Acronal NX4627 in Tack/Bond Coat Emulsions
A bond coat is a very light spray application of diluted asphalt emulsion. It is used to promote a bond between the existing surface and the new asphalt application.
Types of emulsions used

- CSS-1h, CSS-1, SS-1h, SS-1
  - These emulsions chosen for their stability and miscibility with dilution to water.
  - The base asphalt are chosen for the climate conditions and are usually similar, to slightly harder (more viscous) than the paving grade.
  - Polymers traditionally not used do to the lack of understanding as to what they could provide for the application
    - Cost/benefit
    - Polymers too sticky and create tracking scenarios
Tack/Bond Coat

What to look for – rates and precautions

- **Typical Rates**
  - Application rate (emulsion) is usually 0.05-0.10 Gal/yd$^2$ of a 30-50% residue emulsion (diluted just prior to application)

- **Precautions**
  - Dry/clean pavement
  - Application rate for a thin uniform coating of emulsion
  - Dilution of emulsion to aid in the uniform distribution
  - Emulsion should be broken (brown to black in color), usually determined by application rate and environmental conditions.
Tack/Bond Coat Application

Proper Spraying - Even

Uneven or “Stripped”
Illinois Tack Coat Study - 2009

- SS-1hP, RC-70, & PG64-22
- Application rates (residual)
  - 0.02, 0.04, and 0.09 gal/yd²
- Highlighted Findings:
  - Recommended 0.04 gal/yd² residual application rate
  - SS-1hP and PG64-22 showed better rut resistance than RC-70
  - Uneven tack coat showed worse rut resistance

TACK COAT OPTIMIZATION FOR HMA OVERLAYS: ACCELERATED PAVEMENT TEST REPORT
Tack/Bond Coat
Why utilize Acronal NX4627?

- Reduced Tracking
  - The acrylic gives a very good resistance to tracking by forming a very thin layer of acrylic on the surface of the broken bond coat emulsion.
  - The acrylic allows this to be accomplished with the customer using normal asphalt base materials (no hard pen necessary)

- Better bond performance
  - Use of polymers is starting to be noticed as improving the bonding of the new pavement to existing old pavement
## Tack Coat Residue Testing

### Traditional

**ASTM Evaporation or Distillation Procedures**

<table>
<thead>
<tr>
<th>Test</th>
<th>CSS-1</th>
<th>CSS-1h</th>
<th>Modified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration @ 25°C, dmm</td>
<td>100 - 250</td>
<td>40 - 90</td>
<td>40 - 90</td>
</tr>
<tr>
<td>Ductility @ 25°C, cm</td>
<td>40 min.</td>
<td>40 min.</td>
<td></td>
</tr>
<tr>
<td>Softening point, °C</td>
<td></td>
<td></td>
<td>60 min.</td>
</tr>
<tr>
<td>Elastic Recovery @ 10°C, %</td>
<td></td>
<td></td>
<td>50 min.</td>
</tr>
</tbody>
</table>
# Tack/Bond Coat Emulsion Testing With and Without Acronal NX4627

## SHRP TEST REPORT FORM

<table>
<thead>
<tr>
<th>Grade</th>
<th>% Acronal NX 4627 X</th>
<th>% Emulsifier (CRS Type)</th>
<th>Tests on unaged material:</th>
</tr>
</thead>
<tbody>
<tr>
<td>NuStar</td>
<td>NuStar</td>
<td>NuStar</td>
<td>NuStar</td>
</tr>
<tr>
<td>PG58-28</td>
<td>PG58-28</td>
<td>PG64-22</td>
<td>PG64-22</td>
</tr>
<tr>
<td>0</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>0.35</td>
<td>0.35</td>
<td>0.35</td>
<td>0.35</td>
</tr>
</tbody>
</table>

### Phase Angle (delta)

<table>
<thead>
<tr>
<th>°C</th>
<th>Spec Limit</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>58</td>
<td>80.0</td>
<td>76.8</td>
</tr>
<tr>
<td>64</td>
<td>82.4</td>
<td>79.4</td>
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<tr>
<td>70</td>
<td>84.5</td>
<td>81.9</td>
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<tr>
<td>76</td>
<td>65.6</td>
<td>84.1</td>
</tr>
<tr>
<td>82</td>
<td>68.5</td>
<td>70.1</td>
</tr>
</tbody>
</table>

### G*/sin delta @ 10 rad/sec,kPa

<table>
<thead>
<tr>
<th>°C</th>
<th>Spec Limit</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>58</td>
<td>3.15</td>
<td>7.98</td>
</tr>
<tr>
<td>64</td>
<td>1.69</td>
<td>3.77</td>
</tr>
<tr>
<td>70</td>
<td>0.88</td>
<td>1.88</td>
</tr>
<tr>
<td>76</td>
<td>0.82</td>
<td>1.45</td>
</tr>
<tr>
<td>82</td>
<td>0.88</td>
<td></td>
</tr>
</tbody>
</table>

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**ASTM D7497 Procedure**
Tracking Test Procedures
What is being looked at?

- Variation on ASTM D711
  - Information regarding Virginia DOT procedure
- BASF Modifications to improve the procedure
  - Wheel changes
  - Drawdown adjustment
  - Felt paper consistency issues
Tracking Testing
Example of ASTM D711 Equipment

Tracking Wheel

Drawdown Apparatus

Information from VADOT TRB Paper: Clark, Rorrer & McGhee
Tracking Test Procedure
Modified to reduce variability

- **Procedure**
  - 30 lb roofing felt is glued to a particle board using a spray adhesive
  - 0.015” thickness of emulsion is drawn down on the felt paper – wide enough for three test times
  - Sample is cured at a specific temperature and time intervals prior to testing
  - At testing interval, 10 lb wheel with 4” diameter rubber (cam-lock) rings are rolled across the tack coat onto poster board paper placed on the same thickness of particle board

- **Measurement**
  - Visually determine the degree of tracking at each time interval and the time that no tracking appears
Tracking Testing – Original Procedure
Bond Coat Emulsion with CRS Chemistry

25°C Curing – 10, 20 and 30 Minutes
Prior to modification of felt paper to particle board and wider drawdown
Tracking Test Procedure

- **Draw Down Apparatus**

  Can be adjusted easily for varying thicknesses, and wide enough for at least three measurements with the wheel.

<table>
<thead>
<tr>
<th>Distributer</th>
<th>Film Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.02 gal/yd²</td>
<td>0.0036 in.</td>
</tr>
<tr>
<td>0.05 gal/yd²</td>
<td>0.0089 in.</td>
</tr>
<tr>
<td>0.10 gal/yd²</td>
<td>0.0180 in.</td>
</tr>
</tbody>
</table>
Tracking Test Procedure

- Tracking Wheel
  - Ten pound stainless wheel that can accommodate two four inch square (cam-lock) o-rings
Tracking Testing at various temperatures
Bond Coat Emulsion with CRS Chemistry

Ambient – 25°C

35°C

50°C

10 Minute
20 Minute
30 Minute
Tracking Testing at 50°C (122°F)
PG58-28 Base – CRS Chemistry

Without Modification

With 5% Acronal NX4627
Tracking Testing at $60^\circ\text{C} (140^\circ\text{F})$

PG58-28 Base – CRS Chemistry

Bond Coat on felt and paper
Bond Strength Testing

- **Types of Bond strength testing**
  - Shear or tensile
    - Shear testing applies a horizontal force to the pavement section to “shear” the specimen
    - Tensile testing “pulls” the top section away from the existing pavement

- **How strong do you need a bond to be?**
  - Just like gluing or welding two materials together, the strength of the bond needs to be greater than the materials being bonded.
Bond Strength Testing
Florida procedure

- PG58-28 based emulsion
  - Tack coat at 0.1 Gallon/yd²
  - Tested at 25°C
  - Bond Strength
    - 182.1 psi (1.26 MPa)
Bond Strength Testing
Florida procedure

- PG64-22 – Based Emulsion
  - Tack coat at 0.1 gallon/yd²
  - Tested at 25°C
  - Bond Strength
    - 207.9 psi (1.43MPa)

Illinois Report showed the same findings on shear strength testing between SS-1hP and SS-1h
Bond Strength Testing
Louisiana Interlayer Shear Strength Tester

- **Test Apparatus**

- Normal Load Actuator
- Horizontal Sensor
- Vertical Sensors
- Loading Frame
- Reaction Frame

Taken from Louay Mohammad’s Draft Test Procedure
Bond Strength Testing
Louisiana Interlayer Shear Strength Tester

- PG58-28 and PG64-22 based cationic emulsion
- 4, 25 and 60°C Temperatures – 0.05 gal/yd²

![Graph showing bond strength comparison of cationic asphalt emulsions by base stock.](image)
Bond Strength Comparison
Florida vs. LISST Procedure

- Similar Emulsion Manufactured for both
- Converted to MPa for both

<table>
<thead>
<tr>
<th>Emulsion Base</th>
<th>PG58-28 MPa</th>
<th>PG64-22 MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Florida</td>
<td>1.26</td>
<td>1.43</td>
</tr>
<tr>
<td>LISST</td>
<td>1.21</td>
<td>2.08</td>
</tr>
</tbody>
</table>

Florida Data converted to MPa
1MPa = 145 lb/in²