



Reduced Sensitivity RDX, a review and an update

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Presentation Outline

RS-RDX: state of the art

RS-RDX:update

Conclusions

State of the Art



The ways to IM (Insensitive Munition)

require

Modelling and simulation
Barriers and Packaging
Venting Devices
Propellants
Explosive...



State of the Art

IM

(Insensitive Munition)

Explosive

-use of Intrinsically Insensitive Explosives
such as TATB , NTO, GUDN...

-improve the properties of classical
explosives such as RDX (reduce the sensitivity
of Nitramine crystals)



State of the Art

RS-RDX

Reduction of the sensitivity of nitramine crystals:

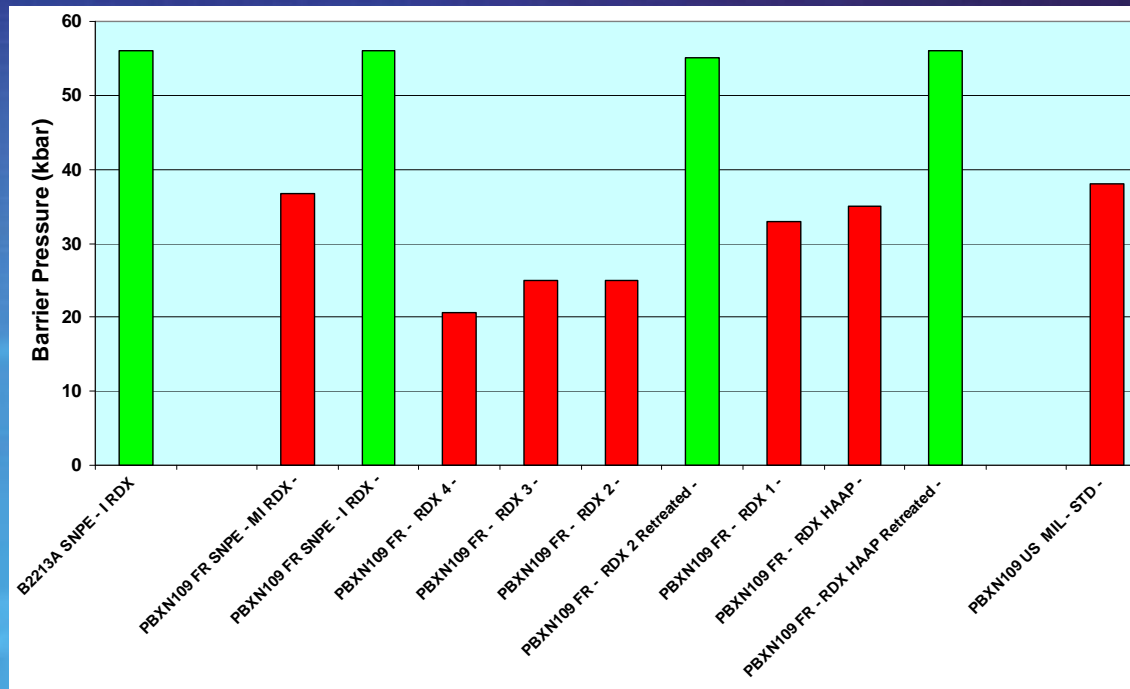
A special RDX with a *lower level of shock sensitivity* than regular RDX, called **I-RDX[®]** has been industrially produced by EURENCO for *more than 40 years*

Up to now, benefit of this low shock sensitivity **I-RDX[®]** is *mainly acknowledged when I-RDX[®] is used in Cast PBX*

State of the Art

RS-RDX

Reduction of the sensitivity of nitramine crystals:



*As measured on
PBX N 109 through
ISGT
(STANAG 4488 Annex B)*

End of 1990th

State of the Art

RS-RDX

That is why

**RS-RDX has become of major interest for IM
community**

From work done (including a Round Robin test) :

Other RDX manufacturers have RS-RDX

↪ Based on Woolwich process, three producers (including EURENCO) do have a RS-RDX quality

↪ Based on Bachmann process, one producer do have a RS RDX quality.

State of the Art RS-RDX

From work already done :

- RDX produced by the standard Woolwich process leads to:
 - ↳ Product with low levels of shock sensitivity and no reversion after ageing
- RDX produced by the standard Bachmann process leads to:
 - ↳ products of higher level of sensitivity or
 - ↳ products which after adapted recrystallization in order to produce RS-RDX, may not remain «insensitive» after ageing

State of the Art RS-RDX

From work already done :

As one of the main differences between Bachmann
and Woolwich process is the residual content of
HMX:

↳ it has been claimed that the presence of HMX
in RDX should have an influence on the level of
shock sensitivity

State of the Art

HMX role

From work already done

↪ **PBXN 109 prepared**

☞ with a mixture of I-RDX[®] and HMX, or

☞ with RDX obtained by recrystallization of a mixture of I-RDX[®] and a small amount of HMX (ca 0.5 %)

behave like PBXN 109 prepared with I-RDX[®]

↪ **PBXN 109 prepared**

☞ with RDX obtained by recrystallization of a mixture of I-RDX[®] and a higher amount of HMX (ca 5 %)

is more sensitive than PBXN 109 prepared with I-RDX[®]

State of the Art

HMX role

Now the question is:

What will happen if we remove HMX from the standard Bachmann RDX or decrease (to less than 0.5 %) its residual content?

RS-RDX update

RS-RDX production

• Production, by crystallization, of two batches of low HMX (<0.5 %) Bachmann RDX (Batch 1 and Batch 2)

RDX identification	Sieve (µm, % retained)				Mean diameter (laser µm)	HMX content %
	800	315	150	74		
Batch 1	0	41	72	89	323	0.2
Batch 2	0	29	68	86	313	0.4

Results in **red** do not fulfil MIL spec class 1

RS-RDX update

PBXN 109 production

Preparation and characterization of the corresponding cast cured compositions with Batch 1 and Batch 2 RDX

RDX identification	Density	Mechanical properties		Shore Hardness
		Sm (MPa)	Em (%)	
Batch 1	1.689	0.30	37.5	50
Batch 2	1.692	0.44	24.8	54
Reference Mean value for PBXN 109 (standard deviation)	1.674 (0.008)	0.52 (0.09)	40 (12)	53 (6.4)

RS-RDX update

PBXN 109 Evaluation

Gap test (ISGT) results at t_0 and after ageing 10 weeks at 60°C with « fresh » Batch 1 and Batch 2 **RDX**

RDX identification	ISGT result at t_0		After 10 weeks at 60C	
	Card number	Barrier Pressure kBars	Card number	Barrier Pressure kBars
Batch 1	140	53.7	145	51.2
Batch 2	135	56.4	145	51.2
PBXN 109 Reference values	135-145	51.2-56.4	No change after ageing	

RS-RDX update

PBXN 109 Evaluation

Gap test (ISGT) results at t_0 and after ageing at 60°C **with aged** batch 2 **RDX** (3 and 6 months)

RDX identification	ISGT result at t_0		ISGT on PBXN 109 aged	
	Card number	Barrier Pressure kBars	3 months	6 months
Batch 2	145	51.2	51.2	40.4-44.4
PBX N 109 Reference values	135-145	51.2-56.4	No change after ageing	

RS-RDX update

PBXN 109 Evaluation

From the shock sensitivity test results on PBX N 109
obtained so far

↪ **Removal** (down to 0.5 %) **of HMX** from
Bachmann RDX **lead to RS-RDX**

↪ **but** there is evidence of **reversion after
ageing**

RS-RDX update

RDX crystal characterization

Characterization techniques:

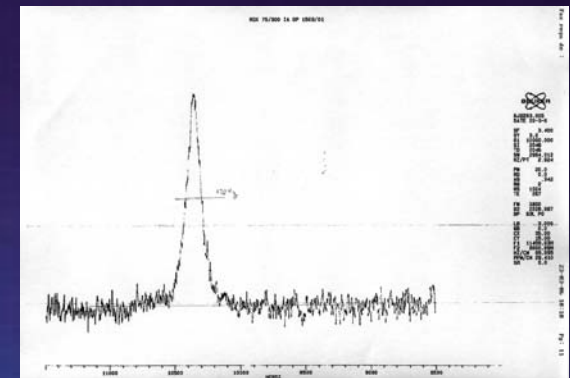
- NQR
- DSC
- defects quantification
 - matching refractive Index microscopy
 - density, solvent and water content

RS-RDX update

RDX crystal characterization

NQR results

RDX type	Peak width (Hz)	Process
ADI	125	Woolwich
BAE Royal Ordnance RDX	114	Woolwich
EURENCO I-RDX	123	Woolwich
DYNO RS-RDX	197	Bachmann
BAE OSI	320	Bachmann
EURENCO MI-RDX	329	Woolwich
DYNO Type II RDX	429	Bachmann



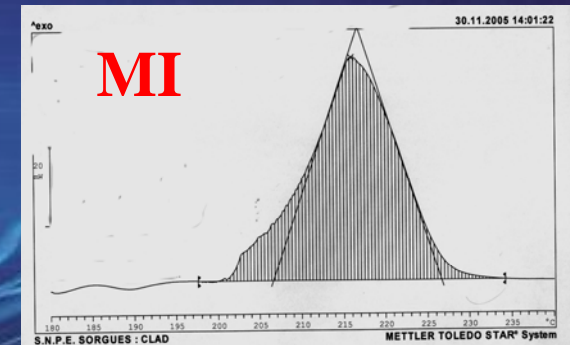
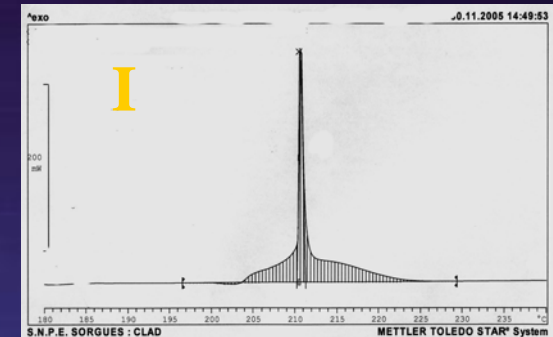
↳ No detectable
peak for both
RDX samples

RS-RDX update

RDX crystal characterization

Advanced DSC results

RDX type	Character	Process
ADI	I	Woolwich
BAE Royal Ordnance RDX	I	Woolwich
EURENCO I-RDX	I	Woolwich
DYNO RS-RDX	intermediate	Bachmann
BAE OSI	MI	Bachmann
EURENCO MI-RDX	(I)	Woolwich
DYNO Type II RDX	MI	Bachmann
Batches 1 and 2	intermediate	Bachmann

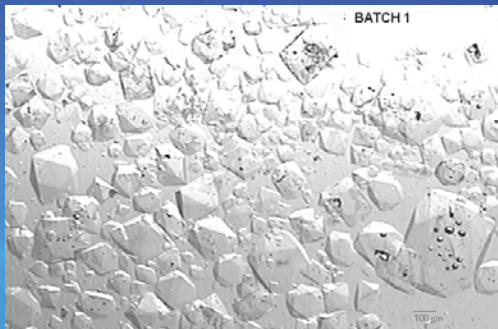


RS-RDX update

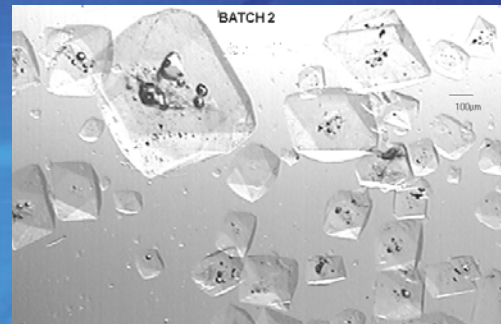
RDX crystal characterization

Internal defects measurement

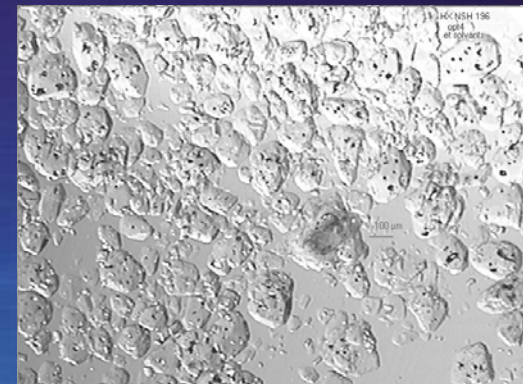
Matching refractive Index microscopy



Batch 1



Batch 2



Standard Bachmann RDX

RS-RDX update

RDX crystal characterization

Internal defects measurement

RDX type	Batch 1	Batch 2
Solvent content (ppm)	1020	4800

Batch 1 further characterization

Characterization method	Fraction >315 μm	Fraction 150-315 μm	Fraction < 150 μm
HMX content (%)	0.1	0.2	0.5
HPLC (CyOx content, ppm)	125	120	150
Solvent content (ppm)	3590	690	70
DSC (Insensitive Character)	I	Intermediate	MI

RS-RDX update

RDX crystal characterization

Conclusions

↳ **NQR and Advanced DSC** do not seem appropriate for RS character determination for Bachmann RS-RDX .

↳ **A high solvent content** (Batch 2) does not seem to alter significantly the initial shock sensitivity, but may be a reason for the observed evolution after ageing.

↳ **Advanced DSC** seems to be very sensitive to residual HMX content.

Conclusions

↳ **EURENCO** has introduced a RDX quality called **I-RDX[®]** which confers **low shock sensitivity** to the corresponding cast PBX compositions

↳ This low sensitivity is **maintained after ageing** whatever the ageing conditions.

↳ From the work done in the field of RS-RDX

-there are **other producers of RS-RDX**

-residual content of **HMX** seems to **play a role**

Conclusions

From the update presented here:

↳ If standard Bachmann RDX is not Reduced Sensitivity (or may not remain),

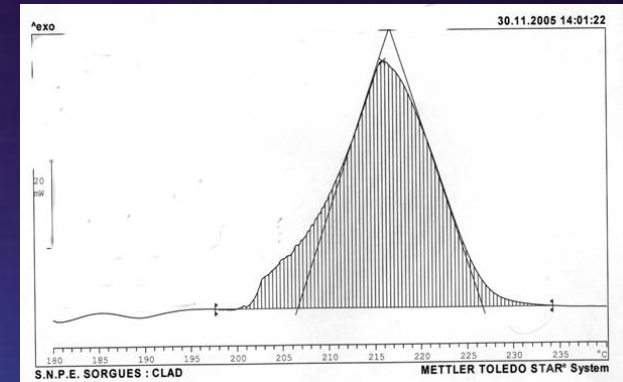
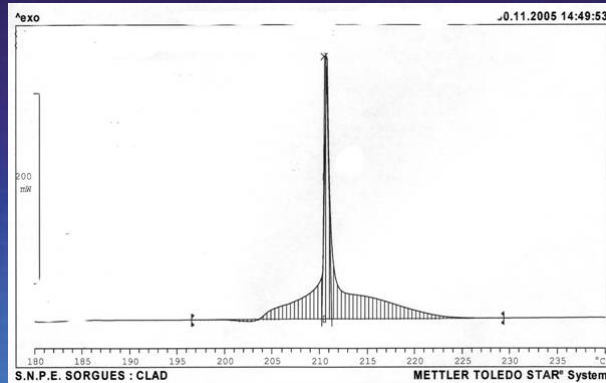
↳ **Removal of** most (to less than 0.5 %) of the **HMX** from Bachmann RDX may **not** be **enough** as reversion of shock sensitivity after ageing has been observed.

↳ There is still no reliable technique to distinguish RS-RDX from standard RDX at crystal level

Conclusions

Anyhow

En route
now
for



V.I.P.
(Very Insensitive Products)

Thank you very much for your attention