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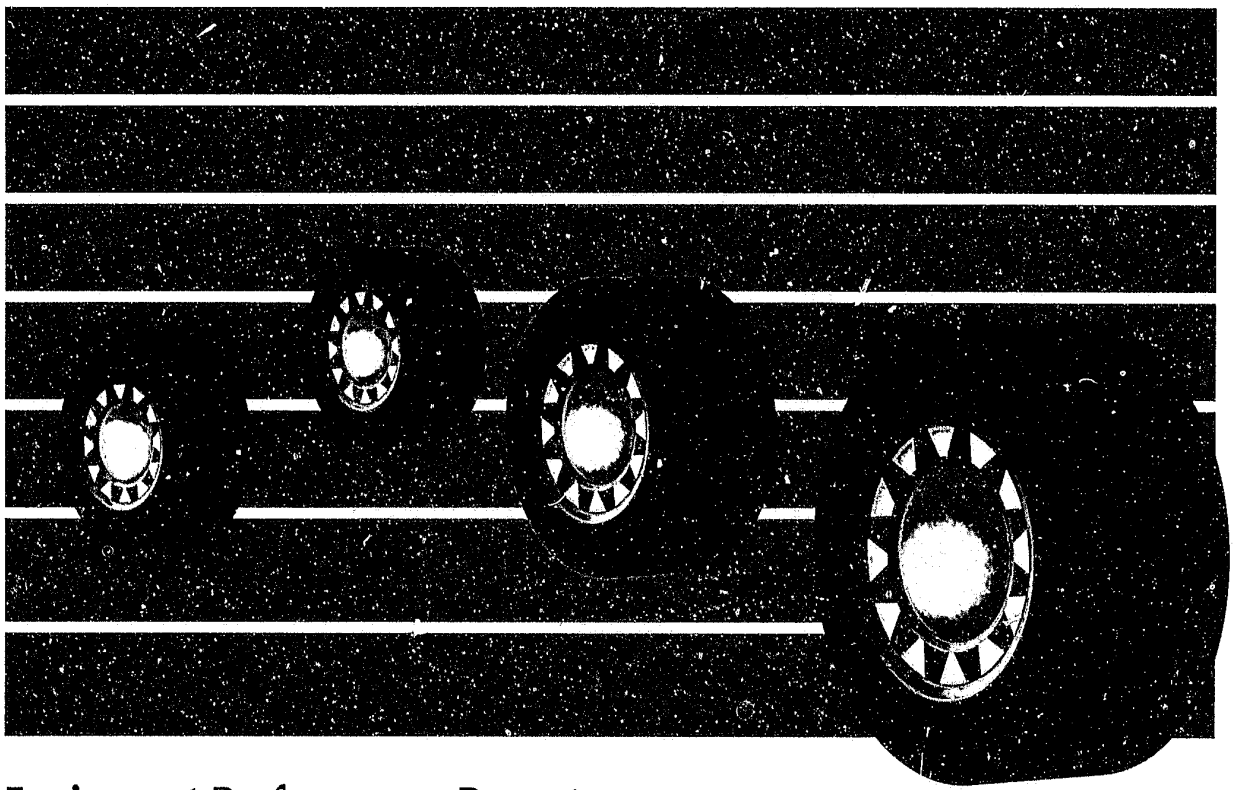

Equipment Performance Report:

1994 Patrol Vehicle Tires

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148450

U.S. Department of Justice
Office of Justice Programs
National Institute of Justice

Equipment Performance Report: 1994 Patrol Vehicle Tires

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National Institute of Justice

Carol V. Petrie
Acting Director

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The National Institute of Justice is a component of the Office of Justice Programs, which also includes the Bureau of Justice Assistance, Bureau of Justice Statistics, Office of Juvenile Justice and Delinquency Prevention, and Office for Victims of Crime.

Preface

The National Institute of Justice's Technology Assessment Program is pleased to present the results of its first comprehensive evaluation of patrol vehicle tires. When the project was first visualized, the goal was to provide law enforcement agencies across the country with information that would help them make more informed decisions about which tires would be best for their patrol vehicle fleets.

This report contains a large amount of data generated throughout the evaluation, which was conducted under a variety of test conditions. Score sheets compare the tires' performance in various categories but do not identify any overall "winner" or "loser." Because driving conditions in different parts of the country vary so widely, individual agencies are left with the task of identifying the most suitable tires for their patrol vehicles based on their own driving conditions and needs. It is important that agencies place the appropriate weight on those portions of the test data most representative of the conditions they may encounter. For example, the tire that best meets the needs of a law enforcement agency in the desert Southwest, which has much more dry than wet weather, may be different than what would be best for an agency in the Pacific Northwest, where wet weather is more the norm. In addition, the most suitable tire may also depend on the make and model of the patrol vehicle—the best tire for use on a Ford Crown Victoria may be different from the best tire for a Chevrolet Caprice.

The major manufacturers of police tires were asked to participate and submit samples of tires for evaluation. Three companies donated tires for testing. The three tire brands tested were the Firestone Aerofire, General XP–2000, and Goodyear Eagle GT+4.

Each brand of tire was tested on two vehicles: a Ford Crown Victoria and a Chevrolet Caprice. These two cars were used as test vehicles because they represent the vast majority of police cars and are, in fact, the only full-size "police package" vehicles currently available. The tire size tested on the Ford Crown Victoria was P225/70R–15 100H, and on the Chevrolet Caprice P235/70R–15 102V. The tread pattern and overall appearance of the two sizes of Firestone and Goodyear tires were essentially identical. However, the two sizes of General tires were not. The P225 tires used on the Ford Crown Victoria were designated XP–2000 AS, whereas the P235 tires used on the Chevrolet Caprice were XP–2000 V4. In addition to the designations and tread patterns, the overall performance characteristics of the two sizes of General tires were also different.

Each of the test procedures were described as completely as possible. Some changes in the test methodology were made as the tires were being tested. Additional changes that were necessary but not practical to make for this evaluation will be made in future tests.

In the serpentine, stopping distance, and static circle tests, the pavement surface of the test course was granite asphalt and had a high coefficient of friction. Although this type of surface would normally be good, the surface was also rough (bumpy and porous) and may not have provided as much tire adhesion under *dry conditions* as new, relatively smooth asphalt might have. Conversely, because a layer of water may not be able to form on such a rough surface, tire adhesion under *wet conditions* may have been better on this surface than on a newer, smoother asphalt surface. As a result, the differences in the tires' performance between dry and wet conditions might have been greater had the test been conducted on a smoother pavement surface. Nevertheless, the tires were tested on the same surface and had the same chance to perform well.

The results presented in this report were calculated on a computer spreadsheet program with an infinite number of decimal places. Some calculations made on an adding machine or calculator will result in slightly different totals.

Acknowledgments

This patrol vehicle tire evaluation is the result of a recommendation made by the Technology Assessment Program Advisory Council. The Council consists of criminal justice officials from Federal, State, and local agencies who assess equipment needs and set priorities for developing equipment standards, guides, test reports, and other publications. The Council felt that an evaluation of police tires was crucial to addressing the informational needs of law enforcement agencies in procuring equipment critical to the operation of their patrol vehicle fleets. It is hoped that this evaluation will assist the agencies to select, in a cost-effective manner, the best tires for their fleets.

The National Institute of Justice's Technology Assessment Program (TAP) thanks the Institute of Police Technology and Management at the University of North Florida, which cosponsored the evaluation and provided drivers, meals and lodging, and other crucial logistical support.

TAP would like to thank Kelsey-Hayes for providing a test facility in Green Cove Springs, Florida, that was well-equipped to meet the needs for this evaluation.

Also greatly appreciated is the use of the road course at the Federal Law Enforcement Training Center in Glynco, Georgia, on such short notice.

TAP thanks the Ford Motor Company and the Chevrolet Division of General Motors Corporation for the use of "police package" cars and police wheels for this evaluation. The companies that submitted the tires for testing deserve recognition and thanks as well: Bridgestone-Firestone, Inc.; General Tire Company; and Goodyear Tire and Rubber Company.

About the National Institute of Justice

The National Institute of Justice is a principal research branch of the U.S. Department of Justice. The Institute's mission is to develop knowledge about crime, its causes and control. Priority is given to policy-relevant research that can yield approaches and information that State and local agencies can use in preventing and reducing crime. The decisions made by criminal justice practitioners and policymakers affect millions of citizens, and crime affects almost all our public institutions and the private sector as well. Targeting resources, assuring their effective allocation, and developing new means of cooperation between the public and private sector are some of the emerging issues in law enforcement and criminal justice that research can help illuminate.

Carrying out the mandate assigned by Congress in the Justice Assistance Act of 1984, the National Institute of Justice:

- Sponsors research and development to improve and strengthen the criminal justice system and related civil justice aspects, with a balanced program of basic and applied research.
- Evaluates the effectiveness of justice improvement programs and identifies programs that promise to be successful if continued or repeated.
- Tests and demonstrates new and improved approaches to strengthen the justice system, and recommends actions that can be taken by Federal, State, and local governments, private organizations, and individuals to achieve this goal.
- Disseminates information from research, demonstrations, evaluations, and special programs to Federal, State, and local governments, and serves as an international clearinghouse of justice information.
- Trains criminal justice practitioners in research and evaluation findings, and assists practitioners and researchers through fellowships and special seminars.

The Director of the Institute is appointed by the President of the United States and, upon confirmation by the Senate, serves at the President's pleasure. The Director establishes the research and development objectives of the Institute. The Director has final authority to approve grants, contracts, and cooperative agreements, and maintains responsibility for fiscal operations of the Institute. In establishing its research agenda, the Institute is guided by the priorities of the Attorney General and the needs of the criminal justice field. The Institute actively solicits the views of law enforcement, courts, and corrections practitioners as well as the private sector to identify the most critical problems and to plan research that can help resolve them.

Carol V. Petrie
Acting Director
National Institute of Justice

About the Technology Assessment Program

The Technology Assessment Program (TAP) is an applied research project of the National Institute of Justice (NIJ). TAP develops minimum performance standards for law enforcement equipment and tests equipment based on these standards.

To accomplish program tasks, NIJ coordinates the activities of two organizations: the TAP Information Center (TAPIC) and the Office of Law Enforcement Standards (OLES) of the National Institute of Standards and Technology (NIST). OLES prepares equipment standards, reports, and guides; TAPIC coordinates testing of law enforcement equipment by independent laboratories and publishes the test results. OLES, TAPIC, and NIJ support one another in accomplishing TAP's tasks and goals.

TAP's major tasks and goals are:

Coordination of the TAP Advisory Council. Composed of nationally recognized professionals from Federal, State, and local criminal justice agencies, the Advisory Council helps NIJ set priorities for developing new equipment standards and for testing available products.

Coordination of equipment testing. TAPIC develops Requests for Proposals to select testing laboratories, evaluates proposals with assistance from OLES, selects laboratories, and monitors the testing activities.

Compilation and dissemination of test results. TAPIC compiles and analyzes the test results and, after review by NIJ and OLES, publishes the results in TAP bulletins (summaries issued periodically) and in *Equipment Performance Reports* (also published periodically and containing complete testing data on specific equipment).

Dissemination of information. TAP educates the criminal justice community about its resources and services in a number of ways. Staff prepare articles for criminal justice periodicals, develop exhibits, make presentations at major criminal justice conferences, and serve as a clearinghouse of information about equipment and technology.

For more information, or to add your name to TAPIC's mailing list, call 1–800–248–2742 or 301–251–5060.

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General Comments On Statistical Analysis

The statistical techniques used in this analysis were standard parametric methods. As such, they assume a normally distributed base population. Although testing for normality was not done, there is no reason to believe that the data presented in this report should not follow such a distribution.

In all cases, the objective of the analysis was to determine if there existed a statistically significant difference between two or more populations of measurements as represented by experimental sampling. To determine this, a One-Way Analysis of Variance (ANOVA) was performed on the sample measurements. If the ANOVA showed a significant difference, or a tendency toward significance, further analysis between pairs of groups was performed using a two-sample T-test. To further clarify the data set, a basic statistical summary was also performed.

In all cases, a 90-percent confidence limit was used to define significance. It was felt that the 90-percent confidence limit offers a strong case for differentiation when accepted, yet is not prohibitively stringent.

In some cases, data transformations were employed to increase the size of the data set and reduce irrelevant variability. The transformations were performed in consultation with persons knowledgeable about the experimental design and this type of testing. Care was taken not to bias the results of the testing through data transformation.

Where the evaluation shows minor performance differences between the tires on a given test but analysis of the data indicates the differences are not statistically significant, a specific notation has been made on the overall score page for that test, and detailed explanations are given in Appendix I: Analysis To Determine Statistical Significance.

Appendix I was compiled by Carl Davis, who analyzed the data to determine their statistical significance.

Testing Equipment

The following test equipment was used in the static circle, stopping distance, serpentine, and high-speed handling portions of the evaluation program.

LABORATORY EQUIPMENT CORPORATION (Labeco)
Box 158, Mooresville, IN 46158
Tracktest Fifth Wheel
DD 1.1 Digital Velocity Meter
DD 2.1 Digital Distance Meter
Transmitter Assembly for DD 1.1 and DD 2.1

CHRONOMIX CORPORATION
650F Vaqueros Avenue
Sunnyvale, CA 94086–3580
Compusport 737 Multi-Function Printing Timer

MICRO SWITCH
Division of Honeywell
Freeport, IL 61032
Modulated LED Control (photoelectric micro switch)
Model FE–MLS–3B

ALGE-TELESIGNAL TX/RX
Phoenix Sports Technology
1344 Rt. 100 S., P.O. Box 774
Trexlertown, PA 18087
Alge Sports Timing Telesignal Transmitter—Model TX
Alge Sports Timing Telesignal Receiver—Model RX

AMMCO TOOLS, INC.
Wacker Park
North Chicago, IL 60064
Windshield Mount Decelerometer, Model 7350

ATKINS TECHNICAL, INC.
3401 S.W. 40th Boulevard
Gainesville, FL 32608
Atkins Model 39658–K Digital Thermometer with Tire Probes

BELL PRO POLICE
Box 927
Rantol, IL 61866
Bell MC–500VBL76 Nascar Style Driving Helmets

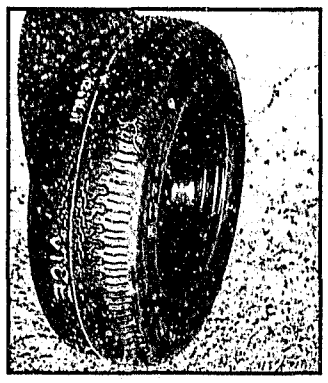
Police Tire Descriptions

Tested on Chevrolet Caprice

Firestone Aerofire

P235/70R–15 102V M&S
Tread 6 plies – 2 Polyester/2 Steelcord/2 Nylon
Sidewall 2 plies Polyester
Max Load 1896 lbs. (860 kg)
Max Inflation 44 psi (300 kpa)

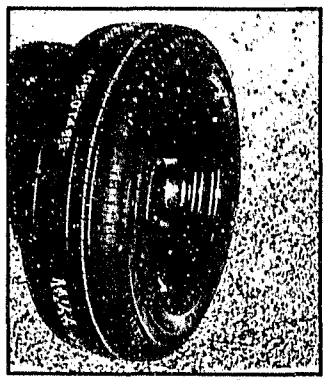
U.S. Government mandated ratings:		
	Treadwear	220
	Traction	A
	Temperature	A



General XP–2000 V4

P235/70R–15 102V M&S
Tread 6 plies – 2 Steel/2 Polyester/2 Nylon
Sidewall 2 plies Polyester
Max Load 1896 lbs. (860 kg)
Max Inflation 44 psi (300 kpa)

U.S. Government mandated ratings:		
	Treadwear.	220
	Traction	A
	Temperature	A



Goodyear Eagle GT+4

P235/70R–15 102V M&S
Tread 6 plies – 2 Polyester Cord/2 Steel Cord/2 Nylon Cord
Sidewall 2 plies Polyester
Max Load 1896 lbs. (860 kg)
Max Inflation 44 psi (300 kpa)

U.S. Government mandated ratings:		
	Treadwear	240
	Traction	A
	Temperature	A

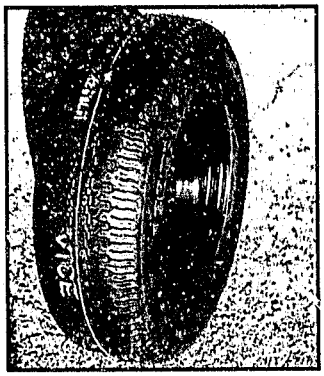
Police Tire Descriptions

Tested on Ford Crown Victoria

Firestone Aerofire

P225/70R–15 100H M&S
Tread 6 plies – 2 Polyester/2 Steelcord/2 Nylon
Sidewall 2 plies Polyester
Max Load 1753 lbs. (795 kg)
Max Inflation 35 psi (240 kpa)

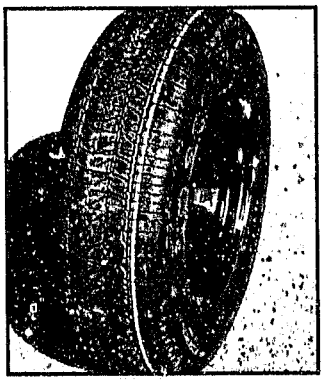
U.S. Government mandated ratings:		
	Treadwear	220
	Traction	A
	Temperature	A



General XP–2000 AS

P225/70R–15 100H M&S
Tread 6 plies – 2 Steel/2 Polyester/2 Nylon
Sidewall 2 plies Polyester
Max Load 1753 lbs. (795 kg)
Max Inflation 35 psi (240 kpa)

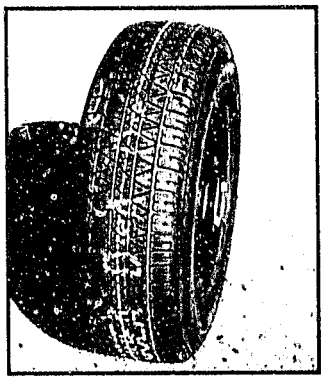
U.S. Government mandated ratings:		
	Treadwear	300
	Traction	A
	Temperature	A



Goodyear Eagle GT+4

P225/70R–15 100H M&S
Tread 6 plies – 2 Polyester Cord/2 Steel Cord/2 Nylon Cord
Sidewall 2 plies Polyester
Max Load 1753 lbs. (795 kg)
Max Inflation 44 psi (300 kpa)

U.S. Government mandated ratings:		
	Treadwear	240
	Traction	A
	Temperature	A



Static Circle Test
Dry Pavement Surface

Test Objective

Determine the road-holding performance characteristics of the test tires in a steady-state turning situation on a dry pavement surface. The course used has a flat granite asphalt surface on which a circle with both inside and outside lane lines is painted. The circle measures 1,310 feet in circumference. The driver is allowed two laps to accelerate and stabilize the vehicle at the highest speed possible while remaining within the marked lane. Once the vehicle is stabilized, the following four laps are timed, and the average of the timed laps is used to determine the final score for this portion of the evaluation, which is expressed in the percentage of lateral G's attained—lateral G's being the measurement of the resistance of lateral movement before the tire loses adhesion and the vehicle begins to slip. Deficiencies in tire adhesion, or the tendency of the tire to slip sideways under hard, steady-state cornering maneuvers, will result in slower speeds, longer lap times, and a relatively lower overall score on this portion of the evaluation.

Test Methodology

Following a two-lap tire warm-up, each test vehicle equipped with the make and model of tire to be evaluated makes a minimum of four timed laps around the static circle course. The final score for each tire on this portion of the evaluation is the average of the four timed laps and is expressed as the percentage of lateral G's attained.

Formulas

To determine the percentage of lateral G's attained, divide the circumference of the test circle by the lap time and square this quotient. Divide by the radius of the circle, and then divide by 1 G.

Example:

(1,310 ft. ÷ lap time) × (1,310 ft. ÷ lap time) ÷ 208.493 ft. ÷ 32.2 ft./sec.^{2}
(circumference) (radius of circle) (1 G)

To determine speed, divide the circumference of the test circle by 1.4667 ft./sec.^{2}, then divide by the lap time.

Example:

1,310 ft. ÷ 1.4667 ft./sec.^{2} ÷ lap time

Static Circle Test
Dry Pavement Surface (1,310 feet in circumference)

TIRE: **Firestone Aerofire**
SIZE: **P235/70R–15**
CAR: **Chevrolet Caprice**
DRIVER: **Matuszak**

Run number	Elapsed time (seconds)	Speed (mph)	Percent of lateral G's
1	18.470	48.36	0.749
2	18.494	48.29	0.747
3	18.613	47.99	0.738
4	18.544	48.16	0.743
Average	18.530	48.20	0.744
Final score (percent of lateral G's)			**0.744**

Static Circle Test
Dry Pavement Surface (1,310 feet in circumference)

TIRE: **General XP–2000 V4**
SIZE: **P235/70R–15**
CAR: **Chevrolet Caprice**
DRIVER: **Matuszak**

Run number	Elapsed time (seconds)	Speed (mph)	Percent of lateral G's
1	18.113	49.31	0.779
2	18.409	48.52	0.754
3	18.739	47.66	0.728
4	18.810	47.48	0.722
Average	18.518	48.23	0.745
Final score (percent of lateral G's)			**0.745**

Static Circle Test
Dry Pavement Surface (1,310 feet in circumference)

TIRE: **Goodyear Eagle GT+4**
SIZE: **P235/70R–15**
CAR: **Chevrolet Caprice**
DRIVER: **Matuszak**

Run number	Elapsed time (seconds)	Speed (mph)	Percent of lateral G's
1	18.540	48.17	0.744
2	18.570	48.10	0.741
3	18.775	47.57	0.725
4	18.775	47.57	0.725
Average	18.665	47.85	0.734
Final score (percent of lateral G's)			**0.734**

Static Circle Test
Dry Pavement Surface (1,310 feet in circumference)

TIRE: **Firestone Aerofire**
SIZE: **P225/70R–15**
CAR: **Ford Crown Victoria**
DRIVER: **Matuszak**

Run number	Elapsed time (seconds)	Speed (mph)	Percent of lateral G's
1	18.245	48.95	0.768
2	18.178	49.13	0.774
3	18.339	48.70	0.760
4	18.335	48.71	0.760
Average	18.274	48.88	0.765
Final score (percent of lateral G's)			**0.765**

Static Circle Test
Dry Pavement Surface (1,310 feet in circumference)

TIRE: General XP–2000 AS
SIZE: P225/70R–15
CAR: Ford Crown Victoria
DRIVER: Matuszak

Run number	Elapsed time (seconds)	Speed (mph)	Percent of lateral G's
1	18.304	48.80	0.763
2	18.386	48.58	0.756
3	18.428	48.47	0.753
4	18.414	48.50	0.754
Average	18.383	48.59	0.756
Final score (percent of lateral G's)			**0.756**

Static Circle Test
Dry Pavement Surface (1,310 feet in circumference)

TIRE: Goodyear Eagle GT+4
SIZE: P225/70R–15
CAR: Ford Crown Victoria
DRIVER: Matuszak

Run number	Elapsed time (seconds)	Speed (mph)	Percent of lateral G's
1	18.657	47.87	0.734
2	18.310	48.78	0.762
3	18.402	48.54	0.755
4	18.454	48.40	0.751
Average	18.456	48.39	0.750
Final score (percent of lateral G's)			**0.750**

Static Circle Test
Dry Pavement Surface (1,310 feet in circumference)
Overall Scores

	Elapsed time (seconds)	Average speed (mph)	Percent of lateral G's	Percent difference*
CAR: **Chevrolet Caprice** TIRE SIZE: **P235/70R–15**				
Firestone Aerofire**	18.530	48.20	0.744	0.06%
General XP–2000 V4**	18.518	48.23	0.745	0.00%
Goodyear Eagle GT+4**	18.665	47.85	0.734	0.79%
CAR: **Ford Crown Victoria** TIRE SIZE: **P225/70R–15**				
Firestone Aerofire***	18.274	48.88	0.765	0.00%
General XP–2000 AS***	18.383	48.59	0.756	0.59%
Goodyear Eagle GT+4***	18.456	48.39	0.750	1.00%

* The percent difference is obtained by subtracting the average speed of the tire of interest from the average speed of the best scoring tire (highest score is the best) and dividing that number by the speed of the best scoring tire. The percent difference can also be determined using this formula with the elapsed time of the tire of interest and the elapsed time of the best scoring tire (lowest elapsed time is the best).

** Analysis showed no statistically significant difference between the three brands of tires tested on the Chevrolet Caprice in this test (see Appendix I).

*** Analysis showed a statistically significant difference between the Firestone and both the General and the Goodyear on the Ford Crown Victoria in this test; however, there is no statistically significant difference between the General and the Goodyear (see Appendix I).

Static Circle Test
Wet Pavement Surface

Test Objective

Determine the road-holding performance characteristics of each test tire in a steady-state turning situation on a wet pavement surface. The course used has a flat granite asphalt surface on which a circle with both inside and outside lane lines is painted. The circle is 1,310 feet in circumference. The driver is allowed two laps to accelerate and stabilize the vehicle at the highest speed possible while remaining within the marked lane. Once the vehicle is stabilized, the following four laps are timed, and the average of the timed laps is used to determine the final score for this portion of the evaluation, which will be expressed in the percentage of lateral G's attained. Deficiencies in tire adhesion, or the tendency of the tire to slip sideways under hard, steady-state cornering maneuvers, will result in slower speeds, longer lap times, and a relatively lower overall score on this portion of the evaluation.

Test Methodology

Following a two-lap tire warm-up, each test vehicle equipped with the make and model of tire to be evaluated makes a minimum of four timed laps around the static circle course. The final score for each tire on this portion of the evaluation is the average of the four timed laps and is expressed in the percentage of lateral G's attained.

Formulas

To determine the percentage of lateral G's attained, divide the circumference of the test circle by the lap time and square this quotient. Divide by the radius of the circle and then divide by 1 G.

Example:

(1,310 ft. ÷ lap time) × (1,310 ft. ÷ lap time) ÷ 208.493 ft. ÷ 32.2 ft./sec.^{2}
(circumference) (radius of circle) (1 G)

To determine speed, divide the circumference of the test circle by 1.4667 ft./sec.^{2}, then divide by the lap time.

Example:

1,310 ft. ÷ 1.4667 ft./sec.^{2} ÷ lap time

Static Circle Test
Wet Pavement Surface (1,310 feet in circumference)

TIRE: **Firestone Aerofire**
SIZE: **P235/70R–15**
CAR: **Chevrolet Caprice**
DRIVER: **Matuszak**

Run number	Elapsed time (seconds)	Speed (mph)	Percent of lateral G's
1	18.860	47.36	0.719
2	19.073	46.83	0.703
3	19.206	46.50	0.693
4	19.427	45.98	0.677
Average	19.142	46.66	0.698
Final score (percent of lateral G's)			**0.698**

Static Circle Test
Wet Pavement Surface (1,310 feet in circumference)

TIRE: **General XP–2000 V4**
SIZE: **P235/70R–15**
CAR: **Chevrolet Caprice**
DRIVER: **Matuszak**

Run number	Elapsed time (seconds)	Speed (mph)	Percent of lateral G's
1	18.850	47.38	0.719
2	18.919	47.21	0.714
3	19.015	46.97	0.707
4	19.256	46.38	0.689
Average	19.010	46.98	0.707
Final score (percent of lateral G's)			**0.707**

Static Circle Test
Wet Pavement Surface (1,310 feet in circumference)

TIRE: Goodyear Eagle GT+4
SIZE: P235/70R–15
CAR: Chevrolet Caprice
DRIVER: Matuszak

Run number	Elapsed time (seconds)	Speed (mph)	Percent of lateral G's
1	19.386	46.07	0.680
2	19.364	46.12	0.682
3	19.586	45.60	0.666
4	19.497	45.81	0.672
Average	19.458	45.90	0.675
Final score (percent of lateral G's)			**0.675**

Static Circle Test
Wet Pavement Surface (1,310 feet in circumference)

TIRE: Firestone Aerofire
SIZE: P225/70R–15
CAR: Ford Crown Victoria
DRIVER: Matuszak

Run number	Elapsed time (seconds)	Speed (mph)	Percent of lateral G's
1	18.729	47.69	0.729
2	18.861	47.35	0.719
3	18.872	47.33	0.718
4	18.734	47.68	0.728
Average	18.799	47.51	0.723
Final score (percent of lateral G's)			**0.723**

Static Circle Test
Wet Pavement Surface (1,310 feet in circumference)

TIRE: General XP–2000 AS
SIZE: P225/70R–15
CAR: Ford Crown Victoria
DRIVER: Matuszak

Run number	Elapsed time (seconds)	Speed (mph)	Percent of lateral G's
1	19.616	45.53	0.664
2	19.464	45.89	0.675
3	19.321	46.23	0.685
4	19.062	46.86	0.703
Average	19.366	46.12	0.682
Final score (percent of lateral G's)			**0.682**

Static Circle Test
Wet Pavement Surface (1,310 feet in circumference)

TIRE: Goodyear Eagle GT+4
SIZE: P225/70R–15
CAR: Ford Crown Victoria
DRIVER: Matuszak

Run number	Elapsed time (seconds)	Speed (mph)	Percent of lateral G's
1	18.714	47.73	0.730
2	18.870	47.33	0.718
3	18.920	47.21	0.714
4	18.820	47.46	0.722
Average	18.831	47.43	0.721
Final score (percent of lateral G's)			**0.721**

Static Circle Test
Wet Pavement Surface (1,310 feet in circumference)
Overall Scores

	Elapsed time (seconds)	Average speed (mph)	Percent of lateral G's	Percent difference*
CAR: **Chevrolet Caprice** TIRE SIZE: **P235/70R–15**				
Firestone Aerofire**	19.142	46.66	0.698	0.68%
General XP–2000 V4**	19.010	46.98	0.707	0.00%
Goodyear Eagle GT+4**	19.458	45.90	0.675	2.30%
CAR: **Ford Crown Victoria** TIRE SIZE: **P225/70R–15**				
Firestone Aerofire***	18.799	47.51	0.723	0.00%
General XP–2000 AS***	19.366	46.12	0.682	2.93%
Goodyear Eagle GT+4***	18.831	47.43	0.721	0.17%

* The percent difference is obtained by subtracting the average speed of the tire of interest from the average speed of the best scoring tire (highest score is the best) and dividing that number by the average speed of the best scoring tire. The percent difference can also be determined with this formula using the elapsed time of the tire of interest and that of the best scoring tire (lowest score is best).

** Analysis showed no statistically significant difference between the Firestone and the General on the Chevrolet Caprice; however, there is a statistically significant difference between both of them and the Goodyear in this test (see Appendix I).

*** Analysis showed no statistically significant difference between the Firestone and the Goodyear on the Ford Crown Victoria; however, there is a statistically significant difference between both of them and the General in this test (see Appendix I).

Serpentine Test
Dry Pavement Surface

Test Objective

Determine each tire's transient response characteristics and performance on a dry pavement surface. The course used has a straight, flat granite asphalt surface, with pylons set in a straight line and spaced 100 feet apart. The approach speed is 60 mph, and the driver is required to weave through the pylons while maintaining speed as close to the approach speed as possible. (See illustration below.) Serious deficiencies in transient response will result in longer elapsed times, slower speeds, and a lower overall score on this portion of the evaluation.

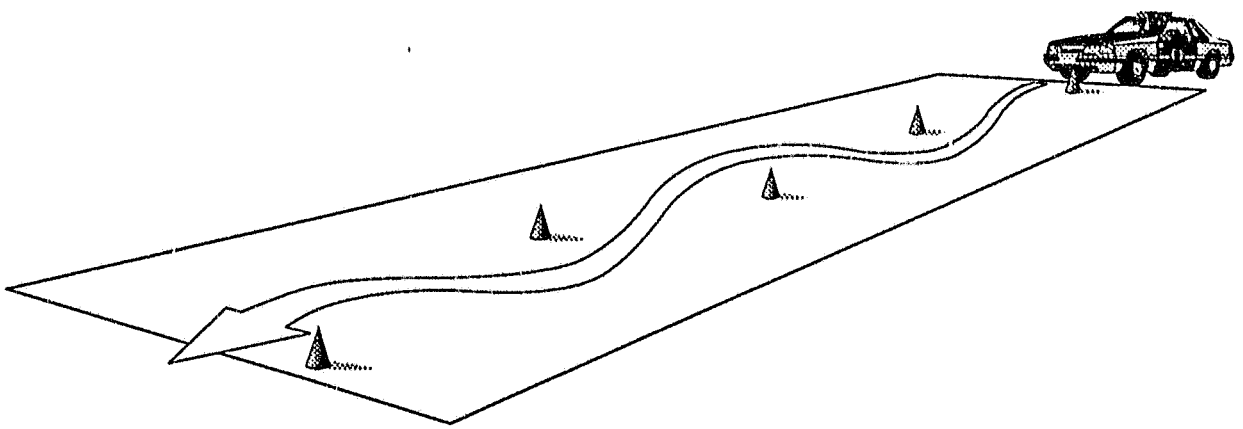
Test Methodology

Following a 1-mile tire warm-up, each test vehicle equipped with the make and model of tire to be evaluated is driven through the serpentine course by each of the 2 drivers a minimum of 6 times, for a total of 12 runs. Both the average and the final scores for the tires are the average of the fastest four runs by each of the drivers, for a total of eight runs.

Formula

To determine the vehicle's speed, divide the length of the course (704 ft.) by 1.4667 ft./sec.^{2}, then divide by the elapsed time.

Example:
704 ft. ÷ 1.4667 ft./sec.^{2} ÷ elapsed time
(length
of course)



Serpentine Test
Dry Pavement Surface (704 feet)

TIRE: **Firestone Aerofire**
SIZE: **P235/70R–15**
CAR: **Chevrolet Caprice**

Driver	Run number	Elapsed time (seconds)	Speed (mph)
Jacob	1	7.697	62.36
	2	7.488	64.10
	3	7.632	62.89
	4	7.630	62.91
	5	7.631	62.90
	6	7.778	61.71
	Average*	7.595	63.20
Matuszak	1	7.593	63.21
	2	7.495	64.04
	3	7.490	64.08
	4	7.468	64.27
	5	7.585	63.28
	6	7.495	64.04
	Average*	7.487	64.11
Final score**		**7.541**	**63.65**

* Calculated from the four fastest runs.

** Calculated from the eight fastest runs.

Serpentine Test
Dry Pavement Surface (704 feet)

TIRE: **General XP–2000 V4**
SIZE: **P235/70R–15**
CAR: **Chevrolet Caprice**

Driver	Run number	Elapsed time (seconds)	Speed (mph)
Jacob	1	7.563	63.47
	2	7.588	63.26
	3	7.483	64.14
	4	7.790	61.62
	5	7.440	64.51
	6	7.525	63.79
	Average*	7.503	63.98
Matuszak	1	7.217	66.51
	2	7.249	66.21
	3	7.272	66.01
	4	7.168	66.96
	5	7.277	65.96
	6	7.193	66.73
	Average*	7.207	66.60
Final score**		**7.355**	**65.26**

* Calculated from the four fastest runs.

** Calculated from the eight fastest runs.

Serpentine Test
Dry Pavement Surface (704 feet)

TIRE: **Goodyear Eagle GT+4**
SIZE: **P235/70R–15**
CAR: **Chevrolet Caprice**

Driver	Run number	Elapsed time (seconds)	Speed (mph)
Jacob	1	7.941	60.44
	2	7.723	62.15
	3	7.833	61.28
	4	7.860	61.07
	5	7.782	61.68
	6	7.857	61.09
	Average*	7.799	61.55
Matuszak	1	7.490	64.08
	2	7.462	64.32
	3	7.388	64.97
	4	7.495	64.04
	5	7.428	64.62
	6	7.426	64.64
	Average*	7.426	64.64
Final score**		**7.612**	**63.05**

* Calculated from the four fastest runs.

** Calculated from the eight fastest runs.

Serpentine Test
Dry Pavement Surface (704 feet)

TIRE: **Firestone Aerofire**
SIZE: **P225/70R–15**
CAR: **Ford Crown Victoria**

Driver	Run number	Elapsed time (seconds)	Speed (mph)
Jacob	1	7.721	62.17
	2	7.602	63.14
	3	7.722	62.16
	4	7.498	64.02
	5	7.622	62.97
	6	7.497	64.02
	Average*	7.555	63.53
Matuszak	1	7.311	65.65
	2	7.271	66.01
	3	7.246	66.24
	4	7.174	66.91
	5	7.260	66.11
	6	7.186	66.80
	Average*	7.217	66.51
Final score**		**7.386**	**64.99**

* Calculated from the four fastest runs.

** Calculated from the eight fastest runs.

Serpentine Test
Dry Pavement Surface (704 feet)

TIRE: **General XP–2000 AS**
SIZE: **P225/70R–15**
CAR: **Ford Crown Victoria**

Driver	Run number	Elapsed time (seconds)	Speed (mph)
Jacob	1	7.651	62.74
	2	7.711	62.25
	3	7.486	64.12
	4	7.580	63.32
	5	7.855	61.11
	6	7.806	61.49
	Average*	7.607	63.10
Matuszak	1	7.393	64.92
	2	7.518	63.85
	3	7.336	65.43
	4	7.374	65.09
	5	7.459	64.35
	6	7.313	65.64
	Average*	7.354	65.27
Final score**		**7.481**	**64.17**

* Calculated from the four fastest runs.

** Calculated from the eight fastest runs.

Serpentine Test
Dry Pavement Surface (704 feet)

TIRE: **Goodyear Eagle GT+4**
SIZE: **P225/70R–15**
CAR: **Ford Crown Victoria**

Driver	Run number	Elapsed time (seconds)	Speed (mph)
Jacob	1	7.866	61.02
	2	7.524	63.79
	3	7.709	62.26
	4	7.660	62.66
	5	7.674	62.55
	6	7.700	62.34
	Average*	7.640	62.83
Matuszak	1	7.424	64.65
	2	7.431	64.59
	3	7.368	65.15
	4	7.289	65.85
	5	7.496	64.03
	6	7.363	65.19
	Average*	7.361	65.21
Final score**		**7.500**	**64.00**

* Calculated from the four fastest runs.

** Calculated from the eight fastest runs.

Serpentine Test
Dry Pavement Surface (704 feet)
Overall Scores

	Elapsed time (seconds)	Average speed (mph)	Percent difference*
CAR: **Chevrolet Caprice** TIRE SIZE: **P235/70R–15**			
Firestone Aerofire**	7.541	63.65	2.47%
General XP–2000 V4**	7.355	65.26	0.00%
Goodyear Eagle GT+4**	7.612	63.05	3.39%
CAR: **Ford Crown Victoria** TIRE SIZE: **P225/70R–15**			
Firestone Aerofire***	7.386	64.99	0.00%
General XP–2000 AS***	7.481	64.17	1.26%
Goodyear Eagle GT+4***	7.500	64.00	1.52%

* The percent difference is obtained by subtracting the average speed of the tire of interest from the average speed of the best scoring tire (highest score is the best) and dividing that number by the average speed of the best scoring tire.

** Analysis showed statistically significant differences between each of the three tires on the Chevrolet Caprice in this test (see Appendix I).

*** Analysis showed a statistically significant difference between the Firestone and both the General and the Goodyear on the Ford Crown Victoria in this test; however, there is no statistically significant difference between the General and the Goodyear in this test (see Appendix I).

Serpentine Test
Wet Pavement Surface

Test Objective

Determine each tire's transient response characteristics and performance on a wet pavement surface. The course used has a straight, flat granite asphalt surface, with pylons set in a straight line and spaced 60 feet apart. The approach speed is 35 mph, and the driver is required to weave through the pylons while maintaining speed as close to the approach speed as possible. (See illustration below.) Serious deficiencies in transient response during wet pavement maneuvering will result in longer elapsed times, slower speeds, and a lower overall score on this portion of the evaluation.

Test Methodology

Following a 1-mile tire warm-up, each test vehicle equipped with the make and model of tire to be evaluated is driven through the serpentine course by each of the 2 drivers a minimum of 6 times, for a total of 12 timed runs. Both the average and the final scores for each tire are the average of the fastest four runs by each of the drivers, for a total of eight runs.

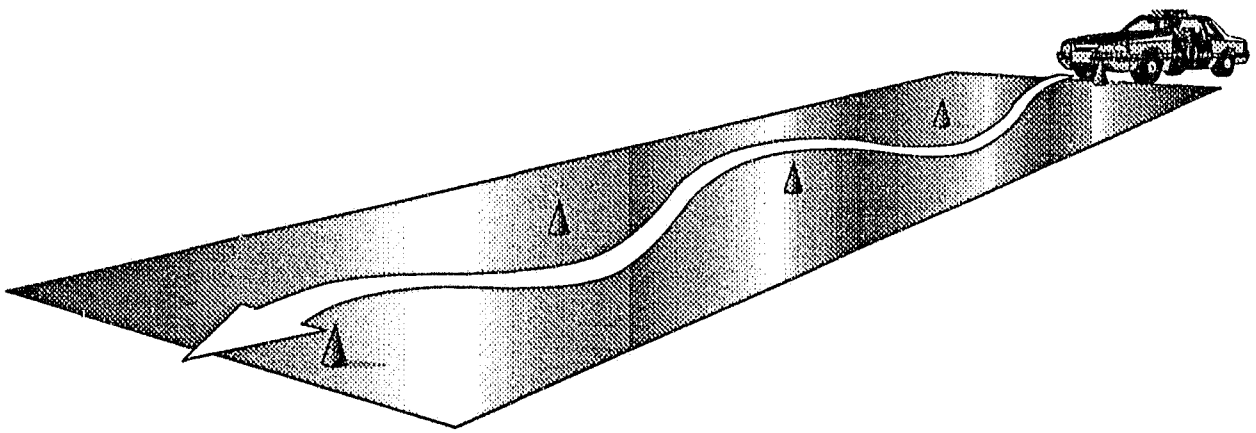
Formula

To determine the vehicle's speed, divide the length of the course (505 ft.) by 1.4667 ft./sec.^{2}, then divide by the elapsed time.

Example:

505 ft. ÷ 1.4667 ft./sec.^{2} ÷ elapsed time

(length of course)



Serpentine Test
Wet Pavement Surface (505 feet)

TIRE: **Firestone Aerofire**
SIZE: **P235/70R–15**
CAR: **Chevrolet Caprice**

Driver	Run number	Elapsed time (seconds)	Speed (mph)
Jacob	1	10.447	32.96
	2	10.288	33.47
	3	10.244	33.61
	4	10.173	33.85
	5	10.255	33.57
	6	10.312	33.39
	Average*	10.240	33.62
Matuszak	1	10.351	33.26
	2	9.909	34.75
	3	10.038	34.30
	4	9.619	35.79
	5	10.049	34.26
	6	10.002	34.42
	Average*	9.892	34.81
Final score**		**10.066**	**34.21**

* Calculated from the four fastest runs.

** Calculated from the eight fastest runs.

Serpentine Test
Wet Pavement Surface (505 feet)

TIRE: **General XP–2000 V4**
SIZE: **P235/70R–15**
CAR: **Chevrolet Caprice**

Driver	Run number	Elapsed time (seconds)	Speed (mph)
Jacob	1	10.525	32.71
	2	10.397	33.12
	3	10.469	32.89
	4	10.129	33.99
	5	10.029	34.33
	6	10.259	33.56
	Average*	10.204	33.74
Matuszak	1	10.482	32.85
	2	10.161	33.89
	3	9.977	34.51
	4	10.023	34.35
	5	9.942	34.63
	6	10.104	34.08
	Average*	10.012	34.39
Final score**		**10.108**	**34.06**

* Calculated from the four fastest runs.

** Calculated from the eight fastest runs.

Serpentine Test
Wet Pavement Surface (505 feet)

TIRE: **Goodyear Eagle GT+4**
SIZE: **P235/70R–15**
CAR: **Chevrolet Caprice**

Driver	Run number	Elapsed time (seconds)	Speed (mph)
Jacob	1	10.514	32.75
	2	10.429	33.01
	3	10.188	33.80
	4	10.738	32.06
	5	10.393	33.13
	6	10.225	33.67
	Average*	10.309	33.40
Matuszak	1	10.241	33.62
	2	10.261	33.56
	3	10.241	33.62
	4	10.260	33.56
	5	10.453	32.94
	6	10.149	33.93
	Average*	10.223	33.68
Final score**		**10.266**	**33.54**

* Calculated from the four fastest runs.

** Calculated from the eight fastest runs.

Serpentine Test
Wet Pavement Surface (505 feet)

TIRE: **Firestone Aerofire**
SIZE: **P225/70R–15**
CAR: **Ford Crown Victoria**

Driver	Run number	Elapsed time (seconds)	Speed (mph)
Jacob	1	10.612	32.45
	2	10.621	32.42
	3	10.677	32.25
	4	10.593	32.50
	5	10.550	32.64
	6	10.407	33.08
	Average*	10.541	32.67
Matuszak	1	10.864	31.69
	2	11.029	31.22
	3	10.771	31.97
	4	10.917	31.54
	5	10.626	32.40
	6	10.456	32.93
	Average*	10.679	32.24
Final score**		**10.610**	**32.45**

* Calculated from the four fastest runs.

** Calculated from the eight fastest runs.

Serpentine Test
Wet Pavement Surface (505 feet)

TIRE: **General XP–2000 AS**
SIZE: **P225/70R–15**
CAR: **Ford Crown Victoria**

Driver	Run number	Elapsed time (seconds)	Speed (mph)
Jacob	1	10.622	32.41
	2	10.605	32.47
	3	10.584	32.53
	4	10.912	31.55
	5	10.533	32.69
	6	10.728	32.09
	Average*	10.586	32.53
Matuszak	1	9.734	35.37
	2	10.246	33.60
	3	10.093	34.11
	4	10.123	34.01
	5	9.681	35.57
	6	10.046	34.27
	Average*	9.889	34.82
Final score**		**10.237**	**33.63**

* Calculated from the four fastest runs.

** Calculated from the eight fastest runs.

Serpentine Test
Wet Pavement Surface (505 feet)

TIRE: **Goodyear Eagle GT+4**
SIZE: **P225/70R–15**
CAR: **Ford Crown Victoria**

Driver	Run number	Elapsed time (seconds)	Speed (mph)
Jacob	1	10.629	32.39
	2	11.041	31.18
	3	10.796	31.89
	4	10.552	32.63
	5	10.863	31.70
	6	10.864	31.69
	Average*	10.710	32.15
Matuszak	1	10.107	34.07
	2	9.860	34.92
	3	10.187	33.80
	4	9.914	34.73
	5	10.380	33.17
	6	10.225	33.67
	Average*	10.017	34.37
Final score**		**10.364**	**33.22**

* Calculated from the four fastest runs.

** Calculated from the eight fastest runs.

Serpentine Test
Wet Pavement Surface (505 feet)
Overall Scores

	Elapsed time (seconds)	Average speed (mph)	Percent difference*
CAR: **Chevrolet Caprice** TIRE SIZE: **P235/70R–15**			
Firestone Aerofire**	10.066	34.21	0.00%
General XP–2000 V4**	10.108	34.06	0.44%
Goodyear Eagle GT+4**	10.266	33.54	1.96%
CAR: **Ford Crown Victoria** TIRE SIZE: **P225/70R–15**			
Firestone Aerofire***	10.610	32.45	3.51%
General XP–2000 AS***	10.237	33.63	0.00%
Goodyear Eagle GT+4***	10.364	33.22	1.22%

* The percent difference is obtained by subtracting the average speed of the tire of interest from the average speed of the best scoring tire (highest score is the best) and dividing that number by the average speed of the best scoring tire.

** Analysis showed no statistically significant difference between the Firestone and the General on the Chevrolet Caprice; however, there is a statistically significant difference between both of them and the Goodyear in this test (see Appendix I).

*** Analysis showed statistically significant differences between each of the three tires on the Ford Crown Victoria in this test (see Appendix I).

Stopping Distance Test Dry Pavement Surface

Test Objective

Determine the performance characteristics of the test tires in a simulated "panic" stop of a patrol vehicle on a dry pavement surface. The course used has a straight, flat granite asphalt surface. A center lane marks where the braking maneuvers are to be done. The approach speed is just over 60 mph. The test vehicle is in Anti-Lock Brake System (ABS) mode when the driver applies the brakes as close to 60 mph as possible. Both the exact speed at brake application and the distance from brake application to complete stop are electronically recorded. Average deceleration rate is then determined. Deficiencies in tire adhesion will result in longer stopping distances and a relatively lower score on this portion of the evaluation.

Test Methodology

Following a 1-mile tire warm-up, each test vehicle equipped with the make and model of tire to be evaluated makes a minimum of four measured panic stops, with the ABS in operation. The final score for each tire on this portion of the evaluation is the average of the four measured stops.

Formula

To determine the deceleration rate, translate the initial speed into ft./sec. by multiplying the initial speed by 1.4667. Square this ft./sec. product and divide the resulting square by twice the listed stopping distance.

Example:

1. 60.50 mph × 1.4667 = 88.735 ft./sec.
2. 88.735 ft./sec. × 88.735 ft./sec. = 7,873.90 $ft.^2/sec.^2$
3. 7,873.90 $ft.^2/sec.^2$ ÷ (157.00 ft. × 2) = 25.08 $ft./sec.^2$

Stopping Distance Test
Dry Pavement Surface

TIRE: **Firestone Aerofire**
SIZE: **P235/70R–15 102V**
CAR: **Chevrolet Caprice**
DRIVER: **Jacob**

Run number	Initial speed (mph)	Stopping distance (ft.)	Deceleration rate (ft./sec.^{2})
1	60.50	157.00	25.08
2	59.90	149.90	25.75
3	60.60	157.40	25.10
4	60.10	150.10	25.88
Average score	60.28	153.60	25.44
(Calculated stopping distance from 60 mph)			**152.20 feet**

Stopping Distance Test
Dry Pavement Surface

TIRE: **General XP–2000 V4**
SIZE: **P235/70R–15 102V**
CAR: **Chevrolet Caprice**
DRIVER: **Jacob**

Run number	Initial speed (mph)	Stopping distance (ft.)	Deceleration rate (ft./sec.^{2})
1	59.70	154.20	24.86
2	60.30	150.10	26.06
3	60.70	150.90	26.26
4	60.30	152.80	25.60
Average score	60.25	152.00	25.69
(Calculated stopping distance from 60 mph)			**150.74 feet**

Stopping Distance Test
Dry Pavement Surface

TIRE: **Goodyear Eagle GT+4**
SIZE: **P235/70R–15 102V**
CAR: **Chevrolet Caprice**
DRIVER: **Jacob**

Run number	Initial speed (mph)	Stopping distance (ft.)	Deceleration rate (ft./sec.^{2})
1	59.50	155.40	24.50
2	61.00	166.80	23.99
3	60.10	163.20	23.81
4	59.20	154.40	24.41
Average score	59.95	159.95	24.17
(Calculated stopping distance from 60 mph)			**160.22 feet**

Stopping Distance Test
Dry Pavement Surface

TIRE: **Firestone Aerofire**
SIZE: **P225/70R–15 100H**
CAR: **Ford Crown Victoria**
DRIVER: **Jacob**

Run number	Initial speed (mph)	Stopping distance (ft.)	Deceleration rate (ft./sec.^{2})
1	60.40	155.30	25.27
2	60.40	153.20	25.61
3	60.60	150.60	26.23
4	60.50	152.30	25.85
Average score	60.48	152.85	25.74
(Calculated stopping distance from 60 mph)			**150.46 feet**

Stopping Distance Test
Dry Pavement Surface

TIRE: **General XP–2000 AS**
SIZE: **P225/70R–15 100H**
CAR: **Ford Crown Victoria**
DRIVER: **Jacob**

Run number	Initial speed (mph)	Stopping distance (ft.)	Deceleration rate (ft./sec.^{2})
1	60.70	156.70	25.29
2	60.40	151.20	25.95
3	59.70	145.30	26.38
4	62.70	159.90	26.44
Average score	60.88	153.28	26.01
(Calculated stopping distance from 60 mph)			**148.90 feet**

Stopping Distance Test
Dry Pavement Surface

TIRE: **Goodyear Eagle GT+4**
SIZE: **P225/70R–15 100H**
CAR: **Ford Crown Victoria**
DRIVER: **Jacob**

Run number	Initial speed (mph)	Stopping distance (ft.)	Deceleration rate (ft./sec.^{2})
1	60.00	155.60	24.89
2	60.10	153.30	25.34
3	60.90	153.70	25.95
4	60.40	149.60	26.23
Average score	60.35	153.05	25.60
(Calculated stopping distance from 60 mph)			**151.28 feet**

Stopping Distance Test
Dry Pavement Surface
Overall Scores

	Average deceleration rate (ft./sec.^{2})	Stopping distance* (ft.)	Percent difference**
CAR: **Chevrolet Caprice** TIRE SIZE: **P235/70R–15**			
Firestone Aerofire***	25.44	152.20	0.97%
General XP–2000 V4***	25.69	150.74	0.00%
Goodyear Eagle GT+4***	24.17	160.22	6.29%
CAR: **Ford Crown Victoria** TIRE SIZE: **P225/70R–15**			
Firestone Aerofire****	25.74	150.46	1.05%
General XP–2000 AS****	26.01	148.90	0.00%
Goodyear Eagle GT+4****	25.60	151.28	1.60%

* Calculated stopping distance from 60 mph. Both vehicles are ABS-equipped.

** The percent difference is obtained by subtracting the stopping distance of the tire of interest from the stopping distance of the best scoring tire (lowest score is the best) and dividing that number by the stopping distance of the best scoring tire.

*** Analysis showed no statistically significant difference between the Firestone and the General on the Chevrolet Caprice; however, there is a statistically significant difference between both of them and the Goodyear in this test (see Appendix I).

**** Analysis showed no statistically significant difference between the three brands of tires tested on the Ford Crown Victoria in this test (see Appendix I).

Stopping Distance Test Wet Pavement Surface

Test Objective

Determine the performance characteristics of the test tires in a simulated "panic" stop of a patrol vehicle on a wet pavement surface. The course used has a straight, flat granite asphalt surface. A center lane marks where the braking maneuvers are done. The approach speed is just over 60 mph. The vehicle is in ABS mode when the driver applies the brakes as close to 60 mph as possible. Both the exact speed at brake application and the distance from brake application to complete stop are electronically recorded. Average deceleration rate is then determined. Deficiencies in tire adhesion will result in longer stopping distances and a relatively lower score on this portion of the evaluation.

Test Methodology

Following a 1-mile tire warm-up, each test vehicle equipped with the make and model of tire to be evaluated makes a minimum of four measured panic stops, with the ABS in operation. The final score for each tire on this portion of the evaluation is the average of the four best measured stops.

Formula

To determine the deceleration rate, translate the initial speed into ft./sec. by multiplying the initial speed by 1.4667. Square this ft./sec. product and divide the resulting square by twice the listed stopping distance.

Example:

1. 60.50 mph × 1.4667 = 88.735 ft./sec.
2. 88.735 ft./sec. × 88.735 ft./sec. = 7,873.90 $ft.^2/sec.^2$
3. 7,873.90 $ft.^2/sec.^2$ ÷ (157.00 ft. × 2) = 25.08 $ft./sec.^2$

Stopping Distance Test
Wet Pavement Surface

TIRE: **Firestone Aerofire**
SIZE: **P235/70R–15 102V**
CAR: **Chevrolet Caprice**
DRIVER: **Jacob**

Run number	Initial speed (mph)	Stopping distance (ft.)	Deceleration rate (ft./sec.^{2})
1	60.90	157.60	25.31
2	60.00	151.30	25.59
3	60.10	152.90	25.41
4	60.50	151.90	25.92
Average score	60.38	153.43	25.55
(Calculated stopping distance from 60 mph)			**151.53 feet**

Stopping Distance Test
Wet Pavement Surface

TIRE: **General XP–2000 V4**
SIZE: **P235/70R–15 102V**
CAR: **Chevrolet Caprice**
DRIVER: **Jacob**

Run number	Initial speed (mph)	Stopping distance (ft.)	Deceleration rate (ft./sec.^{2})
1	60.40	149.10	26.32
2	60.30	148.80	26.28
3	60.60	145.20	27.20
4	60.60	150.10	26.32
Average score	60.48	148.30	26.53
(Calculated stopping distance from 60 mph)			**145.98 feet**

Stopping Distance Test
Wet Pavement Surface

TIRE: **Goodyear Eagle GT+4**
SIZE: **P235/70R–15 102V**
CAR: **Chevrolet Caprice**
DRIVER: **Jacob**

Run number	Initial speed (mph)	Stopping distance (ft.)	Deceleration rate (ft./sec.^{2})
1	60.30	163.80	23.88
2	60.30	165.10	23.69
3	60.40	163.60	23.99
4	60.60	166.10	23.78
Average score	60.40	164.65	23.83
(Calculated stopping distance from 60 mph)			**162.48 feet**

Stopping Distance Test
Wet Pavement Surface

TIRE: **Firestone Aerofire**
SIZE: **P225/70R–15 100H**
CAR: **Ford Crown Victoria**
DRIVER: **Jacob**

Run number	Initial speed (mph)	Stopping distance (ft.)	Deceleration rate (ft./sec.^{2})
1	60.90	157.60	25.31
2	60.30	158.50	24.68
3	60.60	154.90	25.50
4	60.30	152.90	25.58
Average score	60.53	155.98	25.26
(Calculated stopping distance from 60 mph)			**153.28 feet**

Stopping Distance Test
Wet Pavement Surface

TIRE: **General XP–2000 AS**
SIZE: **P225/70R–15 100H**
CAR: **Ford Crown Victoria**
DRIVER: **Jacob**

Run number	Initial speed (mph)	Stopping distance (ft.)	Deceleration rate (ft./sec.^{2})
1	60.30	159.10	24.58
2	60.40	160.20	24.49
3	59.60	157.10	24.32
4	60.50	159.80	24.64
Average score	60.20	159.05	24.51
(Calculated stopping distance from 60 mph)			**157.99 feet**

Stopping Distance Test
Wet Pavement Surface

TIRE: **Goodyear Eagle GT+4**
SIZE: **P225/70R–15 100H**
CAR: **Ford Crown Victoria**
DRIVER: **Jacob**

Run number	Initial speed (mph)	Stopping distance (ft.)	Deceleration rate (ft./sec.^{2})
1	60.10	150.30	25.85
2	59.30	145.10	26.07
3	59.90	148.60	25.97
4	60.60	152.60	25.88
Average score	59.98	149.15	25.94
(Calculated stopping distance from 60 mph)			**149.27 feet**

Stopping Distance Test
Wet Pavement Surface
Overall Scores

	Average deceleration rate (ft./sec.^{2})	Stopping distance* (ft.)	Percent difference**
CAR:	**Chevrolet Caprice**		
TIRE SIZE:	**P235/70R–15**		
Firestone Aerofire***	25.55	151.53	3.80%
General XP–2000 V4***	26.53	145.98	0.00%
Goodyear Eagle GT+4***	23.83	162.48	11.30%
CAR:	**Ford Crown Victoria**		
TIRE SIZE:	**P225/70R–15**		
Firestone Aerofire***	25.26	153.28	2.69%
General XP–2000 AS***	24.51	157.99	5.84%
Goodyear Eagle GT+4***	25.94	149.27	0.00%

* Calculated stopping distance from 60.0 mph. Both vehicles are equipped with ABS.

** The percent difference is obtained by subtracting the stopping distance of the tire of interest from the stopping distance of the best scoring tire (lowest score is the best) and dividing that number by the stopping distance of the best scoring tire.

*** Analysis showed statistically significant differences between each of the three tires on both the Chevrolet Caprice and the Ford Crown Victoria in this test (see Appendix I).

High-Speed Handling Test

Test Objective

Determine each tire's high-speed pursuit handling characteristics and performance on a 1.43-mile (7,553 feet) road racing type course. The course contains high-speed curves, low-speed corners, and straightaways and, with the exception of other traffic, simulates actual pursuit conditions in the field. This evaluation is a test of the tire manufacturers' success in blending the transient response, cornering, and rapid deceleration characteristics of a tire. Serious deficiencies in any of these critical areas will result in longer lap times and a lower overall score on this portion of the evaluation.

Test Methodology

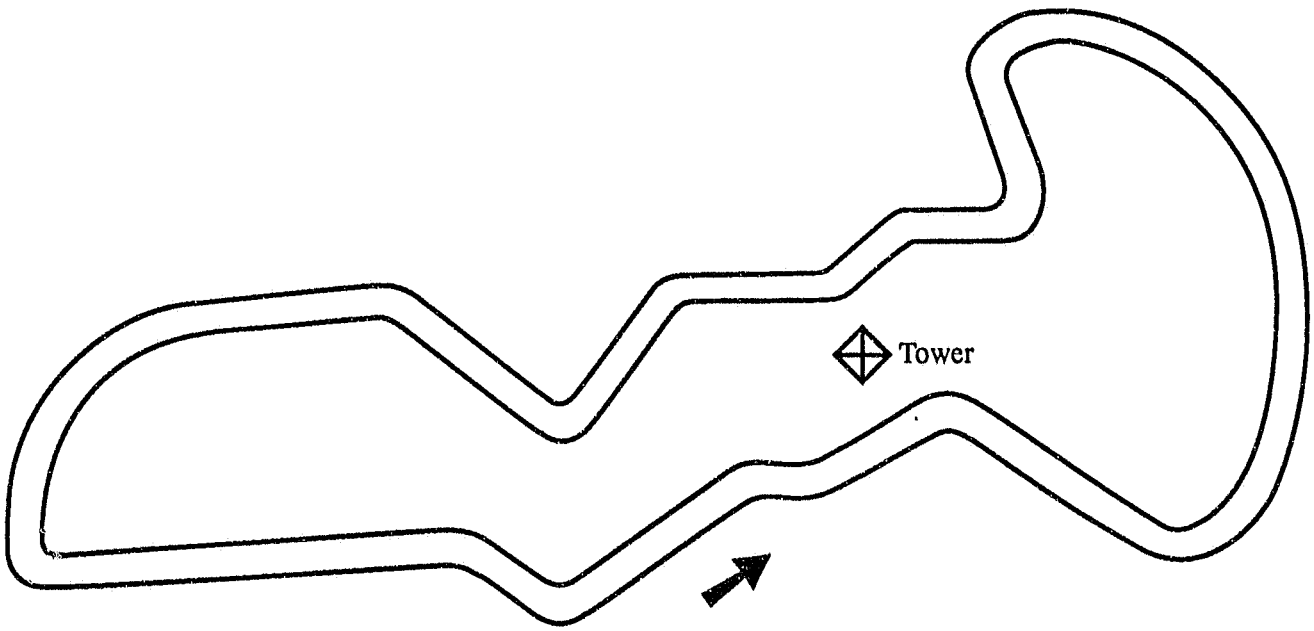
Following 2 warm-up laps, each test vehicle equipped with the make and model of tire to be evaluated is driven over the course by 3 drivers, for at least 12 timed laps. The final score for each tire will be the average of the fastest three laps by each of the drivers, for a total of nine laps.

Formula

To determine the average speed, divide the number of feet in the road course by the overall average, then divide by 1.4667 ft./sec.^{2}.

Example:
7,553 ft. ÷ overall average ÷ 1.4667 ft./sec.^{2}

Test Facility Diagram
Federal Law Enforcement Training Center
Highway Response Course—Range #7
Brunswick, Georgia



1.43 Miles

High-Speed Handling Test

CAR: **Chevrolet Caprice**

Tire	Jacob (seconds)	Matuszak (seconds)	VanDenBerg (seconds)	Overall average (seconds)	Average speed (mph)
Firestone	92.417	93.007	89.738		
Aerofire	91.862	93.415	89.250		
P235/70R–15	91.707	94.009	89.565		
	92.530	95.069	89.053		
Average:	**92.129**	**93.875**	**89.402**	**91.587**	**56.23**
General	92.271	92.919	89.904		
XP–2000 V4	91.506	94.404	89.461		
P235/70R–15	91.793	93.603	89.816		
	91.866	93.885	89.852		
Average:	**91.859**	**93.703**	**89.758**	**91.633**	**56.20**
Goodyear	93.376	93.981	92.723		
Eagle GT+4	91.798	94.530	91.140		
P235/70R–15	92.324	93.747	90.808		
	92.606	95.284	90.343		
Average:	**92.526**	**94.386**	**91.254**	**92.364**	**55.75**

High-Speed Handling Test

CAR: Ford Crown Victoria

Tire	Jacob (seconds)	Matuszak (seconds)	VanDenBerg (seconds)	Overall average (seconds)	Average speed (mph)
Firestone	91.456	93.868	88.969		
Aerofire	92.181	94.635	90.109		
P225/70R–15	91.905	92.929	89.921		
	91.989	93.361	89.286		
Average:	**91.883**	**93.698**	**89.571**	**91.520**	**56.27**
General	93.300	95.742	89.281		
XP–2000 AS	93.678	96.469	90.138		
P225/70R–15	92.930	95.937	89.759		
	93.617	95.077	90.224		
Average:	**93.381**	**95.806**	**89.851**	**92.865**	**55.45**
Goodyear	93.863	93.538	91.246		
Eagle GT+4	92.249	93.245	91.129		
P225/70R–15	91.609	93.853	91.617		
	92.290	95.228	90.880		
Average:	**92.503**	**93.966**	**91.218**	**92.227**	**55.84**

High-Speed Handling Test
Overall Scores

	Average lap time (seconds)	Average speed (mph)	Percent difference*
CAR: **Chevrolet Caprice** TIRE SIZE: **P235/70R–15**			
Firestone Aerofire**	91.587	56.23	0.00%
General XP–2000 V4**	91.633	56.20	0.05%
Goodyear Eagle GT+4**	92.364	55.75	0.85%
CAR: **Ford Crown Victoria** TIRE SIZE: **P225/70R–15**			
Firestone Aerofire***	91.520	56.27	0.00%
General XP–2000 AS***	92.865	55.45	1.46%
Goodyear Eagle GT+4***	92.227	55.84	0.76%

* The percent difference is obtained by subtracting the average speed of the tire of interest from the average speed of the best scoring tire (highest score is the best) and dividing that number by the average speed of the best scoring tire.

** Analysis showed no statistically significant difference between the Firestone and the General on the Chevrolet Caprice; however, there is a statistically significant difference between both of them and the Goodyear in this test (see Appendix I).

*** Analysis showed statistically significant differences between each of the three tires on the Ford Crown Victoria in this test (see Appendix I).

Tire Wear Measurements

Test Objective

Determine each tire's wear characteristics when subjected to the entire performance evaluation. Tread depth measurements are taken of a sample of each brand, model, and size of tire tested, and these measurements are used as a baseline for all tires of that brand, model, and size. Wear measurements are taken at the conclusion of each major portion of the evaluation. For instance, after each tire has completed all wet pavement surface tests (static circle, serpentine, and stopping distance), a wear measurement is taken. Another measurement is taken after all the tests have been completed on dry pavement surface, and the tire is removed from the vehicle. New tires are used at the beginning of the high-speed handling evaluation, and a tread depth measurement is taken after this test sequence is completed. After all testing has been completed and all tread depth measurements taken, the total wear recorded for each test tire on the wet and dry pavement surface and the high-speed handling tests is averaged to determine the actual one-thousandth of an inch of tread depth worn away as a result of the testing procedures. Because the wet and dry procedures result in extremely uneven wear patterns, the final score for this portion of the evaluation is based on the percentage of tread remaining after the high-speed handling (road course) test only, as it more closely approximates the normal wear found in police patrol service.

Test Methodology

Following each major portion of the testing sequence, as indicated above, the tread depth on each tire is measured. The measurements are taken in four places across the tread of the tire, from outside to inside. In the following tables, the measurements across the tread are labeled with 1, 2, 3, and 4, with 1 being the measurement at the first tread groove and 4 the measurement at the inside tread groove. These four across-the-tread measurements are taken in two areas 180° apart on the left front, left rear, and right rear tires. Because the right front tire receives the most wear, tire manufacturers requested that the tread depth measurements be taken in four areas 90° apart on the right front tire. The average tread depth total is the average of all the tread depths measured.

The tire wear measurements shown in this report resulted from extremely severe operating conditions. As such, they may not be an accurate predictor of achievable tire mileage when used in normal police patrol service, and should not be used to extrapolate actual tire life.

Tire Wear Measurements
(in one-thousandth of an inch)

TIRE: **Firestone Aerofire**
SIZE: **P235/70R–15 102V**
CAR: **Chevrolet Caprice**

	Left front				Right front				Right rear				Left rear				Average tread depth
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
New tires	338	354	357	338	338	354	357	338	338	354	357	338	338	354	357	338	
	342	355	354	344	342	355	354	344	342	355	354	344	342	355	354	344	348
After wet tests	345	350	345	337	342	346	352	334	345	342	348	344	338	346	348	329	
					337	347	342	334									343
	351	356	351	330	331	347	348	344	338	344	346	345	341	345	348	342	
					340	346	351	342									
After dry tests	341	342	334	311	322	333	340	333	325	331	331	342	337	337	331	325	
					314	322	345	338									332
	335	344	343	316	316	323	332	329	325	336	332	340	338	343	331	323	
					329	329	342	338									
After handling tests	341	342	344	324	326	346	349	322	342	340	343	346	335	341	344	335	
					333	344	341	337									339
	340	344	339	323	334	346	347	338	337	335	344	344	335	334	340	345	
					336	339	342	331									

Tire Wear Measurements
(in one-thousandth of an inch)

TIRE: General XP–2000 V4
SIZE: P235/70R–15 102V
CAR: Chevrolet Caprice

	Left front				Right front				Right rear				Left rear				Average tread depth
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
New tires	339	342	348	332	339	342	348	332	339	342	348	332	339	342	348	332	339
	333	338	346	333	333	338	346	333	333	338	346	333	333	338	346	333	
After wet tests	330	334	337	326	323	328	338	328	330	339	346	330	330	334	339	329	333
					326	330	346	330									
	329	334	343	320	330	336	348	332	328	334	342	334	331	334	341	328	
					327	334	346	329									
After dry tests	329	329	329	300	303	316	333	318	321	323	334	322	328	324	330	315	322
					309	318	332	318									
	328	325	329	303	315	323	336	321	319	322	334	324	324	323	329	315	
					307	321	334	318									
After handling tests	332	301	344	320	326	331	344	314	331	337	346	326	331	330	342	320	330
					329	337	342	312									
	333	334	345	320	325	334	343	310	331	331	344	326	331	331	339	320	
					325	330	343	321									

Tire Wear Measurements
(in one-thousandth of an inch)

TIRE: **Goodyear Eagle GT+4**
SIZE: **P235/70R–15 102V**
CAR: **Chevrolet Caprice**

	Left front				Right front				Right rear				Left rear				Average tread depth
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
New tires	317	316	319	315	317	316	319	315	317	316	319	315	317	316	319	315	316
	319	313	316	312	319	313	316	312	319	313	316	312	319	313	316	312	
After wet tests	310	313	311	304	299	308	309	305	309	309	309	303	313	307	309	309	308
					301	313	312	310									
	308	310	307	306	299	309	311	304	305	310	305	303	307	308	308	306	
					305	308	310	308									
After dry tests	307	307	302	295	296	304	305	305	294	299	298	290	308	300	306	296	302
					289	303	306	308									
	308	308	302	296	284	304	306	305	304	308	304	283	307	298	300	301	
					294	300	304	311									
After handling tests	307	310	298	295	293	301	296	293	284	295	292	294	296	280	273	282	296
					302	307	297	297									
	307	305	300	302	298	303	293	298	298	300	301	302	299	285	282	288	
					305	298	294	298									

Tire Wear Measurements
(in one-thousandth of an inch)

TIRE: **Firestone Aerofire**
SIZE: **P225/70R–15 100H**
CAR: **Ford Crown Victoria**

	Left front				Right front				Right rear				Left rear				Average tread depth
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
New tires	347	344	349	340	347	344	349	340	347	344	349	340	347	344	349	340	345
	344	349	348	340	344	349	348	340	344	349	348	340	344	349	348	340	
After wet tests	324	345	337	322	325	336	344	332	340	339	337	335	338	343	334	336	335
					324	337	338	334									
	336	344	338	329	330	339	341	344	338	340	329	329	340	343	343	330	
					333	327	342	321									
After dry tests	330	341	324	310	305	326	328	319	322	326	320	332	330	331	330	328	325
					300	324	327	335									
	327	342	326	304	306	322	327	338	322	329	319	333	342	337	319	326	
					305	322	341	336									
After handling tests	339	336	323	321	331	337	332	331	339	332	325	335	317	337	333	336	330
					332	338	330	323									
	325	336	323	328	318	330	330	334	334	330	328	324	334	329	323	330	
					320	335	335	332									

Tire Wear Measurements
(in one-thousandth of an inch)

TIRE: General XP–2000 AS
SIZE: P225/70R–15 100H
CAR: Ford Crown Victoria

	Left front				Right front				Right rear				Left rear				Average tread depth
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
New tires	330	333	331	329	330	333	331	329	330	333	331	329	330	333	331	329	332
	335	334	332	329	335	334	332	329	335	334	332	329	335	334	332	329	
After wet tests	325	328	320	313	322	320	324	317	318	323	319	317	326	326	322	317	320
					318	321	317	317									
	325	321	320	311	316	319	320	319	321	320	321	317	328	321	325	314	
					320	318	316	315									
After dry tests	319	321	314	293	308	318	313	317	313	312	307	309	319	313	314	303	311
					307	310	307	316									
	319	316	307	288	304	309	303	312	313	313	303	305	321	319	313	308	
					306	313	313	313									
After handling tests	313	323	317	299	306	315	313	300	317	319	317	307	316	317	317	302	312
					306	319	311	299									
	318	323	319	298	305	316	312	301	309	314	307	301	318	319	316	300	
					306	323	322	309									

Tire Wear Measurements
(in one-thousandth of an inch)

TIRE: **Goodyear Eagle GT+4**
SIZE: **P225/70R–15 100H**
CAR: **Ford Crown Victoria**

	Left front				Right front				Right rear				Left rear				Average tread depth
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
New tires	304	306	306	305	304	306	306	305	304	306	306	305	304	306	306	305	305
	304	307	305	304	304	307	305	304	304	307	305	304	304	307	305	304	
After wet tests	299	297	293	292	290	296	298	298	292	295	296	297	295	297	295	293	296
					292	297	304	301									
	292	299	299	293	295	301	299	301	292	294	296	294	298	299	293	292	
					292	296	298	301									
After dry tests	296	292	291	284	278	290	296	296	286	284	289	294	296	295	292	286	290
					286	294	297	293									
	294	297	287	286	286	292	294	298	289	283	291	297	290	290	290	286	
					271	290	292	297									
After handling tests	301	297	296	298	290	303	298	296	295	292	290	298	297	292	290	293	296
					295	298	297	300									
	303	304	295	297	296	297	297	300	295	293	291	296	293	290	296	297	
					296	297	300	300									

Tire Wear Measurements
Overall Comparisons

	New (inch)	After wet tests (inch)	After dry tests (inch)	After handling tests (inch)	Average wear measured* (inch)
CAR: **Chevrolet Caprice** TIRE SIZE: **P235/70R–15 102V**					
Firestone Aerofire**	0.348	0.343	0.332	0.339	0.012
General XP–2000 V4**	0.339	0.333	0.322	0.330	0.013
Goodyear Eagle GT+4**	0.316	0.308	0.302	0.296	0.017
CAR: **Ford Crown Victoria** TIRE SIZE: **P225/70R–15 100H**					
Firestone Aerofire***	0.345	0.335	0.325	0.330	0.017
General XP–2000 AS***	0.332	0.320	0.311	0.312	0.020
Goodyear Eagle GT+4***	0.305	0.296	0.290	0.296	0.012

* To determine the average wear measured, subtract the after-dry-tests tread depth from the tread depth when the tire was new. The after-handling-tests tread depth is subtracted from the new tread depth as well. The two resulting totals are added and the sum is divided by two.

Example:

1. 0.348 inch – 0.332 inch = 0.016 inch
2. 0.348 inch – 0.339 inch = 0.009 inch
3. 0.016 inch + 0.009 inch = 0.025 inch
4. 0.025 inch ÷ 2 = 0.012 inch

** Analysis showed no statistically significant differences between the three brands of tires tested on the Chevrolet Caprice in this test (see Appendix I).

*** Analysis showed statistically significant differences between each of the three tires on the Ford Crown Victoria in this test (see Appendix I).

Tire Wear Measurements
Overall Comparisons
Road Course Tire Wear Only

	New (inch)	After handling test (inch)	Average wear measured (inch)	Tread depth remaining* (percent)
CAR: **Chevrolet Caprice** TIRE SIZE: **P235/70R–15 102V**				
Firestone Aerofire**	0.348	0.339	0.009	0.974
General XP–2000 V4**	0.339	0.330	0.009	0.975
Goodyear Eagle GT+4**	0.316	0.296	0.020	0.938
CAR: **Ford Crown Victoria** TIRE SIZE: **P225/70R–15 100H**				
Firestone Aerofire***	0.345	0.330	0.015	0.957
General XP–2000 AS***	0.332	0.312	0.020	0.940
Goodyear Eagle GT+4***	0.305	0.296	0.009	0.971

* To determine the tread depth remaining, subtract the average-wear-measured figure from the new tire measurement. The resulting figure should be equal to the after-handling-test measurement. This figure is then divided by the new tire measurement.

Example:

1. 0.348 inch – 0.009 inch = 0.339 inch
2. 0.339 inch ÷ 0.348 inch = 0.974 percent

** Analysis showed no statistically significant difference between the Firestone and the General on the Chevrolet Caprice; however, there is a statistically significant difference between both of them and the Goodyear in this test (see Appendix I).

*** Analysis showed statistically significant differences between each of the three tires on the Ford Crown Victoria in this test (see Appendix I).

Overall Scores

All Test Categories

The following two pages contain the overall scores from each of the various test categories. The way they are presented is intended to assist the reader in making direct comparisons of the performance of the tires under various test conditions, and on different makes and models of cars.

To most fairly compare the performance of the various tires, we have shaded some of the results to indicate when two or more tires are statistically equal. Hence, when two of the three tires on a given test are within a shaded box, they should be viewed as having equal scores on that test, even though their numerical scores show a small difference.

Likewise, when all three tires are within a shaded box, there is essentially no difference between them, and they should be viewed as having equal scores on that test. (The reader should note that the tires within a shaded box may be equally better or equally worse on that test than the tire not in a shaded box.) In those categories where none of the scores are shaded, there are significant differences among the three tires tested.

Overall Scores All Test Categories

CAR: Chevrolet Caprice
TIRE SIZE: P235/70R–15 102V

Tire	Static circle dry (percent of lateral G's)	Static circle wet (percent of lateral G's)	Serpentine evaluation dry (mph)	Serpentine evaluation wet (mph)	Stopping distance dry (feet)	Stopping distance wet (feet)	High-speed handling (seconds)	Tread depth remaining (percent)
Firestone Aerofire	0.744	0.698	63.65	34.21	152.20	151.53	91.587	0.974
General XP–2000 V4	0.745	0.707	65.26	34.06	150.74	145.98	91.633	0.975
Goodyear Eagle GT+4	0.734	0.675	63.05	33.54	160.22	162.48	92.364	0.938

Overall Scores All Test Categories

CAR: Ford Crown Victoria
TIRE SIZE: P225/70R–15 100H

Tire	Static circle dry (percent of lateral G's)	Static circle wet (percent of lateral G's)	Serpentine evaluation dry (mph)	Serpentine evaluation wet (mph)	Stopping distance dry (feet)	Stopping distance wet (feet)	High-speed handling (seconds)	Tread depth remaining (percent)
Firestone Aerofire	0.765	0.723	64.99	32.45	150.46	153.28	91.520	0.957
General XP–2000 AS	0.756	0.682	64.17	33.63	148.90	157.99	92.865	0.940
Goodyear Eagle GT+4	0.750	0.721	64.00	33.22	151.28	149.27	92.227	0.971

Epilogue

The test results may be used in two ways. First, they may be used as is to determine the tires that best meet the needs of your department. In this case, you should emphasize some portions of the evaluation to reflect the needs of your department. Second, the overall test results may be used to adjust the manufacturer's bid price for these tire brands.

The following pages contain a scoring and bid adjustment system which you may find useful in making decisions about your patrol vehicle tires. All the data used in the example are fictitious. Likewise, the category weights used are arbitrary. They should be adjusted to represent the actual conditions your agency faces and those factors important to you. The category weights should total 100. The example given is biased toward a dry climate, in which one may encounter wet roads infrequently. It could as easily have been biased toward wet road conditions, as might be encountered in the Pacific Northwest.

Scoring/Bid Adjustment Methodology

Step I—Raw Scores

Raw scores are developed, through testing, for each tire in each of the eight evaluation categories. The raw scores are expressed in terms of percentage of lateral G's, speed in mph, stopping distance in feet, time, or remaining tread depth.

Static circle -dry- (% of lateral G's)	Static circle -wet- (% of lateral G's)	Serpentine -dry- (speed)	Serpentine -wet- (speed)	Stopping distance -dry- (feet)	Stopping distance -wet- (feet)	High-speed handling (sec.)	Remaining tread depth (%)
0.763	0.702	63.92	34.12	151.64	159.44	91.724	0.982

Step II—Deviation Factor

In each evaluation category, the best tire's score establishes the benchmark against which each of the other test tire's score is compared. In the static circle and serpentine tests and the tire wear measurement section the highest score is best, whereas the lowest score is best in the stopping distance and high-speed handling tests. The best scoring tire in each test category receives a "deviation factor" of 0. The deviation factor is then calculated for the other tires by determining the absolute difference between each tire's raw score and the best score in the category. This difference is then divided by the best score, resulting in the "deviation factor."

Tire make and model	Serpentine -dry-
Tire A	63.92 0.021
Tire B	64.88 0.006
Tire C	65.26 0

Example:

Best score (Tire C)		Other tire score (Tire A)		Absolute difference		Best score		Deviation factor (Tire A)
65.26	–	63.92	=	1.34	+	65.26	=	0.021

Step III—Weighted Category Score

The weighted category score of each tire is determined by multiplying the deviation factor (as determined in Step II) by the category weight.

Weighted Score	20	
Serpentine -dry- (speed)		
Raw score	63.92	
Deviation factor	0.021	0.021 × 20 = 0.420
Weighted category score	0.420	

Step IV—Total Weighted Score

The total weighted score for each tire is the sum of the eight weighted category scores for that tire.

	15	5	20	5	15	5	30	5	
Tire	Static circle -dry- (% of lateral G's)	Static circle -wet- (% of lateral G's)	Serpentine -dry- (speed)	Serpentine -wet- (speed)	Stopping distance -dry- (feet)	Stopping distance -wet- (feet)	High-speed handling (time)	Remaining tread depth (%)	Total weighted score
Tire A	0.763	0.702	63.92	34.12	151.64	159.44	91.724	0.982	
	0.023	0	0.021	0	0.039	0.007	0.004	0.125	
	0.345	0	0.420	0	0.585	0.035	0.120	0.625	2.130

Step V—Bid Adjustment Figure

The bid adjustment figure that we chose to use in this example is 6 percent of the lowest bid price received. (This figure is arbitrary and may be adjusted upward or downward.) In this step and the following two steps, the lowest bid price received was $57.50 per tire, which results in a bid adjustment figure of $3.45.

Step VI—Actual Dollar Adjustment

The actual dollar adjustment for a tire is determined by multiplying that tire's total weighted score by the bid adjustment figure.

Total weighted score	×	Bid adjustment figure	=	Actual dollar adjustment
2.130		$3.45		$7.35

Step VII—Adjusted Bid Price

The actual dollar adjustment amount for each tire is added to that tire's actual bid price. The tire with the adjusted low bid price would be purchased, provided all other bid conditions are met. (The amount paid for the purchased tires is the actual bid price.)

Actual dollar adjustment	+	Actual dollar bid price	=	Adjusted bid price
$7.35		$59.95		$67.30

Appendix I—Analysis To Determine Statistical Significance

Summary of Static Circle Results

The static circle test was conducted under both wet and dry pavement surface conditions. For each pavement surface condition in this test, a number of combinations were tested using a single driver, two cars, and tires from three manufacturers. Each tire and car combination generated four data points representing laps around the static circle.

One interfering feature of the data set was the general degradation of speed (and the related G-force) with succeeding laps. The reason for this was twofold: The tires degraded with each succeeding lap, and they also became hotter, resulting in reduced adhesion. This observation was particularly apparent in the dry testing, as would be expected. To test this feature, a One-Way Analysis of Variance (ANOVA) was performed between laps across all tires for the Chevrolet Caprice on the dry test. The result was significant at the 90-percent level, showing a probable effect.

An attempt was made to adjust for the degradation on the dry test. By taking the average time per lap across all tire brands, a weighting factor was determined that, when applied, would offset the effect of the degradation. As it turned out, this modification did reduce the variability within each data set, but it did not result in additional statistically significant information.

Dry Static Circle—Chevrolet Caprice

ANOVA showed no significant difference in G-force between the three tires when all are considered simultaneously.

Dry Static Circle—Ford Crown Victoria

ANOVA showed a significant difference in G-force between the tires at the 90-percent confidence level when all three are considered simultaneously.

T-tests between pairs showed the following:

1. Firestone to General—Firestone has significantly higher results.

2. Firestone to Goodyear—Firestone has significantly higher results.

3. General to Goodyear—No significant difference.

Wet Static Circle—Chevrolet Caprice

ANOVA showed a significant difference in G-force between the tires at the 90-percent confidence level when all three are considered simultaneously.

T-tests between pairs showed the following:

1. Firestone to General—No significant difference.

2. Firestone to Goodyear—Firestone has significantly higher results.

3. General to Goodyear—General has significantly higher results.

Wet Static Circle—Ford Crown Victoria

ANOVA showed a significant difference in G-force between the tires at the 90-percent confidence level when all three are considered simultaneously.

T-tests between the pairs showed the following:

1. Firestone to General—Firestone has significantly higher results.

2. Firestone to Goodyear—No significant difference.

3. General to Goodyear—Goodyear has significantly higher results.

Summary of Serpentine Results

The serpentine tests were conducted under both wet and dry pavement surface conditions. For each pavement surface condition, a number of combinations were tested using two drivers, two cars, and tires from three manufacturers. Each tire, car, and driver combination generated six data points representing trips through a serpentine test route.

An examination of the data showed quite clearly that there was an obvious difference between the speed of the two drivers through the course, independent of the differences between tires. This difference was, in part, designed into the test to simulate drivers with different capabilities using the tires. However, the variability between drivers also adds substantial variability to the data set. Therefore, it was decided to offset the driver-specific effect by weighting each observation by the difference between a particular driver's average speed through the course and the average of both drivers' speeds through the course. The result was an increase in the speed for one driver by a constant, and a decrease in the other driver's speed by the same constant. The resulting mean did not change, but the variability of the data set was reduced substantially.

It is true that driver-specific results are eliminated with this sort of transformation. However, we feel that this method does simulate an average driver and is therefore valid.

Dry Serpentine—Chevrolet Caprice

ANOVA showed a significant difference in serpentine speed between the tires at the 90-percent confidence level when all three are considered simultaneously.

T-tests between pairs showed the following:

1. Firestone to General—General was significantly faster.

2. Firestone to Goodyear—Firestone was significantly faster.

3. General to Goodyear—General was significantly faster.

(General was fastest; Firestone was next; Goodyear was slowest.)

Dry Serpentine—Ford Crown Victoria

ANOVA showed a significant difference in serpentine speed between the tires at the 90-percent confidence level when all three are considered simultaneously.

T-tests between pairs showed the following:

1. Firestone to General—Firestone was significantly faster.

2. Firestone to Goodyear—Firestone was significantly faster.

3. General to Goodyear—No significant difference.

(Firestone was fastest; Goodyear and General essentially tied.)

Wet Serpentine—Chevrolet Caprice

ANOVA showed a significant difference in serpentine speed between the tires at the 90-percent confidence level when all three are considered simultaneously.

T-tests between the pairs showed the following:

1. Firestone to General—No significant difference.

2. Firestone to Goodyear—Firestone was marginally, but significantly, faster.

3. General to Goodyear—General was marginally, but significantly, faster.

(Firestone and General are essentially tied for fastest; Goodyear was slowest, although all tires are relatively even in this test.)

Wet Serpentine—Ford Crown Victoria

ANOVA showed a significant difference in serpentine speed between the tires at the 90-percent confidence level when all three are considered simultaneously.

T-tests between the pairs showed the following:

1. Firestone to General—General was significantly faster.

2. Firestone to Goodyear—Goodyear was significantly faster.

3. General to Goodyear—General was marginally, but significantly, faster.

(General was fastest; Goodyear was next; Firestone was slowest.)

Summary of Stopping Distance Results

The stopping distance tests were conducted under both wet and dry pavement surface conditions. For each pavement surface condition, a number of combinations were tested using one driver, two cars, and tires from three manufacturers. Each tire and car combination generated four data points representing deceleration rates.

Dry Stopping Distance—Chevrolet Caprice

ANOVA showed a significant difference in deceleration rate between the tires at the 90-percent confidence level when all three are considered simultaneously.

T-tests between the pairs showed the following:

1. Firestone to General—No significant difference.

2. Firestone to Goodyear—Firestone has a significantly higher average deceleration rate.

3. General to Goodyear—General has a significantly higher average deceleration rate.

(Firestone and General tied for highest; Goodyear was lowest.)

Dry Stopping Distance—Ford Crown Victoria

ANOVA showed no significant difference in average deceleration rate between the tires at the 90-percent confidence level when all three are considered simultaneously.

T-tests between pairs showed the following:

1. Firestone to General—No significant difference.

2. Firestone to Goodyear—No significant difference.

3. General to Goodyear—No significant difference.

Wet Stopping Distance—Chevrolet Caprice

ANOVA showed a significant difference in average deceleration rate between the tires at the 90-percent confidence level when all three are considered simultaneously.

T-tests between pairs showed the following:

1. Firestone to General—General has significantly higher deceleration rate.

2. Firestone to Goodyear—Firestone has significantly higher deceleration rate.

3. General to Goodyear—General has significantly higher deceleration rate.

(General was highest; Firestone next; Goodyear was lowest.)

Wet Stopping Distance—Ford Crown Victoria

ANOVA showed a significant difference in average deceleration rate between the tires at the 90-percent confidence level when all three are considered simultaneously.

T-tests between pairs showed the following:

1. Firestone to General—Firestone has significantly higher deceleration rate.

2. Firestone to Goodyear—Goodyear has significantly higher deceleration rate.

3. General to Goodyear—Goodyear has significantly higher deceleration rate.

(Goodyear was highest; Firestone next; General was lowest.)

Summary of High-Speed Handling Tests

The high-speed handling test was conducted using three drivers, two cars, and tires from three manufacturers. Each tire, car, and driver combination generated four data points representing laps around a road racing type course to simulate a county road pursuit. A data point, in this case, is the number of seconds required to complete one lap; the lower the number, the faster the lap.

An examination of the data set showed quite clearly that there were obvious differences among the speed of the three drivers through the course, independent of the differences between tires. This difference was, in part, designed into the test to simulate drivers with different capabilities using the tires. The variability among the drivers, however, also adds substantial variability to the data set. Therefore it was decided to offset the driver-specific effect by weighting each observation by the difference between a particular driver's average speed through the course and the average of all three drivers' speeds through the course. The result was an increase in the speed for some drivers by a constant, and a decrease by a constant for others. The resulting mean did not change but the variability of the data set was reduced substantially.

It is true that driver-specific results are eliminated with this sort of transformation; however, we feel that this method does simulate an average driver and is therefore valid.

High-Speed Handling—Chevrolet Caprice

ANOVA showed a significant difference in average lap time between the tires at the 90-percent confidence level when all three are considered simultaneously.

T-tests between pairs showed the following:

1. Firestone to General—No significant difference.

2. Firestone to Goodyear—Firestone was significantly faster.

3. General to Goodyear—General was significantly faster.

(Firestone and General were fastest; Goodyear was slowest.)

High-Speed Handling—Ford Crown Victoria

ANOVA showed a significant difference in average lap time between the tires at the 90-percent confidence level when all three are considered simultaneously.

T-tests between pairs showed the following:

1. Firestone to General—Firestone was significantly faster.

2. Firestone to Goodyear—Firestone was significantly faster.

3. General to Goodyear—Goodyear was marginally, but significantly, faster.

(Firestone was fastest; Goodyear next; General was slowest.)

Summary of the Tire Wear Measurement Results

The data associated with the tire wear analysis are based on the measured depth of tread of new tires as compared to tires that have undergone various amounts of testing. Each tire was measured in four traction grooves across the tire and at two points around the circumference of the tire (four points on the right front tire). Tread depth measurements were taken when the tires were new (with only break-in miles), at the conclusion of the wet pavement surface tests, after the dry pavement surface tests, and following the high-speed handling test.

To eliminate the variability created by unequal initial tread depths, the data were transformed into percentage of tread worn away as a result of testing.

Worst Case Scrubbing

Inspection of the data set showed extreme variability of measurements related to tire position on the car after the wet and dry testing, in all likelihood related to the static circle testing. This made combining data between tire positions on the car impractical. It was determined that the best evaluation of the data was to look at the most loaded tire and evaluate it alone as a "worst case" condition of abuse. In the case of this testing, the most loaded tire is the right front tire. As such, the data for the right front tire were evaluated following the tests on the dry pavement surface. As a further restriction, only data from the right groove of that tire was evaluated. The right groove is the most scrubbed area of the right front tire.

Worst Case Scrubbing Analysis—Chevrolet Caprice

ANOVA showed no significant differences in scrubbing wear between the tires at the 90-percent confidence level when all three tires are considered simultaneously.

Worst Case Scrubbing Analysis—Ford Crown Victoria

ANOVA showed strong significant differences in scrubbing wear between the tires at the 90-percent confidence level when all three tires are considered simultaneously.

T-tests between the pairs showed the following:

1. Firestone to General—Firestone showed less wear than General.

2. Firestone to Goodyear—Goodyear showed less wear than Firestone.

3. General to Goodyear—Goodyear showed less wear than General.

(Goodyear showed the least wear; Firestone next; General had the most wear.)

High-Speed Handling (Road Course)

The road course handling test generated more uniform data than the previously discussed set. This outcome was to be expected since the high-speed handling test is more balanced and less biased than the other tests. As such, it was possible to consider all the data, regardless of tire position on the car. This not only yielded a larger data set, but also gave a good general feel for the durability of all of the test tires in high-speed pursuit type drziving.

High-Speed Handling—Chevrolet Caprice

ANOVA showed strong significant differences in the percentage of tread wear between the tires at the 90-percent confidence level when all three are considered simultaneously.

T-tests between the pairs showed the following:

1. Firestone to General—No significant difference.

2. Firestone to Goodyear—Firestone showed less wear than Goodyear.

3. General to Goodyear—General showed less wear than Goodyear.

(Firestone and General showed the least wear; Goodyear had the most wear.)

High-Speed Handling—Ford Crown Victoria

ANOVA showed strong significant differences in the percentage of tread wear between the tires at the 90-percent confidence level when all three are considered simultaneously.

T-tests between the pairs showed the following:

1. Firestone to General—Firestone showed less wear than General.

2. Firestone to Goodyear—Goodyear showed less wear than Firestone.

3. General to Goodyear—Goodyear showed less wear than General.

(Goodyear showed the least wear; Firestone was next; General had the most wear.)

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