TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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REMOTE INVESTIGATION OF A DRIVER AIR BAG FATALITY

NASS CASE NO. 1997-45-042B

VEHICLE - 1992 BUICK LESABRE

LOCATION - TENNESSEE

CRASH DATE - APRIL, 1997

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 remote investigation focused on the injury mechanisms of a single vehicle crash that involved a 1992 Buick LeSabre Limited, 4-door sedan. The Buick was equipped with a Supplemental Inflatable Restraint (SIR) that deployed as a result of the crash. The vehicle was driven by an unrestrained 78 year old female who suffered fatal injuries.

The crash occurred when the driver of the eastbound Buick lost control of the vehicle while attempting to avoid a non-contact vehicle. The driver initiated an avoidance maneuver by braking and steering clockwise. The Buick traveled off the right side of the road and struck a utility pole with the right front corner of the vehicle. The CDC of the Buick was 12-FREN-2, with a measured crush of 47.0 cm (18.5 in) at the right front bumper corner. The delta V of the Buick was calculated to be 33.5 km/h (20.8 mph).

At impact the unrestrained driver initiated a forward trajectory in response to the 12 o'clock direction of the impact force and interfered with the deployment of the driver air bag. The forward position of the driver restricted the proper opening of the cover flaps and egress of the air bag. The air bag did not properly unfold and expand toward the driver. The fabric fused internally from the heat of the inflator.

EMS found the driver without a pulse and apneic, with only an agonal heart rhythm. The driver was transported, arriving in the ER 24 minutes post-crash. She was pronounced deceased 32 minutes post-crash of blunt chest trauma. The medical records only indicated the driver suffered a laceration to the lip and chin and bruising to the anterior neck (AIS 1). The driver had an extensive cardiac history. No autopsy was performed.

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REMOTE INVESTIGATION OF A DRIVER AIR BAG FATALITY
NASS CASE NO. 1997-45-042B

VEHICLE: 1992 BUICK LESABRE LIMITED, 4 DOOR SEDAN
LOCATION: TENNESSEE
CRASH DATE: APRIL, 1997

BACKGROUND

This task involved the remote investigation of a single vehicle crash that involved a 1992 Buick LeSabre Limited, 4-door sedan. The vehicle was equipped with a Supplemental Inflatable Restraint (SIR) that consisted of a driver air bag. The vehicle was driven by an unrestrained 78 year old female, with a height and weight of 163 cm (64 in) and 54 kg (120 lb). The driver was fatally injured in the crash. The Buick traveled off the roadway and struck a utility pole, after the driver lost control avoiding a non-contact vehicle. The vehicle's driver air bag improperly deployed due to the forward position of the driver. The crash was originally selected for investigation in the NASS system as case 1997-45-042B. Calspan SCI informed the Field Operations Branch of the National Highway Traffic Safety Administration (NHTSA) November 7, 1997, of the possibility of an air bag related fatality after review of the case. NHTSA in-turn assigned Calspan SCI the crash as a remote investigation effort the same day.

SUMMARY

This single vehicle crash occurred in the afternoon hours of April, 1997. The crash occurred on a two-lane east/west straight and level asphalt roadway. At the scene, there was a two-lane road intersecting from the north and a private driveway intersecting from the south (Figure 1). A utility pole was located 2.2 m (7.2 ft) south of the fog line and 1.1 m (3.6 ft) east of the driveway (Figure 2). At the time of the crash, the weather was not a factor and the road was dry. The speed limit in the area of the crash was 64 km/h (40 mph).

Figure 1: Eastbound trajectory view.

Figure 2: View of the utility pole.

The 1992 Buick LeSabre Limited, 4-door sedan, was traveling east behind a non-contact vehicle. The Buick was operated by a 78 year old unrestrained female. Reconstruction of the speed of the Buick, by

trajectory and damage analysis, determined the vehicle was traveling approximately 56 to 64 km/h (35 to 40 mph). Immediately preceding the crash, the non-contact vehicle slowed to turn left onto the intersecting road. The driver of the Buick initiated an avoidance maneuver by steering clockwise and braking and subsequently lost control of the vehicle. The Buick traveled off the south side of the road and struck a utility pole with the right corner of the front bumper. A 15.7 m (51.5 ft) skid mark, attributed to the right front tire of the Buick, was identified by the NASS researcher. The skid mark arced southward off the road, over its length, from the travel lane to the right edge line. The end of the mark was directly in line with the pole. The skid mark began and ended 25.8 m (84.6 ft) and 10.1 m (33.1 ft) west of the pole, respectively.

The Collision Deformation Classification (CDC) of the Buick was coded 12-FREN-2, with a measured crush of 47.0 cm (18.5 in) at the right corner of the front bumper. The direct contact damage width was 32.0 cm (12.6 in), located 40.0 to 72.0 cm (15.7 to 28.3 in) right of the vehicle centerline. The deformation was localized to the vehicle's right frontal area. The bumper, right front fender, hood and the unitized structure forward of the right front axle were damaged. There was no measurable change in the right side wheelbase dimension. The crush profile measured across the full 162 cm (64 in) width of the front bumper was as follows: C1 = 6.0 cm (2.4 in), C2 = 7.0 cm (2.8 in), C3 = 11 cm (4.3 in), C4 = 20 cm (7.9 in), C5 = 32 cm (12.6 in), C6 = 47.0 cm (18.5 in). Figures 3 through 5 are views of the Buick's frontal damage.

Figure 3: Right front view of the Buick.

Figure 4: Right lateral view across the frontal plane.

Figure 5: Close-up view of the right front corner.

The Buick struck the utility pole with the structures of the right front corner, outboard of the unitized frame rail. The vehicle's structures outboard of the frame rail are less stiff than structures that incorporate the frame rail. Because the impact occurred in an area of reduced stiffness, the triggering of the air bag deployment was delayed to a time late in the collision sequence when the driver was out-of-position over the top of the module. The Barrier model of the SMASH algorithm (with pole impact parameters) calculated the delta V of the Buick to be 33.5 km/h (20.8 mph). The longitudinal delta V of -33.5 km/h (-20.8 mph) was above the threshold required to deploy the vehicle's air bag system.

The unrestrained driver was seated in a forward position, due to her small stature, with a presumed normal posture. At impact, she responded to the 12 o'clock direction of the impact forces by initiating a forward trajectory. Several specific areas of occupant interaction with the front interior structures of the vehicle and driver air bag were identified during the NASS inspection. The driver's chest and abdomen contacted and deformed the steering wheel rim and compressed the steering column. The driver's right knee was displaced forward into the knee bolster. This kinematic pattern positioned the driver directly over the top of the driver air bag module at the time of deployment.

The driver's forward position restricted the proper opening of the cover flaps upon initiation of the deployment sequence. This impeded the air bag's normal egress from the module. The air bag remained captured within the air bag module during its initial expansion, which caused pressure to build within the module. The increased pressure caused the module cover to eventually deform, Figures 6 and 7. This allowed the air bag to deploy through the module's 1 to 5 o'clock sectors. The failure of the air bag to properly unfold, during the expansion, allowed the air bag fabric to come in contact with the hot inflator. This contact caused the fabric to fuse/melt onto itself. (Refer to the Supplemental Inflatable Restraint section, page 4 for further detail.)

Figure 6: Deformed driver air bag module.

Figure 7: Lateral view of the driver air bag module.

The cover flaps and improperly expanding air bag contacted the driver in the face, neck and chest. The medical records indicated the only codeable injuries sustained in the crash were a laceration to the lower lip and chin, and a bruising to the anterior neck, both AIS-1 injuries. When the paramedics arrived at the crash scene, the driver was without pulse and apneic, with only an agonal heart rhythm. CPR was

initiated in the field and continued in the Emergency Room of the local hospital. The driver was transported and delivered to the ER 24 minutes after the crash and she was pronounced dead 8 minutes after arrival in the ER. The cause of death was blunt force trauma to the chest resulting in sudden heart stoppage. The driver had a reported extensive cardiac history, although her son indicated that she was in good health and very active.

AIR BAG VEHICLE

The 1992 Buick LeSabre Limited, 4-door sedan, was identified by the manufacturer's vehicle identification number (VIN) of 1G4HR53L6NH (production sequence deleted). The vehicle was equipped with a 3.8 liter, V-6 engine and automatic transmission. The vehicle's interior was tan in color and was a high grade vinyl or leather. The front seats were a 60/40 split bench with reclining backrests and adjustable head restraints. Upon inspection, the left front seat was located in a mid-track position with the seat back slightly reclined. The head restraint was adjusted in the full up position. There were no seat performance failures.

INTERIOR DAMAGE

Inspection of the vehicle's interior located a windshield fracture in the upper center area of the laminate, adjacent to the center mirror. The reflective surface in the center mirror was also fractured. This damage was caused by contact from the driver's right hand/forearm. The steering wheel was adjustable and was in the full up position. The steering wheel rim was deformed in a forward direction at the 6 o'clock sector. The deformation was measured at 7.0 cm (2.8 in). The driver side knee bolster was padded and exhibited a scuff mark right of the steering column centerline. This mark was attributed to contact with the driver's right knee. An area of blood spatters was identified on the right front passenger seat and the center carpeting, in the area where the driver probably came to rest. The passenger side carpeting was soiled by an area of vomit to the right of the vehicle's centerline.

MANUAL RESTRAINT SYSTEM

The vehicle's manual restraint system consisted of 3-point lap and shoulder belts in the front outboard seated positions. The left upper anchorage (D-ring) was adjusted to the full down position. The police report indicated that the seat belt was used. However, inspection of the left front restraint webbing and hardware surfaces did not yield any evidence of witness marks that indicated seat belt usage in this crash. A first responder to the crash was a witness traveling behind the subject vehicle. He arrived at the vehicle within seconds after the crash and found the driver unrestrained by the seat belt and slumped to the right. The driver's kinematics pattern, injuries, the witness statement and the lack of evidence on the restraint all indicate that the driver was not restrained in this crash.

SUPPLEMENTAL INFLATABLE RESTRAINT

The Supplemental Inflatable Restraint (SIR) in the vehicle consisted of a driver side air bag configured in the typical manner in the center of the steering wheel. The H-configuration module cover flaps measured 20.0 cm (7.9 in) laterally and the height of the upper and lower flaps measured 6.0 cm (2.4 in)

SUPPLEMENTAL INFLATABLE RESTRAINT (CONT'D)

and 5.0 cm (2.0 in), respectively. The air bag measured 62 cm (24 in) in diameter in its deflated state and was not tethered. The bag was vented by two ports located on the back side in the 2 and 10 o'clock sectors. The driver air bag deployment was triggered by the impact. However, due to the forward position of the driver, the cover flaps failed to properly open at the tear seams. A heavy black smudge located in the 11 o'clock sector on the front side of the air bag was identified by the researcher, Figure 8. This smudge was caused by the friction heating between the expanding air bag's and the interior surface of the module cover during the altered deployment sequence.

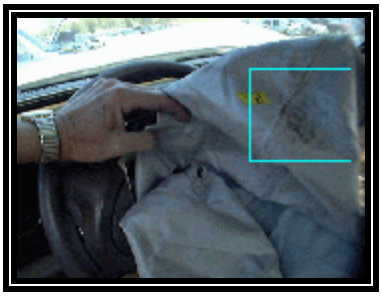

Figure 8: View of the smudge to the face of the air bag.

The air bag remained captured within the air bag module during its initial expansion, which caused pressure to build within the module. The right side of the upper cover flap was torn from the inflator module. The air bag did not unfold properly and was not able to fully expand toward the driver. The NASS researcher initially indicated a problem with the stitching around the vent port as the cause of the air bag's improper expansion. It is more probable that the failure of the air bag to properly unfold, during the expansion, allowed the air bag fabric to come in contact with the hot inflator. This contact caused the fabric to fuse/melt onto itself, (Figures 9 and 10).

Figure 9: Driver air bag.

Figure 10: Close-up view of the fused fabric.

DRIVER INJURIES

Injury	Injury Severity (AIS 90)	Injury Mechanism
Laceration of the lower lip and chin	Minor (290600.1,8)	Deploying driver air bag
Contusions - anterior neck	Minor (390402.1,5)	Deploying driver air bag

DRIVER KINEMATICS

The 78 year old female unrestrained driver reportedly was 163 cm (64 in) tall and weighed 54 kg (120 lb). She was likely seated in a forward track position due to her small stature. In response to the 12 o'clock impact force, the driver exhibited a forward trajectory and loaded the steering column. The deformation noted to the 6 o'clock sector of the steering wheel rim and the knee bolster contact occurred at this time. The driver's chest was in contact with the air bag module at deployment and interfered with the opening of the cover flaps. A second witness that responded to the crash and the wrecker operator both commented, in their respective interviews, that the driver's blouse was ripped open. This tearing/ripping of the blouse was also indicative of the driver's interaction with the air bag module in the early stages of its deployment.

The driver air bag deployment was impeded by the loading of the driver's chest which caused the air bag to improperly expand. The expansion of the air bag lacerated the lower lip and chin and caused the contusions to the anterior aspect of the driver's neck. The driver's right hand/forearm was displaced from the steering wheel up into center mirror causing the fractures at that location. The air bag's continued expansion caused the driver to rebound rearward. She was found in the left front seat, slumped to the right.

MEDICAL TREATMENT/HISTORY

The driver had a reported extensive cardiac history, although her son indicated that she was in good health and very active. The medical records indicated the only injuries sustained in the crash were a laceration to the lower lip and chin, and a bruising to the anterior neck, both AIS -1 injuries. When the paramedics arrived at the crash scene, the driver was without a pulse and apneic, and with only an agonal heart rhythm. CPR was initiated in the field and continued in the Emergency Room of the local hospital. The driver was transported and delivered to the ER 24 minutes after the crash and she was pronounced dead 8 minutes after arrival in the ER. The cause of death was complications resulting from blunt force trauma to the chest. No autopsy was performed.