Interim Update – NHTSA Tire Aging Test Development Project

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Statistics: N. American Tire Industry

- 2003 - North American tire sales:
  - $23.5 Billion

- 2003 - NA passenger & LT tires shipped:
  - 291 million (798,000/day)

- Average passenger tire service life:
  - 2002: 44,700 miles / 3.7 years
  - 2003: 46,300 miles / 3.8 years
  - +1,600 miles of average service life added last year
  - Large distributions in average service lives

Data Sources: Rubber Manufacturer’s Association - www.rma.org;
Tire Aging Project Background

Tread Separation Rate (service condition):
Recalled Tires Only*

Cumulative Claim Rates - Tread Separation (Serv. Cond.)
All Recalled Tires P235/75R15

*Wilson Wildness tires are shown for comparison only.
Wilson Wildness tires are not part of the recall.

Source: Summary Root Cause Analysis Bridgestone/Firestone, Inc., Slide #13
Tire Aging Project Background

Summary - The agency has noted that:

- Tire service life is increasing
- States with high average ambient temperatures have higher tire failure rates
- Tire failures often don’t manifest until many years of use
- Testing new tires from the factory may not identify defective designs
Tire Aging Project Basics

Quantify How Tires Age During Use in High Ambient Temperature Regions

Evaluate Effectiveness of Proposed New Tire Aging Methods

Develop an Accelerated Tire Aging Test for Tires Covered by the FMVSS 139
Quantify How Tires Age During Use in High Ambient Temperature Regions

Basic Approach: Compare tires collected from on-vehicle use in a southern state to new versions of themselves to quantify the amount of degradation that occurs with age & use
Tire Model Selection Requirements

- **Production Availability**
  - In production 1998 to 2003

- **Popularity**
  - OE: Must have been OE on at least one US vehicle
  - Replacement: Must be available at a large tire retailer

- **Design Legacy**
  - No ‘major’ design changes from 98 – 03
NHTSA Field Tire Collection

- Field Tire Collection
  - Stated Goal:
    - 12 tire models
    - 60 of each model
    - 20 in each age group 1: 97-98, 2: 99-00, 3: 01-03

- Original Equipment
  - P-metric tires
    - Compact car
    - Mid-size car
    - Mid-size SUV
    - Large SUV

- Replacement Brand
  - P-metric tires
    - Mid-size car
    - Full-size car
    - Large SUV
  - Light Truck
    - Load Range E
NHTSA Field Tire Collection

Collection Area: Maricopa County (Phoenix), Arizona

- Average annual temperature 72.9°F (22.7°C)
- The state of Arizona had the highest per capita tire tread separation rate for the recalled Firestone tires
- Maricopa County population: 3,072,149 (2000 U.S. Census)
Phase I Test Tires

Field Collection
- Completed March, 2003
- Collected 600+ tires off of Phoenix area vehicles
- The six tire models (out of 12) with the best distribution of tires were selected for Phase I

<table>
<thead>
<tr>
<th>Type</th>
<th>Size</th>
<th>Load Index</th>
<th>Speed Rating</th>
<th>Brand</th>
<th>Model</th>
</tr>
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<tbody>
<tr>
<td>P-metric</td>
<td>P195/65R15</td>
<td>89</td>
<td>S</td>
<td>BFGoodrich</td>
<td>Touring T/A</td>
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<tr>
<td>P-metric</td>
<td>P205/65R15</td>
<td>92</td>
<td>V</td>
<td>Goodyear</td>
<td>Eagle GA</td>
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<tr>
<td>P-metric</td>
<td>P235/75R15</td>
<td>108*</td>
<td>S</td>
<td>Michelin</td>
<td>LTX M/S</td>
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<tr>
<td>Metric</td>
<td>255/65R16</td>
<td>109</td>
<td>H</td>
<td>General</td>
<td>Grabber ST A/S</td>
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<tr>
<td>P-metric</td>
<td>P265/75R16</td>
<td>114</td>
<td>S</td>
<td>Firestone</td>
<td>Wilderness AT</td>
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<tr>
<td>LT</td>
<td>LT245/75R16/E</td>
<td>120**</td>
<td>Q</td>
<td>Pathfinder</td>
<td>ATR A/S OWL</td>
</tr>
</tbody>
</table>

*Extra Load / **Load Range E
Phase I New and Used Tire Tests

Component Properties
- Microscopy
- Innerliner Air Permeability (21°C & 70°C)*
- Peel Strength (23°C & 100°C)
- Variable Speed Peel Strength
- Total Crosslink Density
- Crosslink Density Distribution
- Fixed Oxygen by Weight
- Tensile Properties
- Shore Hardness
- Innerliner Compound (FTIR, TGA)*
- Micro Demattia
- Torsional Test on Belt Ply
- Two-ply Laminate Fatigue
- Pure Shear Crack Growth
- Interlaminar Shear

Whole Tire Properties
- Air Permeability(21°C & 70°C)*
- Shearography
- Stepped-Up Load Resistance
- Stepped-Up Speed Resistance
- Intra-carcass Pressure*
- Tread Depth

*New Tires Only
Example Test Method

Stepped-Up Load to Failure Test - Based on the FMVSS 139 Endurance Test, New & Used Tires

<table>
<thead>
<tr>
<th>Test Stage (#)</th>
<th>Duration (hours)</th>
<th>Percent Max Load</th>
<th>Speed (mph)</th>
<th>Test</th>
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<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>85%</td>
<td>75</td>
<td>FMVSS 139 Endurance</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>90%</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>24</td>
<td>100%</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Inspection</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>110%</td>
<td>75</td>
<td>Stepped-Up Load to Failure</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>120%</td>
<td>75</td>
<td>Catastrophic Failure</td>
</tr>
<tr>
<td>Etc.</td>
<td>4</td>
<td>+10% every 4 hours</td>
<td>75</td>
<td></td>
</tr>
</tbody>
</table>

67” Roadwheel Dynamometer
Example Test Method

- Stepped-Up Load to Failure - Roadwheel Dynamometer Test
  - Tires underwent detailed pre-test visual inspection
    - No visible defects or repairs (patches, plugs, exposed belt edge, etc.) were allowed
  - Tires underwent full pre-test bead to bead shearography evaluation
    - No excessive shearography separation (indicative of damage/abuse) was allowed
  - Spare tires separated out
  - Time to failure results plotted against age, mileage, treadwear, etc.
Example Test Method
Roadwheel Removal Conditions
Example Test Method

Preliminary Findings – Stepped-Up Load to Failure Test:

- New versions of the six tire models did very well in the stepped-up load test
- Tires collected from use in Phoenix, Arizona exhibited a degradation in performance, many significantly, with age & use
- Tires from different makes/models degraded at different rates
- Tires from different service applications degraded at different rates
Evaluate the Effectiveness of Proposed Tire Aging Methods

Basic Approach: Compare testing results using current new tire aging methods to real world tire data
Project Requirements

- § 571.139 Standard No. 139; New pneumatic radial tires for light vehicles
  - Tire aging test was deferred for further development in the June 2003 final rule
  - A NPRM for a tire aging test is anticipated in 2005
  - The FMVSS 139 goes into effect June 1, 2007
Aging Tests Being Evaluated

Aging Tests Currently Being Evaluated:

- ASTM - Air Permeability (F1112-00)
- Continental General - P-END
- Ford - Hybrid Oven/Roadwheel Aging
- Michelin - Long Term Durability Endurance (LTDE)

Aging Tests Not Being Evaluated:

- General Motors - Accelerated Tire Endurance (ATE)
- NHTSA - Roadwheel Conditioning & Peel Force (NPRM FMVSS 139)
Tentative Tire Aging Project Schedule

Meet with Industry / Project Planning

Tire Collection in Phoenix, Arizona

Analysis & Testing of Field Tires

Evaluation of Tire Aging Methods

Tire Aging Test Development

Complete

Complete

10/03 - 10/04

10/03 - 10/04

10/04 - 6/05
Tire Aging Project Data and Findings

- The agency anticipates publishing a final report and releasing the data in conjunction with the issuance of the FVMSS 139 Tire Aging Test NPRM

- All data, pictures, graphs, etc. from the project are being organized in a searchable digital database. The goal is to make this database available to the public once finalized.