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GUIDE TO HIGH SPEED

PATROL CAR TIRES



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GUIDE TO

HIGH SPEED PATROL CAR TIRES

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NBS Special Publication 480-33

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FOREWORD

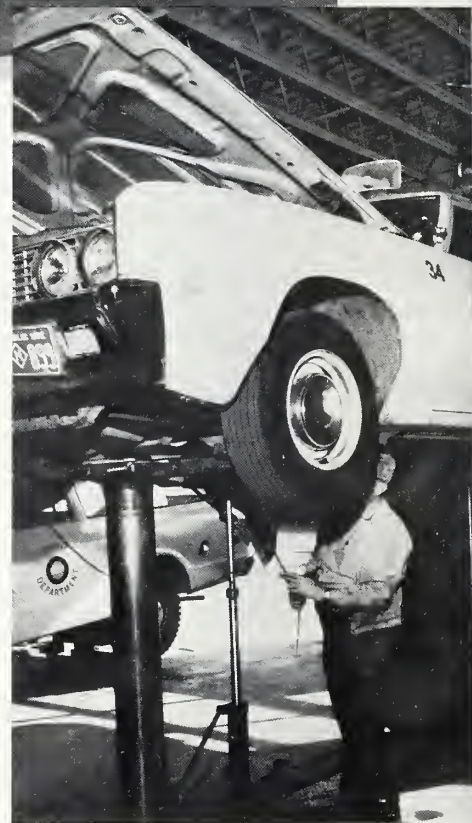
The Law Enforcement Standards Laboratory (LESL) of the National Bureau of Standards (NBS) furnishes technical support to the National Institute of Law Enforcement and Criminal Justice (NILECJ) program to strengthen law enforcement and criminal justice in the United States. LESL's function is to conduct research that will assist law enforcement and criminal justice agencies in the selection and procurement of quality equipment.

LESL is: (1) Subjecting existing equipment to laboratory testing and evaluation and (2) conducting research leading to the development of several series of documents, including national voluntary equipment standards, user guides, and technical reports.

This document is a law enforcement equipment guide developed by LESL under the sponsorship of NILECJ. Additional guides as well as other documents are being issued under the LESL program in the areas of protective equipment, communications equipment, security systems, weapons, emergency equipment, investigative aids, vehicles and clothing.

Technical comments and suggestions concerning this guide are invited from all interested parties. They may be addressed to the authors or to the Law Enforcement Standards Laboratory, National Bureau of Standards, Washington, D.C. 20234.

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INTRODUCTION

Tires form one of the major subsystems of an automobile. They serve as the interface between the road and the car's brake, suspension and steering systems; they provide the traction that starts and stops the vehicle; they absorb a portion of the initial impact with a road defect; and they provide the traction necessary for steering. Tires also contribute to the comfort characteristics of the ride and affect the performance obtained from the engine. Pursuit tires, i.e., those certified for speeds up to 125 mph (200 km/h),¹ have the additional task of performing these functions at high speeds.

Tire purchases comprise a significant portion of a police department's transportation budget.² If they are not properly selected and cared for, they wear faster, reduce gasoline mileage, make the car handle poorly on the road, and may cause accidents. Properly selected and maintained tires can save money and improve the safety and performance of patrol cars.

Selecting the best type of tire for use by a particular department is not an easy task because of the various conditions under which they are used. The selection of pursuit tires on the basis of their wet traction capabilities has been particularly difficult, due to the lack of comparative information on different brands, constructions, and sizes. One thing definitely known is that non-pursuit tires are not advisable for high speed police work! [3]³

This guide is designed to supply the information needed to select tires to suit particular needs and to maintain them for maximum safety, tire life, and performance.

¹ This guide gives data in the familiar English units followed, in parentheses, by their approximate metric equivalents, rounded to the nearest meaningful unit. Measurements or units quoted from other sources may not have metric equivalents.

² Based on information obtained from a 1976 survey by the International Association of Chiefs of Police, 379 police departments spent nearly \$5,400,000 for pursuit tires in 1975, an average expenditure of more than \$14,000 per department.

³ Numbers in brackets refer to the references listed on page 29.

APPLICATION ASPECTS

Police patrol vehicles are subject to far greater strain and punishment than regular passenger cars. The same holds true for the tires. Given this, one might assume that most patrol vehicles would be equipped with high performance tires that are designed for high speed traction and durability. However, a survey of police departments throughout the country by the International Association of Chiefs of Police (IACP) indicated that, of the 973 police departments that responded to the questionnaire, only 379, or 38.9 percent, used high speed pursuit tires on their patrol cars. *Table 1* gives the number and location of departments that use (or do not use) high speed pursuit tires.

Thirty-four percent of the responding police departments were located in the Western states, which comprise Washington, Oregon and California. *Table 1* shows that 42.8 percent of the police departments that indicated they do not use high speed pursuit tires are located in those states. It is interesting to note that 77.7 percent of the respondent departments in the Western states do not use high speed pursuit tires, yet there are many more miles of highways in those states than in some of the other areas.

The following sections discuss the ways pursuit tires are used, based on information obtained from the IACP survey. Since only those police departments that used high speed pursuit tires were asked to complete the questionnaire, the discussions apply only to pursuit tire usage.

Types of Roads Driven

According to the survey, patrol cars travel over a variety of road surfaces on which they must start, stop, turn, and sometimes travel at speeds in excess of 100 mph (160 km/h).

The amount of wear and tear placed upon tires is dependent upon the types of roads within the jurisdictions served by the police departments. About half of the 379 police departments that responded indicated that 76 to 100 percent of the driving done by their patrol cars is on city streets.

About 40 percent of the police departments stated that 15–25 percent of the driving done by their patrol cars is on interstate highways and state primary roads. About half of these police departments revealed that poor tread wear is one of their most serious tire problems.

TABLE 1. DISTRIBUTION OF POLICE DEPARTMENTS THAT USE AND DO NOT USE HIGH SPEED PURSUIT TIRES, BY GEOGRAPHIC AREA (1975)

Geographic Area	Police Departments Using Pursuit Tires			Police Departments Not Using Pursuit Tires		
	Number of Police Departments	Percent of Area	Percent of Total Using	Number of Police Department	Percent of Area	Percent of Total Not Using
1. New England (80)*	45	56.3	11.9	35	43.7	5.9
2. Middle Atlantic (125)	54	43.2	14.2	71	56.8	11.9
3. East North Central (168)	70	41.7	18.5	98	58.3	16.5
4. West North Central (65)	41	63.1	10.8	24	36.9	4.0
5. South Atlantic (105)	45	42.9	11.9	60	57.1	10.1
6. East South Central (17)	11	64.7	2.9	6	35.3	1.0
7. West South Central (35)	19	54.3	5.0	16	45.7	2.7
8. Mountain (51)	21	41.1	5.5	30	58.9	5.1
9. Western (327)	73	22.3	19.3	254	77.7	42.8
Total (973)	379	----	100	594	----	100

*Number of respondents.

Source: 1976 IACP survey.

Pursuit Driving

Pursuit tires are presently certified by certain manufacturers for speeds up to 125 mph (200 km/h). The use of regular tires for pursuit driving should never be considered, since the Department of Transportation regulations require that regular tires be certified for speeds up to only 85 mph (136 km/h). Of the 379 police departments that use high speed pursuit tires, 316, or 83 percent, do not abort high speed pursuits after a specified distance; this further justifies the use of pursuit tires, since sustained high speed places extra stress on tires. A breakdown on these departments by section of the country is given in *table 2*.

Tire Maintenance

Failure to use high speed pursuit tires is not the only danger faced by police departments involved in pursuit work. Driving at high speeds can be very dangerous if tire maintenance is poor. High speed driving will cause underinflated tires to run hot and will lead to tire failures. The survey results suggest that police department tire maintenance programs may need improvement.

About half of the police departments that use high speed pursuit tires indicated that maintenance checks on pursuit tires are performed weekly or bi-monthly. The tire pressure is rechecked each shift, daily, or weekly by 65 percent of the police departments that use high speed pursuit tires. The other 35 percent stated that maintenance checks are only done as needed.

Only 25 percent of the police departments indicated that tire damage, inflation pressure, and tread wear are checked during maintenance inspections of pursuit tires. Alignment is checked by 65 percent of the departments. Less than 5 percent inspect balancing and rotation during maintenance checks.

Pocket gauges, which are more accurate than service station gauges [1], were used by 58 percent of the police departments to check inflation pressure. To assure that tire maintenance procedures were being followed, 60 percent of the departments performed spot checks of tires. Only 4 percent, however, performed maintenance shop audits to assure that tire maintenance procedures were being followed and only 14 percent had written tire maintenance procedures.

TABLE 2. DISTANCES AT WHICH POLICE DEPARTMENTS ABORT HIGH SPEED PURSUITS (1975)

Geographic Area	Do Not Abort	Distance					
		1 Mile	2 Miles	3 Miles	4 Miles	5 Miles	More Than 5 Miles
1. New England	38*	2	1	2	0	1	1
2. Middle Atlantic	45	1	1	1	0	4	1
3. East North Central	58	0	3	1	0	3	5
4. West North Central	30	1	3	1	0	4	2
5. South Atlantic	38	1	2	1	0	1	2
6. East South Central	9	0	0	0	0	0	2
7. West South Central	18	0	0	0	0	0	1
8. Mountain	16	2	0	2	0	0	0
9. Western	64	3	1	0	0	5	0
Total	316	10	11	8	0	18	14

*Number of respondents.

Source: 1976 IACP survey.

**TABLE 3. MAJOR TIRE PROBLEMS OF POLICE DEPARTMENTS
BY GEOGRAPHIC AREA (1975)**

Geographic Area	Poor Tread Wear		Lack of High Speed Endurance		Frequent Maintenance	
	Police Departments Number	Percent	Police Departments Number	Percent	Police Departments Number	Percent
1. New England (45)*	25	56	1	2	3	7
2. Middle Atlantic (54)	28	52	0	0	5	9
3. East North Central (70)	28	40	3	4	15	21
4. West North Central (41)	18	44	1	2	7	17
5. South Atlantic (45)	17	38	4	9	9	20
6. East South Central (11)	5	45	1	9	1	9
7. West South Central (19)	7	37	4	21	5	26
8. Mountain (21)	10	48	1	5	2	10
9. Western (73)	34	47	1	1	6	8
Total (379)	172	45	16	4	53	14

*Number of respondents.

Source: 1976 IACP survey.

The criteria for removing tires are relatively consistent. More than half of the police departments stated that the reasons for removing pursuit tires from patrol cars involved in pursuit work are wear bar showing, minor damage, cracked sidewall, chunking, blistering, or puncture.

Hazard Exposure

Driving on city streets places much more wear and tear on tires than driving on highways. Cars must constantly stop and go while driving on city streets; they often come in contact with curbs; and debris is found much more frequently on city streets than on highways. Frequent cornering also causes increased tread wear.

Table 3 shows how the police departments responded to the question of what they considered as their most serious tire problems.

Types of Tires Used

The responses from the survey showed that more police departments use steel radial-ply

and fabric radial-ply tires than belted bias-ply and bias or cross-ply tires. *Table 4* illustrates this finding.

Tire Mileage

In addition to the numbers of responding police departments that use the various types of tires, *table 4* also gives the average mileage obtained for each of the four types of tires. In 7 of the 9 geographic regions the departments averaged 1000 mi (1600 km) to 8000 mi (12,800 km) more from the belted bias-ply tires than from the bias or cross-ply tires. In all the geographic regions the police departments averaged more mileage from the fabric radial-ply tires than from the belted bias-ply tires. The departments averaged more mileage from the steel radial-ply tires than from the fabric radial-ply tires in 5 of the geographic regions.

Snow Tires

Because of the severe winters in some areas, patrol cars may be equipped with snow tires for

over half of the year. This may encourage some police departments to leave snow tires on patrol cars during the warmer months, with the assumption that this can save money. The cost of mounting and removing tires every fall and every spring should not, however, be the only factor that is considered. Other factors, such as fuel economy during summer months and tread life, are also important.

Laboratory tests conducted by Calspan Corporation for the Department of Transportation revealed the following about the use of snow tires during the summer months [11].

- Snow tires have greater rolling resistance than conventional tires, thus reducing gas mileage by 2 percent.
- Snow tires have poorer cornering performance than conventional tires. This means that a car equipped with snow tires on the rear wheels is more likely to spin out in a skid while cornering on dry pavement, particularly at higher speeds.

- The stopping distance is greater for snow tires than for conventional tires, since snow tires develop less traction on dry roads.
- Since snow tires incorporate a rubber compound that tends to remain relatively soft in cold weather, they wear at a somewhat higher rate than regular tires of the same construction type.

Radials Versus Snow Tires

Radial tires, as a group, give superior rupture resistance, tread life, and cornering ability; however, tests conducted by the National Safety Council's Committee on Winter Driving Hazards show that snow tires provide more traction over a wide range of snow-covered road conditions than conventional radial tires that do not have snow treads. The Committee also stated that radial tires offer no advantage over conventional tires in either stopping, traction or cornering performance on glare ice.

TABLE 4. AVERAGE TREAD LIFE FOR EACH TYPE OF TIRE, BY GEOGRAPHIC AREA (1975)

Geographic area	Bias or cross-ply	No.	Belted bias-ply	No.	Fabric radial-ply	No.	Steel radial-ply	No.
1. New England	14,100 mi* (22,700 km)	7**	11,700 mi (18,800 km)	10	23,500 mi (37,800 km)	24	25,800 mi (41,500 km)	20
2. Middle Atlantic	12,800 mi (20,600 km)	12	15,900 mi (25,600 km)	13	17,300 mi (27,800 km)	28	21,200 mi (34,100 km)	22
3. East North Central	15,200 mi (24,500 km)	9	18,300 mi (29,500 km)	21	24,200 mi (38,900 km)	38	24,100 mi (39,800 km)	24
4. West North Central	13,500 mi (21,700 km)	10	14,700 mi (23,700 km)	9	27,400 mi (44,100 km)	25	26,200 mi (42,200 km)	22
5. South Atlantic	15,400 mi (24,800 km)	5	14,900 mi (24,000 km)	11	18,800 mi (30,300 km)	32	19,500 mi (31,400 km)	10
6. East South Central	10,000 mi (16,100 km)	2	15,000 mi (24,100 km)	2	22,900 mi (36,900 km)	8	14,500 mi (23,300 km)	2
7. West South Central	10,700 mi (17,200 km)	3	16,700 mi (26,900 km)	7	26,200 mi (42,200 km)	14	33,800 mi (54,400 km)	8
8. Mountain	13,800 mi (22,200 km)	4	17,000 mi (27,400 km)	9	25,600 mi (41,200 km)	8	21,100 mi (34,000 km)	10
9. Western	10,000 mi (16,100 km)	8	18,100 mi (29,100 km)	23	19,100 mi (30,700 km)	44	22,100 mi (35,600 km)	24
Total		60		105		221		142

*Mileage figures rounded to nearest 100.

**Number of respondents.

Source: 1976 IACP survey.

TECHNICAL ASPECTS

Construction

Purchasers of pursuit tires have a choice of three types of tire construction. Although all pursuit tires look similar on the outside, on the inside the various types—bias-ply, bias-belted, and radial—differ markedly. Basically, every tire consists of beads, a carcass, and a tread. The tread provides the traction. Manufacturers produce a variety of tread patterns to meet various driving requirements. The carcass is the body of the tire. The beads are the two edges of the tire, reinforced with steel cable, that contact and seal the tire against the wheel rim.

Bias-Ply

The bias-ply is the oldest and most familiar type of tire in this country. Its carcass, underneath the rubber skin, consists of fabric layers or plies which run at about a 35° angle to the direction of travel (*fig. 1a*). The bias-ply tire has an equal number of plies in the tread and sidewalls. It provides a soft, quiet ride, but the relative lack of stability in the tread area causes the tread to distort and squirm on contact with the road, resulting in more rapid tread wear.

Bias-Belted

The bias-belted tire combines the diagonal layers of the bias-ply tire with a 2-ply belt under the tread (*fig. 1b*). The result is a tire with improved tread mileage, better traction, and more protection against punctures and bruises than the bias-ply tire.

Radial

The radial tire has plies that run at right angles to the tread (*fig. 1c*). The sidewalls are more flexible than bias-ply sidewalls, and give a better ride, readily absorb impacts, reduce squirm, and provide a cooler running tire. This tire construction also gives superior performance in the areas of tread mileage, wet skid protection, and steering.

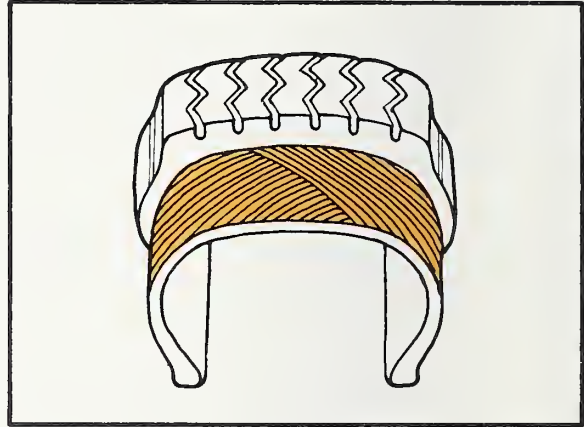


FIGURE 1a

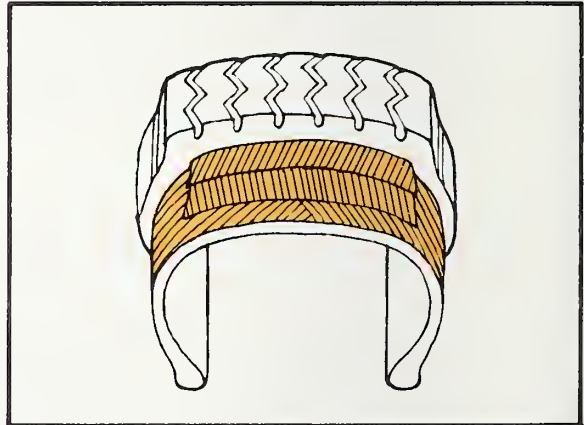


FIGURE 1b

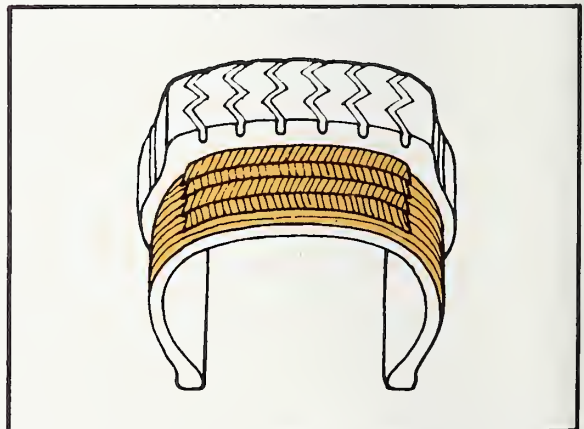


FIGURE 1c

Tire Markings

As specified in Motor Vehicle Safety Standard No. 109, each tire has molded into or onto both sidewalls the size designation, the maximum permissible inflation pressure, the maximum load rating, the name of each cord material, the actual number of plies in the sidewalls and the actual number of plies in the tread area if different, the words “tubeless” or “tube type” as applicable and the word “radial” if the tire is a radial-ply tire.

The following explanation of the markings on a GR70-15 tire (fig. 2) is based on that given in the B. F. Goodrich Passenger Tire Manual [6].

GR70-15—Tire Designation

G—Size Designation

Letters are used to designate tire size, and have an important bearing on load carrying capacity. A G-size tire is designed to carry a load of 1380 pounds at 24 psi inflation, and a maximum load

of 1620 pounds at maximum air pressure of 32 psi, for Load Range B. In comparison, a G-size, Load Range D tire can carry a maximum load of 1830 pounds at a maximum pressure of 40 psi. The load carrying capacities were established by The Tire and Rim Association, Inc., and are given in appendix A.

As shown in that appendix, the load carrying capacity of a tire in a specific letter size is dependent on the inflation pressure; its load carrying capacity can be increased by raising its inflation pressure. The maximum inflation pressure which a tire can carry is controlled by its load range. Maximum load and inflation pressure are branded on the tire sidewall.

For a specific letter size (G in this case) the carrying capacity is the same for all tires irrespective of rim diameter, series (aspect ratio) or type of construction.



FIGURE 2



FIGURE 3. TIRE PROFILES BY SERIES (NOT TO SCALE)

R—Radial

The 'R' means that this tire is a radial tire.

70—Series

The '70' indicates that the height of the tire is 70 percent of its width. The lower the number, the wider and lower the tire (*fig. 3*). The tread width is proportional to the tire width.

15—Rim Diameter

The '15' indicates that this tire is designed for a 15 inch diameter wheel.

Load Range

The load range identifies a given size tire with its load and pressure limits.

As stated previously, the load range of a tire affects its maximum load carrying capacity. Most passenger tires are Load Range B and are restricted to a maximum load which can be carried with the maximum inflation pressure of 32 psi. Where greater load carrying capacity is needed, Load Range C or D tires may be used. These can withstand higher maximum inflation pressures and carry greater loads.

Formerly, the term 'ply rating' was used instead of 'load range.' Confusion arose from trying to equate the ply rating with the actual number of plies in the tire. An example is 4-ply vs. 4-ply rating/2-ply. Both tires had equal strength and load and inflation ratings, but the actual numbers of plies differed. The tire industry therefore adopted the term 'load range' to replace 'ply rating.' The letters B, C, and D identify the load ranges of most passenger car tires. They correspond to the former 4-, 6-, and 8-ply ratings, respectively.

Tread Plies—Sidewall Plies

Every tire has markings to reveal the cord material and the number of plies in the body and in the belt (if it's a belted tire). The tire shown in *figure 2* has a total of four plies, including two body plies and two tread plies.

DOT

These are the initials of the Department of Transportation, the Federal agency that sets tire standards. They denote that the tire meets or exceeds Federal requirements. Following this symbol is a serial number which identifies the tire manufacturer, manufacturing plant, type

of tire construction and date manufactured.

Pursuit Tires

Pursuit tires have an added identification which distinguishes them from regular tires. Some examples are: "Patrol," "Police Special," "High Speed Pursuit," etc.

Tire Materials

The cords are the strands that form the plies in a tire. The tire cord is the backbone of a tire because it is the major source of its strength. The cords provide bruise and fatigue resistance, comfort, and maneuverability. They can also contribute to improved tread wear resistance. In spite of the fact that tire cords play such a significant role, they are only about ten percent of the weight of the tire.

Rayon, nylon, and polyester are the fabrics commonly used in tire carcass plies. Rayon is the oldest of these materials and provides a smooth ride at all speeds. It is preferred as the carcass cord in radial-ply tires because of its excellent flex fatigue resistance. Nylon is one of the strongest and coolest-running tire cord materials, providing the greatest protection when speed and loads are severe. Polyester has the strength of nylon and is preferred for passenger tire carcasses because of its superior ride qualities.

Rayon, nylon, and polyester are also used as belt cords. Rayon makes an excellent material for radial tire belts because of its dimensional stability and its good ride characteristics. Steel wire and fiberglass, due to their stiffness, low stretch, and high strength, are also used very effectively in belts to provide good tread wear. They also reduce tread scuffing and provide added protection against bruises and impacts.

Aramid is a new fiber developed specifically as a tire cord. It is stronger and lighter than steel, yet it will not stretch, shrink, grow, or distort like other fibers.

Use of Chains

There are several misconceptions about radial tires, both favorable and unfavorable. One is the belief that the sidewalls of a radial tire are more susceptible to damage from chains than those of bias or bias-belted tires.

Tests made by the United States Auto Club (USAC) for the National Association of Chain Manufacturers [9] show that this is not the case. The USAC tests were run at a sustained speed of 35 mph (56 km/h) on bare pavement, and even after a distance of 150 mi (240 km) showed no evidence of sidewall damage to any of the radials tested. However, driving for as little as 15-20 mi (24-32 km) on dry pavement caused the original equipment bias-ply and belted-bias tires tested to develop severe sidewall and tread gouges. This did not occur on wet pavement, indicating the lubricating effect of moisture. Correct chain size, proper fit, moderate driving speeds and minimal driving on dry pavement are essential for long life and maximum performance of both tires and chains.

Tires and Gasoline Mileage

A study conducted for the U.S. Department of Transportation [11] showed that the use of radial tires on automobiles can improve gasoline mileage over either bias-ply or bias-belted tires. The rolling resistances of 35 different tires of the three basic constructions, of various carcass and belt materials, design loads and height-to-width ratios, were measured. The tests were conducted on a tire tester which accurately simulates actual highway conditions.

The rolling resistance losses of a tire do not produce useful work and are dissipated mainly in the form of tire heat. A reduction in these tire energy losses thus increases fuel economy. Though there were differences between tire brands of the same construction type, the study showed that under normal driving conditions radial-ply tires provide about 6 percent better fuel economy than bias-ply tires.

SELECTION AND PURCHASING OF TIRES

Principles of Selection

Tires for patrol cars should be selected on the basis of how they will be used. For example, it would be wasteful to put high speed tires on patrol cars that seldom exceed 60 mph (96 km/h) and never exceed 75 mph (120 km/h).

IT IS IMPORTANT TO REMEMBER THAT REGULAR PASSENGER CAR TIRES SHOULD NEVER BE PURCHASED FOR USE ON PATROL CARS INVOLVED IN PURSUIT WORK. Regular passenger car tires, of all grades and constructions, are not suitable for high speed police use. Tests conducted by the U.S. Department of Transportation showed that such tires failed at average speeds of 100 mph (160 km/h) when tested on a high speed drum [3]. An analysis of their data is given in *table 5*. Patrol cars which may be used in sustained high speed driving should be equipped with tires that are certified by the manufacturer for use at speeds of at least 125 mph (200 km/h).

Cost Factors

There are many different factors to be considered in buying tires. Cost is one important factor. However, the lowest-cost tire may not be the cheapest tire. Some police departments purchase tires on the basis of low bid only. Many use this method believing that there are no alternatives or that justification for departing from low bid is too difficult. Others use the low bid method because the economics of buying tires are not considered. Tire cost goes beyond the purchase price. A tire that costs \$30 and lasts 12,000 mi (19,200 km) is just as expensive as one that costs \$100 and lasts 40,000 mi (64,000 km). In fact, when the cost of removing, replacing, and balancing tires is considered, the \$30 tire is far more expensive.

Tire warranties, another factor to consider, vary considerably from manufacturer to manufacturer. Some warranties on tires are for specified miles against tread wear and road hazards based on the car's odometer readings. This means that if the tire wears out or fails after the

odometer shows the tire rolled only 75 percent of the miles specified on the warranty, a 25 percent credit is given toward a new tire. Other companies have the same policy in connection with tread wear, but their road hazard warranties operate differently. If the tire fails, the dealer measures the tire's remaining tread depth and bases the adjustment on the percentage of tread that has worn away, regardless of how many miles the tire has been driven. Also, dealers may not honor a warranty if the cause of the tire wear appears to be improper wheel alignment or failure to perform recommended rotation.

In addition, when evaluating tire expenditures for pursuit applications, factors such as safety of personnel and equipment, vehicle control under emergency conditions, and the potential economic cost of a disastrous tire failure must be considered.

Performance

In addition to being designed for speeds up through 125 mph (200 km/h), a pursuit tire should provide good traction for starting, stopping, and cornering, be strong enough to withstand the usual road hazards, and give long wear. To meet these requirements tires need to be selected with care; however, there is rarely enough information on hand to make this possible. Just as there is no one tire that is the most economical for departments with different requirements, there is probably no one tire at any price that is the best overall performer. Compromises have to be made on the conflicting requirements of cost, ride, handling, high-speed endurance, tread wear, resistance to damage, rolling resistance, traction under various driving and braking conditions, etc. Some tire manufacturers might, for example, favor a smooth quiet ride in preference to handling precision, while others might favor wet-road safety over long tread life.

In order to measure the variation in the wet traction performance of pursuit tires made by

different manufacturers, tests were conducted for the Law Enforcement Standards Laboratory by the Safety Research Laboratory of the U.S. Department of Transportation [5]. They performed braking, cornering, and driving traction tests using modified ASTM procedures.

The tires tested for wet traction are described in table 6, and the test results are given in table 7. Though the tires are ranked from 1 through 10, some of the differences in rank are not significant. Measurements underlined by a common line do not differ significantly from one another in the statistical sense, and identify tires of equal rank. Those entries to the left or right of an underlined group do differ significantly, at the 0.05 confidence level, from those in the underlined group.

Braking Traction

The conclusions presented here are based on the stopping distance data.

- The Goodyear Flexten tire performed better than any other tire in the braking test, stopping in 420 ft (128 m). If a police car using four of these tires were to lock its brakes on a 50.2 SN (skid number per ASTM E 274-70) surface, the car would stop in 210 ft (64 m). (Since sets of two tires were braked in the test, the stopping distance must be divided by 2 in order to obtain the equivalent result for 4 wheel braking.)
- The average stopping distance for the tires in the next group, sets 2, 4, 9, 1 and 8, was 449 ft (137 m). Thus, the increase in stopping distance due to the use of the second best rather than the best tires would be 29 ft (9 m), or 7 percent.
- Set 6 performed poorest, with a stopping distance of 499 ft (152 m); there is thus a difference of 19

TABLE 5. TIRE FAILURES, BY CONSTRUCTION* [3]

Construction	mph km/h	Speed At Failure**											Total Number of Tires Tested
		80 129	85 137	90 145	95 153	100 161	105 169	110 177	115 185	120 193	Did Not Fail	Average Speed at Failure	
Bias ply		—	—	1	4	14	5	1	2	—	—	101 mph (162 km/h)	27
Bias belted		—	2	4	6	2	4	1	3	—	2***	101 mph (163 km/h)	24
Fabric radial		—	1	—	4	2	1	3	—	—	—	(100 mph (161 km/h)	11
Steel radial		1	—	1	2	9	10	1	—	—	—	101 mph (162 km/h)	24
Total													86

*This analysis is based upon data provided by the Safety Research Laboratory, U.S. Department of Transportation. Tires were standard grade passenger tires selected from stocks on hand. The data were obtained from tests conducted on a high speed drum, and may not reflect failures at these speeds on open road operations.

**DOT Test Procedure: Break-in at 50 mph (80 km/h) for four hours; cool tires to ambient temperature (100°F or 37.8°C); run tires for 30 minutes at 75 mph (121 km/h); increase speed in 5 mph (8 km/h) increments and run for 30 minutes at each new speed until failure occurs.

***Two tires withstood 30 minutes at 120 mph (193 km/h) without failure; the tests were suspended at that point. For averaging purposes, these were assumed to have failed at 125 mph (20 km/h).

TABLE 6. DESCRIPTION OF POLICE TIRES, IN ORDER TESTED [5]

Set No.	Make*	Serial Number	Size	Construction	Material	
					Sides	Tread
1	Armstrong	CEU6A51 176	H70-15	Bias	—	<u>4 Ply Nylon</u> 4 Ply Nylon
2	Dunlop Gold Seal	DAVXA53176	H78-15	Bias	—	<u>4 Ply Nylon</u> 4 Ply Nylon
3	Dunlop Elite	DBVYA2A	HR78-15	Radial	—	<u>2 Ply Polyester</u> 2 Ply Aramid 2 Ply Nylon
4	Goodrich Pursuit Radial	BEU7LL2 475	HR70-14	Radial	—	<u>2 Ply Rayon</u> 6 Ply Rayon
5	Goodyear Flexten	MKU73FH 156	HR70-15	Radial	—	<u>6 Ply Polyester</u> 4 Ply Aramid
6	Goodyear Police Special	MBVXPAA 066	H78-15	Bias	—	<u>4 Ply Nylon</u> 4 Ply Nylon
7	Michelin	FHTVA2FX 215 FHTVA1FX 245 FHTVA2FX 245 FHTVA2FX 215	215HR15XVS (HR78-15)	Radial	—	<u>2 Ply Rayon</u> 2 Ply Rayon 2 Ply Steel
8	Pirelli	XBTUXKLLK 095	215HRCN75 (HR78-15)	Radial	—	<u>2 Ply Rayon</u> 2 Ply Rayon 2 Ply Steel 2 Ply Nylon
9	Firestone Super 125	VCVYW77166	HR78-15	Radial	—	<u>2 Ply Polyester</u> 2 Ply Polyester 2 Ply Aramid
10	Firestone Super 125	VCU7W77136	HR70-15	Radial	—	<u>2 Ply Polyester</u> 2 Ply Polyester 2 Ply Aramid

*The use of brand names in this report in no way constitutes endorsement of these products by the National Bureau of Standards or any other agency of the Federal Government. Since not all brands of tires were submitted by their manufacturers for high speed testing, the omission of any brand from this report should not be construed as indicating that the brand is either unsafe or inferior in quality, nor should the inclusion of a brand be construed as evidence that future production runs of that tire will perform in the same manner as those tested.

TABLE 7. RANKING OF 10 PAIRS OF POLICE TIRES FOR BRAKING, CORNERING,
DRIVING AND SPINNING TRACTION [5]

Rank	1	2	3	4	5	6	7	8	9	10
Braking Traction¹										
Tire Set No.	5	2	4	9	1	8	3	10	7	6
Stopping distance (ft), at 60 mph	<u>419.7</u>	<u>440.2</u>	<u>440.8</u>	<u>451.8</u>	<u>454.0</u>	<u>456.1</u>	<u>460.8</u>	<u>464.6</u>	<u>475.9</u>	<u>499.0</u>
Relative traction (%)	108.0	103.5	103.4	101.0	100.5	100.0	99.0	98.2	95.7	90.6
Cornering Traction²										
Tire Set No.	8	7	9	5	10	2	4	3	1	6
Cornering traction coefficient	<u>0.576</u>	<u>0.554</u>	<u>0.550</u>	<u>0.549</u>	<u>0.545</u>	<u>0.535</u>	<u>0.533</u>	<u>0.527</u>	<u>0.513</u>	<u>0.490</u>
Relative traction (%)	107.2	103.1	102.4	102.2	101.5	99.6	99.2	98.1	95.5	91.2
Driving Traction³										
Tire Set No.	8	4	9	7	5	10	3	6	1	2
Peak driving traction coefficient	<u>1.197</u>	<u>1.149</u>	<u>1.131</u>	<u>1.123</u>	<u>1.120</u>	<u>1.109</u>	<u>1.090</u>	<u>0.918</u>	<u>0.873</u>	<u>0.864</u>
Relative traction (%)	113.2	108.7	107.0	106.2	105.9	104.5	103.1	86.8	82.6	81.7
Spinning Traction³										
Tire Set No.	5	10	7	9	3	4	6	8	2	1
Spinning traction coefficient	<u>0.904</u>	<u>0.869</u>	<u>0.858</u>	<u>0.853</u>	<u>0.843</u>	<u>0.837</u>	<u>0.825</u>	<u>0.812</u>	<u>0.770</u>	<u>0.753</u>
Relative traction (%)	108.6	104.4	103.1	102.5	101.3	100.6	99.1	97.5	92.5	90.5

¹Tested per ASTM F403-74.

²Tested per ASTM F376-73.

³Tested per ASTM F424-75.



**FATAL HIGH SPEED FAILURE OF STANDARD GRADE PASSENGER TIRE
(ALABAMA STATE POLICE – 1974)**

percent between the best tire (set 5) and the worst tire (set 6).

- The radial tires braked slightly better than the bias-ply tires; the average stopping distance for the bias-ply tires was 464 ft (141 m) vs. 453 ft (138 m) for the radial tires, a difference of 2 percent.
- The 70 series tires braked better than the 78 series tires; the average stopping distance for the 78 series tires was 464 ft (141 m) vs. 445 ft (136 m) for the 70 series tires, a difference of 4 percent.

Cornering Traction

- The cornering traction test divided the tires into four groups. The set 6 tires performed significantly poorer than any of the other tires. On a 200 ft (61 m) radius curve, the maximum speed would be 38 mph (62 km/h).
- The radial tires cornered better than the bias-ply tires. The average cornering coefficient for the bias-ply tires was 0.51 vs. 0.55 for the radials. This represents an 8 percent better

performance by the radials. In other words, a car could negotiate a 200 ft (61 m) radius curve of the test pavement with radial tires at 41 mph (66 km/h), and with bias-ply tires at 39 mph (63 km/h).

- No significant difference was found between the cornering performances of the 70 series and the 78 series tires.

Driving Traction

- The radial tires performed better as a group than the bias-ply tires in wet driving traction.
- There was no significant difference between 70 and 78 series tires in wet driving traction.

Endurance and Tread Wear

The General Services Administration has recently conducted endurance and tread wear performance tests on police pursuit tires. The data obtained from these tests enabled them to compile the Qualified Products List shown in appendix B. Certain brands that appear on this list were not tested for traction, and vice versa.

Installation

Once the proper tires have been selected, the job is not ended; good service practices are also important. These include mounting and balancing the tires, wheel alignment, tire rotation, and timely replacement.

Mounting Tires on Wheels

Before new tires are mounted, the wheels should be visually inspected to make sure they are in good condition, and the tires should be inspected for defects in material and workmanship. The following are procedures to follow when mounting a set of new tires.

- Remove old balance weights.
- Carefully clean the tire beads and the bead seat areas of the wheel of dirt and rust. This will help to insure an airtight seal between the tire and the rim.
- Replace old valves with new ones. It is recommended that metal clamp-in valves be used instead of the rubber snap-in type. During high speed runs air loss can occur through the tire valve due to centrifugal force. To prevent this, dome seal type valve caps should be used.
- Thoroughly lubricate the side and base of the tire beads as well as the rim bead seat ledges with an approved mounting solution, thin vegetable oil, soap, or plain water, before putting the tire on the rim. Under no circumstances should they be mounted dry, nor should antifreeze, detergents, brake fluid or other petroleum base liquids be used.
- In mounting the tire push the bottom bead in the well of the wheel to prevent tearing of the beads. The side of the wheel with the narrow ledge must be facing up.
- To start mounting the top bead, push that portion of the top bead directly in front of you down into the wheel well and hold it there while the machine runs the remainder of the bead onto the wheel.
- There are several types of bead expanders on the market and it is recommended that one be available for hard-to-seat beads. One method of seating beads without a bead expander is as follows: Position the tire-wheel assembly so that the valve is facing down. Press the upper bead by hand against the lower bead on the lower ledge of the wheel. Turn the assembly over with the valve facing up. If the lower bead has been forced on sufficiently tightly, this bead will now stay on the topside of the wheel and the loose bead will fall down against the lower edge, effecting a seal so that the tire can be inflated.
- Inflate the tire in the usual manner. For safety, install the valve core in the valve stem before attempting to inflate the tire. Proper seating of the beads may require initial inflation pressures higher than operating pressures, but these should never exceed 40 psi (276 kPa). After the beads are seated, reduce the pressure to the proper operating pressure.
- While standard mounting machines and tools can be used for mounting radial tires, special precautions must be taken to see to it that the tire beads seat properly against the rim flanges. The seating is more difficult than for tires of other construction, and can be checked by sighting the circumferential ridge on the tire just above the flange area to see if it is visible and running parallel to the rim flange all the way around.

(A)



(B)

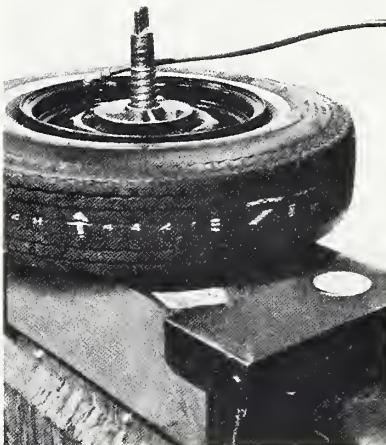


(C)



(D)

(E)



- (A) CLEAN THE RIM THOROUGHLY.
- (B) LUBRICATE THE TIRE BEADS.
- (C) SEAT THE BOTTOM BEAD IN THE WELL OF THE WHEEL.
- (D) SEAT THE TOP BEAD IN THE WELL OF THE WHEEL.
- (E) INFLATE THE TIRE.

Inflation Pressure

Maintaining the proper inflation pressure is one of the best ways of realizing the advantages and benefits of pursuit tires. This will assure that the tires will carry the specified weight; provide maximum traction in a curve or corner; resist damage from rocks and potholes; and squirm less and run cooler than at lower pressures. Tires should be inflated to the pressure recommended by the car manufacturer or the tire manufacturer. The air pressures recommended are always the cold inflation pressures, i.e., those obtained during installation or after the car has been parked for several hours. Appendix A gives the maximum permissible air pressure and load range for a given tire size. Underinflation can greatly shorten the life of a tire and can cause internal tire damage and

failure in extreme cases. Underinflation also causes rapid wear on the outer edges of the tread. As can be seen in *figure 4*, underinflation has a significant effect on the contained-air temperature of tires. Overinflation can also cause internal damage to tires and causes them to wear faster at the center of the tread.

After the tires are mounted and inflated, the following services should be performed.

- Dynamically balance all four wheels. High speed tires should not be balanced using static methods (bubble balancing).
- Set front wheel toe-in to the value established by the car manufacturer to achieve the best vehicle and tire performance.

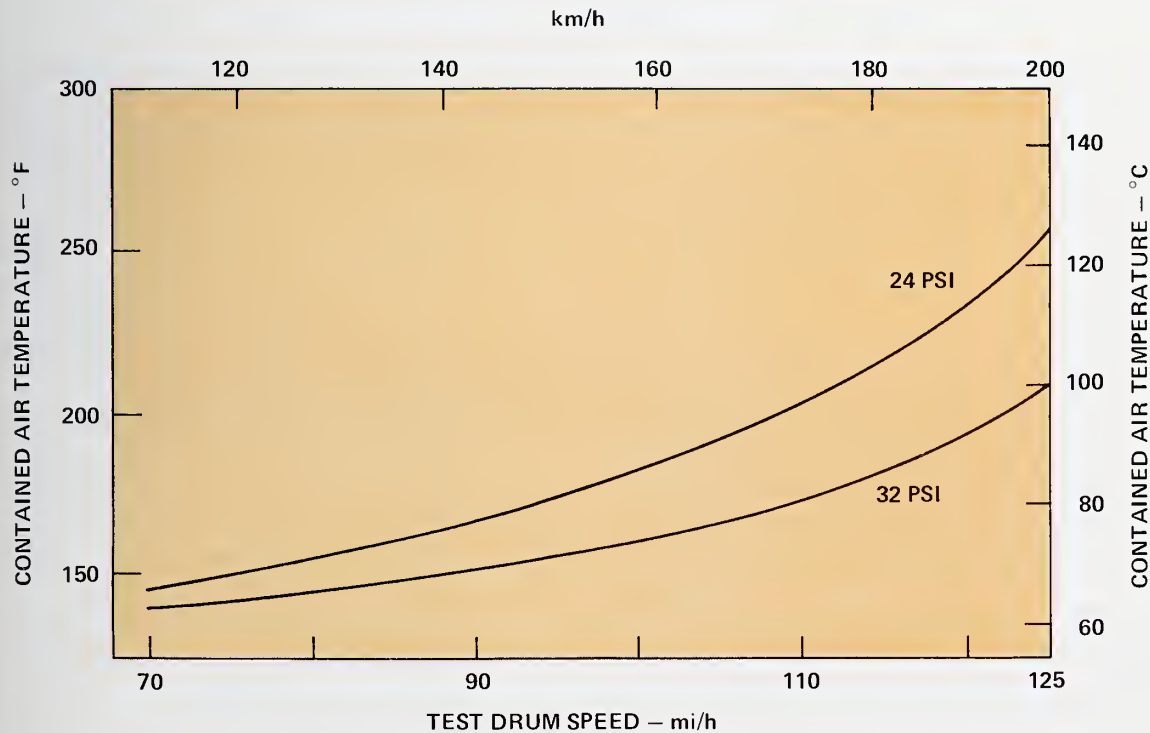


FIGURE 4. RELATION OF CONTAINED-AIR TEMPERATURE AND TEST DRUM SPEED AT 24 PSI AND 32 PSI [8]

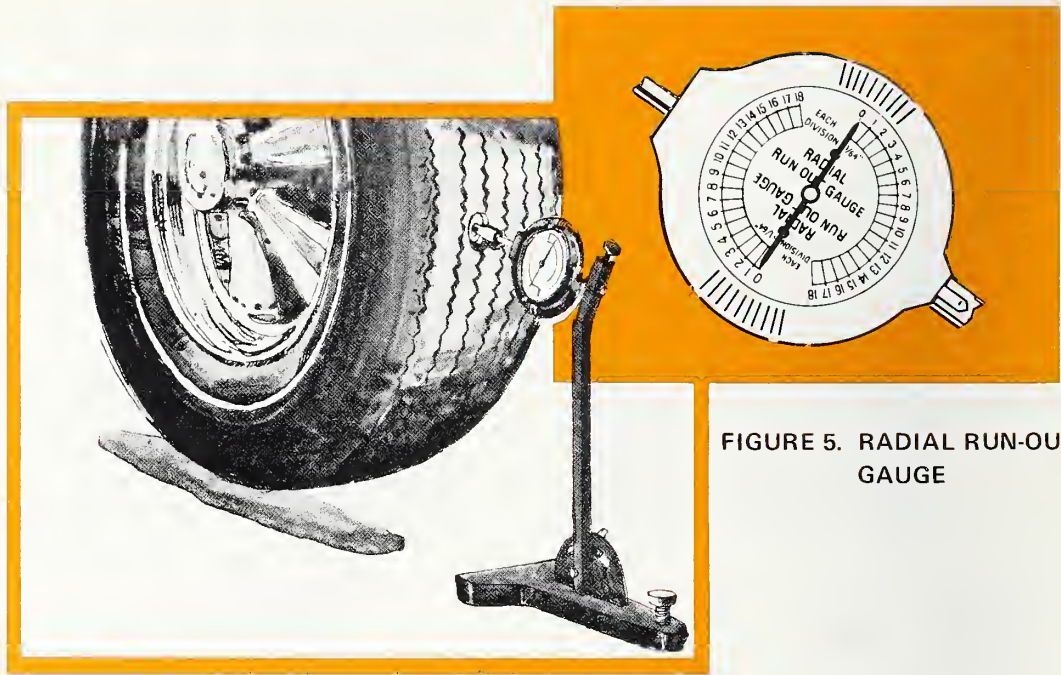


FIGURE 5. RADIAL RUN-OUT GAUGE

FIGURE 6.

- Check camber and caster to make certain they are set within the car manufacturer's specifications.
- Check shock absorbers, wheel bearings, steering components, and brakes to make certain they are in good condition and functioning properly.

Radial Run-Out

Wheel vibrations are usually attributed to unbalanced or improperly balanced tires, but the unbalance component due to radial run-out (out of roundness) has often been ignored. To assure optimum performance, however, radial run-out should be minimized. The radial run-out gauge (fig. 5) is a precision instrument used to measure wheel and tire out-of-roundness, the distance between the high and low points around the circumference.

The following procedure should be used to measure and minimize radial run-out:

- Newly installed belted-bias or radial

tires usually do not require warm-up. However, if the tires are to be warmed up to eliminate any possible flat spots, the car should be driven for a distance of at least 6 mi (10 km).

- Jack up the car immediately to avoid the development of flat spots and to allow all four wheels to run freely.
- Place the run-out gauge in front of the tire and wheel assembly to be checked so that the rotating disc on the end of the plunger is in contact with the tire (fig. 6). On new installations the radial run-out should be checked on the second tread rib in from the outer edge.
- Rotate the tire slowly, stop at the point where the gauge reads closest to zero, and adjust the reading to exactly zero. Rotate the tire once to confirm that this is actually the lowest spot on the tire and then mark this radius on both the tire and the wheel with the letter "L."

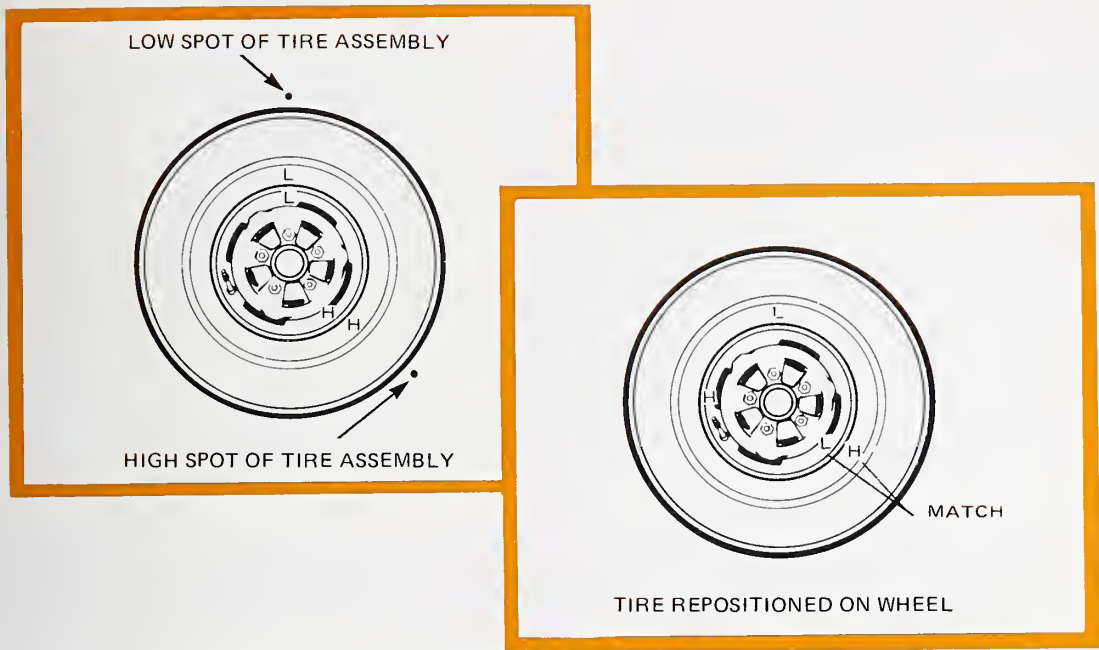


FIGURE 7. MINIMIZING RADIAL RUN-OUT

- Rotate the tire slowly and note the amount of variance from zero on the gauge. Locate the highest point and mark both the tire and the wheel with the letter "H."
- The maximum run-out of each wheel and tire combination should be determined and recorded.
- If the radial run-out is $\frac{3}{64}$ in (1.2 mm) or less, proceed to balance the tire in the usual way. If it is over $\frac{3}{64}$ in (1.2 mm), attempt to minimize it as follows:
 - Mark one of the wheel studs and the bolt hole using that stud.
 - Reposition the wheel assembly on the hub so that the marked stud and bolt are as far apart as possible.
 - If the radial run-out still exceeds $\frac{3}{64}$ in (1.2 mm), reposition the tire on the wheel so that the previously marked high point on the tire (H) coincides with the low point on the wheel (L) (fig. 7).

- If the overall run-out is still over $\frac{3}{64}$ in (1.2 mm), check the radial run-outs of each bead seat on the wheel (without tire) to help decide whether the wheel or tire should be repaired or replaced.

Balancing

After their radial run-outs are minimized, the wheel assemblies must be balanced. If this is not done properly the resulting vibration will increase tire wear and will also cause excessive wear in bearings, ball joints, drive shafts, etc., and substantially reduce their service life. This is especially true in vehicles that are driven at greater than average speeds or at the resonating speed of the wheel/tire assembly.

There are three basic types of unbalance: static, couple, and dynamic.

- Static unbalance (fig. 8), formerly also called force or kinetic unbalance, causes "wheel hop" or "bounce." In its simplest form, the total unbalance

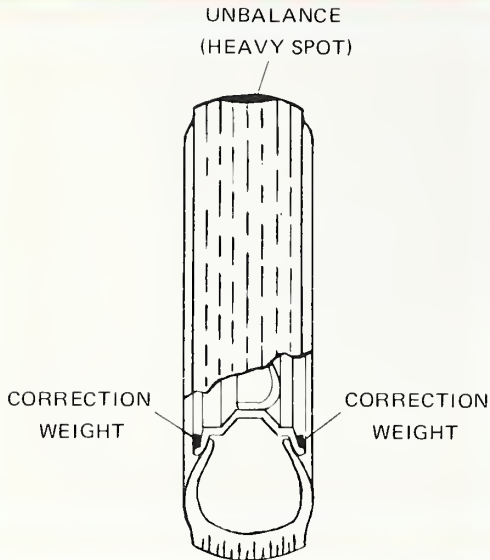


FIGURE 8

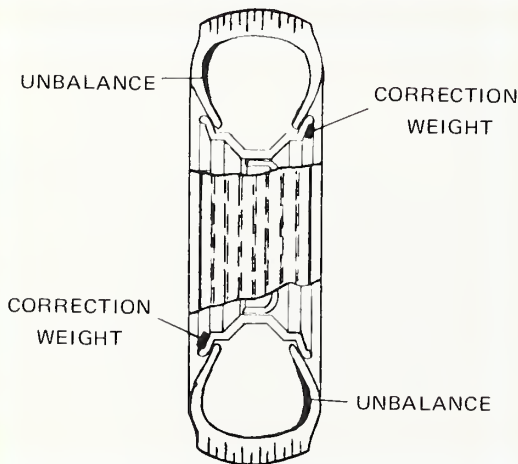


FIGURE 9.

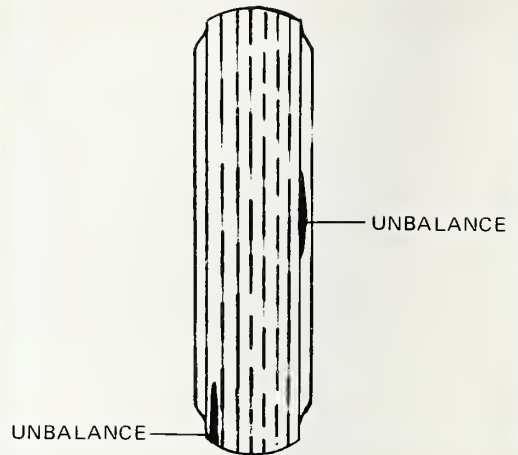


FIGURE 10.

mass is located in one spot equidistant between the two rims of the wheel. It can be corrected by placing equal weights of the proper size on each side of the wheel exactly 180° opposite the location of the heavy spot.

- Couple unbalance (*fig. 9*), sometimes called moment unbalance, causes "wheel wobble." In one form, two unbalance masses are positioned on opposite sides of the tire and spaced 180° from each other. It can be corrected with two weights placed on opposite sides of the wheel and 180° from each other. In other words, a couple unbalance needs a counter-couple to correct it.
- Dynamic unbalance (*fig. 10*) is a combination of static and couple unbalance and is found in nearly all wheel assemblies.

Before any balancing is attempted, mud and dirt must be cleaned from the wheel and tire. Another rule is to split the weights to be applied whenever the amount required exceeds one ounce.

The functions of a balancing machine are to

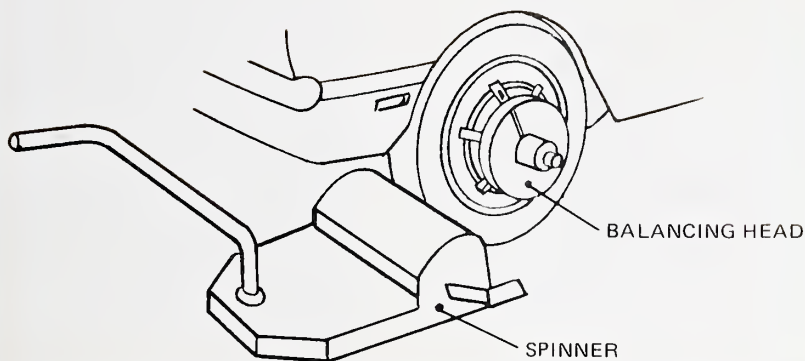


FIGURE 11.

determine whether a wheel assembly is out of balance and, if it is, to indicate the amount of weight that must be added, and the location at which it must be added to bring about balance.

There are basically two types of on-car balancers, the mechanical type and the electronic type. In using either type it is important to remember that limited slip differentials require that both rear wheels be off the ground during balancing.

Mechanical On-the-Car Balancer (fig. 11)

These balancers are often erroneously referred to as dynamic balancing systems; however, most of them are only designed to correct static unbalance. A few can also detect couple unbalance, but are rarely operated in that mode. Most of these balancers use a hubcap-type balancing head containing movable weights. This balancing head must be carefully secured to the rim to prevent the fixture itself from introducing unbalance into the system. After the car is raised off the floor a separate motor-driven spinner is used to spin the non-drive wheels. Those cars having disc brakes require a 3 hp (minimum) wheel spinner to achieve the proper amount of wheel spin. Drive wheels without

limited slip differentials can be spun by allowing one wheel to remain on the ground or blocked while the other is driven by the engine. In this instance 35 mph (about 55 km/h) on the speedometer equals 70 mph (about 110 km/h). On vehicles with limited slip differential both wheels must be off the floor and the car should be accelerated to a maximum of 80 mph (130 km/h) on the speedometer, which is also 80 mph wheel speed. In both cases the acceleration should be gradual. The spinning, unbalanced wheel assembly is then allowed to coast and the weights in the balancing head are adjusted until the vibration caused by the unbalance is reduced to a point where the operator, either by sight or touch, determines that operation is smooth. The permanent weights are then attached at the positions indicated by the adjustable weights inside the balancing head. After the initial spin balance, the balancing head should be removed and the wheel spun again to check for vibration. If vibration is present on a freely spinning wheel, it may be due to static unbalance (caused by removal of the balancing mechanism) or by couple unbalance (which the balancer was never able to correct in the first place). Additional balancing weights should then be placed on both the inside and outside of the wheel, by trial and error, until smooth operation is achieved.

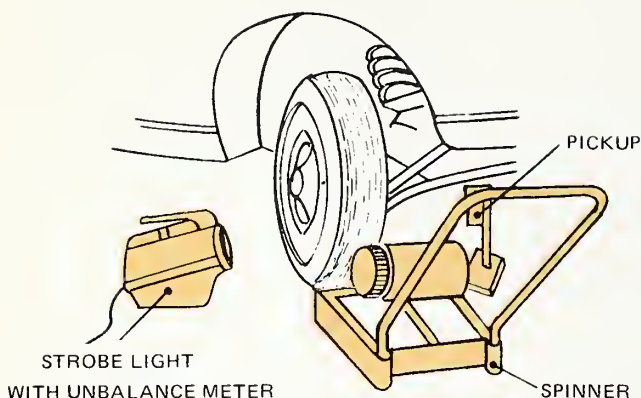


FIGURE 12.

Electronic On-the-Car Balancer

This device (*fig. 12*) utilizes a displacement measuring vibration pick-up which is placed under the car in a position to measure vibration either vertically (static) or horizontally (couple). A strobe light is used to determine the angle of unbalance and a meter indicates the approximate amount of unbalance correction. The wheels are spun as with the mechanical balancers. Front wheels can be balanced to remove static and couple unbalance separately, thereby attaining dynamic balance. The rear wheels, however, can only be measured for static unbalance.

Wheels can usually be balanced for smoother operation with this machine than with a bubble or static balancer; however, the operator using this machine plays a more significant role. He must know how to interpret the meter readings during a momentary peak while the wheel coasts down through a resonance which may be affected by the tightness of the front end linkages, by variable damping from shock absorbers, wheel bearings, dragging brakes, etc. Getting under the car repeatedly to attach or change trial weights and to change the pick-up position requires considerable patience.

Off-the-Car Dynamic Balancer

This is a machine capable of rotating a wheel assembly at high speed. The wheel assembly is

mounted either horizontally or vertically, depending on the design of the balancer (*fig. 13*). The horizontal mounting machine has an advantage in that the wheel is better able to center itself. Most dynamic balancers provide an unbalance readout combining static and couple unbalance into a dynamic reading. This enables the wheel assembly to be balanced by adding one correction weight to each side of the wheel. The major advantage of this machine is that generally a wheel can be balanced faster and to a finer degree than with a bubble, static, or on-the-car system.

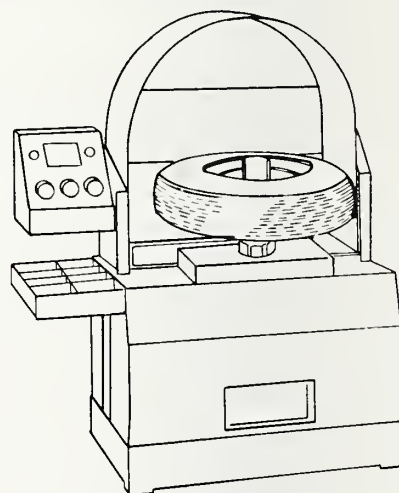


FIGURE 13a. HORIZONTAL OFF-THE-CAR DYNAMIC BALANCER

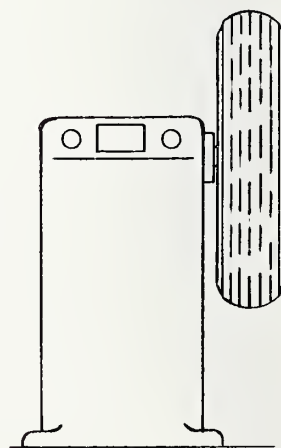


FIGURE 13b. VERTICAL OFF-THE-CAR DYNAMIC BALANCER

Alignment

Improper alignment of the front wheels with respect to the direction of travel is another factor which can cause excessive wear. The three angles associated with alignment, shown in figure 14, are camber, caster, and toe-in.

Camber is the inclination of the wheel from the vertical. Caster is the inclination from the vertical of the axis through the ball-joints or king pins. Caster causes the front wheels to straighten after a turn. It also helps counteract the tendency of a car to wander due to wind or uneven road surfaces. Camber and rolling resistance tend to force the front wheels outward at their forward edge. To compensate for this tendency, the front wheels are turned slightly inward (i.e., toe-in) when the car is at rest.

Tires worn primarily on one side indicate a problem with toe-in or camber. If toe-in is incorrect on one wheel, the car will probably pull to one side or the other. If toe-in is incorrect on both wheels, the car is probably hard to steer in either direction. Tire cupping can result from worn shock absorbers, one wheel out of alignment, a bent spindle, or a combination of these.

Safety Precautions

There are several safety hazards associated with mounting and inflating tires that are sometimes overlooked by service personnel. To help prevent serious personal injury or tire damage when mounting automobile tires the Tire Industry Safety Council recommends the following:

- Make certain that the valve core is inserted in the valve stem prior to inflating. If this is attempted after inflation, the valve can become a dangerous projectile.
- Use an extension gauge with a clip-on chuck during the bead seating process (fig. 15) so that the air pressure buildup can be closely watched while standing well back from the tire.
- Wear safety glasses or goggles.

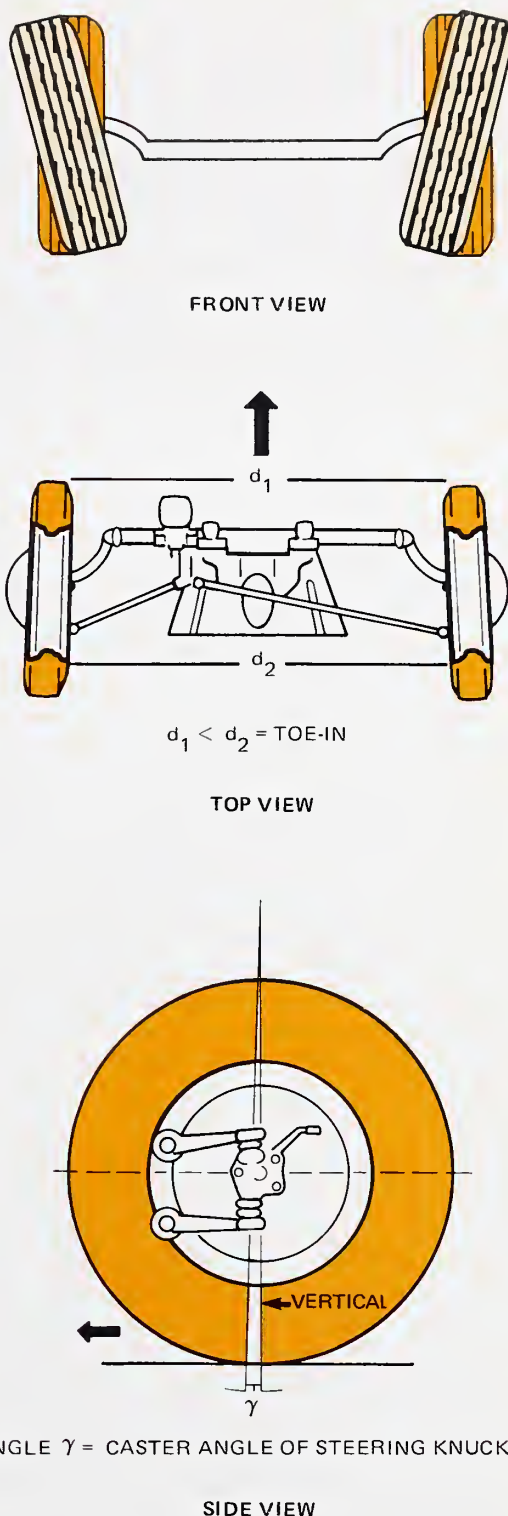


FIGURE 14. CAMBER, TOE-IN, AND CASTER:
THE ALIGNMENT ANGLES

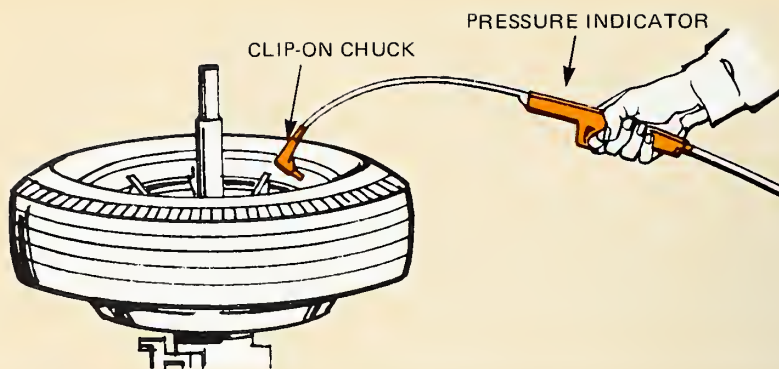


FIGURE 15

Operations

There are many factors that can affect the performance of tires. Below are some suggestions to keep in mind in order to get the best performance from pursuit tires.

Break-in

Break-in is needed because of the greater amount of heat generated during initial flexing. High-speed tires, like regular tires, need a break-in period. They should be broken in by driving 55 mph (90 km/h) for the first 50 mi (80 km). This will help to avoid possible damage to the tires by giving the various parts of the tires a chance to "seat in."

Inflation and Loading

Keeping tires properly inflated for the load carried is very important for tire safety and wear. The load which a tire will safely carry depends on its size, its load range or ply rating, and its inflation pressure. The load range table (appendix A) gives the load limits (pounds per tire) for tires normally used on passenger vehicles. In order to use the table, first check the Car Owner's Manual for the normal weight of the car, add the additional weight the car is expected to carry, and divide by four. This will give an approximation of the weight per tire.

In the row where the tire designation appears (for example, G78-15), look under the load range section for the maximum load each tire is

expected to carry. The figure at the head of the column is the correct cold air pressure for a tire carrying a particular load. The tires should be inflated cold to an air pressure which is at least as high as the value given in the table.

Thus, Load Range B tires are for pressures of 32 psi (220 kPa) or under; Load Range C tires are for pressures of 36 psi (248 kPa) or under and Load Range D are for pressures of 40 psi (276 kPa) and under. This information is also marked on the sidewalls of all new tires; for example, "max. load 1620 lb @ 32 psi max. pressure."

Road Conditions

Broken cords in the rim area of a tire may be caused by a severe blow. This usually occurs from the impact of a tire hitting a curb or chuckhole. This type of injury to a tire is not repairable. Broken cords directly under the tread are caused by sharp head-on impact. The position and size of the break is determined by the angle and force of the impact. To avoid these and other damages such as cuts, bruises and blowouts, slow down on bad roads, and avoid driving over curbs and other obstructions.

Driver Habits

Driving habits have a direct bearing on tire wear. Using brakes more than necessary increases tire wear. Some ways to avoid this are to use the engine compression to help

decelerate and to slow down before reaching a corner. When a sudden stop has to be made avoid locking the wheels. A locked wheel panic stop not only wears tires severely and unevenly, but reduces stopping ability and may cause one to lose control of the car. Rapid starts, driving at excessive speeds, and riding the edge of the pavement all tend to wear away tread rubber rapidly.

Mechanical Condition of Vehicle

Maintenance of the vehicle in good mechanical condition not only improves its riding characteristics and safety, but also helps in gaining maximum tire mileage by reducing irregular wear. Misalignment of the front wheels, rear wheel misalignment due to a sprung axle housing or a bent wheel, worn bushings, faulty or "grabbing" brakes, and faulty or worn shock absorbers con-

tribute to uneven and rapid tread wear and should be corrected.

Maintenance

In order to get the maximum wear and performance from a tire, it is important to perform the necessary maintenance. Good maintenance can eliminate most tire trouble, and at the same time help to promote safety on the highway.

Although inflation, balance, alignment, and rotation are not the only factors to consider, they should be the main factors in any maintenance program.

Inflation Checks

Because of the extremely high speeds at which patrol vehicles may be driven, tire manufacturers recommend that their tires be inflated to the maximum allowable "cold" pressure for the appropriate load range. Using the maximum allowable pressure reduces tire deflection and heat buildup and allows tires to operate in a satisfactory temperature range. Pressure should be checked daily with an accurate pressure gauge.

The readings of air hose pressure gauges at service stations should not be relied upon. They are not subject to regular testing or any kind of certification for accuracy and are often seriously inaccurate. Tests in 1971 by the National Bureau of Standards [1] revealed that approximately one out of three air tower gauges was wrong by 4 psi (28 kPa) or more, and three out of five were wrong by 2 psi (14 kPa) or more. Pocket gauges were more accurate. Only one in ten was found to be wrong by 2 psi (14 kPa) or more. There is the further complication that the trip to the service station warms up the tires, thereby temporarily increasing their pressure by an unknown amount. This may be negligible or may exceed 6 psi (41 kPa), depending on circumstances. To get a correct measurement, one must check the pressure after the tires have had time to cool for three hours or longer after a trip. One must never deflate or "bleed" a hot tire down to the recommended pressure. To do so could leave the tire seriously underinflated. *Figure 16* shows tires in various states of inflation.



FIGURE 16. STATES OF TIRE INFLATION

Tire Rotation

To equalize tread wear, tires should be rotated in accordance with the recommendation in the Car Owner's Manual, if available, or at 6000–8000 mi (10,000–13,000 km) intervals. However, if irregular wear begins to develop, the causes should be corrected and the tires rotated before the recommended mileage interval.

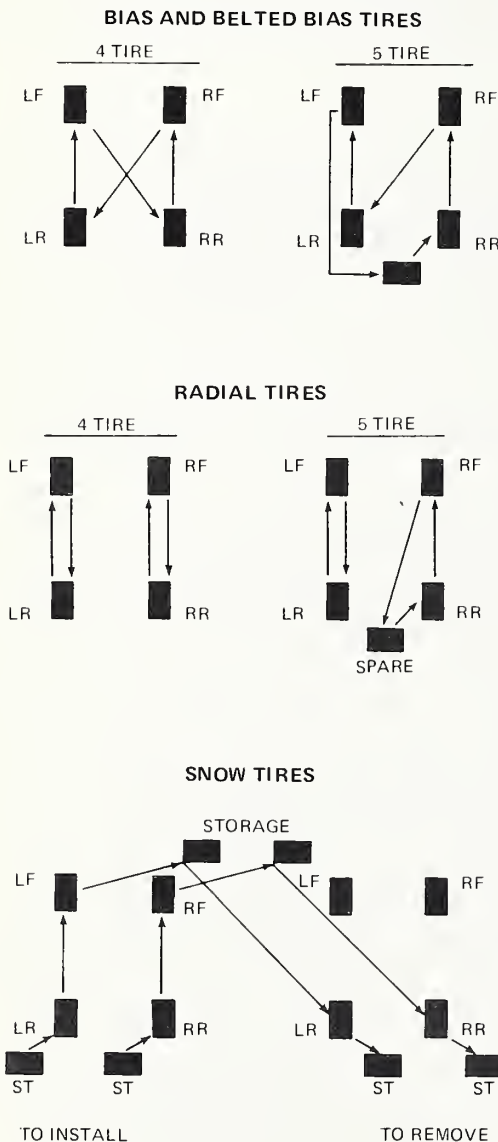


FIGURE 17. TIRE ROTATION [4]

As shown in figure 17, the rotation pattern for bias and bias-belted tires is different from that for radial-ply tires.

Because of change in the tire-wheel-brake assembly during normal service or due to rotation, rebalancing may be required.

Detection of Faults and Impending Troubles

A visual inspection should be performed during the daily inflation pressure check in order to determine the condition of the tires, valves, and wheels. Missing valve caps should be replaced. The following conditions are signs of trouble:

- Tread or sidewall cuts, cracks, or snags deep enough to expose tire ply cords.
- Bulges or knots, indicating possible separation of tread or sidewall from tire body.
- Front tire wear different from the rear.
- Uneven wear across the tread of any tire.
- Left front and right front tire wear unequal.
- Left rear and right rear tire wear unequal.
- Cupping, flat spotting, etc.
- Front tire tread having scuffed appearance, with feathered edges on one side of tread ribs or blocks.

There are other types of tire damage that are internal and not evident unless the tire is removed from the rim.

Mixing and Matching Tires

Tests conducted by the Calspan Corporation for the National Highway Traffic Safety Administration on the influence of tire properties on car handling characteristics show that mixing different types and sizes of tires on the front and rear wheels can make some cars less stable in severe maneuvers that might be experienced in accident avoidance situations. Tires performed best when fitted in complete

The uneven tread wear patterns shown below were caused by wrong inflation pressure, misalignment, improper balance or suspension neglect. These conditions can be avoided or corrected.

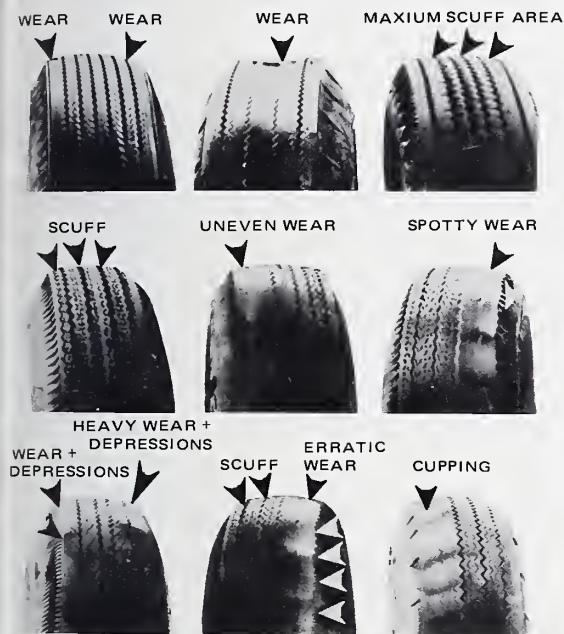


FIGURE 18. UNEVEN TREAD WEAR

sets. Different constructions (bias, bias-belted, and radial) should never be mixed on the same axle. The same applies for different sizes. Appendix C gives a summary of the rules on mixing as recommended by the Rubber Manufacturers Association.

Positioning of Least Worn Tires

The available accident data suggest that tires having similar amounts of tread wear be placed on the same axle, with the least-worn tires installed on the rear of the car. When putting two new tires on a vehicle mount them on the rear wheels. This will provide better traction, handling, and blowout protection. If only a single new tire is being installed, pair it with the best remaining tire and place them on the rear axle.

Abnormal Tread Wear

As mentioned earlier the mechanical condition of the car and the tire inflation pressure play significant roles in tire tread mileage. The causes of abnormal tread wear should be corrected as soon as they are discovered. *Figure 18* illustrates some of the uneven tread wear patterns which may be encountered.

A tire should be replaced if it wears unevenly so that two or more adjacent grooves of the tread are less than 1/16 in (1.6 mm) thick. Tires made since 1968 have built-in wear indicators which appear as smooth narrow "wear bars" across the tread when the tread depth gets down to this level (see *fig. 19*).

Repairs and Servicing

If a tire loses all or most of its air pressure, particularly at high speed, and is run even a short distance while flat, it should be considered unsuitable for high speed use, since the extent of the damage is not always easy to determine. The damaged tire should be repaired, if possible, and used on a vehicle in other than pursuit or emergency service.

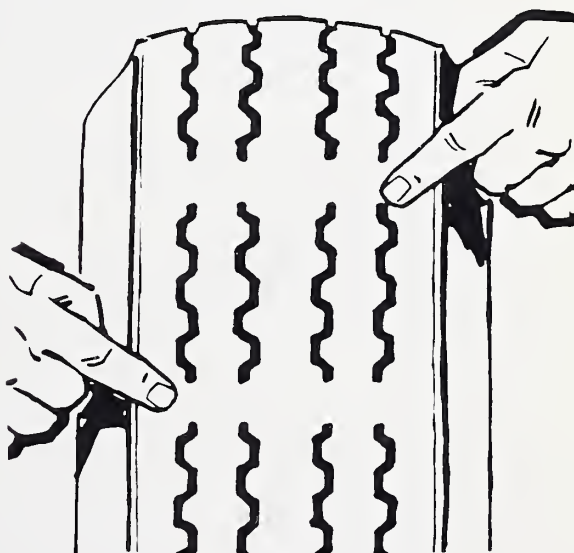


FIGURE 19. WEAR BARS

IACP Postscript

At the request of the Law Enforcement Standards Laboratory (LESL), this tire guide was reviewed by the International Association of Chiefs of Police, National Advisory Committee for Law Enforcement Equipment and Technology (NACLEET). While the guide is excellent for the most part, NACLEET felt that certain important information concerning the use of the guide should be brought to the attention of the law enforcement user.

- The guide contains the results of tests conducted to evaluate the comparative traction performance of various brands and sizes of high speed pursuit tires. Although the procedures used in the tests were methods developed and standardized by the American Society for Testing and Materials (ASTM) for standard passenger vehicle tires, NACLEET believes that the use of 6-inch rims and an inflation pressure of 24 psi are not representative of police usage and might have produced results and rankings which are inapplicable. Most police patrol cars are equipped with 6.5-inch or 7-inch rims and use the manufacturer's recommended inflation pressure of 30 or 32 psi. Therefore, NACLEET has recommended that future tests of pursuit tires be conducted with cars equipped with the wider rims and with tires inflated to the higher pressures.
- Not all manufacturers submitted tires for high speed testing by the General Services Administration (GSA). Therefore, the omission of a particular brand or size of tire from the GSA Qualified Products List (Appendix B) does not necessarily mean that the tire is unacceptable for police use. Conversely, the inclusion of a particular brand or size of tire on the List should not be considered a guarantee of satisfactory future performance. NACLEET strongly concurs with the LESL recommendation that whenever high speed performance is required, departments should always procure tires which have been certified by the manufacturer for high speed pursuit—usually 125 mph.
- The recommendations contained in the guide for tire maintenance and inspection should be followed unless they conflict with a manufacturer's recommendation. In that case, the manufacturer's recommendation should take precedence. Well maintained and inspected tires will lessen the risk of high speed tire failure and reduce injuries and property damage.

Colonel James C. Crawford, *Chief*

Minnesota State Patrol

Chairman, NACLEET/IACP

Assistant Chief Louis L. Sporrer

Los Angeles Police Department

Chairman, Transportation Subcommittee, NACLEET/IACP

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- Neill, A. H., Jr., and Hinch, J. A., "Selection Guide for High Speed Police Pursuit Tires (Traction)," NHTSA Technical Note T-1020, National Highway Traffic Safety Administration, Washington, D.C. 20590, September 1976.
- "Passenger Tire Manual," B. F. Goodrich Tire Co., 500 Main Street, Akron, Ohio 44318.
7. "Radial Auto Tire Service Manual," Goodyear Tire and Rubber Co., 1144 E. Market St., Akron, Ohio 44316.
8. "Radial Pursuit Tire Maintenance Procedures," Firestone Tire and Rubber Co., 1200 Firestone Parkway, Akron, Ohio 44317.
9. "Radial Tire Chain Test," United States Auto Club, 4910 West 16 St., Speedway, Indiana 46224, April 1975.
10. "Radial Tire Service Manual," B. F. Goodrich Tire Co., 500 Main St., Akron, Ohio 44318.
11. "Rolling Resistance of Tires Measured Under Transient and Equilibrium Conditions on Calspan Research Facility," DOT-TSC-OST-76-9, U.S. Department of Transportation, Washington, D.C. 20590, March 1976.
12. "Tire Application Guide for Passenger Cars," Rubber Manufacturers Assoc., 444 Madison Ave., New York, N.Y. 10022.

APPENDIX A

Appendix A—Tire Interchangeability and Load and Inflation Data [4]

Tire size or designation						Load limits (pounds per tire)										
						Load Range B (4-ply rating) →										
						Load Range C (6-ply rating) →										
Tire size or designation						Load Range D (8-ply rating) →										
Bias and belted bias ply			Radial ply			Cold inflation pressures—pounds per square inch										
Former designation	78 series	70 series	Metric	78 series	70 series	20	22	24	26	28	30	32	34	36	38	40
	D78-14	D70-14		DR78-14	DR70-14	1010	1070	1120	1170	1220	1270	1320	1360	1410	1450	1490
7.35-14			185R14			1040	1100	1160	1210	1260	1310	1360	1400	1450	1490	1540
	E78-14	E70-14		ER78-14	ER70-14	1040	1100	1160	1210	1260	1310	1360	1410	1450	1500	1540
						1070	1130	1190	1240	1300	1350	1400	1440	1490	1540	1580
7.75-14			195R14			1150	1210	1270	1330	1390	1440	1500	1550	1600	1650	1690
	F78-14	F70-14		FR78-14	FR70-14	1150	1210	1270	1330	1390	1440	1500	1540	1590	1640	1690
						1160	1220	1280	1340	1400	1450	1500	1550	1610	1650	1700
8.25-14			205R14			1250	1310	1380	1440	1500	1560	1620	1670	1730	1780	1830
	G78-14	G70-14		GR78-14	GR70-14	1250	1310	1380	1440	1500	1560	1620	1680	1730	1780	1830
						1250	1310	1380	1440	1500	1560	1620	1680	1730	1780	1830
8.55-14			215R14			1360	1430	1510	1580	1640	1710	1770	1830	1890	1950	2000
	H78-14	H70-14		HR78-14	HR70-14	1360	1430	1510	1580	1640	1710	1770	1830	1890	1950	2010
						1360	1440	1510	1580	1650	1710	1770	1830	1890	1950	2010
8.85-14			225R14			1430	1510	1580	1660	1730	1790	1860	1920	1990	2050	2100
	J78-14	J70-14		JR78-14	JR70-14	1430	1500	1580	1650	1720	1790	1860	1920	1980	2040	2100
						1430	1510	1580	1660	1730	1790	1860	1920	1980	2040	2100
	L70-14			LR70-14		1520	1600	1680	1750	1830	1900	1970	2040	2100	2170	2230
7.35-15			185R15			1070	1130	1180	1240	1290	1340	1390	1440	1480	1530	1570
	E78-15	E70-15		ER78-15	ER70-15	1070	1130	1190	1240	1300	1350	1400	1440	1490	1540	1580
						1070	1130	1180	1240	1290	1340	1390	1430	1480	1520	1570
7.75-15			195R15			1150	1210	1270	1330	1380	1440	1490	1540	1590	1640	1690
	F78-15	F70-15		FR78-15	FR70-15	1160	1220	1280	1340	1400	1450	1500	1550	1610	1650	1700
8.15-15			205R15			1240	1300	1370	1430	1490	1550	1610	1660	1720	1770	1820
8.25-15	G78-15	G70-15		GR78-15	GR70-15	1250	1310	1380	1440	1500	1560	1620	1680	1730	1780	1830
						1250	1310	1380	1440	1500	1560	1620	1670	1730	1780	1830
8.45-15			215R15			1340	1410	1480	1550	1620	1680	1740	1800	1860	1920	1970
8.55-15	H78-15	H70-15		HR78-15	HR70-15	1340	1410	1480	1550	1620	1680	1740	1800	1860	1910	1970
						1360	1440	1510	1580	1650	1710	1770	1830	1890	1950	2010
						1360	1430	1510	1580	1640	1710	1770	1830	1890	1950	2000
8.85-15			225R15			1430	1510	1580	1650	1720	1790	1860	1920	1980	2040	2100
	J78-15	J70-15		JR78-15	JR70-15	1430	1500	1580	1650	1720	1790	1860	1920	1980	2040	2100
9.15-15			235R15			1510	1600	1680	1750	1830	1900	1970	2030	2100	2160	2230
	L78-15	L70-15		LR78-15	LR70-15	1510	1600	1680	1750	1830	1900	1970	2040	2100	2170	2230
						1520	1600	1680	1750	1830	1900	1970	2040	2100	2170	2230

APPENDIX B

FEDERAL QUALIFIED PRODUCTS LIST OF PRODUCTS QUALIFIED UNDER FEDERAL SPECIFICATION

QPL-ZZ-T-381M-3
June 1, 1978
SUPERSEDEDING
QPL-ZZ-T-381M-2
April 22, 1976, and
QPL-ZZ-T-381M-1
May 24, 1974

ZZ-T-381M

FSC 2610

TIRES, PNEUMATIC, VEHICULAR (HIGHWAY)

This Qualified Products List has been prepared by the General Services Administration for passenger car tires, Group 1A; light truck tires, Groups 2 and 2A; and truck-bus tires, Groups 3 and 3A; which have been approved for procurement by the Federal Government. The list is based upon the results of road tests prescribed in Federal Specification ZZ-T-381M. This list is subject to change without notice; revision or amendment will be issued as necessary. The inclusion of tires in this list does not release the supplier from compliance with the specification requirements for tires supplied to the Government. Use of this Qualified Products List for advertising in such a manner as to state or imply that tires listed herein are endorsed or preferred by the Federal Government or are considered by the Government to be superior to other tires is prohibited.

The activity responsible for this Qualified Products List is the General Services Administration, Federal Supply Service, Washington, D.C. 20406.

- NOTE: 1. SINCE ALL TIRES MANUFACTURED WERE NOT OFFERED FOR TESTING, THE OMITSION OF ANY TIRE FROM THIS QPL DOES NOT NECESSARILY MEAN THAT THE UNLISTED TIRE IS EITHER UNSAFE OR INFERIOR IN QUALITY.
2. ALL SIZES AND PLY RATINGS FOR TIRE BRANDS SHOWN IN THIS QPL ARE ACCEPTABLE (SEE FEDERAL STANDARD NOS. 316 AND NO. 345.)

GOVERNMENT DESIGNATION AND ITEM NUMBER	SUPPLIER'S "BRAND NAME"	TEST OR QUALIFICATION REFERENCE	SUPPLIER'S NAME AND ADDRESS
Passenger:	<u>Pursuit and Emergency High Speed 78 Series, Bias Ply, Tubeless Construction Tires</u>		
		FMA-1-22363-73	Armstrong Rubber Company 500 Sargent Drive New Haven, CT 06507
Group 1A-Passenger Car (Tubeless) Item No. 1.P.D.1A.1.1	"SUPER HPG," tubeless, nylon, 4/4, regular tread, black and white wall, high speed, highway service		<u>Code</u> <u>Plant</u> CV Natchez, MO CE West Haven, CT
Group 1A-Passenger Car (Tubeless) Item No. 1.P.D.1A.1.2	"SUPER HPG," tubeless, nylon, 6/6, regular tread, black and white wall, high speed, highway service	FMA-11-22363-73	CV Natchez, MO CE West Haven, CT
Group 1A-Passenger Car (Tubeless) Item No. 1.P.D.1A.11.1	"POLICE SPECIAL," tubeless, nylon, 4/4, regular tread, in black wall only, high speed, highway service.		Goodyear Tire & Rubber Co. Akron, OH 44316 <u>Code</u> <u>Plant</u> MB Akron II, OH

FEDERAL QUALIFIED PRODUCTS LIST CONTINUATION SHEET

GOVERNMENT DESIGNATION AND ITEM NUMBER	SUPPLIER'S "BRAND NAME"	TEST OR QUALIFICATION REFERENCE	SUPPLIER'S NAME AND ADDRESS
Passenger: Pursuit and Emergency High Speed 78 Series, Bias Ply, Tubeless Construction Tires			
Group 1A-Passenger Car (Tubeless) Item No. 1.P.D.1A.11.2	"WINGFOOT SPECIAL," tubeless, nylon, 4/4, regular tread, in black and white wall, high speed, highway service.	Con't. FMA-11-22363-73	Goodyear Tire & Rubber Co. Akron, OH 44316 MB Akron II, OH
Group 1A-Passenger Car (Tubeless) Item No. 1.P.D.1A.11.3	"POLICE SPECIAL SUBURBANITE XG78," tubeless, nylon, 4/4, mud/snow tread, black wall only, high speed, highway service.		Code Plant MB Akron II, OH
Group 1A-Passenger Car (Tubeless) Item No. 1.P.D.1A.11.4	"WINGFOOT SPECIAL SUBURBANITE XG78," tubeless, nylon, 4/4, mud/snow tread, black and white wall, high speed, highway service.		MB Akron II, OH
Passenger: Pursuit and Emergency High Speed 78 Series, Bias-belted, Tubeless Construction Tires			
		FMA-11-22363-73	Goodyear Tire & Rubber Co. Akron, OH 44316 Code Plant
Group 1A-Passenger Car (Tubeless) Item No. 1.P.B.1A.11.1	"POLICE SPECIAL POLYGLAS," tubeless, poly/glass, 4+2/4, regular tread, in black wall only, high speed, highway service.		MJ Topeka, KS
Group 1A-Passenger Car (Tubeless) Item No. 1.P.B.1A.11.2	"WINGFOOT SPECIAL POLYGLAS," tubeless, poly/glass, 4+2/4, regular tread, in black and white wall, high speed, highway service.		MJ Topeka, KS
Group 1A-Passenger Car (Tubeless) Item No. 1.P.B.1A.11.3	"POLICE SPECIAL SUBURBANITE POLYGLAS," tubeless, poly/glass, 4+2/4, mud/snow tread, in black wall only, high speed, highway service.		MJ Topeka, KS
Group 1A-Passenger Car (Tubeless) Item No. 1.P.B.1A.11.4	"WINGFOOT SPECIAL SUBURBANITE POLYGLAS," tubeless, poly/glass, 4+2/4, mud/snow tread, in black and white wall, high speed, highway service.		MJ Topeka, KS

FEDERAL QUALIFIED PRODUCTS LIST CONTINUATION SHEET

GOVERNMENT DESIGNATION AND ITEM NUMBER	SUPPLIER'S "BRAND NAME"	TEST OR QUALIFICATION REFERENCE	SUPPLIER'S NAME AND ADDRESS
Passenger: <u>Pursuit and Emergency High Speed 78 Series, Radial Ply-belted, Tubeless Construction Tires</u>			
		FMA-5-22363-73	Dunlop Tire & Rubber Co. Box 1109 Buffalo, NY 14240
			<u>Code</u> <u>Plant</u>
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.5.1	"ELITE R.S. PATROL RADIAL," tubeless, poly/aramid/nylon, 2+2/4, regular tread, in black wall only, high speed, highway service.		DB Huntsville, AL
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.5.2	"CW-R44 R.S. PATROL RADIAL," tubeless, poly/aramid/nylon, 2+2/4, mud/snow tread, in black wall only, high speed, highway service.		DB Huntsville, AL
		FMA-6-22363-73	Firestone Tire & Rubber Co. Akron, OH 44317
			<u>Code</u> <u>Plant</u>
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.6.1	"SUPER 125 RADIAL," tube- less, poly/aramid, 2+2/4, regular tread, in black wall only, high speed, highway service.		VC Albany, GA
Group 1A-Passenger (Tubeless) Item No. 1.P.R.1A.6.2	"TOWN AND COUNTRY SUPER RADIAL," tubeless, polyes- ter/aramid, traction tread (mud/snow), highway and off-the-road service.		VC Albany, GA
		FMA-11-22363-73	Goodyear Tire & Rubber Co. Akron, OH 44316
			<u>Code</u> <u>Plant</u>
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.11.1	"POLICE SPECIAL RADIAL," tubeless, poly/rayon, 2+4/4, regular tread, black wall only, high speed, highway service.		MK Union City, TN
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.11.2	"WINGFOOT SPECIAL RADIAL," tubeless, poly/rayon, 2+4/4, regular tread, black and white wall, high speed, highway service.		MK Union City, TN
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.11.3	"POLICE SPECIAL SUBURBANITE RADIAL," tubeless, poly/ rayon, 2+4/4, mud/snow tread, black wall only, high speed, highway service.		MK Union City, TN
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.11.4	"WINGFOOT SPECIAL SUBURBAN- ITE RADIAL," tubeless, poly/rayon, 2+4/4, mud/snow tread, black wall only, high speed, highway service.		MK Union City, TN

FEDERAL QUALIFIED PRODUCTS LIST CONTINUATION SHEET

GOVERNMENT DESIGNATION AND ITEM NUMBER	SUPPLIER'S "BRAND NAME"	TEST OR QUALIFICATION REFERENCE	SUPPLIER'S NAME AND ADDRESS
Con't. Passenger: Pursuit and Emergency High Speed 78 Series, Radial Ply-belted, Tubeless Construction Tires			
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.11.5	"POLICE SPECIAL RADIAL FLEXTEN," tubeless, poly/aramid, 2+4/4, regular tread, black wall only, high speed, highway service.	Con't FMA-11-22363-73	Goodyear Tire & Rubber Co. Akron, OH 44316 MM Fayetteville, NC
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.11.6	"CUSTOM H.P. RADIAL FLEXTEN," tubeless, poly/ aramid, 2+4/4, regular tread, black and white wall, high speed, highway service.		MM Fayetteville, NC
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.11.7	"F32 ALL WINTER RADIAL FLEX- TEN," tubeless, poly/aramid, 2+2/4, mud/snow tread, black and white wall, high speed, highway service.		MK Union City, TN
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.11.8	"F32 ALL WINTER RADIAL FLEX- TEN," tubeless, poly/aramid, 2+2/6, mud/snow tread, black and white wall, high speed, highway service.		MK Union City, TN
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.23.1	"CN-75 CENTURINO," tube- less, rayon/steel/nylon 2+2+2/4, regular tread, black and white wall, high speed, highway service.	FMA-23-22363-73	Pirelli Tire 600 3rd Avenue New York, NY 10016 <u>Code</u> <u>Plant</u> XB Settimo-Torino, Italy
Passenger: Pursuit and Emergency High Speed 70 Series, Radial Ply-belted, Tubeless Construction Tires			
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.4.1	'HSP-125," tubeless, poly/ aramid 2+2/4, regular tread, in black wall only, high speed, highway service.	FMA-4-22363-73	Dayton Tire & Rubber Co. P.O. Box 1026 Dayton, OH 45401 <u>Code</u> <u>Plant</u> HY Oklahoma City, OK
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.11.9	"POLICE SPECIAL RADIAL," tubeless, poly/rayon 2+4/4, regular tread, black wall only, high speed, highway service.	FMA-11-22363-73	Goodyear Tire & Rubber Co. Akron, OH 44316 <u>Code</u> <u>Plant</u> MK Union City, TN

FEDERAL QUALIFIED PRODUCTS LIST CONTINUATION SHEET

GOVERNMENT DESIGNATION AND ITEM NUMBER	SUPPLIER'S "BRAND NAME"	TEST OR QUALIFICATION REFERENCE	SUPPLIER'S NAME AND ADDRESS
		Con't FMA-11-22263-73	Goodyear Tire & Rubber Co. Akron, OH 44316
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.11.10	"WINGFOOT SPECIAL RADIAL," tubeless, poly/rayon 2+4/4, regular tread, black and white wall, high speed, highway service.		MK Union City, TN
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.11.11	"POLICE SPECIAL SUBURBANITE RADIAL," tubeless, poly/ rayon 2+4/4, mud/snow tread, black wall only, high speed, highway service.		MK Union City, TN
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.11.12	"WINGFOOT SPECIAL SUBURBAN- ITE RADIAL," tubeless, poly/rayon 2+2/4, mud/snow tread, outlined white letters, high speed, high- way service.		MK Union City, TN
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.11.13	"POLICE SPECIAL RADIAL FLEX- TEN," tubeless, poly/aramid 2+4/4, regular tread, high speed, highway service.		MK Union City, TN
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.11.14	"CUSTOM H.P. RADIAL FLEX- TEN," tubeless, poly/aramid 2+4/4, regular tread, black and white wall, high speed, highway service.		MK Union City, TN
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.11.15	"CUSTOMARD GT RADIAL FLEXTEN," tubeless, poly/ aramid 2+4/4, regular tread, black and white wall, high speed, highway service.		MK Union City, TN
			<u>Code</u> <u>Plant</u>
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.11.16	"F32 ALL WINTER RADIAL FLEXTEN," tubeless, poly/ aramid 2+2/4, mud/snow tread, black and white wall, high speed, highway service.		MK Union City, TN
Group 1A-Passenger Car (Tubeless) Item No. 1.P.R.1A.11.17	"F32 ALL WINTER RADIAL FLEXTEN," tubeless, poly/ aramid 2+2/6, mud/snow tread, black and white wall, high speed, highway service.		MK Union City, TN

APPENDIX C

Appendix C—Tire Mixing Guide [12]

Construction		Read down for rear tire recommendation							
		Bias on front				Radial on front			
Series (Profile)		78 Series	70 Series	78 Series	70 Series	Metric	78 Series	70 Series	
Bias on Rear Belted Bias on Rear Radial on Rear	78 series	Preferred	Acceptable	Acceptable	No	No	No	No	
	70 series	Acceptable	Preferred	Acceptable	Acceptable	No	No	No	
	78 series	Acceptable	Acceptable	Preferred	Acceptable	No	No	No	
	70 series	Acceptable	Acceptable	Acceptable	Preferred	No	No	No	
Metric		Acceptable	Acceptable	Acceptable	Acceptable	Preferred	Acceptable	Acceptable	
78 series		Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Preferred	Acceptable	
70 series		Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Preferred	

