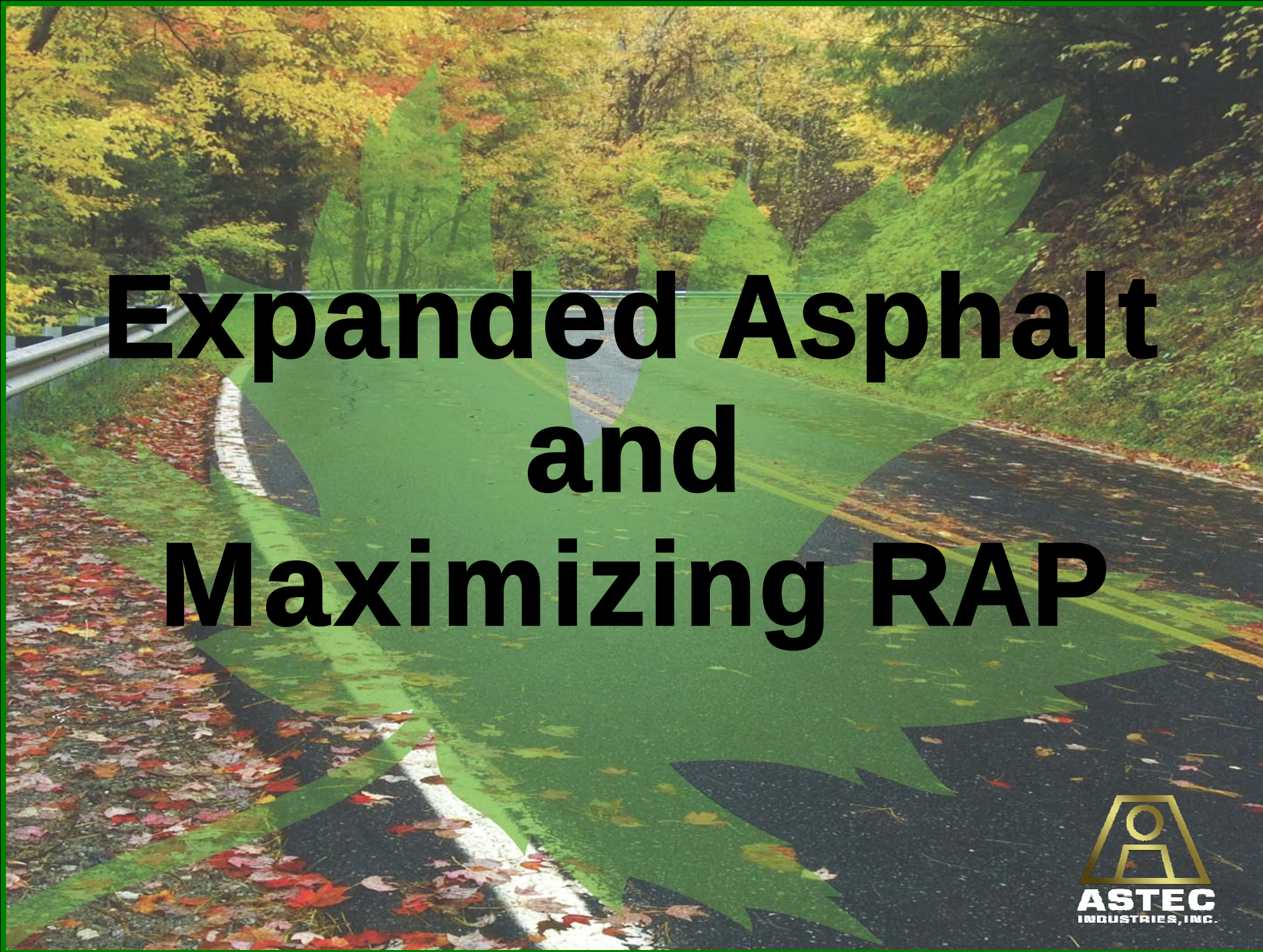

Expanded Asphalt
and
Maximizing RAP
ASTEC
INDUSTRIES, INC.


by
TURNING GREEN
with
SUSTAINABILITY
ASTEC
INDUSTRIES, INC.

PROOF OF GLOBAL WARMING

And at the same time

- Conserving our resources
- Reducing energy cost
- Reducing Greenhouse Emission
- Being more environmentally friendly
- And building a better, long-lasting pavement

Barriers to increasing the use of more Recycle

- Fear of making a mistake
- Meeting voids & asphalt content with Superpave Mix Design
- Meeting skid requirements
- Hardness of asphalt with high RAP - need to use softer virgin asphalt cement…fatigue cracking
- Special mixes like SMA
- Limit RAP to 15% when polymers are used

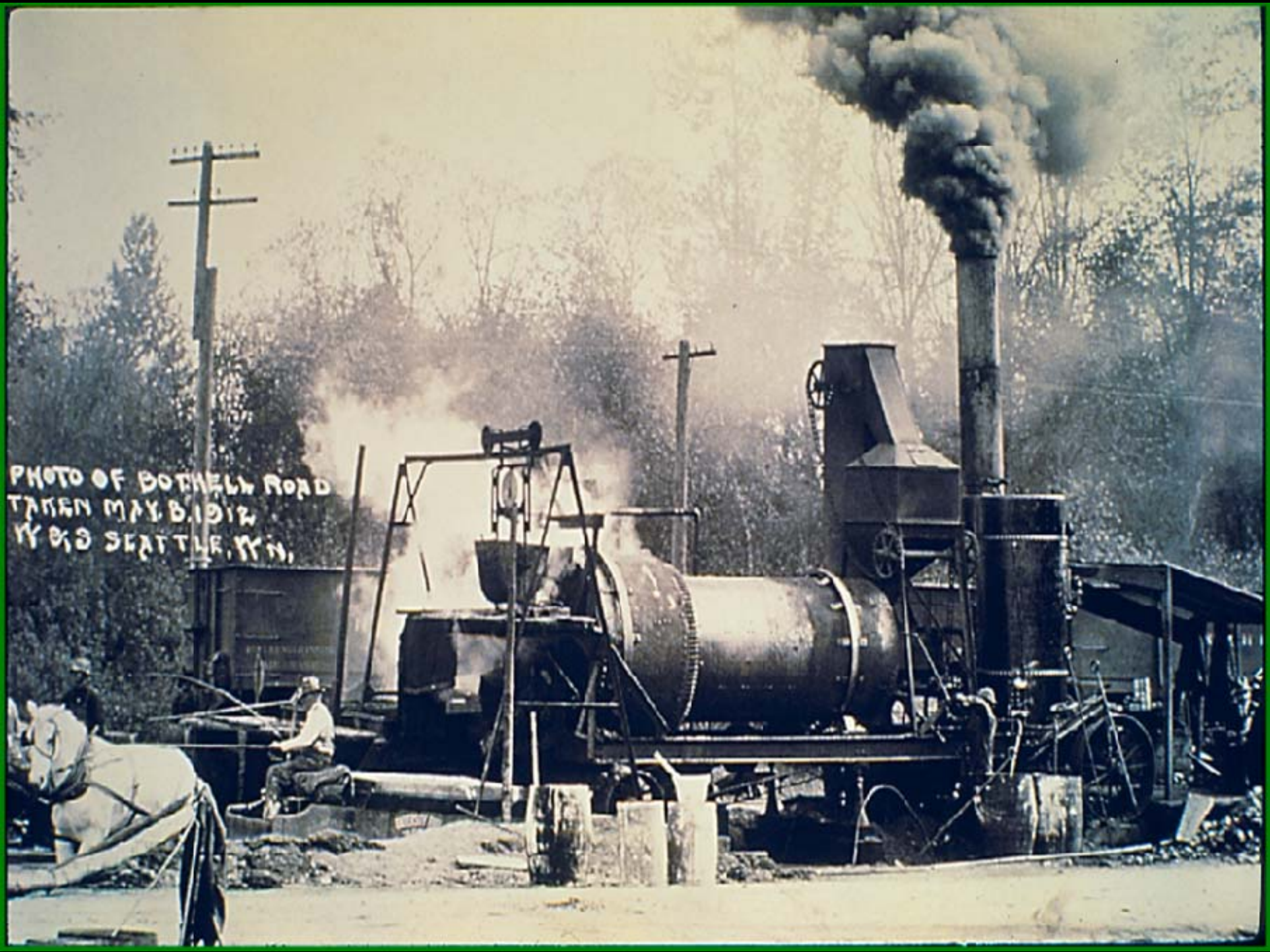
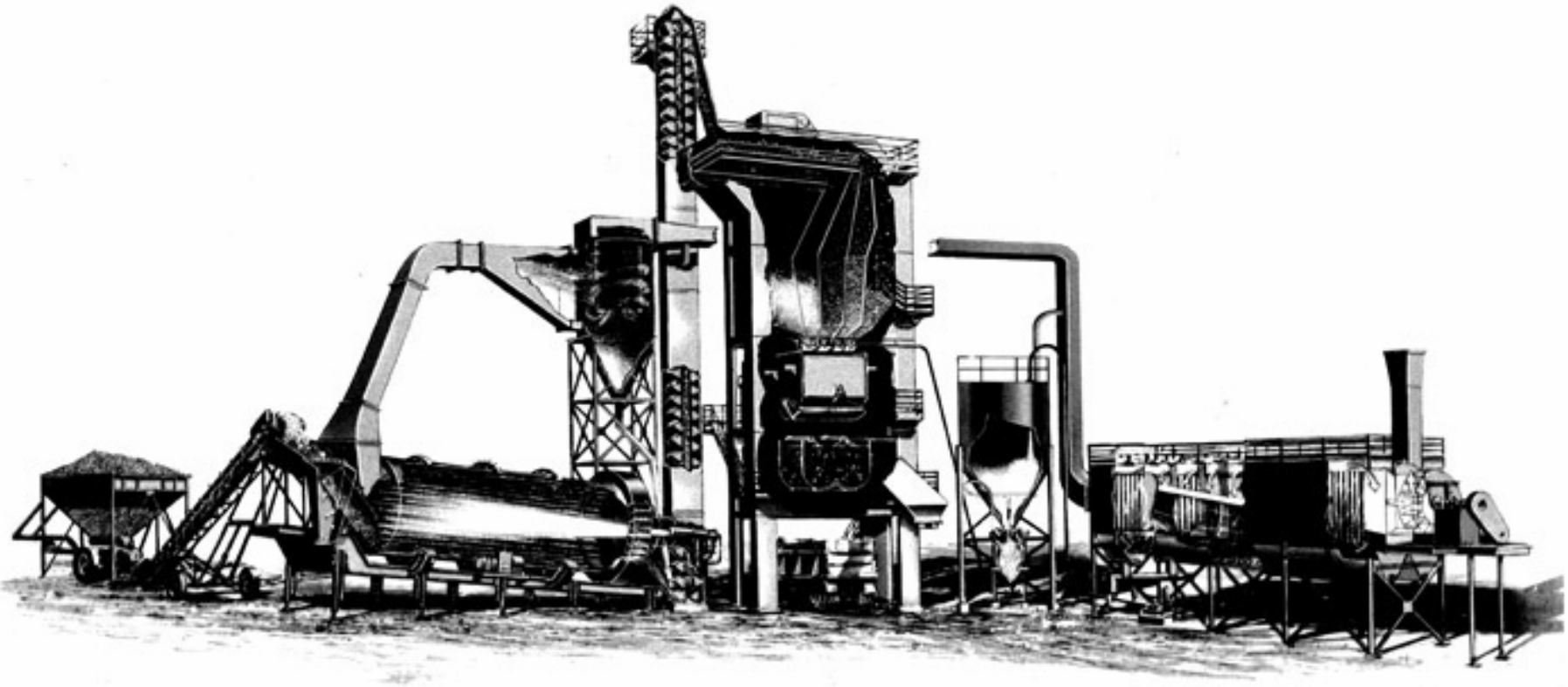
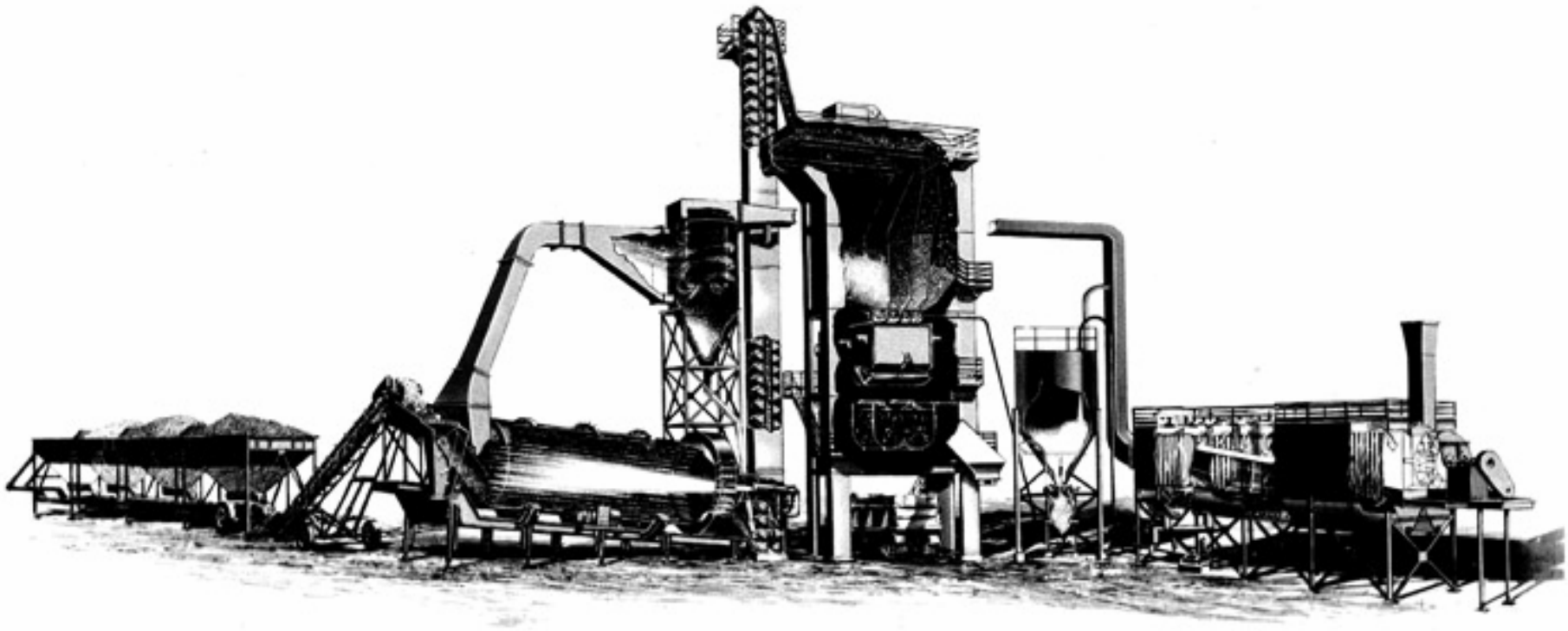


PHOTO OF BOTHELL ROAD
TAKEN MAY 8, 1912
BY B.B. SEATTLE, WASH.



BATCH PLANT

ONE BIN COLD FEED



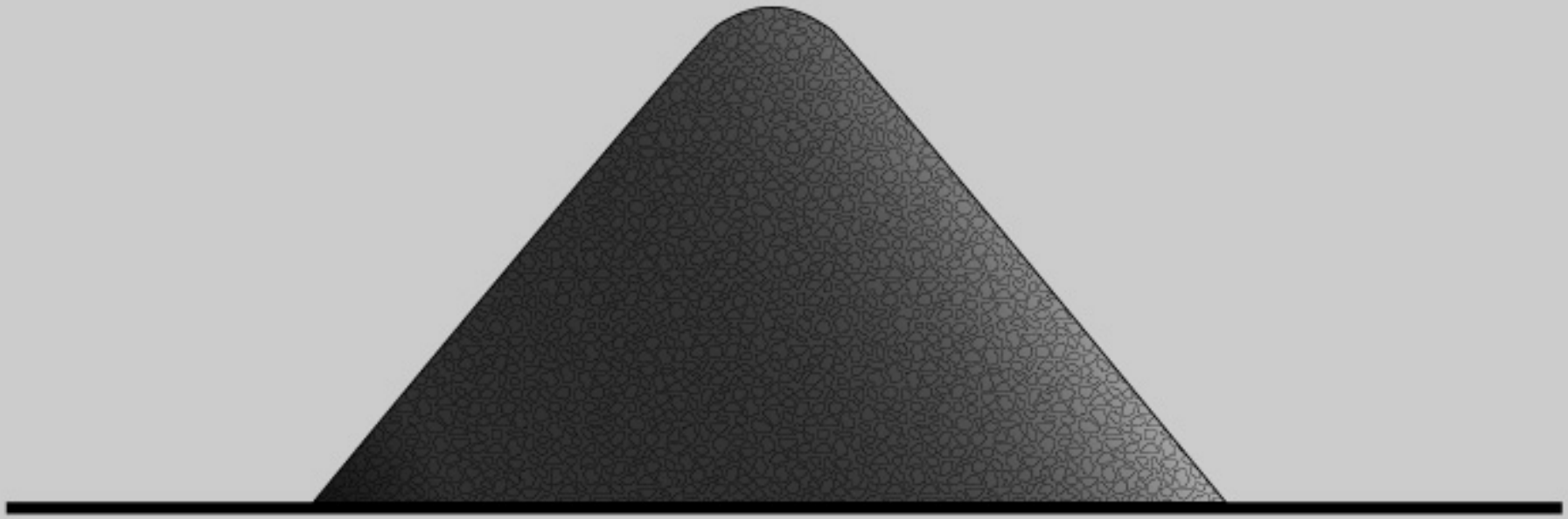
BATCH PLANT

FOUR BIN COLD FEED

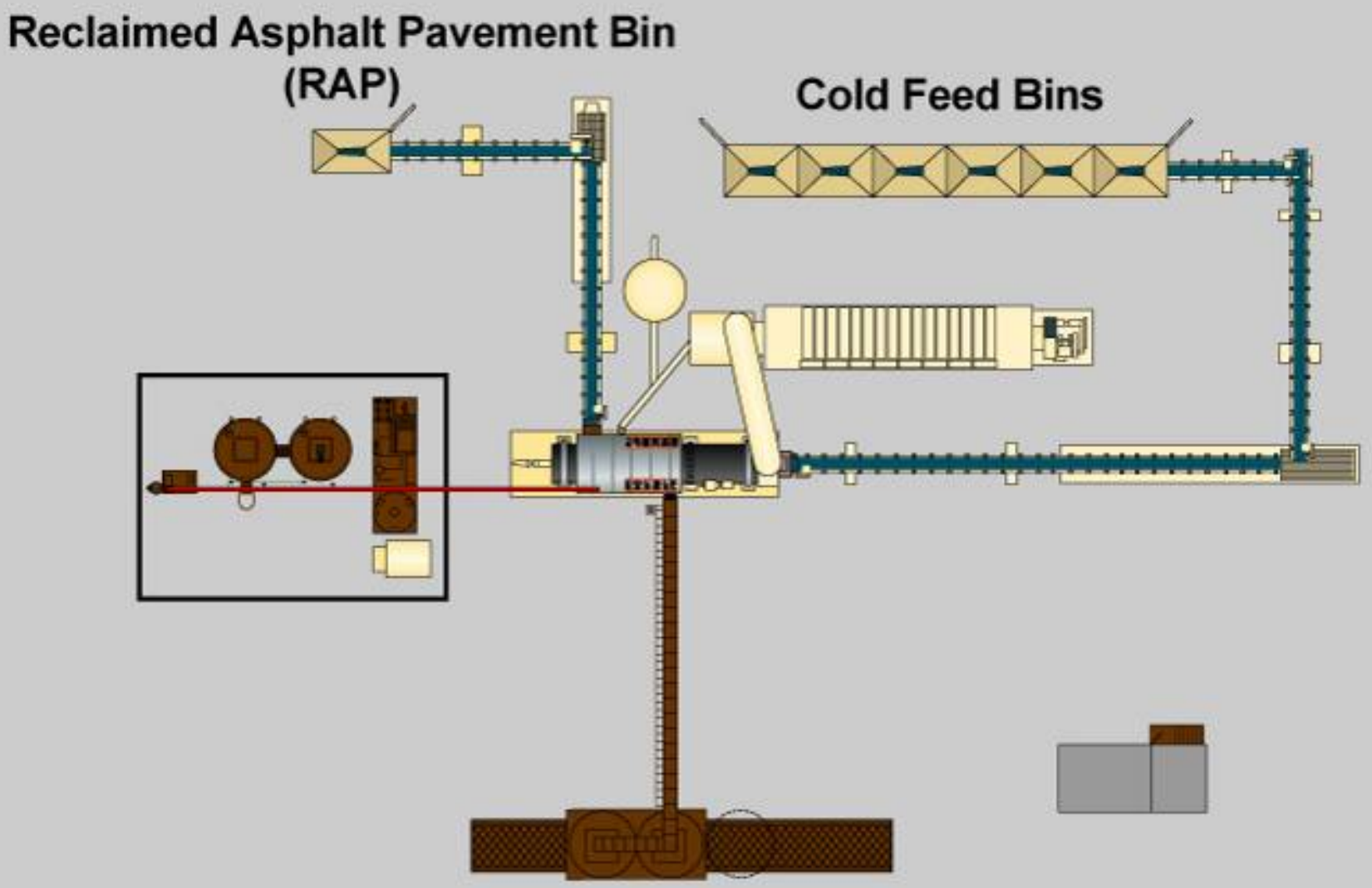

Spray Saver
Spray Saver
Spray Saver
SCALE HOUSE
AND PLANTS

Full-Lane Milling Machine

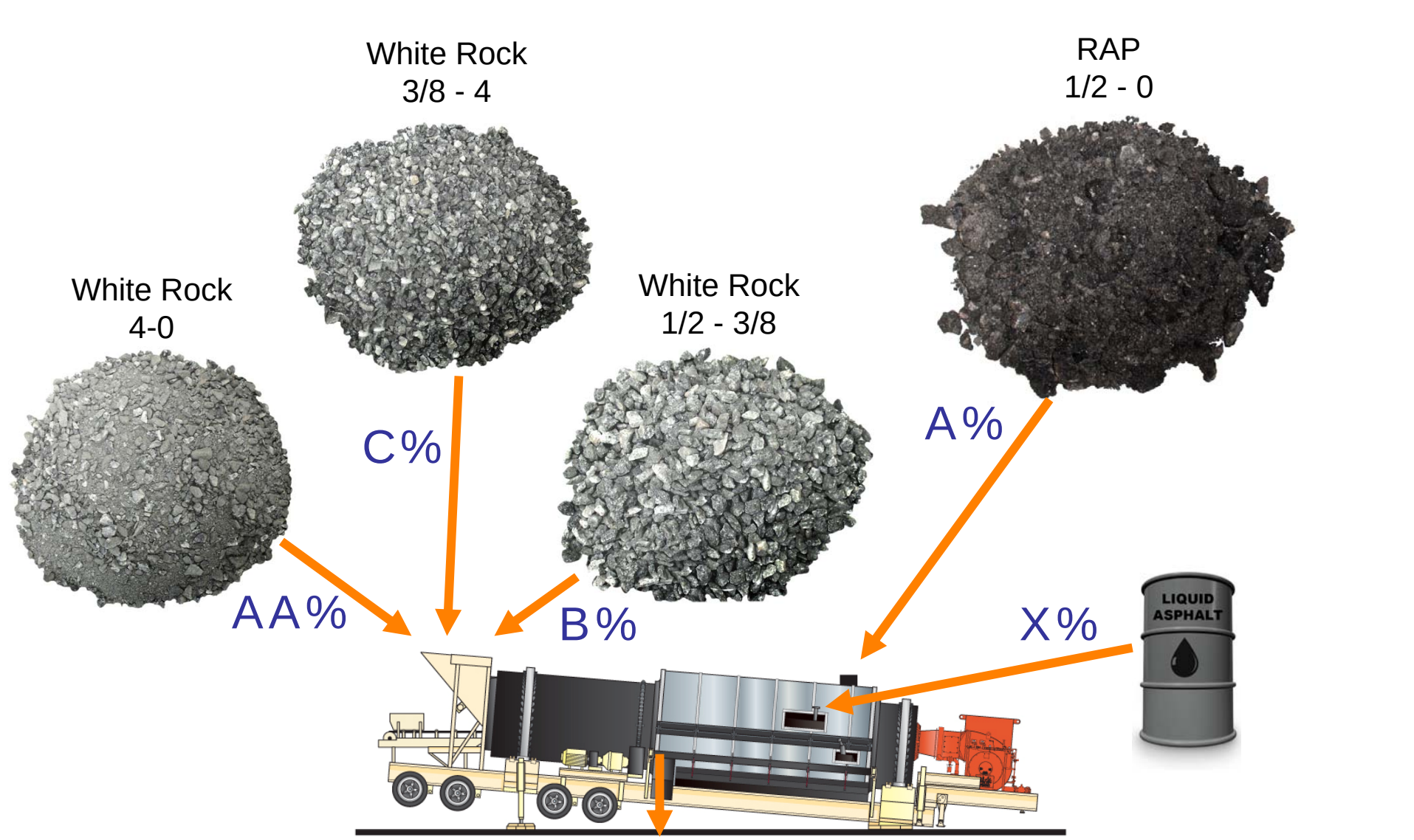
Reclaimed Asphalt Pavement
(RAP)



RAP Pile With 1/2” Minus to 3/4” Minus Aggregate



1980-1990's HMA Facility with Single RAP Bin



SUPERPAVE MIX WITH 1/2 RAP

1/2 x 0

6% AC

1/2 x 4

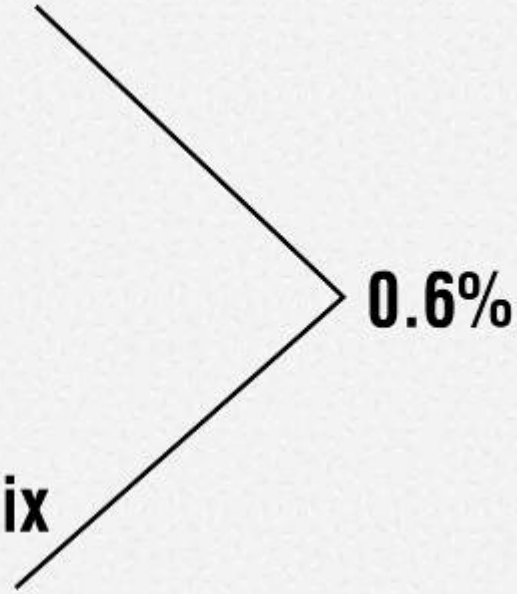
4% AC

4 x 0

7% AC

@ 20% RAP Coarse AC Contribution to Mix

= 0.20 x 4% = 0.8%

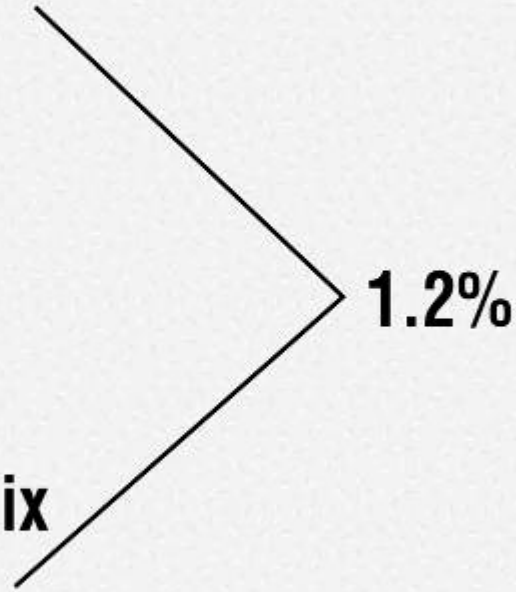


Fine AC Contribution to Mix

= 0.20 x 7% = 1.4%

@ 40% RAP Coarse AC Contribution to Mix

= 0.40 x 4% = 1.6%



Fine AC Contribution to Mix

= 0.40 x 7% = 2.8%

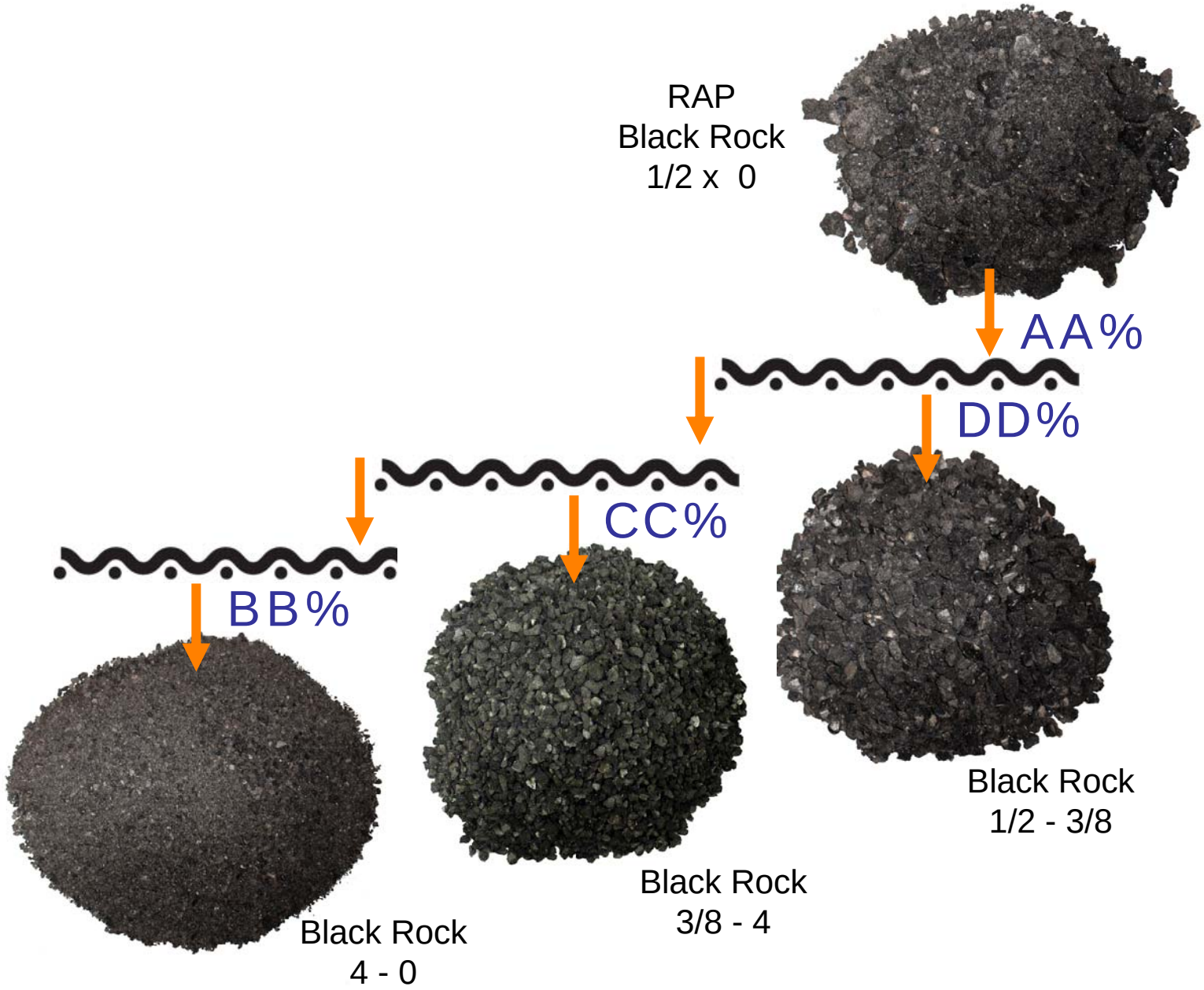
Rutting Often Occurs in Older Overlay Pavements


Blaw-Knox
UltiMat

End of Load Segregation

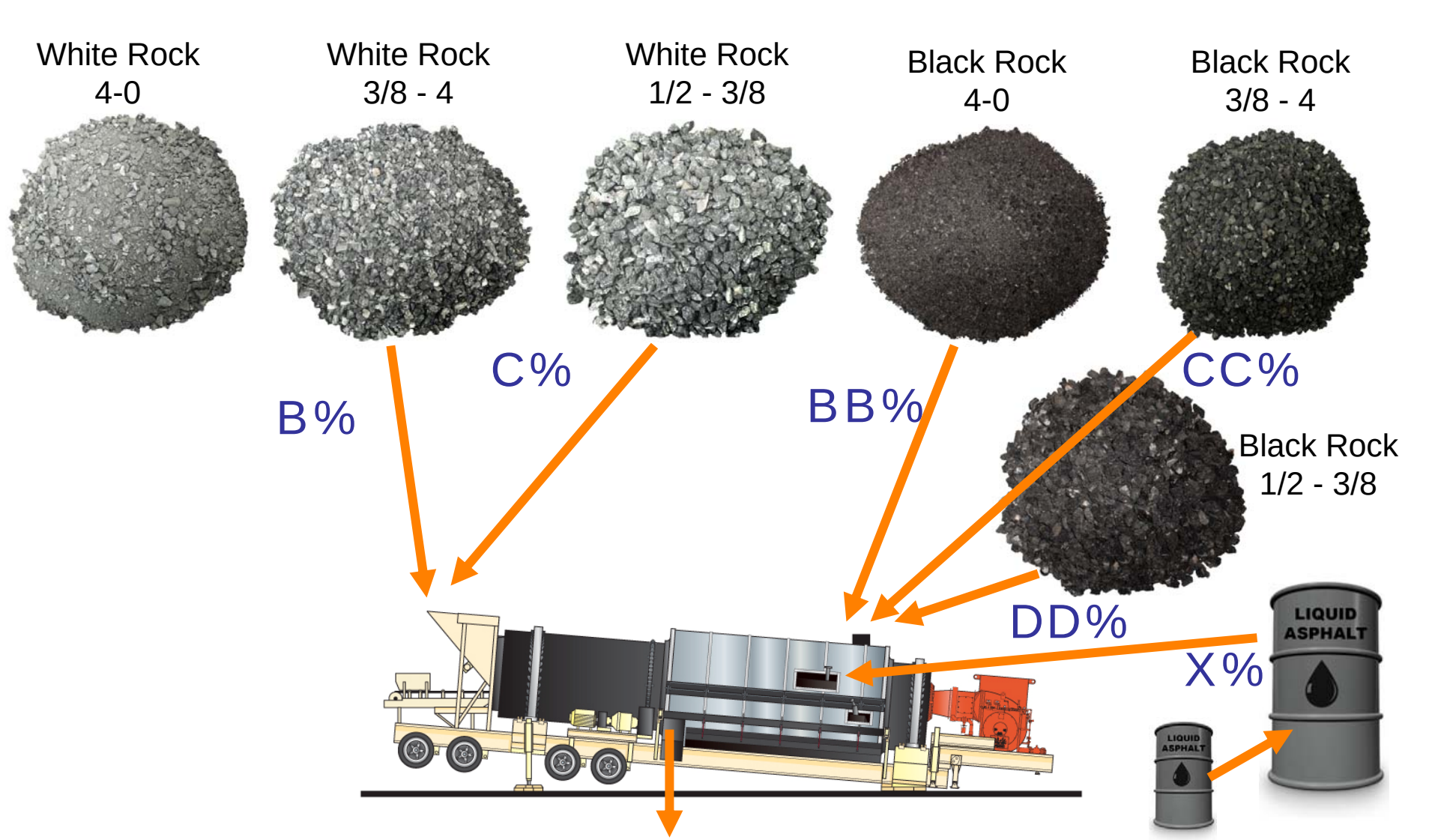
Rock Quarry

Oil Well



PROCESSED RAP SCREENED TO ORIGINAL INGREDIENTS


2007 6 7



SUPERPAVE MIX WITH PROCESSED RAP - CHOICE #2

White Rock
4-0

White Rock
3/8 - 4

White Rock
1/2 - 3/8

Black Rock
4-0

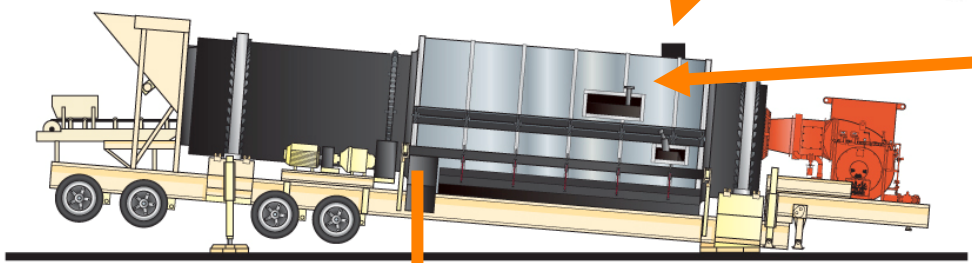
Black Rock
3/8 - 4

B%

C%

BB%

Black Rock
1/2 - 3/8



X%

SUPERPAVE MIX WITH PROCESSED RAP - CHOICE #1


НБАТВС
НБАТВС

How much water?

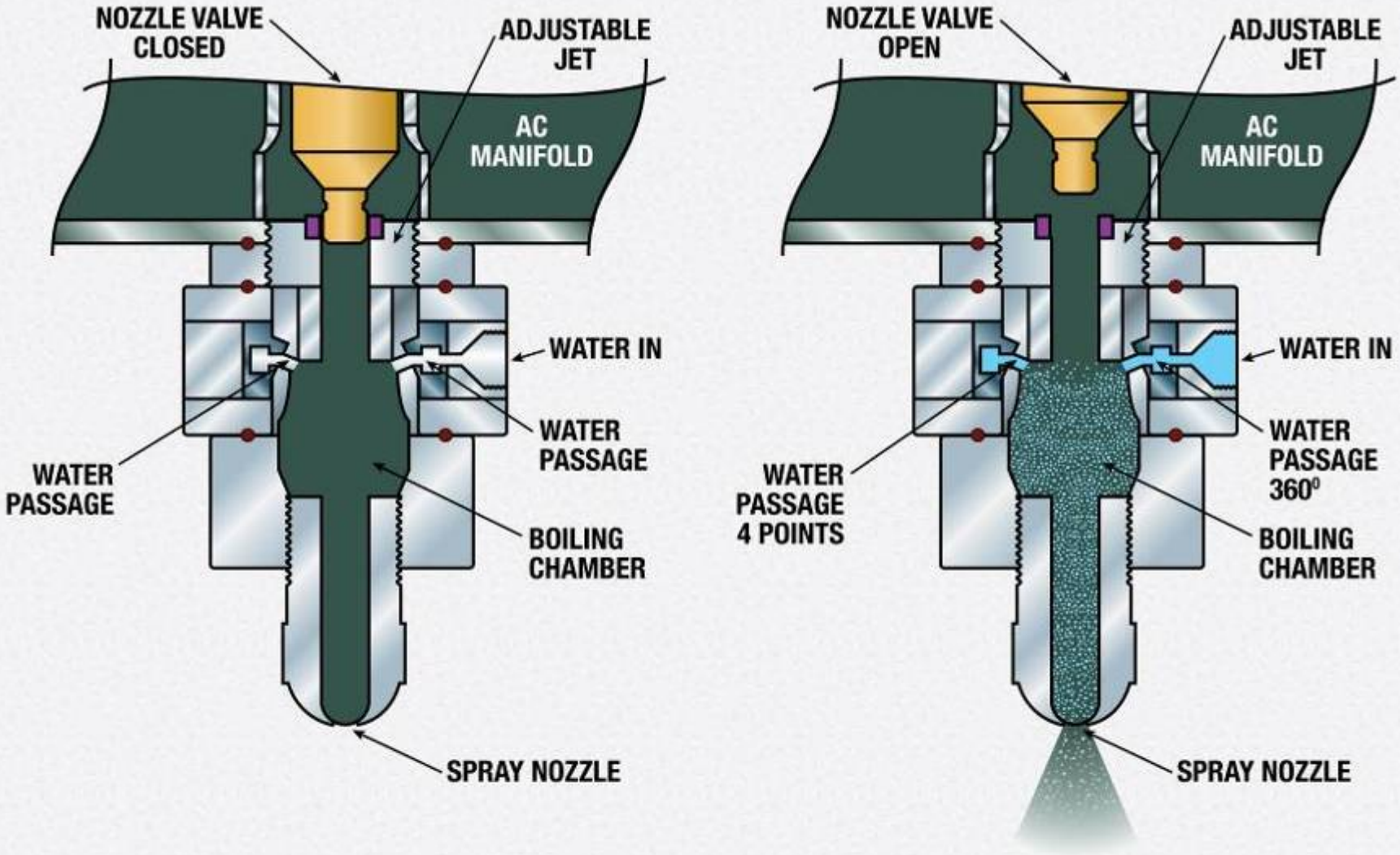
1 ton mix – 2,000 lb.

5.3% liquid – 106 lb.

Volume of liquid – 1.63 cu. ft.

1 lb. H_2O when converted to steam = 30 cu. ft.

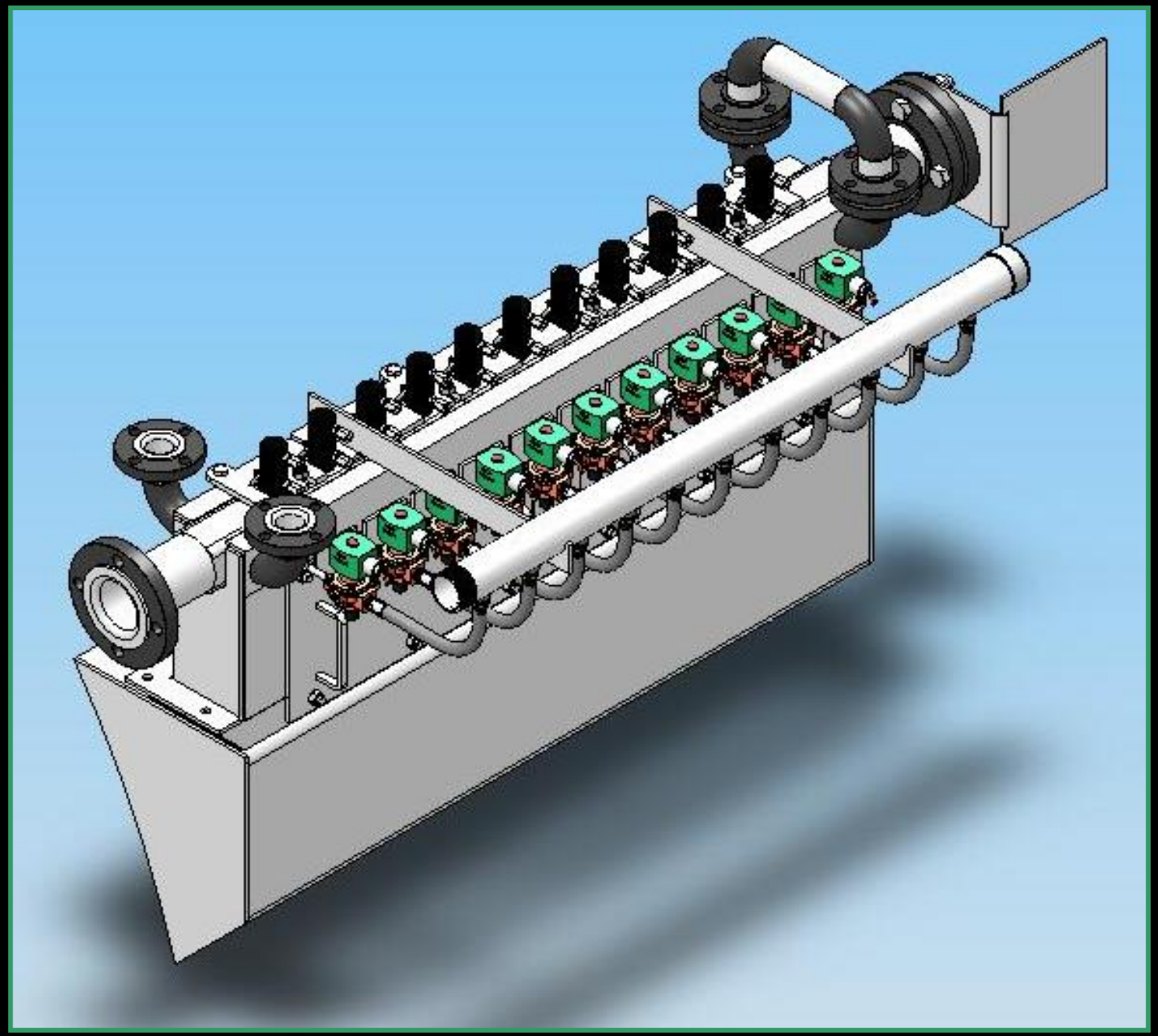
Expansion - $\frac{30}{1.63}$ = 18

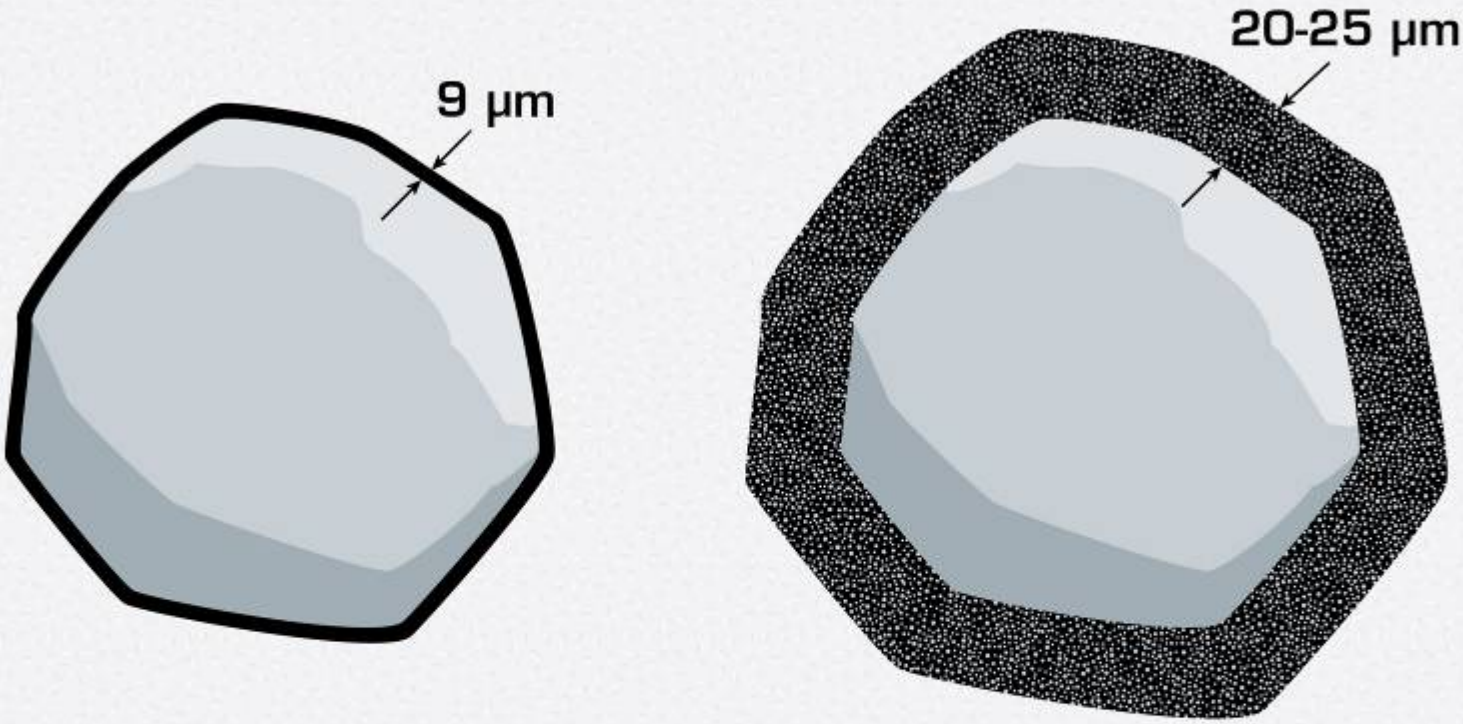


FOAM NOZZLE CLOSED

FOAM NOZZLE OPEN

FOAM NOZZLE

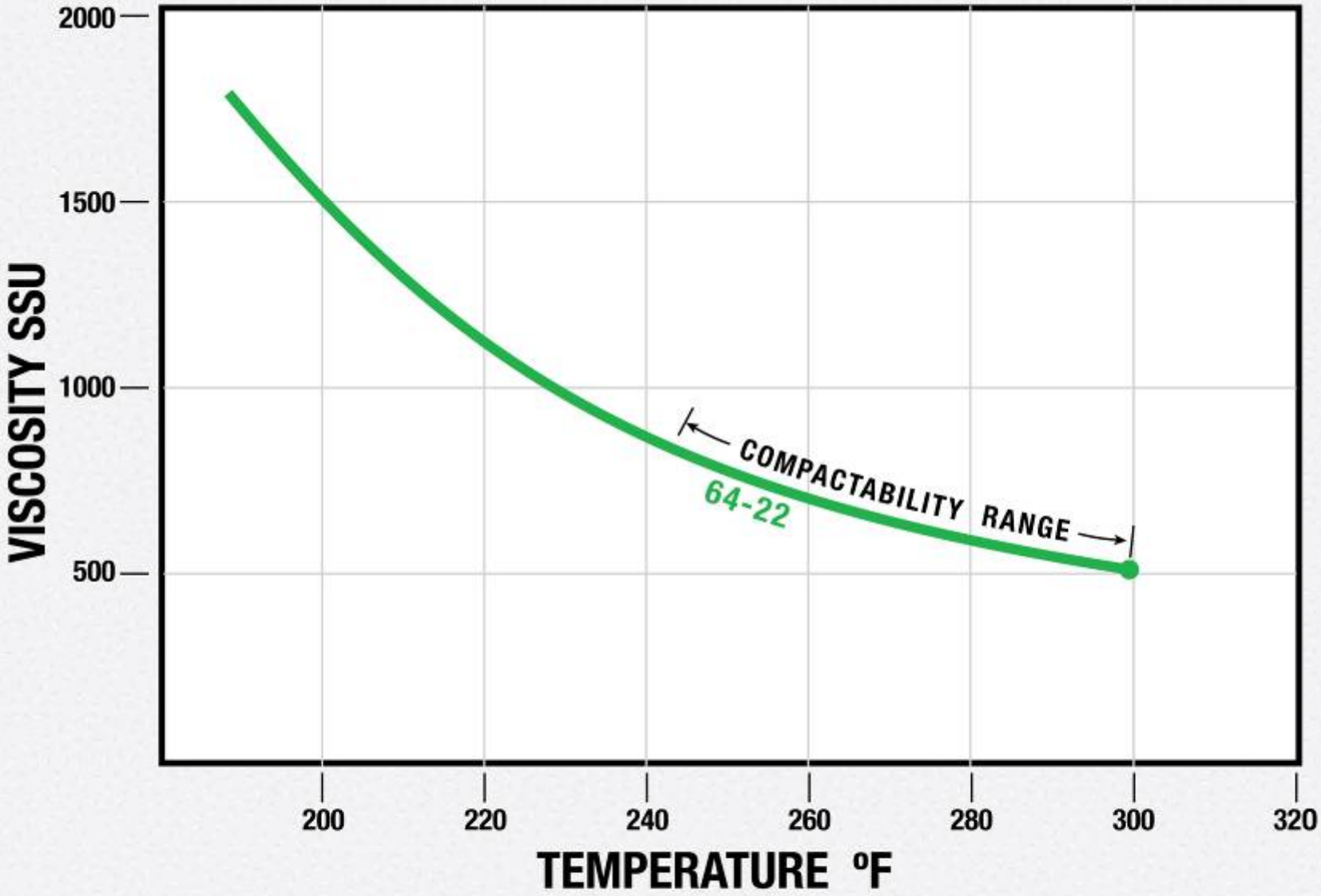




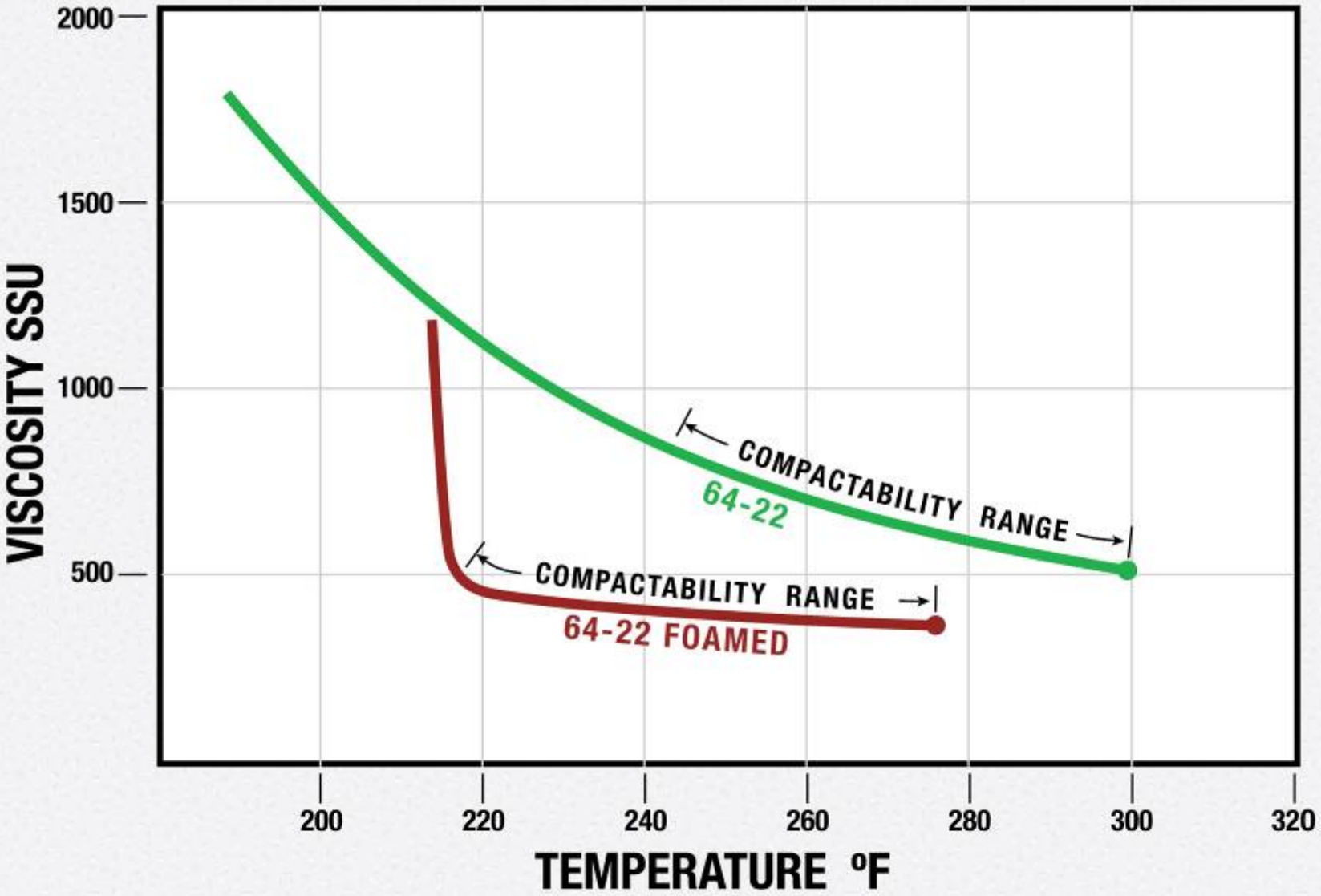
NORMAL COATING

DB GREEN FOAM COATING

COATING THICKNESS



VISCOSITY / TEMPERATURE PG 64 -22 (Approx.)



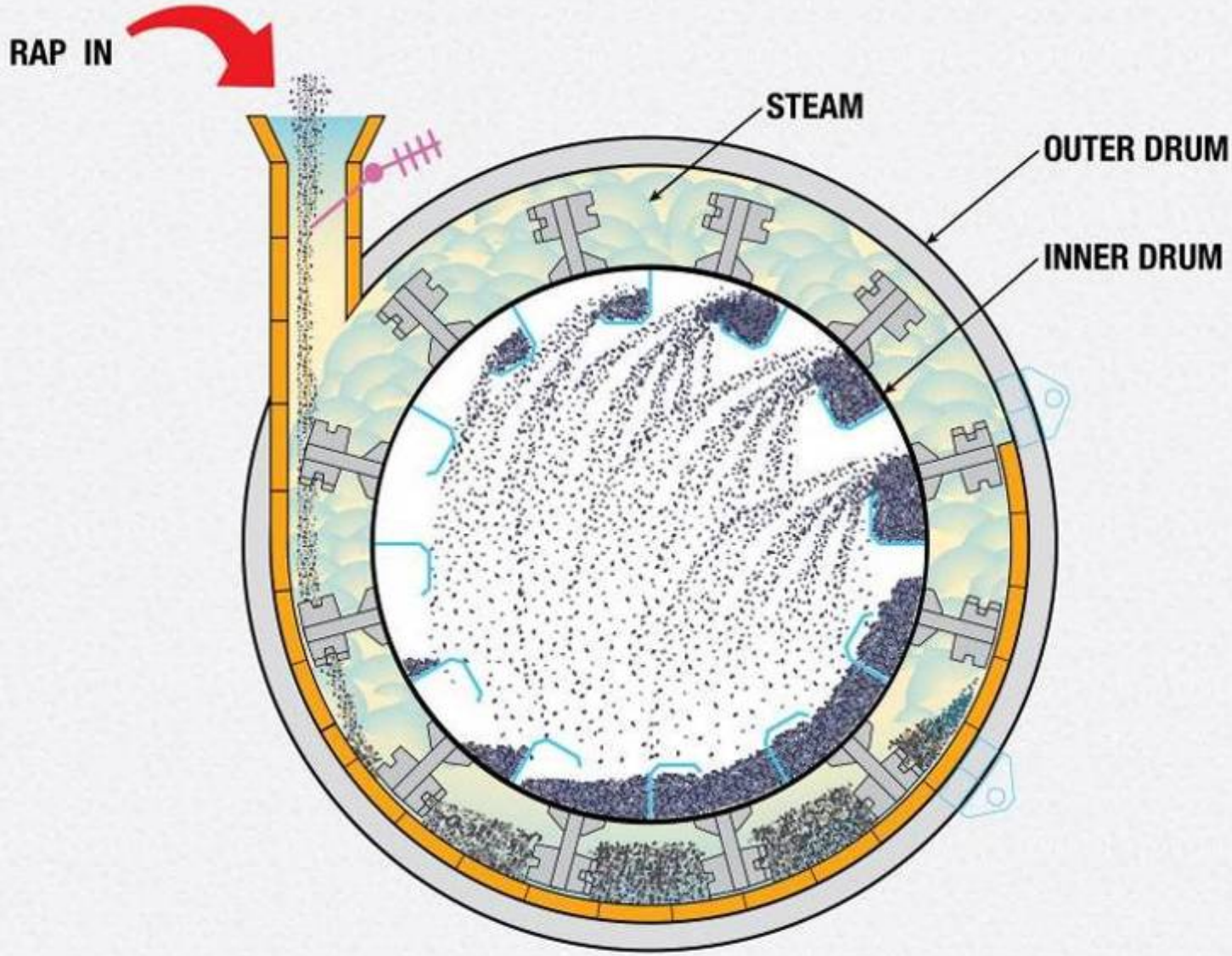
VISCOSITY / TEMPERATURE PG 64 -22 (Approx.)

No Smoke – No Smell…Why?

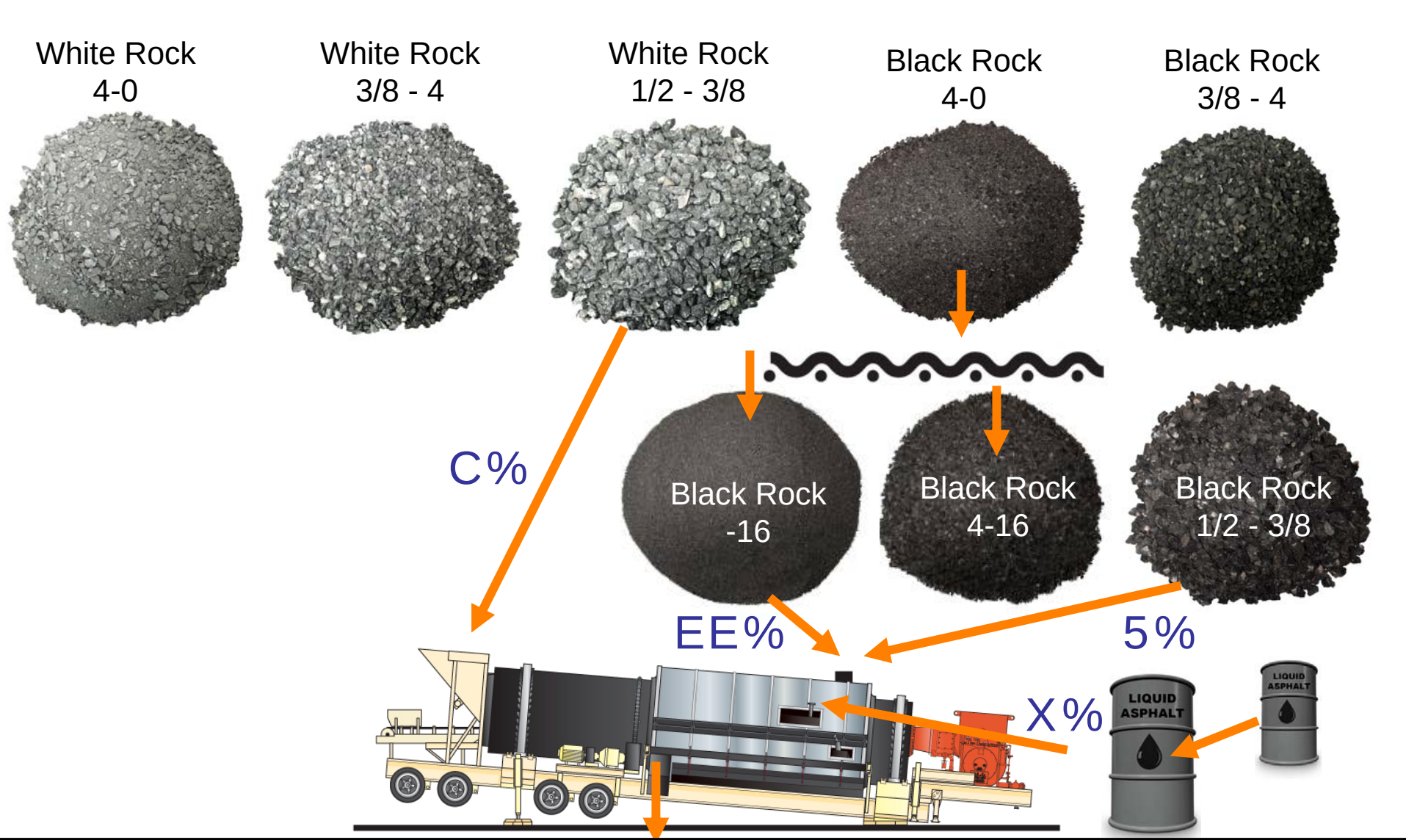
- Light oils are either put in asphalt or left in asphalt during refining
- These light oils boil at above 285ºF
- By mixing at below 285ºF, the boiling point is never reached…eliminating smoke (vapor) and corresponding smell

High Percentage Recycle Mix with Standard Grade of Asphalt

- To achieve compaction (density)…run 275°F and foam virgin liquid
- By using a standard liquid 64-22, you produce a much softer product than with virgin mix due to:
  - Lower temperature results in less oxidation
  - Light oil remains in liquid
  - Steam produced from drying the RAP creates an inert atmosphere



RAP GENERATES STEAM IN OUTER DRUM



SUPERPAVE MIX WITH PROCESSED RAP - CHOICE #3

Polymers SBS (How much is enough)

Aggregate in Mix-Uncrushed Gravel

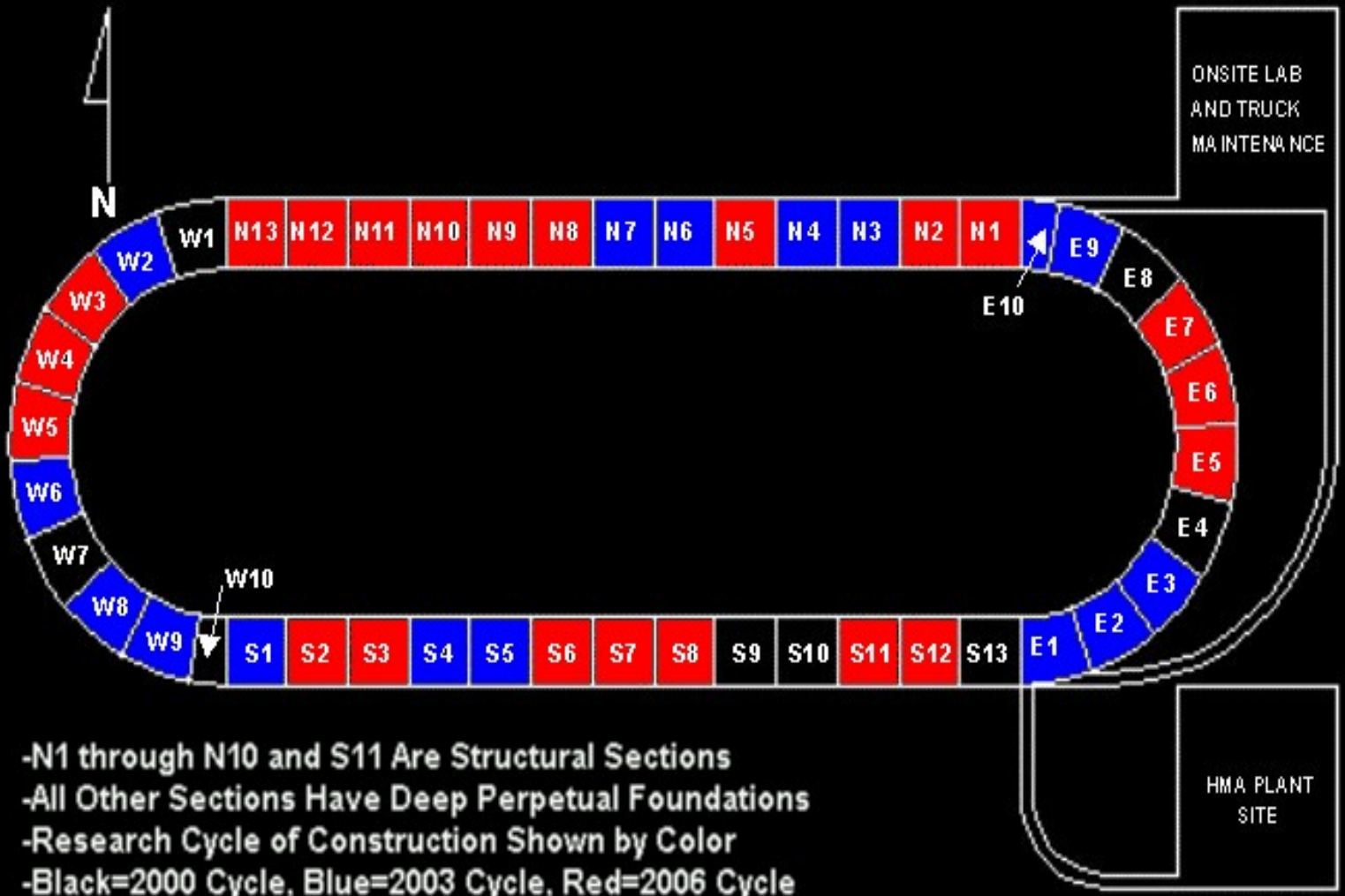
Rut test performed on APA @ 147°F (64°C)

% Polymers	Rut depth	Cycles
0	12.5 mm	2,000
1	9.0 mm	8,000
2	8.0 mm	8,000
3	7.0 mm	8,000
4	6.5 mm	8,000

With RAP @ 50%...4% polymers in virgin liquid results in 2% in final mix plus RAP liquid is harder


NCAT PAVEMENT TEST TRACK
www.pavetrack.com

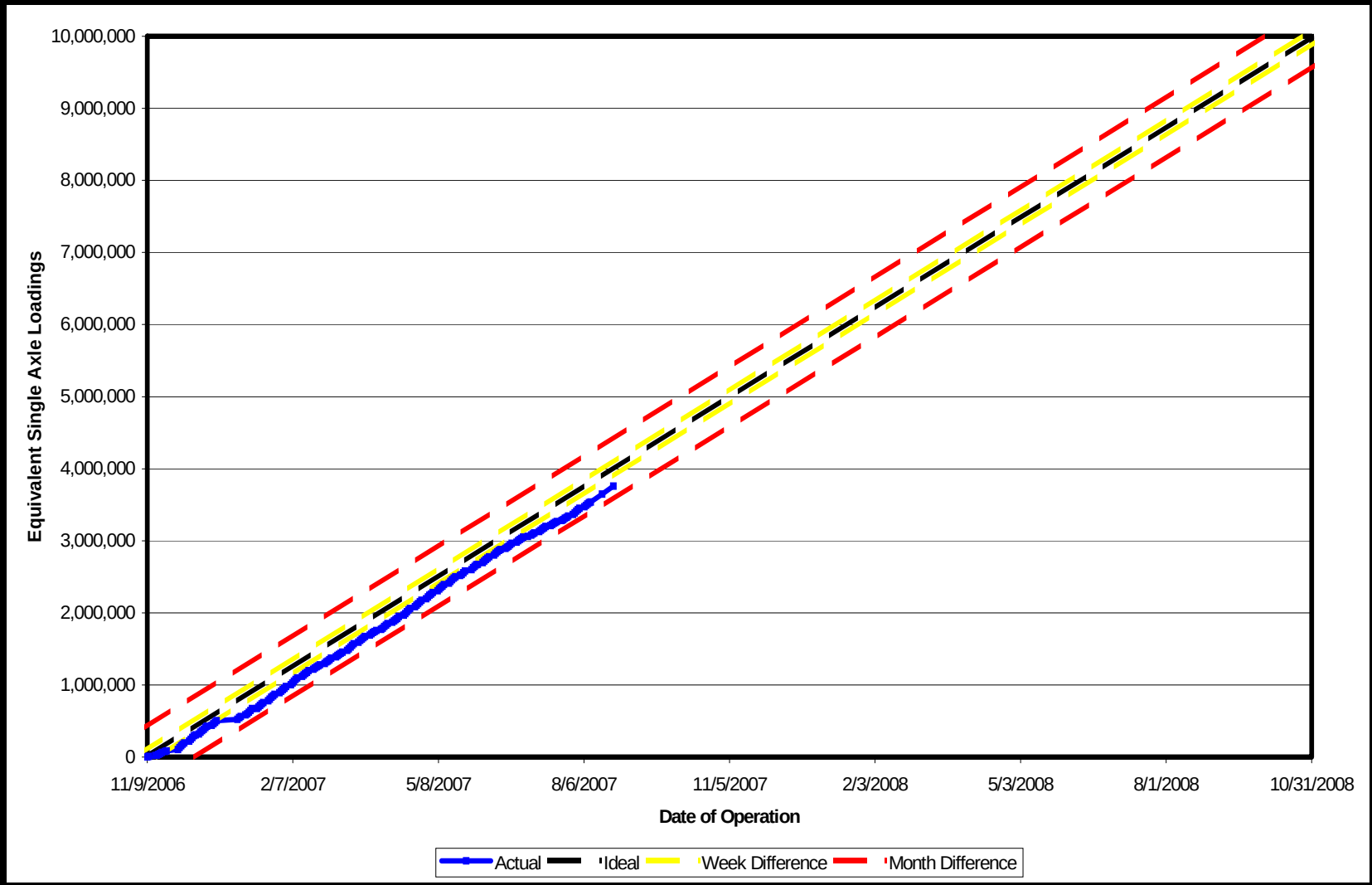
2006 RESEARCH CYCLE



-N1 through N10 and S11 Are Structural Sections
-All Other Sections Have Deep Perpetual Foundations
-Research Cycle of Construction Shown by Color
-Black=2000 Cycle, Blue=2003 Cycle, Red=2006 Cycle

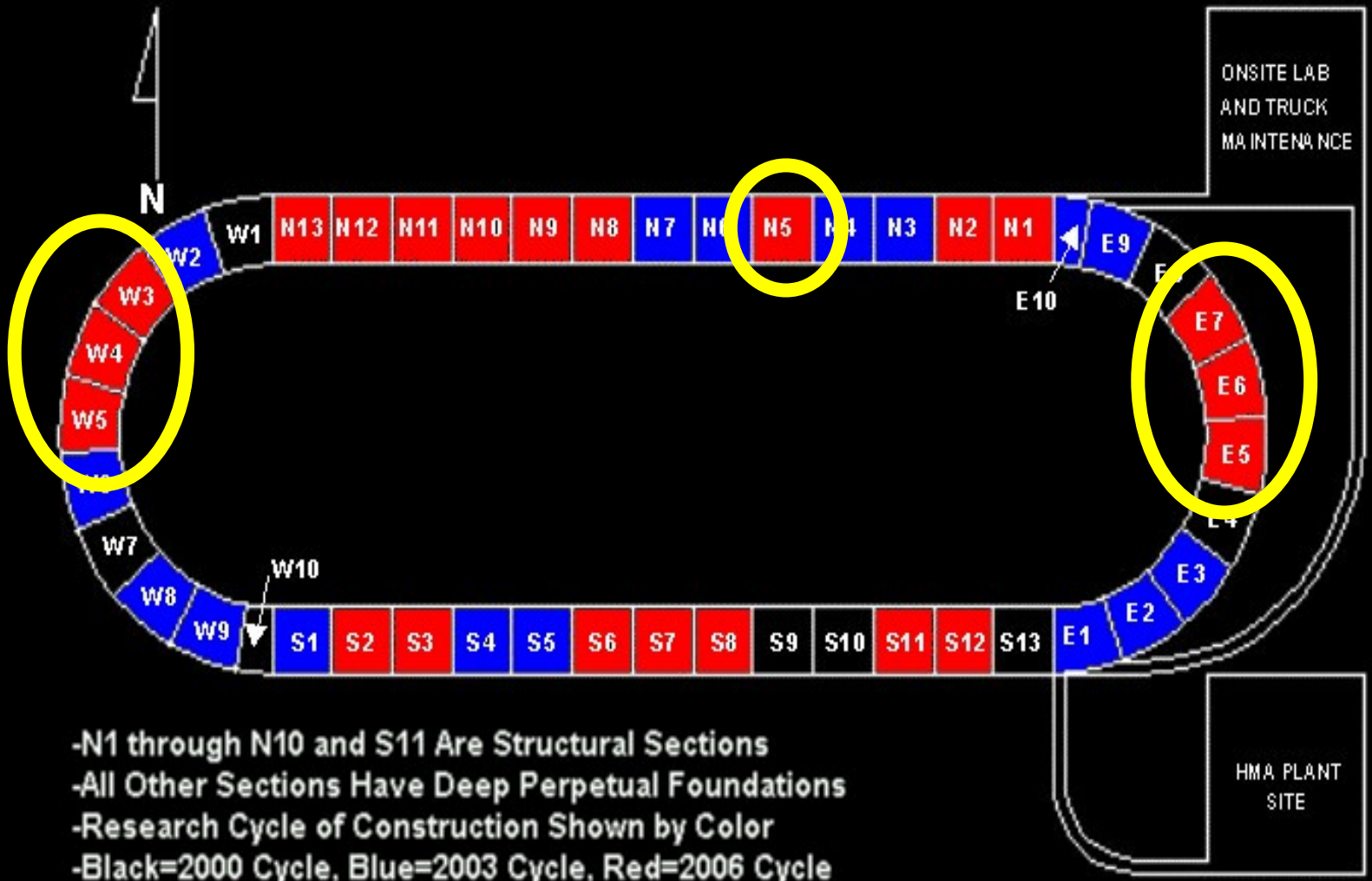
NCAT Pavement Test Track

TRAFFIC APPLICATION



NCAT Pavement Test Track

RAP STUDY SECTIONS



-N1 through N10 and S11 Are Structural Sections
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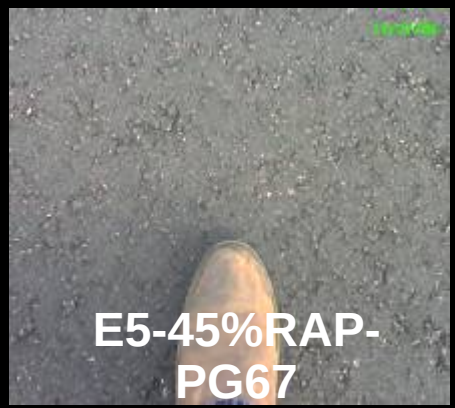
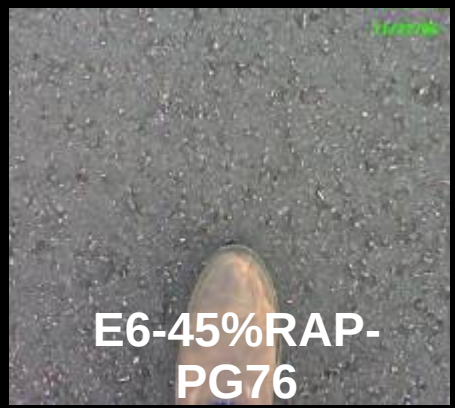
NCAT Pavement Test Track

PLANT RAP FRACTIONATION

NCAT Pavement Test Track

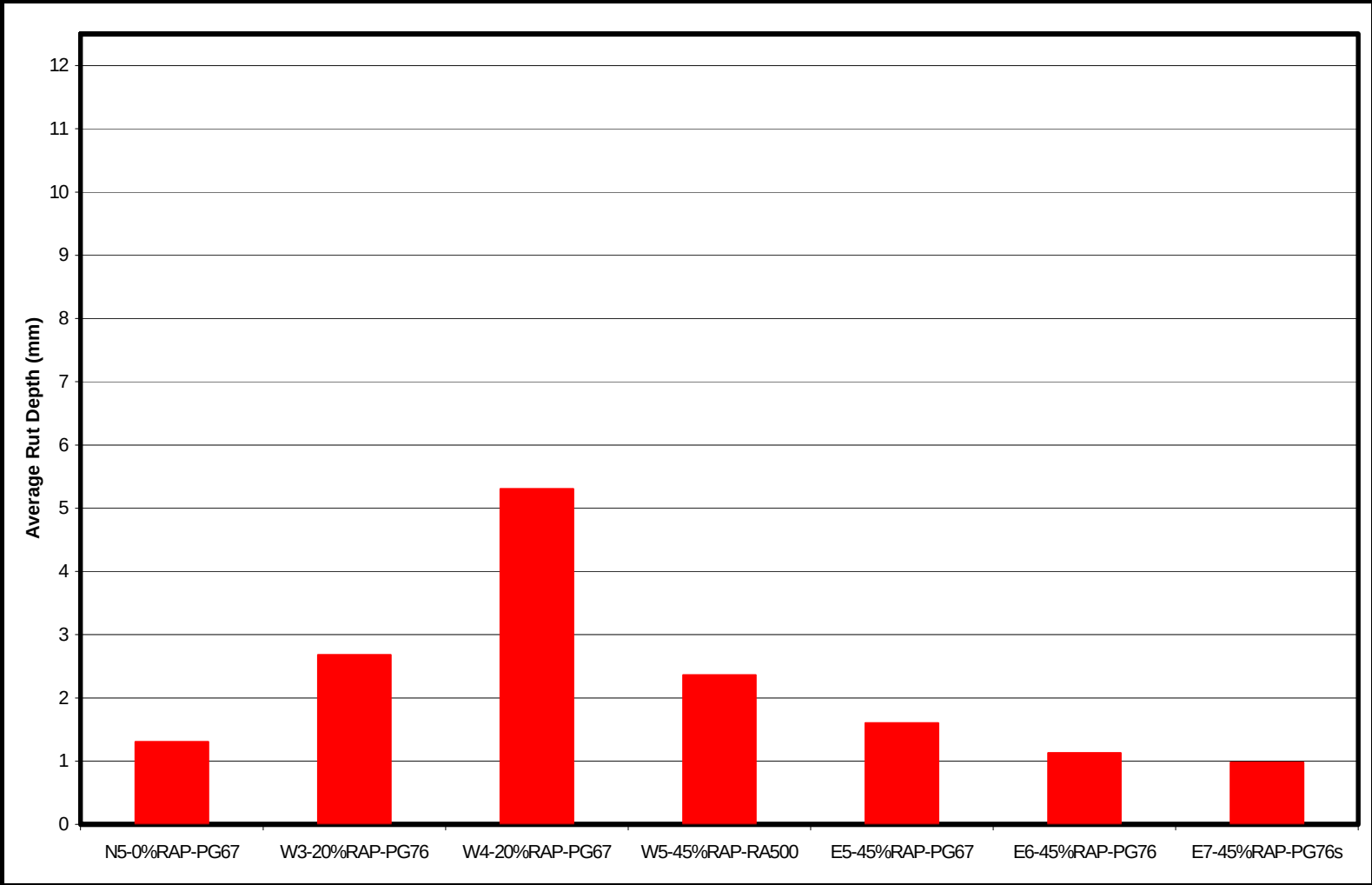
RAP STUDY MATS





NCAT Pavement Test Track

8/27/07 AVERAGE RUT DEPTHS



NCAT Pavement Test Track

For the Producer / Contractor

- Improved Workability
- No Smoke – No Smell
- High Percentage Recycle Mix with Standard Grade of Asphalt
- 14% Less Fuel
- 14% Higher Production
- No Increase in Cost

For the Worker

- **Comfort & Safety**

For the DOT/Public

- Comfort & Safety of workers
- Improve Mixes

Why will we have a Longer Life Pavement?

- Less oxidation of mix
- More uniformity of compaction
- With fractionating RAP…more uniform

For the DOT/Public

- Comfort & Safety of workers
- Improve mixes
- Sustainability

Why Sustainability?

- By Milling & Recycling – 100% of the material can be re-used
- Reduce new aggregate requirement by 245,000,000 tons/year…annually (from 15% to 50%)
- Reduce oil consumption by 80,000,000 bbl/year…approximately 7 days of imported oil

For the DOT/Public

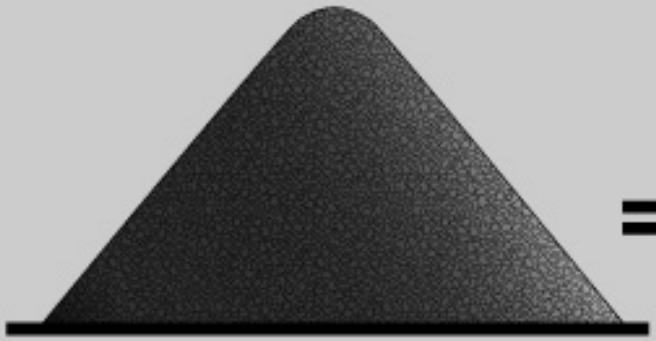
- Comfort & Safety of workers
- Improve mixes
- Sustainability
- Green

It's Green!

- Use 14% less fuel due to 50°F lower temperature
- No volatiles
- Use more recycle

For the DOT/Public

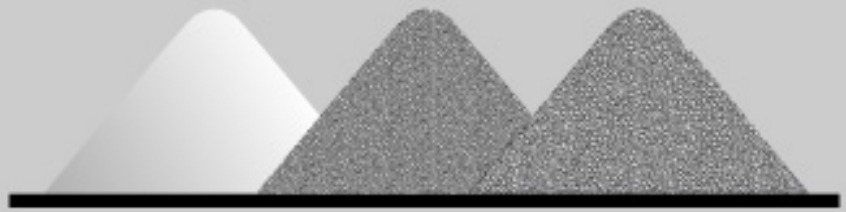
- Comfort & Safety of workers
- Improve mixes
- Sustainability
- Green
- Reduce Cost



30,000 Tons of RAP

=

70 - 6,000 Gallon Transport Trailers
and 28,200 Tons of Clean Aggregate



RAP is Worth the Virgin Material It Replaces

Virgin Aggregate (per ton) ..... $25 x 0.94 = $23.50

Liquid Asphalt (per ton) ..... $350 x 0.06 = $21.00

$44.50

Cost of Milling (per ton) ..... $ 3.00

Cost of Trucking (per ton) ..... $ 2.00

Crushing/Processing Cost (per ton) .. $ 3.00

Total Cost of RAP (per ton) ..... $ 8.00 ..... $ 8.00

Difference $36.50

10% RAP	$ 3.65/ton	10 tons mix
20% RAP	$ 7.30/ton	5 tons mix
50% RAP	$18.25/ton	2 tons mix

Savings: Virgin Materials vs. RAP (if RAP is purchased)

- No Smoke – No Smell
- 14% Less Fuel
- 14% Higher Production
- High Percentage Recycle Mix with Standard Grade of Asphalt
- Longer Life Pavement
- Improved Workability
- No Increase in Cost

What we have done to date

- Produced approximately 300 tons of surface mix @ 240ºF with 64-22 and placed in front of Astec factory


ROADTEC
ROADTEC
ROADTEC

What we have done to date

- Produced approximately 300 tons of surface mix @ 240ºF with 64-22 and placed in front of Astec factory
- Paved approximately 200 tons of binder with 30% RAP with 64-22 @ 270ºF

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- Produced approximately 300 tons of surface mix @ 240ºF with 64-22 and placed in front of Astec factory
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- Paved approximately 200 tons of surface with 30% RAP with 64-22 @ 270ºF

What we have done to date

- Produced approximately 300 tons of surface mix @ 240ºF with 64-22 and placed in front of Astec factory
- Paved approximately 200 tons of binder with 30% RAP with 64-22 @ 270ºF
- Paved approximately 200 tons of surface with 30% RAP with 64-22 @ 270ºF
- Run 40% RAP with 64-22…shovel test

What we have done to date

- Produced approximately 300 tons of surface mix @ 240ºF with 64-22 and placed in front of Astec factory
- Paved approximately 200 tons of binder with 30% RAP with 64-22 @ 270ºF
- Paved approximately 200 tons of surface with 30% RAP with 64-22 @ 270ºF
- Run 40% RAP with 64-22…shovel test
- Run 2% polymers at 260ºF…shovel test
- Stored in silos for 48 hours

Demonstration

- On June 21st, The City of Chattanooga agreed to mill high traffic road and use 50% RAP @ 270ºF with 64-22
- The RAP was fractionated
- The 64-22 AC was foamed
- Southeastern Materials produced and laid the mix

Testing the temperature of the mix.


HUNT
H43


ROADTEC


Southdowns

Other Expanded Asphalt/High RAP Projects

- September 8th, Lafarge – Vancouver, B.C.
- September 12th, S.T. Wooten – Wilson, NC
- September 26th, Lojac, Inc. – Nashville, TN
- October 3rd, Lojac, Inc. – Nashville, TN
- October 10th, Boggs Paving – Rock Hill, SC

Lafarge
Columbia Bitulithic
Vancouver, British Columbia
Warm Mix Demo

September 8, 2007

- **50% RAP @ 260°F / AC20**


128

S. T. Wooten Corporation

Wilson, North Carolina

Warm Mix Demo

September 12, 2007

- **40% RAP @ 270°F / PG 64-22**
- **2,000 tons binder**
- **2,000 tons surface mix**


LEGEND
26 1.0


251.0
MAX 253


712
8515
LeeBoy
LEGEND

Lojac Inc.

Nashville, Tennessee

Warm Mix Demo

September 26, 2007

- **30% RAP @ 260°F / PG 64-22**
- **700 tons binder**
- **700 tons surface mix**
- **100 tons surface / PG 76-22 @ 270°F**


2007 9 26


DOUBLE
BARREL
ASTEC
2007 9 26
RSC


2007 9 26


STOP
STOP
ROADTEC
2007 9 26

Lojac Inc.

Nashville, Tennessee

Warm Mix Demo

October 3, 2007

- **Tennessee D.O.T. Warm Mix Test**


2007 10 3


ROADTEC
LoJac
02
2007 10 3

Mix Comparison From Franklin Plant

- Advera WMA
- 1150 Tons Placed
- % AC 5.16 & 5.28
- % Air Voids 4.7
- Stability 1475
- TSR 51.9%
- Density 92.7%

- Sasobit
- 705 Tons Placed
- % AC 5.14
- % Air Voids 3.5
- Stability 1825
- TSR 65.5%
- Density 91.0%

Mix Comparison From Danley and Murfreesboro Plant

- Astec Green System
- 775 Tons Placed
- % AC 5.19 & 5.29
- % Air Voids 4.0
- Stability 2200
- TSR 84.3%
- Density 91.6%

- Evotherm
- 750 Tons Placed
- % AC 5.22 & 5.36
- % Air Voids 5.1
- Stability 1455
- TSR 72.7%
- Density 91.0%

Boggs Paving, Inc.

Rock Hill, South Carolina

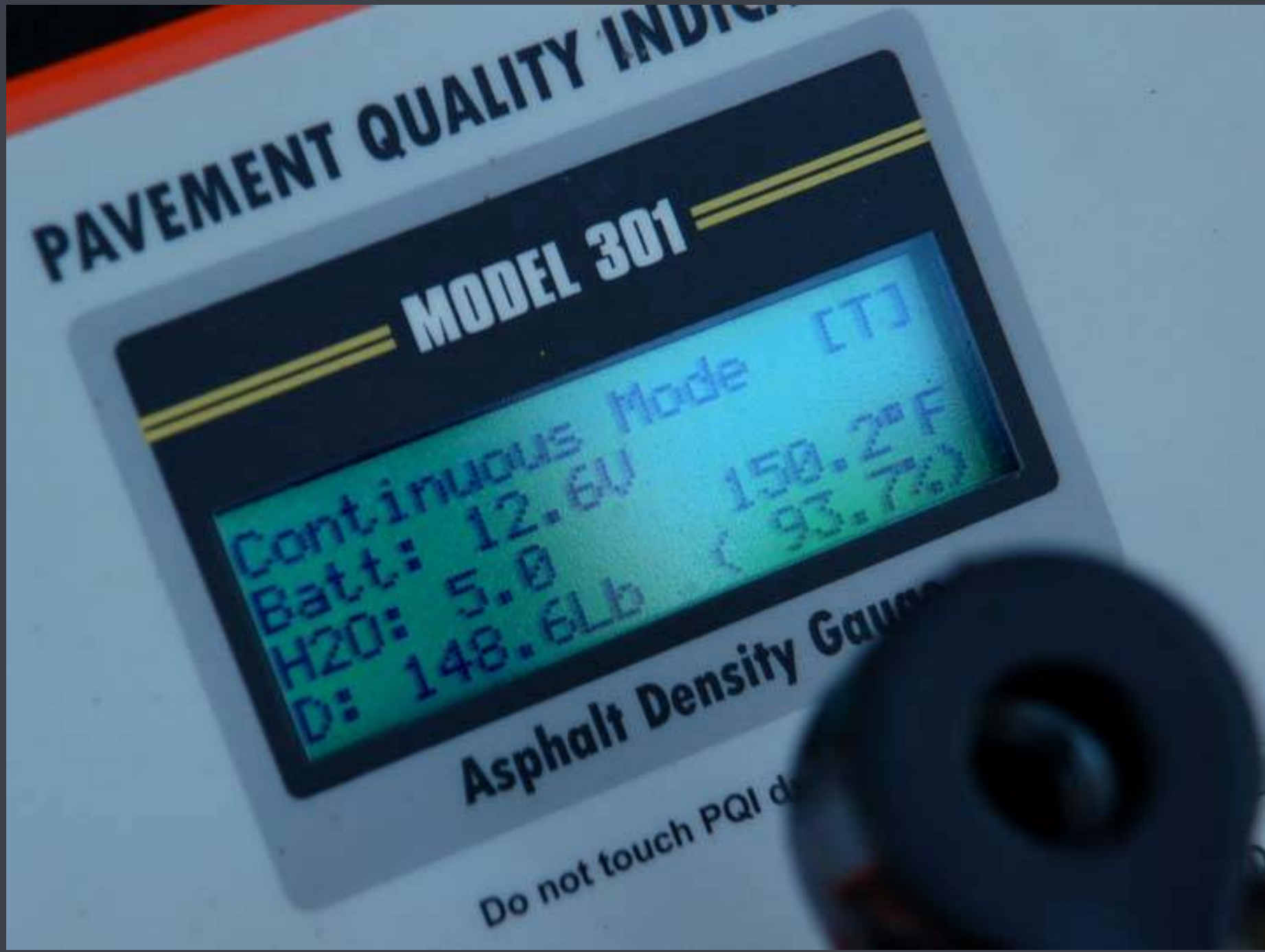
Warm Mix Demo

October 10, 2007

- **15,000 tons**
- **50% RAP @ 270°F / PG 64-22**
- **Contractor has 50,000 more tons under contract**


A SIX PACK
Boggs
Boggs
NO
TRUCK DRIVERS
IN
CONTROL TOWER
Boggs
ALL TRUCKS
MUST BE ON
CB CHANNEL
13


ASTEC


PAVEMENT QUALITY
MODEL 301
Continuous Mode [T]
Batt: 12.6V 150.2°F
H2O: 5.0 93.2°
D: 148.6Lb
Asphalt Density
Do not touch PQI


This Street
Paved With
Environmentally
Friendly
Warm Mix Asphalt
York County
South Carolina
ASTEC
Boggs
PAVING, INC.
GREEN

State D.O.T has $5,000,000.^{00} to spend on mix…

no haul, no laydown, milling paid separately

Assume

- **$400.^{00} Liquid – 64-22**
- **$450.^{00} Liquid when using Recycle**
- **5.5% Liquid**
- **Processing Recycle Cost – $3.00 / ton**
- **Haul Cost – $3.^{00} / ton**
- **Aggregate Cost – $10.^{00} / ton**
- **Plant Processing Cost – $6.^{00} / ton**
- **Overhead and Profit – $4.^{00} / ton**

1. **If State D.O.T. purchases – All Virgin Mix**

   Tons of Virgin Mix = 120,627 tons

2. **If State D.O.T. purchases 50% RAP Mix – 2" Inlay – Contactor gets RAP**

   Tons of RAP Mix = 166,113 tons


TURNING GREEN
ASTEC
INDUSTRIES, INC.