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# **Aging Evaluation of Certain Reduced sensitivity RDXs in a Formulation Based on a Wax Binder System**

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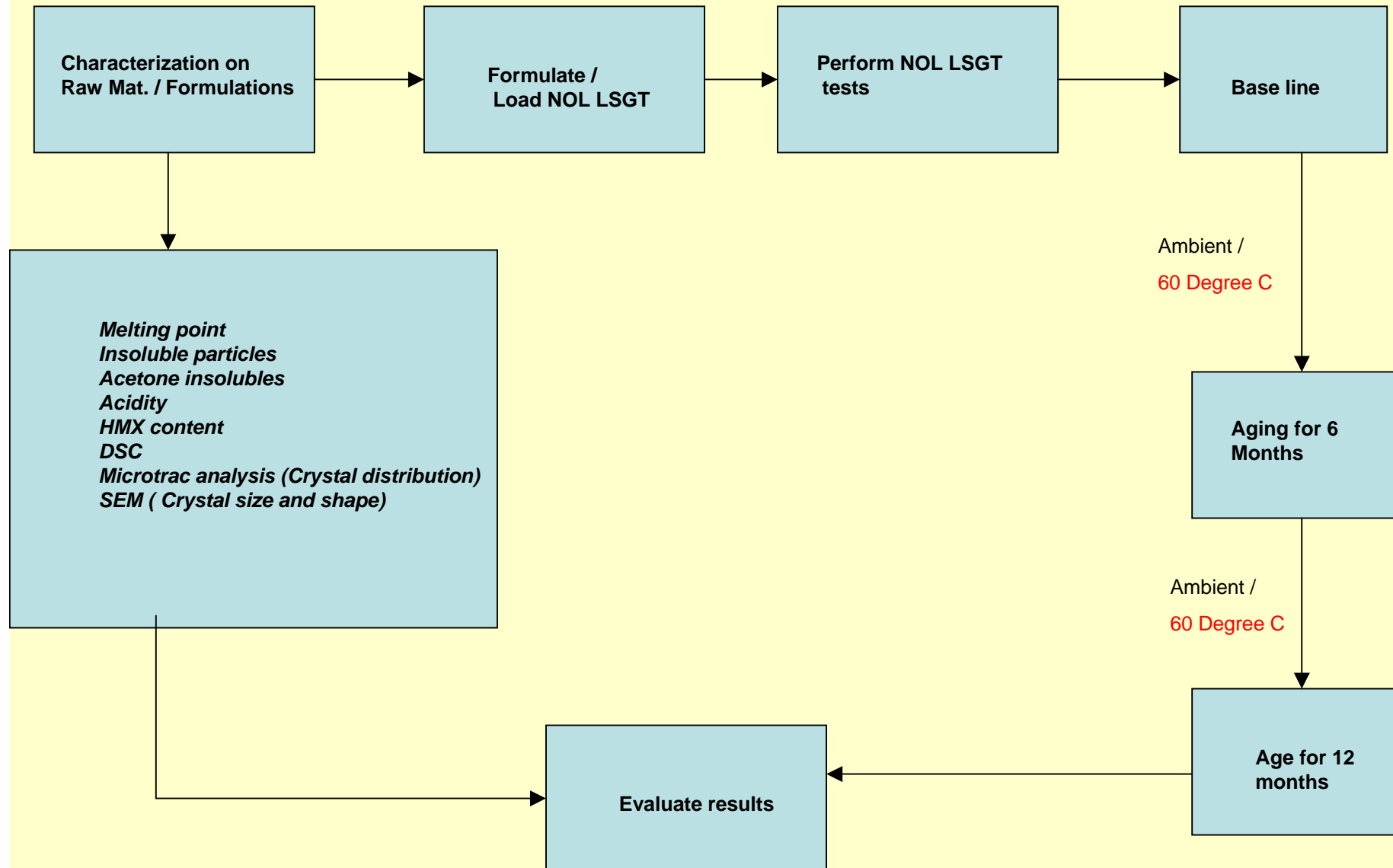
# Purpose of the Study

- The purpose of the study was to quantify an aging sensitization effect that had been observed in a formulation made with a certain desensitized RDX and attempt to identify the cause.

# TEST EXPLOSIVES

- The experimental melt cast formulation (inert binder) PAX/AFX194 was studied using three versions of RDX:
  - US Type II RDX (referred to as HRDX)
    - A particular HRDX supply (“project standard”) was used throughout
  - Type I I-RDX<sup>®</sup> produced by Eurenco (SNPE)
    - All from a single lot with Class V made by grinding Class I
  - SNPE reprocessed US Type II according to the process used to produce I-RDX<sup>®</sup> (referred to as HIRDX)
    - Two separate HIRDX lots, produced 12 months apart, were utilized with Class V made by grinding
    - The first lot was made from the “project standard” Class I

# Scope of the Program



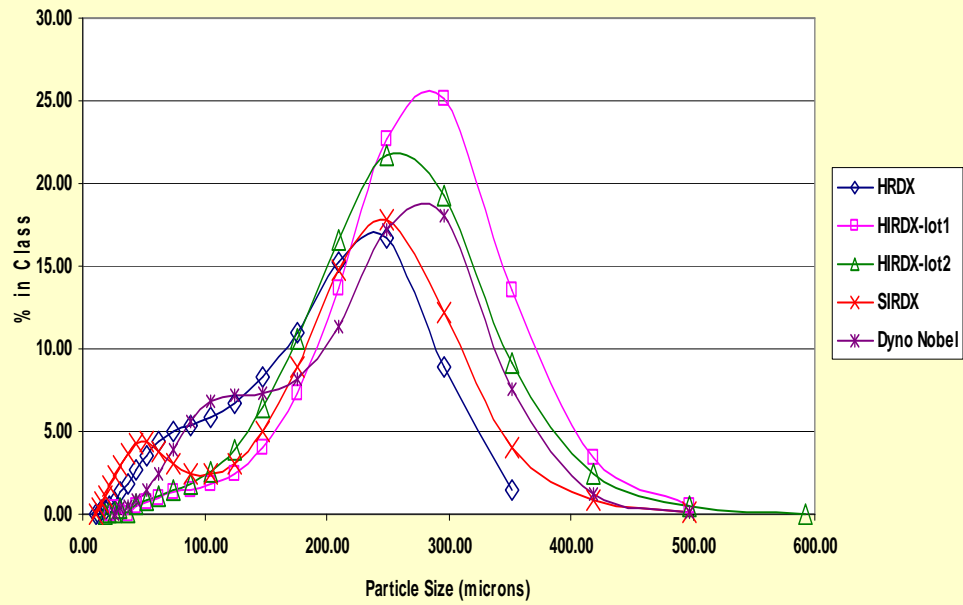
# Testing and Analyses

- Tools employed to examine the HIRDX were:
  - Particle size measurements
  - SEM photography
  - Chemical assay of cast charges
  - HMX impurity determinations (HPLC)
  - DSC & Melting point determinations
  - Extensive NOL LSGT testing
  - Standard Safety tests

# Particle Characteristics

- No obvious change in HIRDX Lot #1 particle size distribution from 2000 to 2002 was indicated
- SEM did not show differences between the two Lots of HIRDX nor changes with time and only subtle differences between HIRDX and I-RDX®

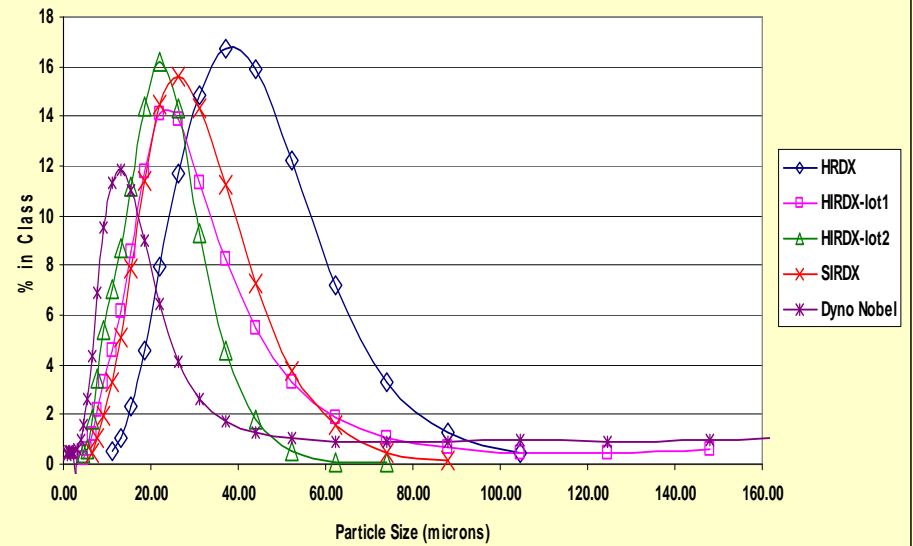
Particle Size Distribution for various Class 1 RDX materials



## Class I

## Class V

Particle Size Distribution for various Class 5 RDX materials



# Chemical assay

- The fraction of energetic varied from a low of 80.9 % and a high of 83.7%, so only minor variation was observed for the formulations made in this study.
- HIRDX had wide variations in HMX contaminant measurements
  - “Project standard” HIRDX values varied from 9.3% to 13.6%
  - HIRDX Lot #1 samples varied from 2.9% to 11.9% HMX



# Weight % HMX impurity

Class I material except as noted

	SNPE initial (2000)	ARDEC initial (2001)	URL initial (2003)	URL 6 months 60°C (2004)	URL 12 months 60°C (2004)
HRDX	13.6	9.3	15.5	14.5	15.6
HIRDX Lot #1	10.3	2.9 also 14.02 & 9.98	2.9	6.6	5.4
HIRDX Lot #1 Class V		10.6			
HIRDX Lot #2			1.9	6.9	4.7

ARDEC aging study starting 2003  
Class I / Class V HIRDX in ratio 3 / 1

	initial	6 months 60 °C	12 months 60 °C	12 months ambient
HRDX	11.75	10.64	11.72	12.14
HIRDX Lot #1	11.89	11.29	11.45	11.64
HIRDX Lot #2	7.01	7.04	6.72	7.7

# Melting Point Measurements

- Melting point measurements supported the HPLC values for HMX impurity
  - Melting temperature approximately linear with weight % HMX impurity:

$$T_m(^{\circ}\text{C}) = 205.4 - .562(\text{wt.}\% \text{ HMX})$$

for the range up to 15 wt% HMX

## Melting Point of Class I material (°C)

	Initial at SNPE 2000	Received at ARDEC 2001	URI Start of aging study 2003	ARDEC Start of aging study 2003	6 month ambient	6 month 60°C	12 month ambient	12 month 60°C
HRDX	197 13.6%	191 9.3%	189~192	192	190~191	190~191	190~191	190~191
HIRDX Lot #1	198 10.3%	198 2.9% (also 196 different box)		194	194~195	194~195	192	192
HIRDX Lot #2			201~201	195	193~195	193~195	190	191
I-RDX®		203		203	203~204	203~204	203	203

DSC @ 5°C/minute except ARDEC "aging" used method from MIL-DTL-389D

Blue is HPLC HMX impurity value for the sample (where known)

## Melting Point of Class V material (°C)

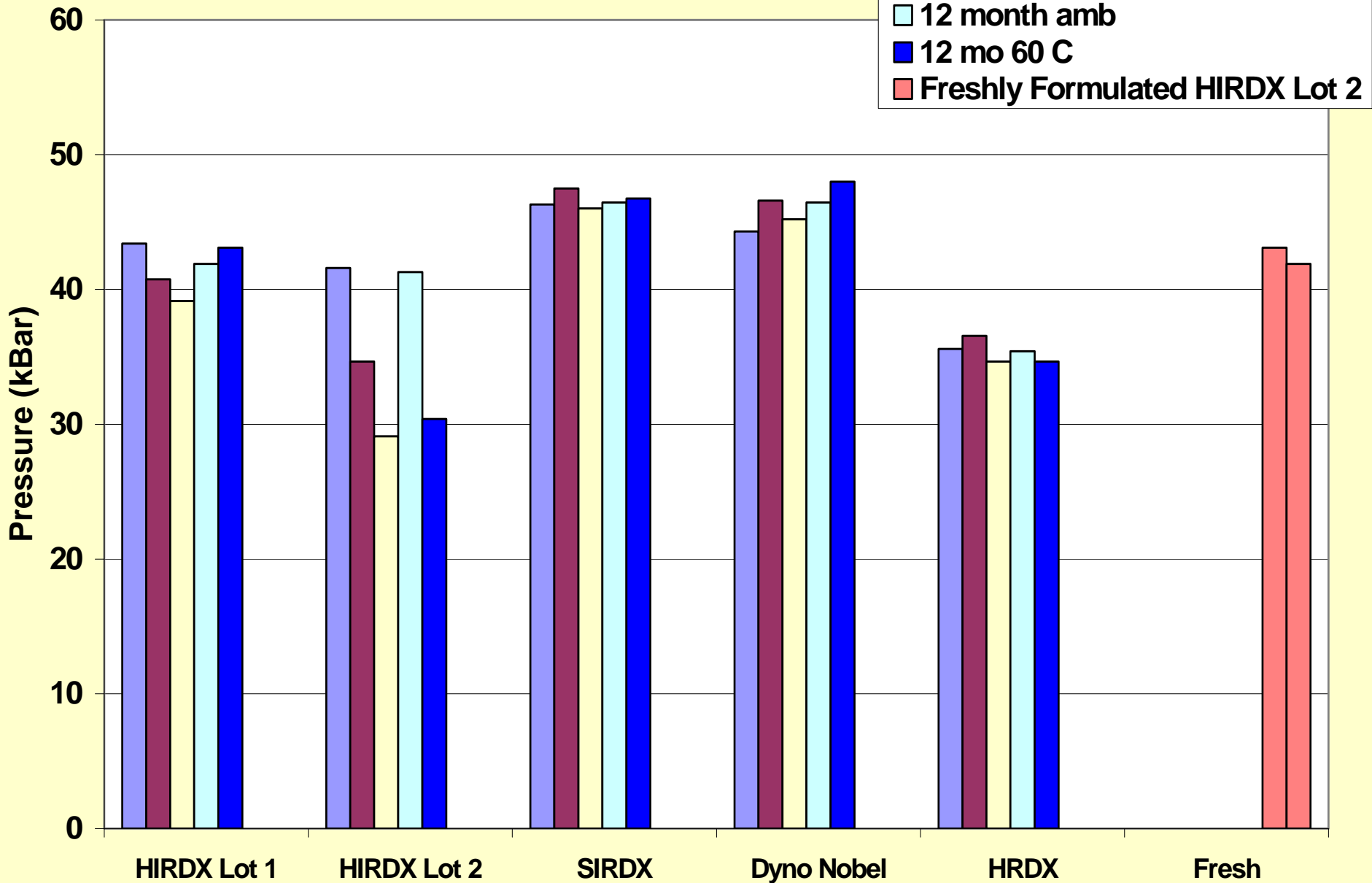
	Received at ARDEC 2001	Start of aging program 2003	6 month ambient	6 month 60°C	12 month ambient	12 month 60°C
HRDX	193 10.6%	194	192~193	192~193	192~193	192~193
HIRDX Lot #1	191 10.6% (also 195 on retest)	193	192~193	192~193	191~192	191~192
HIRDX Lot #2		194	194~196	194~196	196	197
I-RDX®	203	204	203~204	204	201~202	201~202

# Large Scale Gap Test Results

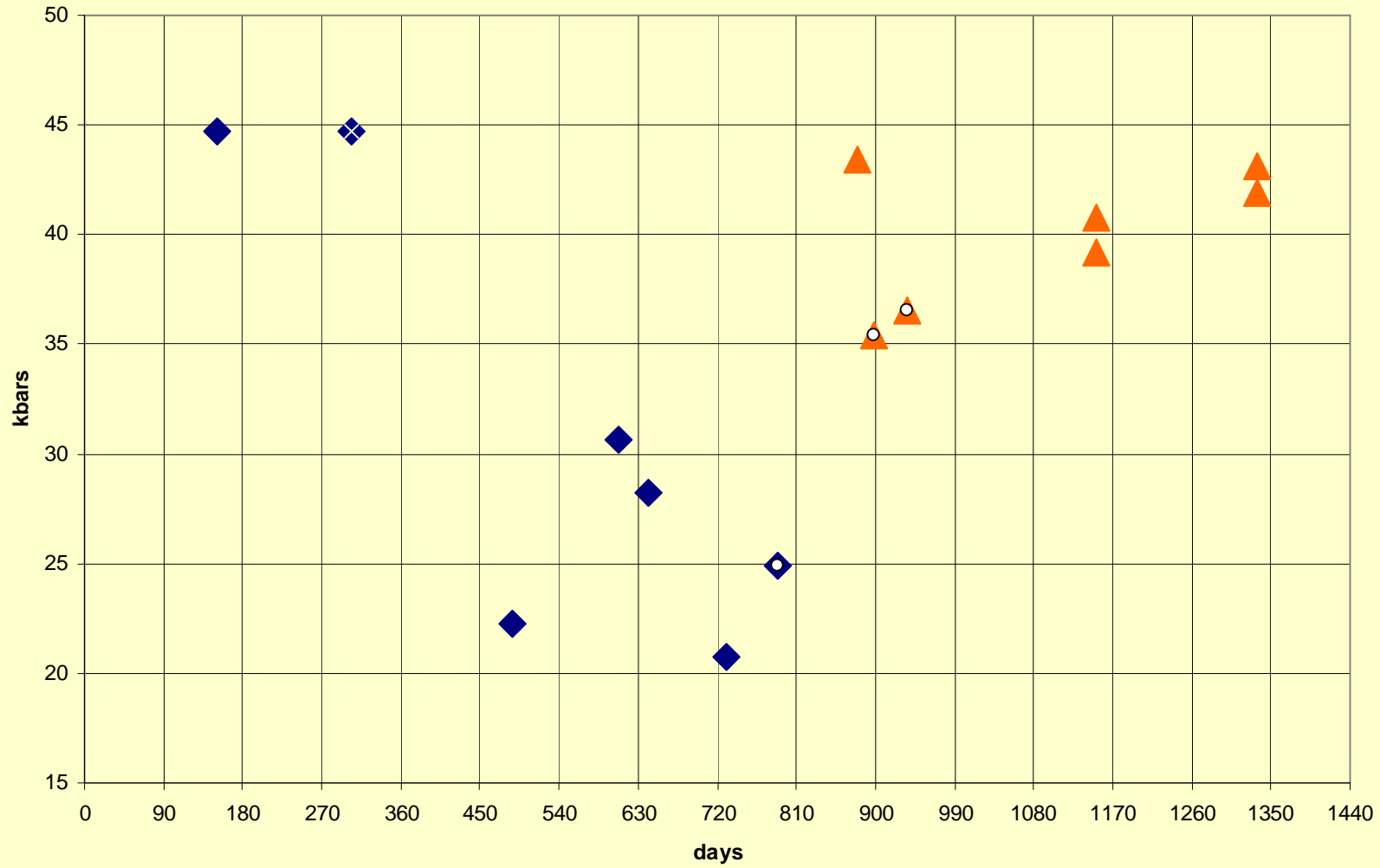
	Baseline	6 month Ambient	6 month 60 deg C	12 month Ambient	12 month 60 deg C	Freshly Formulated
Material	Kbar	Kbar	Kbar	Kbar	Kbar	
HIRDX Lot 1	43.4	40.75	39.15	41.9	43.1	
HIRDX Lot 2	41.6	34.65	29.1	41.3	30.4	
SIRDY	46.3	47.5	46	46.45	46.75	
Dyno Nobel	44.3	46.6	45.2	46.45	48	
HRDX	35.6	36.55	34.65	35.4	34.65	
Fresh HIRDX Lot 2						43.1
Fresh HIRDX Lot 2						41.9

**PAX/AFX 194:  
Large Scale Gap Test - 50% Point - Aging study results**

- Baseline
- 6 month Ambient
- 6 month 60 deg C
- 12 month amb
- 12 mo 60 C
- Freshly Formulated HIRDX Lot 2

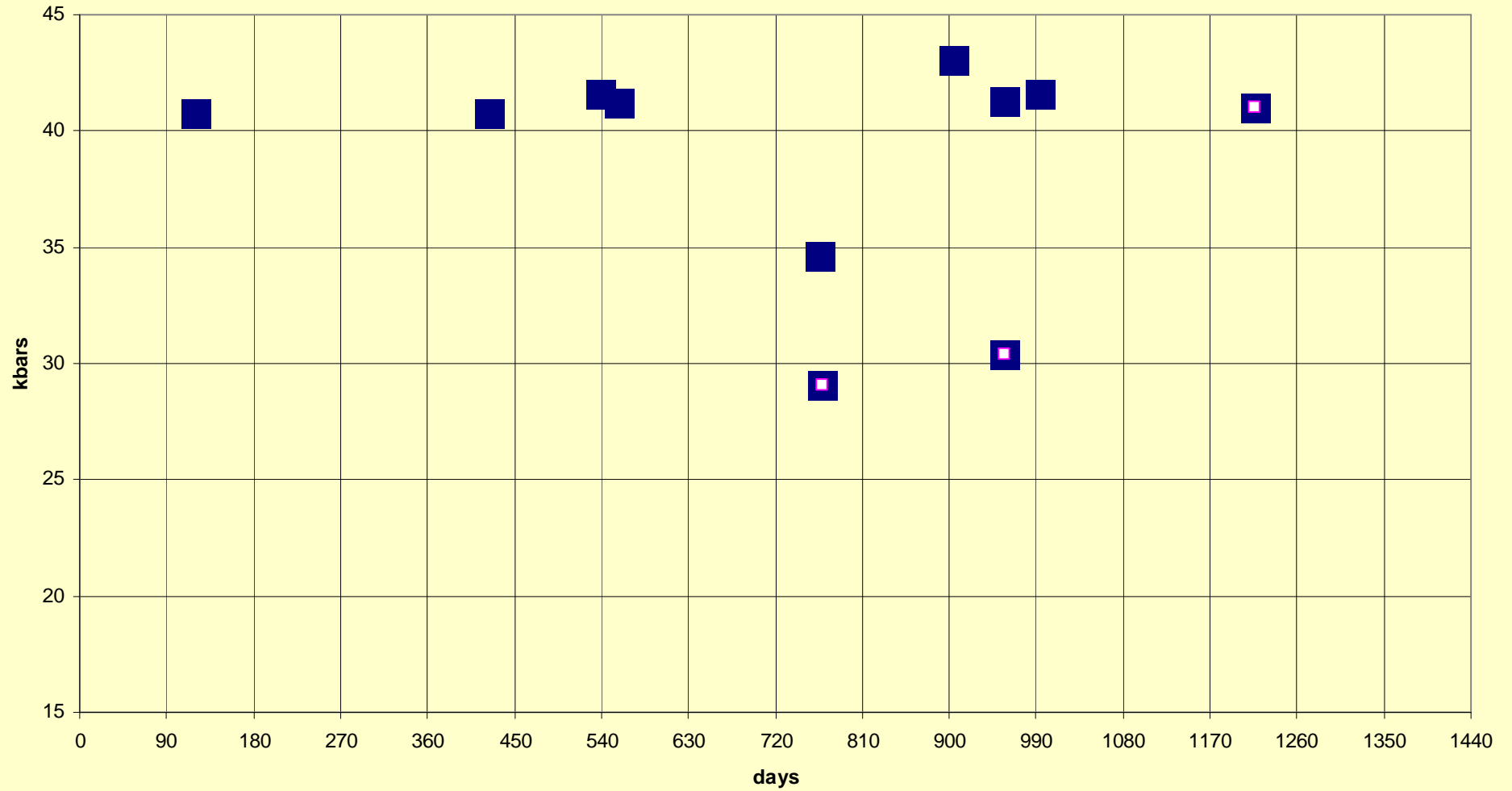


# HIRDX Lot #1



◆ non-ARDEC data    SD TEST    ▲ ARDEC    ○ downloaded M107    ○ downloaded M107

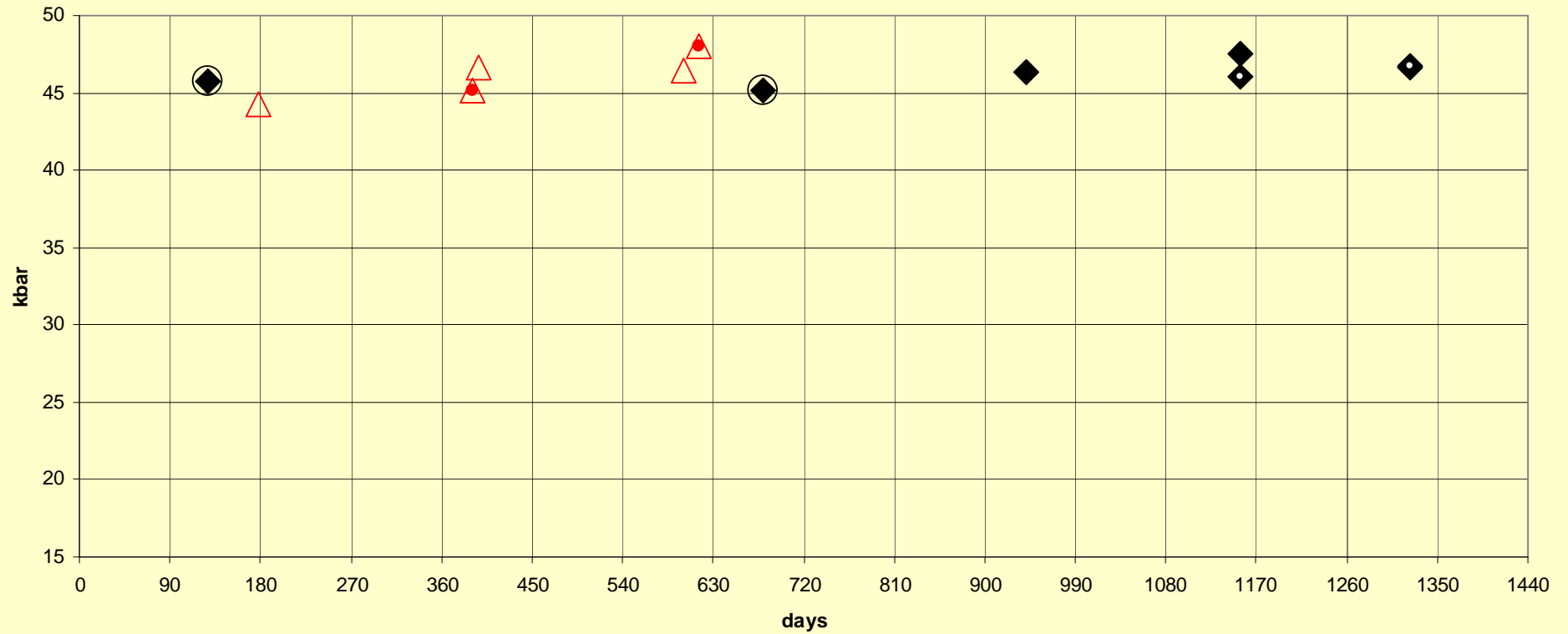
# HIRDX Lot #2



■ ARDEC Lot #2 □ aged hot



# HMX free RDX's

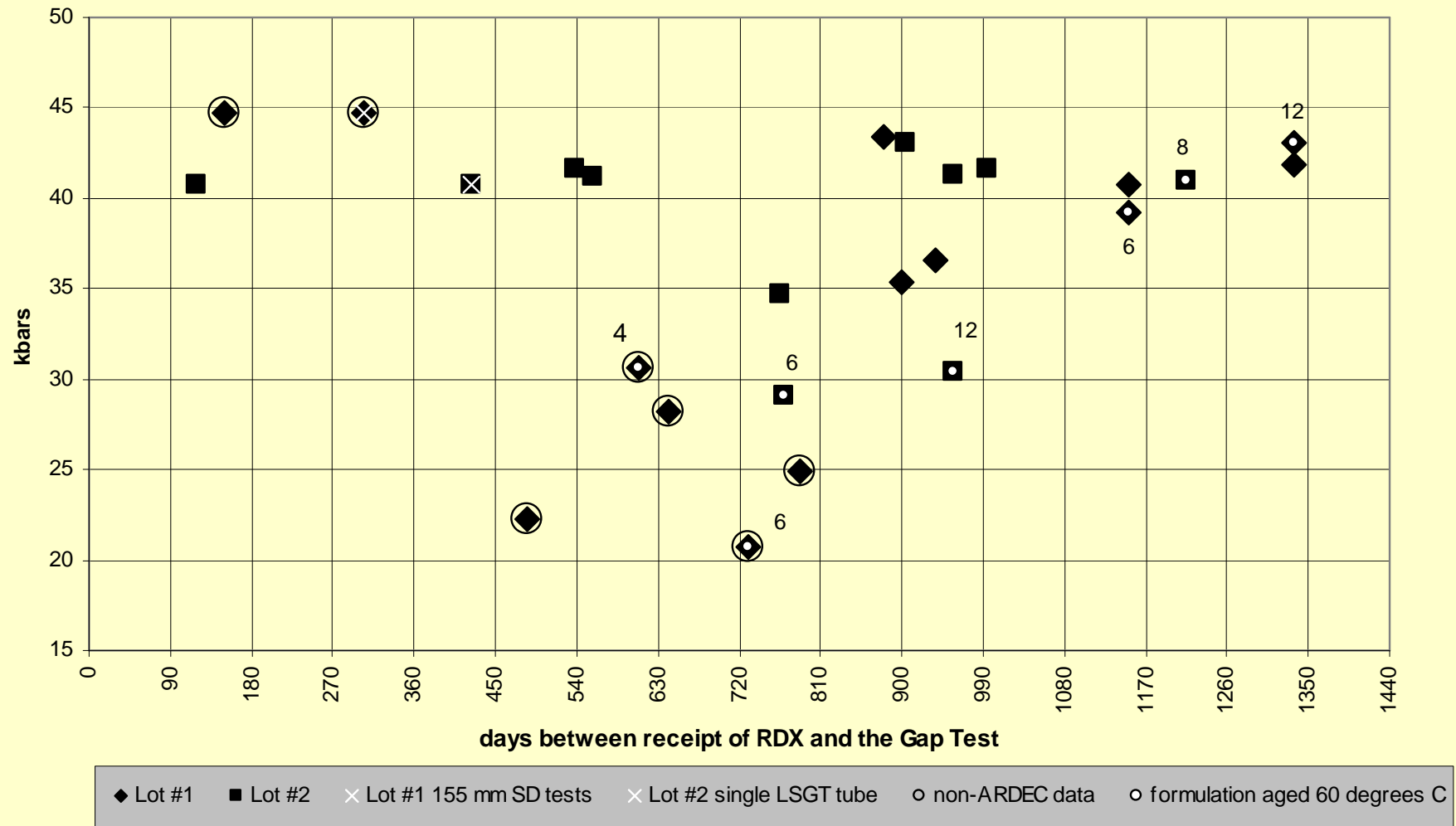


◆ PAX 194B ○ non-ARDEC data ○ formulation aged 60 degrees C △ RS-RDX ● aged hot

Dot indicates aged at 60°C

Circle indicates non-ARDEC data

# Sensitivity versus nominal age of RDX



Lot #2 data shifted by about 12 months to account for its later manufacturing date.

Numbers indicate months formulation was aged at 60 °C.

# Conclusions

- I-RDX<sup>®</sup> always gave the same good sensitivity in this formulation.
- HMX impurity was not uniformly distributed in HIRDX.
- Both Lots of HIRDX sensitized, but eventually trended back towards to their original sensitivity.
  - This was independent of being aged in the formulation or in bulk storage.
  - Samples hot aged nominally followed the pattern seen with other samples – no obvious special effect from hot aging.
  - The timeline seems to start with the date of manufacture and the pattern was roughly similar for both Lots.
  - It is not known if HIRDX would continue to change or eventually becomes stable.
  - No obvious explanation for the HIRDX sensitivity pattern was found.