TIRES AND PASSENGER VEHICLE FUEL ECONOMY

Informing Consumers, Improving Performance

Every 3 to 5 years, the typical U.S. automobile owner chooses new tires that will affect the vehicle's handling, traction, ride, and appearance, as well as its fuel economy. Annually $20 billion is spent on approximately 200 million replacement tires for personal vehicles, and an equal number of used tires is discarded. The collective outcome of these consumer choices about tires is a matter of public interest and national concern.

This report assesses the feasibility of reducing rolling resistance in replacement tires and examines the effects on vehicle fuel consumption, tire wear life, scrap tires, and operating performance safety.

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SPECIAL REPORT 286

TIRES AND PASSENGER VEHICLE FUEL ECONOMY

Informing Consumers, Improving Performance

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

CHARGE

- Evaluate effects of lowering rolling resistance of replacement passenger tires on:
  - Vehicle fuel consumption
  - Tire wear and scrap tire generation
  - Tire performance characteristics and safety
  - Consumer spending on tires and fuel

Conclusions

1. REDUCING ROLLING RESISTANCE OF REPLACEMENT TIRES IN FLEET BY 10% IS FEASIBLE
   - **Changes in mix of existing tires purchased**
     - We found that rolling resistance already varies across *comparable* tires by 10 percent or more. Many replacement tires have "low" rolling resistance relative to the average.
   - **Migration of OE tire technologies**
     - We found that OE tires have lower rolling resistance by 10 to 25 percent across all classes of tires.
   - **Improvement can happen sooner if accompanied by more vigilant pressure maintenance**

- **ROLLING RESISTANCE HAS A MEANINGFUL EFFECT ON FUEL ECONOMY**
  - **10% reduction in rolling resistance will increase fuel economy by 1 to 2 %**
  - **80 percent of passenger vehicles have replacement tires.**
  - **Each 1% improvement in fuel economy of these vehicles will save ~1 billion gallons of fuel.**
  - **10% reduction in replacement tire rolling resistance = fuel saved by taking 2 to 4 million cars and light trucks off the road.**

3. EFFECT ON TIRE WEAR LIFE UNCLEAR: *BECAUSE ROLLING RESISTANCE CAN BE REDUCED IN DIFFERENT WAYS*

- **Tread material and quantity is a major determinant of rolling resistance**
  - **RR will decline by ~20% over a tire's life span due to tread wear**
- **Most promising course: Tread-based technologies are being developed and used to reduce rolling resistance without reducing wear life.**
  - **Proprietary, but being used in OE tires**
- **Least promising course: Building tires with less tread to reduce rolling resistance is not a good idea in general.**
  - **Fuel savings will be small, while tire life will be shorter.**
  - **Each 1% reduction in tire life costs consumers $1.20 more in tire expenditures per year.**
  - **Reducing tire life results in more scrap tires.**

4. TRACTION CHARACTERISTICS MAY BE AFFECTED, BUT SAFETY CONSEQUENCES UNDETECTABLE

- **Changes are routinely made to tires that can affect traction to some extent.**
  - Changes made for noise mitigation, appearance, handling, ride comfort, etc—not just rolling resistance.

- **Few studies/data available linking large changes in tire traction capability with crashes. Thus, not possible to detect the impact of incremental changes in traction associated with changes to reduce rolling resistance.**

- **Reducing RRC and maintaining generally acceptable traction is feasible**
  - Many tires in the replacement market have UTQG "A" rating and rolling resistance >10% below average.

5. REDUCING AVERAGE RR OF REPLACEMENT TIRES PROMISES NET SAVINGS TO CONSUMERS

- 1 to 2% savings in fuel = $12 to $24 per year in avg. fuel savings. $2 to $4 billion nationally.

- New technologies may add $1 to $2 per to price of a tire. Increase consumer tire spending by $1 to $2 per year.

- Important that tire wear life is not shortened.
  - **Focus must be on promising, but often proprietary, technology that does not sacrifice wear.**

HOW WILL CONSUMERS RESPOND?

- **We don't know how individual consumers will respond. Each will weigh costs and savings differently.**
- **No major price differences observed among similar tires with different RR. Perhaps information will spur interest in this characteristic?**
- **CONSUMER INFORMATION IS NOT AVAILABLE TODAY.**
- **If RR is lowered on average, it is likely to result from some combination of changes in:**
  - Mix of tires purchased by consumers
  - Technology
  - Consumer behavior in maintaining inflation pressure.

RECOMMENDATION

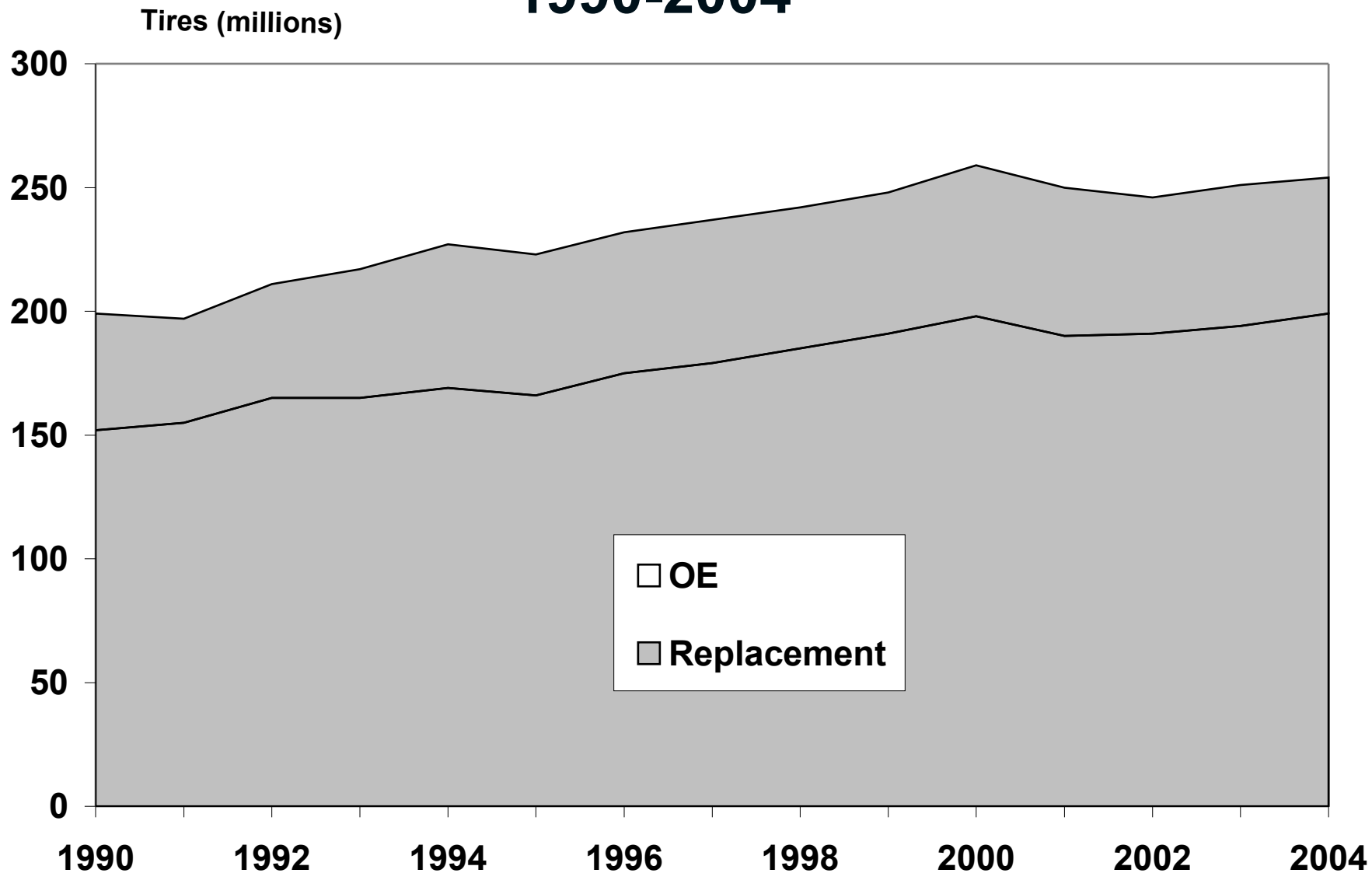
- Congress should authorize and provide resources to NHTSA to:
  - **Gather and report information on the influence of passenger tires on vehicle fuel economy.**
  - **Information should be made widely available and easy to understand by tire buyers and sellers.**
  - **It should cover a large portion of passenger tires sold with respect to sizes, models, and types.**

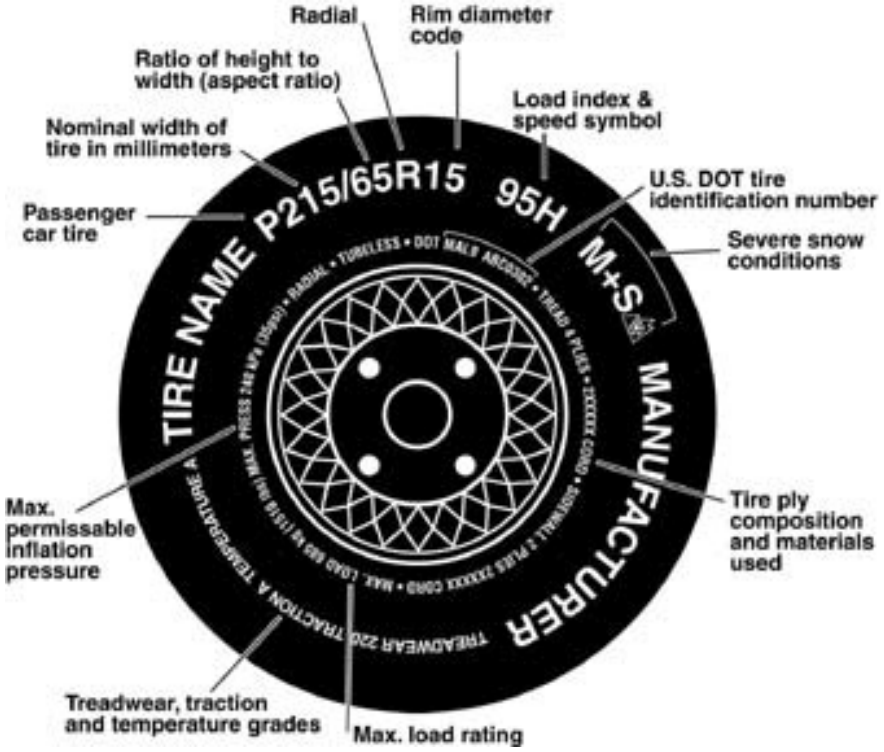
- Consult with EPA on ways to convey the information to consumers.
- Seek participation by entire tire industry.
- Periodically review the initiative's:
  - Utility to consumers
  - Industry cooperation
  - Contribution to national energy goals
- Accompanied by efforts to promote tire inflation maintenance.

BACKUP SLIDES

TERMS AND TRENDS

OE and Replacement Tire Shipments in US, 1990-2004




Radial
Rim diameter code
Ratio of height to width (aspect ratio)
Load index & speed symbol
Nominal width of tire in millimeters
U.S. DOT tire identification number
Passenger car tire
Severe snow conditions
TIRE NAME
P215/65R15
95H
M+S
MANUFACTURER
Max. permissable inflation pressure
Tire ply composition and materials used
Treadwear, traction and temperature grades
Max. load rating


Tire width (W)
Section height (H)
Rim diameter
Outer diameter

Trends

- Speed-rated tires increasing in popularity
- Wheels getting larger, aspect ratios lower
  - 5 of 10 most popular OE tires are 17-in.
  - OE tire sizes migrate to replacement market
- Run-flat tires growing in number, and have higher RR by ~10%

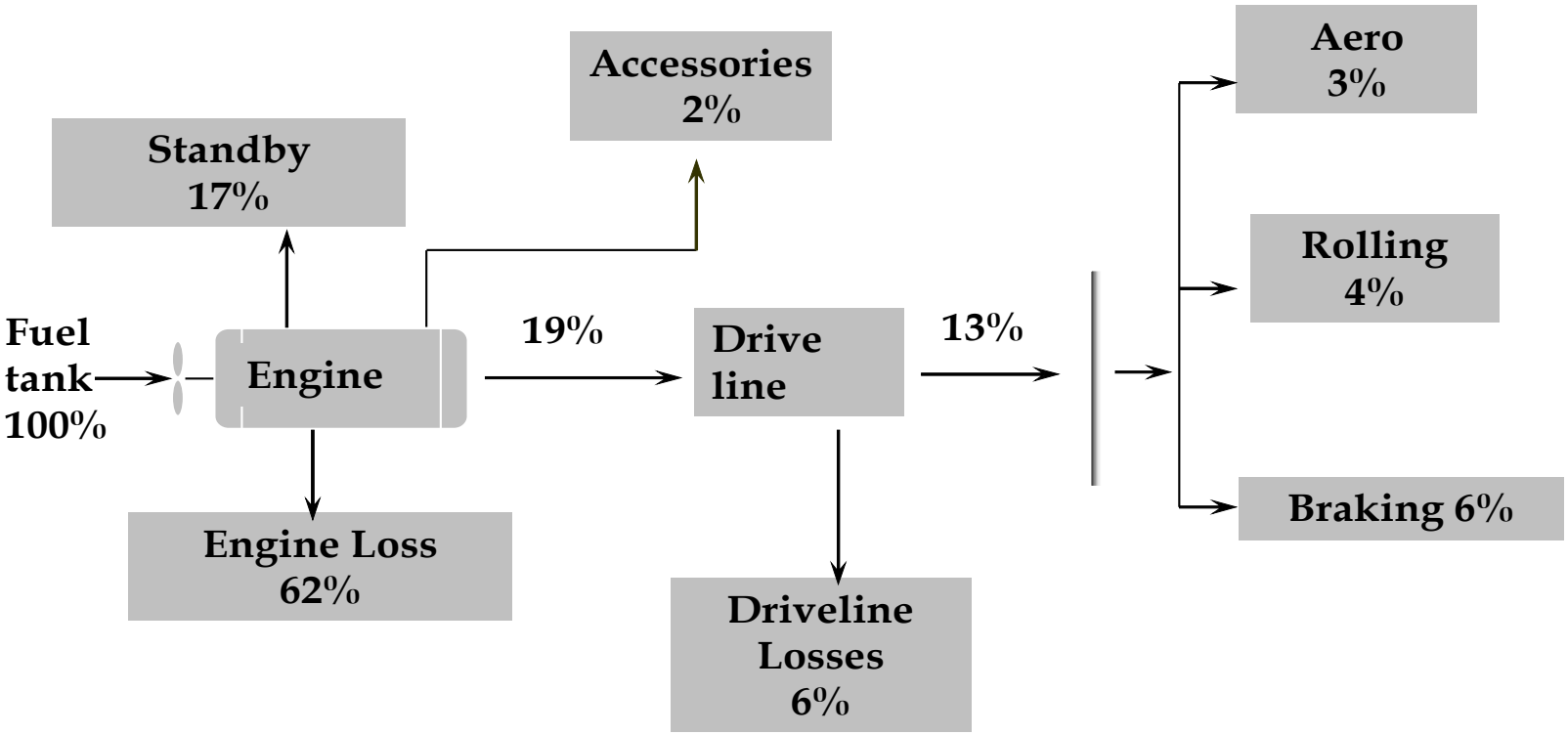
Speed Ratings

- S,T (112-118 mph) 83% OE 74% Repl.
- H,V (130-149 mph) 15% OE 22% Repl.
- W,Y,Z (>149) 2% OE 4% Repl.

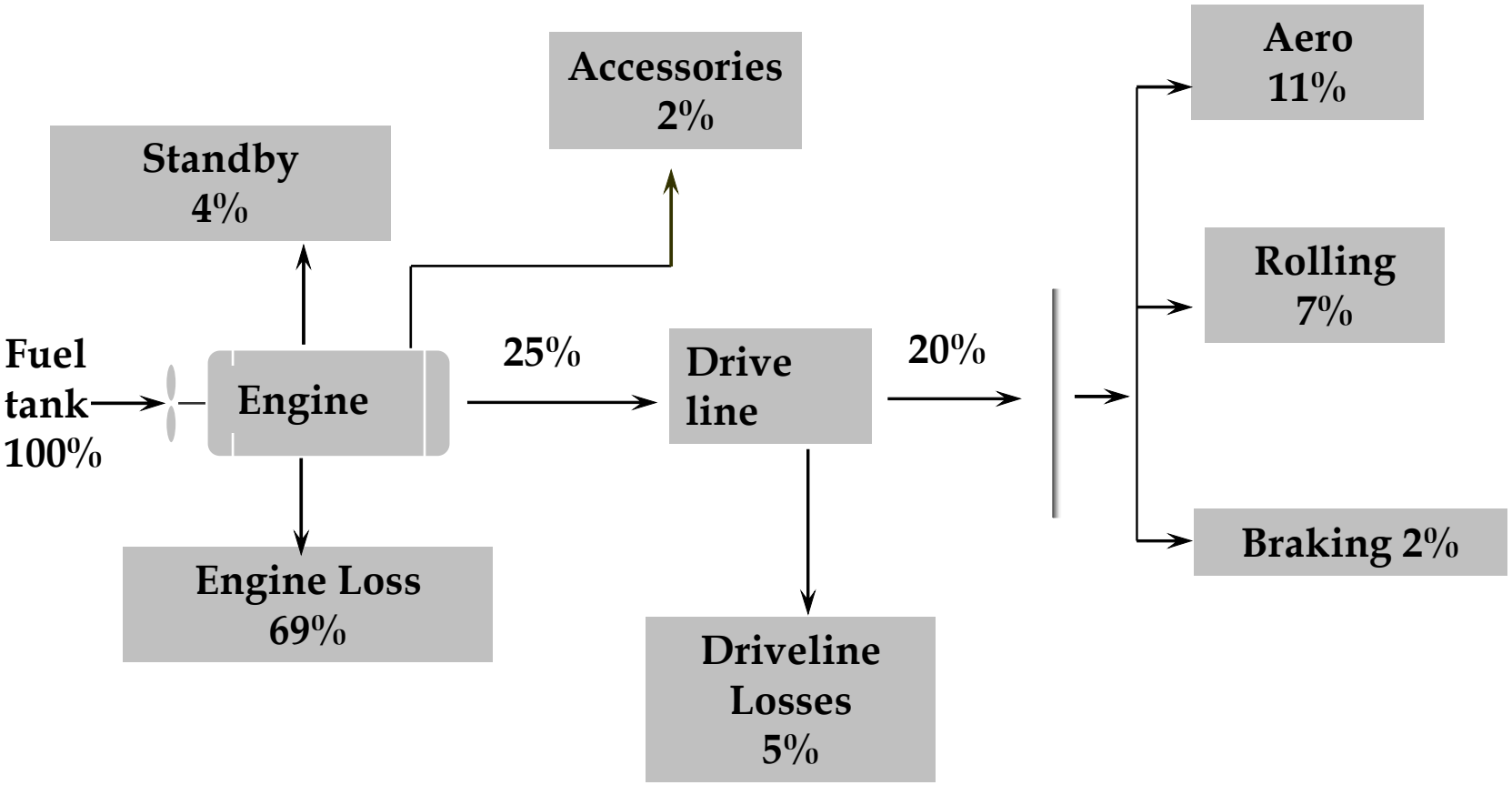
EFFECT ON FUEL ECONOMY

– Where the energy goes

Urban Driving



Highway Driving



Hysteresis: Main Cause of RR

- Rubber deforms—energy lost as heat
- Design variables affecting RR
  - Dimensions, materials and quantity, construction type
  - Tread has much of the tire rubber and accounts for ~50% of hysteretic energy loss
- Operating factors
  - Wheel load, inflation pressure, temperature.
  - Speed is not a main factor.

Measuring RR

- Rolling Resistance Coefficient (RRC)
  - derived by dividing rolling resistance by wheel load
  - typically measured for new tires
  - RRC of 0.001 = 40lb of force per tire, 4,000lb car
- SAE Test Procedures
  - J1269 and J2452
  - J1269 most prevalent test for replacement tires

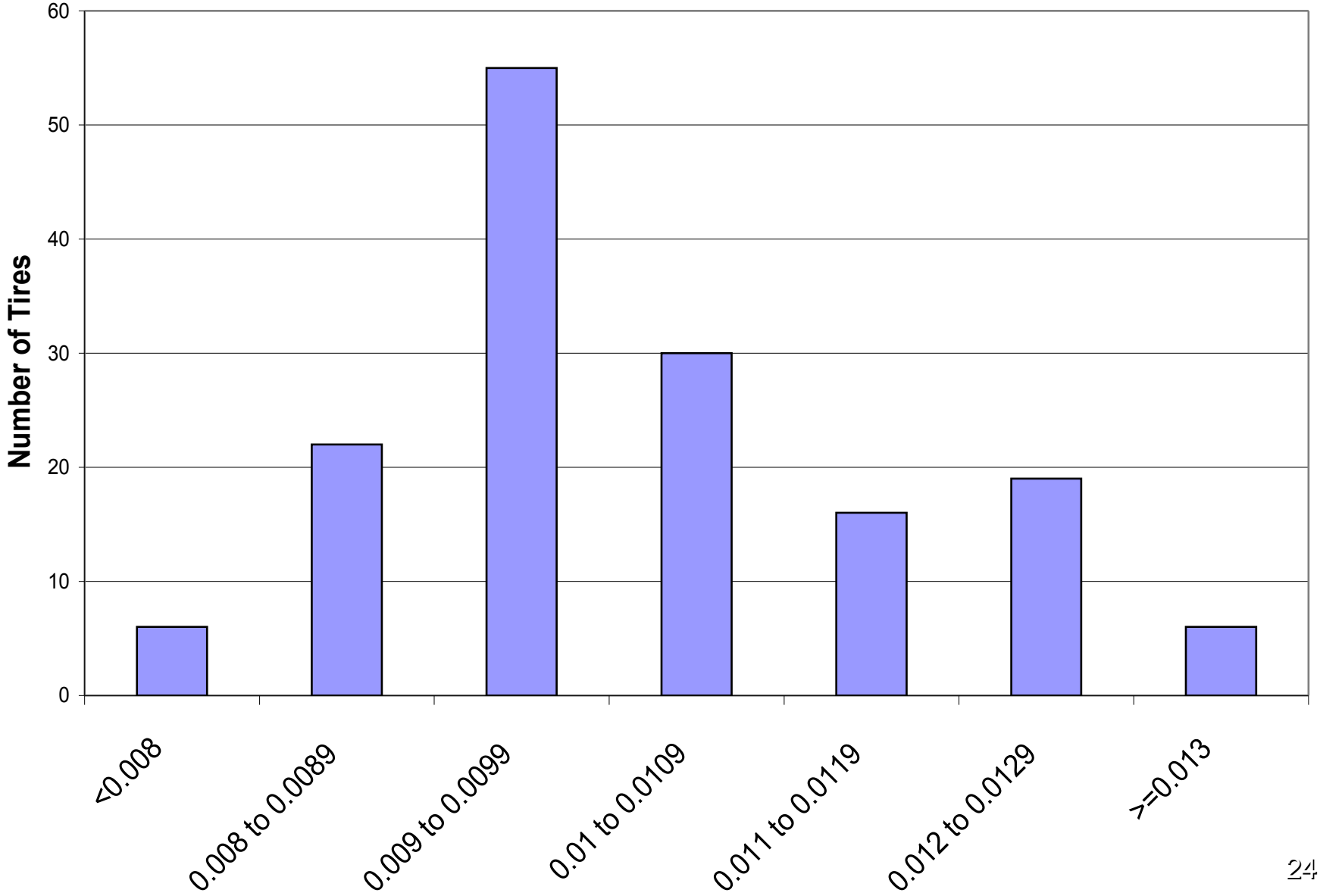
Models of Effect on MPG from 10% Change in RRC (base= 0.008)

	RRC down 10%		RRC up 10%	
	City Mpg	Hwy Mpg	City Mpg	Hwy Mpg
GM	+1.1	+1.6	-1.4	-1.9
NETL	+0.7	+2.0	-0.7	-1.7
Ross	+1.0	+1.9	-1.0	-1.9
EEA	+1.3	+2.0	-1.3	-1.9

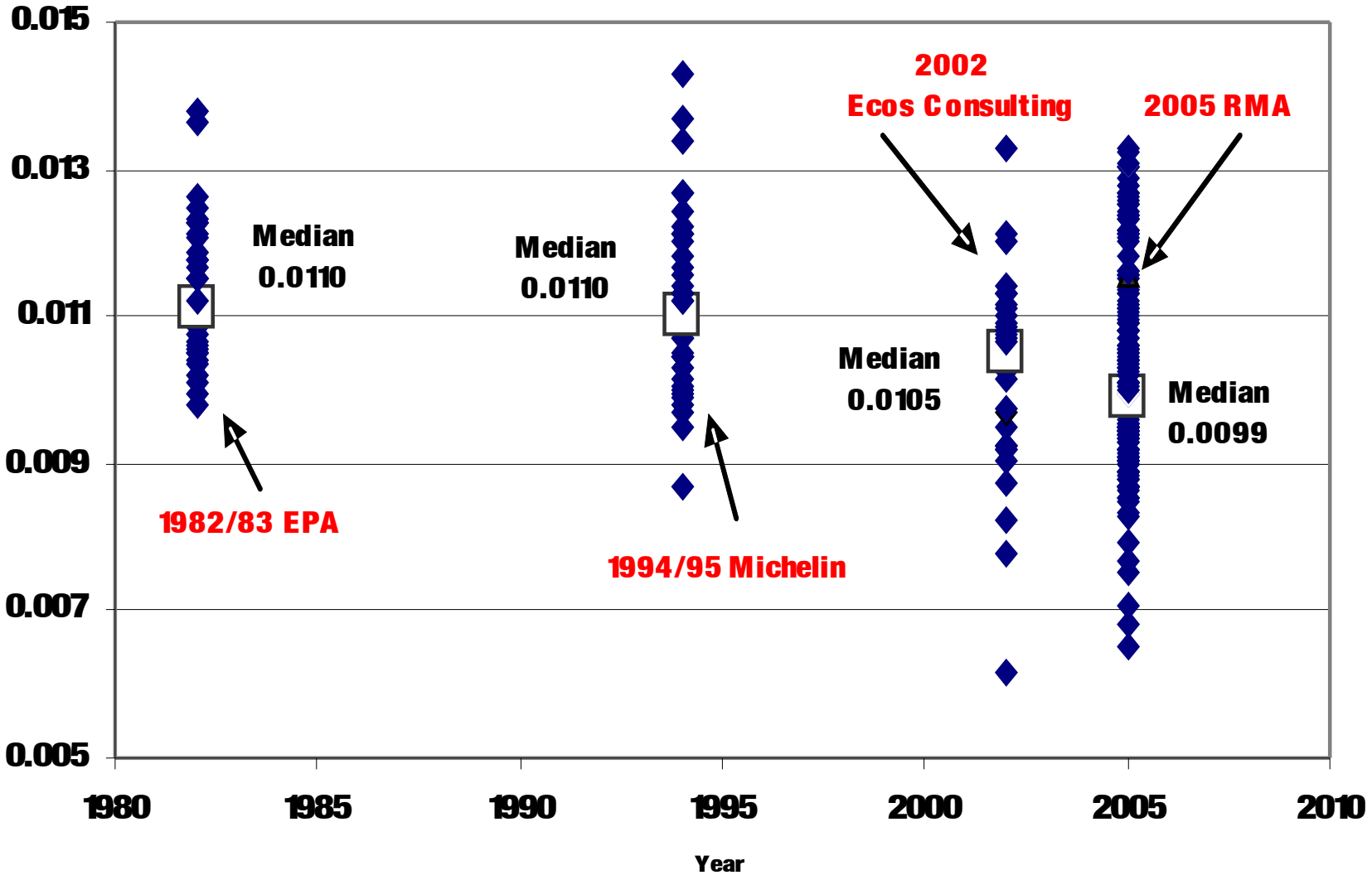
1 to 2% change is reasonable rule of thumb

RRC Data

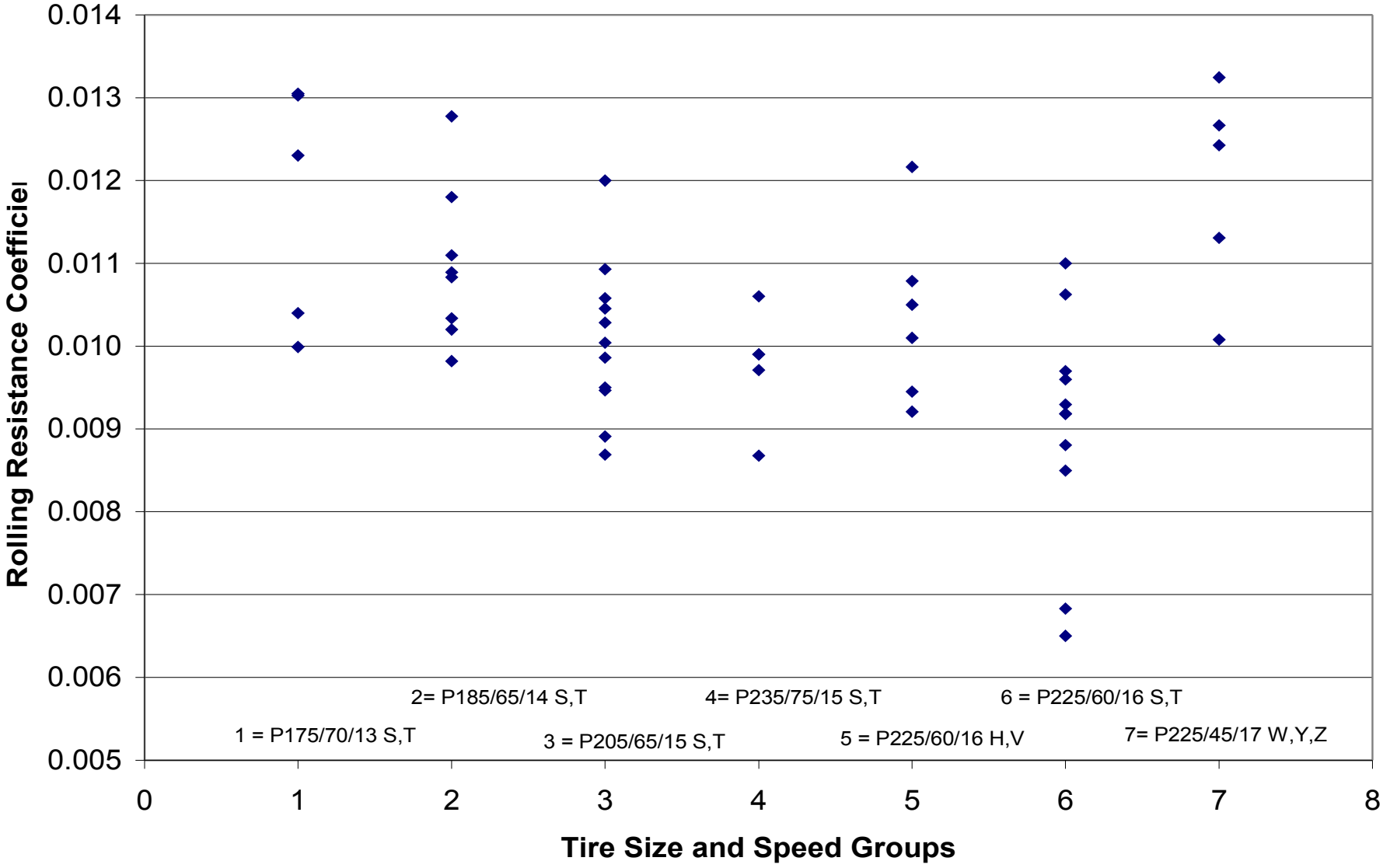
RRC Distribution
RMA Data for Replacement Tires Today



Rolling Resistance of Replacement Tire Samples, 1982 to 2005



RRC by Tire Size and Speed Rating



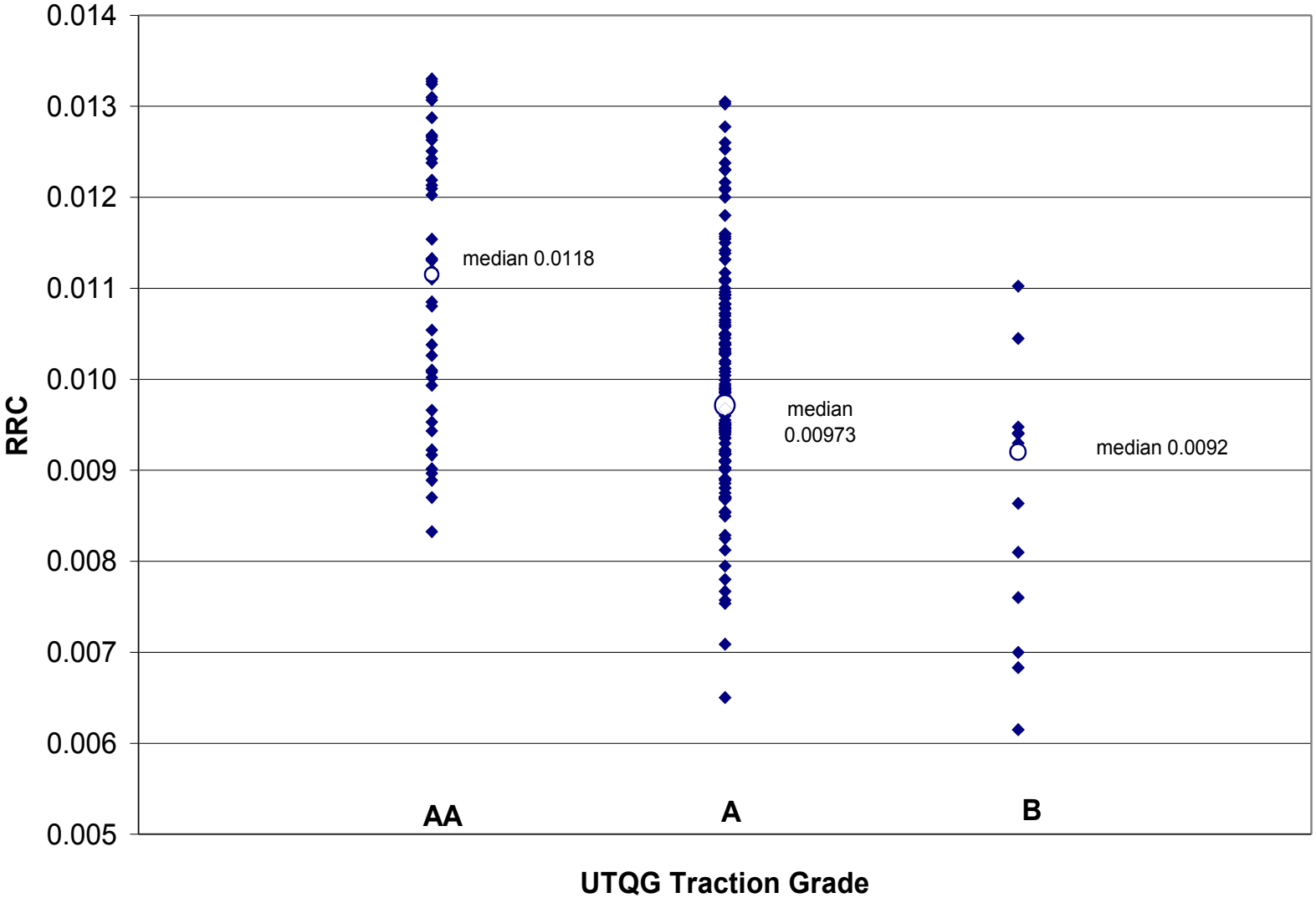
OE Tires and RRCs*

- INTERVIEWS WITH 3 OEMS
  - ALL SEASON TIRES: 0.005 to 0.007
  - TOURING: 0.0058 to 0.008
  - PERFORMANCE: 0.0065 to 0.010
  - HIGH PERFORMANCE: 0.009 and up
  - LIGHT TRUCK (P-METRIC): 0.0075 to 0.010

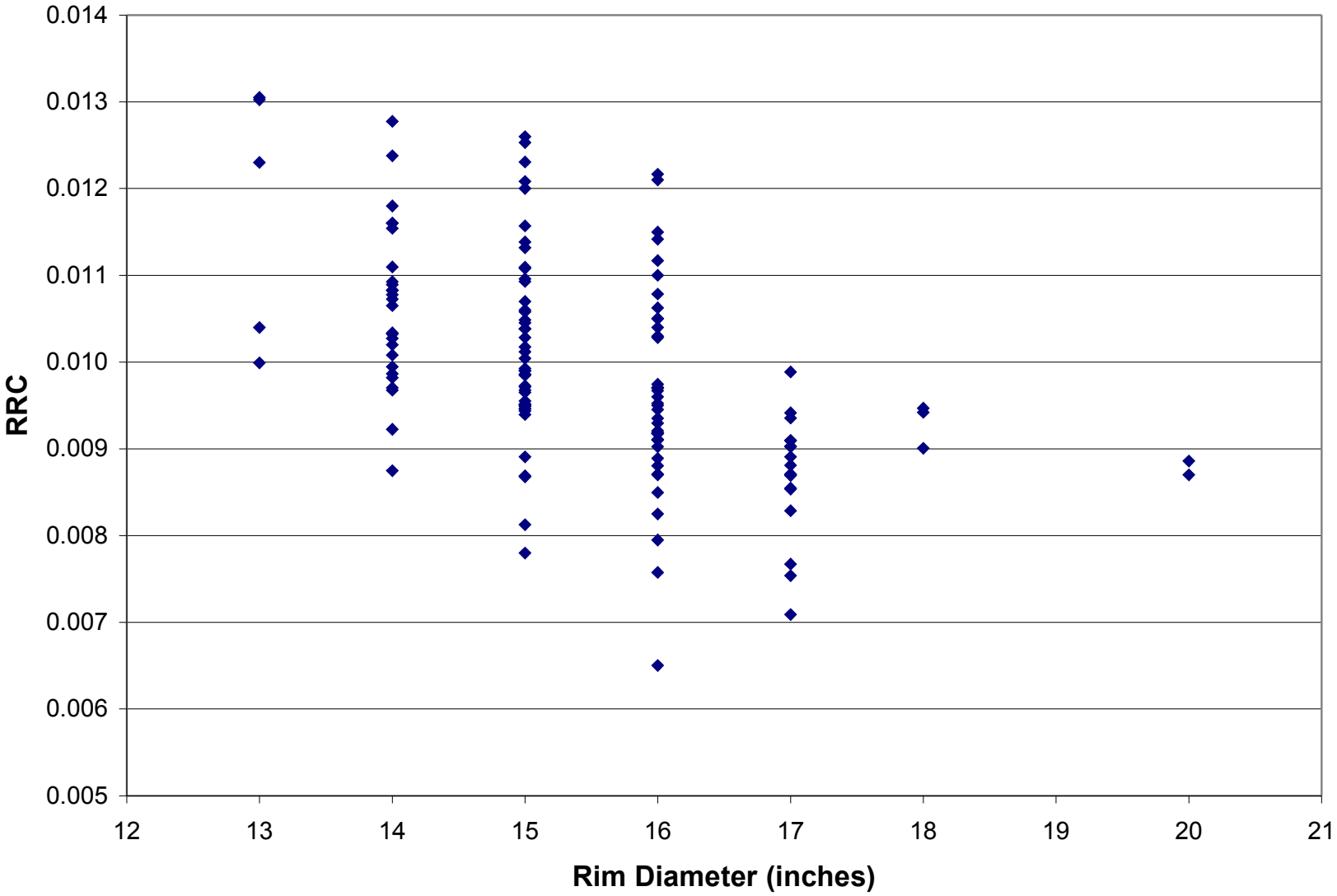
✸ Some measurements taken from SAE 2452 test

RRC and Traction

RRC by UTQG Traction Grade

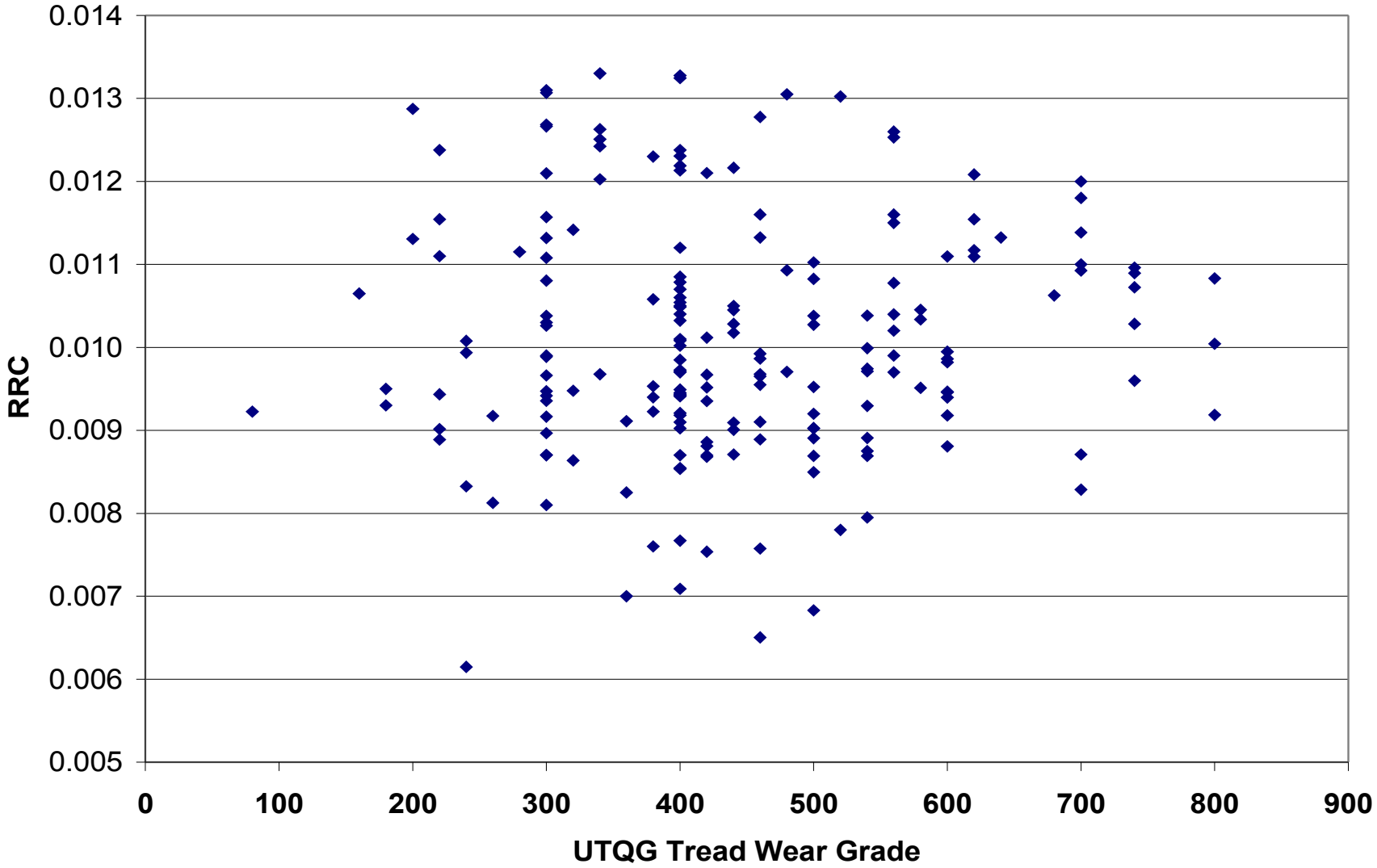


–RRCs for “A” Traction Rated Tires

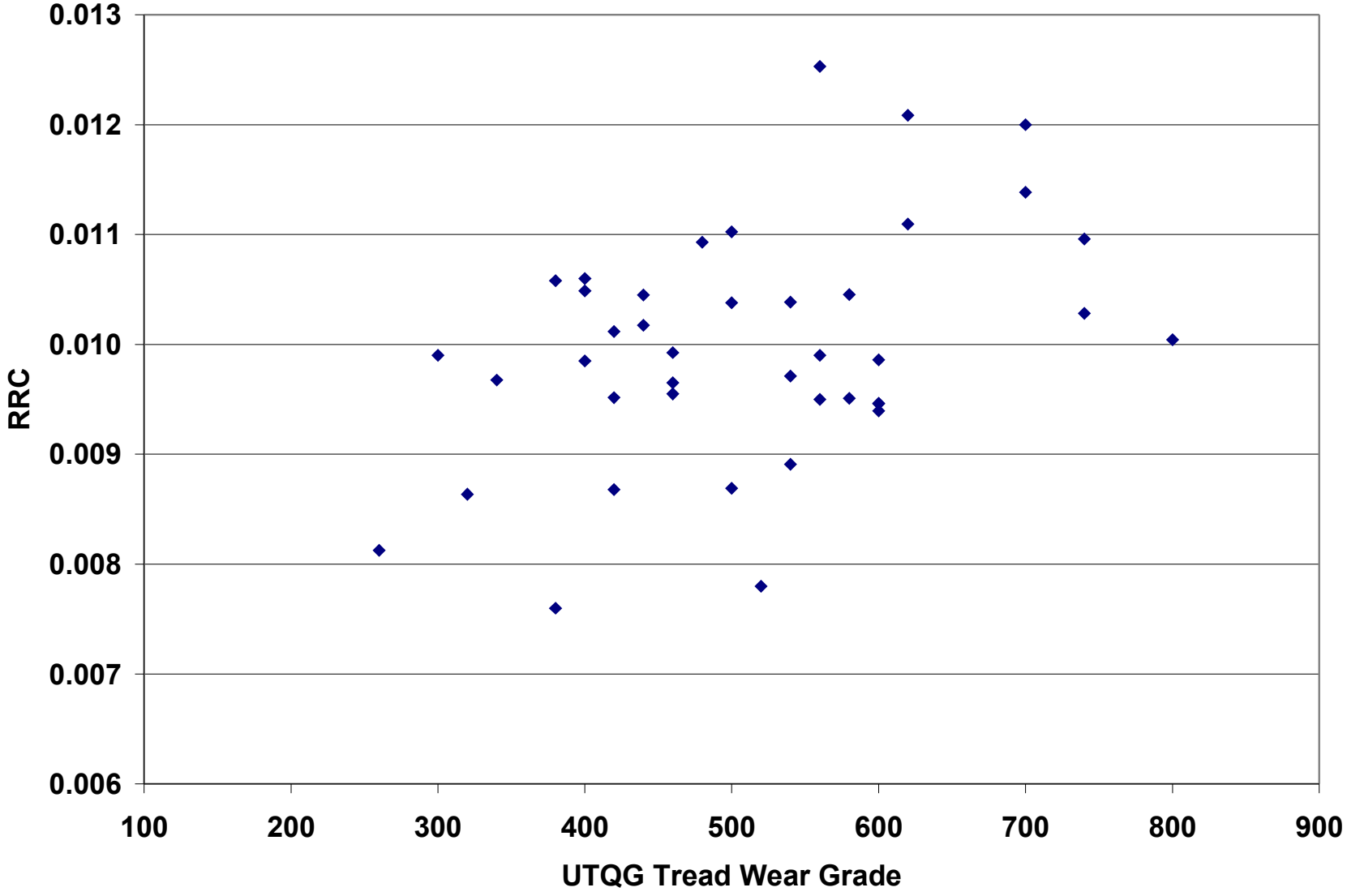


RRC and Tread Wear

All passenger tires



S,T 15-inch tires



Regression Results

- Reducing tread depth by 18% in new tires (~2/32-in.) reduces RRC by 10%
- Each 10% reduction in tread depth is associated with 10% reduction in wear grade of average tire (400 UTQG)
- Risk that reducing tread to achieve lower RRC will cause substantial loss of wear life

Consumer Savings and Cost Calculations

- **All are national annualized averages.**
- **Fuel Savings**
  - **Vehicles average 600 gallons per year**
  - **1 to 2% improvement in fuel economy = ~6 to 12 gal/ yr $2 per gallon (DOE) = $12 to $24 savings/yr**
  - **175 million vehicles use replacement tires**
  - **175 million x 6 to 12 gallons = 1 to 2 billion gallons/yr**
  - **175 million x $12 to $24 = ~$2 to $4 billion in savings/yr**

Consumer Savings and Cost Calculations

- **Tire Expenditures (tire prices, frequency of tire purchases)**
  - No price differences observed among existing replacement tires related to RRC.
  - Average tire price $97
  - OE technologies cost ~$1 more per tire (estimate)
  - Motorists buy an average of 1.14 replacement tires per year = added spending of $1 to $2 per year on tires.
  - If tires wear out sooner? 10% loss in wear life would mean consumers buy . 0.11 more tires per year,
    - 0.11 more tires = $10.67
    - Installation costs = $1.38
  - Total cost could exceed fuel savings
- **Thus, focus must be on options that preserve wear life**

end