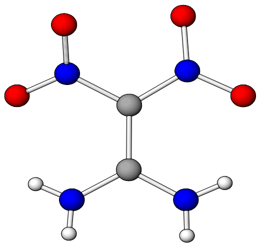


Formulation and Testing of a Comp B Replacement Based on FOX-7

Carina Eldsäter, Åke Pettersson and

Marita Wanhatalo

FOI
SWEDISH DEFENCE
RESEARCH AGENCY

Acknowledgement

Pierre Bengtsson

Hans-Göran Ohlsson

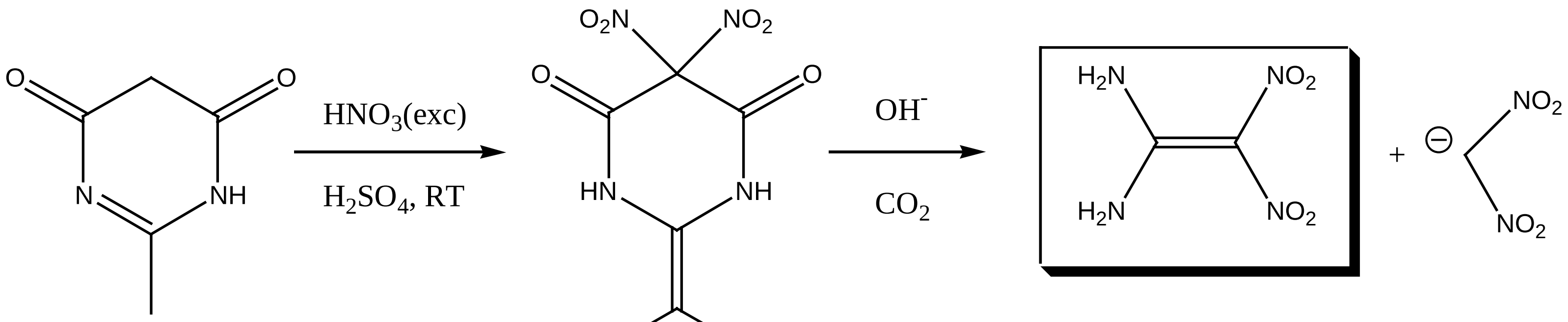
Alf Prytz

and co-workers at Saab Bofors Dynamics AB, Sweden

EURENCO Bofors AB, Sweden

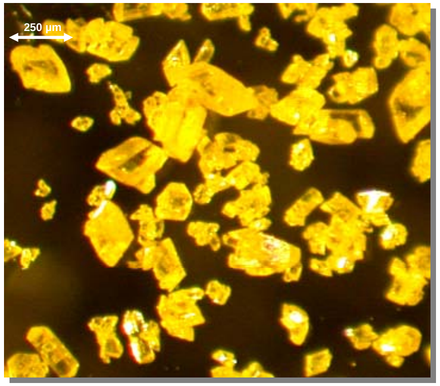
Defence Material Administration, Sweden

Synthesis of FOX-7



A.A. Astrat'ev et al. Russ. Chem. J. Org. Chem. 37, 2001, 729
N. V. Latypov et al. Proc. IMEMTS 2001, Bordeaux.

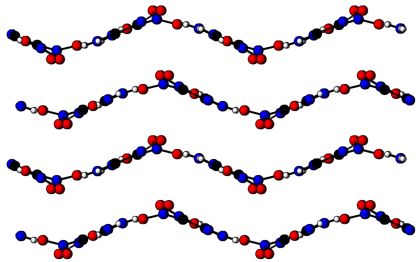
Properties of FOX-7



Density	1.885 g/cm^3	(RDX	1.816 g/cm^3)
Oxygen balance	-21.6%	(RDX	-21.6%)
Heat of formation	-32 kcal/mole	(RDX	16 kcal/mole)
Detonation velocity	8870 m/s (calc)	(RDX	8930 m/s) (calc)
	8340 m/s (exp)*	*) 1.5% wax	
Detonation pressure	34.0 GPa (calc)	(RDX	34.6 GPa) (calc)

H. Östmark et al. *Proc. ICT Int. Ann. Conf.,* Karlsruhe (2001)
S. Karlsson et al. *Proc. Int. Det. Symp.,* San Diego (2002)

Sensitivity of FOX-7



Small-scale sensitivity

- Impact sensitivity — 13-25 J — (RDX 7.5 J)
- Friction sensitivity — >340 N — (RDX 120 N)

Thermal sensitivity

- Ignition temperature (Wood's) — 215°C — (RDX 220°C)
- Ignition temperature (FSD 0214) — 225-250°C

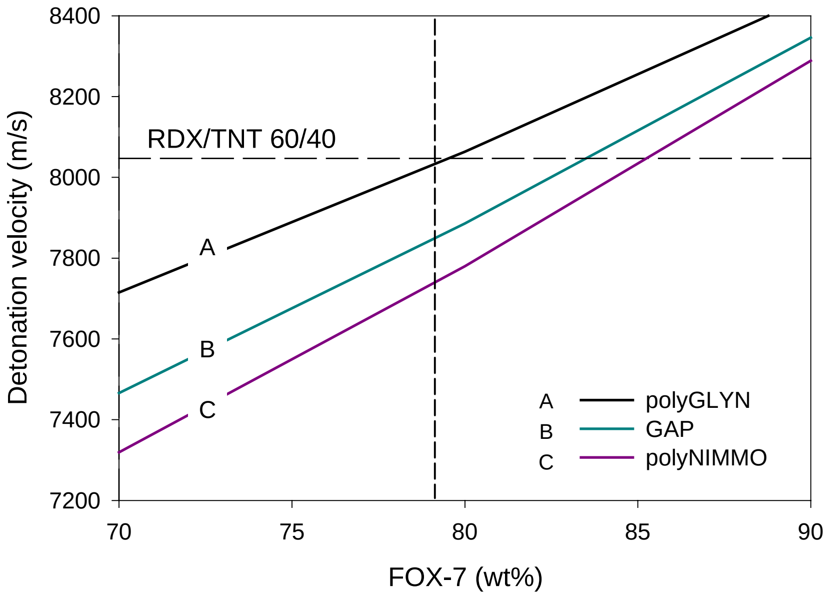
Shock sensitivity

- small-scale gap test — ~ TNT (pressed)
- medium-scale gap test — ~ TNT (pressed)

H. Östmark et al. *Proc. 11th Int. Det. Symp.,* Snowmass (1998)
C. Eldsäter et al. *Proc. EuroPyro*, Sain Malo (2003)

Aim

The aim of this work was to find a replacement for Comp B but with improved sensitivity.



Requirements

- Low-sensitive energetic material (e.g. FOX-7)
- Energetic binder with high density (e.g. polyGLYN)

FOF-2 2001

FOX7 (255-350µm)	50 %
FOX7 (< 70µm)	20 %
Energetic binder	30 %
• PolyGlyN	21 %
• Butyl-NENA	5 %
• H_{12}MDI (Desmodur-W)	4 %
• DBTDL	

Very high viscosity!

25 mm Detonation Test - Results

NaCl

Comp B

FOF-2

Small-Scale Slow Cook-Off

Comp B

$T_{cook-off}$ 207°C (Type I reaction)

FOF-2

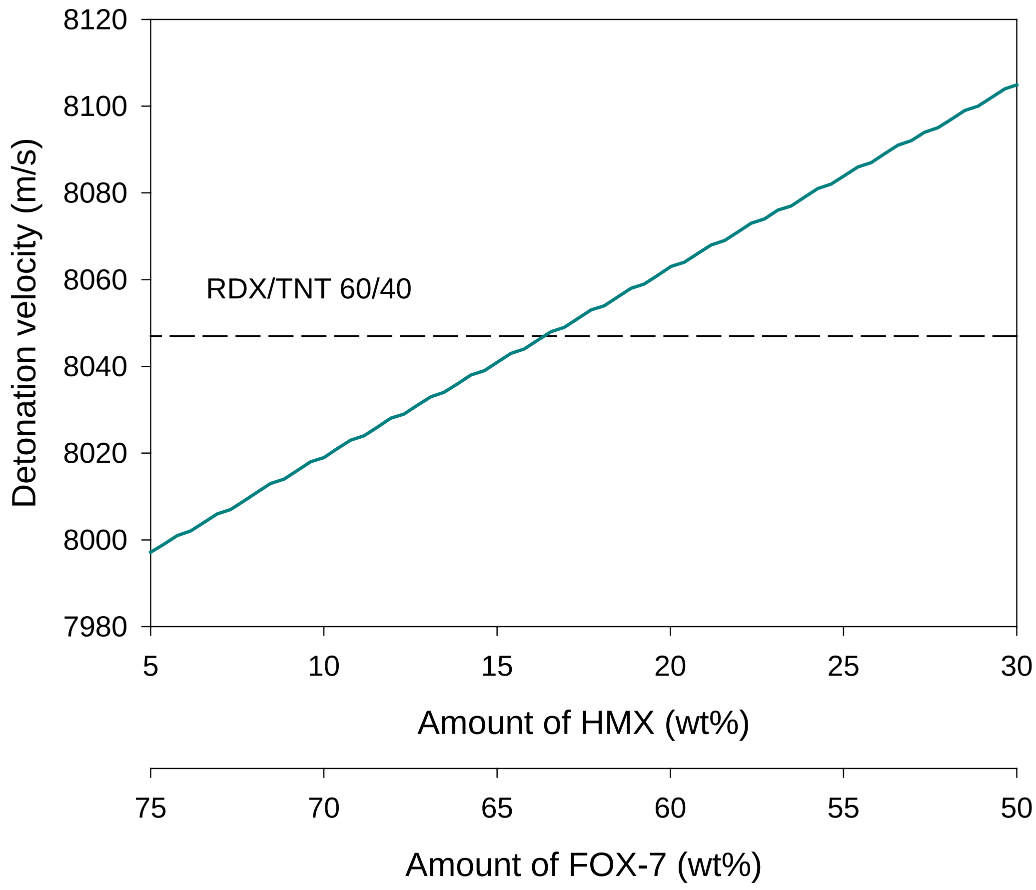
$T_{cook-off}$ 220°C (Type V reaction)

FOF-3 2002

FOX7 (350-800µm)	35 %
FOX7 (< 70µm)	35 %
Energetic binder	30 %
• PolyGlyN	11 %
• GAP	11 %
• Butyl-NENA	5 %
• H_{12}MDI (Desmodur-W)	3 %
• DBTDL	

New binder - lower viscosity but lower performance!

Improved Performance with HMX



Comp B performance

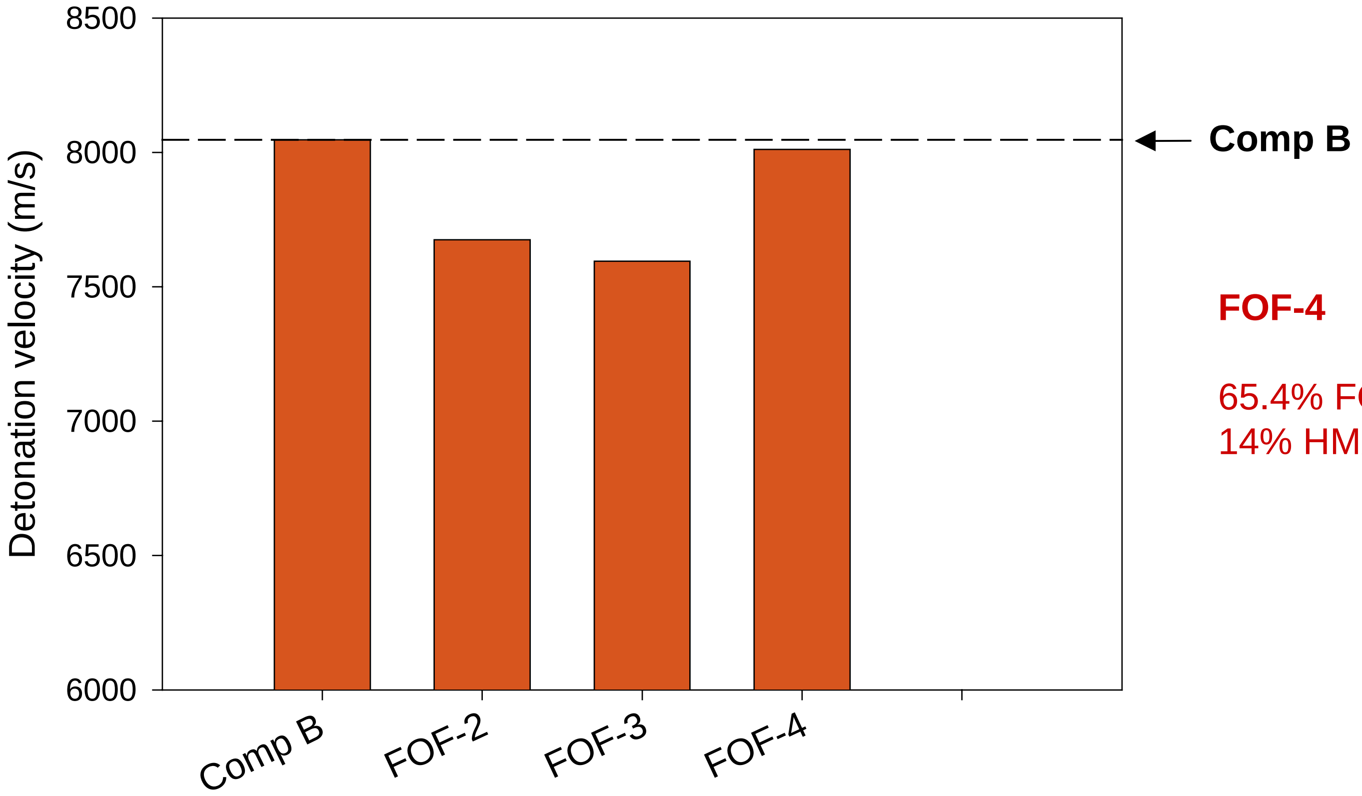
63.5% FOX-7
16.5% HMX

FOF-4 2003

FOX7 (350-800µm)	65.4 %
HMX (22µm)	14.0 %
Energetic binder	20.6 %
• PolyGlyN	7.4 %
• GAP	7.4 %
• Butyl-NENA	3.7 %
• H_{12}MDI (Desmodur-W)	2.1 %
• DBTDL	

Improved performance but high viscosity due to broad particle size distribution!

Theoretical performance



FOF-4

65.4% FOX-7
14% HMX

25 mm Detonation Test - Results

NaCl

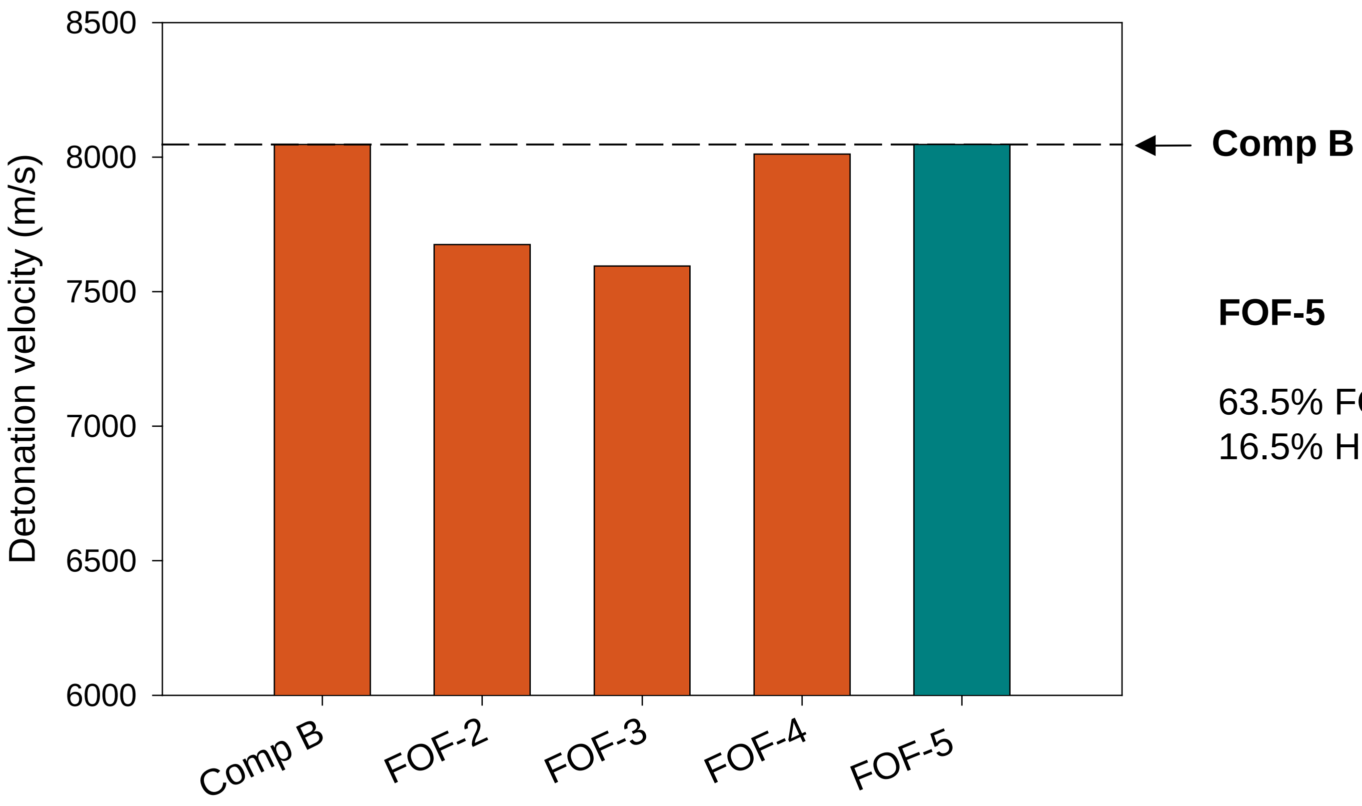
Comp B

FOF-4

FOF-5 2003

FOX7 (238µm)	38.1 %
FOX7 (32µm)	25.4 %
HMX (22 µm)	16.5 %
Energetic binder	20 %
• PolyGlyN	7.2 %
• GAP	7.2 %
• Butyl-NENA	3.6 %
• H_{12}MDI (Desmodur-W)	2 %
• DBTDL	

Theoretical Performance



FOF-5

63.5% FOX-7
16.5% HMX

Initial ”IM Testing” of FOF-5

40 mm artillery shells

- Slow cook-off (MIL-STD-2105B)
- Fast cook-off (MIL-STD-2105B)
- Bullet impact (MIL-STD-2105B)

- HNS II-based fuze
- Cartridge filled with rice to simulate propellant grains

Fast Cook-Off

Blast pressure (max 160 Pa) and no significant heat radiation

⇨ Type IV response (fire)

Debris (fuze) recovered at > 24 meters from test stand

⇨Type IV response (deflagration)

Composition B ⇨ Type I response (detonation)

Slow Cook-Off

First test (inert fuze) ⇨ Type V response (fire)

Second test (HNS II-based fuze) ⇨ Type IV response (deflagration)

Composition B ⇨ *Type I response (detonation)*

Slow Cook-Off

Before test

After first test

After second test

FOI
SWEDISH DEFENCE
RESEARCH AGENCY

Bullet Impact

Debris (fuze) recovered less than 15 meters from test stand

⇨ Type V response (fire)

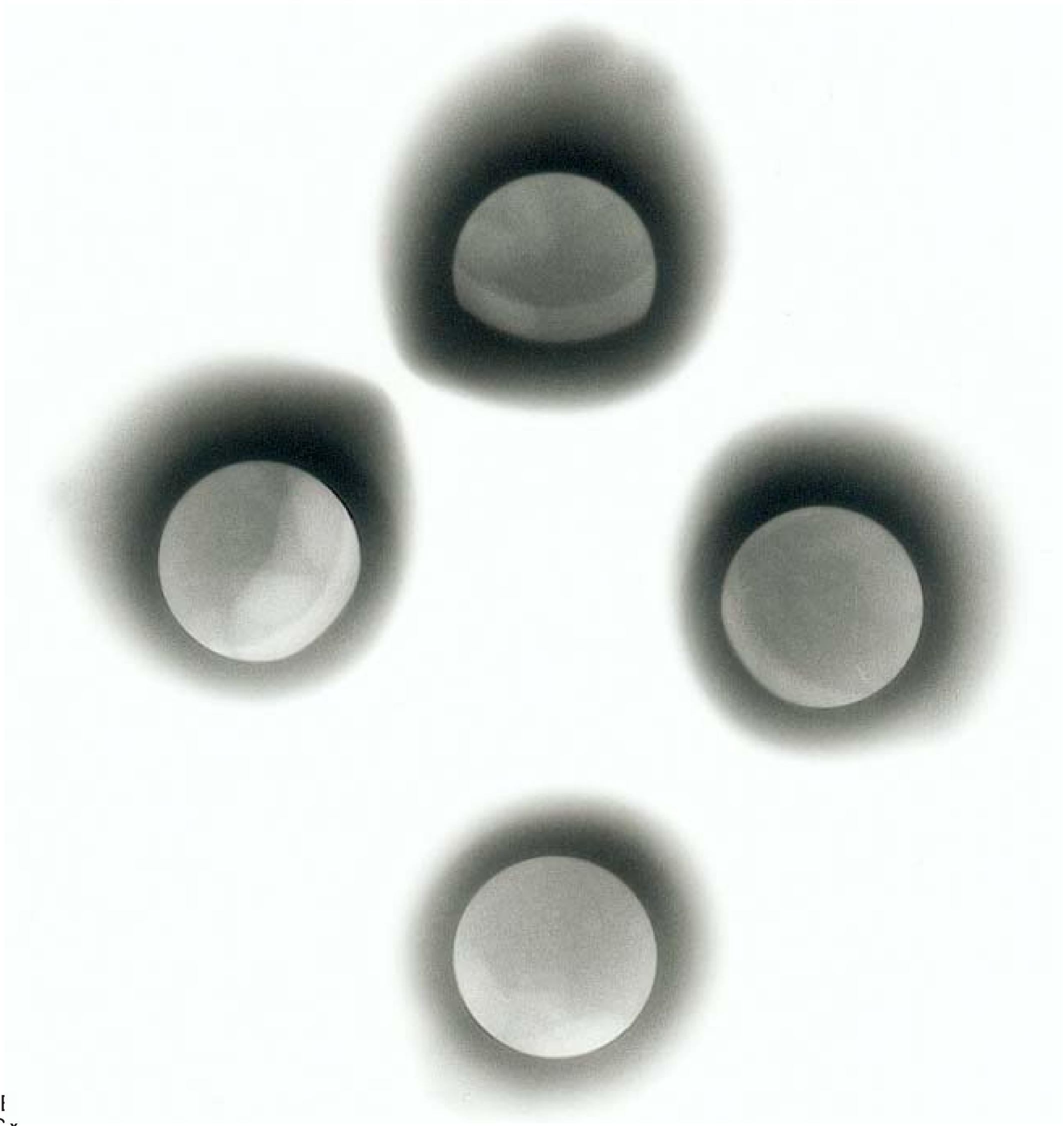
Composition B ⇨ Type I response (detonation)

Initial ”IM Testing” - summary

FOF-5 show much lower response to SCO, FCO and BI than Comp B.

	Slow Cook-Off	Fast Cook-Off	Bullet Impact
FOF-5	Fire (test 1) Fire/Defl (test 2)	Deflagration	Fire
Comp B	Detonation	Detonation	Detonation

Voids



Conclusions

- FOF-5 show much lower response to SCO, FCO and BI than Comp B.
- A better cast explosive charge with higher density and thus fewer voids will most likely improve the responses to fast and slow heating.
- Preliminary results show that the solid loading of FOF-5 can be increased even further without compromising viscosity.