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United States Government Accountability Office
Washington, DC 20548

February 9, 2007

The Honorable Byron L. Dorgan
United States Senate

Subject: *Underinflated Tires in the United States*

Dear Senator Dorgan:

More than a quarter of automobiles and about a third of light trucks (including sport utility vehicles, vans, and pickup trucks) on the roadways of the United States have one or more tires underinflated 8 pounds per square inch (psi) or more below the level recommended by the vehicle manufacturer, according to a report by the Department of Transportation's (DOT) National Highway Traffic Safety Administration (NHTSA).[1] A decrease in tire pressure can be caused by poor maintenance, driving habits, punctures, road conditions, and the quality of material used in tire construction. According to tire experts, under normal driving conditions, air-filled tires can lose from 1 to 2 psi per month as air permeates through the tires. Vehicles with underinflated tires have had handling problems that caused crashes resulting in fatalities and injuries. In addition, the fuel economy of vehicles driving on underinflated tires is slightly lower. In response to your request for information on these issues, we addressed the following questions: (1) What is the impact of tire underinflation on safety and fuel economy, and what actions has the federal government taken to promote proper tire inflation? and (2) what technologies are currently available to reduce underinflation and what are their implications for safety and fuel economy?

To address these questions, we interviewed officials from federal agencies, tire industry associations and businesses, and public advocacy groups. We examined their studies on tire pressure and its impact on safety and fuel economy, and the technologies used to detect underinflation and maintain tire pressure. Unless otherwise specified, in this report we refer to the nongovernmental organizations that we contacted collectively as "industry." We also examined federal legislation and DOT requirements on tire pressure monitoring systems (TPMS), DOT's program for increasing public awareness on maintaining proper tire inflation, and fleet maintenance directives provided by the General Services Administration (GSA) to federal agencies that lease GSA vehicles. Finally, we assessed the methodology that NHTSA used to conduct a survey on tire underinflation and found it, and some of the conclusions derived by the agency from the survey, appropriate for our use in this report. (See encl. I for additional information on our methodology, including a list of

[1]NHTSA, *Research Note: Tire Pressure Special Study* (Washington, D.C., August 2001).

organizations we contacted.) We conducted our work from July 2006 through December 2006 in accordance with generally accepted government auditing standards.

Summary

Underinflated tires impact a driver's ability to control a vehicle against skidding, blowouts, and other tire failures. While not a leading cause of highway accidents and fatalities, a NHTSA study shows that, in 1999, underinflated tires contributed to 247, or 0.8 percent, of 32,061 fatalities and 23,100, or 0.8 percent, of almost 3 million injuries. In addition, NHTSA estimates that 41 vehicular-related deaths occur annually because of blowouts alone from underinflated tires. Moreover, tires that are not inflated to the appropriate pressure result in a slight decline in fuel economy. The Department of Energy's designated economist on this issue indicated that, of the 130 billion gallons of fuel that the Transportation Research Board (TRB)[2] estimated were used in passenger cars and light trucks in 2005, about 1.2 billion gallons were wasted as a result of driving on underinflated tires. The federal government is using legislation, public information, and educational programs to inform the public about tire underinflation. For example, the Transportation Recall Enhancement Accountability Documentation (TREAD) Act of 2000 required NHTSA to develop regulations for installing a tire pressure monitoring system in new passenger cars and light trucks.[3] These regulations are being phased in and will be effective for all new passenger cars and light trucks produced for the 2008 model year. The regulations will require a TPMS that will alert drivers when one or more tires are underinflated 25 percent below the vehicle manufacturer's recommended inflation pressure or a minimum pressure specified in the regulation, whichever is higher.[4] In addition, NHTSA works with industry to promote public awareness of the importance of properly inflated tires, and GSA provides information on the issue to federal agencies, such as DOD, that lease vehicles.

Several technologies are currently available to reduce tire underinflation, and all of them have the potential to increase safety and fuel economy when used appropriately. The federal government and industry recommend using a tire pressure gauge to check pressure regularly and reinflate tires to maintain proper inflation. Also, TPMS equipment for passenger cars and light trucks will alert drivers when a tire's pressure falls 25 percent below a vehicle manufacturer's recommended level or minimum activation pressure specified in the regulations, whichever is higher. When there is a need to increase tire pressure, consumers generally have a choice between two products—compressed air and nitrogen. Compressed air is readily available at service stations and retail tire outlets nationwide and is either free or relatively inexpensive for consumers. However, compressed air leaks from tires over time. Nitrogen permeates through tires slower than air and studies have shown that tires

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[2]The Transportation Research Board is a division of the National Research Council of the National Academy of Sciences. See Transportation Research Board, *Special Report 286: Tires and Passenger Vehicle Fuel Economy Informing Consumers, Improving Performance* (Washington, D.C., 2006), http://onlinepubs.trb.org/onlinepubs/sr/sr286.pdf.

[3]Public Law 106-414, 114 Stat. 1800 (2000).

[4]Specifically, the regulations require that the TPMS alert drivers when one or more tires are underinflated 25 percent below the vehicle manufacturer's recommended cold tire inflation pressure or a minimum activation pressure specified in the regulation, whichever is higher.

filled with nitrogen retain pressure levels longer and age more slowly. However, researchers pointed out that nitrogen has not been assessed under normal driving conditions. Transport Canada, the Canadian government's transportation ministry, has been studying the benefits of nitrogen inflation in truck tires and expects to complete this work in early 2007. It is unclear when the results of this work will be made public. NHTSA expects to complete testing on nitrogen inflation's effects on the rate of loss of inflation pressure and nitrogen inflation's effects on tire aging by April 2007 and March 2007, respectively. Currently, relatively few nitrogen outlets are available for consumers to use, and while the cost of nitrogen varies, it can exceed the cost of compressed air. The materials used to make tire innerliners,[5] can affect the amount of air and water vapor permeability. Finally, single-wide tires[6] and the use of pressure management and tire pressure monitoring systems on large trucks can also reduce the incidence of underinflated tires.

Underinflated Tires Can Impact Vehicle Safety and Fuel Economy

While underinflated tires are not a significant cause of highway fatalities and injuries, studies indicate that drivers have less control of their vehicles when tires are not properly inflated. In an analysis performed for the TREAD Act, NHTSA estimated that less than 1 percent of passenger vehicle occupant fatalities and injuries occurring in 1999 resulted from loss of control and skidding caused by underinflated tires. Specifically, 247, or 0.8 percent, of 32,061 fatalities and 23,100, or 0.8 percent, of almost 3 million injuries were related to underinflation. NHTSA also estimates that 41 deaths and 1,028 injuries occur annually because of blowouts resulting from tire underinflation. In addition, the International Tire and Rubber Association reported that underinflation was the "single most common" factor in tire failure. Further, NHTSA reported that underinflation influences skidding, hydroplaning, increased stopping distance, flat tires, and blowouts.

Underinflated tires can have a slight impact on fuel economy.[7] According to a 2006 congressionally mandated TRB study on fuel efficiency, passenger car and light trucks use an estimated 130 billion gallons of fuel per year.[8] In addition, DOE's designated economist on this issue estimates that vehicles with underinflated tires waste approximately 1.2 billion gallons of fuel per year due to the increased resistance of the tires.

Government Is Taking Steps to Address Tire Underinflation

The federal government has enacted legislation and is using public information and educational programs to inform the public about tire underinflation. Congress enacted the TREAD Act in 2000 in response to reports that tire failures caused by tread separation from certain Firestone tires installed on Ford SUVs and trucks

[5]Innerliners are the coating laminated to the inside of tubeless tires that provide a barrier between the substance used to inflate the tire (e.g., compressed air) and the tire.
[6]Single-wide tires are designed to replace dual-mounted tires on trucks—one single-wide tire is mounted on each side of an axle.
[7]Other factors that affect fuel efficiency include driving habits such speeding, as well as a vehicle's load.
[8]TRB *Special Report 286*.

that—according to NHTSA—resulted in about 268 fatal crashes from January 1991 to August 2001. In addition to requiring upgrades to the agency's safety standards for tires, the TREAD Act required NHTSA to develop regulations for a TPMS. In response, NHTSA issued a rule in 2002 that required a TPMS to be installed on new passenger cars and light trucks (i.e., those with a gross vehicle weight rating of 10,000 pounds or less).[9] However, some consumer safety groups challenged NHTSA's rule in court because they were concerned about whether certain types of TPMS allowed under the rule could sufficiently detect tire underinflation. In August 2003, a federal court vacated the rule and directed NHTSA to conduct further rule making that would be consistent with the court's ruling.[10] NHTSA subsequently issued a new rule in 2005 that requires manufacturers to install a TPMS on all new passenger cars and light trucks by the 2008 model year.[11] This rule, like its predecessor, is also in litigation.

Two types of TPMS are currently available for some passenger cars and light trucks: direct and indirect. A direct TPMS reads a tire's inflation pressure level with an electronic device mounted inside the tire either on the valve stem or the wheel, and sends the information via a wireless signal to a receiving unit in the vehicle. In contrast, an indirect TPMS checks the inflation level of a tire by monitoring the rotational speeds of the wheels (using the vehicle's anti-lock braking system) and identifying rotational differences between the wheels. NHTSA requires both types of TPMS to have an indicator on the dashboard that alerts a driver if the pressure of one or more tires falls either 25 percent below the pressure recommended by the vehicle manufacturer or a minimum pressure specified in the regulation, whichever is higher.[12] Once all new passenger vehicles and light trucks are equipped with a TPMS, NHTSA estimates that 119 to 121 passenger car and light truck fatalities will be prevented each year because it expects that 90 percent of drivers with TPMS technology will check and reinflate their tires in response to indications of tire underinflation. In addition, NHTSA estimates that this increased attention will enable drivers to save from $15 to $23 over the life of a vehicle because of better fuel economy. (See encl. II for additional information on TPMS.)

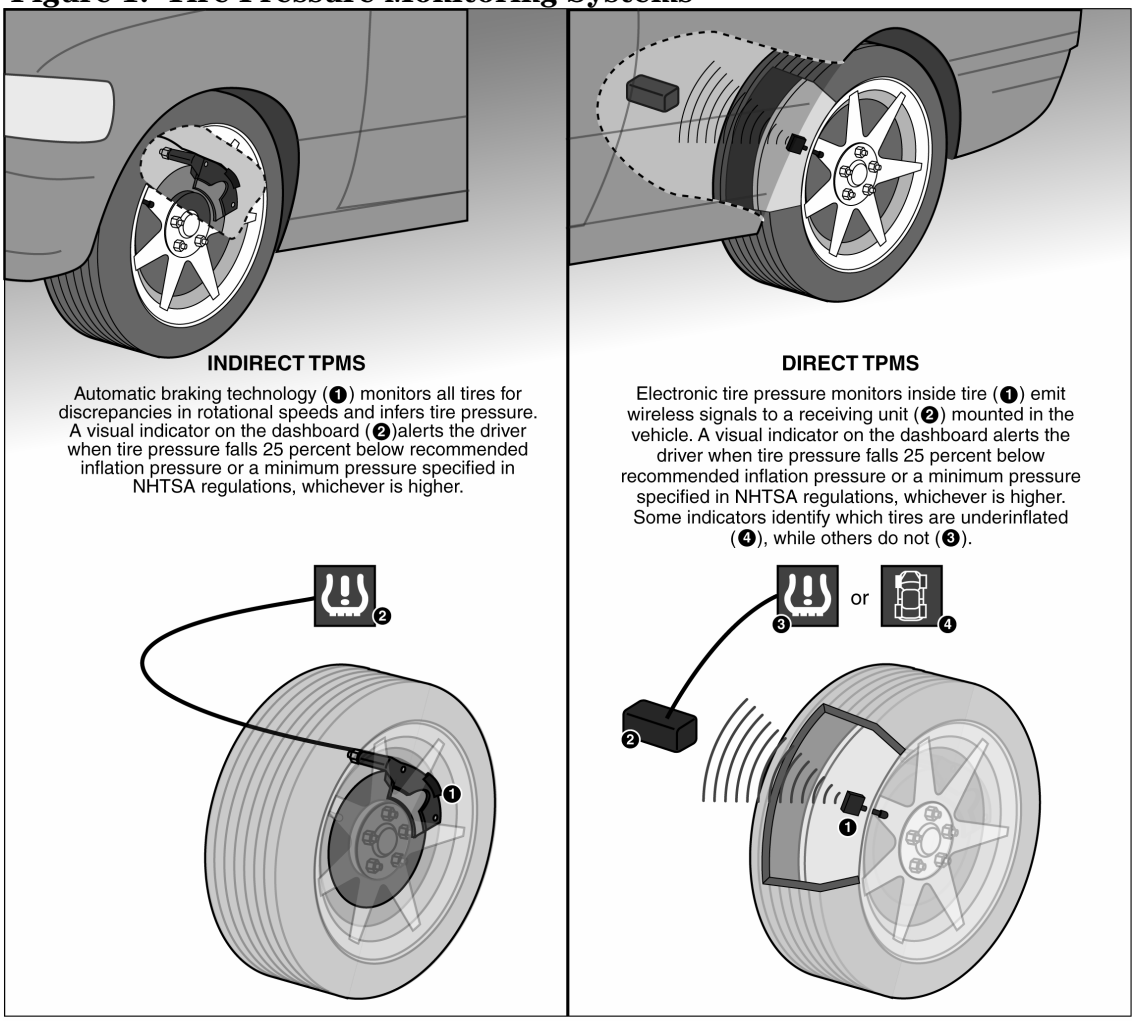
[9]Federal Motor Vehicle Safety Standard (FMVSS) No. 138 was promulgated through a final rule published in the *Federal Register* on June 5, 2002 (67 Fed Reg. 38704).

[10]The groups that participated in the lawsuit were Public Citizen Inc., New York Public Interest Research Group, and the Center for Auto Safety. *Public Citizen v. Mineta*, 340 F. 3d 39 (2d Cir. 2003).

[11]FMVSS No. 138, 70 Fed. Reg. 18136 (Apr. 5, 2005); see, also, 70 Fed. Reg. 53079 (Sept. 7, 2005) (Final Rule; responses to petitions for reconsideration). In accordance with our policy, we did not address the matters in litigation.

[12]The recommended pressure is posted on a label or placard inside the vehicle. NHTSA has developed a table that establishes the lowest pressure levels for various tires based on tire type, a floor at which the TPMS warning would be triggered regardless of the manufacturer's recommended pressure level.

Figure 1: Tire Pressure Monitoring Systems



Source: GAO.

NHTSA also uses public information and educational campaigns to convey the importance of maintaining properly inflated tires. In 2005, for example, NHTSA issued brochures for a campaign it called "What's Your PSI?" to encourage the public to check its tires regularly for proper inflation. NHTSA partnered with both the Rubber Manufacturers Association (RMA) and the American Automobile Association's Motor Clubs, which distributed the brochures to members. Additionally, NHTSA, in conjunction with RMA, sponsors a "Tire Safety Week" during the last week of April each year.[13] A NHTSA official told us that the agency plans to have public information campaigns about TPMS before the requirement becomes fully implemented for the 2008 model year.

GSA, which leased about 185,000 vehicles to federal agencies in fiscal year 2005,[14] provides ongoing guidance to federal fleet managers on the maintenance of their

[13]RMA also has a public awareness effort, referred to as "Be Tire Smart," that includes brochures aimed at informing the public of the need to properly maintain tire pressure.

[14]According to GSA's *Federal Fleet Report Fiscal Year 2005*, the federal fleet included more than 632,000 vehicles. GSA leases 29 percent of these vehicles to agencies, 69 percent are purchased by the agencies, and 2 percent are leased from commercial sources.

vehicles, including suggestions for maintaining proper tire pressure.[15] For example, in response to the President's 2005 directive to conserve natural gas, electricity, gasoline, and diesel fuel after Hurricanes Katrina and Rita, GSA sent fleet customers fuel conservation tips that contained information on proper tire inflation. GSA does not operate maintenance shops of its own but instead tracks fleet vehicle maintenance. GSA also notifies lessees of upcoming or past-due maintenance requirements and follows up to assure work is completed. Agencies that lease vehicles from GSA are responsible for procuring maintenance and repair services from private vendors. They are also responsible for assuring proper tire inflation. According to GSA's Director of Fleet Operations, GSA's fees for leased vehicles are determined by a combination of a monthly rate and a mileage rate.[16] In addition, GSA funds fuel and maintenance costs. However, if a vehicle's tires wear out sooner than expected, or are not maintained appropriately, GSA charges the customer agency for the increased costs.

The Department of Defense, with one of the largest fleets of GSA-leased vehicles, instituted a policy requiring users to maintain tires at the maximum pressure recommended by the vehicles' manufacturers.[17] Various DOD departments implemented this policy by requiring periodic and consistent tire inspections. For example, the Air Force requires vehicle operators to document tire pressure inspections each month at a minimum. The Navy requires vehicle operators to check tire pressure before using a vehicle and conduct preventive maintenance on vehicles, including tire pressure and tread checks, at least every 3 months, 5,000 miles, or 200 hours of use. Similarly, the Defense Logistics Agency requires vehicle operators to check vehicle equipment, including tire pressure daily.

Technologies Used to Reduce Tire Underinflation May Promote Better Fuel Economy and Safer Vehicle Handling

Several technologies are currently available to reduce tire underinflation, including tire pressure gauges, TPMS, compressed air, nitrogen, and improved tire materials. Drivers of passenger cars, as well as drivers of light and heavy trucks, use tire pressure gauges to check tire pressure. TPMS equipment is programmed to alert drivers of passenger vehicles when tire pressure falls 25 percent below the level recommended by vehicle manufacturers or a minimum pressure set by regulation, whichever is higher. Compressed air and nitrogen are available to the public to inflate tires, and newer materials for tire innerliners and designs for truck tires will maintain tire pressure levels longer. In addition, tire pressure management systems

[15]GSA sells and leases passenger cars and vans; light, medium, and heavy trucks; and buses and emergency vehicles to customer agencies.

[16]All of GSA Fleet's preventive maintenance instructions include checking tire pressure as part of the preventive maintenance service. Additionally, GSA Fleet places in the glove box of every vehicle it leases to customer agencies a pamphlet entitled *A Guide to Your GSA Fleet Vehicle*. The pamphlet informs vehicle operators about proper tire care to include the importance of checking air pressure regularly. The pamphlet also describes for operators how to determine proper tire pressure for a vehicle.

[17]DOD, *Management Acquisition and Use of Motor Vehicles*, Section C12.2.5.5, from DOD 4500.36-R. (Washington, D.C., 1996).

and central inflation systems are available to address tire underinflation on heavy trucks. TPMS equipment also alerts drivers of heavy trucks when tire pressure falls below a certain level. The basic features of each type of technology are discussed below. If used properly, all of the features have the potential to increase fuel economy and enhance vehicle safety.

Tire Pressure Gauges

The federal government and industry recommend that drivers of passenger vehicles use a tire pressure gauge to check their tire pressure at least once a month, when tires are cold, and inflate them to the pressure recommended by the vehicle manufacturer.[18] (See fig. 2.) Tire industry officials indicated that large trucking fleets recognize this as a good practice, since tires and their maintenance represent a portion of their operating costs, and generally monitor their vehicles' tire pressure on a more frequent basis.[19] The American Trucking Association's Technology and Maintenance Council also recommends that its members use quality truck tire pressure gauges and check them weekly against a "master gauge."

[18]The vehicle manufacturer's recommended pressure is posted inside the vehicle on the placard.
[19]Other costs are labor and fuel.

Figure 2: Two Types of Tire Pressure Gauges

Source: GAO.

TPMS

TPMS technology will be available on all passenger vehicles starting with the 2008 model year. According to DOT, the TPMS final rule's phase-in has increased the prevalence of TPMS in the new vehicle fleet. Under the April 8, 2005 final rule,

- 20 percent of a vehicle manufacturer's passenger vehicles and light trucks are required to comply with the standard from October 5, 2005, to August 31, 2006;
- 70 percent are required to comply from September 1, 2006, to August 31, 2007; and
- all of these vehicles must comply by September 1, 2007.

Although TPMS is now available on certain luxury cars and is available as optional equipment on large trucks, questions remain about how TPMS will operate on most vehicles. For example, NHTSA does not require that the TPMS identify the specific underinflated tire and only requires that it work with the tires originally installed by the vehicle manufacturer. NHTSA requires the TPMS used on passenger cars and light trucks to include a malfunction indicator lamp to alert the driver of the presence of incompatible replacement tires on the vehicle and when the TPMS is unable to detect low tire pressure for other reasons.

Compressed Air

Compressed air, which is a combination of mostly nitrogen and oxygen,[20] is customarily used to inflate tires and is widely available at facilities such as service stations and retail tire outlets. In addition, the cost of using compressed air is usually free or relatively inexpensive. According to some industry officials, compressed air permeates tires more quickly than other products such as nitrogen. However, tire researchers and others indicate that either product is effective if drivers check their tires regularly and reinflate when necessary.

Nitrogen

Some industry officials promote the use of nitrogen to inflate vehicle tires. Nitrogen permeates the rubber used in tires more slowly than air. Studies have shown that nitrogen retains tire pressure longer and slows tire degradation.[21] However, according to researchers, no studies have been conducted that show the results of nitrogen use on safety and fuel efficiency under normal driving conditions.

Currently, studies are being conducted on the use of nitrogen to inflate tires. A Canadian nitrogen manufacturer is planning to submit a report to Transport Canada, the Canadian government's transportation ministry, in early 2007 on the effect of nitrogen inflation on fuel efficiency and costs in long-haul trucks.[22] It is unclear when the report will be made available to the public. NHTSA is conducting two laboratory studies on this topic for passenger and light truck tires—one on the effects of nitrogen inflation on the rate of loss of inflation pressure, with testing expected to be complete in April 2007, and another on the effects of nitrogen inflation on tire aging. NHTSA expects to complete testing on the tire aging study in March 2007, with public reports on the two studies to follow.

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[20]Air is composed of 78 percent nitrogen and 21 percent oxygen. Argon and carbon dioxide make up the remaining 1 percent.

[21]For information on tire pressure retention, see Guy Walenga, Bridgestone/Firestone, *Nitrogen Inflation for Truck Tires* (presented at Clemson Tire Conference, Mar. 11, 2004). For information on tire degradation, see Uday Karmaker, Akron Rubber Development Laboratory, Inc., Harold Herzlich, Herzlich Consulting, Inc., *Effect of Nitrogen Purity on the Oxidation of Belt Coat Compound* (presented at International Tire Exhibition and Conference 2006, Akron, Ohio); and John M. Baldwin, David R. Bauer, Kevin, R. Ellwood, Ford Motor Co., *Effects of Nitrogen Inflation on Tire Aging and Performance* (conference paper, May 2004).

[22]The study was originally undertaken to evaluate technologies to reduce greenhouse gases.

Two challenges affecting the widespread use of nitrogen in passenger cars and light truck tires include the lack of infrastructure that would make it readily available to consumers and the cost of filling tires. According to federal and industry officials, researchers, and public safety advocates, most service stations and tire retailers do not have nitrogen pumps or generators. Retailers such as Costco and some Sam's Club locations are exceptions and currently offer nitrogen, at no cost, to their members when they purchase tires. Since other retailers offer nitrogen on a more limited basis nationwide, and the cost of using it varies depending on the retailer or the location, we could not reliably determine the average cost of filling a tire. Industry officials indicated that some retailers may purge air from a vehicle's tires and replace it with nitrogen at no cost while others may charge prices ranging from $20 to $79 per vehicle.[23]

Tire Innerliners

Tire manufacturers can select from a variety of materials to make tire innerliners—the coating laminated to the inside of tires. The type of material selected determines the amount of air and water vapor that permeates a tire and causes it to deflate and degrade. Currently, the tires most often available to consumers include innerliners that are made from varying blends of synthetic rubber polymers (known as halobutyls) and other types of rubber. Tire researchers and experts have shown that innerliners made from high ratios of bromobutyl, one type of halobutyl, are the least permeable to air and water vapor and best able to retain pressure. However, innerliners made from high ratios of this material are more expensive than those made with high ratios of natural and synthetic rubbers and, according to researchers, are more likely found in original equipment tires than replacement tires.

Truck Tire Design and Inflation Systems

Improvements in heavy truck tire testing and central inflation systems have the potential to reduce tire underinflation and increase fuel economy. Single-wide tires have replaced dual tires on some large trucks and tractor trailers. According to the Environmental Protection Agency (EPA), single-wide tires could improve fuel economy by up to 4 percent because they have less rolling resistance and weight. According to DOT, single-wide tires also reduce by half the number of points to check and tires to inflate, significantly reducing the time needed to check tire pressure on a tractor-trailer combination vehicle. Tire pressure monitoring systems can provide an early warning of air pressure loss before a tire sustains damage. Single-wide tires also present several disadvantages that involve transition costs for fleets and their potential damage to highway pavement (see encl. III). In addition, central inflation systems on trucks can continually monitor and adjust the amount of inflation pressure in tires while the vehicle is in motion. According to officials from the EPA and the Federal Motor Carrier Safety Administration, these systems could also improve fuel economy. (See encl. III for further discussion of these technologies.)

[23]Because of the relative lack of studies showing the impact of nitrogen on fuel economy, and the varying costs cited for inflating tires with nitrogen, we did not determine the extent to which the increased cost for inflating tires may be offset by lower fuel costs and a less frequent need to purchase replacement tires.

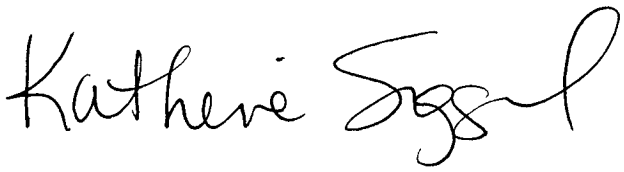
Agency Comments

We provided copies of a draft of this report to the Departments of Transportation, Defense, and Energy; the General Services Administration; and the Environmental Protection Agency. Their technical comments have been incorporated into the report, as appropriate.

As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies to other interested congressional committees. We will also make copies available to others upon request. In addition, the report will be available at no charge on GAO's Web site at http://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-6570 or siggerudk@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Individuals making key contributions to this report are listed in enclosure IV.

Sincerely yours,



Katherine A. Siggerud
Director, Physical Infrastructure Issues

Enclosures

Enclosure I: Scope and Methodology

We obtained information on a variety of issues involving passenger and truck tires in the United States by interviewing officials, and examining the documents they provided, with the federal agencies, tire and automotive industries, businesses, and public safety advocacy groups shown in table 1. Officials with the Department of Transportation's (DOT) National Highway Traffic Safety Administration (NHTSA) and Federal Motor Carrier Safety Administration (FMCSA) provided documents on their public information efforts to encourage the public to regularly check their tires for proper inflation; data on accidents and fatalities caused by underinflated tires; analyses developed for the tire pressure monitoring system (TPMS) regulations; and information about ongoing studies on tires. Officials with the public safety advocacy groups and some industries provided their views on TPMS regulations. In addition, we reviewed NHTSA's survey of tire pressures in passenger vehicles and studies on tire safety. The General Services Administration provided information on its vehicle leasing program, including details on maintenance as a factor in agencies' lease rates. We obtained information on the role that civilian and military Department of Defense employees have in maintaining appropriate tire pressure levels for vehicles in its fleet. The Department of Energy, Environmental Protection Agency, National Academy of Sciences' Transportation Research Board, Akron Rubber Development Laboratory, and the business groups provided information and data on using compressed air and nitrogen to inflate tires, and the impact on safety and fuel economy of each product. We also obtained information from industry associations on their initiatives to alert the public on tire inflation.

Industry officials provided information on the materials used to make and inflate tires and the impact that a TPMS will have on tires. The public advocacy groups provided information on the impact that a TPMS may have on tire safety.

We received information from some organizations listed in table 1 on the technologies currently available to reduce underinflation and their implications for fuel economy and safety. In addition, we interviewed manufacturers (e.g., Ingersoll-Rand) that produce nitrogen generation equipment for tire inflation to determine why they believe it is a better product for inflating tires, as well as retailers (e.g., Costco) that offer both nitrogen and compressed air to consumers. We also obtained comments from officials we interviewed on the reliability, safety, cost effectiveness, and fuel efficiency of compressed air and nitrogen to inflate tires. We performed our work from July 2006 through December 2006 in accordance with generally accepted government auditing standards.

Table 1: Organizations Contacted during Our Review

Federal organizations	
	Department of Transportation (NHTSA and FMCSA)
	Department of Defense
	Department of Energy
	General Services Administration
	Environmental Protection Agency
Industry associations	
	Rubber Manufacturers Association[a]
	American Trucking Association
	American Automobile Association
	Alliance of Automobile Manufacturers[b]
	Tire Industry Association
	Tire Retread Information Bureau
Businesses	
	Ford Motor Company
	Roush Racing
	NASCAR
	American Airlines
	Akron Rubber Development Laboratory
	Ingersoll-Rand
	Branick Industries
	Parker Hannifin
	Schrader-Bridgeport
	EnTire Solutions
	Costco
	Wal-Mart
	Discount Tire Company
	Tire Kingdom
Public advocacy organizations	
	Center for Auto Safety
	Advocates for Highway and Auto Safety
	Public Citizen

Source: GAO.

[a]Representatives from Bridgestone, Continental, Goodyear, Michelin, and Pirelli tire companies participated in this meeting.
[b]Representatives from General Motors and Daimler Chrysler participated in this meeting.

Enclosure II: Tire Pressure Monitoring Systems

NHTSA requires all new 2008 model year passenger cars and light trucks to have a tire pressure monitoring system (TPMS) to alert drivers when the pressure in one or more tires falls 25 percent below the vehicle manufacturer's recommended inflation pressure or a minimum activation pressure specified by NHTSA, whichever is higher.[24] NHTSA also requires the TPMS to include a malfunction indicator that alerts drivers when the TPMS is not functioning because of either a system failure or the placement of incompatible replacement tires on the vehicles.

Industry developed two types of TPMS—direct and indirect. A direct TPMS uses an electronic device mounted either on the valve stem or the inside of a wheel to read inflation pressure. It sends a wireless signal about a tire's inflation level to a receiving unit that alerts the driver through a warning light on the dashboard if tire pressure falls below a certain threshold.[25] An indirect TPMS uses a vehicle's existing anti-lock braking system equipment to monitor the rotational speeds of the wheels. When it detects a difference in rotational speed in one wheel compared with the others, the system infers that a tire is underinflated and alerts the driver through a visual alarm.

Industry and public safety advocacy groups have expressed concern about the capabilities of TPMS as it relates to NHTSA's requirements. For example, a tire industry official said that if replacement tires not compatible with the TPMS are installed, NHTSA regulations require that the malfunction indicator lamp illuminate to alert the driver that the TPMS cannot detect underinflation.[26] In such cases, the owner would have to replace the new equipment for tires or wheels that are compatible with the TPMS. According to DOT, however, available data suggest that only a very small number of replacement tires are likely to generate problems for TPMS, although it has not been possible to identify problematic tires based on size or construction characteristics. Although DOT officials claim that vehicle manufacturers report few warranty claims based on instances of replacement tires being incompatible with a TPMS, we think that conclusions about this area should wait until after 2008, when more vehicles are equipped with a TPMS.

At the time of our review, no indirect TPMS has been marketed that meets NHTSA's requirement to identify one to four underinflated tires at a time. Further, the indirect TPMS cannot detect underinflation when all four tires are equally underinflated. An indirect TPMS is considered the least expensive option, however, because it requires less additional hardware on vehicles equipped with anti-lock brakes. As previously noted, NHTSA's current rule is in litigation. In accordance with our policy, we neither included in our objectives nor addressed matters in litigation.

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[24]FMVSS No. 138. 70 Fed. Reg. 18136 (April 5, 2005); see, also, 70 Fed. Reg. 54079 (Sept. 7, 2005), "Tire Pressure Monitoring Systems."

[25]Although NHTSA requires that the alert be triggered when pressure falls 25 percent below the vehicle manufacturer's recommended level, some TPMS, depending on the manufacturer, will trigger alerts earlier.

[26]NHTSA requires that original equipment manufacturers certify TPMS on the tires installed on the vehicle at the time of the initial vehicle sale.

Enclosure III: New Tire Designs and Technologies for Heavy Trucks Offer Enhanced Safety and Improved Fuel Economy

Several recent innovations in truck tire and wheel technology are designed to enhance fuel economy and also offer safety benefits. For example, single-wide tires[27] are designed to replace traditional dual-mounted tires on trucks—one single-wide tire is mounted on each side of an axle. Single-wide tires can be used for all tractor and trailer tire positions except for the steer tires at the front of the tractor. Using single-wide tires, a traditional 18-wheel tractor-trailer, with 2 steer tires, 4 pairs of drive tires, and 4 pairs of trailer tires, would have a total of only 10 tires—2 steer tires, 4 drive tires, and 4 trailer tires. According to the EPA's SmartWay Transport Partnership,[28] the reduced rolling resistance and weight of the tires and wheels could improve fuel economy by up to 4 percent.[29] According to DOT, single-wide tires also reduce by half the number of points to check and tires to inflate, significantly reducing the time needed to check tire pressure on a tractor-trailer combination vehicle. Similarly, the American Trucking Association (ATA) noted that single-wide tires effectively eliminate the problem of checking inflation pressure on the inner dual-mounted tire. Additionally, tire pressure monitoring systems can provide an early warning of air pressure loss before a tire sustains damage.

ATA noted, however, that single-wide tires present several disadvantages. For example, transition costs might pose a challenge, since fleets would have to maintain two sets of wheel hardware until the entire fleet was converted. Another disadvantage is the potential damage to pavement. According to ATA and Virginia Tech's Transportation Institute, the first generation of single-wide tires damaged pavement at a greater rate than dual-mounted tires.[30] However, as the design of single-wide tires has evolved, the tires have become increasingly wider. According to a FMCSA official, wider tires distribute the load over a greater area, reducing the impact on the pavement. These experts also say that potential for pavement damage from the newest generation of single-wide tires is comparable with conventional dual-mounted tires. A potential disadvantage, according to DOT, involves the safety of the truck if one of the single-wide tires fails. In contrast, when one of a pair of dual-mounted tires fails, there is still another tire available.

Central inflation systems are another technology for trucks to reduce underinflation. These systems can monitor and continually adjust the inflation pressure in tires, even while the truck is in motion. Two main types of systems are currently available. One system uses the truck's existing air-brake compressor to supply air to tires. Another uses self-contained compressors on each hub that generate compressed air through

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[27]Also known as "super-singles" or "wide-base" tires, single-wide tires have been used on trucks in Europe and Canada since the early 1980s. A distinction should be made between first generation "super-single" tires, which were introduced in the 1980s and "new generation" super-singles" tires.

[28]EPA's SmartWay Transport Partnership is a voluntary collaboration between U.S. EPA and the freight industry designed to increase energy efficiency while significantly reducing greenhouse gases and air pollution.

[29]This assumes single-wide tires are mounted using weight-saving aluminum rims on all applicable axles of the tractor and the trailer.

[30]I. L. Al-Qadi, M. Elseifi, and P.J. Yoo, Virginia Tech Transportation Institute, *Pavement Damage Due to Different Tires and Vehicle Configurations* (Blacksburg, Virginia, May 2004); and Jim Tipka, American Trucking Institute, *New Generation Wide Based Single Tires* (June 2006).

the rolling motion of the wheels. According to FMCSA, central inflation systems could offer significant savings to fleet operators by improving fuel economy and safety. According to EPA's SmartWay Transport Partnership, these systems could annually save long-haul trucks up to $200 in tire maintenance costs, and $170 in fuel costs per truck. However, these systems also present several disadvantages. For example, according to an ATA official, systems operating from the air-brake compressor involve an extensive array of tubing and valves, increasing the potential for leaks.

Enclosure IV: GAO Contact and Staff Acknowledgments

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Staff Acknowledgments

In addition to the contact named above, Nabajyoti Barkakati, Lindsay Bach, Colin Falon, Jay Cherlow, Lynn Filla-Clark, H. Brandon Haller, Phillis Riley, Karla Springer, Don Watson, and Mindi Weisenbloom made key contributions to this report.

(542094)

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