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ACCIDENT RESEARCH GROUP

Calspan SRL Corporation
Buffalo, New York 14225

CALSPAN REMOTE SIDE AIR BAG NON-DEPLOYMENT INVESTIGATION

CALSPAN CASE NO. CA97-032

VEHICLE - 1998 CADILLAC DEVILLE

LOCATION - STATE OF NEW JERSEY

CRASH DATE - SEPTEMBER, 1997

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, 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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16. *Abstract* This remote investigation focused on a two-vehicle crash that involved a 1998 Cadillac DeVille and a 1992 Chevrolet Cavalier. The Cadillac was equipped with a Supplemental Inflatable Restraint (SIR) system that consisted of dual frontal air bags and dual side air bags in the forward occupant compartment. The right front corner of the Cavalier struck the left side of the Cadillac at a shallow angle, while the vehicles were passing. The left side air bag in the Cadillac did not deploy in the crash. The damage to the Cadillac was limited to the left side structure and left doors of the vehicle. The left fenders/quarter-panels fore and aft of the doors were not damaged. The Cadillac sustained a maximum lateral crush of 29.0 cm (11.4 in) measured along the lower sill, at the left B-pillar. The occupants in the Cadillac consisted of the 53 year old male driver and the 50 year old female right front passenger. Both occupants reportedly complained of minor injuries after the crash, but declined medical attention.			
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TABLE OF CONTENTS

CALSPAN REMOTE SIDE AIR BAG NON-DEPLOYMENT INVESTIGATION
CALSPAN CASE NO. CA97-32

VEHICLE #1 - 1998 CADILLAC DEVILLE

LOCATION - NEW JERSEY
CRASH DATE - SEPTEMBER, 1997

BACKGROUND

This task involved the remote investigation into a two vehicle crash that occurred in the afternoon hours of September, 1997. The crash involved a 1992 Chevrolet Cavalier that struck the left side of a 1998 Cadillac DeVille. The Cadillac was equipped with a Supplemental Inflatable Restraint (SIR) System that consisted of frontal air bags for the driver and front passenger and side air bags located in the vehicle's front doors. The Cadillac's side air bag system did not deploy in the crash. A NASS researcher from PSU-04, in the course of conducting routine field work, was informed of this non-deployment side air bag crash by a local body shop. The vehicle had been disassembled and was in a state of repair at the time of the researcher's inspection. The researcher contacted the Field Branch Office of the National Highway Traffic Safety Administration (NHTSA) on September 29, 1997. NHTSA in-turn assigned a remote task effort to the Calspan Special Crash Investigation (SCI) team on September 30, 1997.

SUMMARY

The police report indicated the crash occurred on a four lane east/west county roadway. The eastbound and westbound lanes were separated by double yellow center lines. There was a left curve and grade for eastbound traffic at the crash scene. The weather was not a factor in the crash and the roads were dry. The speed limit in the area of the crash was 72 km/h (45 mph).

The 1998 Cadillac DeVille was eastbound on the outboard lane of the road and the 1992 Chevrolet Cavalier was eastbound on the inboard lane. The crash occurred when the Cadillac changed from the outboard to inboard lane directly into the path of the Cavalier. The right front corner of the Cavalier struck the left side of the Cadillac at a shallow angle and sideswiped the left doors. The probable impact configuration was 7 o'clock/1 o'clock for Cadillac and Cavalier respectively. The Cadillac's contact damage was limited to the left side doors. The vehicle was not damaged aft of the C-pillar nor forward of the A-pillar. The Chevrolet Cavalier was not inspected. The police report only indicated right front damage for the Cavalier. Both vehicles were towed from the crash scene.

The driver of the Cadillac was a 53 year old male of unknown height and weight. The right front passenger in the vehicle was a 50 year old female. Both occupants of the Cadillac were reportedly restrained by the manual lap and shoulder belt systems available in the vehicle and sustained no codeable injuries. The

occupants complained of pain after the crash but declined medical attention. Cooperation with the driver was not obtained therefore, the information regarding restraint usage and injuries was derived from the police report. The driver of the Cavalier was a 25 year old female, reportedly restrained, and similarly complained of pain but declined medical attention post-crash.

VEHICLE #1

The subject vehicle was a 1998 Cadillac DeVille, 4 door sedan. The vehicle was identified by the vehicle identification number (VIN) 1G6KD54Y5WU (production sequence omitted) and was equipped with a 4.6 liter, V-8 engine and a 4-speed automatic transmission. Additional safety equipment included an anti-lock braking system and traction control. The manual restraint system consisted of lap and shoulder belts in the front outboard seated positions.

The vehicle was in a state of disassembly and repair at the time of the NASS researcher's inspection. The left front fender and left side doors had been removed from the vehicle as well as the interior components. The vehicle damage was limited to the left side uni-body structure and doors. A triangular pattern of deformation was measured along the lower sill (Figures 1-3). The direct damage was 168 cm (66 in) in length and began 41 cm (16 in) forward of the rear axle. The maximum lateral deformation was 29.0 cm (11.4 in) and was located approximately at the B-pillar (Figure 4). The Cadillac's Collision Deformation Classification (CDC) was 07-LPES-2.

Figure 1: Left front view

Figure 2: Left rear view

Figure 3: Maximum crush

Figure 4: Lateral view of max. crush

The measured crush values are listed in the table below:

C1 = 5.0 cm (2.0 in)	C2 = 14.0 cm (5.5 in)	C3 = 29.0 cm (11.4 in)
C4 = 20.0 cm (7.9 in)	C5 = 12.0 cm (4.7 in)	C6 = 8.0 cm (3.2 in)

Deformation to the outer sheet metal of the left doors consisted primarily of rear-to-front sideswiping damage with lateral displacement (Figures 5 and 6). The outer sheet metal sections had been cut from the doors, to gain access for disassembly. The photographs of the doors did not indicate that their was any significant deformation to the doors' internal structure (Figures 7 and 8). The doors' interior trim panels were intact and probably reused in the repairs (Figure 9).

Figure 5: Left front door sheet metal

Figure 6: Left rear door sheet metal

Figure 7: Left front door exterior

Figure 8: Left front door internal

Figure 9: Left front door interior trim

The owner of the body shop indicated the left doors and B-pillar deformed laterally in the crash. Reportedly, the arm rest of the left front door was in contact with the left front seat. He further indicated that the floor pan had to be pulled laterally several inches during the repair process.

RECONSTRUCTION AND DELTA V CALCULATIONS

The estimated delta V of the Cadillac was determined through the use of the SMASH algorithm using the barrier model of the "Damage Only" routine. The initial SMASH calculation by the NASS team indicated

the lateral delta V of the vehicle was approximately 21.4 km/h (13.3 mph). This calculation indicated the vehicle's delta V was near the 21 km/h (13 mph) deployment threshold for the side air bags. The PDOF used in the calculation was 270 degrees (-90 deg.) with respect to the vehicle.

Initial SMASH Calculation	
Total delta V:	21.4 km/h (13.3 mph)
Longitudinal delta V:	0.0 km/h (0.0 mph)
Lateral delta V:	21.4 km/h (13.3 mph)
PDOF:	270 (-90) degrees
Energy Dissipated:	33,036 Joules (24,366 ft*lb)
Barrier Equiv. Speed:	21.4 km/h (13.3 mph)

Analysis of the damage patterns and the pre-impact vehicle dynamics indicate the PDOF in the crash was in the 7 o'clock sector. The Cadillac was in the process of a lane change and entered the path of Cavalier. In general, the heading angle of the Cadillac would only deviate approximately 3 to 5 degrees with respect to the road axis in a controlled lane change maneuver. This necessitates that the Cadillac and the Cavalier be nearly co-linear at the time of impact. The sideswiping nature of the damage also was indicative of the shallow impact angle.

A SMASH calculation using a PDOF of 210 (-150) degrees was performed. The results are tabulated below. While the dissipated energy and total delta V remain constant, the calculated lateral delta V was reduced to 10.5 km/h (6.5 mph). This calculation indicates the magnitude of the Cadillac's lateral delta V component in the crash was far below the threshold required to deploy the side air bags.

Final SMASH Calculation	
Total delta V:	21.0 km/h (13.0 mph)
Longitudinal delta V:	18.2 km/h (11.3 mph)
Lateral delta V:	10.5 km/h (6.5 mph)
PDOF:	210 (-150) degrees
Energy Dissipated:	33,036 Joules (24,366 ft*lb)
Barrier Equiv. Speed:	21.0 km/h (13.0 mph)

SUPPLEMENTAL INFLATABLE RESTRAINT SYSTEM

The 1998 Cadillac DeVille was equipped with Supplemental Inflatable Restraint (SIR) System that consisted of dual frontal air bags and door mounted side air bags for the front occupants. The frontal SIR system consisted of the following components:

1. Inflatable Restraint Sensing and Diagnostic Module (SDM);
2. Driver air bag module;
3. Right front passenger air bag module;
4. Front end mounted discriminating sensor;
5. Air bag warning indicator in the instrument cluster.

The driver side frontal air bag module was mounted in the typical manner in the center of the steering wheel. The right side frontal air bag module was a top mount configuration located on the right side of the instrument panel. The SDM in the system was a multi-function device that performs diagnostic monitoring of the SIR system, in addition to frontal crash detection and control of the frontal air bag deployment.

The side impact SIR system consisted of the following components:

1. Two side impact sensing modules (SISM), one in each front door;
2. Two side impact inflator modules, one in each front door;
3. Air bag warning indicator in the instrument cluster;
4. Inflatable Restraint Sensing and Diagnostic Module (SDM).

The side impact modules were located in the upper rear quadrant of the vehicle's forward doors. Deployment of the side air bag would occur through the interior trim panel. The image below (Figure 10) was released by the manufacturer in an advertisement and is a depiction of the side air bag in full deployment.

Figure 10

The design of the air bag was described as "a shoe-shaped configuration" by the manufacturer and reportedly provides optimum protection to the occupant's thorax regardless of the seat track position.

The side impact SIR was a stand alone system. The deployment of the side impact air bags would be controlled by the door mounted side impact sensors (SISM). A sensor on-board the SISM measures lateral acceleration. The SISM then calculates the vehicle's lateral delta V and if the calculated delta V exceeds the design threshold, deployment would then be initiated. The deployment threshold of the 1998 Cadillac DeVille's SISM is a lateral delta V of 21 km/h (13 mph). The final SMASH calculation indicates the lateral delta V for the Cadillac in the crash was below the deployment threshold, therefore the side impact SIR worked as designed by not initiating deployment.

The only function of the SDM relative to the side impact SIR was to monitor system readiness (as opposed to its control of the frontal SIR system deployment). The deployment of the side impact air bags would be controlled entirely by the door mounted SISM. Each SISM communicates with the SDM via a diagnostic line. If a fault exists in the side impact SIR, the SDM stores the history and alerts the driver by illuminating the instrument cluster's air bag warning indicator.

OCCUPANT ISSUES

Cooperation could not be obtained with the driver of the Cadillac, therefore there is minimal first hand information regarding the crash. It is known that the three individuals involved in the crash all complained of minor injuries but declined medical attention at the crash scene. The absence of any serious injury is suggestive of the minor nature of this crash, as is the non-deployment of the side air bag system