TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER

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ON-SITE SIDE IMPACT PROTECTION/DRIVER FATALITY INVESTIGATION

VERIDIAN CASE NO: CA98-045

VEHICLE: 1997 CADILLAC DEVILLE

LOCATION: OHIO

CRASH DATE: AUGUST 1998

Contract No. DTNH22-94-07058

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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 be 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 of the involved vehicle(s) or their safety systems.

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17. *Abstract* This investigation focused on the performance of the Supplemental Restraint System (SRS) in a 1997 Cadillac DeVille and the fatal injury mechanisms of the 58 year old female driver. The Cadillac was equipped with a SRS that consisted of frontal air bags and door-mounted side impact air bags for the driver and front right passenger. The Cadillac's frontal air bags and the left side impact air bag deployed as a result of a left side impact with a 1985 Oldsmobile Ninety-Eight during a six-vehicle inter-state highway crash sequence. The restrained driver of the Cadillac sustained a complete aortic transection and multiple blunt force chest injuries, as a result of the impact. The Special Crash Investigations team of Veridian Engineering was notified of the crash by the Crash Investigations Division of the National Highway Traffic Safety Administration (NHTSA). The NHTSA was notified by the Ohio State Police two days after the crash. An investigator from the Veridian SCI team was on-site the day after notification. The Sensing Diagnostic Module (SDM) of the Cadillac's SRS was downloaded by ESIS Claims Investigations and interpreted by the General Motors Product Analysis as a supplement to the SCI investigation.			
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ON-SITE SIDE IMPACT PROTECTION/DRIVER FATALITY INVESTIGATION
VERIDIAN CASE NO. CA98-045
1997 CADILLAC DEVILLE
LOCATION: OHIO
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BACKGROUND

This investigation focused on the performance of the Supplemental Restraint System (SRS) in a 1997 Cadillac DeVille and the fatal injury mechanisms of the 58 year old female driver. The Cadillac was equipped with a SRS that consisted of frontal air bags and door-mounted side impact air bags for the driver and front right passenger. The Cadillac's frontal air bags and the left side impact air bag deployed as a result of a left side impact with a 1985 Oldsmobile Ninety-Eight during a six-vehicle inter-state highway crash sequence. The restrained driver of the Cadillac sustained a complete aortic transection and multiple blunt force chest injuries, as a result of the impact.

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SUMMARY

Crash Site

This six-vehicle crash occurred during the afternoon hours of August 1998. At the time of the crash, it was daylight and the weather was not a factor. The crash occurred on a four lane divided (two eastbound, two westbound) concrete state highway. The respective travel lanes were separated by a 12 m (40 ft) wide depressed grass median. There was a positive 1.7 percent grade in the eastbound direction. The outboard travel lanes were bordered by 3.2 m (10.5 ft) wide breakdown lanes and guardrails in the area of the crash. The posted speed limit was 105 km/h (65 mph). **Figure 1** is an eastbound view at the crash site.

Figure 1: Eastbound view at the loss of control.

Pre-crash

Figure 20, page 17, is a schematic depicting the crash sequence. The 1997 Cadillac DeVille was traveling eastbound in the outboard (right) travel lane driven by a 58 year old restrained female. The front right

passenger was a 64 year old restrained male. He reported to the police investigator, he was asleep at the time of the crash and unaware of the details leading up to the impact..

Crash Sequence

A witness trailing the Cadillac reported that the Cadillac drifted to the left and sideswiped the right side plane of a 1997 Buick Skylark. The driver of the Buick Skylark steered left in an unsuccessful attempt to avoid the Cadillac. The driver then countersteered and stopped the vehicle, without further contact, on the inboard shoulder of the eastbound lanes.

The startled driver of the Cadillac reacted to the contact with the Buick by oversteering to the right and then back to the left. The Cadillac crossed the eastbound lanes and the vehicle entered the right breakdown lane. The driver's oversteering maneuvers caused the vehicle to break traction and the Cadillac re-crossed the eastbound travel lanes in a counterclockwise yaw. Refer to Figure 1 above.

The Cadillac DeVille crossed the grass median in yawing trajectory. As it entered the inboard (left) westbound travel lane, the vehicle had rotated counterclockwise approximately 70 degrees. The left aspect of the Cadillac's front plane end-swiped the left side plane of a 1996 Buick Regal. The driver of the Buick reacted to the Cadillac with avoidance steering and lost control. The Buick departed the roadway to the left where it subsequently rolled six quarter turns and came to rest on its roof in the median.

The Cadillac continued rotating counterclockwise after separation from the Buick Regal and was facing in a southwesterly direction. Coincident to this a 1996 Ford Thunderbird was westbound in the inboard lane. The driver of a Ford attempted to avoid contact with the Cadillac by applying full brakes and steering to the left. The frontal plane of the Cadillac end-swiped the right side of the Ford. The Ford continued westward and came to rest on the inboard shoulder area adjacent to the median.

The Cadillac separated from the Ford and was positioned between the left and right westbound travel lanes in a southeasterly heading. The left side plane of the Cadillac was then struck by the frontal plane of the westbound 1985 Oldsmobile Ninety-Eight with an 11 o'clock force direction (with respect to the Cadillac). This impact sequence deployed both the left side door mounted air bag and the frontal air bags of the Cadillac. The delta V calculated by the Damage model of the WINSMASH program was 33.0 km/h (20.5 mph). The longitudinal and lateral delta V components were -25.3 km/h (-15.7 mph) and 21.2 km/h (13.2 mph), respectively.

The Cadillac rotated an additional 180 degrees counterclockwise from this impact and came to the rest blocking the inboard westbound lane facing northward. The Oldsmobile was redirected to the right where it departed the right roadway edge and struck the W-beam guardrail with the left front bumper. The Oldsmobile came to rest in contact with the guardrail, in the breakdown lane. **Figure 2** is a westward view of the final rest positions of the Cadillac and Oldsmobile.

Figure 2: Final rest position of the Cadillac and Oldsmobile.

A sixth vehicle, a 1993 Saturn SL1, traveling eastbound was struck by flying debris generated by Buick Regal as it was initiating its rollover sequence within the median. The Saturn came to rest without further incident on the outboard shoulder of the eastbound lanes.

Post-Crash

The police responded within minutes of the crash and were among the first to assess participants for injury. It was readily apparent to the police that the female driver of the Cadillac had sustained serious trauma during the crash. She was found restrained within the driver's seat and unresponsive. Three nurses who were in the area came forward to assist the injured. They initially obtained a strong pulse from the female driver and noted that she was breathing on her own. Within minutes, however, the driver's vital signs began to decline. She was removed from the vehicle and placed on the roadway surface. She subsequently experienced cardiac arrest and was resuscitated by the nurses. Rescue arrived and transported the driver via helicopter to an area medical facility. The driver was pronounced dead 1 hour and 42 minutes post-crash.

The front right passenger of the Cadillac complained of sore left ribs (attributed to the manual restraint system). He was transported and reportedly admitted for observation. The other individuals involved in this crash sustained minor abrasions and lacerations but no other serious or life-threatening injuries.

1997 CADILLAC DEVILLE

The 1997 Cadillac DeVille, **Figure 3**, was identified by the Vehicle Identification Number (VIN): 1G6KD54Y0VU (production sequence deleted). The 4-door sedan was equipped with a 4.6 liter/V8 engine linked to a 4-speed automatic transmission. The manual restraint system consisted of 3-point lap and shoulder belts for the five seat positions. The Supplemental Restraint System (SRS) consisted of frontal air bags for the driver and front right passenger and front door-mounted side impact air bags. The frontal air bags and the left front door side air bag deployed as the result of the impact with the 1985 Oldsmobile Ninety-Eight. The Cadillac's electronic odometer could not be read due to the lack of electrical power.

Exterior Vehicle Damage

Exterior damage to the Cadillac involved the front bumper, grille, hood, both front fenders, right front wheel, left side wheels, right front fender, right front door, left front and left rear doors, the left A-pillar, left B-pillar, roof, left front door glazing, and windshield. The left doors were jammed closed due to the deformation. The right front wheel was displaced rearward 4.0 cm (1.6 in) while the left side wheelbase was extended 22.1 cm (8.7 in) as the result of the rearward displacement of the left rear wheel.

Figure 3: Front view of the Cadillac.

The Cadillac sustained impact damage to its front and left side planes as a result of the multiple vehicle/multiple impact sequence. The sequence of events is summarized in the table below:

Event	Contact Vehicle/Plane	Impact Configuration	Collision Deformation Classification
1	1997 Buick Skylark/Right side	Side-swipe	Unknown left side
2	1996 Buick Regal/Left side	End-swipe	Unknown frontal
3	1996 Ford Thunderbird/Right side	End-swipe	Unknown frontal
4	1985 Oldsmobile Ninety Eight/Front	Left Side to Front	11-LDAW-3

The damage that resulted from the sideswiping contact with the Buick Skylark was masked by the impact damage resulting from the impact with the Oldsmobile. Considering the impact configuration and the residual damage to the Buick, the Cadillac's left side damage would have been minor, probably consisting of localized paint transfers and abrasions.

The vehicle's frontal plane sustained two below (air bag deployment) threshold end-swipe contacts. Refer to **Figure 3** above. These impacts were minor and did not warrant deployment of the frontal air bag system, considering the vehicular engagement and configuration. The crush profile of the front plane along the bumper reinforcement bar was a resulted of the two overlapping impacts. The combined width of the direct and induced damage extended across the vehicle's entire 163 cm (64 in) end width. The documented residual crush was as follows: C1 = 17.8 cm (7.0 in), C2 = 6.4 cm (2.5 in), C3 = 1.9 cm (0.75 in), C4 = 0.6 cm (0.25 in), C5 = 0, C6 = 7.6 cm (3.0 in).

The left side of the Cadillac sustained moderate damage as a result of the impact with the Oldsmobile, **Figures 4 and 5**. The combined width of the direct and induced left side damage began 95.2 cm (37.5 in) forward of the left rear bumper corner and extended forward 323.9 cm (127.5 in). The width of the direct damage field measured 303.5 cm (119.5 in) and began 108.0 cm (42.5 in) forward of the left rear bumper corner. The maximum left lateral crush of 35.6 cm (14.0 in) was located 224.8 cm (88.5 in) forward of the left rear bumper corner, on the mid-aspect of the left front door and left B-pillar. The left side crush profile resultant to the impact with the Oldsmobile was as follows: C1 = 2.5 cm (1.0 in), C2 = 25.4 cm (10.0 in), C3 = 35.6 cm (14.0 in), C4 = 35.6 cm (14.0 in), C5 = 19.7 cm (7.75 in), C6 = 6.4 cm (2.5 in). The Collision Deformation Classification (CDC) was 11-LDAW-3. The delta V calculated by the Damage model of the WINSMASH program was 33.0 km/h (20.5 mph). The longitudinal and lateral delta V components were -25.3 km/h (-15.7 mph) and 21.2 km/h (13.2 mph), respectively. The WINSMASH calculated delta V was underestimated compared to the crash event data recorded by the Sensing Diagnostic Module (SDM).

Figure 4: View of the Cadillac's left side damage.

Figure 5: Close-up of the damaged left front door.

ESIS Claims downloaded the crash event data recorded and stored within the air bag system's SDM. Analysis of that data by GM Product Analysis determined the longitudinal delta V recorded by the SDM was -31.7 km/h (-19.7 mph). Refer to the Cadillac's Supplemental Restraint System section of this report for further information.

1985 OLDSMOBILE NINETY-EIGHT

The 1985 Oldsmobile Ninety-Eight was identified by the Vehicle Identification Number (VIN): 1G3CW6935F4 (production sequence deleted). The 4-door sedan was powered by a 3.5 liter/V8 engine linked to a four-speed automatic transmission. The manual restraint system consisted of 3-point lap and shoulder belts in the four outboard positions. It was not equipped with a Supplemental Restraint System. The odometer read 195,535 km (121,503 miles) at inspection.

Exterior Damage

The front plane of the Oldsmobile sustained 104 cm (41 in) of direct contact damage during the impact with the left side plane of the Cadillac. The direct damage began 22.9 cm (9.0 in) right of center and extended to the left corner of the front bumper. The combined with of the direct and induced frontal damage extended across the entire 162.6 cm (64.0 in) frontal end-width of the vehicle. The maximum crush of 83.8 cm (33.0 in) was located at the left front bumper corner. Vehicle components damaged included the front bumper, grille, hood, windshield, left headlight assembly, left A-pillar, left front door and window glazing, and the left front and right front wheel. The crush profile measured along the front bumper was as follows: C_1 = 83.8 cm (33.0 in), C_2 = 59.7 cm (23.5 in), C_3 = 40.0 cm (15.75 in), C_4 = 20.3 cm (8.0 in), C_5 = 5.1 cm (2.0 in), C_6 = 0 cm. The left wheelbase was reduced 20 cm (8 in). The right wheelbase measurement was unchanged. The total delta V calculated by the Damage algorithm of the WINSMASH model was 40.0 km/h (24.9 mph). The longitudinal and lateral delta V components were -40.0 km/h (-24.9) and 0 km/h (0 mph), respectively. The CDC of the impact was 12-FYEW-3.

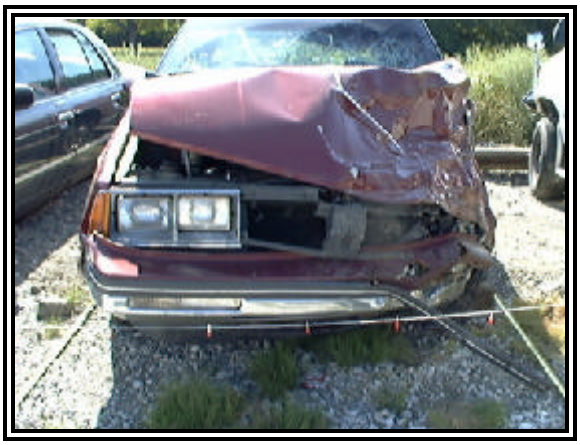

Figure 6: Front view of the Oldsmobile 98.

Figure 7: Left front view.

Figure 8: Left rear view.

SECONDARY VEHICLES INVOLVED IN THE CRASH
1997 BUICK SKYLARK

Exterior Damage

The 1997 Buick Skylark, **Figure 9**, was identified by the Vehicle Identification Number (VIN): 1G4NJ52TXVC (production sequence deleted). The 4-door sedan was equipped with a 2.4 liter/I4 engine linked to a 4-speed automatic transmission. The vehicle was manufactured in February 1997 and the odometer read 62,067 km (38,568 miles). The vehicle was equipped with a Supplemental Restraint System (SRS) that consisted of frontal air bags for the driver and front right passenger. The air bag system did not deploy as the result of the sideswiping contact with the Cadillac. The vehicle was driven from the scene by the driver, but later was determined to be disabled. The vehicle was subsequently towed from a service plaza due to suspension damage.

Figure 9: Right front view of the Buick Skylark.

The exterior damage to Buick Skylark involved the abrasions and paint transfers to right rear quarterpanel and the right front fender, as well as abrasions to both right side wheels. There was a 12.7 mm (0.5 in) elongation of the right wheel base. There were two minor areas of direct contact along the right side plane. The first area began 19.1 cm (7.5 in) rearward of the right front axle and extended forward on the right front fender 82.6 cm (32.5 in) in length. The maximum crush measured 3.8 cm (1.5 in). The second direct contact area measured 92.7 cm (36.5 in) in length. This contact pattern began 19.1 cm (7.5 in) forward of the right rear axle and extended rearward onto the right rear quarterpanel. The maximum crush of the quarterpanel measured 3.8 cm (1.5 in). The Collision Deformation Classification (CDC) for the impact was 06-RDES-1.

1996 BUICK REGAL

Exterior Damage

The 1996 Buick Regal was identified by the Vehicle Identification Number (VIN): 2G4WB52K4T1 (production sequence deleted). The 4-door sedan was equipped with a 3.8 liter/V6 linked to a 4-speed automatic transmission. The vehicle was equipped with a Supplemental Restraint System (SRS) consisting of dual front air bags which did not deploy during the crash sequence. The vehicle's odometer registered 33,615 km (20,888 miles). **Figures 10 and 11** are the left rear and right front views of the vehicle, respectively.

The left side plane of the Buick Regal end-swiped the front plane of the Cadillac. The Buick then traveled into the median and subsequently rolled over six quarter turns coming to rest on its roof. Contact on the

left side plane began 235.0 cm (92.5 in) rearward from the left front bumper corner and extended rearward 237.5 cm (93.5 in). The crush profile measured at the mid-door elevation was as follows: C_1 = 16.5 cm (6.5 in), C_2 = 20.3 cm (8.0 in), C_3 = 17.8 cm (7.0 in), C_4 = 12.1 cm (4.75 in), C_5 = 7.6 cm (3.0 in), C_6 = 4.4 cm (1.75 in). Both side planes and the top plane were damaged in the rollover event with the roof sustaining a maximum crush of 20.3 cm (8.0 in). The center portion of the windshield was holed and the right side glazing and left rear side glazing was disintegrated from the rollover event. All four doors were jammed due to damage. The right front window frame was displaced forward a distance of 55.9 cm (22.0 in). The CDC's of the left side impact and the rollover event were 11-LZEW-2 and 00-TDDO-4, respectively.

Figure 10: Left rear view of the damaged Buick Regal.

Figure 11: Right front view of the Buick Regal.

1996 FORD THUNDERBIRD

Exterior Damage

The 1996 Ford Thunderbird was identified by the Vehicle Identification Number (VIN): 1FALP6245TH1 (production sequence deleted). The 4-door sedan was equipped with a 3.8 liter/V6 linked to a 4-speed automatic transmission. The vehicle was equipped with a Supplemental Restraint System (SRS) consisting of dual front air bags which did not deploy during the crash sequence. The vehicle's odometer registered 30,559 km (18,989 miles). **Figure 12** is a right front view of the Ford.

Figure 12: Right front view of the Ford Thunderbird.

The right side of the Ford end-swiped the front plane of the Cadillac. The damage began at the right front bumper corner and extended rearward 303.5 cm (119.5 in) to the side panel behind the right front door.

The exterior damage consisted of abrasions and paint transfers to the vehicle's body panels. The maximum crush was an estimated 3.8 cm (1.5 in). The CDC for this impact was 12-RYES-1.

1993 SATURN SL1

The 1993 Saturn SL1 was struck by debris displaced from the median during the rollover crash sequence of the 1996 Buick Regal. The vehicle was driven from the crash scene at the conclusion of the on-scene police investigation. This vehicle was not inspected.

1997 CADILLAC DEVILLE

Interior Damage

Interior vehicle damage to the 1997 Cadillac DeVille, **Figure 13**, was attributed to intrusion, occupant contacts, and the deployment of the Supplemental Restraint System (SRS). The left side of the vehicle sustained the highest magnitude of intrusion from the impact with the 1985 Oldsmobile Ninety-Eight. The left rear door surface, the left B-pillar, and the sill below the left rear door intruded laterally into the left rear occupant space 27.9 cm (11.0 in). The left front door panel at the armrest was intruded laterally 12.7 cm (5.0 in) while the left roof side rail and the sill below the left front door was displaced 6.4 cm (2.5 in) laterally. The left A-pillar was displaced longitudinally 16.5 cm (6.5 in).

Figure 13: Right interior view.

The front seat row was a 60/40 split bench with separate seat back supports. The lateral dimension of the driver's seat cushion measured 66.0 cm (26.0 in) which included a 19.1 cm (7.5 in) lateral distance designated as part of the center seat position. The incline of the seat cushion measured 14 degrees with the leading edge measuring 26.7 cm (10.5 in) above the floor. The six-way electric adjustable seat was adjusted in a mid-track position with the leading edge of the cushion measuring 6.4 cm (2.5 in) rearward from the vertical surface of the instrument panel. The driver's seat back support measured 53.3 cm (21.0 in) laterally and was reclined 22 degrees. It was equipped with a movable inboard armrest which was reportedly in the down position at the time of the crash. A black colored transfer mark was noted on the inboard surface of the head restraint which measured 10.2 cm (4.0 in) longitudinally and 12.7 cm (5.0 in) vertically. This mark was attributed to possible contact by the upper torso of the right front occupant during the crash sequence.

Figure 14: Left front interior contacts.

There were indentations, hair, scuffs, and transfers noted to the left front interior side structure of the vehicle which were attributed to contact by the driver during the impact sequence with the Oldsmobile. Refer to **Figure 14**. A heavy scuff was observed on the left ceiling mounted grab handle which measured 4.5 cm (1.75 in) in length and was located 54.0 cm (21.25 in) rearward of the instrument panel. This was attributed to contact by the driver's head. Just below this area there was a 10.2 cm (4.0 in) long heavy abraded mark on the fabric of the roof side rail. This mark was located 39.4 cm (15.5 in) rearward from the instrument panel and was also attributed to contact by the driver's head.

Strands of hair were detected in the rubber gasket of the upper front portion of the left window frame. The hair strands were located below the abraded mark and 38.1 cm (15.0 in) rearward from the instrument panel. The hair strands were visible over a 12.7 cm (5.0 in) length.

There was a 1.3 cm (0.5 in) indentation of the door closure grab bar which measured 14.0 cm (5.5 in) in length and was located 32.4 cm (12.75 in) rearward from the instrument panel. This indentation was attributed to contact by the driver's left hip area. The driver's left hip also contacted the door panel just below the door closure grab bar which was noted by a transfer mark which measured 10.2 cm (4.0 in) in length and was located 34.3 cm (13.5 in) rearward from the instrument panel.

The driver’s knee bolster did not exhibited any contact points related to loading by the driver. Although the steering column shear capsules could not be examined due to the damage, the steering column did not appear to be compressed. The tilt steering column measured 10 degrees above horizontal. The steering wheel rim was not deformed.

The six-way electric adjustable right front seat appeared to be in a full rear adjusted position which was 6.4 cm (2.5 in) further rearward than the driver side seat. The seat back support was located 87.6 cm (34.5 in) rearward from the leading edge of the upper instrument panel at a height of 48.3 cm (19.0 in) above the seat cushion. The seat back angle was reclined 19 degrees.

There was a scuff mark on the right side of the ashtray which was attributed to contact by the right front occupant's left leg during the crash sequence. A 17.8 cm (7.0 in) lateral black transfer mark was noted along the lower instrument panel below the glove compartment door which was attributed to contact by the passenger's right knee. This mark was located 43.2 cm (17.0 in) right of the vehicle centerline.

The left aspect of the windshield was fractured due to the exterior crash forces. The right aspect of the windshield was also fractured. The fracture pattern appeared to have a focal contact point located 43.8 cm (17.25 in) right of the vehicle centerline and 40.6 cm (16.0 in) below the windshield header. The fracture was surrounded by a circular spider web pattern. This fracture was attributed to contact from the top surface of the with the instrument panel as it deformed during the deployment sequence of the front right passenger air bag.

Manual Restraint System

The Cadillac was equipped with manual lap and shoulder restraints in the four outboard positions. The front outboard restraints consisted of two separate lap and shoulder belt webbings sewn to a common latch plate. The left front inertial locking retractor was locked due to the B-pillar deformation and the driver's webbing was extended at inspection. There was visible deposits of blood on the torso belt which indicated that the female driver was wearing the restraint at the time of the crash, **Figure 15**. The adjustable D-ring was in the lowest position over a 7.6 cm (3.0 in) adjustment range.

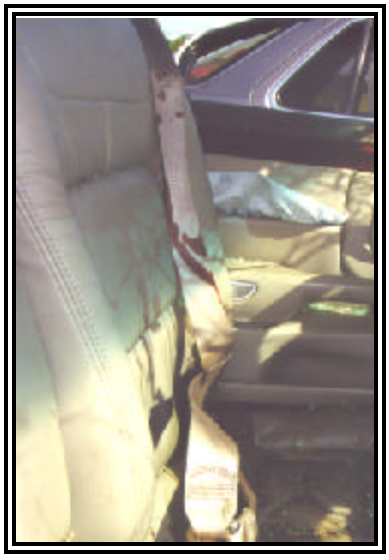

Figure 15: Driver restraint.

The male front right passenger was wearing the lap and torso belt at the time of the crash. This was apparent from the D-ring transfer on the torso belt which was located 108.0 cm (42.5 in) from the latch plate. The restraint was stowed within the retractor upon inspection and was operational. The adjustable D-ring was noted in the full down position over a vertical adjustable range of 7.6 cm (3.0 in).

Supplemental Restraint System

The 1997 Cadillac DeVille was equipped with a Supplemental Restraint System that consisted of frontal air bags for the driver and front right passenger and front door-mounted side impact air bags. The SRS was controlled by a Sensing and Diagnostic Module (SDM) fastened to the floor pan under the driver's seat. An external satellite crash sensor for frontal impact was located on the radiator support and external side impact sensors were located within the respective front door panels. The SDM had the capability to record crash event data. This data was downloaded by ESIS Claim Investigations and interpreted by GM Product Analysis.

Analysis of the crash event data determined the Cadillac's longitudinal delta V was -31.7 km/h (-19.7 mph). The air bag warning lamp, located within the instrument cluster, was off and there were no fault codes stored with the module. The SRS was operating properly at the time of the impact.

The Cadillac struck three vehicles prior to impacting 1985 Oldsmobile Ninety-Eight. Due to the respective directions of force and the Cadillac's respective decelerations, the first three impacts were below the deployment threshold of the SRS. The impact with the Oldsmobile with the force direction in the 11 o'clock sector deployed both the frontal air bags and left side impact air bag.

The delta V calculated by the Damage model of the WINSMASH program was 33.0 km/h (20.5 mph). The longitudinal and lateral delta V components were -25.3 km/h (-15.7 mph) and 21.2 km/h (13.2 mph), respectively. This analysis underestimated the severity of the crash as compared to the data downloaded from the SDM.

Left Side Impact Air Bag

The left front door-mounted side impact air bag module was located in the upper aft aspect of the door panel. The interior module cover was comprised of two flaps which opened in an H configuration. The lateral dimension of the top flap at the hinged edge measured 33.0 cm (13.0 in) while the dimension at the bottom flap hinge was 29.2 cm (11.5 in). The vertical height of the top and bottom flaps measured 8.9 cm (3.5 in) and 7.6 cm (3.0 in), respectively. The forward vertical seam edge of the air bag module cover was located 40.6 cm (16.0 in) rearward from the instrument panel with the top flap hinge edge located 10.2 cm (4.0 in) below the window sill. The rear vertical seam line of the air bag module was located 2.5 cm (1.0 in) forward of the trailing edge of the left front door.

The driver seat was adjusted forward along the seat track which resulted in partial occlusion of the air bag by the seat back support. The forward vertical edge of the air bag module cover was located 21.6 cm (8.5 in) forward of the seat back support. The remaining rearward portion of the module cover was masked by the 20.3 cm (8.0 in) thick outboard aspect of the seat back support.

The left front side air bag deployed and was compressed against the outboard aspect of the driver seat back support by the intruding door surface and B-pillar. A 16.5 cm (6.5 in) portion of the air bag was longitudinally forward of the seat back support with a 8.9 cm (3.5 in) portion rearward of the seat back support. Refer to **Figures 16 and 17**. The longitudinal dimension of the air bag measured 48.3 cm (19.0 in). The lateral excursion of the air bag into the occupant space measured 7.6 cm (3.0 in), **Figure 18**. There was no evidence of occupant contact noted on the air bag.

Figure 16: View of the left side impact air bag forward of the driver seat back.

Figure 17: View of the left side impact air bag behind the driver's seat back.

The outside surface of the left front door was separated from the vehicle during the impact with Oldsmobile. During this impact sequence, the crash sensing device for the side air bag was separated from the wiring harness. The separation of the sensor occurred after the initiation of the air bag deployment sequence.

The left side impact air bag inflator unit was visible from the outside of the vehicle due to the separation of the door panel during the crash sequence, **Figure 19**. The inflator unit was a circular design which measured 8.6 cm (3.375 in) in diameter and was attached by a six bolt mounting system to the inner door panel. The identification was as follows:

TEMIC EG-20V002
970160100639

Figure 18: Top view of the lateral excursion of the left side impact air bag.

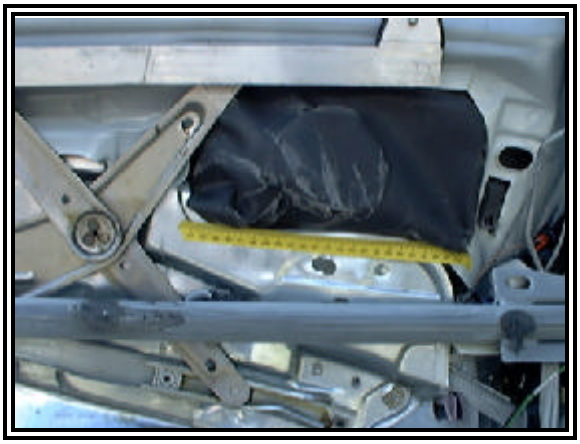

Figure 19: Exterior view of the left side impact module.

Driver Air Bag

The driver air bag module cover was configured in the center hub of the steering wheel rim with an I-configuration flap design. The vertical height of the flaps measured 10.8 cm (4.25 in) with the lateral width of each flap measuring 8.9 cm (3.5 in). There was a black transfer mark noted in the lower right corner of the right flap which was attributed to post crash events. There was no evidence which indicated driver contact with the module cover during the deployment sequence.

The front left air bag was a non tethered design which had two 1.9 cm (0.75 in) diameter vent ports located at the 9 o'clock and 3 o'clock positions on the back side of the air bag. There were blood deposits over the surface of the air bag which were attributed to post crash driver contact. The air bag measured 68.6 cm (27.0 in) in diameter. There was a identifying part number attached to the underside of the air bag module flap which read as follows:

Part No. 16758060
Lot # 06673A3

Front Right Passenger Air Bag

The front right air bag was a top mount design which incorporated the top panel of the instrument panel as the air bag module cover. During the deployment cycle, the top panel was displaced upward and toward

the windshield. There was no occupant contact evidence noted to the surface of this panel. The air bag inflator unit measured 30.5 cm (12.0 in) in length and was located 221.0 cm (8.25 in) right of the vehicle centerline.

The front surface of the air bag measured 45.7 cm (18.0 in) laterally and 45.7 cm (18.0 in) vertically. The rearward excursion of the air bag measured 30.5 cm (12.0 in) from the instrument panel. There were two 2.5 cm (1.0 in) diameter vent ports located on the inboard and outboard side surfaces of the air bag which were adjacent to the instrument panel.

The air bag construction utilized four tethers which were attached to the front surface of the air bag along the side seam lines with two located at the top and two at the bottom corners. The top tethers measured 53.3 cm (21.0 in) long and the bottom tethers measured 61.0 cm (24.0 in) in length.

There were no obvious occupant contact artifacts on the surface of the air bag. The air bag identification number was as follows:

ID# 16759479-16
Cadillac E/K
TRAE70179665

OCCUPANT DEMOGRAPHICS

1997 Cadillac DeVille

	Driver	***Front Right Passenger***
Age/Sex:	58 years old/Female	64 year old/Male
Height/Weight:	Unknown	Unknown
Manual Restraint Use:	3-point lap and shoulder	3-point lap and shoulder
Usage Source:	SCI inspection	SCI inspection
Medical Treatment:	Fatally injured	Hospitalized and released

1997 CADILLAC DEVILLE DRIVER INJURIES

Injury	***Severity (AIS 98 update)***	***Injury Mechanism***
Complete transection of the aorta at the isthmus, 800 cc hemoperitoneum	Maximum (420218.6,4)	Intruding left door panel
Laceration of the left diaphragm with the stomach in the left chest	Severe (440606.4,8)	Intruding left door panel

Multiple left rib fractures with left hemothorax, NFS	Serious (450211.3,2)	Intruding left door panel
Superficial liver laceration	Moderate (541822.2,1)	Intruding left door panel
Superficial spleen laceration	Moderate (544222.2,2)	Intruding left door panel

Note: the above injuries were identified in the County Coroner's Verdict.

1997 CADILLAC DEVILLE
DRIVER KINEMATICS

The 58 year old restrained female driver of the Cadillac was seated in mid-track position with a presumed normal posture. The driver lost control of the vehicle subsequent to a lane change maneuver into the path of another vehicle. The driver oversteered the Cadillac causing the rear tires to break traction. The Cadillac yawed counterclockwise through the median and into the opposing travel lanes. The Cadillac then was endswiped by two vehicles while continuing its counterclockwise rotation. The use of the manual lap and shoulder restraint maintained the driver within the left front occupant space and she probably had minimal contact with the interior during this portion of the crash sequence.

The left frontal area of the Oldsmobile impacted the left side of the Cadillac in the area of the A-pillar. The 11 o'clock impact force caused the frontal air bags and the left side impact air bag to deploy. The center aspect of the door-mounted side impact air bag was masked by the driver seat back as a result of its mid-track adjustment. The driver responded to the 11 o'clock direction of the impact by exhibiting a leftward and forward trajectory. The left aspect of the driver's torso contacted the center aspect of the intruding door panel evidenced by the multiple contacts and deformations noted to the door panel. This interaction with the door occurred at the forward aspect of the side impact air bag. The driver probably had minimal contact with the side impact air bag. No evidence of direct contact was identified on the air bag. The driver's contact to the intruding door panel resulted the in a complete transection of the aorta with hemoperitoneum, a laceration of the diaphragm, multiple left ribs fractures with hemothorax, and superficial spleen and liver lacerations. The driver then rebounded into the seat where she was found.

1997 CADILLAC DEVILLE
FRONT RIGHT PASSENGER KINEMATICS AND INJURY

The 64 year old front right passenger of the Cadillac was restrained by the 3-point manual lap and shoulder belt system at the time of the crash. The use of the manual restraint maintained the occupant's position within the front right interior space during the initial crash sequence.

Upon impact with the Oldsmobile, the passenger exhibited a left and forward trajectory in response to the 11 o'clock direction of the impact. The left aspect of his torso loaded the manual restraint system. The

loading of the restraint was evidenced by the identified belt transfers. The passenger complained of sore left ribs (attributed to the manual restraint system), and sustained no codeable injuries. The passenger also probably contacted the deployed front right passenger air bag minizing his contact to the hard structures of the interior.

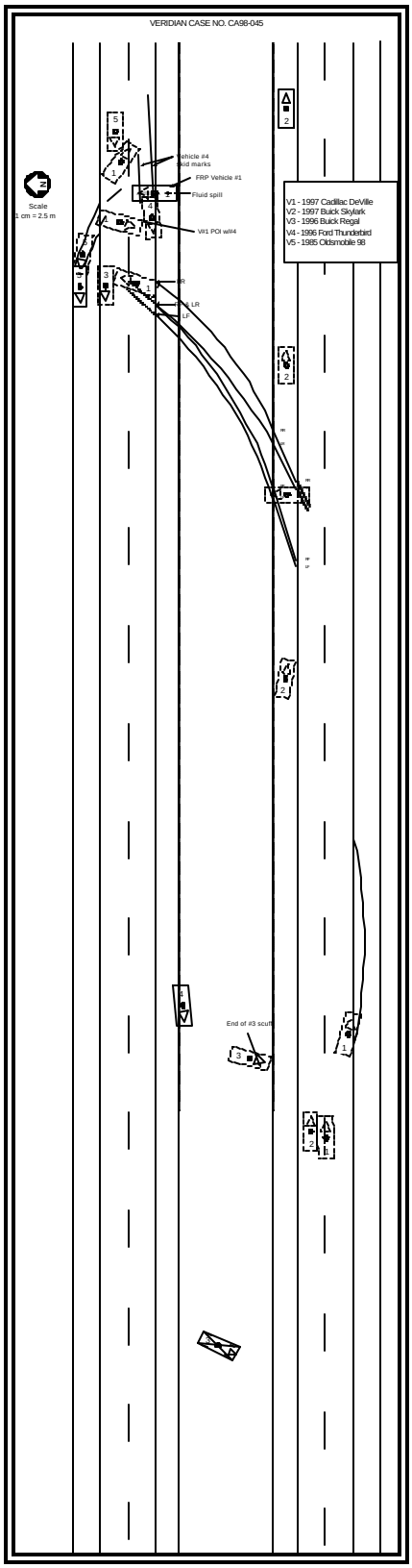

Figure 20: Scene schematic.