Special Investigation Report:
Selected Issues in Passenger Vehicle Tire Safety
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Rafael Marshall, PhD
Background

- >500 die in tire-related passenger vehicle crashes each year
- ~19,000 injured
- Most of these crashes are preventable
Tire Safety Special Investigation

Product of:

- Four crash investigations
- Tire safety symposium
Centerville, Louisiana
February 15, 2014

- Left rear tire tread separation
- SUV crossed median and collided with school bus
- 4 fatalities, 32 injured

Source: Louisiana State Police
Centerville, Louisiana
February 15, 2014

- 10 years old
- Poorly maintained
Lake City, Florida
February 21, 2014

- Left rear tire tread separation
- Ran off roadway and rolled over
- 2 fatalities, 8 injured

Source: Florida Highway Patrol
Lake City, Florida
February 21, 2014

- Tire had been part of a safety recall in July 2012
- Recall notices sent but not received

Source: Florida Highway Patrol
Eloy, Arizona
March 29, 2014

• 2002 Ford F250 crossed center median after front tire tread separation
• 5 fatalities, 2 injured

Source: Arizona Department of Public Safety
Patterson, California
May 23, 2014

- 1999 Ford Explorer rolled over after tread separation on a 12-year-old right rear tire
- Driver died

Source: California Highway Patrol
www.ntsb.gov/tiresafety
Investigative Issues

- Tire registration and recall system
- Consumer guidance on tire aging
- Poor tire maintenance practices
- Barriers to innovation
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Overview of Tire Construction and Summary of Tire Examinations

Donald Kramer, PhD
Functional Role of Tires

- Support weight of vehicle
- Maintain traction with ground during acceleration, braking, and cornering
Overview of Tire Construction

- Tread
- Steel belts
- Gum strips
- Belt wedge
- Sidewall
- Cushion
- Body plies
- Belt edges
- Body plies
- Body plies
Centerville, Louisiana

Inner edge of tread

Outer edge of tread
Separated Side of Tread

Inner edge of tread

Outer edge of tread
Indications of Improper Maintenance and Use

- Multiple penetrations of tread
- Fractured wires in outer belt
- Slipping of balance weight
- Cracking of sidewall at shoulder
- *Tire was not properly maintained*
Lake City, Florida

Inner edge of tread

Outer edge of tread
Separated Side of Tread

Inner edge of tread

Outer edge of tread
No Indications of Improper Maintenance or Use

- No indications of improper maintenance, underinflation, or overdeflection
- No patches or repairs
- No indications of third body damage
- No suspect tread wear patterns
- *Tire appeared to be properly used and maintained*
Overview

- Improvements are needed to increase tire registrations
- Safety recalls could be improved by providing more information to tire owners
- Improvements are needed in tire identification number (TIN) labeling
Tire Registration

• Lake City, FL, crash involved a failed tire that was the subject of a safety recall
• Tire had not been registered
• Because the tire was not registered, the owner could not be notified of the recall
Tire Registration

• Sole purpose of tire registration is to notify owners of recalls

• Tire registration is vital for owner notification of any recall

• Responsibilities differ between manufacturer-controlled and independent tire dealers, which affects purchaser involvement
Tire Registration

• Manufacturer-owned or -controlled dealers must register all tires they sell

• Independent tire dealers are required to provide a paper registration form to the purchaser
Tire Registration

- Independent dealers have the option to register purchaser's tires
- Tire owners may also be able to register their tires through a manufacturer’s website
- Tire owners may be unaware of the importance of tire registration
Tire Registration

- ~100% registration rate for manufacturer-controlled tire dealers
- <10% registration rate for independent tire dealers
- 92% of tire retailers are independent dealers
Tire Registration

- Point-of-sale registration by all dealers could increase the rate of registration and reduce purchaser confusion.
- Technology can provide effective solutions for all dealers to register the tires they sell.
Tire Safety Recalls

• 2009–2013 average completion rate for tire recalls was 44%
• Recall rate for motor vehicles is about 78%
• Recall success depends on owner notification
Tire Safety Recalls

- Manufacturers lack alternatives for owner notification
- Contact information is limited
Tire Identification Number (TIN)

- Full TIN has 7–13 characters that uniquely identify week of production
- Last 4 numerals specify week and year of manufacture
Tire Safety Recalls

• Currently, no means to search for tire recall by TIN

• Web-based TIN search tool for recalls would improve identification of recalled tires

• TIN search tool should be available through NHTSA and manufacturer websites
Tire Identification Number

Partial TINs facing outboard
Tire Identification Number

Full TIN – inboard sidewall

Source: Arizona Department of Public Safety

Partial TIN – outboard sidewall

Source: Arizona Department of Public Safety
Summary

• Registration of tires is crucial to safety recalls, and the process needs improvement
• Web-based TIN lookup tool would improve the recall process
• Tire owners would be better informed if the full TIN were on both tire sidewalls
Tire Aging

Rafael Marshall, PhD
Introduction

• Why is tire aging a concern?
• What has been done to address tire-aging risks?
• What more needs to be done?
Tire Aging

“The reduction or loss in a tire’s material properties, which over time leads to a reduction of its performance capabilities”

(NHTSA 2007)
Tire Aging: Why a Concern?

• Tires degrade with time regardless of use
• Several vehicle manufacturers recommend replacement of tires after 6 years of service
• Several tire manufacturers recommend replacement of tires after 10 years, regardless of use
Tire Aging: Why a Concern?

• Factors that accelerate tire aging:
  – High travel speeds
  – Chronically underinflated or overloaded tires
  – Prolonged exposure to elements
  – High ambient temperatures

• 23% of tire-related crashes involved tire aging
Examples of Tire Aging

Source: California Highway Patrol
Tire Aging: What’s Been Done?

- Congress passed TREAD Act in 2000

- NHTSA required in 2007
  - Tire pressure monitoring systems (TPMS) (FMVSS 138)
  - More robust tires (FMVSS 139)

- Accelerated tire-aging protocol created but not included in regulation

• Confirm that risks associated with tire aging have decreased
• Publish consistent information to targeted populations on how they can reduce tire-aging-related risk
Consumer Awareness

Rafael Marshal, PhD
Introduction

- Basic tire maintenance
- Current outreach efforts
- Poor state of consumer tire safety awareness
- Next steps to improve consumer behavior
Basic Tire Maintenance

• Rotate, align, and balance in accordance with vehicle owner's manual

• Feel vibration or hear a noise? Have your tires checked
Drivers: Manage Tire Risks for a Safer Ride

Tire Maintenance and Registration Can Decrease Crash Risk

www.ntsb.gov/safety/safety-alerts
Current Outreach Efforts

Source: NHTSA

Source: Rubber Manufacturers Association

Source: Michelin North America Inc.
Level of Consumer Awareness

• 50% use wrong tire inflation pressure
• 69% have an underinflated tire
• 63% don’t rotate their tires
• 12% have at least one bald tire
Next Step

• Outreach efforts have yielded little change in consumer behavior

• Evaluation of current efforts may identify techniques most effective in improving consumer behavior
Technologies to Prevent/Mitigate Tire-Related Crashes

Shane Lack
Overview

- Dynamics of Tire Failure
- Technologies
  - Vehicle-based
  - Tire-based
Front Tire Failure

- Reduced
- Rotation
- Lateral motion
- Plowing
  (understeer)

Understeer
Rear Tire Failure

- Less stable
- Excessive
  - Rotation
  - Lateral motion
- Spin-out (oversteer)
Risks Associated with Rear Tire Failure

• Forces generated by the tire failure may cause vehicle to veer off the roadway

• Sudden changes in handling

• Increased risk of driver accidentally steering off the roadway
Vehicle-Based Technologies

- Electronic Stability Control Systems (ESC)
- Radar and cameras
- Tire Pressure Monitoring Systems (TPMS)
- Active steering
Tire-Based Technologies

- Integrated air pumps
- Integrated tread-monitoring systems
- Intelligent tires
- Non-pneumatic and run-flat tires
Summary

• Tire failures pose unique challenges
  • Potentially large, sudden changes in vehicle response characteristics
  • Risk of driver accidently steering off the roadway
• Encourage technological improvements