Crash Data Retrieval System Validation Testing

Wisconsin State Patrol Academy
November 2, 2001

2001 Crash Reconstruction In-Service
Test Results Compiled By Trooper Tim Austin

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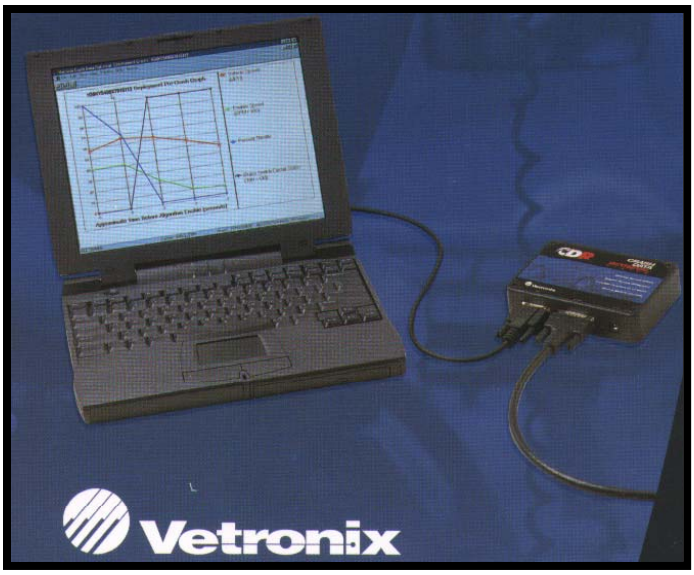
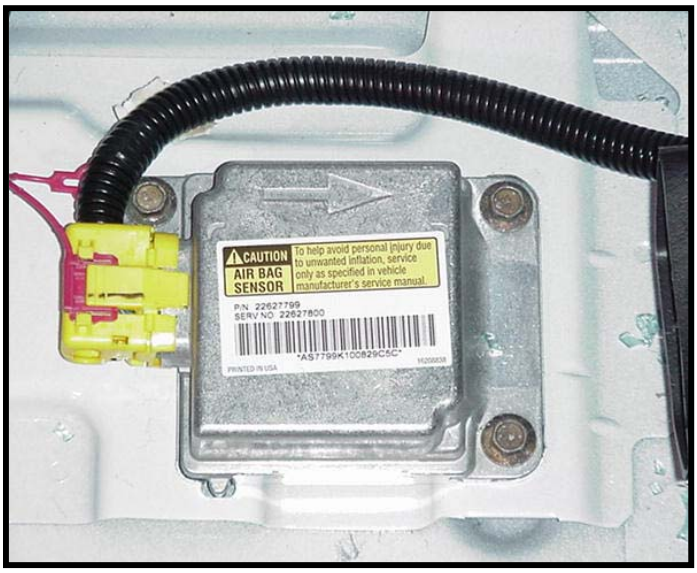
INTRODUCTION

As of this writing, the Wisconsin State Patrol has had success in retrieving collision information from passenger cars and trucks. Using hardware and software manufactured by the Vetronix® corporation, data recorded by vehicle Airbag Sensing and Diagnostic Modules (SDM's) can be recovered and viewed in table and graph form. Currently, the Division only has the ability to retrieve data from late model General Motors vehicles. However, it is anticipated that some vehicles manufactured by the Ford Motor Company will be accessible by early 2002.



To explain what exactly this system is, the following summary is offered. In 1997, the National Transportation Safety Board (NTSB) made a recommendation to vehicle manufacturers that crash data be recorded using on-board sensing devices. In response, General Motors expanded the information stored by their Airbag Sensing and Diagnostic Modules (SDM's). For the purposes of explanation, this is the electronic instrument that "senses" a crash and makes the "decision" as to whether or not the airbags should be deployed. When the vehicle is running, vehicle speed, engine speed, percent throttle, and brake position data is transmitted to the SDM once every second by either the Powertrain Control Module (PCM) or the Antilock Brake System (ABS) module. If the vehicle is involved in a collision and the SDM "decides" to deploy the airbags, it will also take a "snapshot" of the last five data transmissions it received from the PCM and/or the ABS module. The same is true when a near-deployment incident occurs, that is, when the negative longitudinal deceleration is such that the sensor recognizes the event, but does not trigger an airbag deployment. Using hardware and software manufactured by the Vetronix® Corporation, this data can be retrieved and analyzed.



On November 2, 2001, Division crash reconstructionists organized and participated in a training study of the Vetronix® Crash Data Retrieval (CDR) system and an examination of deceleration properties on various surfaces. It should be noted here that the intention of this compilation is not to discuss the technical aspects of the CDR system, but rather to simply report test results and offer an interpretation of the data retrieved. It is also stated that the primary purpose of the testing was to provide exposure, training, and experience to Wisconsin State Patrol reconstruction personnel in regards to the SDM data collection process. It was not intended to serve as a *scientific* validation study of SDM or CDR technologies for external publication.

TEST VEHICLES

- ***2000 Chevrolet Blazer***

The first test vehicle utilized is identified as a 2000 Chevrolet Blazer four-door sport utility vehicle. It is red in color, and was manufactured with the engine specifications listed in the below table. This vehicle is privately owned by Trooper Jamie Zynda, who volunteered its use. Trooper Zynda also served as the vehicle driver for the testing.

Vehicle Year	Make	Model	Type:	Color:	Vehicle Identification Number (VIN):
2000	Chevrolet	Blazer	SUV	Red	1GNDT13W3Y2356464

Approx Mileage:	Engine Size:	Tire Make:	Tire Model:	Tire Size:	Tire Tread:
39,000	4.3 Liter, 6-Cylinder	Uniroyal	Laredo	P235-70R15	7/32”

- ***2000 Chevrolet Red Impala***

The second vehicle used in the testing procedures is identified as a 2000 Chevrolet Impala sedan passenger car. The first of two such vehicles, this unit is red in color and utilized by the Wisconsin State Patrol as a police cruiser. The Impala is assigned to Trooper Ted Staffen, who operated the vehicle during its test runs.

Vehicle Year	Make	Model	Type:	Color	Vehicle Identification Number (VIN):
2000	Chevrolet	Impala	Sedan	Red	2G1WF55K3Y9256515

Approx Mileage:	Engine Size:	Tire Make:	Tire Model:	Tire Size:	Tire Tread:
63,300	3.8 Liter, 6-Cylinder	Good Year	Eagle	P225-60R16	4/32”

- ***2000 Chevrolet Black Impala***

The third test vehicle is also identified as a Chevrolet Impala sedan. Again, this vehicle has been equipped as a police vehicle for the Wisconsin State Patrol. It is black in color, and presently assigned to the Division's Headquarters in Madison. During the various tests, it was operated by Lieutenant Dan Lonsdorf.

Vehicle Year	Make	Model	Type:	Color:	Vehicle Identification Number (VIN):
2000	Chevrolet	Impala	Sedan	Black	2G1WF55K1Y9256027

Approx Mileage:	Engine Size:	Tire Make:	Tire Model:	Tire Size:	Tire Tread:
27,000	3.8 Liter, 6-Cylinder	Good Year	Eagle	P225-60R16	5/32"

Note: In all tests, vehicle operators and passengers were utilizing safety restraints (seat belts).

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VALIDATION TESTING INSTRUMENTS

The following instruments were utilized during the testing process to record data concerning the vehicle decelerations. All units are owned by the Wisconsin State Patrol, and used by investigators on a regular basis.

- ***Vericom® VC2000 Braking Test Computers***

According to literature included at the time of purchase, the VC2000 Braking Test Computer utilizes an internal accelerometer to measure motion (acceleration and deceleration) in terms of speed change rate. The G-force sustained by the instrument is sampled 100 times each second to calculate the average G. This computation, in combination with an internal crystal clock, is then used by the instrument to calculate speed. Following a test run, the unit will offer its computations of speed, distance, and time, and list deceleration values for every one tenth of a second. This deceleration data is then further broken down into average and peak values.

Serial Number, VC2000 Braking Test Computer One: 92250903

Serial Number, VC2000 Braking Test Computer Two: 98114343

- ***Kustom KR-10 SP Radar***

A Kustom KR-10 SP standard police radar device was used to independently measure oncoming vehicle speeds. It was utilized in stationary mode by a trained radar operator, and checked for proper operation both before and after the testing. This particular radar only displays whole numbers, thus essentially rounding the speeds down to the nearest mile per hour.

Unit Serial Number:	Antenna Serial Number:
EE11157	CC11871
65 Tuning Fork Number:	35 Tuning Fork Number:
26996	28669

TEST METHODOLOGY

- ***CDR Validation Testing***

To create near-deployment files in the test vehicles, they were accelerated to a high rate of speed, at which point a hard brake application was initiated. As the vehicle was nearing the hard-brake application point, a radar operator observed the vehicles' approach speeds. A passenger in the test vehicles operated the Vericom VC2000 Braking Test Computer, and recorded the speed, stopping distance, and average deceleration factor calculated by the instrument. The VC2000 was mounted on the windshield glass in accordance with the device's operations manual (see figure 1).


Figure 1

Once the individual vehicle had stopped, the Airbag Sensing and Diagnostic Module was accessed remotely via the Data Link Connection (DLC) port located under the dashboard (figure 2). Using the Vetronix® hardware and software, near-deployment data was recorded (figure 3). This recovered pre-crash data was then compared to the radar operator's observations and the VC2000 calculations. All data obtained is listed under the next *CDR TEST* topic heading series.


Figure 2

- ***Deceleration Factor Testing***

To determine the deceleration properties of the gravel and grass surfaces, vehicles were first accelerated to a moderate speed range on the questioned terrain. This was then immediately followed by a hard brake application. Again, as the vehicles approached, a radar operator noted their speeds. Likewise, a passenger in the test vehicle operated the Vericom® VC2000 and recorded stop time, stop distance, and the average deceleration factor calculated by the computer. The Vericom® speed data was then compared to the radar operator's observations. Data results are listed further in this compilation.

Note: All test vehicles were used with the Antilock Brake System(s) operational.

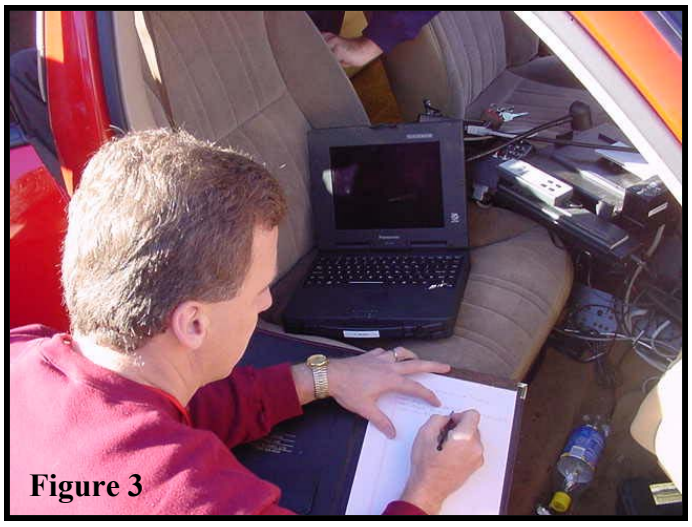


Figure 3

CDR TEST NUMBER ONE

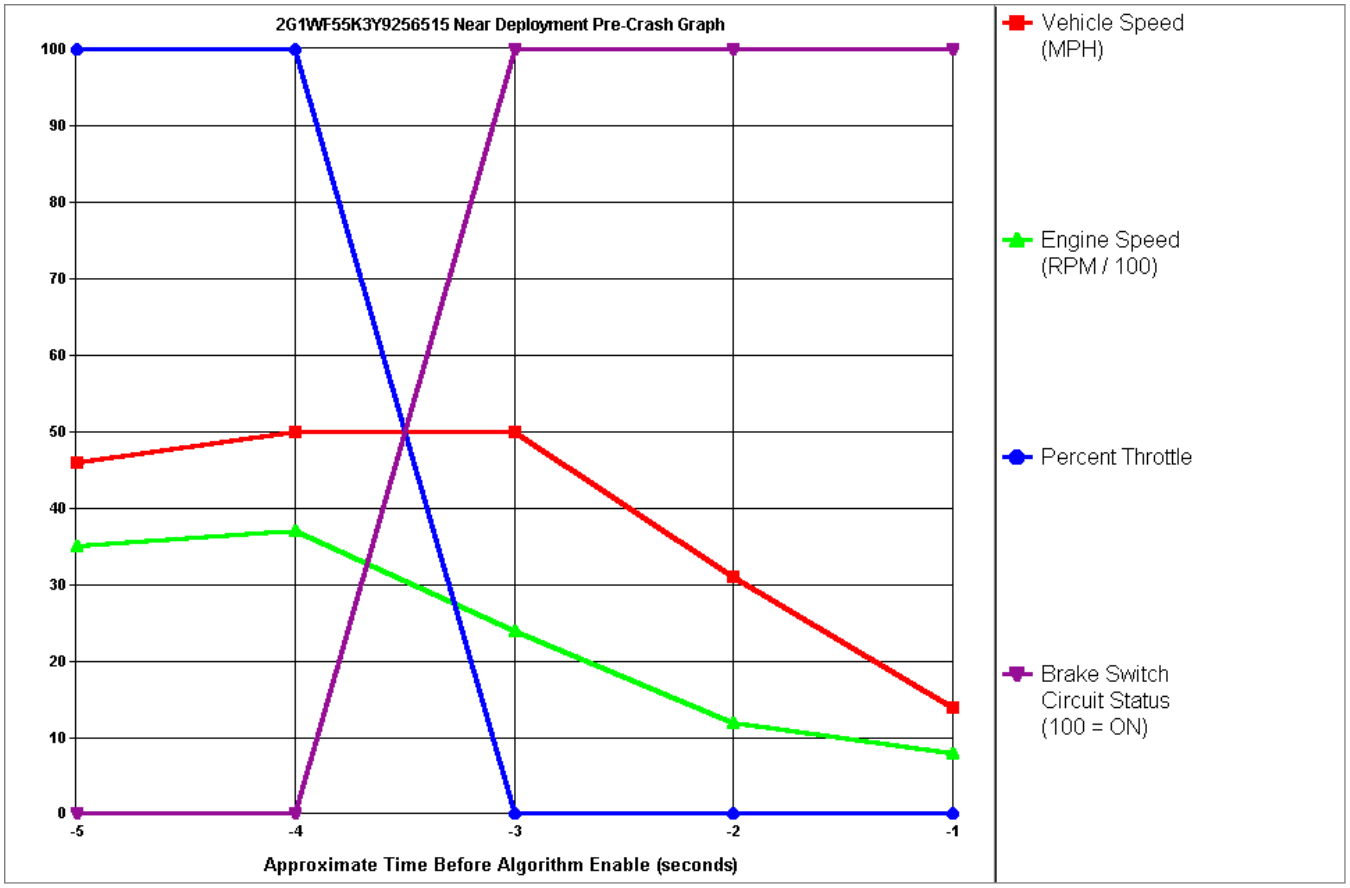
Test Vehicle: Chevrolet Impala (Red) VIN 2G1WF55K3Y9256515

- ***CDR Data***

2G1WF55K3Y9256515 System Status At Near Deployment	
SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Passenger Front Air Bag Suppression Switch Circuit Status	Air Bag Not Suppressed
Ignition Cycles At Near Deployment	1163

PRE-CRASH DATA — Electronic Data Validity Check Status = VALID

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	46	3520	100	OFF
-4	50	3712	100	OFF
-3	50	2368	0	ON
-2	31	1152	0	ON
-1	14	768	0	ON



- ***Radar/VC2000 Data***

Radar:	VC2000 Indicated Distance:	VC2000 Indicated Time:	VC2000 Indicated Speed:	VC2000 Indicated Average G:
N/R	**102 feet**	**2.79 sec**	**50.2 mph**	**.820**

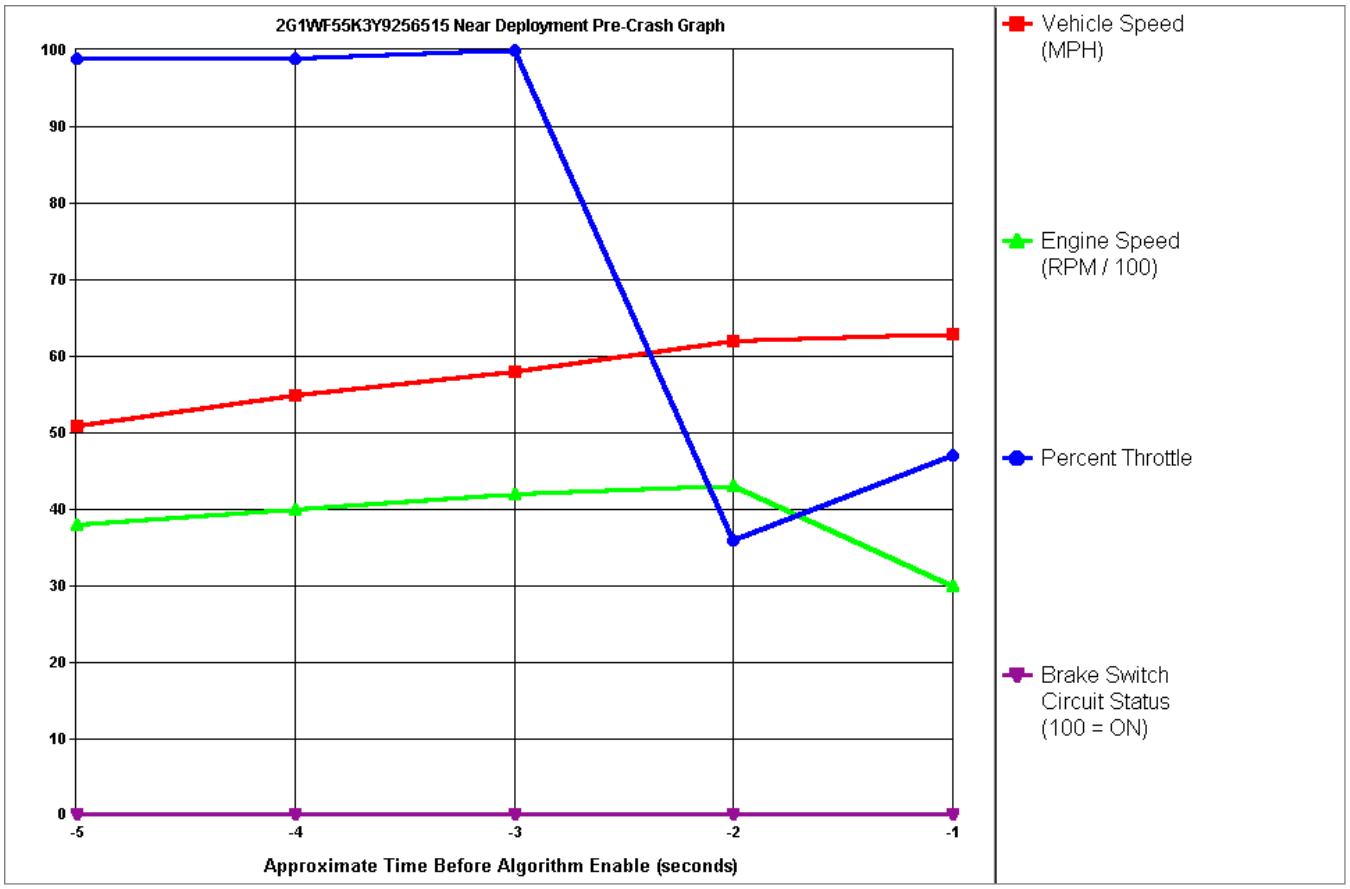
CDR TEST NUMBER TWO

Test Vehicle: Chevrolet Impala (Red) VIN 2G1WF55K3Y9256515

- ***CDR Data***

2G1WF55K3Y9256515 System Status At Near Deployment	
SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Passenger Front Air Bag Suppression Switch Circuit Status	Air Bag Not Suppressed
Ignition Cycles At Near Deployment	1167

PRE-CRASH DATA				Electronic Data Validity Check Status = VALID
Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	51	3776	99	OFF
-4	55	3968	99	OFF
-3	58	4224	100	OFF
-2	62	4288	36	OFF
-1	63	3008	47	OFF



- ***Radar/VC2000 Data***

Radar:	VC2000 Indicated Distance:	VC2000 Indicated Time:	VC2000 Indicated Speed:	VC2000 Indicated Average G:
N/R	**180 feet**	**3.84 sec**	**61 mph**	**.723**

CDR TEST NUMBER THREE

Test Vehicle: 2000 Chevrolet Blazer (Red) VIN 1GNDT13W3Y2356464

- ***CDR Data***

The SDM download was not successful. Instead, data from a previous near-deployment incident was recovered.

- ***Radar/VC2000 Data***

Radar:	VC2000 Indicated Distance:	VC2000 Indicated Time:	VC2000 Indicated Speed:	VC2000 Indicated Average G:
N/R	**138 feet**	**3.40 sec**	**55.5 mph**	**.743**

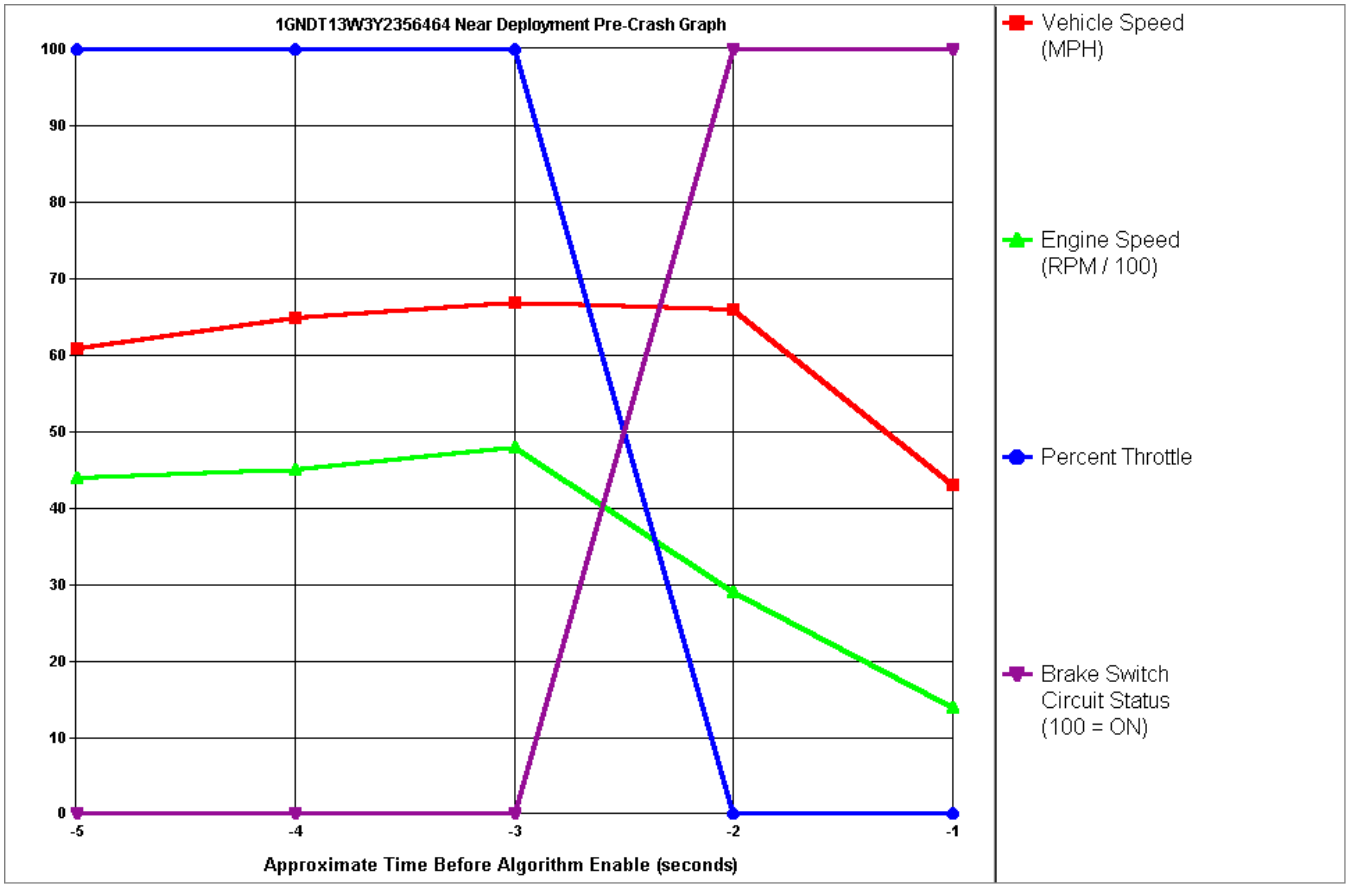
CDR TEST NUMBER FOUR

Test Vehicle: 2000 Chevrolet Blazer (Red) VIN 1GNDT13W3Y2356464

- ***CDR Data***

1GNDT13W3Y2356464 System Status At Near Deployment	
SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Passenger Front Air Bag Suppression Switch Circuit Status	Air Bag Not Suppressed
Ignition Cycles At Near Deployment	3761

PRE-CRASH DATA				Electronic Data Validity Check Status = VALID
Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	61	4352	100	OFF
-4	65	4544	100	OFF
-3	67	4800	100	OFF
-2	66	2880	0	ON
-1	43	1408	0	ON



- ***Radar/VC2000 Data***

Radar:	VC2000 Indicated Distance:	VC2000 Indicated Time:	VC2000 Indicated Speed:	VC2000 Indicated Average G:
N/R	**193 feet**	**3.83 sec**	**70.2 mph**	**.836**

CDR TEST NUMBER FIVE

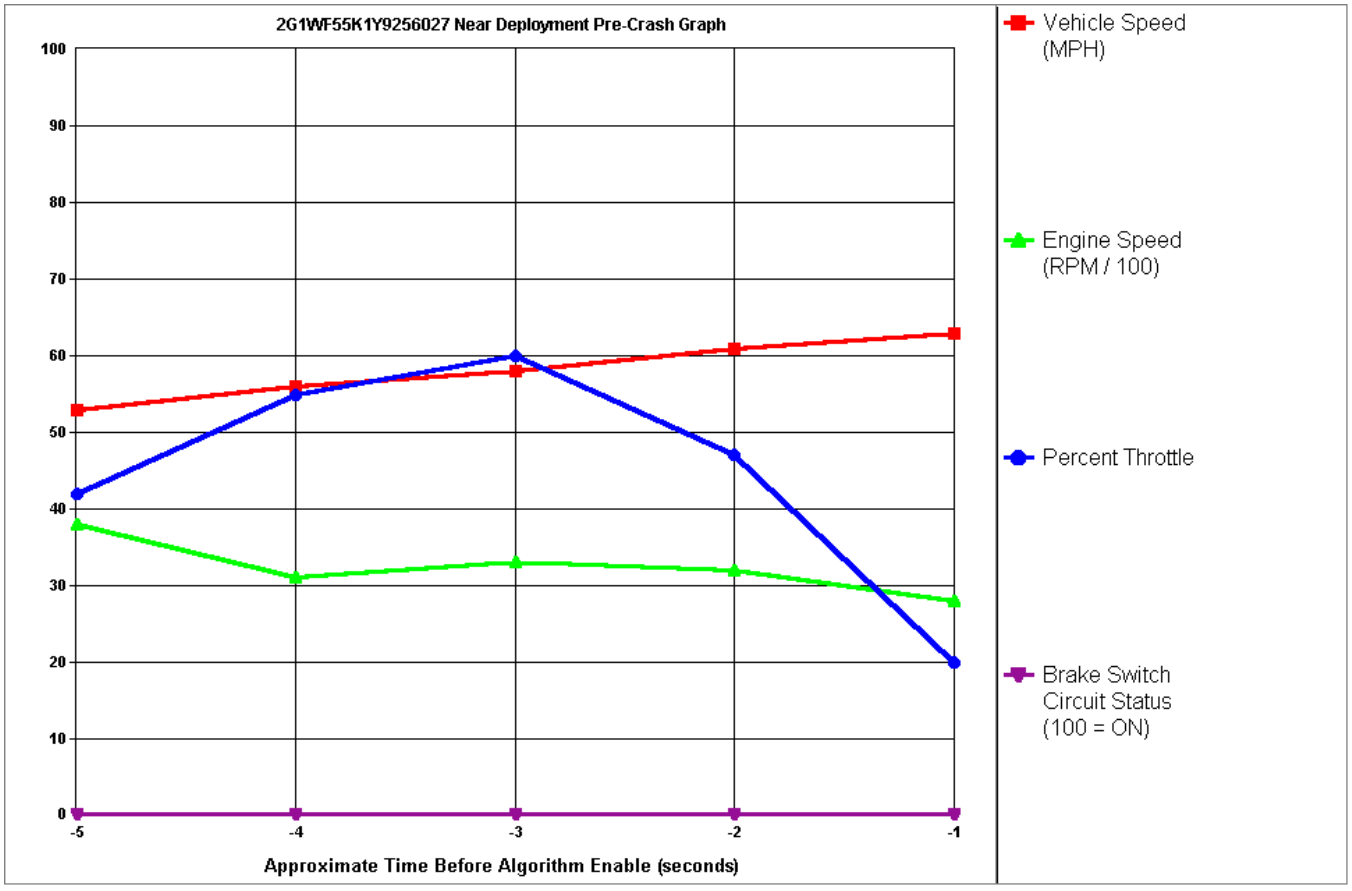
Test Vehicle: Chevrolet Impala (Black) VIN 2G1WF55K1Y9256027

- ***CDR Data***

2G1WF55K1Y9256027 System Status At Near Deployment	
SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Passenger Front Air Bag Suppression Switch Circuit Status	Air Bag Not Suppressed
Ignition Cycles At Near Deployment	1569

PRE-CRASH DATA — Electronic Data Validity Check Status = VALID

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	53	3840	42	OFF
-4	56	3072	55	OFF
-3	58	3264	60	OFF
-2	61	3200	47	OFF
-1	63	2752	20	OFF



- ***Radar/VC2000 Data***

Radar:	VC2000 Indicated Distance:	VC2000 Indicated Time:	VC2000 Indicated Speed:	VC2000 Indicated Average G:
63	**185 feet**	**3.93 sec**	**63.6 mph**	**.738**

CDR TEST NUMBER SIX

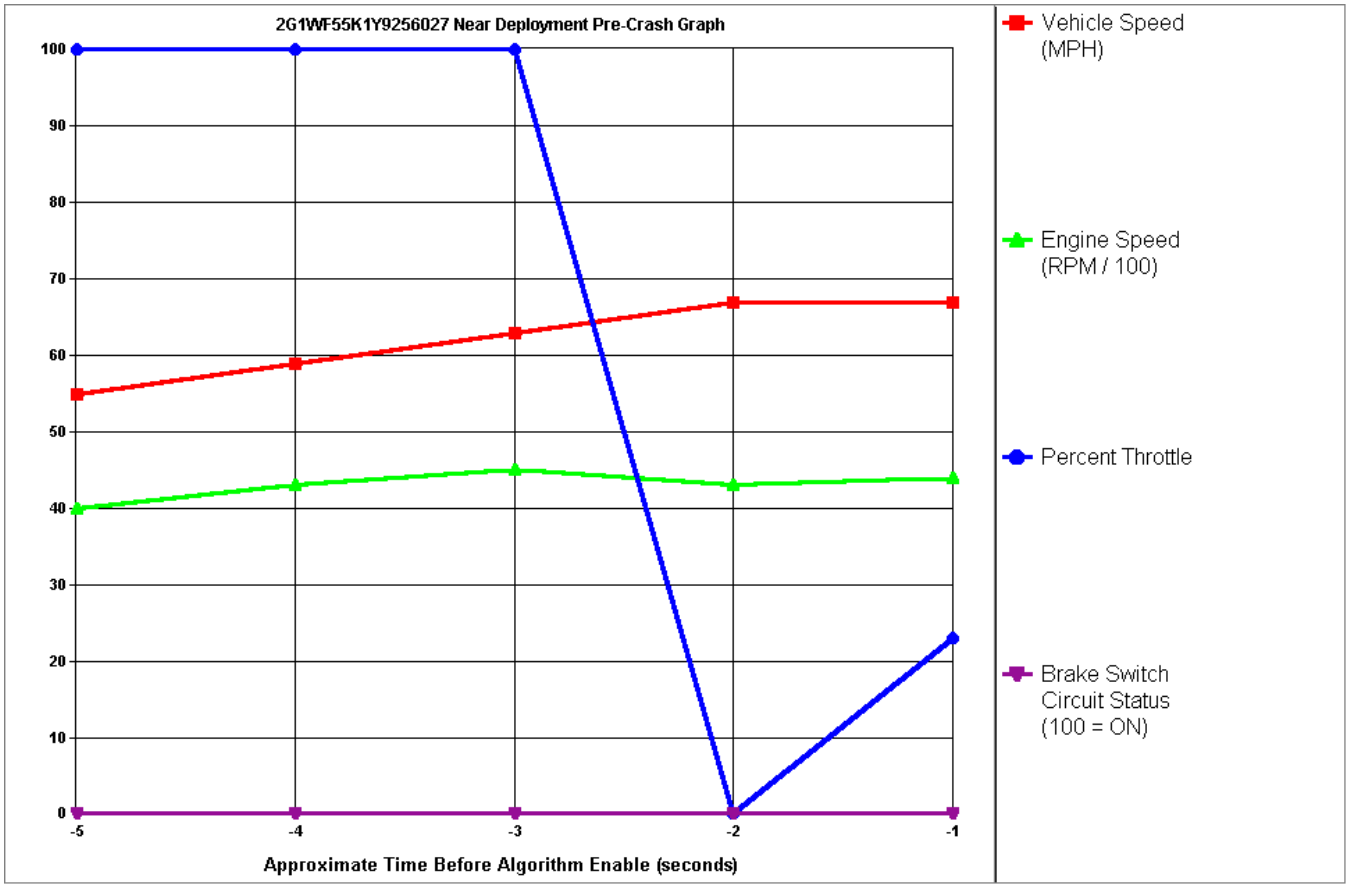
Test Vehicle: Chevrolet Impala (Black) VIN 2G1WF55K1Y9256027

- ***CDR Data***

2G1WF55K1Y9256027 System Status At Near Deployment	
SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Passenger Front Air Bag Suppression Switch Circuit Status	Air Bag Not Suppressed
Ignition Cycles At Near Deployment	1571

PRE-CRASH DATA — Electronic Data Validity Check Status = VALID

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	55	4032	100	OFF
-4	59	4288	100	OFF
-3	63	4480	100	OFF
-2	67	4288	0	OFF
-1	67	4416	23	OFF



- ***Radar/VC2000 Data***

Radar:	VC2000 Indicated Distance:	VC2000 Indicated Time:	VC2000 Indicated Speed:	VC2000 Indicated Average G:
67	*	*	*	*

CDR TEST NUMBER SEVEN

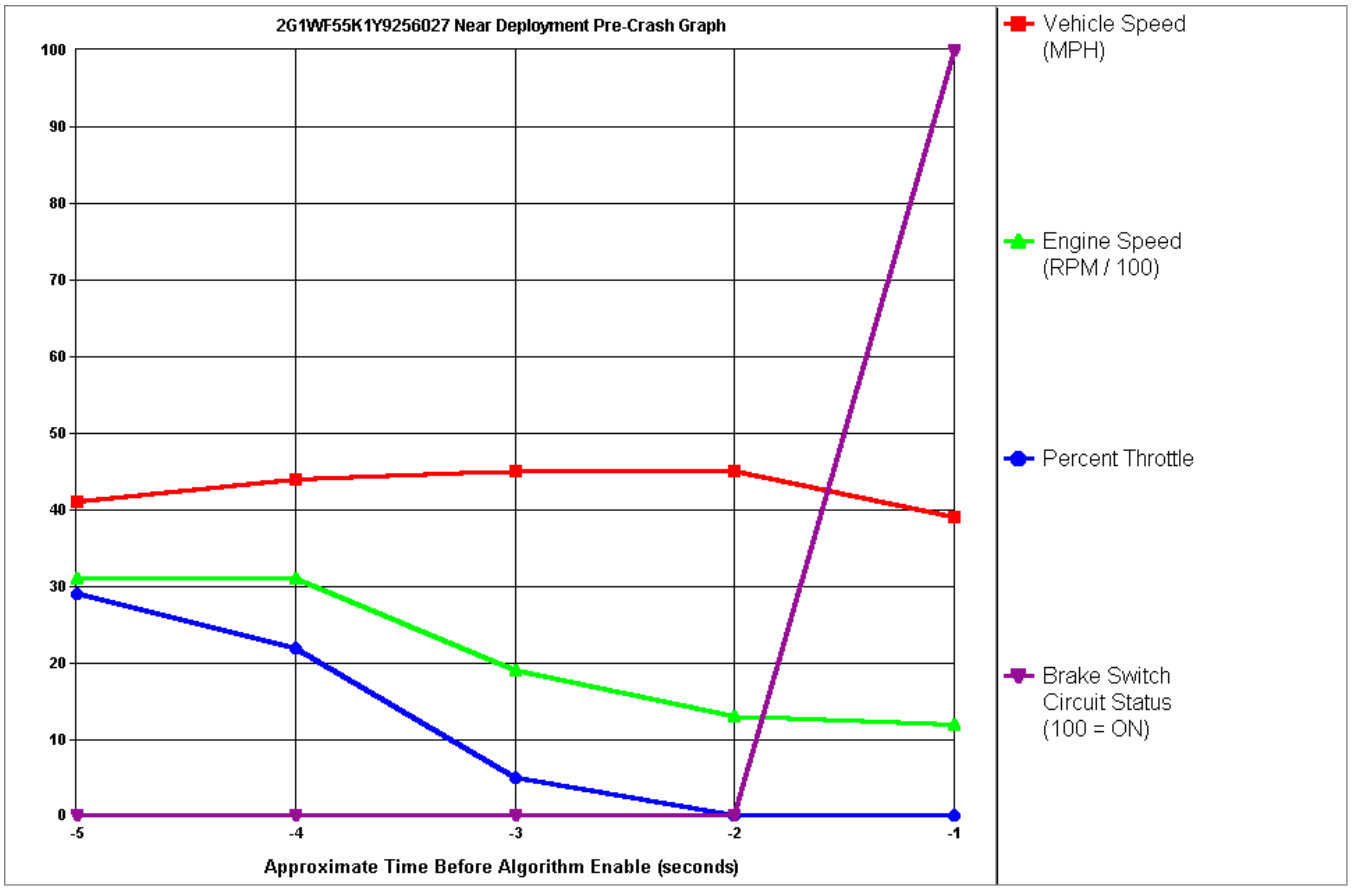
Test Vehicle: Chevrolet Impala (Black) VIN 2G1WF55K1Y9256027

- ***CDR Data***

2G1WF55K1Y9256027 System Status At Near Deployment	
SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Passenger Front Air Bag Suppression Switch Circuit Status	Air Bag Not Suppressed
Ignition Cycles At Near Deployment	1574

PRE-CRASH DATA — Electronic Data Validity Check Status = VALID

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	41	3072	29	OFF
-4	44	3136	22	OFF
-3	45	1856	5	OFF
-2	45	1280	0	OFF
-1	39	1152	0	ON



- ***Radar/VC2000 Data***

Radar:	VC2000 Indicated Distance:	VC2000 Indicated Time:	VC2000 Indicated Speed:	VC2000 Indicated Average G:
45	**N/R**	**4.24 sec**	**46.5 mph**	**.500**

CDR VALIDATION TEST RESULTS SUMMARY

- ***Table of Results***

The following table summarizes the test results and allows for simplified comparison. The SDM and radar speeds listed are the *highest* speeds observed.

Test Number	Vehicle Tested	SDM Speed	Radar Speed	VC2000 Speed
1	Red Impala	50	N/A	50.2
2	Red Impala	63	N/A	61
3	Red Blazer	N/A	N/A	55.5
4	Red Blazer	67	N/A	70.2
5	Black Impala	63	63	63.6
6	Black Impala	67	67	N/A
7	Black Impala	45	45	46.5

- ***Discussion***

CDR ACCURACY

In comparing the seven tests for the purposes of CDR validation, an increased weight is placed on the final three runs. These tests, numbers 5, 6, and 7, incorporated the use of the standard police radar to note the highest vehicle speed obtained. Time and preparation limitations prevented the device from being utilized on the first four runs. In each of the latter cases, the highest speed observed by the radar operator matched that which was recorded by the SDM. These comparisons do indeed suggest a validation of the SDM data recordings. Chidester, et al.[1] suggests SDM vehicle speed reporting to be accurate to within +/- 4%. However, the three runs utilizing the black 2000 Chevrolet Impala and Kustom radar seem to indicate an even greater accuracy, at least in these limited tests.

While a greater emphasis is placed on those runs incorporating the police radar unit, the previous four tests should not be overlooked. With the exception of test three (which will be addressed in the following sub-heading), the SDM speed data was within three whole miles per hour of the VC2000 data. While this may at first appear as a discrepancy, it should be reminded that the VC2000 and SDM record or calculate speed via two very different techniques. The Vericom instrument, which was set to activate at .2 g's, calculates vehicle speed after obtaining accelerometer data and combining this information with its internal crystal clock. The SDM, however, obtains data directly from the transmission output shaft via magnetic pickup. For all test vehicles, the wheels/tires did match manufacturer's specifications, thereby increasing the likelihood of accurate vehicle speed recording. The rather small difference in speed readings between the two techniques, however, does indeed serve to validate the SDM data.

Other data provided by the SDM, in addition to speed information, was found to be accurate. The Driver's Belt Switch Circuit Status indicator, for example, correctly reported the driver's seatbelt use in all seven of the test runs. The ignition cycles were also monitored by test participants, to both ensure an

[1] Chidester, Augustus, et al. Recording Automotive Crash Event Data. National Highway Traffic Safety Administration.

accurate counting by the SDM's, and to verify that the data recovered was indeed from the staged test. In each case, the proper numerical sequence was observed.

TEST THREE – FAILURE TO OBTAIN NEAR-DEPLOYMENT FILE

In test number three, that being the first involving the 2000 Chevrolet Blazer, a near-deployment file was recovered from the SDM. However, an examination of the retrieved data suggested that it had been generated by a prior incident. Although the controlled test parameters may indeed have triggered a near-deployment event, it is possible that it was less severe than the file previously recorded by the module. Therefore, the "snapshot" of pre-crash data did not overwrite that which was previously saved. According to information provided by the Vetronix® Corporation[2], near-deployment data recorded by the module can generally only be overwritten by either a more severe occurrence, or with the passage of time in terms of 250 ignition cycles. This time is estimated by Chidester[3] to be the equivalent of 60 normal driving days.

A second possibility for this failure to obtain a near-deployment file from test number three is that the algorithm may simply not have been enabled. Haight[4] offers that in order for a near-deployment event to occur, the SDM must detect that the negative forward acceleration exceeds –1 to –2 g's. Chidester further explains these requirements, stating that the SDM's internal longitudinal accelerometer is sampled every 312 microseconds (.000312 seconds). If the SDM detects that two consecutive samples exceed approximately -2 g's, then algorithm enable occurs. For the sport utility vehicle (SUV) tested, it is probable that the higher end of this range is required for activation. Put simply, the more rugged design intentions of the Chevrolet Blazer would likely mandate a higher threshold for algorithm enable.

[2] Vetronix Corporation. CDR Crash Data Retrieval System.
[3] Chidester, Augustus, et al. Recording Automotive Crash Event Data. National Highway Traffic Safety Administration.
[4] Haight, W.R. Automobile Event Data Recorder Technology. Collision Safety Institute

GRAVEL SURFACE DECELERATION TESTING

- ***Surface Description***

The test surface can best be described as a well-traveled (packed) gravel roadway.

- ***Test One***

Vehicle Year	Make	Model	Type:	Color:	Vehicle Identification Number (VIN):
2000	Chevrolet	Blazer	SUV	Red	1GNDT13W3Y2356464
Radar Indicated Speed:	VC2000 Indicated Time:			VC2000 Indicated Speed:	VC2000 Indicated Average G:
45 mph	4.10 sec			45.5 mph	**.505**

- ***Test Two***

Vehicle Year	Make	Model	Type:	Color:	Vehicle Identification Number (VIN):
2000	Chevrolet	Blazer	SUV	Red	1GNDT13W3Y2356464
Radar Indicated Speed:	VC2000 Indicated Time:			VC2000 Indicated Speed:	VC2000 Indicated Average G:
47 mph	4.50 sec			46.1 mph	**.467**

- ***Test Three***

Vehicle Year	Make	Model	Type:	Color:	Vehicle Identification Number (VIN):
2000	Chevrolet	Impala	Sedan	Black	2G1WF55K1Y9256027
Radar Indicated Speed:	VC2000 Indicated Time:			VC2000 Indicated Speed:	VC2000 Indicated Average G:
48 mph	4.26 sec			49.9 mph	**.531**

- ***Test Four***

Note: This test is also documented under CDR Test Number Seven.

Vehicle Year	Make	Model	Type:	Color:	Vehicle Identification Number (VIN):
2000	Chevrolet	Impala	Sedan	Black	2G1WF55K1Y9256027
Radar Indicated Speed:	VC2000 Indicated Time:			VC2000 Indicated Speed:	VC2000 Indicated Average G:
45 mph	4.24 sec			46.5 mph	**.500**

- ***Discussion***

The four tests all show agreement and concurrence between the radar indicated speed and VC2000 indicated speed. Each test was completed at near speeds, with reported average deceleration results ranging from .467 g's to .531 g's. The average of these drag factors is calculated as .500 g's.

GRASS SURFACE DECELERATION TESTING

- ***Surface Description***

The terrain utilized was a grass ditch adjacent to a closed Ft. McCoy street. The grass was dry and uncut, measuring approximately 6" to 1'. The underlying soil was composed of a dry sandy loam.

- ***Test One***

Vehicle Year	Make	Model	Type:	Color:	Vehicle Identification Number (VIN):
2000	Chevrolet	Impala	Sedan	Black	2G1WF55K1Y9256027
Radar Indicated Speed:	VC2000 Indicated Time:			VC2000 Indicated Speed:	VC2000 Indicated Average G:
30 mph	3.17 sec			33.9 mph	**.485**

- ***Test Two***

Vehicle Year	Make	Model	Type:	Color:	Vehicle Identification Number (VIN):
2000	Chevrolet	Impala	Sedan	Black	2G1WF55K1Y9256027
Radar Indicated Speed:	VC2000 Indicated Time:			VC2000 Indicated Speed:	VC2000 Indicated Average G:
36 mph	3.26 sec			36.4 mph	**.509**

- ***Test Three***

Vehicle Year	Make	Model	Type:	Color:	Vehicle Identification Number (VIN):
2000	Chevrolet	Blazer	SUV	Red	1GNDT13W3Y2356464
Radar Indicated Speed:	VC2000 Indicated Time:			VC2000 Indicated Speed:	VC2000 Indicated Average G:
31 mph	4.09 sec			32.1 mph	**.357**

- ***Test Four***

Vehicle Year	Make	Model	Type:	Color:	Vehicle Identification Number (VIN):
2000	Chevrolet	Blazer	SUV	Red	1GNDT13W3Y2356464
Radar Indicated Speed:	VC2000 Indicated Time:			VC2000 Indicated Speed:	VC2000 Indicated Average G:
31 mph	3.07 sec			30.9 mph	**.457**

- ***Discussion***

For this series of tests, the Chevrolet Impala and Blazer were steered off of the paved portion of the roadway and into a shallow ditch prior to the hard brake application. There was some difficulty in terms of the VC2000 activating prematurely in the Impala due to the test vehicle entering the ditch and traveling over the surface irregularities (bumps) therein. These unsuccessful runs were immediately terminated without data being recorded. The above test results show a drag factor range of .357 g's on the low end to .509 on the high end. The average of these deceleration factors is calculated to be .452 g's.

APPENDIX

List of Validation Testing Participants

TESTING PARTICIPANTS

Wisconsin State Patrol Academy
November 2, 2001

PARTICIPANT NAME	AGENCY	TESTING ROLE
Allison, Michael J.	Wisconsin State Patrol District 5	Observer
Andraschko, Mark J.	Wisconsin State Patrol District 3	Digital Video Camera Operator
Asp, Arden A.	Wisconsin State Patrol District 5	Observer
Austin, Timothy P.	Wisconsin State Patrol District 3	VC2000/Radar Operator
Berg, Timothy J.	Wisconsin State Patrol District 3	Digital Camera Operator
Derse, Thomas S.	Wisconsin State Patrol District 4	Observer
DeStefano, Anthony I.	Wisconsin State Patrol District 7	Observer
Erdmann, Thomas W.	Wisconsin State Patrol District 2	Observer
Erickson, Brian D.	Wisconsin State Patrol District 6	Observer
Fish, David R.	Wisconsin State Patrol District 6	Observer
Floyd, Lorie J.	Wisconsin State Patrol District 5	Observer
Fowles, David A.	Wisconsin State Patrol District 3	Observer
Hanson, Derrek R.	Wisconsin State Patrol District 7	Observer
Jacobsen, Mark E.	Wisconsin State Patrol District 5	Observer
Jarvela, Scott A.	Wisconsin State Patrol District 2	Observer
Jensen, Aaron M.	Wisconsin State Patrol District 6	Observer
Johnson, Eugene L.	Wisconsin State Patrol District 2	Observer
Kinlen, Bruce P.	Wisconsin State Patrol District 6	Observer
Kittelson, Marvin J.	Wisconsin State Patrol District 6	Observer
Krueger, Steven G.	Wisconsin State Patrol District 4	Observer
Llanas, Alan J.	Wisconsin State Patrol District 2	VC2000 Operator
Lonsdorf, Daniel W.	Wisconsin State Patrol Hqtrs	Black Impala/CDR Operator
Marquardt, Michael J	Wisconsin State Patrol District 1	Observer
McConnell, Dennis M.	Wisconsin State Patrol District 4	Observer
McCormack, Timothy M.	Wisconsin State Patrol District 2	Observer
Messa, Martin P.	Wisconsin State Patrol District 7	Observer
Meyers, Duane R.	Wisconsin State Patrol District 3	CDR Operator
Parrott, Thomas W.	Wisconsin State Patrol District 1	Observer
Prouty, Steven L.	Wisconsin State Patrol District 2	Observer
Rahmer, Thomas J.	Wisconsin State Patrol District 4	Observer
Reidel, George T.	Wisconsin State Patrol District 5	Observer
Schilling, Paul R.	Wisconsin State Patrol District 7	Observer
Smith, Michael D.	Wisconsin State Patrol District 2	Observer
Sparling, Larry L.	Wisconsin State Patrol District 4	Observer
Staffen, Theodore D.	Wisconsin State Patrol District 1	Red Impala Operator
Steele, Daniel P.	Wisconsin State Patrol District 5	Observer
VerGowe, Jeremy J.	Wisconsin State Patrol District 3	Observer

Test Participants, Cont

Voight, Gerald C.	Wisconsin State Patrol District 6	Observer
Waite, Theodore E.	Wisconsin State Patrol District 4	Observer
Walters, Tom C.	Wisconsin State Patrol District 6	Observer
Waterman, Darwin F.	Wisconsin State Patrol District 7	Observer
Weber, Jerry L.	Wisconsin State Patrol District 4	Observer
Wegener, Dale F.	Wisconsin State Patrol District 2	Observer
Weyek, Paul D.	Wisconsin State Patrol District 6	Observer
Young, Keith A.	Wisconsin State Patrol District 6	Observer
Zukowski, Ryan J.	Wisconsin State Patrol District 2	Observer
Zynda, Jamie M.	Wisconsin State Patrol District 3	Red Blazer Operator