TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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REDESIGNED AIR BAG SPECIAL STUDY (RABSS)
SCI TECHNICAL SUMMARY REPORT

NASS RABSS CASE NO. 1998-12-801E

RABSS VEHICLE - 1998 CADILLAC DEVILLE

LOCATION - STATE OF MICHIGAN

CRASH DATE - AUGUST, 1998

Contract No. DTNH22-94-D-07058

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

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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.

TECHNICAL REPORT STANDARD TITLE PAGE

1. *Report No.* 98-12-801E	2. *Government Accession No.*	3. *Recipient's Catalog No.*	
4. *Title and Subtitle* Redesigned Air Bag Special Study (RABSS) RABSS Vehicle - 1998 Cadillac Deville Location - State of Michigan		5. *Report Date*: February, 2000 6. *Performing Organization Code*	
7. *Author(s)* Crash Research Section		8. *Performing Organization Report No.*	
9. *Performing Organization Name and Address* Transportation Sciences Crash Research Section Veridian Engineering (Calspan Operations) P.O. Box 400 Buffalo, New York 14225		10. *Work Unit No.* C01115.0238.(0000-0009) 11. *Contract or Grant No.* DTNH22-94-D-07058	
12. *Sponsoring Agency Name and Address* U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		13. *Type of Report and Period Covered* Technical Summary Report Crash Date: August, 1998 14. *Sponsoring Agency Code*	
15. *Supplementary Notes* NASS investigation of a frontal collision (into a fixed object) that involved a 1998 Cadillac Deville with redesigned frontal air bags.			
16. *Abstract* This investigation focused on a single vehicle crash involving a 1998 Cadillac Deville 4-door sedan. The Cadillac Deville was equipped with redesigned frontal air bags that deployed as a result of a frontal collision with a ditch. The vehicle was also equipped with door-mounted side impact air bags which did not deploy as a result of the crash. The driver was operating the Cadillac southbound on a rural two lane roadway when she allowed the vehicle to depart the left (east) pavement edge. As the vehicle exited the east pavement edge, the front left area struck the ditch resulting in moderate damage. The 71 year old female driver was seated in an upright posture and restrained by the available 3-point manual lap and shoulder belt system. At impact, she initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. Contact to the deployed air bag resulted in multiple contusions to the facial area. She also sustained (left-unspecified) fractured teeth which may have been a result of contact to a secondary surface during the crash sequence. The driver was transported by ambulance to a local trauma center for treatment and admitted for 15 days due to an unrelated heart condition.			
17. *Key Words* Redesigned frontal air bag system Collision Deformation Classification (CDC): 12-FYEW-2 Proper use of the manual belt system Facial contusions		18. *Distribution Statement* General Public	
19. *Security Classif. (of this report)* Unclassified	20. *Security Classif. (of this page)* Unclassified	21. *No. of Pages* 5	22. *Price*

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BACKGROUND

This investigation focused on a single vehicle crash involving a 1998 Cadillac Deville 4-door sedan. The Cadillac Deville was equipped with redesigned frontal air bags that deployed as a result of a frontal collision with a ditch. The vehicle was also equipped with door-mounted side impact air bags which did not deploy as a result of the crash. The driver was operating the Cadillac southbound on a rural two lane roadway when she allowed the vehicle to depart the left (east) pavement edge. As the vehicle exited the east pavement edge, the front left area struck the ditch resulting in moderate damage. The 71 year old female driver was seated in an upright posture and restrained by the available 3-point manual lap and shoulder belt system. At impact, she initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. Contact to the deployed air bag resulted in multiple contusions to the facial area. She also sustained (left-unspecified) fractured teeth which may have been a result of contact to a secondary surface during the crash sequence. The driver was transported by ambulance to a local trauma center for treatment and admitted for 15 days due to an unrelated heart condition.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as case number 98-12-801E for the Redesigned Air Bag Special Study. The Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) assigned the Special Crash Investigation (SCI) team at Veridian/Calspan the task of case review and final report preparation.

SUMMARY

Crash Site

This single vehicle crash occurred during the afternoon hours of August, 1998. At the time of the crash, it was daylight with no adverse conditions as the roads were dry. The crash occurred off the east pavement edge of a straight and level two lane north/south concrete roadway **(see Figure 7 - page 5)**. No traffic control was present at the scene which had a posted speed limit of 72 km/h (45 mph). The roadside environment featured paved shoulders, gravel driveways and a ditch located approximately 3.0 meters (9.8 feet) off the east pavement edge *(depth not reported)*.

Pre-Crash

The 71 year old female driver of the 1998 Cadillac Deville was operating the vehicle southbound at a (driver reported) speed of 72 km/h (45 mph) when for unknown reasons, she allowed the vehicle to depart the left (east) pavement edge in a forward tracking mode **(Figure 1)**. There were no brake marks documented within the vehicle's trajectory indicative of driver avoidance maneuvers.

Figure 1. Southbound approach for the 1998 Cadillac Deville.

Crash

As the Cadillac exited the east pavement edge of the rural two lane roadway, it traveled 3.0 meters (9.8 feet) to impact with the ditch. The front left area pitched slightly downward as it struck the ditch at the leading edge of a private driveway **(Figures 2&3)**, resulting in moderate damage. The impact induced deceleration was sufficient to deploy the Cadillac's redesigned frontal air bag system. Although the impact was classified as out of scope (yielding object), the damage algorithm of the WinSMASH program computed a (barrier equivalent) velocity change of 18.9 km/h (11.7 mph). The specific longitudinal component was -18.6 km/h (-11.6 mph) with a lateral component of 3.3 km/h (2.1 mph). The Collision Deformation Classification (CDC) for this impact to the Cadillac Deville was 12-FYEW-2. The vehicle continued in a southeasterly direction approximately 12.0 meters (39.3 feet) and came to rest in a private yard facing southeast.

Figure 2. Southeast view of impacted ditch.

Figure 3. Northwest lookback view showing depth of ditch and trajectory to final rest.

Post-Crash

The driver was removed from the vehicle while not oriented to time or place. She was transported by ambulance to a local trauma center for treatment and admitted for 15 days due to an unrelated heart condition. The vehicle was towed from the scene due to disabling damage.

RABSS VEHICLE

The 1998 Cadillac Deville was identified by the Vehicle Identification Number (VIN): 1G6KD54Y1WU (production sequence deleted). The vehicle was a 4-door sedan equipped with front wheel drive and a 4.6 liter, Northstar engine. The vehicle's odometer reading was 14,484 km (9,000 miles) at the time of the crash. The police report did not specify the owner of the vehicle. The seating was configured with front split (with separate backs) and rear bench seats. The driver reported no previous crashes or maintenance on the air bag system (original equipment). No cell phone was present or in-use at the time of the collision.

VEHICLE DAMAGE

Exterior Damage

The 1998 Cadillac Deville sustained moderate frontal damage as a result of the impact with the ditch **(Figure 4)**. The direct contact damage began at the front left bumper corner and extended 75.0 cm (29.5 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 153.0 cm (60.2 in). Six crush measurements were documented at the level of the bumper: C1= 30.0 cm (11.8 in), C2= 19.0 cm (7.5

Figure 4. Frontal damage to the 1998 Cadillac Deville.

in), C3= 11.0 cm (4.3 in), C4= 6.0 cm (2.4 in), C5= 4.0 cm (1.6 in), C6= 2.0 cm (0.8 in). The left section of the *bumper assembly* shifted upward approximately 8.9 cm (3.5 in). The depth of the ditch and downward pitch of the front left area during the collision resulted in vertical contact damage to the level of the hood with minor displacement noted. The left fender was also deformed rearward which restricted the left front wheel/tire (not deflated). The windshield was fractured from exterior impact forces and the interior front right air bag. Reduction in the left side wheelbase measured 3.0 cm (1.2 in).

Interior Damage

Interior damage to the Cadillac Deville identified through the NASS vehicle inspection was minimal and was attributed to occupant contact. A scuff mark was documented to the left knee bolster (rigid plastic type). No intrusions were found in the vehicle. No deformation was noted to the steering wheel hub/rim (tilt column placed to the center position).

REDESIGNED AIR BAG SYSTEM

Figure 5. 1998 Cadillac Deville redesigned driver air bag.

The 1998 Cadillac Deville was equipped with redesigned frontal air bags for the driver and front right passenger positions. The air bags had deployed as a result of the crash. The driver air bag was housed in the center of the steering wheel with a vertically oriented flap tear seam (I-configuration) which followed the contour of the Cadillac emblem on the center of the hub. The flaps were symmetrical in shape and measured 10.0 cm (3.9 in) in width and 11.0 cm (4.3 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, lipstick transfers were documented to the upper right quadrant along with blood spattering to the lower right quadrant of the air bag. The NASS researcher measured the diameter of the driver air bag at 60.0 cm (23.6 in) in its deflated state **(Figure 5)**. No internal tether straps were present. The bag was vented by two ports located at the 3 o'clock and 9 o'clock sectors on the rear aspect of the air bag.

Figure 6. 1998 Cadillac Deville redesigned passenger air bag.

The front right passenger air bag deployed from the right mid-instrument panel area with a module design recessed into the instrument panel. This configuration did not utilize a conventional flap as the instrument panel separated to allow the bag to expand. No contact evidence was identified on the air bag or exterior surface of the module cover flap. The NASS researcher measured the passenger air bag at 40.0 cm (15.7 in) in width and 68.0 cm (26.8 in) in height in its deflated state **(Figure 6)**. No internal tether straps were present. The bag was vented by two ports located at the 10 o'clock and 2 o'clock sectors on the side aspect of the air bag. The right mid-windshield area was fractured by the air bag. No cutoff switch was reported for the front right redesigned passenger air bag.

The 1998 Cadillac Deville was also equipped with door-mounted side impact air bags for the front left and right seating positions. The air bags did not deploy as a result of the crash. The air bags were housed in the door panel above the armrest with a horizontally oriented flap tear seam (H-configuration).

DRIVER DEMOGRAPHICS

Age/Sex:	71 year old female
Height:	168 cm (66 in)
Weight:	69 kg (152 lb)
Seat Track Position:	Middle position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, driver interview, police report
Eyeware:	Prescription glasses
Type of Medical Treatment:	Transported to a local trauma center and admitted (15 days)

Driver Injuries

Injury	***Severity (AIS 90)***	***Injury Mechanism***
Facial contusions (not further specified)	Minor (290402.1,9)	Front left air bag
Laceration right lip (minor)	Minor (290602.1,8)	Bit lip *(self-inflicted)*
Laceration tongue	Minor (243400.1,8)	Bit tongue *(self-inflicted)*
Laceration right cheek *(internal)*	Minor (243204.1,1)	Bit cheek *(self-inflicted)*
Fractured teeth (left-not further specified)	Minor (251404.1,8)	Unknown *(door panel?)*

Driver Kinematics

The 71 year old female driver of the 1998 Cadillac Deville was seated in an upright posture with her hands at the 10 o'clock and 2 o'clock sectors on the steering wheel rim. The seat back was slightly reclined with the seat track adjusted to the middle position. She was restrained by the available 3-point manual lap and shoulder belt system. Belt usage was confirmed by the lack of significant injury and contact points within the vehicle.

At impact, the driver initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. Contact to the deployed air bag resulted in multiple facial contusions as evidenced by the lipstick transfers documented to the upper right quadrant of the bag (counterclockwise rotation of the steering wheel rim during ditch engagement). The combination of restraint options provided protection against further contact to the steering wheel hub/rim. She reportedly bit her lip and tongue which resulted in the minor self-inflicted lacerations. Although all injury sources were identified as the front left air bag in the *NASS case file*, limited medical/interview data would not allow for a closer evaluation of the fractured teeth. A possibility exists

that she moved laterally to the left and struck a secondary surface (door panel/A-pillar) during this elongated crash sequence. The driver was transported by ambulance to a local trauma center for treatment and admitted for 15 days due to an unrelated heart condition.

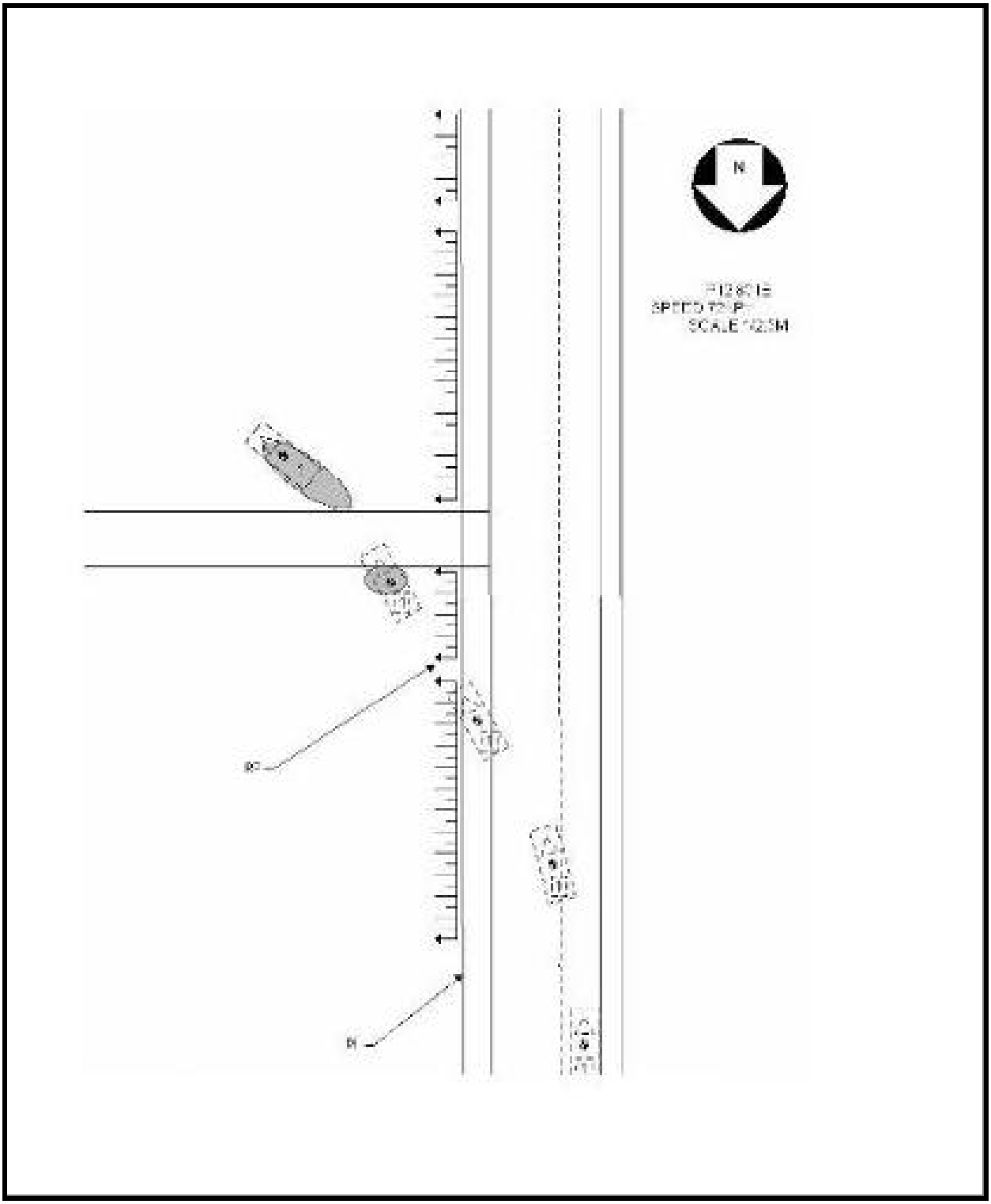

Figure 7. NASS Scene Diagram.