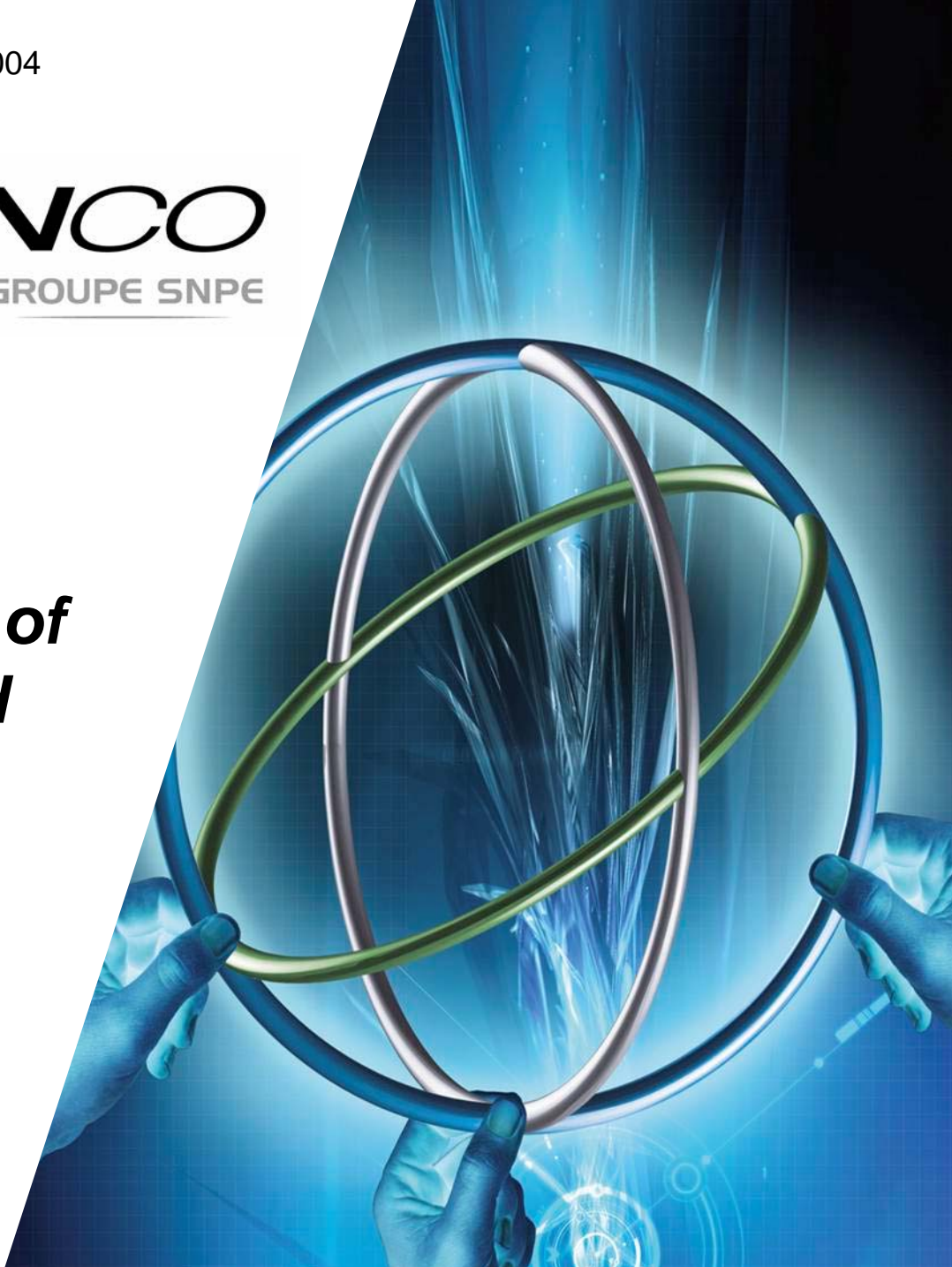




***Ageing of I-RDX[®] and of
compositions based
on I-RDX[®]***

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PRESENTATION OUTLINE

STATUS OF I-RDX[®]

AGEING OF COMPOSITIONS BASED ON I-RDX[®] or IH-RDX

RDX AGEING

FURTHER ANALYTICAL INVESTIGATIONS

CONCLUDING REMARKS

Status of I-RDX[®]

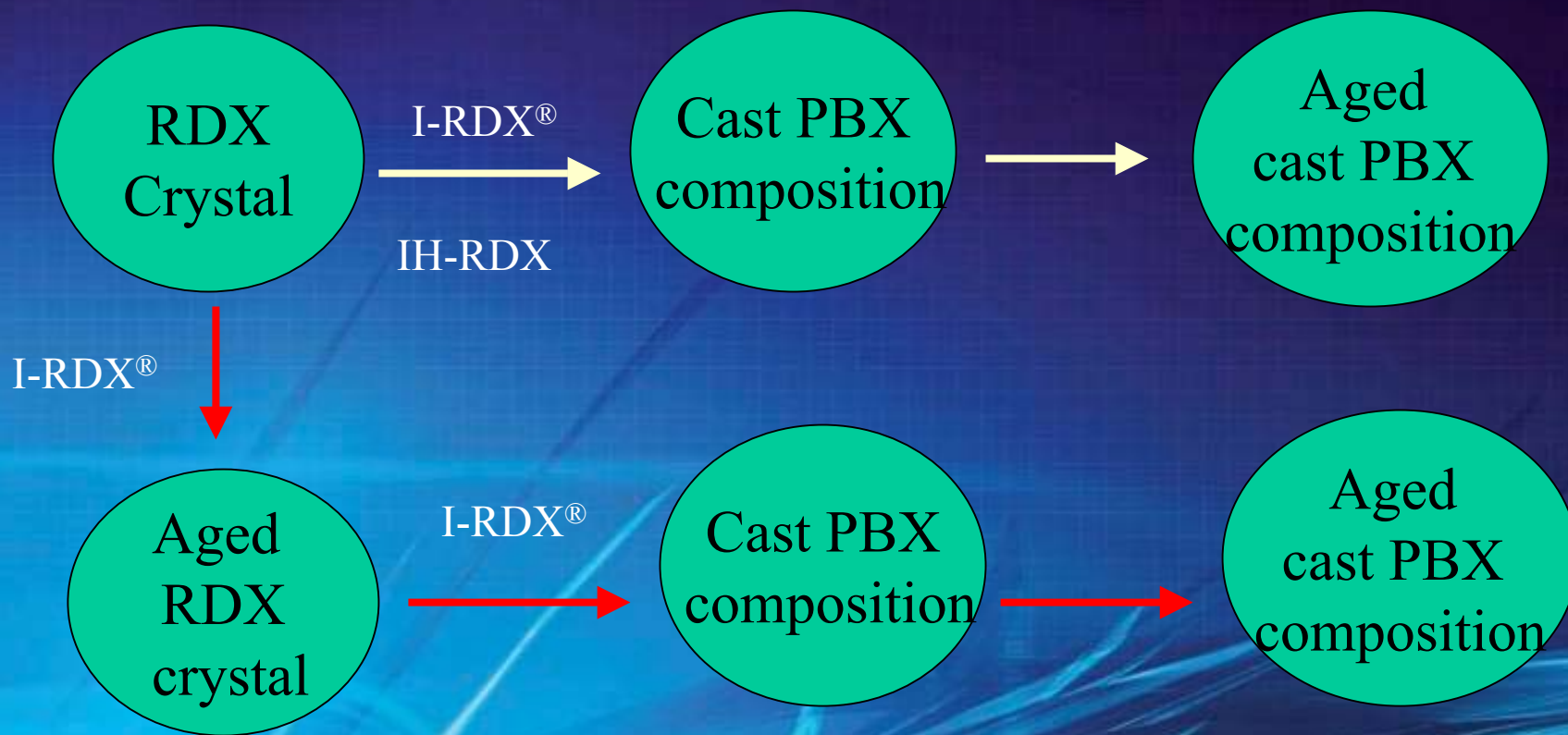
- A special RDX with a **lower level of shock sensitivity** than regular RDX, obtained by a specific and **unique recrystallization process** patented by EURENCO
- This quality of RDX, has been industrially produced at Sorgues plant for **more than 40 years**
- Up to now, this low shock sensitivity of I-RDX[®] is **mainly acknowledged when I-RDX[®] is used in Cast PBX**

Status of I-RDX[®]

The insensitive character of I-RDX[®] is highly reproducible.
This is proven by LSGT test results such as:

Name	composition	sampling	Barrier pressure Mean (kbars)	Standard deviation (kbars)
HBU88 A	I-RDX [®] = 88 % HTPB = 12 %	6 different lots of I-RDX [®] tested during 1987-95	50	3
HBU 88 B (B 2263 A)	I-RDX [®] = 88 % HTPB = 12 %	3 different lots tested during 2001-2004	50	3
B2213	I-RDX [®] = 64% Al = 20 % HTPB = 16 %	5 different lots tested during 1997-98	56	3
PBXN-109	I-RDX [®] = 64% Al = 20 % HTPB = 16 %	12 different lots of I- RDX [®] tested during 2002- 03	54	2

Ageing of compositions



Ageing of compositions

- ageing of compositions prepared with « fresh » I-RDX[®]

Composition	RDX nature	Cast PBX ageing conditions	LSGT results (kbars)	
			To	Aged
HBU 88 A	I-RDX [®]	13 years room temperature	50	51
B 2263 A	I-RDX [®]	3 months 60°C	51	49
B 2213	I-RDX [®]	6 months 60°C	56	57

No significant evolution

Ageing of compositions

- ageing of compositions prepared with « fresh » IH-RDX

Composition	RDX nature	Ageing conditions	LSGT results (kbars)	
			To	Aged
B 2263 A (HBU 88 B)	IH-RDX (EURENCO recrystallization of Bachmann crystallized RDX)	3 months 60°C	44	38.5
		9 months 60°C		33
		9 months room temperature		37

**Indication of
reversion of shock
sensitivity**

Ageing of compositions

- compositions prepared with aged I-RDX[®]

composition	I-RDX [®] ageing conditions	LSGT result after ageing (kbars)	LSGT reference value (kbars)
PBX N-109	I-RDX [®] aged dry 8 months at room temperature	54	m = 54 σ = 2
PBX N-109	I-RDX [®] aged 3 months in Isopropyl alcohol/water at room temperature	52	m = 54 σ = 2
B 2263A	I-RDX [®] / DOA aged 18 months at room temperature	47 *	m = 50 σ = 3

*the initial (To) LSGT value with I-RDX[®]/ DOA is 50 kbars

No significant evolution

Ageing of compositions

- ageing of compositions prepared with aged I-RDX[®]

Composition	I-RDX [®] ageing conditions	Cast PBX ageing conditions	LSGT results (kbars)	
			To	Aged
PBXN 109	I-RDX [®] aged 3 months in Isopropyl alcohol/water at RT	3 months 60°C	52	52
B 2263 A	I-RDX [®] / DOA aged 18 months at room temperature	2 months 60°C	47	50

No significant evolution

Ageing of compositions

- **Conclusions**

- With I-RDX® there is no evidence of any modification of shock sensitivity after ageing
- With IH-RDX (EURENCO recrystallization of Bachmann RDX), **reversion** of shock sensitivity is observed .

Ageing of compositions

- RDX may be obtained by two different processes:
 - Woolwich or nitric acid process (type I: almost no HMX)
 - Bachmann or aceto-nitric process (type II: HMX content usually 4-17 %)
- *What is causing the initial insensitivity?*
- *What is the ageing affecting ?*

RDX Ageing

- **Base of the study:**
 - **Five different qualities of RDX class 1 MIL differing by:**
 - **Their origin (or process of production)**
 - **Their HMX content**
 - **Their crystallization process (EURENCO or not)**

RDX Ageing

- Ageing conditions

15 %
Water/Isopropyl alcohol
2/1

DOA 5%

Carnauba wax
(RDX/ Carnauba 85/15)

-Room temperature ageing : 6 months

-Accelerated ageing (60°C): 30 days

RDX Ageing

Products and characterization methods

Reference	Quality	Particle size (µm)	HMX content (%)
I-RDX®	I-RDX®	211	0,1
A	I-RDX® + 10% HMX	206	9,0
B	Crystallized Bachmann RDX	143	11,8
C	B recrystallized by EURENCO	297	11,7
D	EURENCO recrystallized crude Bachmann RDX	228	5,4

Infra-red
Spectroscopy

HPLC

DSC

Particle size

Morphology

RDX Ageing

- Conclusions

Based on the classical techniques used in this study to characterize the crystals, whatever the ageing conditions and the nature of RDX

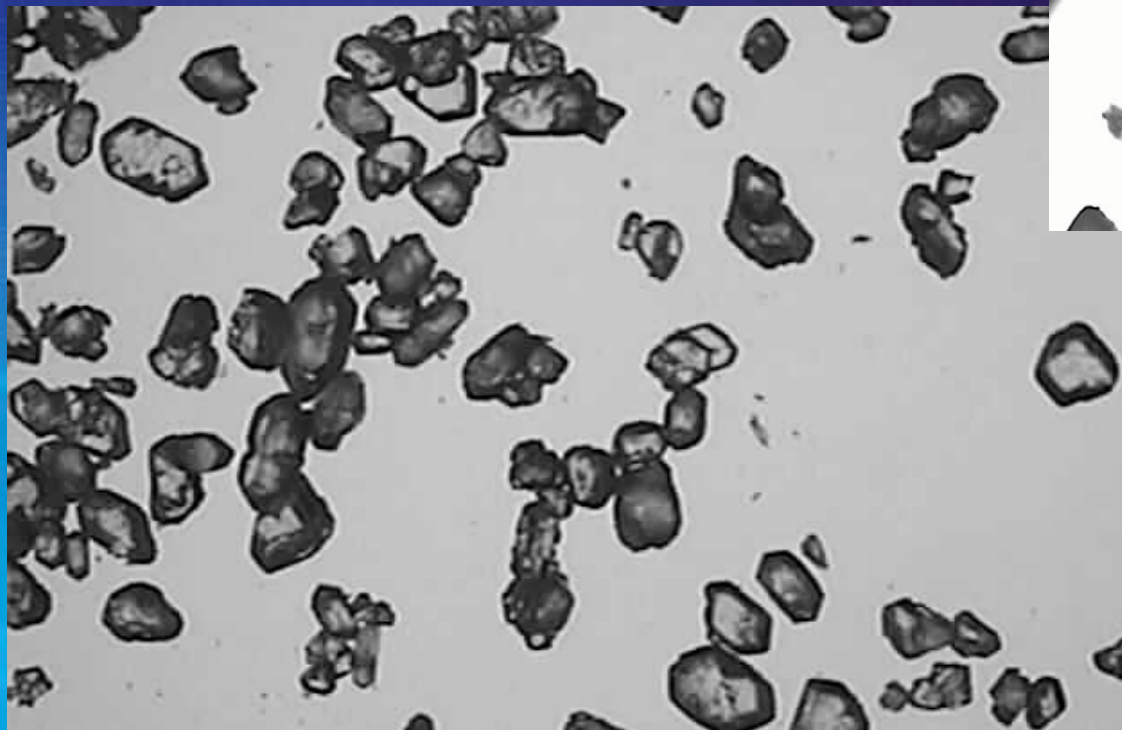
**No significant
evolution**

Further analytical investigations

- Ageing must be affecting the RDX itself
 - What may explain the difference after ageing in between I-RDX[®] and IH-RDX ?
 - Is this difference due to the presence of HMX in RDX ?
 - Do we have changes of RDX crystal in the cast PBX composition after ageing ?

Further analytical investigations

HMX in RDX ?



Where ?

Further analytical investigations

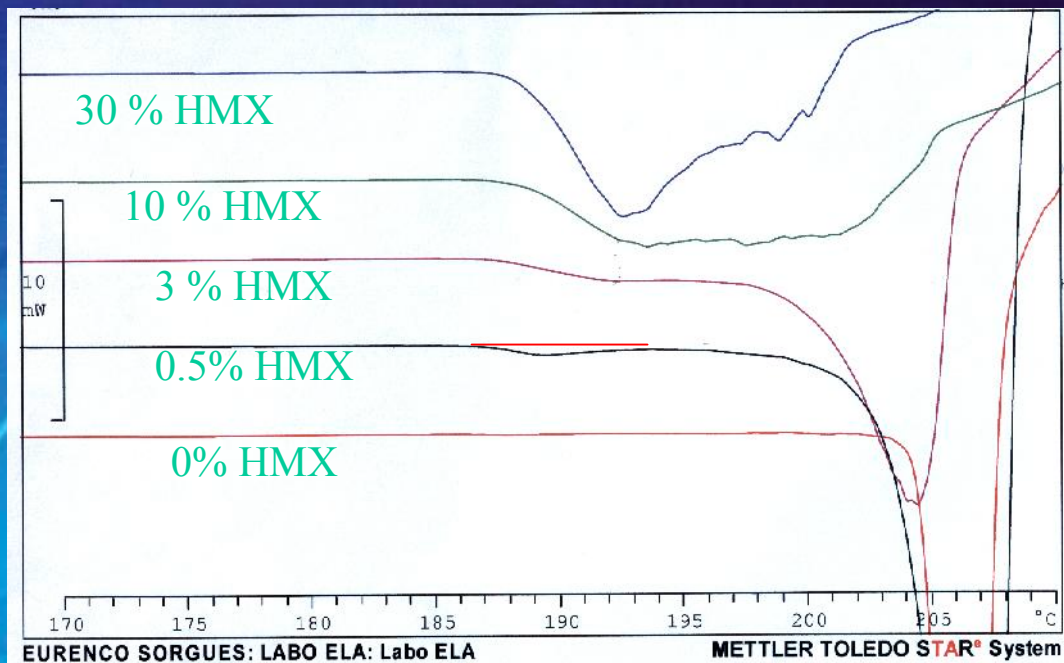
- Where is the HMX ?
 - Based on solubility data, and HMX distribution in RDX (mostly in the fines)
 - In the Woolwich process RDX and HMX are totally separated
 - In the Bachmann process, RDX and HMX are mostly separated but may be not completely (partial co-crystallization ?)

Further analytical investigations

- How to determine HMX in RDX ?
 - Flotation technique inadequate
 - 0.1 % HMX → density increase of 0.0001
 - Infra-red, DSC and HPLC for example
 - Adequate to determine the presence of HMX
 - Inadequate to say if HMX is in or out of RDX crystal

Further analytical investigations

- HMX in RDX ?
 - By DSC, modification of the endotherm associated with melting



Further analytical investigations

- Changes of RDX crystal in cast PBX after ageing
 - **NQR** measurements on cast PBX compositions

Composition	RDX nature	Cast PBX Ageing conditions	NQR W ½ (Hz)	LSGT (kbars)
PBX N 109	I-RDX[®]	No	157 (145-179)	54
		4 years RT	164	
B 2263 A	I-RDX[®]	No	154	50
		1 year RT*	207	50
	IH-RDX	9 months RT	333	37

*Aged (18 months) I-RDX[®]/DOA

Concluding remarks

- **EURENCO produce from RDX obtained by Woolwich process a unique low shock sensitivity RDX called I-RDX[®]**
- **For this I-RDX[®], ageing of the raw material itself and ageing of compositions prepared with fresh or aged I-RDX[®] do not alter the low shock sensitivity of the cast PBX compositions**

Concluding remarks

- **For IH-RDX (obtained by EURENCO recrystallisation of RDX from Bachmann process), ageing may show alteration of low shock sensitivity**
- **Further work is still needed to understand this evolution with time**