# Summary of NHTSA Tire Aging Test Development Research

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# Safety Issue

- NHTSA estimates that about **400 fatalities per year** (~1% of total motor vehicle fatalities) may be attributed to tire failures of all types*
  - Many contributing factors involved
- "Tire Aging" Definition
  - Fatalities, injuries, and crashes resulting from tire failures where thermo-oxidative degradation of the tire components is a cause or a factor
    - Mechanism: Tires are primarily degrading from the inside-out, due permeation and reaction of the pressurized oxygen within the tire structure, with rates proportional to temperature



*Based on analysis of NASS-CDS data, from 1994 through 2004

# Tire Aging Project Background

## Overall Research Approach

- Study tires retrieved from on-vehicle service in a southwestern US state
  - Higher temperatures = higher rates of degradation
- Develop an accelerated laboratory aging process for new tires followed by a roadwheel durability test that:
  - Simulates several years of use in states with high ambient temperatures
  - Evaluates a tire's ability to retain safety-critical durability properties after simulated aging

# Tire Aging Project Phase 1

## Phoenix, Arizona Tire Study

# Phoenix, AZ Tire Collection

## Tires collected during March to April 2003

- Tires had to be in production from 1998 to 2003 with no ‘significant’ design changes in that period
- Separated out 20% of tires full-size spare and tires that did not experience full-time service in AZ
- Tested 250 tires of six different models

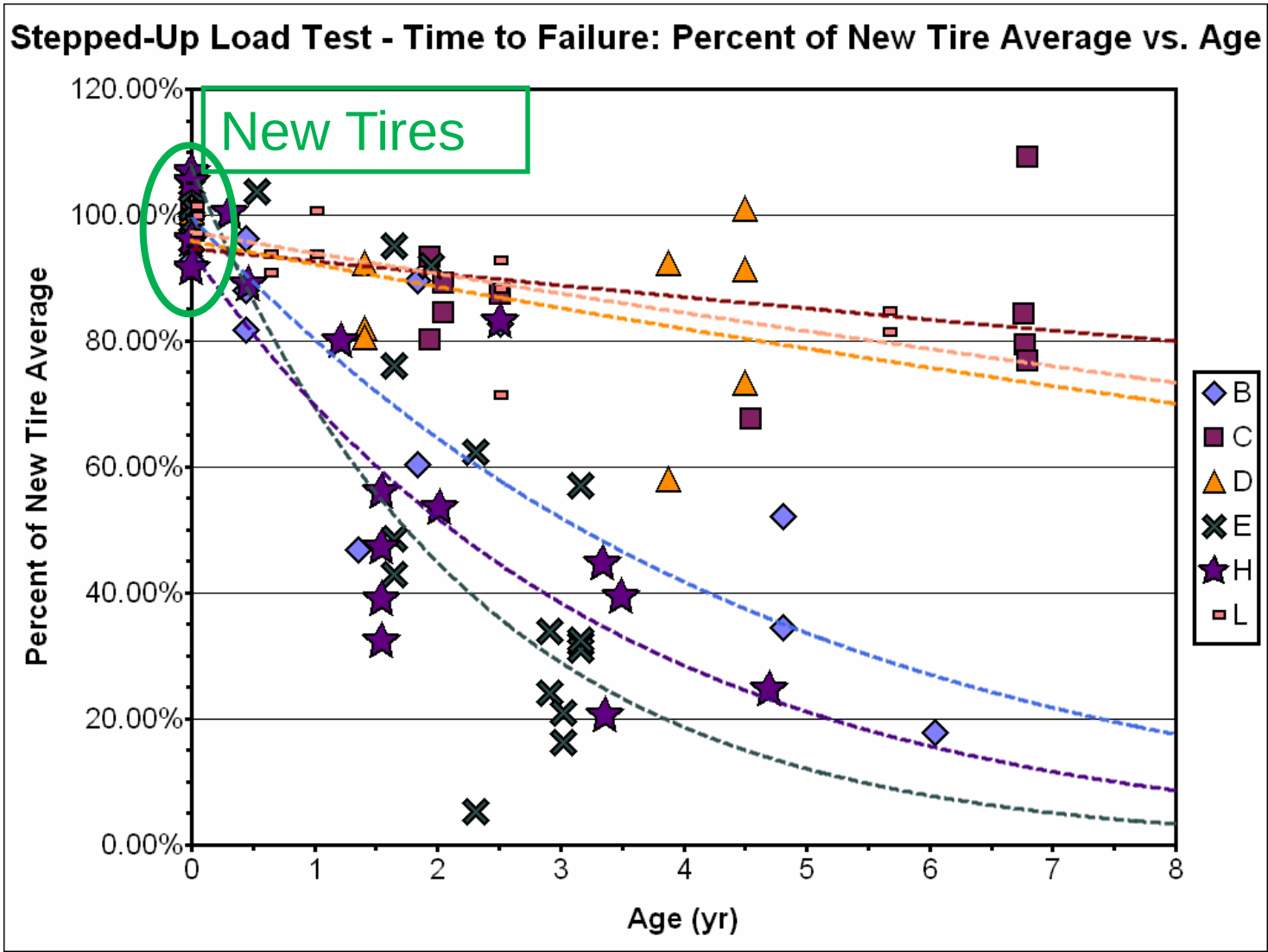
# Phase 1 Results

When tires of the six models collected from on-vehicle service in Phoenix, AZ were compared to new tires of each model:

- There was a marked decrease in time-to-failure in endurance and high-speed laboratory roadwheel tests with increased tire age & mileage
- Tire component material/structural properties exhibited increased degradation with increased tire age & mileage

# Stepped-Up Load Roadwheel Test Results – New vs. Phoenix Tires

Tires become less resistant to overloading or underinflation with age…



# Tire Aging Project Phase 2

## Evaluation of Laboratory Tire Aging Methods

# Laboratory Tire Aging Methods

New versions of each of the six tire models collected from Phoenix were subjected to three accelerated aging methods:

- Continental General – "P-END" Roadwheel Test
  - 104 valid tests
- Michelin – "LTDE" Roadwheel Test
  - 134 valid tests
- Ford – Oven Aging Protocols
  - 91 valid tests

# Phase 2 Results

Oven aging was the only method of the three examined that could replicate the material properties of the six Phoenix-retrieved tire models

- Valid test conditions:
  - 3 weeks < Oven Time < 12 weeks
  - 55-70 degrees C
  - 50/50 N2/O2 inflation gas
    - Weekly pressure maintenance required
  - Pre-oven roadwheel break-in necessary

# Phase 3

## Oven Aging Test Development

# Oven Aging Test Development

- 18 Additional (i.e., non-Phase 1 & 2) Tire Models
  - Multiple test conditions evaluated:
    - 7-10 weeks, 60°C, weekly inflation gas replacement
    - 5-8 weeks, 65°C, weekly inflation gas replacement
    - Pre-test 23-hr roadwheel break-in @ 50 mph, 5-8 weeks, 65°C, weekly inflation gas replacement

# Phase 3 Conclusions

- Both 60 deg C and 65 deg C oven aging elicited the desired material properties in the regions studied
  - Use of 65 deg C results in a shorter oven test
- Weekly venting and refilling with fresh 50/50 N2/O2 shortened test
  - Prevents oxygen depletion during oven aging
- Pre-oven roadwheel break-in is required
  - Produces a better match to “in-service” tire rubber properties

# Phase 4 Results

## Oven Aging Test Validation Phase

# Phase 4 – Oven Aging Test Validation

## Evaluation of final oven test procedure

- 20 additional (i.e., non-Phase 1-3) tire models
- Pre-test roadwheel break-in
  - 2-hour, 50 mph FMVSS No. 139 High Speed test break-in
- 65 degrees C
  - 3-5 weeks with weekly vent & refill of inflation gas
- Post-oven durability test
  - FMVSS No. 139 Endurance and Low-Pressure test sequence

# Phase 4 Results

As the oven test severity was increased (i.e., longer durations of oven aging), more tires failed the FMVSS No. 139 Endurance & Low Pressure roadwheel test sequence

- An independent analysis of tire model material properties and constructions suggest that tires that passed the roadwheel test after oven aging contained features making them more resistant to heat aging

# Next Steps

Research Report to Congress on Tire Aging, DOT HS 810 799, August 2007, Docket NHTSA-2005-21276-0042

- *"NHTSA is currently evaluating the feasibility of a regulation related to tire aging by analyzing:*
  - *The safety problem (tire aging as a significant causal factor in crashes)*
  - *Potential benefits and costs of a requirement for minimum performance based on an aging method."*

# Documents

- http://www.regulations.gov
  - NHTSA Tire Aging Docket
    - NHTSA-2005-21276
  - Historical FMVSS No. 139 Dockets
    - NHTSA-2000-8011
    - NHTSA-2003-15400