Multiple Stress Creep Recovery (MSCR): Binder Selection and Lessons Learned

2017 North Dakota Asphalt Conference

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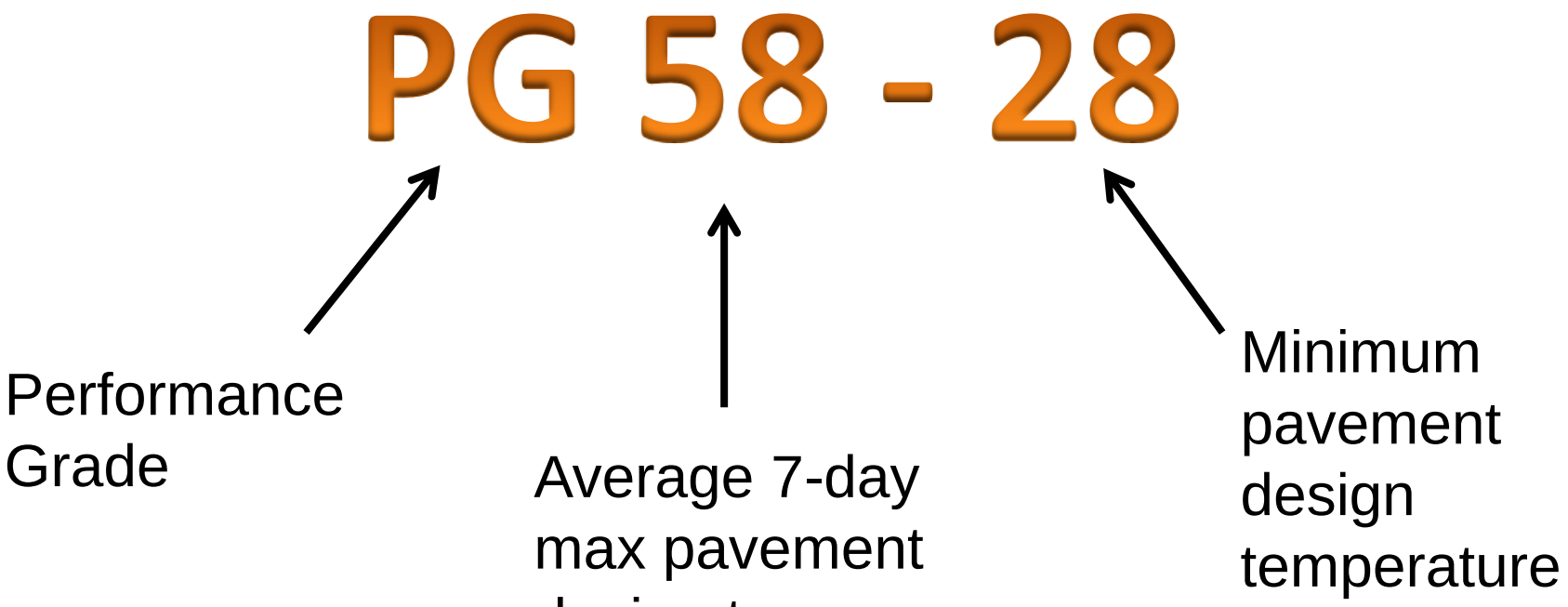
Past Asphalt Binder Specification

- Grading System Based on Climate



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MSCR Asphalt Binder Specification

- Grading System Based on Climate **and Traffic**

PG 58H - 28

Performance Grade

Average 7-day max pavement design temp

Traffic Level

Minimum pavement design temperature

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MSCR Asphalt Binder Specification

Letter Designation	Traffic Level
S	Standard
H	Heavy
V	Very Heavy
E	Extreme

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Specification Differences

- Past Asphalt Binder Specification
  - The greater the temperature spread, the greater the modification level
- MSCR Asphalt Binder Specification
  - Temperature spread doesn't change
  - Rather, the greater the traffic level "letter", the greater the modification level

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Why Change to the MSCR Specification?

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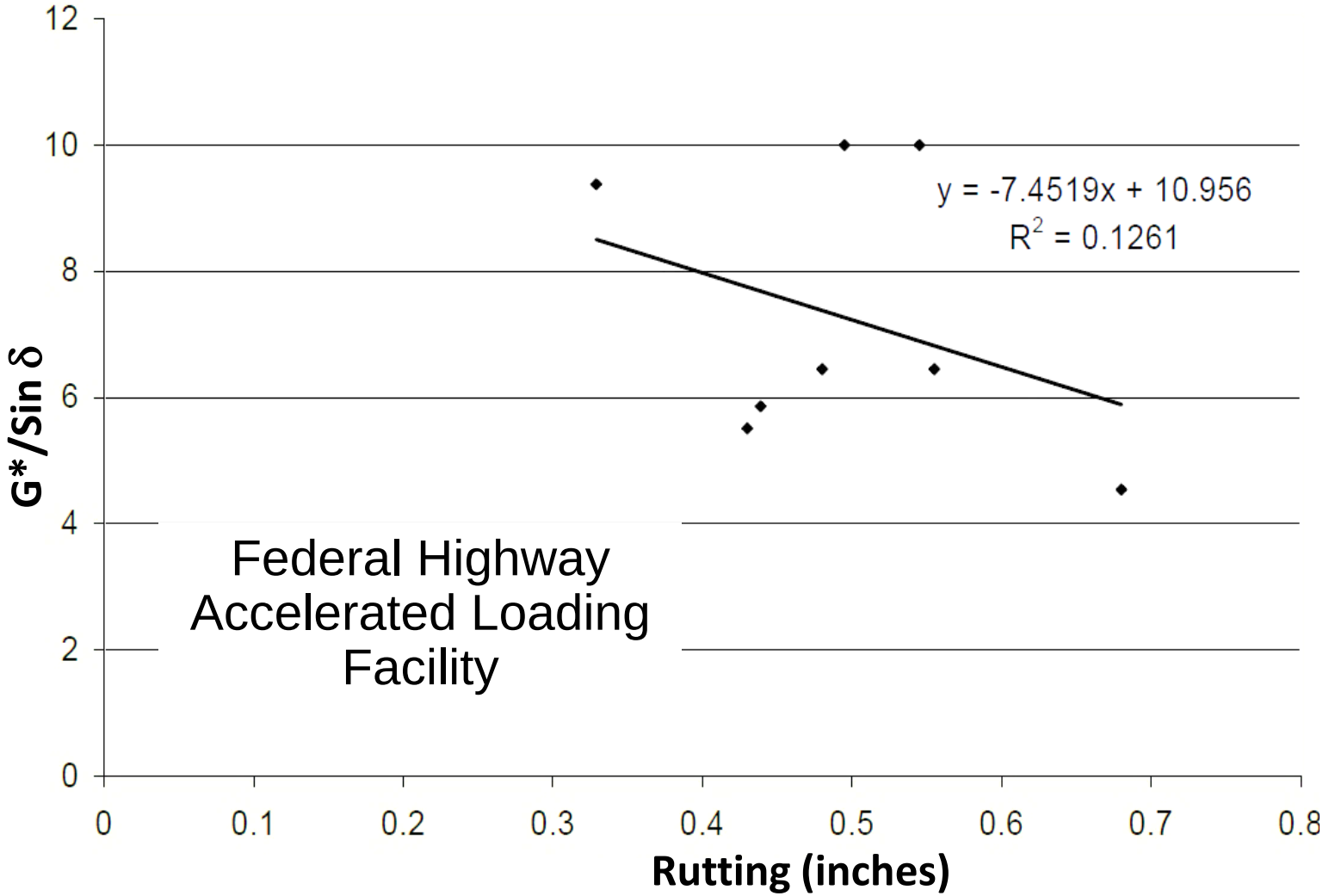
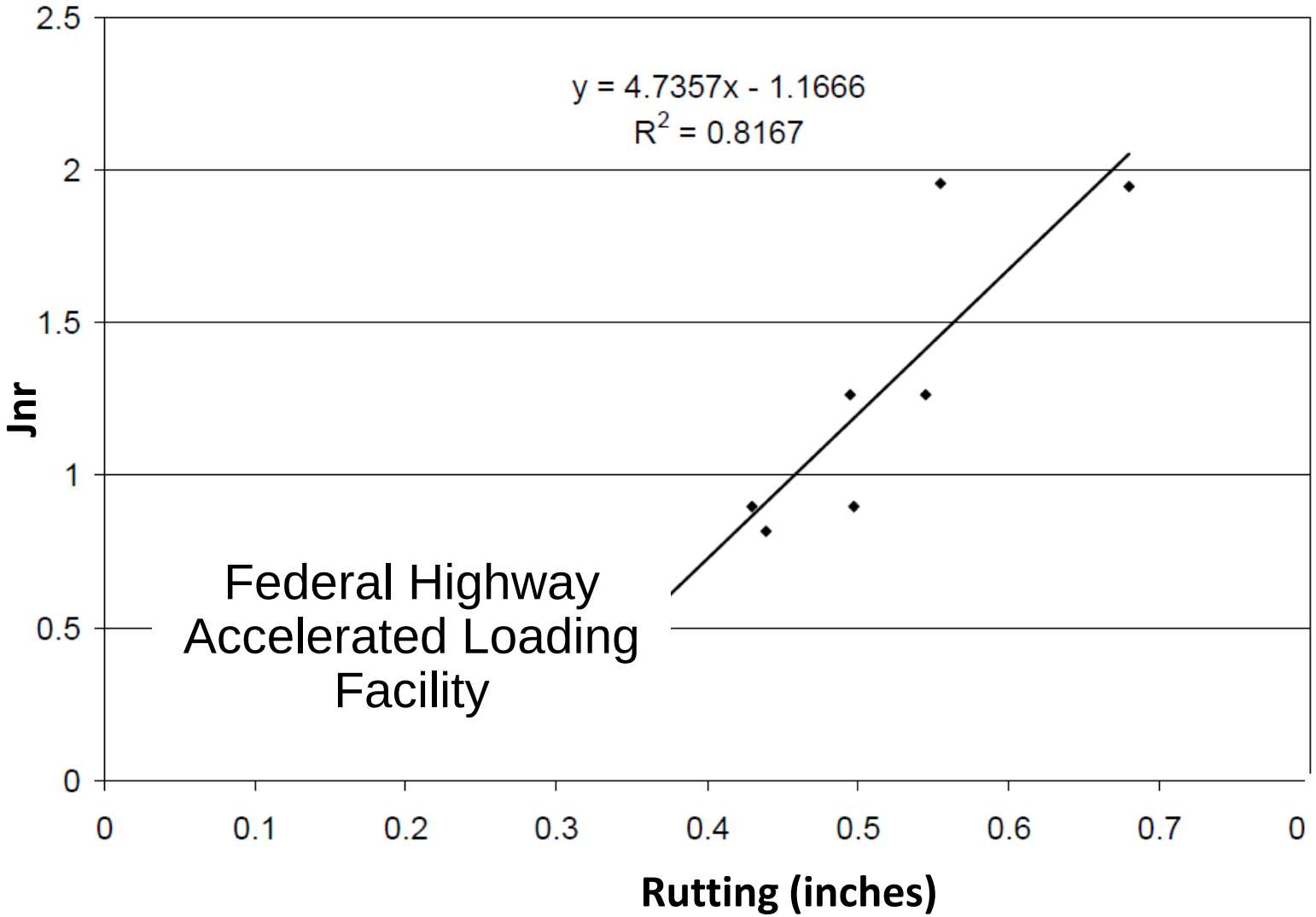
G*/Sinδ - Poor Rutting Correlation



https://www.fhwa.dot.gov/pavement/materials/pubs/hif11038/hif11038.pdf

Jnr - Improved Rutting Correlation



https://www.fhwa.dot.gov/pavement/materials/pubs/hif11038/hif11038.pdf

Development of the MSCR Test

- Still use the DSR
- Test at actual pavement temperature
- No temperature bumping
- Change the specification value rather than the test temperature

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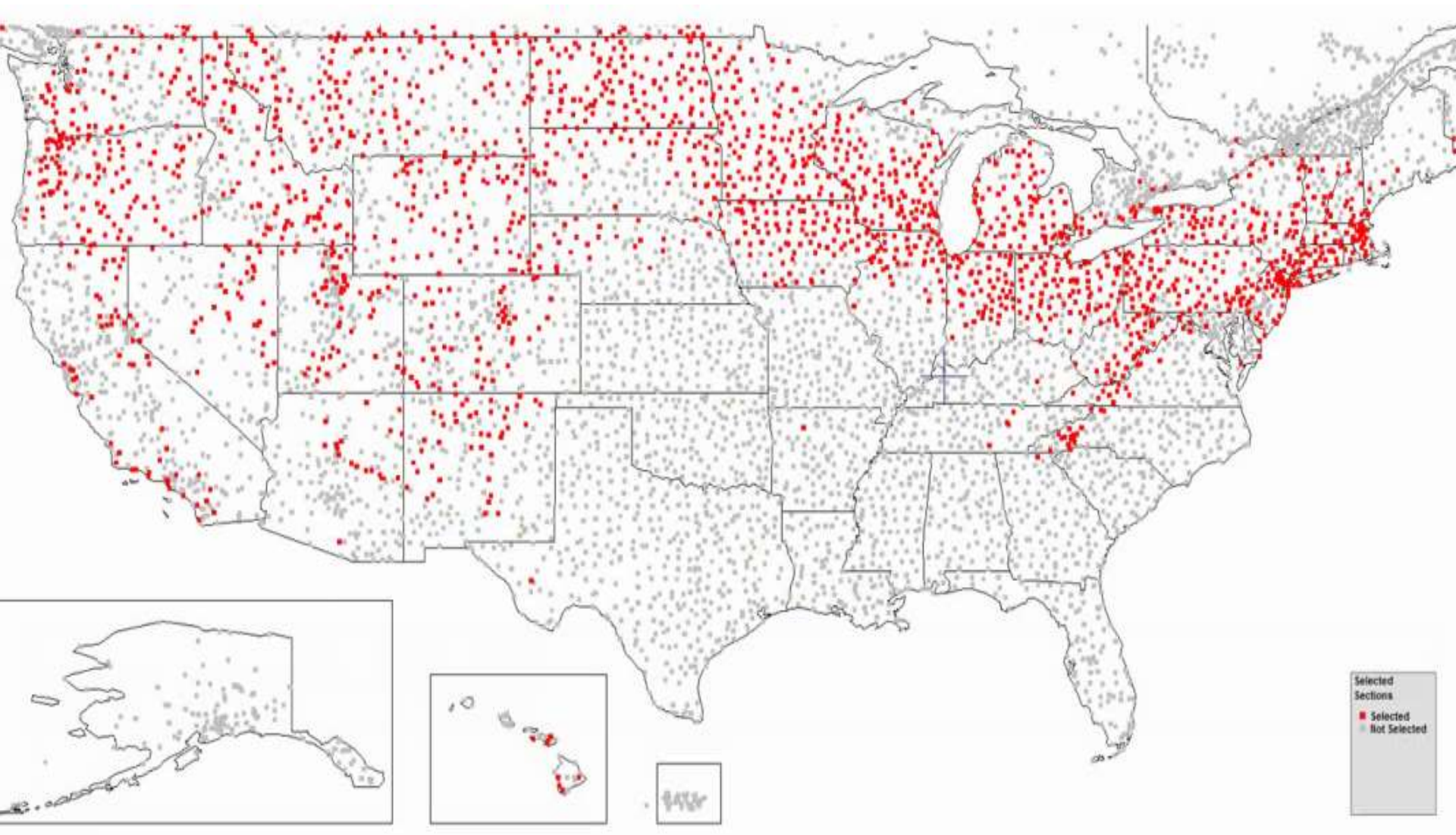
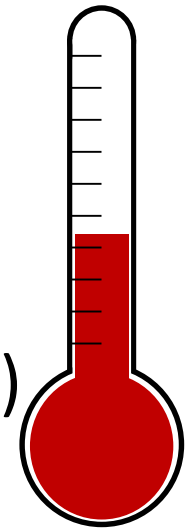
58°C (98% Confidence)



Past Temperature Grade Bumps

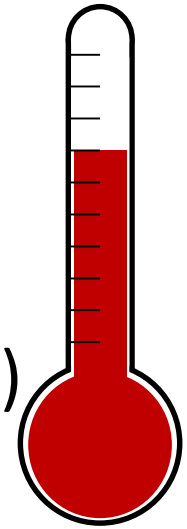
58°C
(136°F)



PG 58-28

- Standard traffic

64°C
(147°F)

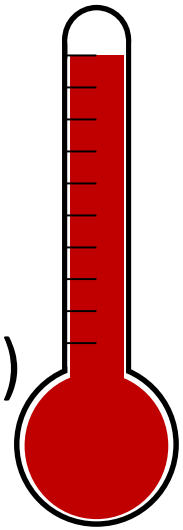


PG 64-28

1 Bump

- Slow or heavy traffic

70°C
(158°F)

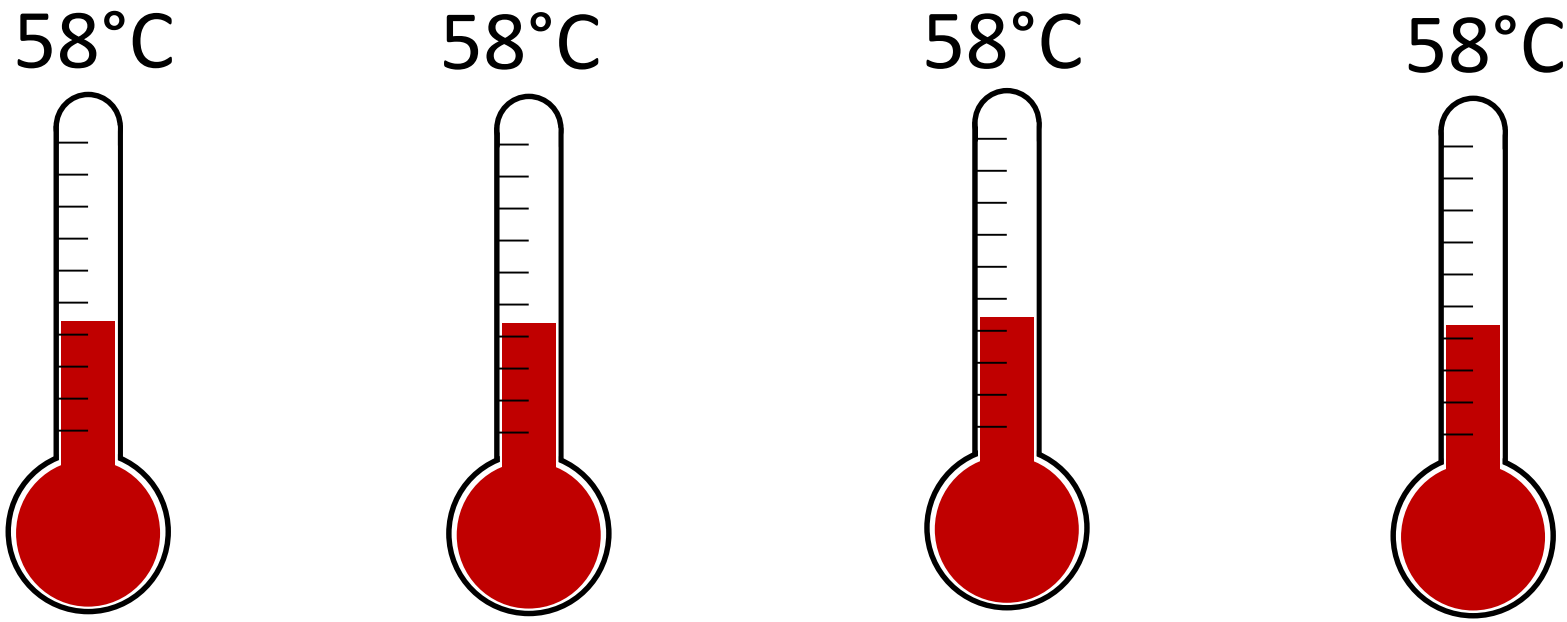


PG 70-28

2 Bumps

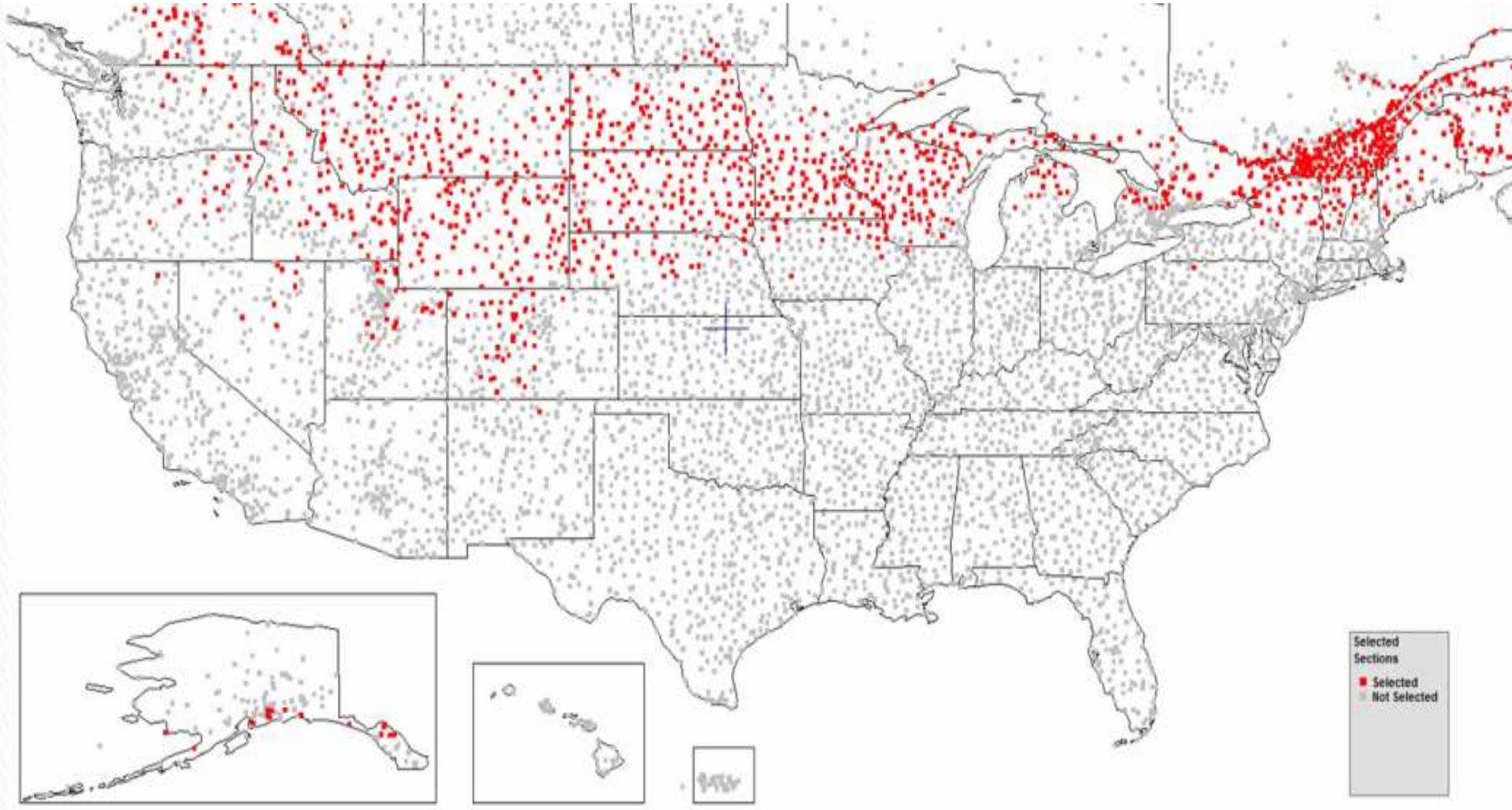
- Stationary or high volume traffic

MSCR Traffic Bumping



PG 58**S**-28	PG 58**H**-28	PG 58**V**-28	PG 58**E**-28
	1 Bump	2 Bumps	3 Bumps
Standard traffic	Heavy traffic	Very heavy traffic	Extreme traffic

-34°C (98% Confidence)



Combined States MSCR Specifications

Letter	Traffic Level	Jnr Value	% Recovery
58**S** – 28	< 3 M ESAL's	< 4.5 kPa^{-1}	
58**H** – 28	> 3 M ESAL's	< 2.0 kPa^{-1}	≥ 30%
58**V** – 28	> 10 M ESAL's	< 1.0 kPa^{-1}	≥ 55%
58**E** – 28	> 30 M ESAL's	< 0.5 kPa^{-1}	≥ 75%

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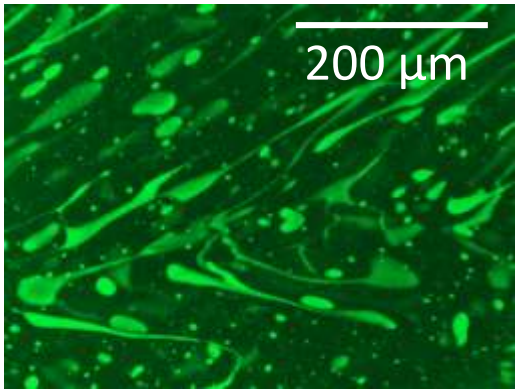
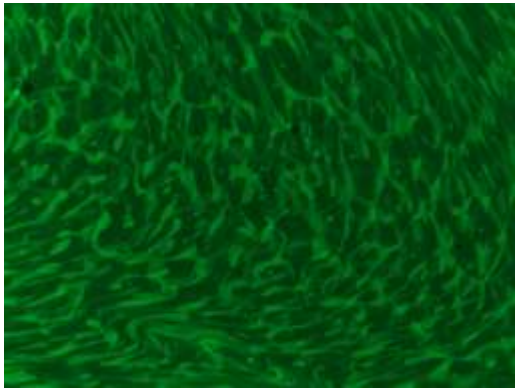
Benefit of % Recovery
PMAC under Fluorescence Microscope





Unreacted	
% R = 21.0	Jnr = 0.68 Pa^{-1}

Partially Reacted	
%R = 46.4	Jnr = 0.39 Pa^{-1}

Fully Reacted	
%R = 58.3	Jnr = 0.31 Pa^{-1}

Binder Grade Comparisons

This MSCR Grade…	**Is close (not equal) to a…**
PG 58S – 28	PG 58 – 28
PG 58H – 28	PG 64 – 28
PG 58V – 28	PG 64/70 – 28
PG 58E – 28	PG 70/76 – 28
PG 58S – 34	PG 58 – 34
PG 58H – 34	PG 58 – 34
PG 58V – 34	PG 58/64 – 34
PG 58E – 34	PG 64/70 – 34

Lessons learned with MSCR

- Temperature bumping + traffic bumping
  - Results in over designing an asphalt binder

PG 64V-34 → PG 70 – 34

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Lesson's learned with MSCR

- Challenges with JnrDiff
  - The JnrDiff specification was designed to limit stress sensitivity
  - Parameter has high variability (no spec tolerance)
  - AMRL does not certify labs on this parameter
  - Never properly evaluated for -34 binders
  - In fall 2016, the Binder ETG created a task group to investigate
  - Other CSBG DOT's have waived JnrDiff

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Summary

- MSCR eliminates bumping the high temperature
- New parameters relate better to pavement rutting
- Selecting the right asphalt binder is only one part of producing long lasting roads
  - Aggregate selection, mix design, hot mix production, and application technique will remain as integral parts for project success

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Thank You

Questions ?

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Lessons learned with MSCR

- Accounting for RAP
  - Lower the low temperature PG since that's where the failures are on RAP mixes
  - Some States lower the high temperature too
  - Iowa is trying 52°C for RAP mixes
  - All other CSGB States are sticking with 58°C

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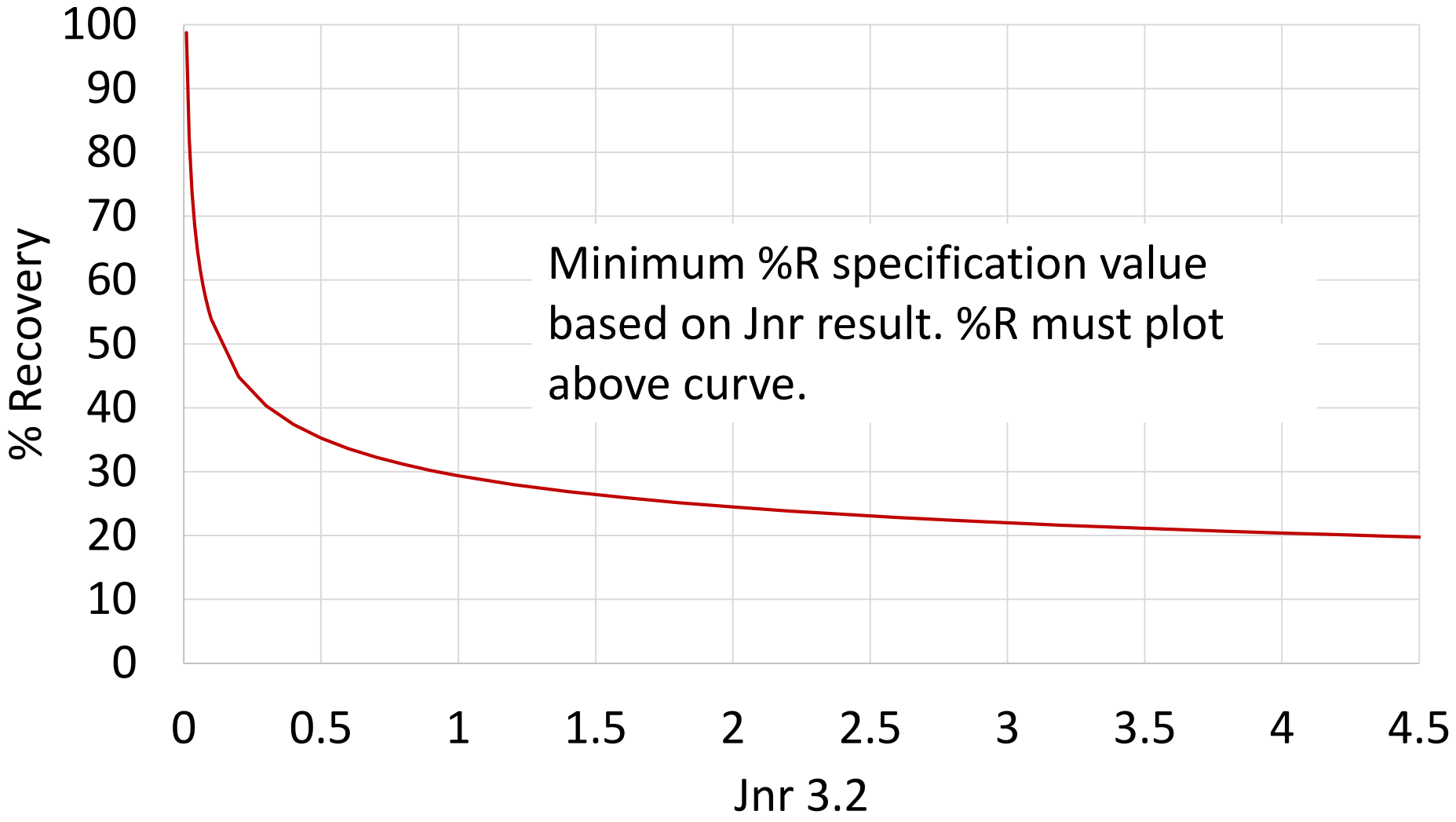
AASHTO M332 – Jnr vs %R Curve



AASHTO M332 – CSBG Modified