TRANSPORTATION SCIENCES
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VERIDIAN REMOTE SIDE IMPACT OCCUPANT PROTECTION SYSTEM INVESTIGATION
VERIDIAN CASE NO. CA00-016
VEHICLE: 1997 CADILLAC d'ELEGANCE
LOCATION: CALIFORNIA
CRASH DATE: NOVEMBER 1998

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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 remote investigation focused on the deployment of a door mounted side impact air bag and the driver injuries associated with the left side impact sequence. The crash involved a 1997 Cadillac DeVille d'Elegance that was occupied by a 76 year old male driver and a 76 year old female front right passenger. The Cadillac was equipped with frontal air bags for the driver and right passenger positions and front door mounted side impact air bags. The driver of the Cadillac was restrained by the manual 3-point lap and shoulder belt system. He attempted to enter a four-leg intersection and was struck on the left passenger compartment area by a 1988 Nissan passenger car. The lateral impact crushed the side structure of the Cadillac approximately 29 cm, resulting in 11 cm of intrusion of the front left door panel. The crash deployed the door mounted side impact air bag. The driver sustained an abrasion of the left lateral chest and lateral fractures of left ribs 6-8 with left anterior pneumothorax that resulted from the deployment of the driver's side impact air bag. The front right passenger sustained minor (unspecified) injuries.			
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BACKGROUND

This remote investigation focused on the deployment of a door mounted side impact air bag and the driver injuries associated with the left side impact sequence **(Figure 1)**. The crash involved a 1997 Cadillac DeVille d'Elegance that was occupied by a 76 year old male driver and a 76 year old female front right passenger. The Cadillac was equipped with frontal air bags for the driver and right passenger positions and front door mounted side impact air bags. The driver of the Cadillac was restrained by the manual 3-point lap and shoulder belt system. He attempted to enter a four-leg intersection and was struck on the left passenger compartment area by a 1988 Nissan passenger car. The lateral impact crushed the side structure of the Cadillac approximately 29 cm, resulting in 11 cm of intrusion of the front left door panel. The crash deployed the door mounted side impact air bag. The driver sustained an abrasion of the left lateral chest and lateral fractures of left ribs 6-8 with left anterior pneumothorax that resulted from the deployment of the driver's side impact air bag. The front right passenger sustained minor (unspecified) injuries.

Figure 1. Left side damage to the Cadillac

The crash was initially reported to NHTSA as a non, or partial deployment of the door mounted side impact air bag. It was alleged that the side air bag penetrated through the door mounted cover flaps, but failed to inflate. The crash was assigned to the Veridian Special Crash Investigation team on May 17, 2000 as a remote investigation.

SUMMARY

Crash Site

The crash occurred at a four-leg intersection during daylight hours with overcast skies. The asphalt road surfaces were dry. The Cadillac was traveling on a two lane east/west road that interested a four-lane roadway in a T-configuration. Westbound traffic flow entering the four-lane roadway was regulated by a stop sign. Paved shoulders bordered the four-lane road. The speed limits were not reported.

Crash Sequence

Pre-Crash

The 76 year old male driver of the Cadillac was traveling in a westerly direction on a two lane road on approach to a three-leg intersection. The driver slowed and stopped for a regulatory stop sign at the mouth of the intersection. The driver was preparing to initiate a left turn onto the four-lane road, however, his view of approaching northbound traffic was reportedly obstructed by a non-contact motor home that was parked on the east shoulder of the north/south roadway. The Cadillac driver accelerated across the northbound lanes into the path of the 1988 Nissan.

The Nissan was traveling in a northerly direction on the inboard travel lane. It was unknown if the driver of the Nissan detected the Cadillac to initiate avoidance actions.

Crash

The full frontal area of the Nissan impacted the left passenger compartment area of the Cadillac. Resultant directions of force were within the 9 o'clock sector for the struck Cadillac and probably within the 12 o'clock sector for the striking Nissan, although there were no photographs of the Nissan available for this remote investigation. The impact resulted in an estimated velocity change of 24 km/h (15 mph) for the struck Cadillac.

Post-Crash

The impact displaced the Cadillac laterally to its right while the Nissan continued forward from its at-impact position. Both vehicles came to rest within the boundaries of the intersection. At rest, the Cadillac was facing in a westerly direction vehicle the Nissan was facing in a northerly direction. The driver of the Cadillac was transported by ambulance to a regional trauma center where he was admitted for treatment of left rib fractures.

Vehicle Data

1997 Cadillac DeVille d'Elegance

The subject vehicle for this remote investigation was a 1997 Cadillac DeVille d'Elegance, four-door sedan. The Cadillac was equipped with a V-8 engine linked to a four-speed automatic overdrive transmission and front wheel drive. The braking system consisted of four-wheel disc brakes with anti-lock (ABS). The interior was configured with a split bench front seat with separate seat backs, adjustable head restraints, and a rear bench seat. Manual belt systems consisted of three-point lap and shoulder belts with adjustable D-rings for the front seated positions. Automatic occupant protection was provided by frontal air bags for the driver and right passenger positions and front door mounted side impact air bags. This side impact crash deployed the driver's side impact air bag system.

Vehicle Damage - 1997 Cadillac

Exterior

The left side of the Cadillac sustained moderate severity damage as a result of the intersection crash with the 1988 Nissan. The direct contact damage began at the leading edge of the left front door and extended rearward approximately 184 cm (72") to the trailing edge of the left rear door. Maximum crush was estimated at 29 cm, located on the left rear door, aft of the B-pillar. The Collision Deformation Classification (CDC) for this impact event was 09-LPEW-3 **(Figure 2)**. Damaged components included both left doors, the left B-pillar, the left sill, and the left rear door glazing. All other glazing remained intact.

Figure 2. Left side damage to the Cadillac.

Interior

The interior of the Cadillac sustained moderate damage and was associated with intrusion and side impact air bag deployment. Maximum intrusion involved approximately 20 cm of lateral displacement of the left rear door panel. The left front door panel intruded approximately 11 cm into the driver's space. The left B-pillar was reportedly intruded approximately 14 cm laterally.

The left front door mounted side impact air bag deployed as a result of the lateral impact sequence. The door panel trim/cover flaps opened at the designated tear seams. There was no additional damaged noted to the interior of the Cadillac.

Figure 3. Intrusion of the left door and B-pillar components.

Air Bag Systems

The Cadillac was equipped with a frontal air bag system and a side impact air bag system for the driver and front right passenger positions. The frontal system consisted of steering wheel and right upper instrument panel air bag modules, a center upper radiator support mounted crash sensor, and a sensing and diagnostic module with event data recording (EDR) capabilities located under the driver's seat. The frontal air bag system did not deploy during this crash.

The side impact air bag system consisted of door mounted side air bag modules that were concealed by H-configuration cover flaps within the padded interior door panel **(Figure 4)**. Side impact sensing was achieved by sensors located in the mid aspect of the front doors. The left side impact air bag deployed as a result of the intersection crash.

Figure 4. Left side impact air bag module.

Figure 5. Air bag nomenclature.

Figure 6. Nomenclature on the lower module cover flap.

Figure 7. Air bag membrane and the module flap system.

The left side impact air bag module was identified by the following nomenclature **(Figures 5 and 6)**:

16759018-16
TRAK70108375

The left side impact air bag membrane was folded and rolled into the module. A second flap system concealed the bag within the module **(Figure 7)**. These H-configuration flaps opened at the designated seams. Data from General Motors listed the capacity of the side air bag at 12 liters with a "may" deploy threshold of 13 km/h (8 mph) and a must deploy threshold of 21 km/h (13 mph).

Driver Demographics

Age/Sex:	76 year old male
Height:	188 cm (74")
Weight:	82 kg (180 lb)
Manual Restraint Usage:	3-point lap and shoulder belt system
Usage Source:	Interview data
Mode of Transport From Scene:	Ambulance
Type of Medical Treatment:	Admitted to a regional trauma center for treatment

Driver Injuries

Injury	Injury Severity (AIS 98 Update 98)	Probable Injury Source
Closed lateral fractures of the left 6-8 ribs with left anterior pneumothorax	Serious (450222.3,2)	Side air bag module cover flap and expanding left side impact air bag
Left lateral chest abrasion	Minor (490202.1,2)	Side air bag module cover flap and expanding left side impact air bag

* Source of injury data - Hospital staff

Driver Kinematics

The driver of the Cadillac was seated in a presumed upright driving posture. Although unconfirmed by the remote level investigation, the power adjusted seat track was probably set to rear track position. In this position, his left lateral ribs were exposed to the door mounted side impact air bag. It should be noted that the left door armrest was at a level that was below the fractured ribs.

As the Cadillac was impacted on the left side by the Nissan, the left door mounted side impact air bag deployed. The door also intruded approximately 11 cm into the driver's space. The left lateral chest of the driver was exposed to the expanding side impact air bag. As the bag deployed, the upper cover flap and the bag membrane **(Figure 8)** contacted the lateral chest of the driver which resulted in an abrasion of the lateral chest and fractures of left ribs 6-8 with minor left pneumothroax.

Figure 8. Expanding side impact air bag.

The driver was removed from the vehicle post-crash and transported to a regional trauma center where he was admitted for treatment of his injuries.

Front Right Passenger Demographics

Age/Sex:	76 year old female
Height:	Not reported
Weight:	Not reported
Manual Restraint Usage:	3-point lap and shoulder belt system
Usage Source:	Hospital data
Mode of Transport From Scene:	Unknown
Type of Medical Treatment:	Unknown

Front Right Passenger Injuries/Kinematics

The front right adult female passenger of the Cadillac was reportedly restrained by the manual belt system. She would have responded to the lateral impact force by initiating a lateral trajectory to her left. She probably loaded the manual belt system which restricted her motion within the vehicle. Although unconfirmed, the passenger possibly slid out of the shoulder belt webbing and impacted the right side of the driver. She sustained unspecified minor severity injuries. The driver did not sustain right side injuries from this possible occupant-to-occupant interaction.