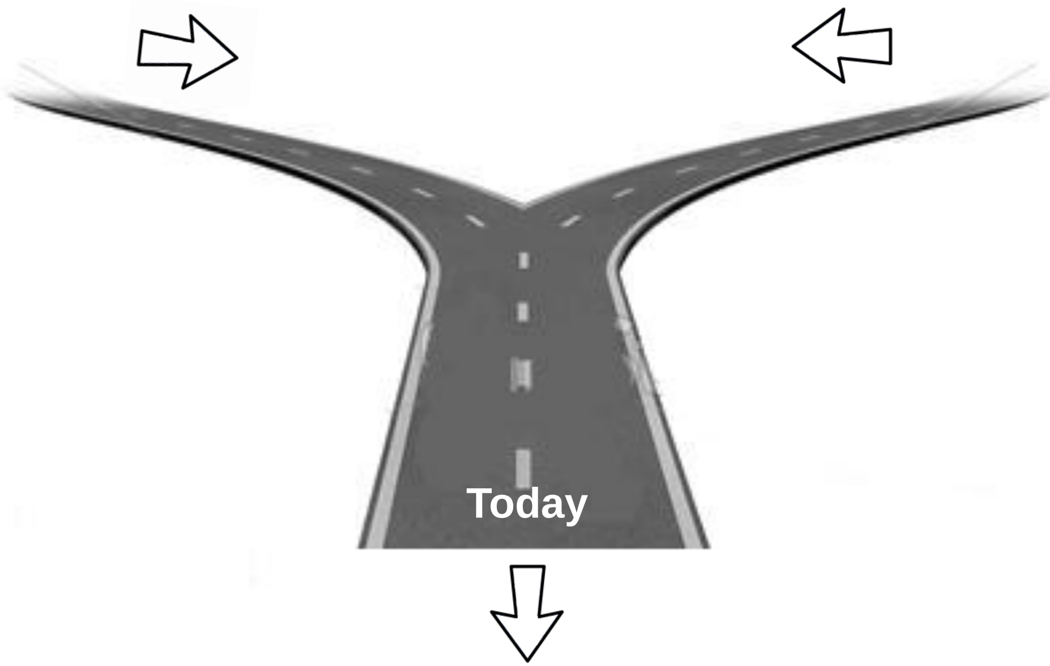
Detonics performances

XF®12366
(HMX-based)

Insensitivity

XF®13333
(NTO-based)

Fully qualified by French DGA and mass production in progess




**XF®11585**

**(NTO / RDX-based)**

# Context of the study (4/4)

- “IM” technology is a trade-off between energetic material and ammunition design

R&D Energetic Materials

Ammunition R&D Department

Development of low vulnerability explosive compositions

XF® Family


Design ammunition

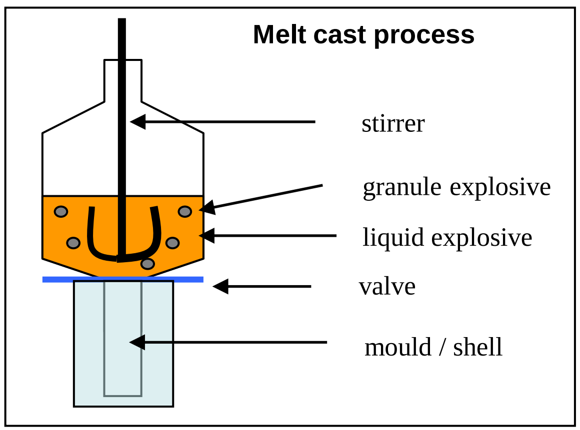
For example venting plug for 155 mm LU211 IM

Synergy between these 2 departments :

From low vulnerability ammunition to insensitive ammunition

# Explosive melt cast process

- Description of the melt cast process: TNT based
  - Leadership of Nexter Munitions in this field
  - Conventional & simple process

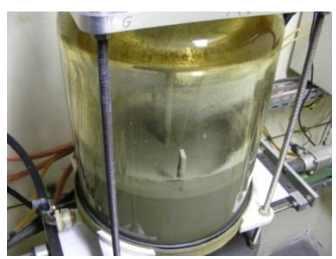



Reversibility

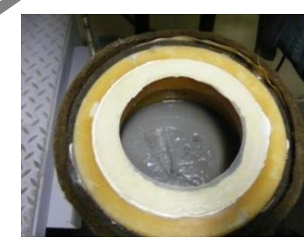
(demilitarisation)

Mixing phase

Cooling phase



Gravitational casting phase



# Pyrotechnics properties of XF®11585

## Main properties

### Hazard characterisation

| | XF®11585 | TNT | Compo B | AFNOR standard | STANAG |
|---|---|---|---|---|---|
| | 50% Go results | | | | |
| **Friction sensitivity** | **0% at 353 N** | 10% at 353 N | 158 N | | 4489 |
| **Electrostatic Discharge** | **> 736 mJ** | > 4,5 J | > 736 mJ | NF T70-539 | |
| **Impact Sensitivity** | **30 % at 50 J** | 50 % at 25 J | > 50 J | | 4487 |

Low sensitivity to basic stimuli

### Mechanical properties

| Composition Sample | Caliber | Density (g.cm$^{-3}$) | Stress, max (MPa) | Young Modulus (MPa) | Deformation, max (%) | Sample porosity (%) |
|---|---|---|---|---|---|---|
| **XF®11585** | *From 155 to 60 mm* | *1,73* | *20,8* | *1986* | *1,18* | *< 0,8* |
| **XF®13333** | 155 mm | 1,75 | 23,1 | 1853 | 1,35 | < 1,2 |
| **Compo B** | From 155 to 60 mm | 1.70 | 16,1 | 1877 | 0,94 | ND |

# Pyrotechnics properties of XF®11585

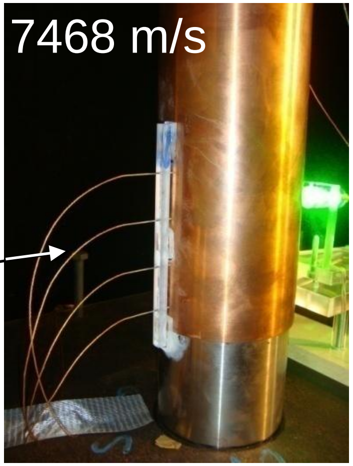
## Main properties

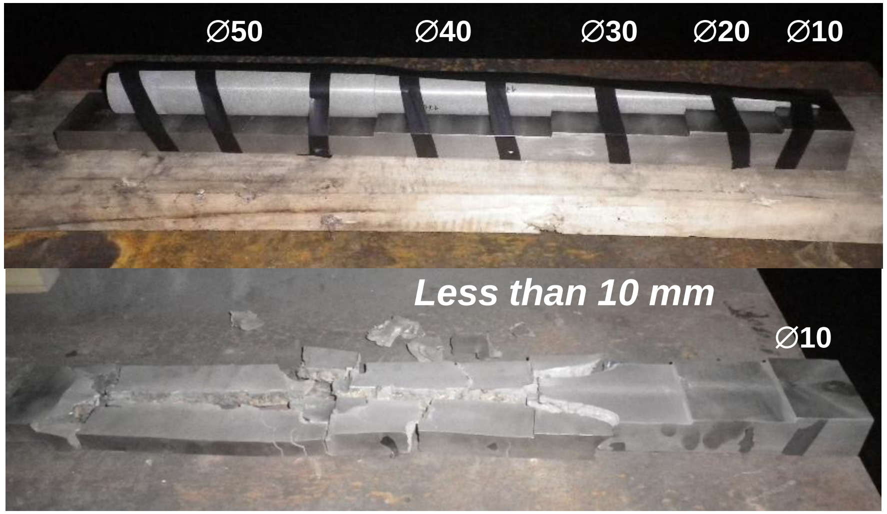
- Thermal properties: DSC according to the STANAG 4515: 5°C/min

| | Compo B | XF®11585 | IMX 104 |
|---|---|---|---|
| **Endothermic peak** | 80°C | ***80°C*** | 89°C |
| **Onset / Exothermic peak** | 202 / 235°C | ***204 / 230 °C*** | 212 / 224 °C |
| **Activation energy** | 163 kJ/mol | ***151 kJ/mol*** | ND |

- Detonics performances
  - Confined detonation velocity and unconfined critical diameter

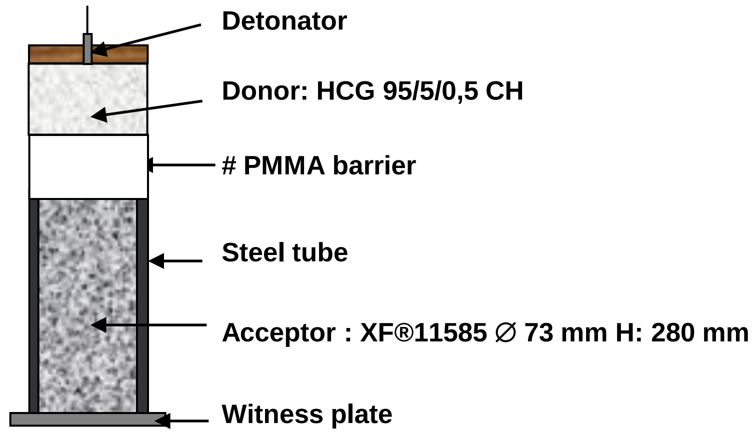
**Detonation probes**



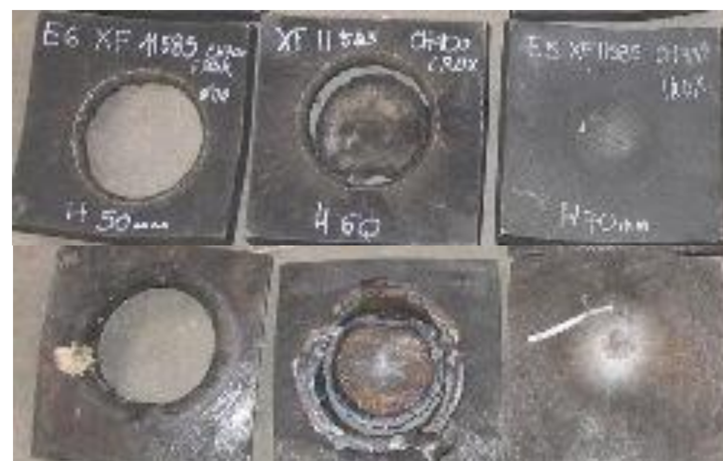
# Detonics properties of XF®11585

- Ignition pressure characterisation
  - Large Scale Gap test: according to the STANAG 4488


| | XF®11585 | |
|---|---|---|
| PMMA barrier | Charge density | Go or No go |
| 50 mm (P=62 kbar) | 1.73 g/cm$^3$ | Go |
| 60 mm (P=50 kbar) | 1.73 g/cm$^3$ | **Go** |
| 70 mm (P=41 kbar) | 1.73 g/cm$^3$ | **No Go** |
| 80 mm (P=33 kbar) | 1.73 g/cm$^3$ | No Go |
| 90 mm (P=26 kbar) | 1.73 g/cm$^3$ | No Go |

50 mm 60 mm 70 mm



# Detonics properties

- Ignition tests
  - Ignition with a standard fuze without booster: 4 configurations have been performed

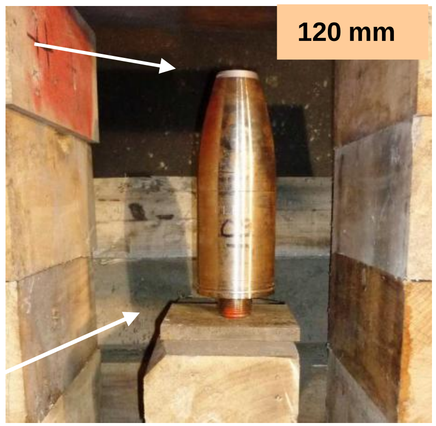
## 155 & 120 mm configurations

PDM 557 Fuze

Pellet of XF®11585

Witness plate

120 mm



## Caliber 76 up to 100 mm configurations

120 mm Fuze

∅73 mm H 280 mm

100 mm

## XF®11585 nominal detonation


Steel mark : ∅ 60 mm & depth 8 mm

***No booster required***

# Vulnerability performances (1/4)

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- Thermal threats: Fast cook off and slow coof off in 2 configurations
  - GEMO mock up: representative of artillery shell

Screwed cover

Shell body
1 cm thickness

Bottom

*French Standard NF T 70-500*

**Slow Heating: SH**


**Fast Heating: FH**


*Nexter Munitions Vent plug patent*

  - 120 mm HE

**Slow Heating: SH**


**Fast Heating: FH**


*Ramp gaz device*

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EUROPEAN MANUFACTURERS GROUP

*Expert Working Group*

# Vulnerability performances (2/4)

- Mechanical threats: Bullet impact in 2 configurations
  - GEMO mock up: representative of artillery shell

Screwed cover

Shell body
1 cm thickness

Bottom

*French Standard NF T 70-500*

**Bullet Impact – GEMO Mock-up**


**Type V**

**STANAG 850 m/s**

**No Reaction**


**No Reaction**

- 120 mm HE

**Bullet impact – 120 mm**


**STANAG 850 m/s**

**No Reaction**

# Vulnerability performances (3/4)

- Mechanical threats: Shaped Charge Jet and Fragment Impact in 2 configurations

**Fragment Impact**

Speed camera views

**Type V**

**SCJI CCEV62 – GEMO Mock-up**

**Shaped Charge**

**∅ 62 mm**

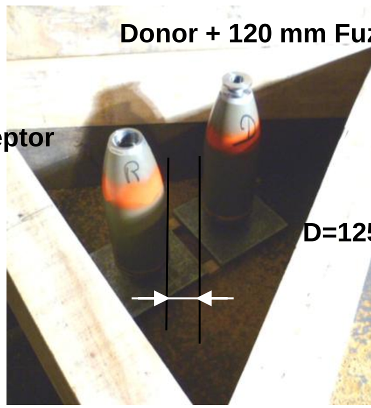
Work in progress- Trial expected in June 2012.

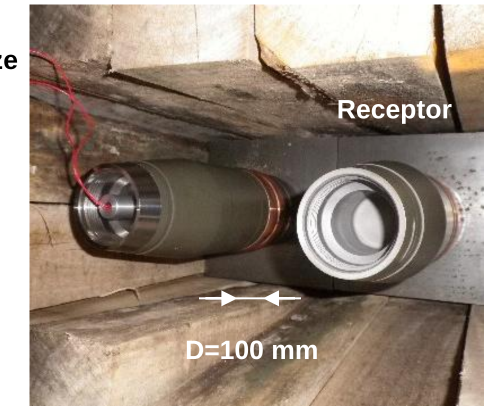
On GEMO mock-up and on 155 mm artillery shell

# Vulnerability performances (4/4)

- Mechanical threats: Sympathetic Reaction
  - Ignition with a standard fuze without additionnal booster: 2 configurations performed

| 120 mm Tank ammunition | 100 mm Navy ammunition |
|---|---|




**XF®11585 nominal detonation – SR types of reaction**


**Type IV**

Donor witness plate

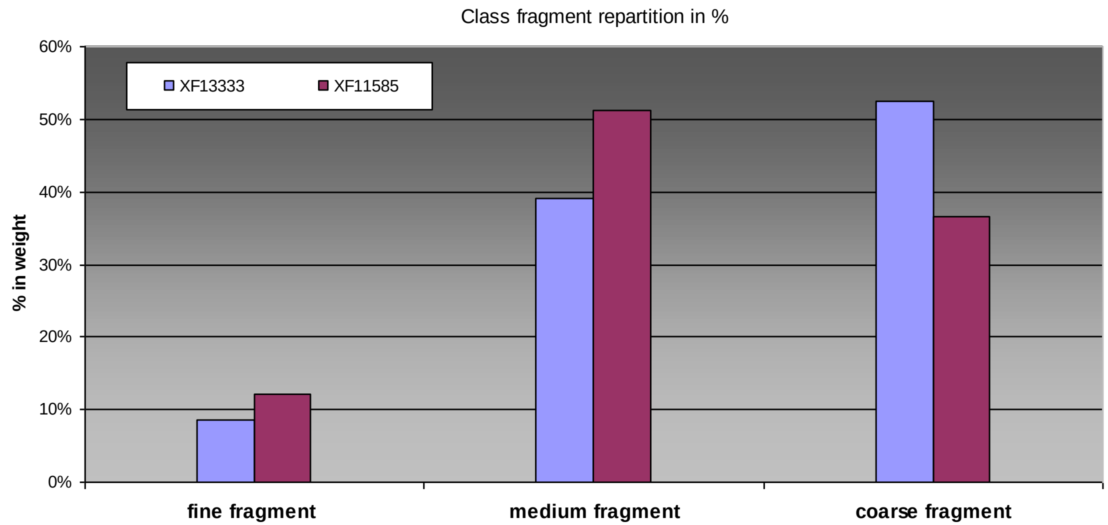


**No Reaction**

# Ammunition terminal efficiency

- Fragment impact efficiency 120 mm HE-IM:

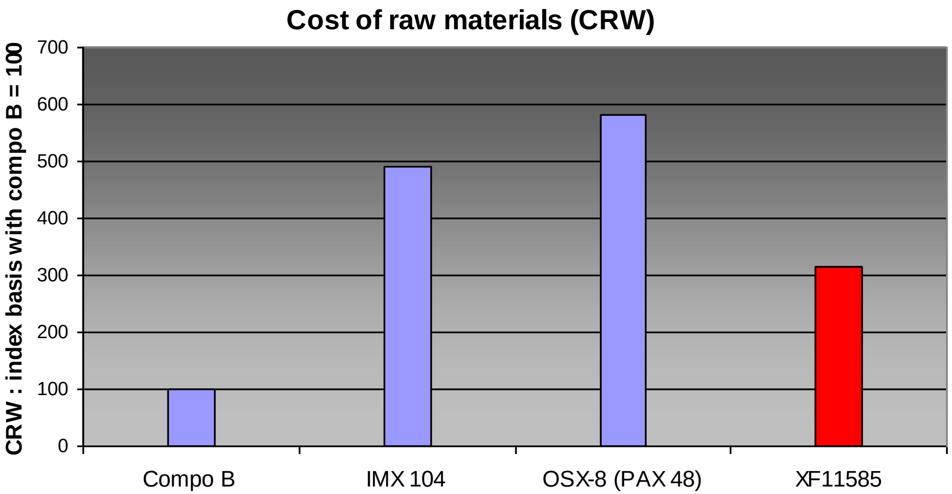
*95% fragment mass recovery was achieved*




As the explosive composition XF®13333, this new explosive composition allows us to treat a large range of targets.

# Potential IM munitions using XF®11585

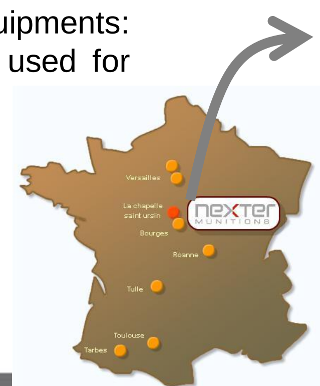
## Cost comparison for constitutive raw materials




Reminder:
XF®11585 is based on NTO/RDX/TNT and Aluminium

## Industrial aspect

New XF®11585 requires the same equipments: mixing, casting and cooling than those used for conventional explosives.



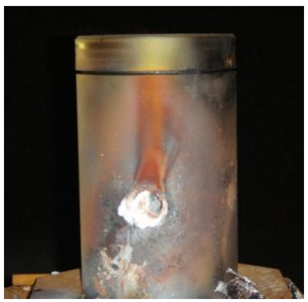

# Potential IM munitions using XF®11585

- Signature expected with explosive composition XF®11585:

Caption :
t for tested and recorded result

Required signature for IM test results according to STANAG 4439

| FCO | SCO | FI | FI | SR | SCJI |
|---|---|---|---|---|---|
| V | V | V | V | III | III |



Artillery shell: 155 mm

| FCO | SCO | BI | FI | SR | SCJI |
|---|---|---|---|---|---|
| V | V | NR | V | III | |
| | t | t | t | | |

Tank ammunition: 120 mm

| FCO | SCO | BI | FI | SR | SCJI |
|---|---|---|---|---|---|
| V | V | NR | V | IV | |
| | t | t | | t | |

Navy ammunition: 100 mm

| FCO | SCO | BI | FI | SR | SCJI |
|---|---|---|---|---|---|
| V | V | NR | V | NR | |
| | | | | t | |

Mortar bombs: 76 mm (81 & 60 mm)

| FCO | SCO | BI | FI | SR | SCJI |
|---|---|---|---|---|---|
| V | V | NR | V | NR | |

# Conclusion

- R&D activities
  - Researching low sensitivity explosive composition to enhance XF® Familly
  - Work on the "IM" design ammunition to be compliant with STANAG 4439
- Intrinsic explosive composition XF®11585 performances
  - Low sensitivity, detonics performances similar to Compo B
  - Raw materials relatively less expensive than EM competitors
- Operational advantages of ammunition filled with XF®11585
  - Cost effectiveness
  - IM & detonics performances
  - Simple pyrotechnic train (robust design)
  - Simple way of demilitarisation (potential re-use of raw materials)

*Standard "IM" explosive XF®11585*
*dedicated to multipurpose "IM" ammunition*

## QUESTIONS ?

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