

**TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION**

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CALSPAN ON-SITE DEPOWERED AIR BAG DEPLOYMENT INVESTIGATION

CALSPAN CASE NO. CA97-052

VEHICLE - 1998 CHEVROLET SUBURBAN

LOCATION - NEW YORK

CRASH DATE - NOVEMBER, 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. <i>Abstract:</i> This on-site investigation focused on a three-vehicle crash that involved a 1998 Chevrolet Suburban, a 1977 BMW 320i and a 1991 Chevrolet Lumina Z34. The 1998 Chevrolet Suburban was equipped with a Supplemental Restraint System (SRS) that consisted of depowered driver and front passenger air bags that deployed as a result of the crash. The driver of the Suburban suffered minor AIS 1 contusions to the lower extremities and the right front passenger only had a post-crash complaint of pain. The 1977 BMW 320i was traveling north followed by the 1998 Chevrolet Suburban. The 1991 Chevrolet Lumina was traveling south and traveled left of center into the northbound lane, around a stopped southbound non-contact vehicle. The front of the Lumina struck the left front corner and left side of the BMW in a 1/11 o'clock impact configuration. Upon separation, the BMW slid approximately 9 m (30 ft) northeastward and came to rest in the mouth of the intersecting east roadway facing northeast. The driver of the BMW was fatally injured in the crash. The driver of the Chevrolet Suburban reacted to the first collision by braking. However after the first impact, the Lumina continued southward in the northbound lane and struck the left frontal area of the Chevrolet Suburban in a 2/12 o'clock impact configuration. The frontal area of the Lumina then slid along the left side of the Suburban in a protracted engagement as the vehicles passed one another. The Collision Deformation Classification (CDC) of the Chevrolet Suburban was 12-FLEW-03. The Suburban's change in velocity (delta V) calculated by the Barrier Model of the WINSMASH program was 27.6 km/h (17.2 mph).			
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**CALSPAN ON-SITE DEPOWERED AIR BAG DEPLOYMENT INVESTIGATION
CALSPAN CASE NO. CA97-052**

**VEHICLE: 1998 CHEVROLET SUBURBAN
LOCATION: NEW YORK
CRASH DATE: NOVEMBER, 1997**

BACKGROUND

This on-site investigation focused on a three-vehicle crash that involved a 1998 Chevrolet Suburban, a 1977 BMW 320i and a 1991 Chevrolet Lumina Z34. The northbound BMW and Chevrolet Suburban were both struck by the southbound Chevrolet Lumina. The 1998 Chevrolet Suburban was equipped with a Supplemental Restraint System (SRS) that consisted of depowered driver and front passenger air bags that deployed as a result of the crash. The driver of the Suburban sustained minor AIS 1 contusions to his lower extremities and the right front passenger only had a post-crash complaint of pain. The driver of the BMW was fatally injured in the crash.

The National Highway Traffic Safety Administration (NHTSA) was notified on this crash through the Fatal Accident Reporting System (FARS) on December 22, 1997. NHTSA assigned this investigation to the Calspan Special Crash Investigations Team on December 29, 1997. The vehicles were located in the investigating agency's police impound, pending resolution of the criminal aspect of this crash. To preserve the chain of evidence for the criminal case, the vehicle inspection had to set-up through the County's District Attorney's Office. The on-site inspection was completed on January 22, 1998.

SUMMARY

This three-vehicle crash occurred in the nighttime hours of November 1997. At the time of the crash, it was dark with street lighting and it was raining. The roads were wet. The crash occurred in the northbound lane of a two-lane north/south roadway located in a residential neighborhood. At the crash scene, the road grade was level and there was a gradual left curve for northbound traffic. There was a two lane road intersecting from the west, approximately 13 m (42 ft) south of the area of impact and a two lane road intersecting from the east, approximately 28 m (92 ft) north of the impact area. The primary roadway was 10 m (33 ft) in width, delineated by white fog lines and a double yellow center line. The speed limit in the area of the crash was 48 km/h (30 mph). **Figure 1** is a northbound trajectory view of the crash scene.



Figure 1: Northbound trajectory view.

The crash occurred in the following manner. The 1977 BMW 320i was traveling north followed by the 1998 Chevrolet Suburban. The 1991 Chevrolet Lumina was traveling south and traveled left of center into the northbound lane, around a stopped southbound non-contact vehicle. The front of the Lumina struck the left front corner and left side of the BMW in a 1/11

o'clock impact configuration. Upon separation, the BMW slid approximately 9 m (30 ft) northeastward and came to rest in the mouth of the intersecting east roadway facing northeast. The driver of the BMW was fatally injured in the crash.

The driver of the Chevrolet Suburban reacted to the first collision by braking. However after the first impact, the Lumina continued southward in the northbound lane and struck the left frontal area of the Chevrolet Suburban in a 2/12 o'clock impact configuration. The frontal area of the Lumina then slid along the left side of the Suburban in a protracted engagement as the vehicles passed one another. The impact caused the Lumina to rotate counterclockwise and the vehicle slid to rest facing eastward approximately 20 m (65 ft) south of the 2nd point of impact, 9 m (30 ft) south of the intersecting west roadway. The Suburban slid to the northeast and came to rest, facing northeast, in the mouth of the intersecting east roadway, approximately 20 m (65 ft) north of the 2nd point of impact, approximately 6 m (20 ft) south of the BMW. The force of the impact caused the SRS of the Suburban to deploy.

The Collision Deformation Classification (CDC) of the Chevrolet Suburban was 12-FLEW-03, **Figure 2**. The direct contact damage was 46 cm (18 in) in width, began 46 cm (18 in) left of center and extended to the left corner of the front bumper. The maximum deformation at the left corner was approximately 79 cm (31 in). The crush profile (less assumed free space) was as follows: C1=79 cm (31 in), C2=30 cm (12 in), C3=16 cm (6 in), C4=0, C5=0, C6=0. The Suburban's change in velocity (delta V) calculated by the Barrier Model of the WINSMASH program was 27.6 km/h (17.2 mph). The damaged components include: the front bumper, grille, hood, left front fender and wheelhouse, left front suspension and left frame rail. There was intrusion into the foot well of the driver's space. The windshield was cracked on the left lower aspect from the exterior impact force. The left side damage continued onto the left front door which was deformed rearward into the left B-pillar causing the door to be jammed shut. The left rear door could be opened slightly but was restricted by the front door's deformation. The impact cut and aired out the left front tire and circumferentially fractured the aluminum wheel rim.



Figure 2: Left front view of the Chevrolet Suburban.



Figure 3: Front view of the Chevrolet Lumina.

Figure 3 is a front view of the 1991 Chevrolet Lumina. The CDC of the Chevrolet Lumina could not be coded (99-9999-99). The areas of direct contact in the two impacts directly overlapped and it was not possible to distinguish the damage extent associated to the two impacts. Overall, the vehicle's direct contact damage was 96 cm (38 in) in width beginning 18 cm (7 in) right of center and extended to the left corner of the front bumper. The entire front structure of the vehicle was displaced laterally 51 cm (20 in) to the left. The maximum deformation at the left front corner (less assumed free space) was approximately 76 cm (30 in).

The damaged components included: the front bumper fascia and reinforcement, hood, left front fender and wheel house, left front suspension and left unitized frame rail.

The CDC of the 1977 BMW 320i (**Figure 4**) was 11-LDAW-03. The front of the Chevrolet Lumina contacted the outboard 10 cm (4 in) of the left corner of the front bumper and continue down the left side of the vehicle. The direct contact damage extended 363 cm (143 in) longitudinally, from the left front corner, along the side of the vehicle. The impact deformed the left front suspension rearward into the left side of the firewall buckling the A-pillar and roof. The left front wheel rim was displaced from the axle. The windshield was displaced from the frame and fractured. All left side windows were shattered. The left front door's hinge pillar and the floor pan intruded into the occupant space.



Figure 4: Left front view of the BMW 320i.

The 1998 Chevrolet Suburban was driven by a 46 year male with a reported height/weight of 188 cm (74 in) and 145 kg (320 lb). He was seated in a normal posture, restrained by the vehicle's manual 3-point restraint in a mid/rear track position. The right front passenger was a 52 year old female with a reported height/weight of 168 cm (66 in) and 77 kg (170 lb). She was wearing prescription glasses. The right front passenger was restrained with her seat adjusted to a mid-track position. The occupants of the Suburban were eating chips and salsa at the time of the crash evidenced by the soiled condition of the vehicle's interior.

Post-crash, the police and medical personnel responded to the crash scene. The occupants of the Suburban had removed themselves from the vehicle post-crash without assistance. The driver of the Suburban suffered minor contusions to the knees and ankles as a result of contact with the left knee bolster and foot controls. The right front passenger complained of pain/soreness to her chest and about the nose. The chest pain/soreness was caused by inertial contact with the 3-point restraint and deployed front passenger air bag. The soreness about her nose was a result of the interaction between her face, glasses and the deployed front passenger air bag. Both occupants were transported to a local hospital, examined and released the evening of the crash. The above injury information was reported by the driver. He consented to an interview but declined signing a medical release form. Attempts to contact the right front passenger were unsuccessful.

DEPOWERED AIR BAG VEHICLE

The 1998 Chevrolet Suburban was identified by the VIN of 2GNGK26J2WJ (production sequence deleted). The Suburban was configured as a four-wheel drive, 3/4 ton multi-purpose vehicle equipped with a 7.4 liter, V8 engine coupled to a four-speed automatic transmission. The vehicle was equipped with a Supplemental Restrain System (SRS) that consisted of depowered driver and front passenger air bags. Additional safety equipment included a four-wheel anti-lock braking system.

The vehicle's interior was leather, tan in color. The front seats were bucket seats with reclining backs. The head restraints were adjustable and both restraints were adjusted to the lowest position. The seats were electronically adjustable (powered). The left front seat was positioned between the mid and rear track. The seat back was reclined approximately 25 degrees. The right front seat was adjusted to a mid-track position and the seat back was reclined 30 degrees. There were no seat performance failures.

MANUAL RESTRAINT SYSTEM

The manual restraint system consisted of 3-point lap and shoulder belts for the front seating positions. The belt system consisted of dual retractors with separate lap and shoulder belt webbings attached to a fixed latch plate. The D-rings were adjustable. Both the left front and right front D-rings had a 10 cm (4 in) adjustment range and were positioned 4.4 cm (1.8 in) below the upper most adjustment. The left D-ring exhibited a faint transfer mark indicative of restraint usage in the crash. The right front restraint was also in use at the time of the crash, evidenced by the soiled condition of the webbing's surface. (The right front restraint was covered with (dried) salsa that was spilled by the right front occupant during the crash.)

SUPPLEMENTAL RESTRAINT SYSTEM

The Chevrolet Suburban was equipped with a Supplemental Restraint System that consisted of depowered driver and front passenger air bags. The driver air bag module was configured in the typical manner in the center hub of the steering wheel. The steering wheel was a tilt wheel adjusted to its most vertical position. It is likely that this adjustment of the rim occurred during the post-impact egress of the driver. The 4-spoke steering wheel rim was not deformed. Inspection of the steering columns' shear capsules indicated there was no movement of the column from occupant (driver) loading. **Figure 5** is a view of the shear capsules taken from underneath the instrument panel. The steering wheel was located (out of the field of view) at the bottom of the figure.

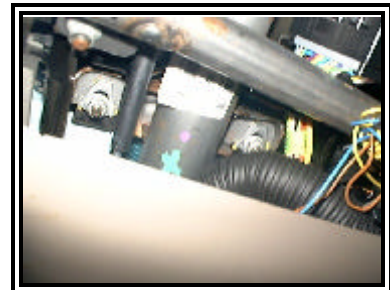


Figure 5: View of the steering column shear capsules.

The driver air bag module cover flaps were designed as an I-configuration that opened as designed during the deployment sequence. The symmetrical flaps measured 10.8 cm (4.3 in) vertically by 7.6 cm (3.0 in) horizontally. The driver air bag was a tethered bag, 61 cm (24 in) in diameter, **Figure 6**. The two internal tether straps sewn to the center of the air bag's front surface were located at the 3 and 9 o'clock positions. When the bag was extended during the inspection, the tether straps allowed the deflated bag to extend 30 cm (12 in) from the module. There were two 2.5 cm (1.0 in) diameter vent ports located at the 11 o'clock/1 o'clock on the back side of the bag. The lower right quadrant of the air bag face was



Figure 6: Driver air bag.

spattered/soiled with dried salsa. There was no residual evidence of any other occupant contact.

The front passenger air bag was a mid-mount configuration housed in the right side of the instrument panel.



Figure 7: Front passenger air bag.

The H-configuration cover flaps measured 6.6 cm (2.6 in) vertically by 32.4 cm (12.8 in) horizontally. In its deflated state, the front passenger air bag measured 36 cm (14 in) vertically by 56 cm (22 in) horizontally at its extended face. The face of the bag extended 61 cm (24 in) from the module. The air bag was not tethered and was vented by two 5.7 cm (2.3 in) diameter ports located on the side panels in the 3/9 o'clock positions. The only evidence on the air bag fabric was dried salsa that covered the entire face of the bag. There was an additional concentration of dried salsa on the bottom left corner of the fabric. There was no residual evidence of any other occupant contact.

DRIVER INJURIES

Injury	Severity (AIS 90)	Injury Mechanism
Unspecified superficial contusions - knees	Minor (890402.1,3)	Knee bolster contact
Unspecified superficial contusions - ankles	Minor (890402.1,3)	Foot controls contact

DRIVER KINEMATICS

The Chevrolet Suburban was driven by a 46 year male with a reported height/weight of 188 cm (74 in) and 145 kg (320 lb). He was seated in a normal posture, restrained by the vehicle's manual 3-point restraint in a mid/rear track position. The driver was braking the vehicle in response to the collision that had occurred in front of him. Upon impact, the driver initiated a forward trajectory, loaded the 3-point restraint and the deployed depowered driver air bag. There was no measurable displacement of the steering columns shear capsules. His trajectory displaced his knees forward and in contact with the knee bolster causing unspecified contusions to his knees. The driver's ankles contacted the foot controls causing minor contusions.

RIGHT FRONT PASSENGER INJURIES

Injury	Severity (AIS 90)	Injury Mechanism
Unspecified pain/soreness - chest	Minor (n/a)	Inertial contact 3-point restraint
Unspecified pain/soreness - nose	Minor (n/a)	Deployed depowered front passenger air bag/glasses

RIGHT FRONT PASSENGER KINEMATICS

The right front passenger was a 52 year old female with a reported height/weight of 168 cm (66 in) and 77 kg (170 lb). She was restrained, seated in a mid-track position. She was wearing prescription glasses. The occupant was eating chips and salsa and was holding a jar of salsa most likely in her left hand evidenced by the soiled condition of the vehicle's interior. Upon braking and impact, the right front passenger initiated a forward trajectory and loaded the 3-point restraint and the deployed depowered right front passenger air bag. The occupant's head and upper torso contacted the deployed air bag. The unspecified pain/soreness about the occupant's nose was resultant to this contact and the interaction with the occupant's glasses. The occupant's unspecified pain/soreness to the chest was a result of the inertial contact with the manual 3-point restraint.