

**TRANSPORTATION SCIENCES  
CRASH DATA RESEARCH CENTER**

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**VERIDIAN ON-SITE ADAPTIVE AND EVENT DATA  
RECORDER (EDR) EQUIPPED VEHICLE INVESTIGATION**

**VERIDIAN CASE NO. CA01-036**

**VEHICLE - 2000 CHEVROLET G2500 EXPRESS VAN**

**LOCATION - STATE OF NEW YORK**

**CRASH DATE - JUNE, 2001**

Contract No. DTNH22-94-D-07058

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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16. <i>Abstract</i> This on-site investigation focused on the injury mechanisms that caused the death of a 79 year old female rear left wheelchair passenger of a 2000 Chevrolet G2500 Express van. The Chevrolet was equipped with redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of an offset frontal collision with a 1998 Mazda 626 4-door sedan. The driver of the Mazda was operating the vehicle southbound when she failed to observe the northbound Chevrolet as she turned left (east) at a 4-leg urban intersection. As the Mazda crossed the northbound lanes of the intersection, the front right area was impacted by the frontal area of the Chevrolet resulting in moderate damage to both vehicles. The restrained 58 year old male driver of the 2000 Chevrolet Express initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. He was reported by police as uninjured in the collision. The 79 year old female rear left passenger of the 2000 Chevrolet Express was in a slumped posture and improperly restrained within a wheelchair by the vehicle's 2-point manual lap belt system. At impact, she submarined the lap restraint which resulted in an abrasion to the anterior neck and unspecified extensive trauma to the liver and spleen. The passenger was transported to a local trauma center and pronounced deceased shortly after arrival. Injury information is limited as the interviews and autopsy report were not obtained.			
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VERIDIAN CASE NO. CA01-036  
VEHICLE - 2000 CHEVROLET G2500 EXPRESS VAN  
LOCATION - STATE OF NEW YORK  
CRASH DATE - JUNE, 2001**

***BACKGROUND***

This on-site investigation focused on the injury mechanisms that caused the death of a 79 year old female rear left wheelchair passenger of a 2000 Chevrolet G2500 Express van. The Chevrolet was equipped with redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of an offset frontal collision with a 1998 Mazda 626 4-door sedan. The driver of the Mazda was operating the vehicle southbound when she failed to observe the northbound Chevrolet as she turned left (east) at a 4-leg urban intersection. As the Mazda crossed the northbound lanes of the intersection, the front right area was impacted by the frontal area of the Chevrolet resulting in moderate damage to both vehicles. The restrained 58 year old male driver of the 2000 Chevrolet Express initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. He was reported by police as uninjured in the collision. The 79 year old female rear left passenger of the 2000 Chevrolet Express was in a slumped posture and improperly restrained within a wheelchair by the vehicle's 2-point manual lap belt system. At impact, she submarined the lap restraint which resulted in an abrasion to the anterior neck and unspecified extensive trauma to the liver and spleen. The passenger was transported to a local trauma center and pronounced deceased shortly after arrival. Injury information is limited as the interviews and autopsy report were not obtained.

This investigation was identified by a Veridian Engineering SCI Investigator on Friday, June 15<sup>th</sup> and forwarded to NHTSA on Monday, June 18, 2001. Due to the involvement of a 2000 Chevrolet G-series adaptive vehicle an on-site investigative effort was assigned Tuesday, June 19. The on-site investigator completed field activities on Thursday, June 21, 2001.

***SUMMARY***

**Crash Site**

This two vehicle crash occurred during the afternoon hours of June, 2001. At the time of the crash, it was daylight with no adverse conditions as the roads were dry. The crash occurred in the northbound lanes of an urban (straight/level) 4-leg intersection which was controlled by an overhead signal system in green phase for north/southbound traffic (**see Figure 12 - page 9**). The asphalt surfaced roadway was bordered by barrier curbs and sidewalks. The posted speed limit at the crash site was 72 km/h (45 mph) for southbound and 56 km/h (35 mph) for northbound traffic.

**Pre-Crash**

The 16 year old female driver of the 1998 Mazda 626 was operating the vehicle southbound (**Figure 1**) when she approached the 4-leg intersection and came to a stop in anticipation of a left turn (east). The driver failed to observe the northbound Chevrolet as she initiated the left turn at a (police reported) speed of 16 km/h (10 mph).

The 58 year old male driver of the 2000 Chevrolet G2500 Express van was operating the vehicle northbound (**Figure 2**) at a (police reported) speed of 72 km/h (45 mph) when he proceeded through the 4-leg intersection and observed the Mazda cross his path of travel. The police reported no pre-impact tire marks at the scene indicative of driver avoidance maneuvers.



**Figure 1. Southbound approach for the 1998 Mazda 626.**



**Figure 2. Northbound approach for the 2000 Chevrolet Express van.**

### **Crash**

As the Mazda crossed the northbound lanes of the urban 4-leg intersection, the front right area was impacted by the frontal area of the Chevrolet resulting in moderate damage to both vehicles. At this point, the Mazda underrode the Chevrolet which allowed the bumper on the Mazda to engage the structure under the Chevrolet van. Impact resulted in deployment of the redesigned frontal air bag systems in each vehicle. The Chevrolet's Event Data Recorder (EDR) recorded a deployment event (see **Figure 13 - page 10**) with a longitudinal velocity change of -21.9 km/h (-13.6 mph) at the 150 millisecond interval. Impact speeds and velocity changes were computed utilizing the WinSMASH reconstruction program. The WinSMASH trajectory algorithm computed speeds *at impact* of 40.3 km/h (25.0 mph) for the subject vehicle and 21.7 km/h (13.5 mph) for the struck Mazda. Computed velocity changes were 19.3 km/h (12.0 mph) for the subject vehicle and 36.1 km/h (22.4 mph) for the struck Mazda. Respective longitudinal components were -19.0 km/h (-11.8 mph) and -33.9 km/h (-21.1 mph). At this point, the Mazda rotated counterclockwise 100 degrees as the vehicles sustained contact 9.4 meters (30.8 feet) to final rest in the northeast sector of the intersection facing northeast.

### **Post-Crash**

Both drivers reportedly exited their respective vehicles under their own power. The Chevrolet driver was reported by police as uninjured as the rear left wheelchair passenger was removed from the vehicle through the right rear door by rescue personnel (in a semi-responsive state) and transported by ambulance to a local trauma center where she was pronounced deceased approximately 52 minutes following the crash. The Mazda driver refused direct transport from the scene. She sought treatment later at a local hospital for an air bag expansion related abrasion to the anterior aspect of the right forearm and (air bag fling related) abrasion to the posterior aspect of the right hand. Both vehicles were towed from the scene with disabling damage.

### **VEHICLE DATA**

The 2000 Chevrolet G2500 Express van was manufactured in May, 2000 and identified by the vehicle identification number (VIN): 1GCFG25R7Y1 (production number deleted). The company-owned

vehicle was an adaptive van equipped with rear-wheel drive, four-wheel anti-lock braking system (ABS), and a 5.7 liter, V-8 engine. At the time of the crash, the odometer had recorded 54,021 km (33,568 miles). The seating was configured with front box-mounted (van type) bucket seats. The driver and his attorney refused the SCI interview, therefore, previous crashes or maintenance on the Chevrolet's frontal air bag system were unknown. There were no adaptive controls for the driver position.

## **VEHICLE DAMAGE**

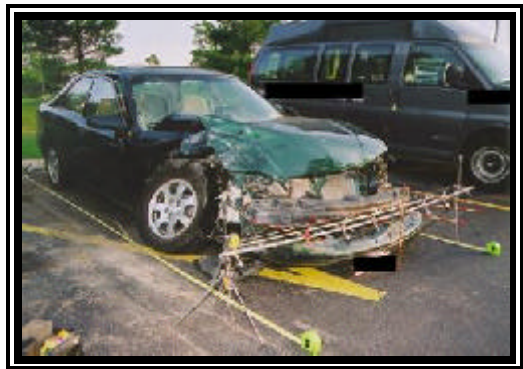
### **Exterior**

The 2000 Chevrolet G2500 Express van sustained moderate frontal damage as a result of the impact with the 1998 Mazda 626 (**Figure 3**). The direct contact damage began 15.0 cm (5.9 in) inboard of the front left bumper corner and extended to the right 154.0 cm (60.6 in). The impact deformed the entire front end width resulting in a combined direct and induced damage length (Field L) of 173.0 cm (68.1 in). Six crush measurements were documented at the level of the bumper: C1= 21.0 cm (8.3 in), C2= 31.0 cm (12.2 in), C3= 47.0 cm (18.5 in), C4= 24.0 cm (9.4 in), C5= 4.0 cm (1.6 in), C6= 0 cm. The Collision Deformation Classification (CDC) for this impact to the Chevrolet 12-FDEW-4 with a principal direction of force of (-)10 degrees. Dark colored paint transfers were documented along the direct contact damage. An indentation was identified to the center bumper area and attributed to the front right bumper corner on the Mazda. The hood was deformed up and rearward from the impact force. Both fenders were displaced slightly rearward (no restricted/deflated wheels). Reduction in the left side wheelbase measured 1.5 cm (0.6 in). All glazing remained undamaged.



**Figure 3. Frontal damage to the 2000 Chevrolet G2500 Express van.**

The 1998 Mazda 626 4-door sedan sustained moderate frontal damage as a result of the impact with the 2000 Chevrolet Express van (**Figure 4**). The direct contact damage began at the front right bumper corner and extended 88.0 cm (34.6 in) inboard. The impact deformed the entire front end width resulting in a combined direct and induced damage length (Field L) of 140.0 cm (55.1 in). Six crush measurements were documented at the level of the reinforcement bar (*bumper fascia separation*): C1= 4.5 cm (1.8 in), C2= 1.5 cm (0.6 in), C3= 4.5 cm (1.8 in), C4= 6.50 cm (2.6 in), C5= 8.5 cm (3.3 in), C6= 18.5 cm (7.3 in). A secondary crush profile was obtained 11.0 cm (4.3 in) above the level of the bumper to capture the underride damage resulting in an *averaged profile* of: C1= 5.0 cm (2.0 in), C2= 11.0 cm (4.3 in), C3= 19.0 cm (7.5 in), C4= 20.0 cm (7.9 in), C5= 20.0 cm (7.9 in), C6= 19.0 cm (7.5 in). The CDC for this impact to the Mazda was 01-FZEW-2 with a principal direction of force of (+)20 degrees. The hood was deformed up and rearward from the impact force. The right fender was displaced rearward which restricted the right front wheel/tire (not deflated). Direct contact damage was also documented on the right fender and attributed sustained vehicle contact (wrap contact) during post-impact travel to



**Figure 4. Front right damage to the 1998 Mazda 626.**

final rest. The left front tire was deflated (not restricted) with minor abrasions noted on the wheel. Induced contact damage produced buckling along the right A-pillar and B-pillar. The windshield was fractured in multiple locations from exterior impact forces (only). Reduction in the right side wheelbase measured 4.5 cm (1.8 in) while elongation of the left side wheelbase measured 2.0 cm (0.8 in).

### **Interior**

Interior damage to the Chevrolet was minimal and was attributed to occupant contact. A small scuff mark and indentation were documented on the left knee bolster. Although no deformation was identified on the steering wheel rim, 1.0 cm (0.4 in) of column compression was noted on the left side. Abrasions and scratch marks were documented on the rear aspect of the driver seat back near the floor level. Abrasions were also documented on the driver restraint buckle stalk with blood pooling surrounding the adjacent floor area. A smudge mark was also noted on the left rear glazing. No component intrusions were found in the vehicle.

### **ADAPTIVE EQUIPMENT**

#### **Wheelchair Lift System**

The 2000 Chevrolet G2500 Express van was modified for the transport of wheelchair patients. Placards affixed to the hydraulic arms confirmed that the modifications complied with ADA and national school bus standards, however, police removed the vehicle from service (post-crash) due to inadequate/non-operational restraints for the wheelchair passengers. The adaptive vehicle was equipped with a hydraulic wheelchair lift system (**Figure 5**) with a maximum load rating of 362.9 kg (800.0 lb). The lift system operated from the right rear doors which must be latched in the full open position for the mechanism to operate. The lift system utilized both an automatic and manual release design. To automatically deploy the lift, the operator must first fully open the rear doors, activate the “deploy” switch on the remote unit (stowed on the aft side door) to unfold the platform to the vehicle floor level, and then activate the “down” switch to lower the platform to ground level. The operator must enter the platform centrally facing outward and lock the wheelchair brakes. The operator activates the “up” switch to raise the platform to the vehicle floor level, then release the wheelchair brakes to enter the vehicle. The operator must activate the “stow” switch to fold the platform, which stops automatically when completely folded. A manual lever is provided with operational instructions and located adjacent to the aft lift arm. Warning labels were affixed to key components of the lift system for safe operation and use, as designated handrails and platforms were identified by yellow paint markings. The roof encompassed the full length of the vehicle (header to backlight) and extended 37.0 cm (14.6 in) above the level of the side rail for increased headroom. There was no damage or separation of the fiberglass roof from the vehicle sheet metal.



**Figure 5. Wheelchair lift system in the down and retracted position.**



### Passenger Wheelchair

The 79 year old female passenger of the 2000 Chevrolet Express van was seated in a manually operated wheelchair (**Figure 6**) secured in the rear left area by a nylon strap harness system. The wheelchair harness system utilized a floor anchorage system as the nylon straps are looped through the designated frame slots and secured to the floor with adjustable fasteners. Improper placement of the 2-point manual lap belt through the wheelchair frame resulted in impact related deformation to the frame and hip panels. Small pillows were identified in the wheelchair which were placed between the hip and side panel. An oxygen tank was found strapped to the rear of the wheelchair.



**Figure 6. Passenger wheelchair.**

### *MANUAL RESTRAINT SYSTEMS*

The interior of the Chevrolet Express consisted of a two passenger seating configuration with front box-mounted (van type) bucket seats. The driver 3-point manual lap and shoulder belt system consisted of a continuous loop belt webbing with a sliding latchplate and a dual mode retractor (inertial lock/belt sensitive). Loading evidence consisted of light abrasions to the D-ring and latchplate with an associated transfer to the shoulder belt webbing. The front right seating position was equipped with a 3-point manual lap and shoulder belt system which consisted of a continuous loop belt webbing with a sliding latchplate and a retractor equipped with an inertial and switchable lock mechanism. The Chevrolet was not equipped with pretensioner devices for the front seating positions. The rear (two) wheelchair positions were equipped with 3-point manual lap and shoulder belt systems which consisted of a non-integral/non-continuous loop belt webbing with a fixed latchplate and a dual mode retractor (inertial lock/belt sensitive). Tissue was identified on the lap belt webbing of the rear left restraint as the shoulder portion was found to be tied off and rendered non-operational (**Figure 7**).



**Figure 7. Loading evidence to the driver's D-ring and rear left manual lap belt.**

### ***SUPPLEMENTAL RESTRAINT SYSTEMS***

The 2000 Chevrolet G2500 Express van was equipped with redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of the crash (**Figure 8**). The driver air bag was identified by the following part number: \*P16761159008\* with a bar coded lot number of: \*TML1308S1363\*. The air bag was housed in the center of the steering wheel with a vertically oriented flap tear seam (I-configuration). The flaps were symmetrical in shape and measured 6.7 cm (2.6 in) in width and 10.7 cm (4.2 in) in height. No contact evidence was identified on the exterior surface of the module cover flaps. Light smudge marks were documented across the lower portion of the air bag face along with black vinyl transfers to the upper left quadrant from expansion within the module. The diameter of the driver air bag measured 65.0 cm (25.6 in) in its deflated state (**Figure 9**). The bag was tethered by four internal straps and vented by two 2.7 cm (1.1 in) ports located at the 10 o'clock and 2 o'clock sectors on the rear aspect of the air bag. Rearward air bag excursion measured 23.0 cm (9.1 in) from the steering wheel hub.



**Figure 8. 2000 Chevrolet Express deployed redesigned frontal air bag system.**

The front right passenger air bag deployed from the right mid-instrument panel area with a horizontally oriented flap tear seam (H-configuration). The flaps were rectangular and symmetrical in shape and measured 32.0 cm (12.6 in) in width and 6.5 cm (2.6 in) in height. No contact evidence was identified on the air bag or exterior surface of the module cover flaps. The passenger air bag measured 63.0 cm (24.8 in) in width and 58.0 cm (22.8 in) in height in its deflated state (**Figure 10**). The bag was vented by two 4.5 cm (1.8 in) diameter ports located at the 10 o'clock and 2 o'clock sectors on the side aspect of the bag. No internal tether straps were present.



**Figure 9. 2000 Chevrolet Express deployed redesigned driver air bag.**



**Figure 10. 2000 Chevrolet Express deployed redesigned passenger air bag.**

### **Event Data Recorder (EDR)**

The 2000 Chevrolet G2500 Express Sensing and Diagnostic Module (SDM) was located under the driver's seat as the event data was retrieved via the J1962 connector found to the left of the steering column. The Event Data Recorder (EDR) records deployment and near-deployment events for the frontal air bag system. In this crash, the EDR recorded a deployment event at ignition cycle number 2504, as the ignition cycle at investigation was 2521. The EDR previously recorded an unrelated near-

deployment event at ignition cycle number 2439. The driver's brake switch and belt switch circuit system status were not recorded.

### ***DRIVER DEMOGRAPHICS***

Age/Sex: 58 year old male  
Height: 173 cm (68 in)  
Weight: 77 kg (170 lb)  
Seat Track Position: Middle position [13.0 cm (5.1 in) aft of the full forward position or 9.5 cm (3.7 in) forward of the full rearward position]  
Manual Restraint Use: 3-point lap and shoulder belt system  
Usage Source: Vehicle inspection  
Eyeware: Unknown  
Type of Medical Treatment: None

### **Driver Injuries**

<b><i>Injury</i></b>	<b><i>Severity (AIS 90)</i></b>	<b><i>Injury Mechanism</i></b>
Not injured	N/A	N/A

Source: police\*

### **Driver Kinematics**

The 58 year old male driver of the 2000 Chevrolet Express van was restrained by the available 3-point manual lap and shoulder belt system, and presumed to be seated in an upright posture with the seat track adjusted to the middle position. Belt usage was confirmed by the loading evidence documented to the D-ring, latchplate, and shoulder belt webbing of the front left restraint. Furthermore, belt usage was confirmed by the vehicle's EDR summary.

At impact, the driver initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint, knee bolster and deployed redesigned driver air bag (**Figure 11**). Contact to the deployed redesigned driver air bag was confirmed by the smudge marks documented across the face of the membrane. Loading of the knee bolster was evidenced by the indentation and scuff mark identified to the right of the steering column, however, he was reported by police as uninjured in the collision. Possible injury information is unknown as the driver and his attorney refused the SCI interview. Following the collision, he unbuckled his seatbelt and attended to the rear left passenger.

### ***REAR LEFT PASSENGER DEMOGRAPHICS***

Age/Sex: 79 year old female  
Height: 160 cm (63 in)  
Weight: 68 kg (150 lb)  
Seat Track Position: Not applicable (seated in a wheelchair)  
Manual Restraint Use: 2-point lap belt system (*improper usage*)  
Usage Source: Vehicle inspection, police interview  
Eyeware: None  
Type of Medical Treatment: Transported to a local trauma center and pronounced deceased

## Rear Left Passenger Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
*Splenic trauma (NFS)	Moderate (544299.2,2)	Lap belt webbing
*Liver trauma (NFS)	Moderate (541899.2,1)	Lap belt webbing
*Abrasion anterior neck	Minor (390202.1,5)	Lap belt webbing
*Laceration right ankle	Minor (890602.1,1)	Driver seat back frame

Source: police\*

## Rear Left Passenger Kinematics

The 79 year old female passenger of the 2000 Chevrolet Express van was improperly restrained within the wheelchair by the available 2-point manual lap belt system with the lap belt positioned high over the abdomen (shoulder portion not used). She was presumed to be seated in a slumped posture against the wheelchair seat back with her buttocks forward on the cushion. Belt usage was confirmed by the tissue transfer documented on the lap portion of the rear left restraint relative to the type of injuries sustained.



Figure 11. Blood stained shoe and pooling area.

At impact, the rear left passenger initiated a forward trajectory in response to the 12 o'clock impact force and submarined the manual lap restraint resulting in an abrasion to the anterior aspect of the neck and unspecified fatal liver and spleen injuries. She also sustained a laceration of the medial right ankle from contact to the driver's lower seat back frame. This injury mechanism was evidenced by the location of the injury relative to the deformation documented to this component. Following the crash, the Chevrolet driver reportedly found the passenger slumped forward onto the floor (partially out of the wheelchair) with the lap restraint around her neck. Her lower extremities were positioned in the front center floor area in a pool of blood (**Figure 11**). The driver unbuckled the lap belt and laid the passenger onto the rear floor area as rescue personnel arrived on-scene within minutes of the crash to find her semi-responsive. The rear left passenger was subsequently transported by ambulance to a local trauma center and pronounced deceased approximately 52 minutes following the crash. Injury information is limited as the driver and his attorney refused the SCI interview.

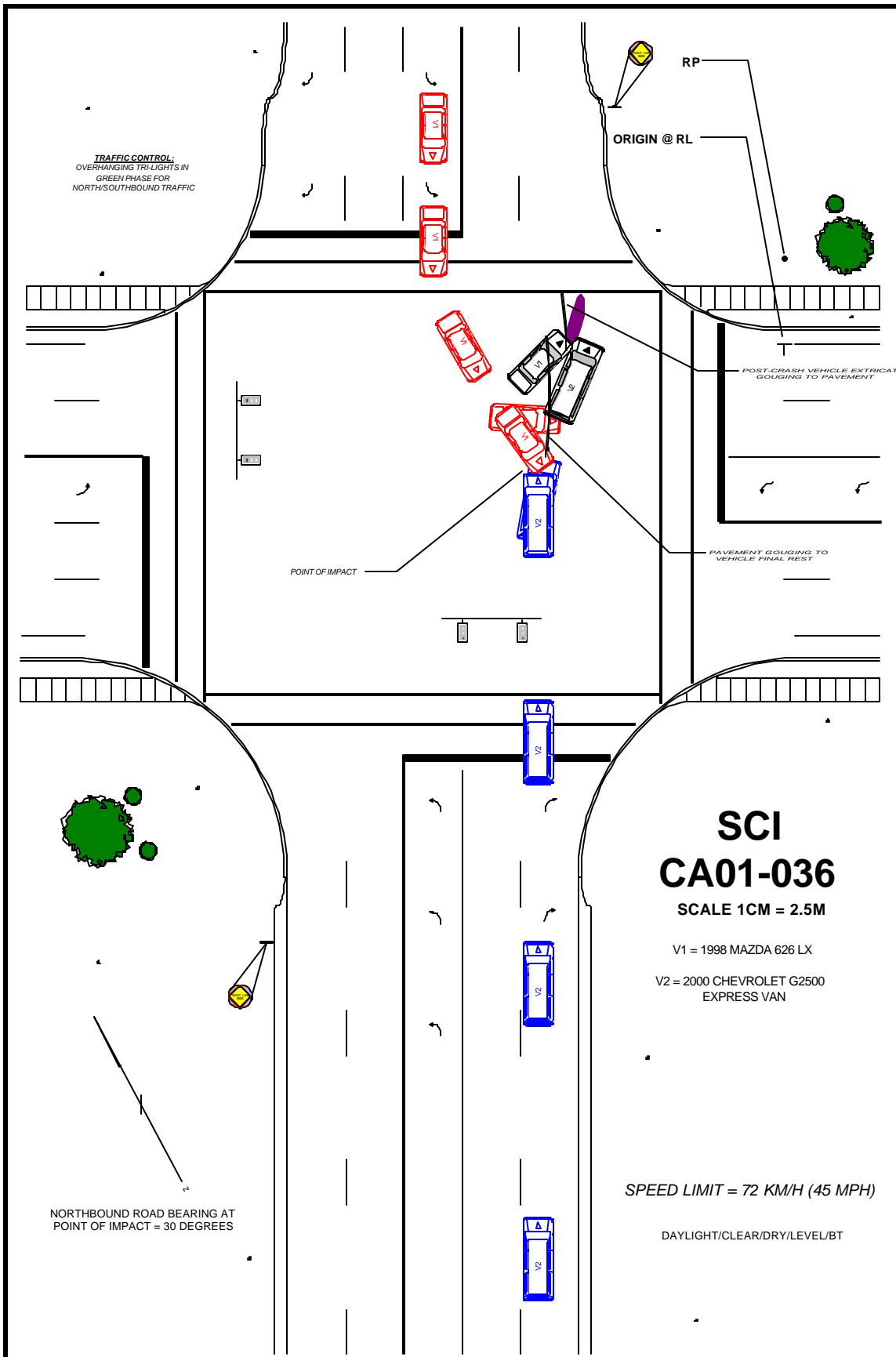
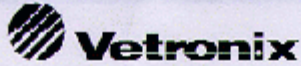
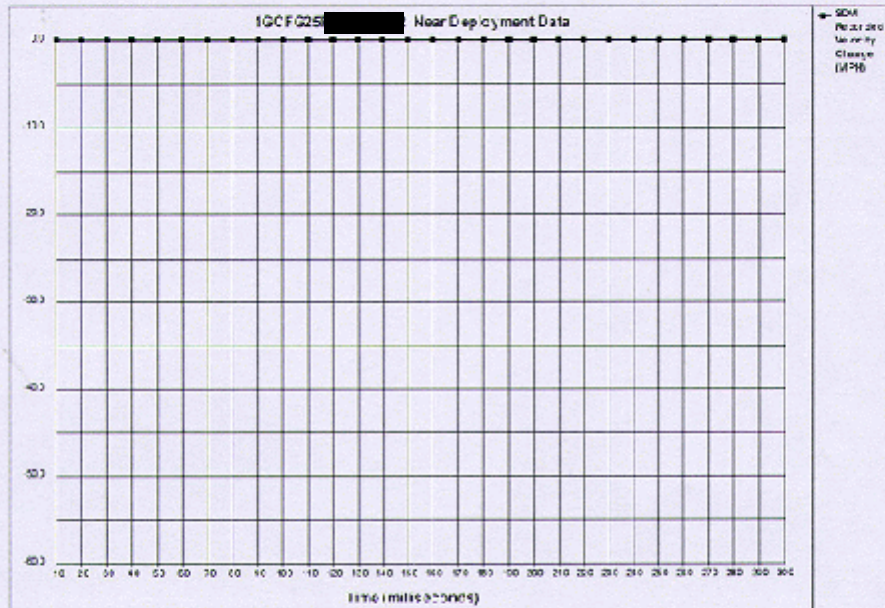


Figure 12. Scene Diagram.



### 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	2739
Ignition Cycles At Investigation	2621
Algorithm Enable to Maximum EDM Recorded Velocity Change (msec)	0
Maximum EDM Recorded Velocity Change (MPH)	0

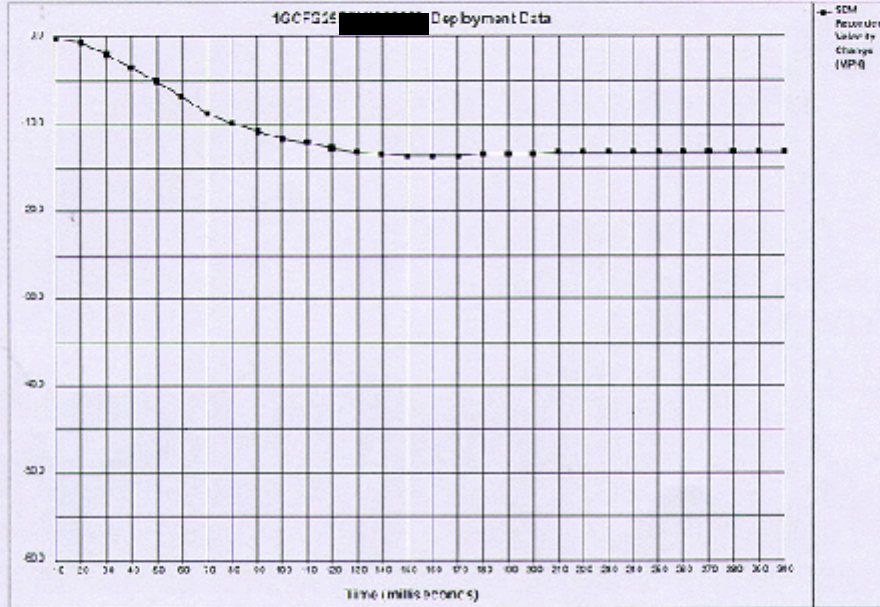


Time (in milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Time (in milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Figure 13. 2000 Chevrolet Express van EDR report (unrelated near deployment event).

**System Status At 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 Deployment	2504
Ignition Cycles At Investigation	2521
Time From Algorithm Enable To Deployment Command (msec)	21.26
Time Between Near Deployment And Deployment Events (sec)	N/A



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	13.22	13.36	13.51	13.65	13.80	13.94	14.09	14.23	14.38	14.52	14.67	14.81	14.96	15.10	15.25
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Recorded Velocity Change (MPH)	13.40	13.54	13.68	13.82	13.96	14.10	14.24	14.38	14.52	14.66	14.80	14.94	15.08	15.22	15.36

Figure 14. 2000 Chevrolet Express van EDR report (deployment event).