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Jeremy Travis, Director

B U L L E T I N

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Michigan State Police Tests 1998 Patrol Vehicles

The National Law Enforcement and Corrections Technology Center (NLECTC), of the National Institute of Justice (NIJ), provides law enforcement agencies with practical information on equipment and technology. A pioneer in researching new technologies, NIJ, through NLECTC, encourages and helps agencies to maximize their budgets, ensure reliability of product performance, and safeguard their employees. The advancements that emerge from the annual Michigan State Police Patrol Vehicle Tests validate the success of these efforts.

Every year, the Michigan State Police (MSP) tests new patrol vehicles as part of its procurement policy. This year, from September 20 through 22, the MSP tested nine special service package cars (two Camaros, two Cherokees, two Subarus, two Explorers, and one Expedition) and six police patrol package cars. This NLECTC bulletin contains a synopsis of the test results; a detailed report is also available.

Table 1
Tests and scoring

Test	Points
Vehicle dynamics	30
Acceleration	20
Top speed	15
Braking	20
Ergonomics and communications	10
Fuel economy	5
Total	100

Table 2
Vehicles tested

Vehicle	Engine
Chevrolet Camaro (Automatic)	5.7L (350 cid) SFI
Chevrolet Camaro (6-speed manual)	5.7L (350 cid) SFI
Chevrolet Lumina	3.8L (231 cid) SFI
Chevrolet Tahoe (2-wheel drive)	5.7L (350 cid) SFI
Chrysler Jeep Cherokee (2-wheel drive)	4.0L (242 cid) PFI
Chrysler Jeep Cherokee (4-wheel drive)	4.0L (242 cid) PFI
Ford Crown Victoria	4.6L (281 cid) SFI
Ford Crown Victoria (CNG)	4.6L (281 cid) SFI
Ford Expedition (2-wheel drive)	5.4L (329 cid) SFI
Ford Explorer (2-wheel drive)	5.0L (302 cid) PFI
Ford Explorer (All-wheel drive)	5.0L (302 cid) PFI
Subaru Legacy Outback Wagon (All-wheel drive)	2.5L (150 cid) SFI
Subaru Legacy Sport Utility Sedan (All-wheel drive)	2.5L (150 cid) SFI
Volvo S-70 T5 Sedan	2.3L (142 cid) PFI Turbo
Volvo V-70 T5 Wagon	2.3L (142 cid) PFI Turbo

cid = Cubic inch displacement CNG = Compressed natural gas L = Liter
PFI = Multiport fuel injection SFI = Sequential port fuel injection
Turbo = Turbocharged

There are differences between manufacturers in the operation of their vehicles' 4-wheel-drive and all-wheel-drive systems. For a detailed explanation of how a particular system works on a specific vehicle, contact the respective vehicle manufacturer or the manufacturer's authorized sales and service dealership in your area.

Page 4 of this bulletin contains information on how to obtain the report.

Each vehicle is subjected to six major tests and evaluations. The results are weighted to reflect the relative importance of each attribute as related to MSP operational requirements. Table 1 lists the tests and point scores.

Table 3 **Results of vehicle dynamics testing**

Make/Model	Average*
Chevrolet Camaro (Automatic) 5.7L SFI	1:18.98
Chevrolet Camaro (6-speed manual) 5.7L SFI	1:20.59
Chevrolet Lumina 3.8L SFI	1:26.62
Chevrolet Tahoe (2-wheel drive) 5.7L SFI	1:26.62
Chrysler Jeep Cherokee (2-wheel drive) 4.0L PFI	1:25.82
Chrysler Jeep Cherokee (4-wheel drive) 4.0L PFI	1:26.91
Ford Crown Victoria 4.6L SFI	1:24.51
Ford Crown Victoria (CNG) 4.6L SFI	1:28.59
Ford Expedition (2-wheel drive) 5.4L SFI	**
Ford Explorer (2-wheel drive) 5.0L PFI	**
Ford Explorer (All-wheel drive) 5.0L PFI	**
Subaru Legacy Outback Wagon (All-wheel drive) 2.5L SFI	1:28.37
Subaru Legacy Sport Utility Sedan (All-wheel drive) 2.5L SFI	1:27.33
Volvo S-70 T5 Sedan 2.3L PFI Turbo	1:22.55
Volvo V-70 T5 Wagon 2.3L PFI Turbo	1:23.40

NOTE: Times are in minutes, seconds, and hundredths of a second; i.e., 1:29.74 = 1 minute, 29 seconds, and 74/100 of a second.

* Average time for fastest 12 laps.

** Ford Motor Co. has indicated that these vehicles are not designed nor intended to be used as pursuit vehicles. Therefore, these vehicles were not subjected to vehicle dynamics testing.

MSP scores each vehicle's overall performance, reviews the manufacturer's bid price, and calculates a final score for each vehicle using a sophisticated formula that combines the overall performance score and the manufacturer's price.

It should be noted that the MSP vehicle specifications, test categories, and scoring reflect MSP needs. If your department employs this or a similar method, consider your own needs carefully and alter the weighting factors accordingly. Table 2 (page 1) lists the vehicles alphabetically.

Vehicle dynamics testing

Objective: To determine high-speed pursuit handling characteristics. The 1.635-mile road racing course contains hills, curves, and corners; except for the absence of traffic, it simulates actual pursuit conditions. The evaluation measures each vehicle's blending of suspension components, acceleration capabilities, and braking characteristics.

Methodology: Each vehicle is driven at least 12 timed laps by at least three drivers. The final score is the average of the fastest of at least 9 timed laps.

Table 3 shows the average results of the vehicle dynamics test.

Ford Motor Company submitted three different models for testing (pictured from left to right): the Expedition, the Explorer (tested in 2- and all-wheel-drive versions), and the Crown Victoria (tested in both gasoline and compressed natural gas (CNG) fueled versions).

Photo courtesy of Michigan State Police.

Chevrolet Motor Division of General Motors Corporation submitted three models for testing (pictured from left to right): the Camaro (tested in two different versions—a six-speed manual transmission and an automatic transmission), the Tahoe, and the Lumina.

Photo courtesy of Michigan State Police.

Acceleration and top-speed testing

Acceleration

Qualification test objective: To determine the ability of each vehicle to accelerate from a standing start to 60 mph within 10.0 seconds, 80 mph within 17.2 seconds, and 100 mph within 28.2 seconds.

Competitive test objective: To determine acceleration time to 100 mph.

Methodology: Using a Datron non-contact optical sensor, in conjunction with a personal computer, each vehicle is driven through four acceleration sequences—two northbound and two southbound to allow for wind direction. The average of the four times is used to derive scores on the competitive test.

Top speed

Qualification test objective: To determine the vehicle's ability to reach 110 mph within 1 mile, and 120 mph within 2 miles.

Competitive test objective: To determine the actual top speed (up to 150 mph) obtained within 14 miles from a standing start.

Methodology: Following the fourth acceleration run, the vehicle continues to accelerate to the top speed attainable within 14 miles from the start of the run. The highest speed attained within the 14 miles is the vehicle's score on the competitive test. Table 4 (page 5) summarizes the acceleration and top-speed tests.

Braking test

Qualification test objective: To determine the acceptability of each vehicle's braking performance for pursuit service. The ability of the vehicle to make a panic stop within its own lane and evidence of brake fade are evaluated, as well as the ability to achieve an average score of 25.0 ft/sec^2 on two impending stops (threshold stops from 60 mph).

Competitive test objective: To determine the deceleration rate on two 60-to-0 mph impending skid stops. Vehicles are scored on their average deceleration rate attained in comparison with the other vehicles in the test group.

Methodology: Each vehicle is first required to make four decelerations at 22 feet per second squared from 90-to-0 mph, with the driver using a decelerometer to maintain the deceleration rate. The vehicle then makes a 60-to-0 mph impending skid.

The exact initial velocity at the beginning of the deceleration and the exact distance required to make the stop are recorded by means of a fifth wheel with electronic digital speed and distance meters. From these figures, the average deceleration rate for the stops is calculated. Following a 4-minute cooling period, this sequence is repeated. The second sequence is followed by one 60-to-0 mph panic stop to determine the ability of the vehicle to stop in a straight line within its lane and to detect evidence of brake fade. Table 5 (page 5) shows the results of the braking test.

Ergonomics and communications

Objectives: To rate the vehicle's ability to provide a suitable environment for patrol officers to perform their job, to accommodate the required communications and emergency warning equipment, and to assess the relative difficulty of installing the equipment.

Methodology: A minimum of four officers independently and individually score each vehicle on comfort and instrumentation. Personnel from the Motor Transport Division, Police Car Prep Section, conduct the communications portion of the evaluation based on the relative difficulty of the necessary installations. Each factor is graded on a 1-to-10 scale, with 1 representing totally unacceptable and 10 representing superior. The scores are averaged to minimize personal prejudice. Table 6 (page 6) shows the results of the ergonomics and communications test. (Only one of each model was tested since the interior dimensions are essentially the same.)

Fuel economy

Objective: To determine fuel economy potential. The scoring data are valid and reliable for comparison but may not necessarily be an accurate prediction of the car's actual fuel economy.

Methodology: The vehicles are scored based on estimates for city fuel economy to the nearest 1/10 mile per gallon developed from data supplied by the vehicle manufacturers. Table 7 (page 6) shows the estimated EPA fuel economy.

If you would like a copy of the full report, write or call the National Law Enforcement and Corrections Technology Center, P.O. Box 1160, Rockville, MD 20849–1160, 800–248–2742, or 301–519–5060; or download from JUSTNET, http://www.nlectc.org.

The Jeep Division of the Chrysler Corporation submitted the Cherokee (pictured at right) in both a 2-wheel-drive and a 4-wheel-drive version.

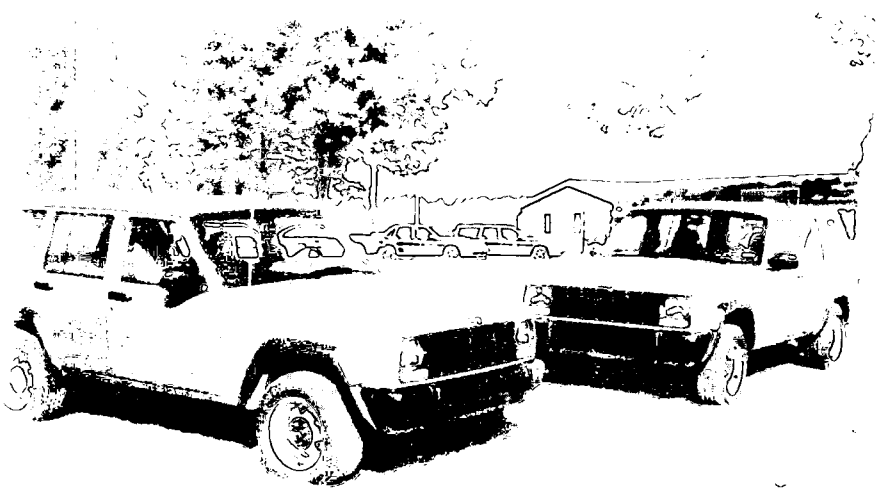

Photo courtesy of Michigan State Police.

Table 4 **Results of acceleration* and top-speed testing**

Speed (mph)	Chevrolet Camaro (Automatic) 5.7L SFI	Chevrolet Camaro (6-speed manual) 5.7L SFI	Chevrolet Lumina 3.8L SFI	Chevrolet Tahoe (2-wheel drive) 5.7L SFI	Chrysler Jeep Cherokee (2-wheel drive) 4.0L PFI	Chrysler Jeep Cherokee (4-wheel drive) 4.0L PFI	Ford Crown Victoria 4.6L SFI	Ford Crown Victoria (CNG) 4.6L SFI	Ford Expedition (2-wheel drive) 5.4L PFI	Ford Explorer (2-wheel drive) 5.0L PFI	Ford Explorer (All-wheel drive) 5.0L PFI	Subaru Legacy Outback Wagon (All-wheel drive) 2.5L PFI	Subaru Legacy SU Sedan (All-wheel drive) 2.5L PFI	Volvo S-70 T5 Sedan 2.3L PFI	Volvo V-70 T5 Wagon 2.3L PFI
0 – 20	1.54	1.68	2.16	1.98	2.08	2.11	1.93	2.41	2.25	2.03	2.11	2.41	2.40	2.29	2.35
0 – 30	2.44	2.60	3.38	3.29	3.48	3.56	3.19	4.18	3.88	3.46	3.65	3.90	3.86	3.58	3.69
0 – 40	3.37	3.52	4.91	4.77	4.97	5.15	4.73	6.06	5.58	5.27	5.54	6.10	5.95	4.88	5.06
0 – 50	4.55	4.65	7.05	6.88	7.39	7.69	6.68	8.41	7.73	7.53	8.06	8.75	8.52	6.31	6.59
0 – 60	6.00	5.93	9.55	9.40	9.96	10.42	9.01	11.79	10.42	10.15	10.84	11.68	11.35	8.14	8.57
0 – 70	7.52	7.55	12.49	12.27	13.19	13.94	11.82	15.41	13.55	13.68	14.73	15.99	15.48	10.10	10.75
0 – 80	9.35	9.36	16.41	16.13	18.53	19.65	15.50	19.88	17.62	18.26	19.69	21.89	20.97	12.40	13.15
0 – 90	11.85	11.52	21.55	22.05	24.68	26.30	20.10	26.31	23.82	23.77	25.67	28.78	27.35	15.60	16.66
0 – 100	14.64	14.00	28.31	29.50	33.30	36.23	25.91	36.47	31.79	37.86	42.49	38.36	36.05	19.32	20.62
Top Speed in mph	150[a]	150[a]	123[b]	123	111[b]	112[b]	130[b]	104[b]	106[b]	106[b]	106[b]	111[b]	112[b]	147	142

[a] Due to the limitations of the test track, drivers were told not to exceed 150 mph.

[b] Vehicle equipped with an electronic speed limiter.

* Figures represent the average of four runs.

Table 5 **Results of braking test**

	Chevrolet Camaro (Automatic) 5.7L SFI	Chevrolet Lumina 3.8L SFI	Chevrolet Tahoe (2-wheel drive) 5.7L SFI	Chrysler Jeep Cherokee (2-wheel drive) 4.0L PFI	Chrysler Jeep Cherokee (4-wheel drive) 4.0L PFI	Ford Crown Victoria 4.6L SFI	Ford Crown Victoria (CNG) 4.6L SFI	Ford Expedition (2-wheel drive) 5.4L PFI	Ford Explorer (2-wheel drive) 5.0L PFI	Ford Explorer (All-wheel drive) 5.0L PFI	Subaru Legacy Outback Wagon (All-wheel drive) 2.5L PFI	Subaru Legacy SU Sedan (All-wheel drive) 2.5L PFI	Volvo S-70 T5 Sedan 2.3L PFI	Volvo V-70 T5 Wagon 2.3L PFI
Phase I														
Initial speed (mph)	60.20	60.40	60.10	59.80	60.20	60.60	61.50	60.40	61.10	61.40	60.20	60.10	60.10	60.10
Stopping distance (ft)	136.30	169.70	173.50	152.30	150.90	134.80	141.00	155.10	171.20	169.80	142.50	141.10	132.30	153.00
Deceleration rate (ft/sec sqd)	28.60	23.12	22.39	25.26	25.83	29.30	28.85	25.30	23.45	23.88	27.35	27.53	29.37	25.39
Phase II														
Initial speed (mph)	59.90	60.50	59.70	60.00	60.30	60.40	**	60.40	60.70	60.40	60.30	59.50	60.10	60.60
Stopping distance (ft)	137.40	165.20	172.80	149.80	149.40	139.80	**	151.00	161.10	163.30	140.90	139.40	132.20	149.80
Deceleration rate (ft/sec sqd)	28.09	23.83	22.18	25.85	26.18	28.07	**	25.99	24.60	24.03	27.76	27.32	29.39	26.37
Average Deceleration Rate (ft/sec sqd)	28.34	23.48	22.29	25.55	26.00	28.69	**	25.64	24.03	23.96	27.56	27.43	29.38	25.88
Stopping distance from 60 mph based on average deceleration rate (ft)	136.6	164.9	173.7	151.5	148.9	135.0	**	151.0	161.2	161.6	140.5	141.2	131.8	149.6

All vehicles have anti-locking brake systems.

** Due to an electronic malfunction (alternator failure), this vehicle was unable to complete the brake testing portion of the evaluation.

Table 6

Results of ergonomics and communications test

Vehicle	Score*
Chevrolet Camaro	161.17
Chevrolet Lumina	194.29
Chevrolet Tahoe	238.89
Chrysler Jeep Cherokee	189.20
Ford Crown Victoria	219.71
Ford Crown Victoria (CNG)	216.65
Ford Expedition	224.62
Ford Explorer	215.25
Subaru Legacy Outback Wagon	176.92
Subaru Legacy Sport Utility Sedan	179.26
Volvo S-70 T5 Sedan	186.32
Volvo V-70 T5 Wagon	194.09

* Scores are the total points the automobile received for each of 29 attributes the MSP considers important in determining the acceptability of the vehicle as a patrol car—for example, front seat adjustability, clarity of instrumentation, and visibility front and back. The higher the number, the better the vehicle scored.

Table 7

Fuel economy

Make/Model	City EPA miles per gallon
Chevrolet Camaro (Automatic) 5.7L (350 cid) SFI	16.8
Chevrolet Camaro (6-speed manual) 5.7L (350 cid) SFI	17.8
Chevrolet Lumina 3.8L (231 cid) SFI	18.1
Chevrolet Tahoe (2-wheel drive) 5.7L (350 cid) SFI	13.4
Chrysler Jeep Cherokee (2-wheel drive) 4.0L (242 cid) PFI	15.5
Chrysler Jeep Cherokee (4-wheel drive) 4.0L (242 cid) PFI	15.1
Ford Crown Victoria 4.6L (281 cid) SFI	16.0
Ford Crown Victoria (CNG) 4.6L (281 cid) SFI*	17.3
Ford Expedition (2-wheel drive) 5.4L (329 cid) SFI	12.9
Ford Explorer (2-wheel drive) 5.0L (302 cid) PFI	13.8
Ford Explorer (All-wheel drive) 5.0L (302 cid) PFI	13.7
Subaru Legacy Outback Wagon (All-wheel drive) 2.5L (150 cid) SFI	20.6
Subaru Legacy Sport Utility Sedan (All-wheel drive) 2.5L (150 cid) SFI	20.6
Volvo S-70 T5 Sedan 2.3L (142 cid) PFI Turbo	18.7
Volvo V-70 T5 Wagon 2.3L (142 cid) PFI Turbo	18.7

* EPA mileage estimate is in gasoline equivalent.

Pictured from left to right are the Subaru Legacy Outback Wagon, the Subaru Legacy Sport Utility Sedan, the Volvo S-70 T5 Sedan, and the Volvo V-70 T5 Wagon, which were also evaluated during this year's testing.

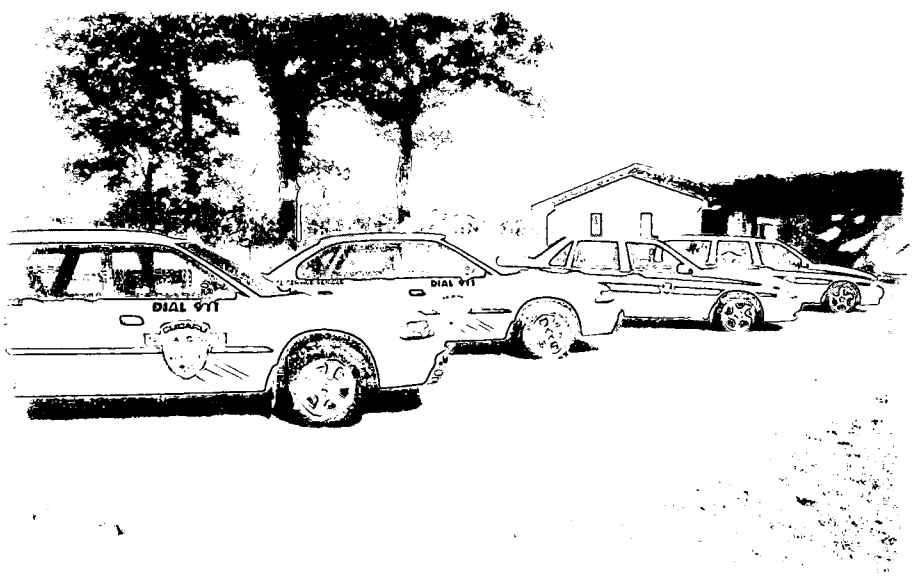

Photo courtesy of Michigan State Police.

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New Publications

The following publications are available from the National Law Enforcement and Corrections Technology Center:

Equipment Performance Report: 1997 Patrol Vehicle Tires. This report provides results of comprehensive testing of 1997 patrol vehicle tires. The report contains a large amount of data generated throughout the evaluation, which was conducted under a variety of test conditions.

Police Body Armor Consumer Product List Update: Fall 1997. This consumer product list (CPL) identifies models of armor that were tested and found to comply with the NIJ standard. CPL's are updated to include new models that have passed the test. This edition is an update to the Spring 1994 edition of the CPL; both documents are required to have a complete listing of NIJ-approved models.

1997 Evaluation of Replacement Brake Pads in Police Patrol Vehicles. This bulletin summarizes the results of the comprehensive evaluation of replacement brake pads for police patrol vehicles.

The following publications will be available soon:

Selection and Application Guide to Police Body Armor. While body armor is a household word in the law enforcement community, questions about its selection and use are frequently asked. This guide responds to commonly expressed concerns. It provides information to assist in determining the level of protection required for individual officers consistent with the threats to which they are exposed.

Equipment Performance Report: Replacement Brake Pads for Police Patrol Vehicles. This report provides complete results of the May 1997 comprehensive evaluation of replacement brake pads for police patrol vehicles. The report contains a large amount of data generated throughout the evaluation, which was conducted under a variety of test conditions.

Equipment Performance Report: 1998 Model Year Patrol Vehicle Testing. This report provides complete data on the 1998 Michigan State Police patrol vehicle testing.

To obtain any of the above publications, write NLECTC, P.O. Box 1160, Rockville, MD 20849–1160; call 800–248–2742; or download from JUSTNET at http://www.nlectc.org.

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