

CRASH DATA RESEARCH CENTER

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ON-SITE INADVERTENT AIR BAG DEPLOYMENT INVESTIGATION

CALSPAN CASE NO: CA04-039

VEHICLE – 2004 CADILLAC CTS

LOCATION – NEW JERSEY

CRASH DATE – SEPTEMBER, 2004

Contract No. DTNH22-01-C-17002

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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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<p>16. <i>Abstract</i></p> <p>This on-site investigation focused on the inadvertent deployment of multiple air bags in a 2004 Cadillac CTS. The Cadillac was equipped with advanced dual-stage frontal air bags, seat-mounted side impact air bags for the driver and front right passenger, and (two) inflatable side curtain air bags. At the time of the inadvertent deployment, the Cadillac was parked in the driveway of the owner and occupied by a 42 year old female seated in the driver's position. The driver was in the process of starting the vehicle's engine when the air bags deployed. In the incident, the frontal air bags, both seat-mounted side impact air bags and the right inflatable side curtain deployed. The driver sustained a burn/abrasion of the left cheek (below the left eye to center chin) from contact with the expanding driver air bag, an abrasion of the left upper arm from the expanding left side impact air bag and unspecified pain to the upper back. She was transported via ground ambulance to a local hospital where she was treated and released.</p> <p>This incident was reported to the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) by the investigating police officer. The NHTSA subsequently assigned an on-site investigation to the Calspan Special Crash Investigations team on September 8, 2004. Cooperation was established with an attorney representing the driver and a joint inspection of the Cadillac was scheduled with a technical representative of General Motor's ESIS Group. The vehicle inspection took place October 13, 2004.</p>			
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**ON-SITE INADVERTENT AIR BAG DEPLOYMENT INVESTIGATION
CALSPAN CASE NO: CA04-039**

**VEHICLE: 2004 CADILLAC CTS
LOCATION: NEW JERSEY
CRASH DATE: SEPTEMBER, 2004**

BACKGROUND

This on-site investigation focused on the inadvertent deployment of multiple air bags in a 2004 Cadillac CTS, **Figure 1**. The Cadillac was equipped with advanced dual-stage frontal air bags, seat-mounted side impact air bags for the driver and front right passenger, and (two) inflatable side curtain air bags. At the time of the inadvertent deployment, the Cadillac was parked in the driveway of the owner and occupied by a 42 year old female seated in the driver's position. The driver was in the process of starting the vehicle's engine when the air bags deployed. In the incident, the frontal air bags, both seat-mounted side impact air bags and the right inflatable side curtain deployed. The driver sustained a burn/abrasion of the left cheek (below the left eye to center chin) from contact with the expanding driver air bag, an abrasion of the left upper arm from the expanding left side impact air bag and unspecified pain to the upper back. She was transported via ground ambulance to a local hospital where she was treated and released.



Figure 1: Front left view of the Cadillac.

This incident was reported to the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) by the investigating police officer. The NHTSA subsequently assigned an on-site investigation to the Calspan Special Crash Investigations team on September 8, 2004. Cooperation was established with an attorney representing the driver and a joint inspection of the Cadillac was scheduled with a technical representative of General Motor's Corporation. The vehicle inspection took place October 13, 2004.

VEHICLE DATA
2004 Cadillac CTS

The 2004 Cadillac CTS was identified by the Vehicle Identification Number (VIN): 1G6DM577040 (production sequence deleted). The rear-wheel drive, four-door sedan was equipped with a 3.6 liter/V6 engine linked to a five-speed automatic transmission. The brakes were a vented disc system with four-wheel ABS. The manual restraint system consisted of three-point lap and shoulder belts in the five seat positions. The front restraints were equipped with buckle pretensioners that fired during the incident. The Cadillac CTS was equipped with multiple air bags, all of which were standard equipment. The vehicle's air bags consisted of

advanced dual stage frontal and seat-mounted side impact air bags for the front occupants and two inflatable side curtain air bags mounted in the respective roof side rails. The vehicle's air bag systems were monitored and controlled by a Sensing and Diagnostic control Module (SDM) that was located on the vehicle's center tunnel. The SDM had the capabilities of recording crash event data. The Cadillac was also equipped with satellite radio and OnStar. The owner subscribed to the OnStar "Safe and Sound" service plan. OnStar did not receive notification from the vehicle of the inadvertent air bag deployment.

At the time of the incident, the odometer had registered 20,885 km (12,978 miles). The vehicle's date of manufacture was August 2003. The Cadillac was purchased new by the driver and delivered on October 13, 2003. The Cadillac had no prior crash history. It had been only serviced once and that was for an oil change at approximately 11,265 km (7,000 miles). The service was conducted at the Cadillac dealership. The driver had no problems or complaints with the vehicle prior to the incident. The driver indicated that the air bag warning lamp was not illuminated (indicating a system problem) prior to the incident.

SUMMARY

Incident Circumstances

This single-vehicle incident occurred during the afternoon hours in September, 2004. At the time of the incident, it was daylight and the weather was not a factor. The Cadillac was parked in the driveway of the owner's private residence, **Figure 2**. The residence was located in a suburban residential setting. Immediately prior to the incident, the vehicle was stationary and was in the process of being started. There was no crash or impact precipitating the deployment.



Figure 2: View of the incident site.

Prior to the incident, the driver's day had been routine. She reported that she was at work until mid-afternoon and had then returned home. The Cadillac was parked in the driveway for approximately 30 minutes when the driver entered the vehicle to attend to some errands. The driver recalled that she opened the left front door, sat down in the driver seat and closed the door. She then leaned slightly forward and right in order to better see the ignition key port and inserted the ignition key. As she rotated the key to start the engine, multiple air bags in the vehicle deployed.

The driver was not sure if she lost consciousness for a short period of time or not. After regaining her faculties, she was able to exit the Cadillac. She ran back to her house and called 9-1-1 to alert the authorities of the situation. The police and ambulance personnel arrived on scene a short time later. The driver asked the police officer to turn-off the ignition in the vehicle as she was apprehensive about entering the vehicle. The Cadillac's engine did start in the incident and was running when the police arrived. The driver sustained an abrasion/burn to the

left cheek, an abrasion to her upper arm and unspecified upper back/left shoulder soreness. She was transported to a local hospital, treated in the emergency room and released the same day.

VEHICLE INSPECTION

The Cadillac CTS was parked in the owner's driveway and covered with a tarp from the time of the incident until the day of the inspection. On the day of the inspection, the vehicle was transported via a rollback truck to a privately owned automotive service facility of the Cadillac's owner's choosing. At that time, a visual inspection of the Cadillac's exterior, interior and undercarriage was completed, as well as, an interrogation of the vehicle's SDM. A technical representative from GM's ESIS Group participated in the inspection.

Figures 3, 4 and 5 are the front left, front right and back views of the vehicle. The inspection of the vehicle's exterior was unremarkable. There was no crash type damage.



Figure 4: Front left view.



Figure 3: Front right view.



Figure 5: Back view.

Figure 6 is a view of the front interior. All the interior damage to the Cadillac was related the deployment of the multiple air bags. The right aspect of the windshield was fractured by the rotation of the front right passenger air bag module cover flap.

The power driver seat, **Figure 7**, was located in a mid-track position. The seat position was programmed into memory and was adjusted for the subject driver. The seat position measured 12.7 cm (5.0 in) forward of the full rear position. The total seat track travel measured 22.9 cm (9.0 in). The seat back recline angle measured 20 degrees. In this position, the horizontal distance from the center of the driver air bag module to the seat back measured 50.8 cm (20.0 in).



Figure 6: View of the front interior.



Figure 7: Driver's interior view.

The front manual safety restraints in the Cadillac CTS were integrated into the front seats. The buckles attached to the respective inboard aspect of the front seats were equipped with pretensioners. Both buckle pretensioners fired in the incident. The heights of the buckles were visibly reduced and the trim panels surrounding the buckles were displaced due to the full stroke of the pretensioner. At inspection, the driver's webbing was stowed within its Emergency Locking Retractor (ELR). Inspection of the belt revealed indicators of historical use but was otherwise unremarkable. At the time of the incident, the driver reported that she had not fastened her safety belt. It was her habit to enter the vehicle, start the engine and then buckle the restraint prior to driving.

The deployed driver air bag was housed in the center hub of the steering wheel within an H-configuration module. The deployed air bag measured 56 cm (22 in) in diameter in its deflated state. The bag was tethered by four 7.6 cm (3.0 in) wide straps and vented by two 2.5 cm (1.0 in) diameter ports. Inspection of the air bag was unremarkable. No contact evidence was identified on the driver air bag.

The front right passenger air bag was a top mount design located in the right aspect of the instrument panel. The module cover flap was trapezoidal in shape and was manufactured from thin gauge formed sheet metal covered by vinyl. The flap was hinged on its forward side and

fractured the windshield during its rotation. The width and height of the face of the deployed front right passenger air bag measured 36 cm by 25 cm (14 in by 10 in). The rearward excursion of the air bag measured 38 cm (15 in) from the vertical face of the instrument panel. The bag was tethered by a single 30 cm (12 in) wide strap and was vented by two 3.8 cm (1.5 in) diameter side panel ports. There was no contact evidence on the front right passenger air bag.

The driver and front right passenger side impact air bags had deployed. The side impact air bags were design to offer thorax protection and were located within a vertically oriented module located in the outboard aspect of the front seat back. The module cover flap was rectangular and measured 8.9 cm by 20.3 cm (3.5 in by 8.0 in), width by height. The flap was hinged on its aft aspect. During deployment, the cover flap rotated open and it was in contact with the B-pillar at inspection. The side impact air bags were elliptical in shape. The major and minor axes of the ellipse measured 44.4 cm and 34.3 cm (17.5 in and 13.5 in), respectively. No contact evidence was identified on either air bag.

The right inflatable side curtain also had deployed in the incident. The curtain was installed along the roof side rail underneath the headliner. The deployed curtain was rectangular in shape and measured 132 cm by 38 cm (52 in by 15 in), length by height. There was no contact evidence identified on the air bag. The left inflatable side curtain did not deploy in the incident.

At the time of the vehicle inspection, the driver stated that the sun roof was initially closed and became partially open after the incident. It was theorized the sun roof was displaced by the sudden pressure change that developed in the vehicle's interior during the incident due to the deploying air bags.

AIR BAG SYSTEM DIAGNOSTICS

During the vehicle inspection, diagnostic procedures were conducted to determine the pre-incident state and post-incident of the air bag system, in order to possibly determine the root cause of the inadvertent deployment.

- The first step in these procedures was to ascertain the status of the air bag warning lamp in the instrument cluster. Upon inserting the key and rotating the ignition switch to "ON", the warning lamp flashed eight times and then stayed illuminated. The steady illuminated state of the lamp indicated that the air bag system required service. The message center located in the center instrument stack also illuminated a message indicating that the air bag system required service.
- Step two in the diagnostic procedures involved interrogating the Cadillac's SDM with the Vetronix Crash Data Retrieval (CDR) tool to download any recorded event data. The Diagnostic Link Connector (DLC) located on the lower left side of the instrument panel was used as the interface. Communication between the CDR tool and the SDM was successfully established, however, there was no stored event data. The CDR tool displayed the following message:

*Data Collection Successful
This Module Has No Stored Events*

The design intent of the SDM was to record non-deployment and deployment event data directly related to a crash. The fact that the Cadillac was not involved in a crash and that the module had no stored events was consistent with the circumstances of an inadvertent deployment.

- Step three involved utilizing the GM's Tech 2 Diagnostic Tool to establish the current status of the air bag system and to recover any history fault codes that might have been stored by the module. The Tech 2 tool is proprietary. It is a software driven, multi-menu tool developed by General Motors in communicate with the SDM. The History Function of this procedure revealed the SMD had no stored history codes and the Current Status Function properly indicated deployed status of the multiple air bags and pretensioners. The Tech 2 diagnostics did not reveal any potential problems or faults within the air abg system.
- Step Four involved visually examining the SDM. The SDM was located on the center tunnel under the console, **Figures 8 and 9**. The module and its electrical connector were found intact and undamaged. An examination of the connector and the module's mating pins was unremarkable. The mounting location of the module on the center tunnel was elevated relative to its surrounding and was unlikely to have been contaminated by water or other fluids. The following nomenclature identified the module:

PN: 25745630
SERV NO: 12229320
Bar Code: AS5630K132263HOB



Figure 8: Longitudinal view of the SDM.



Figure 9 Right lateral view of the SDM.

None of the diagnostic procedures conducted during the course of the vehicle inspection yielded any information that indicated the Cadillac had a pre-existing problem within the air bag system. The root cause of the inadvertent deployment could not determined.

DRIVER DEMOGRAPHICS

Age/Sex: 42 year old/Female
Height: 165 cm (65 in)
Weight: 69 kg (153 lb)
Seat Position: Mid-track position
Restraint Use: Unrestrained
Usage Source: Interview
Medical Treatment: Transported by ambulance to a local hospital, treated and released

DRIVER INJURY

<i>Injury</i>	<i>Injury Severity (AIS 98 update)</i>	<i>Injury Source</i>
Burn to left cheek, 1 st degree	Minor (292002.1,2)	Deploying driver air bag gases
Burn to lips, 1 st degree	Minor (292002.1,8)	Deploying driver air bag gases
Chin abrasion	Minor (290202.1,8)	Expanding driver air bag
Left upper arm abrasion	Minor (790202.1,2)	Expanding left side impact air bag

Note: the above injuries were identified in the Emergency Room records of the treating hospital.

DRIVER KINEMATICS

Immediately prior to the incident, the driver had just entered the vehicle and was seated in a mid-track position. She leaned slightly forward and right in order to better see the ignition port. She inserted the key and upon rotation of the switch, multiple air bags inadvertently deployed. The Cadillac's engine did start during the incident.

The driver air bag deployed from its module located in the center of steering wheel rim. The driver's face, positioned forward and right, was exposed to the gases of the deployment sustained burns to the lips and left cheek. The air bag membrane expanded across the left aspect of the face also abraded the chin. The deploying left seat-back mounted side impact air bag contacted the driver's upper arm resulting in the reported abrasion. After the incident, the driver came to rest within the driver seat.

Upon regaining her composure, the driver exited the vehicle under her own power and reported the incident to the via the 9-1-1 system.