DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

49 CFR Parts 571 and 590

[Docket No. NHTSA 2000–8572]

RIN 2127–AI33

Federal Motor Vehicle Safety Standards; Tire Pressure Monitoring Systems; Controls and Displays

AGENCY: National Highway Traffic Safety Administration (NHTSA), Department of Transportation (DOT).

ACTION: Final rule.

SUMMARY: In response to a mandate in the Transportation Recall Enhancement, Accountability, and Documentation (TREAD) Act of 2000, this agency is issuing a two-part final rule.

The first part is contained in this document. It establishes a new Federal Motor Vehicle Safety Standard that requires the installation of tire pressure monitoring systems (TPMSs) that warn the driver when a tire is significantly under-inflated. The standard applies to passenger cars, trucks, multipurpose passenger vehicles, and buses with a gross vehicle weight rating of 10,000 pounds or less, except those vehicles with dual wheels on an axle.

This document establishes two compliance options for the short-term, for the period between November 1, 2003, and October 31, 2006. Under the first compliance option, a vehicle's TPMS must warn the driver when the pressure in any single tire or in each tire in any combination of tires, up to a total of four tires, has fallen to 25 percent or more below the vehicle manufacturer's recommended cold inflation pressure for the tires, or a minimum level of pressure specified in the standard, whichever pressure is higher. Under the second compliance option, a vehicle's TPMS must warn the driver when the pressure in any single tire has fallen to 30 percent or more below the vehicle manufacturer's recommended cold inflation pressure for the tires, or a minimum level of pressure specified in the standard, whichever pressure is higher. Compliance with the options would be phased in during that period by increasing percentages of production.

The second part of this final rule will be issued by March 1, 2005, and will establish performance requirements for the long-term, *i.e.,* for the period beginning on November 1, 2006. In the meantime, the agency will leave the rulemaking docket open for the submission of new data and analyses concerning the performance of TPMSs. The agency also will conduct a study comparing the tire pressures of vehicles without any TPMS to the pressures of vehicles with TPMSs, especially TPMSs that do not comply with the four-tire, 25 percent compliance option.

Based on the record now before the agency, NHTSA tentatively believes that the four-tire, 25 percent option would best meet the mandate in the TREAD Act. However, it is possible that the agency may obtain or receive new information that is sufficient to justify a continuation of the options established by this first part of this rule, or the adoption of some other alternative.

DATES: This final rule is effective August 5, 2002. Under the rule, vehicles will be required to comply with the requirements of the standard according to a phase-in beginning on November 1, 2003. If you wish to submit a petition for reconsideration of this rule, your petition must be received by July 22, 2002.

ADDRESSES: Petitions for reconsideration should refer to the docket number and be submitted to: Administrator, Room 5220, National Highway Traffic Safety Administration, 400 Seventh Street, SW, Washington, DC 20590.

FOR FURTHER INFORMATION CONTACT: For technical and other non-legal issues, you may call Mr. George Soodoo or Mr. Joseph Scott, Office of Crash Avoidance Standards (Telephone: 202–366–2720) (Fax: 202–366–4329).

For legal issues, you may call Mr. Dion Casey, Office of Chief Counsel (Telephone: 202–366–2992) (Fax: 202–366–3820).

You may send mail to these officials at National Highway Traffic Safety Administration, 400 Seventh Street, SW, Washington, DC 20590.

You may call Docket Management at 202–366–9324. You may visit the Docket on the plaza level at 400 Seventh Street, SW, Washington, DC, from 10:00 a.m. to 5:00 p.m., Monday through Friday.

SUPPLEMENTARY INFORMATION:

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I. Executive Summary

A. Highlights of the Notice of Proposed Rulemaking

NHTSA initiated this rulemaking with the publication of a Notice of Proposed Rulemaking (NPRM)(66 FR 38982, Docket No. NHTSA–2000–8572) on July 26, 2001. The NPRM proposed to require passenger cars, light trucks, multipurpose passenger vehicles, and buses with a gross vehicle weight rating of 10,000 pounds or less, except those vehicles with dual wheels on an axle, to be equipped with a tire pressure monitoring system (TPMS).

The agency sought comment on two alternative sets of performance requirements for TPMSs and proposed adopting one of them in the final rule. The first alternative would have required that the driver be warned when the pressure in any single tire or in each tire in any combination of tires, up to a total of four tires, had fallen to 20 percent or more below the vehicle manufacturer's recommended cold inflation pressure for the vehicle's tires (the placard pressure), or a minimum level of pressure specified in the standard, whichever was higher. (This alternative is referred to below as the four-tire, 20 percent alternative.) The second alternative would have required that the driver be warned when the pressure in any single tire or in each tire in any combination of tires, up to a total of three tires, had fallen to 25 percent or more below the placard pressure, or a minimum level of pressure specified in the standard, whichever was higher. (This alternative is referred to below as the three-tire, 25 percent alternative.) The minimum levels of pressure were the same in both proposed alternatives. The adoption of four-tire, 20 percent alternative would have required that drivers be warned of under-inflation sooner and in a greater array of circumstances. It would also have narrowed the range of technologies that manufacturers could use to comply with the new standard.

There are two types of TPMSs currently available, direct TPMSs and indirect TPMSs. Direct TPMSs have a tire pressure sensor in each tire. The sensors transmit pressure information to a receiver. Indirect TPMSs do not have tire pressure sensors. Current indirect TPMSs rely on the wheel speed sensors in an anti-lock braking system (ABS) to detect and compare differences in the rotational speed of a vehicle's wheels. Those differences correlate to differences in tire pressure because decreases in tire pressure cause decreases in tire diameter that, in turn, cause increases in wheel speed.

To meet the four-tire, 20 percent alternative, vehicle manufacturers likely would have had to use direct TPMSs because even improved indirect systems would not likely be able to detect loss of pressure until pressure has fallen 25 percent and could not detect all combinations of significantly under-inflated tires. To meet the three-tire, 25 percent alternative, vehicle manufacturers would have been able to install either direct TPMSs or improved indirect TPMSs, but not current indirect TPMSs.

B. Highlights of the Preliminary Determination About the Final Rule

NHTSA preliminarily determined to issue a final rule that would have specified a four-year phase-in schedule[1] and allowed compliance with either of two options during the phase-in, i.e., between November 1, 2003 and October 31, 2006. Under the first option, a vehicle's TPMS would have had to warn the driver when the pressure in one or more of the vehicle's tires, up to a total of four tires, was 25 percent or more below the placard pressure, or a minimum level of pressure specified in the standard, whichever pressure was higher. (This option is referred to below as the four-tire, 25 percent option.) Under the second option, a vehicle's TPMS would have had to warn the driver when the pressure in any one of the vehicle's tires was 30 percent or more below the placard pressure, or a minimum level of pressure specified in the standard, whichever pressure was higher. (This option is referred to below as the one-tire, 30 percent option.) The minimum levels of pressure specified in the standard were the same for both compliance options.

After the phase-in, *i.e.,* after October 31, 2006, the second option would have been terminated, and the provisions of the first option would have become mandatory for all new vehicles. Thus, all vehicles would have been required to meet a four-tire, 25 percent requirement.

C. OMB Return Letter

After reviewing the draft final rule, OMB returned it to NHTSA for reconsideration, with a letter explaining its reasons for doing so, on February 12, 2002. In the letter, OMB stated its belief that the draft final rule and accompanying regulatory impact analysis did not adequately demonstrate that the agency had selected the best available method of improving overall vehicle safety.

D. Highlights of the Final Rule

In response to the OMB return letter, the agency has decided to divide the final rule into two parts. The first part is contained in this document, which establishes requirements for vehicles manufactured during the first three years, *i.e.,* between November 1, 2003, and October 31, 2006, and phases them in by increasing percentages of production. The second part will establish requirements for vehicles manufactured on or after November 1, 2006.

The agency has divided the final rule into two parts because it has decided to

[1] The phase-in schedule was as follows: 10 percent of a manufacturer's affected vehicles would have had to comply with either compliance option in the first year; 35 percent in the second year; and 65 percent in the third year. In the fourth year, 100 percent of a manufacturer's affected vehicles would have had to comply with the long-term requirements, i.e., the four-tire, 25 percent compliance option.

defer its decision as to which long-term performance requirements for TPMS would best satisfy the mandate of the TREAD Act. This deferral will allow the agency's consideration of additional data on the effect and performance of TPMSs. From the beginning, the agency has sought to comply with the mandate and safety goals of the TREAD Act in a way that encourages innovation and allows a range of technologies to the extent consistent with providing drivers with sufficient warning of low tire pressure under a broad variety of the reasonably foreseeable circumstances in which tires become under-inflated.

1. Part One—Phase-in (November 2003 through October 2006)

NHTSA has decided to require vehicle manufacturers to equip their light vehicles (*i.e.,* those with a gross vehicle weight rating (GVWR) of 10,000 lbs. or less) with TPMSs and to give them the option for complying with either of two sets of performance requirements during the period covered by the first part of the final rule, *i.e.,* from November 1, 2003 to October 31, 2006. The options are the same as those in the preliminary determination about the final rule.

Under the first set or compliance option, the vehicle's TPMS will be required to warn the driver when the pressure in any single tire or in each tire in any combination of tires, up to a total of four tires, is 25 percent or more below the vehicle manufacturer's recommended cold inflation pressure for the tires, or a minimum level of pressure specified in the standard, whichever pressure is higher. Under the second compliance option, the vehicle's TPMS will be required to warn the driver when the pressure in any single tire is 30 percent or more below the vehicle manufacturer's recommended cold inflation pressure for the tires, or a minimum level of pressure specified in the standard, whichever pressure is higher.[2]

The two compliance options are outgrowths of the alternative sets of requirements proposed in the NPRM. In response to comments confirming that current indirect TPMSs cannot meet the proposed three-tire, 25 percent under-inflation requirements, and in order to allow those systems to be used during the phase-in, the agency is adopting requirements for detection of one-tire, 30 percent under-inflation as the first option. For the second option, the agency is adopting requirements for detection of 4-tire, 25 percent under-inflation. Adopting those requirements, instead of the proposed requirements for four-tire, 20 percent under-inflation, will permit manufacturers to use either direct TPMSs or hybrid TPMSs, *i.e.,* TPMSs that combine direct and indirect TPMS technologies. One TPMS supplier indicated the potential for developing and producing hybrid systems, although it also indicated that it did not currently have plans for doing so. The agency believes that the difference in benefits between TPMSs meeting four-tire, 20 percent requirements and TPMSs meeting four-tire, 25 percent requirements should not be substantial.

To facilitate compliance with the options, the rule phases them in by increasing percentages of production. Ten percent of a vehicle manufacturer's light vehicles will be required to comply with either compliance option during the first year (November 1, 2003 to October 31, 2004), 35 percent during the second year (November 1, 2004 to October 31, 2005), and 65 percent during the third year (November 1, 2005 to October 31, 2006). These percentages are the same as those in the preliminary determination about the final rule. The agency is allowing carry-forward credits for vehicles that are manufactured during the phase-in and are equipped with TPMSs that comply with the four-tire, 25 percent option. It is not allowing credits for TPMSs complying with the other option for the same reason that the agency is requiring manufacturers to provide consumers with information about the performance limitations of those systems.

The combination of the two compliance options and the phase-in will allow manufacturers to continue to use current indirect TPMSs during that period and ease the implementation of the TPMS standard. The agency notes that, for vehicles already equipped with ABS, the installation of a current indirect TPMS is the least expensive way of complying with a TPMS standard. The compliance options and phase-in will also give manufacturers the flexibility needed to innovate and improve the performance of their TPMSs. This flexibility will improve the chances that ways can be found to improve the detection of under-inflation as well as reduce the costs of doing so.

The owner's manual for vehicles certified to either compliance option will be required to include written information explaining the purpose of the low tire pressure warning telltale, the potential consequences of driving on significantly under-inflated tires, the meaning of the telltale when it is illuminated, and the actions that drivers should take when the telltale is illuminated. In addition, the owner's manual in vehicles certified to the one-tire, 30 percent option will be required to include information on the inherent performance limitations of current indirect TPMSs because the agency anticipates that most indirect TPMSs installed to comply with that option will exhibit those limitations and because a vehicle owner survey indicates that a significant majority of drivers would be less concerned, to either a great extent or a very great extent, with routinely maintaining the pressure of their tires if their vehicle were equipped with a TPMS. Under both compliance options, the TPMS will be required to have a low tire pressure-warning telltale (yellow).

2. Part Two—November 2006 and Thereafter

Beginning November 1, 2006, all passenger cars and light trucks, multipurpose passenger vehicles, and buses under 10,000 pounds GVWR will be required to comply with the requirements in the second part of this final rule. The agency will publish the second part of this final rule by March 1, 2005, in order to give manufacturers sufficient lead time before vehicles must meet the requirements.

In anticipation of making the decision in part two of this final rule about the long-term requirements, the agency will leave the rulemaking docket open for the submission of new data and analyses. The agency also will conduct a study comparing the tire pressures of vehicles without any TPMS to the pressures of vehicles with TPMSs that do not comply with the four-tire, 25 percent compliance option. When completed, it will be placed in the docket for public examination. After consideration of the record compiled to this date, as supplemented by the results of the tire pressure study and any other new information submitted to the agency, NHTSA will issue the second part of this rule by March 1, 2005.

Based on the record now before the agency, NHTSA tentatively believes that the four-tire, 25 percent option would best meet the mandate in the TREAD Act. However, it is possible that the agency may obtain or receive new information that is sufficient to justify a continuation of the compliance options established by the first part of this final rule, or the adoption of some other alternative.

[2] The minimum levels of pressure are the same for both compliance options.

E. Summary Comparison of the Preliminary Determination and the Final Rule

The primary difference between the preliminary determination and the final rule is one of timing, instead of substance. The options and percentages of production for the phase-in years are unchanged.[3] The final rule does differ from the preliminary determination in the timing of the agency's decision about the performance requirements for the years following the phase-in period.

SUMMARY COMPARISON OF THE PRELIMINARY DETERMINATION AND THE FINAL RULE

	Preliminary determination	Final rule
Application	Passenger cars, trucks, multipurpose passenger vehicles, and buses with a GVWR of 10,000 pounds or less, except those vehicles with dual wheels on an axle.	Same.
Short-term (11/1/03—10/31/06):		
Compliance Options	Option 1: TPMS must warn the driver when the pressure in any single tire or in each tire in any combination of tires, up to a total of four tires, has fallen to 25 percent or more below the vehicle manufacturer's recommended cold inflation pressure for the tires, or a minimum level of pressure specified in the standard, whichever pressure is higher.	Same.
	Option 2: TPMS must warn the driver when the pressure in any single tire has fallen to 30 percent or more below the vehicle manufacturer's recommended cold inflation pressure for the tires, or a minimum level of pressure specified in the standard, whichever pressure is higher.	Same.
Phase-in Schedule	10% of a vehicle manufacturer's light vehicles will be required to comply with either compliance option during the first year (November 1, 2003 to October 31, 2004), 35 percent during the second year (November 1, 2004 to October 31, 2005), and 65 percent during the third year (November 1, 2005 to October 31, 2006).	Same.
Long-term (11/1/06 & thereafter):		
Performance Requirements	TPMS must warn the driver when the pressure in any single tire or in each tire in any combination of tires, up to a total of four tires, has fallen to 25 percent or more below the vehicle manufacturer's recommended cold inflation pressure for the tires, or a minimum level of pressure specified in the standard, whichever pressure is higher.	Decision to be made by March 1, 2005.

II. Background

A. The Transportation Recall Enhancement, Accountability, and Documentation Act

Congress enacted the TREAD Act on November 1, 2000.[4] Section 13 of the TREAD Act mandated the completion of ''a rulemaking for a regulation to require a warning system in new motor vehicles to indicate to the operator when a tire is significantly under inflated'' within one year of the TREAD Act's enactment. Section 13 also requires the regulation to take effect within two years of the completion of the rulemaking.

B. Previous Rulemaking on Tire Pressure Monitoring Systems

NHTSA first considered requiring a ''low tire pressure warning'' device in 1970. However, the agency determined that the only warning device available at that time was an in-vehicle indicator whose cost was too high.

During the 1970s, several manufacturers developed inexpensive, on-tire warning devices. In addition, the price of in-vehicle warning devices dropped significantly.

As a result, on January 26, 1981, NHTSA published an Advanced Notice of Proposed Rulemaking (ANPRM) soliciting public comment on whether the agency should propose a new Federal motor vehicle safety standard requiring each new motor vehicle to have a low tire pressure warning device which would ''warn the driver when the tire pressure in any of the vehicle's tires was significantly below the recommended operating levels.'' (46 FR 8062.)

NHTSA noted in the ANPRM that under-inflation increases the rolling resistance of tires and, correspondingly, decreases the fuel economy of vehicles. Research data at the time indicated that the under-inflation of a vehicle's radial tires by 10 pounds per square inch (psi) reduced the fuel economy of the vehicle by 3 percent. Because of the worldwide oil shortages in the late 1970s and early 1980s, NHTSA was interested in finding ways to increase the fuel economy of passenger vehicles (i.e., passenger cars and multipurpose passenger vehicles). Since surveys by the agency showed that about 50 percent of passenger car tires and 13 percent of truck tires were operated at pressures below the vehicle manufacturer's recommended (placard) pressure, the agency believed that low tire pressure warning devices would encourage drivers to maintain their tires at the proper inflation level, thus maximizing their vehicles' fuel economy.

Moreover, a 1977 study by Indiana University concluded that under-inflated tires were a probable cause of 1.4 percent of all motor vehicle crashes.[5] Based on that figure, and the approximately 18.3 million motor vehicle crashes then occurring annually in the United States, the agency suggested that under-inflated tires were probably responsible for 260,000 crashes each year (1.4 percent x 18.3 million crashes).

In the ANPRM, NHTSA sought answers from the public to several questions, including:

(1) What tire pressure level should trigger the warning device?

[3] The final rule does require that additional information be placed in the vehicle's owner manual.

[4] Public Law 106–414.

[5] Tri-Level Study of the Causes of Traffic Accidents, Treat, J.R., et al. (1979) (Contract No. DOT HS 034–3–535), DOT HS 805 099, Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration.

(2) Should the agency specify the type of warning device (i.e., on-tire or in-vehicle) to be used?

(3) What would it cost to produce and install an on-tire or in-vehicle warning device?

(4) What is the fuel saving potential of low tire pressure warning devices?

(5) What studies have been performed which would show cause and effect relationships between low tire pressure and auto crashes?

(6) What would be the costs and benefits of a program to educate the public on the benefits of maintaining proper tire pressure?

NHTSA terminated the rulemaking on August 31, 1981, because public comments indicated that the low tire pressure warning devices available at the time either had not been proven to be accurate and reliable (on-tire devices) or were too expensive (in-vehicle devices). (46 FR 43721.) The comments indicated that in-vehicle warning devices had been proven to be accurate and reliable, but would have had a retail cost of $200 (in 1981 dollars) per vehicle. NHTSA stated, ''Such a cost increase cannot be justified by the potential benefits, although those benefits might be significant.'' (46 FR 43721.) The comments also indicated that on-tire warning devices cost only about $5 (in 1981 dollars), but they had not been developed to the point where they were accurate and reliable enough to be required. The comments also suggested that on-tire warning devices were subject to damage by road hazards, such as ice and mud, as well as scuffing at curbs. Despite terminating the rulemaking, the agency stated that it still believed that ''[m]aintaining proper tire inflation pressure results in direct savings to drivers in terms of better gas mileage and longer tire life, as well as offering increased safety.'' (46 FR 43721.)

C. Summary of the Notice of Proposed Rulemaking

On July 26, 2001, the agency published the NPRM proposing to establish a standard for TPMSs pursuant to section 13 of the TREAD Act. (66 FR 38982.) The agency proposed two alternative versions of the standard.

The two alternatives differed in two important respects: in how they defined ''significantly under-inflated,'' and in the number of significantly under-inflated tires that they would be required to be able to detect at any one time. The first alternative (four tires, 20 percent) would have defined ''significantly under-inflated'' as the tire pressure 20 percent or more below the placard pressure, or a minimum level of pressure specified in the standard, whichever was higher. It would have required the low tire pressure warning telltale to illuminate when any tire, or when each tire in any combination of tires, on the vehicle became significantly under-inflated.

The second alternative (three tires, 25 percent) would have defined ''significantly under-inflated'' as the tire pressure 25 percent or more below the placard pressure, or a minimum level of pressure specified in the standard, whichever was higher. The minimum levels of pressure were the same in both proposed alternatives. The alternative would have required the low tire pressure warning telltale to illuminate when any tire, or when each tire in any combination of tires, up to a total of three tires, became significantly under-inflated.

In most other respects, the two alternatives were identical. Both would have required passenger cars, multipurpose passenger vehicles, trucks, and buses with a GVWR of 4,536 kilograms (10,000 pounds) or less, manufactured on or after November 1, 2003, to be equipped with a TPMS and a low tire pressure warning telltale (yellow) to alert the driver. They would have required the telltale to illuminate within 10 minutes of driving after any tire on the vehicle became significantly under-inflated. They would have required the telltale to remain illuminated as long as any of the vehicle's tires remained significantly under-inflated, and the key locking system was in the ''On'' (''Run'') position. They would have required that the telltale be deactivatable, manually or automatically, only when the vehicle no longer had a tire that was significantly under-inflated. They would have required the TPMS in each vehicle to be compatible with all replacement or optional tires/rims of the size recommended for that vehicle by the vehicle manufacturer, i.e., each TPMS would have been required to continue to meet the requirements of the standard when the vehicle's original tires were replaced with tires of any optional or replacement size(s) recommended for the vehicle by the vehicle manufacturer. Finally, they would have required vehicle manufacturers to provide written instructions, in the owner's manual if one is provided, explaining the purpose of the low tire pressure warning telltale, the potential consequences of significantly under-inflated tires, and what actions drivers should take when the low tire pressure warning telltale is illuminated.

NHTSA believed that the only currently available TPMSs that would have been able to meet the requirements of the four-tire, 20 percent alternative were direct TPMSs. There were two reasons for this belief. First, currently available indirect TPMSs typically cannot detect significant under-inflation until the pressure in one of the vehicle's tires is about 30 percent below the pressure in at least some of the other tires. Second, they cannot detect when all four tires lose inflation pressure equally.

The agency believed that both currently available direct TPMSs and improved indirect TPMSs, but not current indirect TPMSs, would have been able to meet the requirements of the three-tire, 25 percent alternative.

In the NPRM, NHTSA anticipated that vehicle manufacturers would minimize their costs of complying with the three-tire, 25 percent alternative by installing improved indirect TPMSs in vehicles already equipped with ABSs and direct TPMSs in vehicles without ABSs. For vehicles already equipped with an ABS, the cost of modifying that system to serve the additional purpose of indirectly monitoring tire pressure would be significantly less than the cost of adding a direct TPMS. For vehicles not so equipped, adding a direct TPMS would be significantly less expensive than adding ABS to monitor tire pressure.

For the NPRM, NHTSA had two sets of data, one from Goodyear and another from NHTSA's Vehicle Research and Test Center (VRTC), on the effect of under-inflated tires on a vehicle's stopping distance. The Goodyear data indicated that a vehicle's stopping distance on wet surfaces is significantly reduced when its tires are properly inflated, as compared to when its tires are significantly under-inflated. The VRTC data indicated little or no effect on a vehicle's stopping distance. For purposes of the NPRM, NHTSA used the Goodyear data to establish an upper bound of benefits and the VRTC data to establish a lower bound. The benefit estimates below are the mid-points between those upper and lower bounds.

NHTSA estimated that the four-tire, 20 percent alternative would have prevented 10,635 injuries and 79 deaths at an average net cost of $23.08 per vehicle.[6] NHTSA estimated that the

[6] 6 The range of injuries prevented was 0 to 21,270, and the range of deaths prevented was 0 to 158. These benefit estimates did not include deaths and injuries prevented due to reductions in crashes caused by blowouts and skidding/loss of control because the agency was unable to quantify those benefits at the time the NPRM was published. For this final rule, the agency was able to quantify those benefits. They are discussed in the Benefits section below. Net costs included $66.33 in vehicle costs minus $32.22 in fuel savings and $11.03 in tread wear savings. These cost estimates did not include maintenance costs. For this final rule, the agency has estimated maintenance costs. They are discussed in the Costs section below.

three-tire, 25 percent alternative would have prevented 6,585 injuries and 49 deaths at an average net cost of $8.63 per vehicle.[7] NHTSA estimated that the net cost per equivalent life saved would have been $1.9 million for the four-tire, 20 percent alternative and $1.1 million for the three-tire, 25 percent alternative.

Finally, the agency requested comments on whether a compliance phase-in with carry-forward credits would be appropriate. The agency suggested a phase-in period of 35 percent of production in the first year (2003), 65 percent in the second year, and 100 percent in the third year.

D. Summary of Public Comments on Notice

The agency received comments from tire, vehicle, and TPMS manufacturers, consumer advocacy groups, and the general public. In general, the tire manufacturers' comments, including the comments of the international tire industry associations European Tyre and Rim Technical Organisation (ETRTO), Japan Automobile Tyre Manufacturers Association (JATMA), and International Tire & Rubber Association (ITRA), echoed the comments of the Rubber Manufacturers Association (RMA). In general, the vehicle manufacturers' comments, including the comments of the Association of International Automobile Manufacturers (AIAM), were similar to the comments of the Alliance of Automobile Manufacturers (Alliance).

The tire manufacturers generally supported the four-tire, 20 percent alternative. The vehicle manufacturers generally supported requirements that would permit both direct and current indirect TPMSs to comply. TPMS manufacturers generally supported the alternative that would allow the type of system they manufacture. The consumer advocacy groups—Consumers Union and Advocates for Highway and Auto Safety (Advocates) supported by Public Citizen, Consumer Federation of America, and Trauma Foundation—generally supported the four-tire, 20 percent alternative. The general public was about evenly divided between those who supported and those who opposed a Federal standard requiring TPMSs.

The major issues discussed by the commenters are summarized below. The comments are addressed in the discussion of the final rule below

1. Vehicles Covered

The agency proposed to require TPMSs on passenger cars, multipurpose passenger vehicles, trucks, and buses with a GVWR of 4,536 kilograms (10,000 pounds) or less. The agency did not propose to require TPMSs on motorcycles, trailers, or low speed vehicles, or on medium (10,001–26,000 pounds GVWR) vehicles, or heavy (greater than 26,000 pounds GVWR) vehicles for reasons explained in the NPRM.

The Alliance recommended that the agency limit the applicability of the standard to these types of vehicles to those having a GVWR of 3,856 kilograms (8,500 pounds or less). The Alliance stated that the majority of vehicles above 8,500 pounds GVWR are used commercially. The Alliance argued that those vehicles are maintained on a regular basis and do not need a TPMS to assist in maintaining proper inflation pressure in the vehicles' tires.

The Alliance also recommended that the agency explicitly exclude incomplete vehicles, i.e., vehicles that are built in more than one stage, from the standard. Normally, the first-stage vehicle manufacturer is responsible for certifying that all vehicle systems that are not directly modified by subsequent-stage manufacturers meet all Federal motor vehicle safety standards. The Alliance stated that in the case of direct TPMSs, the first-stage manufacturer will be unable to guarantee that, even if physically undisturbed, a non-defective TPMS will function as designed after vehicle modifications (such as adding metal hardware to the vehicle or lengthening its wheelbase) are made by subsequent-stage manufacturers.

Advocates recommended that the agency expand the application of the standard to include medium (10,001–26,000 pounds GVWR) and heavy (over 26,000 pounds) trucks and buses. Advocates stated that tire under-inflation is a pervasive problem with these vehicles, especially given the high percentage of these vehicles that are equipped with re-treaded tires.

2. Phase-In Options and Long-Term Requirements

a. Definition of ''Significantly Under-Inflated''

RMA recommended that the agency define ''significantly under-inflated'' as any inflation pressure that is less than the pressure required to carry the actual vehicle load on the tire per tire industry standards (or any pressure required to carry the maximum vehicle load on the tire if the actual load is unknown), or the minimum activation pressure specified in the standard, whichever is higher. RMA argued that some vehicles have a placard pressure that is barely adequate to carry the vehicle's maximum load. If the tire pressure falls 20 or 25 percent below the placard pressure, the tire pressure will be insufficient to carry the load. RMA stated that the definition of ''significantly under-inflated'' should not be tied to placard pressure unless the standard includes a requirement for all vehicles to have a reserve in the placard pressure above a specified minimum (e.g., 20 or 25 percent).

RMA also recommended that the agency change the minimum activation pressures for P-metric standard load tires from 20 to 22 psi and for P-metric extra load tires from 23 to 22 psi. Finally, RMA recommended that the agency change the ''Maximum Pressure'' heading in Table 1 to ''Maximum or Rated Pressure'' because light truck tires are not subject to maximum permissible inflation pressure labeling requirements. RMA recommended that the agency change the rated pressure for Load Range E tires from 87 to 80 psi. Finally, RMA, supported by the Retread/Repair Industry Government Advisory Council (RIGAC),[8] recommended that the agency adopt, in this rulemaking proceeding, an amendment to upgrade Standard No. 109, ''New Pneumatic Tires,'' by requiring that ''a tire for a particular vehicle must have sufficient inflation and load reserve, such that an inflation pressure 20 or 25 percent less than the vehicle manufacturer's recommended inflation pressure is sufficient for the vehicle maximum load on the tire, as defined by FMVSS–110.'' [9]

The ITRA recommended that the agency consider only direct TPMSs. The ITRA stated that indirect TPMSs have too many limitations, including the inability to detect when all four of a vehicle's tires are significantly under-inflated. The ITRA claimed that, although direct TPMSs are more expensive than indirect TPMSs, their cost is minor when compared to their safety, handling, tread wear, and fuel economy benefits.

The Alliance recommended that the agency define ''significantly under-inflated'' as any inflation pressure 20 percent below a tire's load carrying

[7] The range of injuries prevented was 0 to 13,170, and the range of deaths prevented was 0 to 97. Net costs included $30.54 in vehicle costs minus $16.40 in fuel savings and $5.51 in tread wear savings. These estimates did not include maintenance costs. The agency has estimated maintenance costs for this final rule.

[8] RIGAC consists of representatives from the Tire Association of North America (TANA), Tread Rubber Manufacturers Group (TRMG), ITRA, and RMA.

[9] Standard No. 110 specifies requirements for tire selection to prevent tire overloading.

limit, as determined by a tire industry standardizing body (such as the Tire and Rim Association) or the minimum activation pressure specified in the standard, whichever is higher. The Alliance agreed with the agency's minimum activation pressure of 20 psi for P-metric standard load tires. The Alliance cited data from tests performed by RMA indicating that the average tire was able to operate at high speeds (120 and 140 km/h) at load-inflation conditions more extreme than the worst case that the Alliance proposal would allow.

The Alliance also stated that a 25 percent differential from placard pressure would be inadequate to allow the use of indirect TPMSs. The Alliance claimed that a minimum of 30 percent differential is necessary to ensure accuracy with an indirect TPMS and avoid excessive nuisance warnings.

The AIAM recommended that the agency define ''significantly under-inflated'' as any pressure more than 30 percent below the placard pressure. Alternatively, the AIAM suggested that the agency use the load-carrying limit of the tire as defined by a tire industry standardizing body as the baseline for determining the warning threshold.

Several manufacturers indicated that they are either developing or could develop indirect or hybrid TPMSs that perform better than current indirect TPMSs. In its comments on the NPRM, TRW Automotive Electronics (TRW), which manufactures both direct and indirect TPMSs, stated that it could, in concept, combine direct and indirect TPMS technologies to produce a hybrid TPMS that performs better than TRW's current indirect TPMS. TRW stated this could be accomplished by adding the equivalent of two direct pressure-monitoring sensors and a radio frequency receiver to an indirect TPMS. TRW suggested that this hybrid TPMS could comply detect 25 under-inflation for about 60 percent of the cost of a full direct TPMS. However, it did not indicate whether it had any plans to develop a hybrid system.

Sumitomo Rubber Industries, which manufactures indirect TPMSs, indicated that indirect TPMSs will be able to detect a 25 percent differential in inflation pressure.

Toyota, which uses an indirect TPMS on its Sienna van, stated that its next generation of indirect TPMSs (i.e., TPMSs not available for current production) would be able to detect a 20 percent differential in tire pressure by monitoring the resonance frequency as well as the dynamic radius changes of the tires. However, Toyota stated that this performance will be achieved only under ideal conditions, i.e., the vehicle is traveling in a relatively straight line at 30 to 60 km/h for at least 20 minutes. Thus, Toyota recommended that the agency adopt the Alliance proposal of 30 percent under-inflation. Toyota also stated that its next generation of indirect TPMSs would be able to detect significant under-inflation in all four tires. Toyota was not certain when its next generation of indirect TPMSs will be ready for implementation.

Advocates supported the definition of ''significantly under-inflated'' contained in the four-tire, 20 percent alternative, i.e., any pressure 20 percent or more below the placard pressure, or the minimum activation pressure specified in the standard. Advocates also supported the agency's minimum activation pressures.

b. Number of Tires Monitored

Advocates, the ITRA, and RMA recommended that the agency require TPMSs to be able to detect when all four of a vehicle's tires become significantly under-inflated. RMA argued that it is very likely that all four tires will lose air pressure at a similar rate and become significantly under-inflated within a six-month period.[10] RMA stated that drivers would rely heavily on TPMSs for tire pressure maintenance, which will make this scenario even more likely.

The Alliance and AIAM recommended that the agency require only that TPMSs be able to detect significant under-inflation in a single tire. The Alliance argued that TPMSs are not meant to replace the normal tire maintenance that would detect pressure losses due to natural leakage and permeation. Instead, TPMSs are intended to detect a relatively slow leak due to a serviceable condition, such as a nail through the tread or a leaky valve stem. Since such leaks rarely affect more than one tire simultaneously, the Alliance argued, it is sufficient to require only that TPMSs be able to detect a single significantly under-inflated tire. In further support of this position, the Alliance argued that tires do not lose pressure at the same rate.

As noted above, TRW commented that a hybrid TPMS could be developed that would be capable of monitoring all four of a vehicle's tires. According to TRW, a hybrid system would involve installing two direct pressure sensors, one in a front wheel and one in a back wheel located diagonally from each other (*e.g.,* the front left and back right wheels), on a vehicle already equipped with an indirect TPMS. The pressure sensors would directly monitor the pressure in those two tires, while the indirect TPMS would use the wheel speed sensors to indirectly monitor the pressure in the other two tires. This would solve the problem indirect TPMSs have in detecting when two tires on the same axle or the same side of the vehicle become significantly under-inflated because a direct pressure sensor will be in a wheel on each axle and on each side of the vehicle. It would also solve the problem indirect TPMSs have in detecting when all four tires become significantly under-inflated.

Advocates and RMA also recommended that the agency require TPMSs to monitor a vehicle's spare tire. RMA argued that the spare tire should be monitored to ensure its functionality, if and when it is needed. Advocates stated, ''Vehicle owners chronically neglect to maintain minimal air pressure in spare tires.''

The Alliance recommended that the agency require only that TPMSs monitor full-size, matching spare tires, and only when they are installed on the vehicle (i.e., not when they are stowed). The Alliance stated that temporary-use spare tires, including full-size, non-matching and compact spare tires, are not intended to be part of the normal tire rotation cycle for the vehicle. Because these temporary-use spare tires degrade the aesthetic appearance of a vehicle or have speed and distance limitations, vehicle owners normally replace them quickly. Thus, the Alliance recommended that the agency not require TPMSs to monitor temporary-use tires, whether stowed or installed on the vehicle.

RMA supported the agency's proposed requirement that TPMSs function properly with all replacement tires and rims of the size(s) recommended by the vehicle manufacturer. Advocates recommended that the agency require TPMSs to function properly with all replacement tires and rims, regardless of size.

The Alliance recommended that the agency require only that TPMSs function properly with those tires and rims offered as original or optional equipment by the vehicle manufacturer. The Alliance stated that there are a large number of replacement brands and types of tires and rims with different dynamic rolling radii, size variations, load variations, and temperature characteristics. The Alliance argued that since vehicle manufacturers do not control tire compliance for aftermarket tires and rims, they could not guarantee that the TPMS will work, or will work with the same level of precision, in all cases.

[10] RMA stated that normal air pressure loss is approximately 1 to 2 psi per month.

3. Lead Time

The Alliance and most vehicle manufacturers recommended the following four-year phase-in schedule: 15 percent of a manufacturer's affected products equipped with a semi- or fully-compliant TPMS in the first year; 35 percent in the second year; 70 percent in the third year; and 100 percent of a manufacturer's affected products equipped with a fully compliant TPMS in the final year. According to the Alliance, a semi-compliant TPMS is one that meets all but specified interface requirements, i.e., those concerning the display of information about under-inflation, and would be allowed only during the phase-in period. The Alliance and AIAM also recommended that the agency provide credits for early introduction of TPMSs to encourage early implementation of the standard.

TRW supported the agency's four-year phase-in period. TRW stated that direct TPMSs are ready so that manufacturers could start production to meet such a phase-in. However, TRW stated that the improvements in indirect TPMSs that will be necessary to meet the requirements of this final rule would make it difficult to meet the compliance date of November 1, 2003.

Ford Motor Company (Ford) commented that its recent experience with direct TPMSs demonstrates that this technology still needs a thorough prove-out. Ford stated that when it tested 138 direct pressure sensors on 30 vehicles, nine sensors experienced a malfunction. This translates to a sensor failure rate of 6.5 percent. However, Ford stated that if the final rule required five sensors per vehicle (all four tires plus the spare tire), nearly 33 percent of vehicles could experience the failure of at least one sensor. Ford recommended that the agency adopt the phase-in schedule set forth by the Alliance.

Vehicle Services Consulting, Inc. (VSC), which submitted comments on behalf of small volume vehicle manufacturers (i.e., those manufacturers who produce fewer than 5,000 vehicles worldwide each year), recommended that the agency provide phase-in discretion so that small volume manufacturers have until the end of the phase-in period before having to comply with the TPMS requirements. VSC claimed that small volume manufacturers could not obtain the TPMS technology at the same time as large volume manufacturers.

4. Reliability

In the NPRM, the agency noted that the components of direct TPMSs, especially when tires are taken off the rim, might be susceptible to damage. The agency requested comments on the likelihood of such damage. TRW stated:

> Direct TPMSs are relatively new systems and, therefore, the likelihood of damage during driving or maintenance is unknown. However, direct TPMS sensors are designed to minimize the likelihood of damage during driving or maintenance operations. Most sensors are valve-mounted and rest in the drop center well of the rim, and are contoured to minimize the likelihood of damage during tire servicing. They can be packaged in a high impact plastic material, which can withstand high G forces and mechanical vibration/shock levels associated with the tire/wheel system. The likelihood of damage during operation is also minimized by the selected mounting location and the protection offered by the rim during flat conditions. These factors, combined with training for service center technicians, should reduce the overall likelihood of damage.

Beru Corporation, which manufacturers direct TPMSs, stated that it had sold over 800,000 direct TPMS wheel electronics and had received no reports of damage during operation or failures due to mounting error.

The European Community (EC) supported a rulemaking requiring TPMSs. The EC Stated, ''The European Community is convinced (as is the NHTSA) of the appropriateness of a regulation in this field, and of its justification for the safety of road users.'' The EC stressed ''the paramount importance of reliability and accuracy of the technology.'' The EC stated that ''a temperature correction device might be a necessary feature in order to guarantee the reliability and accuracy of the device.''

5. Costs and Benefits Estimates

The Alliance stated that the benefits NHTSA estimated resulting from a reduction in stopping distance were based on three principal conclusions: (1) Properly inflated tires result in shorter stopping distances than under-inflated tires; (2) these shorter stopping distances have equal safety benefits in all types of crashes and under all environmental conditions; and (3) the benefits of shorter stopping distances associated with properly-inflated tires will be greater for direct TPMSs than for indirect TPMSs. The Alliance argued that each of these conclusions is highly questionable and not supported by the information in the rulemaking record.

The Alliance noted that in estimating the safety benefits resulting from stopping distance reductions, the agency relied on Goodyear data. The Alliance argued that these data ''are neither conclusive with respect to the effect of under-inflation on stopping distance, nor reproducible according to the agency's own study demonstrating that there is no significant effect of tire under-inflation on stopping distance.'' The Alliance also argued that even if the Goodyear data were valid, NHTSA's benefits estimates must be adjusted to claim benefits only for vehicles experiencing the same conditions as those in the Goodyear tests, i.e., all four of the vehicle's tires are at 17 psi or below and on wet pavement.[11] The Alliance questioned NHTSA's assumption that 80 percent of drivers would respond appropriately to a direct TPMS, but that only 60 percent of drivers would respond appropriately to an indirect TPMS. The Alliance argued that there was no evidence in the record supporting this assumption.

Finally, the Alliance agreed that TPMSs should produce some of the unquantified benefits listed in the NPRM. However, the Alliance stated that there was no evidence that these benefits would be greater for direct TPMSs than for indirect TPMSs.

The ITRA stated that when developing training programs, it looks closely at tire performance and has the opportunity to analyze a significant number of tires that failed in service. They find that the single most common cause of tire failure is under-inflation. Thus, the ITRA claimed that the agency's benefits estimates may be under-stated.

TRW stated that current indirect TPMSs would have to be upgraded to meet the requirements of the three-tire, 25 percent alternative. TRW estimated that these upgrades would increase the cost of indirect TPMSs to 60 percent of the cost of a direct TPMS.[12]

IQ-mobil Electronics, a TPMS manufacturer in Germany, commented that it has developed ''a batteryless transponder chip'' that ''costs half as much as the battery transmitter it replaces,'' thus reducing ''high replacement costs for the tire transmitter, and an annual environmental burden of millions of batteries.''

E. Submission of Draft Final Rule to OMB

Since this final rule is considered ''significant'' under Executive Order 12866, Regulatory Planning and Review, it was subject to review by the Office of Management and Budget (OMB) under that Order. The agency submitted a draft

[11] Goodyear conducted its tests on pavement with 0.05 inch water on the surface and found significant effects on stopping distance only when the pressure in the vehicle's tires was lowered to 17 psi.

[12] This estimate would apply only to vehicles that were already equipped with ABS.

final rule to OMB on December 18, 2001.

The draft final rule specified short and long-term performance requirements.[13] For the short term, it specified a phase-in of the TPMS requirements beginning November 1, 2003. During the phase-in, the draft final rule permitted vehicles to comply with either a four-tire, 25 percent option, which essentially would have required manufacturers to install direct TPMSs or improved indirect TPMSs, or a one-tire, 30 percent option, which would have permitted manufacturers to install either direct TPMSs or any type of indirect TPMSs, including current indirect TPMSs. For the long-term, the period beginning November 1, 2006, the requirements of the four-tire, 25 percent option would have become mandatory for all vehicles subject to the TPMS standard.

As explained further below in section V.A. ''Alternative Long-Term Requirements Analyzed in Making Preliminary Determination,'' NHTSA analyzed three alternatives for the long term requirement in developing the draft final rule: a four-tire, 20 percent alternative, a three-tire, 25 percent alternative, and a four-tire, 25 percent alternative.

F. OMB Return Letter

After reviewing the draft final rule, OMB returned it to NHTSA for reconsideration, with a letter explaining its reasons for doing so, on February 12, 2002.[14]

In the letter, OMB stated its belief that the draft final rule and accompanying regulatory impact analysis did not adequately demonstrate that the agency had selected the best available method of improving overall vehicle safety. OMB said further that: NHTSA should base its decision about the final rule on overall vehicle safety, instead of just tire safety; while direct TPMSs can detect under-inflation under a greater variety of circumstances than indirect TPMSs, the indirect system captures a substantial portion of the benefit provided by direct systems; NHTSA should consider a fourth alternative for the long-term requirement, a one-tire, 30 percent compliance option, indefinitely, since it would allow vehicle manufacturers to install current indirect TPMSs; NHTSA, in analyzing long-term alternatives, should consider both their impact on the availability of ABS as well as the potential safety benefits of ABS; and that NHTSA should provide a better explanation of the technical foundation for the agency's safety benefits estimates and subject those estimates to sensitivity analyses.

G. Public Comments on OMB's Return Letter

Consumers Union (CU) and Public Citizen (PC) submitted comments on the OMB return letter.[15]

CU stated that direct TPMSs offer significant safety advantages over indirect TPMSs. CU recently performed tire air leakage testing and found that all four tires on a vehicle will likely lose pressure at a similar rate.[16] CU said that direct TPMSs could detect such pressure losses, while indirect TPMSs could not.

CU questioned OMB's returning the TPMS final rule and asking NHTSA to consider the potential benefits of ABS in making a final decision on TPMS requirements. CU stated:

> We cannot understand the logic of delaying an important safety measure like direct tire pressure monitoring systems while NHTSA studies issues related to a less effective alternative because that alternative might encourage automakers to make ABS more widely available.

Finally, CU stated that, while Congress mandated that NHTSA issue a regulation for TPMSs, Congress did not mandate that the agency issue a regulation requiring ABS to be installed in all vehicles.

PC also supported the four-tire, 20 percent alternative. PC argued that indirect TPMSs have shortcomings, including:

- They can detect under-inflation only if one tire is more than 25 percent less inflated than the other tires.
- They cannot detect when all four tires are equally under-inflated, a likely scenario if the tires are purchased or checked at the same time.
- They also cannot detect when two tires on the same side of the vehicle or the same axle are under-inflated, but can detect when diagonal tires are under-inflated.

PC also objected to OMB's returning the TPMS final rule and asking NHTSA to consider the potential benefits of ABS in making a final decision on TPMS requirements. PC questioned OMB's return letter, arguing that it employs

> unproven assumptions about the cost and market effects of combining indirect systems with a requirement for anti-lock brakes (ABS) (a long-controversial area outside the focus of the agency's current rulemaking mandate), which, in turn, has only statistically insignificant and highly disputed safety effects.

PC also questioned the potential benefits of ABS cited by OMB. In response to OMB's reliance on a study by Charles Farmer, the PC asserted that Mr. Farmer

> found that ABS *had no statistically significant effect on crash fatalities.* [Emphasis original.] Farmer was unable to determine whether ABS ultimately saved or cost lives across the vehicle fleet, making the ''between 4 and 9 percent reduction'' in crash fatalities [cited in the OMB letter] a statistical blip that may actually be zero percent.

H. Congressional Hearing

On February 28, 2002, the House Committee on Energy and Commerce held an oversight hearing on the implementation of the TREAD Act. During the hearing, several Congressmen discussed their expectations for the TPMS rulemaking. Expressing concern about the cumulative damage done to a tire that is run while under-inflated, Congressman Tom Sawyer asked whether a warning threshold of 25 percent below placard pressure was low enough. Given the potential for catastrophic failure of tires run too long while under-inflated, the Congressman stated that it was important that the TPMS not encourage drivers to drive on under-inflated tires.

Congressman Markey, the sponsor of the amendment that added the TPMS mandate to the TREAD Act, indicated that the reliance of drivers on the TPMS warning light could lead to safety problems if the TPMS does not provide sufficient warnings. He acknowledged that, during the consideration of the TPMS amendment, he had mentioned a TPMS that was then in use (an ABS-based TPMS on the Toyota Sienna). He said that while any TPMS was acceptable during the initial implementation period for the TPMS requirements, the real intent of the amendment is to provide a warning in all instances.

III. Safety Problem

Many vehicles have significantly under-inflated tires, primarily because drivers infrequently check their

[13] The rationales for the provisions of that draft final rule are discussed below in section VI.A., ''Summary of Preliminary Determination about the Final Rule.''

[14] A copy of the return letter has been placed in the docket (Docket No. NHTSA–2000–8572–202). The letter also is available electronically at www.whitehouse.gov/omb/inforeg/dot_revised_tire_rtnltr.pdf.

[15] Both letters have been placed in the docket. The CU letter is Docket No. NHTSA–2000–8572–204, and the PC letter is Docket No. NHTSA–2000–8572–199.

[16] CU tested three samples of 36 tire models over a six-month period. CU mounted the tires on new rims and inflated the tires to 30 psi. Then CU stored the tires indoors at room temperature for six months and checked their inflation pressure each month. After six months, the average pressure loss was about 4.4 psi. A copy of CU's test procedures and the test results has been placed in the docket. (Docket No. NHTSA–2000–8572–203.)

vehicles' tire pressure. Other contributing factors are the difficulty of visually detecting when a tire is significantly under-inflated and the loss of tire pressure due to natural leakage and seasonal climatic changes.

A. Infrequent Driver Monitoring of Tire Pressure

Surveys have shown that most drivers check the inflation pressure in their vehicles' tires infrequently. For example, in September 2000, the Bureau of Transportation Statistics (BTS) conducted an omnibus survey for NHTSA. One of the questions posed was: ''How often do you, or the person who checks your tires, check the air pressure in your tires?'' The answers indicated that 29 percent of the respondents stated that they check the air pressure in their tires monthly; another 29 percent stated that they check the air pressure only when one or more of their vehicle's tires appears under-inflated; 19 percent stated that they only have the air pressure checked when the vehicle is serviced; 5 percent stated that they only check the air pressure before taking their vehicle on a long trip; and 17 percent stated that they check the air pressure on some other occasion. Thus, 71 percent of the respondents stated that they check the air pressure in the vehicles' tires less than once a month.[17]

In addition, NHTSA's National Center for Statistics and Analysis (NCSA) conducted a survey in February 2001. The survey was designed to assess the extent to which passenger vehicle drivers are aware of the recommended air pressure for their vehicles' tires, if drivers monitor air pressure, and to what extent actual tire pressure differs from placard pressure.

Data was collected through the infrastructure of the National Accident Sampling System—Crashworthiness Data System (NASS–CDS). The NASS–CDS consists of 24 Primary Sampling Units (PSUs) located across the country. Within each PSU, a random selection of zip codes was obtained from a list of eligible zip codes. Within each zip code, a random selection of two gas stations was obtained.

A total of 11,530 vehicles were inspected at these gas stations. This total comprised 6,442 passenger cars, 1,874 sports utility vehicles (SUVs), 1,376 vans, and 1,838 pick-up trucks. For analytical purposes, the data were divided into three categories: (1) Passenger cars; (2) pick-up trucks, SUVs, and vans with P-metric tires; and (3) pick-up trucks, SUVs, and vans with either light truck (LT) or flotation tires.

Drivers were asked how often they normally check their tires to determine if they are properly inflated. Their answers are in the following table:

How often is tire pressure checked?	Drivers of passenger cars (%)	Drivers of pick-up trucks, SUVs, and vans (%)	
		P-metric tires	LT or flotation tires
Weekly	8.76	8.69	8.16
Monthly	21.42	25.19	39.88
When they seem low	25.63	23.58	15.59
When serviced	30.18	27.72	25.54
For long trip	0.99	2.39	2.17
Other	6.46	8.27	6.97
Do not check	6.56	4.16	1.69

These data indicate that only about 30 percent of drivers of passenger cars, 34 percent of drivers of pick-up trucks, SUVs, and vans with P-metric tires, and 48 percent of drivers of pick-up trucks, SUVs, and vans with either LT or flotation tires claim that they check the air pressure in their vehicles' tires at least once a month.

B. Loss of Tire Pressure Due to Natural and Other Causes

According to data from the tire industry, 85 percent of all tire air pressure losses are the result of slow leaks that occur over a period of hours, days, or months. Only 15 percent are rapid air losses caused by contact with a road hazard, e.g., when a large nail that does not end up stuck in the tire punctures a tire.

Slow leaks may be caused by many factors. Tire manufacturers commented that tires typically lose air pressure through natural leakage and permeation at a rate of about 1 psi per month. Testing by CU supports those comments. In addition, tire manufacturers said that seasonal climatic changes result in air pressure losses on the order of 1 psi for every 10 degree F decrease in the ambient temperature. Slow leaks also may be caused by slight damage to a tire, such as a road hazard that punctures a small hole in the tire or a nail that sticks in the tire. NHTSA has no data indicating how often any of these causes results in a slow leak.

C. Percentage of Motor Vehicles With Under-Inflated Tires

During the February 2001 survey, NASS–CDS crash investigators measured tire pressure on each vehicle coming into the gas station and compared the measured pressures to the vehicle's placard pressure. They found that about 36 percent of passenger cars and about 40 percent of light trucks had at least one tire that was at least 20 percent below the placard pressure.[18] About 26 percent of passenger cars and 29 percent of light trucks had at least one tire that was at least 25 percent below the placard pressure. The agency notes those levels of under-inflation because they are the threshold levels for the low-tire pressure warning telltale illumination under the two alternatives the agency proposed in the NPRM for TPMSs. (66 FR 38982, July 26, 2001).

D. Consequences of Under-Inflation of Tires

1. Reduced Vehicle Safety—Tire Failures and Increases in Stopping Distance

When a tire is used while significantly under-inflated, its sidewalls flex more and the air temperature inside the tire increases, increasing stress and the risk of failure. In addition, a significantly under-inflated tire loses lateral traction,

[17] The agency notes that it seems likely that the respondents in both of the surveys cited overstated the frequency with which they check tire pressure, particularly given the fact that these surveys were conducted during the height of publicity about tire failures on sport utility vehicles in the late 2000 and early 2001.

[18] For purposes of this discussion, the agency classified pick-up trucks, SUVs, and vans with either P-metric, LT, or flotation tires as light trucks.

making handling more difficult. Under-inflation also plays a role in crashes due to flat tires and blowouts. Finally, significantly under-inflated tires can increase a vehicle's stopping distance.

NHTSA's current crash files do not contain any direct evidence that points to low tire pressure as the cause of any particular crash.[19] However, this lack of data does not imply that low tire pressure does not cause or contribute to any crashes. The agency believes that it simply reflects the fact that measurements of tire pressure are not among the vehicle information included in the crash reports received by the agency and placed in its crash data bases.[20]

The only tire-related data element in the agency's crash databases is ''flat tire or blowout.'' However, even in crashes for which a flat tire or blowout is reported, crash investigators cannot tell whether low tire pressure contributed to the tire failure.

The agency examined its crash files to gather information on tire-related problems that resulted in crashes. The NASS–CDS has trained investigators who collect data on a sample of tow-away crashes around the United States. These data can be weighted to generate national estimates.

The NASS–CDS General Vehicle Form contains a value indicating vehicle loss of control due to a blowout or flat tire. This value is used only when a vehicle's tire went flat, causing a loss of control of the vehicle and a crash. The value is not used for cases in which one or more of a vehicle's tires were under-inflated, preventing the vehicle from performing as well as it could have in an emergency situation.

NHTSA examined NASS–CDS data for 1995 through 1998 and estimated that 23,464 tow-away crashes, or 0.5 percent of all crashes, are caused by blowouts or flat tires each year. The agency placed the tow-away crashes from the NASS–CDS files into two categories: passenger car crashes and light truck crashes. Passenger cars were involved in 10,170 of the tow-away crashes caused by blowouts or flat tires, and light trucks were involved in the other 13,294.

NHTSA also examined data from the Fatality Analysis Reporting System (FARS) for evidence of tire problems in fatal crashes. In FARS, if tire problems are noted after the crash, the simple fact of their existence is all that is noted. No attempt is made to ascribe a role in the crash to those problems. Thus, the agency does not know whether the noted tire problem caused the crash, influenced the severity of the crash, or simply occurred during the crash. For example, a tire may have blown out and caused the crash, or it may have blown out during the crash when the vehicle struck some object, such as a curb.

Thus, while an indication of a tire problem in the FARS file gives some clue as to the potential magnitude of tire problems in fatal crashes, the FARS data cannot give a precise measure of the causal role played by those problems. The very existence of tire problems is sometimes difficult to detect and code accurately. Further, coding practices vary from State to State. Nevertheless, the agency notes that, from 1995 to 1998, 1.1 percent of all light vehicles involved in fatal crashes were coded as having tire problems. Over 535 fatal crashes involved vehicles coded with tire problems.

Under-inflated tires can contribute to types of crashes other than those resulting from blowouts or tire failure, including crashes which result from: skidding and/or a loss of control of the vehicle in a curve or in a lane change maneuver; an increase in a vehicle's stopping distance; or hydroplaning on a wet surface.

The 1977 Indiana Tri-level study associated low tire pressure with loss of control on both wet and dry pavements. The study never defined low tire pressure as a ''definite'' (i.e., 95 percent certainty that the crash would not have occurred absent this condition) cause of any crash, but did identify it as a ''probable'' (80 percent certainty that the crash would not have occurred absent this condition) cause of the crash in 1.4 percent of the 420 in-depth crash investigations.

The study divided ''probable'' cause into two levels: a ''causal'' factor and a ''severity-increasing'' factor. A ''causal'' factor was defined as a factor whose absence would have prevented the accident from occurring. A ''severity-increasing'' factor was defined as a factor whose presence was not sufficient, by itself, to result in the occurrence of the accident, but which resulted in an increase in speed of the initial impact. The study determined that under-inflated tires were a causal factor in 1.2 percent of the probable cause cases and a severity-increasing factor in 0.2 percent of the probable cause cases.

Note that more than one probable cause could be assigned to a crash. In fact, there were a total of 138.8 percent causes listed as probable causes (92.4 percent human factors, 33.8 percent environmental factors, and 12.6 percent vehicle factors). Thus, tire under-inflation's part of the total is one percent (1.4/138.8). The agency focused solely on the probable cause cases, which represent 0.86 percent of crashes (1.2/1.4 * 1.0).

Tires are designed to maximize their performance capabilities at a specific inflation pressure. When a tire is under-inflated, the shape of its footprint and the pressure it exerts on the road surface are both altered, especially on wet surfaces. An under-inflated tire has a larger footprint than a properly inflated tire. Although the larger footprint results in an increase in rolling resistance on dry road surfaces due to increased friction between the tire and the road surface, it also reduces the tire load per unit area. On dry road surfaces, the countervailing effects of a larger footprint and reduced load per unit of area nearly offset each other, with the result that the vehicle's stopping distance performance is only mildly affected by under-inflation.

On wet surfaces, however, under-inflation typically increases stopping distance for several reasons. First, as noted above, the larger tire footprint provides less tire load per area than a smaller footprint. Second, since the limits of adhesion are lower and achieved earlier on a wet surface than on a dry surface, a tire with a larger footprint, given the same load, is likely to slide earlier than the same tire with a smaller footprint because of the lower load per footprint area. The rolling resistance of an under-inflated tire on a wet surface is greater than the rolling resistance of the same tire properly-inflated on the same wet surface. This is because the slightly larger tire footprint on the under-inflated tire results in more rubber on the road and hence more friction to overcome. However, the rolling resistance of an under-inflated tire on a wet surface is less than the rolling resistance of the same under-inflated tire on a dry surface because of the reduced friction caused by the thin film of water between the tire and the road surface. The less tire load per area and lower limits of adhesion of an under-inflated tire on a wet surface are enough to overcome the increased friction caused by the larger footprint of the under-inflated tire. Hence, under-inflated tires cause longer stopping distance on wet surfaces than properly-inflated tires.

[19] In response to the TREAD Act, NHTSA has added new tire related variables and attributes, including tire make, model, recommended tire pressure, actual tire pressure, and tread depth to its crash databases. These new variables will provide more specific tire data for vehicles involved in crashes.

[20] These crash databases are the NASS–CDS and the Fatality Analysis Reporting System (FARS).

The agency has received data from Goodyear indicating that significantly under-inflated tires increase a vehicle's stopping distance.[21] The effects of tire under-inflation on vehicle stopping distance are discussed in greater detail in the agency's Final Economic Analysis (FEA).

As explained in the FEA, the agency did not use the VRTC data or the Goodyear data that the agency used to estimate benefits in the NPRM because of concerns with the way in which the both tests were performed.[22] The agency believes that the more recent Goodyear test methodology adequately addressed these concerns.[23]

2. Reduced Tread Life

Unpublished data submitted to the agency by Goodyear indicate that when a tire is under-inflated, more pressure is placed on the shoulders of the tire, causing the tread to wear incorrectly.[24] The Goodyear data also indicate that the tread on an under-inflated tire wears more rapidly than it would if the tire were inflated to the proper pressure.

The Goodyear data indicate that the average tread life of a tire is 45,000 miles, and the average cost of a tire is $61 (in 2000 dollars). Goodyear also estimated that a tire's average tread life would drop to 68 percent of the expected tread life if tire pressure dropped from 35 psi to 17 psi and remained there. Goodyear assumed that this relationship was linear. Thus, for every 1-psi drop in tire pressure, tread life would decrease by 1.78 percent (32 percent/18 psi). This loss of tread life would take place over the lifetime of the tire. Thus, according to Goodyear's data, if the tire remained under-inflated by 1 psi over its lifetime, its tread life would decrease by about 800 miles (1.78 percent of 45,000 miles).

As noted above, data from the NCSA tire pressure survey indicate that 26 percent of passenger cars had at least one tire that was under-inflated by at least 25 percent. The average level of under-inflation of the four tires on passenger cars with at least one tire under-inflated by at least 25 percent was 6.8 psi. Thus, on average, these passenger cars could lose about 5,440 miles (6.8 psi under-inflation x 800 miles) of tread life due to under-inflation, if their tires were under-inflated to that extent throughout the life of the tires.

Also as noted above, data from the NCSA tire pressure survey indicate that about 29 percent of light trucks had at least one tire that was under-inflated by at least 25 percent. The average level of under-inflation of the four tires on light trucks with at least one tire under-inflated by at least 25 percent was 8.7 psi. Thus, on average, these light trucks could lose about 6,960 miles (8.7 psi under-inflation x 800 miles) of tread life due to under-inflation, if their tires were under-inflated to that extent throughout the life of the tires.

3. Reduced Fuel Economy

Under-inflation increases the rolling resistance of a vehicle's tires and, correspondingly, decreases the vehicle's fuel economy. According to a 1978 report, fuel efficiency is reduced by one percent for every 3.3 psi of under-inflation.[25] More recent data provided by Goodyear indicate that fuel efficiency is reduced by one percent for every 2.96 psi of under-inflation.[26]

NHTSA notes that there is an apparent conflict between these data, which indicate that under-inflation increases rolling resistance and thus decreases fuel economy and the previously mentioned Goodyear data that indicates under-inflated tires increase a vehicle's stopping distance. While an under-inflated tire typically has a larger tread surface area (*i.e.,* tire footprint) in contact with the road, which might be thought to improve its traction during braking, the larger tire footprint also reduces the tire load per unit area. The larger footprint does result in an increase in rolling resistance on dry road surfaces due to increased friction between the tire and the road surface. On dry road surfaces, though, the countervailing effects of a larger footprint and reduced load per unit of area nearly offset each other, with the result that the vehicle's stopping distance performance is only mildly affected by under-inflation on those surfaces. However, as explained above in section III.D.1., ''Reduced Vehicle Safety—Tire Failures and Increases in Stopping Distance,'' on wet surfaces other attributes of under-inflation lead to increased stopping distances.

IV. Tire Pressure Monitoring Systems

There are currently two types of TPMSs: direct and indirect. Other types, including hybrid TPMSs that combine aspects of both direct and indirect systems, may be developed in the future. Direct TPMSs directly measure the pressure in a vehicle's tires, while indirect TPMSs estimate differences in pressure by comparing the rotational speed of the wheels. To varying degrees, both types can inform the driver when the pressure in one or more tires falls below a pre-determined level. Unless the TPMS is connected to an automatic inflation system, the driver must stop the vehicle and inflate the under-inflated tire(s), preferably to the pressure recommended by the vehicle manufacturer. Currently, TPMSs are available as original equipment on a few vehicle models. They are available also as after-market equipment, but few are sold. At this time, NHTSA does not have any information indicating that a hybrid TPMS is being planned for production. However, the agency received comments from TRW, a TPMS manufacturer, stating its belief that such a system could be produced.

The VRTC evaluated six direct and four indirect TPMSs that are currently available.[27] The VRTC found that the direct TPMSs were accurate to within an average of ±1.0 psi.[28] This leads the agency to believe that those current TPMSs are more accurate than the systems that were available at the time of the agency s 1981 rulemaking on TPMSs.

Following is a description of the two currently available types of TPMSs and their capabilities.

[21] Goodyear submitted these data to the docket in a letter dated September 14, 2001. See Docket No. NHTSA–2000–8572–160. OMB criticized NHTSA's application of these data to certain vehicle types in estimating safety benefits for this rulemaking. The agency responds to that criticism below in section VI.F., ''Technical Foundation for NHTSA's Safety Benefit Analyses.'' The Alliance also questioned NHTSA's use of the Goodyear data. The agency explains its use of the Goodyear data below in footnotes 22 and 23, and in the agency's Final Economic Analysis (FEA).

[22] For example, the VRTC only tested new tires, not worn tires that are more typical of the tires on most vehicles. In addition, the NHTSA track surface is considered to be aggressive in that it allows for maximum friction with tire surfaces. It is more representative of a new road surface than the worn surfaces experienced by the vast majority of road traffic. The previous Goodyear tests on wet surfaces were conducted on surfaces with .05 inch of standing water. This is more than would typically be encountered under normal wet road driving conditions. The agency expressed concerns with the adequacy of both sets of test data in a memo to the docket. (Docket No. NHTSA–2000–8572–81.)

[23] For example, in its more recent tests Goodyear tested tires with two tread depths: full tread, which is representative of new tires, and half tread, which is representative of worn tires. Goodyear also conducted wet surface tests on surfaces with .02 inch of standing water, which is more representative of typical wet road driving conditions.

[24] Docket No. NHTSA–2000–8572–26.

[25] The Aerospace Corporation, Evaluation of Techniques for Reducing In-use Automotive Fuel Consumption, June 1978.

[26] Docket No. NHTSA–2000–8572–26.

[27] An Evaluation of Existing Tire Pressure Monitoring Systems, May 2001. A copy of this report is available in the docket. (Docket No. NHTSA–2000–8572–29.)

[28] This is not to say that the systems were able to detect a 1.0 psi drop in pressure. The systems were accurate within ±1.0 psi once tire pressure had fallen by a certain percentage.

A. Indirect TPMSs

Current indirect TPMSs work with a vehicle's ABS. The ABS employs wheel speed sensors to measure the rotational speed of each of the four wheels. As a tire's pressure decreases, the rolling radius decreases, and the rotational speed of that wheel increases correspondingly. Most current indirect TPMSs compare the sums of the wheel speeds on each diagonal (i.e., the sum of the speeds of the right front and left rear wheels as compared to the sum of the speeds of the left front and right rear wheels). Dividing the difference of the sums by the average of the four wheels speeds allows the indirect TPMS to have a ratio that is independent of vehicle speed. This ratio is best expressed by the following equation: [(RF + LR) − (LF + RR)/Average Speed]. If this ratio deviates from a set tolerance, one or more tires must be over- or under-inflated. A telltale then indicates to the driver that a tire is under-inflated. However, the telltale cannot identify which tire is under-inflated. Current vehicles that have indirect TPMSs include the Toyota Sienna, Ford Windstar, and Oldsmobile Alero.

Current indirect TPMSs must compare the average of the speeds of the diagonal wheels for several reasons. First, current indirect TPMSs cannot compare the speed of one wheel to the speeds of the other three wheels individually or to the average speed of the four wheels. During any degree of turning, the outside tires must rotate faster than the inside tires. Thus, all four wheel speeds deviate significantly when the vehicle is in a curve or turn. If a current indirect TPMS compared each individual wheel speed to the average of all four wheels speeds, the system would provide a false alarm each time the vehicle rounded a curve or made a turn. The same would be true if the indirect TPMS compared each individual wheel speed to the speed of the other three wheels individually. Since the outside wheels would rotate much faster than the inside wheels in a curve or turn, each outside tire would appear to be under-inflated when compared to an inside tire.

Current indirect TPMSs also cannot compare the speeds of the front wheels to the speeds of the rear wheels because in curves, the front and rear wheels (on both sides of the vehicle) rotate at different speeds. This is primarily due to the fact that the front axle is steerable and follows a different trajectory than the rear axle. As a result, current indirect TPMS must compare a tire from each side and a tire from the front and rear axles to factor out the speed difference caused by curves and turns. Thus, current indirect TPMSs must compare the average speed of the diagonal wheels.

The VRTC tested four current ABS-based indirect TPMSs. None met all the requirements of either alternative proposed in the NPRM. All but one did not illuminate the low tire pressure warning telltale when the pressure in the vehicle's tires decreased to 20 or 25 percent below the placard pressure.[29] The VRTC determined that since reductions in tire diameter with reductions in pressure are very slight in the 15–40 psi range, most current indirect TPMSs require a 20 to 30 percent drop in pressure before they are able to detect under-inflation. The VRTC also concluded that those thresholds were highly dependent on tire and loading factors.

The VRTC also found that none of the tested indirect TPMSs were able to detect significant under-inflation when all four of the vehicle's tires were equally under-inflated, or when two tires on the same axle or two tires on the same side of the vehicle were equally under-inflated. However, the VRTC did find that indirect TPMSs could detect when two tires located diagonally from each other (e.g., the front left and back right tires) became significantly under-inflated.

B. Direct TPMSs

Direct TPMSs use pressure sensors, located in each wheel, to directly measure the pressure in each tire. These sensors broadcast pressure data via a wireless radio frequency transmitter to a central receiver. The data are then analyzed and the results sent to a display mounted inside the vehicle. The type of display varies from a simple telltale, which is how most vehicles are currently equipped, to a display showing the pressure in each tire, sometimes including the spare tire. Thus, direct TPMSs can be linked to a display that tells the driver which tire is under-inflated. An example of a vehicle equipped with a direct system is the Chevrolet Corvette.

Since direct TPMSs actually measure the pressure in each tire, they are able to detect when any tire or when each tire in any combination of tires is under-inflated, including when all four of the vehicle's tires are equally under-inflated. Direct TPMSs also can detect small pressure losses. Some systems can detect a drop in pressure as small as 1 psi.

[29] The Continental Teves indirect TPMS on the BMW M3 activated the warning telltale at pressures between 9 and 21 percent below the placard pressure.

C. Hybrid TPMSs

In their comments on the NPRM, TRW, a manufacturer of both direct and indirect TPMSs, stated that in order to meet the proposed requirements of the 3-tire, 25 percent alternative, current indirect TPMSs would need the equivalent of the addition of two tire pressure sensors and a radio frequency receiver. The tire pressure sensors would be installed on wheels located diagonally from each other.

For the following reasons, the agency believes that such a ''hybrid'' TPMS would be able to overcome the limitations of current indirect TPMSs, i.e., the inability to detect when all four tires, or two tires on the same axle or same side of the vehicle are under-inflated. First, a hybrid TPMS would be able to detect when two tires on the same axle or the same side of the vehicle were under-inflated because one of those tires necessarily would contain a direct pressure sensor. Second, a hybrid TPMS would be able to detect when the two tires without a direct pressure sensor were under-inflated because they would be located diagonally from each other, and, as the VRTC found in its review of current TPMSs, current indirect TPMSs are able to detect when two tires located diagonally from each other are under-inflated. Third, a hybrid TPMS would be able to detect when three or four tires were under-inflated because one of those tires necessarily would contain a direct pressure sensor.

However, since the agency does not have any information indicating that a hybrid TPMS is currently being planned for production, the agency does not know when such a system could be produced.

V. Summary of Preliminary Determination About the Final Rule

In this section, NHTSA summarizes its preliminary determination about the final rule that was submitted to OMB in December 2001.

A. Alternative Long-Term Requirements Analyzed in Making Preliminary Determination

For purposes of the preliminary determination, the agency analyzed three alternatives. The first alternative (four tires, 20 percent) would have required a vehicle's TPMS to warn the driver when the pressure in any single tire or in each tire in any combination of tires, up to a total of four tires, fell to 20 percent or more below the placard pressure, or a minimum level of pressure specified in the standard, whichever pressure was higher. The

second alternative (three tires, 25 percent) would have required a vehicle's TPMS to warn the driver when the pressure in any single tire or in each tire in any combination of tires, up to a total of three tires, fell to 25 percent or more below the placard pressure, or a minimum level of pressure specified in the standard, whichever pressure was higher. The third alternative (four tires, 25 percent) combined aspects of the first two alternatives. It would have required a vehicle's TPMS to warn the driver when the pressure in any single tire or in each tire in any combination of tires, up to a total of four tires, fell to 25 percent or more below the placard pressure, or a minimum level of pressure specified in the standard, whichever pressure was higher. The minimum levels of pressure specified in the standard would have been the same for all three alternatives.

The agency estimated that the four-tire, 20 percent alternative would have prevented from 141 to 145 fatalities and prevented or reduced in severity from 10,271 to 10,611 injuries per year.[30] The agency estimated that the average net cost of this alternative would have been from $76.77 to $77.53 per vehicle.[31] Since approximately 16 million vehicles are produced for sale in the United States each year, the total annual net cost of this alternative would have been from $1.228 billion to $1.241 billion. The net cost per equivalent life saved would have been from $5.1 million to $5.3 million.

The agency estimated that the three-tire, 25 percent alternative would have prevented 110 fatalities and prevented or reduced in severity 7,526 injuries per year. The agency estimated that the average net cost would have been $63.64 per vehicle, and the total annual net cost would have been $1.018 billion. The net cost per equivalent life saved would have been $5.8 million.

The agency estimated that the four-tire, 25 percent alternative would have prevented 124 fatalities and prevented or reduced in severity 8,722 injuries per year. The agency estimated that the average net cost would have been $53.87 per vehicle, and the total annual net cost would have been $862 million. The net cost per equivalent life saved would have been $4.3 million.

The agency noted that the vehicle costs of these alternatives could be reduced in the future as manufacturers learned how to produce TPMSs more efficiently. Moreover, maintenance costs could be significantly reduced in the future if manufacturers could mass produce a direct TPMS that did not require the pressure sensors to be replaced when the batteries are depleted.[32]

NHTSA considered these three alternatives because the agency believed that TPMSs that complied with these alternatives would warn drivers of significantly under-inflated tires in a wide variety of reasonably foreseeable circumstances, including when more than one tire was significantly under-inflated. The agency also believed that improved indirect TPMSs could be developed to meet the requirements of the three-tire, 25 percent alternative and hybrid TPMSs could be developed to meet the three-tire, 25 percent and four-tire, 25 percent alternatives. Thus, the agency believed that these alternatives would provide an effective warning while striking a reasonable balance between encouraging further improvements in TPMS technology and stringency of the performance requirements and striking a reasonable balance between safety benefits and costs.

B. Phase-In and Long-Term Requirements

To facilitate compliance, the preliminary determination specified a four-year phase-in schedule,[33] During the phase-in, i.e., between November 1, 2003 and October 31, 2006, it would have allowed compliance with either of two options: a four-tire, 25 percent option or a one-tire, 30 percent option. Under the first option, a vehicle's TPMS would have had to warn the driver when the pressure in one or more of the vehicle's tires, up to a total of four tires, was 25 percent or more below the placard pressure, or a minimum level of pressure specified in the standard, whichever pressure was higher. Under the second option, a vehicle's TPMS would have had to warn the driver when the pressure in any one of the vehicle's tires was 30 percent or more below the placard pressure, or a minimum level of pressure specified in the standard, whichever pressure was higher. The minimum levels of pressure specified in the standard were the same for both compliance options.

Under both options, the preliminary determination would have required the low tire pressure warning telltale to remain illuminated as long as any one of the vehicle's tires remained significantly under-inflated, and the key locking system was in the ''On'' (''Run'') position. The telltale could have been deactivated automatically only when all of the vehicle's tires ceased to be significantly under-inflated, or manually in accordance with the vehicle manufacturer's instructions.

The preliminary determination would have required each TPMS to be compatible with all replacement or optional tires (but not rims) of the size(s) recommended for use on the vehicle by the vehicle manufacturer. It would also have required that the telltale perform a bulb-check at vehicle start-up. It specified written instructions explaining the purpose of the low tire pressure warning telltale, the potential consequences of significantly under-inflated tires, the meaning of the telltale when it was illuminated, and what actions drivers should take when the telltale is illuminated, to be placed in the vehicle's owner's manual.

The preliminary determination would not have required TPMSs to monitor the spare tire, either when the tire was stowed or when it was installed on the vehicle. It also would not have required the TPMS to indicate a system malfunction.

The agency created the one-tire, 30 percent option so that vehicle manufacturers could continue to install current indirect TPMSs for several more years, thus providing additional time and flexibility for innovation and technological development. The agency created the other option by adjusting the definition of ''significantly under-inflated'' for the four-tire option to 25 percent (instead of 20 percent) so that

[30] NHTSA assumed that drivers would respond differently to different information displays. To get the upper bound, the agency assumed that manufacturers that installed direct TPMSs would also install a display showing the pressure of each tire. Currently only direct TPMSs are capable of displaying individual tire pressure. The agency also assumed that 33 percent of drivers would respond to such a display by re-inflating their tires when they became under-inflated by 10 percent, and that the other 67 percent would respond by re-inflating their tires when they became under-inflated by 20 percent, i.e., when the warning telltale would have been activated. To get the lower bound, the agency assumed that manufacturers would install only a low tire pressure warning telltale, as would have been required. Thus, all drivers would not re-inflate their tires until they became under-inflated by 20 percent, and the warning telltale was activated.

[31] The net cost is the vehicle cost plus the maintenance cost minus the fuel and tread wear savings. The difference in costs is due to the cost of adding an individual tire pressure display. The agency assumed that manufacturers would install direct TPMSs on vehicles that are not equipped with ABS because the cost of adding a direct TPMS was significantly less than the cost of adding ABS and an indirect TPMS.

[32] One TPMS manufacturer, IQ-mobil Electronics of Germany, indicated in its comments that it has developed a pressure sensor that does not require a battery.

[33] The phase-in schedule was as follows: 10 percent of a manufacturer's affected vehicles would have had to comply with either compliance option in the first year; 35 percent in the second year; and 65 percent in the third year. In the fourth year, 100 percent of a manufacturer's affected vehicles would have had to comply with the long-term requirements, i.e., the four-tire, 25 percent compliance option.

improved indirect TPMSs and hybrid TPMSs could be used to comply with the TPMS standard. After the phase-in, i.e., after October 31, 2006, the second option would have been terminated, and the provisions of the first option would have become mandatory for all new vehicles.

The agency tentatively believed that a four-tire, 25 percent requirement was preferable for the long-term because it would require TPMSs that warn drivers about all combinations of significantly under-inflated tires and provide more timely and effective warnings. The agency tentatively believed that a one-tire, 30 percent requirement would allow TPMSs that do not warn about all combinations of significantly under-inflated tires and do not provide warnings until the extent of under-inflation reaches 30 percent below the placard pressure. Thus, it appeared that a four-tire, 25 percent requirement would better fulfill the purposes of the TPMS mandate in the TREAD Act, while encouraging further improvements in TPMS technology.

VI. Response to Issues Raised in OMB Return Letter About Preliminary Determination

Pursuant to section 6(a)(3) of Executive Order 12866, NHTSA is required to provide a written response to the points made by OMB in its February 12 return letter. As noted above, OMB stated in its return letter that: NHTSA should base its decision about the final rule on overall safety, instead of tire safety; while direct TPMSs can detect under-inflation under a greater variety of circumstances than indirect TPMSs, the indirect system captures a substantial portion of the benefit provided by direct systems; NHTSA should consider a fourth alternative for the long-term requirement, a one-tire, 30 percent compliance option, indefinitely, since it would allow vehicle manufacturers to install current indirect TPMSs; NHTSA, in analyzing long-term alternatives, should consider both their impact on the availability of ABS as well as the potential safety benefits of ABS; and that NHTSA should provide a better explanation of the technical foundation for the agency's safety benefits estimates and subject those estimates to sensitivity analyses.

A. Criteria for Selecting the Long-Term Requirement

1. Tire Safety and Overall Vehicle Safety

OMB stated in its return letter that ''a rule permitting indirect systems may provide more overall safety than a rule that permits only direct or hybrid systems.'' OMB said:

> Although direct systems are capable of detecting low pressure under a greater variety of circumstances than indirect systems, the indirect system captures a substantial portion of the benefit provided by direct systems. Moreover, allowing indirect systems will reduce the incremental cost of equipping vehicles with anti-lock brakes, thereby accelerating the rate of adoption of ABS technology * * *. Both experimental evidence and recent real-world data have indicated a modest net safety benefit from anti-lock brakes.

While NHTSA's general obligation under the Vehicle Safety Act is to improve overall vehicle safety, it is mindful that its specific, immediate obligation in this rulemaking is to comply with the mandate of section 13 of the TREAD Act. The agency is seeking to comply with the mandate and safety goals of the TREAD Act in a way that encourages innovation and allows a range of technologies to the extent consistent with providing drivers with sufficient warning of low tire pressure under a broad variety of the reasonably foreseeable circumstances in which tires become under-inflated.

2. Statutory Mandate

Section 13 of the TREAD Act mandated the completion of ''a rulemaking for a regulation to require a warning system in new motor vehicles to indicate to the operator when a tire is significantly under inflated'' within one year of the TREAD Act's enactment. As noted below, the agency tentatively believes, based on the current record, that a four-tire, 25 percent under-inflation requirement would best meet the mandate.

B. Relative Ability of Direct and Current Indirect TPMSs To Detect Under-Inflation

As noted above, current indirect TPMSs work, in part, by adding the speeds of diagonal sets of tires and subtracting the sum of one set from the sum of the other. As a result, if all four tires are significantly under-inflated, and the difference in the tire pressures is not 30 percent or greater, current indirect TPMSs will not provide a warning. Similarly, if two tires on the same axle or same side of the vehicle are significantly under-inflated, current indirect TPMSs will not provide a warning.

These combinations of significantly under-inflated tires occur frequently enough that current indirect TPMSs would have provided a warning in only about 50 percent of the instances in which NHTSA found significant under-inflation in the February 2001 NCSA survey. Conversely, current direct TPMSs would have provided warnings in all those instances.

The following figures indicate how often current direct and indirect TPMSs would provide warnings when a vehicle has at least one tire that is at least 30 percent below the placard pressure.

Of the 5,967 passenger cars in the February 2001 NCSA survey, 1,199 (20 percent) had at least one tire that was at least 30 percent below the placard pressure. Current direct TPMSs would have provided a warning in every case, while current indirect TPMSs would have provided a warning in only 653 cases (54 percent).

Of the 3,950 light trucks in the NCSA survey, 789 (20 percent) had at least one tire that was at least 30 percent below the placard pressure. Current direct TPMSs would have provided a warning in every case, while current indirect TPMSs would have provided a warning in only 359 cases (46 percent).

Thus, of the total 9,917 passenger cars and light trucks in the NCSA survey, 1,988 (20 percent) had at least one tire that was at least 30 percent below the placard pressure. Current direct TPMSs would have provided a warning in every case, while current indirect TPMSs would have provided a warning in only 1,012 cases (51 percent).

Current indirect TPMSs would have failed to provide a warning in the remainder of the cases for various reasons. Many of the vehicles had one tire that was 30 percent below the placard pressure, but not 30 percent below the pressure in the other tires. As noted above, current indirect TPMSs require at least a 30 percent differential in tire pressure before providing a warning. Other vehicles had more than one tire that was 30 percent below the placard pressure. As noted above, current indirect TPMSs cannot detect when all four of a vehicle's tires, or two tires on the same side of the vehicle or the same axle, are under-inflated.

The absence of a warning in approximately 50 percent of the instances of significant under-inflation is a matter of concern given that many drivers will rely on a TPMS instead of regularly checking their tire pressure. Data from the July 2001 BTS omnibus survey indicate that 65 percent of people would be less concerned, to either a great extent or a very great extent, with routinely maintaining the pressure of their tires if their vehicle were equipped with a TPMS.[34]

[34] NHTSA notes that in its prepared statement submitted in connection with the February 28, 2002 hearing before the House Committee on Energy and

C. Analysis of a Fourth Alternative Long-Term Requirement: One-Tire, 30 Percent Under-Inflation Detection

As explained above in section V.A., ''Alternative Long-Term Requirements Analyzed in Making Preliminary Determination,'' NHTSA analyzed three alternatives: a four-tire, 20 percent alternative; a three-tire, 25 percent alternative and a four-tire, 25 percent alternative.

OMB recommended that the agency analyze a fourth alternative that would require a vehicle's TPMS to warn the driver when the pressure in any one of the vehicle's tires is 30 percent or more below the vehicle manufacturer's recommended cold inflation pressure for the tires, or a minimum level of pressure specified in the standard, whichever pressure is higher. (This alternative is referred to below as the ''one-tire, 30 percent alternative.'') The agency's analysis of the benefits and costs of this alternative follows.

The agency estimates that the one-tire, 30 percent alternative would prevent 79 fatalities and prevent or reduce in severity 5,176 injuries. The agency estimates that the average per vehicle cost of this alternative would be $33.34. Since approximately 16 million light vehicles are produced for sale in the United States each year, the total annual cost of this alternative would be $533 million. The agency estimates that the average per vehicle maintenance cost would be $13.50,[35] and that the average per vehicle fuel and tread life savings over the lifetime of the vehicle would be $2.06 and $0.65, respectively. Thus, the net per vehicle cost of this alternative would be $44.13, and the total annual net cost would be $706 million. The net cost per equivalent life saved would be $5.8 million.

D. Impact of One-Tire, 30 Percent Alternative on Installation Rate of ABS

OMB said that NHTSA should analyze the impact of adopting its long-term regulatory alternatives as well as an additional long-term alternative, a one-tire, 30 percent alternative, on the installation rate of ABS. Since the additional alternative is the only one that would permit compliance by means of installing current indirect TPMSs, and since OMB's suggestion that a TPMS standard could induce increased installation of ABS is dependent upon the manufacturers' being able to install that type of TPMS, NHTSA's analysis focuses on that alternative.

The agency believes there is no reliable basis for concluding that permitting current indirect TPMSs to comply would lead to a significant increase in installation of ABS in light vehicles for the following reasons.

First, the final rule does not mandate the installation of ABS. Vehicle manufacturers always have the option of providing a measure that exceeds NHTSA's standards. However, nothing in the final rule requires manufacturers to install ABS.

Second, the rulemaking record does not contain a reliable basis for concluding that manufacturers will voluntarily install ABS in significantly more light vehicles in response to being permitted to install current indirect TPMSs. When the Alliance addressed the issue of increased voluntary installation of ABS in its September 6, 2001 comments, it said only that a manufacturer ''may well'' opt to make ABS standard equipment on models for which optional ABS is currently available and is currently in high market demand. Further, only one manufacturer, Toyota, indicated that it might make ABS standard equipment on more vehicles if indirect TPMSs were allowed. Toyota provided this indication not in its written comments, but orally in a meeting with the agency. Nothing requires Toyota to make ABS standard equipment.

Third, several manufacturers orally indicated that they would not install ABS on their light trucks even if indirect TPMSs were allowed. General Motors (GM) and Ford told NHTSA that they would install a direct TPMS on their trucks, rather than a four-channel ABS and indirect TPMS, because ABS was significantly more expensive. Further, the agency notes that in April 2002, GM announced that it would cease offering ABS as standard equipment on a number of its less expensive models of cars to make those models more price competitive.

Fourth, it is not economically reasonable for manufacturers to install ABS voluntarily on significantly more vehicles in response to being permitted to install current indirect TPMSs. In the absence of written comments from individual manufacturers indicating that they are very likely to increase voluntarily their installation of ABS if allowed to install current indirect TPMSs, NHTSA may not simply assume that manufacturers will elect to spend $240 per vehicle to install ABS to save $53, the difference between the cost of a direct TPMS ($66) and an indirect TPMS ($13). The market for ABS has been static for several years, with the installation rate at about 63 percent. Absent a market demand for more installations, a manufacturer would not gain a market advantage by increasing the percentage of its vehicles with ABS.

In NHTSA's Final Economic Assessment (FEA), the agency states that although a manufacturer may elect to increase the installation of ABS, it is solely a marketing decision.[36] The influence, if any, this rulemaking might have on their marketing decisions is purely speculative. There are many factors that influence a manufacturer's decision to install equipment. Cost impact is only one of them.

E. Overall Safety Effects of ABS

In addition to recommending that the agency assume that the adoption of the one-tire, 30 percent compliance option would induce vehicle manufacturers to increase their installation of ABS, OMB also recommended that the agency take into account the potential safety benefits of ABS when estimating the benefits of that option. OMB suggested that ABS could reduce fatalities in light vehicles.

NHTSA has analyzed ABS and has determined that there is currently no statistically reliable basis for concluding that ABS reduces fatalities in light vehicles for the following reasons.

First, NHTSA has analyzed the impacts of ABS on light vehicle fatalities for the past decade, with mixed findings.[37] In general, test track results indicate that ABS is a very promising technology that enables drivers to keep vehicles under control under adverse road conditions. Under some pavement conditions, ABS allows the driver to stop a vehicle more rapidly while maintaining steering control, even during panic braking.

However, the agency's analysis of real world crash data shows that, on balance, ABS has not been proven, thus far, to be greatly beneficial in real world fatal crashes.

NHTSA explored the desirability of requiring ABS on light vehicles in an

Commerce on the TREAD Act, OMB stated: The 1-tire standard will provide warnings when 1 tire is underinflated but will not necessarily detect situations when 2 or more tires are underinflated. A further weakness of the 1-tire standard is that consumers may misperceive that their tires are fine (since the warning light is off) when in fact all four of their tires are equally underinflated. The 4-tire standard overcomes these problems.

[35] If the one-tire, 30 percent alternative were the only alternative available to vehicle manufacturers, the agency anticipates that the approximately ⅓ of vehicles not equipped with ABS would nevertheless comply by means of direct TPMSs. The approximately $40.91 of maintenance costs for each of those vehicles, if averaged over the entire fleet, is approximately $13.50.

[36] A copy of the FEA has been placed in the docket.

[37] See ''Preliminary Evaluation of the Effectiveness of Antilock Brake Systems for Passenger Cars,'' NHTSA, December 1994, DOT HS 808 206. This study is available from the National Technical Information Service (NTIS) or NHTSA's Technical Reference Library.

ANPRM issued in 1994 (59 FR 281; January 4, 1994) in response to the National Highway Traffic Safety Administration Authorization Act of 1991. (Public Law 102–240, December 18, 1991). The Act directed the agency to consider the need for any additional brake performance standards for passenger cars, including ABS standards. The ANPRM solicited comments about whether rulemaking was warranted to require that all light vehicles be equipped with ABS. It also posed a number of questions relative to the regulatory approaches that might be employed if requirements were imposed; the types of performance tests that might be used; varieties of ABSs that might be appropriate; and regulatory implementation strategies and schedules that might be employed if requirements were established.

Two years later, the agency issued a notice announcing that it had decided to defer indefinitely a decision whether to require equipping light vehicles with ABS. (61 FR 36698; July 12, 1996) In that notice, the agency stated that it was currently ''inappropriate'' to mandate ABS for the following reasons:

(1) Most studies that have analyzed the accident involvement experiences of ABS-equipped light vehicles have found mixed patterns, with a reduction in accidents in some crash modes but an increase in accidents in other crash modes, (2) even without a Federal requirement, a significant majority of light vehicles will be voluntarily equipped with ABS, (3) and requiring ABS on those light vehicles that will not be equipped with ABS would result in significant costs that, on balance, cannot be justified at this time.

In the 1996 notice, the agency lowered the prediction that it had made in its 1994 ANPRM that the rate of voluntary ABS installation in passenger cars would increase from 55 percent in 1994 to 85 percent in 1999. Given that there had been almost no increase in the rate between the 1994 model year and 1995 model year, the agency suggested in the 1996 notice that the rate in 1999 could be as low as 70 percent. Even that reduced figure has been shown by subsequent events to be overly optimistic. In 2000, the rate had reached only 63 percent for passenger cars.

The agency noted in the 1996 notice that the costs of bringing the percentages up to 100 percent for both passenger cars and light trucks could be very high, over $1.5 billion annually.

Since the 1996 notice, NHTSA has conducted additional studies. In one study, NHTSA measured the braking performance of a group of ABS-equipped production vehicles over a broad range of maneuvers on different road surfaces. Results of this study showed that for most maneuvers, ABS-assisted stops yielded shorter stopping distances in comparison to non-ABS vehicles.[38]

NHTSA has conducted several studies to examine possible reasons for the absence of overall safety benefits. One possible reason is that drivers are not adequately familiar or have inadequate or incorrect knowledge on the use of ABS. The agency has examined this possibility by conducting a national telephone survey to assess drivers' knowledge of ABS, its functionality and their expectations of its effects on vehicle performance. The results showed that, although most drivers had heard of ABS, many did not know what it did or how it affected vehicle performance.[39]

The agency also investigated whether the apparent increase in single vehicle crashes was due to driver ''oversteering'' in crash-imminent situations. The steering capability could have contributed to vehicles going off of the roadway during crash avoidance maneuvers. However, this steering activity was not found to result in a significant number of road departure crashes in NHTSA's research.[40]

The agency also evaluated possible ABS-related behavioral adaptation of drivers through the collection of more detailed data about the driving behavior of subjects in a naturalistic research setting. This study did not indicate any statistically significant trend towards behavioral adaptation by drivers of ABS equipped vehicles in comparison to others.[41]

It is clear from the above comprehensive agency research efforts during the past five years that the agency still cannot explain why ABS systems do not produce the benefits anticipated from test track performance. Similarly, research by others has not yet succeeded in providing an explanation. Efforts by NHTSA and others continue today to try to explain this phenomenon.

Second, OMB's apparent conclusion that increased installation of ABS in light vehicles could have a modest net safety benefit is based upon data that are not statistically significant. Those data are taken from a study by Charles M. Farmer for the Insurance Institute for Highway Safety (IIHS).[42]

In the April 15, 2000 edition of its Status Report, IIHS said the following about the study:

New evidence suggests that cars with antilock braking systems no longer are disproportionately involved in certain types of fatal crashes. However, antilocks still aren't producing reductions in overall fatal crash risk * * *

* * * As before, vehicles with antilock brakes were less likely than cars with standard brakes to be in crashes fatal to occupants of other vehicles. At the same time, the vehicles with antilocks no longer were found to be overinvolved in crashes fatal to their own occupants. Particularly important is the reduction in single-vehicle, run-off-the-road crashes.

The data from the Farmer study are set forth in the table below:

	All crashes	95 Percent confidence bounds	
	Fatalities in ABS cars Fatalities in Non-ABS cars	Lower	Upper
1. GM cars in 1993–95	1.03	0.94	1.12
2. GM cars in 1996–98	0.96	0.87	1.05
3. GM cars in 1993–98	0.99	0.93	1.05
4. Non-GM cars in 1986–95	1.16 (Significant)	1.06	1.27

[38] ''NHTSA Light Vehicle Antilock Brake System Research Program Task 4: A Test Track Study of Light Vehicle ABS Performance Over a Broad Range of Surfaces and Maneuvers,'' January 1999, DOT HS 808 875, available at *http://www-nrd.nhtsa.dot.gov/vrtc/ca/capubs/NHTSAabsT4FinalRpt.pdf.*

[39] ''NHTSA Light Vehicle Antilock Brake System Research Program Task 2: National Telephone Survey of Driver Experiences and Expectations Regarding Conventional Brakes versus ABS,'' November 2001, DOT HS 809 429, available at *http://www-nrd.nhtsa.dot.gov/vrtc/ca/capubs/abssurvey_rptfinal.pdf.*

[40] ''Driver Crash Avoidance Behavior with ABS in an Intersection Incursion Scenario on Dry Versus Wet Pavement,'' (SAE Paper No. 1999–01–1288), available at *http://www-nrd.nhtsa.dot.gov/vrtc/ca/lvabs.htm.*

[41] ''NHTSA Light Vehicle Antilock Brake System Research Program Task 7.1: Examination of ABS-Related Driver Behavioral Adaptation—License Plate Study,'' November 2001, DOT HS 809 430, available at *http://www-nrd.nhtsa.dot.gov/vrtc/ca/capubs/abs71.pdf.*

[42] ''New Evidence Concerning Fatal Crashes by Passenger Vehicles Before and After Adding Antilock Braking System,'' Charles M. Farmer, Insurance Institute for Highway Safety, February 2000. A copy of this study has been placed in the docket. (Docket No. NHTSA–2000–8572–206).

	All crashes	95 Percent confidence bounds	
	Fatalities in ABS cars Fatalities in Non-ABS cars	Lower	Upper
5. Non-GM cars in 1996–98	0.91	0.77	1.06
6. Non-GM cars in 1986–98	1.09 (Significant)	1.01	1.18

A ratio of 1.0 in the second column means that ABS did not have any effect on fatalities. A ratio above 1.0 indicates a higher risk of fatalities in ABS-equipped vehicles, while a ratio below 1.0 indicates a lower risk of fatalities in ABS equipped vehicles.

In order for the ratio for any group of vehicles to be statistically significant, both the lower and upper confidence bounds for that group must be either below 1.0 or above 1.0. This is true for only two groups of vehicles in the table: those in row 4, non-GM cars in 1986–95, and those in row 6, non-GM cars in 1986–98. For both of these groups, fatalities increased in ABS-equipped vehicles. Thus, in no subset of vehicles in the Farmer study is there any statistically significant advantage for ABS-equipped vehicles in crash fatalities.

OMB interpreted the study to indicate a 4–9 percent reduction in fatalities in ABS-equipped vehicles.[43] However, NHTSA does not believe that these data are statistically significant because one confidence bound is below 1.0 and the other is above 1.0. Thus, these alleged benefits are more than 5 percent likely to be due purely to chance.[44]

Mr. Farmer, the study's author, has indicated to NHTSA that people might have learned how to better use ABS by calendar years 1996–98, so that they were no longer at as great a risk of run-off-the-road fatal crashes as in prior years.[45] Even so, Farmer never stated in his study that ABS reduced fatalities. Regarding the Non-GM cars in 1996–98, he stated, ''When all fatal crash involvements were considered, disregarding in which vehicle the fatalities occurred, the risk ratio was slightly lower than, but not significantly different from, 1.0.''

Third, the most recent NHTSA study showed an improved picture regarding benefits and disbenefits compared to earlier studies, but still no overall benefits in fatal crashes. [46] The study examined ABS effects separately for passenger cars and light trucks for five types of crashes: frontal impacts, side impacts, rollover, run-off-the-road, and pedestrian.

The study found that, when both non-fatal and fatal crashes were combined, there were reductions in crashes for vehicles equipped with ABS. ABS was found to result in statistically significant reductions in crashes for most types of crashes, except side impact crashes, especially those involving cars.

However, when only fatal crashes were considered, there were not any statistically significant overall reductions of those crashes for ABS-equipped vehicles. In fact, the only statistically significant finding was that fatal light truck rollover crashes increased in vehicles with ABS as compared to vehicles without ABS. (That did represent an improvement over a 1998 study[47] that found statistically significant increases for several types of crashes.) No statistically significant effects, positive or negative, were found for any type of fatal passenger car crashes or for other types of fatal light truck crashes.

It is unclear whether the evidence in recent studies represents a statistical aberration relative to earlier studies or whether it is indicative of a real and positive trend. NHTSA will continue to monitor the real world performance of ABS on light vehicles. As with all protective devices, NHTSA plans to update its estimates for ABS as more data become available. If NHTSA obtains data enabling it to show that ABS reduces net fatalities and is cost/beneficial in light vehicles, the agency will consider initiating a separate rulemaking to address the issue of whether to require their installation.

F. Technical Foundation for NHTSA's Safety Benefit Analyses

OMB recommended that NHTSA better explain the technical foundation for the agency's estimates of safety benefits and subject those estimates to sensitivity analyses.[48] Since conducting these desired sensitivity analyses is relevant primarily to making a decision about the TPMS requirements for the long-term, the agency believes that its decision to postpone the final decision on TPMS requirements to the second part of this final rule makes it unnecessary to conduct additional sensitivity analyses at this time.

The agency will complete its new study of TPMS by March 1, 2004. In this study, NHTSA will examine whether the tire pressure of vehicles without any TPMS are substantially closer to the vehicle manufacturer's recommended pressure than the tire pressure of vehicles with TPMSs, especially TPMSs that do not comply with the four-tire, 25 percent compliance option. If necessary, the agency will perform sensitivity analyses on these data.

OMB specifically questioned the estimates of safety benefits that NHTSA made based on reduced skidding and better control, since these estimates were based on the Indiana Tri-level study published in 1977. The agency does not have later data of this quality on the effects of under-inflation on crashes. The agency has started to collect tire pressure data as part of its NASS-CDS data collection. However, NASS-CDS is not a system designed to determine the cause of a crash. Thus, NHTSA does not anticipate receiving significant further data on this issue.[49] However, if this issue becomes a critical element for the decision for the second part of this final rule, the agency will

[43] The 4 percent figure is based on data for GM cars in 1996–98, while the 9 percent figure is based on data for non-GM cars in 1996–98.

[44] Most statisticians consider data that are more than 5 percent likely to be due purely to chance to be statistically insignificant.

[45] Mr. Farmer indicated this in an ex parte conversation with Jim Simons of NHTSA on February 14, 2002. (Docket No. NHTSA–2000–8572–210.)

[46] ''Analysis of the Crash Experience of Vehicles Equipped with All Wheel Antilock Braking Systems (ABS)—A Second Update Including Vehicles with Optional ABS,'' NHTSA, DOT HS 809 144, September 2000. A copy of this study has been placed in the docket. (Docket No. NHTSA–2000–8572–205.) It is also available at *http://www-nrd.nhtsa.dot.gov/vrtc/ca/capubs/lvabstask1—crashdatareport.pdf.*

[47] ''An Analysis of the Crash Experience of Passenger Vehicles with Antilock Braking Systems-An Update,'' NHTSA, DOT HS 808 758, August 1998.

[48] When performing a sensitivity analysis, the agency changes assumptions it has made and then calculates differences in its benefits estimates. For example, the agency assumed that 20 percent of blowouts are caused by low tire pressure. If the agency performed a sensitivity analysis, it could change that assumption to 10 percent or 30 percent and then calculate a potential range of benefits.

[49] Although these data probably will not indicate whether low tire pressure caused a crash, the agency is collecting these data to determine the extent of the correlation between tire pressure and skidding/loss of control crashes.

perform sensitivity analyses on the data from the 1977 study.

OMB also noted NHTSA's use of Goodyear data, rather than VRTC data, on the effects of under-inflation on stopping distance. As explained in greater detail in the FEA, the agency did not use the VRTC data because of its concerns with the way in which the tests were performed.[50] The agency believes that the Goodyear test methodology adequately addressed these concerns.[51]

In addition, OMB questioned the agency's use of the Goodyear data from a minivan to represent passenger cars. The critical element that is being measured is the difference in the tire's response when under-inflated. It is true that the absolute stopping distance will vary by vehicle weight and other vehicle performance characteristics. However, these same characteristics will influence both the properly inflated and the under-inflated tests in a similar fashion. Therefore, while Goodyear's test sample was confined to only two vehicles (a Dodge Caravan and a Ford Ranger), the differences measured under various inflation levels should still be indicative of the effect that could be expected.

Finally, OMB questioned NHTSA's assumption that under-inflation is involved in 20 percent of blowouts that cause crashes. The agency does not know precisely how many blowouts that cause crashes are influenced by under-inflation. As noted above in Section III.D.1., ''Reduced Vehicle Safety—Tire Failures and Increases in Stopping Distance,'' while the only tire-related data element in the agency's crash databases is ''flat tire or blowout,'' even in crashes for which a flat tire or blowout is reported, crash investigators cannot tell whether under-inflation contributed to the blowout. The agency's best estimate is that under-inflation plays a role in 20 percent of blowouts that cause crashes.

In making this estimate, the agency was mindful of the fact that many blowouts occur when one tire is punctured, begins to lose air at a rate somewhat faster than the normal rate due to natural causes, and then fails after being driven for some time while under-inflated. In these cases, a TPMS meeting either compliance option would be able to warn the driver of the under-inflated tire before the tire failed, possibly avoiding a crash.

NHTSA emphasizes that the choice of 20 percent as its estimate of the percentage of under-inflation's involvement in blowouts that cause crashes made little difference in the agency's benefits analyses. As noted below in Section VIII.A.3., ''Flat Tires and Blowouts,'' the agency estimates that the number of fatalities prevented per year due to reductions in crashes involving blowouts and flat tires will be 39 if all light vehicles meet the four-tire, 25 percent compliance option, and 32 if all light vehicles meet the one-tire, 30 percent compliance option. The choice of a somewhat higher or lower figure for the percentage of under-inflation's involvement would change only negligibly the relative benefits of the two compliance options.

VII. The Final Rule

A. Decision To Issue Two-Part Final Rule

As noted above, NHTSA was required to submit a draft final rule to OMB for review. The agency submitted a draft final rule to OMB on December 18, 2001. During the review process, OMB raised questions about the available data and the conclusions the agency preliminarily drew from them. OMB also raised questions about the effect of the final rule on the installation of ABS and the possibility of obtaining braking safety benefits as well as tire safety benefits.

To allow for the consideration of additional data regarding the requirements for vehicles manufactured after October 31, 2006, the agency has decided to divide the final rule into two parts. In this first part, the agency is establishing the requirements for vehicles manufactured from November 1, 2003 to October 31, 2006.

The agency will leave the rulemaking docket open for the submission of new data and analyses. During this period, the agency requests that commenters address how the performance characteristics of particular types of TPMSs satisfy the statutory requirement that systems provide a warning ''when a tire is significantly under-inflated.''

NHTSA is especially interested in data and information about TPMS, both the systems in the field as well as systems under development. Commenters are urged to substantiate their comments with data and information to the maximum extent possible. Unsubstantiated comments are less useful.

The agency also will conduct a study comparing the tire pressures of vehicles without any TPMS to the pressures of vehicles with TPMSs, especially TPMSs that do not comply with the four-tire, 25 percent compliance option. Based on the record compiled to this date, the results of that study, and any other new information submitted to the agency, NHTSA will issue the second part of this rule. The second part will be issued by March 1, 2005, and will apply to vehicles that are manufactured after October 31, 2006.

Based on the record now before the agency, NHTSA tentatively believes that the four-tire, 25 percent option would best meet the mandate in the TREAD Act. However, it is possible that the new information may be sufficient to justify a continuation of the requirements in the first part of this rule, or some other alternative.

B. Part One of the Final Rule—November 2003 through October 2006

1. Summary

The first part of this final rule establishes requirements for vehicles manufactured between November 1, 2003, and October 31, 2006, subject to a phase-in schedule.[52] The final rule requires passenger cars, multipurpose passenger vehicles, trucks, and buses with a GVWR of 4,536 kilograms (10,000 pounds) or less, except those vehicles with dual wheels on an axle, to be equipped with a TPMS to alert the driver that one or more of the vehicle's tires are significantly under-inflated.

For these vehicles, the first part of the final rule provides two compliance options.[53] Under the first compliance option, a vehicle's TPMS must warn the driver when the pressure in one or more of the vehicle's tires, up to a total of four tires, is 25 percent or more below the vehicle manufacturer's recommended cold inflation pressure for the tires, or a minimum level of pressure specified in the standard, whichever pressure is higher. Under the second compliance option, a vehicle's TPMS must warn the driver when the pressure in any one of the vehicle's tires is 30 percent or more below the vehicle manufacturer's recommended cold inflation pressure

[50] For example, the VRTC only tested new tires, not worn tires that are more typical of the tires on most vehicles. In addition, the NHTSA track surface is considered to be aggressive in that it allows for maximum friction with tire surfaces. It is more representative of a new road surface than the worn surfaces experienced by the vast majority of road traffic.

[51] For example, Goodyear tested tires with two tread depths: full tread, which is representative of new tires, and half tread, which is representative of worn tires.

[52] Under the phase-in, 10 percent of a manufacturer's affected vehicles will have to comply with one of the two compliance options the first year (vehicles manufactured between November 1, 2003 and October 31, 2004); 35 percent will have to comply the second year (between November 1, 2004 and October 31, 2005); and 65 percent will have to comply the third year (between November 1, 2005 and October 31, 2006).

[53] The agency is requiring manufacturers to irrevocably select the option to which they will certify each vehicle.

for the tires, or a minimum level of pressure specified in the standard, whichever pressure is higher.[54]

Vehicles certified to either compliance option will be required to provide written information in the owner's manual explaining the purpose of the low tire pressure warning telltale, the potential consequences of significantly under-inflated tires, the meaning of the telltale when it is illuminated, and what actions drivers should take when the telltale is illuminated. Vehicles certified to the one-tire, 30 percent option will be required to provide additional information on the inherent limitations of current indirect TPMSs.

Under both compliance options, the TPMS must include a low tire pressure-warning telltale (yellow). Under the four-tire, 25 percent option, the telltale must remain illuminated as long as any of the vehicle's tires remains significantly under-inflated, and the key locking system is in the ''On'' (''Run'') position. The telltale can be deactivated automatically only when all of the vehicle's tires cease to be significantly under-inflated, or manually in accordance with the vehicle manufacturer's instructions.

The one-tire, 30 percent option requires that the telltale remain illuminated as long as one of the vehicle's tires remains significantly under-inflated, and the key locking system is in the ''On'' (''Run'') position. The telltale can be deactivated automatically only when that tire ceases to be significantly under-inflated, or manually in accordance with the vehicle manufacturer's instructions.[55]

Both compliance options require that the low tire pressure-warning telltale perform a bulb-check at vehicle start-up.

Under both compliance options, each TPMS must be compatible with all replacement or optional tires (but not rims) of the size(s) recommended for use on the vehicle by the vehicle manufacturer. The TPMS is not required to monitor the spare tire, either when it is stowed or when it is installed on the vehicle. The TPMS also does not have to indicate a system malfunction.

In response to comments regarding the need to manually reset indirect TPMSs after adding pressure to the tires, the agency is permitting the warning telltale to be deactivated manually, in accordance with the vehicle manufacturer's instructions.

In response to comments regarding variations in rim designs, the agency is requiring TPMSs to be compatible with all replacement or optional tires, but not rims, of the size(s) recommended for use on the vehicle by the vehicle manufacturer.

In response to BTS survey data indicating that 65 percent of people would be less concerned to either a great extent or a very great extent with routinely maintaining their tire pressure if their vehicle were equipped with a TPMS, the agency is requiring the low tire pressure warning telltale to perform a bulb-check during vehicle start-up.

In response to comments, the agency is also making minor changes to the required written instructions, and requiring vehicles certified to the one-tire, 30 percent option to provide additional information on the inherent limitations of current indirect TPMSs.

2. Congressional Intent

Section 13 of the TREAD Act simply mandates ''a rulemaking for a regulation to require a warning system in new motor vehicles to indicate to the operator when a tire is significantly under inflated.'' None of the sources of legislative history commonly recognized as being legally authoritative, such as the House and Senate Reports or the Congressional Record, shed any light on the type of TPMS that Congress intended to mandate with this amendment.[56]

In the absence of any legally authoritative sources, the Alliance turned in its comments to statements made by Congressman Markey, the sponsor of the TPMS amendment, as quoted in an unofficial transcript of the House Committee on Energy and Commerce markup of the bill that became the TREAD Act.[57] In explaining and arguing for his amendment, Congressman Markey referred to a TPMS on an existing vehicle model. That TPMS was an indirect TPMS. Based on the Congressman's having mentioned an indirect TPMS in the course of his remarks, the Alliance argued that the Congressman must have intended that current indirect TPMSs be allowed under the rulemaking mandated by the TPMS amendment.

While the Alliance's interpretation of Congressman Markey's statements during markup is not inconsistent with those statements, it goes well beyond anything that the Congressman directly said in them. Further, that interpretation is contrary to Congressman Markey's statements at the February 28, 2002 House Committee on Energy and Commerce hearing. In those later statements, Congressman Markey said that the intent of his TPMS amendment was to require TPMSs that provide warnings in all instances of under-inflation, thus suggesting a preference for direct TPMSs, which can provide such warnings, over current indirect TPMSs, which cannot. While those statements at the hearing likewise do not constitute any legally authoritative legislative history of the TREAD Act, they do suggest that the Alliance's interpretation of Congressman Markey's earlier statements is not persuasive.

3. Vehicles Covered

The final rule requires TPMSs on passenger cars, multipurpose passenger vehicles, trucks, and buses with a GVWR of 4,536 kilograms (10,000 pounds) or less, except those vehicles with dual wheels on an axle. It does not require TPMSs on motorcycles, trailers, low-speed vehicles, medium vehicles, or heavy vehicles.

NHTSA is not requiring TPMSs on motorcycles because, unlike the types of vehicles that are subject to the final rule, some motorcycles still use tubed tires. In order for a direct TPMS to work with tubed tires, the pressure sensor would not only have to be inside the tire, but also inside the tube itself. The agency is not aware of any TPMSs that are made to work with tubed tires. The agency requested comments on this issue but received none.

Advocates recommended that the agency open rulemaking to set regulatory requirements for retreaded and recapped medium (10,001—26,000 pounds GVWR) and heavy (over 26,000 pounds) vehicle tires. Advocates stated that there is a ''serious, pervasive problem of tire underinflation among medium and heavy vehicles, especially given the high percentage of trucks and buses above 10,000 pounds gross vehicle weight which use re-treaded tires.'' However, Advocates did not provide any data to support this statement.

As discussed in the NPRM, NHTSA is not requiring TPMSs on medium (10,001—26,000 lbs. GVWR) and heavy (greater than 26,001 lbs. GVWR) vehicles at this time for two reasons. First, this rulemaking is required by the TREAD Act, which required a final rule to be issued in one year and was passed in response to problems with certain Firestone tires. Since those tires were

[54] As noted above, the minimum levels of pressure are the same for both compliance options.

[55] Since indirect TPMSs do not actually monitor tire pressure, they must be told when the vehicle's tires have been re-inflated. Thus, indirect TPMSs require the driver to push a reset button after re-inflating the vehicle's tires.

[56] The agency also notes that the issue of direct vs. indirect TPMSs was not before Congress when the bill that became the TREAD Act was being considered.

[57] This sort of legislative history is not entitled to much, if any, weight.

used on light vehicles, and the time frame was so tight, the agency has limited its study of under-inflation to light vehicles.

Second, the issues associated with under-inflated tires on medium and heavy vehicles are different from and more complex than the issues associated with under-inflated tires on light vehicles. For example, medium and heavy vehicles are equipped with tires that are much larger and have much higher pressure levels than the tires used on light vehicles. In addition, medium and heavy vehicles are generally equipped with more axles and tires than light vehicles. Since the TREAD Act imposed a one-year deadline on this rulemaking, the agency did not have the time to study and analyze those issues sufficiently.

The Alliance recommended that the agency limit the applicability of the standard to vehicles having a GVWR of 3,856 kilograms (8,500 pounds or less). The Alliance stated that the majority of vehicles above 8,500 pounds GVWR are used commercially. The Alliance argued that such vehicles are maintained on a regular basis and do not need a TPMS to assist in maintaining proper inflation pressure in the vehicles' tires.

NHTSA is aware of at least two non-commercial vehicle models—the Chevrolet Suburban and Ford Excursion, both SUVs—that have a GVWR between 8,500 and 10,000 pounds. In addition, 15-passenger vans are typically in this weight rating range. If the agency adopted the Alliance's recommendation, these vehicles would be excluded from the standard. These vehicles are as subject to under-inflated tires as other light SUVs and vans. Thus, the agency is not adopting the Alliance's suggestion.

However, to address the Alliance's concern about the standard's applicability to commercial vehicles, the agency is excluding from the standard trucks, buses, and multipurpose passenger vehicles that have a GVWR under 10,000 pounds and dual wheels on an axle. This includes vehicles such as step vans, tow trucks, and some large pick-up trucks. The agency notes that these vehicles are normally used in a commercial capacity, and, as the Alliance argued, commercial vehicles normally undergo maintenance on a regular basis. Thus, these vehicles are less likely to experience significantly under-inflated tires. Moreover, since these vehicles have more wheels on an axle, they are less likely to experience the adverse effects on vehicle handling and other safety problems associated with significantly under-inflated tires.

The Alliance also recommended that the agency explicitly exclude incomplete vehicles from the standard.[58] Normally, the first-stage vehicle manufacturer is responsible for certifying that all vehicle systems that are not directly modified by subsequent-stage manufacturers meet all Federal motor vehicle safety standards. The Alliance stated that, in the case of direct TPMSs, the first-stage manufacturer will be unable to guarantee that, even if physically undisturbed, a non-defective TPMS will function as required after vehicle modifications (such as adding metal hardware to the vehicle or lengthening its wheelbase) are made by subsequent-stage manufacturers.

The agency notes that many incomplete vehicles are manufactured into custom vans and recreational vehicles. The agency believes that these vehicles should be equipped with the same or similar safety systems as passenger cars, multipurpose passenger vehicles, trucks, and buses. In particular, the agency believes that these types of vehicles should be equipped with a TPMS, as they are just as likely to experience significantly under-inflated tires as other light vehicles. In addition, the agency notes that if subsequent-stage manufacturers modify the TPMS on a vehicle, they will be responsible for certifying that the vehicle meets the standard. Therefore, the agency is not adopting the Alliance's suggested exclusion of incomplete vehicles.

4. Phase-In Options and Requirements

a. Alternatives Considered

For purposes of this first part of the final rule, the agency considered four alternatives, three of which are discussed above in section V.A., ''Alternative Long-Term Requirements Analyzed in Making Preliminary Determination.'' The fourth alternative considered by the agency is the one-tire, 30 percent alternative suggested by OMB. This alternative would require a vehicle's TPMS to warn the driver when the pressure in any one of the vehicle's tires is 30 percent or more below the placard pressure, or a minimum level of pressure specified in the standard, whichever pressure is higher. The benefits and costs of the one-tire, 30 percent alternative are discussed above in section VI.C. ''Analysis of a Fourth Alternative Long-Term Requirement: One-Tire, 30 Percent Under-Inflation Detection.''

While the agency ultimately considered four alternatives, in the NPRM the agency proposed only two alternative versions of a standard for TPMSs and requested comments on them. The two alternatives were the four-tire, 20 percent alternative and the three-tire, 25 percent alternative.

To simplify the agency's analysis and discussion of the comments, NHTSA is separately addressing below the two most significant aspects of these two alternatives, *i.e.,* the definition of the term ''significantly under-inflated'' and the number of tires the TPMS should monitor.

In the NPRM, the agency provided two alternate definitions of the term ''significantly under-inflated,'' and then used that term in specifying performance requirements for the low tire pressure warning telltale, while not specifying any performance requirements for the TPMS itself. After reviewing this approach to drafting and organizing the regulatory text, the agency decided to adopt a simpler, more direct approach. Instead of defining the term ''significantly under-inflated'' in the final rule, the agency is specifying performance requirements, including the threshold level of under-inflation that must trigger a warning, for two compliance options: the four-tire, 25 percent option and the one-tire, 30 percent option.

i. Threshold Level of Under-Inflation

As explained above in section II.D, ''Summary of Public Comments on Notice,'' RMA recommended that the agency define ''significantly under-inflated'' as any inflation pressure that is less than the pressure needed to carry the actual vehicle load on the tire per tire industry standards (or any pressure required to carry the maximum vehicle load on the tire if the actual load is unknown), or the minimum activation pressure specified in the standard, whichever is higher. RMA also recommended that the agency change the minimum activation pressures for P-metric standard load tires from 20 to 22 psi and for P-metric extra load tires from 23 to 22 psi. RMA also recommended that the agency change the ''Maximum Pressure'' heading in Table 1 to ''Maximum or Rated Pressure'' because light truck tires are not subject to maximum permissible inflation pressure labeling requirements. RMA recommended that the agency change

[58] 49 CFR Part 568.3 defines ''incomplete vehicle'' as ''an assemblage consisting, as a minimum, of frame and chassis structure, power train, steering system, suspension system, and braking system, to the extent that those systems are to be part of the completed vehicle, that requires further manufacturing operations, other than the addition of readily attachable components, such as mirrors or tire and rim assemblies, or minor finishing operations such as painting, to become a completed vehicle.''

the rated pressure for Load Range E tires from 87 to 80 psi. Finally, RMA, supported by RIGAC, recommended that the agency adopt a requirement in the agency's separate rulemaking to upgrade Standard No. 109, ''New Pneumatic Tires,'' that ''a tire for a particular vehicle must have sufficient inflation and load reserve, such that an inflation pressure 20 or 25 percent less than the vehicle manufacturer's recommended inflation pressure is sufficient for the vehicle maximum load on the tire, as defined by FMVSS–110.'' [59]

The ITRA recommended that the agency consider only direct TPMSs. The ITRA stated that indirect TPMSs have too many limitations, including the inability to detect when all four of a vehicle's tires are significantly under-inflated. The ITRA claimed that although direct TPMSs are more expensive than indirect TPMSs, their benefits outweigh their costs.

The Alliance recommended that the agency define ''significantly under-inflated'' as any inflation pressure 20 percent below a tire's load carrying limit, as determined by a tire industry standardizing body (such as the Tire and Rim Association) or the minimum activation pressure specified in the standard, whichever is higher. The Alliance agreed with the agency's minimum activation pressure of 20 psi for P-metric standard load tires.

The Alliance also stated that a 25 percent differential from placard pressure would be inadequate to allow the use of indirect TPMSs. The Alliance claimed that a minimum of 30 percent differential is necessary to ensure accuracy with an indirect TPMS and avoid excessive nuisance warnings.

The AIAM recommended that the agency define ''significantly under-inflated'' as any pressure more than 30 percent below the placard pressure. Alternatively, the AIAM suggested that the agency use the load carrying limit of the tire as defined by a tire industry standardizing body as the baseline for determining the warning threshold.

TRW stated that indirect TPMSs that are currently on the market could be improved to detect a 25 percent differential in inflation pressure. TRW stated this could be accomplished by adding the equivalent of two direct pressure sensors and a receiver to an indirect TPMS.

Advocates supported the definition of ''significantly under-inflated'' contained in the first alternative, *i.e.,* any pressure 20 percent or more below the placard pressure, or the minimum activation pressure specified in the standard, whichever is higher.

The agency notes that both RMA and the Alliance recommend that the agency tie the definition of ''significantly under-inflated'' to the load carrying capacity of the tire rather than the placard pressure. NHTSA declines to adopt this recommendation for two reasons.

First, the placard pressure provided by the vehicle manufacturer assumes loading at GVWR and also takes into consideration ride, handling, and other factors for safe vehicle operation. Some manufacturers also include a certain amount of reserve load capacity in the event that the tire is overloaded. Therefore, when tire pressure is down to 25 percent below the placard pressure, it is not necessarily below the pressure that is needed to safely carry the weight of the vehicle. Moreover, the agency notes that the calculations in the Tire and Rim Association (T&RA) tables are based on the volume of air in the tire, and do not consider differing performance capabilities of different tire materials or manufacturing quality.[60]

Second, consumers are currently not familiar with using the T&RA tables to determine the correct tire inflation pressure for their vehicles. However, they do have some familiarity with using the vehicle's placard pressure to maintain proper inflation pressures. It would be counter-productive to introduce a new frame of reference for consumers to use at this time unless there are compelling reasons to do so.

The agency agrees with the Alliance's statement that most current indirect TPMSs are not able to detect a 25 percent differential from placard pressure. Of the indirect TPMSs evaluated by the VRTC, only one was capable of activating the warning telltale at pressures at least 25 percent below the placard pressure.[61]

The agency believes that, as the technology matures, manufacturers will be able to improve the performance of indirect TPMSs. TRW, which manufactures both direct and indirect TPMSs, stated that the indirect TPMSs currently on the market could be improved to detect a 25 percent differential from placard pressure. However, TRW was not certain that these improvements could be developed and implemented by the 2003 effective date of the final rule. Sumitomo's comments indicated that indirect TPMSs would be able to detect a 25 percent differential in inflation pressure. Toyota stated that its next generation of indirect TPMSs would be able to detect a 20 percent differential in tire pressure by monitoring the resonance frequency as well as the dynamic radius changes of the tires. Again, however, Toyota did not have a timetable for the introduction of this next generation of indirect TPMSs.

Nevertheless, the fact remains that current indirect TPMSs are not capable of meeting a four-tire, 25 percent requirement. Accordingly, the agency is providing two compliance options in the first part of the final rule.[62]

These options will permit manufacturers to continue to use current indirect TPMSs while they continue to improve those systems. The agency notes that, for vehicles already equipped with ABS, the installation of a current indirect TPMS is the least expensive way of complying with the TPMS standard. Consumers will benefit from the resulting cost savings. The choice of compliance options will also give manufacturers the flexibility needed to innovate and improve the performance of the indirect TPMSs.

NHTSA notes that in some cases, 30 percent below placard pressure will be less than 20 psi, the minimum activation pressure specified for P-metric tires in Table 1. For example, if a tire's placard pressure were 27 psi, 30 percent below that would be about 19 psi. This final rule requires the TPMS to activate the low tire pressure telltale at 20 psi, not 19 psi. The agency has established the minimum activation pressures for the reasons given below. This final rule requires the telltale to be activated at the higher of the pressure that is 30 (or 25) percent below the placard pressure or the minimum activation pressure in Table 1, *whichever pressure is higher.* Thus, if a vehicle's tires have a placard pressure below 28 psi, and the manufacturer chooses to comply with the one-tire, 30 percent option, the telltale must be activated at 20 psi.

[59] Standard No. 110 specifies requirements for tire selection to prevent tire overloading.

[60] These tables, contained in the T&RA yearbook, establish the load carrying capacity of a tire at a specific inflation pressure.

[61] The indirect TPMS is manufactured by Continental Teves for the BMW M3. In the testing, it was able to detect when one, two (only if diagonally opposite each other) or three tires were significantly under-inflated.

[62] As noted above, the first part of this final rule covers vehicles manufactured from November 1, 2003 to October 31, 2006. During this period, the rule's requirements will be phased in according to the following schedule: 10 percent of a manufacturer's affected vehicles the first year, 35 percent the second year, and 65 percent the third year. Beginning November 1, 2006, all affected vehicles will have to be equipped with a TPMS. These vehicles will have to comply with the requirements in the second part of this final rule. The agency will issue the second part of this final rule by March 1, 2005.

The agency is not adopting RMA's suggestion to change the minimum activation pressures for P-metric standard load tires from 20 to 22 psi and for P-metric extra load tires from 23 to 22 psi. As noted in the NPRM, the agency recently tested a variety of Standard Load P-metric tires at 20 psi with 100 percent load at 75 mph for 90 minutes on a dynamometer. None of the tires failed. This leads the agency to believe that warnings provided at or above that level will give drivers sufficient time to check and re-inflate their vehicles' tires before the tires fail. Moreover, in a different TREAD Act rulemaking, the agency proposed to upgrade its tire standard.[63] Part of this upgrade would require tires to be tested at 20 psi under load and speed conditions. All tires would be required to pass this test after completing the proposed endurance test. The agency believes these proposed tests would ensure that tires are capable of operating safely for at least 90 minutes at the minimum activation pressures specified in Table 1 of this final rule. Finally, RMA provided no reason for this change. The agency notes that until 2001, the T&RA tables listed 20 psi as the minimum acceptable pressure for Standard Load P-metric tires. The agency does not know why this minimum pressure was changed to 22 psi in the 2001 T&RA tables.

The agency is adopting RMA's suggestion to change the ''Maximum Pressure'' heading in Table 1 to ''Maximum or Rated Pressure'' because light truck tires do not have maximum permissible inflation pressure labeling requirements. The agency is also adopting RMA's suggestion to change the rated pressure for Load Range E tires from 87 to 80 psi. The agency is also changing the corresponding kPa value from 600 to 550, and the corresponding minimum activation pressure from 350 to 320 kPa (51 to 46 psi).

The minimum activation pressures are set forth in the following table:[64]

TABLE 1—LOW TIRE PRESSURE WARNING TELLTALE—MINIMUM ACTIVATION PRESSURE

Tire type	Maximum or rated inflation pressure		Minimum activation pressure	
	(kPa)	(psi)	(kPa)	(psi)
P-metric-Standard Load	240, 300, or 350	35, 44, or 51	140	20
P-metric-Extra Load	280 or 340	41 or 49	160	23
Load Range C	350	51	200	29
Load Range D	450	65	260	38
Load Range E	550	80	320	46

Moreover, as noted above, part of the Standard No. 109 upgrade would require tires to be tested at 20 psi under load and speed conditions. All tires would be required to pass this test after completing the proposed endurance test. The agency believes these proposed tests, in effect, would require tires to have a reserve load.

ii. Number of Tires Monitored

As noted above, in the NPRM the agency proposed two alternatives: the four-tire, 20 percent alternative and the three-tire, 25 percent alternative. The agency specified only three tires in the three-tire, 25 percent alternative because currently available indirect TPMSs are not able to detect when all four of a vehicle's tires became significantly under-inflated.

Advocates, ITRA, and RMA recommended that the agency require TPMSs to detect when all four of a vehicle's tires become significantly under-inflated. RMA argued that it is very likely that all four tires will lose air pressure at a similar rate and become significantly under-inflated within a six-month period.[65] RMA stated that drivers would rely heavily on TPMSs for tire pressure maintenance, which will make this scenario even more likely.

The Alliance and AIAM recommended that the agency require TPMSs to detect significant under-inflation in only one of a vehicle's tires. The Alliance argued that TPMSs are not meant to replace the normal tire maintenance that would detect pressure losses due to natural leakage and permeation. Rather, TPMSs are designed to detect a relatively slow leak due to a serviceable condition, such as a nail through the tread or a leaky valve stem. Since such leaks rarely affect more than one tire simultaneously, the Alliance argued, it is sufficient to require TPMSs to detect only one significantly under-inflated tire.

The Alliance also claimed that if the agency required that more than one significantly under-inflated tire be detected simultaneously, manufacturers would not be able to use an indirect TPMS. The Alliance stated that indirect TPMSs look at wheel speed to calculate relative differences in the size of the rolling radii of the four wheels. However, due to load variances, steering effects, and variations in tire characteristics, differences in wheel speed must be compared between tires on opposite sides of the vehicle for the algorithm to reliably identify a relative pressure difference.

TRW stated that current indirect TPMSs could be improved to be able to detect more than one significantly under-inflated tire. TRW stated that this could be accomplished by adding a direct sensor to two wheels, one on each side of the vehicle.

NHTSA agrees with the Alliance's comment that TPMSs should not replace normal tire maintenance. The agency also accepts the Alliance's comment that most current indirect TPMSs would have difficulty detecting when more than one of a vehicle's tires is significantly under-inflated. As noted above, while the VRTC found that indirect TPMSs did warn the driver when one tire, two tires located diagonally from each other, and three tires were significantly under-inflated, the indirect TPMSs did not warn the driver when all four of a vehicle's tires, or two tires on the same axle or the same side of the vehicle, were significantly under-inflated.

However, the agency also believes that TPMSs should do more than detect a relatively slow leak due to a serviceable condition. There are other

[63] Docket No. NHTSA–2000–8011. The NPRM was published at 67 FR 10049, March 5, 2002.

[64] NHTSA notes that 1 psi equals 6.9 kPa. The agency has rounded the English conversions to the nearest psi.

[65] RMA states that normal air pressure loss is approximately 1 to 2 psi per month.

reasonably foreseeable circumstances in which significant under-inflation may occur. Further, the agency believes that many drivers will rely on the TPMS to prompt them to do inflation pressure maintenance. As noted above, data from the July 2001 BTS omnibus survey indicated that 65 percent of drivers would be less concerned with routinely maintaining their tire pressure if their vehicle were equipped with a TPMS.

The agency has data indicating that tires typically lose about 1 psi per month due to natural leakage and permeation. Although all four of a vehicle's tires probably will not lose pressure at exactly the same rate, they will lose some pressure. Thus, it is likely that all four of a vehicle's tires will be somewhat under-inflated at any time.

According to data from the February 2001 NCSA survey detailed above, 12 percent of passenger cars and 15.3 percent of light trucks with P-metric tires had at least two tires under-inflated by at least 25 percent; 5 percent of passenger cars and 7.2 percent of light trucks had at least three tires under-inflated by at least 25 percent; and 2.8 percent of passenger cars and 3.9 percent of light trucks had at least four tires under-inflated by at least 25 percent. If the agency adopted the Alliance's one-tire, 30 percent recommendation permanently, drivers of some vehicles, e.g., those equipped with current indirect TPMSs, would not be alerted to some of these potentially dangerous conditions. While these percentages are small, when applied to the entire light vehicle fleet (over 200,000,000 vehicles), these percentages translate into about 7,000,000 vehicles having all four tires significantly under-inflated at any time.

If the agency adopted the Alliance's recommendation permanently, TPMSs would only be required to detect when one of a vehicle's tires became under-inflated by 30 percent or more below placard pressure. As a result, TPMSs would not be required to detect many situations involving significant under-inflation in the real world. Consequently, the agency tentatively believes that, in the long-term, the four-tire, 25 percent option would best meet the mandate in the TREAD Act and best serve the American public.

However, as noted above in section VII.B.4.a.i., ''Threshold Level of Under-Inflation,'' the agency wants to allow vehicle manufacturers to use current indirect TPMS in the short run, *i.e.*, during the first part of this final rule, and to give them additional time to improve indirect TPMSs or develop hybrid TPMSs. The comments from TRW, Sumitomo, and Toyota indicate that current indirect TPMSs can be improved (whether by monitoring the resonance frequency of tires or by creating hybrid systems) to detect more than one significantly under-inflated tire.

To reconcile the limitations of current indirect TPMSs with the agency's belief that such systems can and should be improved to enhance safety, NHTSA has decided to give manufacturers two compliance options during the first part of this final rule period, *i.e.*, from November 1, 2003 through October 31, 2006.[66]

b. Option One: Four Tires, 25 Percent Under-Inflation

Under the first compliance option, a vehicle's TPMS must warn the driver when the pressure in one or more of the vehicle's tires, up to a total of four tires, is 25 percent or more below the vehicle manufacturer's recommended cold inflation pressure for the tires, or a minimum level of pressure specified in the standard, whichever pressure is higher. Vehicles certified to this compliance option also will have to comply with the remainder of the performance requirements, discussed below in section VII.B.5., ''Other Requirements,'' with the exception of the special written instructions for vehicles certified to the one-tire, 30 percent compliance option.

This compliance option is limited to light vehicles manufactured between November 1, 2003, and October 31, 2006. Light vehicles manufactured after October 31, 2006 will be subject to the requirements of the second part of this final rule, which the agency will publish by March 1, 2005. The remainder of the performance requirements, except for the special written instructions required for vehicles certified to the one-tire, 30 percent compliance option, will apply to light vehicles manufactured on or after November 1, 2003. c. Option Two: One Tire, 30 Percent Under-Inflation

Under the second compliance option, a vehicle's TPMS must warn the driver when the pressure in any one of the vehicle's tires is 30 percent or more below the vehicle manufacturer's recommended cold inflation pressure for the tires, or a minimum level of pressure specified in the standard, whichever pressure is higher.[67] Vehicles certified to this compliance option also will have to comply with the remainder of the performance requirements, discussed below in section VII.B.5. ''Other Requirements,'' including the special written instructions for vehicles certified to the one-tire, 30 percent compliance option.

This compliance option also is limited to light vehicles manufactured between November 1, 2003, and October 31, 2006. Light vehicles manufactured after October 31, 2006 will be subject to the requirements of the second part of this final rule, which the agency will publish by March 1, 2005. The remainder of the performance requirements, except for the special written instructions requirement, will apply to light vehicles manufactured on or after November 1, 2003.

d. Special Written Instructions for Option Two TPMSs

In the NPRM, the agency proposed that the vehicle owner's manual provide an image of the TPMS warning telltale and the following information, in English:

> When the TPMS warning light is lit, one of your tires is significantly under-inflated. You should stop and check your tires as soon as possible, and inflate them to the proper pressure as indicated on the vehicle's tire inflation placard. Driving on an under-inflated tire causes the tire to overheat and can eventually lead to tire failure. Under-inflation also reduces fuel efficiency and tire tread life, and may affect the vehicle's handling and stopping ability.

The agency also proposed to allow each vehicle manufacturer, at its discretion, to provide additional information about the significance of the low tire pressure warning telltale and description of corrective action that should be undertaken.

The Alliance stated that it was not opposed to the language the agency proposed. However, the Alliance recommended that the agency include additional language addressing inherent system limitations, owner/driver responsibility, and replacement tires and rims. The Alliance did not recommend any specific language.

NHTSA is accepting this Alliance comment. The agency notes that indirect TPMSs have several limitations, including the inability to detect when all four tires, and other combinations of tires, are significantly under-inflated. In addition, the agency notes that data from the July 2001 BTS omnibus survey indicate that 65 percent of drivers would be less concerned to a great extent or a very great extent with routinely maintaining their tire pressure if their vehicle were equipped with a TPMS. This substantial shift in reliance from routine maintenance to TPMS

[66] The agency is requiring manufacturers to irrevocably select the option to which they will certify their vehicles.

[67] As noted above, the minimum levels of pressure are the same for both compliance options.

concerns the agency, given the performance limitations of indirect TPMSs. To avoid the creation of a false sense of security, therefore, the agency is requiring vehicle manufacturers to provide additional information on the inherent limitations of TPMSs, if the vehicle is certified to the one-tire, 30 percent option. The additional information must immediately follow the general written instructions for all TPMSs, specified below, and read, in English, as follows:

Note: The TPMS on your vehicle will warn you when one of your tires is significantly under-inflated and when some combinations of your tires are significantly under-inflated. However, there are other combinations of significantly under-inflated tires for which your TPMS may *not* warn you. These other combinations are relatively common, accounting for approximately half the instances in which vehicles have significantly under-inflated tires. For example, your system may not warn you when both tires on the same side or on the same axle of your vehicle are significantly under-inflated. It is particularly important, therefore, for you to check the tire pressure in all of your tires regularly and maintain proper pressure.

5. Other Requirements

a. Time Frame for Telltale Illumination

NHTSA notes that in the NPRM the agency included this performance requirement in the requirements for the low tire pressure warning telltale. After reviewing this arrangement, however, the agency has decided that it was confusing. Thus, in the regulatory text of this final rule, the agency has shifted this performance requirement to the section of the regulatory text that specifies requirements for TPMSs.

In the NPRM, the agency proposed that the warning telltale illuminate not more than ten minutes after a tire becomes significantly under-inflated.

Advocates supported a much briefer time period, but did not specify a time period. Advocates stated that the agency had given no reason for a ten-minute time period. RMA stated that the earlier the driver is warned the better, but also did not specify a time period.

The Alliance stated that a detection window of ten minutes likely would be problematical for indirect TPMSs, which require different detection times at different speeds. The Alliance recommended that the detection requirement be changed to a driving interval of ten miles (16 kilometers) instead of ten minutes to accommodate indirect TPMSs.

According to data from the tire industry, 85 percent of tire pressure losses are slow pressure losses, in which it takes anywhere from several minutes to several weeks for a tire to become significantly under-inflated. The other 15 percent of tire pressure losses are rapid pressure losses, which typically result from a tire being punctured (without the puncturing object becoming embedded in the tire) or ruptured. TPMSs are designed to alert the driver to slow pressure losses, not rapid pressure losses. In addition, as noted above, all of the tires that the agency tested for endurance at 20 psi for 90 minutes passed. Thus, the agency believes that ten minutes between the time that a tire becomes significantly under-inflated and the time that the TPMS illuminates the low tire pressure warning telltale will provide the driver ample time to take corrective action and avoid the possibility of serious tire degradation. Accordingly, the agency is not adopting Advocates' suggestion that the agency shorten the time frame for telltale activation.

The agency notes that the test procedures proposed in the NPRM specified a test speed of 50 to 100 km/h. That means it would take a vehicle about 10 to 20 minutes to travel the 16 kilometers proposed by the Alliance. The agency also notes that in its survey of TPMSs, NHTSA's VRTC found that direct TPMSs could illuminate the warning telltale in less than one minute after a tire became significantly under-inflated (by 50 percent under placard pressure). The VRTC also found that indirect TPMSs took from less than a minute to over eight minutes. This leads the agency to believe that ten minutes is ample time for both direct and indirect TPMSs.

Thus, the agency is not adopting the Alliance's suggestion that the agency change the detection requirement to a driving interval of ten miles instead of ten minutes.

Accordingly, for the four-tire, 25 percent option, this final rule requires that the TPMS illuminate the low tire pressure warning telltale not more than ten minutes after the inflation pressure in one or more tires, up to total of four tires, is 25 percent or more below the placard pressure, or a minimum level of pressure specified in the standard, whichever pressure is higher. For the one-tire, 30 percent option, this final rule requires that the TPMS illuminate the low tire pressure warning telltale not more than ten minutes after the pressure in one tire is 30 percent or more below the placard pressure, or a minimum level of pressure specified in the standard, whichever pressure is higher.[68]

b. Duration of Warning

NHTSA notes that in the NPRM the agency included this performance requirement in the requirements for the low tire pressure warning telltale. After reviewing this arrangement, however, the agency has decided that it was confusing. Thus, in the regulatory text of this final rule, the agency has shifted this performance requirement to the requirements for TPMSs.

In the NPRM, the agency proposed to require that the warning telltale be illuminated as long as any of the vehicle's tires remains significantly under-inflated, and the ignition switch is in the ''On'' (''Run'') position, whether or not the engine is running. The agency also proposed that the telltale be deactivatable, manually or automatically, only when all of the vehicle's tires cease to be significantly under-inflated.

Advocates and RMA supported this proposal. Advocates stated that if manual disengagement of the illuminated telltale were permitted, a driver could indefinitely defer inspecting and correcting a significantly under-inflated tire simply by manually disengaging the telltale.

Johnson Controls, Inc. (JCI), a manufacturer of both direct and indirect TPMSs, was concerned that a strict reading of NHTSA's proposals may preclude a driver's ability to access other information when the significant under-inflation telltale is activated within a multi-functional console display. JCI argued that the agency should allow sufficient flexibility to permit the vehicle occupant to check other information on a multi-functional display even in a significant under-inflation situation. According to JCI, with current center displays in vehicles that incorporate a TPMS feature, the owner is allowed to toggle between features on the display. For example, on certain current tire and non-tire specific displays located in center consoles, the low pressure display will persist until the vehicle occupant chooses to view another display (e.g., a miles to empty display). In that circumstance, the new display will remain active for a period of 60 seconds and then the pressure warning will be redisplayed. In some instances, the redisplay will be accompanied by an audible warning. JCI argued that as long as alternative displays are selected by the vehicle occupant as a matter of conscious

[68] As noted above, the minimum levels of pressure are the same for both options.

choice and are of sufficiently short duration, the cautionary function of the display will be preserved. Accordingly, JCI recommended amending Section 4.2.1(e) to read as follows:

S4.2.1(e) Can be deactivated, manually or automatically, only when all of the vehicle's tires cease to be significantly under-inflated, or when the vehicle occupant chooses to view another feature on the same display provided that the pressure cautionary message is automatically redisplayed not more than 60 seconds after the display is toggled to another feature.

The Alliance stated that the requirement that the warning telltale be deactivated, manually or automatically, only when all of the vehicle's tires cease to be significantly under-inflated requires the vehicle to ''know'' that all the tires have ceased to be significantly under-inflated. This would prohibit the use of indirect TPMSs, which do not measure actual inflation pressure, and are therefore incapable of ''knowing'' when the tires are no longer significantly under-inflated. This is the reason indirect TPMSs come with a manual re-calibration capability—because all indirect TPMSs must be ''told'' that repair, rotation, replacement, or re-inflation has occurred.

The Alliance also noted that some vehicles have different placard pressures for the front and rear tires. For these vehicles, the TPMS warning cannot be fully automated. The driver or service agent must manually recalibrate the TPMS after rotating or correctly inflating the tires. For these reasons, the Alliance recommended amending Section 4.2.1(d) to read as follows:

S4.2.1(d) Remains activated (continuously or periodically) until automatically deactivated when all of the vehicle's tires cease to be significantly under-inflated or until manually deactivated in accordance with manufacturer's instructions.

NHTSA is not adopting JCI's suggestion because the agency does not believe the driver should be able to temporarily deactivate the warning telltale, even if the deactivation can only last for 60 seconds. The agency does not normally allow warning telltales to be temporarily deactivated by the driver. The agency also believes that the warning telltale should be separate from a reconfigurable display.

However, NHTSA is adopting the Alliance's suggestion that the agency allow the warning telltale to be manually extinguished in accordance with the vehicle manufacturer's instructions. The agency agrees with the Alliance's arguments. An indirect TPMS cannot ''know'' when a tire is no longer significantly under-inflated because it does not actually measure inflation pressure. An indirect TPMS must be told that the significantly under-inflated tire has been re-inflated. This is done with a manual reset button.

The agency noted in the NPRM that a reset button may invite human error. For example, a driver may accidentally press the reset button when one or more of the vehicle's tires are under-inflated, but not significantly under-inflated. This would re-calibrate the system so that the under-inflated condition would be accepted as a normal variable. The indirect TPMS then would not be able to detect a significantly under-inflated tire until one or more tires were 25 percent lower than it already was. This could also occur as a result of misuse, i.e., if the driver simply pressed the reset button when the warning telltale illuminated. The telltale would be extinguished without the driver having taken any corrective action.

While NHTSA is concerned by these potential problems, the agency notes that indirect TPMSs must have a reset button. Moreover, direct TPMSs need a reset button under certain circumstances. For example, some vehicle manufacturers specify more than one placard pressure for a vehicle's tires—one applicable when the vehicle is lightly loaded and another when the vehicle is at maximum load. If a manual reset were not allowed, then the direct system would not know that the applicable recommended inflation pressure had changed.

In addition, these human error problems are no different from the driver simply ignoring the warning telltale if it is illuminated. The agency can attempt to prevent these problems only through driver education. Thus, the agency will allow the warning telltale to be deactivated manually in accordance with the vehicle manufacturer's instructions.

Accordingly, the agency is adding paragraph S4.2.1(b) to the requirements for the four-tire, 25 percent option, to read as follows:

(b) Continue to illuminate the low tire pressure warning telltale as long as the pressure in any of the vehicle's tires is equal to or less than the pressure specified in (a), and the key locking system is in the ''On'' (''Run'') position, whether or not the engine is running, or until manually reset in accordance with the vehicle manufacturer's instructions.

The requirement for the one-tire, 30 percent option is slightly different because under that option the TPMS only has to be able to detect when one tire is 30 percent or more below the placard pressure. Accordingly, the agency is adding paragraph S4.2.2(b) to the requirements for the one-tire, 30 percent option, to read as follows:

(b) Continue to illuminate the low tire pressure warning telltale as long as the pressure in that tire is equal to or less than the pressure specified in (a), and the key locking system is in the ''On'' (''Run'') position, whether or not the engine is running, or until manually reset in accordance with the vehicle manufacturer's instructions.

c. Temporary Disablement

The Alliance noted that TPMSs might be disabled, deliberately or by default, under certain conditions. For example, TPMSs could be disabled on four-wheel-drive applications whenever the vehicle is operated in ''4WD Lo'' mode, typically during off-road use, or under very poor road conditions. The Alliance noted that most manufacturers of four-wheel-drive vehicles recommend that the tires be deflated to a lower pressure during certain conditions of off-road use. A TPMS calibrated to a threshold appropriate for on-road use would otherwise provide an unnecessary warning under this special condition. The Alliance also stated that certain types of all-wheel-drive vehicles that selectively lock the differential under specific operating conditions typically disable the TPMS under these conditions. The Alliance concluded that such selective disablement is inconsequential to safety, as vehicles operating under such conditions are generally moving at relatively slow speeds where low tire pressure is not a significant safety concern.

The Alliance also stated that TPMSs may be temporarily disabled or reduced in detection sensitivity by default due to technical limits on system capability. For example, indirect TPMSs are not capable of operating normally on rough roads, or at very high speeds (i.e., above 75 mph) where the high centrifugal force prevents accurate detection of differences in rolling radius. Direct TPMSs are not capable of operating when radio frequency interference disrupts the transmission of sensor signals between the wheel sensors and the receiver, or when a tire without a sensor (such as a temporary spare) is installed on the vehicle.

NHTSA has decided to prohibit any control that automatically disables the TPMS under any condition. The agency normally does not allow safety systems to be disabled, and the Alliance has provided no good reason for allowing the TPMS to be disabled. If drivers lower their tire pressure before off-road driving, and the low tire pressure warning telltale illuminates, it will serve as a reminder to the drivers to re-

inflate their tires before returning to the road. The agency does not believe that drivers will be inconvenienced if the telltale illuminates while they are driving off-road. Moreover, the Alliance indicated that drivers may also shift into ''4WD-Lo'' while driving on very poor road conditions. Since tire under-inflation plays a role in vehicle handling and stability, the agency believes that it is especially important that the TPMS be functioning when the vehicle is being driven on poor road conditions.

Finally, the agency notes that all technology has limitations, and there may be situations in which the TPMS may not function properly. The agency considered those situations in specifying the test conditions and procedures in this standard. The agency will not perform compliance tests under any conditions or procedures that would prevent TPMSs from functioning properly.

d. System Calibration

In the NPRM, the agency noted that most indirect TPMSs need time to calibrate the system, i.e., to ''learn'' the variables associated with distinct tire types under varying driving conditions. In its survey of current TPMSs, the VRTC found that the four indirect TPMSs it evaluated took anywhere from several minutes to several hours to calibrate. This calibration is necessary when a vehicle is driven for the first time (i.e., when it is new), when the pressure in a tire is changed, and when the tires are rotated or replaced. During the calibration mode, an indirect TPMS's ability to monitor tire pressure is severely limited. Thus, if one or more tires became significantly under-inflated while the system was calibrating, the driver might not be alerted.

The agency did not propose in the NPRM that the TPMS indicate to the driver that the system is in calibration mode. However, in the proposed test procedures, the agency specified that the vehicle be driven for 20 minutes to allow for system calibration. Thus, in effect, the agency required that TPMSs be able to calibrate within 20 minutes of driving.

The Alliance recommended that the agency allow manufacturers to provide, but not require, a calibration notification feature. The Alliance stated that recalibration generally takes place after the driver inflates the tires to the correct pressure. The driver then would be aware that calibration was taking place. The Alliance also argued that the likelihood of another significantly under-inflated tire occurring during the recalibration time frame is extremely low.

TRW recommended that the agency not require indirect TPMSs to indicate that they are in calibration mode. TRW stated that this feature would not be necessary with direct TPMSs because they do not require calibration.

The agency has decided not to require that the TPMS indicate when it is in calibration mode. The agency notes that calibration is necessary only for indirect TPMSs, and then it is necessary only when a vehicle is driven for the first time, when the pressure in a tire is changed, and when the tires are rotated or replaced. These are all times when significant under-inflation due to a slow leak should not be a problem. At these times, the tires either will be new or will have been checked. In addition, the agency notes that the driver is not able to take any action when given an indication of system calibration. For these reasons, the agency does not believe that a calibration indication feature would provide any safety benefits. However, if manufacturers wish to provide a calibration notification feature, they are free to do so. The agency is not prohibiting such a feature.

e. Replacement Tires

In the NPRM, the agency proposed to require that each TPMS be able to function properly when any of the vehicle's original tires or rims are replaced with any optional or replacement tire or rim of the size(s) recommended for use on the vehicle by the vehicle manufacturer.

RMA supported the agency's proposal. Advocates recommended that the agency require TPMSs to function properly with all replacement tires and rims, regardless of size.

The Alliance recommended that the agency require TPMSs to function properly only with those tires and rims offered as original or optional equipment by the vehicle manufacturer. The Alliance stated that there are a large number of replacement brands and types of tires and rims with different dynamic rolling radii, size variations, load variations, and temperature characteristics. The Alliance argued that since vehicle manufacturers do not control tire compliance for aftermarket tires and rims, they cannot guarantee that the TPMS will work, or will work with the same level of precision, in all cases.

JCI requested that the agency clarify that it was not requiring TPMSs to function when custom tires and rims not recommended by the vehicle manufacturer are installed on the vehicle. JCI stated that both indirect TPMSs (because of tire diameter changes and different tire pressure thresholds) and direct TPMSs (because of the potential inability to install and operate the transmitter) are compromised by such installations.

The Specialty Equipment Market Association (SEMA) claimed that the proposed rule would have a major effect on business that sell aftermarket tires and rims. SEMA was concerned that the rule could: (1) Disallow aftermarket equipment that does not match the vehicle manufacturer's recommendations; (2) fail to require manufacturers to implement the TPMS in a manner that allows reprogramming by aftermarket installers; (3) fail to require that vehicle manufacturers design tire pressure sensors to be compatible with aftermarket tire and wheel combinations and standardized communication protocols to ensure that aftermarket sensors are compatible with OEM systems; (4) fail to direct consumers to inflate the tire to the pressure for the specific wheel and tire combination in use; and (5) render servicing by independent repair facilities more difficult.

In this final rule, the agency is requiring that each TPMS meet the requirements of the standard when any of the vehicle's original tires are replaced with any optional or replacement tire of the size(s) recommended for use on the vehicle by the vehicle manufacturer and installed on the original rims. This requirement is the same for TPMSs complying with the four-tire, 25 percent option or the one-tire, 30 percent option.

The agency is not requiring that TPMSs meet the requirements of the standard when any of the vehicle's original rims are replaced with any optional or replacement rim of the size recommended for use on the vehicle by the vehicle manufacturer. The agency notes that since most direct TPMS sensors are mounted on the rim, the rim must be of a design that will accommodate the sensor. Some aftermarket rims may be the same size as the original rim, but have a design that will not accommodate a TPMS sensor. Thus, the agency does not believe that requiring TPMSs to work with all replacement rims of the same size recommended for use by the vehicle manufacturer is feasible.

However, the agency does believe that requiring TPMSs to work with all replacement tires of the same size recommended by the vehicle manufacturer is feasible. The agency notes that while tires may have different designs, they are basically designed to

meet tire industry standards. The agency also notes that aftermarket direct TPMSs currently are available on the market. These TPMSs necessarily must be able to function regardless of the brand of tire. Moreover, RMA supported the agency's proposal to require TPMSs to work with all replacement tires of the same size or size recommended by the vehicle manufacturer. RMA did not state that this would be impossible due to differences in tire brands.

The agency emphasizes that this requirement only applies to replacement tires that are of a size recommended for use on the vehicle by the vehicle manufacturer. It does not apply to any tires of a size not recommended for use on the vehicle by the vehicle manufacturer. If a tire retailer or repair business installs these tires on a vehicle, neither this final rule nor the statute under which it is issued requires the vehicle's TPMS to continue to meet the requirements of the final rule.

NHTSA notes that 49 U.S.C. 30122 prohibits manufacturers, distributors, dealers, and motor vehicle repair businesses from knowingly making inoperative any part of a device or element of design installed on or in a motor vehicle or motor vehicle equipment in compliance with an applicable Federal motor vehicle safety standard. The agency has determined that if such a business installed on a vehicle aftermarket rims that are not identical to the original rims, or tires that are not of the same size recommended for use on the vehicle by the vehicle manufacturer, the business would not violate the make inoperative provision. However, if such a business knowingly renders a vehicle's TPMS inoperative while rotating the vehicle's tires or installing tires that are of the same size recommended for use on the vehicle by the vehicle manufacturer, and does not repair the TPMS, the business has violated the make inoperative provision.

f. Monitoring of Spare Tire

In the NPRM, the agency did not propose that the TPMS be required to monitor the pressure in the spare tire because NHTSA does not require vehicles to be equipped with a spare tire.

Advocates and RMA recommended that the agency require TPMSs to monitor a vehicle's spare tire. RMA argued that the spare tire should be monitored to ensure its functionality, if and when it is needed. Advocates stated, ''Vehicle owners chronically neglect to maintain minimal air pressure in spare tires.'' However, Advocates did not provide any evidence to support its position.

The Alliance recommended that the agency require TPMSs to monitor only matching, full-size spare tires, and only when they are installed on the vehicle (*i.e.,* not while they are stowed). The Alliance stated that temporary-use spare tires, including full-size, non-matching and compact spare tires, are not intended to be part of the normal tire rotation cycle for the vehicle. Because these temporary-use spare tires degrade the esthetic appearance or have speed and distance limitations, vehicle owners normally replace them quickly. Thus, the Alliance recommended that the agency not require TPMSs to monitor temporary-use tires, whether stowed or installed on the vehicle. However, the Alliance recommended that the agency require the TPMS to monitor a matching, full-size spare tire when it is installed on the vehicle.

The agency has decided not to require TPMS to monitor the spare tire, either when the tire is stowed or when it is installed on the vehicle, for several reasons.

First, temporary-use tires are not intended to be used on the road for long periods of time. The agency also notes that compact spare tires pose problems for both direct and indirect TPMSs. A compact spare requires much a higher inflation pressure and a different warning threshold. A compact spare is also much smaller, and thus has a smaller rolling radius, than original tires. This could cause an indirect TPMS to give a false warning.

Second, drivers know when a temporary-use spare tire has been installed on the vehicle, and they know that the tire is intended for temporary-use only. The agency believes that most, if not all, drivers will have such spare tires replaced as quickly as possible. For these reasons, the agency is not requiring the TPMS to monitor temporary-use spare tires, including compact spares and non-matching, full-size temporary tires.

Notwithstanding the Alliance's comment, the agency does not believe that matching, full-size spare tires need be monitored, even though such tires may be used in the tire rotation. The agency has no data indicating how many vehicles are provided with a matching, full-size spare tire. In addition, the agency is concerned that requiring the TPMS to monitor the spare tire would add to the cost of the rule significantly because vehicle manufacturers would have to provide an additional pressure sensor (in the case of a direct TPMS) and a matching rim, with little, if any, safety benefit. Finally, the agency is concerned that requiring this would provide a disincentive to vehicle manufacturers to provide vehicles with matching, full-size spare tires.

g. Temperature Compensation

In the NPRM, the agency noted that when a vehicle is being driven, the temperature in its tires increases. The increased temperature causes increases in the inflation pressure of the tires.[69] This phenomenon could impact the ability of a TPMS to measure or calculate the cold inflation pressure in a tire accurately. A temperature compensation feature in a TPMS compensates for the increased inflation due to temperature increases.

It is possible that, without temperature compensation, the low tire pressure warning telltale could be extinguished due to the increase in tire pressure experienced during normal driving. For instance, if a vehicle's tires became significantly under-inflated overnight, while the vehicle's tires were cold, the low tire pressure warning telltale would be illuminated. However, if the driver did not re-inflate the vehicle's tires, the temperature of the tires, and thus the inflation pressure, would increase during normal driving. This could cause the telltale to be extinguished.

In addition, large fluctuations in the ambient temperature could result in the low tire pressure warning telltale's being activated on vehicles during ignition, and then automatically de-activated, if the vehicle has that capability, after the vehicle has been driven for a while and the temperature (and thus the pressure) in a tire increases.

NHTSA did not propose that TPMSs have a temperature compensation feature. The agency believed that such a feature would add to the cost of the proposed standard and that indirect TPMSs would not be able to meet such a requirement. NHTSA did, however, request comments on whether such a feature should be required.

The Alliance commented that indirect TPMSs do not require temperature compensation because temperature variances are accounted for naturally in the rolling radii of the tires. Moreover, increases in temperature, and thus in pressure, affect all of a vehicle's tires equally. Thus, the pressure in all four

[69] The actual tire pressure increase due to heat appears to depend on several factors, including whether the tire is under-inflated to start with, the load on the tire, and how much braking has occurred recently. The agency believes that the maximum increase in tire pressure due to increased temperature is 4 psi.

tires increases similarly and does not affect an indirect TPMS's calculation of tire pressure.

The Alliance also stated that direct TPMSs may employ temperature compensation to prevent nuisance warnings. The Alliance recommended that the agency not require temperature compensation because good engineering practices and concern for customer satisfaction (*i.e.,* by preventing nuisance warnings) will compel this feature where needed, regardless of regulation.

Advocates and the EC recommended that the agency require temperature compensation. Advocates stated that temperature compensation is crucial not only to reliable operation of TPMSs in providing accurate detection and notification of low pressure conditions in tires, but also to ensure that TPMSs provide positive feedback and confidence among vehicle operators as meaningful indicators of incipient safety problems which require rapid attention. Advocates expressed concerned that without temperature compensation, the low tire pressure warning telltale would activate and de-activate with temperature, and corresponding pressure, increases. Advocates believed this would encourage drivers to ignore the warning telltale. The EC suggested that temperature compensation might be necessary to ensure the reliability and accuracy of TPMSs.

NHTSA has decided not to address this in this new standard. As noted in the Alliance comments, indirect TPMSs do not need temperature compensation. For direct TPMSs, the agency believes that it is appropriate to allow flexibility to address issues like these, particularly in the early stages of a technology like TPMS. If real-world experience shows that the public is getting nuisance warnings, the agency will revisit this issue.

h. Low Tire Pressure Warning Telltale

The performance requirements for the low tire pressure warning telltale discussed below are the same for both the four-tire, 25 percent option and the one-tire, 30 percent option.

i. Color

In the NPRM, the agency proposed to require that the color of the warning telltale be yellow. The agency received several comments on this issue.

Advocates recommended that the agency require the color to be red. Advocates stated that a number of current lighted warning telltales providing status information to driver of vehicle operating systems (*e.g.,* brake systems and engine oil) use red lamps. Advocates argued that, in most cases, an imminent safety hazard is not present when these warning lamps are illuminated, yet their color is red. Advocates also argued that the low tire pressure warning telltale would alert drivers about the existence of a potentially dangerous situation that needs rapid correction. Advocates stated that a red lamp would convey this urgency to drivers better than a yellow lamp.

The Alliance agreed that yellow is the appropriate color for the warning telltale. However, the Alliance recommended that if a manufacturer chooses to imbed the warning telltale in a reconfigurable display, the telltale be excluded from the yellow color requirement. The Alliance argued that the changing appearance of the display would serve the purpose of drawing the driver's attention to the warning, which is otherwise accomplished by lighting a lamp.

The agency is not adopting Advocates' suggestion. The use of the color red for telltales is usually reserved for telltales warning of an imminent safety hazard. The brake systems warning telltale is required to be red because a failure in a vehicle's brake system results in an imminent safety hazard that requires immediate attention. The agency does not believe that a significantly under-inflated tire represents an imminent safety hazard. As noted above, the agency has tested a variety of tires at 20 psi, the minimum activation pressure for the warning telltale, for 90 minutes. None of the tires failed. In addition, as noted above, the agency will propose to test all Standard Load P-metric tires at 20 psi under load and speed conditions for 90 minutes after they undergo a stringent endurance test. This proposal was included in the agency's NPRM to upgrade its tire standard.[70] The agency believes that these tests will ensure that tires will be able to operate safely for at least 90 minutes at the minimum activation pressures specified in this standard. Moreover, the agency notes that since most Standard Load P-metric tires have a placard pressure of at least 30 psi, the warning telltale will have to illuminate at a pressure above the minimum activation pressure. Accordingly, the agency concludes that yellow is the appropriate color because it conveys the message that the driver can continue driving, but should check and adjust the tire pressure at the earliest opportunity.

NHTSA is also not adopting the Alliance's suggestion. The agency notes that reconfigurable displays can be reconfigured by the driver. The driver might reconfigure the display to not show the tire pressure for hours, days, or weeks at a time. Thus, if the low tire pressure warning telltale were imbedded in the reconfigurable display, the driver might not be alerted to the existence of a significantly under-inflated tire. The agency has no objection if manufacturers wish to use a reconfigurable display to display individual tire pressure. However, the agency does not believe the telltale itself should be imbedded in a reconfigurable display.[71] Thus, the agency is not adopting the Alliance's suggestion that the agency exclude reconfigurable displays from the color requirement.

ii. Symbol

In the NPRM, the agency proposed three symbols for the low tire pressure warning telltale. The first was an image of the vehicle with lamps located at the image's tires to indicate which tire is significantly under-inflated. The agency noted that such an image, with lamps around the image that illuminate when there is a problem (*e.g.,* an incompletely closed door) in that area, is already built into the dashboard of some vehicles. Thus, the agency proposed that this image, with lamps at the image's tires to indicate which tire is significantly under-inflated, be required if a vehicle manufacturer provides a display that identifies which tire is significantly under-inflated.

The agency received no comments opposing the use of this image. Thus, the final rule requires the use of this image, with lamps at the image's tires to indicate which tire is significantly under-inflated, if a vehicle manufacturer provides a display that identifies which tire is significantly under-inflated.

In addition to the vehicle image, the agency proposed a choice between two symbols for TPMSs that do not inform the driver which tire is significantly under-inflated. The first was developed by the International Organization for Standardization (ISO). It is used to identify tire malfunctioning and is currently used in some vehicles with TPMSs. The second was a symbol of a low tire developed by the agency. All three symbols are set out below:

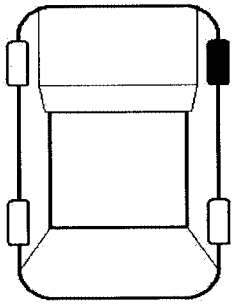
BILLING CODE 4910–59–P

[70] Docket No. NHTSA–2000–8011. The NPRM was published at 67 FR 10049, March 5, 2002.

[71] To prevent the telltale from being installed in a reconfigurable display, the agency is requiring that the telltale, once illuminated, remain illuminated until automatically extinguished when all of the vehicle's tires cease to be significantly under-inflated or until manually extinguished in accordance with the vehicle manufacturer's instructions.

ISO Symbol

NHTSA Low Tire Symbol



Vehicle Symbol Indicating Which Tire Is Significantly Under-Inflated

BILLING CODE 4910–59–C

Prior to issuing the NPRM, the agency conducted symbol comprehension tests to aid the agency in determining which symbol best conveyed a tire pressure problem to drivers. The agency asked 120 people to look at 15 symbols, including the ISO symbol and the low tire symbol developed by the agency, and fill in the blank in the following statement: ''This image has just appeared on your vehicle's dashboard. It is a warning for ___.''

Results of this test indicated that the ISO symbol was the least understood among the 15 symbols, with a comprehension rate of only 38 percent. The low tire symbol developed by the agency had a comprehension rate of 100 percent.

The agency received several comments on this issue. Advocates and ITRA recommended that NHTSA require the low tire symbol developed by the agency because it had high recognition value, while the ISO symbol had low recognition value.

The Alliance recommended that the agency require the ISO symbol for several reasons. First, the Alliance argued that while the agency-developed low tire symbol is easier to recognize than the ISO symbol on paper, it is not easier to recognize when reduced to the size, and placed in the medium, that would be used for a dashboard display.[72] The Alliance claimed that on a dashboard display, the resolution of the low tire symbol would not allow for the flat portion of the tire to be seen. The ISO symbol, according to the Alliance, remains visible and recognizable, even when reduced and placed in a dashboard.

Second, the Alliance argued that the low tire symbol falsely indicates that a tire is flat, rather than that pressure is low. The ISO symbol does not provide this misleading information.

Third, the Alliance argued that while the ISO symbol initially may not be recognized as a low tire warning, the near-universal requirement for TPMSs will rapidly lead to widespread recognition of whatever symbol NHTSA ultimately decides to require.

Finally, the Alliance argued that the ISO symbol has already been adopted as a voluntary standard and is in widespread use among those manufacturers currently offering TPMSs. Were NHTSA to require a unique symbol for the U.S. market, manufacturers who already use the ISO symbol would be required to re-tool their instrument clusters to accommodate the unique symbol. According to the Alliance, this would be expensive and time-consuming.

ITRA recommended that the agency require an audible warning as well as a warning lamp. ITRA stated that many drivers ignore a warning lamp, especially on bright days.

The agency agrees with the Alliance's arguments. Although the NHTSA-developed low tire symbol had a high recognition rate on paper, its level of detail, and thus its recognition rate, might not be retained when reduced in size and translated from paper to a dashboard display. Moreover, the agency believes that when TPMSs are first introduced, no matter what symbol the agency requires, drivers will consult their owner's manual to determine exactly what the symbol means and what they should do when the telltale illuminates. Drivers then will associate that telltale with a significantly under-inflated tire. Finally, the agency is interested in harmonizing its standards when it can do so consistent with the interests of safety. Since the ISO symbol is currently being used by manufacturers in Europe and the U.S., and since it will likely be readily learned, the agency can easily harmonize this requirement. For these reasons, the agency is requiring the ISO symbol. The agency also has decided to allow the use of the words ''Low Tire'' with the ISO symbol so that drivers will become familiar with the low tire pressure warning telltale more rapidly.

The agency is not requiring an audible warning in addition to the telltale lamp. The agency notes that although ITRA stated that many drivers ignore a warning lamp, it provided no such evidence. The agency believes that requiring an audible warning would increase the cost of TPMSs without providing any additional benefits.

iii. Self-Check

In the NPRM, the agency did not propose that the TPMS conduct a self-check or a bulb-check at vehicle start-up. However, it did request comments on the desirability of requiring such a check.

Advocates strongly supported both a system-check and a bulb-check. Advocates stated that vehicle systems regularly provide a system readiness check or a bulb-check to provide an initial indication to the driver that the system is operational. Advocates recommended a system- and bulb-check which provides several seconds of separate notification to the driver after the vehicle is started instead of the fleeting notification which is usually supplied only when the ignition is first engaged.

RMA also supported both a system-check and a bulb-check. RMA argued that, with the broad installation of TPMSs, much of the motoring public will rely heavily on the systems for tire inflation maintenance. The frequency of routinely checking tire pressure is expected to drop significantly. Accordingly, RMA recommended that TPMSs go through a self-diagnostic check, including a bulb-check, with each vehicle start-up to indicate to the driver that the system is operational.

TRW stated that both direct and indirect TPMSs could perform a bulb-check and a self-check. TRW stated that with direct TPMSs, each tire pressure sensor can be set to periodically transmit an indication that it is functioning. If a sensor is not transmitting, or a sensor's battery is low, the receiver can send a system-malfunction message to the vehicle's body control module and illuminate the TPMS telltale. If the telltale is not illuminated, the driver is being told that the TPMS is functioning properly and no tire is significantly under-inflated. TRW stated that, for indirect TPMSs, the ABS system already performs a system malfunction monitoring process. This includes both static and dynamic checks that are handled in a continuous monitoring process.

The Alliance recommended that the agency not require either a bulb-check or a self-check. The Alliance stated that vehicle manufacturers include serviceability provisions as a matter of normal design practice and do not need regulatory requirements in this regard.

After considering all the comments on this issue, the agency has decided to require a bulb-check, but not a self-check, at vehicle start-up. The agency believes that a bulb-check will add little, if any, cost to the TPMS and provide drivers with useful information, i.e., that the warning telltale bulb is functional.[73] Accordingly, the agency is adding a new section S4.3.3 as follows:

S4.3.3 (a) Except as provided in paragraph (b) of this section, each low tire pressure warning telltale must be activated as a check of lamp function either when the key locking system is turned to the ''On'' (''Run'') position when the engine is not running, or when the key locking system is in a position between ''On'' (''Run'') and ''Start'' that is designated by the manufacturer as a check position.

[72] In the symbol comprehension tests, the symbols were presented on paper as 18×18 mm images. The telltales in vehicle dashboards average about 8×8 mm.

[73] The agency did not quantify the cost of a bulb-check, but the agency notes that most of the TPMSs tested by the VRTC performed a bulb-check. Since the agency used these systems in estimating the costs of this rulemaking, the cost of a bulb-check likely was already included, *e.g.,* in the cost of the control module.

(b) The low tire pressure warning telltale need not be activated when a starter interlock is in operation.

The agency has decided not to require that the TPMS perform a self-check. The agency agrees with RMA's comment that drivers will rely on the TPMS for tire inflation maintenance and check their tire pressure less often. However, NHTSA only requires a self-check for air bag and brake systems, i.e., major safety systems. Moreover, the agency is uncertain of the costs and benefits of requiring a self-check.[74] According to TPMS manufacturer comments, the TPMSs in service to date have shown outstanding reliability, so there appears to be little need for a requirement in this area.

i. General Written Instructions for All TPMSs

In the NPRM, the agency proposed that the vehicle owner's manual provide an image of the TPMS warning telltale and the following information, in English:

When the TPMS warning light is lit, one of your tires is significantly under-inflated. You should stop and check your tires as soon as possible, and inflate them to the proper pressure as indicated on the vehicle's tire inflation placard. Driving on an under-inflated tire causes the tire to overheat and can eventually lead to tire failure. Under-inflation also reduces fuel efficiency and tire tread life, and may affect the vehicle's handling and stopping ability.

The agency also proposed to allow each vehicle manufacturer, at its discretion, to provide additional information about the significance of the low tire pressure warning telltale and description of corrective action that should be undertaken.

The Alliance stated that it was not opposed to the language the agency proposed. However, the Alliance recommended that the agency include additional language addressing inherent system limitations, owner/driver responsibility, and replacement tires and rims. The Alliance did not recommend any specific language.

Advocates recommended that the agency change the first sentence to read: ''When the TPMS warning light is lit, one *or more* of your tires *are seriously* under-inflated.'' Advocates also recommended that the agency remove the word ''eventually'' from the third sentence to encourage drivers to take immediate action.

RMA recommended that the written instructions be revised to read as follows:

When the TPMS warning light is lit, one of your tires is significantly under-inflated. You should stop and check your tires as soon as possible, and inflate them to the proper pressure as indicated on the vehicle's tire inflation placard. If checking air pressure when the tire is hot from driving, never ''bleed'' or reduce air pressure, as it is normal for pressures to increase above recommended cold pressures. Driving on a significantly under-inflated tire causes the tire to overheat and can eventually lead to tire failure. Under-inflation also reduces fuel efficiency and tire tread life, and may affect the vehicle's handling and stopping ability. Each tire, including the spare, should be checked monthly when cold and set to the recommended inflation pressure as specified on the vehicle placard and owner's manual.

The agency is accepting Advocates' recommendation to add the words ''or more'' to the first sentence and remove the word ''eventually'' from the third sentence. The agency notes that activation of the low tire pressure warning telltale could signify that more than one tire is significantly under-inflated. The agency also notes that the word ''eventually'' could lead drivers to believe that a significantly under-inflated tire is not a potentially dangerous condition.

The agency also is accepting the last sentence of RMA's recommended instructions. The agency has no objection to this information being added and believes it may be useful in encouraging drivers to check their tire pressure more often.

The agency is not adopting Advocates' recommendation to change the word ''significantly'' in the first sentence to ''seriously.'' The standard does not define either term. However, Section 13 of the TREAD Act refers to ''significant'' rather than ''serious'' under-inflation. Moreover, in the NPRM the agency discussed ''significant'' rather than ''serious'' under-inflation. For the sake of consistency, the agency believes the phrase ''significantly under-inflated'' should be used in the written instructions. The agency also is not adopting the third sentence of RMA's recommended language. The agency notes that if the low tire pressure warning telltale is lit, then one or more of the vehicle's tires is significantly under-inflated. The agency does not believe that drivers will respond to the warning telltale by reducing air pressure. Thus, that sentence is unnecessary.

As noted above, the agency is accepting the Alliance's recommendation to add language concerning the inherent limitations of TPMSs. The agency specified the additional information vehicles certified to the one-tire, 30 percent compliance option must include in the owner's manual. That information must follow the general written instructions specified below.

As for the Alliance's recommendation for additional language on driver responsibility and replacement tires, the agency is allowing manufacturers, at their discretion, to add additional information regarding the particular TPMS installed in the vehicle. This should allow manufacturers to add information concerning the limitations of the particular TPMS, driver responsibility, replacement tires, whether the TPMS works with the vehicle's spare tire, and how to use the reset button, if one is provided. However, any additional language should be placed after the written instructions the agency is requiring. The written instructions specified by the agency should be placed in the owner's manual, in English, as specified below:

When the TPMS warning light is lit, one or more of your tires is significantly under-inflated. You should stop and check your tires as soon as possible, and inflate them to the proper pressure as indicated on the vehicle's tire information placard. Driving on a significantly under-inflated tire causes the tire to overheat and can lead to tire failure. Under-inflation also reduces fuel efficiency and tire tread life, and may affect the vehicle's handling and stopping ability. Each tire, including the spare, should be checked monthly when cold and set to the recommended inflation pressure as specified in the vehicle placard and owner's manual.

j. Test Conditions

In the NPRM, the agency proposed that each vehicle be tested at its GVWR and its lightly loaded vehicle weight (LLVW), defined as unloaded vehicle weight plus up to 400 pounds (including test driver and instrumentation). The ambient temperature would be between 0 degrees C (32 degrees F) and 40 degrees C (104 degrees F). The test road surface would be dry and smooth. The vehicle would be tested at speeds between 50 km/h (31.1 mph) and 100 km/h (62.2 mph).

Advocates supported these proposed test conditions. RMA recommended that vehicles be tested at speeds up to 120 km/h (75 mph) to reflect real-world driving conditions. RMA argued that drivers typically travel on interstate highways at speeds of 75 mph and higher for extended periods of time. Thus, TPMSs should be tested to ensure

[74] The cost of a self-check for air bag and brake systems was included in the cost of the electronic control units for those systems. The agency was unable to separately estimate the cost of a self-check for those systems. Similarly, in its tear-down study of TPMSs to estimate their costs, the agency was unable to separately estimate the cost of a self-check for TPMSs.

that they function properly at highway speeds.

The Alliance recommended several changes to the proposed test conditions. The Alliance recommended separate test conditions for direct and indirect TPMSs as follows:

Test Conditions for Indirect TPMS:

S5.1 Ambient temperature. The ambient temperature is between 0°C (32°F) and 40°C (104°F). The ambient temperature during the test procedure must not change more than +/−1.5°C (+/−2.5°F).

S5.2 Road test surface.

S5.2.1 Test Surface Description. Tests are conducted on a dry, smooth level roadway.

S5.2.2 Radius of Curvature. Minimum radius of curvature of 1600 mm.

S5.2.3 Longitudinal Acceleration. Maximum longitudinal acceleration generated +/−0.05 g at the test speeds indicated.

S5.2.4 Gradient. The test surface has no more than a 1% gradient in the direction of testing and no more than a 2% gradient perpendicular to the direction of testing.

S5.2.5 Pavement Friction. The road test surface produces a peak friction of coefficient of 0.9 when measured using an American Society of Testing Materials (ASTM) E1136 standard reference test tire, in accordance with ASTM Method E 1337–90, at a speed of 64.4 km/h (40 mph), without water delivery.

S5.3 Altitude. Tests are conducted at an altitude between 0 to 500 m (0 to 1640 ft) above sea level.

S5.4 Vehicle conditions.

S5.4.1 Test weight. The vehicle is tested at its lightly loaded vehicle weight and at its gross vehicle weight rating without exceeding any of its gross axle weight ratings. The weights should also be evenly distributed between the left and right sides. The difference between the left and right side static corner weights should be less than 3% of the total vehicle weight.

S5.4.2 Vehicle speed. The vehicle is tested at a speed between 50 km/h (31.1 mph) and 100 km/h (62.2 mph).

Test Conditions for Direct TPMSs:

The Alliance's recommended test conditions for direct TPMSs are the same as those for indirect TPMSs, with the following additions:

S5.4 Barometric Pressure. Barometric Pressure will be recorded and the measured significantly under-inflated tire pressure threshold will be corrected using the following equation: P (adjusted threshold) = P (significantly under-inflated) = 1 Atmosphere − Barometric Pressure. Note: 1 atmosphere = 101.3kpa (14.7 psi).

NHTSA is not adopting the additional conditions recommended by the Alliance. The agency notes that specifications regarding radius of curvature, longitudinal acceleration, gradient, and pavement friction are useful in braking tests, but have little relevance to the testing of TPMSs. The agency also notes that changes in altitude and barometric pressure should make little difference, if any, in the outcome of these tests. The agency also does not see the need to specify that the vehicle weights should be evenly distributed and that the difference between the left and right side static corner should be less than 3 percent of the total vehicle weight. NHTSA does not specify this for braking or any other tests that need a high degree of precision and specificity.

NHTSA also is not adopting RMA's recommended test speed. While passenger vehicles are regularly driven on interstate highways at speeds of 75 mph, those vehicles are also regularly driven at even higher speeds. The point of the test speeds is not to test the speed capability of the vehicle. Instead, the test speeds must cover a sufficient variety of driving speeds to reflect real-world usage. The agency believes that the proposed test speeds do that.

NHTSA has decided to revise the definition of ''lightly loaded vehicle weight'' to make it consistent with Standard No. 135, ''Passenger car brake systems.'' The definition now reads as follows:

> *Lightly loaded vehicle weight* means unloaded vehicle weight plus the weight of a mass of 180 kg (396 pounds), including test driver and instrumentation.

These test conditions are the same for both the four-tire, 25 percent and one-tire, 30 percent compliance options.

k. Test Procedures

In the NPRM, the agency proposed that the vehicle's tires be inflated to the placard pressure. Then the vehicle would be driven between 50 km/h (31.1 mph) and 100 km/h (62.2 mph) for up to 20 minutes. While driving at that speed, any combination of tires (from one to four for the first alternative and from one to three for the second) would be deflated until it was significantly under-inflated. Then the elapsed time between the time that the vehicle's tire or combination of tires became significantly under-inflated and the time the low tire pressure warning telltale was illuminated would be recorded. After the telltale illuminates, pressure would be added to the tire or combination of tires that was deflated such that the tire or each of the tires was one psi below the level of significant under-inflation. Then the warning telltale would be checked to see if it remained illuminated. If the telltale remained illuminated, a manual reset would be attempted. These test procedures were to be repeated for each tire and rim combination recommended for the vehicle by the vehicle manufacturer.

The Alliance claimed that the proposed test procedures would not allow for fair and adequate assessments of both direct and indirect TPMS performance. The Alliance recommended separate test procedures for indirect and direct TPMSs as follows:

Test Procedures for Indirect TPMSs:

(a) Inflate the vehicle's tires to the vehicle manufacturer's recommended cold inflation pressure.

(b) If applicable, initiate a TPMS reset and calibration using the specified vehicle manufacturer's instructions. Record all the tire pressure values.

(c) While driving within the speed range specified in paragraph S5.4.2 of this standard, deflate any single tire at a rate of 10 kPa/min +/−5 kPa/min (1.5 psi/min +/−0.7 psi/min) until that tire is significantly under-inflated.

(d) Continue to drive within the speed range specified in paragraph S5.4.2 of this standard. Monitor the tire pressures and adjust pressures (if necessary) to remain significantly under-inflated. Record the elapsed time and cumulative driving distance at a constant speed (maximum longitudinal acceleration < +/−0.05 g) and straight (lateral acceleration < +/−0.05 g) until the low tire pressure warning telltale is illuminated or 10 miles of straight, constant speed driving has accumulated, whichever happens first.

(e) Turn the ignition off and let the vehicle sit for 5 minutes. Turn the key back on to confirm that the warning telltale re-illuminates. If the warning telltale does not re-illuminate, repeat step 6(d) to verify that the warning telltale does re-illuminate. This completes the test.

(f) To test a single tire deflation at other tire locations on the vehicle using the same tire and rim combination:

(1) Record all the tire pressure values and re-inflate the low tire to the matching tire on the opposite side of the same axle.

(2) Initiate a system reset of the warning telltale per the manufacturer's instructions.

(3) Repeat steps S6(b) through (e).

(g) To test a single tire deflation using another tire and rim combination, which is recommended by the vehicle

manufacturer, repeat steps 6(a) through (e).

Test Procedures for Direct TPMSs:

(a) Inflate the vehicle's tires to the vehicle manufacturer's recommended cold inflation pressure.

(b) If applicable, initiate a TPMS reset. Drive the vehicle to precondition the tires using the specified vehicle manufacturer's instructions. Record all the tire pressure values.

(c) While driving within the speed range specified in paragraph S5.4.2 of this standard, deflate any tire or combination of tires at a rate of 10 kPa/min +/−5 kPa/min (1.5 psi/min +/−0.7 psi/min) until the tire(s) is (are) significantly under-inflated to threshold P (adjusted threshold).

(d) Continue to drive within the speed range specified in paragraph S5.4.2 of this standard. Monitor the tire pressures and adjust pressures (if necessary) to remain significantly under-inflated. Record the elapsed time and cumulative driving distance at a constant speed (maximum longitudinal acceleration < +/−0.05 g) and straight (lateral acceleration < +/−0.05 g) until the low tire pressure warning telltale is illuminated or 10 miles of straight, constant speed driving has accumulated, whichever happens first.

(e) Turn the ignition off and let the vehicle sit for 5 minutes. Turn the key back on to confirm that the warning telltale re-illuminates. If the warning telltale does not re-illuminate, repeat step 6(d) to verify that the warning telltale does re-illuminate. This completes the test.

(f) To test other combinations of tire deflations for this tire and rim combination:

(1) Re-inflate the tires to the tire pressure value recorded in step S6(b).

(2) Initiate a system reset of the warning telltale per the manufacturer's instructions.

(3) Repeat steps S6(b) through (e).

(g) To test a single tire deflation using another tire and rim combination, which is recommended by the vehicle manufacturer, reset the warning telltale per the manufacturer's instructions and repeat steps 6(a) through (e).

NHTSA is not adopting the Alliance's recommended test procedures. The agency believes that the test procedures contained in this final rule adequately test both direct and indirect TPMSs under conditions similar to real-world conditions. The test procedures are as follows:

S6. *Test procedures.*

(a) Inflate the vehicle's tires to the vehicle manufacturer's recommended cold inflation pressure for the applicable vehicle load conditions specified in paragraph S5.3.1 of this standard. If the vehicle manufacturer has not recommended an inflation pressure for the lightly loaded condition, the inflation pressure specified by the vehicle manufacturer for the gross vehicle weight rating is used.

(b) With the vehicle stationary and the key locking system in the ''Lock'' or ''Off'' position, turn the key locking system to the ''On'' or ''Run'' position. The tire pressure monitoring system must perform a check of telltale lamp function as specified in paragraph S4.3.3 of this standard.

(c) If applicable, reset the tire pressure monitoring system in accordance with the instructions specified in the vehicle owner's manual.

(d) Drive the vehicle at any speed specified in paragraph S5.3.2 of this standard for 20 minutes.

(e)(1) For vehicles complying with S4.2.1, stop the vehicle and deflate any combination of one to four tires until the deflated tire(s) is (are) at 7 kPa (1 psi) below the inflation pressure at which the low tire pressure monitoring system is required to activate the low tire pressure warning telltale for that vehicle.

(2) For vehicles complying with S4.2.2, stop the vehicle [75] and deflate any one tire until the deflated tire is at 7 kPa (1 psi) below the inflation pressure at which the low tire pressure monitoring system is required to activate the low tire pressure warning telltale for that vehicle.

(f) Drive the vehicle at any speed specified in paragraph S5.3.2 of this standard. Record the time from when the vehicle speed reaches 50 km/h until the time the low tire pressure warning telltale illuminates. The telltale must illuminate within 10 minutes as required in paragraph S4.2.1(a) or S4.2.2(a) of this standard.

(g) Stop the vehicle and turn the key locking system to the ''Off'' or ''Lock'' position. After a 5-minute period, turn the vehicle's key locking system to the ''On'' or ''Run'' position. The telltale must remain illuminated.

(h) Keep the vehicle stationary for a period of one hour.

(i) Inflate all of the vehicle's tires to the vehicle manufacturer's recommended cold inflation pressure. If the vehicle's tire pressure monitoring system has a manual reset feature, reset the system in accordance with the instructions specified in the vehicle owner's manual.

(j) Drive the vehicle at any speed specified in paragraph S5.3.2 of this standard. The telltale must extinguish as specified in paragraph S4.2.1(b) or S4.2.2(b).

(k)(1) For vehicles complying with S4.2.1, if additional combinations of tires are tested, repeat the test procedures in paragraphs S6(a) through (j).

(2) For vehicles complying with S4.2.2, if the other individual tires are tested, repeat the test procedures in paragraphs S6(a) through (j).

(l) Utilizing the existing vehicle rims, repeat the test procedures in paragraphs S6(a) through (k) for each tire size recommended for the vehicle by the vehicle manufacturer. Note: If a different rim size is required, OEM rim and tire assemblies appropriate for the tire pressure monitoring system are used for testing.

The test procedures recommended by the Alliance are similar to the procedures the agency is specifying in this final rule. The agency notes that separate test procedures for the two compliance options are necessary because the performance requirements are different for each option. For example, the agency must be able to test multiple combinations of under-inflated tires, including all four tires, when testing vehicles that are certified to the four-tire, 25 percent option.

6. Lead Time

In the NPRM, the agency noted that the TREAD Act requires that the agency publish this final rule by November 1, 2001, and that the final rule take effect not more than two years after the final rule. The agency was concerned that TPMS manufacturers would not have the production capacity to supply TPMSs to equip 16 million vehicles annually, and that vehicle manufacturers would not have adequate time to develop TPMSs for all their vehicle applications. Thus, the agency indicated that it would consider a phase-in with a compliance schedule of 35 percent for the first year (2003), 65 percent the second year, and 100 percent in the third year.

No commenter opposed a phase-in of the TPMS requirements for light vehicles.

The Alliance stated that the phase-in proposed by the agency is too aggressive to allow for orderly and cost-effective implementation of the requirements. The Alliance stated that the agency

[75] Upon stopping the vehicle, the agency may deflate the tire(s) immediately or wait until the tire(s) cool to the ambient temperature, or any time in between, *e.g.,* when the tire(s) reach their original cold inflation pressure. The agency recognizes that deflating the tires while they are still hot would be a less stringent test than if the tires were allowed to cool down before being deflated. All vehicles must comply when the tires are warm or cold.

phase-in would jeopardize vehicle development programs, which allow for sufficient ''prove-out'' and implementation of new technology. The Alliance argued that TPMS technology is still relatively new and needs to be properly proved-out to avoid customer complaints and/or recalls.

For these reasons, the Alliance recommended a four-year phase-in as follows: 15 percent of a manufacturer's affected products to be equipped with a semi- or fully-compliant TPMS in the first year; 35 percent in the second year; and 70 percent in the third year; and, in the final year, 100 percent of a manufacturer's affected products to be equipped with a fully-compliant TPMS.The Alliance noted that a semi-compliant TPMS is one that meets all but specified interface requirements, and would only be allowed during the phase-in period but not in the final year of the phase-in. The Alliance claimed that allowing semi-compliant TPMSs during the phase-in would reduce the cost of compliance considerably, as cluster and display alterations are very expensive and require a long lead time to implement. Delaying these interface requirements would allow manufacturers who have already designed and/or implemented TPMSs to receive credit for those systems before and during the phase-in.

The agency agrees with the Alliance's comments about the pace of the phase-in. TPMS technology is still relatively new. While it has been used on a few high-end models for several years, it has not been widely implemented. Moreover, the agency remains concerned that TPMS manufacturers will not be able to produce enough systems and parts to supply 16 million vehicles annually.

Accordingly, the agency is implementing a four-year phase-in period as follows: 10 percent of a vehicle manufacturer's affected vehicles must be equipped with a TPMS that complies with either the four-tire, 25 percent or the one-tire, 30 percent option in the first year (i.e., November 1, 2003 to October 31, 2004); 35 percent in the second year (i.e., November 1, 2004 to October 31, 2005); 65 percent in the third year (i.e., November 1, 2005 to October 31, 2006). After October 31, 2006, 100 percent of a vehicle manufacturer's affected vehicles must be equipped with a TPMS that complies with the requirements set forth in the second part of this final rule. As noted above, the agency will publish the second part of this final rule by March 1, 2005, in order to give manufacturers sufficient lead time.

The agency believes this phase-in period allows for a sufficient prove-out of TPMS technology before widespread implementation in the first two years, followed by the last two years of aggressive implementation. The agency notes that the final rule requires fewer vehicles to comply in the first year of the phase-in (10 percent) than the Alliance recommended (15 percent). NHTSA is lowering the number of vehicles that will have to comply because the agency was unable to meet the statutory deadline of November 1, 2001.

NHTSA also notes that since the agency is permitting manufacturers to comply with the one-tire, 30 percent option until at least October 31, 2006, manufacturers will be able to comply with current indirect TPMSs while working to improve the performance of indirect TPMSs.

The agency is allowing carry-forward credits, but only for vehicles that are manufactured during the phase-in and comply with the four-tire, 25 percent option of the first part of this final rule. Vehicles that comply with the one-tire, 30 percent option cannot be counted for purposes of carry-forward credits.

While the agency is not adopting the Alliance's particular recommendation to allow semi-compliant TPMSs during the phase-in, it has decided to allow compliance with an alternative set of requirements during that period. The agency believes the addition of the one-tire, 30 percent option to the first part of this final rule will provide ample time for manufacturers to complete any development needed to enable them to install either direct, improved indirect, or hybrid TPMSs in their vehicles by the time the second part of this final rule takes effect on November 1, 2006.

The agency is adopting VSC's suggestion that the agency give small volume manufacturers until the end of the phase-in period to comply with the TPMS requirements. The agency has done this in the past when implementing a major rule.

As with previous phase-ins, NHTSA is adopting reporting requirements to monitor the implementation of the phase-in. The agency is including the reporting requirements in 49 CFR Part 590, which currently specifies back door latch, hinge, and lock phase-in reporting requirements. Since the phase-in currently addressed by Part 590 was completed December 31, 1999, the agency is replacing the existing language with regulatory text addressing the phase-in of Standard No. 138's requirements for TPMS.

C. Study of Effects of TPMSs That Do Not Meet a Four-Tire, 25 Percent Under-Inflation Requirement

To help provide additional data on the performance and effectiveness of TPMSs, NHTSA plans to conduct a study comparing the tire pressures of vehicles without a TPMS to the tire pressures of vehicles equipped with a TPMS that does not meet a four-tire, 25 percent compliance option. The agency will arrange for a peer review of the study methodology and of the study results, including the safety significance of any differences in tire pressure between the two groups of vehicles. If sufficient data are available, the agency also will assess the performance and effectiveness of TPMSs that do meet a four-tire, 25 percent option. The study, which will be completed by March 1, 2004, has the following two purposes.

1. Effect on Tire Pressure

The study will give the agency additional information regarding the extent to which vehicles equipped with a TPMS that does not meet a four-tire, 25 percent option have tire pressures closer to the vehicle's manufacturer's recommended inflation pressure than vehicles without a TPMS.

2. Effect on Number of Significantly Under-Inflated Tires

The study also will give the agency additional information regarding the extent to which vehicles equipped with a TPMS that does not meet a four-tire, 25 percent option have fewer significantly under-inflated tires than vehicles without a TPMS.

D. Part Two of the Final Rule—November 2006 and Thereafter

Based on the record compiled to this date, the results of the study, and any other new information (including, for example, information on the overall safety benefits of ABS) submitted to the agency, NHTSA will issue the second part of this final rule. The second part will be issued by March 1, 2005, to ensure vehicle manufacturers have sufficient lead time before November 1, 2006, when all new light vehicles must be equipped with a TPMS.

Based on the record now before the agency, NHTSA tentatively believes that a four-tire, 25 percent requirement would best meet the TPMS mandate in the TREAD Act. Nevertheless, it is possible that the new information may be sufficient to justify a continuation of the requirements in the first part of this final rule, or even some other alternative.

VIII. Benefits

Following is a summary of the benefits associated with this final rule. For a more detailed analysis, see the agency's Final Economic Assessment (FEA). A copy of the FEA has been placed in the docket. In the following discussion, the agency analyzes the benefits and costs of both the four-tire, 25 percent and one-tire, 30 percent options.

For purposes of this analysis, the agency assumes that 95 percent of drivers will respond to a low tire pressure warning by re-inflating their tires to the placard pressure. OMB questioned this assumption in its return letter. NHTSA has little hard evidence supporting this assumption. As discussed in the FEA, a recent study indicated that 97 percent of respondents stated they would respond to a dashboard warning light informing them that their tire pressure was low.[76] However, the agency has some concerns, such as the sample of respondents and the question format, with this study. The agency has attempted to find other studies with data on response rates to similar warning lights, but has been unable to do so.

However, as part of the new study to be completed by March 1, 2004, the agency plans to ask owners of vehicles equipped with a TPMS whether their low tire pressure telltale has ever illuminated, and, if so, how they reacted to it. This should provide useful data for the agency's decision on the requirements for the second part of this final rule.

Under-inflation affects many different types of crashes. These include crashes which result from:

(1) Skidding and/or losing control of the vehicle in a curve, such as a highway off-ramp, or in a lane-change maneuver;

(2) hydroplaning on a wet surface, which can cause increases in stopping distance and skidding or loss of control;

(3) increases in stopping distance; and

(4) flat tires and blowouts; and

(5) overloading the vehicle.

The agency was able to identify target populations for skidding and loss of control crashes, stopping distance (which involves any vehicle that brakes during a crash sequence), flat tires, and blowouts. The agency was not able to identify, from crash files and other reports, a target population for crashes caused by hydroplaning and overloading the vehicle.

A. Tire Safety Benefits

1. Skidding/Loss of Control

Under-inflation reduces tire stiffness, which causes the tire to generate lower cornering force. When a tire is under-inflated, the vehicle requires a greater steering angle to generate the same cornering force in a curve or in a lane-change maneuver. This can result in skidding or loss of control of the vehicle in a tight curve or a quick lane-change maneuver.

The agency estimates that if all light vehicles meet the four-tire, 25 percent compliance option, 46 fatalities will be prevented and 4,345 injuries will be prevented or reduced in severity per year due to reductions in these types of crashes. If all light vehicles meet the one-tire, 30 percent compliance option, 30 fatalities will be prevented and 2,817 injuries will be prevented or reduced in severity per year due to reductions in these types of crashes.

2. Stopping Distance

As explained in greater detail above in section III.D.1., ''Reduced Vehicle Safety—Tire Failures and Increases in Stopping Distance,'' tires are designed to maximize their performance capabilities at a specific inflation pressure. When a tire is under-inflated, the shape of its footprint and the pressure it exerts on the road surface are both altered. This degrades the tire's ability to transmit braking force to the road surface, and increases a vehicle's stopping distance, especially on wet surfaces.

Decreasing stopping distance is beneficial in several ways. Some crashes can be completely avoided. Other crashes will still occur, but at a lower impact speed because the vehicle is able to decelerate more quickly.[77]

The agency estimates that if all light vehicles meet the four-tire, 25 percent compliance option, 39 fatalities will be prevented and 3,410 injuries will be prevented or reduced in severity per year due to reductions in vehicles' stopping distances. If all light vehicles meet the one-tire, 30 percent compliance option, 17 fatalities will be prevented and 1,562 injuries will be prevented or reduced in severity per year due to reductions in vehicles' stopping distances.

3. Flat Tires and Blowouts

Under-inflation, along with high speed and overloading, can cause tire blowouts. A blowout in one of the front tires can cause the vehicle to veer off the road or into oncoming traffic. A blowout in one of the rear tires can cause spinning and loss of control of the vehicle.

The agency estimates that if all light vehicles meet the four-tire, 25 percent compliance option, 39 fatalities will be prevented and 967 injuries will be prevented or reduced in severity per year due to reductions in crashes involving blowouts and flat tires. If all light vehicles meet the one-tire, 30 percent compliance option, 32 fatalities will be prevented and 797 injuries will be prevented or reduced in severity per year due to reductions in crashes involving blowouts and flat tires.

4. Unquantified Benefits

The agency cannot quantify the benefits from a reduction in crashes associated with hydroplaning and overloading vehicles. The primary reason that the agency has been unable to quantify these benefits is the lack of crash data indicating tire pressure and how often these conditions are the cause or contributing factors in a crash. The agency does not collect tire pressure in its crash investigations. NHTSA also has not been able to quantify the benefits associated with reductions in property damage and travel delays that will result from fewer crashes or reductions in the severity of crashes.

B. Non-Tire Safety Benefits

In its return letter, OMB stated that issuing a final rule that allowed current indirect TPMSs to comply would encourage vehicle manufacturers to install ABS on additional vehicles. OMB recommended that NHTSA consider the potential safety benefits of additional vehicles being equipped with ABS.

However, as noted above in section VI., ''Response to Issues Raised in OMB Return Letter About Preliminary Determination,'' there is no reliable basis for concluding that permitting current indirect TPMSs to comply would lead to a significant increase in installation of ABS in light vehicles. Moreover, there is no statistically reliable basis for concluding that ABS reduces fatalities in light vehicles. Thus, the agency does not believe that, even if vehicle manufacturers install ABS on

[76] ''Examining the Need for Cycloid's Pump: An Analysis of Attitudes and a Study of Tire Pressure and Temperature Relationships,'' University of Pittsburgh, Departments of Mechanical and Industrial Engineering, December 7, 2001. A copy of this study has been placed in the docket. (Docket No. NHTSA–2000–8572–209.

[77] The FEA divides the benefits from reductions in stopping distance into fatalities and injuries reduced as a result of reductions in crashes on dry surfaces and on wet surfaces. As noted above, under-inflated tires have a greater impact on stopping distance when a vehicle is on a wet surface than when a vehicle is on a dry surface. However, most crashes occur on dry surfaces. Thus, the agency estimates that more fatalities and injuries will be reduced as a result of reductions in crashes that occur on dry surfaces than crashes that occur on wet surfaces.

additional vehicles, additional safety benefits would be experienced.

C. Total Quantified Safety Benefits

The agency estimates that the total quantified safety benefits from reductions in crashes due to skidding/loss of control, stopping distance, and flat tires and blowouts, therefore, will be 124 fatalities prevented and 8,722 injuries prevented or reduced in severity each year, if all light vehicles meet the four-tire, 25 percent compliance option; and 79 fatalities prevented and 5,176 injuries prevented or reduced in severity each year, if all light vehicles meet the one-tire, 30 percent compliance option.

D. Economic Benefits

1. Fuel Economy

Correct tire pressure improves a vehicle's fuel economy. Recent data provided by Goodyear indicate that a vehicle's fuel efficiency is reduced by one percent for every 2.96 psi that its tires are below the placard pressure. The agency estimates that if all light vehicles meet the four-tire, 25 percent compliance option, vehicles' higher fuel economy will translate into an average discounted value of $16.43 per vehicle over the lifetime of the vehicle. If all light vehicles meet the one-tire, 30 percent compliance option, vehicles' higher fuel economy will translate into an average discounted value of $2.06 per vehicle over the lifetime of the vehicle.

2. Tread Life

Correct tire pressure also increases a tire's tread life. Data from Goodyear indicate that for every 1 psi drop in tire pressure, tread life decreases by 1.78 percent. NHTSA estimates that if all light vehicles meet the four-tire, 25 percent compliance option, average tread life will increase by 1,143 miles. If all light vehicles meet the one-tire, 30 percent compliance option, average tread life will increase by 15 miles. This will delay new tire purchases. The agency estimates that the average discounted value of these delays in tire purchases will be $5.09, if all light vehicles meet the four-tire, 25 percent compliance option; and $0.65 if all light vehicles meet the one-tire, 30 percent compliance option.

IX. Costs

A. Indirect TPMSs

NHTSA estimates that the cost of an indirect TPMS that will meet the one-tire, 30 percent compliance option will be $13.29 per vehicle, if the vehicle already has a four-wheel, four-channel (four wheel-speed sensors) ABS. In the 2000 model year, about 67 percent of all new light vehicles were equipped with a four-wheel ABS. However, about 31 percent of these vehicles only had a three-channel system. A three-channel system has one wheel speed sensor for each front wheel and one for the rear axle. Thus, in order to meet the requirement that the TPMS be able to detect when any tire is significantly under-inflated, a vehicle with a three-channel ABS must be redesigned from having one wheel speed sensor for the rear axle to a wheel speed sensor for each rear wheel. The agency estimates that this will cost $25 per vehicle. Accordingly, the agency estimates that the average cost of providing an indirect TPMS to a vehicle already equipped with ABS will be $21.13 ($13.29 + $25 * .3135) per vehicle.

For vehicles not currently equipped with ABS, manufacturers would have to install either four wheel speed sensors at a cost of $130 per vehicle, or ABS at a cost of $240 per vehicle, in addition to an indirect TPMS. Thus, the average cost of providing an indirect TPMS to a vehicle not already equipped with ABS will be $143.29 ($130 + $13.29) if the manufacturer installs four-wheel speed sensors, or $253.29 ($240 + $13.29) per vehicle if the manufacturer installs ABS.

B. Direct TPMSs

NHTSA estimates that the cost of a direct TPMS that will meet the four-tire, 25 percent compliance option will be $70.35 per vehicle, if the manufacturer chooses to install an individual tire pressure display. This includes $7.50 for each tire pressure sensor ($30 per vehicle), $19 for the control module, $3.85 for an individual tire pressure display, $6 for four valves, and $11.50 for the combination of an instrument panel telltale, assembly, and miscellaneous wiring. The agency assumes that about one percent of vehicles currently comply. Thus, the agency estimates that the incremental cost will be $69.65 per vehicle ($70.35 * 99 percent) if manufacturers install an individual tire pressure display.[78] If manufacturers install only a warning telltale, the agency estimates that the incremental cost will be $65.84 ($70.35 − $3.85 (the cost of a individual tire pressure display) * 99 percent).

C. Hybrid TPMSs

A hybrid TPMS consists of an indirect TPMS for vehicles equipped with an ABS and two direct pressure sensors and a radio frequency receiver. As noted above, insofar as NHTSA is aware, no manufacturer is currently planning to produce a hybrid TPMS. If a manufacturer were to produce a hybrid TPMS, the agency believes that such a system would be able to detect when one to four tires are 25 percent or more below placard. TRW estimated that the cost of such a system would be about 60 percent of the cost of a direct TPMS. Since the hybrid TPMS would not be able to tell drivers the inflation pressure in all four tires, the agency assumes that this type of TPMS would not be accompanied by a display system that would allow the driver to see the pressure for each tire.

Consequently, the agency estimates that the cost of a hybrid TPMS that would meet the four-tire, 25 percent compliance option would be $39.90 ($70.35 − $3.85 (the cost of an individual tire pressure display) * .60).

D. Vehicle Cost

If all light vehicles meet the four-tire, 25 percent compliance option, the agency assumes that manufacturers will install hybrid TPMSs on the 67 percent of vehicles that are currently equipped with an ABS and direct TPMSs on the 33 percent of vehicles that are not so equipped. Thus, the agency estimates that the average incremental cost if all vehicles meet the four-tire, 25 percent compliance option will be $48.19 per vehicle [$39.90 x .67 + $66.50 x .33] x .99 (to account for one percent current compliance)). Since approximately 16 million vehicles are produced for sale in the U.S. each year, the total annual vehicle cost will be about $771 million per year.

If all light vehicles meet the one-tire, 30 percent compliance option, the agency assumes that manufacturers will install an indirect TPMS on vehicles currently equipped with ABS (about 67 percent of new light vehicles), and a direct TPMS on vehicles not equipped with ABS (about 33 percent of new light vehicles). The agency also assumes that about five percent of vehicles currently meet the one-tire, 30 percent compliance option. Thus, the average incremental cost if all vehicles meet the one-tire, 30 percent compliance option will be $33.34 [($21.13 * .67) + ($66.50[79] * .33) * .95]. Since approximately 16 million vehicles are produced for sale in the U.S. each year, the total annual vehicle cost will be about $533 million per year.

[78] The agency estimates that one percent of vehicles are currently equipped with a TPMS that complies with the requirements of the standard.

[79] $66.50 is the cost of a direct TPMS with only a warning telltale.

E. Maintenance Costs

Each pressure sensor in direct TPMSs needs a battery. Currently, these batteries last five to ten years. Thus, they will have to be replaced to keep the system functioning over the full life of a vehicle. At this time, all tire pressure sensors are enclosed packages that do not open so that the battery can be replaced. Thus, when the battery is depleted, the entire sensor must be replaced.

To estimate the present discounted value of this cost, the agency is making the following assumptions. First, the agency assumes that the pressure sensors will be replaced the second time the vehicle's tires are changed, in the 90,000 to 100,000 mile range. The agency multiplied the cost of the sensor ($7.50 each, or $30 for the vehicle) by three to account for typical aftermarket markups. After applying discount factors, the agency estimates that the maintenance costs for direct TPMSs will be $40.91 per vehicle. For hybrid TPMSs, with direct pressure sensors in two wheels, the agency estimates the average maintenance costs will be half the maintenance costs of direct TPMSs, or $20.45.

Thus, the agency estimates that if all light vehicles meet the four-tire, 25 percent compliance option, the present discounted value of the maintenance costs will be $27.20 ($20.45 × .67 + $40.91 × .33) per vehicle. Since approximately 16 million vehicles are produced for sale in the Unites States each year, the total annual maintenance costs will be about $435 million.

NHTSA notes that the maintenance costs associated with direct and hybrid TPMSs may decrease significantly in the future if manufacturers are able to mass produce a pressure sensor that does not require a battery. One TPMS manufacturer, IQ-mobil Electronics of Germany, commented that it has developed a ''batteryless transponder chip'' that ''costs half as much as the battery transmitter it replaces.''

Indirect TPMSs do not need a battery, and are assumed to have no maintenance costs for purposes of this analysis. If all light vehicles meet the one-tire, 30 percent compliance option, the agency assumes that manufacturers will install an indirect TPMS on vehicles currently equipped with ABS (about 67 percent of new light vehicles), and a direct TPMS on vehicles not equipped with ABS (about 33 percent of new light vehicles). Thus, the agency estimates that if all light vehicles meet the one-tire, 30 percent compliance option, the present discounted value of the maintenance costs will be $13.50 ($40.91 × .33) per vehicle.

F. Testing Costs

The agency estimates that the man-hours required to complete the necessary compliance testing will be 6 hours for a manager, 30 hours for a test engineer, and 30 hours for a technician/driver. The agency estimates that the labor costs will be $75 per hour for a manager, $53 per hour for a test engineer, and $31 per hour for a technician/driver. Thus, the agency estimates that the total costs will be $2,970 per vehicle model under both compliance options.

G. Unquantified Costs

The agency anticipates that there may be other maintenance costs for both direct and indirect TPMS. For example, with indirect TPMSs, there may be problems with wheel speed sensors and component failures. With direct TPMSs, the pressure sensors may be broken off when tires are changed. The agency requested comments on this issue in the NPRM, but received none. Without estimates of these maintenance problems and costs, the agency is unable to quantify their impact.

The agency also notes that in order to benefit from the TPMS, drivers must respond to a warning by re-inflating their tires. To accomplish this, most drivers will either make a separate trip to a service station or take additional time to inflate their tires when they are at a service station for fuel. The process of checking and re-inflating tires is relatively simple, and probably would take from three to five minutes. The time it would take to make a separate trip to a service station would vary depending on the driver's proximity to a station at the time he or she was notified.

It is likely that drivers who take the time to re-inflate their tires would consider this extra time to be fairly trivial. Since the action is voluntary, by definition, they would consider it to be worth the potential benefits they will derive from properly inflated tires. However, when tallied across the entire driving population, the total effort involved in terms of man-hours may be significant. NHTSA has no data to indicate what portion of drivers would make a separate trip or wait to re-inflate their tires when they next visited a service station. Thus, the agency has not been able to quantify this cost.

H. ABS Costs

As noted above, the agency estimates that the average cost of equipping a vehicle with ABS is $240.

I. Net Costs and Costs per Equivalent Life Saved

The agency estimates that if all light vehicles meet the four-tire, 25 percent compliance option, the net cost [vehicle cost + maintenance costs − (fuel savings + tread life savings)] will be $53.87 [$48.19 + $27.20 − ($16.43 + $5.09)]. As noted above, the agency estimates the total annual cost will be about $771 million. The agency estimates the total annual net cost will be about $862 million [$771 million + $435 million − ($263 million + $81 million)]. NHTSA estimates that the net cost per equivalent life saved will be about $4.3 million.

The agency estimates that if all light vehicles meet the one-tire, 30 percent compliance option, the net cost will be $44.13 [$33.34 + $13.50 − ($2.06 + $0.65)]. The agency estimates that the total annual cost will be about $533 million per year, and the total annual net cost will be about $706 million [$533 million + $216 million − ($33 million + $10 million)]. NHTSA estimates that the net cost per equivalent life saved will be about $5.8 million.

X. Rulemaking Analyses and Notices

A. Executive Order 12866 and DOT Regulatory Policies and Procedures

Executive Order 12866, ''Regulatory Planning and Review'' (58 FR 51735, October 4, 1993), provides for making determinations whether a regulatory action is ''significant'' and therefore subject to OMB review and to the requirements of the Executive Order. The Order defines a ''significant regulatory action'' as one that is likely to result in a rule that may:

(1) Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or Tribal governments or communities;

(2) Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;

(3) Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or

(4) Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

This final rule is economically significant. Accordingly, it was reviewed under Executive Order 12866. The rule is also significant within the meaning of the Department of

Transportation's Regulatory Policies and Procedures. The agency has estimated that, under the first compliance option, compliance with this rule will cost $771 million per year, and under the second compliance option, compliance with this rule will cost $533 million, since approximately 16 million vehicles are produced for the United States market each year. Thus, this rule will have greater than a $100 million effect.

Because this rule is significant, the agency has prepared a Final Economic Assessment (FEA). The Assessment is summarized above in section VIII., ''Benefits,'' and section IX., ''Costs.'' The FEA is available in the docket and has been placed on the agency's website along with the final rule itself.

B. Regulatory Flexibility Act

Pursuant to the Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*, as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996), whenever an agency is required to publish a notice of rulemaking for any proposed or final rule, it must prepare and make available for public comment a regulatory flexibility analysis that describes the effect of the rule on small entities (i.e., small businesses, small organizations, and small governmental jurisdictions). The Small Business Administration's regulations at 13 CFR part 121 define a small business, in part, as a business entity ''which operates primarily within the United States.'' (13 CFR 121.105(a)). No regulatory flexibility analysis is required if the head of an agency certifies the rule will not have a significant economic impact on a substantial number of small entities. SBREFA amended the Regulatory Flexibility Act to require Federal agencies to provide a statement of the factual basis for certifying that a rule will not have a significant economic impact on a substantial number of small entities.

NHTSA has considered the effects of this final rule under the Regulatory Flexibility Act. I certify that this final rule will not have a significant economic impact on a substantial number of small entities. The rationale for this certification is that currently there are only four small motor vehicle manufacturers (*i.e.,* only four with fewer than 1,000 employees) in the United States that will have to comply with this final rule. These manufacturers will have to rely on suppliers to provide the TPMS hardware, and then they will have to integrate the TPMS into their vehicles.

There are a few small manufacturers that manufacture recreational vehicles that will have to comply with this final rule. However, most of these manufacturers use van chassis supplied by the larger manufacturers, *e.g.,* GM, Ford, or DaimlerChrysler, and could use the TPMSs supplied with the chassis. These manufacturers should not have to test the TPMS for compliance with this final rule since they should be able to rely upon the chassis manufacturer's incomplete vehicle documentation.

The agency has eliminated the most significant potential impact on small businesses by deciding not to require TPMSs to function when the vehicle's original rims are replaced with aftermarket wheels and rims that are not identical to the original wheels and rims.

C. National Environmental Policy Act

NHTSA has analyzed this rulemaking action for the purposes of the National Environmental Policy Act. The agency has determined that implementation of this rule will not have any significant impact on the quality of the human environment.

D. Executive Order 13132 (Federalism)

Executive Order 13132 requires NHTSA to develop an accountable process to ensure ''meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications.'' ''Policies that have federalism implications'' is defined in the Executive Order to include regulations that have ''substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government.'' Under Executive Order 13132, the agency may not issue a regulation with Federalism implications, that imposes substantial direct compliance costs, and that is not required by statute, unless the Federal government provides the funds necessary to pay the direct compliance costs incurred by State and local governments, the agency consults with State and local governments, or the agency consults with State and local officials early in the process of developing the regulation. NHTSA also may not issue a regulation with Federalism implications and that preempts State law unless the agency consults with State and local officials early in the process of developing the regulation.

The agency has analyzed this final rule in accordance with the principles and criteria set forth in Executive Order 13132 and has determined that it will not have sufficient federalism implications to warrant consultation with State and local officials or the preparation of a federalism summary impact statement. The final rule will not have any substantial effects on the States, or on the current Federal-State relationship, or on the current distribution of power and responsibilities among the various local officials. While the agency is providing compliance options, it is not seeking to give each of those options pre-emptive effect.

E. Civil Justice Reform

This final rule will not have any retroactive effect. Under 49 U.S.C. 30103, whenever a Federal motor vehicle safety standard is in effect, a State may not adopt or maintain a safety standard applicable to the same aspect of performance which is not identical to the Federal standard, except to the extent that the state requirement imposes a higher level of performance and applies only to vehicles procured for the State's use. 49 U.S.C. 30161 sets forth a procedure for judicial review of final rules establishing, amending, or revoking Federal motor vehicle safety standards. That section does not require submission of a petition for reconsideration or other administrative proceedings before parties may file suit in court.

F. Paperwork Reduction Act

Under the Paperwork Reduction Act of 1995 (PRA), a person is not required to respond to a collection of information by a Federal agency unless the collection displays a valid OMB control number. The Department of Transportation is submitting the following information collection request to OMB for review and clearance under the PRA.

Agency: National Highway Traffic Safety Administration (NHTSA).

Title: Phase-In Production Reporting Requirements for Tire Pressure Monitoring Systems.

Type of Request: Routine.

OMB Clearance Number: 2127–New.

Form Number: This collection of information will not use any standard forms.

Affected Public: The respondents are manufacturers of passenger cars, multipurpose passenger vehicles, trucks, and buses having a gross vehicle weight rating of 10,000 pounds or less. The agency estimates that there are about 21 such manufacturers.

Estimate of the Total Annual Reporting and Recordkeeping Burden Resulting from the Collection of Information: NHTSA estimates that the total annual hour burden is 42 hours.

Estimated Costs: NHTSA estimates that the total annual cost burden, in U.S. dollars, will be $0. No additional resources will be expended by vehicle manufacturers to gather annual production information because they already compile this data for their own uses.

Summary of Collection of Information: This collection will require manufacturers of passenger cars, multipurpose passenger vehicles, trucks, and buses with a gross vehicle weight rating of 10,000 pounds or less, except those vehicles with dual wheels on an axle, to provide motor vehicle production data for the following three years: November 1, 2003 to October 31, 2004; November 1, 2004 to October 31, 2005; and November 1, 2005 to October 31, 2006.

Description of the Need for the Information and the Proposed Use of the Information: The purpose of the reporting requirements will be to aid NHTSA in determining whether a manufacturer has complied with the requirements of Federal Motor Vehicle Safety Standard No. 138, Tire pressure monitoring systems, during the phase-in of those requirements. NHTSA requests comments on the agency's estimates of the total annual hour and cost burdens resulting from this collection of information. These comments must be received on or before August 5, 2002.

G. National Technology Transfer and Advancement Act

Section 12(d) of the National Technology Transfer and Advancement Act of 1995 (NTTAA), Public Law 104–113, section 12(d) (15 U.S.C. 272) directs NHTSA to use voluntary consensus standards in its regulatory activities unless doing so would be inconsistent with applicable law or otherwise impractical. Voluntary consensus standards are technical standards (e.g., materials specifications, test methods, sampling procedures, and business practices) that are developed or adopted by voluntary consensus standards bodies, such as the Society of Automotive Engineers (SAE). The NTTAA directs NHTSA to provide Congress, through OMB, explanations when the agency decides not to use available and applicable voluntary consensus standards. The NTTAA does not apply to symbols.

There are no voluntary consensus standards available at this time. However, NHTSA will consider any such standards when they become available.

H. Unfunded Mandates Reform Act

Section 202 of the Unfunded Mandates Reform Act of 1995 (UMRA) requires Federal 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 expenditure by State, local, or tribal governments, in the aggregate, or by the private sector, of more than $100 million in any one year (adjusted for inflation with base year of 1995). Before promulgating a rule for which a written statement is needed, section 205 of the UMRA generally requires NHTSA to identify and consider a reasonable number of regulatory alternatives and adopt the least costly, most cost-effective, or least burdensome alternative that achieves the objectives of the rule. The provisions of section 205 do not apply when they are inconsistent with applicable law. Moreover, section 205 allows NHTSA to adopt an alternative other than the least costly, most cost-effective, or least burdensome alternative if the agency publishes with the final rule an explanation why that alternative was not adopted.

This final rule will not result in the expenditure by State, local, or tribal governments, in the aggregate, of more than $100 million annually, but it will result in the expenditure of that magnitude by vehicle manufacturers and/or their suppliers. In the NPRM, the agency requested comments on two alternatives for achieving the purposes of the TREAD Act mandate. In the final rule, the agency has chosen two compliance options that will provide the manufacturers with broad flexibility to minimize their costs of compliance with the Standard during the phase-in period.

I. Regulation Identifier Number (RIN)

The Department of Transportation assigns a regulation identifier number (RIN) to each regulatory action listed in the Unified Agenda of Federal Regulations. The Regulatory Information Service Center publishes the Unified Agenda in April and October of each year. You may use the RIN contained in the heading at the beginning of this document to find this action in the Unified Agenda.

List of Subjects in 49 CFR Parts 571 and 590

Imports, Motor vehicle safety, Reporting and recordkeeping requirements, Tires.

In consideration of the foregoing, NHTSA is amending 49 CFR parts 571 and 590 as follows:

PART 571—FEDERAL MOTOR VEHICLE SAFETY STANDARDS

1. The authority citation for part 571 continues to read as follows:

Authority: 49 U.S.C. 322, 30111, 30115, 30117, and 30166; delegation of authority at 49 CFR 1.50.

2. In § 571.101, paragraph S5.2.3 and Table 2 are revised to read as follows:

§ 571.101 Standard No. 101; Controls and displays.

* * * * *

S5.2.3 Except for the Low Tire Pressure Telltale (that does not identify which tire has low pressure), any display located within the passenger compartment and listed in column 1 of Table 2 that has a symbol designated in column 4 of that table shall be identified by either the symbol designated in column 4 (or symbol substantially similar in form to that shown in column 4) or the word or abbreviation shown in column 3. The Low Tire Pressure Telltale (that does not identify which tire has low tire pressure) shall be identified by either the symbol designated in column 4, or the symbol and the words designated in column 4 and column 3, respectively. Additional words or symbols may be used at the manufacturer's discretion for the purpose of clarity. Any telltales used in conjunction with a gauge need not be identified. The identification required or permitted by this section shall be placed on or adjacent to the display that it identifies. The identification of any display shall, under the conditions of S6, be visible to the driver and appear to the driver perceptually upright.

* * * * *

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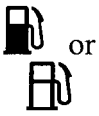
Table 2
Identification and Illustration of Displays

Column 1 *Display*	**Column 2** *Telltale Color*	**Column 3** *Identifying Words or Abbreviation*	**Column 4** *Identifying Symbol*	**Column 5** *Illumination*
Turn Signal Telltale	Green	Also see FMVSS 108	 1,5	———
Hazard Warning Telltale		Also see FMVSS 108	 2, 5	———
Seat Belt Telltale	———4	Fasten Belts or Fasten Seat Belts Also see FMVSS 208	 or	———
Fuel Level Telltale		Fuel	 or	———
Gauge	———			Yes
Oil Pressure Telltale		Oil		———
Gauge	———			Yes
Coolant Temperature Telltale		Temp		———
Gauge	———			Yes
Electrical Charge Telltale		Volts, Charge or Amp		———
Gauge	———			Yes
Highbeam Telltale	Blue or Green 3	Also see FMVSS 108	 5	———

1. The pair of arrows is a single symbol. When the indicator for left and right turn operate independently, however, the two arrows will be considered separate symbols and may be spaced accordingly.
2. Not required when arrows of turn signal tell-tales that otherwise operate independently flash simultaneously as hazard warning tell-tale.
3. Red can be red-orange. Blue can be blue-green.
4. The color of the telltale required by S4.5.3.3 of Standard No. 208 is red; the color of the telltale required by S7.3 of Standard No. 208 is not specified.
5. Framed areas may be filled.

Table 2 (continued)

Column 1 *Display*	Column 2 *Telltale Color*	Column 3 *Identifying Words or Abbreviation*	Column 4 *Identifying Symbol*	Column 5 *Illumination*
Brake System 8	Red 3	Brake, Also see FMVSS 105 and 135	_____	_____
Malfunction in Anti-lock or	Yellow	Antilock, Anti-lock or ABS. Also see FMVSS 105 and 135	_____	_____
Variable Brake Proportioning System 8	Yellow	Brake Proportioning, Also see FMVSS 135	_____	_____
Parking Brake Applied 8	Red 3	Park or Parking Brake, Also see FMVSS 105 and 135	_____	_____
Malfunction in Anti-lock	Yellow	ABS, or Antilock; Trailer ABS, or Trailer Antilock, Also see FMVSS 121	_____	_____
Brake Air Pressure Position Telltale	_____	Brake Air, Also see FMVSS 121	_____	_____
Speedometer	_____	MPH, or MPH and km/h 7	_____	Yes
Odometer	_____	_____ 6	_____	_____
Automatic Gear Position	_____	Also see FMVSS 102	_____	Yes
Low Tire Pressure Telltale (that does not identify which tire has low pressure)	Yellow	Low Tire. Also see FMVSS 138		_____
Low Tire Pressure Telltale (that identifies which tire has low pressure)	Yellow	Low Tire. Also see FMVSS 138		_____

3. Red can be red-orange. Blue can be blue-green.
6. If the odometer indicates kilometers, then "KILOMETERS" or "km" shall appear, otherwise, no identification is required.
7. If the speedometer is graduated in miles per hour and in kilometers per hour, the identifying words or abbreviations shall be "MPH and km/h" in any combination of upper or lower case letters.
8. In the case where a single telltale indicates more than one brake system condition, the word for Brake System shall be used.

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3. Section 571.138 is added to read as follows:

§ 571.138 Standard No. 138; Tire pressure monitoring systems.

S1. *Purpose and scope.* This standard specifies performance requirements for tire pressure monitoring systems to prevent significant under-inflation of tires and the resulting safety problems.

S2. *Application.* This standard applies to passenger cars, multipurpose passenger vehicles, trucks, and buses that have a gross vehicle weight rating of 4,536 kilograms (10,000 pounds) or less, except those vehicles with dual wheels on an axle, according to the phase-in schedule specified in S7 of this standard.

S3. *Definitions.* The following definitions apply to this standard:

Lightly loaded vehicle weight means unloaded vehicle weight plus the weight of a mass of 180 kg (396 pounds), including test driver and instrumentation.

Tire pressure monitoring system means a system that detects when one or more of a vehicle's tires are under-inflated and illuminates a low tire pressure warning telltale.

S4. *Requirements.*

S4.1 *General.* To the extent provided in S7.1 through S7.3, each vehicle must be equipped with a tire pressure monitoring system that meets the requirements specified in S4 under the test procedures specified in S6 of this standard. Prior to November 1, 2006, each tire pressure monitoring system must conform, at the manufacturer's option, to either S4.2.1 or S4.2.2 of this standard. The manufacturer must select the option by the time it certifies the vehicle and may not thereafter select a different option for the vehicle.

S4.2 *Tire pressure monitoring systems: vehicles manufactured after October 31, 2003 and before November 1, 2006.*

S4.2.1 *Option 1: Four tires; 25 percent under-inflation.* The tire pressure monitoring system must:

(a) Illuminate a low tire pressure warning telltale not more than 10 minutes after the inflation pressure in one or more of the vehicle's tires, up to a total of four tires, is equal to or less than either the pressure 25 percent below the vehicle manufacturer's recommended cold inflation pressure, or the pressure specified in the 3rd column of Table 1 of this standard for the corresponding type of tire, whichever is higher; and

(b) Continue to illuminate the low tire pressure warning telltale as long as the pressure in any of the vehicle's tires is equal to or less than the pressure specified in (a), and the key locking system is in the ''On'' (''Run'') position, whether or not the engine is running, or until manually reset in accordance with the vehicle manufacturer's instructions.

S4.2.2 *Option 2: One tire; 30 percent under-inflation.* The tire pressure monitoring system must:

(a) Illuminate a low tire pressure warning telltale not more than 10 minutes after the inflation pressure in one of the vehicle's tires is equal to or less than either the pressure 30 percent below the vehicle manufacturer's recommended cold inflation pressure, or the pressure specified in the 3rd column of Table 1 of this standard for the corresponding type of tire, whichever is higher; and

(b) Continue to illuminate the low tire pressure warning telltale as long as the pressure in that tire is equal to or less than the pressure specified in (a), and the key locking system is in the ''On'' (''Run'') position, whether or not the engine is running, or until manually reset in accordance with the vehicle manufacturer's instructions.

S4.3 *Low tire pressure warning telltale.*

S4.3.1 Each tire pressure monitoring system must include a low tire pressure warning telltale that:

(a) Is mounted inside the occupant compartment in front of and in clear view of the driver;

(b) Is identified by one of the symbols shown for the ''Low Tire Pressure Telltale'' in Table 2 of Standard No. 101 (§ 571.101); and

(c) Is illuminated under the conditions specified in S4.2.1 or S4.2.2.

S4.3.2 In the case of a telltale that identifies which tire(s) is (are) under-inflated, each tire in the symbol for that telltale must illuminate when the tire it represents is under-inflated to the extent specified in either S4.2.1 or S4.2.2.

S4.3.3 (a) Except as provided in paragraph (b) of this section, each low tire pressure warning telltale must be activated as a check of lamp function either when the key locking system is turned to the ''On'' (''Run'') position when the engine is not running, or when the key locking system is in a position between ''On'' (''Run'') and ''Start'' that is designated by the manufacturer as a check position.

(b) The low tire pressure warning telltale need not be activated when a starter interlock is in operation.

S4.4 *Replacement tires.* Each tire pressure monitoring system must continue to meet the requirements of this standard when the vehicle's original tires are replaced with tires of any optional or replacement size(s) recommended for the vehicle by the vehicle manufacturer.

S4.5 *Written instructions.*

S4.5.1 *Vehicles certified to Option 1: Four tires; 25 percent under-inflation.* The owner's manual in each vehicle certified as complying with S4.2.1 must provide an image of the Low Tire Pressure Telltale symbol with the following statement, in English: ''When the tire pressure monitoring system warning light is lit, one or more of your tires is significantly under-inflated. You should stop and check your tires as soon as possible, and inflate them to the proper pressure as indicated on the vehicle's tire information placard. Driving on a significantly under-inflated tire causes the tire to overheat and can lead to tire failure. Under-inflation also reduces fuel efficiency and tire tread life, and may affect the vehicle's handling and stopping ability. Each tire, including the spare, should be checked monthly when cold and set to the recommended inflation pressure as specified in the vehicle placard and owner's manual.'' Each vehicle manufacturer may, at its discretion, provide additional information about the significance of the low tire pressure warning telltale illuminating, description of corrective action to be undertaken, whether the tire pressure monitoring system functions with the vehicle's spare tire, and how to use the reset button, if one is provided.

S4.5.2 *Vehicles manufactured after October 31, 2003 and before November 1, 2006, and certified to Option 2: One tire; 30 percent under-inflation.* The owner's manual in each vehicle certified as complying with S4.2.2 must comply with S4.5.1 and provide the following statement, in English:

''**Note:** The tire pressure monitoring system on your vehicle will warn you when one of your tires is significantly under-inflated and when some combinations of your tires are significantly under-inflated. However, there are other combinations of significantly under-inflated tires for which your tire pressure monitoring system may *not* warn you. These other combinations are relatively common, accounting for approximately half the instances in which vehicles have significantly under-inflated tires. For example, your system may not warn you when both tires on the same side or on the same axle of your vehicle are significantly under-inflated. It is particularly important, therefore, for you to check the tire pressure in all of your tires regularly and maintain proper pressure.''

S5. *Test conditions.*

S5.1 *Ambient temperature.* The ambient temperature is between 0°C (32°F) and 40°C (104°F).

S5.2 *Road test surface.* Road tests are conducted on a dry, smooth roadway.

S5.3 *Vehicle conditions.*

S5.3.1 *Test weight.* The vehicle is tested at its lightly loaded vehicle weight and at its gross vehicle weight rating without exceeding any of its gross axle weight ratings.

S5.3.2 *Vehicle speed.* The vehicle is tested at a speed between 50 km/h (31.1 mph) and 100 km/h (62.2 mph).

S6. *Test procedures.*

(a) Inflate the vehicle's tires to the vehicle manufacturer's recommended cold inflation pressure for the applicable vehicle load conditions specified in paragraph S5.3.1 of this standard. If the vehicle manufacturer has not recommended an inflation pressure for the lightly loaded condition, the inflation pressure specified by the vehicle manufacturer for the gross vehicle weight rating is used.

(b) With the vehicle stationary and the key locking system in the ''Lock'' or ''Off'' position, turn the key locking system to the ''On'' or ''Run'' position. The tire pressure monitoring system must perform a check of telltale lamp function as specified in paragraph S4.3.3 of this standard.

(c) If applicable, reset the tire pressure monitoring system in accordance with the instructions specified in the vehicle owner's manual.

(d) Drive the vehicle at any speed specified in paragraph S5.3.2 of this standard for 20 minutes.

(e)(1) For vehicles complying with S4.2.1, stop the vehicle and deflate any combination of one to four tires until the deflated tire(s) is (are) at 7 kPa (1 psi) below the inflation pressure at which the low tire pressure monitoring system is required to activate the low tire pressure warning telltale for that vehicle.

(2) For vehicles complying with S4.2.2, stop the vehicle and deflate any one tire until the deflated tire is at 7 kPa (1 psi) below the inflation pressure at which the low tire pressure monitoring system is required to activate the low tire pressure warning telltale for that vehicle.

(f) Drive the vehicle at any speed specified in paragraph S5.3.2 of this standard. Record the time from when the vehicle speed reaches 50 km/h until the time the low tire pressure warning telltale illuminates. The telltale must illuminate within 10 minutes as required in paragraph S4.2.1(a) or S4.2.2(a) of this standard.

(g) Stop the vehicle and turn the key locking system to the ''Off'' or ''Lock'' position. After a 5 minute period, turn the vehicle's key locking system to the ''On'' or ''Run'' position. The telltale must remain illuminated.

(h) Keep the vehicle stationary for a period of one hour.

(i) Inflate all of the vehicle's tires to the vehicle manufacturer's recommended cold inflation pressure. If the vehicle's tire pressure monitoring system has a manual reset feature, reset the system in accordance with the instructions specified in the vehicle owner's manual.

(j) Drive the vehicle at any speed specified in paragraph S5.3.2 of this standard. The telltale must extinguish as specified in paragraph S4.2.1(b) or S4.2.2(b).

(k)(1) For vehicles complying with S4.2.1, if additional combinations of tires are tested, repeat the test procedures in paragraphs S6(a) through (j).

(2) For vehicles complying with S4.2.2, if the other individual tires are tested, repeat the test procedures in paragraphs S6(a) through (j).

(l) Utilizing the existing vehicle rims, repeat the test procedures in paragraphs S6(a) through (k) for each tire size recommended for the vehicle by the vehicle manufacturer. Note: If a different rim size is required, OEM rim and tire assemblies appropriate for the tire pressure monitoring system are used for testing.

S7. *Phase-In Schedule.*

S7.1 *Vehicles manufactured on or after November 1, 2003, and before November 1, 2004.* For vehicles manufactured on or after November 1, 2003, and before November 1, 2004, the number of vehicles complying with this standard must not be less than 10 percent of:

(a) The manufacturer's average annual production of vehicles manufactured on or after November 1, 2000, and before November 1, 2003; or

(b) The manufacturer's production on or after November 1, 2003, and before November 1, 2004.

S7.2 *Vehicles manufactured on or after November 1, 2004, and before November 1, 2005.* For vehicles manufactured on or after November 1, 2004, and before November 1, 2005, the number of vehicles complying with this standard must not be less than 35 percent of:

(a) The manufacturer's average annual production of vehicles manufactured on or after November 1, 2001, and before November 1, 2004; or

(b) The manufacturer's production on or after November 1, 2004, and before November 1, 2005.

S7.3 *Vehicles manufactured on or after November 1, 2005, and before November 1, 2006.* For vehicles manufactured on or after November 1, 2005, and before November 1, 2006, the number of vehicles complying with this standard must not be less than 65 percent of:

(a) The manufacturer's average annual production of vehicles manufactured on or after November 1, 2002, and before November 1, 2005; or

(b) The manufacturer's production on or after November 1, 2005, and before November 1, 2006.

S7.4 *Calculation of complying vehicles.*

(a) For purposes of complying with S7.1, a manufacturer may count a vehicle if it:

(1) Is manufactured on or after November 1, 2003, but before November 1, 2004; or

(2) Complies with S4.2.1 or S4.2.2 of this standard.

(b) For purposes of complying with S7.2, a manufacturer may count a vehicle if it:

(1)

(i) Is manufactured on or after November 1, 2003, but before November 1, 2005;

(ii) Is not counted toward compliance with S7.1; and

(iii) Complies with S4.2.1 of this standard, or

(2)

(i) Is manufactured on or after November 1, 2004, but before November 1, 2005; and

(ii) Complies with S4.2.2 of this standard.

(c) For purposes of complying with S7.3, a manufacturer may count a vehicle if it:

(i) Is manufactured on or after November 1, 2003, but before November 1, 2006;

(ii) Is not counted toward compliance with S7.1 or S7.2; and

(iii) Complies with S4.2.1 of this standard, or

(2)

(i) Is manufactured on or after November 1, 2005, but before November 1, 2006; and

(ii) Complies with S4.2.2 of this standard.

S7.5 *Vehicles produced by more than one manufacturer.*

S7.5.1 For the purpose of calculating average annual production of vehicles for each manufacturer and the number of vehicles manufactured by each manufacturer under S7.1 through S7.3, a vehicle produced by more than one manufacturer must be attributed to a single manufacturer as follows, subject to 7.5.2:

(a) A vehicle that is imported must be attributed to the importer.

(b) A vehicle manufactured in the United States by more than one manufacturer, one of which also

markets the vehicle, must be attributed to the manufacturer that markets the vehicle.

S7.5.2 A vehicle produced by more than one manufacturer must be attributed to any one of the vehicle's manufacturers specified by an express written contract, reported to the National Highway Traffic Safety Administration under 49 CFR Part 590, between the manufacturer so specified and the manufacturer to which the vehicle would otherwise be attributed under S7.5.1.

S7.6 *Small volume manufacturers.* Vehicles manufactured during any of the three years of the November 1, 2003 to October 31, 2006 phase-in by a manufacturer that produces fewer than 5,000 vehicles worldwide during that year are not required to comply with the standard.

Tables to § 571.138

TABLE 1.—LOW TIRE PRESSURE WARNING TELLTALE—MINIMUM ACTIVATION PRESSURE

Tire type	Maximum or rated inflation pressure		Minimum activation pressure	
	(kPa)	(psi)	(kPa)	(psi)
P-metric—Standard Load	240, 300, or 350	35, 44, or 51	140	20
P-metric—Extra Load	280 or 340	41 or 49	160	23
Load Range C	350	51	200	29
Load Range D	450	65	260	38
Load Range E	550	80	320	46

4. Part 590 is revised to read as follows:

PART 590—TIRE PRESSURE MONITORING SYSTEM PHASE-IN REPORTING REQUIREMENTS

Sec.
590.1 Scope.
590.2 Purpose.
590.3 Applicability.
590.4 Definitions.
590.5 Response to inquiries.
590.6 Reporting requirements.
590.7 Records.
590.8 Petition to extend period to file report.

Authority: 49 U.S.C. 322, 30111, 30115, 30117, and 30166; delegation of authority at 49 CFR 1.50.

§ 590.1 Scope.

This part establishes requirements for manufacturers of passenger cars, multipurpose passenger vehicles, trucks, and buses with a gross vehicle weight rating of 4,536 kilograms (10,000 pounds) or less, except those vehicles with dual wheels on an axle, to submit a report, and maintain records related to the report, concerning the number of such vehicles that meet the requirements of Standard No. 138, *Tire pressure monitoring systems* (49 CFR 571.138).

§ 590.2 Purpose.

The purpose of these reporting requirements is to assist the National Highway Traffic Safety Administration in determining whether a manufacturer has complied with Standard No. 138 (49 CFR 571.138).

§ 590.3 Applicability.

This part applies to manufacturers of passenger cars, multipurpose passenger vehicles, trucks, and buses with a gross vehicle weight rating of 4,536 kilograms (10,000 pounds) or less, except those vehicles with dual wheels on an axle.

§ 590.4 Definitions.

(a) All terms defined in 49 U.S.C. 30102 are used in their statutory meaning.

(b) *Bus, gross vehicle weight rating, multipurpose passenger vehicle, passenger car, and trucks* are used as defined in 49 CFR 571.3.

(c) *Production year* means the 12-month period between November 1 of one year and October 31 of the following year, inclusive.

§ 590.5 Response to inquiries.

At any time during the production years ending October 31, 2004, October 31, 2005, and October 31, 2006, each manufacturer must, upon request from the Office of Vehicle Safety Compliance, provide information identifying the vehicles (by make, model, and vehicle identification number) that have been certified as complying with Standard No. 138. The manufacturer's designation of a vehicle as a certified vehicle is irrevocable.

§ 590.6 Reporting requirements.

(a) *General reporting requirements.* Within 60 days after the end of the production years ending October 31, 2004, October 31, 2005, and October 31, 2006, each manufacturer must submit a report to the National Highway Traffic Safety Administration concerning its compliance with Standard No. 138 (49 CFR 571.138) for its passenger cars, multipurpose passenger vehicles, trucks, and buses with a gross vehicle weight rating of less than 4,536 kilograms (10,000 pounds) produced in that year. Each report must—

(1) Identify the manufacturer;

(2) State the full name, title, and address of the official responsible for preparing the report;

(3) Identify the production year being reported on;

(4) Contain a statement regarding whether or not the manufacturer complied with the requirements of Standard No. 138 (49 CFR 571.138) for the period covered by the report and the basis for that statement;

(5) Provide the information specified in paragraph (b) of this section;

(6) Be written in the English language; and

(7) Be submitted to: Administrator, National Highway Traffic Safety Administration, 400 Seventh Street, SW., Washington, DC 20590.

(b) *Report content.*

(1) *Basis for statement of compliance.* Each manufacturer must provide the number of passenger cars, multipurpose passenger vehicles, trucks, and buses with a gross vehicle weight rating of 4,536 kilograms (10,000 pounds) or less, except those vehicles with dual wheels on an axle, manufactured for sale in the United States for each of the three previous production years, or, at the manufacturer's option, for the current production year. A new manufacturer that has not previously manufactured these vehicles for sale in the United States must report the number of such vehicles manufactured during the current production year.

(2) *Production.* Each manufacturer must report for the production year for which the report is filed: the number of passenger cars, multipurpose passenger vehicles, trucks, and buses with a gross vehicle weight rating of 4,536 kilograms (10,000 pounds) or less that meet Standard No. 138 (49 CFR 571.138).

(3) *Vehicles produced by more than one manufacturer.* Each manufacturer whose reporting of information is affected by one or more of the express written contracts permitted by S7.5(c)(3) of Standard No. 138 (49 CFR 571.138) must:

(i) Report the existence of each contract, including the names of all parties to the contract, and explain how the contract affects the report being submitted.

(ii) Report the actual number of vehicles covered by each contract.

§ 590.7 Records.

Each manufacturer must maintain records of the Vehicle Identification Number for each vehicle for which information is reported under § 590.6(b)(2) until December 31, 2008.

§ 590.8 Petition to extend period to file report.

A manufacturer may petition for extension of time to submit a report under this Part. A petition will be granted only if the petitioner shows good cause for the extension and if the extension is consistent with the public interest. The petition must be received not later than 15 days before expiration of the time stated in § 590.6(a). The filing of a petition does not automatically extend the time for filing a report. The petition must be submitted to: Administrator, National Highway Traffic Safety Administration, 400 Seventh Street, SW., Washington, DC 20590.

Issued: May 30, 2002.

Jeffrey W. Runge,

Administrator.

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