INFLATION PRESSURE RETENTION EFFECTS ON TIRE ROLLING RESISTANCE AND VEHICLE FUEL ECONOMY

presented to

California Air Resources Board

Sacramento, CA

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Objectives

Establish that low Tire Inflation Pressure Retention loss rates significantly contribute to maintaining tire rolling resistance and increasing vehicle fuel economy

- **Approach**
  - Measure tire rolling resistance as a function of inflation pressure
  - Relate rolling resistance increases to Tire IPR loss rates
  - Estimate fuel losses due to varying tire reinflation time periods
  - Use findings in National Research Council report to estimate potential fuel savings by using tires with low IPR loss rates
  - Estimate potential savings for the State of California

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Agenda

- **Background**
  - **'Twenty in Ten'**
  - **'Tires and Passenger Vehicle Fuel Economy'**
- **Rolling Resistance Measurements**
- **Tire IPR Loss Rates**
- **Tire Reinflation**
- **Tire IPR and Fuel Economy**
- **Summary**

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Background: 'Twenty in Ten' Goal

- **In 2007 State of Union Address, President Bush announced 'Twenty in Ten' goal to reduce U.S. gas consumption by 20% over next 10 yrs**
  - Use 8.5 billion fewer gallons of gasoline per year by 2017 by reforming CAFE
- **"To meet this goal we must make progress on two fronts**
  - On the demand side, the President has proposed **reforming fuel economy standards to make cars more energy efficient**, just like we did for light trucks
  - On the supply side, the President has proposed increasing supply of alternative fuels by setting mandatory fuels standard to require 35 billion gallons of renewable and other alternative fuels in 2017, nearly five times current target"
    (ref: www.whitehouse.gov/news/releases/2007/03/print/20070320-2.html)
- **In 2/2005, National Research Council formed committee to perform a national tire efficiency study and literature review to**
  - **"Consider the relationship that low rolling resistance replacement tires designed for use on passenger cars and light trucks have on fuel consumption and tire wear life"**
  - "Address the potential for securing technically feasible and cost-effective replacement tires that do not adversely affect safety, including the impacts on performance and durability, or adversely impact tire tread life and scrap tire disposal"

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Background:
'Tires and Passenger Vehicle Fuel Economy'

(ref: http://onlinepubs.trb.org/onlinepubs/sr/sr286.pdf)

Key Findings

- **Rolling resistance has meaningful effect on vehicle fuel consumption**
  - Tires are main source of rolling resistance
  - Tires differ in rolling resistance, with RR coefficient ranging from 0.007 to 0.014
- **Average rolling resistance of replacement tires can be reduced 10%**
  - Technically and economically feasible
  - Safety consequences are probably undetectable
  - Could be attained within a decade
- **10% reduction in rolling resistance promises 1-2% increase in fuel economy of passenger cars and light trucks**
  - Save 1-2 billion gallons of fuel
  - Equivalent to taking 2-4 million cars and light trucks off the road
- **"…if rolling resistance is reduced because of better tire maintenance, consumers may end up spending less on tires, because properly inflated tires will have longer wear in addition to providing better fuel economy."**

Achievable Goal:
Reducing Tire Rolling Resistance by 10%

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Agenda

- Background
- Rolling Resistance Measurements
  - Testing Methods and Reproducibility
  - Tire Footprint
  - Cavity Air Temperature
  - Rolling Resistance Coefficient
- Tire IPR Loss Rates
- Tire Reinflation
- Tire IPR and Fuel Economy
- Summary

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Tire Rolling Resistance Characterization

- **Rolling resistance measured at Smithers Scientific Services on 1.7-m indoor roadwheel at 24°C**
  - P205/60 SR15, 100-phr BIIR innerliner with cured gauge of 1.0 mm
  - Six inflation pressures requested: 32, 31, 30, 28, 26, 24 psi
- **Single Point Inflation**
  - Measured at 50 mph, 70% load and one inflation pressure
    - Repeated six times: 32, 31, 30, 28, 26, and 24 psi hot inflation
  - Tire Footprints obtained and areas determined
- **SAE J1269**
  - Current recommended practice used to evaluate tires by tire industry
  - Measured at constant 50 mph speed at 50% and 90% of maximum load and two inflation pressures
- **SAE J2452**
  - Current recommended practice used to evaluate tires and effect on vehicle fuel economy
    - Many vehicle manufacturers use this technique to generate CAFE predictions
  - Measured at speed of 71 mph coasting down to 9 mph at two loads and two inflation pressures
    - Rolling resistance values calculated from regression curve

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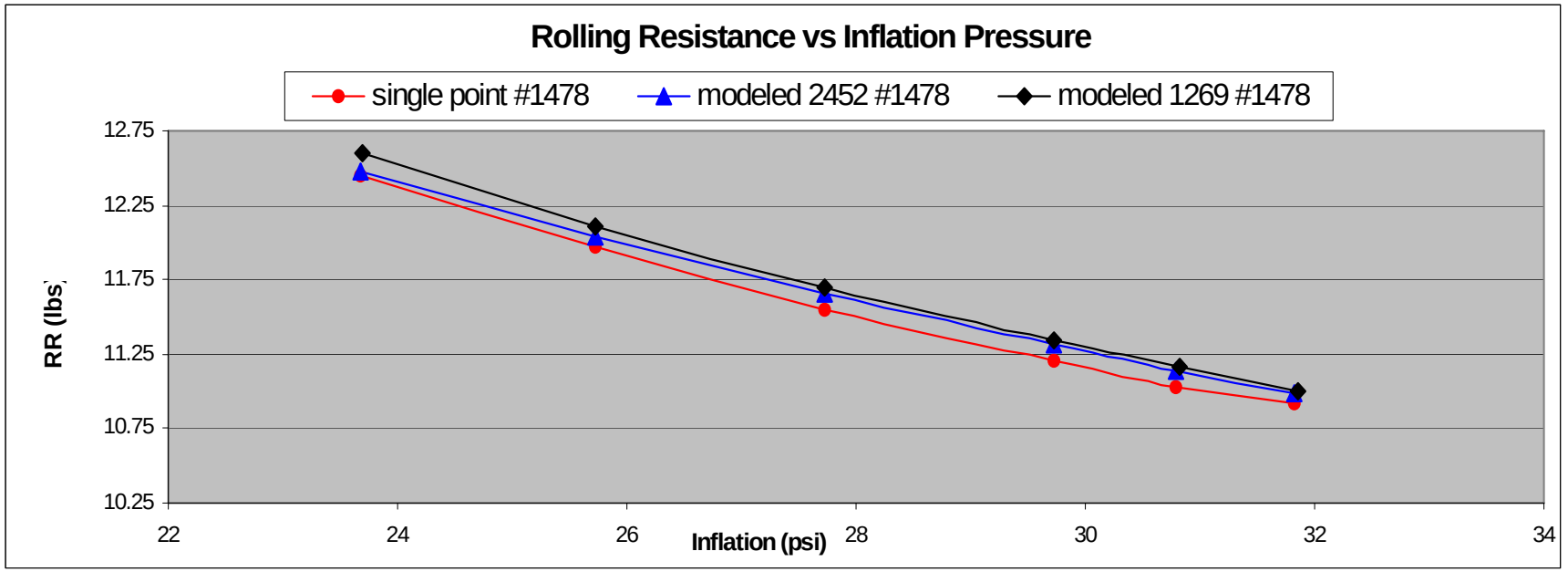
Tire Rolling Resistance Characterization

- **Three tests run: Single-point inflation, SAE J1269 and SAE J2452**
  - Tests on experimental tires: P205/60 SR15, 1-mm, 100-phr BIIR

Test Methods Comparison



- **Rolling resistance (RR) measured experimentally**
  - Excellent reproducibility between three methods: Mean = 10.754, SD = 0.045

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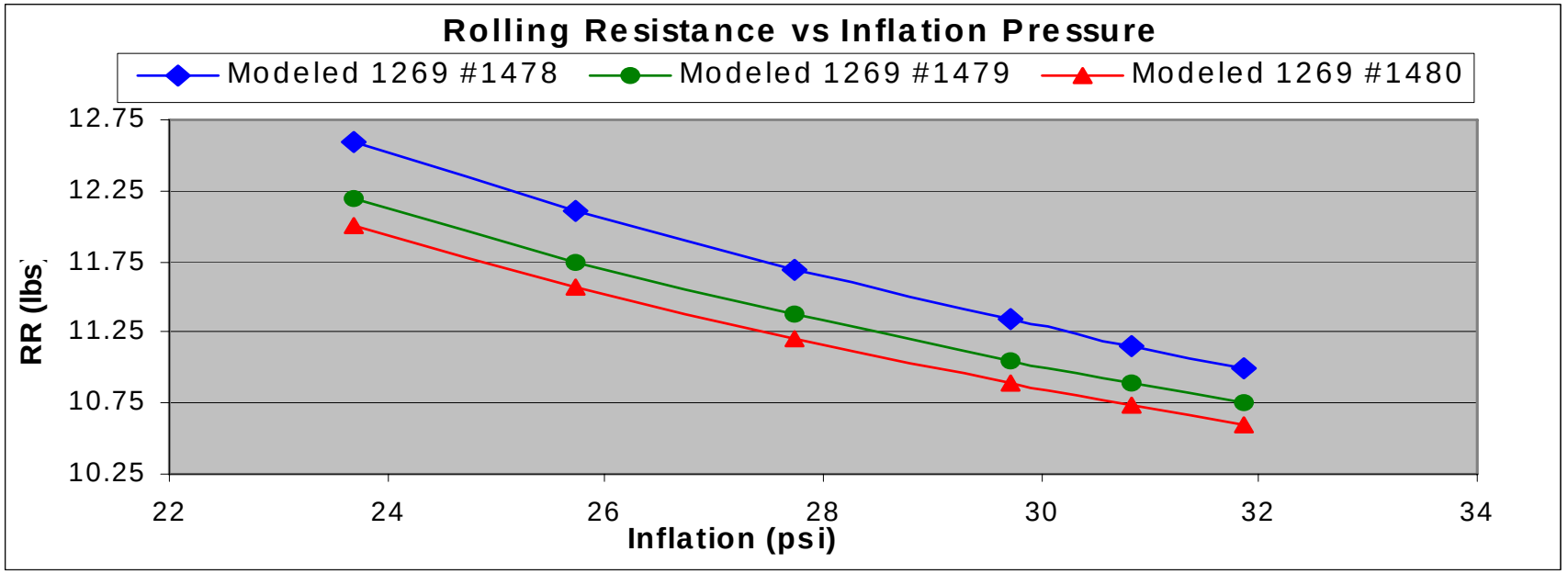
Tire Rolling Resistance Characterization

- **Three tests run: Single-point inflation, SAE J1269 and SAE J2452**
  - Tests on experimental tires: P205/60 SR15, 1-mm, 100-phr BIIR

Tire Reproducibility



- **Rolling resistance (RR) measured experimentally**
  - Excellent reproducibility between three tires: Mean = 10.754, SD = 0.20

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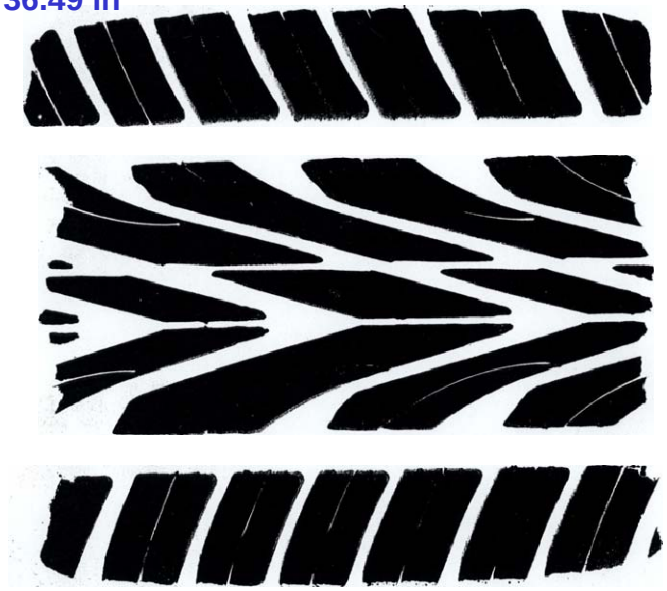
Tire Inflation Pressure Effects

32 psi
Area = 36.49 in^2



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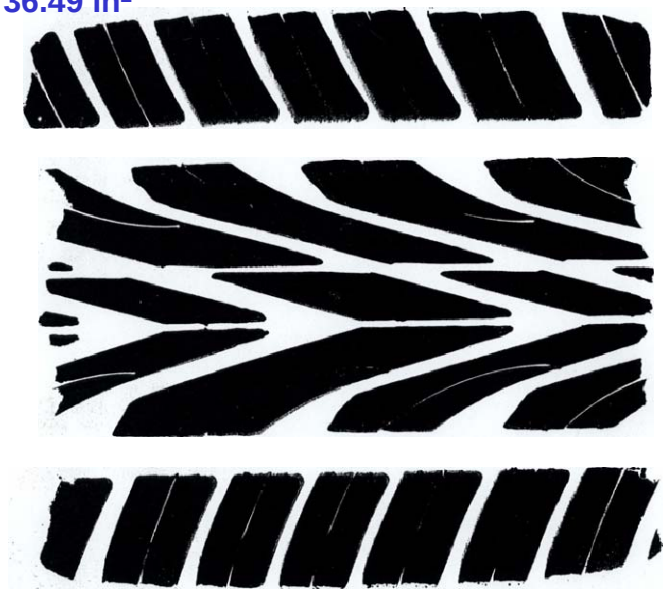
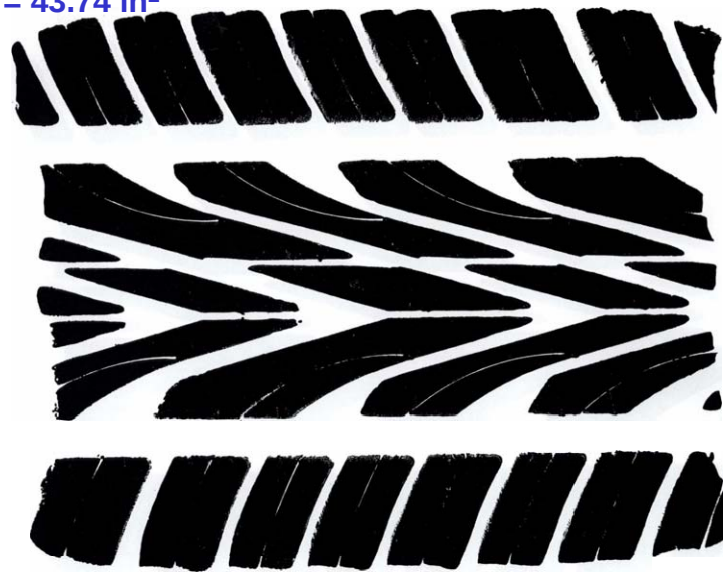


24 psi
Area = 43.74 in^2



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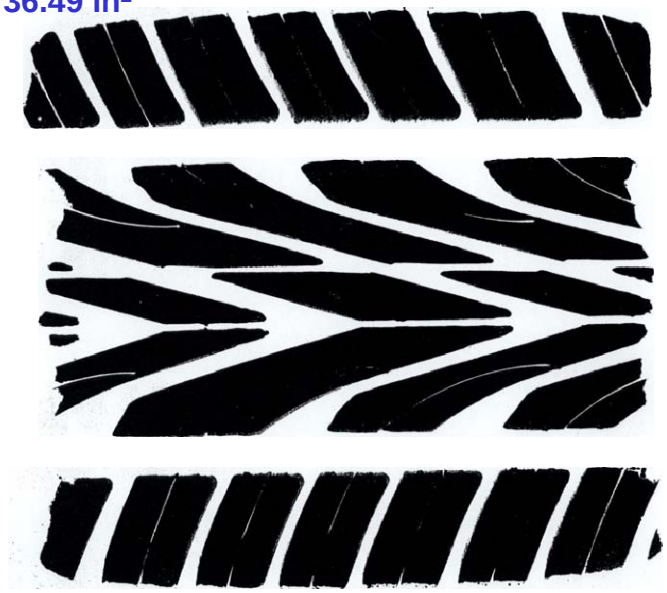

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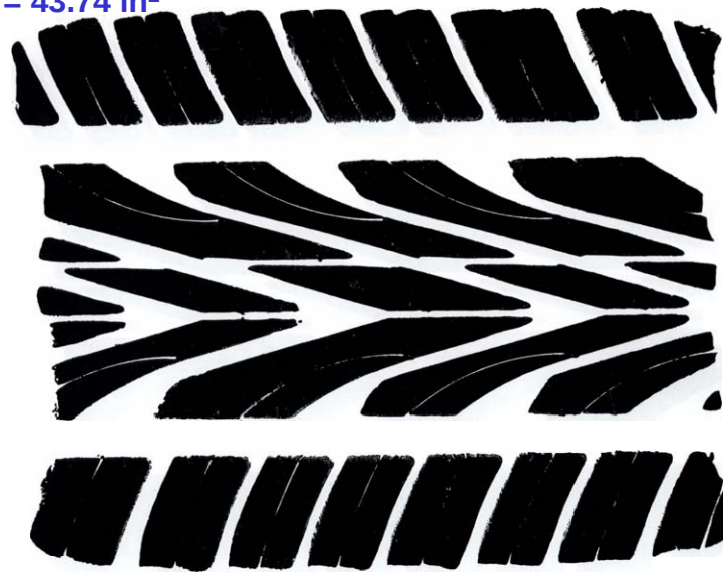

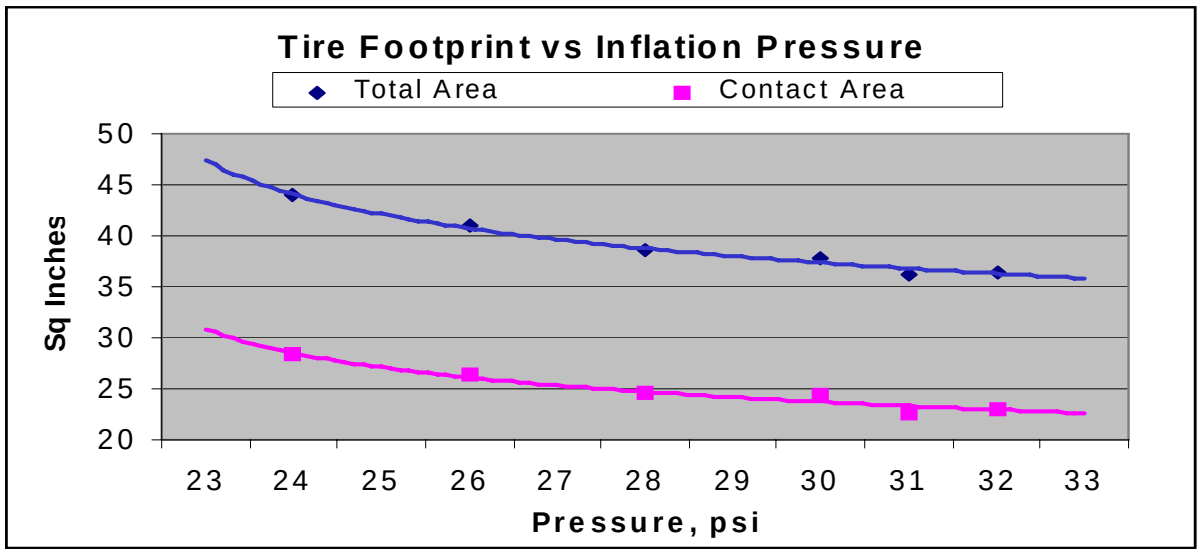

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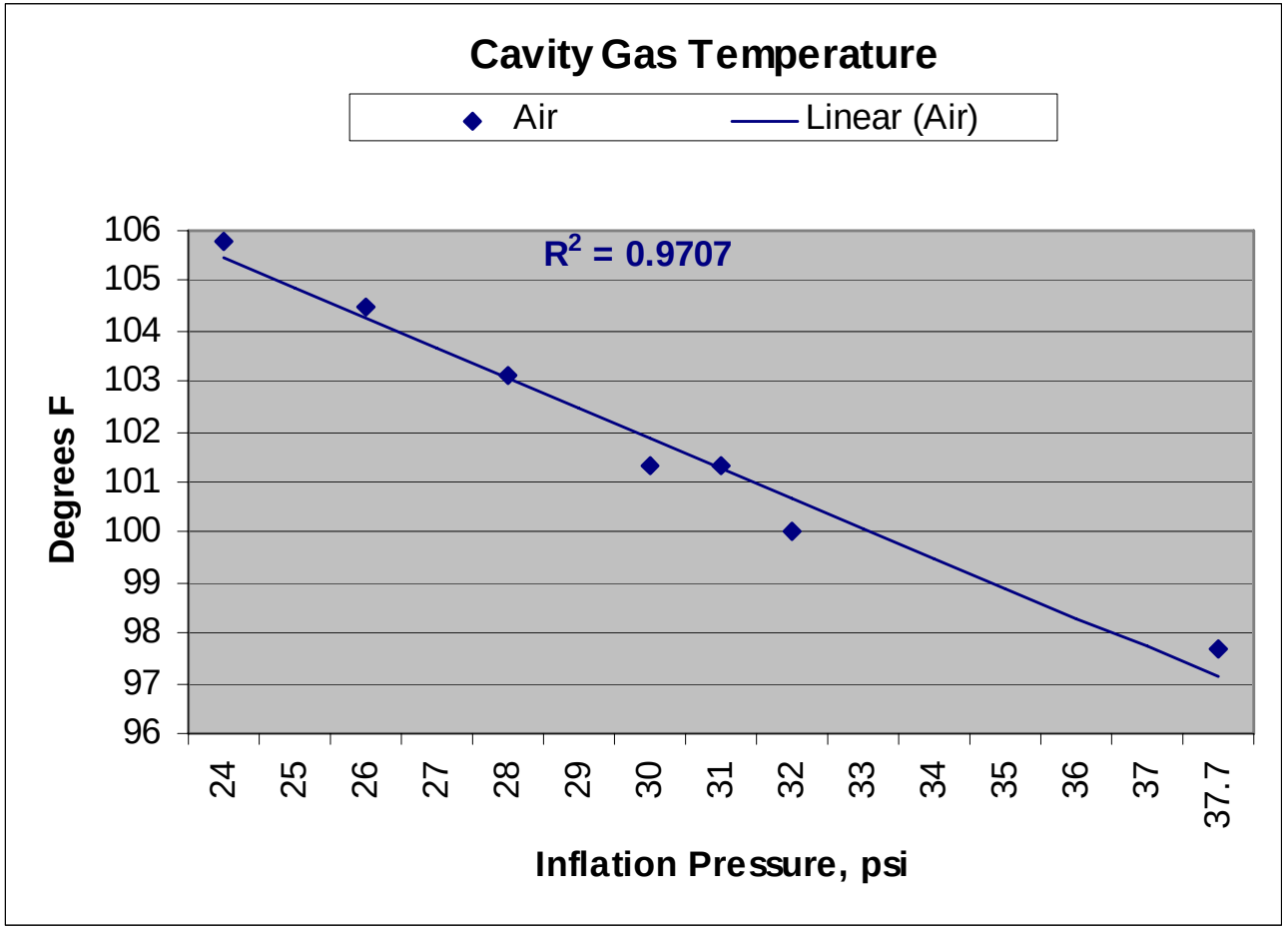
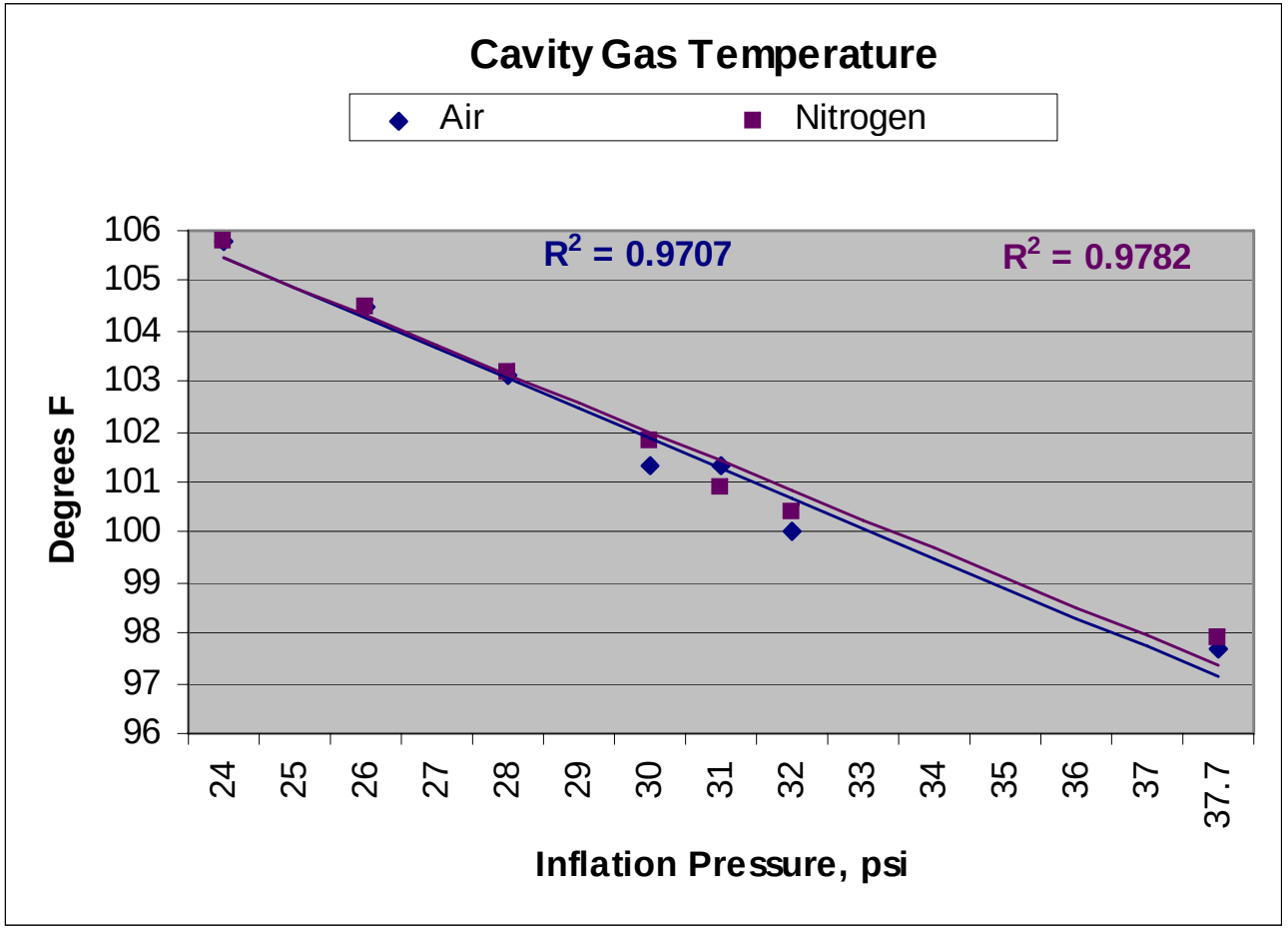
Filling Gas Effects: Cavity Air Temperature



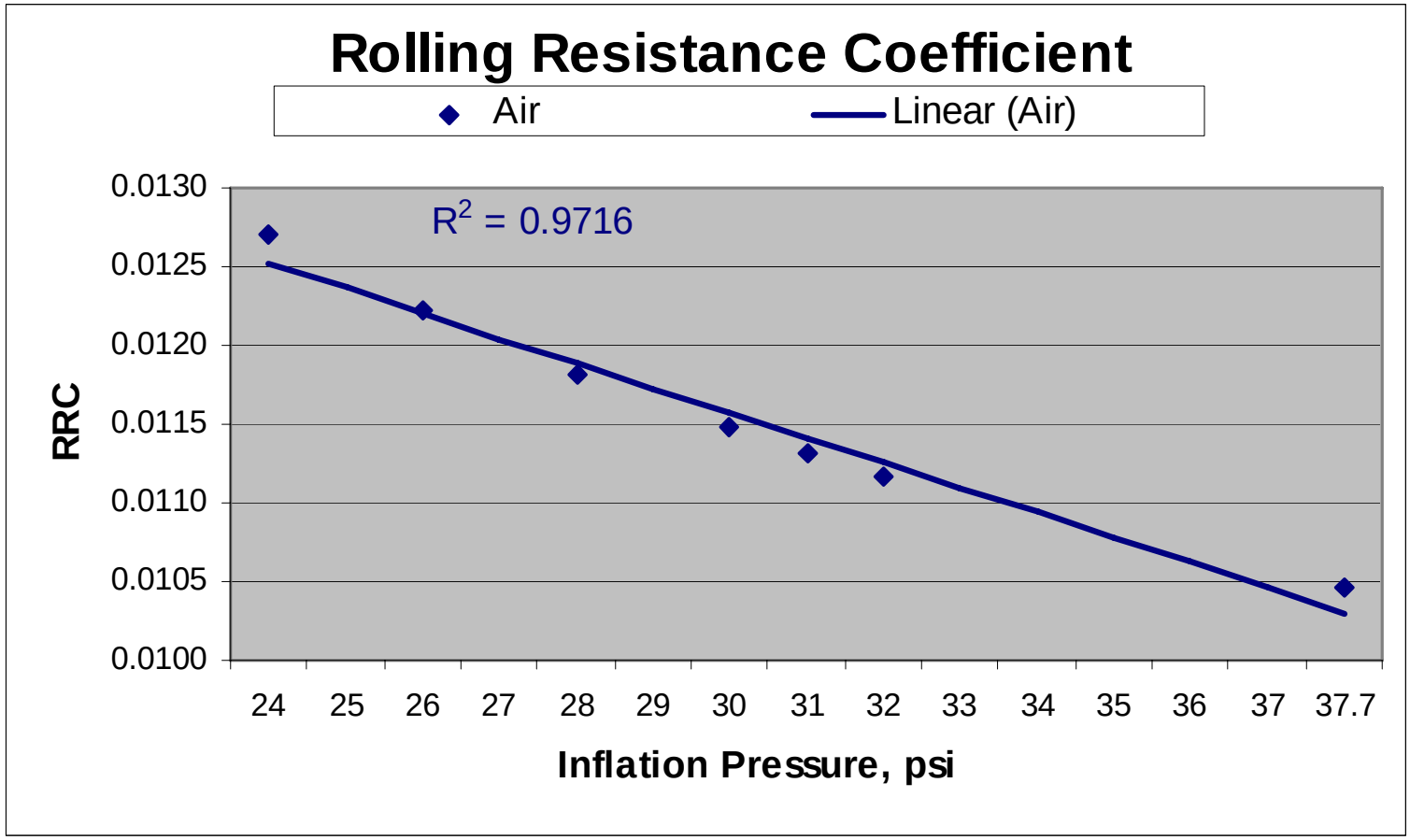
Cavity Air Temperature Dependent Upon Inflation Pressure

Filling Gas Effects: Cavity Gas Temperature



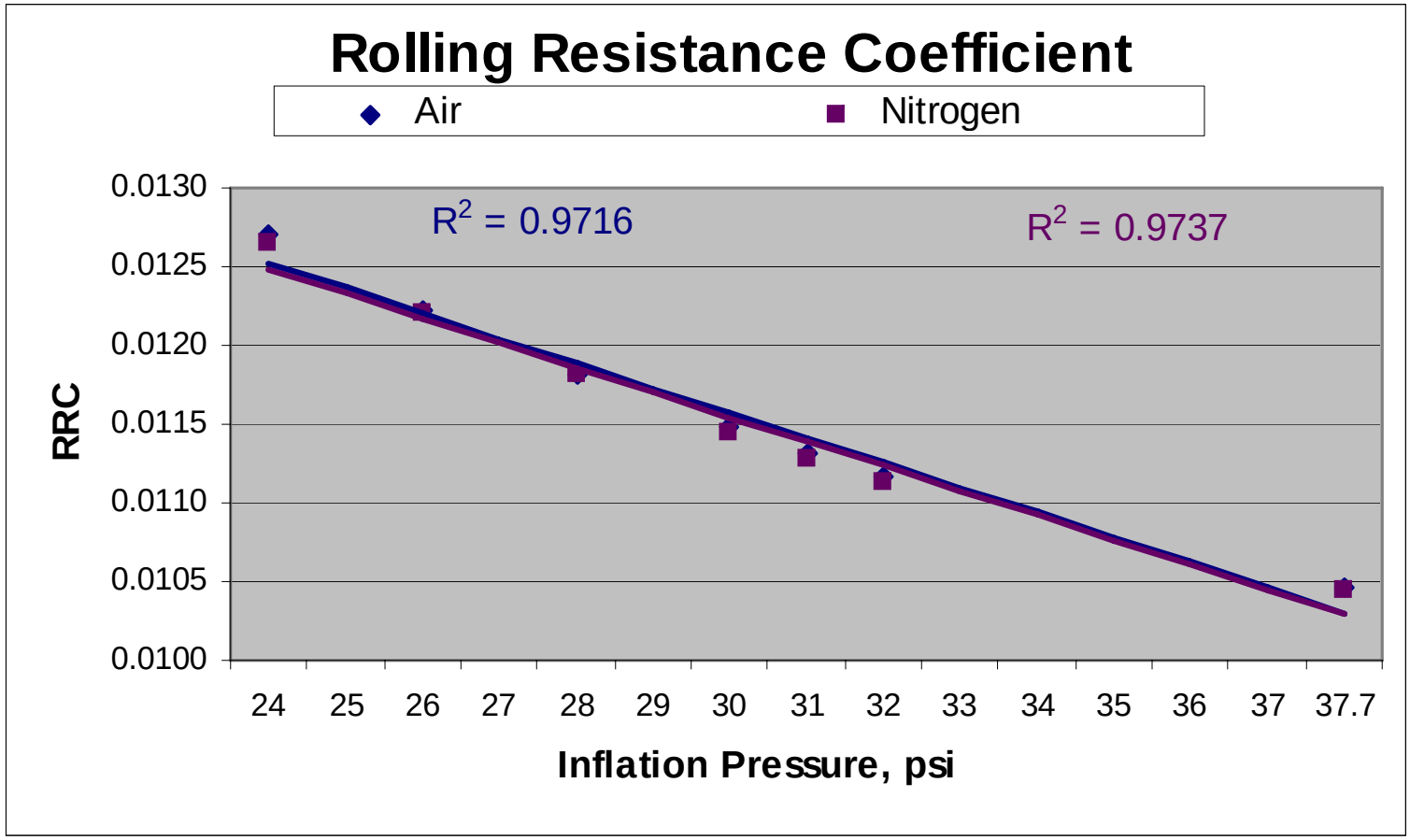
Cavity Air Temperature Does Not Change using Nitrogen Gas

Filling Gas Effects: Tire Rolling Resistance



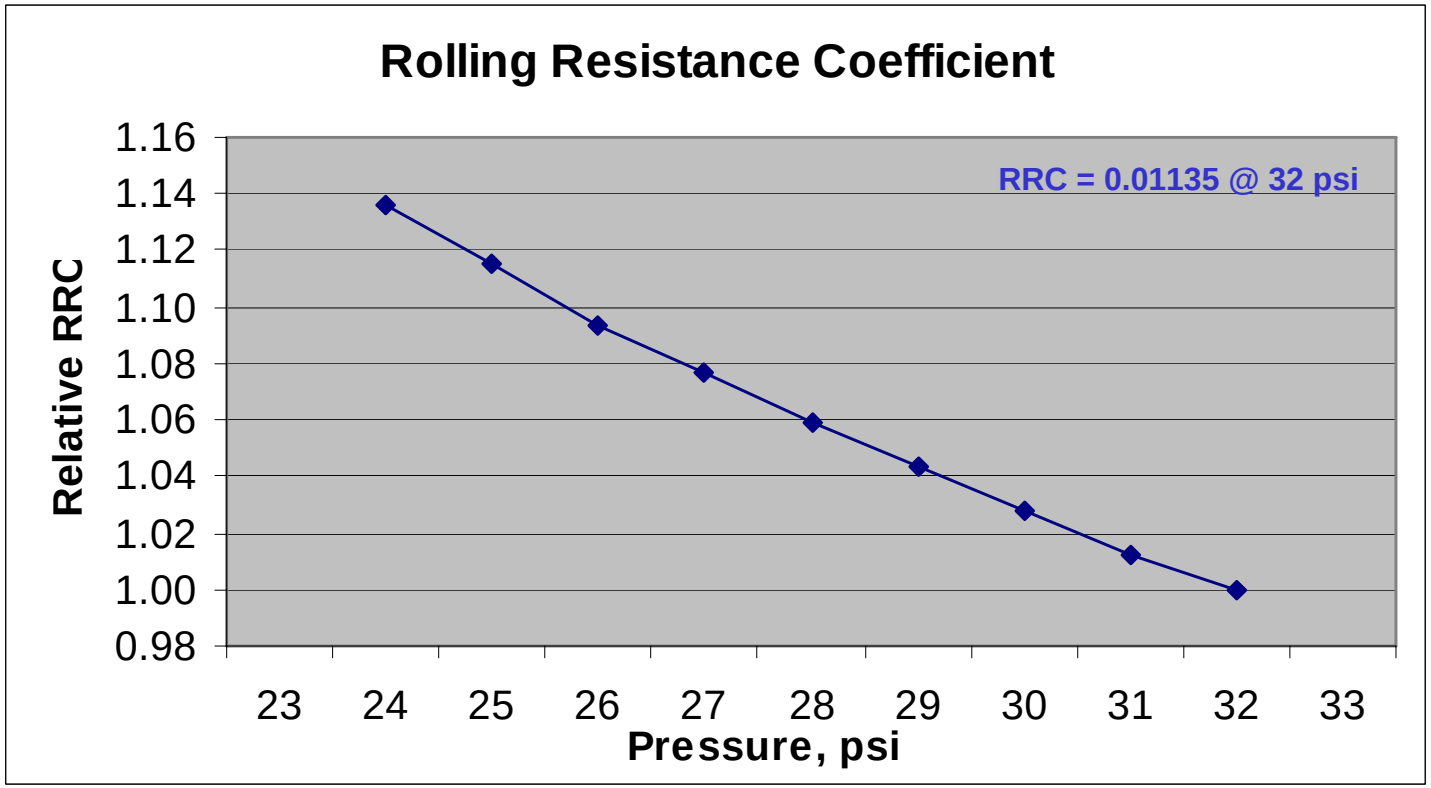
Tire Rolling Resistance Dependent Upon Inflation Pressure

Filling Gas Effects: Tire Rolling Resistance



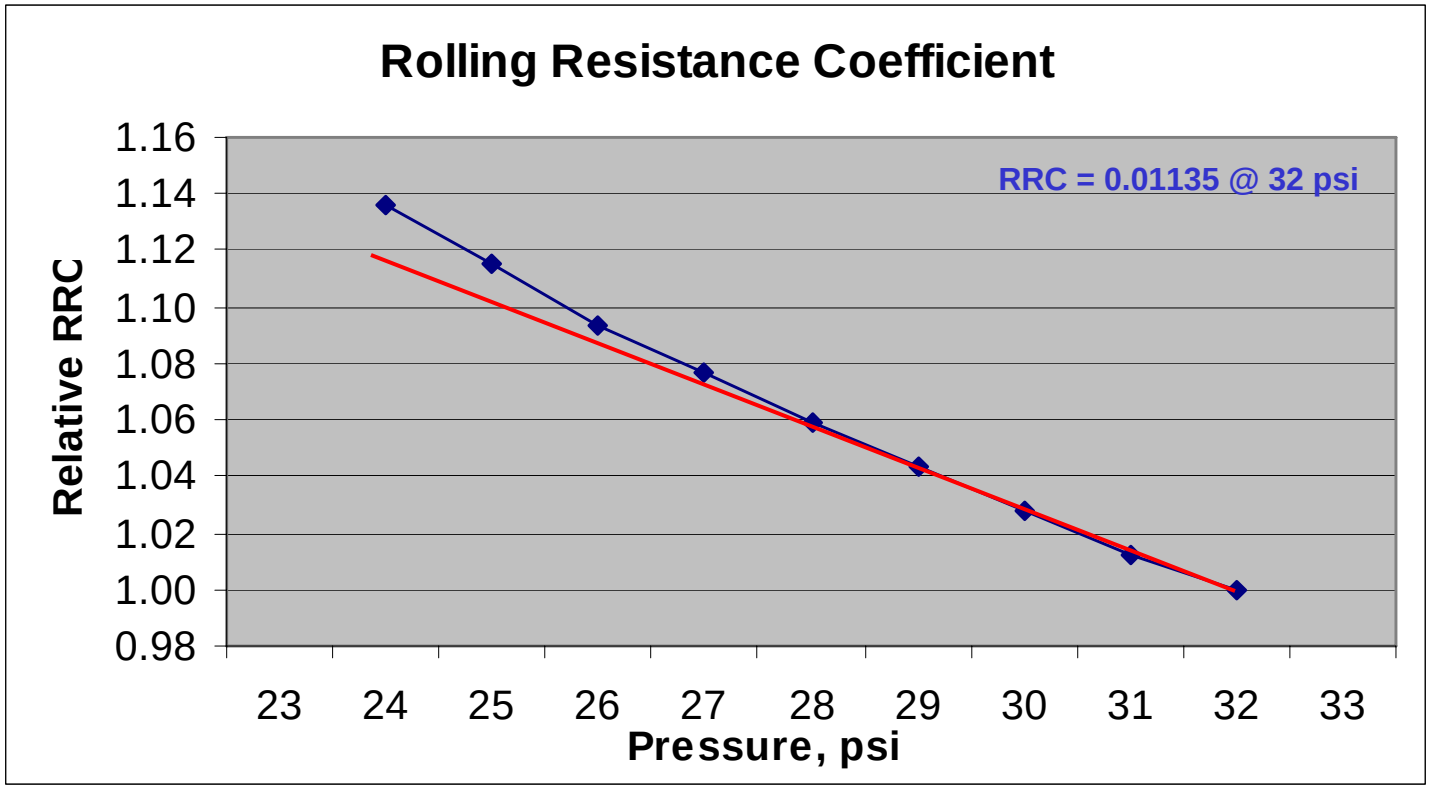
Tire Rolling Resistance Does Not Change Using Nitrogen Gas

Tire Inflation Pressure and Rolling Resistance



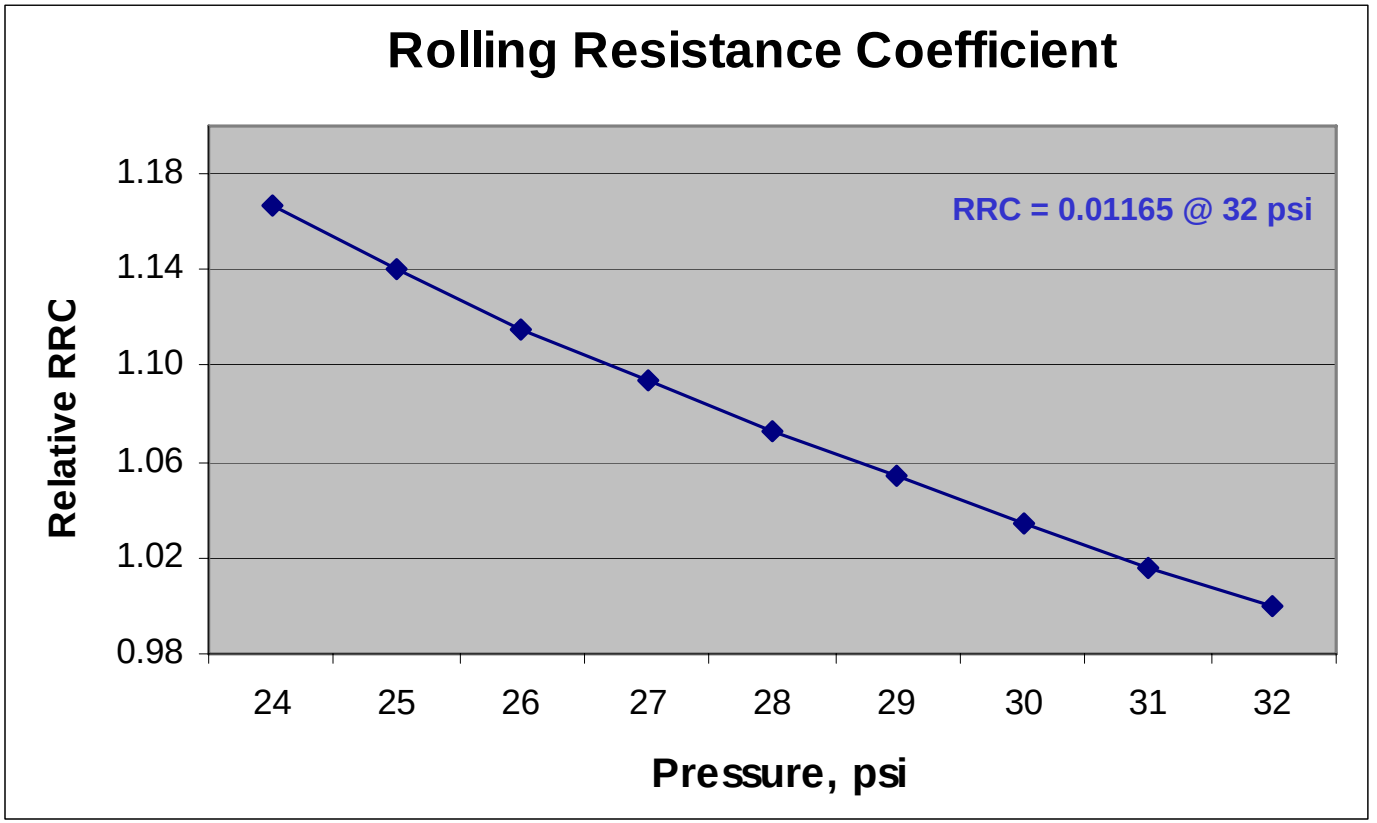
Rolling Resistance of Tire is Non-linear Function of Inflation Pressure

Tire Inflation Pressure and Rolling Resistance



Example 1: Tire Rolling Resistance Coefficient Increases 13.7% as Inflation Pressure Decreases by 25%

Tire Inflation Pressure and Rolling Resistance - 2



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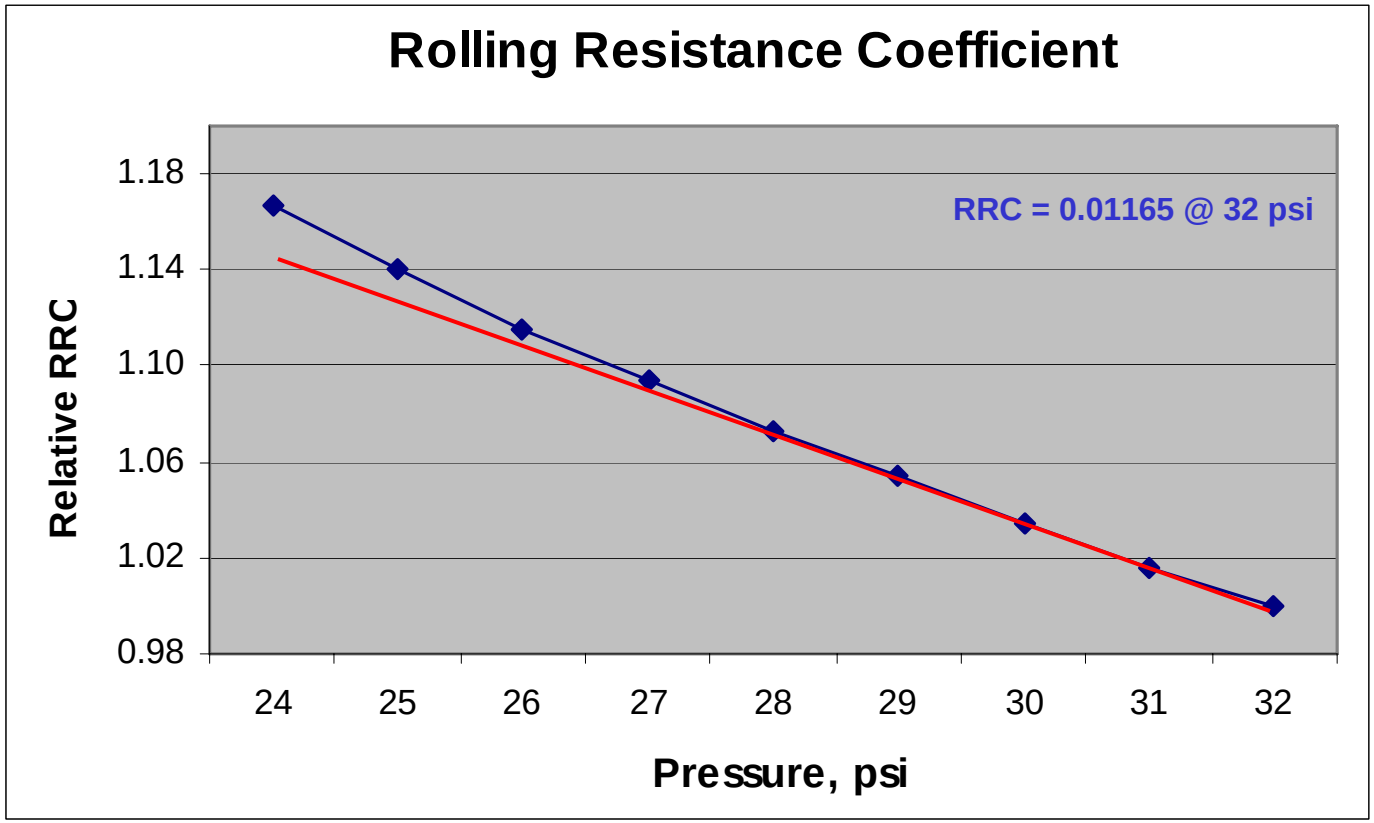
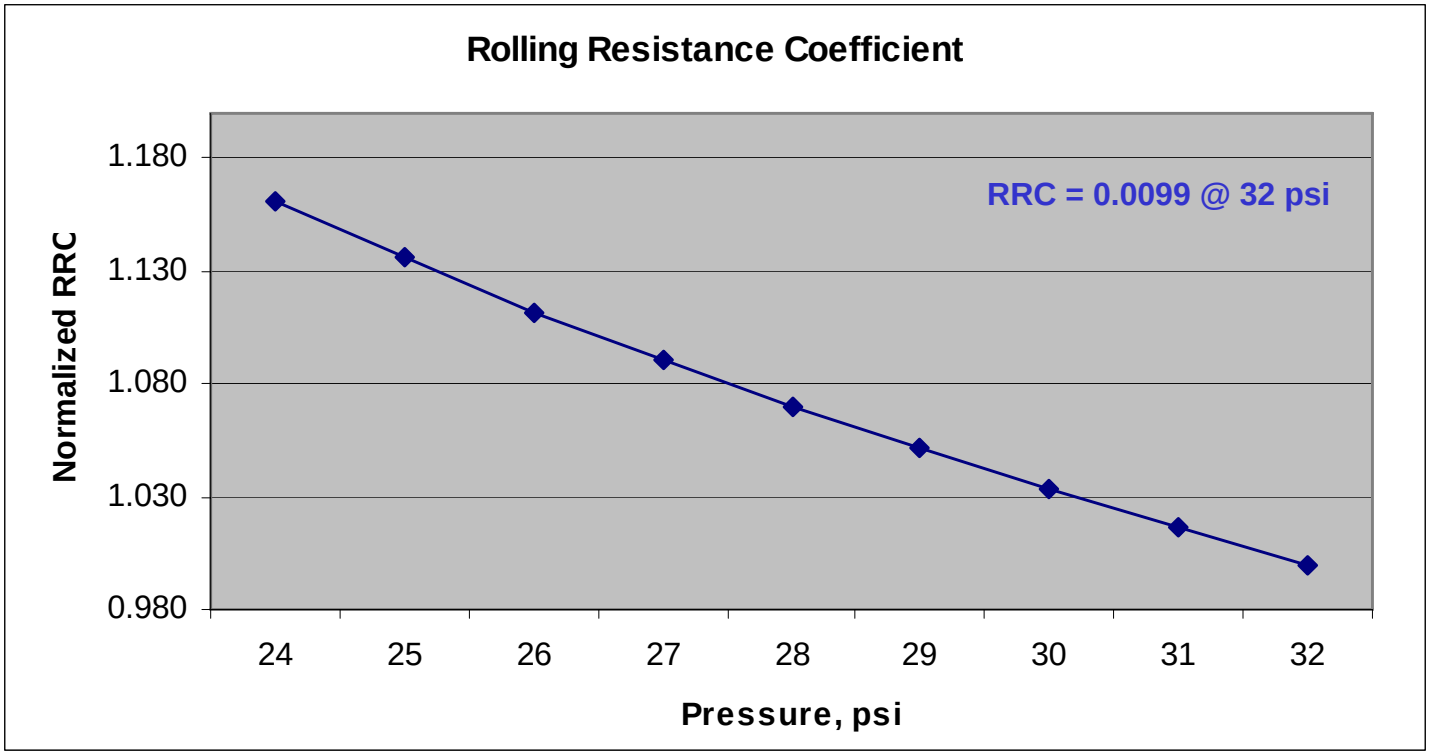


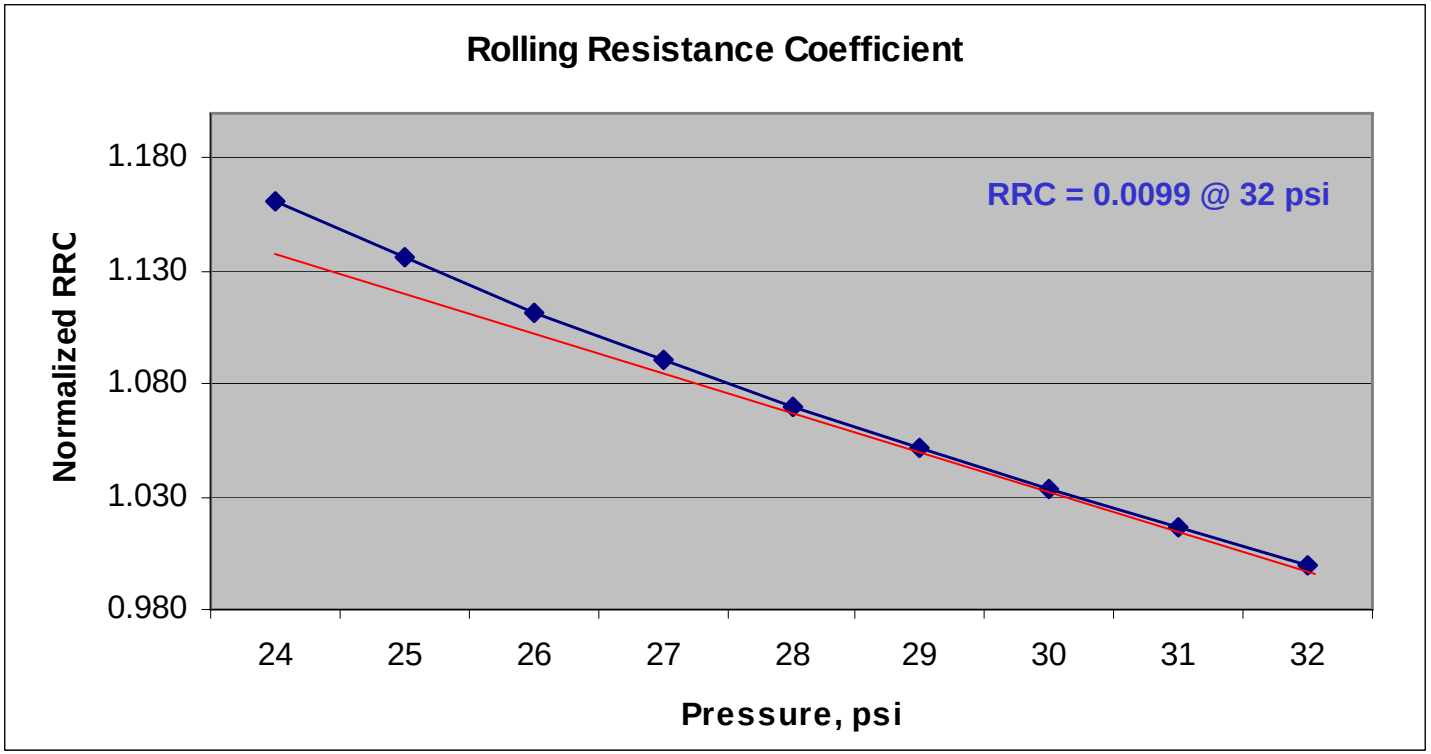
Example 2. Tire Rolling Resistance Coefficient Increases 16.6% as Inflation Pressure Decreases by 25%

Tire Inflation Pressure and Rolling Resistance - 3



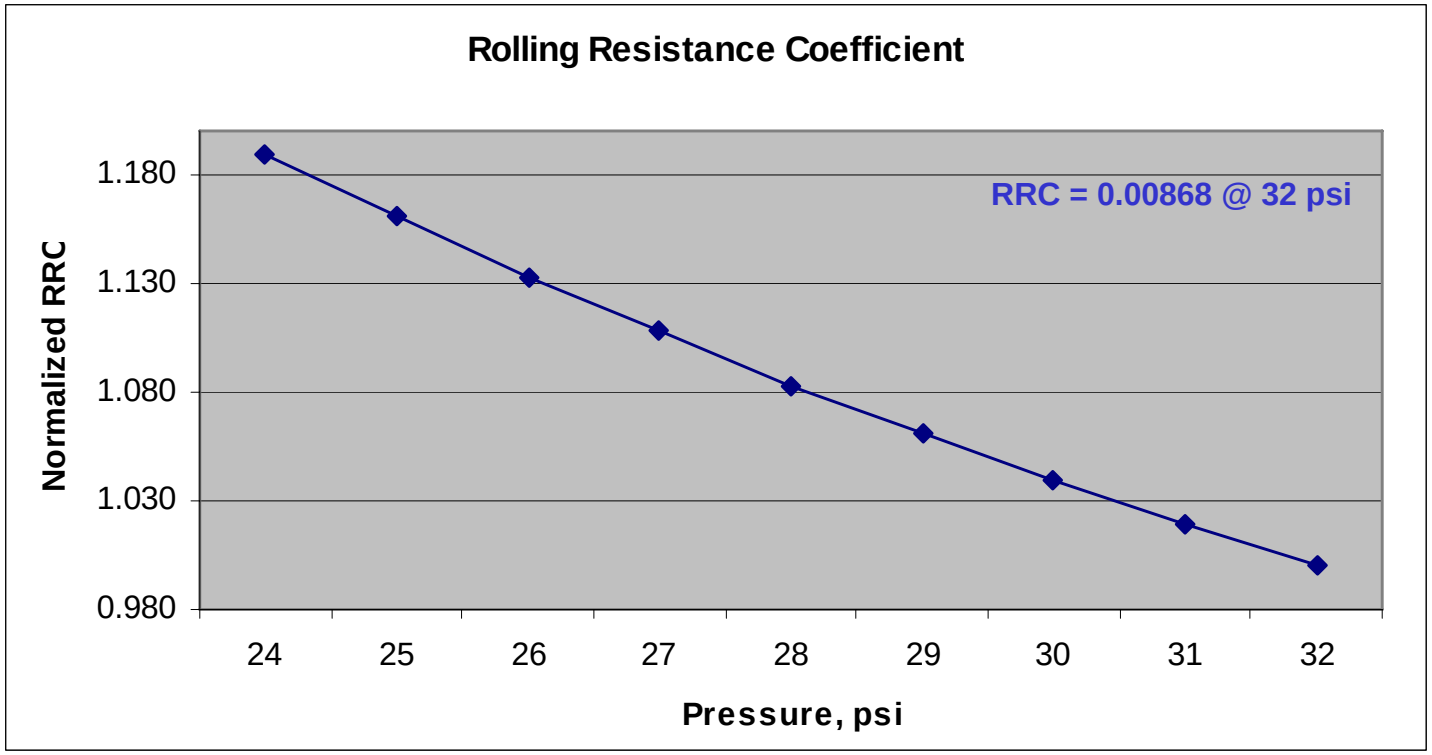
Rolling Resistance of Tire is Non-linear Function of Inflation Pressure

Tire Inflation Pressure and Rolling Resistance - 3



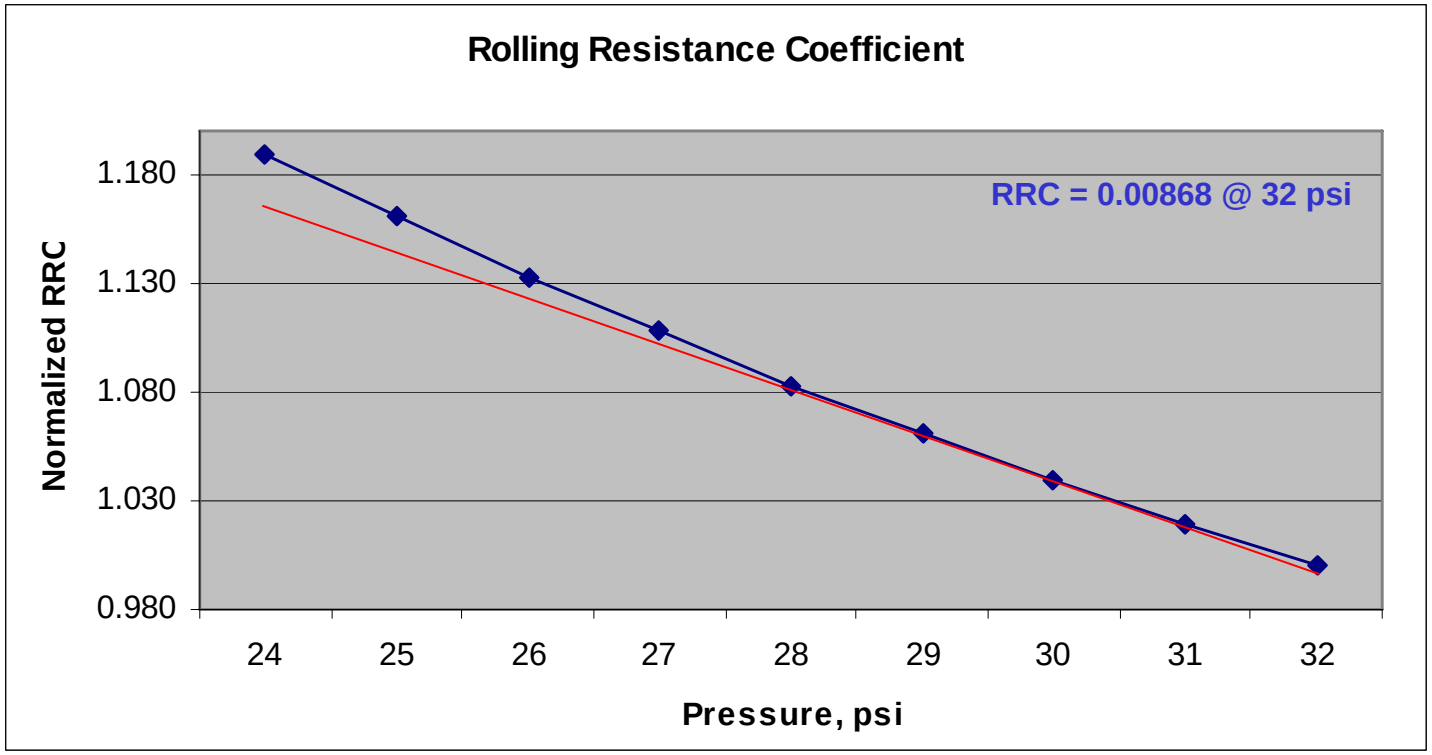
Example 3. Tire Rolling Resistance Coefficient Increases 16.2% as Inflation Pressure Decreases by 25%

Tire Inflation Pressure and Rolling Resistance - 4



Rolling Resistance of Tire is Non-linear Function of Inflation Pressure

Tire Inflation Pressure and Rolling Resistance - 4



Example 4. Tire Rolling Resistance Coefficient Increases 19% as Inflation Pressure Decreases by 25%

Agenda

- Background
- Rolling Resistance Measurements
- Tire IPR
  - Monthly Loss Rates
  - Increases in Rolling Resistance with Pressure Loss
  - Temperature Effects on Tire IPR
  - Operating Effects on Tire IPR
- Tire Reinflation
- Tire IPR and Fuel Economy
- Summary

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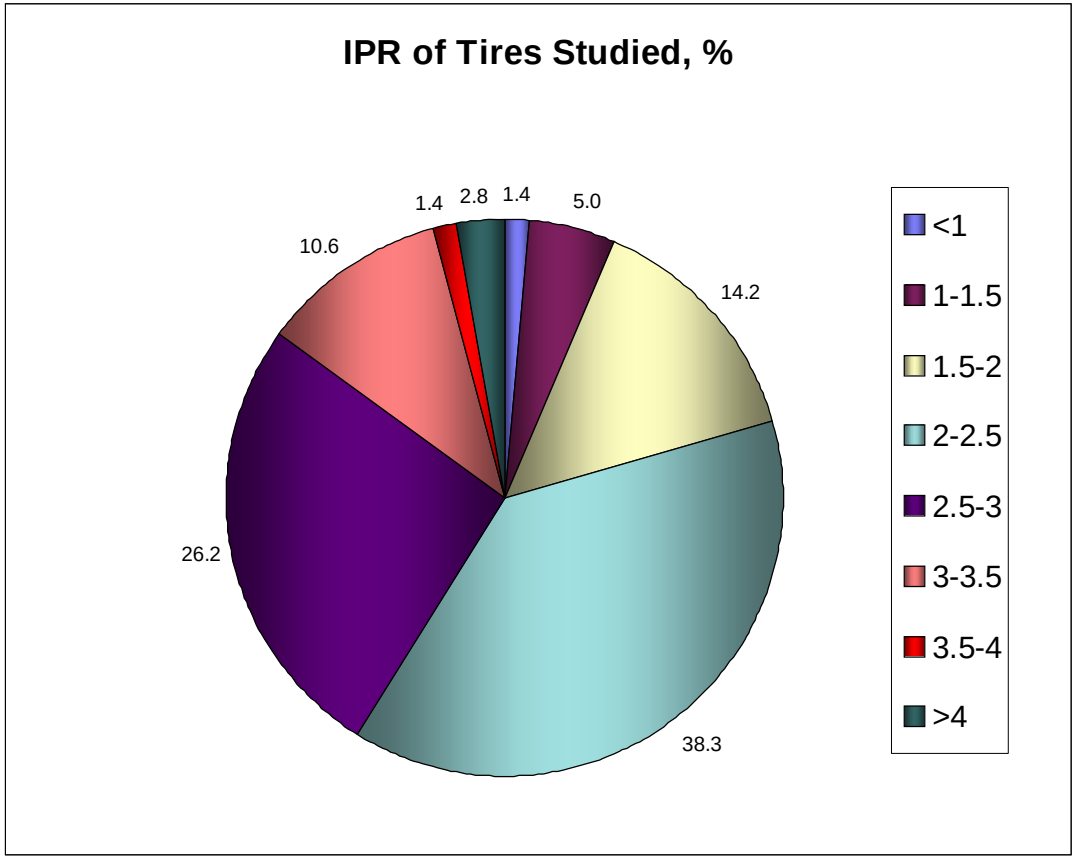
Tire Inflation Pressure Monthly Loss Rates

Tyre Surveys performed during last decade with >140 tire types studied

- 9th Tyre Survey, China/India Tyre Survey, 10th Tyre Survey, others
  - Majority of tyres are H-rated; some Q, S, T, V, Y, and W-rated tyres also included
- Tire IPR loss rate values important parameter measured: ASTM F1112 modified
  - Tire IPR loss rates ranges from 0.86 – 4.6 %-loss/month



41% of Tire Types have IPR Loss Rates > 2.5%

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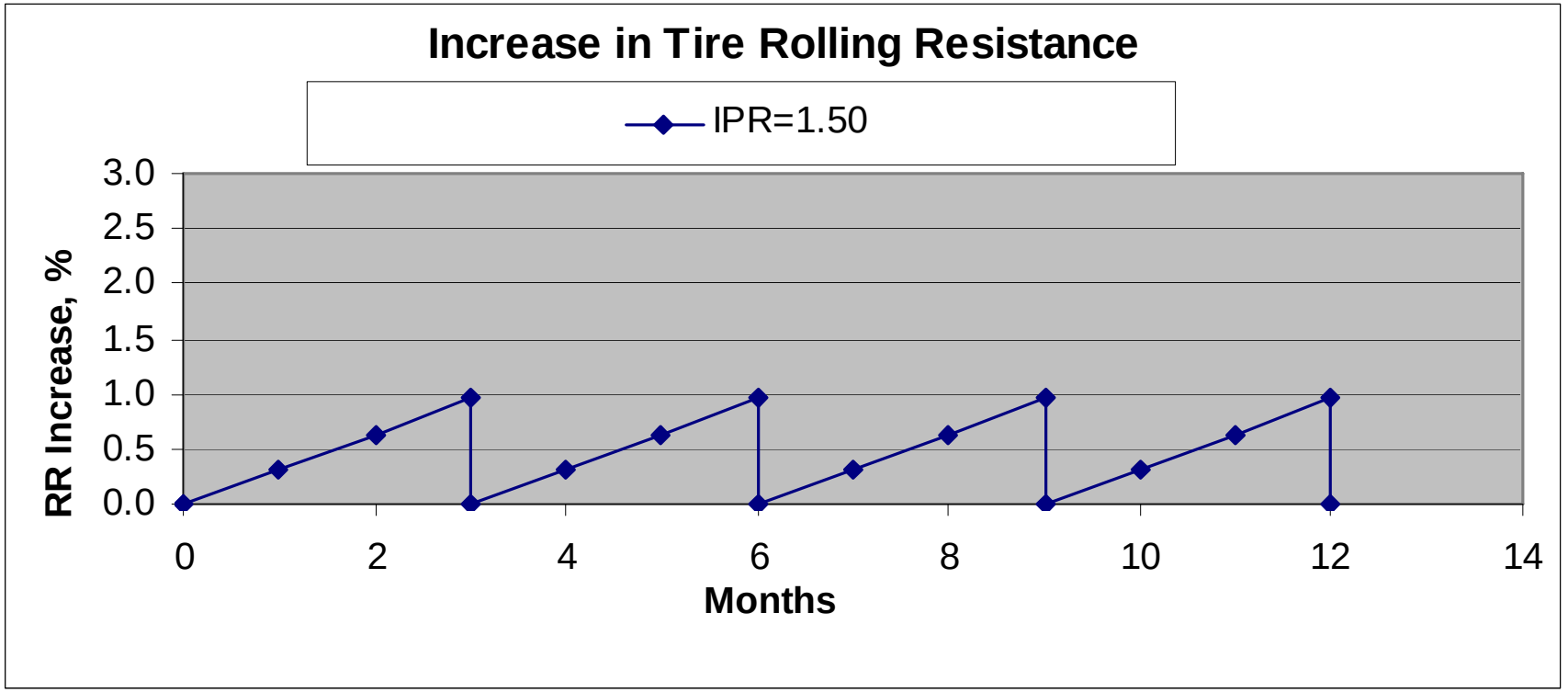
Rolling Resistance and Tire IPR



Rolling Resistance Loss Reinflating Tire Pressure Quarterly

Tire with IPR = 1.5% will have RR Increase of 1%

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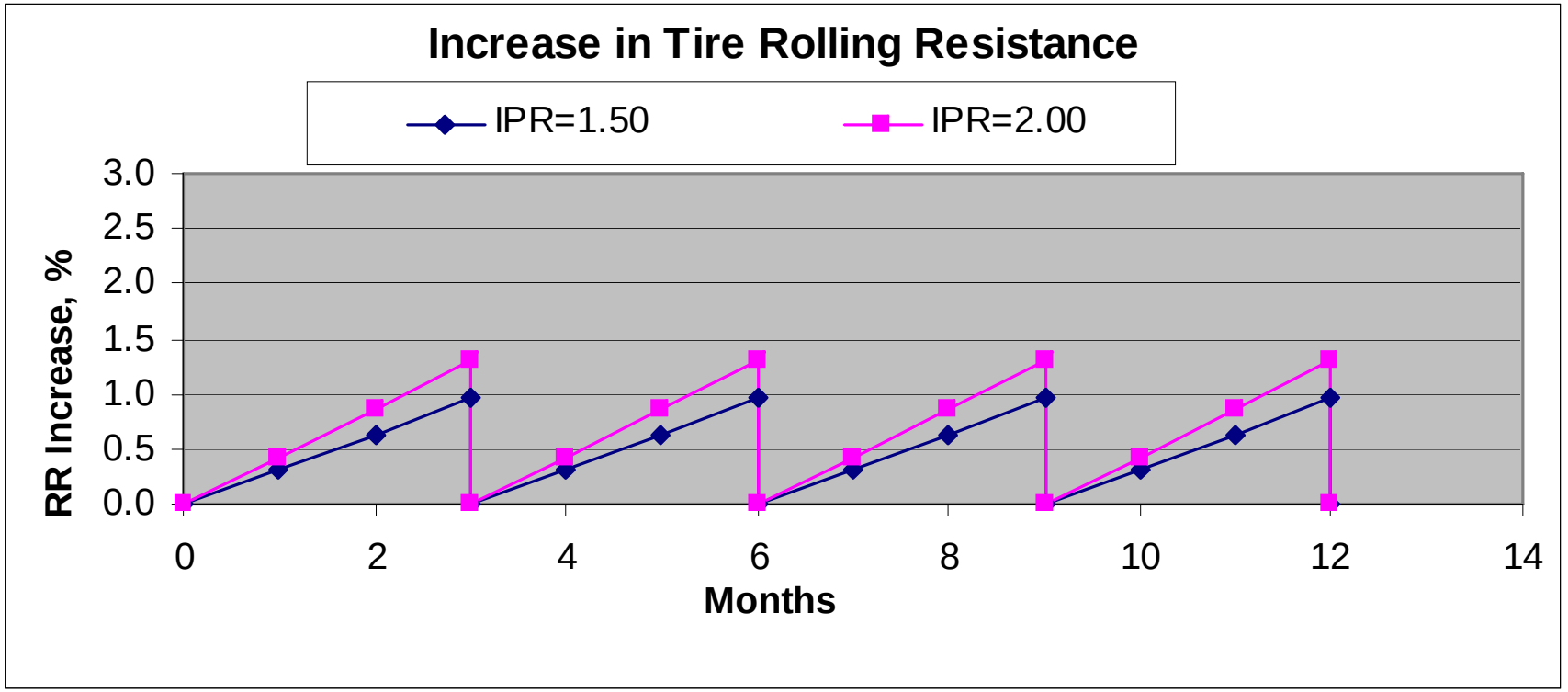
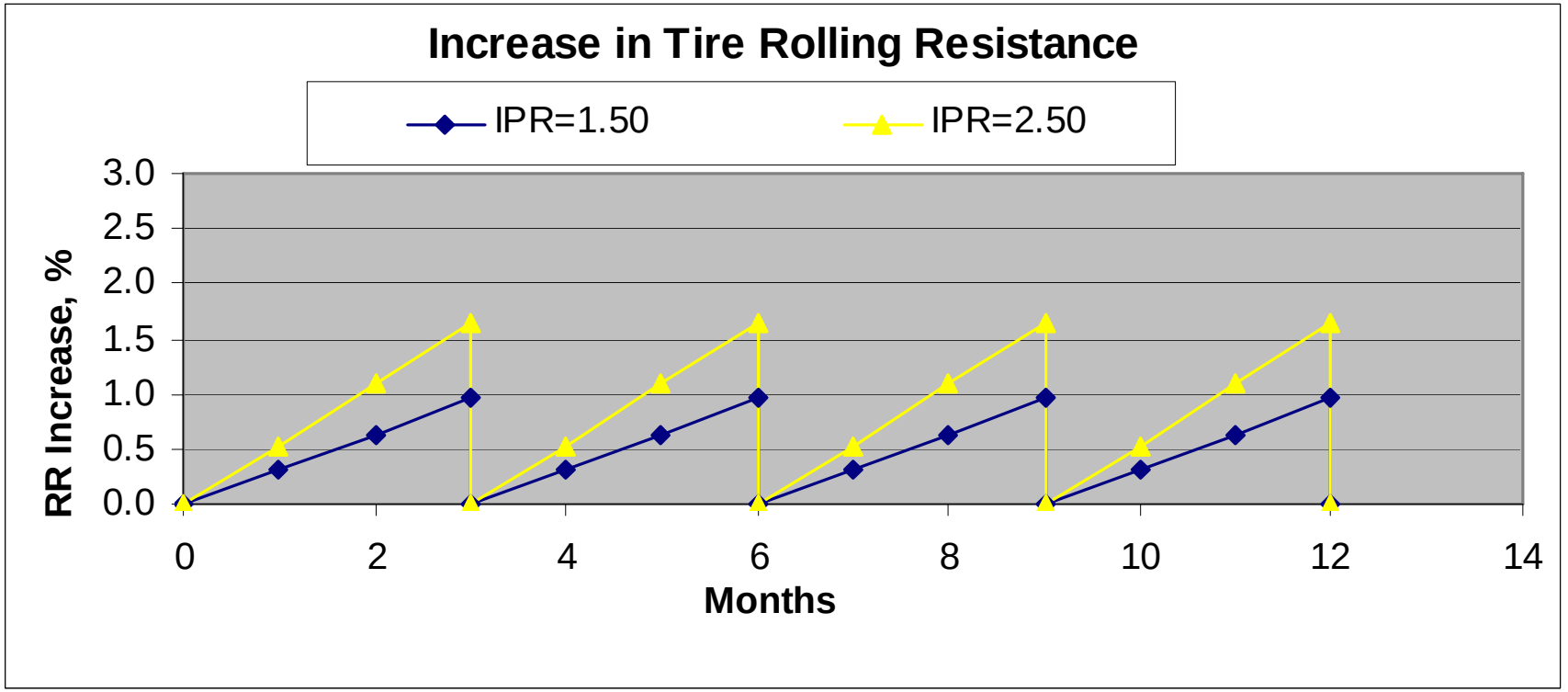
Rolling Resistance and Tire IPR



Rolling Resistance Loss Reinflating Tire Pressure Quarterly

Tire with IPR = 2.0% will have RR Increase of 1.31%

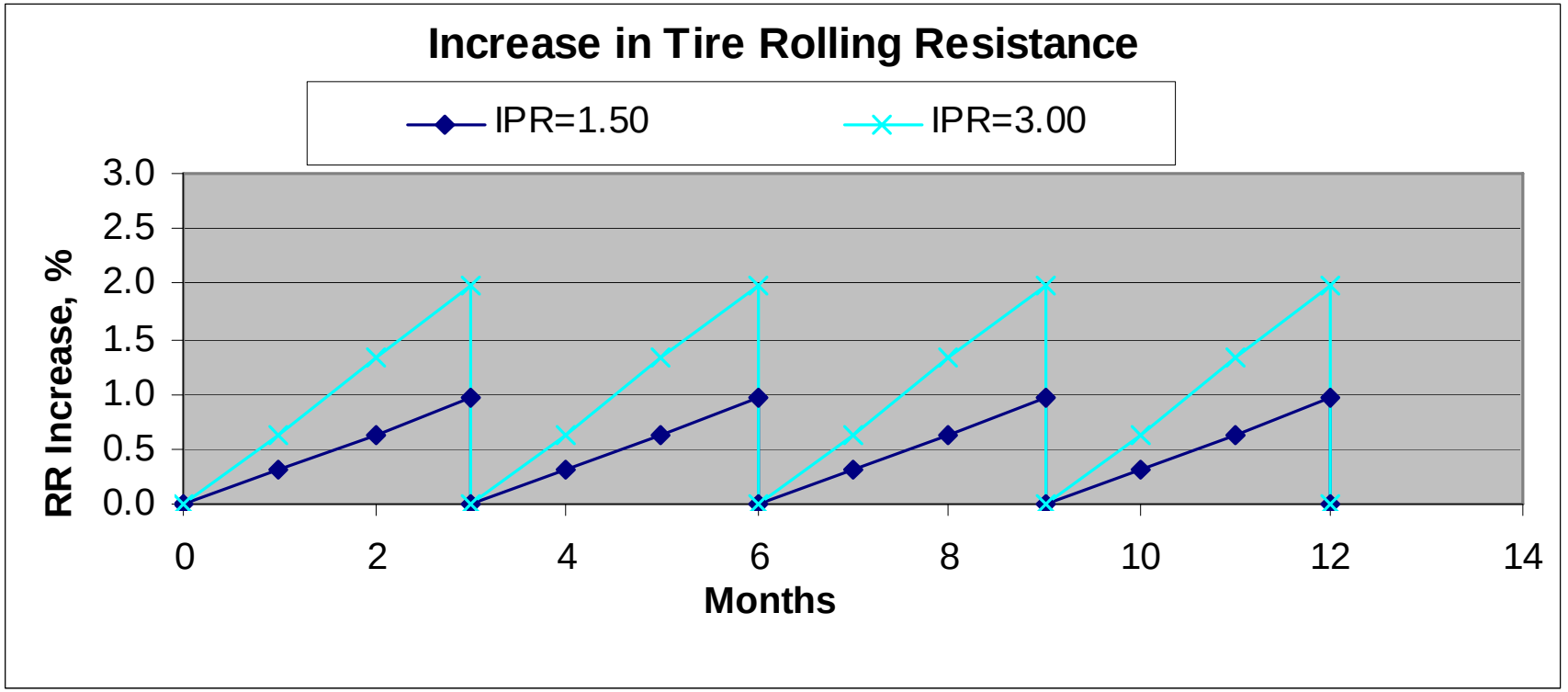
Rolling Resistance and Tire IPR



Rolling Resistance Loss Reinflating Tire Pressure Quarterly

Tire with IPR = 2.5% will have RR Increase of 1.66%

Rolling Resistance and Tire IPR



Rolling Resistance Loss Reinflating Tire Pressure Quarterly

Tire with IPR = 3.0% will have RR Increase of 2%

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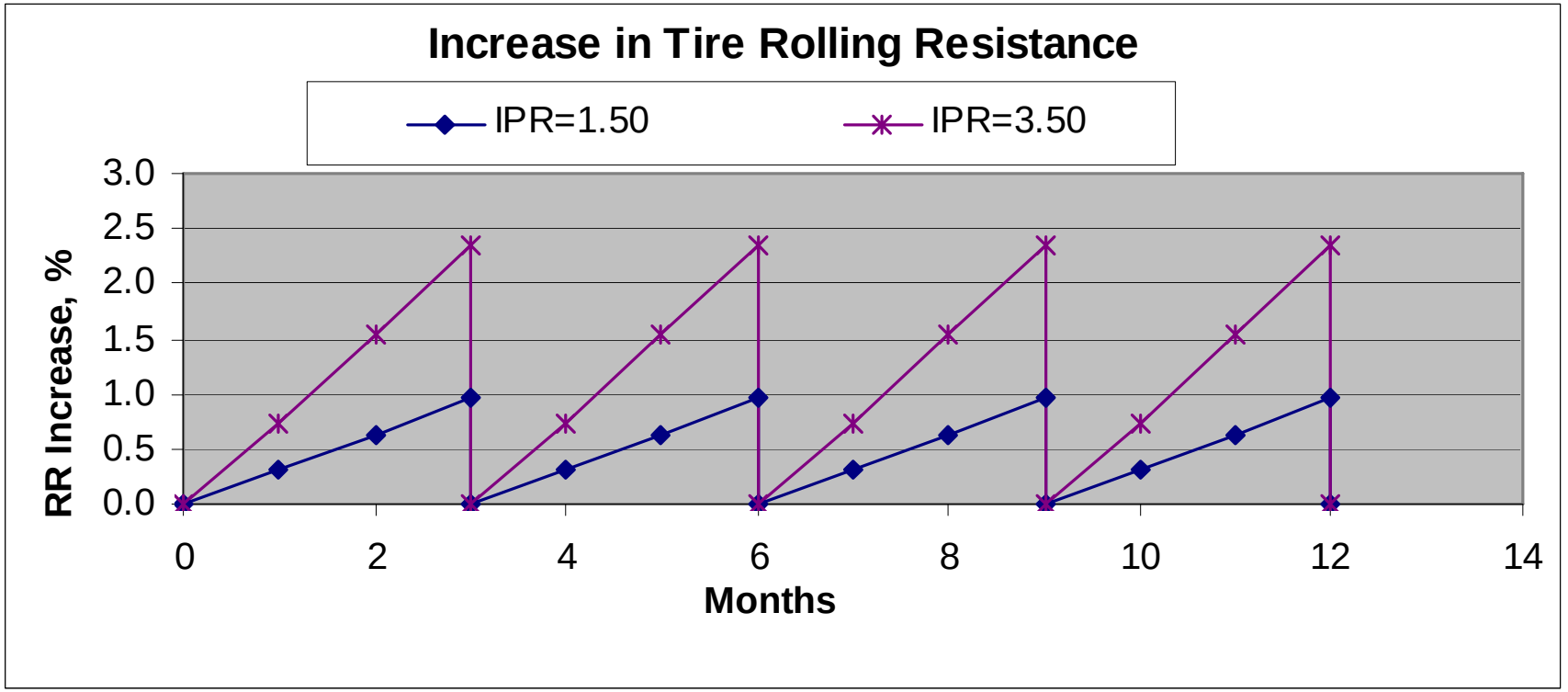
Rolling Resistance and Tire IPR



Rolling Resistance Loss Reinflating Tire Pressure Quarterly

Tire with IPR = 3.5% will have RR Increase of 2.34%

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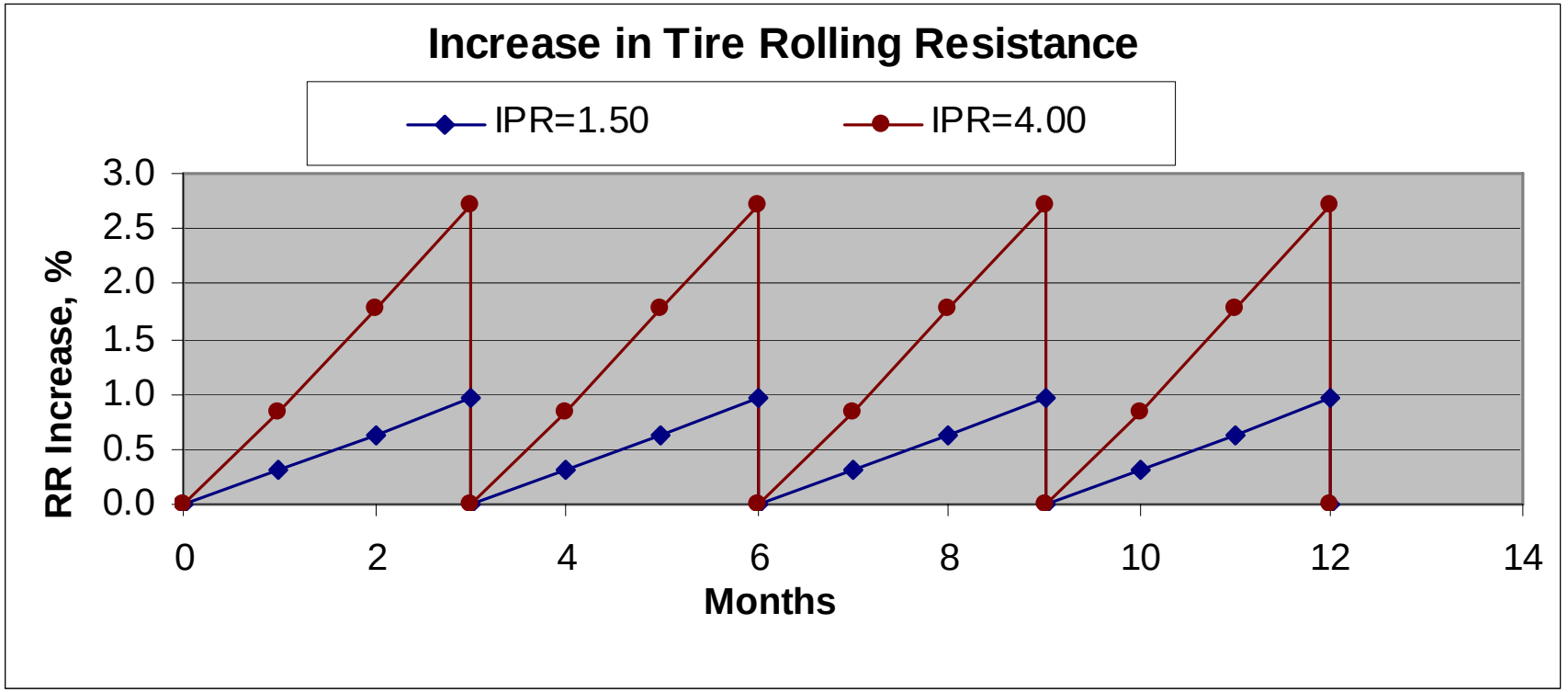
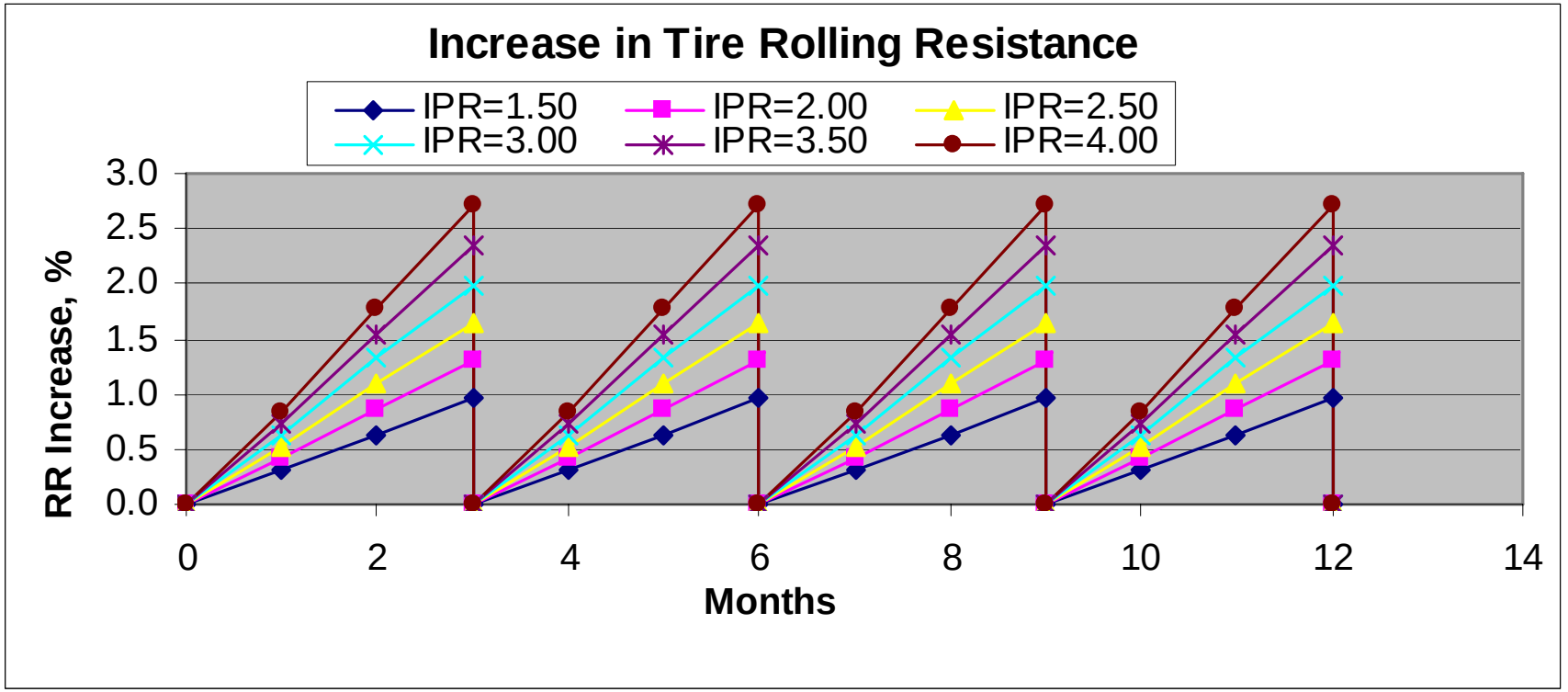
Rolling Resistance and Tire IPR



Rolling Resistance Loss Reinflating Tire Pressure Quarterly

Tire with IPR = 4.0% will have RR Increase of 2.7%

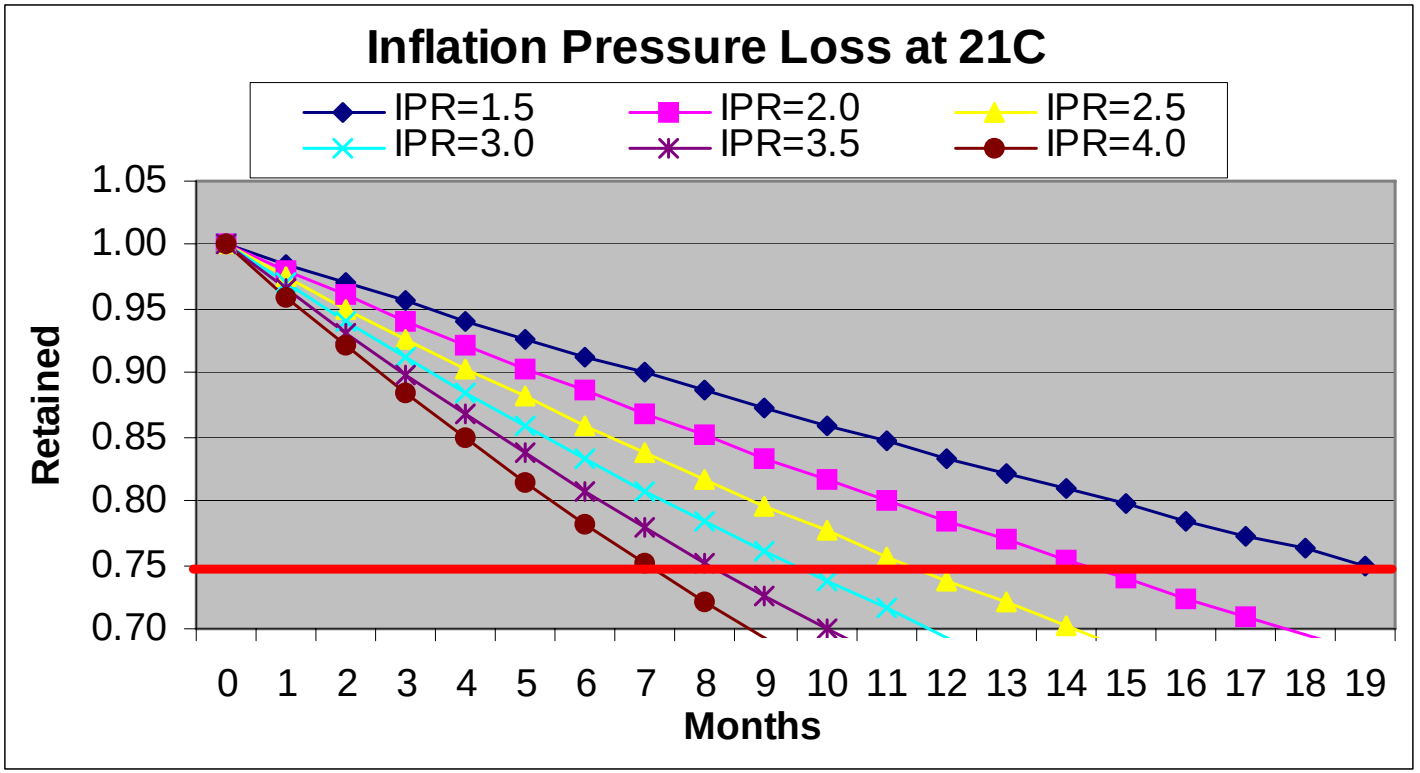
Rolling Resistance and Tire IPR



Rolling Resistance Increases More for Tires with Higher IPR Values

Tire Inflation Pressure Monthly Loss Rates

Can theoretically calculate how long it will take to lose 25% of tire inflation pressure when Tire Pressure Monitoring System activates (Red Line) as Function of Tire IPR Loss Rates at 21°C per ASTM F1112



Time to Lose 25% Pressure Depends Upon Tire IPR Loss Rates

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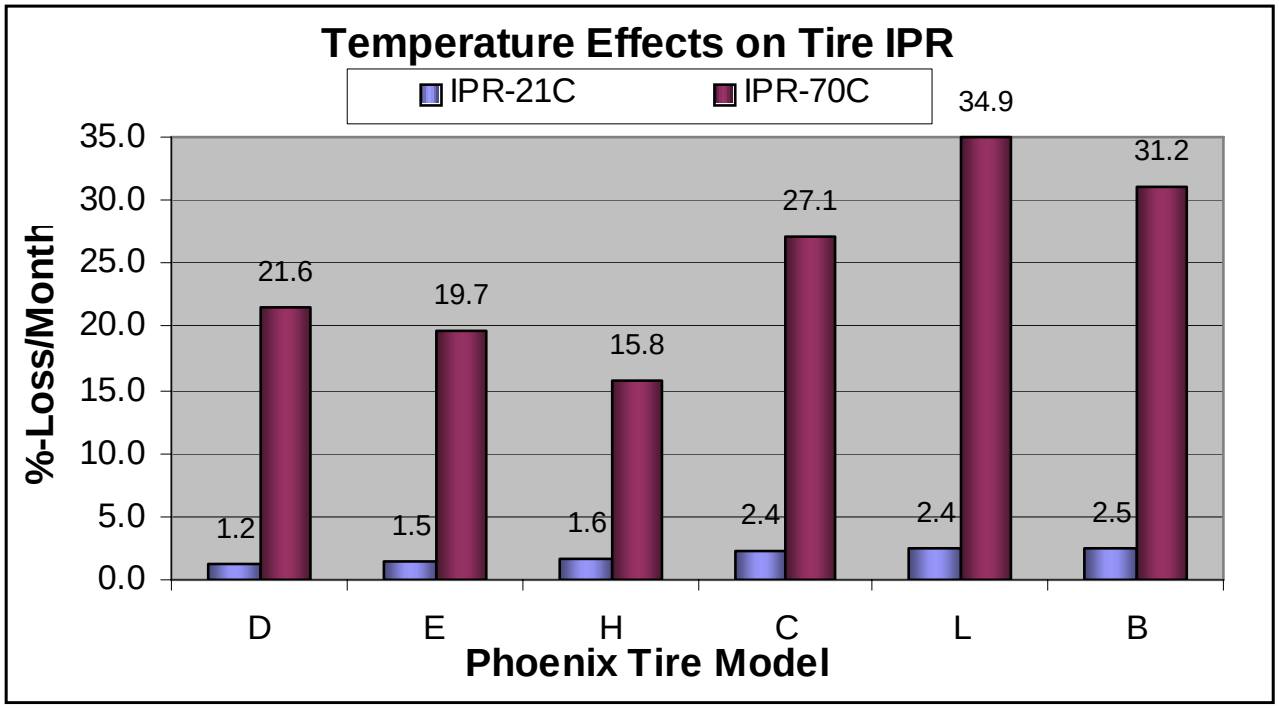
Temperature Effects on Tire IPR Loss Rates

(ref: Harris and MacIsaac, Paper #18, Rubber Division, ACS, October, 2006)

- **Tires lose air faster at the higher operating temperatures**
- **ASTM F-1112 measures static loss rates at 21°C, but tires in-service continually deform and operate at temperatures near 60°C - 70°C**



- **Measured air loss rates increase greatly at higher temperatures**
  - Dependent upon tire manufacturer/type: 10X - 19X higher loss rate at 70°C

Tire with IPR = 2.4% at 21°C ➔ IPR = 30% at 70°C

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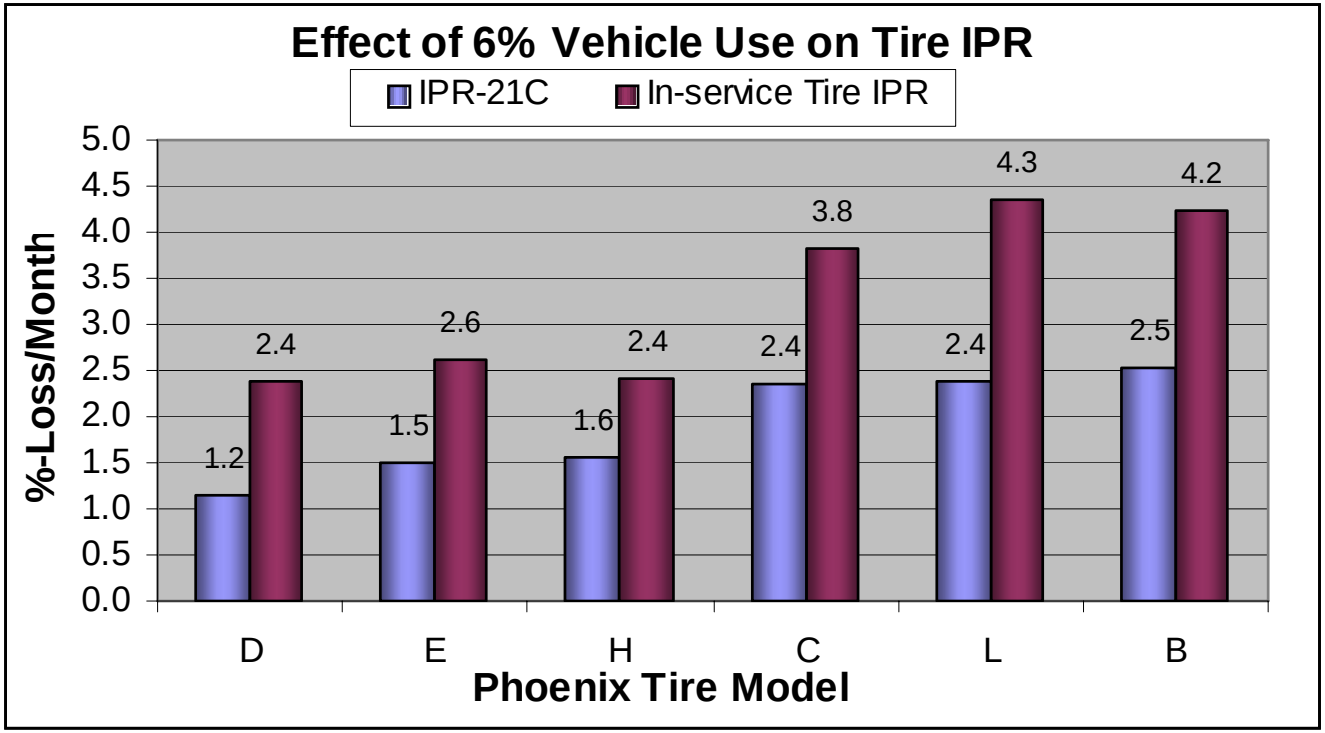
Operating Effects on Tire IPR Loss Rates

- **IPR loss rates increase 10X - 19X at 70°C dependent upon tire type**
- **If vehicle is operated only 6% of time, IPR Loss Rates increased 40–100%**



- **Tire with IPR = 2.4% at 21°C ➔ IPR ~4% when Car Operated 6% of Time**

70% Increase in Tire IPR Loss Rates

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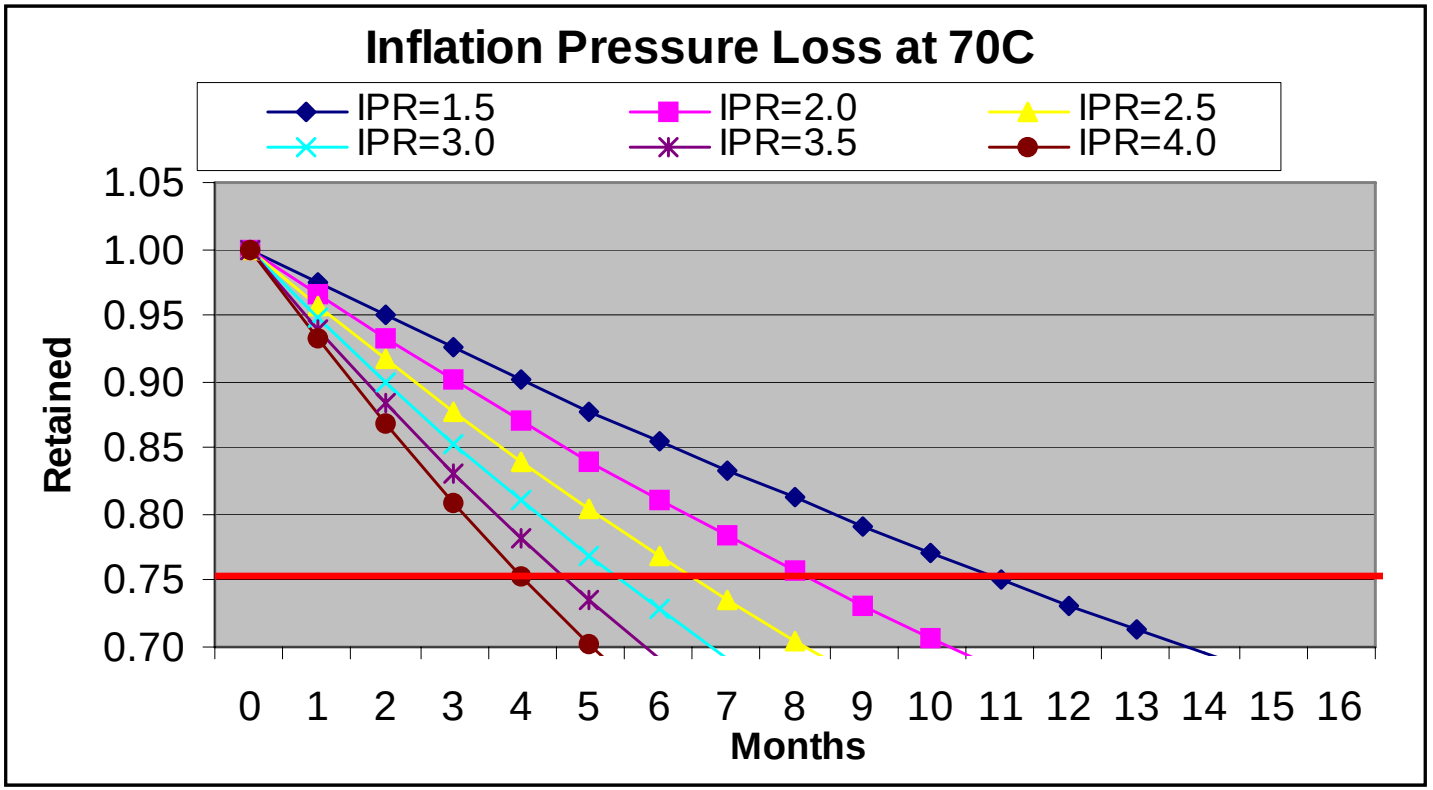
Tire Inflation Pressure Monthly Loss Rates

Can theoretically calculate how long it will take to lose 25% of tire inflation pressure when Tire Pressure Monitoring System activates (Red Line) as a Function of Adjusted Tire IPR Loss Rates



Time to Lose 25% Pressure Decreased Using Hot Tire IPR Loss Rates

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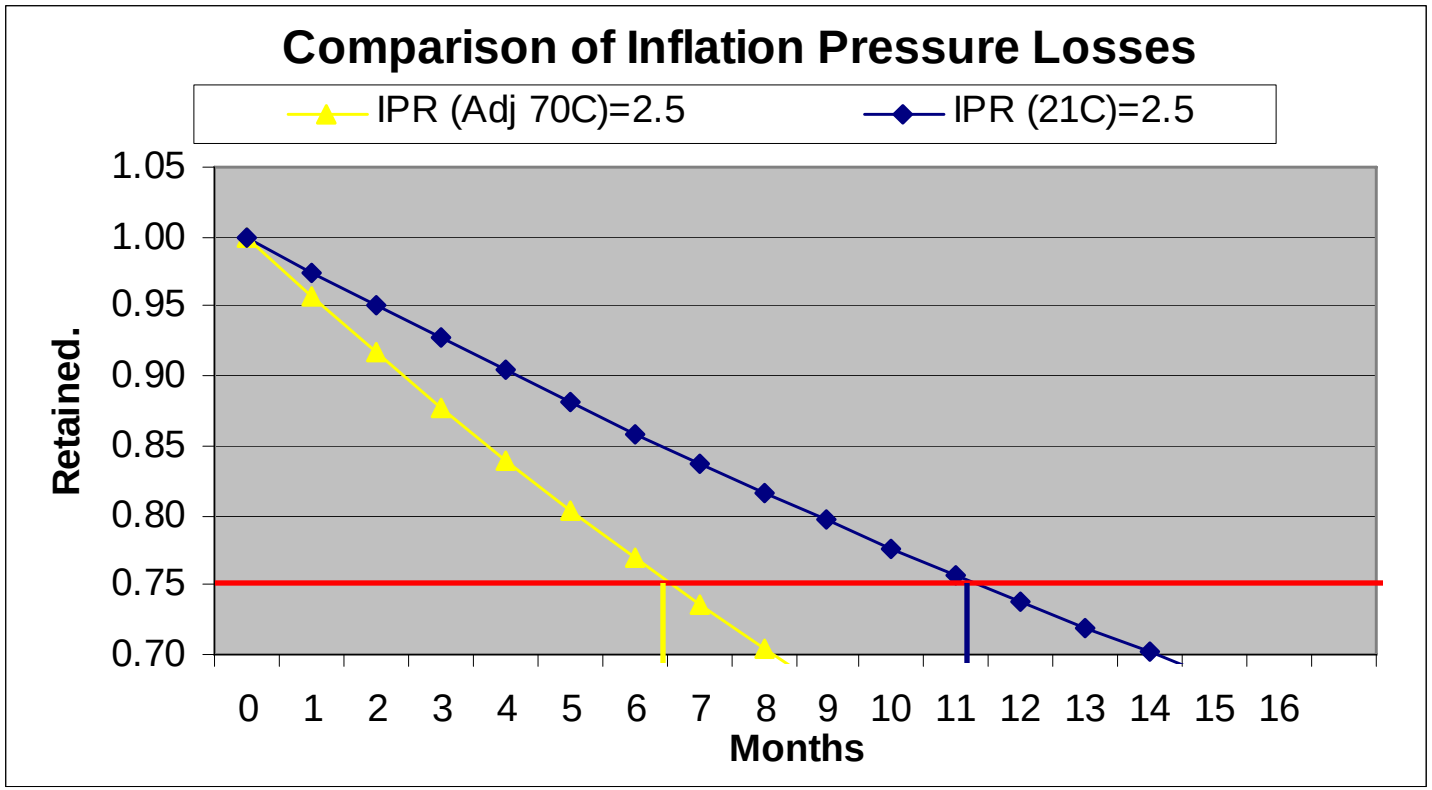
Tire Inflation Pressure Monthly Loss Rates

Comparing how long it will take to lose 25% of tire inflation pressure when Tire Pressure Monitoring System activates (Red Line) as a Function of Tire IPR Loss Rates at 21°C and at 70°C



Time to Lose 25% Pressure Decreased Using Hot Tire IPR Loss Rates

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- Background
- Rolling Resistance Measurements
- Tire IPR Loss Rates
- Tire Reinflation
  - NCSA Study
  - Visual Inspection of Tire Pressure
  - Reinflation Intervals
- Tire IPR and Fuel Economy
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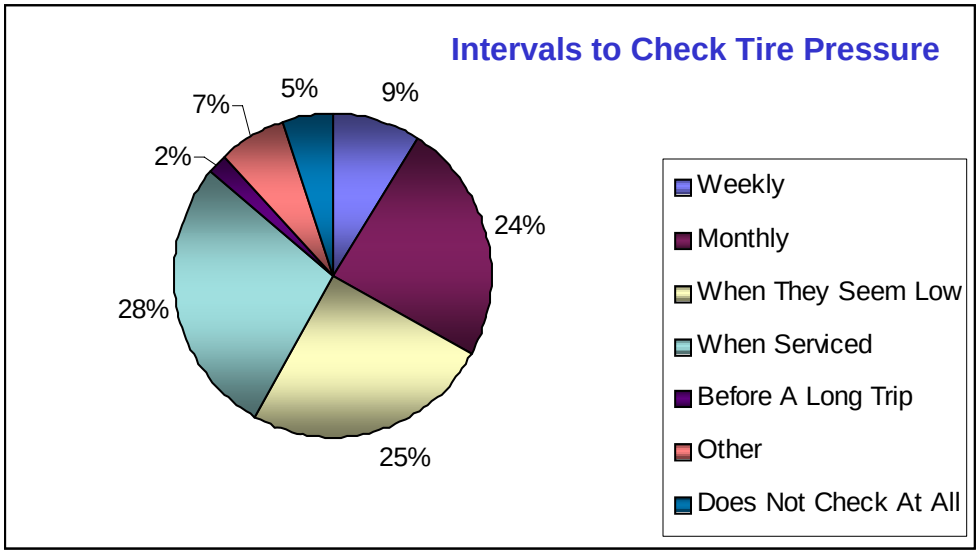
Tire Pressure Maintenance Studies: U.S.

(ref: NHTSA Research Notes DOT 809 316, August 2001)

- **In February 2001, NHTSA's National Center for Statistics & Analysis conducted 'Tire Pressure Special Study'**
  - 11,530 vehicles inspected at 24 locations over a 14-day time period
  - 6,442 Passenger Cars, 1,874 SUV's, 1,376 Vans and 1,838 Pick-up Trucks
- **Overall, 85% of drivers concerned with proper tire inflation, but…**



- **Only 1 in 3 Drivers Check Tire Pressure on Regular Basis**
- **1 in 4 Drivers Check Tire Pressure 'When They Seem Low'**
- **~1 in 4 Drivers have Pressure Checked When Serviced**

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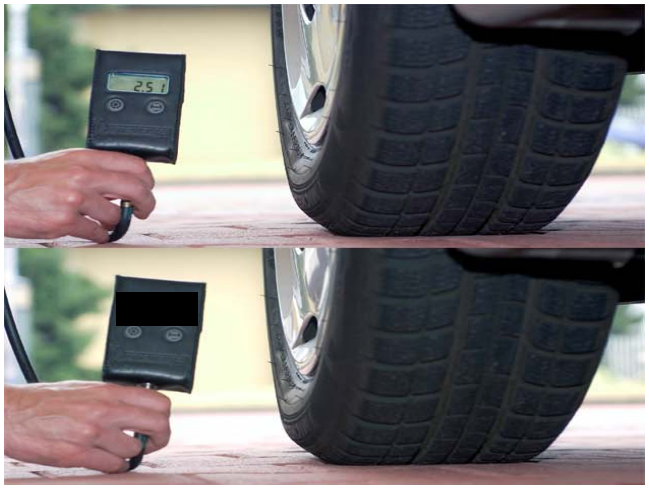
Visual Check of Tire Inflation Pressure



It is important to check your vehicle's tire pressure at least once a month for the following reasons:

- Most tires may naturally lose air over time.
- Tires can lose air suddenly if you drive over a pothole or other object or if you strike the curb when parking.
- With radial tires, it is **usually not possible to determine under inflation by visual inspection.**

(ref:http://www.safercar.gov/Tires/pages/TPandLoadingCheck.htm)

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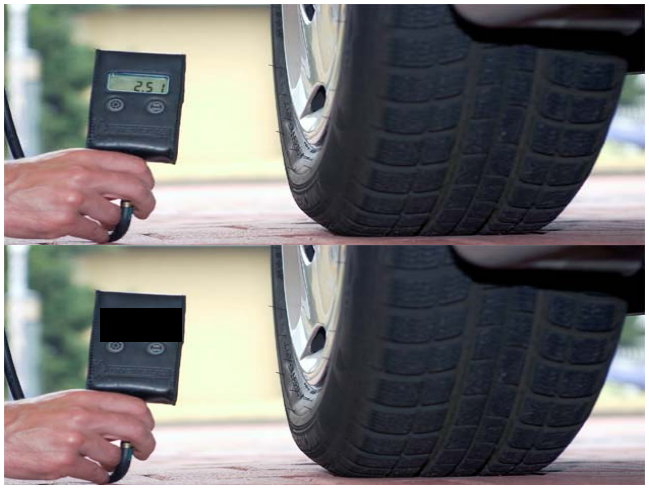
Visual Check of Tire Inflation Pressure



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(ref:http://www.safercar.gov/Tires/pages/TPandLoadingCheck.htm)

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Visual Check of Tire Inflation Pressure

It is important to check your vehicle's tire pressure at least once a month for the following reasons:

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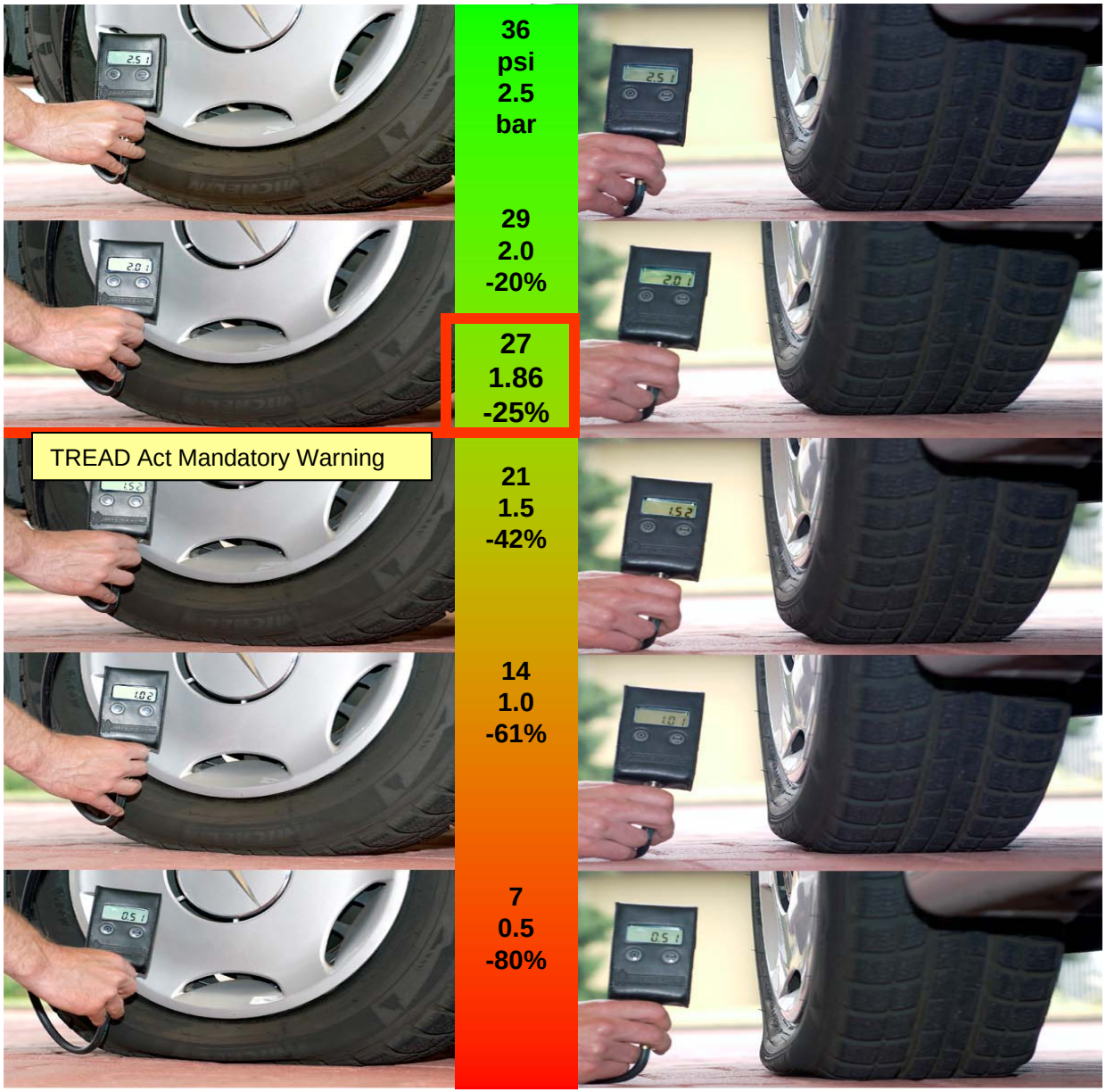
Visual Check of Tire Inflation Pressure



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(ref:http://www.safercar.gov/Tires/pages/TPandLoadingCheck.htm)

(ref: Levy, 'Enhancing Safety Through Direct Tire Pressure Monitoring Systems', Intelligent Tire Technology, 2005)

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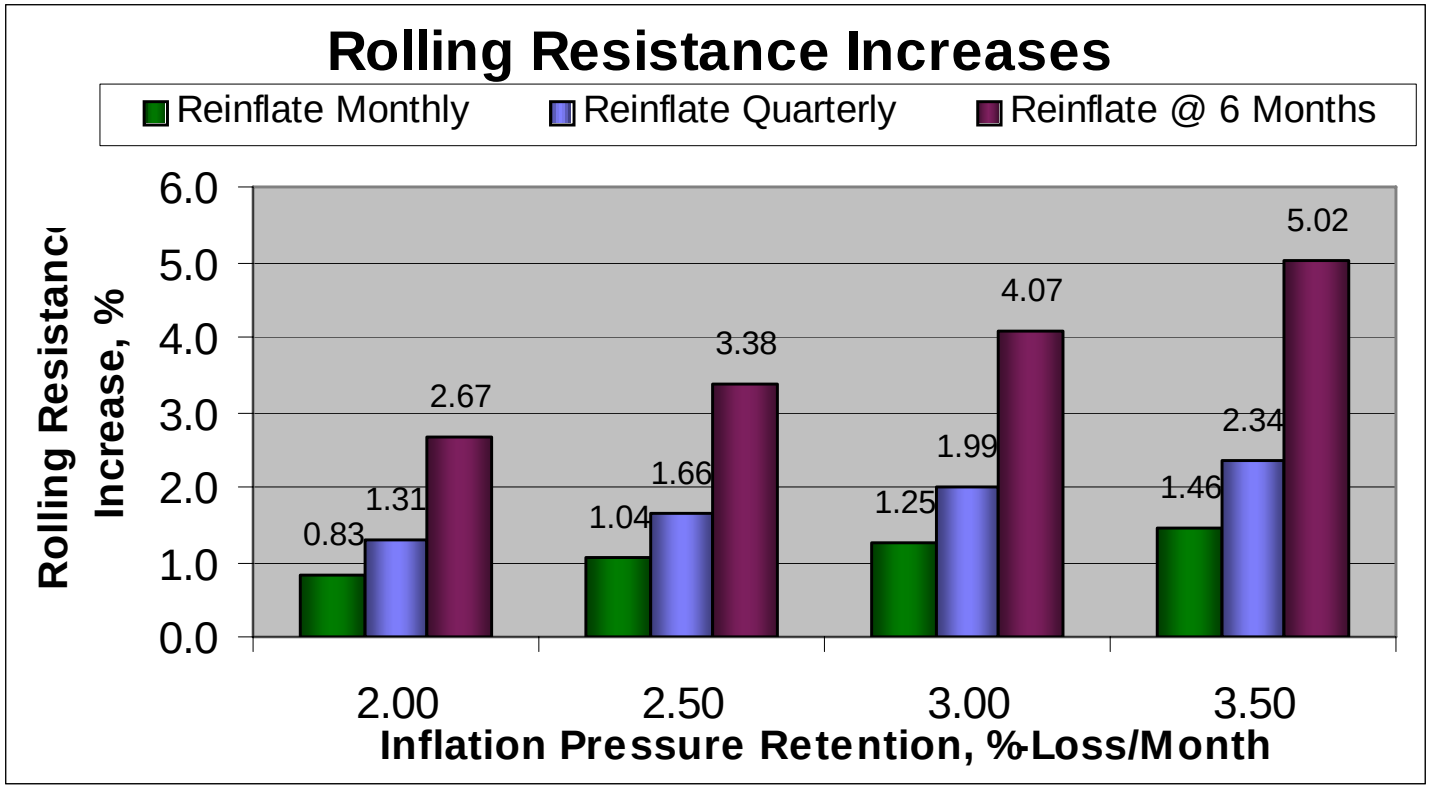
Checking Tire Pressure When Serviced

Tire rolling resistance increases based upon checking tire air pressure at 1, 3 or 6 month intervals



Increases in Rolling Resistance Depend Upon Reinflation Time Period and Tire IPR Loss Rates

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Agenda

- Background
- Rolling Resistance Measurements
- Tire IPR Loss Rates
- Tire Reinflation
- **Tire IPR and Fuel Economy**
  - **Estimates of Potential Annual Fuel Savings**
  - **Potential Effect of TPMS on Fuel Economy**
  - **Potential Effects of Tire IPR_{MAX} Specification**
- Summary

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Estimates of Potential Annual Fuel Savings: U.S.

National Research Council estimates reducing tire rolling resistance 10% promises 1-2% fuel savings for ~220 million light vehicles in U.S.

- Annual national fuel savings estimated at up to 2 billion gallons of gasoline
- Equivalent to taking about 4 million cars and light trucks off the road
- Average individual car annual savings estimated at about 10 gallons/year
- Average savings of 1 gallon for each 1% decrease in tire rolling resistance

Using quarterly reinflation time periods, annual fuel losses due to tire pressure is affected by maximum hot Tire IPR %-loss/month values

Tire IPR, Loss/Month	**Estimate of Tires Affected**	**Rolling Resistance Increase at Three Months**	**Potential Annual Gasoline Savings**	**Potential Annual Reduction in CO2 Emissions**
1.5%	94%	2.1%	731 Mgal	8.1 MMtons
2.0%	79%	3.6%	633 Mgal	7.0 MMtons
2.5%	41%	4.4%	393 Mgal	4.4 MMtons
3.0%	15%	5.1%	164 Mgal	1.8 MMtons
3.5%	4%	5.9%	55 Mgal	0.6 MMtons

Tire IPR_{MAX} = 2.5% Specification Potentially Saves 390 Million Gallons of Gasoline Annually in U.S.

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Estimates of Potential Annual Fuel Savings: State of California

- **State of California has 20,914,500 light vehicles registered in 2007**
  - 12,900 miles/year driven on average
  - 20.1 miles/gallon on average
  - 59.3% automobiles
- **Using quarterly reinflation time periods, annual fuel losses due to tire pressure is affected by maximum hot Tire IPR %-loss/month values**

Tire IPR, Loss/Month	Estimate of Tires Affected	Rolling Resistance Increase at Three Months	Potential Annual Gasoline Savings	Potential Annual Reduction in CO2 Emissions
1.5%	94%	2.1%	74.6 Mgal	0.83 MMtons
2.0%	79%	3.6%	64.7 Mgal	0.72 MMtons
2.5%	41%	4.4%	40.2 Mgal	0.45 MMtons
3.0%	15%	5.1%	16.8 Mgal	0.19 MMtons
3.5%	4%	5.9%	5.6 Mgal	0.062 MMtons

Tire IPR_{MAX} = 2.5% Specification Potentially Saves California
40 Million Gallons of Gas and 0.45 million metric tons of CO_2 Emissions

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Tire Pressure Monitoring Systems

- **FMVSS 138 requires Tire Pressure Monitoring System to alert driver if one or more tires falls either 25% below pressure recommended by vehicle manufacturer or minimum pressure specified in regulation, whichever is higher**
  - National Center for Statistics & Analysis 'Tire Pressure Special Study'
    (ref: NHTSA Research Notes DOT 809 317, August 2001)

Vehicle Type	Number of Tires Underinflated by 8 psi or More				
	0	1	2	3	4
Cars	73	14	7	3	3
Light Trucks	68	13	10	4	6

  - NCSA '12 & 15 Passenger Vans Tire Pressure Study' in April-June, 2004
    (ref: NHTSA Research Notes DOT 809 846, May 2005)

Vehicle	Misinflated by 25% or More	Underinflated by 25% or More
15-Passenger Vans	74%	57%
Other Vans	68%	54%
All Vans	72%	56%
Light Truck from TPSS	39%	29%
Passenger Cars from TPSS	39%	27%

Tire Underinflation an Issue in U.S.

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Potential Effect of TPMS on Fuel Economy

(Ref: RMA letter to NHTSA, Aug 19, 2003)

Rubber Manufacturers Association survey showed that consumers would rely more upon the Tire Pressure Monitoring System

- TPMS required for all light vehicle models in 2008: FMVSS 138
  - Direct or indirect systems activate when pressure in one or more tires is 25% low
- 36% of drivers would check pressure monthly; 23% between 1-3 months
- 25 - 30% of drivers would be less concerned with monitoring tire air pressure

For 40% of drivers that will not check tire air pressure until TPMS light activates, rolling resistance would increase by 15%, causing a 3% loss in fuel economy regardless of actual Tire IPR loss rates

IPR_{MAX} Specification, %-loss/month	**TPMS Activates,** months	**% Tires Affected**	**Potential Annual Gasoline Savings**	**Potential Additional Losses**	**Additional CO2 Emissions**
2.0%	7.0	79%	967 Mgal	334 Mgal	3.7 MMtons
2.5%	5.5	41%	500 Mgal	110 Mgal	1.2 MMtons
3.0%	4.5	15%	210 Mgal	46 Mgal	0.51 MMtons

With IPR_{MAX}=2.5%, 110 Million More Gallons of Gas Could be Saved for 40% of Drivers that Would Not Check Air Pressure Until TPMS Activates

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Summary: Effects of Tire IPR Specification in U.S.

390 million gallons of gas yearly in U.S. is equivalent to

- **Not shipping 3 Ultra Large Crude Carriers**
  - 1 million tons of crude oil

390 Million Gallons Saved Annually is 4.6% of NHTSA
8.5 Billion Gallons Goal for "Twenty in Ten" Gasoline Program

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Summary: Effects of Tire IPR Specification in U.S.

390 million gallons of gas yearly in U.S. is equivalent to

- **Not shipping 3 Ultra Large Crude Carriers**
  - 1 million tons of crude oil

- **Not refining 20 million barrels of crude**
  - U.S. imports 12 million barrels of crude oil daily (ref: Monthly Energy Review, July 2007)
  - Average mix: 19.5 gallons of gas/barrel (ref: www.newton.dep.anl.gov/askasci/eng99/eng99288.htm)

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- **Not sending 65,000 tanker trucks to deliver gas to service stations**
  - 5,000 – 7,000 gallon tanks

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- **Not sending 65,000 tanker trucks to deliver gas to service stations**
  - 5,000 – 7,000 gallon tanks
- **Taking 650,000 light vehicles off the roads**
  - Average of 12,000 miles @ 20 mpg = 600 gallons/vear
    (ref: http://onlinepubs.trb.org/onlinepubs/sr/sr286.pdf)

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390 million gallons of gas yearly in U.S. is equivalent to

- **Not shipping 3 Ultra Large Crude Carriers**
  - 1 million tons of crude oil
- **Not refining 20 million barrels of crude**
  - U.S. imports 12 million barrels of crude oil daily (ref: Monthly Energy Review, July 2007)
  - Average mix: 19.5 gallons of gas/barrel (ref: www.newton.dep.anl.gov/askasci/eng99/eng99288.htm)
- **Not sending 65,000 tanker trucks to deliver gas to service stations**
  - 5,000 – 7,000 gallon tanks

- **Taking 650,000 light vehicles off the roads**
  - Average of 12,000 miles @ 20 mpg = 600 gallons/vear
    (ref: http://onlinepubs.trb.org/onlinepubs/sr/sr286.pdf)

- **Emitting 4.4 million fewer metric tons of CO_2**
  - 22.2 lbs of CO_2 / gallon of gasoline consumed (2.28 kg / liter)
    (ref: www.epa.gov/otaq/greenhousegases.htm)

390 Million Gallons Saved Annually is 4.6% of NHTSA
8.5 Billion Gallons Goal for "Twenty in Ten" Gasoline Program

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Summary: Effects of TPMS on Tire IPR_{MAX} in U.S.

500 million gallons of gas yearly in U.S. is equivalent to

- **Not shipping 4 Ultra Large Crude Carriers**
  - 1.4 million tons of crude oil
- **Not refining 25.6 million barrels of crude**
  - U.S. imports 12 million barrels of crude oil daily (ref: Monthly Energy Review, July 2007)
  - Average mix: 19.5 gallons of gas/barrel (ref: www.newton.dep.anl.gov/askasci/eng99/eng99288.htm)
- **Not sending 83,300 tanker trucks to deliver gas to service stations**
  - 5,000 – 7,000 gallon tanks

- **Taking 833,000 light vehicles off the roads**
  - Average of 12,000 miles @ 20 mpg = 600 gallons/vear
    (ref: http://onlinepubs.trb.org/onlinepubs/sr/sr286.pdf)

- **Emitting 5.6 million fewer metric tons of CO_2**
  - 22.2 lbs of CO_2 / gallon of gasoline consumed (2.28 kg / liter)
    (ref: www.epa.gov/otaq/greenhousegases.htm)

500 Million Gallons Saved Annually is 5.9% of NHTSA
8.5 Billion Gallons Goal for "Twenty in Ten" Gasoline Program

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Summary: Effects of Tire IPR Specification in the State of California

40 million gallons of gas yearly in California is equivalent to

- **Not refining 2 million barrels of crude**
  - U.S. imports 12 million barrels of crude oil daily (ref: Monthly Energy Review, July 2007)
  - Average mix: 19.5 gallons of gas/barrel (ref: www.newton.dep.anl.gov/askasci/eng99/eng99288.htm)

- **Not sending 6,500 tanker trucks to deliver gas to service stations**
  - 5,000 – 7,000 gallon tanks

- **Taking 65,000 light vehicles off the roads**
  - Average of 12,900 miles @ 20.1 mpg = 640 gallons/year

- **Emitting 0.45 million fewer metric tons of CO_2**
  - 22.2 lbs of CO_2 / gallon of gasoline consumed (2.28 kg / liter)
    (ref: www.epa.gov/otaq/greenhousegases.htm)

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Summary

- **Fuel is routinely lost through tire rolling resistance**
  - National Research Council estimates that 10% reduction in tire rolling resistance can save 1-2 billion gallons of gasoline annually in the U.S.
- **Rolling resistance losses increase with tire air pressure losses**
  - At 25% pressure loss, tire rolling resistance coefficient increased by ~16.4%
  - Changes dependent upon Tire Inflation Pressure Retention loss values
  - Lowest IPR tire minimizes rolling resistance losses between inflation periods
- **Increases in tire operating temperatures significantly increases monthly air loss rates**
  - 10X – 18X increase in Tire IPR loss rates at 70^{o}C versus 21^{o}C
  - Operating vehicle only 6% of time increases pressure loss by 70%
- **Annual fuel losses due to tire rolling resistance are affected by Tire IPR loss rates and pressure reinflation time periods**
  - Estimated 390 million gallons of gas can be saved yearly by requiring IPR_{MAX} = 2.50% for tires with higher loss rates (~40%) and reinflating tires quarterly
    - **4.6% of the 'Twenty in Ten' gasoline savings goal assigned to NHTSA**
  - Estimated 4.4 million tons less CO_2 emissions for Tire IPR_{MAX} = 2.50%
  - Potential 500 million gallons savings if more drivers neglect tires due to TPMS

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Inflation Pressure Retention Effects on Tire Rolling Resistance and Vehicle Fuel Economy

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Background: European Commission

(ref: http://ec.europa.eu/reducing_co2_emissions_from_cars/index_en.htm)

- **On 7th February 2007 the European Commission published**
  - "Results of the review of the Community Strategy to reduce CO2 emission from passenger cars and light-commercial vehicles"
  - "Competitive Automotive Regulatory Framework for the 21st Century"
- **Pursue integrated approach reach EU objective of 120 g/km carbon dioxide (CO2) emissions from average new cars by 2012**
- **More specifically, the Commission has proposed the following:**
  a. Setting minimum efficiency requirements for air-conditioning systems
  b. Compulsory fitting of accurate tyre pressure monitoring systems
  c. Setting maximum tyre rolling resistance limits in the EU for tyres fitted on passenger cars and light commercial vehicles
  d. Use of gear shift indicators, taking into account the extent to which such devices are used by consumers in real driving conditions
  e. Fuel efficiency progress in light-commercial vehicles (vans) with the objective of reaching 175 g/km CO2 by 2012 and 160 g/km CO2 by 2015
  f. Increased use of bio fuels maximizing environmental performance
- **The above will be measurable, monitorable, accountable and non double-counting the reductions of CO2**

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Tire Pressure Maintenance Studies: Europe

(ref:http://www.autobloggreen.com/2007/03/10/bridgestone-study-finds-under-inflated-tires-costing-8-1b-liters/)

Safety checks conducted on 29,000 passenger cars in 19 E.U. countries during 2005/2006 by Bridgestone's Technical Centre Europe

- **Only 6.5% of motorists had all tyres correctly inflated**
  - 54% had some degree of low inflation
  - 39.5% had at least one tyre significantly under inflated (<1.5 bar (21.8 psi))
  - 12.0% of cars were in danger of tyre failure
- **25% of tyre wear is lost as a result of low inflation pressure**
  - 56 million tyres lost because of premature wear of 5.0 billion €/year
- **Inflation pressure has strong influence on tyre rolling resistance, which is key factor in determining vehicle fuel consumption**
  - 40% of vehicles face increased fuel consumption of 2.8% due to underinflation wasting 8.1 billion litres of fuel costing €9.5 billion
  - Additional 18.4 million tons of CO_2 released into the atmosphere every year
  - Equivalent of extra 93.2 kg of CO_2 a year, or 6.9 g/km, for every car
- **European Commission will require all new passenger cars sold within EU meet a 130 g/km fleet-average CO_2 emissions limit by 2012; 163 g/km in 2004**

Tire Underinflation an Issue in Europe

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Tire Pressure Maintenance Study: Canada

(ref:http://www.rubberassociation.ca/pdf_docs/studyexecutivesummaryoct82003.pdf)

1,871 drivers in 6 locations in Canada surveyed during winter 2003 for Rubber Association of Canada and Government of Canada

- **70% of vehicles had at least one tire over/underinflated by >10%**
- **33% of vehicles had 3 or 4 tires over or underinflated by >10%**
- **Underinflation was a bigger problem than overinflation**
  - 56% of vehicles had at least tire underinflated by >10%, 23% underinflated by >20%
- **Only 38% knew pressure should be checked when tires are cold**
  - 36% do not know how to properly measure tire pressure
- **Only 39% measure their tire pressure monthly or more frequently**
  - 53% said they checked their tire pressure when the tires 'looked low'
- **Slightly more severe problem with improper inflation of light truck tires than on passenger car tires, tires on older vehicles versus younger vehicles, and tires with less tread depth**
  - 25% of tires were bald or nearly bald
- **By keeping tires properly inflated, Canadians can prevent 1.5 million tons of carbon dioxide from entering the atmosphere**

Tire Underinflation an Issue in Canada

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"Hot Temps, Low Air Pressure May Lead to Tire Trouble"

(ref: RMA emailing 053584)

- **WASHINGTON, June 28, 2007 -- Summer time heat and under inflated tires may spell trouble on the road. The National Highway Traffic Safety Administration estimates that 660 fatalities and 33,000 injuries occur each year due to under inflated tires.**
- **The Rubber Manufacturers Association, which represents tire manufacturers, recommends that tire pressure be checked every month and before long trips.**
  - Remember to check tires before driving -- when tires are cold -- to get an accurate reading. Driving even a mile can cause tire inflation pressure to increase.
  - Use the correct tire inflation pressure, which can be found on a label on the driver's door or check the owner's manual.
- **"Heat is the enemy of a tire," says Donald B. Shea, president and CEO, Rubber Manufacturers Association. "Under inflation generates heat within a tire and when combined with hot, summer air temperatures can cause dangerous safety issues for your vehicle. Properly inflated tires help maximize safety, fuel economy and tire longevity."**

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"Hot Temps, Low Air Pressure May Lead to Tire Trouble"

(ref: RMA emailing 053584)

A 2007 motorist survey by Rubber Manufacturers Association found:

- **85% of drivers fail to properly check tire pressure**
  - Properly checking pressure means checking every month when tires are cold and using the correct tire pressure
  - 65% of drivers don't know where to find the correct inflation pressure for their vehicle. The correct pressure is found on a label on the driver's door or check the owner's manual -- not the tire sidewall
  - 26% of drivers wrongly believe that the best time to check their tires is when they are warm after being driven for at least a few miles
- **Nearly seven in ten drivers wash their vehicle every month but only 15% properly check tire pressure**
- **"Checking tire pressure takes only five minutes every month with a tire gauge. If you're unsure of what to do, most tire retailers, auto dealers and auto service facilities will check and adjust tire pressure free of charge."**

Proper Tire Pressure Promotes Safety, Saves Gas, Helps Tires Last

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