TRANSPORTATION SCIENCES
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VERIDIAN ON-SITE AIR BAG NON-DEPLOYMENT FATALITY INVESTIGATION
VERIDIAN CASE NO. CA00-037
VEHICLE: 2001 CADILLAC DeVILLE
LOCATION: LOUISIANA
CRASH DATE: SEPTEMBER 2000

Contract No.
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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. *Abstract* This on-site crash investigation focused on the non-deployment issues of the redesigned frontal air bag system in a 2001 Cadillac DeVille. The Cadillac was equipped with redesigned frontal air bags, integrated front seat belt systems with buckle pretensioners, seat mounted side impact air bags, and an Event Data Recorder (EDR). The Cadillac crossed the centerline of a two lane roadway in an 89 km/h (55 mph) speed zone and impacted a 1989 Nissan King cab pickup truck in an off-set, head-on configuration. The Cadillac's frontal air bag system failed to deploy as a result of the severe head-on crash. The 68 year old male driver of the Cadillac was restrained by the manual integrated belt system. He loaded the manual belt system and the intruding steering assembly which resulted in severe thoracic injuries. He was pronounced deceased at the scene of the crash. The 21 year old female driver of the Nissan was transported to a local hospital where she expired due to crash related injuries. The Cadillac was equipped with an EDR that was downloaded during the SCI on-site investigation. A Near Deployment Event was recorded. The EDR file recorded the System Status at the Near Deployment, however, the pre-crash data was listed as DATA INVALID.			
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BACKGROUND

This on-site crash investigation focused on the non-deployment issues of the redesigned frontal air bag system in a 2001 Cadillac DeVille. The Cadillac was equipped with redesigned frontal air bags, integrated front seat belt systems with buckle pretensioners, seat mounted side impact air bags, and an Event Data Recorder (EDR). The Cadillac crossed the centerline of a two lane roadway in an 89 km/h (55 mph) speed zone and impacted a 1989 Nissan Kingcab pickup truck in an off-set, head-on configuration. The Cadillac's frontal air bag system failed to deploy as a result of the severe head-on crash **(Figure 1)**. The 68 year old male driver of the Cadillac was restrained by the manual integrated belt system. He loaded the manual belt system and the intruding steering assembly which resulted in multiple thoracic injuries. He was pronounced deceased at the scene of the crash. The 21 year old female driver of the Nissan was transported to a local hospital where she expired due to crash related injuries. The Cadillac was equipped with an EDR that was downloaded during the SCI on-site investigation. A Near Deployment Event was recorded. The EDR file recorded the System Status at the Near Deployment, however, the pre-crash data was listed as DATA INVALID.

Figure 1. Frontal damage to the 2001 Cadillac.

SUMMARY

Crash Scene

The crash occurred on a state route during daylight hours. In the vicinity of the crash site **(Figure 2)**, the roadway was 7.1 m (23.3') in width and delineated into two travel lanes by a solid and broken centerline that prohibited passing in the southbound direction. The asphalt travel lanes were straight with a 1.5 percent grade, positive to the south. The weather conditions were clear and dry, with dry environmental surfaces. The travel lanes were bordered by 3.2 m (10.5') wide asphalt shoulders. The east shoulder was bordered by a 3.7 m (12.1') wide grassy area that had a gradual negative slope that transitioned into a shallow, irregular 1.1 m (3.6') wide drainage ditch that was approximately 20.3 cm (8.0") in depth. A wooded area of mature trees bordered the ditch. The posted speed limit was 89 km/h (55 mph).

Figure 2. View of the crash site.

Vehicle Data

2001 Cadillac DeVille

The 2001 Cadillac DeVille was purchased by the driver five days prior to the crash as a new vehicle. The vehicle was manufactured on 08/01/2000 and was identified by vehicle identification number 1G6KD54Y11U (production number deleted). At time of vehicle delivery, the odometer reading was 25.7 km (16.0 miles), however, the odometer reading at the time of the crash was unknown. The Cadillac was a four-door sedan that was equipped with a 4.8 liter V-8, transverse mounted engine that was linked to a 4-speed automatic overdrive transmission with a steering column mounted transmission selector lever. The Cadillac was front wheel drive with four-wheel disc brakes with anti-lock (ABS). In addition to the standard features that included power front seats, power windows, leather seats, security system, tilt steering wheel, this Cadillac was equipped with OnStar and StabiliTrac 2.0, a vehicle stability control system.

The safety systems of the Cadillac DeVille included redesigned frontal air bags for the driver and front right passenger positions, front door mounted side impact air bags, and integrated 3-point lap and shoulder belts for the front outboard seated positions with buckle pretensioners. The frontal air bag system was controlled by a single point Sensing and Diagnostic Module (SDM) that had crash recording capabilities known as an Event Data Recorder (EDR). Although the Cadillac sustained severe frontal damage, the frontal air bag system did not deploy. The EDR was downloaded during this on-site investigation, A Near Deployment event was recorded, however, the Pre-Crash data was listed as Data Invalid.

1989 Nissan KingCab Pickup Truck

The 1989 Nissan King Cab pickup truck was an extended cab model built on a 269.5 cm (106.1") wheelbase. The truck was a 4x2 configuration with rear wheel drive. The brakes were power-assisted front disc/rear drum without anti-lock. The wheels were OEM alloy equipped with all-season radial tires. The interior was configured with front bucket seats and two side facing rear jump seats. The Nissan was equipped with 3-point lap and shoulder belt systems for the front outboard seated positions. The pickup was not equipped with a frontal air bag system. The Nissan was identified by Vehicle Identification Number (VIN) 1N6HD16SXKC (production number deleted). At the time of the crash, the odometer reading was 200,502.7 km (124,590.0 miles).

Crash Sequence

Pre-Crash

The driver of the 2001 Cadillac was en route to his residence and was traveling in a southerly direction on the two lane state route at a witness estimated speed of 89-96 km/h (55-60 mph). This witness was following the Cadillac for approximately 10 km (6 miles) and noted that on several occasions, the driver of the Cadillac allowed the vehicle to crossed the centerline of the two lane roadway **(Figure 3)**. This witness further noted that each time the driver of the Cadillac crossed the centerline, he redirected

Figure 3. Trajectory of the Cadillac DeVille.

the vehicle back onto the southbound lane. On approach to the crash site, the witness observed the Cadillac drift across the centerline into the northbound travel lane and into the path of the southbound Nissan pickup truck. The witness noted that the driver of the Cadillac did not attempt avoidance action by braking or steering as no brake lights illuminated immediately prior to impact. The Crash Schematic is attached as **Figure 14**, Page 12 of this report.

The driver of the Nissan pickup truck was traveling in a northerly direction on the two lane state route at an estimated speed of 89 km/h (55 mph). She was traveling on a straight segment of the asphalt road surface on her approach to the impending crash site. Although unconfirmed by physical evidence, the resulting vehicle damage pattern suggested the driver of the Nissan probably initiated a slight clockwise steering input in an attempt to avoid the Cadillac as it encroached into her lane of travel.

Crash

The Cadillac impacted the Nissan pickup truck in the northbound travel lane **(Figure 4)** in a head-on, off-set configuration. Initial contact involved the front left and center areas with resultant directions of force within the 12 o'clock sector for both vehicles. The impact initially crushed the frontal structure of the Nissan and rotated the vehicle in a clockwise direction. The full frontal area of the Cadillac subsequently engaged the left front fender area of the Nissan as the vehicles crushed to maximum engagement. The Cadillac sustained 127 cm (50") of maximum crush located at the left corner of the bumper beam while the Nissan sustained 128.5 cm (50.6") of bumper crush. The damage algorithm of the WinSMASH program computed total velocity changes of 55.8 km/h (34.6 mph) for the Cadillac and 80.1 km/h (49.8 mph) for the Nissan. The specific longitudinal and lateral components were -55.0 km/h (-34.2 mph) and -9.7 km/h (-6.0 mph) for the Cadillac and -78.9 km/h (-49.0 mph) and 13.9 km/h (8.6 mph) for the Nissan pickup truck. Although the Cadillac was equipped with a redesigned frontal air bag system, the frontal air bags failed to deploy in this above threshold crash. It should be noted that the Cadillac's seat belt buckle pretensioners fired. The Nissan was not equipped with an air bag system.

Figure 4. Point of impact.

As the vehicles crushed to maximum engagement, the Cadillac initiated a counterclockwise (CCW) rotation across the northbound travel lane. The Cadillac came to rest with its center of gravity straddling the east edge line with the rear tires positioned on the east shoulder and the front of the vehicle blocking the northbound lane. At rest, the Cadillac was facing in a northwesterly direction and had rotated approximately 212 degrees CCW.

The Nissan pickup truck was deflected in a lateral direction to its right as it traversed the east shoulder and grassy area adjacent to the shoulder. As the right side tires entered a shallow drainage ditch, the Nissan initiated a lateral rollover to its right and struck a 25 cm (10") tree in a non-horizontal attitude. The Nissan came to rest against the tree on its right side facing in a northerly direction, parallel to the travel lanes. At rest, the Nissan was located approximately 8.1 m (26.6') outboard of the east edge line and 3.2 m (10.5') north of the point of impact.

Post-Crash

Fire department rescue personnel arrived on-scene within four minutes of the crash. The driver of the Cadillac was found slumped against the left front door with his chin resting on the left corner of the upper instrument panel. He was checked for a pulse in the neck and none was detected. The driver of the Cadillac was further evaluated with a monitor by fire department personnel and was determined deceased. He was officially pronounced deceased at the scene of the crash by the Assistant County Coroner at approximately 58 minutes following the crash. The driver of the Nissan was removed from her vehicle and transported to a regional hospital where she expired due to her crash related injures. Both vehicles sustained severe damage and were towed from the scene.

Vehicle Damage

Exterior - 2001 Cadillac DeVille

The 2001 Cadillac sustained severe frontal damage as a result of the impact with the Nissan pickup truck. The Cadillac sustained 127.0 cm (50.0") of frontal crush located at the left corner of the bumper reinforcement bar. The impact separated the bumper fascia from the vehicle, however, measurements from the fascia indicated the direct contact damage began at the right corner, 85.1 cm (33.5") right of center and extended 170.2 cm (67.0") to the left corner. The damage on the hood face began 53.8 cm (21.2") right of center and extended 108.5 cm (42.7") to the left corner. Although the direct contact damage was distributed across the entire frontal structure **(Figure 5)**, the resultant damage was located primarily on the left aspect of the vehicle, supporting an initial off-set impact configuration with engagement against the left front fender of the Nissan. The damage profile was documented along the bumper fascia **(Figure 6)** that resulted in a Field L measurement of 91.4 cm (36.0"). The crush profile at the level of the reinforcement bar was as follows: C1 = 127.0 cm (50.0"), C2 = 117.2 cm (46.1"), C3 = 94.3 cm (37.1"), C4 = 66.0 cm (26.0"), C5 = 36.2 cm (14.25"), C6 = 8.4 cm (3.3"). The Collision Deformation Classification (CDC) for this impact was 12-FDEW-5.

Figure 5. Frontal damage to the Cadillac DeVille.

Figure 6. Lateral view documenting the extent of frontal crush.

The left wheelbase was reduced in length by 54.7 cm (21.6") while the right wheelbase was elongated by 15.4 cm (6.1"). The impact displaced the left A-pillar rearward and jammed the left front door in its closed position.

The Cadillac was equipped with P225/60R16 all season radial tires mounted on OEM alloy wheels. The left front tire was deflated and compressed into the inner left front fender as a result of the rearward displacement of the axle position. The remaining three tires were inflated to 210 kpa (30 psi). The tires were in new condition with 8 mm (10/32") of tread depth.

The left front door was jammed closed by vehicle deformation and was mechanically opened by the responding fire department personnel. Hydraulic equipment was utilized to cut the striker post from the B-pillar and the door was forced open. The left rear and right rear doors remained closed during the crash and were operational post-crash. The right front door was closed post-crash and was opened by the SCI investigator during the vehicle inspection, however, the door would not re-engage the striker due to body deformation. The Cadillac's windshield was cracked by the crash forces and was cut by fire department personnel along the header and upper A-pillars at the on-set of the extrication of the deceased driver. In addition, the left upper A-pillar was cut by fire department personnel, however, the post-crash position of the pillar was not altered. The left front door glazing was shattered by vehicle deformation. The left rear and both right door glazing were closed at impact and remained intact post-crash. The backlight glazing remained intact. The roof panel was bonded to the roof side rails. The left side bond separated along the side rail, extending from the left A-pillar to the left C-pillar. There was no buckling of the roof panel.

Interior - 2001 Cadillac DeVille

The interior of the Cadillac sustained moderate damage that resulted from exterior deformation and driver contact. The driver's compartment was reduced in size by intrusion of numerous components. Maximum intrusion involved 53.3 cm (21.0") of longitudinal displacement of the left toe pan. The following table identified the occupant space, the intruding components, the magnitude of the intrusion, and the direction of the intrusion.

Occupant Position	Intruding Component	Magnitude of Intrusion	Direction of Intrusion
Driver	Left corner of mid instrument panel	32.0 cm (12.6")	Longitudinal
Driver	Left A-pillar at beltline	28.0 cm (11.0")	Longitudinal
Driver	Left toe pan	53.3 cm (21.0")	Longitudinal
Driver	Header/A-pillar juncture	3.8 cm (1.5")	Longitudinal
Front Center	Center mid instrument panel	19.4 cm (7.6")	Longitudinal

Occupant Position	Intruding Component	Magnitude of Intrusion	Direction of Intrusion
Driver	Base of steering column	16.5 cm (5.0")	Longitudinal
Front Right	Right corner of mid instrument panel	2.5 cm (1.0")	Longitudinal
Front Right	Right toe pan	6.4 cm (2.5")	Longitudinal
Front Right	Mid instrument panel adjacent to radio	16.2 cm (6.4")	Longitudinal

The driver initiated a forward trajectory in response to the frontal impact force and loaded the manual belt system. His loading force on the shoulder belt webbing stretched and distorted the webbing 14.0-62.2 cm (5.5-24.5") above the latch plate. The driver's knees contacted the intruding knee bolster evidenced by blue fabric transfers. The left knee contact was located 50.2-60.8 cm (19.75-23.9") left of the right edge of the rigid bolster panel and 10.4-30.7 cm (4.1-12.1") below the top edge of the panel. The right knee transfer was located 0-5.1 cm (0-2.0") of the right edge of the bolster and 16.5-26.7 cm (6.5-10.5") below the top edge of the panel. A diagonally oriented scuff mark was present near the mid point of the bolster. This scuff mark probably occurred during the extrication of the driver.

The driver loaded the manual integrated (seat mounted) 3-point lap and shoulder belt system. His loading of the belt system was evidenced by stretching of the lap belt webbing. Additionally, the seat back was deflected forward **(Figure 7)** to a post-crash measured value of (-) 1 degree forward of vertical. This seat back deflection allowed the driver to move further forward into the intruding steering assembly. His loading force was transmitted into the energy absorbing steering column as evidenced by approximately 6.0 cm (2.375") of left shear capsule displacement and 5.1 cm (2.0") of right shear bracket separation. The left side of the alloy bracket was fractured. Deformation to the steering wheel was minimal, however, rescue personnel used a chain and the hydraulic boom of the tow truck in an attempt to pull the steering column upward, away from the deceased driver. The tension of this pull fractured the mounting flange of the alloy composition steering wheel, thus separating the wheel from the column. The 12 o'clock sector of the steering wheel rim was deformed vertically upward.

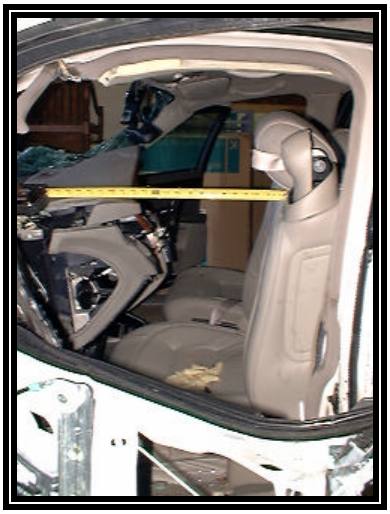


Figure 7. Forward deflection of seat back and rearward intrusion of the steering column and instrument panel.

Exterior - 1989 Nissan KingCab Pickup Truck

The Nissan pickup truck sustained severe frontal damage as a result of the off-set, head-on crash with the

Cadillac. The direct contact damage on the front bumper began 7.6 cm (3.0") right of center and extended 76.2 cm (30.0") to the front left bumper corner. The direct damage on the hood face began 50.8 cm (20.0") inboard of the right corner and extended 87.0 cm (34.25") to the left corner. The frontal impact crushed the left bumper corner rearward to a maximum depth of 128.5 cm (50.2") and shifted the right structure laterally to the left. As a result, the entire frontal structure was deformed that produced a direct and induced damage length (Field L) of 68.6 cm (27.0"), measured parallel to the reference line. The crush profile **(Figure 8)** was documented as follows: C1 = 128.5 cm (50.2"), C2 = 99.1 cm (39.0"), C3 = 83.2 cm (32.75"), C4 = 54.6 cm (21.5"), C5 = 8.0 cm (20.3"), C6 = 0 cm. The Collision Deformation Classification (CDC) for this impact was 12-FYEW-6.

Figure 8. Extent of frontal crush to the Nissan KingCab.

Figure 9. Continuous engagement onto the left side of the Nissan.

As the vehicles crushed, the frontal area of the Cadillac contacted the left front fender and door areas of the Nissan in a continuous engagement pattern **(Figure 9)** resulting in direct contact damage that extended to the left A-pillar area of the pickup truck. As a result of the frontal crush, the left A-pillar was displaced rearward which jammed the left front door in the closed position. Although distorted by deformation, the right front door remained operational.

The Nissan subsequently overturned onto its right side and struck a tree resulting in minor sheetmetal damage. The CDCs for these impact were 00-RDAO-2 and 00-RFMN-2 respectively.

Manual Restraint Systems - 2001 Cadillac DeVille

The 2001 Cadillac DeVille was equipped with integrated 3-point lap and shoulder belts for the driver and front right passenger positions, a center front lap belt, and three rear seat lap and shoulder belt systems.

The front seat integrated belt systems consisted of separate lap and shoulder belt webbings sewn to a common latch plate. The lap belt retractors were affixed to the frame of the seat cushion while the shoulder belt retractor was mounted internally in the lower aspect of the seat back support. The shoulder belt webbing extended through an upper adjustable guide located at the upper outboard aspect of the seat backs. The inboard buckle assembly was affixed to the seat cushion frame and was equipped with a pretensioner. These integrated belt systems were entirely seat mounted and moved fore and aft with the

adjustment of the seat track. The driver's side retractor was an emergency locking retractor (ELR) with a belt sensitive locking mode. The front right retractor was both ELR and automatic locking (ALR) with the belt sensitive mode.

The driver side belt webbing was cut by rescue personnel. The lap belt was cut at a point that was 78.7 cm (31.0") from the latchplate while the shoulder belt was cut 82.6 cm (32.5") above the sewn-on latchplate. The lap belt aspect of the integrated belt system was deformed (curled) and stretched as a result of driver loading. The stitching at the latchplate for both the lap and shoulder belt was elongated, indicative of belt loading.

The rear seat 3-point lap and shoulder belt systems were continuous loop system with sliding latchplates and ELR/ALR retractors.

Automatic Restraint System - 2001 Cadillac

The 2001 Cadillac DeVille was equipped with redesigned frontal air bags and seat back mounted side impact air bags for the driver and front right passenger positions. The air bags did not deploy **(Figures 10 and 11)** as a result of the severe frontal crash sequence with the Nissan pickup truck.

Figure 10. Separated steering wheel with non-deployed air bag module.

Figure 11. Non-deployed front right air bag.

The frontal air bag system consisted of a conventionally mounted driver air bag module that was housed within the four-spoke steering wheel rim. The spokes were configured at the 3/9 and 5/7 o'clock positions. The lower right aspect of the cover flap was identified with AIR BAG molded into the vinyl flap. It should be noted that although the driver's air bag did not deploy, emergency personnel at the scene of the crash pulled the steering wheel with a chain during extrication of the driver. The upper aspect of the wheel rim was deformed **(Figure 10)** and the alloy steering wheel flange fractured which resulted in complete separation of the steering wheel and non-deployed air bag module from the steering column.

The front right passenger air bag was mounted in a top mount configuration under the right upper instrument panel. This application did not utilize a conventional flap design module. At deployment, the upper

instrument panel would separate from the mid panel allowing the bag membrane to deploy. There was minimal separation of these components, however, this separation was related to the interior deformation.

The air bag system utilized a single point Sensing and Diagnostic Module (SDM) that was mounted to the passenger compartment floor under the lower rear aspect of the center console. The SDM provided the vehicle with crash sensing, air bag system diagnostics, and Event Data Recording (EDR). During the on-site investigation, the attorney representing the family of the deceased driver authorized the Veridian SCI investigator and the General Motors representative to disassemble the console to gain access to the SDM for the sole purpose of downloading the EDR data.

The Vetronix Crash Data Retrieval System was utilized to perform the download. Auxiliary 12 volt power was supplied to the Vetronix interface box which was required for this download procedure. The interface cable was plugged directly into the SDM. Utilizing a lap top computer, the EDR was downloaded. The EDR recorded a single Non-Deployment Event for this crash. The frontal air bag system did not deploy, however, the front seat buckle pretensioners fired.

The Non-Deployment Data was as follows:

1G6KD54Y11U (Production Number Deleted)	**System Status At Non-Deployment**
SIR Warning Lamp Status	OFF
Driver's Seat Belt Switch Circuit Status	BUCKLED
Passenger Front Air Bag Suppression Switch Circuit Status	AIR BAG NOT SUPPRESSED
Ignition Cycles At Non-Deployment	158

The Pre-Crash data fields were listed as INVALID. The Non-Deployment Pre-Crash Graph was identified as DATA INVALID. The Pre-Crash Vehicle Speed was defaulted to a value of 158 MPH with default values of 0 for the Engine Speed and Percent Throttle. The Brake Circuit Status was defaulted to OFF. He EDR Output is attached as **Figure 15**, Page 13 of this report.

The Cadillac DeVille was also equipped with side impact air bags that were mounted in the outboard aspect of the front left and front right seat backs. Side impact crash sensors were located in the lower aspect of the B-pillars to detect lateral crashes. The side impact air bags did not deploy as a result of this frontal impact crash.

The front outboard seat positions were equipped with seat belt

Figure 12. Fired seat belt buckle pretensioners.

buckle pretensioners. The buckle was attached to the pretensioner and concealed within a vinyl sleeve with a convoluted jacket located between the buckle and the vinyl sleeve. Both front pretensioners fired during the crash. The left buckle pretensioner reduced the height of the buckle by 4.9 cm (1 15/16") while the right buckle was reduced in height be 5.1 cm (2.0"). The housing for the right buckle assembly, although not engaged with the latchplate for this unoccupied seat position, fractured as a result of the firing of the pretensioner. **Figure 12** shows the fired buckle pretensioners.

Driver Demographics - 2001 Cadillac DeVille

Age/Sex:	68 year old/Male
Height:	170.2 cm (67.0")
Weight:	99.8 kg (220.0 lb)
Seat Track Position:	Mid track
Manual Restraint Usage:	Integrated 3-point lap and shoulder belt system
Usage Source:	Vehicle inspection, observations of first responders to crash scene
Eyeware:	Prescription eyeglasses
Medical Treatment:	N/A, expired at scene

Driver Injuries

Injury	Injury Severity (AIS90/Update 98)	Injury Mechanisms
*Transected thoracic aorta	Maximum (420210.5,4)	Intruding steering wheel rim/air bag module/spokes
*Multiple bilateral rib fractures (NFS) with hemothoraces	Serious (450211.3,1; 450211.3,2)	Intruding steering wheel rim/air bag module/spokes
*Avulsed vena-cava	Serious (421802.3,4)	Intruding steering wheel rim/air bag module/spokes
*Laceration of the right atrium (NFS)	Serious (441008.3,4)	Intruding steering wheel rim/air bag module/spokes
+Right lower leg laceration (NFS)	Minor (890600.1,2)	Unknown

*Source - * Medical Examiner; release of autopsy not permitted by family attorney.*
+ First responders

Driver Kinematics

The 68 year old male driver of the 2001 Cadillac DeVille was seated in a presumed normal driving posture with the seat track adjusted to a mid track position, 12.7 cm (5.0") forward of the full rear and 8.3 cm (3.25") rear of the full forward position. The seat back angle was unknown. The adjustable head restraint was adjusted to the full down position. The driver was restrained by the integral 3-point lap and shoulder

belt system. Belt usage was verified by observations of the first responders to the crash scene, cutting of the belt webbing prior to removal of the driver's body, and forward displacement of the seat back from driver loading of the integral belt system.

At impact, the driver of the Cadillac initiated a forward trajectory in response to the 12 o'clock impact force. He loaded against the integral belt system which deflected the seat back forward to a post-crash measured angle of (-) 1 degree forward of vertical. As he initiated his forward trajectory and deformed the seat back forward, the driver was struck in the chest by the intruding steering assembly. It should be noted that the frontal air bag system did not deploy. The driver continued forward and compressed the energy absorbing steering column. The left V-shaped shear bracket was fractured. The measured separation of the fracture point to the shear capsule block was 6.0 cm (2.375"). The right shear capsule remained intact and had separated 5.1 cm (2.0") due to driver loading. As a result of loading the intruding steering wheel, the driver sustained a transected aorta, multiple bilateral rib fractures, an avulsed vena-cava, and a laceration of the right atrium. It was possible that the shoulder belt loading contributed to the these injuries. The steering wheel rim was subsequently pulled from the vehicle by rescue personnel (pulled via a chain) post-crash. The horizontal distance between the end of the steering column (wheel removed) and the seat back support was 35.6 cm (14.0"). The thickness of the steering wheel, inclusive of wheel and the non-deployed air bag module was 10.2 cm (4.0"), therefore reducing this horizontal distance to approximately 25.4 cm (10.0").

The driver's knees contacted the intruding knee bolster as evidenced by dark blue fabric transfers to the bolster cover **(Figure 13)**. The left knee contact was located 50.2-60.7 cm (19.75-23.9") left of the right edge of the bolster panel and was located 10.4-28.2 cm (4.1-11.1") below the top edge of the bolster. The right knee scuff was located 0-5.1 cm (0-2.0") inboard of the right edge and 16.5-26.7 cm (6.5-10.5") below the top of the bolster. The driver sustained a laceration of the right lower leg. The specific location of the laceration was unknown, therefore it was unknown if the laceration was related to the bolster contact.

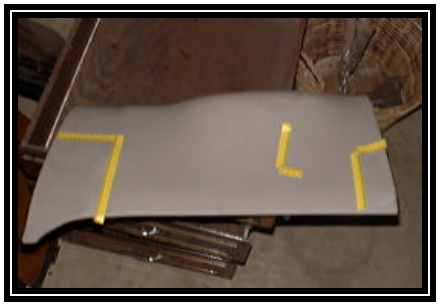


Figure 13. Knee contacts to the knee bolster.

The driver slumped to the left as the Cadillac rotated in a CCW direction to final rest. He was found without pulse with his chin resting on the upper left instrument panel and his torso against the left door panel. The investigating officer noted that the shoulder belt was positioned across the chest of the driver. The driver was pronounced deceased at the scene of the crash. Although an autopsy was performed on the body, the family issued a non-release order of the autopsy report. The documented injures were identified by the medical examiner in a telephone interview at the time of the on-site SCI investigation.

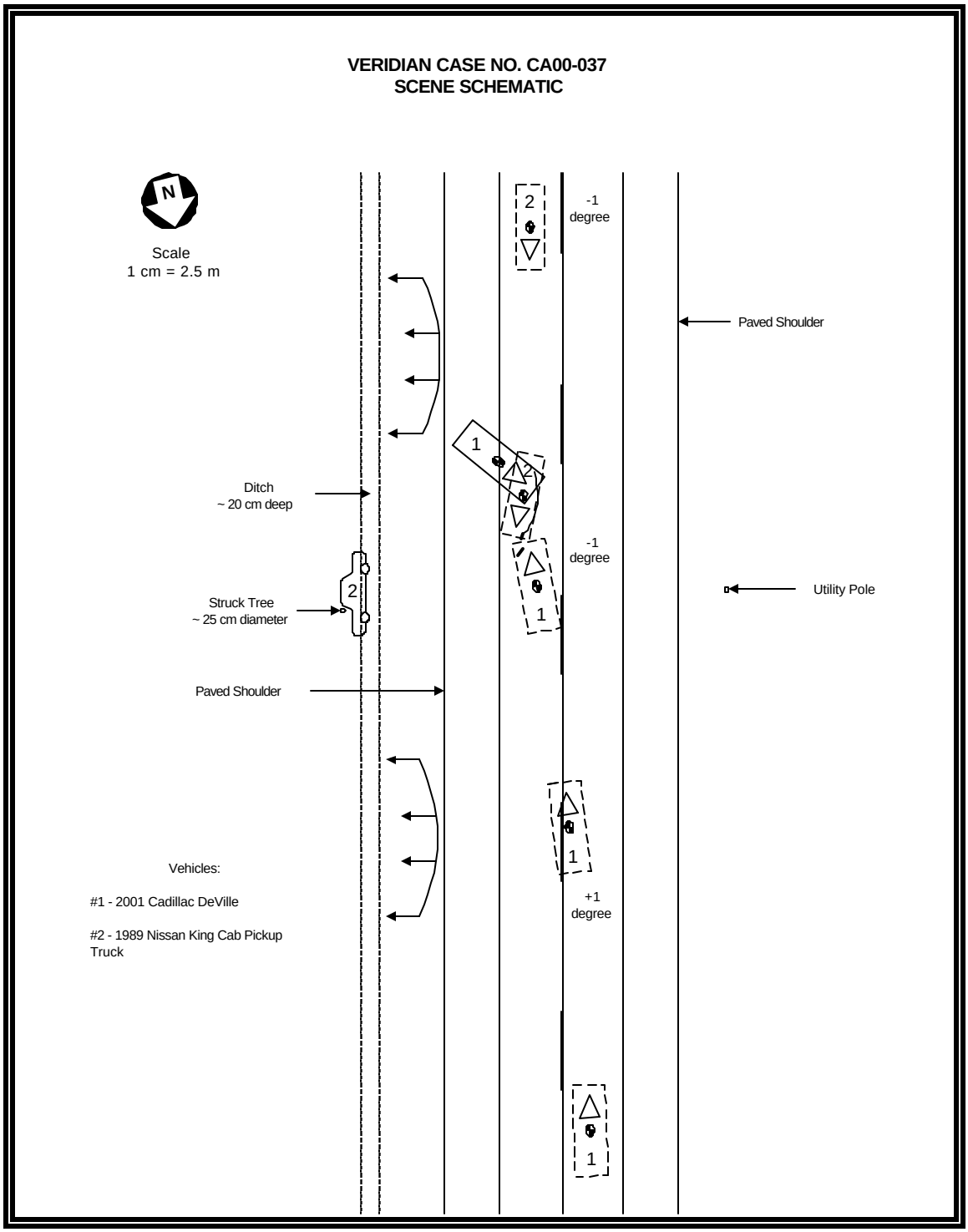


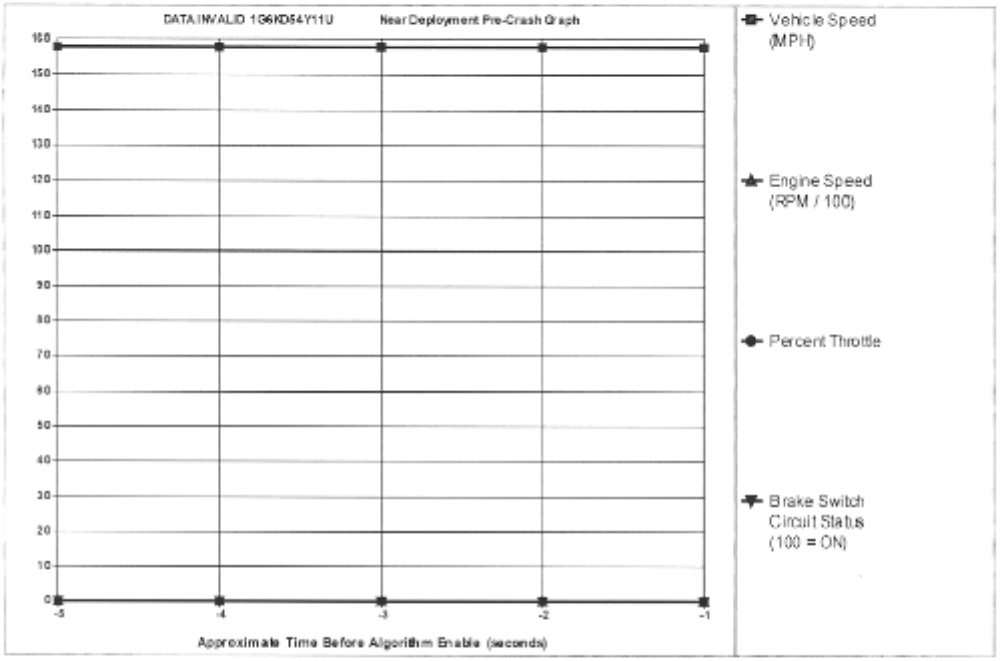
Figure 14. Crash Schematic.

Vetronix

CDR CRASH DATA RETRIEVAL SYSTEM

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	158



Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	158	0	0	OFF
-4	158	0	0	OFF
-3	158	0	0	OFF
-2	158	0	0	OFF
-1	158	0	0	OFF