
TURNING GREEN
ASTEC
INDUSTRIES, INC.

# Boggs Paving, Inc.

Rock Hill, South Carolina

# Warm Mix Demo

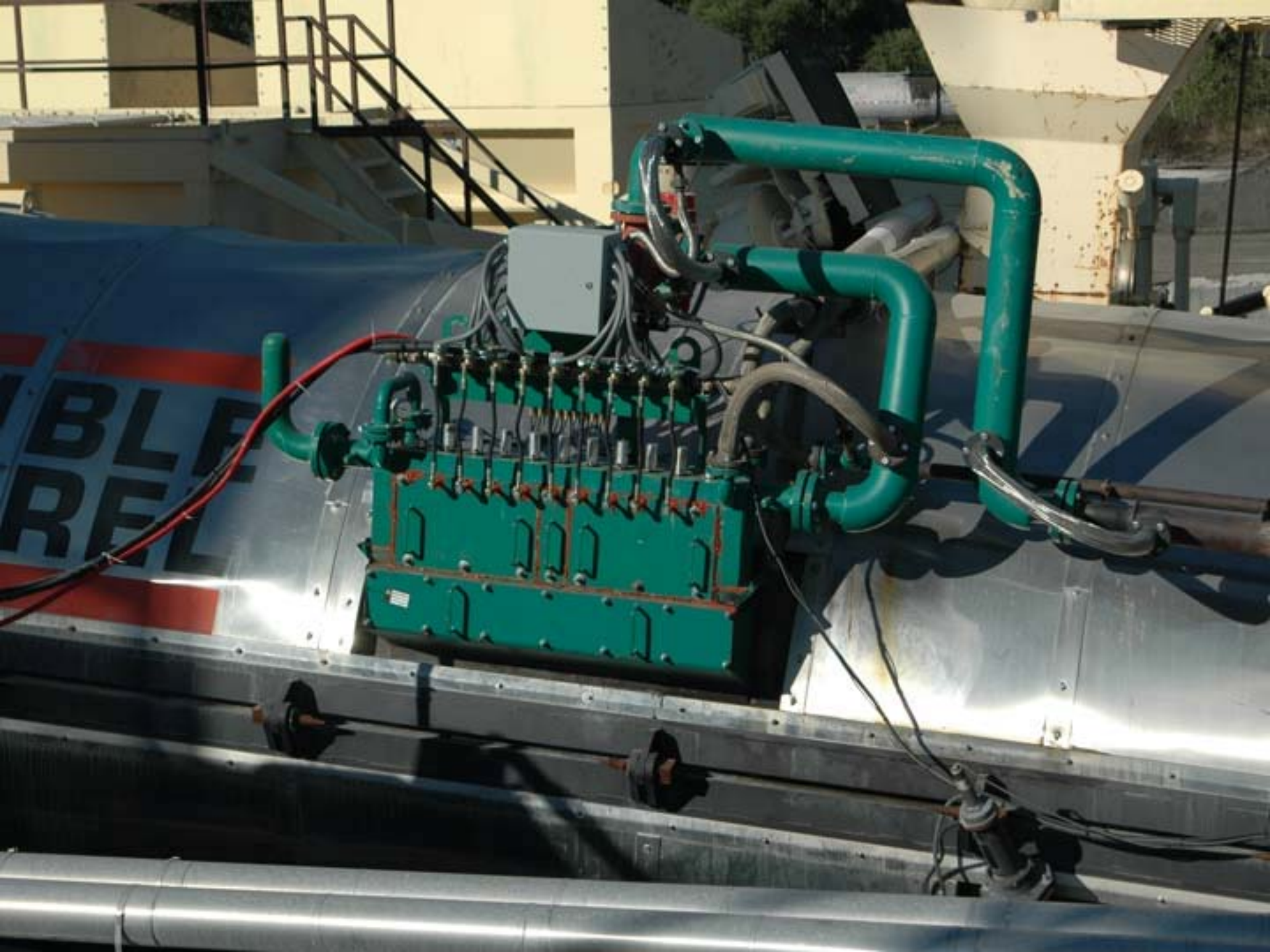
October 10, 2007

- 15,000 tons
- 50% RAP @ 270°F (132 C) / PG 64-22
- Contractor has 50,000 more tons under contract


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


SIX PACK
Boggs
NO
CONTROL TOWER
Boggs
ALL TRUCKS
MUST BE ON
CB CHANNEL
13


ASTEC




CN2
SPORTS

# Background

- Warm Mix: mix temperatures 50-100F cooler than conventional mix methods
- Achieved by lowering the viscosity of the AC binder
- Various methods: additives, additives with water, foaming with water only, etc.
- Foaming first introduced in the 1950’s
- Current trends towards fuel efficiency and emissions reductions make Warm Mix more attractive

# Advantages of Warm Mix

- Economic Advantages:
  - 14% reduction in fuel consumption (50F)
  - Ideal for high percentages of RAP
- Ecological Advantages
  - Reduced fuel consumption = reduced greenhouse gas emissions
  - No visible smoke or odor
  - “Green” asphalt plants = better neighbors

# Additional Warm Mix Advantages

- Less oxidation of AC
- Lower plant cost ($300k - $500k)
- Lower plant maintenance cost
- Plant safety
- Paving crew safety

# No Smoke – No Smell…Why?

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


PHOTO OF BOTHELL ROAD
TAKEN MAY. 8. 1912
W. P. & S. SEATTLE, WASH.


**NO SMOKE AT THE PAVER!**


CONVENTIONAL
HOT MIX
WARM MIX

# DANGER: Di-hydrogen Monoxide

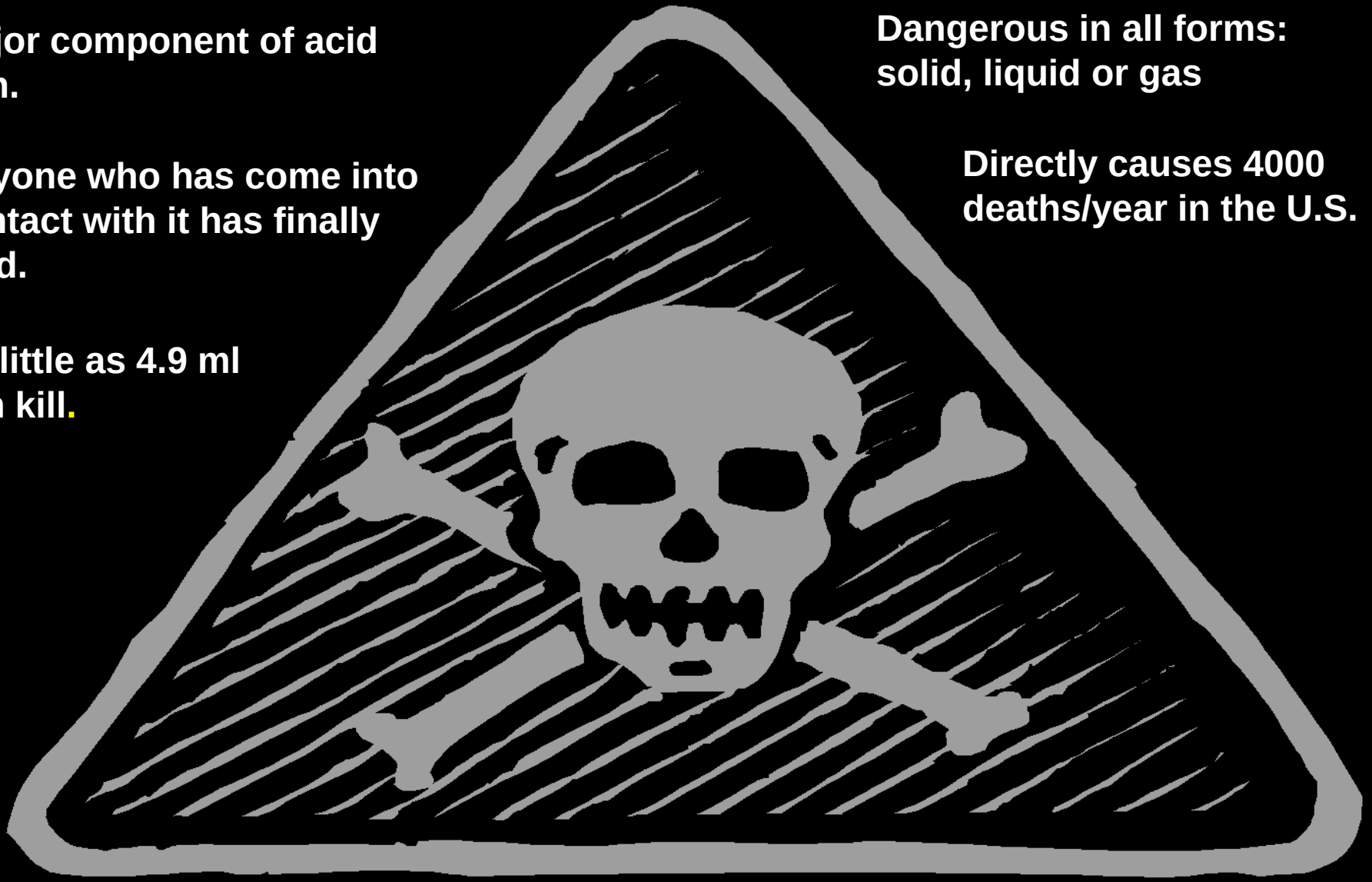
**Major component of acid rain.**

**Anyone who has come into contact with it has finally died.**

**As little as 4.9 ml can kill.**

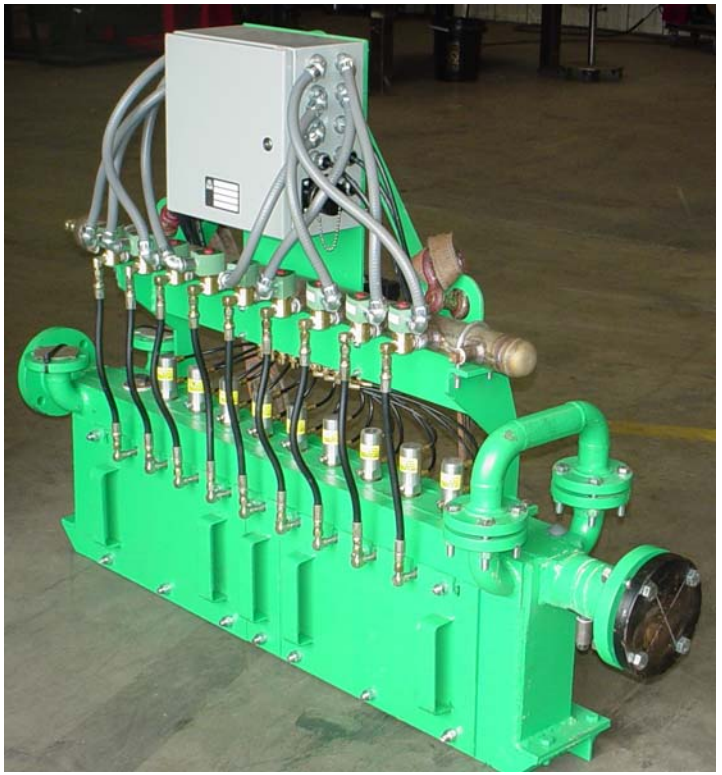
**Dangerous in all forms: solid, liquid or gas**

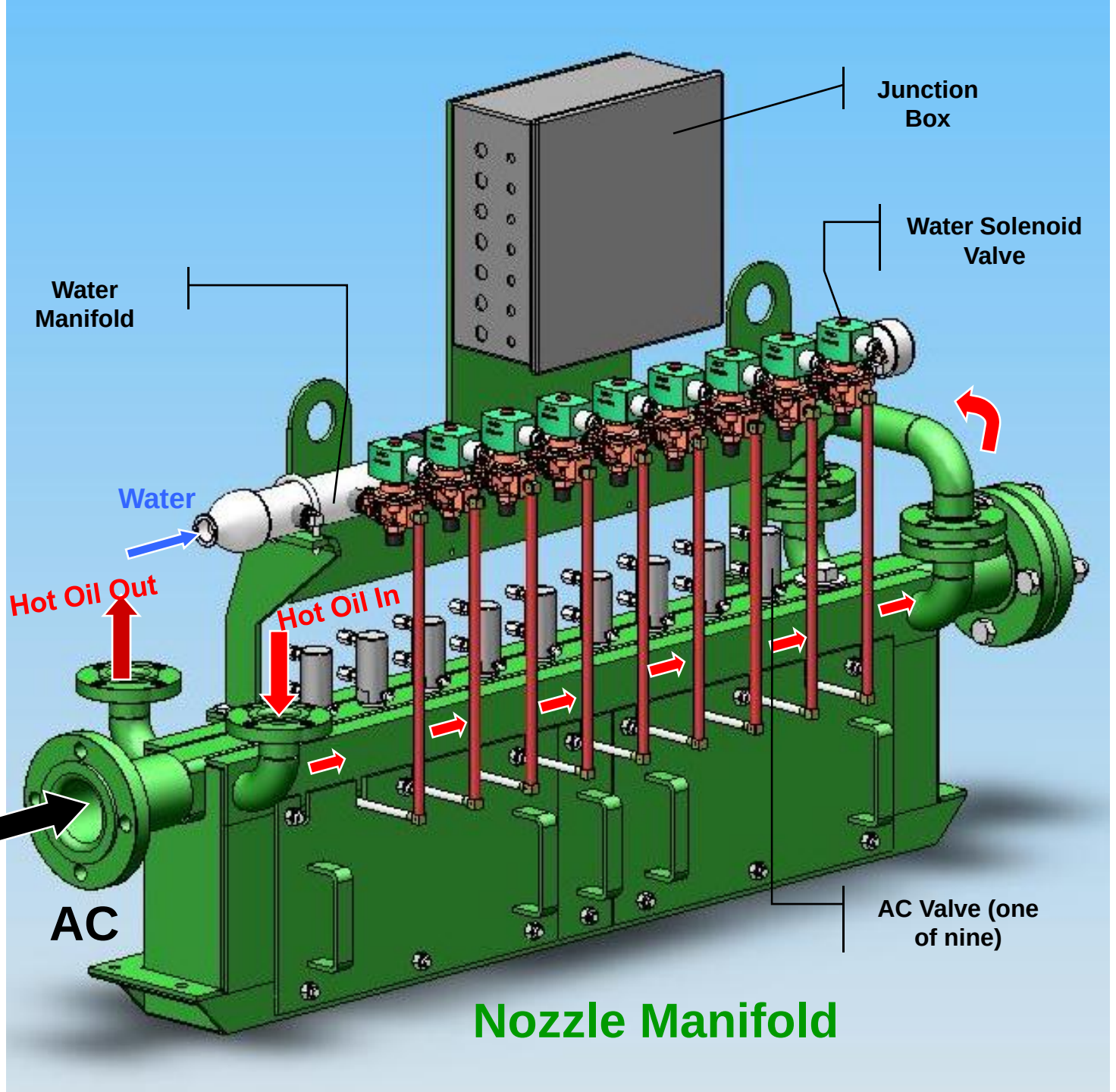
**Directly causes 4000 deaths/year in the U.S.**

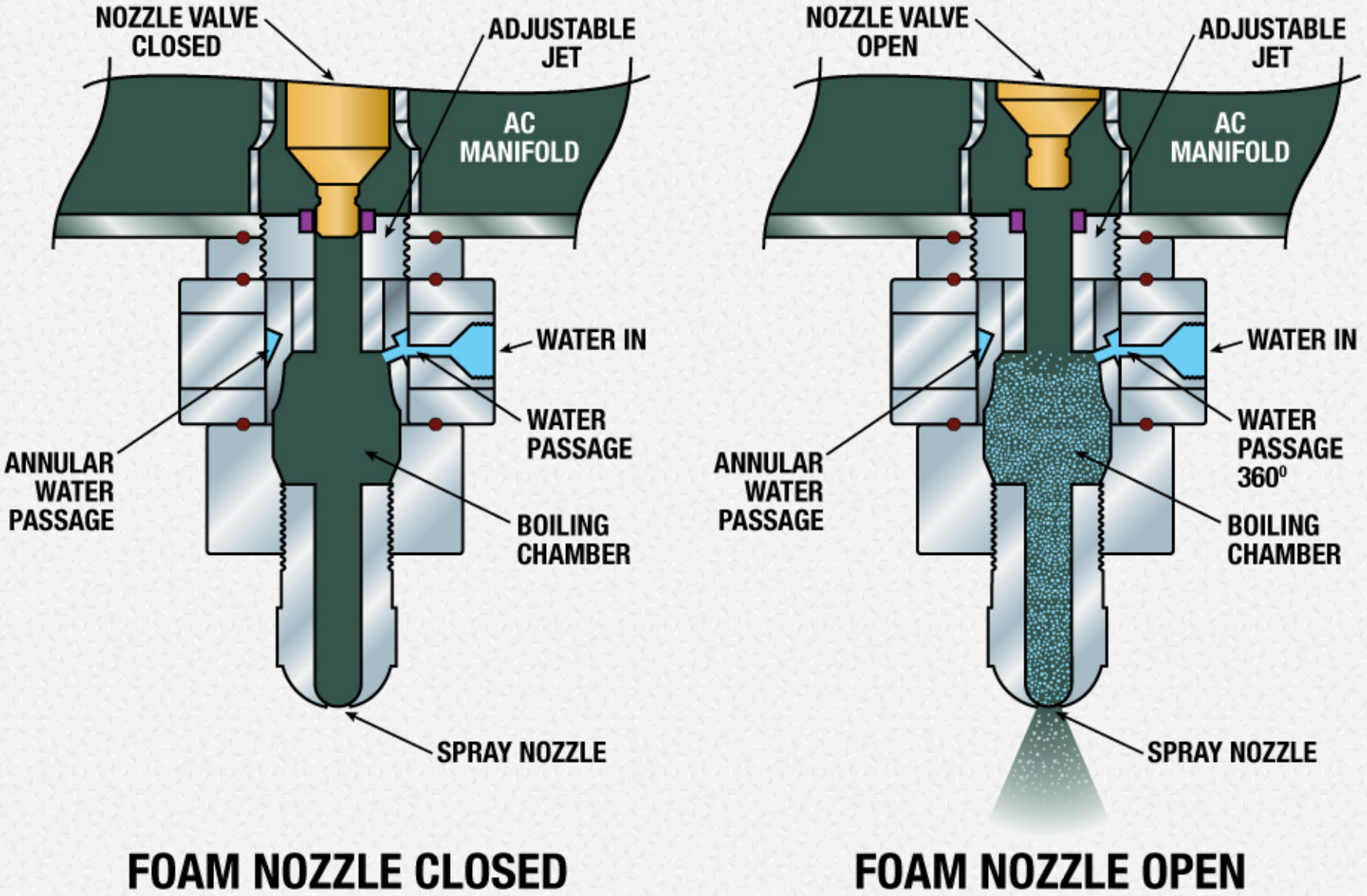


# Astec Multi-nozzle Device

- Mixes water and AC to create microscopic steam bubbles to foam the AC
- Water flow rate = 2%  of AC flow rate (NOT 2% of mix!)
- 2.5 TPH AC per nozzle, 8 nozzles = 400 TPH mix
- PLC controlled
- Mix transported, placed and compacted using “normal” procedures



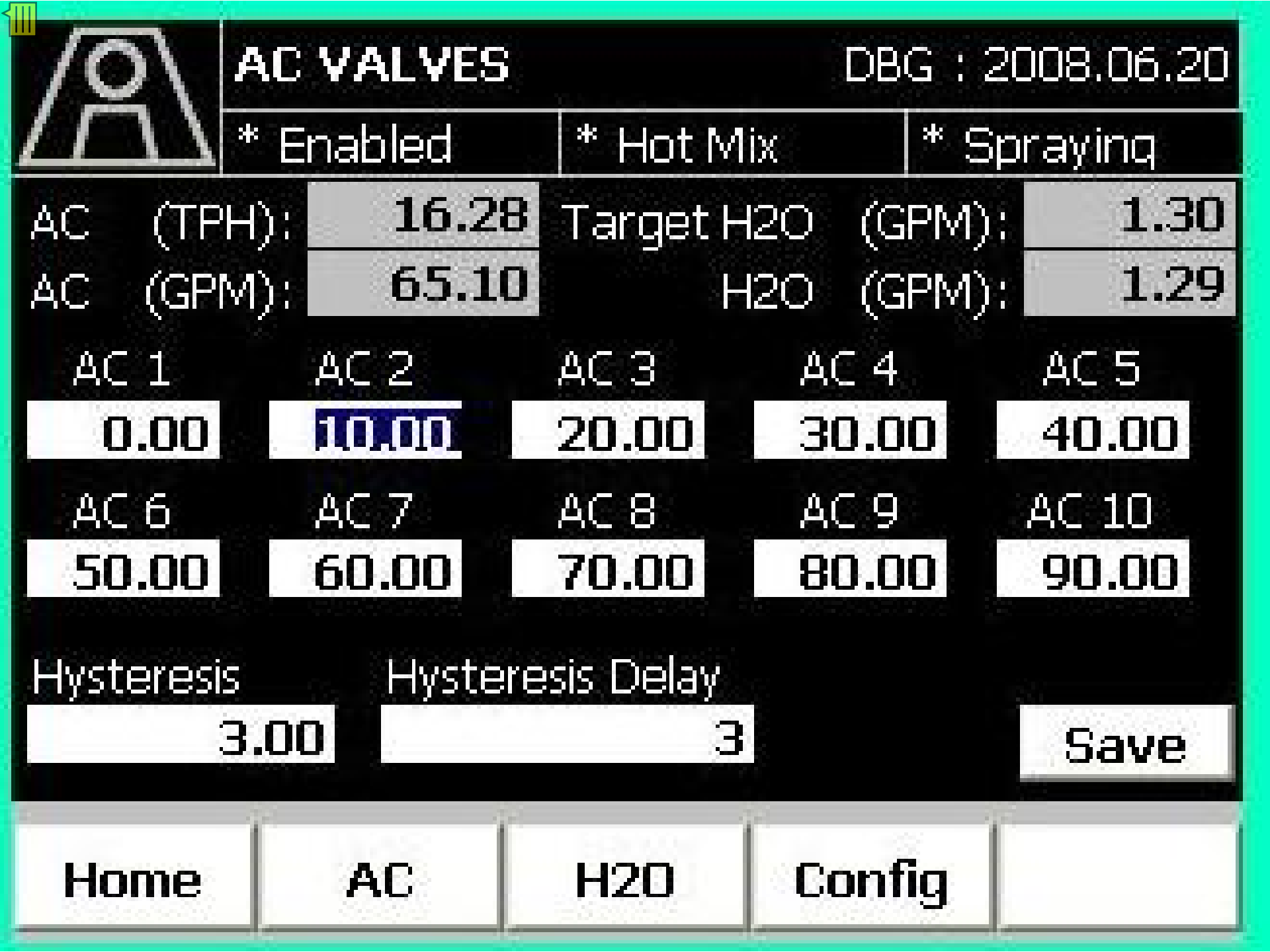

Junction Box
Water Solenoid Valve
Water Manifold
Water
Hot Oil Out
Hot Oil In
AC
AC Valve (one of nine)
Nozzle Manifold


NOZZLE VALVE CLOSED
ADJUSTABLE JET
AC MANIFOLD
WATER IN
WATER PASSAGE
ANNULAR WATER PASSAGE
BOILING CHAMBER
SPRAY NOZZLE
FOAM NOZZLE CLOSED
NOZZLE VALVE OPEN
ADJUSTABLE JET
AC MANIFOLD
WATER IN
WATER PASSAGE 360°
ANNULAR WATER PASSAGE
BOILING CHAMBER
SPRAY NOZZLE
FOAM NOZZLE OPEN

# FOAM NOZZLE

WATER AND CONTROL SKID

# TOUCH PANEL IN CONTROL HOUSE


AC VALVES
DBG : 2008.06.20
* Enabled
* Hot Mix
* Spraying
AC (TPH): 16.28
AC (GPM): 65.10
Target H2O (GPM): 1.30
H2O (GPM): 1.29
AC 1
0.00
AC 2
10.00
AC 3
20.00
AC 4
30.00
AC 5
40.00
AC 6
50.00
AC 7
60.00
AC 8
70.00
AC 9
80.00
AC 10
90.00
Hysteresis
3.00
Hysteresis Delay
3
Save
Home
AC
H2O
Config

Menu Tools Help

# 07-163 Boggs Materials

10/3/2007 4:17:32 PM

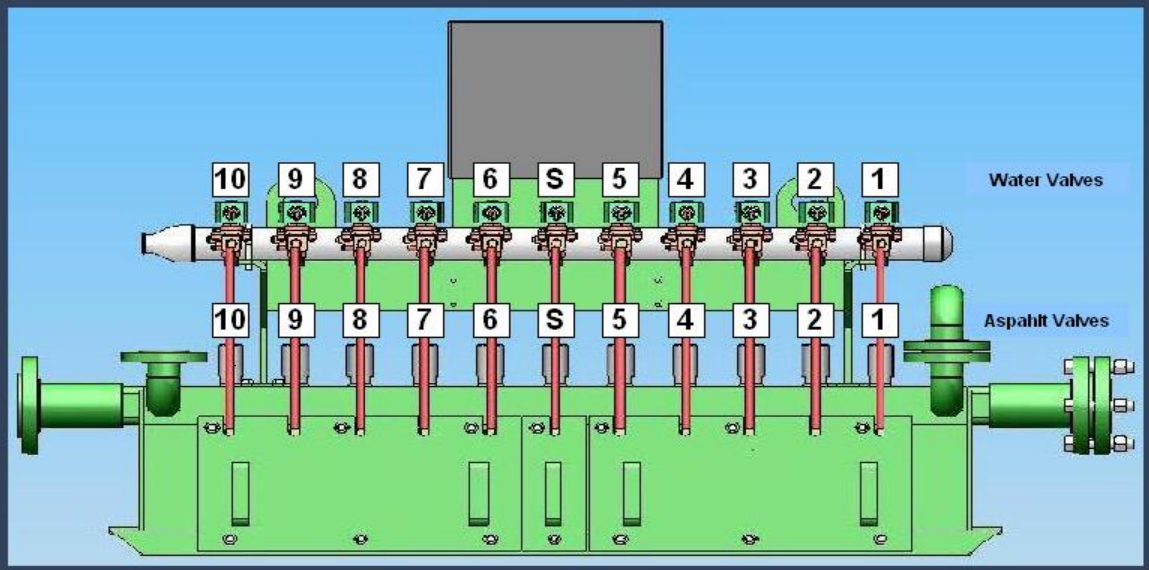
ASTEC

| | TARGET TPH | ACTUAL TPH | AGG TPH | REC TPH | MF TPH | AC TPH | ASA TPH | MIX TEMP | TONS RUN | TONS TO GO |
|---|---|---|---|---|---|---|---|---|---|---|
| PMII | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 13.90 | 0.00 | +95.1 | +767.2 | -135.9 |
| Mix ID: BINDER C 50% | | | | | | | | | | |

AC TEMP 143

AC HOLD ON OFF

## Green Ashpalt Control




Diverted

| Asphalt (Data) | | Water | |
|---|---|---|---|
| AC (GPM) | 0.00 | H2O (GPM) | 0.02 |
| AC (TPH) | 0.00 | Target H2O (GPM) | 0.00 |
| AC Spray Delay | 3.00 | H2O% of AC | 2.00 |
| AC Divert Delay | 2.00 | | |

☐ Enable

☐ Maintenance

| Asphalt (Configuration) | | |
|---|---|---|
| Signal Type | Hysteresis | AC Valve 6 |
| PMII/TCII | 3.00 | 50.00 |
| | AC Valve 2 | AC Valve 7 |
| | 10.00 | 60.00 |
| New Flow Delay | AC Valve 3 | AC Valve 8 |
| 5.00 | 15.00 | 70.00 |
| Post SprayTime | AC Valve 4 | AC Valve 9 |
| 60.00 | 30.00 | 80.00 |
| | AC Valve 5 | AC Valve 10 |
| | 40.00 | 90.00 |

| Water (Configuration) | (PID Setting) | | (Manuals) |
|---|---|---|---|
| H20 Signal | Reset | I Sel | Manual Speed |
| 0 | P Sel | D Sel | 20.00 |
| H2O Signal (Min) | Gain | TM_Lag | |
| 0.00 | 2.00 | 2000 | |
| H2O Signal (Max) | Deadband | PV | |
| 3.50 | 0.10 | 0.00 | |
| | TI | LMN | |
| | 1000 | 20.00 | |
| | TD | ☐ Manual Mode | |
| | 10000 | | |
| | I_Man | | |
| | 20.00 | | |

MOTOR STATUS OFF

MID STREAM STATUS: PLANT OK

| | | | | | |
|---|---|---|---|---|---|
| 10/03/2007 | 04:28:17 AM | S7 Program(1)/SFM_DB | On/Off | 1610612979 | Alarm |
| 10/03/2007 | 05:16:46 AM | S7 Program(1)/SFM_DB | On/Off | 1610613005 | Alarm |
| 10/03/2007 | 03:52:22 PM | PLC Initiated a Midstream Stop! | On/Off | 308 | Alarm |

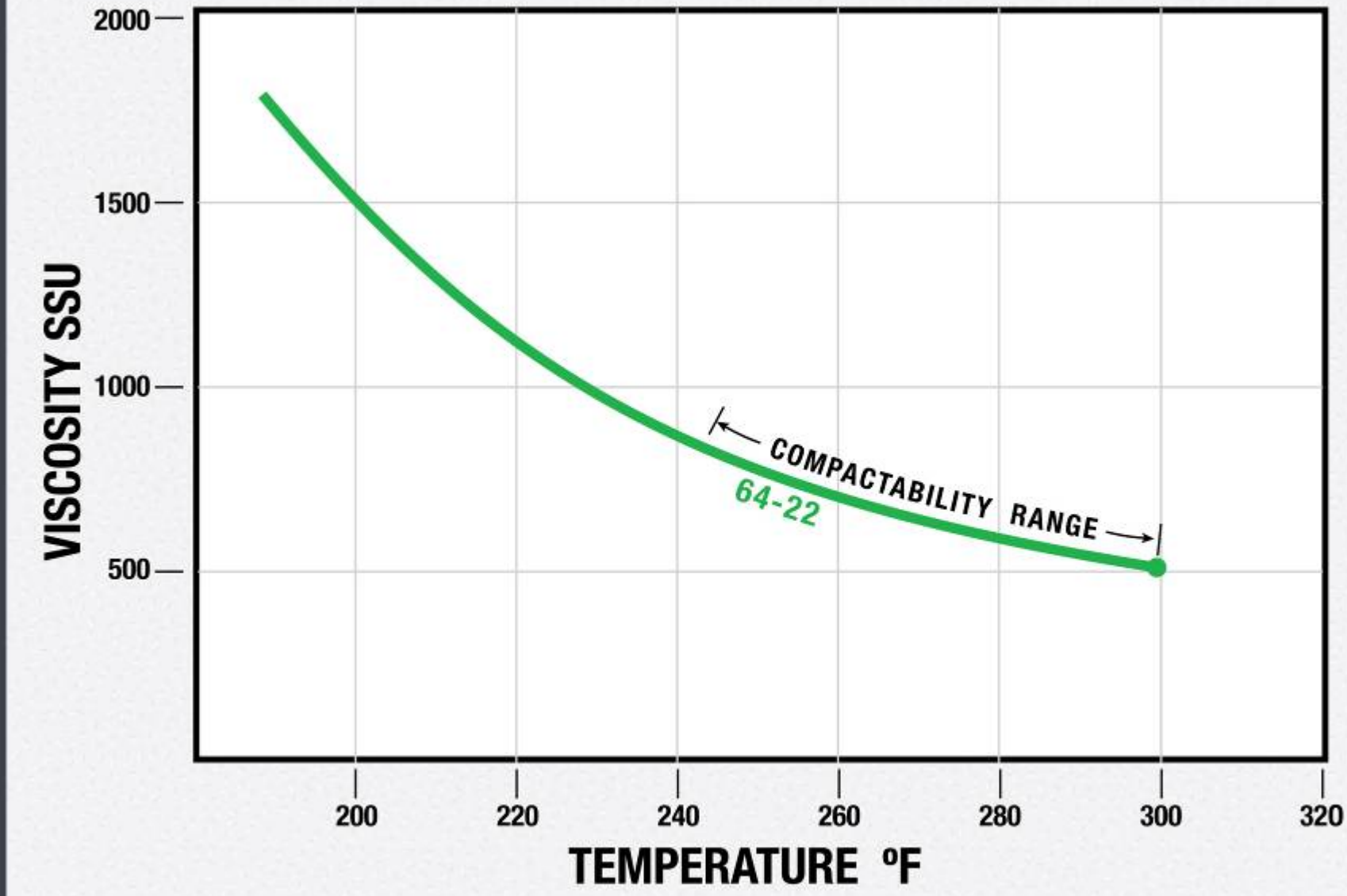
Alarms History

START-UP

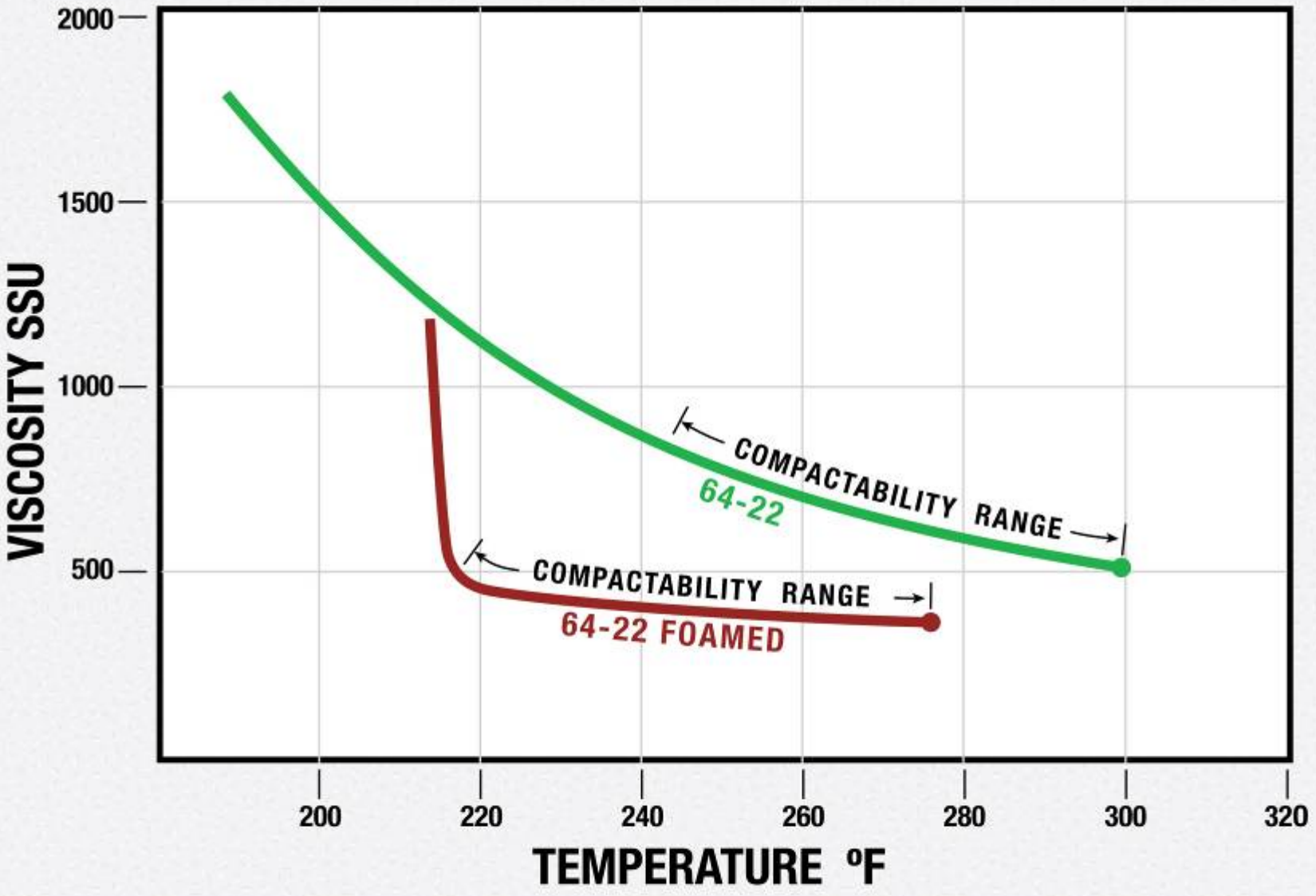
ALARM

AGG 1 2 3 4 5 6 | AC SPRAY 1 | AC TF 1 2 3 4 | ASA 1 | REC 1 2 3 | MF 1

MORE Production Data | Mix Design | Incline Conveyors | Aggregate Bins | Recycle Bins | AC & ASA | Mineral Filler MORE



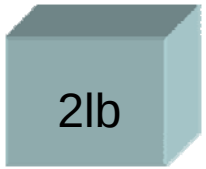

VISCOSITY / TEMPERATURE PG 64 -22 (Approx.)




VISCOSITY / TEMPERATURE PG 64 -22 (Approx.)

# Astec Foamed Asphalt

**How much water <u>injected</u> per virgin ton of mix ?**




3 ¾” x 3 ¾” x 3 ¾”

# How much water stays in the mix?

- AC Content: 5%
- Voids: 25% (pre-compaction), 5% (post-compaction)
- Density: 110 lbm/ft³ (pre-compaction);140 lbm/ft³ (post-compaction)

$$\textbf{Volume of uncompacted mix (ft}^3\textbf{/ton)} = \frac{\textbf{2000 lbm/ton}}{\textbf{110 lbm/ft}^3} = \textbf{18.2 ft}^3\textbf{/ton}$$

Of this 18.2ft³, 25% (4.54ft³) consists of air voids.

$$\textbf{Volume of AC (ft}^3\textbf{/ton)} = \frac{\textbf{5\% X 2000 lbm/ton}}{\textbf{65 lbm/ft}^3} = \textbf{1.54 ft}^3\textbf{/ton}$$

# How much water stays in the mix is limited by the volume of air voids.

Available volume for foamed AC ($ft^3$/ton) = 4.54 $ft^3$/ton + 1.54 $ft^3$/ton = 6.08 $ft^3$/ton

0.016 $ft^3$/lbm (ambient temperature liquid water) to 30.53 $ft^3$/lbm (superheated steam at 300˚F)

## BEFORE COMPACTION

$$\text{Mass of water (lbm/ton)} = \frac{4.54\ ft^3/ton}{30.53\ ft^3/lbm} = 0.149\ lbm/ton$$

$$\text{Mass \% of remaining injected water} = \frac{0.149\ lbm/ton \times 100\%}{2000\ lbm/ton} = 0.0075\%$$

# How much water stays in the mix is limited by the volume of air voids.

## AFTER COMPACTION

$$\text{Volume of compacted mix } (ft^3/ton) = \frac{2000\ lbm/ton}{140\ lbm/ft^3} = 14.3\ ft^3/ton$$

$$\text{Remaining void volume } (ft^3/ton) = 0.05 \times 14.3\ ft^3/ton = 0.715\ ft^3/ton$$

$$\text{Mass of remaining water (lbm/ton)} = \frac{0.715\ ft^3/ton}{30.53\ ft^3/lbm} = 0.0234\ lbm/ton$$

$$\text{Mass \% of remaining injected water} = \frac{0.0234\ lbm/ton \times 100\%}{2000\ lbm/ton} = 0.0012\%$$

# Typical Installation

# System Costs

**¼ ¢/ton additive cost:**

**5 ¢ per truck load**

**$1 for every 400 tons**

Based on 0.0785 $/ft³ water including sewage fee

# What we have done to date

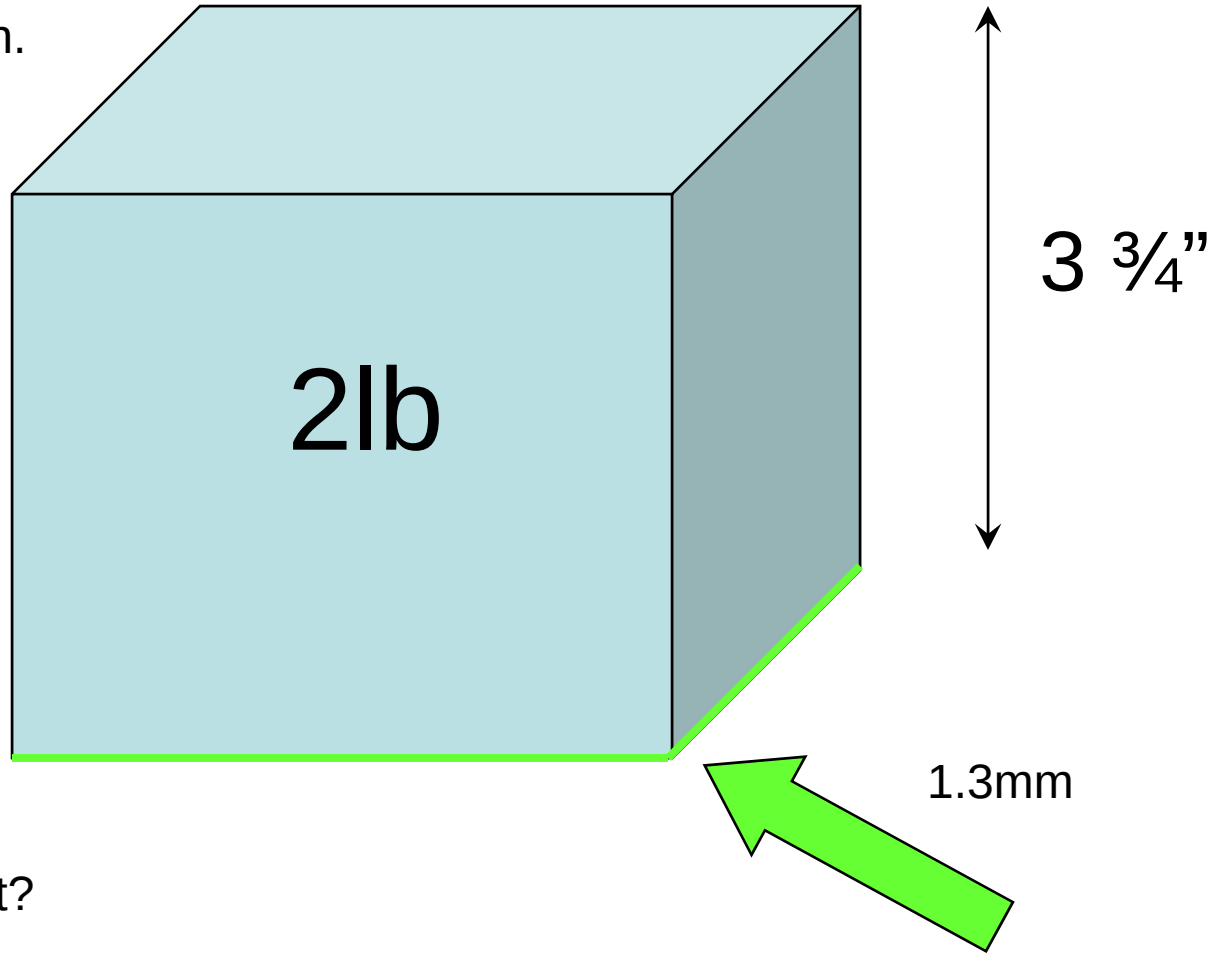
- **Installed over 100 units to create hot foam mechanically**
- **Stored in silo for 4 days**
- **Produced 76-22 (Polymers) and placed at 270ºF**
- **Produced rubber mix at 270ºF**

# What we have done to date

- **Numerous Demonstration Projects**
  - **North Carolina**
  - **South Carolina**
  - **Tennessee x 4**
  - **Alabama**
  - **Texas**
  - **Arkansas**
  - **California**
  - **Kentucky**
  - **British Columbia**
  - **Ohio x 2**
  - **Illinois**
  - **Maryland**
  - **Louisiana**
  - **Florida x 2**
  - **Massachusetts**

# Mix Design Modifications

- No fines addition.
- No AC reformulation.



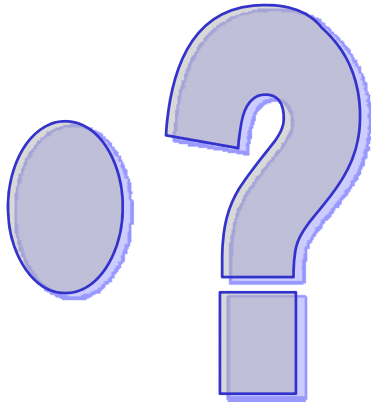

- Anti-stripping agent?

# Production/Construction Techniques and Issues

## If some of the water remains in the mix, won't I show a high AC content?


- A small amount of water remains in the mix after compaction
- Theoretically, this could show up as AC content.
- Maximum of 0.0012% of the water remains.
- Beyond the measurement accuracy of AC content (typically reported to the nearest 0.1%).

## Won’t the baghouse temperature be too low when I lower mix temperature?

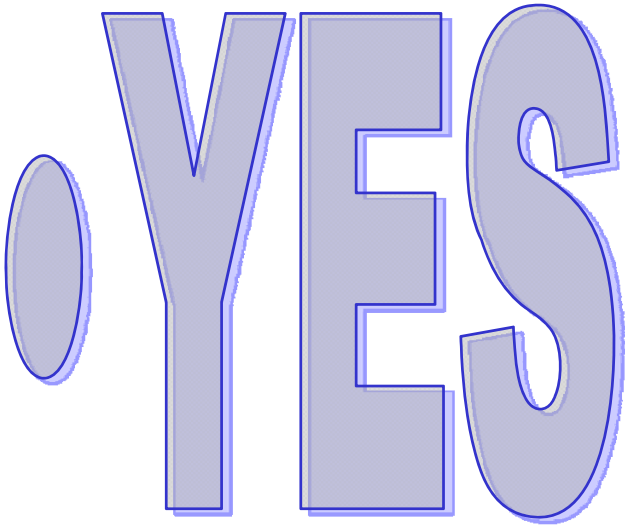


- Depends on a number of factors.
- Decreases BH temps about 35°F to 40°F (CF dryer) all other factors constant.
- **Things go better with RAP**

## Can coating be affected?


- Depends on a number of factors
- Coating is affected by many factors: aggregate, mix temperature, AC type, and/or fines content
- Generally, coating decreases with mix temperature
- **Coating begins to deteriorate below 250 F**
- Good coating has been observed below 200°F
- Green System has significantly improved coating if coating initially appeared less complete

# Do I have to do anything special to my binder?




- Keep standard binder at 300 F or higher
- AC Foaming nozzles have 3/8” openings
- AC temperatures above 300°F ensure low enough viscosity for a reasonable (<40psig) backpressure.

## Won't I experience a drop in mix temperature since I am adding water?


- Significant temperatures drops during ordinary hauls in moderate weather is caused by internal moisture
- Internal moisture signs: steam and water at the silo tops, water running out of the truck beds, and a drop in mix temperature (27 F per ½%).
- Water remaining in the mix post compaction is 0.0012% (0.07 F drop)

## What mix temperatures should I run?

- 240F - 250F (virgin)
- 270F - 280F (RAP)

## Can I run WMA produced using the Astec Green System at higher temperatures?


- There is no danger in running the mix at higher temperatures
- Mix simply remains workable for a longer period

## Can WMA produced using the Astec Green System be stored?


- As long as the corresponding HMA may be stored
- First test was 24 hours then 48 hours
- Have stored as long as 4 days

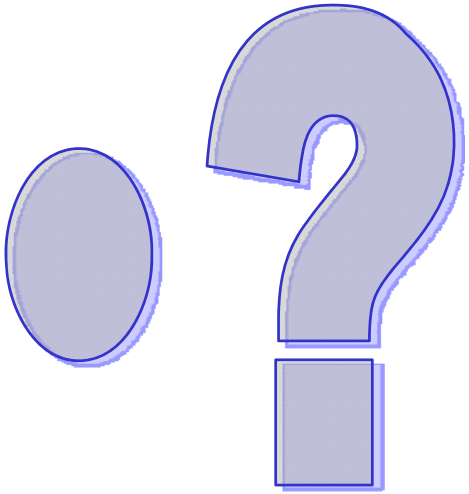
## Will rolling patterns change?


- Generally, crews have been able to begin rolling immediately.
- At some locations, less rolling was required
- Experiment.  Each situation is unique.

## Is handwork different than that of HMA?


- Can be different depending upon the situation
- Cold day tight quarter handwork became difficult on one job
- Straight pulls were no issue.

# Does WMA produced with the Astec Green System look different?



- Can look the same as ordinary HMA minus smoke as smell
- Can look rich (especially virgin mixes) due to film thickness

# Demonstration

- On June 21, 2007, the City of Chattanooga agreed to mill high traffic road and use 50% RAP @ 270°F with 64-22
- The RAP was fractionated
- The 64-22 AC was foamed
- Southeastern Materials produced and laid the mix

# 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


STOP
STOP
ROADTEC
2007 9 26

# Lojac Inc.

## Nashville, Tennessee

# Warm Mix Demo

**October 3, 2007**

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

# QA Testing

## Technology Demonstration Test Results:

## Nashville Area, September 2007, Limestone

| Advera WMA | Sasobit | Evotherm | Astec Green System |
|---|---|---|---|
| 1150 Tons Placed | 705 Tons Placed | 750 Tons Placed | 775 Tons Placed |
| % AC 5.16 & 5.28 | % AC 5.14 | % AC 5.22 & 5.36 | % AC 5.19 & 5.29 |
| % Air Voids 4.7 | % Air Voids 3.5 | % Air Voids 5.1 | % Air Voids 4.0 |
| Stability 1475 | Stability 1825 | Stability 1455 | Stability 2200 |
| TSR 51.9% | TSR 65.5% | TSR 72.7% | TSR 84.3% |
| Density 92.7% | Density 91.0% | Density 91.0% | Density 91.6% |

**State may require TSR test prior to paving**

**Standard QA testing**

**Compaction at 10  F less than plant exit temp.**

**Reheated WMA retains WMA properties**

**Voluntary testing / documentation a good idea**

Questions ?