

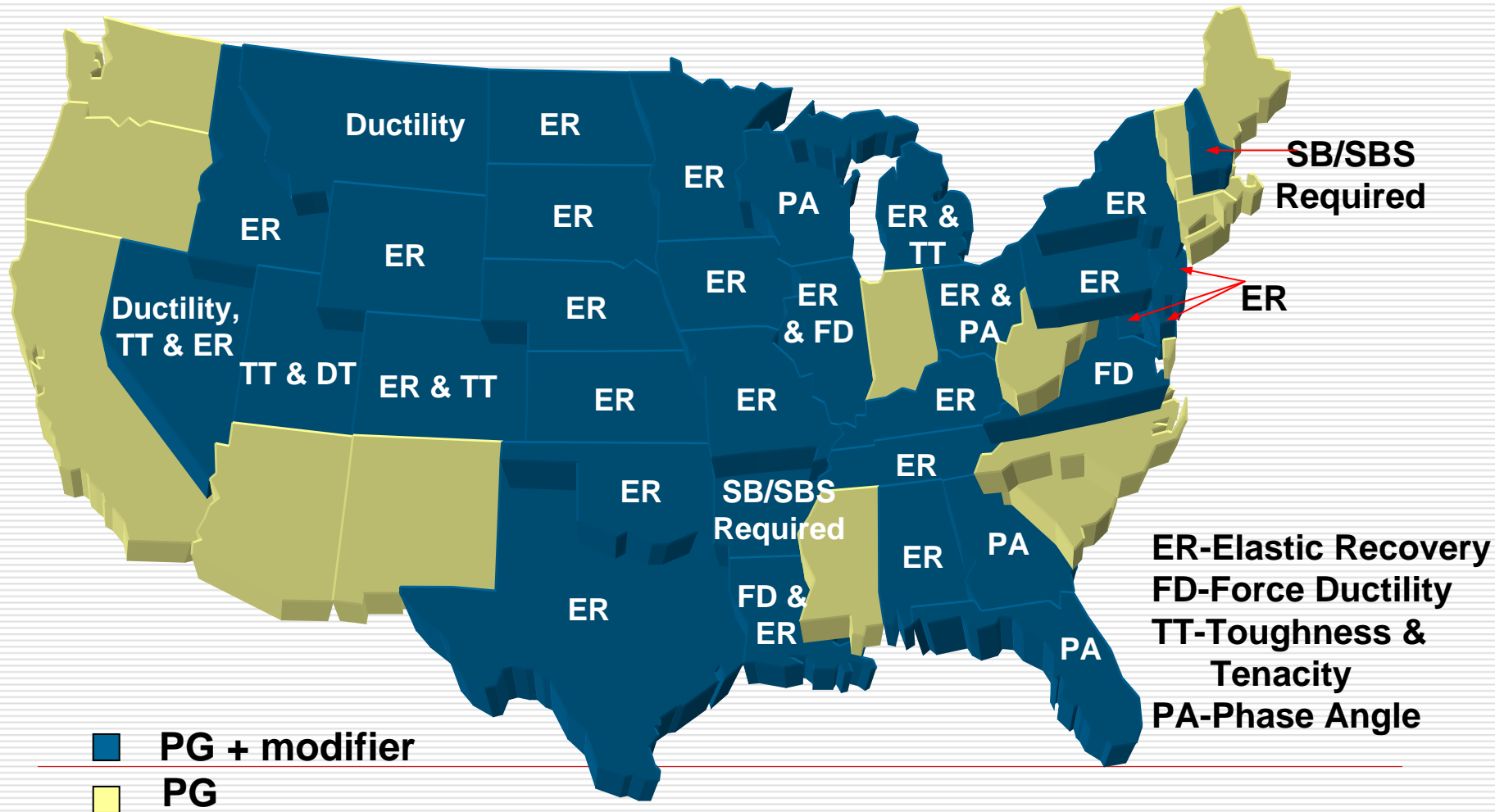
Evaluation of the Repeated Creep and Recovery Test Method as an Alternative SHRP + Requirement

John D'Angelo
Federal Highway Administration
Phone 202-366-0121 fax 202-493-2070
John.D'angelo@fhwa.dot.gov

Why Superpave Plus Specs.

- The existing SHRP specifications do not identify the performance characteristics of modified binders.
 - The existing specifications do not have a criteria for fatigue or durability.
 - Agencies look to other tests to identify modifiers
 - Elastomeric polymer modifiers are desired
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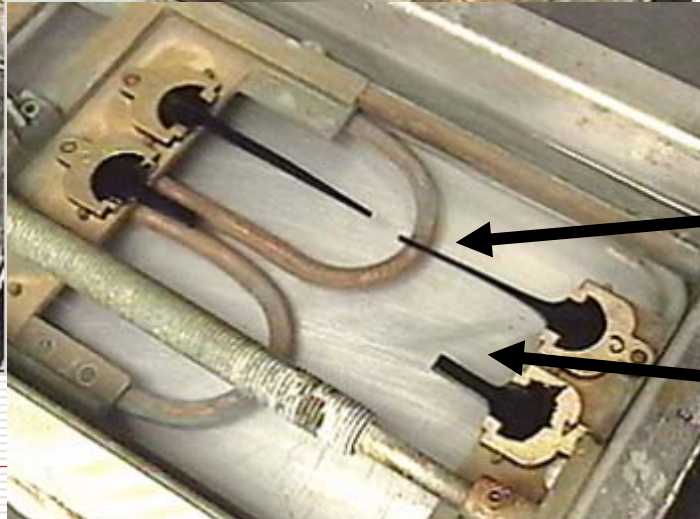
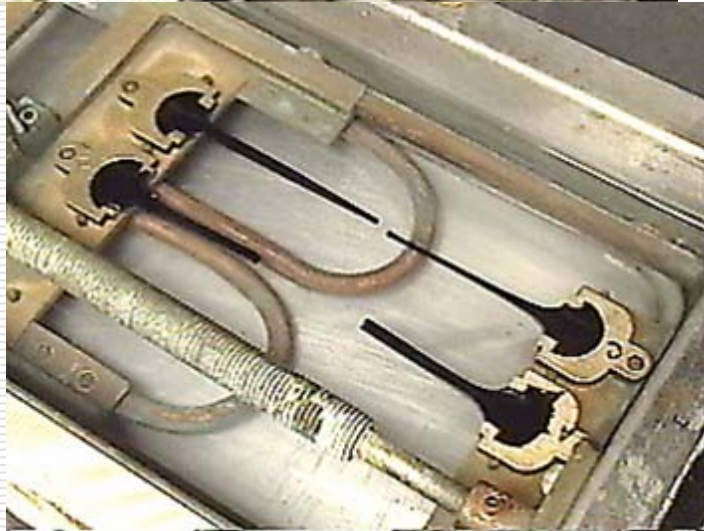
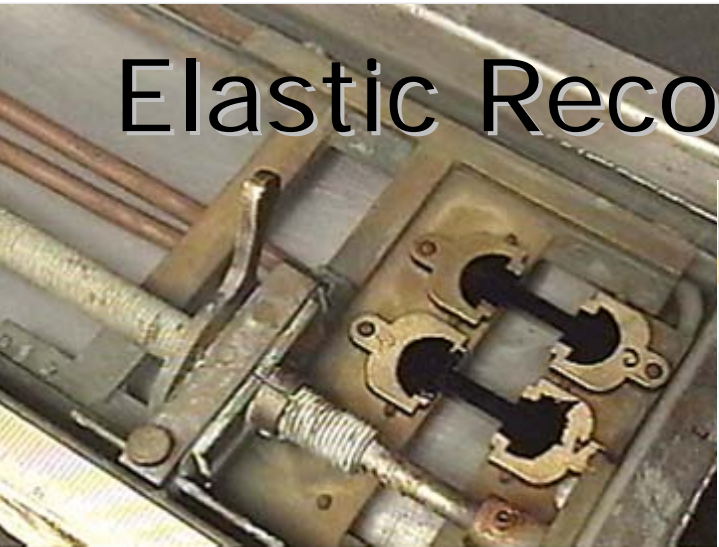
State DOT's Specifying Polymer PG (PG+)



Toughness & Tenacity



Elastic Recovery



**AC doesn't
recover**

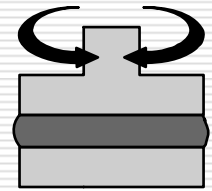
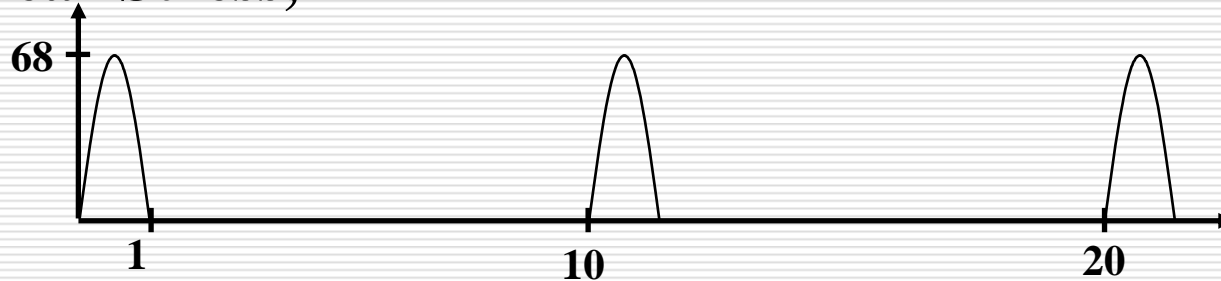
**SB modified
AC recovers**

Problem Statement

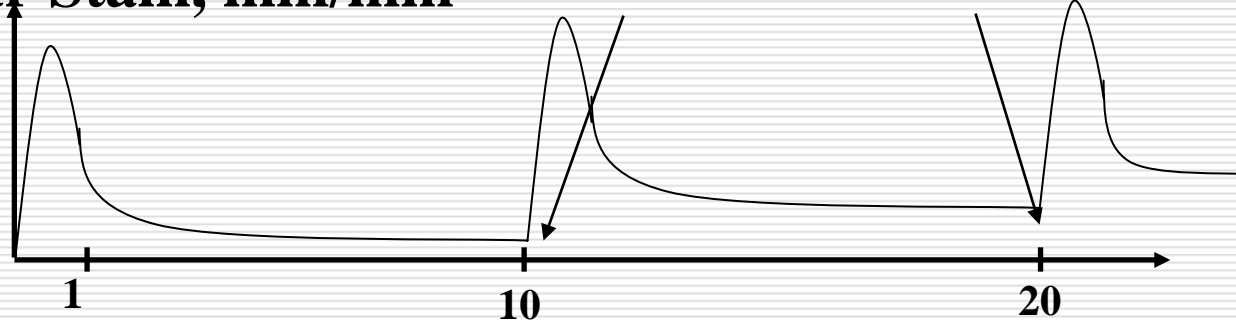
- Provide Users with alternatives to the empirical Superpave Plus tests
 - Elastic Recovery
 - Ductility/ Force Ductility
 - Toughness and Tenacity
 - Approach: Develop AASHTO/ASTM Standard Practice for Superpave Plus Specifications
 - DSR
 - Multiple Stress Creep Recovery
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NCHRP 9-10 Rutting Test Repeated Creep Recovery Test

Shear Stress,



Shear Stain, mm/mm



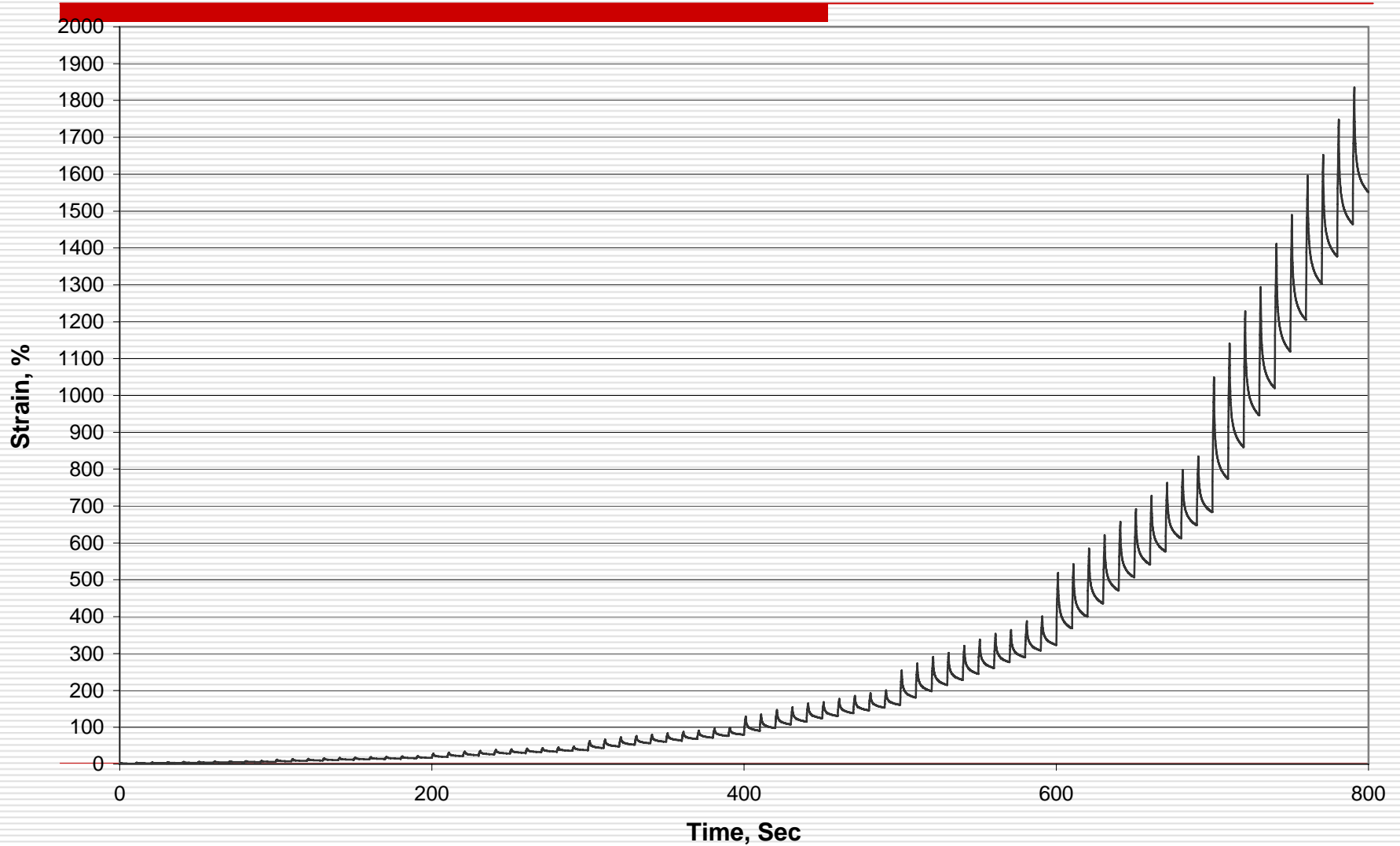
Current work on a new High Temperature Binder Test

□ New test criteria:

- Perform multiple stress levels on the same sample at reduced number of cycles.
 - Stress levels: 25, 50, 100, 200, 400, 800, 1600, and 3200 Pa.
 - Run 10 cycles at each stress level no rest periods
 - Total cycles per test 80.
-

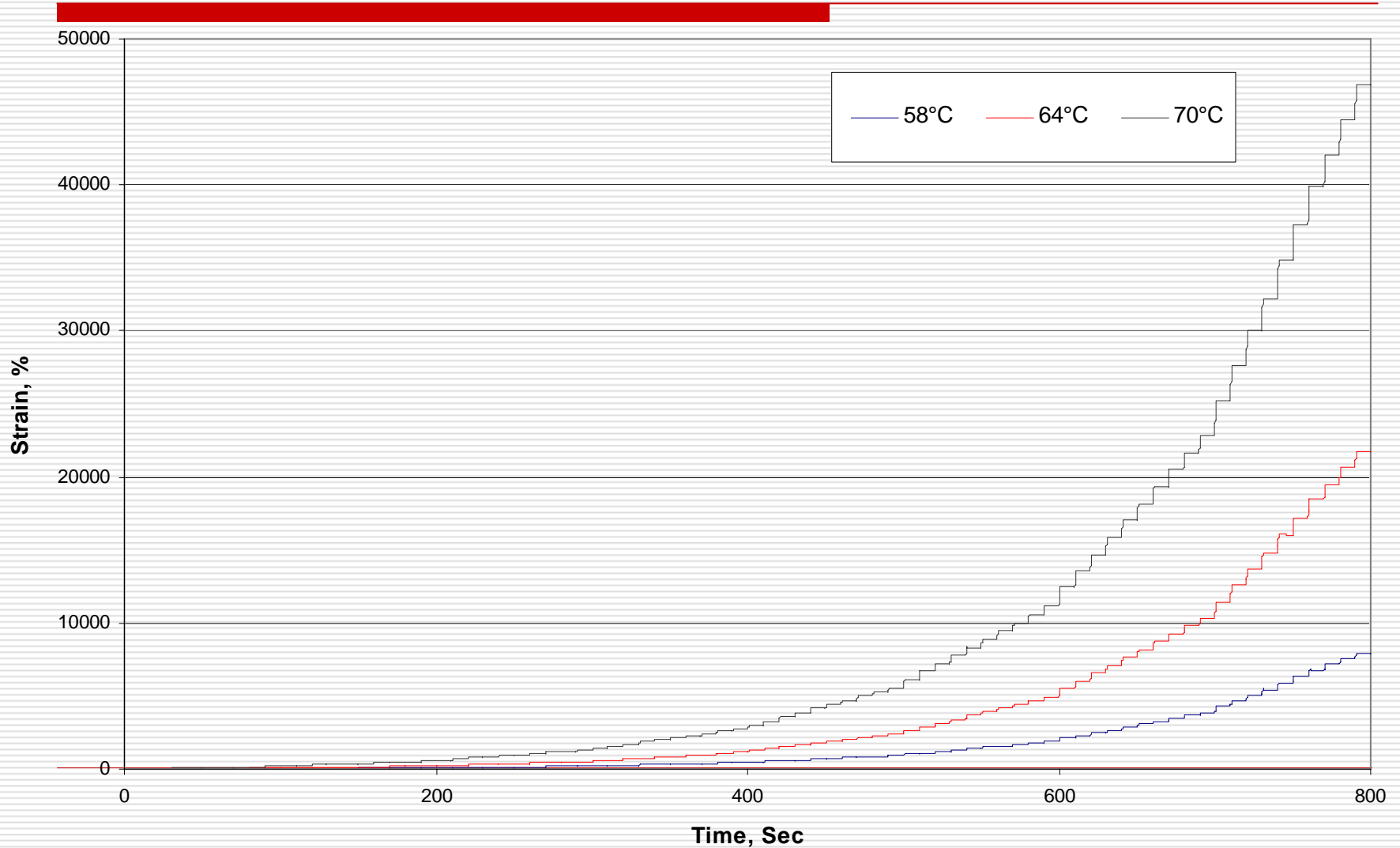
Multi-step Creep and Recovery of Polymer Binder

Sample B6280, Multi-Stress (25-3200Pa) Creep Recovery Data at 70°C

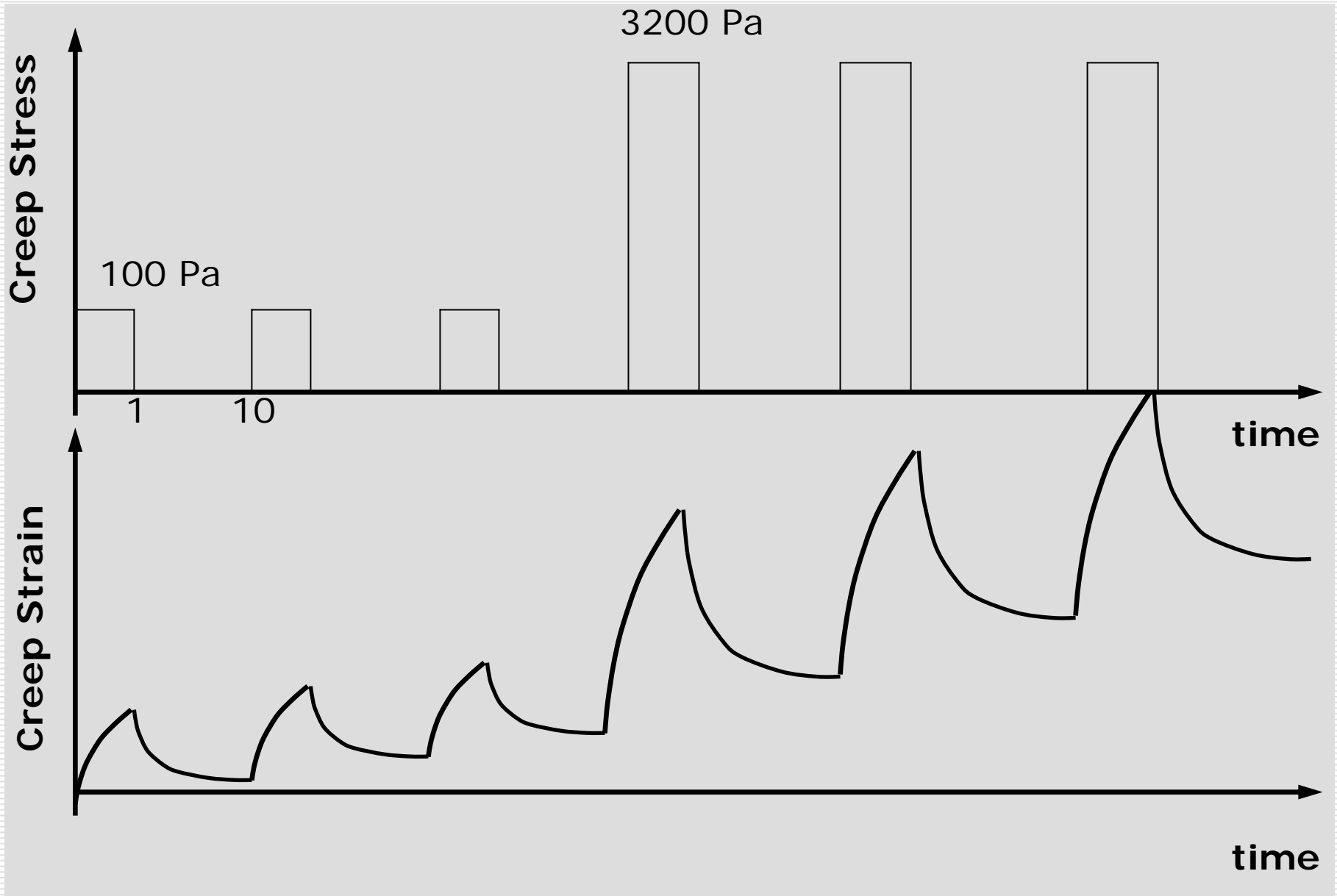


Multi-step Creep and Recovery of Neat Binder

MTE-64-22, Multi-Stress (25-3200Pa) Creep Recovery Data Comparison



Proposed MSCR TEST Protocol



How do we identify Polymers?

Use DSR Approach

Use DSR

Muti Stress Creep Recovery Test

- Two creep stress levels

- Ten cycles per stress level

- For Elastomeric modifiers Specify:

 - % strain recovery 3200 Pa > 15% or 20%

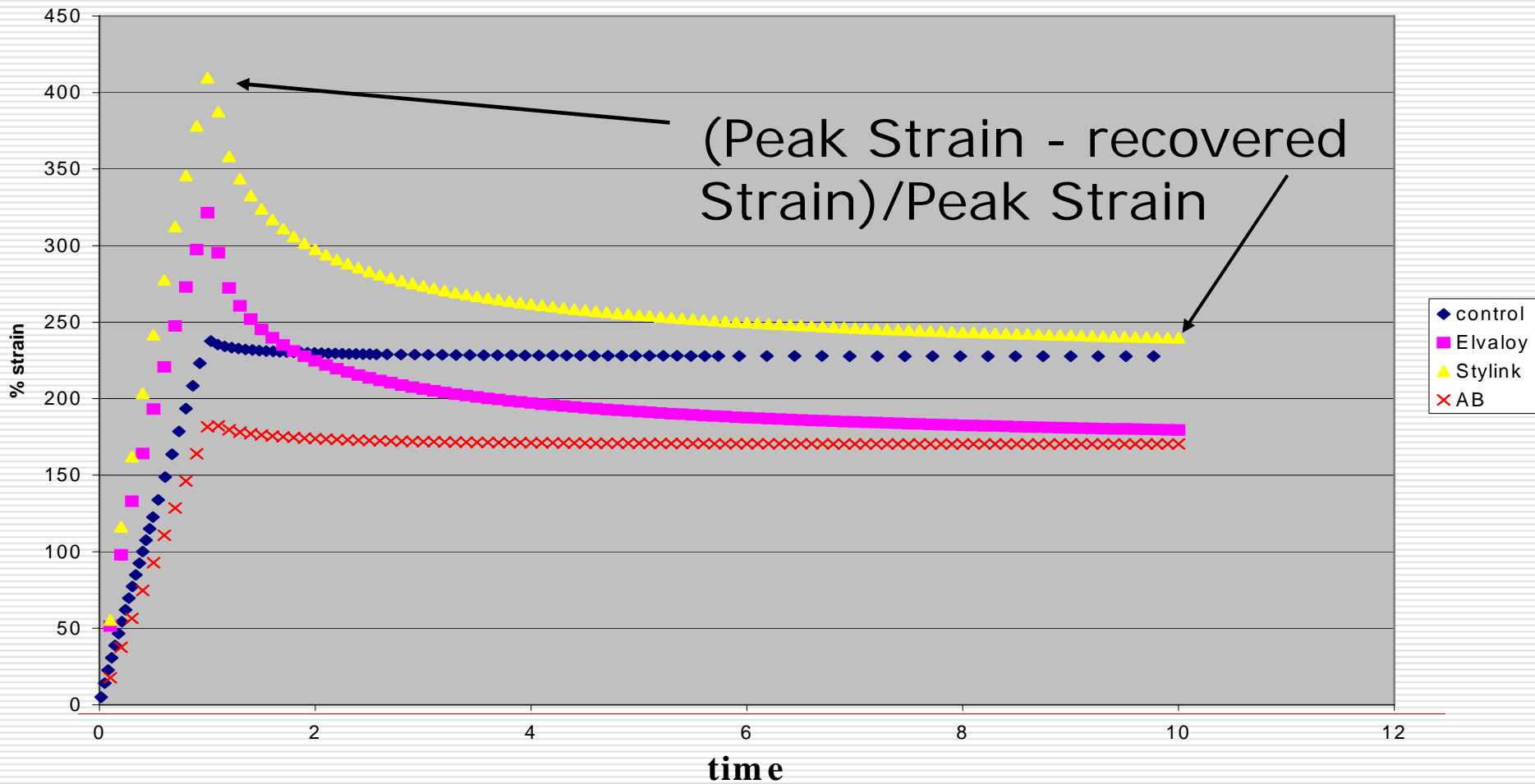
 - Overall change between stress levels 100-3200 Pa < 75%

- Run on the RTFOT

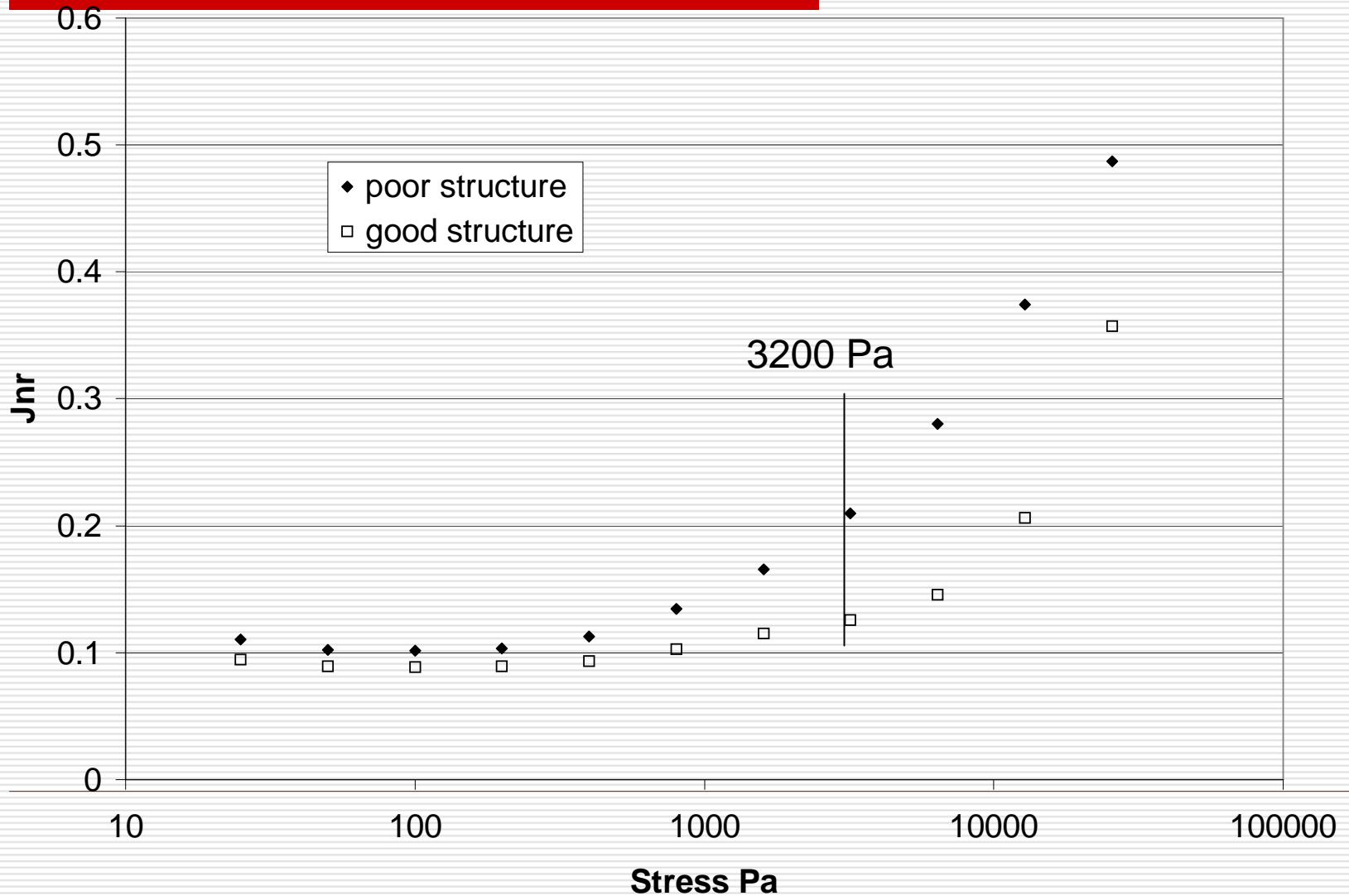
- Run on the same sample as RTFOT grading

What criteria? % recovered strain

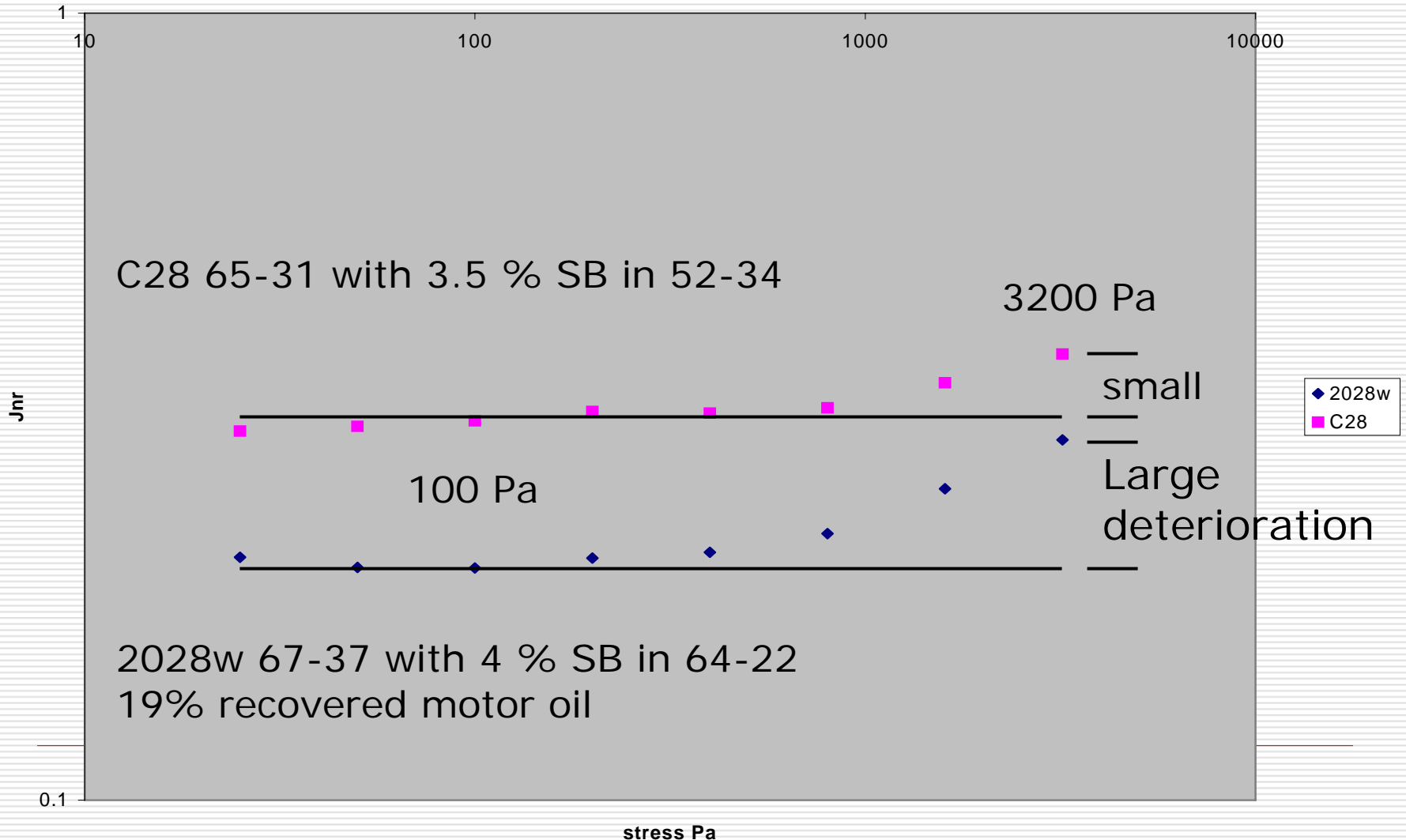
Creep 1st cycle 70C 1000 Pa



MSCR selection of stress levels

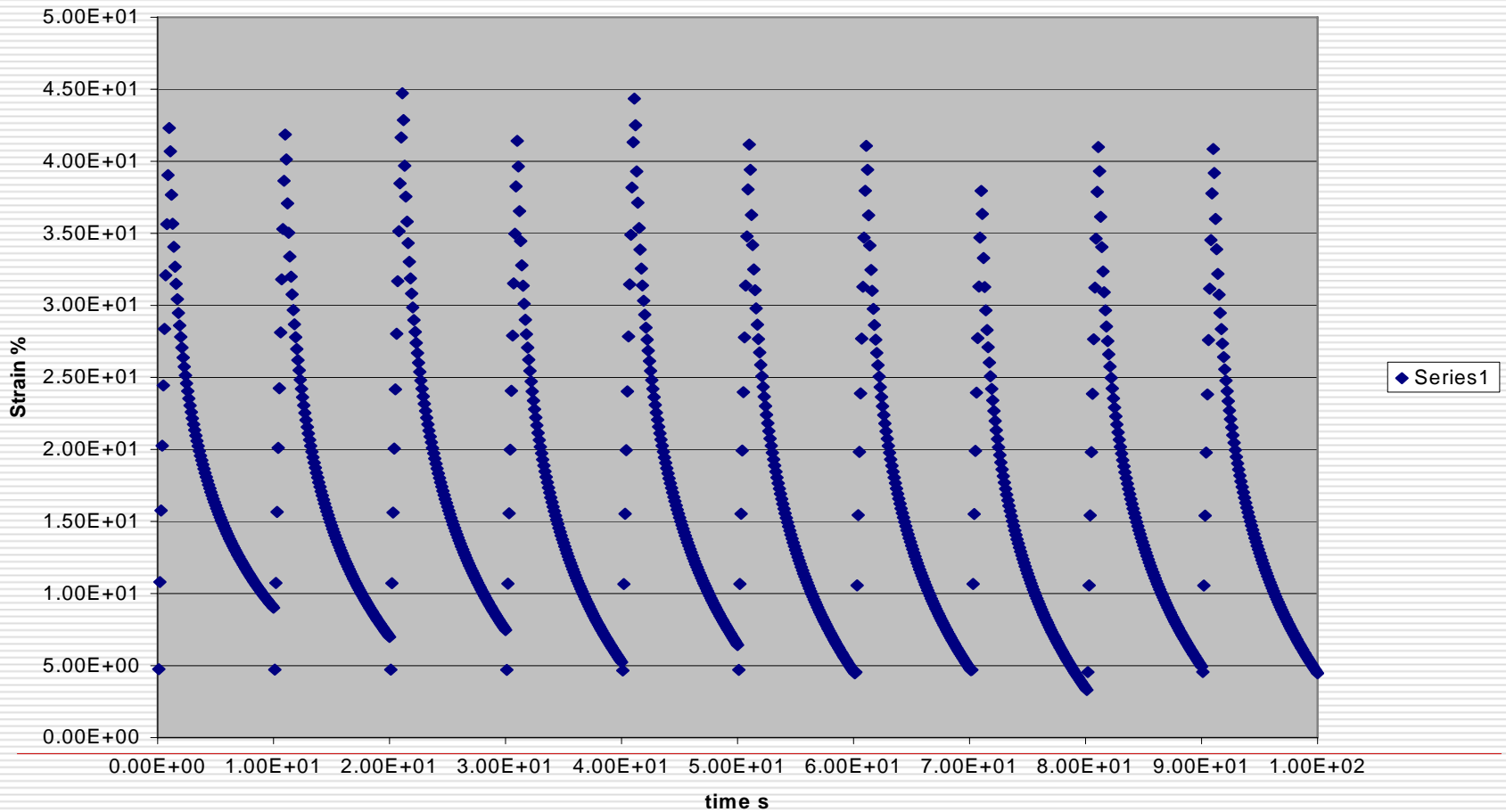


Selection of stress levels



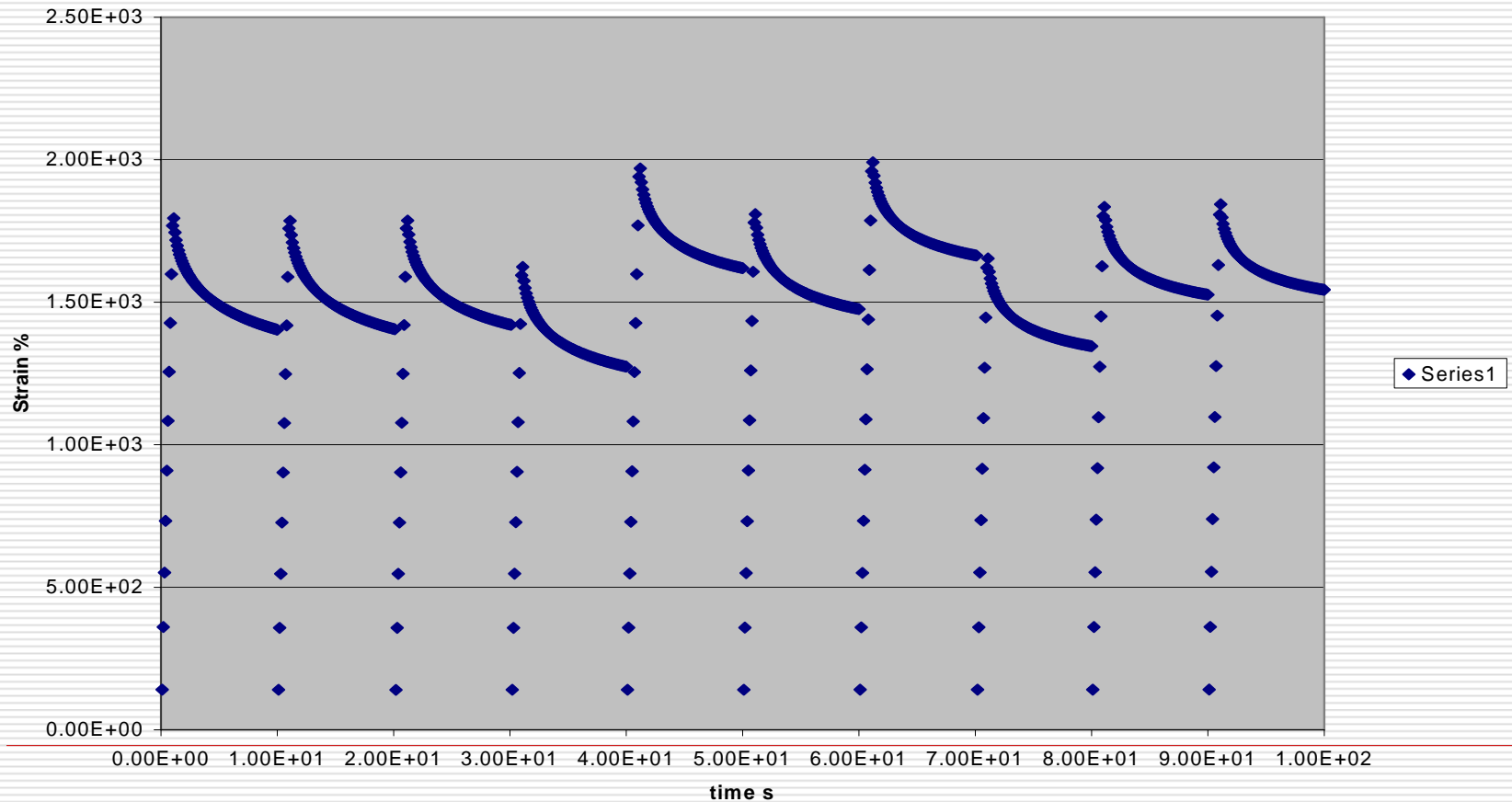
PG 64-34 1101 SBS 83% recovery 100Pa

PG64-34 1101 SBS 100Pa 64C



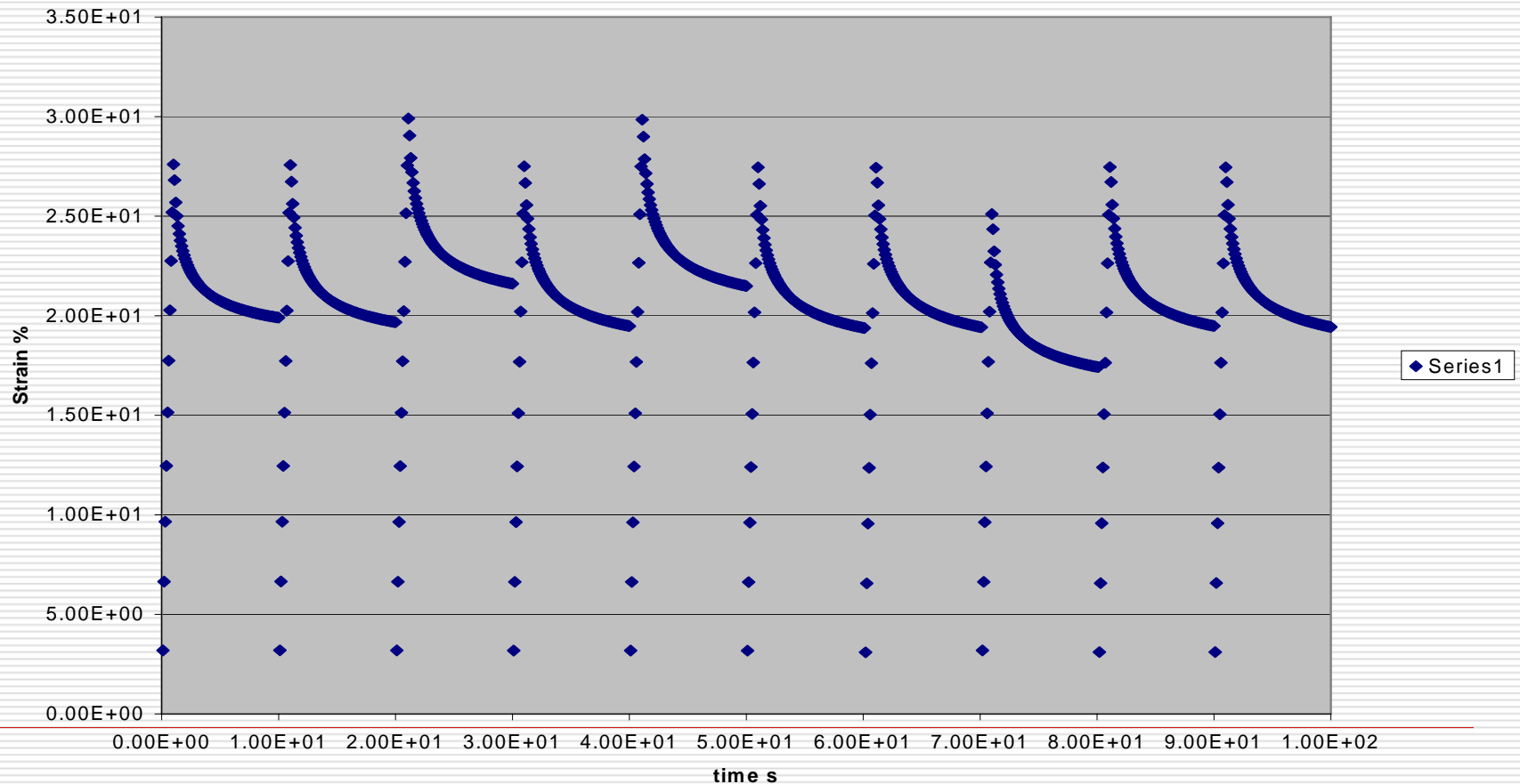
PG 64-34 1101 SBS 21% recovery 3200Pa

PG64-34 1101 SBS 3200Pa 64C



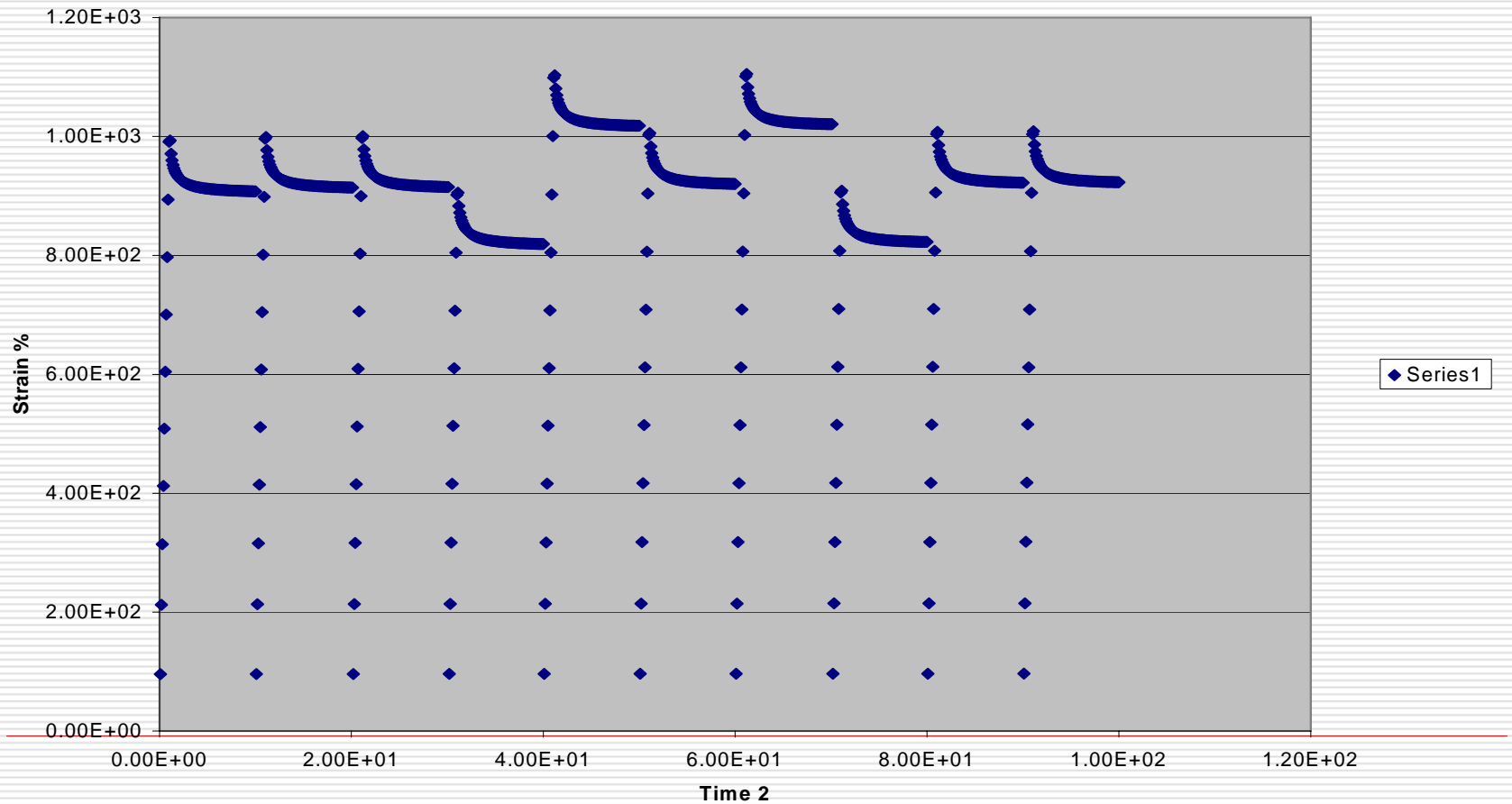
67-34 28% recovery 100Pa

4% SB, 19% oil, PG 67-28, recovery 100 Pa, 67C

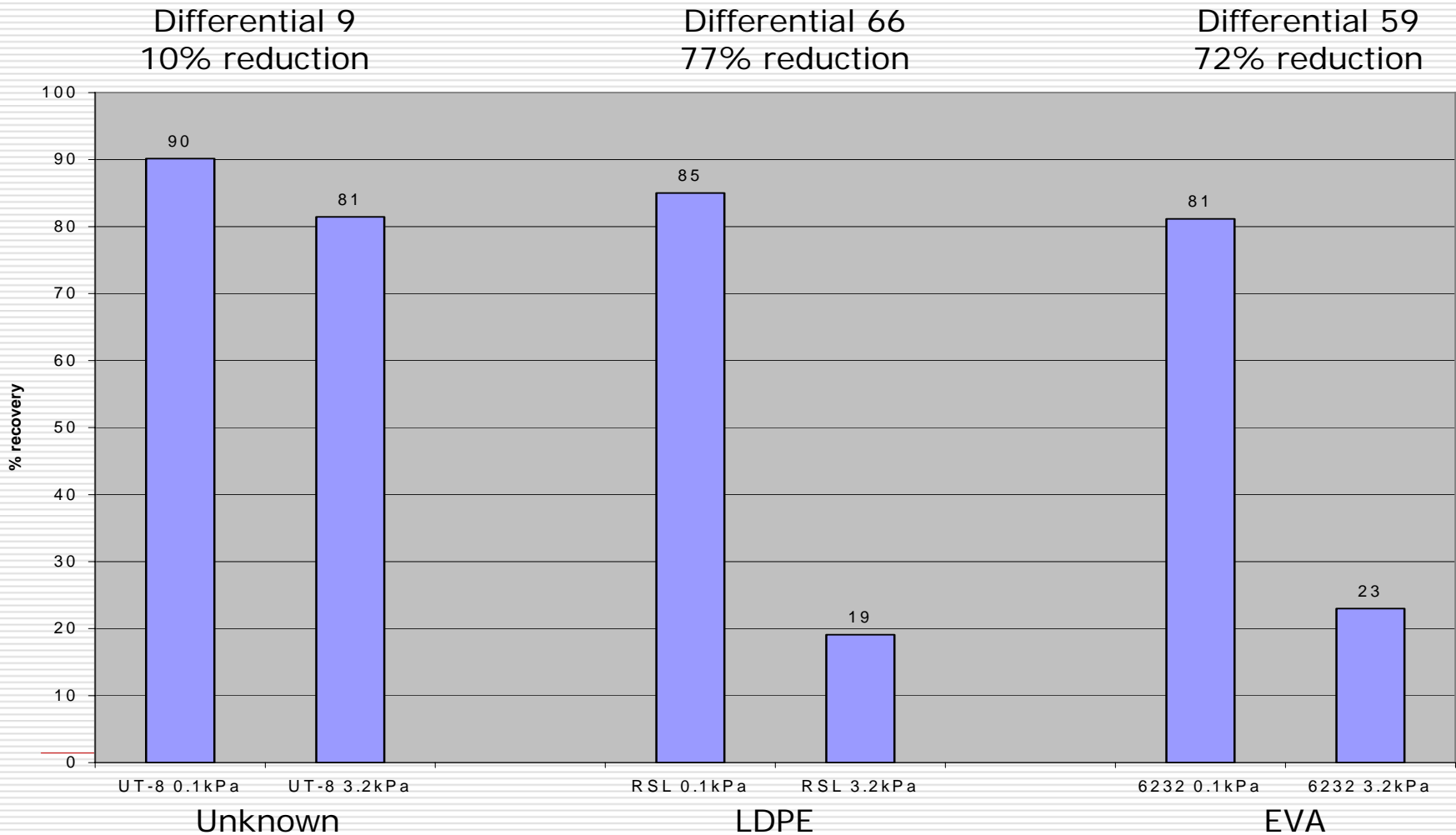


67-34 9% recovery 3200Pa, 75% ER

4% SB, 19% oil, PG 67-28, recovery 3200 Pa, 67C



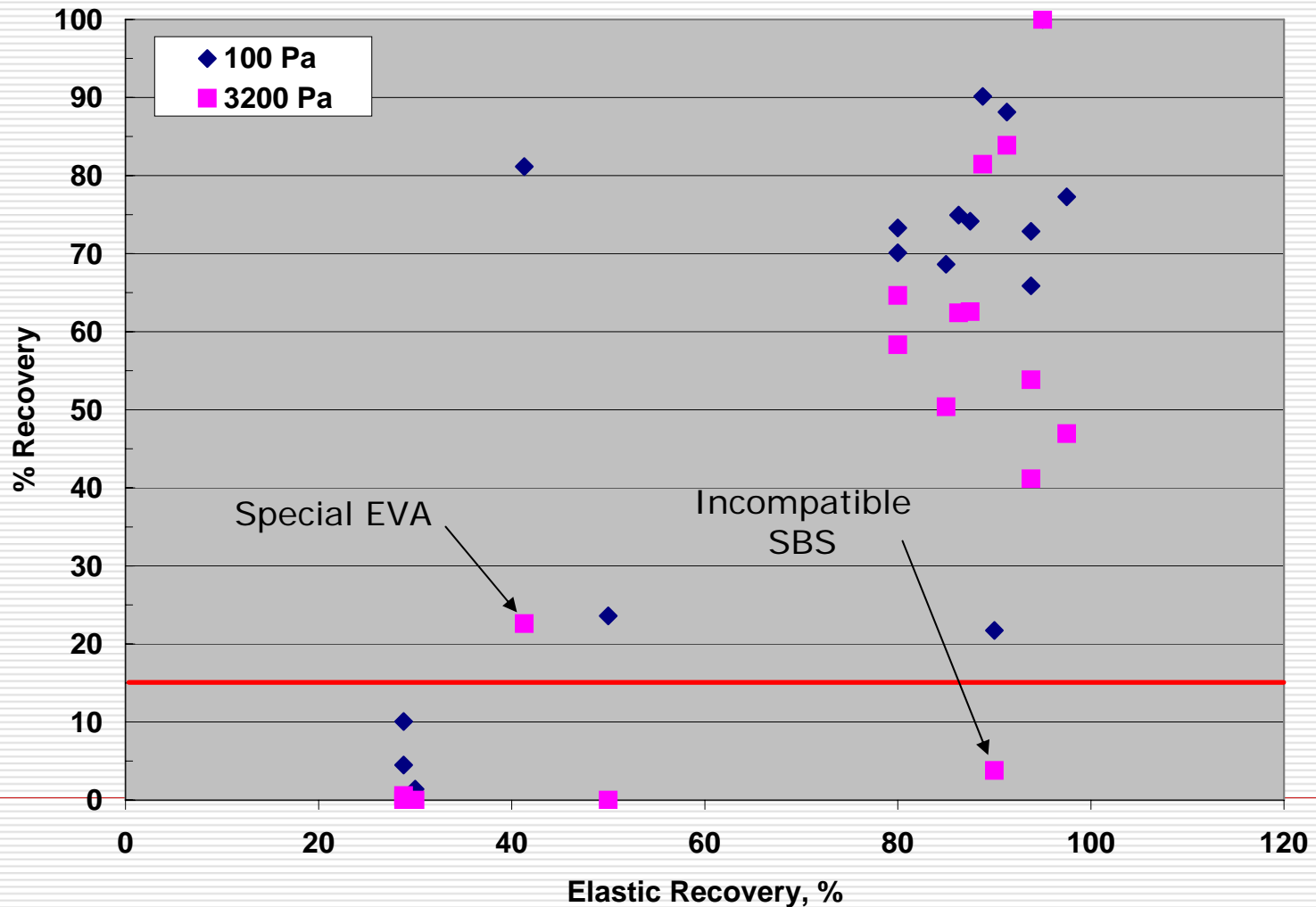
Difference between low stress and high stress shows how sensitive the formulation is to stress



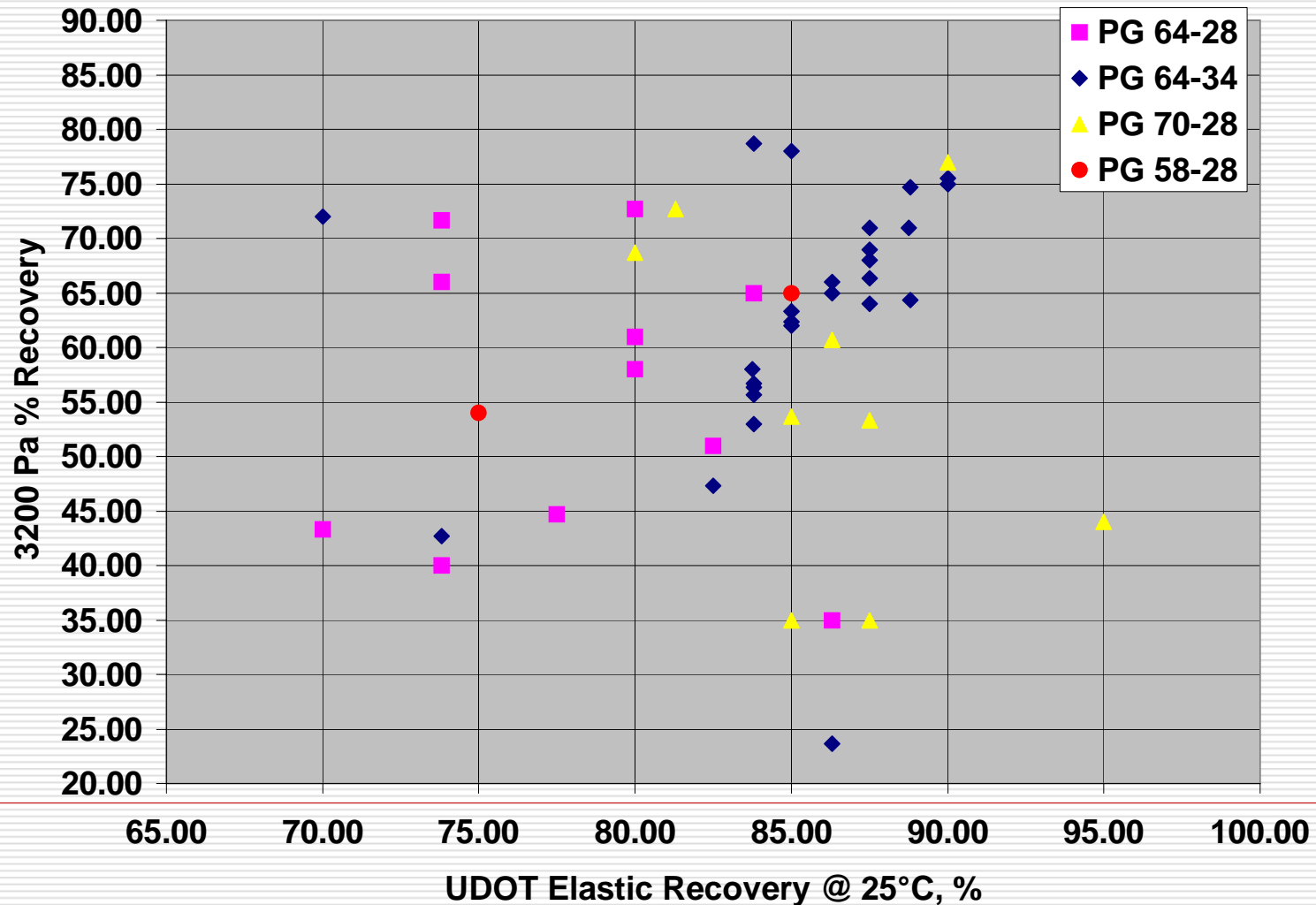
	Elastic Recovery	100 Pa Stress	3200 Pa Stress	% Reduction
64-34	55%	39%	23%	41%
64-28	60%	38%	24%	36.80%
64-28	65%	42%	28%	33.30%
64-28	65%	44%	31%	29.50%
82-28	65%	60%	43%	28.30%
70-28	68%	58%	48%	17.20%
58-34	69%	52%	43%	17.30%
76-28	70%	66%	53%	19.70%



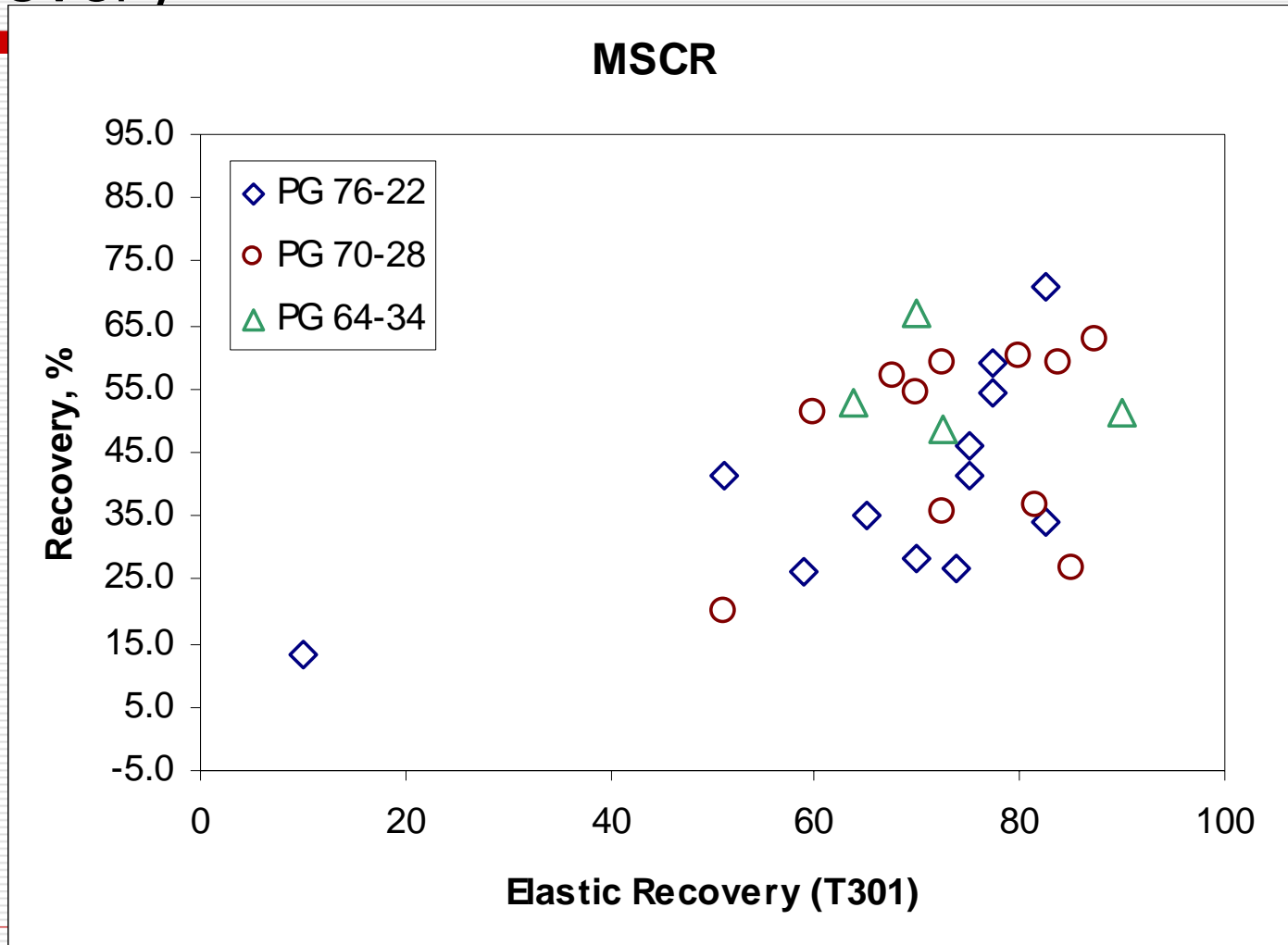
General relationship between ER and MSCR



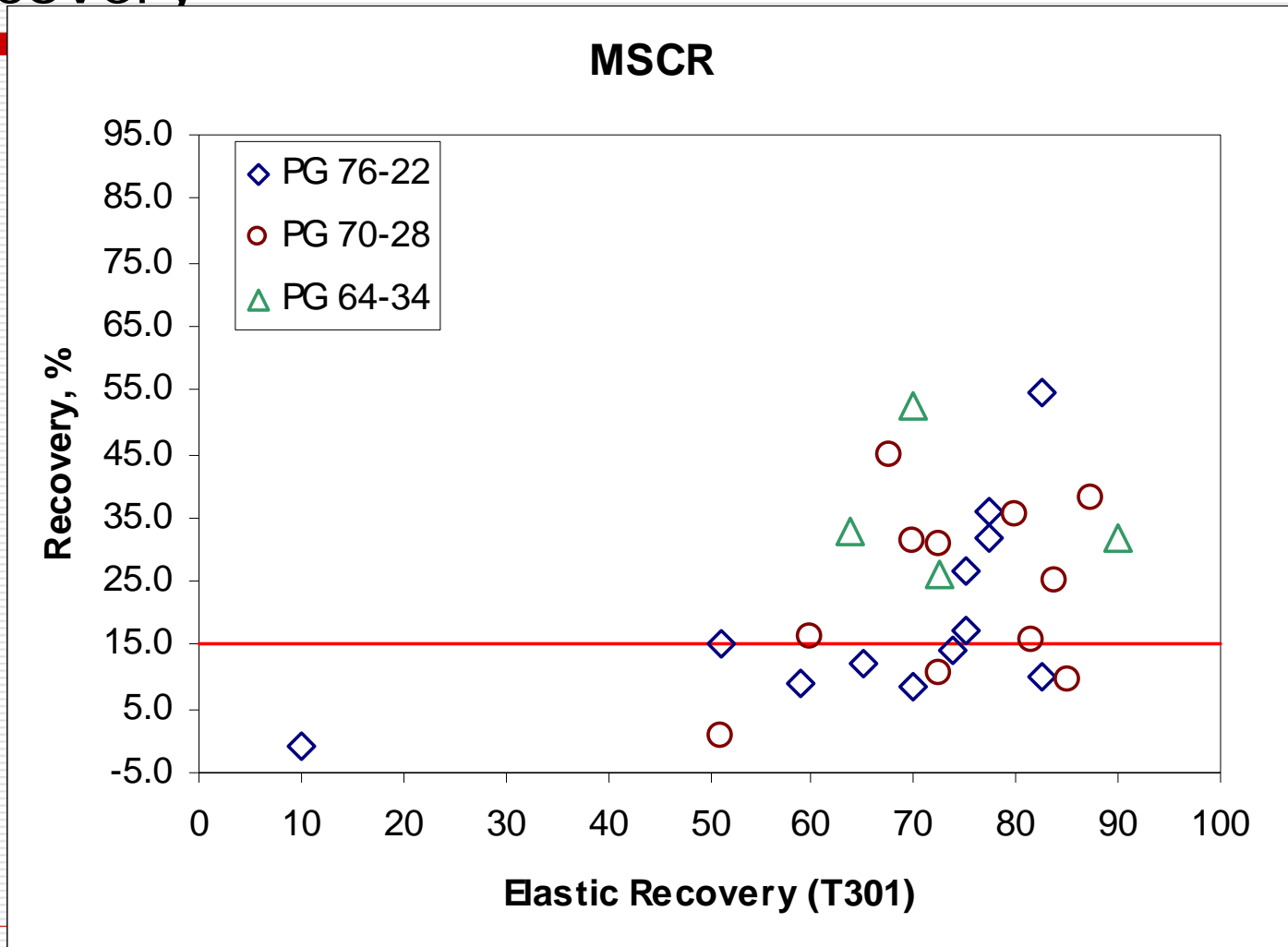
General relationship between ER and MSCR



Binders with 98°C Temperature Interval: Comparison of MSCR-100 Recovery with Elastic Recovery



Binders with 98°C Temperature Interval: Comparison of MSCR-3200 Recovery with Elastic Recovery



Recovered 70-28 binder

Binder ID	Formulation	Age	ER%	100 Pa	3200 Pa	Diff. 100Pa - 3200 Pa
1	NA	Extracted	75	45	21	24
2	NA	Extracted	73	47	20	27
3	NA	Extracted	73	49	25	24
4	NA	Extracted	73	50	26	24
5	NA	Extracted	68	29	8	21
5-Rerun	NA	Extracted	68	31	9	22

SBS blends different percentages and crossed linked and not cross linked

				% recovery		
				100Pa	3200Pa	
A_0623	WTI+ 3.5% SBS, no-X-link	RTFO	NA	32	12	20
A_0624	WTI+3.5%SBS (50% Diluted), 0.15% X-link	RTFO	NA	51	26	25
A_0625	WTI+7%SBS concentrate, 0.3% x-link	RTFO	NA	80	70	10
A_0626	Venez.+3.2% SBS, Diluted, 0.14% X-link	RTFO	NA	39	23	16

SBS is Kraton D1101

WTI is West Texas Intermediate

Venez. Is Venezeulan

70-22 blends

WTCG Round Robin 8 labs

	TOUGHNESS	TENACITY	DUCT. - 4 C - 5 CM/MIN	RES DUCT - 4 C - 5 CM/MIN	ELASTIC - RECOVERY - 25 C	CREEP RECOVERY % @ 100	CREEP RECOVERY % @ 3200
AVERAGE	169	155	63.57	27.45	79.63	54.38	37.91
MAXIMUM	236	248	83.00	34.00	86.00	59.50	41.80
MINIMUM	236	97	55.00	21.00	75.00	50.82	34.31
RANGE	122	151	28.00	13.00	11.00	8.68	7.49
STANDAR	35.08	41.88	8.66	2.98	2.89	3.40	2.89

Findings to date

- The DSR MSCR percent strain recovery criterion can replace the FD, ER, or T&T.
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Future Steps

- Analyze available MSCR percent recovered strain data to finalize creep stress level and test protocol
 - Where available, show relationships with existing ER, FD, Duct., and T&T data
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Questions
