U.S. Department
Of Transportation
**National Highway
Traffic Safety Administration**

www.nhtsa.gov

Preliminary Regulatory Impact Analysis

Notice of Proposed Rulemaking
Replacement Tire
Consumer Information Program
Part 575.106

**Office of Regulatory Analysis and Evaluation
National Center for Statistics and Analysis**
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Executive Summary

This Preliminary Regulatory Impact Analysis accompanies a Notice of Proposed Rulemaking (NPRM) which proposes a new consumer information program on replacement tires that will educate consumers about the effect of tires on fuel economy, safety, and durability. This consumer information program proposes to implement a national tire fuel efficiency rating system for passenger car replacement tires (assumed to be mainly P-metric tires, and not to include LT tires or snow tires), and proposes requirements for providing this information to consumers at the point of sale and online. The agency proposes to require a label with three scales from 0-100 to report replacement tires wet traction, treadwear, and fuel efficiency (rolling resistance)[1]. The goal is to drive the market for replacement tires to better fuel efficiency performance by affecting consumer behavior.

Tires involved

There are 200 million replacement tires sold in the U.S. per year. An estimated 40 million of them have good rolling resistance already, and 19 million[2] are exempt from the program (10 million LT-tires and 9 million snow and other tire types). Thus, there are an estimated 141 million tires in the target population that could potentially decrease their rolling resistance.

Costs

There are two sets of costs involved: costs to set up the information program and provide consumer information and costs to improve the rolling resistance of tires. Program costs are estimated to be around $10.5 million per year. Costs per tire are estimated to range from $2 to $4 per tire and average around $3 per tire. If 2-10 percent of the target tire population (2.8 - 14 million tires) decreased their rolling resistance the annual cost would be $8.5 - 42 million. The combined annual cost of the program would be $18.9 - 52.8 million (in 2008 economics).

Benefits

Improving rolling resistance by 10 percent is estimated to improve vehicle mpg by 1.1 percent. The agency believes that a 10 percent improvement in rolling resistance is achievable, while keeping other tire qualities equivalent.[3] However, recognizing that a 10 percent reduction might not be achieved, we have computed benefits assuming a 5-10

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[1] A decrease in rolling resistance results in a proportional increase in fuel economy, and is depicted as an increase in the fuel economy rating.

[2] Most small SUV's, vans, and pickup trucks use P-metric tires. Only the heaviest of these types of vehicles use tires designated as LT-tires that are exempt from the program.

[3] A 2006 National Academy of Sciences (NAS) report concluded that reduction of average rolling resistance of replacement tires by 10 percent was technically and economically feasible and attainable within a decade through a combination of means, including: consumers could purchase more tires with lower rolling resistance, tire designs could be modified, and more vigilant maintenance of tire inflation pressure. Transportation Research Board Special Report 286, Tires and Passenger Vehicle Fuel Economy, National Research Council of the National Academies, 2 (2006).

percent reduction in the rolling resistance of improved tires. Actual consumer benefits from decreased rolling resistance are dependent upon the consumer's baseline fuel economy, the tire's baseline rolling resistance, the number of miles driven, and other factors. A vehicle that gets 22 mpg and is driven 10,000 miles per year would save 0.6 - 1.2 gallons per year per tire, or 2.8 - 5.6 gallons over the 45,000 mile life of a tire. If gasoline costs $3 per gallon, the discounted savings are $7.85 - $15.62 at a 3 percent discount rate to $7.22 - $14.36 at a 7 percent discount rate. To the extent that consumers spend less time refilling their tanks, there will be additional savings as well.

If 10 percent of all targeted replacement tires decrease their rolling resistance by 10 percent, we could save 78 million gallons of fuel and prevent 757,000 metric tons in CO_2 emissions per year. If 2 percent of targeted replacement tires decrease their rolling resistance by 5 percent, the annual savings would be 7.9 million gallons of fuel and 76,000 metric tons of CO_2.

Note that the aforementioned benefits estimates pertain to fuel savings only. We discuss qualitatively the challenges involved in estimating the benefits or disbenefits related to safety and durability.

Cost/Benefit

Given all the assumptions made above, for a $3 increase in the price of tires, consumers could save $7.85 - $15.62 per tire at a 3 percent discount rate and $7.22 - $14.36 per tire at a 7 percent discount rate. The payback period from the consumer perspective is 10 – 21 months. Even if the price of gasoline were $2 per gallon, the program would be cost-effective for consumers.

From an overall program perspective, taking into account that better tires must be sold to pay off the fixed costs of a consumer information program, if the program can get 1 percent of replacement tire sales with decreased rolling resistance by 10 percent or 2 percent of replacement tire sales with decreased rolling resistance by 5 percent, then from the fuel savings perspective, it will be a benefit to consumers.

I. INTRODUCTION

Tire characteristics influence the safety, efficiency, and durability of motor vehicle transportation. Consumers have an inherent interest in all of these factors, but the ratings and relative importance of these characteristics are often overlooked or difficult for consumers to understand. The agency believes that an improved system of consumer information could enable consumers to make more informed choices than the marketplace currently provides.

A. Energy Independence and Security Act (EISA) of 2007 mandated consumer tire information program

The Motor Vehicle Information and Cost Savings Act, which was enacted in 1972, mandated a federal program to provide consumers with accurate information about the comparative safety and damageability of passenger cars. EISA added a section which gives authority to the Department of Transportation (DOT) to establish a new consumer tire information program to educate consumers about the effect of tires on automobile fuel efficiency, safety, and durability.

We have summarized below the requirements of the consumer tire information program enacted as Section 111 by EISA.

1. Tires subject to the consumer information program

The national tire fuel efficiency consumer information program mandated by EISA and proposed in this notice is applicable "only to replacement tires". Section 575.104 of title 49 CFR is the federal regulation that requires motor vehicle and tire manufacturers and tire brand name owners to provide information indicating the relative performance of passenger car tires in the areas of treadwear, traction, and temperature resistance. This section of NHTSA's regulations specifies the test procedures to determine uniform tire quality grading standards (UTQGS), and mandates that these standards be molded onto tire sidewalls.

Title 49 CFR, section 575.104 applies only to "new pneumatic tires for use on passenger cars … [but] … does not apply to deep tread, winter-type snow tires, space-saver or temporary use spare tires, tires with nominal rim diameters of 12 inches or less, or to limited production." Accordingly, today's proposed tire fuel efficiency consumer information program applies only to replacement passenger car tires[4]. NHTSA is proposing to maintain the exclusions in the UTQGS applicability provision.

2. Mandate to create a national tire fuel efficiency rating system

In the Consolidated Appropriations Act of 2004,[5] Congress provided funding through the USDOT/NHTSA to the National Academy of Sciences (NAS) to develop and perform a

[4] Passenger car tire means a tire intended for use on passenger cars, multipurpose passenger vehicles, and trucks that have a gross vehicle weight rating (GVWR) of 10,000 pounds or less, and excludes LT tires (LT tires are typical intended for use on light trucks designed to carry heavier loads).

[5] H.R. Rep. No. 108-401, at 971 (Nov. 25, 2003) (Conf. Rep.).

national tire fuel efficiency study and literature review.[6] The NAS was to assess the feasibility of reducing rolling resistance in replacement tires and the effects of doing so on vehicle fuel consumption, tire wear life and scrap tire generation, and tire operating performance as it relates to motor vehicle safety. Congress asked that the assessment include estimates of the effects of reductions in rolling resistance on consumer spending on fuel and tire replacement.

In April 2006, the Transportation Research Board and the Board on Energy and Environmental Systems, part of the National Academies' Division on Engineering and Physical Sciences released Special Report 286, Tires and Passenger Vehicle Fuel Economy: Informing Consumers and Improving Performance (2006 NAS Report).[7] The 2006 NAS Report concluded that reduction of average rolling resistance of replacement tires by 10 percent was technically and economically feasible, and that such a reduction would increase the fuel economy of passenger vehicles by 1 to 2 percent, saving about 1 to 2 billion gallons of fuel per year nationwide.[8]

EISA requires NHTSA to "promulgate rules establishing a national tire fuel efficiency consumer information program for replacement tires designed for use on motor vehicles to educate consumers about the effect of tires on automobile fuel efficiency, safety, and durability. EISA specifies that the regulations establishing the program are to be promulgated not later than December 19, 2009.[9]

Section 111 of EISA specifically mandates "a national tire fuel efficiency rating system for motor vehicle replacement tires to assist consumers in making more educated tire purchasing decisions." However, NHTSA may "not require permanent labeling of any kind on a tire for the purpose of tire fuel efficiency information."

The only Committee Report commenting on the legislation that eventually became Section 111 of EISA explained that need for this program was established by the 2006 NAS Report, which concluded that if consumers were sufficiently informed and interested, they could bring about a reduction in average rolling resistance (and thus an increase in average on-road fuel economy) by adjusting their tire purchases and by taking proper care of their tires once in service.[10]

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[6] Ultimately the task was given to the Committee for the National Tire Efficiency Study of the Transportation Research Board, a division of the National Research Council that is jointly administered by the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

[7] Transportation Research Board Special Report 286, Tires and Passenger Vehicle Fuel Economy, National Research Council of the National Academies (2006). A copy of this report will be placed in the docket.

[8] *Id.* at 2-3.

[9] Former President Bush signed EISA into law on December 19, 2007. EISA specifies that "[n]ot later than 24 months after the date of enactment … [NHTSA] shall, after notice and opportunity for comment, promulgate rules establishing a national tire fuel efficiency consumer information program for replacement tires designed for use on motor vehicles to educate consumers about the effect of tires on automobile fuel efficiency, safety, and durability." 49 U.S.C. § 32304A(a)(1).

[10] H.R. Rep. No. 109-537, at 3 (2006).

The 2006 NAS Report concluded that rolling resistance measurement of new tires can be informative to consumers, especially if they are accompanied by reliable information on other tire characteristics such as wear resistance and traction.[11] The 2006 NAS Report further stated that consumers benefit from the ready availability of easy-to-understand information on all major attributes of their purchases, and that tires are no exception. Tires influence on vehicle fuel is an attribute that is likely to be of interest to many tire buyers.[12]

3. Communicating information to consumers

EISA specifies that this rulemaking to establish a national tire fuel efficiency consumer information program must include "requirements for providing information to consumers, including information at the point of sale and other potential information dissemination methods, including the Internet."

NHTSA believes that the suggestion of point of sale requirements indicates that Congress intended NHTSA's authority to establish information dissemination requirements to be broad enough to include requirements of both tire manufacturers and tire dealers/retailers and distributors.

4. Specification of test methods

Section 111 of EISA also mandates that this rulemaking to establish a national tire fuel efficiency consumer information program include "specifications for test methods for manufacturers to use in assessing and rating tires to avoid variation among test equipment and manufacturers."

After publication of the 2006 NAS Report and in anticipation of Congressional legislation based off its recommendations, NHTSA embarked on a large-scale research project in July 2006 to evaluate existing tire rolling resistance test methods and to examine correlations between tire rolling resistance levels and tire safety performance.[13]

5. Creating a national consumer education program on tire maintenance

Section 111 of EISA further directs NHTSA to establish in this rulemaking "a national tire maintenance consumer education program including, information on tire inflation pressure, alignment, rotation, and treadwear to maximize fuel efficiency, safety, and

[11] 2006 NAS Report, *supra* note 10, at 4. The 2006 NAS Report specifically noted that "[i]deally, consumers would have access to information that reflects a tire's effect on fuel economy averaged over its anticipated lifetime of use, as opposed to a measurement taken during a single point in the tire's lifetime, usually when it is new." *Id.* However, "[n]o standard measure of lifetime tire energy consumption is currently available, and the development of one deserves consideration. Until such a practical measure is developed, rolling resistance measurements of new tires can be informative to consumers…" *Id.*

[12] 2006 NAS Report, *supra* note 10, at 4.

[13] *See* NHTSA Tire Rolling Resistance Rating System Test Development Project: Phase 1 – Evaluation of Laboratory Test Protocols (October 2008). The research reports from this Phase 1 research will be placed in the docket.

durability." NHTSA already has some information regarding tire maintenance on its safercar.gov website.[14]

B. Proposal

This proposal contains a rolling resistance test procedure, a rating system and label graphic, and the requirements for tire manufacturers and tire retailers to report and disseminate information.

1. Test procedures

The proposal requires tire manufacturers to rate the fuel efficiency of their tires using a test procedure currently under development by the International Organization for Standardization (ISO), ISO/DIS 28580.

As for the traction and treadwear ratings, due to the statutory deadline, NHTSA is proposing to use traction and treadwear test procedures that are already specified under another tire rating system, the uniform tire quality grading standards (UTQGS).[15] In anticipation of eventual exploration of other metrics for safety and durability, the agency will continue research examining possible correlations between tire fuel efficiency and wet and dry traction, indoor and outdoor treadwear, and vehicle fuel economy.[16]

2. Proposed rolling resistance score metric

The agency is proposing to base a tire's fuel efficiency rating on rolling resistance force (RRF) as measured by the test procedure. This is in contrast to basing a fuel efficiency rating on rolling resistance coefficient (RRC), or RRF divided by load. The agency is aware that the proposed European tire fuel efficiency rating system specifies tire ratings based on RRC.

NHTSA is proposing to base the rolling resistance rating on the RRF metric because such a rating will provide more discrimination among different tires throughout the system, and thus more information to consumers, than a rating based on RRC. RRF translates more directly to the fuel required to move a tire, and based on the goals of EISA, this is the information we should seek to convey to consumers. (See Chapter IV for more details.)

3. Proposed label

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[14] *See generally* http://www.safercar.gov/portal/site/safercar/menuitem.13dd5c887c7e1358fefe0a2f35a67789/?vgnextoid=0e0aaa8c16e35110VgnVCM1000002fd17898RCRD.

[15] *See* 49 CFR § 575.104 (2008).

[16] NHTSA's Phase 2 research tested 15 models of replacement tires, as well as the original equipment tires on a fuel economy test vehicle, to examine possible correlations between tire rolling resistance levels and vehicle fuel economy as measured on a dynamometer, wet and dry traction, and indoor and outdoor treadwear. *See* National Highway Traffic Safety Administration, NHTSA Tire Rolling Resistance Rating System Test Development Project: Phase 2 – Effects of Tire Rolling Resistance Levels on Traction, Treadwear, and Vehicle Fuel Economy (February 2009). This Phase 2 research report will be placed in the docket.

To convey information to consumers, the proposed label, will contain an individual tire's ratings for fuel efficiency (i.e., rolling resistance), safety (i.e., traction), and durability (i.e., treadwear), and which is similar to a ratings label that tested well in consumer research conducted by NHTSA as shown below in Figure I-1.

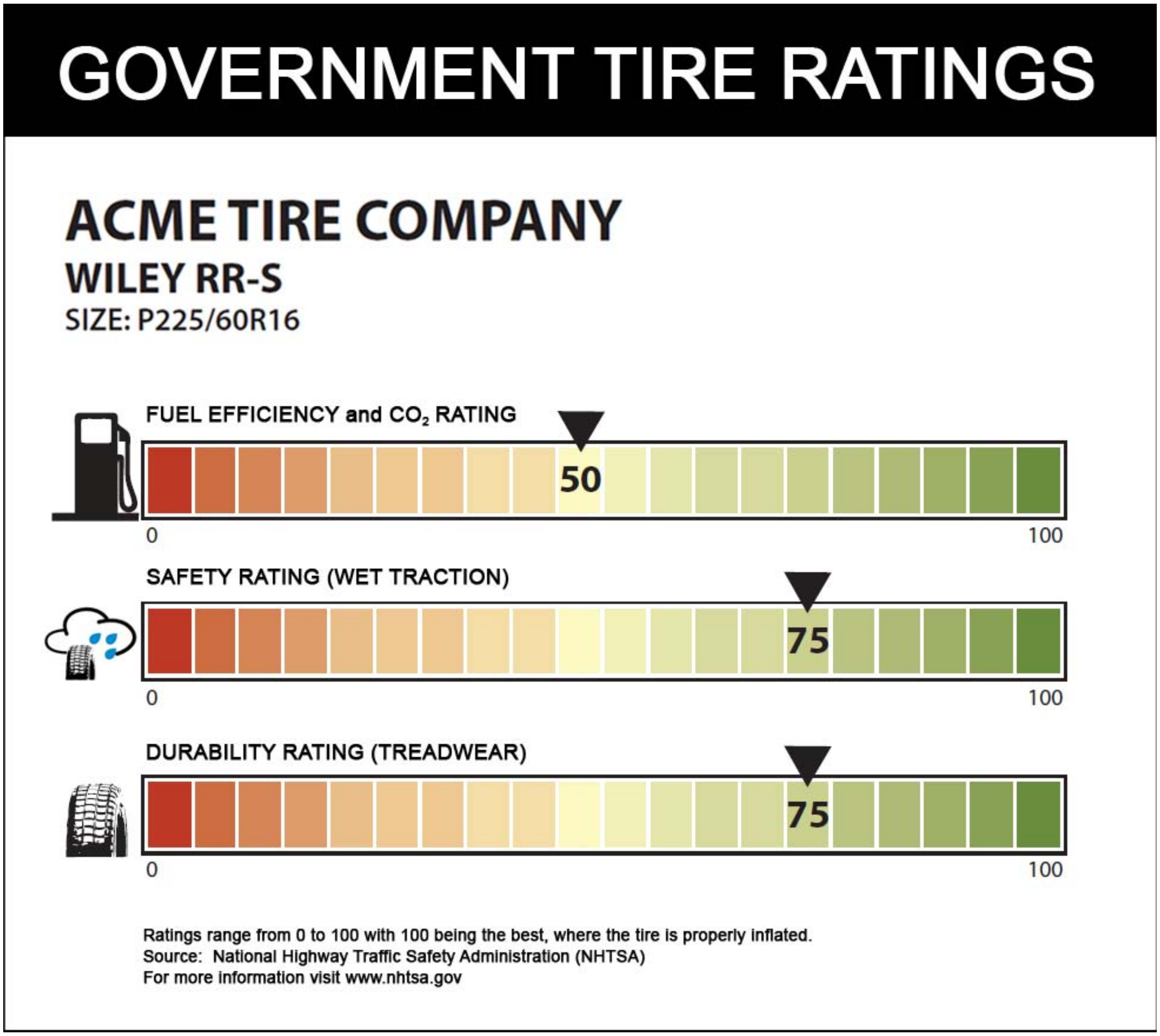

Figure I-1. Proposed Rating System Label

4. Proposed information dissemination and reporting requirements for tire manufacturers and tire retailers

The proposal will require information dissemination from both tire manufacturers and tire retailers. For manufacturers, NHTSA is proposing that manufacturers be required to report rolling resistance data to the agency. This is necessary for both enforcement of the rating system, and for development of NHTSA's tire fuel efficiency website, which will contain a database of tire information with a calculator tool that allows easy comparison between various replacement tires. The agency is also proposing to require tire manufacturers to distribute to tire retailers an electronic version of the label graphic for each differently rated tire it distributes to the retailer. Regarding labeling, the agency proposes to require tire manufacturers to print the tire fuel efficiency graphic shown in (Figure I-1) in color along with any other information manufacturers include on a paper label on the tire.[17] At the manufacturer's option they could also meet the labeling requirement by displaying the tire fuel efficiency rating graphic as a separate label in full color.

For tire retailers, we are proposing a requirement that the paper label containing the new rating information must remain on the tire until the sale of the tire. We are further proposing a requirement that tire retailers must display a poster that NHTSA would print and distribute to them which would explain the rating system and encourage consumers to compare ratings across tires.

In addition, for tire manufacturers and retailers that maintain a website, the agency is proposing to require those websites to link to NHTSA's comprehensive tire website we will be developing as part of the national tire maintenance consumer education program.

5. Consumer education program

The proposal requires NHTSA to implement a consumer education program to inform consumers about the effect of tires and tire maintenance on vehicle fuel economy, safety, and durability. Motorists must be alerted to the fact that even small losses in inflation pressure can greatly reduce tire service life, fuel efficiency, safety, and operating performance.[18] Some of NHTSA's ideas for consumer education include informational posters or brochures that NHTSA would supply to tire dealers for display at the point of sale to be used by NHTSA at trade show exhibits. NHTSA is planning on developing a centralized and expansive government website on tires containing a database of all tire rating information.

NHTSA is aware that the purely numerical ratings do not inform consumers about what, exactly, is gained by a tire with a high ranking rather than a low one. Ideally, consumers would know what they would obtain from a "75" rather than a "25" in terms of fuel economy, safety, and durability. To make the ratings more meaningful, NHTSA is also planning to develop a comparative calculator for its website that would show the amount

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[17] Manufacturers are required to print UTQG information on a paper label pursuant to 49 CFR § 575.104(d)(1)(B). Many manufacturers include other information on this paper label as well. Note that NHTSA uses the term "paper label" in the colloquial sense; many labels on tires are actually made of plastic.

[18] When a tire is under-inflated, the shape of its footprint and the pressure it exerts on the road surface are both altered. One consequence of this alteration can be a reduction in the tire's ability to transmit (or generate) braking force to the road surface. Thus, under-inflated tires may increase a vehicle's stopping distance on wet surfaces. 66 FR 38982, 38986 (July 26, 2001). Under-inflated tires also increase the rolling resistance of vehicles and, correspondingly, decrease their fuel economy. *Id.*

of fuel and money a consumer would save annually or over the estimated lifetime of the tires of varying fuel efficiency ratings. Using the calculator, a consumer could select tires to compare, enter the fuel economy of their vehicle (mpg) and the average number of miles they drive each year and even the dollar amount they are paying for fuel and get a calculation of differences in fuel usage and/or money saved for the tires under comparison. NHTSA is also engaged in ongoing work to make the safety and durability rankings more meaningful and invites comments on how to carry out that task.

6. Overall rating

For the purposes of the final rule, the agency is also considering the concept of a combined rating of some sort, which would convert all three benefit metrics into one overall rating. NHTSA notes that in considering how to revise and improve its National Car Assessment Program, it sought public comment on the roughly parallel notion of simplifying inter-vehicle comparisons and purchase decision making by consumers by combining the individual safety ratings for different crash modes into a single overall rating. Ultimately, the agency adopted plans to develop and implement such a summary rating.

The advantage of such a system for tire performance ratings would be that it would simplify the ratings, potentially relieving consumers of the task of weighing the ratings for three different metrics for one tire against the three ratings for another tire. At the same time, if the single combined rating were presented to the exclusion of individual ratings for each metric, it would obscure the relative performance of individual components that might carry different priorities with different consumers.
Ideally, the goal would be to express the combined rating in terms that are readily understandable and of practical value to the average consumer. The following example attempts to do this by combining the three ratings into a single absolute (as opposed to relative) cost per mile figure reflecting the full cost of buying and using a tire. The in-use costs of a tire would be based on each of the ratings and the useful life of the tire, reflecting the real-world significance of each of the ratings.

- The in-use cost of the fuel efficiency rating would reflect money spent on fuel consumed.
- The in-use cost of the durability rating would reflect money spent on purchasing replacement tires more or less frequently.
- The in-use cost of the safety rating would reflect money spent on traction-related crashes.

Implementing such a system would face several hurdles, especially regarding the safety rating. For example, how would the safety of any particular tire be measured and what baseline would it be measured against? Further, in order to attempt to convert the safety (traction) rating into stopping distance, potentially costly and time consuming testing for the wide variety of tires would be necessary. An example of such a combined system for tires might be one expressed in terms of average overall cost/mile.

The agency seeks comments as to whether such a combined rating could be developed and, if so, should be adopted in the final rule and implemented. The agency seeks comments on the relative advantages and disadvantages of a single combined rating, the three rating system in our proposal, and a third approach combing the first two approaches.

II. BACKGROUND

A. RRF vs. RRC and Harmonization with Europe

Rolling Resistance Force (RRF) vs. Rolling Resistance Coefficient (RRC)
The agency is proposing to require tire manufacturers to rate the fuel efficiency of their tires by measuring rolling resistance. All of the current test procedures result in a measurement of Rolling Resistance Force (RRF) in pounds or kilograms of resistance, or the force at the axle in the direction of travel required to make a loaded tire roll. Rolling resistance can also be expressed as Rolling Resistance Coefficient (RRC), which is calculated by dividing the measured RRF by the tire size's prescribed load during the test. The pending European rating system uses RRC as the metric for a rolling resistance rating/score, however NHTSA is proposing basing the rolling resistance rating on the RRF metric because RRF is technically more accurate in measuring fuel economy and would provide more information to consumers, than a rating based on RRC.

The use of RRF allows the comparison of not only tires of the same size, but also differently sized tires as it directly relates to differences in the amount of fuel that is used to rotate the two different tires, regardless of the load. This is because a lower RRF tire will always use less fuel to move the tire the same distance under normal load conditions. Saving fuel is the goal of the Energy Independence and Security Act (EISA) mandate concerning this program,[19] and RRF translates directly to the work required to move the tire and thus the vehicle. Moreover, since tires are tested near actual in-use load conditions, RRF relates to actual fuel consumption.

Since RRC is calculated from RRF,[20] manufacturers already have this information for the European regulations. Therefore this difference would not be an additional burden for manufacturers. In fact, RRF is the actual output of the test machines, and all correlations and/or corrections must be performed *before* conversion to RRC for reporting under the European regulations. Thus, RRF is beneficial for increased accuracy and transparency.

<u>European Union</u>
Europe is approaching the issue of tire fuel efficiency from two directions. There is currently a proposal before the European Parliament concerning type-approval requirements for the general safety of motor vehicles.[21] One of the new requirements in this proposal would gradually prohibit tires with a rolling resistance coefficient (RRC) above certain levels beginning in October 2012.

Another proposal before the European Parliament would require replacement tires to be rated for rolling resistance, wet grip and noise.[22] The rolling resistance rating is

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[19] *See* Energy Independence and Security Act of 2007, Pub. L. 110-140, 121 Stat. 1492 (2007) ("An Act to move the United States toward greater energy independence and security … *to increase the efficiency of products, buildings, and vehicles* …"); H.R. Rep. 109-537, at 3 (2006).
[20] See Chapter IV for additional discussion on RRF vs. RRC.
[21] http://ec.europa.eu/enterprise/automotive/safety/new_package.htm
[22] *See* http://www.europarl.europa.eu/oeil/FindByProcnum.do?lang=2&procnum=COD/2008/0221 (last visited Feb. 3, 2009)

determined using the same test procedure as the type-approval directive, International Organization for Standardization (ISO) Standard No. 28580, Passenger car, truck and bus tires – Methods of measuring rolling resistance – Single point test and correlation of measurement results.[23] The ratings must be provided to consumers in a label on the tire, and also in technical promotional literature. The label design is the same A to G scale as that used to rate the energy efficiency of household appliances in Europe.[24]

California

In 2001, California Senate Bill 1170 authorized the California Energy Commission (CEC) to conduct a study to investigate opportunities for increasing usage of low rolling resistance tires in California.[25] The study concluded that there was a potential for substantial vehicle fuel savings from an increase in the use of properly inflated, low rolling resistance tires. As a result of this study, in October 2003, the California state legislature adopted Assembly Bill No. 844 (AB 844),[26] which required the CEC to develop a comprehensive fuel efficient tire program.[27]

The program would consist of three phases. In the first phase, the CEC will develop a database with information on the fuel efficiency of replacement tires sold in California, develop a rating system for the energy efficiency of replacement tires, and develop a manufacturer reporting requirement for the energy efficiency of replacement tires.[28] In the second phase, the CEC will consider standards for replacement tires to ensure that replacement tires sold in the state are at least as energy efficient, on average, as original equipment tires.[29] In deciding whether to adopt standards, the CEC must ensure that a standard:

- is technically feasible and cost effective;
- does not adversely affect tire safety;
- does not adversely affect the average life of replacement tires; and
- does not adversely affect the state effort to manage scrap tires.[30]

If standards are adopted, the CEC will also develop consumer information requirements for replacement tires for which standards apply. In the third phase, the CEC must review and revise the program at least every three years.

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[23] *See* http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=44770 (last visited Feb. 3, 2009).

[24] *See* Council Directive 1992/75/EEC, 1992 O.J. (L 297) 16-19 (on the indication by labeling and standard product information of the consumption of energy and other resources by household appliances).

[25] *See* Cal. Pub. Res. Code §§ 25000.5, 25722-25723 (2009); 2001 Cal. Legis. Serv. Ch. 912 (S.B. 1170) (West).

[26] *See* Cal. Pub Res. Code §§ 25770-25773; 2003 Cal. Legis. Serv. Ch. 645 (A.B. 844) (West).

[27] Specifically, AB 844 required the State Energy Resources Conservation Board "to adopt, on or before July 1, 2007, and implement, no later than July 1, 2008, a replacement tire fuel efficiency program of statewide applicability for replacement tires for passenger cars and light-duty trucks, that is designed to ensure that replacement tires sold in the state are at least as energy efficient, on average, as the tires sold in the state as original equipment on those vehicles." Cal. Pub. Res. Code § 25772.

[28] *See id.* at § 25771.

[29] *See id.* at § 25772.

[30] *See id.* at § 25773.

B. Tradeoffs of Safety, Traction and Treadwear

Tire design involves the selection of several performance factors, each of which affects the others. Tire manufacturers plot these factors: Wet Traction; Dry Traction; Snow Traction; Treadwear; Rolling Resistance, Comfort, Noise, Price, etc. on charts that look like spider webs (See Figures II-1, 2, and 3 for examples). The optimization of one factor is usually at the sacrifice of another factor. The traction factors are the most relevant to safety, since these factors influence a vehicle's stopping distance. Traction is measured as either a peak or sliding coefficients of friction by a skid trailer.

A hard compound tire that has a very low rolling resistance will usually perform poorly in the wet traction skid tests, having a longer stopping distances in cars equipped with ABS or ESC, and even worse unstable out-of-control stops with cars not equipped with ABS and ESC. These hard compound tires also usually have good treadwear.

It is generally thought that tire manufactures prefer not to compromise on safety (stopping distance). Thus, tire manufacturers usually have to increase the tire price with the addition of improved compound materials, in order to improve the rolling resistance of their tires without sacrificing the traction properties.

Technical literature extensively indicates that the tradeoff between fuel economy and safety performance can be significantly reduced or eliminated with advanced compounding technologies, which are usually more expensive and proprietary. It is possible that consumer awareness will help spur technological innovation in this domain. However, many aspects of the tire's construction and manufacture affect how much tradeoff remains, and the results of implementing silica tread technology will vary across manufacturers (which ranges from manufacturers who have decades of experience with the technology to manufacturers who have none). At least for the near future, the agency cannot guarantee that there will not be a tradeoff between fuel efficiency and safety. One advantage of a labeling regime is that consumers can make their own tradeoffs among these factors.

When rolling resistance and wet traction have been optimized it is then likely that the tread compound is not as durable, and the treadlife may be somewhat lessened. These trends were verified with measurements taken from the tires tested by VRTC.

Figure II-1

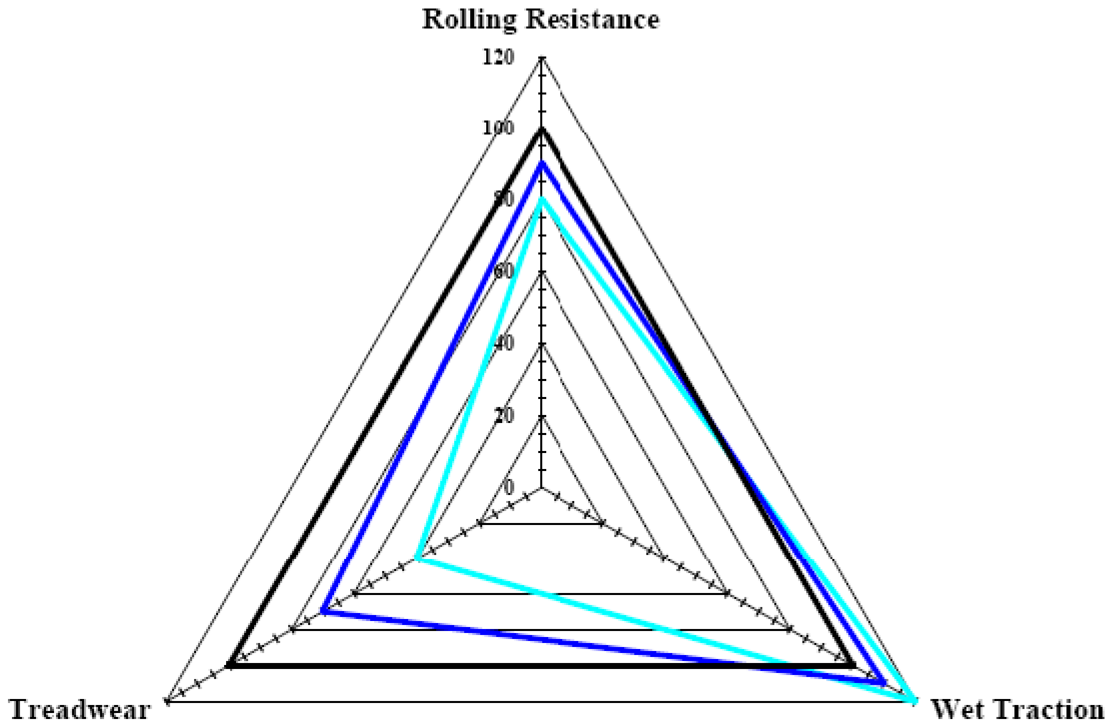
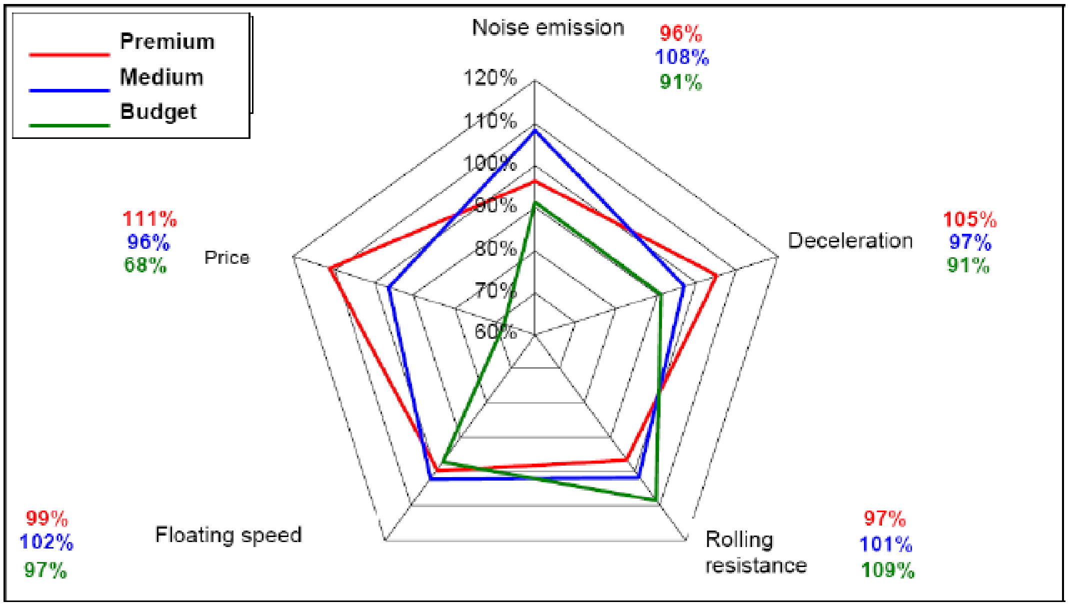

Rolling Resistance
120
100
80
60
40
20
0
Treadwear
Wet Traction

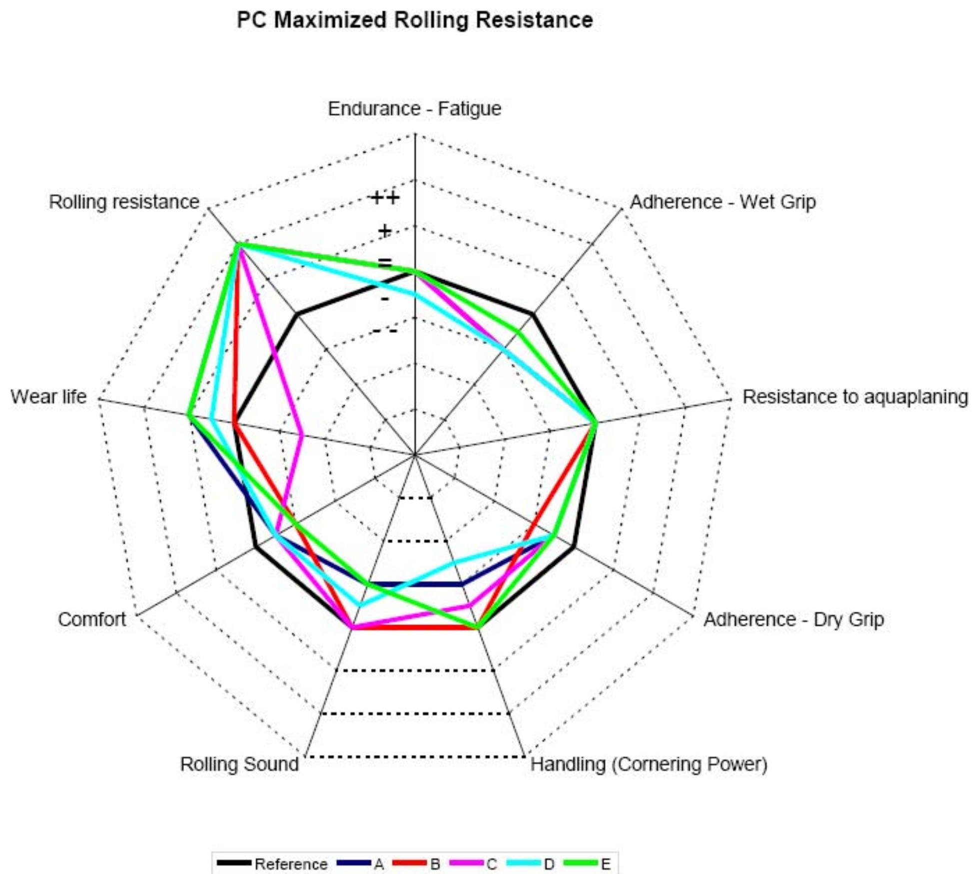
Figure II-2



Notes

– Relative noise emission: a higher percentage means a higher noise emission (i.e. >100% is worse).
– Relative deceleration: a higher percentage means a better braking performance (i.e. >100% is better).
– Relative rolling resistance: a higher percentage means a higher rolling resistance (i.e. >100% is worse).
– Relative floating speed: a higher percentage means a better aquaplaning behaviour (i.e. >100% is better).
– Relative sales price: a higher percentage means a higher sales price (i.e. >100% is worse).

Figure II-3


PC Maximized Rolling Resistance
Endurance - Fatigue
Adherence - Wet Grip
Resistance to aquaplaning
Adherence - Dry Grip
Handling (Cornering Power)
Rolling Sound
Comfort
Wear life
Rolling resistance
++
+
=
-
- -
Reference
A
B
C
D
E

Potential Safety Disbenefits

As with any tire purchase, there are tradeoffs in the tire features, including safety. While NHTSA expects that manufacturers will typically improve rolling resistance and not tradeoff safety, no such assurance can be made for consumers. Armed with information provided by this new labeling program, consumers will have new information that affects the fuel economy of their vehicle and their pocket book, and wet traction. There are a wide variety of tires on the market with different properties and features. There are no guarantees that consumers won't choose tires that have low rolling resistance and poor traction. Thus, relative to consumers having less information, before this program, safety could potentially suffer. The agency has no way of judging what consumers might do when given better information on both traction and rolling resistance.

For example, within the agency's data, tires of the same size had as much as 30 percent difference in wet slide numbers over the range of rolling resistance values. The following table calculates 40 mph stopping distances over the range of these values:

Stopping Distance Formula: Non-ABS with Perception/Reaction/Brake Engagement Time	
SD = Dr+ Ds	SD_1 = tr*V + V^2/(2*g*mu_{S1})
Dr = tr*V	SD_2 = tr*V + V^2/(2*g*mu_{S2})
Ds = V^2/(2*g*mu_S)	tr = 2.0 sec (Standard estimate)
SD = Stopping distance	V = 40 mph (58.67 ft/sec)
Dr = Perception reaction distance	mu_1 = 0.605 (best 225/60R16 tire)
tr = Est. perception/reaction/brake engagement time (sec)	mu_2 = 0.464 (worst 225/60R16 tire)
V = Velocity	SD_1 = 205.7 ft (best)
g = Gravity	SD_2 = 232.5 ft (worst)
mu_S = Slide friction	ΔSD = 26.8 ft (+13%)

From the 40 mph wet slide friction numbers, a 30-percent difference in wet slide number translates into an increase of 27 feet (13 percent) in calculated wet stopping distance for a non-ABS equipped vehicle. So, this is pretty much a worse case example for non-ABS vehicles. ABS vehicles are less of a concern because as ABS causes the vehicle to release and reapply the brakes, the vehicle is more effectively using the peak wet friction to stop as opposed to the sliding wet friction. However, about 1/3 of the current fleet of light vehicles on the road are non-ABS vehicles and will need replacement tires throughout the remainder of their lifetime.

III. TEST RESULTS

The agency is proposing to require tire manufacturers to rate the fuel efficiency of their tires using a test procedure currently under development by the International Organization for Standardization (ISO), ISO/DIS 28580. The agency expects this test procedure to be finalized before publication of the final rule. In addition, as part of tire research, the agency performed a series of tire tests in different test conditions to determine how the reduction in rolling resistance impacts vehicle safety and fuel economy. The evaluation of the test procedures and the test results from these tests are presented in this chapter.

A. Test Procedure

As mentioned previously, subsequent to the recommendations for Congressional action issued in the 2006 NAS Report, NHTSA began a research program to evaluate five existing test methods to measure the rolling resistance of light vehicle tires (Phase 1 Research)[31], and to examine correlations between tire rolling resistance levels and tire safety performance (Phase 2 Research). The five test methods examined in NHTSA's Phase 1 Research included four established and one draft tire rolling resistance test procedure. The five test methods were as follows:

- Society of Automotive Engineers (SAE) J1269 - Sep 2006-09; Rolling Resistance Measurement Procedure for Passenger Car, Light Truck and Highway Truck and Bus Tires (Multi Point).
- SAE J1269 - Sep 2006-09; Rolling Resistance Measurement Procedure for Passenger Car, Light Truck and Highway Truck and Bus Tires (Single Point).
- SAE J2452 - Jun 1999; Stepwise Coastdown Methodology for Measuring Tire Rolling Resistance (Multi Point).
- International Organization for Standardization (ISO) 18164:2005(E); Passenger car, truck, bus and motorcycle tyres -- Methods of measuring rolling resistance (Multi Point).
- ISO/DIS 28580; Passenger car, truck and bus tyres -- Methods of measuring rolling resistance -- Single point test and correlation of measurement results (Single Point).

The Society of Automotive Engineers (SAE) International is an international standards organization providing voluntary industry standards to advance the state of technical and engineering sciences.[32] The International Organization for Standardization (ISO)[33] is a worldwide federation of national standards bodies that prepares standards through

[31] *See* NHTSA Rolling Resistance Rating System Test Development Project: Phase 1 – Evaluation of Laboratory Test Protocols (October 2008). A copy of this report and other research reports relied on in this proposal will be placed in the docket.

[32] SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel (877) 606-7323, www.sae.org.

[33] The standards and test methods published by these bodies are proprietary and protected under U.S. copyright law. While we can describe these test methods in our research results, we cannot reprint them in this notice or in our regulations. When dealing with copyrighted industry standards, NHTSA incorporates them by reference into their standards where appropriate. Parties who need to or wish to conduct the actual tests themselves may obtain a copy of the standards by contacting either SAE or ISO.

technical committees comprised of international organizations, governmental and non-governmental, in liaison with ISO.[34]

The term "multi point" refers to a method that uses more than one set of conditions to test a tire, usually varying speed, pressure, and/or load. Passenger and light truck tires generally have different test conditions and can have even a different number of test points in the set of conditions. The term "single point" refers to a method that uses a single set of test conditions. However, the set of single point test conditions may differ for passenger and light truck tires.

The description of the five test procedures are provided below. (For additional discussion, please see a report titled "NHTSA Tire Rolling Resistance Rating System Test Development Project: Phase 1 – Evaluation of Laboratory Test Protocols".[35]

A.1 SAE J1269 Multi Point Test

SAE J1269 was originally approved in 1979 as a method of determining rolling resistance at four different load and pressure conditions for Passenger car (P) tires, six test conditions for Light Truck (LT) tires, and five test conditions for truck and bus tires. The Phase 1 research evaluated P and LT tires only, therefore truck and bus test conditions are not considered nor reported. This test method uses a 1.707 m (67.23 inch) roadwheel with grit surface and allows the measurement of rolling resistance by the force, torque or power method. The force method measures the reaction force generated at the axle or spindle supporting the tire specimen (Figure III-1). A multi-axis load cell measures the radial load and force tangential to the contact or test surface. With the torque method, a torque cell is located between the drive motor and the roadwheel that measures the input torque required to maintain the roadwheel speed. The power method measures the electrical energy needed to maintain the roadwheel speed. Based on the equipment installed at the two test labs available for the research, all J1269 single and multi-point testing was conducted on machines that utilize the force method of measurement.

Prior to the 2006-09 version of J1269, the pressure used during the test was the maximum pressure found molded on the tire sidewall. These pressures were not always consistent with the maximum pressures from the standardizing bodies for the maximum load. In September 2006, a revision was made to the Recommended Practice for 2007 version of the SAE Handbook. (It should be noted this change was made after the National Academies (NAS) report was issued.) The change revised the definition of "Base Inflation Pressure" (P_r) to specify the inflation pressure corresponding to the maximum load listed in the tables of current T&RA Yearbook or in corresponding tables published

[34] ISO Central Secretariat, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211 Geneva 20, Switzerland, Telephone +41 22 749 01 11, Fax +41 22 733 34 30, www.iso.org.

[35] For additional discussion, see a report titled "NHTSA Tire Rolling Resistance Rating System Test Development Project: Phase 1 – Evaluation of Laboratory Test Protocols," draft, January 2009.

by similar organizations. This meaning of Base Inflation Pressure was used in the Phase 1 research.

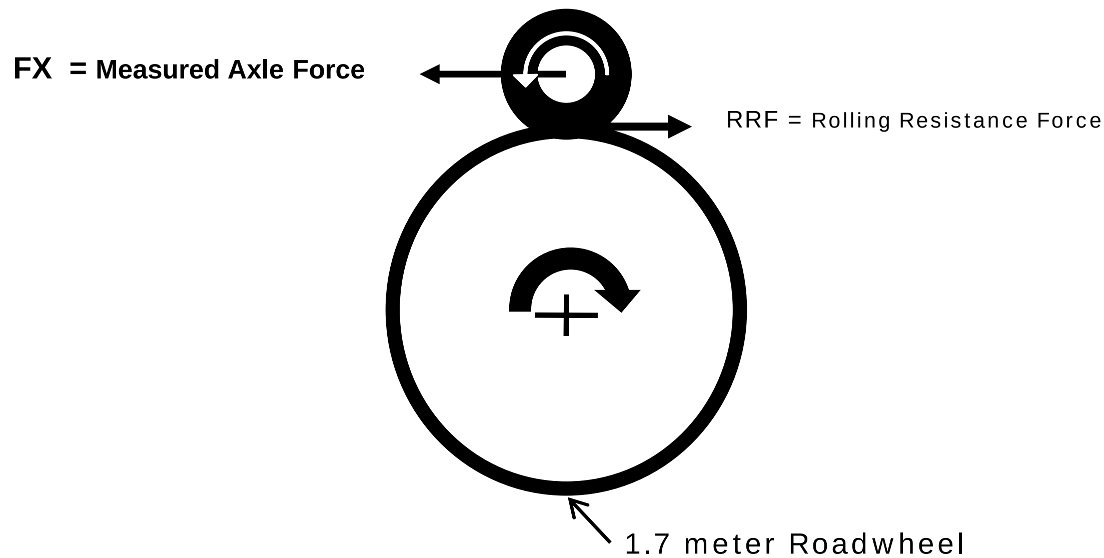


Figure III-1. Force method Rolling Resistance

A.2. SAE J1269 as a Single Point Test

Included in the J1269 2006-09 version is a "Standard Reference Condition" (SRC) that when calculated from the multiple data points sets a rolling resistance value for each tire. This rolling resistance value can then be used to compare tires. To evaluate the possibility of using just the SRC load and inflation as a more efficient means of running the test, a modified version of J1269 was evaluated in which the rolling resistance was directly measured at the SRC.

A.3. SAE J2452 Stepwise Coastdown Test

The J2452 Stepwise Coastdown Test Method was developed by tire industry, automotive manufacturers and laboratory representatives in the late 1990's. This test method is presented by SAE as being valid for pneumatic Passenger car "P" type, metric Light Truck (LT) and high flotation tires. It is acceptable for use on 1.2 meter (48 in.) or greater roadwheels. In the NHTSA Phase 1 research, all work was done using machines with 1.707 m (67.23 inch) roadwheels with grit surface. The machine at Smithers[36] and STL Standard Test Labs, ARDL's contract consortium partner) have been in operation for many years and use the force method. An additional machine was installed at STL during the contract period that uses the torque method.

[36] Smithers Scientific Service, Inc.

Unlike the other test methods, J2452 can only be accomplished on Force or Torque machines. No provision is allowed for Power or Deceleration methods.

A.4. ISO 18164:2005(E) Multi Point Test

ISO 18164:2005(E) is very similar to SAE J1269, therefore only the major differences will be discussed. Like J1269, this method has the possibility to measure rolling resistance with the Force, Torque and Power methods. However, ISO 18164 also includes a Deceleration method. For the Phase 1 research, ISO 18164 was only evaluated on machines that utilize the force method of measurement.

ISO 18164 normally specifies a smooth roadwheel 1.5 meter or greater and then uses a 1.7 meter as the reference. ISO 18164 section B4 specifies the test conditions to be used with the 1.707 m (67.23 inch) roadwheel with grit surface. Testing by Smithers and ARDL-STL were carried out using section B4 of the test method on 1.707 m roadwheels with grit surface.

This method recommends obtaining the test data in increasing values of the rolling resistance for passenger tires, the opposite of J1269. That is the light load/high pressure Test Point (TP)1 is first, followed by decreasing the pressure for TP2, increase the load and pressure for TP3 then decrease the pressure for TP4 completes the order of running the data points.

A.5. ISO 28580 Single Point Test

At the inception of the Phase 1 research, an advanced copy of the ISO 28580 test standard was provided for evaluation. Since that time, some changes have occurred in the standard being balloted. These items will be addressed by noting how this study was conducted, and if a change has been made it will be noted.

The four types of machines noted in ISO 18164 are also available for use in ISO 28580.[37] The types of methods to measure rolling resistance are Force, Torque, Power and Deceleration. During the Phase 1 research, all ISO 18164 testing was conducted on machines that utilized the force method of measurement.

ISO 28580 specifies a roadwheel of at least 1.707 meters and both smooth and optional grit surface as long as it is kept clean. Testing for this study used a 1.707 m (67.23 inch) roadwheel with grit surface. The Passenger and Light Truck testing was performed at 80km/h as was found in ISO 18164. The single point test load is based on the tire Load index (Li) with SL and XL tires being multiplied by 80 percent. LT or “C” tires have the load adjusted to 85 percent of the Li maximum load. These are shown in Figure III-2 and Figure III-3 below.

[37] The machines are for the force, torque, power and deceleration methods.

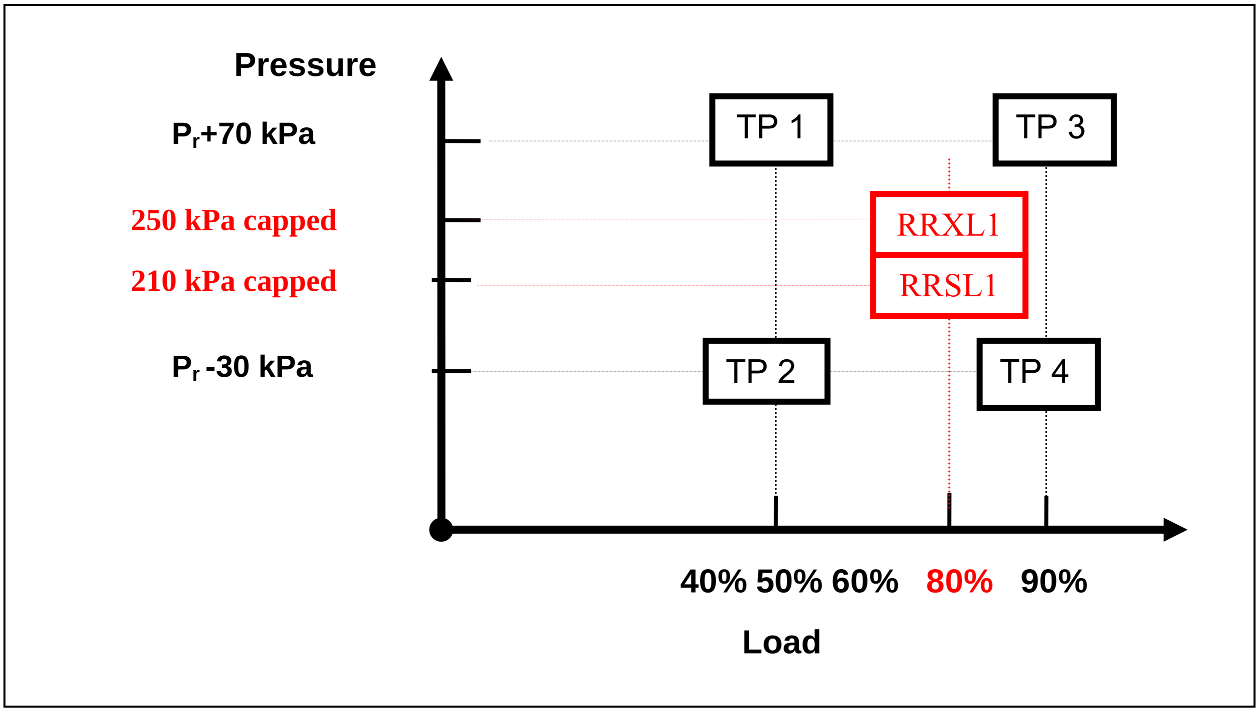


Figure III-2. ISO 28580 Test Conditions for Standard Load (RRSL1) and Extra Load (RRXL1) Passenger Tires

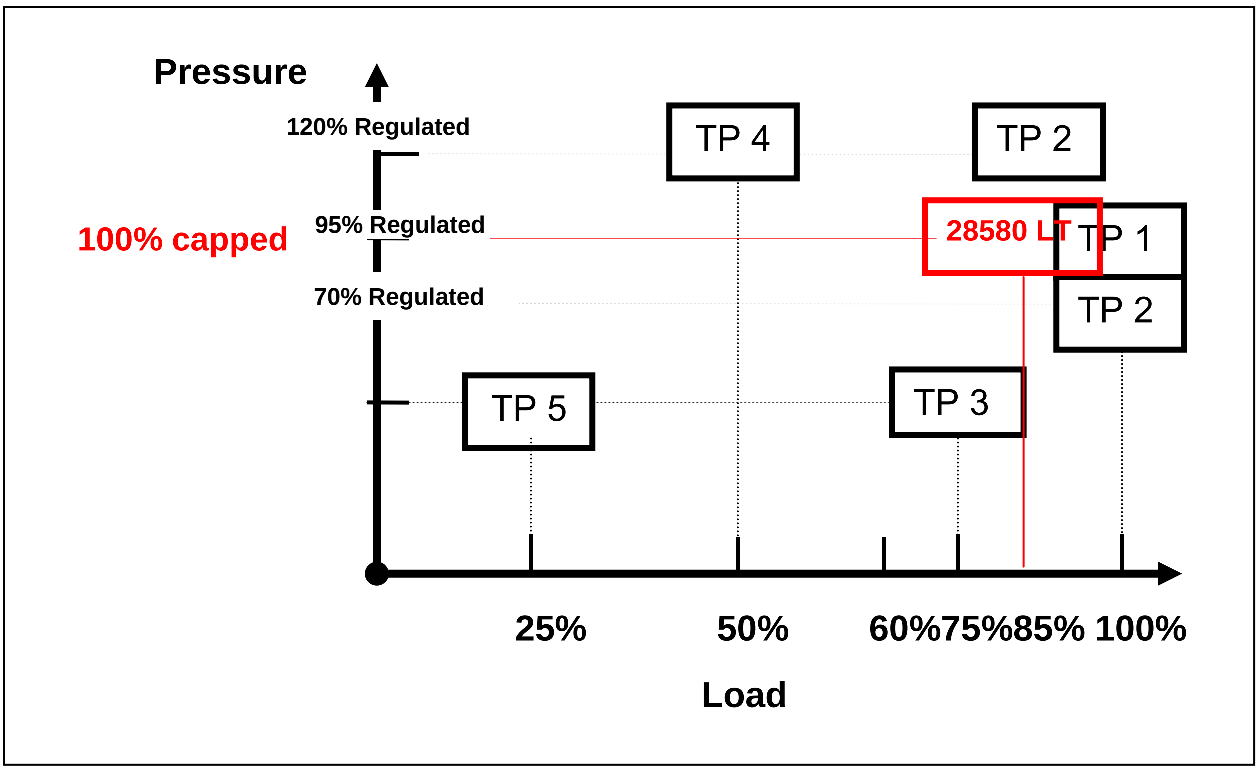


Figure III-3. ISO 28580 Draft Standard Test Conditions for "C" or LT, Li ≥ 121 Tires

The Base Inflation Pressure for ISO 28580 does not have the pressure adjustment for testing on the grit surface, as does ISO 18164. The capped pressures are the same as was specified by ISO 18164 for smooth surface roadwheel.[38]

Test speed in ISO 28580 is 80 km/h (50 mph nominal), actual is running speed at 80 km/h is 49.7 mph.

Test temperature range is specified as 20°C to 30°C. The test temperature is corrected to 25°C using the formula $F_{r25} = F_r[1+K(t_{amb}-25)]$ where:

> F_r is the rolling resistance, in newtons
> T_{amb} is the ambient temperature, in degrees Celsius
> K is equal to:
> > 0.008 for passenger tires
> > 0.010 for truck and bus with load index less than 121
> > 0.006 for truck and bus tires with load index 122 and above

<u>A.6. Difference in ISO 28580 and SAE J1269</u>
One significant difference between the ISO and SAE single-point tests is the inclusion of a procedure which uses two reference tires to correlate any laboratory to a master laboratory. NHTSA's research showed significant variation between the two laboratories used, and therefore addressing this variation is a significant issue. Use of the SAE J1269 single-point test would require NHTSA to develop its own procedure to address lab-to-lab variation.

While there are a larger numbers of tires tested using the SAE J1269 procedure in the databases NHTSA had access to, NHTSA does not see this as an impediment to adopting the ISO test. NHTSA's research shows that the results from either method can be cross-correlated to provide the same information. Specification of the ISO 28580 single-point test will allow manufacturers to do one test to comply with both European and U.S. regulations. California is also considering the ISO test for its regulation.

The ISO 28580 single-point test uses capped inflation pressure, which NHTSA believes will provide a more accurate representation of in-service behavior. Four types of rolling resistance measurement methods are specified in ISO 28580 single-point, Force, Torque, Power and Deceleration. NHTSA is proposing to use only the force method during the test procedure. Additionally, the agency is also proposing specifying the use of 80-grit surface on the roadwheel.

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[38] In the capped test, inflation pressure rose as the tire was tested and resulted in slightly lower rolling resistance versus regulated pressure for the same tire in the same test.

Table III-1. Comparison of the Five Laboratory Rolling Resistance Test Methods Evaluated

	ISO 28580 Draft		**ISO 18164:2005(E)**		**SAE J1269**				**SAE J2452**	
					Single Point		**Multi Point**			
Note	Ref. ISO 28580		Multi point		SRC as Test Conditions					
Roadwheel	1.7 m or correction		1.7 m or correction (1.5m with correction)		1.7 m		1.7m		1.219m to 1.707m	
Measurement Methods	Force		Force		Force FR=FX(1+RL/R)		Force FR=FX(1+RL/R)		Force	
	Torque		Torque		Torque FR=T/R		Torque FR=T/R		Torque	
	Power		Power		FR=c*P/v		FR=c*P/v			
	Deceleration		Deceleration							
Surface	Smooth		Smooth		80 Grit		80 Grit		80 Grit	
Temperature	20 – 30 C		25 C		20 to 28 C		20 to 28 C		20 to 28 C	
Ref. Temp.	25 C		25 C		24 C		24 C		24 C	
Base Pressure					Molded sidewall load@ T&RA pressure		Molded sidewall load@ T&RA pressure		Percent of Max.	
	Passenger		Passenger B4		Passenger & LT		Passenger		Passenger	
	Load	Pressure	Load	Pressure	Load	Pressure	Load	Pressure	Load	Pressure
Load and Pressure	SL 80%	210 kPa Capped	50%	+70 kPa reg.	70%	+20 kPa Regulated	90%	-50 kPa (7.3 psi) Capped	30%	1.4 psi reg.
	XL 80%	250 kPa Capped	50%	-30 kPa reg.			90%	+70 kPa (10.2 psi) reg.	60%	-5.8 psi reg.
			90%	+70 kPa reg.			50%	-30 kPa (4.4 psi) reg.	90%	+8.7 psi reg.
	C, Truck/ Bus (single)		90%	-30 kPa reg.			50%	+70 kPa (10.2 psi) reg.	90%	-5.8 psi reg.
	85%	100 % Capped								
							Light Truck (single)		Light Truck (single)	
			≤Li 121 Highway Truck and Bus B1				100%	100 % Capped	20%	110 % reg.
			Load	Pressure			70%	60 % Reg.	40%	50 % Reg.
			100%	100 % Capped			70%	110 % Reg.	40%	100 % Reg.
			100%	95 % Reg.			40%	30 % Reg.	70%	60 % Reg.
			75%	70 % Reg.			40%	60 % Reg.	100%	100 % Reg.
			50%	120 % Reg.			40%	110 % Reg.		
			25%	70 % Reg.						

The choice of which test procedure to specify for measuring rolling resistance is important because measuring rolling resistance requires precise instrumentation, calibration, speed control and equipment alignment for repeatable results. Agency research examining various rolling resistance test methods indicated that the ISO 28580 test method is unique in that it specifies a procedure to correlate results between laboratories, which is a significant issue. Other established test methods lack such a procedure. Further, the ISO 28580 test procedure is also the specified test method in a proposed European Union Directive on tire fuel efficiency, and will likely be the specified method for a proposed California fuel efficiency rating system. Therefore, specification of the ISO 28580 will allow manufacturers to do one test to comply with several regulations.

The following section discusses the test results from the NHTSA's Phase 1 and Phase 2 tire research programs.

B. NHTSA Phase 1 Research

The Phase 1 research used 600 tires of 25 different model/size combinations to evaluate the five rolling resistance test methods at two different laboratories.[39] Tires of each model were purchased with identical or similar build dates and were tested multiple times in each test method, and multiple times at each laboratory.

Some of the technical challenges involved in selection of a test procedure to measure rolling resistance include specifying a test method that avoids variation among test equipment and manufacturers. NHTSA's research also sought to examine possible tradeoffs between improved rolling resistance and tire safety.

The purposes of the NHTSA Phase 1 testing were to:

- Benchmark the current rolling resistance levels in modern passenger vehicle tires in terms of actual rolling force, rolling resistance coefficient, as well as indexed against the ASTM F2493-06 Standard Reference Test Tire (SRTT).
- Analyze the effect of the input variables on the testing conditions for non-linear response.
- Select a test procedure that would be best for a regulation.
- Examine the variability of the rolling resistance results from lab to lab, machine to machine.
- Evaluate the effects of first test on a tire versus second test on the same tire.
- Investigate methods for reporting the data to consumers.

B.1 Test Tires used in Phase 1 Research Tests

The test program utilized an assortment of approximately 600 new tires of 25 different models. 15 tire models were passenger car tire models, 9 were light truck tire models, and

[39] This study looked at both Passenger car (P) tires and Light Truck (LT) tires. However, The Energy Independence and Security Act (EISA) limits the applicability of this rulemaking to P tires only.

one was the ASTM F2493-06 P225/60R16 97S Standard Reference Test Tire (SRTT). The Energy Independence and Security Act (EISA) of December 2007 required that the National Tire fuel Efficiency Consumer Information Program *"apply only to replacement tires covered under section 575.104(c) of title 49, Code of Federal Regulations* (UTQGS)*, in effect on the date of the enactment of the Ten-in-Ten Fuel Economy Act."* Per 575.104(c), the Uniform Tire Quality Grading System (UTQGS) does not apply to deep tread (which is interpreted as light truck tires), winter-type snow tires, space-saver, or temporary use spare tires, or tires with nominal rim diameters of 12 inches or less, or to limited production tires. However, because the research project initiated more than a year prior (July, 2006) to the enactment of EISA, the mix of 25 tire models includes 2 winter-type passenger tire models and 9 light truck tire models.

B.1.1 ASTM F2493 Radial Standard Reference Test Tire (SRTT)

The ASTM F2493 - *Standard Specification for P225/60R16 97S Radial Standard Reference Test Tire* provides specifications for a tire "for use as a reference tire for braking traction, snow traction, and wear performance evaluations, but may also be used for other evaluations, such as pavement roughness, noise, or other tests that require a reference tire." The standard contains detailed specifications for the design, allowable dimensions, and storage of the SRTTs. As can be observed in Figure III-4, the F2493 SRTT is a variant of a modern 16-inch Uniroyal TigerPaw radial passenger vehicle tire and comes marked with a full USDOT Tire Identification Number and UTQGS grades (Table III-2). The SRTTs were used extensively throughout the test programs at both labs (Smithers and ARDL) as the first and last tire in each block of testing in order to track and account for the variation in machine results. In theory, by monitoring first and last tests for each block of testing at each lab with a SRTT, and referencing rolling resistance results for each tire back to the SRTT results for that block of testing, the results should be corrected for variations in the test equipment over that time period, as well as variations in test equipment from lab to lab.

Figure III-4. ASTM F2493-06 Standard Reference Test Tire (SRTT)

Table III-2. Specifications for ASTM F2493-06 SRTT

Tire Model Code	MFG	Size	Load Index	Speed Rating	Model	UTQGS Treadwear	UTQGS Trac.	UTQGS Temp.	Measured Tread Depth (1/32")	Performance Level
M14	Uniroyal	P225/60R16	97	S	ASTM 16" SRTT	540	A	B	8	ASTM F 2493-06 Reference

B.1.2. Passenger Tire Models

Fifteen DOT-approved passenger tire models were purchased new for testing. Their specifications are detailed in Table III-3.

Table III-3. Specifications for Passenger Tire Models

Test Program Axis	Tire Model Code	MFG	Size	Load Index	Speed Rating	Model	UTQGS Treadwear	UTQGS Trac.	UTQGS Temp.	Measured Tread Depth (1/32")	Performance Level
1	**G10**	Goodyear	P205/75R15	97	S	Integrity	460	A	B	9	Passenger All Season
	G11	Goodyear	P225/60R17	98	S	Integrity	460	A	B	8	Passenger All Season
	G8	Goodyear	225/60R16	98	S	Integrity	460	A	B	9	Passenger All Season
	G9	Goodyear	P205/75R14	95	S	Integrity	460	A	B	9	Passenger All Season
	U3	Dunlop	P225/60R17	98	T	SP Sport 4000 DSST	360	A	B	11	Run Flat
2	**B10**	Bridgestone	225/60R16	98	Q	Blizzak REVO1		-		9	Performance Winter
	B15	Dayton	225/60R16	98	S	Winterforce		-		14	Performance Winter
	B13	Bridgestone	P225/60R16	97	T	Turanza LS-T	700	A	B	11	Standard Touring All Season
	B14	Bridgestone	P225/60R16	97	V	Turanza LS-V	400	AA	A	11	Grand Touring All Season
	B11	Bridgestone	P225/60R16	97	H	Potenza RE92 OWL	340	A	A	11	High Performance All Season
	B12	Bridgestone	P225/60R16	98	W	Potenza RE750	340	AA	A	7	Ultra High Performance Summer
3	**M13**	Michelin	225/60R16	98	H	Pilot MXM4	300	A	A	7	Grand Touring All Season
	D10	Cooper	225/60R16	98	H	Lifeliner Touring SLE	420	A	A	11	Standard Touring All Season
	P5	Pep Boys	P225/60R16	97	H	Touring HR	420	A	A	11	Passenger All Season
	R4	Pirelli	225/60R16	98	H	P6 Four Seasons	400	A	A	11	Passenger All Season

B.1.3 Light Truck Tires

Nine DOT-approved light truck tire models were purchased for testing. Their specifications are detailed in Table III-4.

Table III-4. Specifications for Light Truck Tire Models

Test Program Axis	Tire Model Code	MFG	Size	Load Index	Speed Rating	Model	Measured Tread Depth (1/32")	Performance Level
4	**D7**	Cooper	LT235/85R16	120(E)	N	Discoverer ST-C	19	All terrain on/off road
	D8	Cooper	LT245/75R16	120(E)	N	Discoverer ST-C	19	All terrain on/off road
	D9	Cooper	LT265/75R16	120(E)	N	Discoverer ST-C	19	All terrain on/off road
5	**M10**	Michelin	LT245/75R16	120(E)	R	Michelin LTX A/S	15	All season on-road
	M11	Michelin	LT245/75R16	120(E)	R	Michelin LTX M/S	16	All season on-road
	M12	Michelin	LT245/75R16	120(E)	R	Michelin X RADIAL LT	15	All season on-road
6	**P4**	Pep Boys	LT245/75R16	120(E)	N	Scrambler A/P	15	All season on-road
	C9	General	LT245/75R16	120(E)	Q	AmeriTrac TR	15	All terrain on/off road
	K4	Kumho	LT245/75R16	120(E)	Q	Road Venture HT	15	All season on-road

Wheels of each size used in the test program were purchased new, in identical lots to minimize wheel-to-wheel variation. Tires participating in multiple tests at the same lab or between two labs were mounted once on a single wheel and continued to be tested on that same wheel until completion of all tests.

B.2. Statistical Analysis of Phase 1 test data[40]

As described, each of the five test methods was used to measure the rolling resistance of the tires in two laboratories. Individual tires were systematically measured as a first test on a new tire, and as subsequent tests on the same tire after measurement on other tests and/or in other laboratories. ANOVA analysis was carried out on the data using SAS software to estimate effects. All models produced high R^2 values, above 0.98, and high F values with Probability > F of 0.0001. A general description of the variables analyzed and the effect of each is shown in Table III-5. The most significant variable as measured by any test is the tire type (i.e. individual tire model). This variable was at least an order of magnitude more important to the statistical model than all other variables combined. For each tire type the variability within the group of tires was very low, approximately 2 percent of the mean value.[41] There was a significant offset between data generated by the two labs used in the study of approximately 5 percent. This offset was not linear with force, nor was it uniform for all tests, showing a complete reversal for one test.

[40] For the complete test results, see NHTSA Rolling Resistance Rating System Test Development Project: Phase 1 – Evaluation of Laboratory Test Protocols (October 2008).

[41] One tire of type C9 was excluded from the analysis since it had abnormally high values on multiple tests compared to the rest of the type C9 tires.

The method of inflation maintenance during the test was measured using the SAE J1269 single-point test. In the capped test, the inflation pressure was set to the specified value during the initial cold inflation of the tire and the pressure inside the tire cavity was allowed to rise during the roadwheel testing. In the regulated procedure, the inflation pressure was maintained at the specified pressure during the test using a rotary union coupling. As expected, the higher pressure inside the tire during the capped test produced slightly lower rolling resistance values.

In order to study the feasibility of retesting the same tire periodically as a laboratory control tire, or in a possible dispute of test results, the testing involved the use of the same tire for multiple tests. The effect of test order was estimated by comparing the results of tires tested as a first test with tires of the same type that had been tested previously on other tests or in other labs. One test showed a very slight effect of test order, with a magnitude only slightly more than the random variability. Three tests showed that the effect of repeating tests on the same tire and found that this had little to no effect on test results.

Table III-5: Variables Analyzed in Study and General Comments on Significance

Variable	Significance of Effect	Comments
Tire Type	Very High	Rank ordering of tires shows significant separation of tires by group using any test
Laboratory	High	Smithers showed higher results on four tests and lower results on one test than STL[42]
Inflation Maintenance, (Capped vs. Regulated)	Significant	Only measured on SAE J1269 single-point test
Test Order (First vs. Subsequent Tests)	None / Slight	Three tests showed no statistical significance, one test showed significance with a very small effect, and one test could not be analyzed due to data covariance

Table III-6 compares the variability for the six standard measures of rolling resistance studied using the five test methods. Variability of the tests is very low, as evidenced by the coefficient of variation (C.V.) values of approximately 2 percent. The potential for discrimination in Table III-6 is an estimate of the ability of a test measure to classify the entire range of data for the tires of the study into groups. It is calculated as the range of the means of the data (maximum mean value - minimum mean value) divided by three times the root mean square error for the test. For most tests, the maximum number of groups that the 25 tire models could be divided into ranged from five to six.

[42] The test were conducted at two different laboratories, Smithers and STL.

Table III-6. Variability and Discrimination of Tests for Rolling Resistance of Passenger Tires

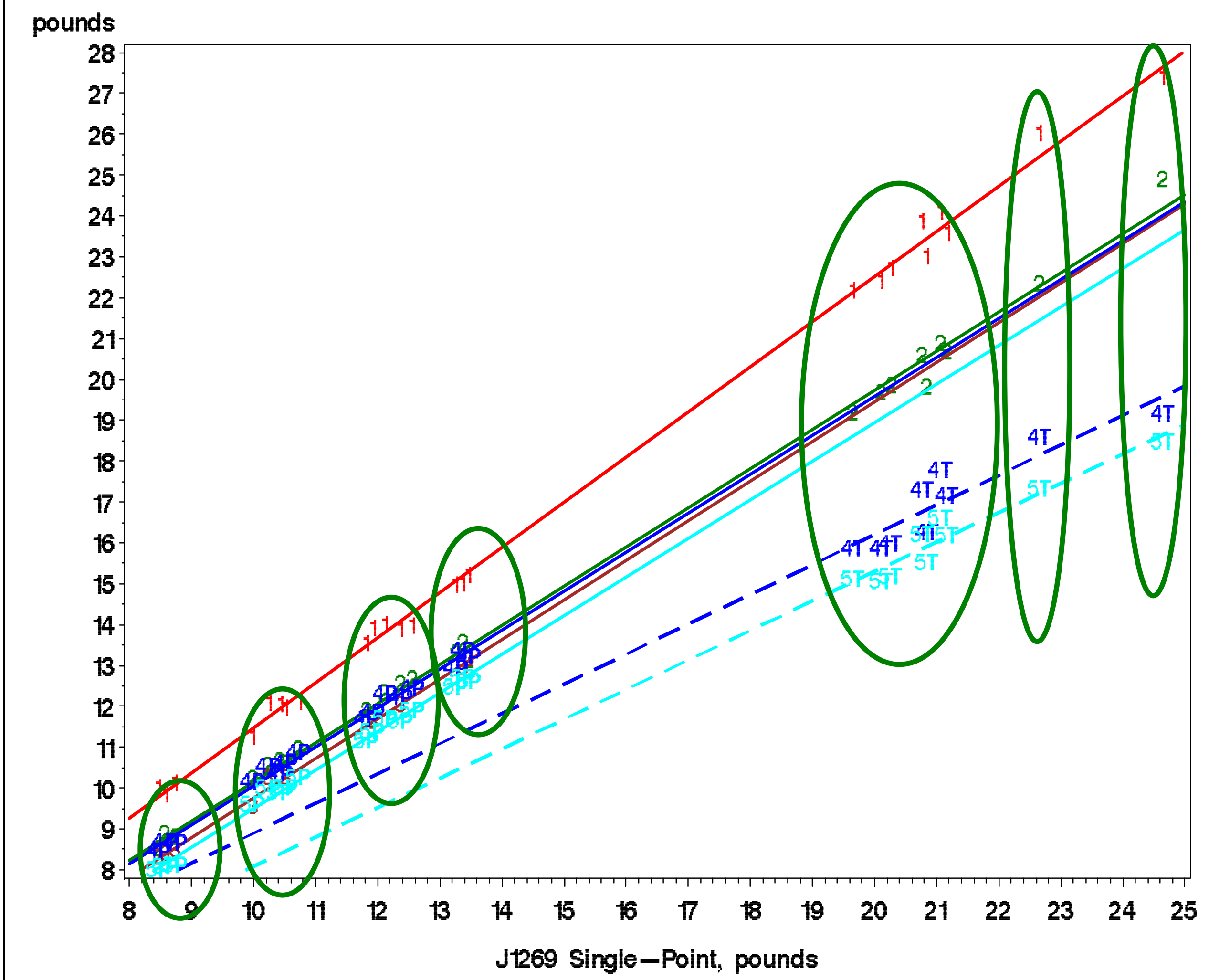
Test	C.V. (%)	Range of Data Means[43]	Potential for Discrimination (Passenger Tires)
SAE J1269 Single-Point	2.37%	4.99	5
ISO 28580 Single-Point	2.21%	5.38	5
SAE J1269 Multi-Point (calculated @ SRC)	2.27%	5.06	5
ISO 18164 Multi-Point[44]	5.25%	4.87	3
SAE J2452 (calculated @ SRC)	1.81%	4.89	6
SAE J2452 (SMERF[45])	1.87%	4.70	6

Based on the low C.V. of each test and the range of data, it appears that any of the tests could be selected to distinguish the rolling resistance values of the tires selected for the study. The test protocols involved different load, inflation, and speed conditions, and it is known that changes in any of these conditions produce different rolling resistance values. Additionally, some values are directly measured, while others are estimated from regression of the data. Thus, the next step in the analysis was to determine if the tests are measuring the same property of the tires, or if the reported rolling resistance is unique to the test conditions or calculations used to generate the response surface.

The values in Figure III-5, showing the pounds force of rolling resistance for each test plotted versus the pounds force found on the SAE J1269 single-point test, appear to be divided in seven groups. It is clear that there is a linear relationship between each test and the SAE J1269 test. If each group contains the same tires tested by each of the different tests, it can be assumed that the tests are all measuring the same property of the tire. The population of the circled groups, numbers 1 through 7 from left to right (lowest to highest rolling resistance), are shown in Table III-7. The tires are listed in order of rolling resistance force values for each test individually. All groups contain the same tires no matter which test was used to rank order the tires (for example, Group 1 contains B11, G8, and G11 regardless of test used). However, the rank ordering of individual tires within a group can change from test to test and are within the expected variation of the tests. It should be noted that the rolling resistance values of tires are a continuous function. Therefore, the group divisions are shown to reinforce the consistency between the tests, and should not be construed as representing groupings of the entire population of tires.

[43] Passenger tires only; (maximum mean value – minimum mean value) of tires in study.
[44] Only 10 passenger tires tested.
[45] SMERF: Standard Mean Equivalent Rolling Force, defined as "for any tire is the MERF for that tire under standard load/inflation conditions defined in Standard Reference Condition. For this document (J2452), the final SMERF is also calculated by weighting the SMERF obtained for the EPA urban and Highway cycles, as discussed previously for MERF calculation".

Figure III-5. Relationship between Rolling Resistance Values for All Tests



1 = ISO 28580 single-point value
2 = SAE J1269 multi-point value @ SRC
3 = ISO 18164 value @ SRC
4P = SAE J2452 value @ SRC, Passenger Tires
4T = SAE J2452 value @ SRC, Light Truck Tires
5P = SAE J2452 SMERF value, Passenger Tires
5T = SAE J2452 SMERF value, Light Truck Tires

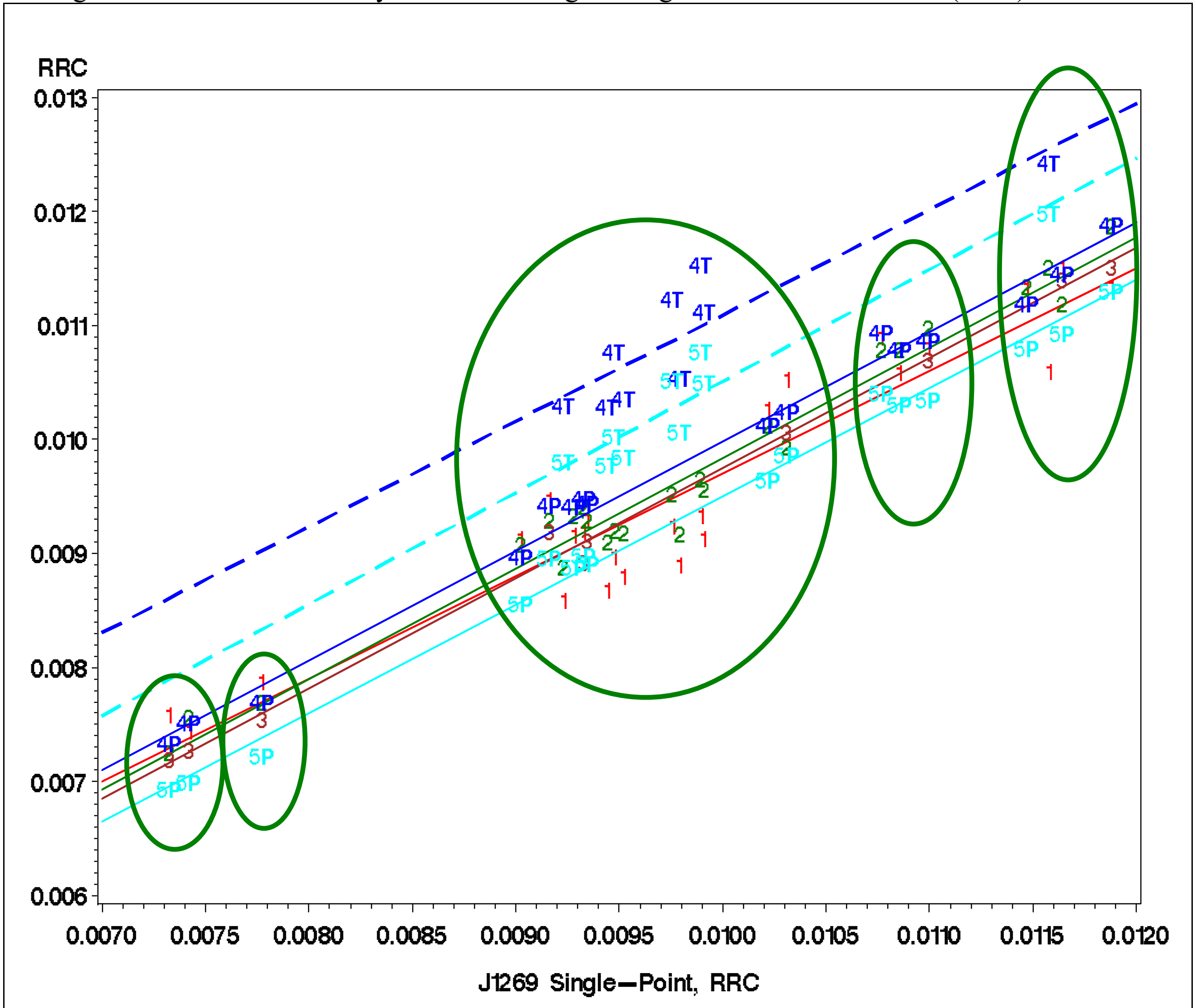
Table III-7. Grouping of Tires by Rolling Resistance Force – Lowest to Highest

Group	Population					
	J1269 single-point	**J1269 multi-point@ SRC**	**ISO 28580**	**ISO 18164**	**J2452 @ SRC**	**J2452, SMERF**
1	B11 G8 G11	G11 B11 G8	G8 B11 G11	G11 G8 B11	G11 B11 G8	G11 G8 B11
2	G9 G10 M13 M14 B10*	G9 G10 M14 M13 B10*	G9 M13 M14 G10 B10*	G9 M14 G10	G9 M13 G10 M14 B10*	G9 M13 G10 M14 B10*
3	D10 U3 P5 B14 B15*	U3 D10 P5 B14 B15*	D10 B14 U3 B15* P5	U3 B14	D10 U3 B14 P5 B15*	D10 U3 B14 P5 B15*
4	R4 B13 B12	B12 R4 B13	R4 B13 B12	B13 B12	R4 B12 B13	R4 B12 B13
Passenger **Light Truck**	**Tires** ↑ **Tires** ↓					
5	M10 M12 M11 D8 K4 D7 P4	M10 M12 K4 M11 D8 P4 D7	M10 M12 M11 K4 P4 D8 D7		M12 M10 M11 K4 P4 D8 D7	M12 M10 M11 K4 P4 D8 D7
6	D9	D9	D9		D9	D9
7	C9	C9	C9		C9	C9

*Snow tires

Figure III-6 shows the rolling resistance coefficient values plotted versus the RRC for the J1269 single-point test. These data can be divided into 5 groups. Again, each group contains the same tires no matter which test is used to rank the tires. We may conclude that the tests have nearly equal ability to discriminate between tires, and that all tests are measuring the same property of the tires in the study, within the error limit of the individual test.

Figure III-6. Tires Ranked by All Tests Using Rolling Resistance Coefficient (RRC)



1 = ISO 28580 single-point value
2 = SAE J1269 multi-point value @ SRC
3 = ISO 18164 value @ SRC
4P = SAE J2452 value @ SRC, Passenger Tires
4T = SAE J2452 value @ SRC, Light Truck Tires
5P = SAE J2452 SMERF value, Passenger Tires
5T = SAE J2452 SMERF value, Light Truck Tires

B.3 Lab-to-lab Correlation Procedures

For any given test there was a significant offset between the data generated by the two labs used in the Phase 1 research. This offset was not consistent between tests, or even between tire types within the same test in some cases. If a test is to be used to compare the rolling resistance of tires tested at different facilities and at different times, some method to account for this offset needs to be developed. Two possible methods were investigated in this study: 1) development of a lab-to-lab correlation equation; and 2) use of the ASTM F2493 Standard Reference Test Tire (SRTT) to normalize data across labs.

The former method was used in the previous section to correct the data to that expected from a single lab (Smithers, in this case). It is also currently under investigation as part of the ISO 28580 standard. In addition to the normal lab calibration procedures within each lab, this correlation would have to be developed across the entire range of rolling resistance values. There is evidence that a single equation for all tire types may not be sufficient to correct data for all tires. No data is available from this study to determine if a lab-to-lab correlation developed at a given time would remain constant over time, or if offsets and/or drifts will occur in a lab that will require a standardization procedure to be employed.

The ASTM F2493 SRTT was used as in internal standard for each lab and all data within the lab for a test was normalized to the SRTT value. This strategy was very successful for lab-to-lab correlation. It has the added benefit of showing good test method-to test method correlation for passenger tires. The advantages to this method are that it would automatically correct for any systematic drift within a laboratory and that it would fit well into any existing SPC/SQC procedures in place in a lab. It could be further refined by providing a “certified” rolling resistance value to each individual SRTT. Additional work would be needed to investigate whether the rolling resistance value of the SRTT is constant over time before this strategy could be employed.

Values are compared in pounds rolling resistance, as reported by the laboratories. The conversion to RRc is a scalar that will not affect the correlation between labs so a separate analysis is not required. Where possible the correlation between the identical tire, measured at each lab, is compared. Otherwise, the means of values for each tire type are used for the comparisons. A linear correlation between labs generally provided an excellent fit for correlation. Since the physical lab calibration procedure provides a zero value for the test it is appropriate to model the values with a zero intercept for each lab. A second order fit with a zero intercept provides a slightly better correlation between labs.

B.3.1 Lab-to-Lab Correlation

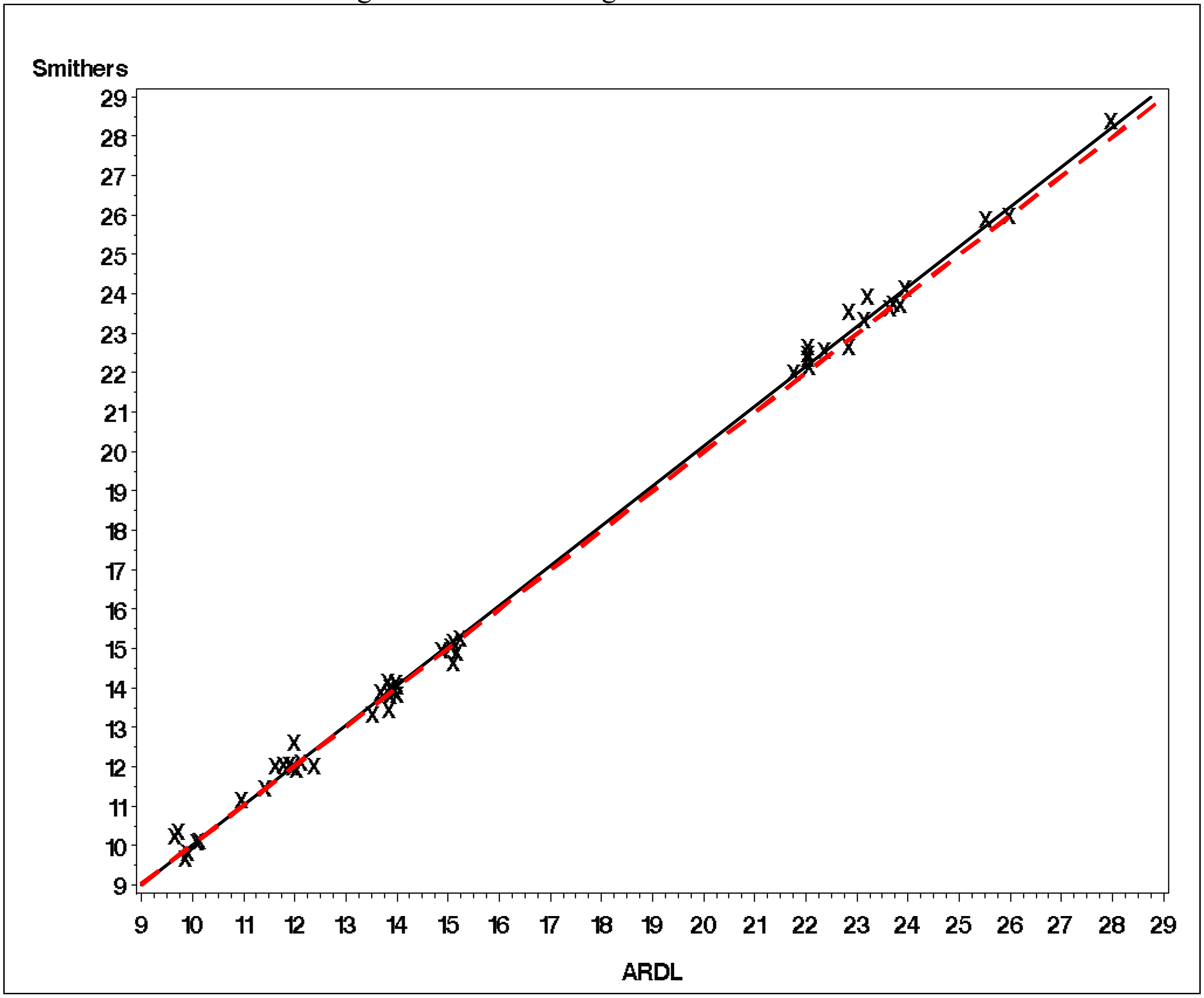
Figure III-19 shows the relationship for rolling resistance values for tires tested at ARDL-STL and at Smithers. Unlike the J1269, in the ISO 28580 test procedure, tires of the identical barcode were not tested at each lab and the relationship is based on the mean values by tire type in each lab. The relationship between the labs is linear and fits Equation 1 below, with an R^2 of 0.9975. This calculation is shown as the solid black line in Figure III-19. Since the calibration procedure at both labs requires a calibration at zero, it may be argued that the intercept should also be forced to zero. This relationship is shown in Equation 2 and as the dashed red line in Equation III-19 below. Analysis of the residual values indicates that Equation 2 is a slightly better fit. Compared to the slope of zero for the residuals using Equation 2, Equation 1predicts values approximately 0.02

pounds (0.08 percent) lower for the highest rolling resistance light truck tire. In practical terms, within this range of rolling resistance values and with a standard deviation for the test of approximately 2 percent for these tires, the equations are indistinguishable.

Equation 1. (Expected Value at Smithers) = -0.099369974 + 1.012042485*(Value at ARDL-STL)

Equation 2. (Expected Value at Smithers) = 0.9967824134*(Value at ARDL-STL) + 0.0004918546*(Value at ARDL-STL)^2

Figure III-7. Rolling Resistance Values for Tires Tested at ARDL-STL and Smithers Using the ISO 28580 Single-Point Method



B.3.2 Normalization to the ASTM F2493-06 Standard Reference Test Tire (SRTT)

Tire M14, the SRTT manufactured according to ASTM F2493-06, was included in all aspects of the study. The fact that there were linear relationships between labs and between all tests for passenger tires indicates that this tire may be used as an internal standard for test reference. Accordingly, all values for passenger tires were normalized to the average value of the SRTT tested at the same conditions. For ease, the values were multiplied by 100 to give an index of rolling resistance (RRIndex).

Figure III-8 shows the correlation between labs for each test using the RRIndex values. Comparing these to the correlations from the previous section shows that the correlations continue to be linear between labs. Figure III-9 shows that using RRIndex the correlation between labs for the ISO and SAE tests are nearly identical. More importantly, all correlations between labs are now very nearly one-to-one for each test, with an average of 1.0022 as shown in Table III-8. The standard deviation of 0.0112 is within the normal range of test repeatability found. Thus, normalization to the SRTT value is a valid method of maintaining correlation between labs. Finally, Figure III-10 shows that not only are the correlations nearly identical between tests, but the actual values obtained for RRIndex are equivalent for passenger tires, no matter which test is employed to measure the rolling resistance. The use of the SRTT as a reference and statistical process control techniques within each lab will give results that can be directly compared. For passenger tires, normalization of RRc data to the RRc of the Standard Tire could also be used as a measure of rolling resistance. Since this data set contains nearly all the same size passenger tires, and were therefore tested at the same load, no substantial conclusions could be drawn about any advantages or disadvantages for this calculation.

Figure III-8. Lab-to-Lab Correlation Using RRIndex (Normalized to SRTT)

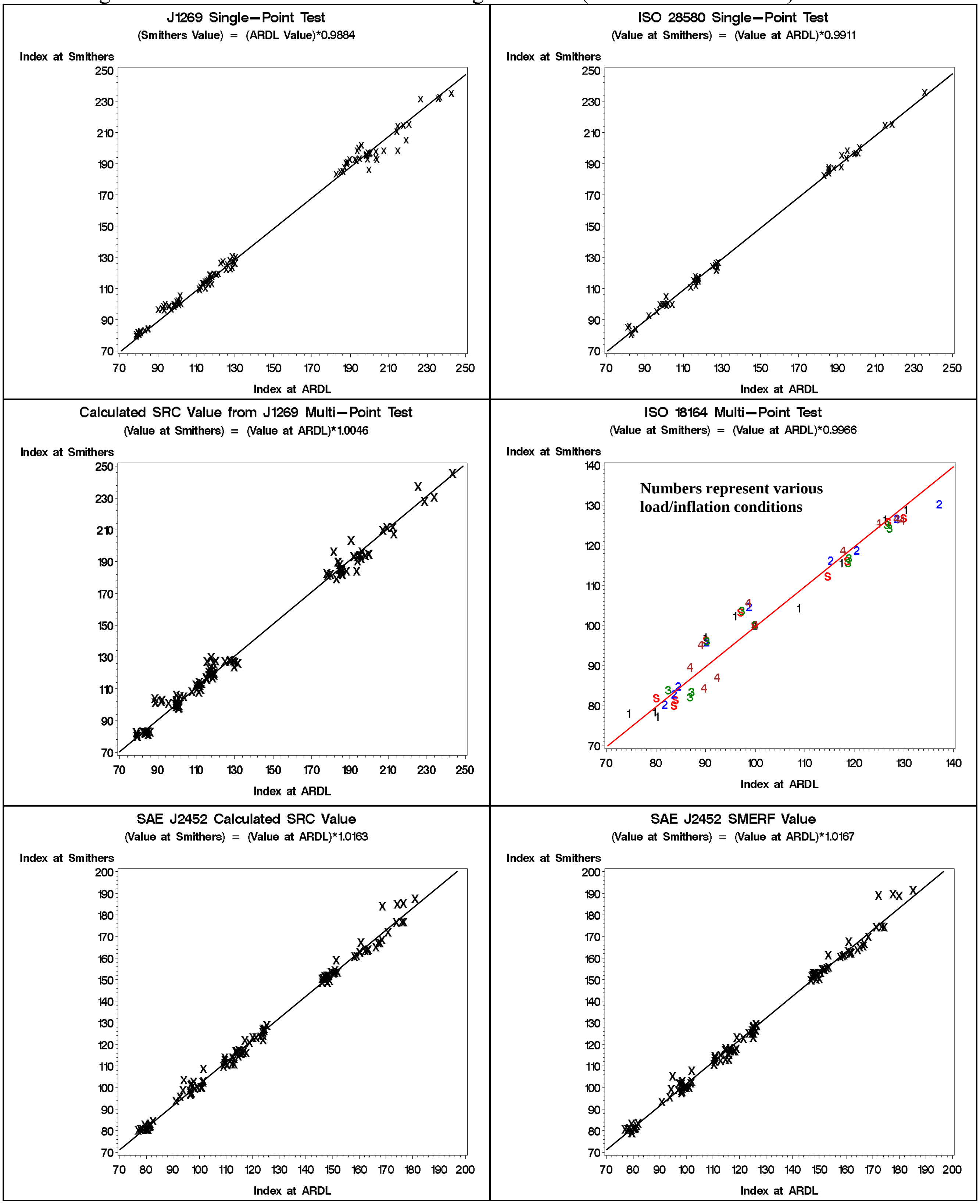


Figure III-9. Correlation of ISO and SAE Test Values for ARDL-STL (-A-) and Smithers (-S-) Normalized to SRTT Value

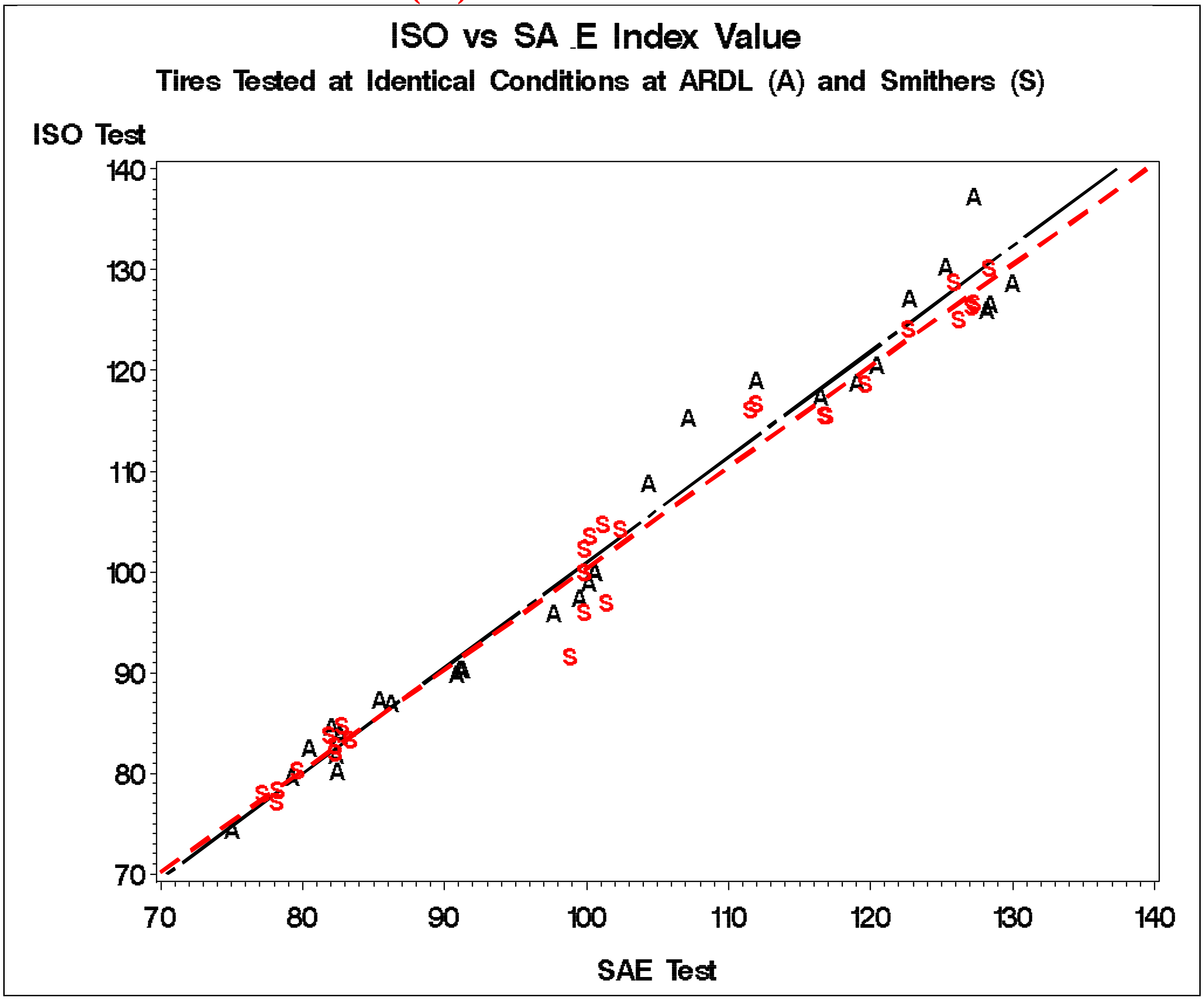
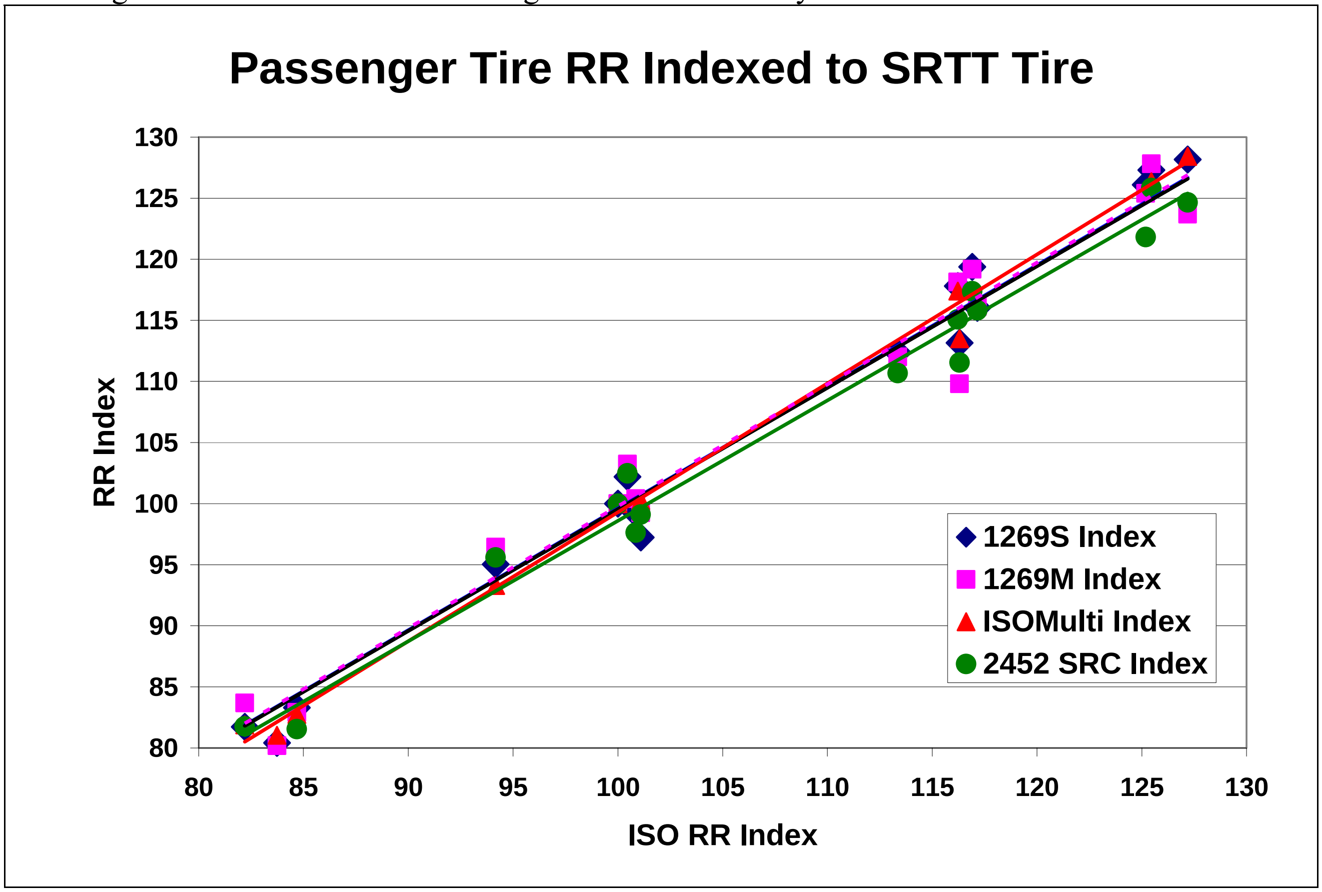


Table III-8. Correlation between Labs Using RRIndex, Normalized to SRTT

Test	(Smithers Index) = (ARDL-STL Index) X:
SAE J1269 Single-Point	0.9884
ISO 28580 Single-Point	0.9911
SAE J1269 Multi-Point @ SRC	1.0046
ISO 18164 Multi-Point (All Conditions)	0.9966
SAE J2452, Calculated @ SRC	1.0163
SAE J2452, SMERF	1.0167
Average	1.0022 ± 0.0112

Figure III-10. RRIndex for Passenger Tires Measured by Various Test Methods



B.4. NHTSA Phase 1 Test Conclusions

The five test procedures studied were all capable of providing data to accurately assess the rolling resistance of the tires surveyed. The variability of all tests was low, with coefficients of variation below 2 percent. Furthermore, all tests rank ordered the tires equivalently. Equations were derived to accurately convert data from any one test to the expected data from any other test. Therefore, either of the two shorter and less expensive single-point rolling resistance test methods appears to be sufficient for the purpose of simply rating individual tires against each other in a rating system.

Within each group of tires, the individual tire model was the most significant variable determining the rolling resistance. Of the 600 tires measured in the study, only one individual tire was significantly different than the other tires of the same model, indicating that the rolling resistance of tires with the same model and construction can be expected to be relatively uniform. There was a significant offset between the data generated by each laboratory testing tires in this study. This could be compensated for by correcting the data to a reference laboratory using the results of regression equations or by the use of a standard reference test tire (SRTT) to align the data. There was little or no significant effect of repeat rolling resistance testing on the same tire. Therefore, repeat testing of the same calibration tire appears to be viable. The pressure rise in the tire during testing using a capped inflation procedure reduced the rolling resistance compared to maintaining the pressure at a constant pressure during the test. Therefore, the choice of a test that uses capped inflation pressure for some or all of the test points should provide a better representation of in-service behavior.

NHTSA's research has shown that both single- and multi-point tests are equally effective and essentially produce the same rating if results are normalized to the 16-inch SRTT.[46] Single-point tests are less expensive and take less time than multi-point test methods. Accordingly, NHTSA tentatively concludes that a single-point, rather than a multi-point, test will better serve the purposes of the proposed rule.

Since all procedures provided reliable and equivalent information about the rank-order of rolling resistance for the tires studied, a single-point test is the most cost effective option. The increased information about the response of an individual tire's rolling resistance due to changes in pressure, load, or speed inherent in the multi-point test procedures do not warrant the increased cost of the testing.

The most significant provision of the ISO 28580 method is the use of defined reference tires to allow comparison of data between labs on a standardized basis. The use of any other procedure would require extensive evaluation and definition of a method to allow direct comparison of results generated in different laboratories or even on different machines in the same laboratory.

Finally, the adoption the ISO 28580 standard is expected to promote harmonization of global standards for testing of tire rolling resistance.

Between the two single-point tests, NHTSA has tentatively decided to specify the ISO 28580 test. The ISO 28580 single-point test is a draft test method that is now at the draft international standard (DIS) stage, and is expected to be finalized by ISO in 2009, likely before publication of a final rule establishing the regulations for this rulemaking.[47] Since the ISO test is balloted for a final standard, there are likely to only be editorial changes at this stage.

[46] *See* NHTSA Rolling Resistance Rating System Test Development Project: Phase 1 – Evaluation of Laboratory Test Protocols (October 2008). A copy of this report and other research reports relied on in this proposal will be placed in the docket.

[47] *See* http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=44770.

C. NHTSA Phase 2 Research

The purposes of the NHTSA Phase 2 testing were to explore relationship between tire rolling resistance and safety & fuel economy measures in terms of traction and treadwear, as shown below[48]:

- NHTSA San Angelo Outdoor Testing. In the test facility, the standard UTQG treadwear and traction tests were conducted. In addition, additional wet & dry traction test were conducted
- Smithers Indoor Laboratory Testing. Tires were tested indoor for their indoor dry traction and indoor treadwear rate.
- EPA Dynamometer Fuel Economy Testing. Tires were test to determine effects of 16 tire groups on a single vehicles economy rating. Additionally, effects of placard and low tire pressure on vehicles fuel economy.

<u>C.1 Test Tires used in Phase 2 Research</u>

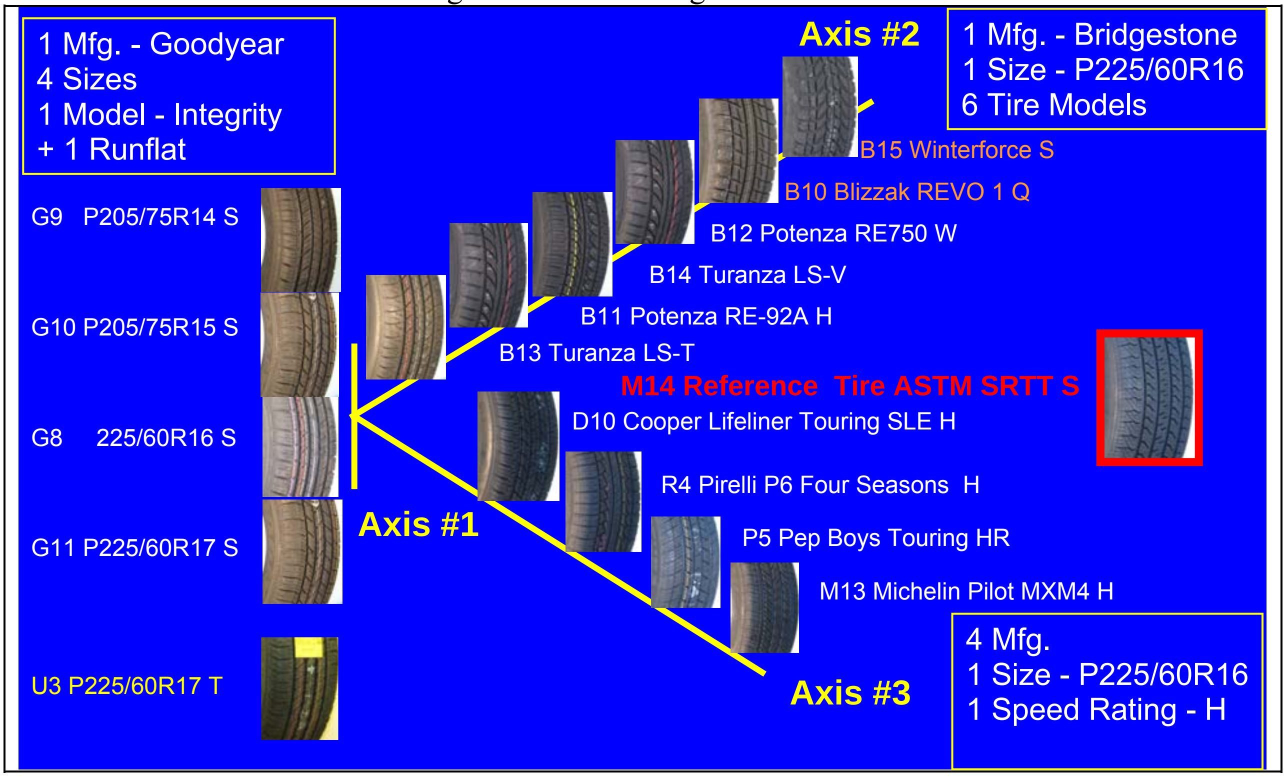
The Phase 1 test program utilized an assortment of approximately 600 new tires of 25 different models. Fifteen tire models were passenger, nine were light truck tire models, and one was the ASTM F2493-06 P225/60R16 97S Standard Reference Test Tire (SRTT). As discussed, only the 16 tire models covered by the EISA requirements were tested in Phase 2. This includes the DOT labeled ASTM SRTT tire and the original equipment tires that came on the fuel economy test vehicle.

<u>C.2 Passenger Tire Models</u>

Fifteen DOT-approved passenger tire models were purchased new for testing. Their specifications are detailed in Table III-3. The passenger tires were separated into three axes in the test program:

[48] For additional discussion, see a report titled "NHTSA Tire Rolling Resistance Rating System Test Development Project: Phase 2 – Effects of Tire Rolling Resistance Levels on Traction, Treadwear, and vehicle Fuel Economy".

Figure III-11. Passenger Tire Axes



When possible, tires were tested on wheels of the corresponding "measuring rim width" for their size. Wheels of each size used in the test program were purchased new, in identical lots to minimize wheel-to-wheel variation. Tires participating in multiple tests at the same lab or between two labs were mounted once on a single wheel and continued to be tested on that same wheel until completion of all tests.

C.3 Statistical Analysis of Phase 2 Test Results

C.3.1. Traction Data Analysis

Sixteen tire models representing a range of rolling resistance and of other characteristics were tested for both dry and wet traction by NHTSA. Data is reported as Slide Number (coefficient of friction x 10^2) and as a ratio to the course monitoring tire (ASTM E501 Standard Reference Test Tire), which is run along with the test tires. The coefficient of variation for the data ranged from 4% to 6%. There appears to be no significant relationship between dry traction values and rolling resistance for the tires studied. For wet traction there is a significant trend for the wet traction values to decrease as the rolling resistance improves. This is particularly evident for the sliding friction values.

C.3.1.1. Dry Traction Data

Table III-9 shows the average Slide Number, and its ratio to the E501 tire. Table III-10 shows the Pearson Product Moment Correlation of the values for dry traction to the tire rolling resistance. The Pearson value indicates the strength and direction of the correlation with values ranging from -1 for complete inverse correlation, to +1 for complete direct correlation, with values near zero indicating no correlation between the measures. It is evident that there is very little correlation between the traction and rolling resistance for these tires. For a value to be statistically significant the probability > |r| would have to be less than 0.050, and no value approaches that number. Figure III-12 and Figure III-13 display clearly that there is no indication that a tire with improved rolling resistance will necessarily have lower dry traction performance in this test.

Table III-9. Dry Traction Results, Slide Number and Ratio to E501 Reference Tire

Tire Type	ISO 28580 Rolling Resistance, lbs	Traction							
		Asphalt				Concrete			
		Peak Value		Sliding Value		Peak Value		Sliding Value	
		Slide Number	Ratio E501	Slide Number	Ratio E501	Slide Number	Ratio E501	Slide Number	Ratio E501
B10	12.02	93.83	94	77.65	127	96.45	91	86.63	107
B11	10.13	94.77	96	60.73	98	101.12	93	74.43	91
B12	15.22	103.90	106	56.33	89	108.18	102	71.95	88
B13	15.01	94.87	94	57.63	96	91.93	88	76.42	98
B14	13.90	101.50	102	75.76	125	107.58	100	85.02	106
B15	13.99	90.64	92	66.99	107	91.93	86	75.42	97
D10	13.56	94.60	95	62.10	101	102.71	96	74.77	94
G10	12.09	98.53	96	74.00	101	102.07	94	78.39	97
G11	10.02	97.45	99	64.66	93	104.07	96	75.95	93
G8	9.83	94.41	95	65.95	110	93.25	88	75.31	95
G9	11.27	98.25	98	74.16	109	102.20	95	78.82	97
M13	12.07	100.12	101	53.75	82	105.62	97	69.66	85
M14	11.96	99.53	101	66.67	104	105.50	97	81.70	100
P5	14.02	95.61	95	56.97	96	94.63	90	71.52	92
R4	14.98	104.19	106	71.13	112	107.86	103	84.38	104
U3	13.91	91.75	94	67.23	108	100.22	93	79.71	103
E501	-	99.23	*100*	63.48	*100*	107.15	*100*	80.32	*100*

Table III-10. Pearson Product Moment Correlation of Dry Traction to Rolling Resistance

Correlation to ISO 28580 Rolling Resistance	Pearson Product Moment Correlation							
	Asphalt, Dry Traction				Concrete, Dry Traction			
	Peak Value		Sliding Value		Peak Value		Sliding Value	
	Slide Number	Ratio E501	Slide Number	Ratio E501	Slide Number	Ratio E501	Slide Number	Ratio E501
	0.209	0.200	-0.158	0.045	0.056	0.209	0.069	0.217
Probability > |r|	0.2518	0.2730	0.3886	0.8073	0.7602	0.2507	0.7059	0.2336

Figure III-12. Dry Traction Slide Numbers Versus ISO 28580 Rolling Resistance

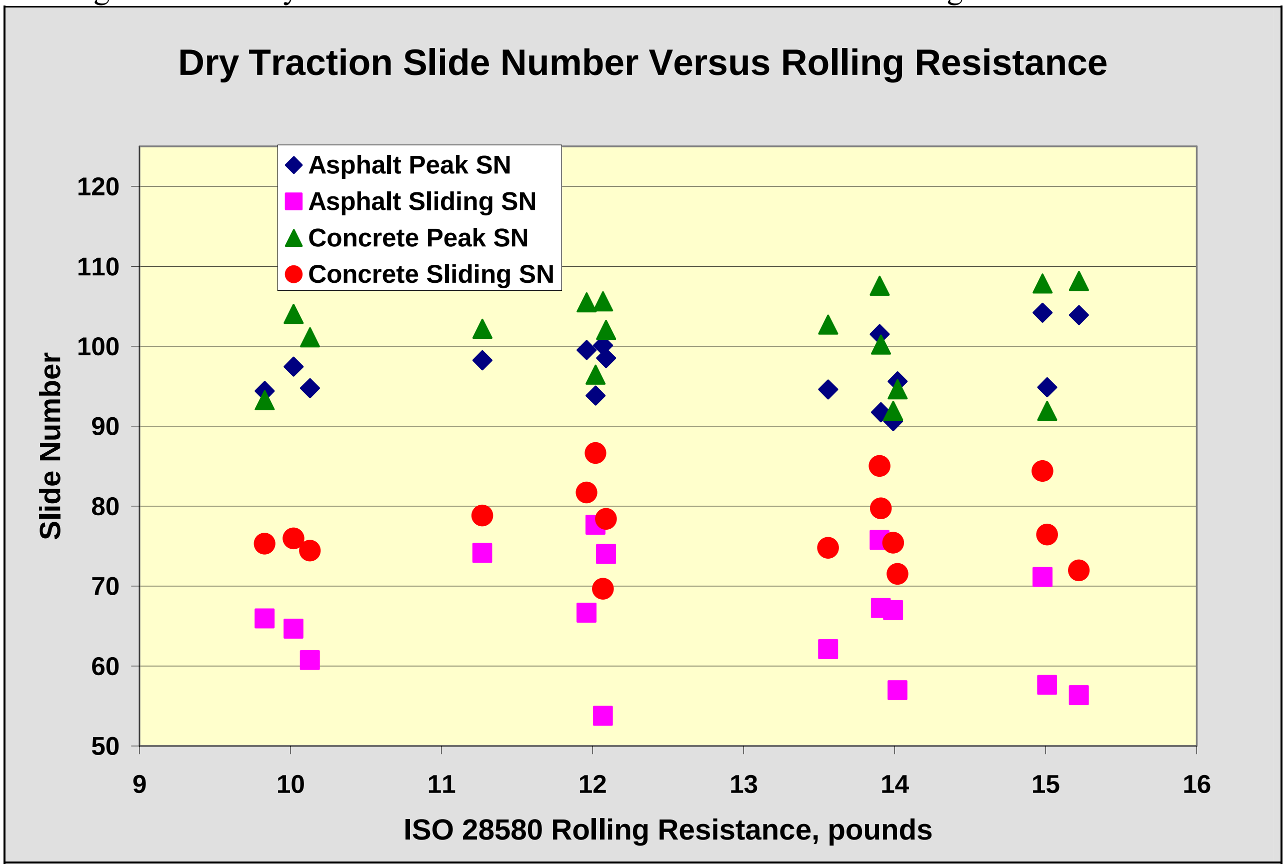
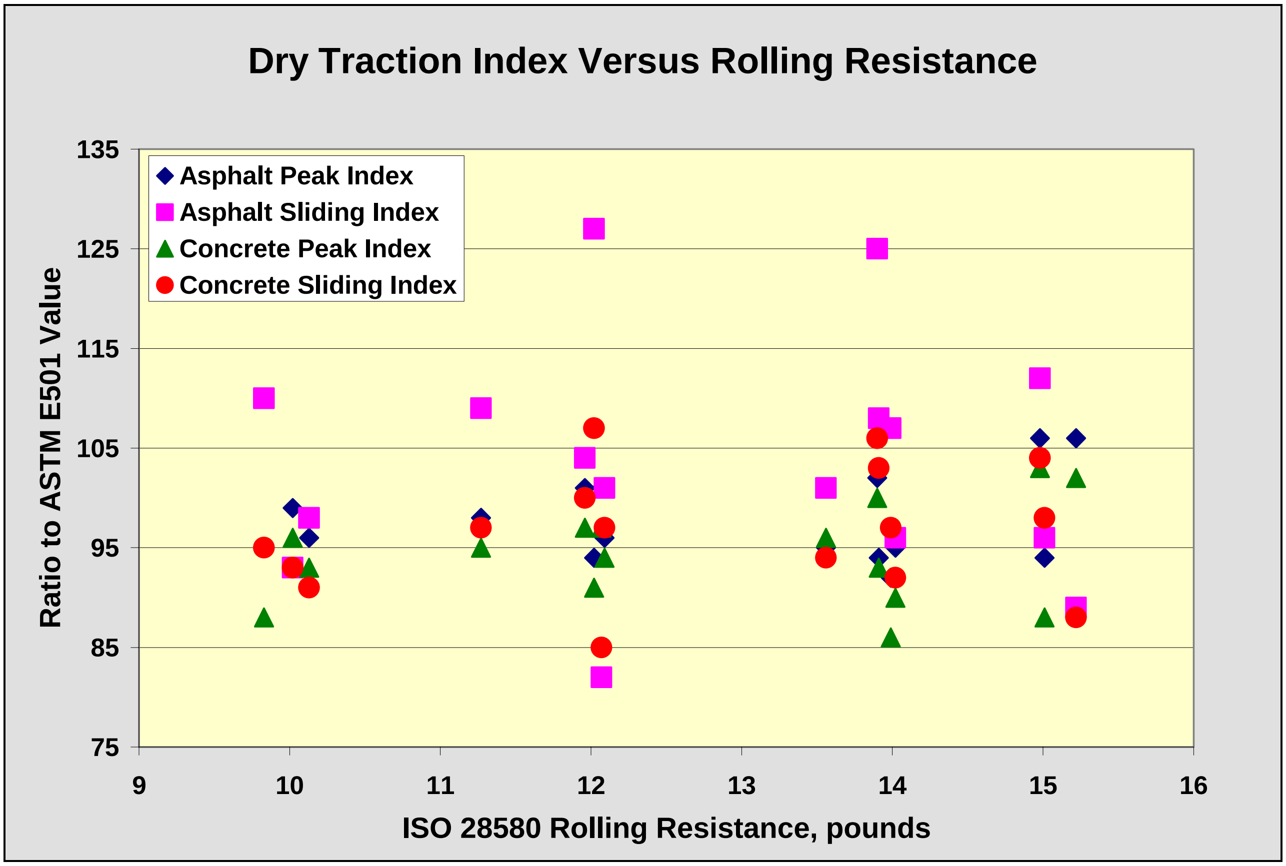


Figure III-13. Dry Traction Ratio to E501 Course Monitoring Tire Versus Rolling Resistance



C.3.1.2 Wet Traction Measurements

Table III-11 shows the average Slide Number, and its ratio to the E501 tire for the wet traction testing. Table III-12 shows the Pearson Product Moment Correlation of the values for wet traction to the tire rolling resistance. The Pearson value indicates the strength and direction of the correlation with values ranging from -1 for complete inverse correlation, to +1 for complete direct correlation, with values near zero indicating no correlation between the measures. For a value to be statistically significant the probability > |r| should be less than 0.050. The sliding values all have a strong and significant relationship between better rolling resistance and poorer wet traction. The peak values display the same tendency but the relationship is much weaker. Figure III-14 and Figure III-15 display these trends graphically for the Slide Numbers and the ratio to the E501 monitoring tire respectively. Even though these tires were not new, having been previously tested for rolling resistance in the laboratory, the UTQGS procedure was used for this testing and the results should display the same trends seen in new tires. The UTQGS traction rating is based on the wet sliding value on asphalt and concrete. Figure III-16 displays the wet traction slide number with the critical values to achieve an A or AA traction rating. Figure III-17 displays the data for the concrete surface. While most of these tires were labeled A traction and tested as such, it is clear that the values increase within the range as rolling resistance increases. From these data, it appears that there tires with lower rolling resistance values will have poorer wet traction performance. This will be particularly significant to consumers without ABS systems on their vehicles since the sliding value will relate most closely to emergency stopping maneuvers. For newer vehicles with ABS or ESC systems the tradeoff is much less significant.

Table III-11. Wet Traction Results, Slide Number and Ratio to E501 Reference Tire

Tire Type	ISO 28580 Rolling Resistance, lbs	Wet Traction							
		Asphalt				Concrete			
		Peak Value		Sliding Value		Peak Value		Sliding Value	
		Slide Number	Ratio E501	Slide Number	Ratio E501	Slide Number	Ratio E501	Slide Number	Ratio E501
B10	12.02	80.0	95	49.5	92	48.6	90	37.4	104
B11	10.13	87.2	102	46.4	90	63.0	110	36.4	99
B12	15.22	96.0	118	59.1	110	80.1	140	42.3	119
B13	15.01	92.3	105	57.7	108	71.1	120	41.0	111
B14	13.90	94.4	108	58.9	111	76.2	128	42.2	115
B15	13.99	79.3	94	52.4	97	54.1	101	35.4	98
D10	13.56	89.3	106	54.5	100	68.2	122	39.5	109
G10	12.09	83.5	105	55.1	101	56.3	106	36.7	103
G11	10.02	82.9	96	49.9	95	63.4	111	36.6	104
G8	9.83	87.6	101	48.9	93	58.9	103	35.1	100
G9	11.27	82.2	101	54.7	102	58.6	102	36.4	102
M13	12.07	93.8	103	50.9	97	73.4	132	40.1	111
M14	11.96	94.8	104	58.8	109	66.2	116	39.6	109
P5	14.02	84.1	99	54.3	105	70.2	124	41.0	112
R4	14.98	86.9	103	60.5	111	64.5	115	39.1	107
U3	13.91	87.5	100	53.7	100	64.9	109	40.2	109
E501	-	85.8	*100*	53.3	*100*	56.4	*100*	36.1	*100*

Table III-12. Pearson Product Moment Correlation of Wet Traction to Rolling Resistance

Correlation to ISO 28580 Rolling Resistance	Pearson Product Moment Correlation							
	Asphalt, Wet Traction				Concrete, Wet Traction			
	Peak Value		Sliding Value		Peak Value		Sliding Value	
	Slide Number	Ratio E501	Slide Number	Ratio E501	Slide Number	Ratio E501	Slide Number	Ratio E501
	0.299	0.391	0.739	0.725	0.465	0.473	0.700	0.628
Probability > |r|	0.0965	0.0270	<0.001	<0.001	0.007	0.006	<0.001	0.001

Figure III-14 Wet Traction Slide Numbers Versus ISO 28580 Rolling Resistance

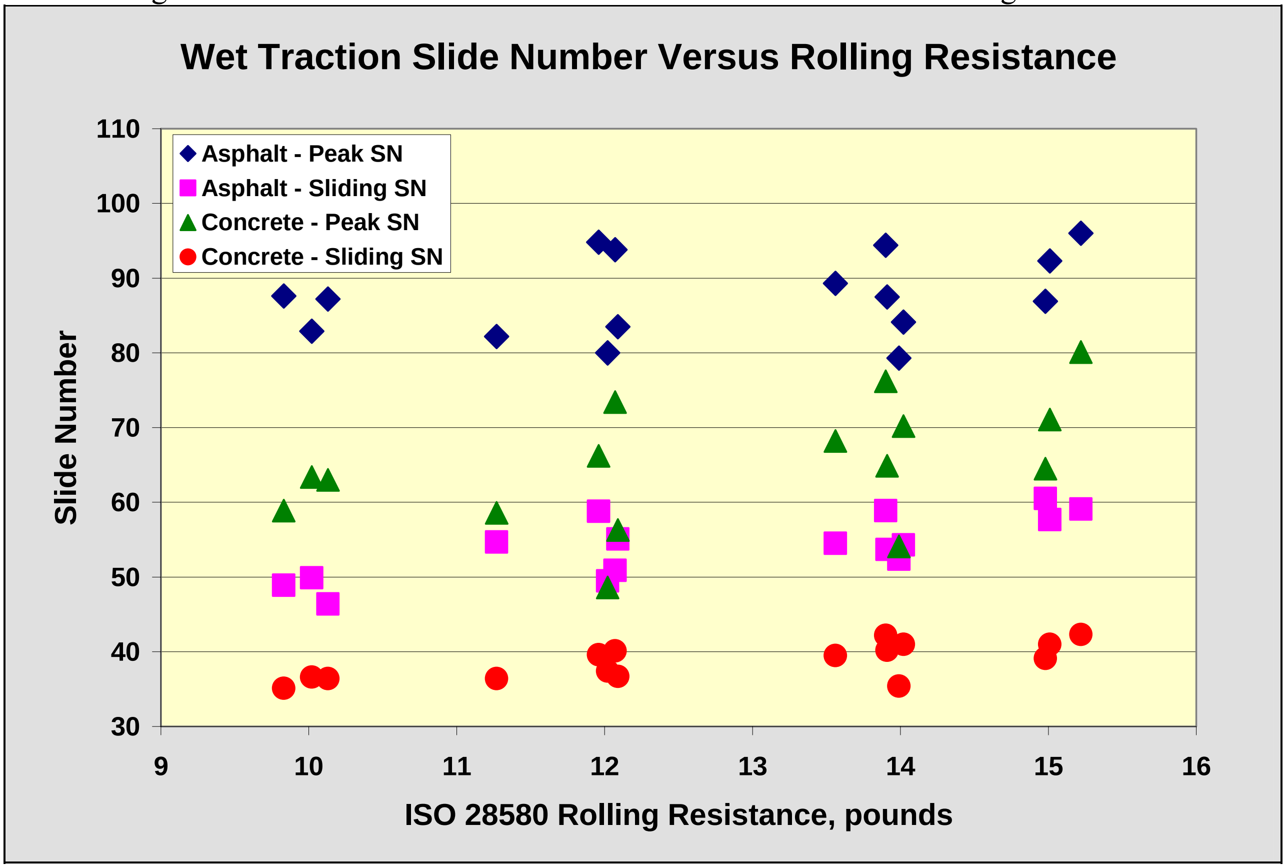


Figure III-15. Wet Traction Ratio to E501 Course Monitoring Tire Versus Rolling Resistance

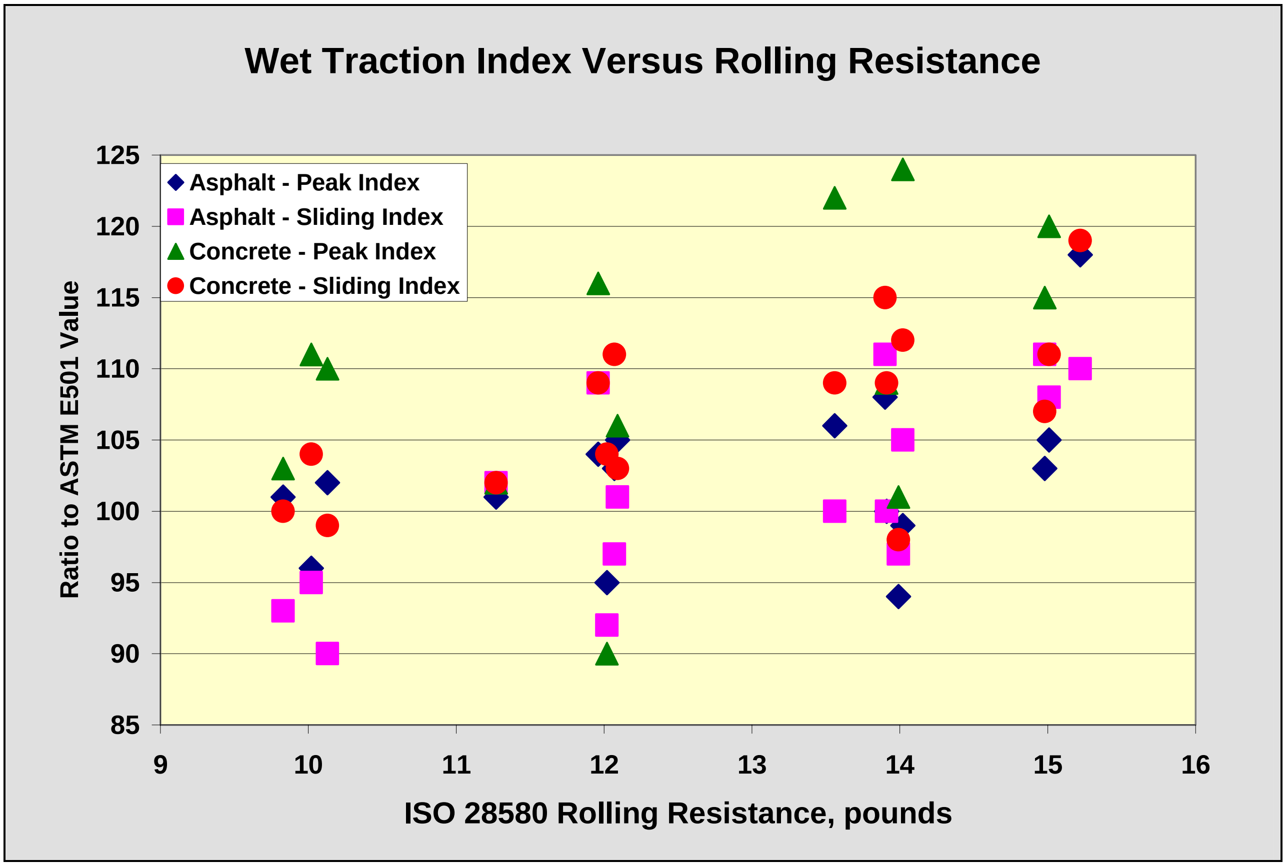


Figure III-16. Asphalt Wet Traction Rating Versus ISO 28580 Rolling Resistance

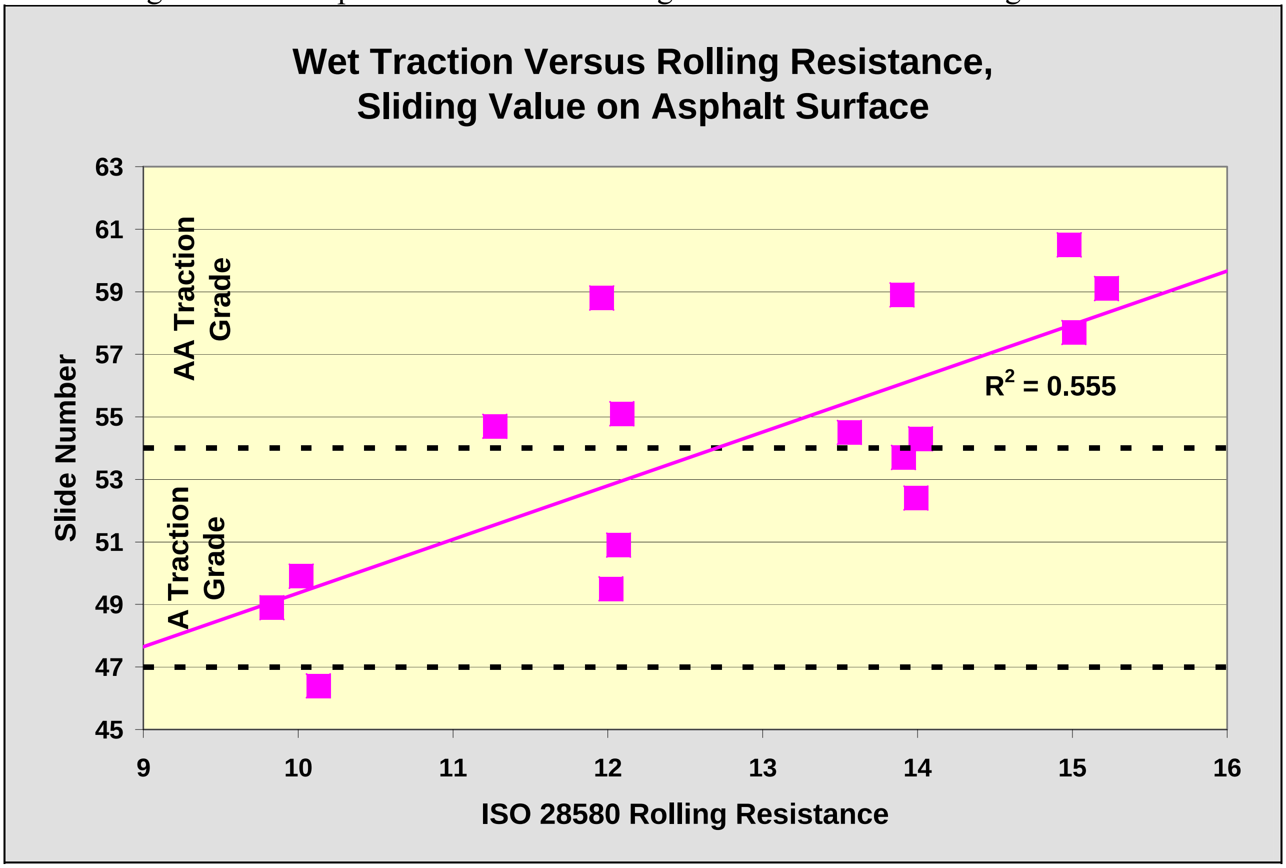
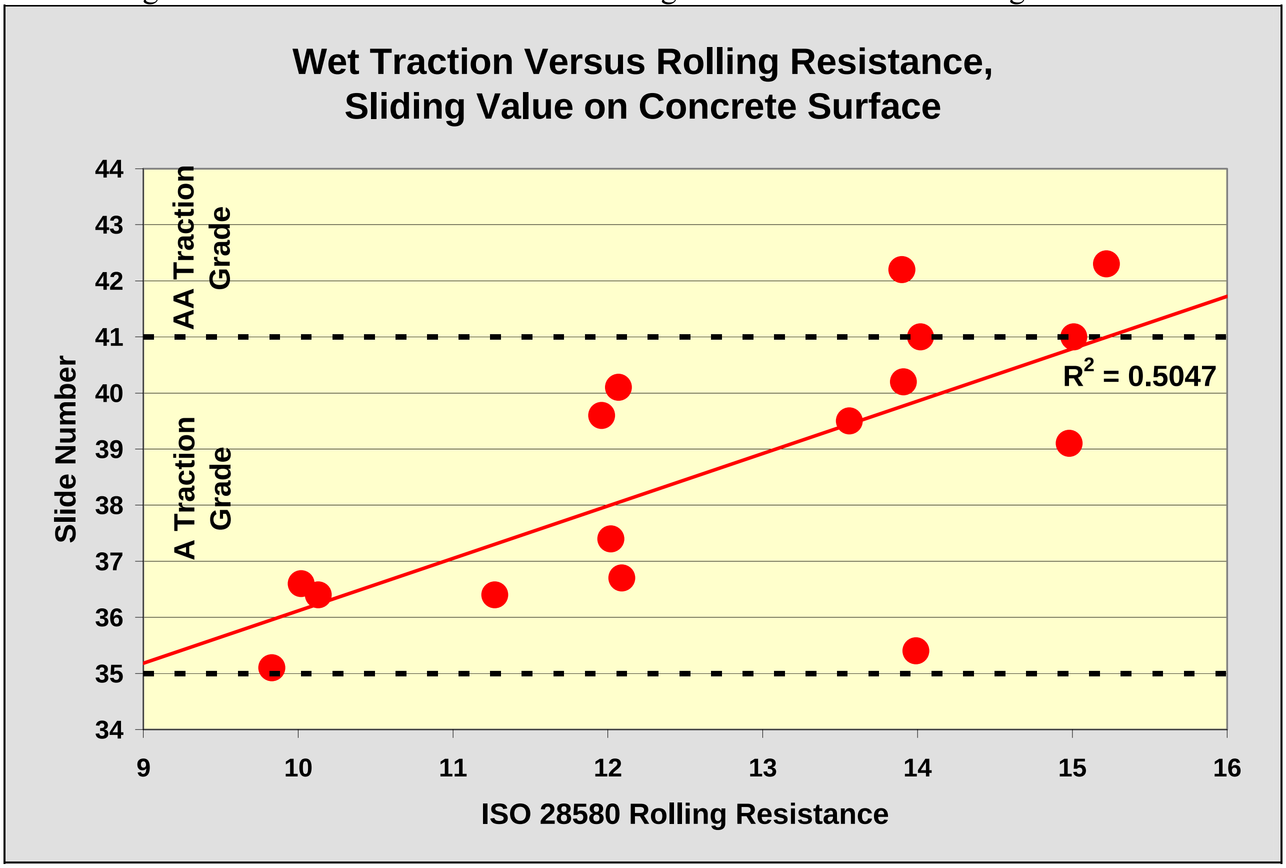


Figure III-17 Concrete Wet Traction Rating Versus ISO 28580 Rolling Resistance



(C.2) Analysis of Wear Data from UTQGS Course

As was seen previously, there was not a good correlation between the rolling resistance and the UTQGS treadwear grade of the tires studied. Four tire models which were selected to represent the range of rolling resistance of the models studied, along with the SRTT (tire type M14), were tested by NHTSA according to the UTQGS testing protocol for treadwear. Although these tires were previously tested for rolling resistance in a laboratory, the wear rates and projected mileages are expected to be similar to those for new tires of the same model. Measurements were taken across the tire at six locations in each groove (1 through 4). Data were analyzed by tire type, by groove, by shoulder (groove 1&4) or tread center (groove 2&3). The coefficients of variation for the wear rates are approximately 0.5% for all tire types indicating that comparisons between tire types at these conditions are reliable. Models for the wear rate against course mileage produced R^2 values of 0.94 to 0.97 for linear models and 0.98 to 0.99 for quadratic models. For all tire types except B13 the quadratic term was statistically significant, indicating that the wear rate tends to change (either increase or decrease) as the tire wears.

Table III-13. Analysis of Tire Wear Data

Tire Type	Coefficient of Variation	Groove 1 to 4	Shoulder Versus Tread Center	Non-Linear Behavior
B11	0.30%	Groove 1 shows faster wear rate[49]	Shoulder wear rate faster than tread center	Wear rate tends to increase
B13	0.44%	-	Similar wear rates	No change in wear rate
G8	0.51%	Groove 4 shows slower wear rate[50]	Similar wear rates	Wear rate tends to increase
M13	0.54%	-	Tread center wear rate faster than shoulder	Wear rate tends to decrease
M14	0.43%	-	Tread center wear rate faster than shoulder	Wear rate tends to decrease

Table III-14 shows the treadwear rates and projected mileage to 2/32^nds tread depth for the tires. For each model the wear rates for the shoulder and tread center were compared along with the projected lifetime for each area. For tire type B11 the wear rate in the shoulder area was significantly faster than the wear rate in the tread center with a corresponding decrease in projected mileage. For tire type M14 the wear rate in the tread center was significantly faster than in the shoulder area with significantly shorter projected tread life in this area. Tire type M13 had faster wear rates in the tread center but this was partially offset by a lesser groove depth in the tread center. Figure III-18 shows the projected average tire mileage to wear out and the minimum projected mileage, versus the rolling resistance for the tire. From these data, there is no relationship between expected tire lifetime and rolling resistance. Since the tread depth may affect both rolling resistance and tire lifetime the average wear rate and the fastest wear rate, either from the shoulder or tread center area, was compared to the rolling resistance. It is evident from Figure III-19 that there is no clear relationship between wear rate and rolling resistance for these tires. In summary, there is no evidence from this data that a tire with reduced rolling resistance will necessarily have reduced tread life.

Table III-14. Wear Rates and Projected Mileage to 2/32^nds Tread Depth from UTQGS Treadwear Course

Performance Level	Tire Type	Rolling Resistance,	Reported Wear Rate, mil/1000mi	Projected Tread Life, miles	Wear Rate in Shoulder, mil/1000mi	Wear Rate in Tread Center, mil/1000mi	Projected Life, miles (Shoulder)	Projected Life, miles (Tread Center)
High performance all season	B11	10.13	5.155	54,840	5.752	4.528	48,550	63,200
Standard touring all season	B13	15.01	6.463	52,020	6.374	6.276	51,790	54,540

[49] Data was influenced by high wear rate of tire #3146. The other B11 tires showed no anomalous behavior for individual grooves

[50] All type G8 tires showed anomalous behavior for groove 4

Passenger all season	G8	9.83	6.447	45,390	6.211	6.471	46,460	45,840
Grand touring all season	M13	12.07	5.448	41,310	4.795	5.768	45,150	40,500
Standard reference test tire	M14	11.96	5.558	45,000	4.359	6.449	56,730	39,230

Figure III-18. Projected Tire Mileage to Wearout (Average and Minimum) Versus ISO 28580 Rolling Resistance

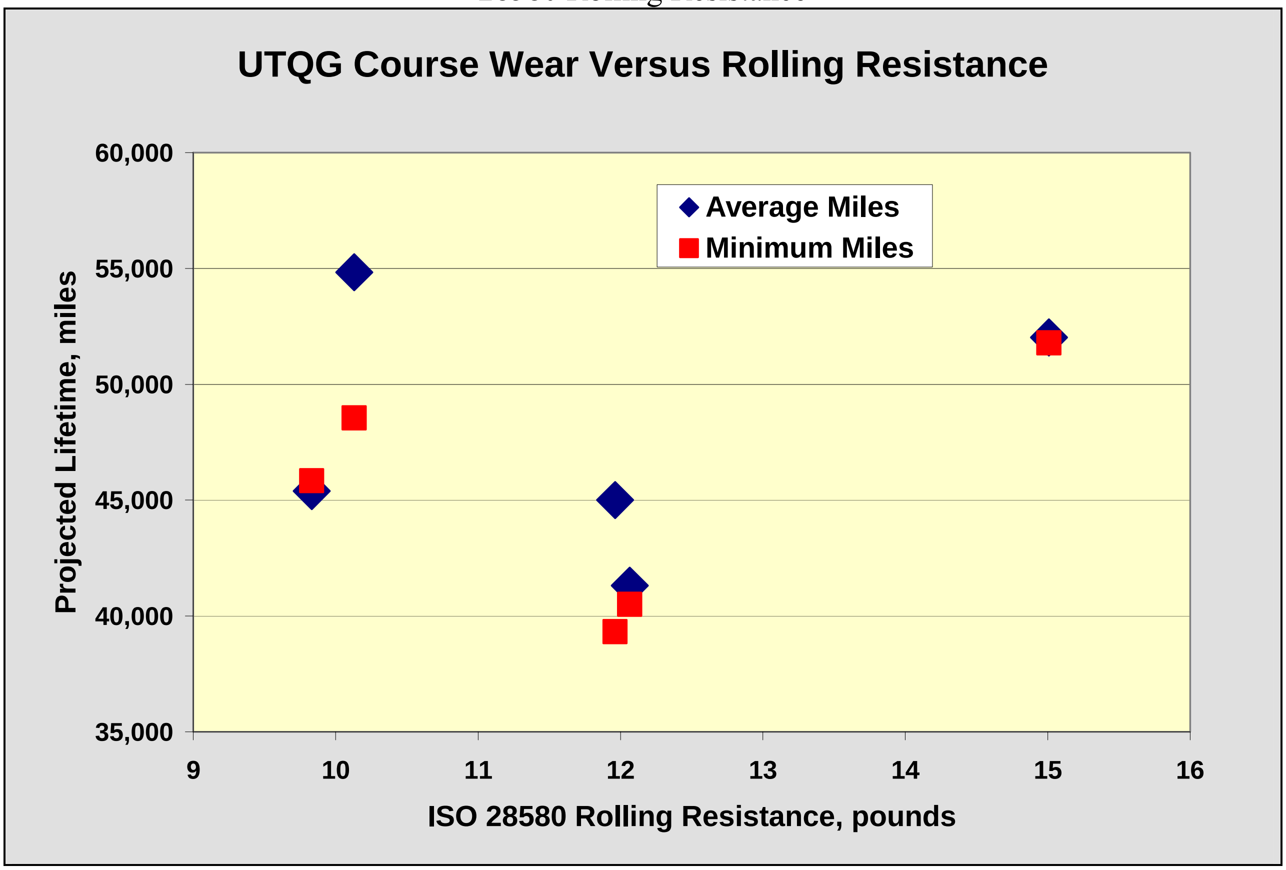
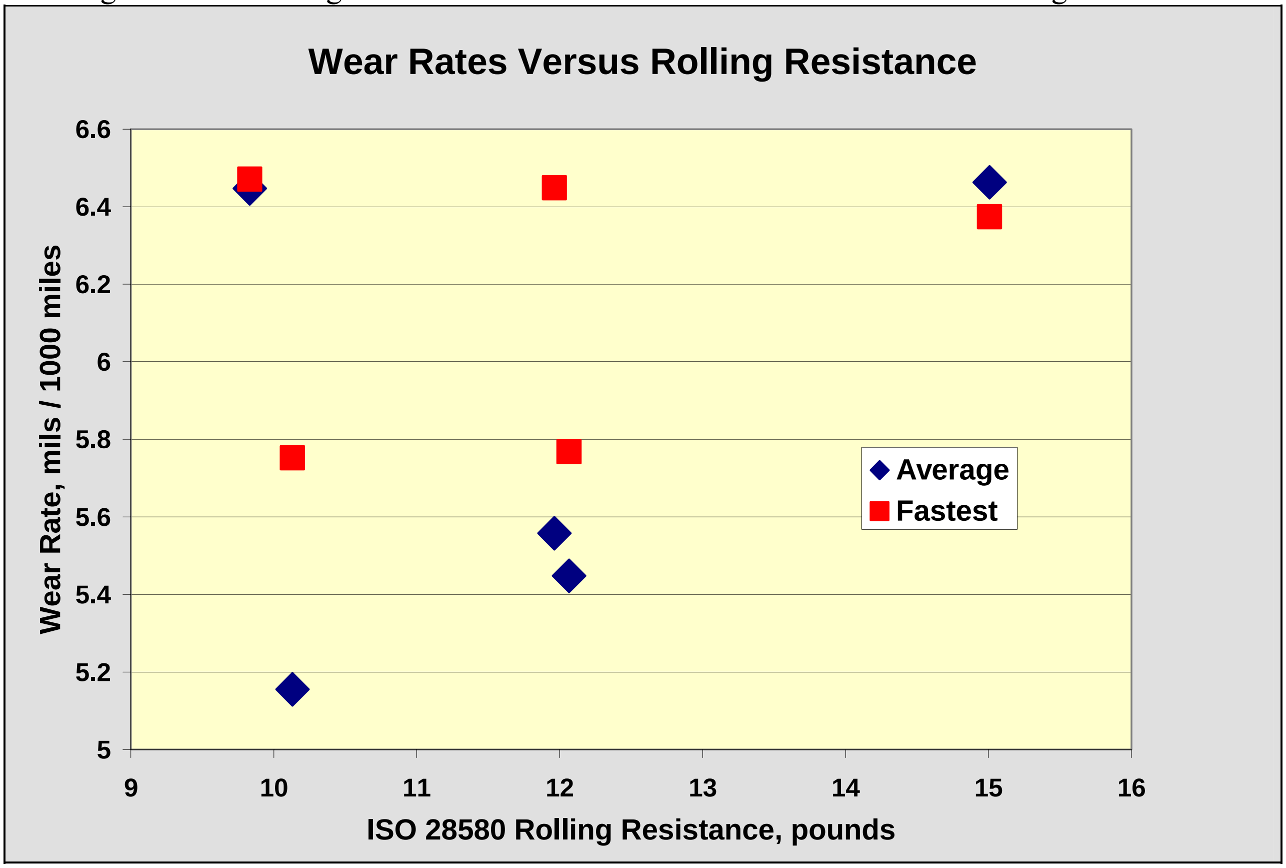


Figure III-19 Average and Fastest Treadwear Rate Versus ISO 28580 Rolling Resistance



C.3. Comparison of Rolling Resistance Force by Performance Levels

When the rolling resistance results from passenger tires were compared by performance levels, tires deigned for passenger cars for all seasons, "Passenger All Seasons" showed a relatively large difference among all season tires. It ranges from 9.84 lbs for the Goodyear tire to 14.98 lbs. for the Pirelli tire, as shown in Table III-15 and Figure III-20. When compared to all season tires, the Performance Winter (winter tires) and the Grand Touring had a relatively small difference in rolling resistance force, 4.19 & 5.15 lbs. versus 1.97 lbs. for the Performance Winter and 1.83 lbs. for the Grand Touring. The results in Table III-16 indicated that the rolling resistance of a tire could be reduced without adversely affecting the performance.

Table III-15. Comparison of Rolling Resistance Force (lbs.) by Performance Levels

Performance Winter	Model	RRF	RRF Difference
Bridgestone	Blizzak REVO1	12.02	
Dayton	Winterforce	13.99	1.97
Passenger All Seasons			
Goodyear	Passenger All Seasons	9.83	
Pep Boys	Touring HR	14.02	4.19
Pirelli	Passenger All Seasons	14.98	5.15
Grand Touring			
Bridgestone	Grand Touring All Seasons	13.90	1.83
Michelin	Pilot MXM4	12.07	

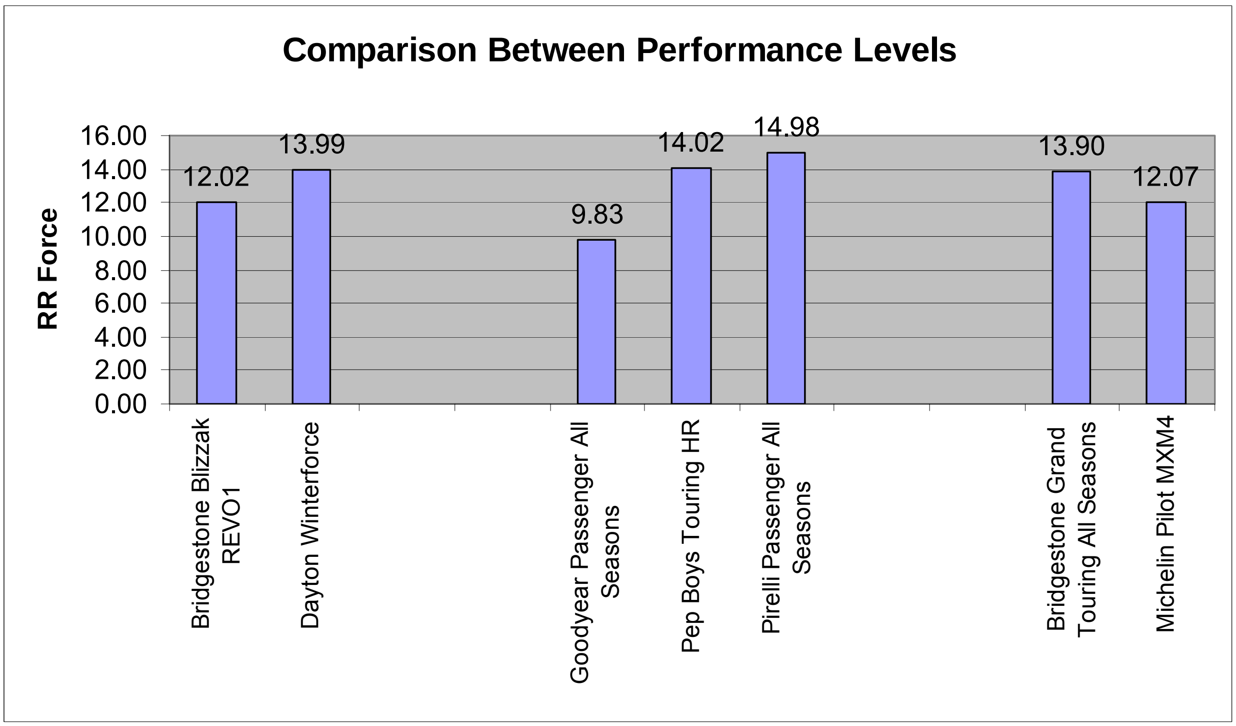


Figure III-20. Comparison between performance levels for passenger tires.

C.4 Fuel saving vs. rolling resistance

We expect a significant increase in fuel economy as tire rolling resistance improves. According to NHTSA dynamometer testing, a 10 percent reduction in rolling resistance results in a 1.1 percent improvement in vehicle fuel economy, as shown below:

Table III-16. Reduction in RR force vs. Fuel Saved

Test	Increase for 1 lb RR force decrease	Increase for 10% RR force decrease
Highway cycle	0.33 mpg	1.1%
City Cycle	0.18 mpg	1.0%
High Speed Cycle	0.23 mpg	1.3%
Cold City Cycle	0.17 mpg	1.1%
Air Conditioning Cycle	0.13 mpg	0.8%

For example, when Bridgestone Grand Touring All Season tire (P225/60R16) is replaced by Michelin Grand Touring All Season tire (225/60R16), it would result in a 13% reduction in rolling resistance force. The 13% reduction in RR force would result in a 1.4% improvement in fuel economy.[51]

C.5 Summary of Phase 2 tests

The wet condition test results showed that the wet traction slide number with the critical values to achieve an A or AA traction rating. While most of these tires were labeled A traction and tested as such, it is clear that of the tires tested the wet traction values decrease as rolling resistance decreases. This will be particularly significant to consumers without ABS systems on their vehicles since the sliding value will relate most closely to emergency stopping maneuvers. However, for newer vehicles with ABS or ESC systems the tradeoff is much less significant.

The treadwear test data showed that there is no relationship between expected tire lifetime and rolling resistance. Since the tread depth may affect both rolling resistance and tire lifetime the average wear rate and the fastest wear rate, either from the shoulder or tread center area, was compared to the rolling resistance. The test data showed that there is no clear relationship between wear rate and rolling resistance for these tires. In summary, there is no evidence from this data that a tire with reduced rolling resistance will necessarily have reduced tread life.

[51] For example, with a 25 mph baseline, 10,000 miles travel per year, with 13% reduction in RRF, the resulting fuel saving can be calculated with the following equation: 10,000 x [1/25 – 1/(25x(1+((0.13/0.1)x0.011))] = 5.6 gallons. The effects of RRF on fuel economy are further discussed in Chapter V.

IV ALTERNATIVES

There were two areas in which the agency considered alternative regulatory approaches for the proposed rule. These alternatives include:

Rolling measurement
Data presentation

IV.A. Rolling Resistance Force (RRF) vs. Rolling Resistance Coefficient (RRC)

Rolling resistance force is simply the manifestation of all of the energy losses associated with the rolling of a tire under load. Accordingly, in a laboratory, rolling resistance is measured by running a tire under load on a test wheel (referred to as “roadwheel”). The energy consumed in driving the tire is measured and the energy recovered from the tire is measured by the test equipment. The difference is the heat energy lost which is the measure of rolling resistance; the smaller the difference, the more fuel efficient the tire. NHTSA is only interested in the force required to maintain a steady state of movement, i.e., speed. Therefore the steady state, or constant, speed test methods are the only ones considered by NHTSA.

Rolling resistance coefficient (RRC) is another measurement of rolling resistance sometimes specified in a test method. To determine RRC, the rolling resistance force (RRF) determined from the test machines must be divided by the load at which the test was performed. RRC is discussed in greater detail below in section V of this notice.

Figure IV-1 shows a typical laboratory test machine for measuring rolling resistance. In this test a tire and rim are mounted on the machine. The tire is held against the roadwheel by an actuating cylinder aligned with the center of the roadwheel. A drive motor coupled to the roadwheel rotates the roadwheel. Consequently, the roadwheel drives the tire through friction at the contact patch. The tire’s rolling resistance retards the roadwheel’s rotation speed. This effect is then measured using any combination of the forces, torques, speeds, or acceleration of the roadwheel. Then the rolling resistance is calculated from the measured quantities.

A tire’s rolling resistance is the energy consumed by a rolling tire, or the mechanical energy converted into heat by a tire, moving a unit distance on the roadway. The magnitude of rolling resistance depends on the tire used, the nature of the surface on which it rolls, and the operating conditions – inflation pressure, load, and speed. *Id.*

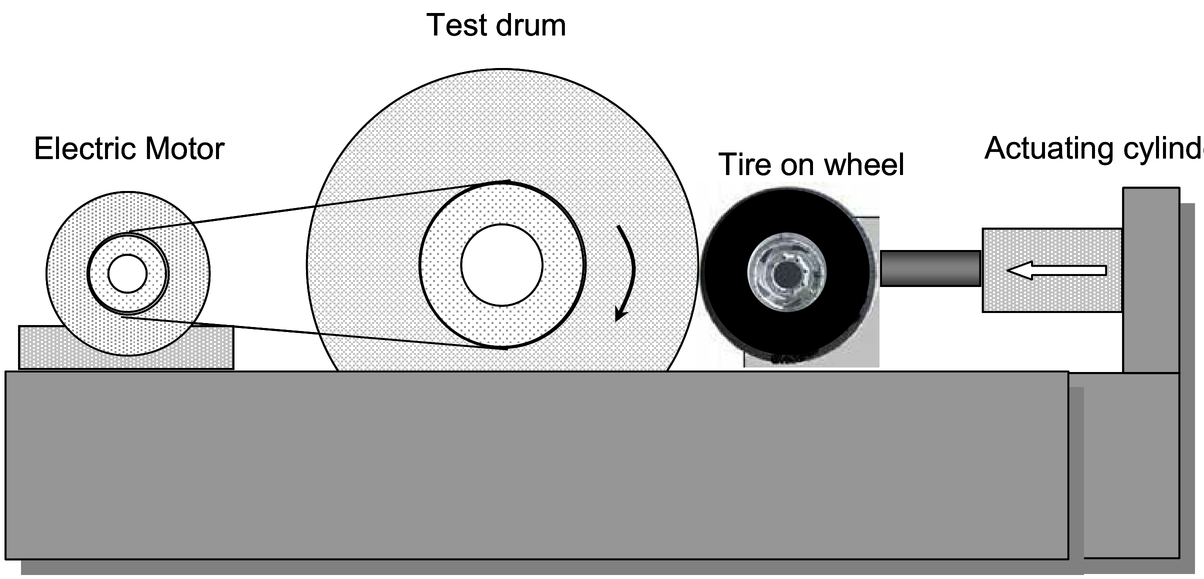


Figure IV-1. Typical Test Configuration for Rolling Resistance Measurements

Four measurement methods of energy loss are in common use and prescribed in test procedures, although not all of the methods are advocated in every standard.[52] The methods described in the test standards include the following: measurement of the resistive force at the tire spindle while rolling at constant speed (force method), measurement of the resistive torque on the roadwheel hub at constant speed (torque method), measurement of the electrical power used by the motor to keep the roadwheel rotating at a constant speed (power method), and measurement of deceleration when the driving force at the roadwheel is discontinued (deceleration method).[53] The two methods evaluated in NHTSA research were the force and torque methods. Therefore deceleration and power methods are not discussed.

Force Method

The force method measures the force at the tire spindle. See Figure IV-2. The roadwheel is brought up to the specified test speed and the tire is warmed up (warm-up) to an equilibrium temperature. The tire is then lightly loaded[54] to measure the losses caused by the spindle holding the tire and aerodynamic losses from the tire spinning. This force measurement is referred to as the skim load value. The tire is then loaded to the test load

[52] The proposed test procedure, ISO 28580, has provisions to use all four methods to measure the energy loss.

[53] National Highway Traffic Safety Administration, The Pneumatic Tire, DOT HS 810 561, at 515 (February 2006).

[54] Lightly loaded is not a specific number of pounds, but just enough load to keep the tire in contact with the roadwheel, so that the speed of the tire is equal to the speed of the roadwheel surface so there is no slippage.

and successive readings of the resistive force at the tire spindle while rolling at constant speed are taken until consistent force values are obtained.[55]

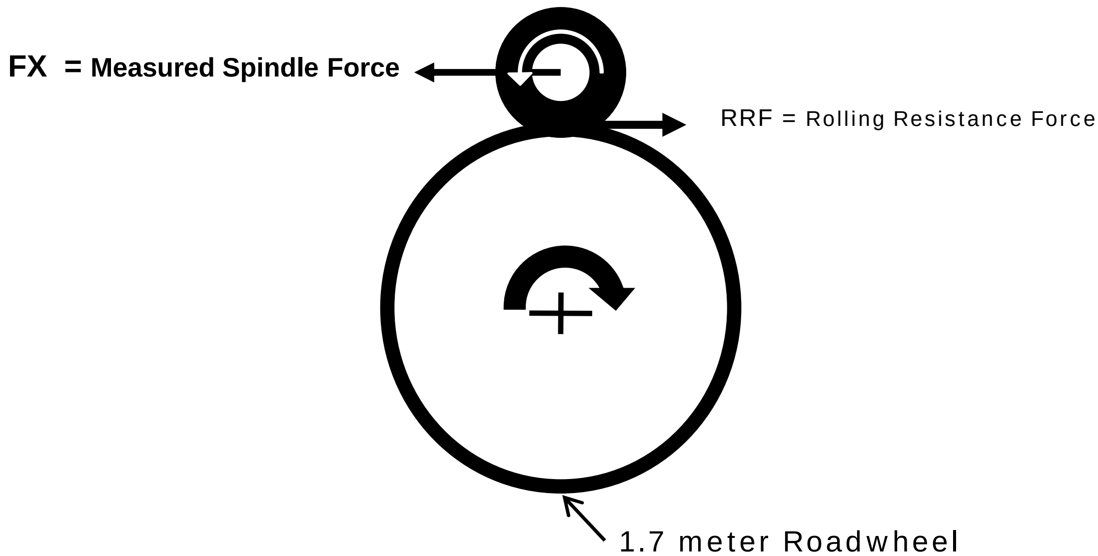


Figure IV-2. Force Method Rolling Resistance

The reported force value is equal to the measured force at the spindle minus the skim load value, thereby reporting actual Rolling Resistance Force (RRF) value of the tire. This force is trying to slow down the rotation or travel of the roadwheel due to the energy loss.

Torque Method

The torque method measures the energy, or torque, required to maintain the rotation of the roadwheel. The roadwheel is connected to the motor through a "torque cell." See Figure IV-3. The roadwheel is brought up to speed and the tire is warmed up (warm-up) to an equilibrium temperature. The tire is then lightly loaded to measure the losses caused by the spindle holding the tire and aerodynamic losses from the tire spinning (skim load value). The tire is then loaded to the test load and successive readings of the resistive torque on the roadwheel hub at constant speed are taken until consistent force values are obtained.

[55] As the machinery ramps up the tire speed to the specified test speed, the force values measured bounce around at first. An accurate measurement can only be taken when the tire is moving at a constant speed and is a constant temperature. Thus, there is a slight delay from ramping up to the specified test speed, and the measurement of an accurate and steady force reading.

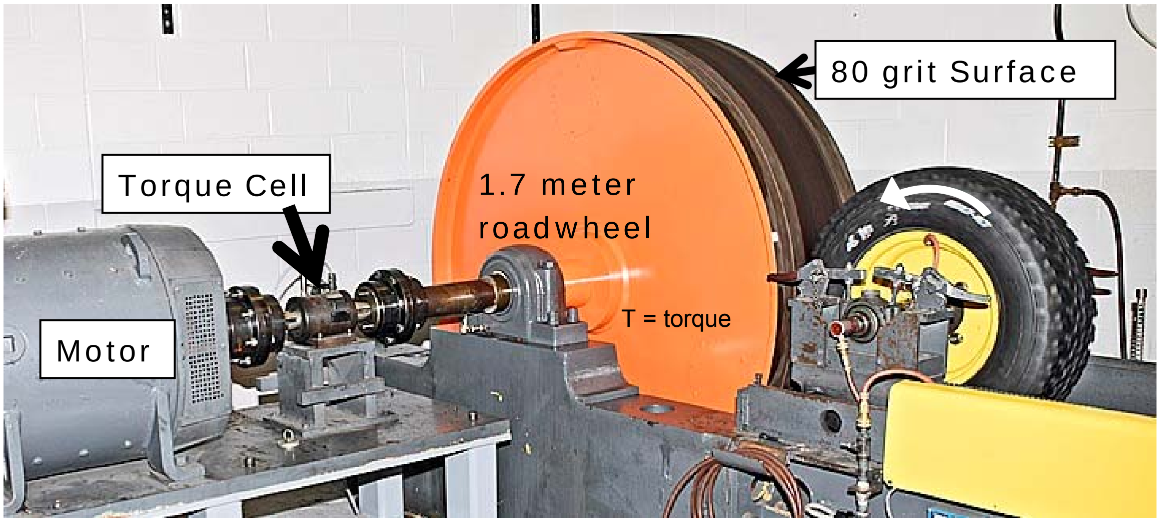


Figure IV-3. Torque Method Rolling Resistance

The values measured for skim and loaded torque must be processed to determine the force (RRF). The skim must be subtracted from the loaded torque value divided by the radius of the roadwheel to determine the tires contribution to the total loss. The result is Rolling Resistance Force (RRF).

The output of the rolling resistance test machines is used to calculate the rolling resistance force (RRF) in pounds of force (lbf) or Newtons (N) at the interface of the tire and drum, or the force at the axle in the direction of travel required to make a loaded tire roll. Rolling resistance is often expressed and reported in terms of Rolling Resistance Coefficient (RRC) (N/kN, kg/tonne, lbf/kip), which is the rolling resistance force divided by the test load on the tire.[56] Since rolling resistance changes with the load on the tire, this makes direct comparisons between the tires tested at different loads difficult. The pending European rating system uses RRC as the metric for a rolling resistance rating/score. However, NHTSA is proposing to base the U.S. tire fuel efficiency rating on the RRF metric. NHTSA has tentatively concluded that a rating based on RRF is more descriptive and would provide more information to consumers, than a rating based on RRC. We request comment on the differences between basing a rolling resistance rating system on RRF versus on RRC, and which is more appropriate for the purposes of our statutory mandate under EISA.

The use of RRC has its roots in the idea that a specific vehicle model will be operated with a nominal vertical load on a tire, but has a range of tire sizes with varying load capacities available for original equipment (OE) fitment. Another application of RRC would be for consumers looking to replace tires on their vehicle with tires of the same size but different maximum load ratings. FMVSS 139 allows load ratings to be

[56] Most test procedures specify test load as a percentage of the maximum load rating of the tire being tested. For example, the ISO 28580 test procedure specifies a load of 80% of the maximum sidewall load.

determined from one of six international organizations,[57] or specified to the agency by an individual manufacturer. For example, the agency's research used a large number of tire models of the most popular P-metric replacement tire size in 2007, P225/60R16. The standard load P225/60R16 Goodyear Integrity tire (type G12), which was OE on the test vehicle, has a load index of 97 (shown later as load rating 97 – LR97) that allows it to carry a maximum of 1609 lbs (730 kg). The metric 225/60R16 Goodyear Integrity tire (type G8) has a load index of 98 (shown later as load rating 98 – LR98), allowing it to carry 1653 lbs (750 kg), or 44 lbs (20 kg) more. Per ISO 28580, the P225/60R16 - LR97 is tested at 80% of 1609 lbs (1287 lbf) and the 225/60R16 LR98 tire at 80% of 1653 lbs (1322 lbf), or 35 lbf more load in the test. In this case, the average rolling resistance in the ISO 28580 test of the P225/60R16 – LR97 Integrity tire was 9.47 lbs, and the 225/60R16 – LR98 was 9.83 lbs. To allow a comparison of the rolling resistance of each tire on a given vehicle, the RRC is calculated. The RRC of the P225/60R16 – LR97 is 9.47 lbf / 1287 lbf = 0.00736 lbf/lbf and the RRC of the 225/60R16 – LR98 is 9.83 lbf / 1322 lbf = 0.00743 lbf/lbf.

The RRC may now be tailored to a given vehicle. Vehicle A may have a GAWR of 2500 lbs (1250 lbs per wheel). Multiplying the 1250 lbs per wheel load of Vehicle A by the RRC of each tire yields a predicted rolling resistance of 0.00736 lbf/lbf * 1250 lbf = 9.20 lbf for the P225/60R16 – LR97, and 9.29 lbf for the 225/60R16 – LR98. As summarized in

[57] The tire load rating shall be that specified either in a submission made by an individual manufacturer, pursuant to *S4*, or in one of the publications described in *S4* for its size designation, type and each appropriate inflation pressure. *S4* (1) The Tire and Rim Association; (2) The European Tyre and Rim Technical Organization; (3) Japan Automobile Tire Manufacturers' Association, Inc.; (4) Tyre & Rim Association of Australia; (5) Associacao Latino Americana de Pneus e Aros (Brazil); (6) South African Bureau of Standards. (FMVSS 571.139).

Table IV-1, the apparent 3.8% difference in rolling resistance between the two tires due to different test loads is reduced to 1% when RRC is used to scale the tires to a specific nominal load. The RRC of each tire is then used to calculate the estimated rolling force of a second example vehicle (B), with largely different GAWR. Since RRC is a ratio based on a single test load in ISO 28580, the predicted difference between the tire models G12 and G8 is the same for vehicles A and B (1.0%).

Table IV-1
Example #1 Comparison of Rolling Force vs. Rolling Resistance Coefficient

	P225/60R16 97 S Integrity (G12) - OE	225/60R16 98 S Integrity (G8)	Difference	% Difference
Max Load (lbs)	1609	1653	44	2.7%
80% Max Load (lbf)	1287.2	1322.4	35.2	2.7%
ISO 28580 RRF (lbf)*	9.47	9.83	0.36	3.8%
RRC (lbf/kip)	7.36	7.43	0.076	1.0%
10% Reserved Load (lbs)	1448.1	1487.7	-	-
Vehicle A GAWR (lbs)	2500	2500	-	-
Estimated RRF(lbf)	9.20	9.29	0.10	1.0%
Vehicle B GAWR (lbs)	2880	2880	-	-
Estimated RRF (lbf)	10.59	10.70	0.11	1.0%

*Required accuracy of spindle force for ISO 28580 is +/- 0.5 N (0.1 lbf)

A second example uses the same two tire sizes but tire type G8 is replaced with type R4, which has a much higher rolling resistance at 14.98 lbf (Table IV-1). When RRC is used for Vehicles A and B, the 58.2% difference in rolling resistance is estimated to be 54.0% when scaled to the specific nominal loads of the two vehicles.

Table IV-1
Example #2 Comparison of Rolling Force vs. Rolling Resistance Coefficient

	P225/60R16 97 S Integrity (G12) - OE	225/60R16 98 H P6 Four Seasons (R4)	Difference	% Difference
Max Load (lbs)	1609	1653	44	2.7%
80% Max Load (lbf)	1287.2	1322.4	35.2	2.7%
ISO 28580 RRF (lbf)*	9.47	14.98	5.51	58.2%
RRC (lbf/kip)	7.36	11.33	3.97	54.0%
10% Reserved Load (lbs)	1448.1	1487.7	-	-
Vehicle A GAWR (lbs)	2500	2500	-	-
Estimated RRF (lbf)	9.20	14.16	4.96	54.0%
Vehicle B GAWR (lbs)	2880	2880	-	-
Estimated RRF (lbf)	10.59	16.31	5.72	54.0%

Therefore, RRC appears to be useful when estimating the rolling resistance of tires with multiple load indexes for a specific vehicle, for which the lowest of the load indexes has sufficient legal load carrying capacity. However, in the case of rating tires for a general vehicle fleet, for which the individual nominal vehicle loads are not known, RRC is no more useful than RRF.

It is also important to consider the implications of using RRC to categorize a wide range of tires in a rating system. When RRC is applied over a large range of tire sizes, it tends to produce lower relative values for large tires than for small tires, despite the fact that the large tires may use more energy. Schuring & Futamura (1990) reported this trend in 1980's era tires (13-15 inch tires sizes).

> If a family of tires of different sizes would be tested for rolling loss at a maximum load (prescribed by the Tire and Rim Association), or at a fixed fraction of maximum load, as well as at a constant pressure and constant speed, and if rolling loss would be directly proportional to maximum load (or a fraction thereof), then by definition, the rolling loss coefficient derived from these tests would be independent of size. This however is not the rule. Rolling loss does increase not quite in proportion with increasing maximum load (or fractions of it); hence, the rolling-loss coefficient of larger tires is mostly smaller than those of smaller tires. … The reason for the slight decline in the rolling-loss coefficient with tire size is not clear. We may speculate that the load formula (a rather complex empirical relation between permissible tire load, pressure, and tire dimensions, developed and continuously amended over the decades by the Tire and Rim Association) had been adjusted such that larger tires experience slightly lower strains than smaller tires.[58]

What Schuring and Futamura observed in 13-15 inch tire sizes is a result of the load term in the denominator of the RRC equation. This is where the non-linear formulas that determine the maximum load ratings have a large effect. For instance, **Error! Reference source not found.** below is the maximum load formula used by the Tire and Rim Association, Inc.[59] Note the coefficients raised to powers, as well as the different values for coefficient depending on the aspect ratio of the tire.

Maximum Load "L" (kg) = $(K) \times (P^{0.50}) \times (S_d^{1.39}) \times (Dr + S_d)$

Variable	30 Series through 35 Series	40 Series through 45 Series	50 Series through 80 Series
K	**5.00×10^{-5}**	**5.67×10^{-5}**	**6.67×10^{-5}**
S_d	$[0.34848+0.6497(A)] \times S_{.85}$		$[0.34848+0.6497(A)] \times S_{.70}$
A	$H/S_{.85}$		$H/S_{.70}$
$S_{.70}$ / $S_{.85}$	Nominal Tire Section (mm)		
H	Section Height (mm)		
Dr	Rim Diameter Code (mm)		
P	Inflation Pressure (kPa); 240 kPa for Standard Load Tires or 280 kPa for Extra Load Tires		

Table IV-3. T&RA Load Formula for "P" Type Tires (S.I. Units)

It is obvious that different values for K and for P and S_d raised to a power are going to provide very different curves for rated load versus these design parameters. Dividing the measured value by this non-linear and discontinuous function will result in a non-linear

[58] Schuring, D. J., & S. Futamura (1990). Rolling Loss of Pneumatic Highway Tires in the Eighties. Rubber Chemistry and Technology, Vol. 62, No. 3, pp. 315–367.

[59] The Tire & Rim Association, (2004). Engineering Design Information for Ground Vehicle Tires, Pages 1-11 & 1-15, Rev. 5, Date 4/15/04.: http://www.us-tra.org/traPubs.html

and discontinuous set of values for RRC, as evidenced by the wide variation in RRC values. In addition to these three curves, certain P-metric tires of aspect ratios 30-45 have maximum loads do not follow the T&RA formulas and were instead set equal to ISO load formulas in order to harmonize internationally. Also, tires sold in the US, for instance metric tires, may be rated by a totally different set of equations using ISO standards, or any of the other aforementioned standards organization.

In Table IV-4, the rolling resistance values of widely different tires of similar overall diameter and load carrying capacity were compared as they might be used on a light-duty pickup truck with Gross Vehicle Weight Rating of 6400 pounds. The OE tires for this truck were size P265/70R15, which could be replaced with much wider tires ranging from 20 to 24-inch rim diameter. The tested values found for these tires and their rating by both the proposed NHTSA grading system and the EU grading system are shown. The final column shows the estimated rolling resistance for the tires on the vehicle at GVWR that was calculated from the regression coefficients of actual multi-point rolling resistance testing. This on-vehicle energy loss is expected to correlate directly with the amount of fuel needed to supply this energy to the drive axle of the vehicle.

Table IV-4
Example Tire and Rim Changes on Light Duty Pickup Truck

Tires	**RRF, lbs**	**RRF Rating**	**RRC**	**EU Grade**	**Force at GVWR**[60]
OE Tires P265/70R15	14.1	60	0.0080	C	13.2 lbs
275/45R20	24.3	31	0.0130	F	23.8 lbs
305/40R23	20.6	41	0.0096	D	19.2 lbs
305/35R24	22.3	36	0.0113	E	21.6 lbs
LT245/75R16	20.5	41	0.0083	C	17.5 lbs

Figure IV-4 shows the rating either by grade based on RRF (Blue) or by RRC (Pink) in Kg/MT for the passenger tires tested versus the estimated on-vehicle rolling resistance of the tires at GVWR. It is clear that either system correctly rank orders the tires in a manner consistent with the expected effects on vehicle fuel economy for the vehicle fitted with these tires. Neither system seems to have an inherent advantage in providing consumers with an estimate of the relative effect that the tires may have on the fuel economy of the vehicle.

[60] Calculated from Multi-point testing regression

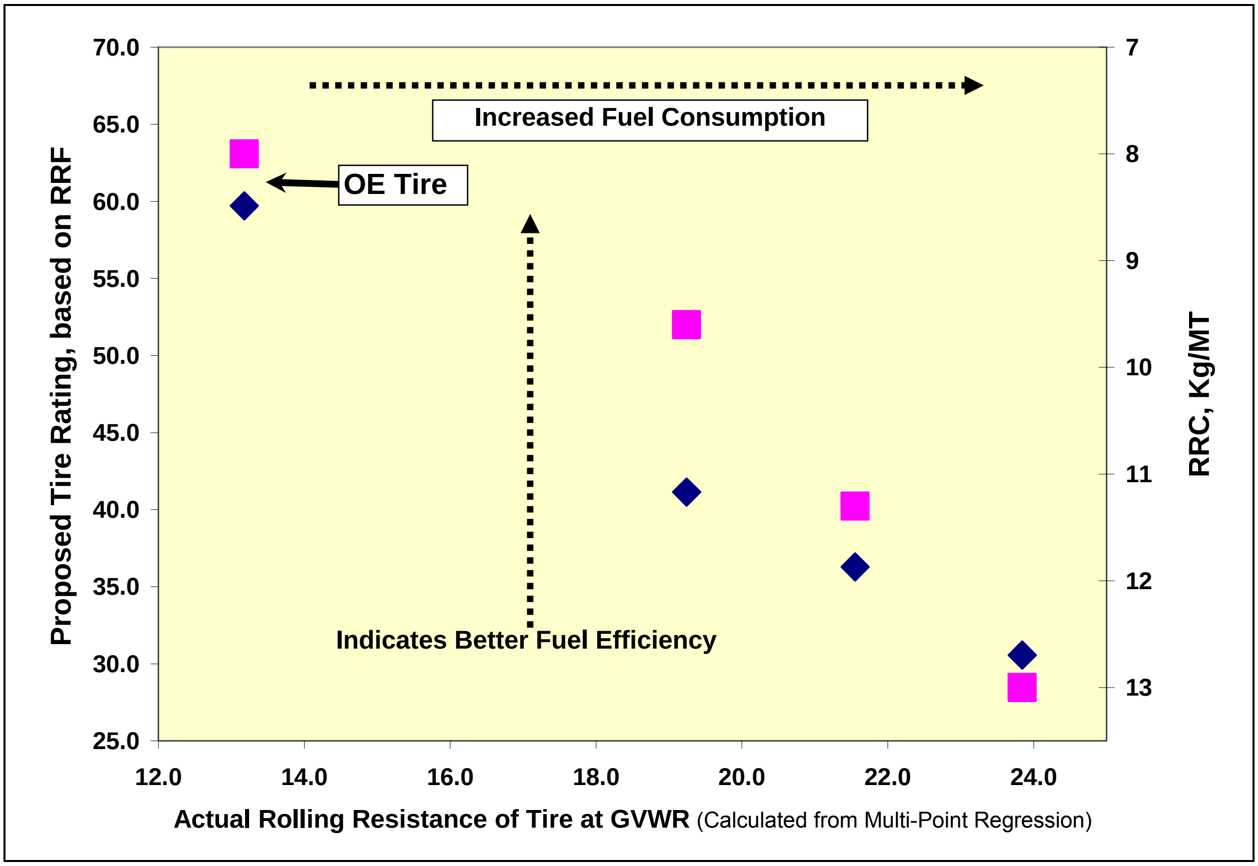


Figure IV-4. Tire Rating Versus Estimated On-Vehicle Tire Rolling Resistance, RRF (Blue) or by RRC (Pink)

One additional concern is the application of RRC in the voluntary rating of LT tires, which is not required but also not prohibited by the rating system.[61] In the Phase 1 report on this project, the results clearly demonstrated that light truck tires had much higher rolling resistance forces (RRF) than the passenger tires tested, but had lower RRC values due to their high load capacities and different test conditions. The final example tire is a LT Load Range E tire. The LT tire tested has a maximum sidewall rated inflation pressure of 550 kPa (80 psi) and is appropriately tested at a higher inflation pressure for rating when placed in service on vehicles for which it is designed. If however the consumer installs this tire on the vehicle and inflates the tire to the vehicle placard pressure, the resulting rolling resistance for the tire is much higher as shown in column 6. This is addressed to some degree in the ECE proposal, which proposes changing the band definitions downward, by one category between C1 and C2 tires. While the definitions for the ECE proposal are based on vehicle class rather than tire class, the C2 tires in the ECE proposal contain many sizes of LT tires sold in the U.S. In Figure IV-5 the rating by RRF and RRC versus the estimated rolling resistance at GVWR <u>and at placard inflation pressure</u> is shown. In this case, the RRC rating estimates a fuel efficiency significantly better than the consumer would experience. The RRC rating would

[61] Because these tires are covered by the proposed European regulation and by the statute, NHTSA anticipates that some manufacturers may wish to voluntarily rate LT tires.

however be expected to correlate to the performance of the LT tire at its rated inflation pressure.

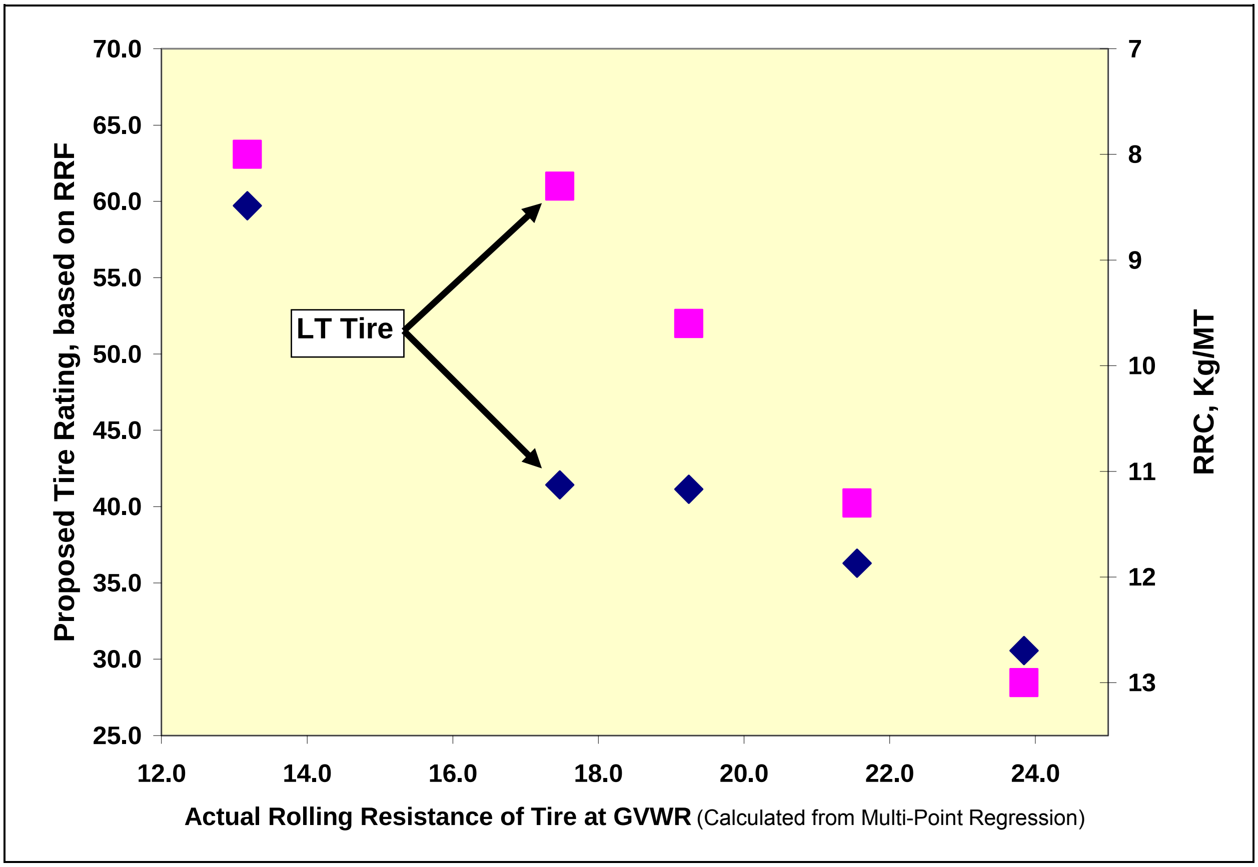


Figure IV-5. Tire Rating Versus Estimated On-Vehicle Tire Rolling Resistance, Including Example LT Tire, RRF (Blue) or by RRC (Pink)

In summary, a rating based on either RRF or RRC can provide a consumer good information to compare tires for an individual vehicle, with the possible exception of installing LT tires on a light truck that was originally equipped with passenger tires. However, when RRC is applied over a large range of tire sizes, it tends to produce lower relative values for larger tires than for smaller tires, despite the fact that the large tires usually use more fuel on that vehicle. This is where the goals of the fuel efficiency rating system may fail to be met if the overall system is not intuitive to consumers. Consumers will continue to use the system to purchase tires for their current and subsequent vehicles, and may have multiple vehicles in their family for which they purchase tires. It is likely that consumers will be confused by a fuel efficiency system that gives equal or better ratings to larger tires that consume more fuel than to smaller tires that consume less. This may lead to unintended effects on purchasing decisions, such as an owner upgrading to a larger tire size due to misinterpretation of the ratings.

For instance, in rating light vehicle fuel economy the estimated fuel mileage given to consumers is not divided by the rated payload capacity of the vehicle. Vehicle fuel economy ratings are instead an estimate of fuel efficiency of a vehicle under typical driving conditions. Consumers may then weigh the fuel efficiency of the vehicle against any consideration such as payload capacity, top speed, number of occupant seats, etc. Dividing the rolling resistance force by a fraction of the maximum load capacity of the tire to avoid larger, less fuel efficient tires from always being rated the lowest appears counter to the goals of the system. Consumers should understand that heaviest passenger vehicles tend to get the poorest fuel economy, in part because the large tires required to carry those vehicles consume more energy. This may in part influence future vehicle purchase decisions.

An argument has been put forth that by providing consumers with fuel economy recommendations for small and large tires on the same scale (RRF), rather than normalizing everything with to load capacity (RRC), the system may encourage consumers to choose smaller tires with insufficient load carrying capacity for their vehicles, thus creating a safety hazard. This rationale is flawed for many reasons. First, consumers have had a strong economic benefit to purchase under-capacity tires for many decades, namely initial purchase price. The smaller tires in a tire line normally cost less, and purchasing under-capacity tires would be an immediate economic benefit at the time of sale. This is contrasted with a future benefit of 6 to 12 gallons in annual fuel savings[62] from purchasing tires with 10 percent lower rolling resistance than their current tires. The issue of lower-cost small tires has not manifest itself as a safety problem due mainly to the fact that consumers lack the equipment to mount their own tires, and that tire installers will not assume the legal liability for installing tires with insufficient load carrying capacity.

As explained above, NHTSA is proposing to communicate tire fuel efficiency information in the form of a rolling resistance rating, because rolling resistance corresponds to the amount of fuel used in the form of mechanical energy dissipated to move the tire. Tire rolling resistance is the most effective metric for rating the "fuel efficiency" of a tire because rolling resistance force (RRF) measures the energy loss that opposes the direction of travel of the rotating tire and, thus, it directly reduces the efficiency of a vehicle in converting the chemical energy in the fuel to motion of the vehicle.

Based on the rolling resistance force test value measured using the ISO 28580 test procedure, the fuel efficiency rating of a given replacement passenger car tire is calculated using the formula specified by NHTSA.

[62] National Research Council of the National Academies (2006). Transportation Research Board Special Report 286, Tires and Passenger Vehicle Fuel Economy, p. 78.

IV.B. Data Presentation – Consumer Preference Focus Group

Strat@comm conducted a consumer preference focus group for NHTSA to assess how consumers might respond to a program like NHTSA's proposal.[63]

The goals of the consumer preference research were to gather information on the tire buying process used by consumers and the factors that consumers currently consider when purchasing tires; gauge whether and how consumers would use information in a tire rating system like NHTSA's proposal; and gauge consumer reaction to five specific label designs NHTSA developed to convey the information mandated by EISA.

Study Methodology

The research was conducted by convening focus groups comprising a total of 54 people in Scottsdale, Arizona; Oak Park, Illinois; and Baltimore, Maryland. Focus group participants were limited to persons who 1) have sole or shared decision-making regarding vehicle service, 2) are at least somewhat concerned about vehicle safety, 3) had brought in a vehicle for maintenance in the past two years, and 4) had purchased a tire in the past three years. The groups were also arranged to comprise a balance of genders, ages, education levels, and income levels. The focus groups were conducted during January 2009, when gasoline averaged about $1.80 per gallon, down from the peak of $4.11 per gallon seen in July 2008[64].

Based on the focus group responses, the research found the following indications. Note that the results from the focus group cannot be generalized, and this approach is preliminary. Qualitative research, by design, is not meant to be projectable within accurate statistical ranges. Focus groups allow for the understanding and investigation of group consensus, not individual reactions. Qualitative research offers insight into the thematic and directional information of the participants. It is also true that what matters most is what approach best informs consumer choices, not what approach is preferred in a focus group setting. Nonetheless, focus group reactions can provide valuable information about how best to inform consumers.

The Tire-Buying Process

The tire-buying process differs depending on whether it is spurred by an urgent need, such as a flat tire, and whether the consumer has purchased tires previously. Focus group participants reported that when making a first purchase of replacement tires and the replacement is not urgent, they often conduct some research for their tire purchase, asking the advice of family, friends, or mechanics, and/or researching options and prices online, by telephone, or by consulting tire store newspaper advertisements. However many participants reported conducting no prior research and going directly to a tire store. In addition, some gender differences in the buying process were reported, with women more frequently relying on the advice of mechanics, spouses, and male friends. When a

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[63] See NHTSA Rolling Resistance Focus Group Report, Strat@comm, February 2009. A copy of this report appears in the docket for this rulemaking.

[64] Retail gasoline prices from the U.S. Energy Information Administration, accessed from http://tonto.eia.doe.gov/dnav/pet/hist/mg_rt_usw.htm .

tire has failed or the consumer has previously purchased replacement tires, the process is shortened and participants reported that they might not conduct research prior to arriving at the store in this situation.

The focus group participants considered tire purchase decisions to be relatively easy, with 42 participants reporting the decision to be "easy" and 12 reporting it to be "difficult". They feel fairly knowledgeable about purchasing tires (6 reported being "very knowledgeable", 33 "somewhat knowledgeable", and 15 "not at all knowledgeable") and feel confident about their purchase decision (26 "very confident" 16 "somewhat confident", and 3 "not at all confident").

Factors in Tire Purchase Decisions

The focus group participants reported the most frequent considerations in their tire purchase decisions to be, in no particular order: cost, warranty, performance, tread, traction, brand name, all-weather capability, durability, and availability.

Safety and fuel efficiency were not raised as considerations for purchasing tires, although they are heavily considered in purchasing vehicles. The participants generally assumed that all tires are reasonably safe. Although most participants were aware that tire inflation impacts fuel efficiency, only about half were aware that tire design and construction also impact fuel efficiency. Many reported skepticism that tire choice would make much of a difference to fuel economy. Likewise, consequences for carbon emissions were not raised as a purchase consideration.

How Consumers Feel About Current Sources of Tire Information

As indicated above, participants reported obtaining tire information from variety of sources, including online and word-of-mouth sources. They felt that an abundance of information is available for their research, and some expressed a concern that the volume of available information can make the process confusing. Information provided by sales personnel was viewed with some skepticism.

Consumers appear to rarely use the current rating system (UTQGS) in their tire purchases. Only two of the 54 focus group participants used the system, although both reported it to be highly useful for their purchase.

Reactions to a Tire Labeling System in General

Focus group participants reacted highly favorably to the idea of a tire labeling system. Some expressed the view that it could change the way that they purchase tires, to one in which they heavily rely on the label's ratings. Knowing that NHTSA or DOT had established the rating system would give consumers confidence in the ratings. (Although the government in general was not highly regarded as a reliable source of information, NHTSA and DOT were viewed as reliable sources.)

General Comments on the Proposed Labels

Participants generally understood the concepts that the "traction" and "treadwear" ratings convey. Nearly all participants understood what "traction" means and associated it with safety. Many understood what "treadwear" means, associating it with the durability.

However, most participants were confused by the term "fuel economy" as it applied to tires, perhaps reflecting the lack of sense that tire design and construction impact fuel economy. When the focus group leader explained the impact of tire choice on fuel economy, many participants felt that the fuel efficiency rating would be more meaningfully conveyed in gallons of gasoline saved per year.

Some participants felt that the label should give an overall rating in addition to component ratings. In addition, one commenter expressed a concern that the labels did not convey what would be good values for the ratings (e.g. whether a "treadwear" value of 60 is good).

Although the labels' icons for fuel efficiency and treadwear received favorable reactions, some participants could not decipher the traction icon and wondered whether it depicted a cowboy hat.

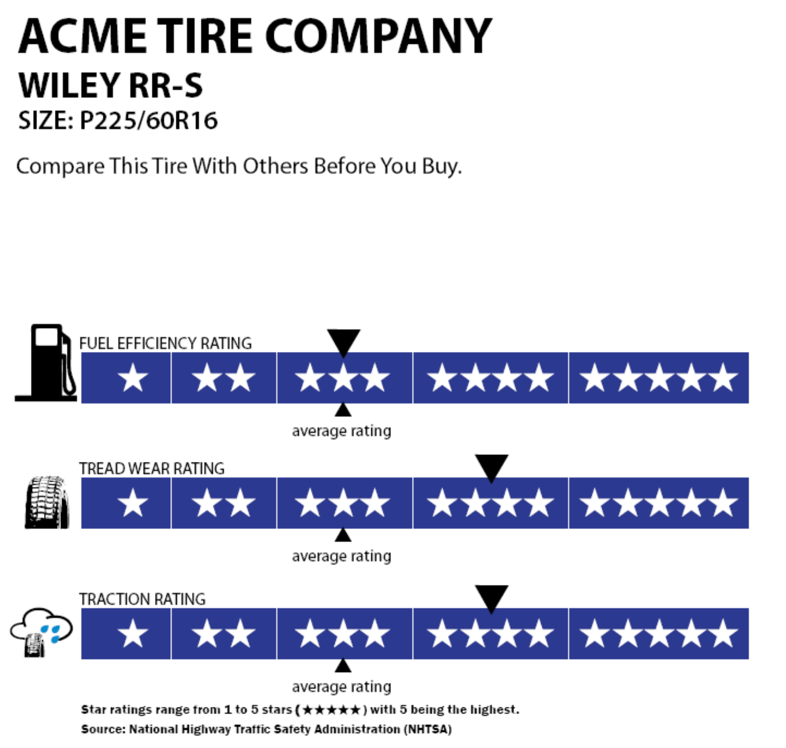
Reactions to the Five Label Designs

One of the five label designs (Label "B" below) was clearly preferred over the others.

Label A

Participants are familiar with and reacted positively to its "star" rating system, but also expressed a desire for a greater degree of discrimination in each rating. They found this label to be too busy, with confusion about the smaller "average rating" indicator below each rating versus the larger indicator above each rating of the tire in question and with the label having too many "stars" on it.

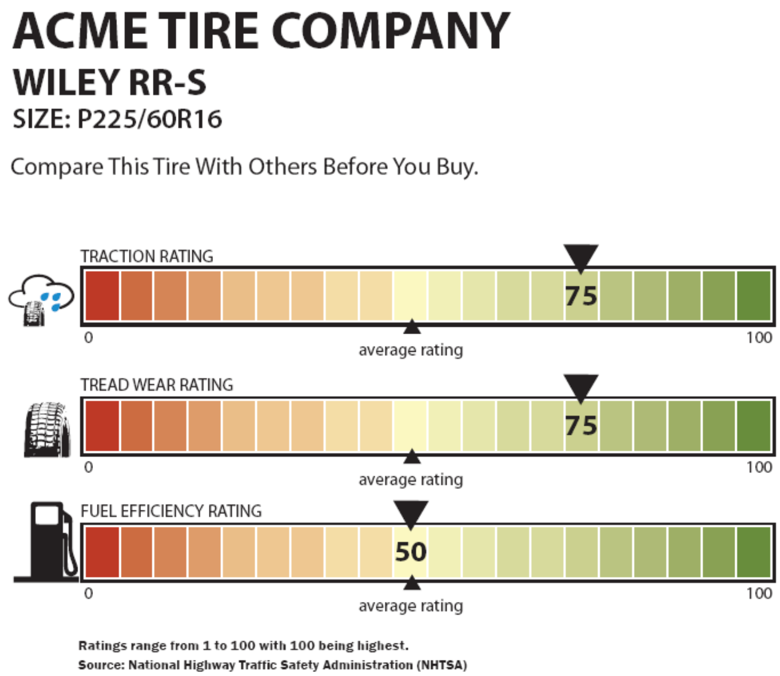
Figure IV-6 – Label A in NHTSA consumer research



<u>Label B</u>

Label B was by far the most preferred. Participants liked the greater discrimination of the 0-100 rating scale and the red and green coloring indicating bad and good values on each scale. They also found the general layout of the label to be visually appealing. Some participants felt the label would benefit by the addition of an overall rating of the tire.

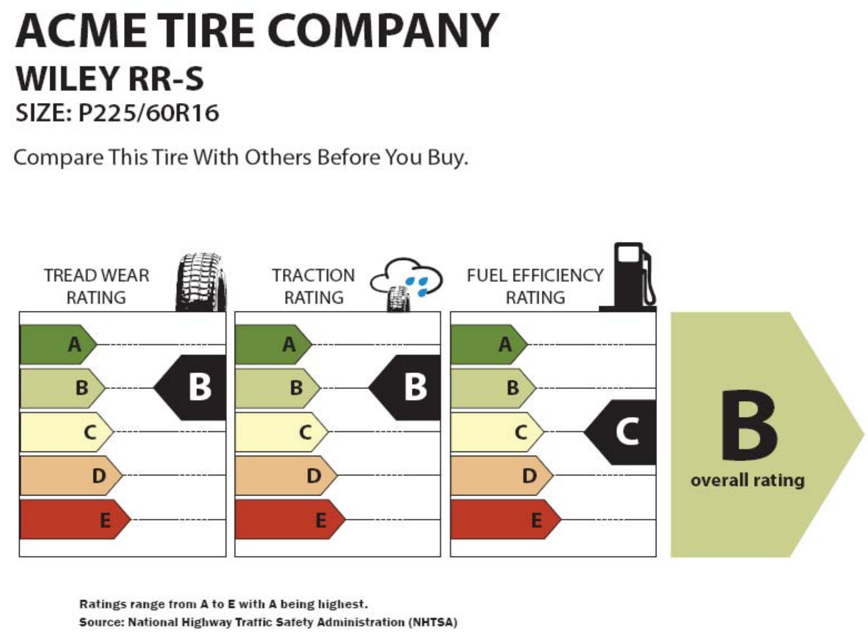
Figure IV-7 – Label B in NHTSA's consumer research



Label C

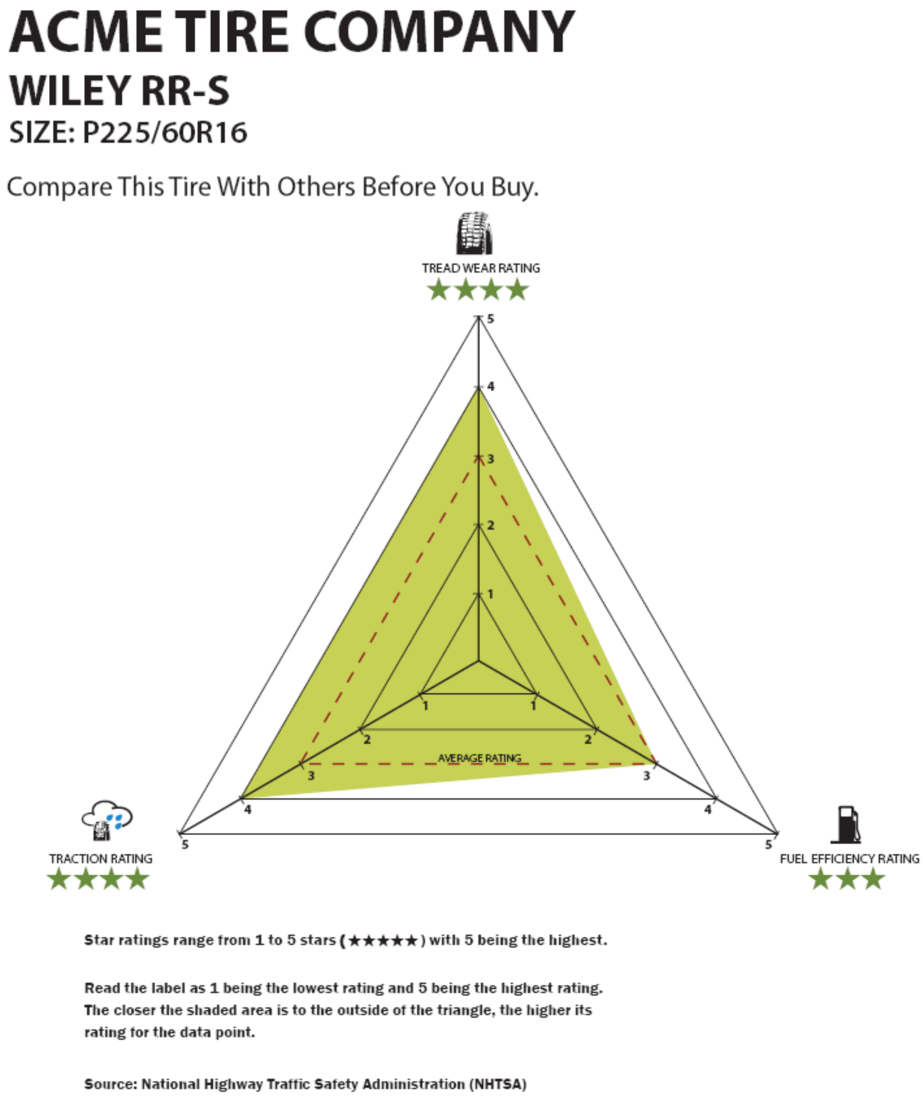
Although participants liked the presence of an overall rating, they found the vertical layout of Label C confusing and had difficulty understanding the rating values conveyed by this label.

Figure IV-8 – Label C in NHTSA's consumer research



<u>Label D</u>
Label D was highly unpopular with the participants. They did not understand this label and reacted negatively to its geometric representation and colors.

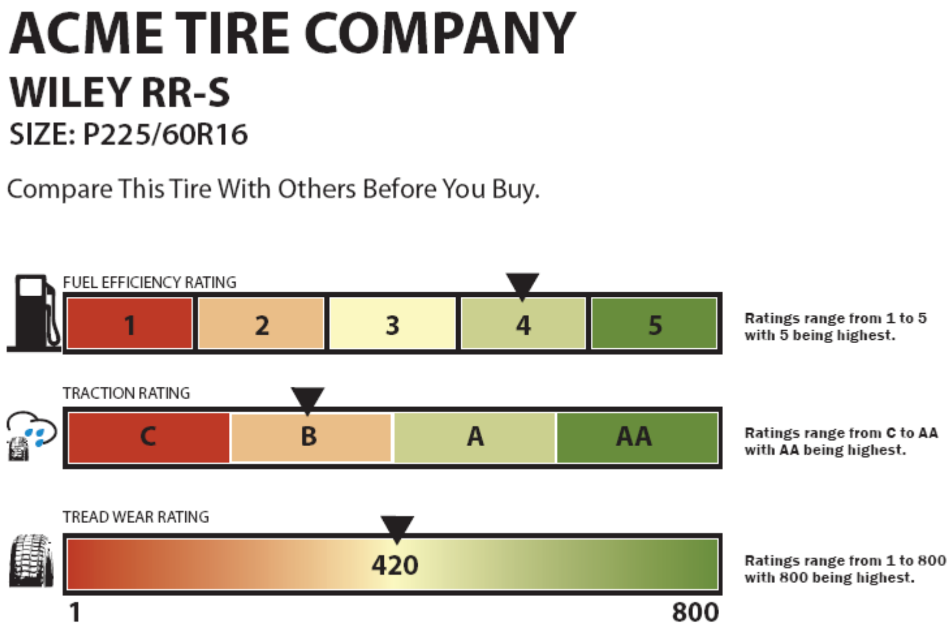
Figure IV-9 – Label D in NHTSA's consumer research



<u>Label E</u>

Label E was also unpopular. Participants found the different rating scales confusing and inconsistent. Participants did not understand why treadwear would be on a 0-800 scale and were confused about whether the "AA" rating for traction was meant to reflect an exceptionally good value.

Figure IV-10 – Label E in NHTSA's consumer research



NHTSA's Proposed Label

Noting its simplicity and its overwhelming preference in the focus group, NHTSA proposes to use Label B's design, with minor modifications. Namely, NHTSA proposes to: add the title "Government Tire Ratings" to the label graphic; reorder the ratings so that the fuel efficiency rating appears first, followed by the traction and treadwear ratings; change the rating identifiers to "Fuel Efficiency and Greenhouse Gas Rating", "Safety Rating (Wet Traction)", and "Durability Rating (Treadwear)"; eliminate the average rating indicators; change the spacing so that triangles indicating the ratings for the given tire cannot overlap with the ratings titles ; and modify the sentences at the bottom of the label to read:

"Ratings range from 0 to 100 with 100 being the best, where the tire is properly inflated.
Source: National Highway Traffic Safety Administration (NHTSA)
For more information, visit www.nhtsa.gov."

We propose to eliminate the average rating indicators because its values will change from year to year. We also propose and seek comment on an alternative traction icon, as the focus group participants found the traction icon in the above labels confusing.

Development of Cost-Benefit Scenario Parameters Regarding Consumer Utilization of the Proposed Program

The cost benefit analyses in this report use a range of potential scenarios regarding consumer utilization of the tire ratings. We developed these scenarios keeping in mind the results of the Strat@comm research. We examined 3 potential rating schemes. These are a thumbs up or thumbs down (good/bad) system, a bin system (or bins designated by stars), and a scale from 0 to 100. In terms of information provided to consumers to discriminate between tires, the scale provides the most information, the stars provides less information, and the thumbs up or thumbs down system provides the least information. These were also the order in which the focus groups preferred the data to be presented, the scale was overwhelmingly preferred to the star system.

For this analysis we assumed that the thumbs up/thumbs down approach would have the least impact of informing consumers and having them buy more fuel efficient tires. We assumed this approach would only result in 1 percent of the applicable replacement tires being more fuel efficient. We assumed that the bin system (stars) would be better, but still would only result in 2 percent of the replacement tires being more fuel efficient. For both of these rating systems we also believe that manufacturers might not have an incentive to change their tires the full 10 percent in rolling resistance, because they might try to move their tires just over the margin to get the better rating. Thus, for the thumbs up/thumbs down and bin systems, we assumed they might increase rolling resistance from 5 to 10 percent. For the scale system (from 0 to 100), we assumed that 10 percent of replacement tires might be made with better rolling resistance and that manufacturers have an incentive to improve their tires as much as possible, a 10 percent improvement in rolling resistance, to increase sales.

The agency does not believe that the UTQGS system is widely used. Since only 2 of 54 focus group participants (less than 4 percent) used the current UTQGS system, for purposes of this analysis we decided to assume a low level of usage for a new system. Since the new rating system appears easier to understand than the UTQGS system, we believe it will result in more consumer demand for tire information, and that perhaps 10 percent of the target tires might be improved. Regardless of the estimates, based on the focus group study, it appears to the agency that the scale system has a better chance of providing more benefits than the bin system or a thumbs up or thumbs down system. Putting assumptions into the analysis provides information to determine what the costs and benefits would be if a certain percentage of tires were built with improved rolling resistance.

V. BENEFITS

A. General Discussion

There are three categories of <u>potential</u> benefits (or disbenefits) from this rule: fuel economy, safety, and durability. For each of these categories a significant unknown is consumer behavior in response to this program, and as a result of that, manufacturer reaction. For example, if consumers value fuel efficiency but are unwilling to increase the price they pay for tires, tires with improved fuel efficiency but decreased safety and/or durability may enter the market. If consumers care most about safety, and if there is a tradeoff between fuel economy and safety, one effect of this rule may be to increase safety while decreasing fuel economy. NHTSA would have to quantify the value of all three categories of benefits/disbenefits under such a scenario and construct a range of likely scenarios to calculate the combined benefits of this rule. Other scenarios can also be imagined. Greater consumer awareness of the relevant variables may help spur innovation in the market, leading to improvements along all three dimensions. NHTSA requests comments on how it might specify the anticipated outcomes of this proposal.

In addition to the unknown reactions of consumers and manufacturers, calculating benefits is complicated by several additional factors. We explain these additional complications for each of the three rating systems in the following sections. In each of these discussions we consider how to compute the benefit of a difference of X points on the particular rating scale.

<u>Fuel Economy</u>

For fuel economy, one of the reasons the agency is basing the fuel efficiency rating on RRF rather than RRC is that it allows the program to provide consumers with a statement such as "a difference of X on the fuel efficiency rating scale equates to Y gallons of fuel saved." To calculate benefits for an individual tire purchase, if you know the baseline fuel economy of the vehicle the tires will be mounted on, the fuel efficiency rating of the existing tires, the fuel efficiency rating of the replacement tires, and the number of miles driven annually, you can calculate the reduction (or increase) in the number of gallons of fuel you will need to operate the vehicle for a year. By using fuel price forecasts, you can estimate the cost of that fuel, and make an economic decision about whether or not to buy those replacement tires. To calculate benefits for this rule, we would need to know how many consumers are likely to purchase lower (or higher) fuel efficiency rated tires as a result of the information in this program and the average reduction (or increase) in rolling resistance of the tires they purchase, and then we would have to take the average fuel economy of the vehicle fleet, and the average number of miles driven annually to estimate the change in total fuel usage each year. The agency is planning to do additional consumer testing or other means to help it estimate the expected consumer reaction to this program. We have calculated range estimates of the fuel economy benefits of the proposal and alternatives in section B of this chapter. The agency requests any information commenters may have about how to estimate consumer reaction.

Safety

Benefit estimates for the safety rating are more difficult to quantify. As noted, information is lacking about likely consumer responses to the proposed label. Even if such information were available it is not as straight forward as it is for a fuel efficiency rating to develop a rule of thumb for the safety rating scale such as "each difference of X on the safety rating scale equates to Y percent fewer crashes and Z dollars less in resultant economic damages." One possible way to do this would be to try and correlate a rating with a set stopping distance, and then estimate the reduction in crash injuries and fatalities resulting from a given reduction in stopping distance. The latter could be done by developing an injury probability profile for crashes as a function of impact speed (Delta-V) and measure the change in Delta-V that would occur when braking distance is changed. The agency has used this method to measure safety impacts in 2 previous rulemakings, those for Tire Pressure Monitoring Systems (TPMS)[65], and for truck tractor braking improvements[66]. If these steps were taken, the increases in safety could be turned into monetary equivalents.

However, these calculations are complicated by the fact that they depend on other factors (in addition to the traction rating of the tires) such as the handling characteristics of the vehicle on which they are mounted, the force with which the brakes are applied, and the loading of the vehicle. To put a tire's safety rating information on an economic scale, all of these characteristics would have to be assumed for all tires. But in reality, there is not a single vehicle that all replacement tires can be mounted on. We invite comments on these important issues, but we are concerned that the difference between two such tire safety ratings would not reflect the same economic difference in terms of safety, where the tires were mounted on two different types of vehicles. What we can communicate with the proposed rating is that tires with better traction ratings stop in less distance than tires with worse ratings. And as noted, the societal safety impacts depend on consumer and manufacturer reactions to the program.

Durability

For durability, the rating is a relative rating compared to a control tire, which would be rated 10 on our scale. A tire rated 20 should last twice as long as a tire rated a 10, and so forth. Several assumptions would need to be made to develop a rule of thumb for the durability rating scale of the form "each difference of X on the durability rating scale equates to equates to a reduction of $Y in tire purchases over the lifetime of the vehicle". Tire lifetimes are complicated by factors such as: the vehicle the tire is mounted on, driving habits, tire maintenance, weather/environment/temperature, .etc. NHTSA could however come up with a set scenario and come up with mileage estimates if the tires are driven as in that scenario. To translate that into a reduction in tire purchase costs over the lifetime of a vehicle you would also have to know the price of the tires being considered

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[65] Final Economic Assessment, Tire Pressure Monitoring System FMVSS No. 138, Office of Regulatory Analysis and Evaluation, Plans and Policy, National Highway Traffic Safety Administration, U.S. Department of Transportation, Washington, D.C., March, 2002

[66] Final Regulatory Impact Analysis, FMVSS No. 121 Air Brake Systems Amending Stopping Distance Office of Regulatory Analysis and Evaluation, National Center for Statistics and Analysis, (Not Yet Published)

– a $50 tire that is expected to last 10,000 miles would have the same expected lifetime cost (over the life of a vehicle) as a $100 tire that is expected to last 20,000 miles.

A Combined Rating

The agency is also considering the concept of a combined rating of some sort, which would bring all three benefit metrics into one measurement. An example of such a system might be expressed as average overall cost/mile. The advantage of such a system would be that it would simplify the ratings, but, at the same time, it would obscure the relative performance of individual components which might carry different priorities with different consumers. In addition, the agency is uncertain as to whether such a combined rating would be practicable. Developing a cost-per-mile estimate would require addressing the myriad of complications expressed in the Fuel Economy, Safety, and Durability sections above. For example, how would the safety of any particular tire be measured and what baseline would it be measured against? The agency cannot identify poor tire traction as the cause of a crash, but may be able to estimate potential benefits or disbenefits from modified stopping distances that result with different traction ratings. How would potential safety impacts be valued? Should values include estimates of the value of life and degradation in quality of life, or just the economic impacts that result from death and injury and property damage? Since these estimates would represent average impacts spread across society, would they be meaningful to individual tire purchasers? The agency seeks comments on the relative advantages and disadvantages of a combined system vs. the three-level system in our proposal.

B. Fuel Economy Benefits

The agency has derived an estimate of the fuel economy benefits of improving tire rolling resistance. The estimates are based on our research that indicates that improving tire rolling resistance by 10 percent results in a 1.1 percent improvement in vehicle fuel economy.[67] The agency believes that a 10 percent improvement in rolling resistance is about the limit of what we could expect, holding all other aspects of the tire at equivalent levels.[68] We express the benefit in terms of gallons of fuel saved and use example vehicle miles traveled (10,000 miles per year) and baseline vehicle mpg to illustrate the potential benefits. We use scaled rolling resistance values with a difference of 5 on the

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[67] See NHTSA Tire Rolling Resistance Rating System Test Development Project: Phase 2 – Effects of Tire Rolling Resistance Levels on Traction, Treadwear, and Vehicle Fuel Economy, February 2009. A copy of this report appears in the docket for this rulemaking. The 1.1% figure reflects a conservative value within the 1-2% range found in a 2006 joint report by the National Academy of Sciences and the National Research Council.

[68] A 2006 National Academy of Sciences (NAS) report concluded that reduction of average rolling resistance of replacement tires by 10 percent was technically and economically feasible and attainable within a decade through a combination of means, including: consumers could purchase more tires with lower rolling resistance, tire designs could be modified, and more vigilant maintenance of tire inflation pressure. Transportation Research Board Special Report 286, Tires and Passenger Vehicle Fuel Economy, National Research Council of the National Academies, 2 (2006).

scale to illustrate what the tire purchaser would see and be able to determine from our calculator.

Table V-1 shows the results of these calculations. For example, if a tire purchaser were looking at two tires that had a scale value of 25 and 30, and that purchaser's baseline vehicle fuel economy was 20 mpg, then the savings for each 10,000 miles driven for purchasing 4 of the higher rates tires would be 2.7 gallons of gasoline. The purchaser can then translate that into dollars saving depending upon the price of gasoline at that time. Three trends in this data are that:

1) As the Tire 1 scale increases, the benefits in terms of gallons saved increases. Thus, at a baseline of 20 mpg, the gallons saved increase from 2.7 at a Tire 1 scale of 25, to 3.6 at a Tire 1 scale of 50, to 5.4 at a Tire 1 scale of 75.
2) As the baseline vehicle mpg, increases, the gallons saved decrease. Thus, this table makes it appear that rolling resistance is more important for a vehicle that gets lower mileage and less important for a vehicle that gets 30 mpg. However, in reality there is a relationship between the baseline rolling resistance scale and the vehicle baseline mpg (cars that get good mileage are smaller and have smaller tires, thus their place on the scales would be naturally higher). The value 3.6 appears diagonally across the table (at 15 mpg and a Tire 1 of 25, at 20 mpg and a Tire 1 value of 50, and at 30 mpg and a Tire 1 value of 75). Thus, it appears likely that the rolling resistance is just as important for all vehicles.
3) Although it is not shown in Table V-1, if you increase the difference in the tire scale from 5 (from Tire 1 to Tire 2) to a scale difference of 10, the gallons saved exactly double.

One question is whether the agency and the tire community can develop and agree on a "Rule of Thumb" answer so that consumers will not have to use a calculator to determine their fuel economy benefits. For example, a "rule of thumb" might be that "For every 10,000 miles you drive, a difference of 5 on the scale equates to 3 gallons of fuel saved when you purchase 4 tires and a difference of 10 on the scale equates to 6 gallons of fuel saved. An approach of this kind might help to overcome the risk that the ratings will not be entirely meaningful to consumers.

Table V-1
Gallons of Fuel Saved by Tire 2
Per 10,000 VMT – Given Baseline mpg

Rolling Resistance Scale		**Baseline vehicle mpg**			
Tire 1	Tire 2	15 mpg	20 mpg	25 mpg	30 mpg
25	30	3.6	2.7	2.2	1.8
50	55	4.9	3.6	2.9	2.4
75	80	7.2	5.4	4.3	3.6

The equation for developing these estimates is:

Gallons saved = VMT*(1/mpg-1/(mpg*(1+0.11*ABS(Tire 1 Scale -Tire 2 Scale)/(125-MIN(Tire 1 scale, Tire 2 Scale)))))

Where VMT = the number of miles driven (10,000) used in our example
Mpg = the baseline vehicle mpg (20) for example
Tire 1 Scale (25) for example
Tire 2 Scale (30) for example

B. Expected Fuel Savings by Alternative

As derived in Section IV.B, we estimate that the three regulatory alternatives and the "100% Participation" scenario will result in the following participation rates and improvements in rolling resistance:

Table V-2
Scenario Assumptions

Scenario	Assumptions	
	% of Applicable Tires Whose Rolling Resistance is Reduced as a Result of the Scenario	Average % Decrease in Rolling Resistance for Such Tires
Alternative 1 (thumbs up/down ratings)	1%	5-10%
Alternative 2 (stars/bins ratings)	2%	5-10%
Proposal (0-100 rating system)	2-10%	5-10%
100% Participation Scenario	100%	10%

<u>Fuel savings per improved tire over its lifetime</u>
The average tire service life is 45,000 miles. Typically the agency would apply its vehicle miles traveled tables by age of vehicle to discount savings over time. Since these are replacement tires that will be purchased sometime during the life of the vehicle, we will make a simplifying assumption that the average vehicle travels 10,000 miles per year and the average tire lasts for 4.5 years. Suppose that the average on-road (as opposed to lab-tested) fuel economy of a vehicle to which the tires covered by this proposed rule could be applied is 22 mpg. (For short, we shall refer to such vehicles as "applicable vehicles".) Assuming that the average improvement in rolling resistance among tires improved as a result of NHTSA's proposal is 10% and using the VRTC estimate that decreasing the rolling resistance of all four tires on a vehicle by 10% improves the vehicle's fuel economy by 1.1%, we compute that the fuel saved by NHTSA's proposal per improved tire (over its useful life) would be as follows:

For a 10% improvement in rolling resistance: (45,000)*(1/22 – 1/(22*1.011)) / 4 tires = 5.6 gallons per tire

For a 5% improvement in rolling resistance: (45,000)*(1/22 – 1/(22*1.0055)) / 4 tires = 2.8 gallons per tire

The price of fuel

NHTSA analyzed the benefits of this rule at a gasoline price of $3 per gallon because if this proposal took effect in 2012, then the predicted societal price of gasoline would average $3.01 (for 2012-2015), using the Annual Energy Outlook (AEO) 2008's high price case for gasoline, including externalities and excluding taxes.[69] *See* Average Fuel Economy Standards for Passenger Cars and Light Trucks Model Year 2011, 74 FR 14196, 14314-14320 (Mar. 30, 2009) (explaining NHTSA's fuel price assumptions); U.S. Department of Energy, Energy Information Administration, Annual Energy Outlook 2008 (June 2008), *available at* http://www.eia.doe.gov/oiaf/archive/aeo08/index.html (last accessed Apr. 8, 2009). See also NHTSA's "Final Regulatory Impact Analysis, Corporate Average Fuel Economy for Passenger Cars and Light Trucks, Model Year 2011", (Docket No. NHTSA-2009-0062-0004.1, Pages VIII-18-VIII-21) for additional discussion of our choice of fuel price.

The estimated price of gasoline at the pumps and the societal cost of gasoline are fairly close. The societal cost of gasoline excludes taxes, since these are a transfer payment, but includes externalities. The price of gasoline at the pumps is estimated to average about 3 cents per gallon more than the societal cost of gasoline during the 2012-2015 time period. For a long discussion of externalities and their values see the CAFE FRIA at the docket number cited above.

If fuel costs $3 per gallon, this savings for a 10 percent improvement in rolling resistance would translate to $16.69 (undiscounted) saved by consumers in fuel not purchased per tire (over the life of the tire). Since the tire lasts an assumed 4.5 years, the savings need to be discounted back to present value[70]. Using the mid-year discount rates for 3 percent and 7 percent shown in Table V-3, the dollar savings get discounted to $15.62 at a 3% discount rate and $14.36 at a 7% discount rate.

Table V-3
Discounting Dollar Savings

Year	Miles Driven per Tire	Mid-Year Value of $1 at a Discount Rate of…		Fuel Saved per Improved Tire		
		3%	7%	Gallons	Discounted value (3%)	Discounted value (7%)
1	10,000	$ 0.99	$ 0.97	1.2	$ 3.65	$ 3.59
2	10,000	$ 0.96	$ 0.90	1.2	$ 3.55	$ 3.35
3	10,000	$ 0.93	$ 0.84	1.2	$ 3.44	$ 3.13

[69] The societal price of gasoline is estimated to be $2.939 in 2012, $2.993 in 2013, $3.049 in 2014, and $3.069 in 2015.

[70] Costs occur at the time of purchase, but benefits accrue over the lifetime of the tire. In order to put costs and benefits on an equal economic basis, the benefits are discounted back to present value as shown in Table V-3.

4	10,000	$ 0.90	$ 0.79	1.2	$ 3.34	$ 2.93
5	5,000	$ 0.88	$ 0.74	0.6	$ 1.62	$ 1.37
4.5-Year Total	45,000	$ 4.65	$ 4.24	5.6	$ 15.62	$ 14.36

If NHTSA's proposal results in the improvement (in rolling resistance) of 10% of tires sold, then the fuel savings per average tire would be 0.56 gallons, for a cost savings of $1.67 per tire (undiscounted). The corresponding discounted values would be $1.56 (at 3%) and $1.44 (at 7%).

Table V-4 and Table V-5 show the (fuel and dollars saved) for the regulatory alternatives and 100% Participation scenario.

Table V-4
Benefits per Improved Tire[1]

Scenario	Fuel Saved (gallons)	Value of Gallons Saved		
		Not Discounted	Discounted at 3%	Discounted at 7%
Alternative 1 (thumbs up/down ratings)	2.8 – 5.6	$ 8.39 – $ 16.69	$ 7.85 – $ 15.62	$ 7.22 – $14.36
Alternative 2 (stars/bins ratings)	2.8 – 5.6	$ 8.39 – $ 16.69	$ 7.85 – $ 15.62	$ 7.22 – $14.36
Proposal (0-100 rating system)	2.8 – 5.6	$8.39 – $16.69	$ 7.85 – $15.62	$ 7.22 – $14.36
100% Participation Scenario	5.6	$16.69	$ 15.62	$ 14.36

[1]Assumes the average tire service life is 45,000, the average on-road fuel economy of applicable vehicles is 22 mpg, and fuel costs $3 per gallon.

Table V-5
Benefits per Average Tire[1]

Scenario	Fuel Saved (gallons)	Value of Gallons Saved		
		Not Discounted	Discounted at 3%	Discounted at 7%
Alternative 1 (thumbs up/down ratings)	0.03 – 0.06	$ 0.08 – $ 0.17	$ 0.08 – $ 0.16	$ 0.07 – $ 0.14
Alternative 2 (stars/bins ratings)	0.06 – 0.11	$ 0.17 – $ 0.33	$ 0.16 – $ 0.31	$ 0.14 – $ 0.29
Proposal (0-100 rating system)	0.06-0.56	$0.17- $1.67	$0.16- $1.56	$0.14- $1.44
100% Participation Scenario	5.56	$16.69	$ 15.62	$ 14.36

[1]Assumes the average tire service life is 45,000, the average on-road fuel economy of applicable vehicles is 22 mpg, and fuel costs $3 per gallon.

Annual fuel savings

In Section VI, we will estimate that 141 million tires per year could potentially be improved for rolling resistance, which would be the 100 percent participation scenario. (That is, their rolling resistance is not currently equivalent to that of current OEM tires). For the other scenarios we assume that 1 percent, 2 percent or 10 percent of the tires will eventually have improved rolling resistance. (This should occur starting in the fifth year of the program, under the assumptions that the average vehicle with replacement tires travels 10,000 miles per year and the average replacement tire lasts for 45,000 miles.)

Consider NHTSA's proposal and suppose that 10% of tires manufactured in any given future year are improved for rolling resistance (compared to the current rolling resistance). Then starting in the fifth year of the program, there are (4.5)*(141) million, or 634.5 million, replacement tires on the road, 10% of which have improved rolling resistance. Assuming the average miles traveled for a vehicle with replacement tires is 10,000 miles, the annual fuel savings (starting in the fifth year) will be:

(.1)(4.5)(141,000,000)(10,000)(1/22 – 1/(22*1.011)) / 4 = 78.4 million gallons,

The corresponding figures for the regulatory alternatives and 100% Participation scenario, and the undiscounted, 3%-discounted, and 7%-discounted values would be as in the following table. This table also presents the reductions in CO2 tailpipe emissions and domestic upstream emissions saved by not burning this fuel:

Table V-6
Steady-State Annual Benefits[1]
(Starting in the Fifth Year of the Program)

Scenario	CO_2 Emissions Saved (in thousands of metric tons)	Fuel Saved (millions of gallons)	Value of Gallons Saved (Millions of $)		
			Not discounted	Discounted at 3%	Discounted at 7%
Alternative 1 (thumbs up/down ratings)	38-76	3.9 – 7.8	$12 - $24	$11 - $22	$10 - $20
Alternative 2 (stars/bins ratings)	76-151	7.9 – 15.7	$24 - $47	$22 - $44	$20 - $41
Proposal (0-100 rating system)	76-757	7.9 - 78.4	$24-$235	$22-$220	$20-$203
100% Participation Scenario	7,573	784	$2,353	$2,202	$2,025

[1]Assumes the average tire service life is 45,000, the average on-road fuel economy of applicable vehicles is 22 mpg, fuel costs $3 per gallon, and that 9,653 grams of CO_2 are emitted in tailpipe and domestic upstream emissions per gallon of fuel burned.

The parameter of 9,653 grams of CO_2 per gallon of fuel is derived as follows:

Fuel Type	% of U.S. Consump-tion	Tailpipe CO2 Emissions (grams/gal)	Domestic Upstream CO2 Emissions (grams/gal)	Total CO2 Emissions (grams/gal)
Conventional Gasoline	63.4%	8,920	766	9,686
Federal Reformulated Gasoline	23.4%	8,716	782	9,498
California Reformulated Gasoline	10.7%	8,741	746	9,487
All Gasoline	97.5%	8,852	767	9,619
Diesel	2.5%	10,239	748	10,987
Weighted Average	100.0%	8,887	767	9,653

This figure (9,653 grams per gallon) is the same used in NHTSA's recently issued Corporate Average Fuel Economy (CAFE) rule for model year 2011 light vehicles.

Note that the benefits in Table V-6 only reflect the impacts related to fuel savings. As we discussed in Section V.A, there are several challenges to estimating the benefits and disbenefits related to safety and durability. We invite comment as to how to calculate these benefit components.

Sensitivity analysis

The above calculations have varying amounts of sensitivity to variations in their input parameters (average vehicle fuel economy, consumer participation, average decrease in rolling resistance, average tire service life, and future fuel price).

We calculated fuel saved per improved tire as:

$$\text{Fuel}(a,b,c,d) = (a/b)\ (1-1/(1+10cd))$$

and consumer dollars saved per improved tire by:

$$\text{Dollars}(a,b,c,d,e) = e\ \text{Fuel}(a,b,c,d)$$

where a, b, c, d, and e denote the following:

a: the average tire life, in miles
b: the average mpg of applicable vehicles
c: the average percentage reduction in rolling resistance among tires whose rolling resistance is improved as a result of the scenario

d: the average percentage improvement in a vehicle's fuel economy if each of the rolling resistance of each of its tires is reduced by 10%
e: the price of fuel, in dollars

Evaluating the partial derivatives of these functions at the assumed values of the parameters under the NHTSA proposal (a=41,000, b=22 mpg, c=10%, d= 1.1%, e=$2) gives the following:

Table V-7
Sensitivity of Fuel Savings per Improved Tire to Parameter Inputs

Variable	Partial Derivative of Fuel(a,b,c,d) Evaluated at the Assumed Parameter Values[1]
a (tire life)	0.005
b (mpg)	-8
c (% reduction in rolling resistance per improved tire)	166
d (% improvement in fuel economy per 10% reduction in rolling resistance)	15,126

[1]The assumed values of the parameters are: a=41,000, b=22 mpg, c=10%, d= 1.1%.

That is, the estimated fuel savings per improved tire increases by about 5 gallons for every 1,000 mile increase in tire life, decreases by 8 gallons for every 1 mpg increase in mpg, increases by about 2 gallons for every percentage point increase in the percentage reduction in rolling resistance per improved tire, and increases by about 15 gallons for every tenth of a percentage point increase in the percentage improvement in fuel economy per 10% reduction in rolling resistance.

C. Expected Tire Manufacturer and Retailer Responses to Rating System

It is difficult to anticipate how tire manufacturers or tire dealers and retailers will respond to a rating system. We made estimates of the percent of tires that might be improved by tire manufacturers (1, 2, or 10 percent). However, these estimates also depend upon how tire retailers use the rating system and the feedback tire manufacturers eventually get back from their customers and retailers.

Many of the E-tailers currently provide a variety of rating systems, including the UTQGS rating, and one would expect that they would pick up this inclusive rating system and supplement or replace the UTQGS system with it. Customers that are buying tires on-line are probably used to looking at ratings and comparisons electronically. They are a good market for a system like the one proposed.

In a tire dealer showroom, a good percentage of customers rely on the tire dealer to recommend specific tires to go on the customer's car and maybe provide them with a few choices. If improving rolling resistance seems like a good deal to customers (from the tire dealer's perspective) then maybe the tire dealer will make more recommendations for those tires with improved rolling resistance. For example, if a set of 4 tires costs $12 more, but the customer can save 5 gallons of gas per year, the tire dealer might suggest to their customers that they should invest more money up front (at the dealer's shop) and save money over the next year or two. The calculator gives tire dealers a way to compare price increases with gallons saved, and provide that information to their customers. And if the economics are right, it is a win-win for the dealer and the customer.

In essence, it is very hard to judge how this tire information might be used, and the extent to which the tire dealers and consumers might influence future tire designs. The agency seeks comment regarding the probable reaction of both consumers and tire manufacturers to its proposed tire ratings system as well as other variations on this system.

VI. COSTS

The proposal could result in a variety of costs to tire manufacturers, tire dealers, the government, and to the consumer. The variety of costs include:

Tire Manufacturer costs

- Upgrades to tires to make them perform better (this is optional, but necessary to provide benefits)
- A possible reduction in costs to take the UTQGS rating off the tires
- Labels provided on the tires
- Testing costs for manufacturers
- Information provided to the government

Tire Dealer[71] costs

- Leave the label on the tire until the tire is sold – no cost.
- Tire dealers with a showroom are required to display information poster provided by NHTSA – no cost.
- Provide information to consumers – considered part of job.
- Possibly no longer required to keep UTQGS booklet available – no cost.

Government costs

- Testing costs for enforcement
- Provide a web site that organizes and provides information on 20,000 tire model/size combinations per year and allows consumers to calculate the fuel economy savings in gallons between different tires.
- Provide a poster to tire dealers that have a showroom.

A. Tire Manufacturer Costs

All costs discussed below are presented in 2008 economics.

Tire Costs: There are many different ways to design the tread of a tire and affect its rolling resistance. The approach using silica for which we have estimated costs is a viable approach currently being used by Michelin and other tire manufacturers. There are other approaches using special grades of carbon black or combinations of silica or other additives with special grades of carbon black. However, we believe that all of the approaches currently being used result in additional costs per tire. We have attempted to give a range of costs that represent these approaches.

[71] Tire dealers includes stores that primarily sell tires, gasoline services stations that sell tires, national retailers, 'eTailers', private brands, specialty tires and department/discount stores that sell tires.

For this analysis we assume that the baseline properties of the tire are not going to be changed, but that the tire will have the same traction, treadwear, and other properties and will improve its rolling resistance. One way to improve the tire's rolling resistance is to include silica in its tread. This requires processing the silica in ways that result in the silica product being a more expensive material than the carbon black it is replacing and results in a more expensive process to make the tire. So, both the material ends up being more expensive and the tire manufacturing process ends up being more expensive. The increased cost per tire depends upon the size of the tire. The agency estimates that the increased cost at the consumer level is $2.00 to $4.00 per tire for P-metric tires and that the average tire affected by this proposal would increase in price by $3.00 if all other tire properties were held constant.[72] These are not costs required by the consumer information program. They are optional costs that a manufacturer may choose to add to their product in the hopes of increasing their sales. All other costs discussed below are required costs.

Label Costs: The proposal also requires a color label to be added to the current label that is glued onto a tire. The label will have the three scales in color and other information. The label should be designed in such a way (e.g. perforated at the end) that the label can be easily torn off at the tire store and handed to the customer. We estimate the cost of the color label to be $0.05 per tire. We assume it will be glued on by machine and will not result in additional labor at the tire manufacturer plant.

There are roughly 200 million replacement tires sold per year[73]. We believe that about 20 percent (40 million) of these replacement tires have low rolling resistance that is equivalent to original equipment manufacturers (OEM) tires and would not be changed for a consumer information program. This estimate is based upon testing by the California Energy Commission. We also estimate that 5 percent (10 million) of the replacement tires are LT tires and 4.5 percent (9 million) of the replacement tires are snow tires or other types of tires that are exempt from the consumer information program.

With these assumptions we estimate that 59 million tires (29.5 percent of the replacement tires) provide good rolling resistance already or are exempt from the requirements. So the number of tires that could potentially be improved for rolling resistance is:
200 million – 59 million = 141 million replacement tires.
And the number of tires that must be supplied with labels is:
200 million – 19 million = 181 million replacement tires.

Thus, the cost to provide consumer information on a label is estimated to be $9.05 million ($0.05*181 million) and the cost to tire consumers if every tire was improved to have good rolling resistance is estimated to be $423 million ($3.00*141 million).

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[72] This is the cost to reduce rolling resistance by 10 percent from today's average replacement tire rolling resistance, holding other tire properties constant. Using silica is a well known method. There are a variety of ways to improve rolling resistance and not hold other properties constant, with different cost implications. That is one reason that the agency feels it is important to have rolling resistance, traction, and treadwear on the same label.

[73] According to Modern Tire Dealer in 2008, there were 198 million replacement tires sold. http://www.moderntiredealer.com/FAQ/

It is very difficult to estimate how the different alternative labeling systems could affect the number or percentage of tires that would improve their rolling resistance. In essence, the agency assumes that the good/bad system would have a small impact (add 1 percentage point to applicable replacement tires or 1.4 million to those with good rolling resistance), that the bins or stars system would have a little bit more of an impact (add 2 percentage points or 2.8 million tires) to those with good rolling resistance, and the scale system will induce manufacturers to produce 10 percentage points of more tires that get a good rating on the scale system (14 million tires).

The costs to achieve these benefits for the tires alone are estimated to be:
1.4 million tires*$3.00 per tire = $4.2 million
2.8 million tires*$3.00 per tire = $8.4 million
14 million tires*$3.00 per tire = $42 million.

UTQGS: The agency is seeking comment on the idea of deleting the UTQGS rating at the same time as proposing this new tire rating system. If adopted, the manufacturers would be able to save a few cents per tire. Those savings would come from not having to include the mold markings for UTQGS when designing molds and from not having the raised letters for the UTQGS rating. The agency estimates this savings to be about $0.02 per tire. There are about 287 million tires sold per year, of which 19 million are LT-tires, snow tires, or others not required to be marked by UTQGS. For all new and replacement tires, the savings would be $5.36 million (287-19 million * $0.02).

Testing costs: Based on a report from Smithers Scientific Services, Inc. on February 5, 2009, on the California Energy Commission's Fuel Efficient Tire Program, there are 20,708 tires that would need to be tested to provide information. If each one of these were tested once for tire rolling resistance, the costs to the industry would be $3,727,000 (an average of $180 per tire). Based on the number of new tire models NHTSA sees in the UTQG program (about 125 per year), we estimate that testing in years two and following of the program to be $22,500. Since the UTQGS already requires testing for treadwear and traction, those costs are already in the baseline and are not incremental costs.

Information reported to NHTSA: In addition the tire manufacturer is required to provide information to NHTSA on the rating system. We are proposing to require manufacturers to report to NHTSA for each tire that is individually rated under this tire fuel efficiency consumer information program data on each of the three ratings: fuel efficiency, traction, and treadwear. In the early warning system there are 28 tire manufacturers that report to us. Each of them will need to set up the software in a computer program to combine the testing information, organize it for NHTSA's use, etc. We estimate this cost to be a one-time charge of about $10,000 per company. In the EWR analysis, we estimated the annual cost per report per tire manufacturer to be $287. There are also computer maintenance costs of keeping the data up to date, etc. as tests come in throughout the year. In the EWR analysis[74], we estimated costs of $3,755 per year per company, and expect these costs to be somewhat less. Thus, the total annual cost is estimated to be $4,042 per company. The total costs would be $280,000 + $113,176 = $393,176 for the first year and $113,176 as an annual cost for the 28 tire manufacturers.

B. Tire Dealer Costs

We estimate that there are approximately 60,000 tire retail establishments nationwide. Based on the Small Business Administration's data, there are an estimated 20,481 tire dealers (whose main business is selling tires). Based on estimates that there are roughly 100,000 fuel stations in the United States and estimates that about 30 percent of them provide vehicle repair service, we estimate that there are approximately 30,000 service stations (whose main business is selling fuel) that sell tires. In addition, there are many other types of stores and websites that sell tires; we estimate approximately 10,000 national retailers, 'eTailers', private brands, specialty tires and department/discount stores that sell tires.

Tire dealer costs are believed to be very minimal, just having to display a poster provided by NHTSA to tire dealers that have display rooms.

C. Government Cost

Costs to the government occur in three areas:
Enforcement costs, where NHTSA would spot check compliance with the requirement. NHTSA estimates that it will set up a $730,000 program to spot check compliance.

Web costs, NHTSA estimates that will be spend $550,000 per year setting up and keeping up to date with a web site that includes information on 20,000 tires.

Information provided to dealers: Currently NHTSA provides a booklet to tire dealers with the UTQGS information. That booklet is on 8.5" x 11" paper and is 141 pages long. The printing costs are $3,190 per year. Posters provided to tire dealers are anticipated to be a similar expense for the Government.

Combined the incremental costs are estimated to be $1.28 million.

[74] Preliminary Regulatory Evaluation, Tread Act Amendments to Early Warning Reporting Regulation Part 579 and Defect and Noncompliance Part 573, August 2008, (Docket No. 2008-0169-0007.1)

Table VI-1
Estimated Costs of the Proposal
(Millions of 2008 dollars)

Required Costs	First Year Costs	Subsequent Annual Year Costs
Manufacturer's label on tire	$9.05	$9.05
Man. Testing cost	$3.73	$0.02
Man. Report to NHTSA	$0.4	$0.1
Government Tests and web	$1.28	$1.28
Total	$14.5 million	$10.5 million
Optional Costs - Improving Rolling Resistance	$3 per tire	$3 per tire
Alternative 1 (thumbs up/down ratings)	$4.2	$4.2
Alternative 2 (stars/bins ratings)	$8.4	$8.4
Proposal (0-100 scaled rating system)	$8.4	$42
100% Participation Scenario	$423	$423
Combined Required and Optional Costs		
Alternative 1 (thumbs up/down ratings)	$18.7 million	$14.7 million
Alternative 2 (stars/bins ratings)	$22.9 million	$18.9 million
Proposal (0-100 scaled rating system)	$22.9-56.8 million	$18.9-52.8 million
100% Participation Scenario	$437.5 million	$433.5 million

* Under the assumptions in this analysis, Alternative 1 would result in 1.4 million tires with 5-10 percent decreased rolling resistance, Alternative 2 would result in 2.8 million tires with 5-10 percent decreased rolling resistance, and Alternative 3 would result in 14 million tires with 10 percent decreased rolling resistance.

D. Leadtime

NHTSA is proposing to require tire manufacturers to report on all existing replacement tires within 12 months of the issuance of the final rule. Tire retailers will receive an additional year after the information is gathered by tire manufacturers to have information available in their stores or on-line sites.

For new tires introduced after the effective date, NHTSA is proposing requiring information from the tire manufacturer at least 30 days prior to introducing the tire for sale. Tire retailers should try to have consumer available information on new tires as soon as possible.

VII. COST BENEFIT ANALYSES

In this chapter we combine the costs and benefits from a consumer's perspective and an overall societal perspective to examine whether the proposal is likely to be cost beneficial. From the consumer perspective, we examine the case where tires cost an estimated $3 more per tire and improve rolling resistance by 10 percent, resulting in a 1.1 percent improvement in fuel economy when all four tires are replaced.

If fuel costs $3 per gallon, this savings for a 10 percent improvement in rolling resistance would translate to $16.69 (undiscounted) saved by consumers in fuel not purchased per tire (over the life of the tire). Since the tire lasts an assumed 4.5 years, the savings need to be discounted back to present value. Using the mid-year discount rates for 3 percent and 7 percent shown in Table V-3, the dollar savings get discounted to $15.62 at a 3% discount rate and $14.36 at a 7% discount rate.

If, as we estimated in Section VI, a tire costs $3 more and achieves a 10 percent improvement in rolling resistance, and the price of gasoline is $3.00 per gallon, the consumer can expect to get back $12.62 to $11.36 over the lifetime of the tire in fuel not purchased. The payback period under these assumptions is about 10 months (1.24 gallons saved in one year * $3 per gallon = $3.72 saved in the first year. $3 cost/$3.72 benefit = 0.8 * 12 months/year = 9.7 months). Even if the tire costs $4 more, achieves a 5 percent improvement in rolling resistance, and the price of gas is $2 per gallon, the discounted benefits of $4.81 to $5.23, outweigh the costs over the tire's expected lifetime.

We now consider costs and benefits from the total perspective, i.e. including all of the estimated costs for manufacturers and tire dealers. Looking five years or more to the future when this program gets established, the costs and benefits are shown in Table VII-1. Given the estimated fixed and variable costs, limiting the benefits to those arising from fuel savings, and assuming that a 10 percent improvement in rolling resistance will be achieved, you need less than 1 percent of the applicable tires to be sold with better rolling resistance to break even. If you assume a 5 percent improvement in rolling resistance will be achieved, you need about 2 percent of the applicable tires to be sold with better rolling resistance to breakeven.

Table VII-1
Combined Total Costs and Benefits
Steady State on an Annual Basis
(2008 Dollars in Millions)

Scenario	**Total Costs**	**Benefits[1] Discounted 3%**	**Net Costs (Net Benefits)**
Alternative 1 (thumbs up/down ratings)	$14.7	$11 - $22	$(7.3) to $3.6
Alternative 2 (stars/bins ratings)	$18.9	$22 - $44	$(25.1) to $(3.2)
Proposal (0-100 rating system)	$18.9-52.8	$22-220	$(163) to $0.8
100% Participation Scenario	$433.5	$2,202	$(1,768)
Scenario	Total Costs	Benefits Discounted 7%	Net Costs (Net Benefits)
Alternative 1 (thumbs up/down ratings)	$14.7	$10 - $20	$(5.6) to $4.5
Alternative 2 (stars/bins ratings)	$18.9	$20 - $41	$(21.6) to $(1.5)
Proposal (0-100 rating system)	$18.9-52.8	$20-203	$(150) to $(1.5)
100% Participation Scenario	$433.5	$2,025	$(1,592)

[1]Benefits reflect fuel savings only, and do not account for benefits or disbenefits regarding safety and durability.

VIII. REGULATORY FLEXIBILITY ACT AND UNFUNDED MANDATES REFORM ACT ANALYSIS

Regulatory Flexibility Act

The Regulatory Flexibility Act of 1980 (5 U.S.C. §601 et seq.) requires agencies to evaluate the potential effects of their proposed and final rules on small businesses, small organizations and small governmental jurisdictions. In compliance with the Regulatory Flexibility Act, 5 U.S.C. 60l et seq., NHTSA has evaluated the effects of this final rule on small entities. The head of the agency has certified that this rule will not have a significant economic impact on a substantial number of small entities.

The factual basis for the certification (5 U.S.C. 605(b)) is set forth below. Although the agency is not required to issue an initial regulatory flexibility analysis, we discuss below many of the issues that an initial regulatory flexibility analysis would address.

5 U.S.C §603 requires agencies to prepare and make available for public comments initial and final regulatory flexibility analysis (RFA) describing the impact of proposed and final rules on small entities. Section 603(b) of the Act specifies the content of a RFA. Each RFA must contain:

1. A description of the reasons why action by the agency is being considered;
2. A succinct statement of the objectives of, and legal basis for a final rule;
3. A description of and, where feasible, an estimate of the number of small entities to which the final rule will apply;
4. A description of the projected reporting, recording keeping and other compliance requirements of a final rule including an estimate of the classes of small entities which will be subject to the requirement and the type of professional skills necessary for preparation of the report or record;
5. An identification, to the extent practicable, of all relevant Federal rules which may duplicate, overlap or conflict with the final rule;
6. Each final regulatory flexibility analysis shall also contain a description of any significant alternatives to the final rule which accomplish the stated objectives of applicable statutes and which minimize any significant economic impact of the final rule on small entities.

1. Description of the reason why action by the agency is being considered

NHTSA is proposing this action in response to the Energy Independence and Security Act of 2007 (EISA).

2. Objectives of, and legal basis for, the final rule

EISA requires the agency to develop a national tire fuel efficiency consumer information program to educate consumers about the effect of tires on automobile fuel efficiency, safety, and durability.

3. Description and estimate of the number of small entities to which the final rule will apply

The final rule will affect 28 tire manufacturers, none of which we believe are small businesses. The final rule will affect an estimated 60,000 tire dealers and retailers. While we don't have exact estimates, many of these, certainly a substantial number, are small businesses.

Business entities are defined as small business using the North American Industry Classification System (NAICS) code, for the purpose of receiving Small Business Administration assistance. The criteria for determining size, as stated in 13 CFR 121.201, are either the number of employees in the firm or total sales. For establishments primarily engaged in manufacturing tires (NAICS 326211), the firm must have less than 1,000 employees to be classified as a small business. For establishments primarily engaged as tire dealers (NAICS 441320), the firm must sell less than $6.0 million to be classified as a small business. For establishments primarily engaged as gasoline stations, (NAICS 447190), the firm must sell less than $7.5 million to be classified as a small business.

<u>4. A description of the projected reporting, record keeping and other compliance requirements of a final rule including an estimate of the classes of small entities which will be subject to the requirement and the type of professional skills necessary for preparation of the report or record.</u>

The proposal includes reporting requirements for tire manufacturers, which are not small businesses. There are no reporting requirements, record keeping, or other compliance requirements for tire dealers or retailers.

The requirement for the tire dealers to "display" the NHTSA provided poster could be considered an "other compliance requirement". However, we believe that this requirement will have no costs and will not result in a significant economic impact on those affected.

<u>5. An identification, to the extent practicable, of all relevant Federal rules which may duplicate, overlap, or conflict with the final rule</u>

The current UTQGS tire marking requirement to some extent duplicates the information proposed on traction and treadwear. The agency is proposing to remove this duplicative information.

6. <u>A description of any significant alternatives to the final rule which accomplish the stated objectives of applicable statutes and which minimize any significant economic impact of the final rule on small entities.</u>

We believe this proposal will have no economic impact on small entities. No alternatives were considered that could further limit the impacts on small entities. Alternatives have been discussed in the PRIA above.

The agency finds that while the proposal will affect a substantial number of small businesses, it will not have a significant economic impact on them.

Unfunded Mandates Reform Act

The Unfunded Mandates Reform Act of 1995 (Public Law 104-4) requires agencies to prepare a written assessment of the costs, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditures by States, local or tribal governments, in the aggregate, or by the private sector, of more than $100 million annually (adjusted annually for inflation with base year of 1995). Adjusting this amount by the implicit gross domestic product price deflator for 2007 results in $130 million (119.816/92.106 = 1.30). This proposal is not estimated to have total costs of $130 million or more. The assessment may be included in conjunction with other assessments, as it is here.