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New VASCAR-plus Timing Mechanism Test Results

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16. Abstract

In a previous study (Analysis of VASCAR, DOT HS 807-748, May 1991), it was found that the VASCAR-plus timing mechanism was biased against the speed limit violator. The VASCAR speed reading was higher than the actual speed. At that time, it was suggested by the Law Enforcement Community that the timing mechanism be modified so that it would be in favor of the violator (VASCAR speed less than actual speed). Since that time, the manufacturer of VASCAR-plus has changed the timing device. The study described in this report was conducted to determine the accuracy of the new timing mechanism.

To determine actual timing errors for the VASCAR-plus with the new timing method, a series of bench tests was performed similar to those described above. Both a Nicolet oscilloscope and a VASCAR-plus unit were simultaneously triggered using two trip switches. The oscilloscope sample rate was set to 1 msec. Two VASCAR-plus units were tested. A total of 50 tests was performed on each unit.

With the new timing data collection method, when the time switch is turned off the VASCAR computer collects data for 2 more 36 msec time steps. The timing errors for this method should range from 36 to 72 msec. Since these timing errors are positive, they would be biased in favor of the violator.

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VASCAR, time-distance speed measurement, timing mechanism, speed measuring device	Document is available to the U.S. public through the National Technical Information Service, Springfield, VA.

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BACKGROUND

In a previous study [1], it was found that the VASCAR-plus timing mechanism was biased against the violator (VASCAR speed greater than actual speed). At that time it was suggested that the timing mechanism be modified so it would be biased in favor of the violator (VASCAR speed less than actual speed). Since this time, the manufacturer of VASCAR-plus has changed the timing device. This study was conducted to determine the accuracy of the new timing mechanism.

VASCAR-plus, manufactured by Traffic Safety Systems, is a time-distance speed measurement device that is used by many state and local police agencies to enforce traffic laws. The VASCAR-plus computer calculates an average speed using the basic formula

$$\text{Speed} = \text{Distance/Time}.$$

According to the manufacturer, VASCAR-plus collects data every 36 milliseconds (i.e., has a 36-millisecond resolution). Consequently, the VASCAR-plus stored time is in milliseconds (1/1000 of a second). VASCAR-plus displays the stored time to 1/100 of a second. To properly assess the accuracy of the VASCAR timing mechanism, the stored time to 1/1000 of a second must be determined.

To determine the stored time to 1/1000 of a second, the manufacturer says to first divide the displayed time by .036 (or 36 milliseconds). This number is then rounded to the next highest integer. This integer value is then multiplied by .036. The resulting value is the stored time. As an example:

VASCAR Displayed Time = 4.60

To get the number of 36 msec time increments, divide the displayed time by .036 and then round to the next highest integer.

$$4.60/.036 = 127.77$$

Number of .036 msec time increments = 128

To get the VASCAR stored time, multiply this number by .036.

VASCAR stored time = 128 x .036 = 4.608

The validity of the manufacturer's method for calculating the stored time was determined in Reference 1.

The accuracy of the VASCAR-plus timing devices was also previously determined [1]. In the study detailed in Reference 1, a total of 58 bench tests was conducted.j Two VASCAR-plus units and a Nicolet oscilloscope were simultaneously triggered using two trip switches. The oscilloscope sample rate was set to 1 msec.

Time error was used to judge the accuracy of the VASCAR-plus device.

Time Error = VASCAR time - True Time (oscilloscope time)

The results showed that the VASCAR-plus timing device always had a negative timing error. The errors ranged from 0 to -41 msec. Since speed is inversely proportional to time, the negative timing errors caused the VASCAR-plus unit to be biased against the violator (VASCAR speed greater than actual speed). The manufacturer of VASCAR-plus has since changed the way it collects time so now it is biased in favor of the violator.

As stated previously, the VASCAR-plus collects data every 36 msec. When the operator turns on the time switch, the VASCAR computer starts collecting data. Formerly, when the operator turned the time switch off, the VASCAR computer went back to the 36 msec time step just prior to turning the switch off. Theoretically, the VASCAR timing errors for this timing method should range from 0 to -36 msec (the measured timing errors were 0-41 msec). For the new timing data collection method, when the time switch is turned off the VASCAR computer collects data for 2 more 36 msec time steps. Theoretically, the timing errors for this method should range from 36 to 72 msec. Since these timing errors are positive, they would be biased in favor of the violator.

TEST PROCEDURES

To determine actual timing errors for the VASCAR-plus with the new timing method, a series of bench tests was performed similar to those described above. Both a Nicolet oscilloscope and a VASCAR-plus unit were simultaneously triggered using two trip switches. The oscilloscope sample rate was set to 1 msec. Two VASCAR-plus units were tested. A total of 50 tests was performed on each unit.

TEST RESULTS

The range, mean, and standard deviation timing errors for each unit and both units combined are listed in Table 1. The timing error ranges are similar to the one predicated by the manufacturer. Though the range of errors for each unit is slightly difference, the mean and standard deviation are very similar. If more tests were performed, the range of timing error values for each unit may agree more closely with each other than they already do. The mean and standard deviation for both units combined are very similar to those for the individual units.

TABLE 1: Range, Mean, and Standard Deviation Values for VASCAR Timing Errors

VASCAR unit	Timing Errors (msec)		
	Range	Mean	Standard Deviation
A - 5457	27 - 67	49.2	10.1
B - 5566	33 - 72	49.5	10.3
Both A and B	27 - 72	49.4	10.1

Ninety-ninth percentile tolerance limits for each unit and both units combined are listed in Table 2. These tolerance limits are based on a 0.95 confidence interval ($K=3.126$ for $n=50$ and $K=2.934$ for $n=100$). The gap between the upper and lower tolerance limits would probably decrease if more tests were conducted.

TABLE 2: 99th Percentile Tolerance Limits for VASCAR Timing Errors

VASCAR unit	99th Percentile Tolerance Limits	
	Upper	Lower
A - 5457	80.7	17.6
B - 5566	81.7	17.3
Both A and B	79.0	19.8

DISCUSSION

The tolerance limits listed in Table 2 are always positive. This suggests that the new timing method employed by VASCAR-plus will always be biased in favor of the violator. Potential VASCAR speed errors are plotted in Figure 1. These potential speed errors are based on the upper 99th percentile tolerance limit for both units combined. These speed errors are based only on potential errors with the timing device. They do not include potential distance measurement error or human error. In Figure 1, the speed errors are negative because VASCAR-plus will underestimate speed.

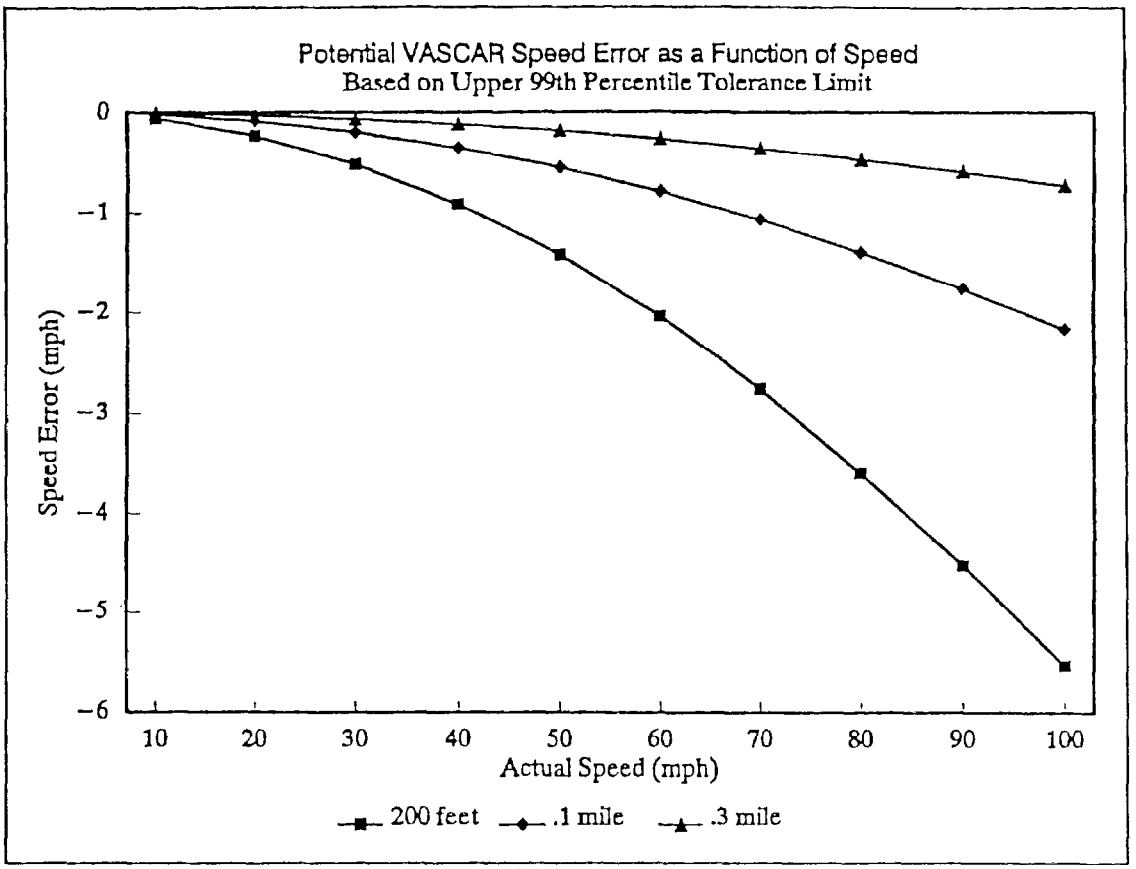

Figure 1

REFERENCES

1. "Analysis of VASCAR", Howe, J. G., NHTSA Final Report No. DOT HS 807 748, May 1991.

APPENDIX

VASCAR-plus Timing Errors - Serial # 5457

OSCILLOSCOPE TIME (SEC)	VASCAR DISPLAYED TIME (SEC)	VASCAR CALCULATED TIME (SEC)	VASCAR CALC.- OSCILLOSCOPE TIME (SEC)
1.917	1.98	1.980	0.063
1.567	1.62	1.620	0.053
1.003	1.04	1.044	0.041
1.297	1.33	1.332	0.035
1.741	1.80	1.800	0.059
2.605	2.66	2.664	0.059
3.105	3.13	3.132	0.027
3.050	3.09	3.096	0.046
2.718	2.77	2.772	0.054
3.328	3.38	3.384	0.056
3.800	3.85	3.852	0.052
3.657	3.70	3.708	0.051
1.763	1.80	1.800	0.037
1.705	1.76	1.764	0.059
2.879	2.91	2.916	0.037
3.233	3.27	3.276	0.043
2.275	2.34	2.340	0.065
3.339	3.38	3.384	0.045
1.076	1.11	1.116	0.040
2.794	2.84	2.844	0.050
3.196	3.24	3.240	0.044
2.753	2.80	2.808	0.055
2.103	2.16	2.160	0.057
2.288	2.34	2.340	0.052
1.697	1.76	1.764	0.067

VASCAR-plus Timing Errors - Serial #5457 (continued)

OSCILLOSCOPE TIME (SEC)	VASCAR DISPLAYED TIME (SEC)	VASCAR CALCULATED TIME (SEC)	VASCAR CALC.- OSCILLOSCOPE TIME (SEC)
1.951	2.01	2.016	0.065
1.789	1.83	1.836	0.047
0.437	0.50	0.504	0.067
3.512	3.56	3.564	0.052
2.619	2.66	2.664	0.045
0.952	1.00	1.008	0.056
1.961	2.01	2.016	0.055
0.884	0.93	0.936	0.052
0.756	0.79	0.792	0.036
1.561	1.62	1.620	0.059
3.765	3.81	3.816	0.051
2.127	2.16	2.160	0.033
2.291	2.34	2.340	0.049
1.175	1.22	1.224	0.049
0.770	0.82	0.828	0.058
1.632	1.69	1.692	0.060
0.863	0.90	0.900	0.037
3.312	3.34	3.348	0.036
3.707	3.74	3.744	0.037
3.701	3.74	3.744	0.043
0.680	0.72	0.720	0.040
1.654	1.69	1.692	0.038
2.415	2.44	2.448	0.033
3.002	3.06	3.060	0.058
0.772	0.82	0.828	0.056

VASCAR-plus Timing Errors - Serial # 5566

OSCILLOSCOPE TIME (SEC)	VASCAR DISPLAYED TIME (SEC)	VASCAR CALCULATED TIME (SEC)	VASCAR CALC.- OSCILLOSCOPE TIME (SEC)
1.570	1.62	1.620	0.050
2.019	2.05	2.052	0.033
2.826	2.88	2.880	0.054
1.316	1.36	1.368	0.052
3.861	3.92	3.924	0.063
0.883	0.93	0.936	0.053
0.541	0.61	0.612	0.071
2.032	2.08	2.088	0.056
0.781	0.82	0.828	0.047
2.374	2.41	2.412	0.038
0.420	0.46	0.468	0.048
2.152	2.19	2.196	0.044
2.693	2.73	2.736	0.043
1.647	1.69	1.692	0.045
3.639	3.67	3.672	0.033
0.799	0.86	0.864	0.065
0.318	0.36	0.360	0.042
3.975	4.03	4.032	0.057
1.431	1.47	1.476	0.045
0.744	0.79	0.792	0.048
1.972	2.01	2.016	0.044
2.297	2.34	2.340	0.043
3.091	3.13	3.132	0.041
0.516	0.57	0.576	0.060
3.301	3.34	3.348	0.047

VASCAR-plus Timing Errors - Serial #5566 (continued)

OSCILLOSCOPE TIME (SEC)	VASCAR DISPLAYED TIME (SEC)	VASCAR CALCULATED TIME (SEC)	VASCAR CALC.- OSCILLOSCOPE TIME (SEC)
1.142	1.18	1.188	0.046
1.707	1.76	1.764	0.057
2.735	2.77	2.772	0.037
1.652	1.69	1.692	0.040
2.970	3.02	3.024	0.054
2.411	2.44	2.448	0.037
1.292	1.33	1.332	0.040
1.093	1.15	1.152	0.059
2.086	2.12	2.124	0.038
0.504	0.57	0.576	0.072
3.836	3.88	3.888	0.052
1.562	1.62	1.620	0.058
2.736	2.77	2.772	0.036
0.768	0.82	0.828	0.060
1.942	1.98	1.980	0.038
1.430	1.47	1.476	0.046
2.418	2.48	2.484	0.066
2.159	2.19	2.196	0.037
3.067	3.13	3.132	0.065
0.859	0.90	0.900	0.041
2.104	2.16	2.160	0.056
2.965	3.02	3.024	0.059
0.775	0.82	0.828	0.053
2.658	2.70	2.700	0.042
1.195	1.26	1.260	0.065