Hot In Place Recycling

Restore “System”
The Process

- Engineered Emulsion Formulated for Process
  - Polymer Modified AC Base
  - Rejuvenating Oils
  - Dictated by Project Mix Design

- Hot In-Place Recycling of up to 2 ¼” of Existing Surface

- Final Surfacing Dictated by Traffic & Road Conditions
The Technology - Engineered HIR Recycling Emulsion

- Formulated with
  - Rejuvenator
  - Elastomeric Polymer Modified Asphalt
  - Grade Selected for Project
- Rejuvenates Aged, Oxidized Asphalt
- Excellent Aggregate/RAP Coating
- Polymer Improves
  - flexibility & durability
  - adhesion
  - temperature susceptibility
  - strength & rutting resistance
  - cracking resistance
## Performance-Related Specifications

<table>
<thead>
<tr>
<th>Property</th>
<th>Criteria</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compaction effort, Superpave Gyratory Compactor</td>
<td>1.25° angle, 600 kPa stress</td>
<td>Density Indicator</td>
</tr>
<tr>
<td><strong>Density</strong>, ASTM D 2726 or equivalent</td>
<td>Report</td>
<td>Compaction Indicator</td>
</tr>
<tr>
<td><strong>Tensile Strength</strong>, ASTM D 4867, 25°C</td>
<td>75 lb/in² min.</td>
<td>Stability Indicator</td>
</tr>
<tr>
<td>Retained stability based on long-term stability</td>
<td>70% min.</td>
<td>Resistance to moisture damage</td>
</tr>
<tr>
<td><strong>Asphalt Pavement Analyzer</strong>, 60°C, wet</td>
<td>8mm max.</td>
<td>Resistance to rutting</td>
</tr>
<tr>
<td><strong>Indirect Tensile Test</strong>, AASHTO T322, Modified</td>
<td>LTPPBind temperature for climate &amp; depth</td>
<td>Resistance to cracking</td>
</tr>
</tbody>
</table>

Also: Mix Design, Construction Equipment, Construction Methods, QC & QA
The Process

Continuous Process with Self-Contained Train

- Asphalt Surface Heated
- Heated Pavement Milled in $\frac{1}{2}''$ to $\frac{3}{4}''$ increments
- Engineered Emulsion Added at Design Content
- Materials Mixed and Windrowed
- Recycled Mix Placed by Paver with Vibratory Screed
- Mat Compacted
- Surface Applied
  - Such as NovaChip, Ralumac, Polymer Chip Seal, Thin HMA overlays, etc.
The Process

RESTORE HIR SYSTEM

Continuous with Self-Contained Train
Surface Heated to Approximately 250°F
The Process

RESTORE HIR SYSTEM

First Heater Unit
The Process

Second Unit: Combination - Heater Unit and First Milling Section
The Process

RESTORE HIR SYSTEM

- Second Unit: Combination - Heater Unit and First Milling Section
- Highlight of Milling
The Process

RESTORE HIR SYSTEM

- Heated, Milled Windrow Going Through Tunnel Heaters
The Process

RESTORE HIR SYSTEM

- Third Heater Unit
The Process

RESTORE HIR SYSTEM

- Fourth Unit: Combination – Heater Unit and Second Milling Section
- Highlight of Deeper Milling
Fourth Unit: Combination – Heater Unit and Second Milling Section

Highlight of “Windrow”
The Process

RESTORE HIR SYSTEM

Fifth Heater Unit
The Process

RESTORE HIR SYSTEM

- Sixth Unit: Combination – Heater Unit and Third Milling Section
- Highlight of “Emulsion Injection”
- Engineered Emulsion Metered at Design Content
The Process

RESTORE HIR SYSTEM

- Sixth Unit: Combination – Heater Unit and Third Milling Section
- Highlight of “Windrow and Product Ready for Paving”
The Process

RESTORE HIR SYSTEM

Side view of “Wind Row”
The Process

RESTORE HIR SYSTEM

Windrow and Windrow Elevator
The Process

RESTORE HIR SYSTEM

Windrow Elevator & Paver
The Process

RESTORE HIR SYSTEM

Recycled Asphalt Mix Placed with Paver and Vibratory Screed
The Process

Recycled Mat Being Rolled
The Process

RESTORE HIR SYSTEM

- Temperature Reading of Pre-Compacted Mat
- Minimum Temperature of 190°C
Finished Mat

- Side by Side with adjacent lane
Finished Mat

RESTORE HIR SYSTEM

Compacted and Finished Product
Finished Mat

RESTORE HIR SYSTEM

Compacted and Finished Product
Benefits

- Aged, Distressed Surfaces Replaced with New Surfaces
  - Deformations Leveled
  - Surface Cracking Removed
  - Clearances, Curb Heights Maintained
  - Reuses Existing Materials
  - Can, Itself, be Recycled
Benefits (Continued)

- Minimizes Lane Closure Time
- Other Lanes Remain Open During Construction
- Quick Return to Traffic
Benefits (Continued)

- Rejuvenates Aged, Oxidized Asphalt
- Excellent Aggregate/RAP Coating
- Polymer Improves
  - Flexibility & Durability
  - Adhesion
  - Temperature Susceptibility
  - Strength & Rutting Resistance
  - Cracking Resistance
Side-by-Side Trial After 2 Winters

K-170
Reading, KS
Construction: HIR + 1” HMA overlay

HIR with Engineered Emulsion

HIR with Conventional Emulsion
Where Can RESTORE HIR be Used?

- Highways, City Streets, Country Roads
- Materials that aren’t Stripping Sensitive
- Structurally Sound Pavements
- Distressed Surfaces
- Good Drainage
Cold and HIR Recycling
Allowable Pavement Condition

Distress Type
- Fatigue Cracking
- Linear or Block Cracking
- Rutting
- Raveling
- Bleeding
- Roughness
- Skid Loss
- Moisture Damage

Extent of Problem
- Minor
- Major

Allowable Pavement Condition
- Effective
- Marginal
- No Impact
- Not Appropriate
US-281
Osborne, Co
US-56
McPherson, Co
K - 156
Pawnee County
K - 28
Cloud/Jewell Co
US-54
Meade/Seward
US-59
Jefferson Co
Oklahoma - Turner Turnpike Tulsa to OKC
Project Details

- Constructed July 17, 2006
  - WB driving lane
  - 1 mile in length
  - Near Stroud, OK toll booth
- Open to traffic 28 days after recycling
  - 335,000 vehicles (total WB)
  - 13,000 ADT
  - +/- 126,000 ESALs
- Surfaced with Bonded Wearing Course
## Rut Depth Measurements

### Mile Marker 194
Westbound Outside Lane

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<tr>
<th>Rut Depths</th>
<th>mm</th>
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<tr>
<td>A</td>
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<td>AA</td>
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<td>E</td>
<td>1.40</td>
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<tr>
<td>EE</td>
<td>1.02</td>
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**Average Rut Depth**: 1.54 mm (0.06 inch)

**Maximum Rut Depth**: (0.1 inch)

***Each Rut was measured within the wheel path; approximately 3’ off the centerline and 3’ off the outside edge of pavement***
High Temperatures While Open to Traffic

High Temperatures
Stroud, OK*
July 18 to August 12, 2006

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</tbody>
</table>

Average temperature = 97.5°F

*Source: www.wunderground.com
Engineered Hot In-Place Recycling

- Cost-Effective
- Quick
- Durable
- Reuses Existing Materials
Thank you.

Questions?