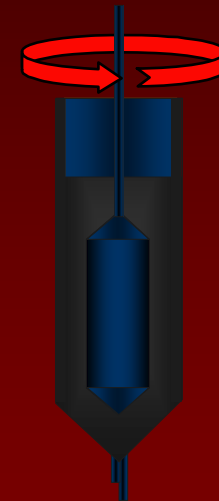
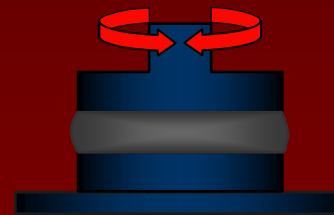
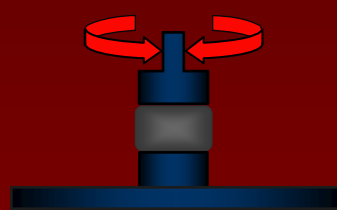
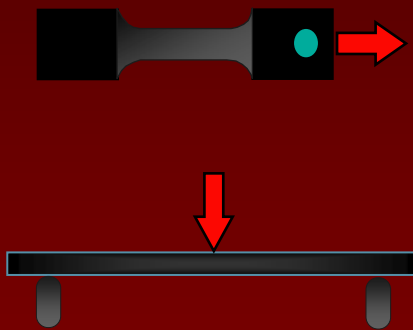
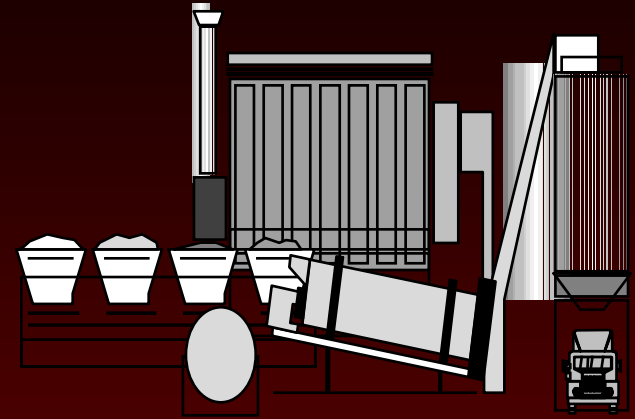




SUPERPAVE BINDER SPECIFICATIONS & SELECTIONS

New Binder Specification SUPERPAVE

- Fundamental properties related to pavement performance
- Environmental factors
- In-service & construction temperatures
- Short and long term aging



- 20

20

60

135

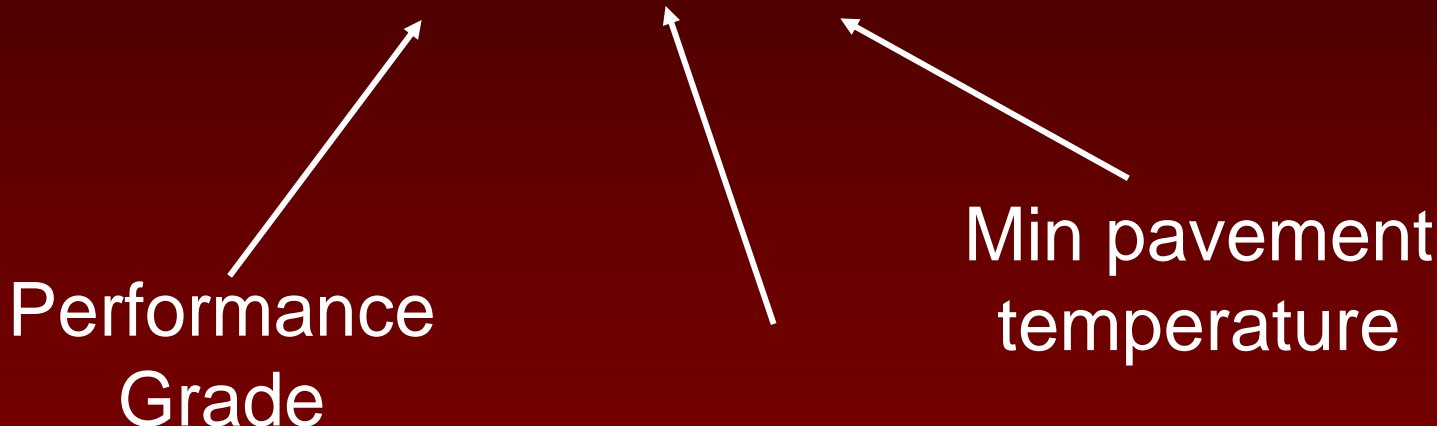
Pavement Temperature, °C

Superpave Asphalt Binder Specification

The grading system is based on climate

PG 64 - 22

Performance
Grade

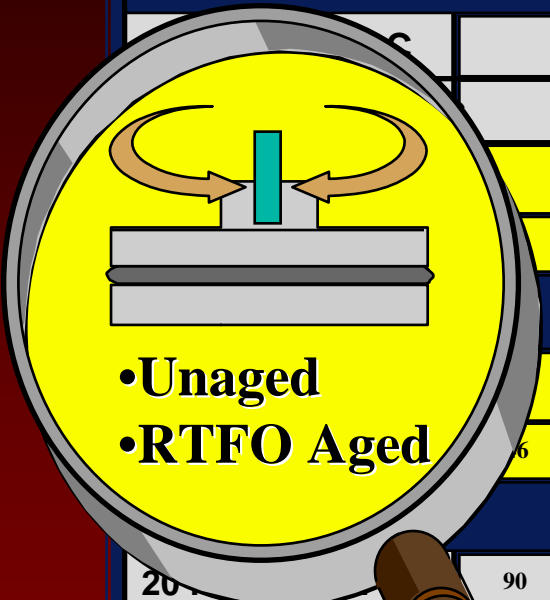


Average 7-day max
pavement temperature

Min pavement
temperature

Permanent Deformation

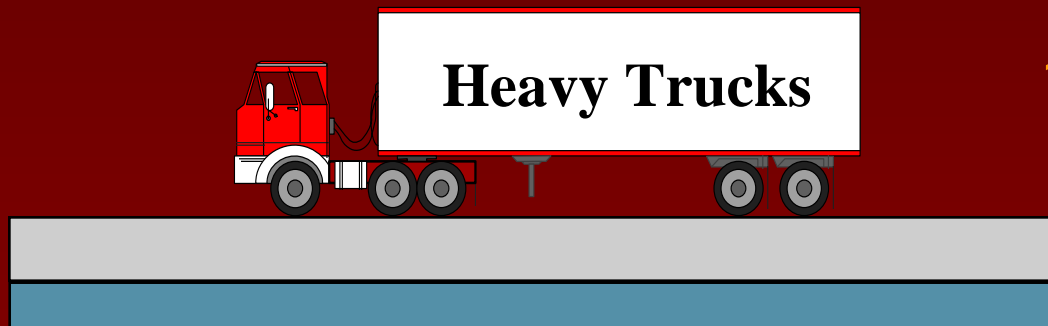
Avg 7-day Max, °C	PG 46			PG 52			PG 58			PG 64			PG 70			PG 76			PG 82																				
1-day Min, °C	-34	-40	-46	-10	-16	-22	-28	-34	-40	-46	-16	-22	-28	-34	-40	-46	-10	-16	-22	-28	-34	-40	-10	-16	-22	-28	-34	-40	-16	-22	-28	-34	-40	-46	-16	-22	-28	-34	-40
ORIGINAL																																							
(Flash Point) FP																																							
(Rotational Viscosity) RV																																							
(Dynamic Shear Rheometer) DSR $G^*/\sin \delta$																																							
				52			58			64			70			76			82																				
(ROLLING THIN FILM OVEN) RTFO Mass Loss $\leq 1.00\%$																																							
(Dynamic Shear Rheometer) DSR $G^*/\sin \delta$																																							
				52			58			64			70			76			82																				
(PRESSURE AGING VESSEL) PAV																																							
20	90			90	100		100			100 (110)			100 (110)			110 (110)																							
(Dynamic Shear Rheometer) DSR $G^* \sin \delta$																																							
$\leq 5000 \text{ kPa}$	4	25	22	19	16	13	10	7	5	25	22	19	16	13	10	31	28	25	22	19	16	34	31	28	25	22	19	16	13	10	37	34	31	28	25	22			
(Bending Beam Rheometer) BBR "S" Stiffness & "m"- value																																							
$S \leq 300 \text{ MPa}$ $m \geq 0.300$	-24	-30	-36	-12	-18	-24	-30	-36	-42	-6	-12	-18	-24	-30	-36	0	-6	-12	-18	-24	-30	0	-6	-12	-18	-24	-30	0	-6	-12	-18	-24	-30	0	-6	-12			
(Bending Beam Rheometer) BBR Physical Hardening																																							
Report Value																																							
(Direct Tension) DT																																							
$\geq 1.00\%$	-24	-30	-36	0	-6	-12	-18	-24	-30	-6	-12	-18	-24	-30	-36	0	-6	-12	-18	-24	-30	0	-6	-12	-18	-24	-30	0	-6	-12	-18	-24	-30	0	-6	-12			



- Unaged
- RTFO Aged

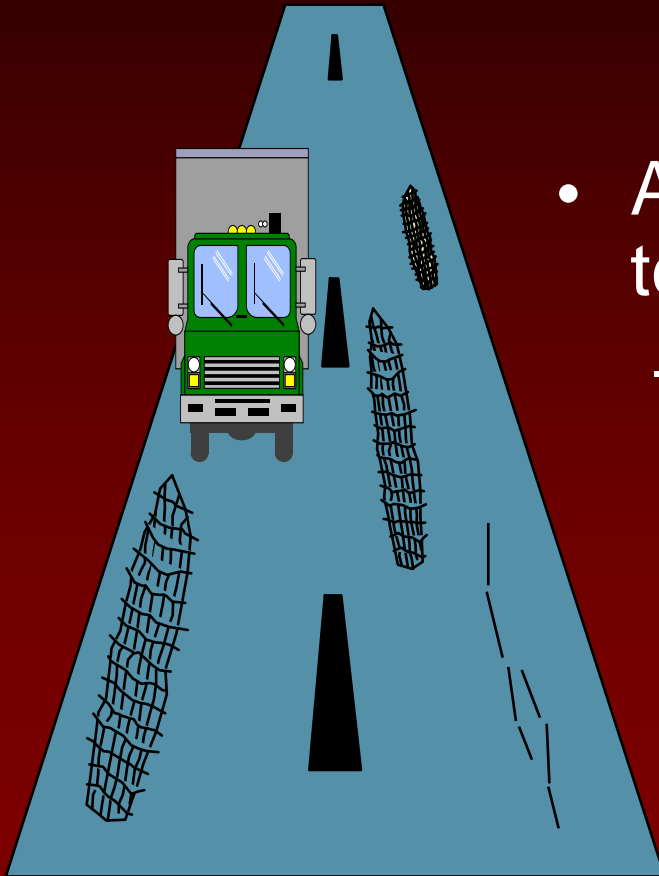
Permanent Deformation

- Addressed by high temp stiffness
 - $G^*/\sin \delta$ on unaged binder ≥ 1.00 kPa
 - $G^*/\sin \delta$ on RTFO aged binder ≥ 2.20 kPa



> *Early part of
pavement
service life*

Fatigue Cracking



- Addressed by intermediate temperature stiffness
 - $G^* \sin \delta$ on RTFO & PAV aged binder ≤ 5000 kPa

> *Later part of pavement service life*

PG Binder Selection

> Many agencies have established zones

PG 52-28



PG 58-22

PG 58-16

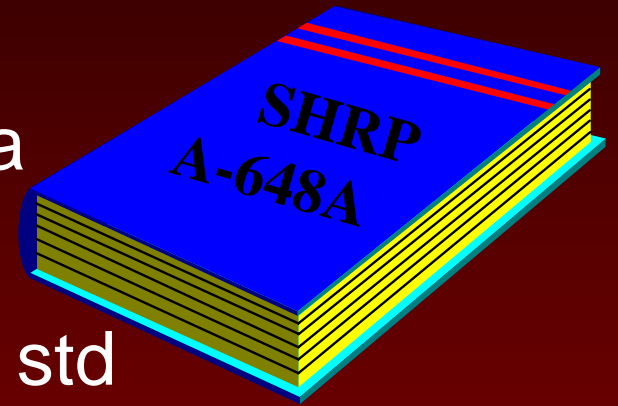


PG 64-10



Developed from Air Temperatures > 20 years

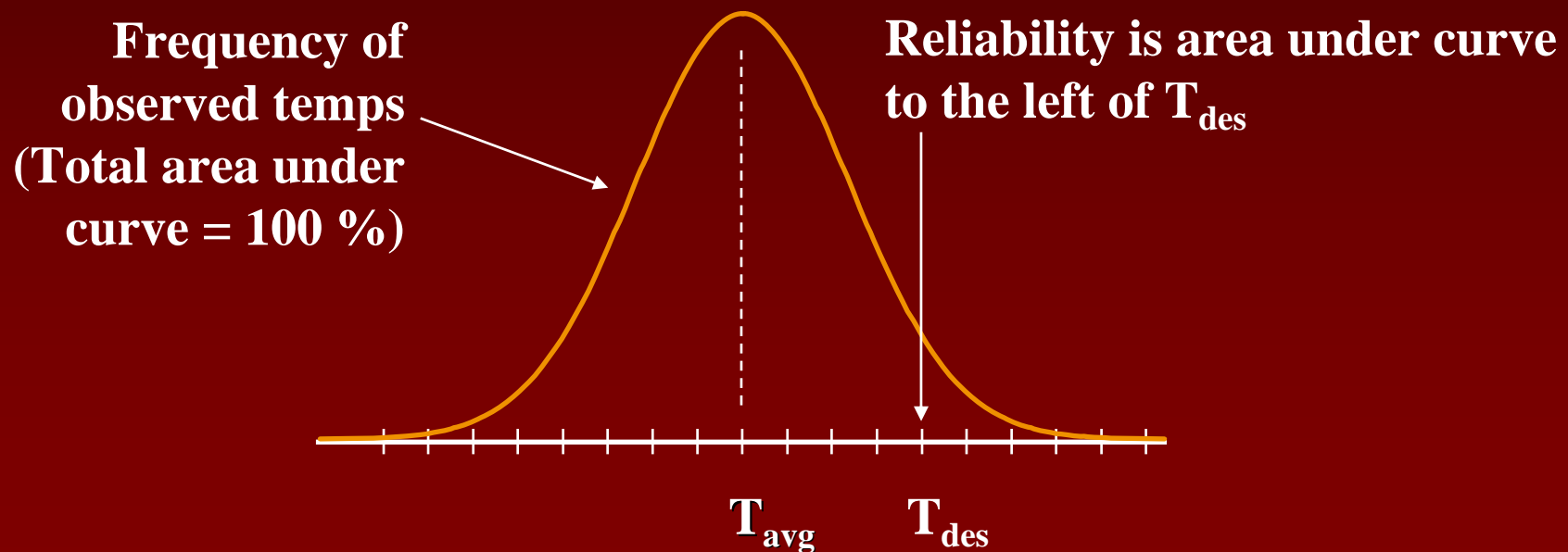
- Superpave Weather Database
 - 6500 stations in U.S. and Canada
- Annual air temperatures
 - hottest seven-day temp (avg and std dev)
 - coldest temp (avg and std dev)
- Calculated pavement temps used in PG selection



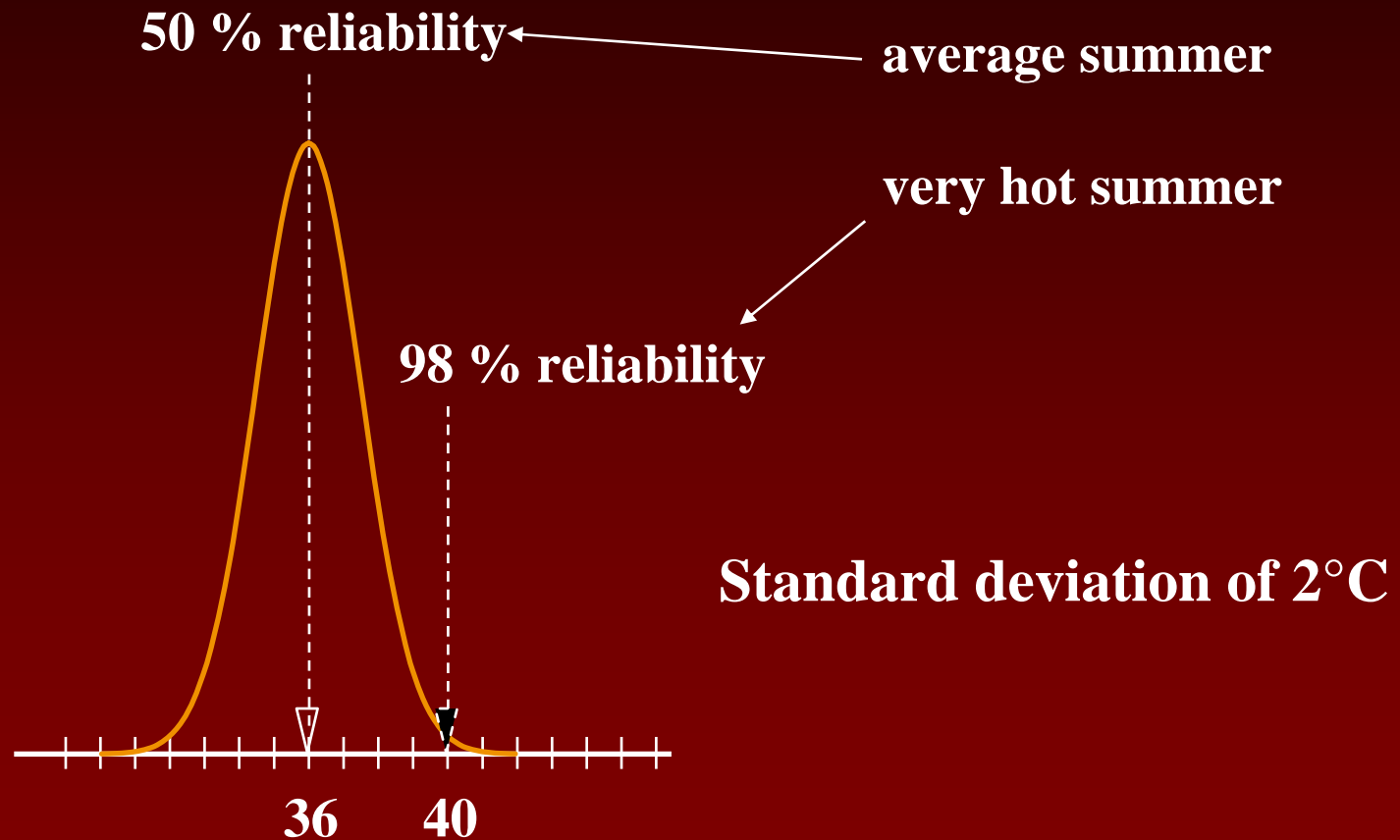
Reliability

- Percent probability of not exceeding design temp

> using Normal Distribution

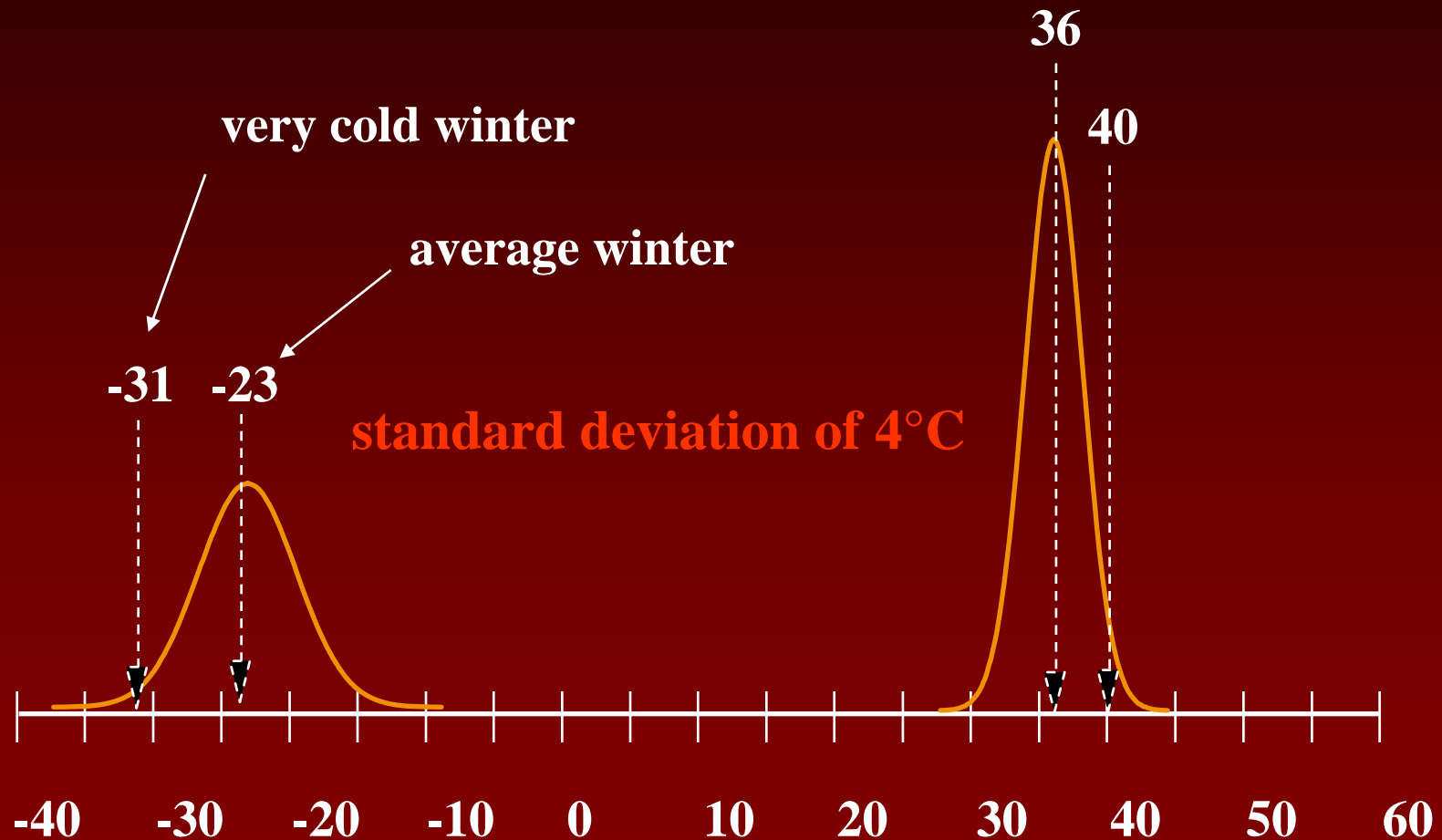


Observed Air Temperatures Topeka, KS



7-Day Maximum Air Temperatures

Observed Air Temperatures Topeka, KS

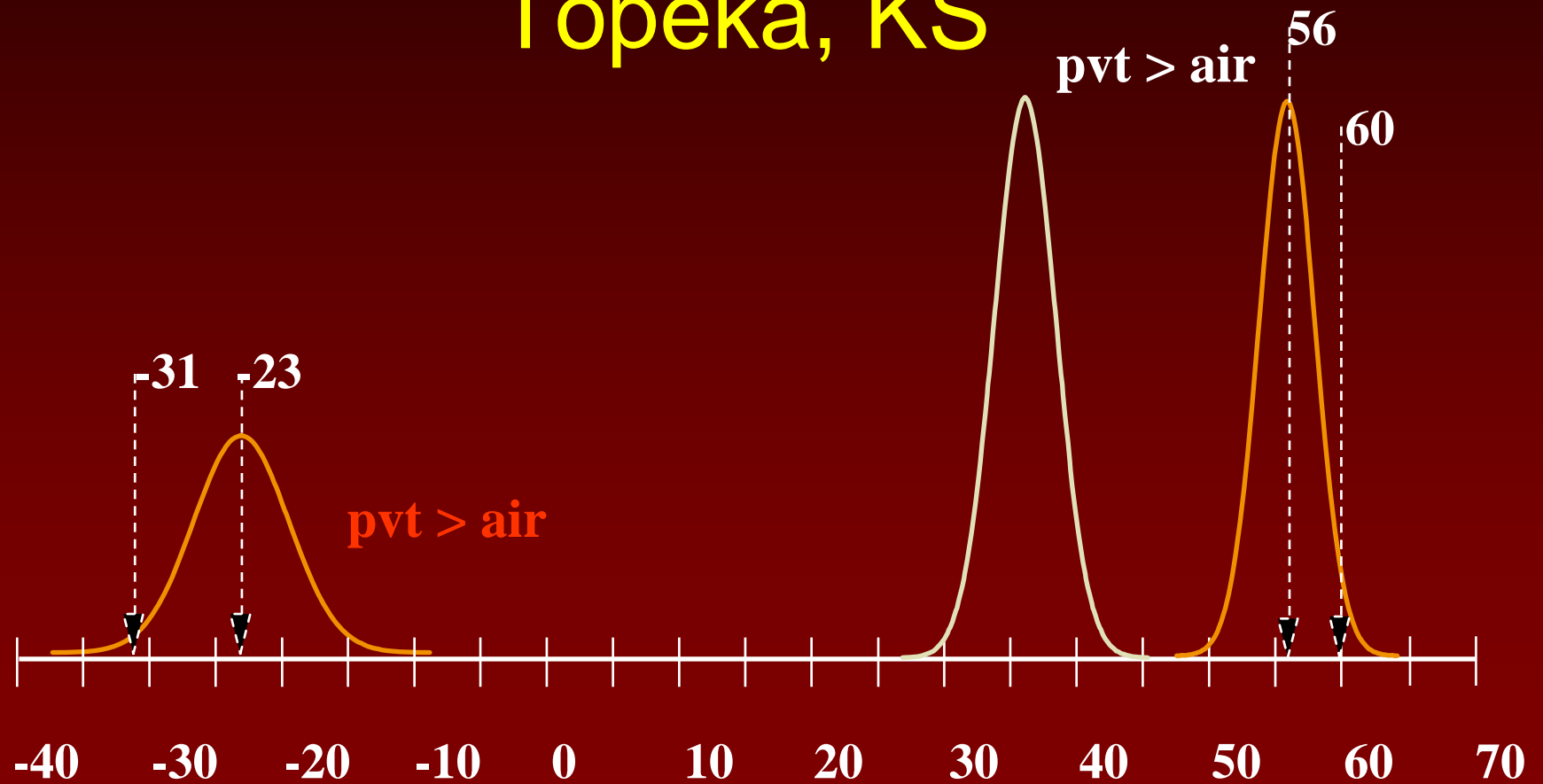


Convert to Pavement Temperature

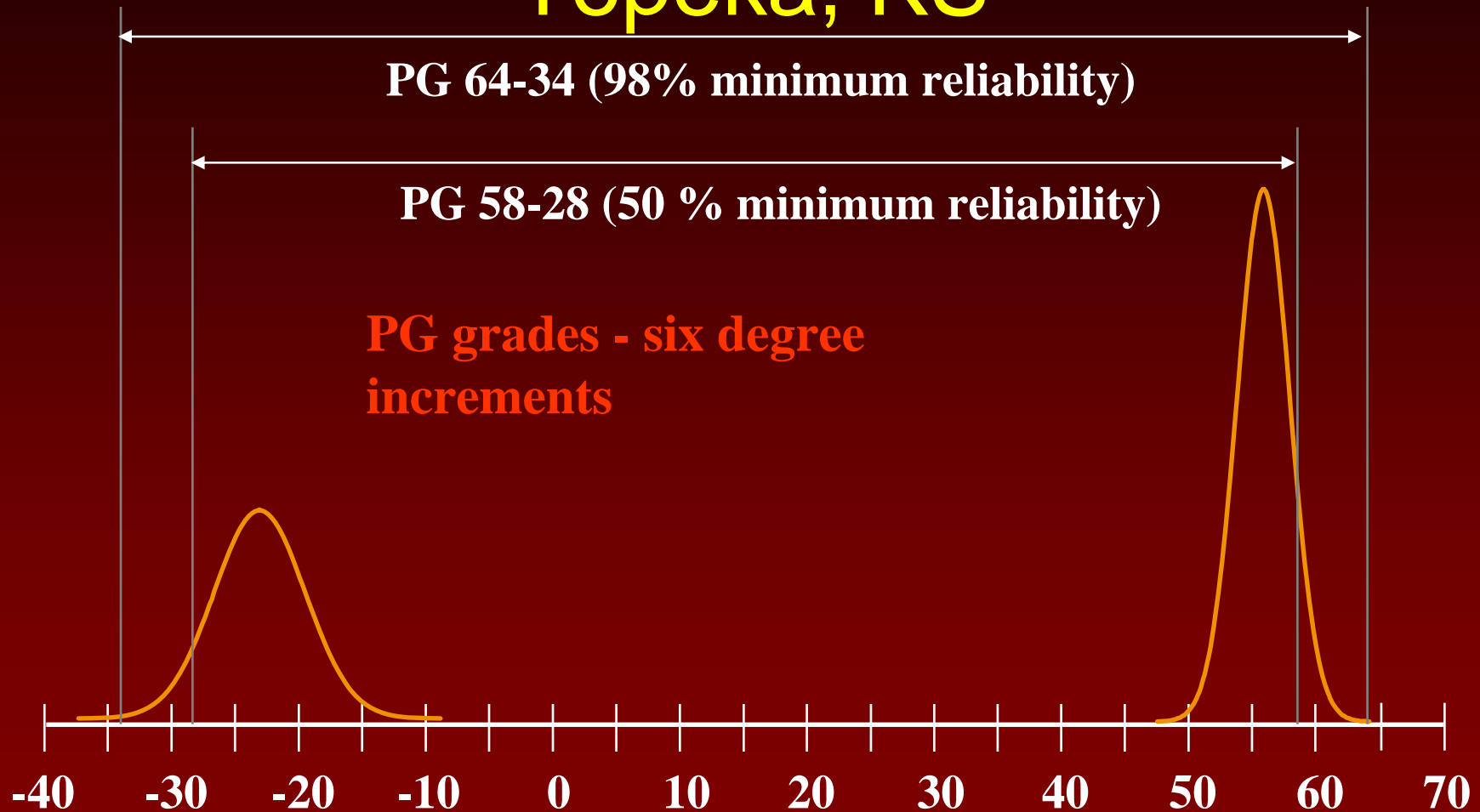
- Calculated by Superpave software
- High Temperature (20 mm below surface of mixture)
- Low Temperature (at surface of mix)



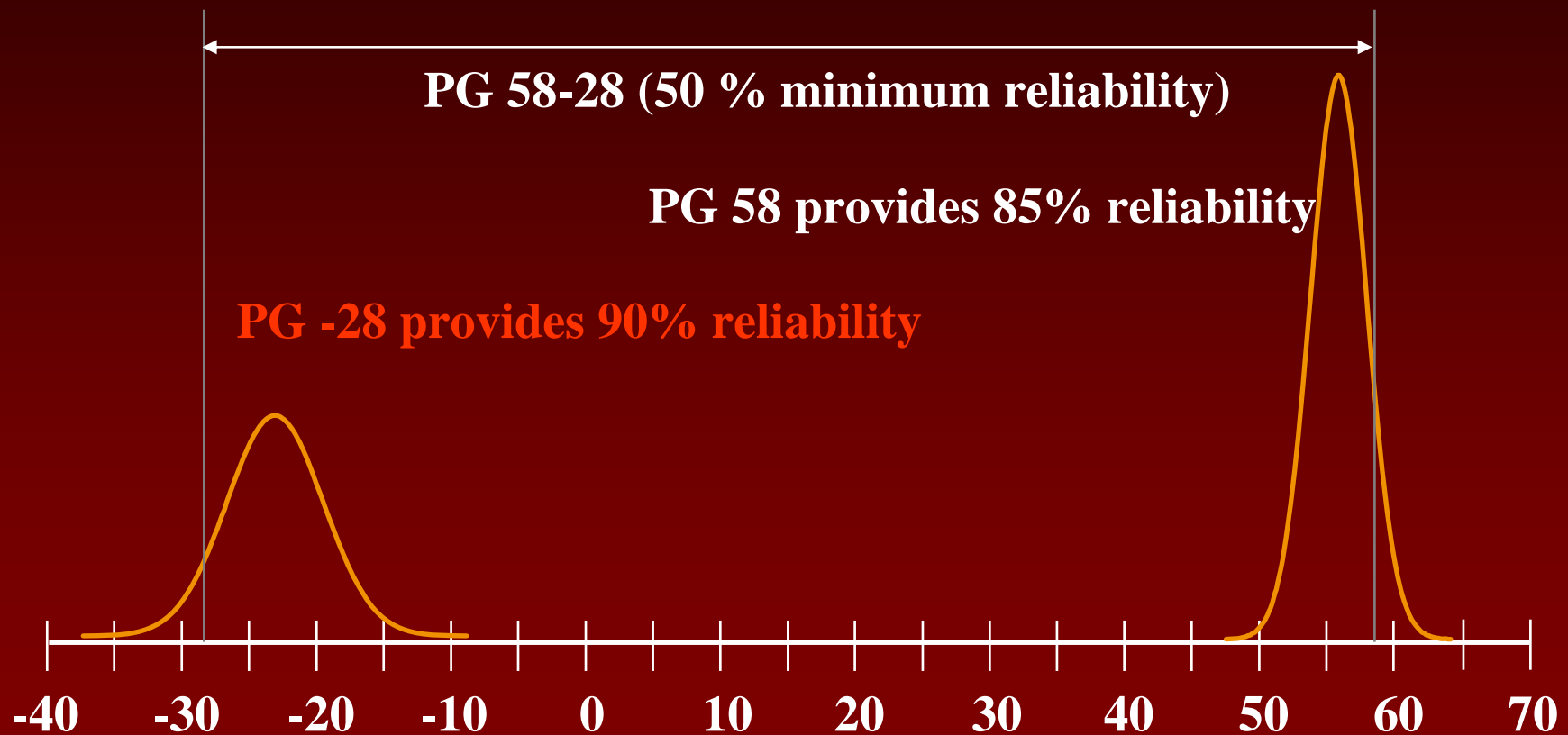
Calculated Pavement Temperatures Topeka, KS



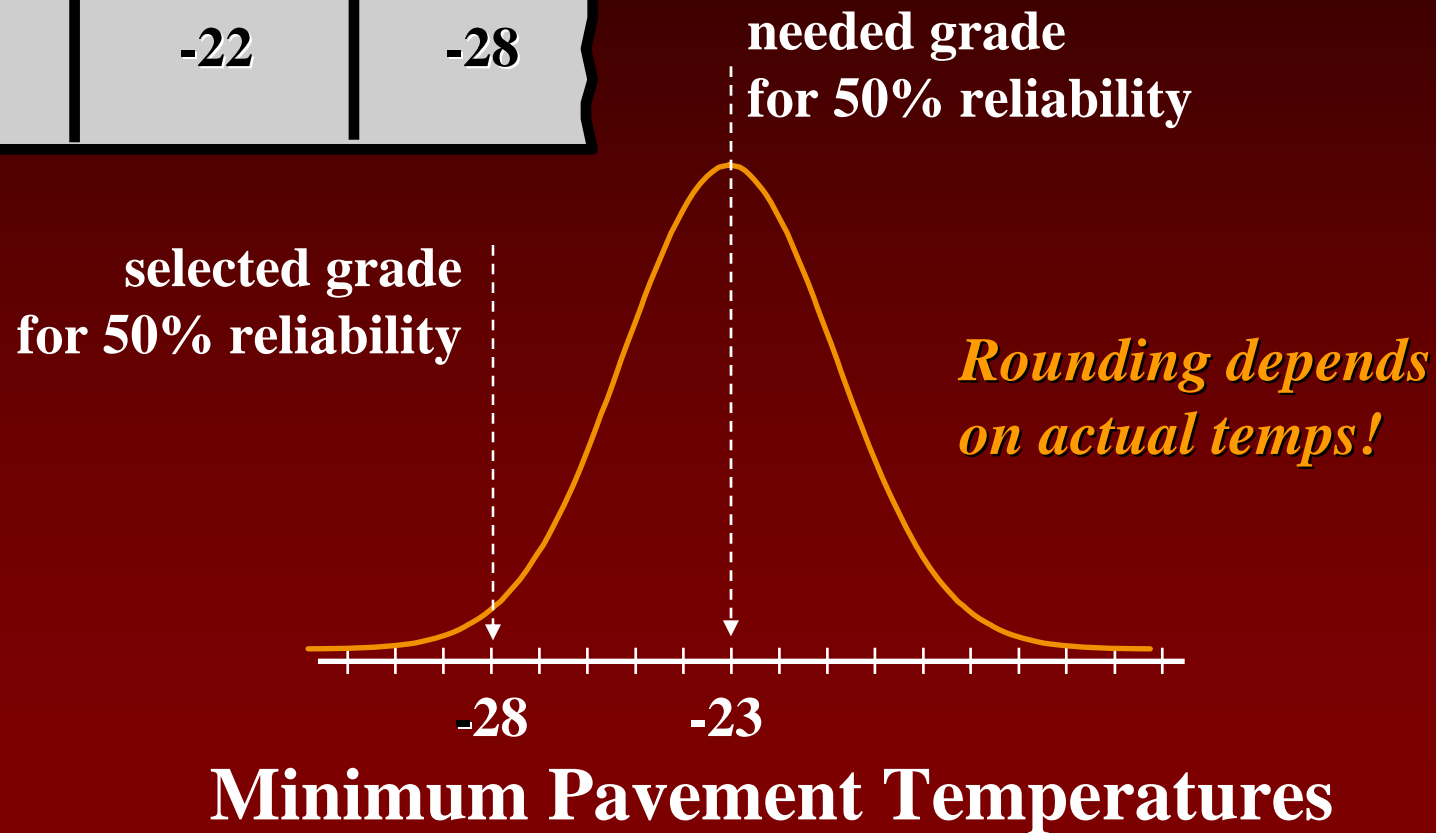
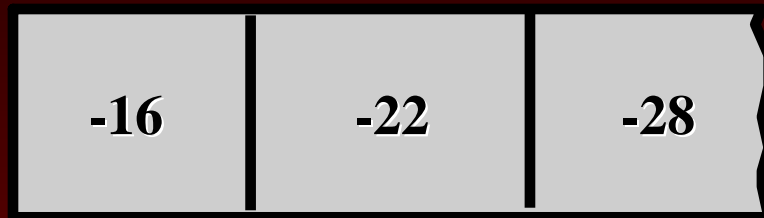
PG Binder Grades Topeka, KS



Effect of Rounding to Standard Grades



Effect of Rounding to Standard Grades

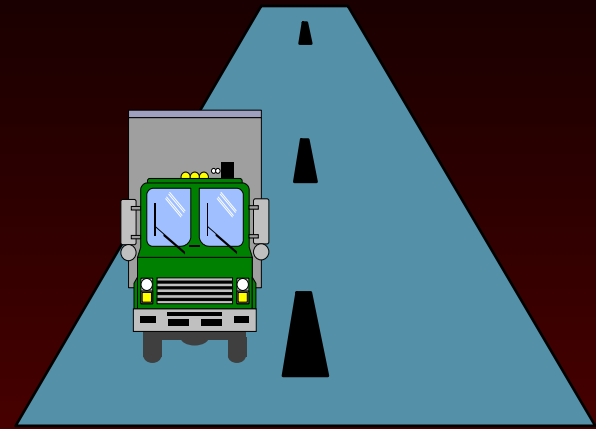


Effect of Loading Rate on Binder Selection



- Dilemma
 - Specified DSR loading rate is 10 rad/sec
 - What about longer loading times ?
- Use binder with more stiffness at higher temps
 - Slow - - increase one high temp grade
 - Stationary - - increase two high temp grades
 - *No effect on low temp grade*

Effect of Loading Rate on Binder Selection



90 kph

- Example
 - for toll road
 - for toll booth
 - for weigh stations

PG 64-22

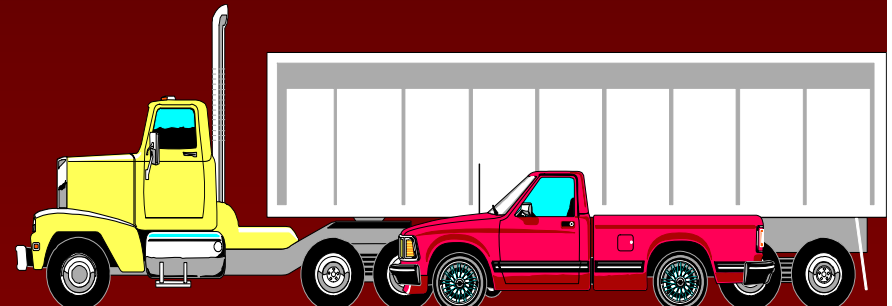
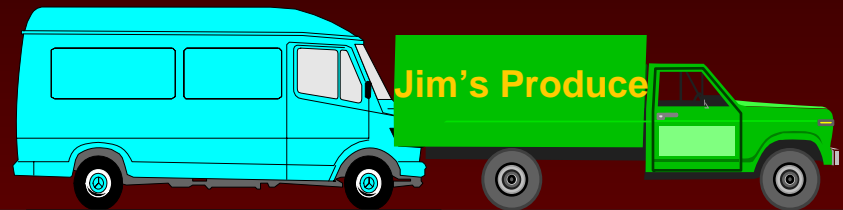
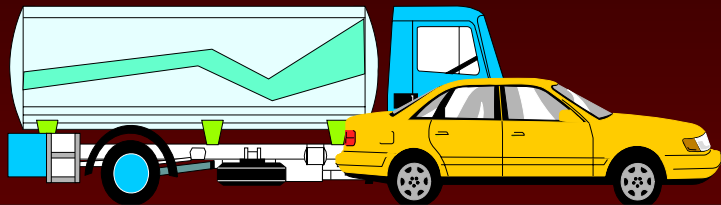
PG 70-22

PG 76-22

Slow

Stopping

All Traffic Converted to ESAL's



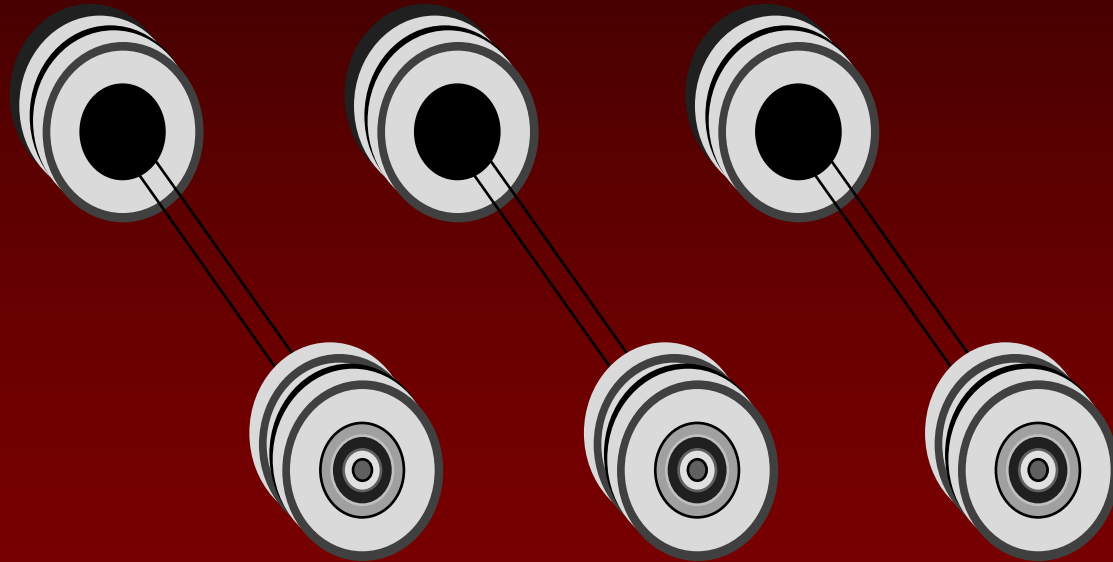
ESAL = Equivalent Single Axle Loads

ESAL Comparison

80 kN
18,000 lb.

100 kN
22,000 lb.

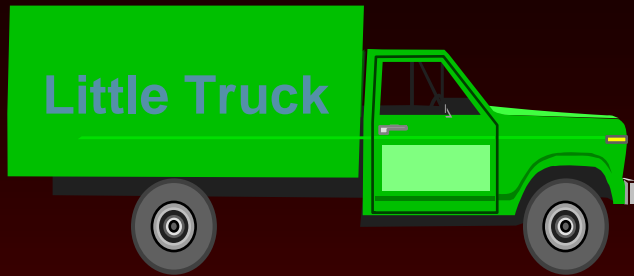
44 kN
10,000 lb.



1
ESAL

2.2
ESAL

.09
ESAL



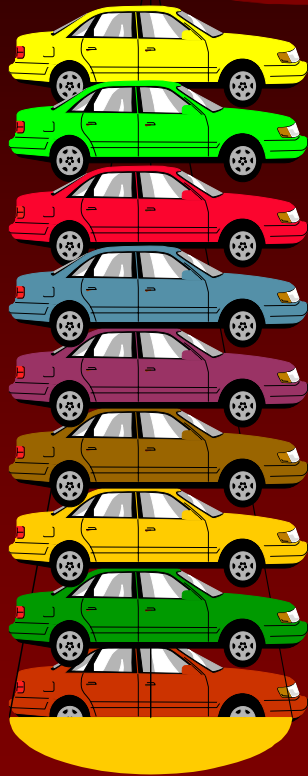
$$\begin{array}{r} 67 \text{ kN} \\ 15,000 \text{ lb} \\ 0.48 \text{ ESAL} \end{array} + \begin{array}{r} 27 \text{ kN} \\ 6,000 \text{ lb} \\ 0.01 \text{ ESAL} \end{array} = \mathbf{0.49 \text{ ESALs}}$$



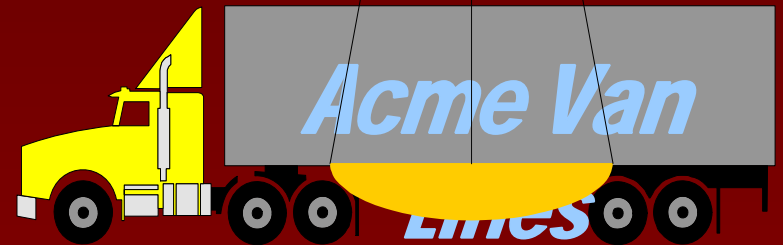
$$\begin{array}{r} 151 \text{ kN} \\ 34,000 \text{ lb} \\ 1.10 \end{array} + \begin{array}{r} 151 \text{ kN} \\ 34,000 \text{ lb} \\ 1.10 \end{array} + \begin{array}{r} 54 \text{ kN} \\ 12,000 \text{ lb} \\ 0.19 \end{array} = \mathbf{2.39 \text{ ESALs}}$$

ESAL

Comparison



3,500-
5,000



1

Effect of Traffic Amount on Binder Selection



- $10 - 30 \times 10^6$ ESAL
 - Consider increasing - - one high temp grade
- $30 \times 10^6 +$ ESAL
 - Recommend increasing - - one high temp grade

> Equivalent Single Axle Loads

Summary of How to Use PG Specification

- Determine
 - 7-day max pavement temperatures
 - 1-day minimum pavement temperature
- Use specification tables to select test temperatures
- Determine asphalt cement properties and compare to specification limits

PG Grade Increments

Average 7-day Maximum Pavement
Temperature

46

52

58

64

70

76

82

Average 1-day Minimum Pavement
Temperature

+2

-4

-10

-16

-22

-28

-34

Prediction of PG Grades for Crude Blends

		High Temp C				
		52	58	64	70	76
Low Temp C	-10	52-16	58-16	64-16	70-16	76-16
	-16	52-22	58-22	64-22	70-22	76-22
	-22	52-28	58-28	64-28	70-28	76-28
	-28	52-34	58-34	64-34	70-34	76-34
	-34	52-40	58-40	64-40	70-40	76-40
-40						

■ Low Quality Crudes
 ■ High Quality Crudes
 ■ Modifier Required

Is a PG a Modified Binder?

Effect of Loading Rate

Reliability

“Rule of 90”

Rounding

Effect of Traffic

Example: PG 64 - 34 has a temperature range of 64 to - 34 or 98 C. Therefore, this binder is probably modified !! (Depends on Asphalt Source!)

**Questions –
does it all
make
sense?**

