

**TRANSPORTATION SCIENCES  
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**REMOTE AIR BAG RELATED DRIVER FATALITY INVESTIGATION**

**VERIDIAN CASE NO. CA97-035**

**VEHICLE - 1994 CHEVROLET CORSICA**

**LOCATION - NEW HAMPSHIRE**

**CRASH DATE - OCTOBER 1997**

**Contract No. DTNH22-94-07058**

**Prepared for:**

**U.S. Department of Transportation  
National Highway Traffic Safety Administration  
Washington, DC 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 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.

## TECHNICAL REPORT STANDARD TITLE PAGE

<p>1. <i>Report No.</i> CA97-035</p>	<p>2. <i>Government Accession No.</i></p>	<p>3. <i>Recipient's Catalog No.</i></p>	
<p>5. <i>Title and Subtitle</i> Remote Air Bag Related Driver Fatality Investigation Vehicle - 1994 Chevrolet Corsica Location - New Hampshire</p>		<p>4. <i>Weights</i></p>	
		<p>6. <i>Report Date:</i> June 2001</p>	
<p>8. <i>Author(s)</i> Crash Data Research Center</p>		<p>7. <i>Performing Organization Code</i></p>	
		<p>9. <i>Performing Organization Report No.</i></p>	
<p>10. <i>Performing Organization Name and Address</i> Transportation Sciences Crash Data Research Center Veridian Engineering P.O. Box 400 Buffalo, New York 14225</p>		<p>11. <i>Work Unit No.</i> C01115 0345-(0000-0009)</p>	
		<p>12. <i>Contract or Grant No.</i> DTNH22-94-D-07058</p>	
<p>13. <i>Sponsoring Agency Name and Address</i> U.S. Department of Transportation National Highway Traffic Safety Administration Washington, DC 20590</p>		<p>14. <i>Type of Report and Period Covered</i> Technical Report Crash Date: October 1997</p>	
		<p>15. <i>Sponsoring Agency Code</i></p>	
<p>16. <i>Supplementary Notes:</i> Remote investigation of a driver fatality in a 1994 Chevrolet Corsica.</p>			
<p>17. <i>Abstract</i></p> <p>This remote investigation focused on the fatal injury mechanisms of an unrestrained 61 year old female driver of a 1994 Chevrolet Corsica.. The Chevrolet was involved in a single vehicle run-off road/fixed object crash. The driver relinquished directional control and the Chevrolet departed the right side of the road, traveled approximately 14 m (45 ft) and impacted a 15 cm (6 in) diameter hardwood tree with the right frontal area of the vehicle. The vehicle was equipped with a Supplemental Inflatable Restraint (SIR) that consisted of a driver air bag. The air bag deployed as a result of the crash. The female driver sustained a basilar skull fracture, atlanto-occipital and atlanto-axial distraction, subarachnoid and subdural brain hemorrhages and associated chin and facial abrasions, as a result of direct contact with the deploying air bag. She was pronounced dead upon arrival at a local hospital.</p> <p>The Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) was informed of the crash on October 7, 1997 by the local police department. NHTSA in-turn assigned an investigation of the crash to the Special Crash Investigation team at Veridian Engineering. At that time and prior to SCI involvement, an attorney representing the driver's family took possession of the vehicle. Cooperation with the attorney could not be established. A remote level investigation was subsequently performed with the information obtained through the medical examiner's office and from the local police department.</p>			
<p>18. <i>Key Words</i> Air Bag Deployment                      Driver Fatality Basilar Skull Fracture                      Hyper-extension Atlanto-occipital Distraction</p>		<p>19. <i>Distribution Statement</i> General Public</p>	
<p>20. <i>Security Classif. (of this report)</i> Unclassified</p>	<p>21. <i>Security Classif. (of this page)</i> Unclassified</p>	<p>22. <i>No. of Pages</i> 7</p>	<p>23. <i>Price</i></p>

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***BACKGROUND***

This remote investigation focused on the fatal injury mechanisms of an unrestrained 61 year old female driver of a 1994 Chevrolet Corsica.. The Chevrolet was involved in a single vehicle run-off road/fixed object crash. The driver relinquished directional control and the Chevrolet departed the right side of the road, traveled approximately 14 m (45 ft) and impacted a 15 cm (6 in) diameter hardwood tree with the right frontal area of the vehicle. The vehicle was equipped with a Supplemental Inflatable Restraint (SIR) that consisted of a driver air bag. The air bag deployed as a result of the crash. The female driver sustained a basilar skull fracture, atlanto-occipital and atlanto-axial distraction, subarachnoid and subdural brain hemorrhages and associated chin and facial abrasions, as a result of direct contact with the deploying air bag. She was pronounced dead upon arrival at a local hospital.

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***SUMMARY***

***Crash Site***

This single vehicle crash occurred during the afternoon hours of October 1997. At the time of the crash, it was daylight and the weather was not a factor. At the crash scene, the roadway was configured with a two-lane and served as an access road to a lake side residential area. The road was predominately straight and level and was north/south in direction. Trees and brush bordered both sides of the roadway. The unposted speed limit was 56 km/h (35 mph). **Figure 1** is a southbound trajectory view at the crash scene and depict the vehicle at final rest.



**Figure 1:** Southbound trajectory view of the vehicle at final rest.

### *Pre-Crash*

The driver of the 1994 Chevrolet Corsica was a 61 year old female with a reported height and weight of 163 cm (64 in) and 80 kg (177 lb). The driver was an out-of-state resident and was in New Hampshire visiting relatives. She was reportedly in good health and was well rested the day of the crash. Fatigue was not cited as a crash factor. The driver normally did not wear a seat belt, as reported by the family. She would only wear a seat belt at the insistence of an accompanying grandchild or other family member. This investigation has concluded she was not restrained during this crash.

The driver was operating the vehicle southbound and relinquished directional control for undetermined reasons. The Chevrolet gradually departed the right side of the road and traveled approximately 14 m (45 ft) prior to the impact. The police investigation identified rolling tire marks in the vegetation growing on the road-side. The marks led to the vehicle's impact and final rest location. The vehicle's trajectory indicated to the investigating police officer that the driver did not take any evasive maneuver during its off-road trajectory. An open soft drink container was found within the vehicle and a saturated wet area was located on the right front seat. The open container was suspected to have been a possible distraction that led to the loss of control.

### *Crash*

The crash occurred with the right frontal area of the Chevrolet impacting a 15 cm (6 in) diameter hardwood tree. The center of the impact damage was located approximately 30 cm (12 in) right of vehicle center line and the resulting longitudinal deformation was an estimated 30 cm (12 in). Examination of the on-scene police photographs, **Figure 2 and 3**, indicated the vehicle rebounded approximately 15 cm (6 in) and came to rest. The estimated delta V of the impact based on SCI field experience was approximately 24 km/h (15 mph). The driver air bag deployed as a result of the above threshold impact.



**Figure 2:** Right view of the vehicle at final rest.



**Figure 3:** Left view of the vehicle at final rest.

### *Post-crash*

The crash was not visually witnessed, but was heard by local residents living in the area of the crash. The first witness on the scene found the driver within the vehicle and unresponsive. He reported the driver air

bag was still venting and the deflated membrane was surrounding the driver's face in an "ear to ear" fashion. He moved the membrane and observed a large volume of blood pour from the driver's nose. The witness noted, the driver was within the driver's seat and was leaning partially to the right, her head tipped onto her right shoulder. He also noted that the driver was seated in close proximity to the steering wheel. He estimated that he arrived at the vehicle within 60 seconds of the crash.

Ambulance personnel arrived on-scene approximately two minutes after crash notification. EMS personnel indicated the driver's glasses were shattered and broken. She had lacerations to her nose and eyelids. A large abrasion was noted on the anterior chin and left side of the face. The technician moved the driver's seat rearward in order to treat the driver. He estimated "the seat was probably all the way up". Cardio-pulmonary resuscitation was started at the scene and continued during transport to a local hospital without success.

### ***1994 CHEVROLET CORSICA***

The 1994 Chevrolet Corsica, 4-door sedan, was identified by the Vehicle Identification Number (VIN): 1G1LD5549RY292149. The vehicle's power train consisted of a 2.2 liter, I-4 engine linked to a 3-speed automatic transmission. The brakes were a standard hydraulic front disc/rear drum system. The manual restraint system consisted of 3-point lap and shoulder belts in the four outboard seat positions and a center rear lap belt. The Supplemental Inflatable Restraint (SIR) consisted of a driver only air bag. The odometer read 56,314 km (34,926 miles). The vehicle was owned and had been purchased new by the driver. Service records found within the vehicle, during the police investigation, indicated the vehicle had been serviced on a regular basis and was free of mechanical defects.

#### ***Exterior Damage***

**Figure 4** is a front view of the Chevrolet Corsica taken during the police investigation. The vehicle's front plane sustained an estimated 15 cm (8 in) of direct contact damage that was centered 25 cm (10 in) right of the vehicle's centerline. The width of the combined direct and induced damage appeared to extend across the vehicle's entire front end width. The maximum deformation was estimated by the police investigation to be 30 cm (12 in). The energy of the crash was managed primarily by the vehicle's structure forward of the radiator support plane. There was no change in the wheelbase dimensions. The front fenders were not damaged. The delta V calculated by the Barrier Algorithm of the WINSMASH (using the estimated damage profile was 22.7 km/h (14.1 mph). The estimated Collision Deformation Classification (CDC) was 12-FZEN-2.



**Figure 4:** Front view of the Chevrolet.

### ***Interior Damage***

Information regarding the post-crash condition of the vehicle's interior was limited. The following data was taken from the supplemental report of the police investigation and a review of the interior photographs, **Figure 5 and 6.**

The front seating system of the subject Corsica consisted of cloth-covered bucket seats. At the time of the crash, the front seat was adjusted to a forward track position consistent with the stature of the driver. The seat was subsequently moved to a rear track position by EMS personnel during evaluation and treatment of the driver. Inspection of the head restraint identified a distinct contact from the driver's head. The contact was located on the right aspect of the head restraint and was consistent with the driver's rebound kinematics. Evidence of driver contact to the steering wheel and column was identified by the police investigation. The steering wheel was noted, in the police report, to have been "torqued or twisted to the left". Additionally, the steering column had been compressed and displaced from the shear capsules due to the combined kinematic loading by the unrestrained driver and the deployment of the driver air bag. The ignition keys were bent and wedged in the ignition port due to contact with the instrument cluster and the combination control stalk mounted on the left aspect of the column had contacted an instrument panel air vent.

A large volume of blood was identified on the interior carpet beneath the front seats, with the heaviest concentration near the center tunnel. Blood was also found on the right aspect of the driver's seat. A large blood stain was evident on the face of the deployed driver air bag, **Figure 5.**

The autopsy report indicated her clothes were blood soiled.

The driver's manual 3-point lap and shoulder restraint was stowed in its retractor at the time of the police inspection. A padded cloth comfort sleeve was located on the shoulder webbing. The aftermarket comfort sleeve was reportedly placed there by the driver. Examination of the seat belt webbing, its hardware and the comfort sleeve found the restraint system free of any blood evidence. Considering the quantity and location of the blood found throughout the vehicle's interior, the left front restraint had to have been stowed in the retractor at the time of the crash.



**Figure 5:** Interior view of the Chevrolet.



**Figure 6:** Driver air bag.





7 cm x 4 cm (2.75 in x 1.5 in) abrasion on the undersurface of the chin	Minor (290202.1,8)	Deploying driver air bag
Subscalpular and subgaleal hemorrhage extending from temporalis to temporalis muscle across the occiput	Minor (190402.1,6)	Rebound contact to head restraint
Transversely oriented diastasis fracture through the lamboid suture, posteriorly	Moderate (150402.2,6)	Rebound contact to head restraint
Approximately 20 cc subdural hemorrhage over inferior aspects of both cerebellar hemispheres as well as the pons	Severe (140442.4,6)	Deploying driver air bag
Subarachnoid hemorrhage over inferior aspects of both cerebellar hemispheres as well as the pons and on the inferior aspects of both temporal lobes	Serious (140466.3,6)	Deploying driver air bag
Complete hinge-type fracture of the base of skull passing anteriorly to both left and right petrous ridges and extending directly into both external auditory canals	Severe (150206.4,8)	Deploying driver air bag
Distraction of the atlanto-occipital and atlanto-axial membranes	Serious (650206.3,6)	Deploying driver air bag
16.5 cm x 15 cm (6.5 in x 6 in) chest abrasion, just left of the sternum and above and medial to the left breast	Minor (490202.1,2)	Deploying driver air bag
6 mm (1/4 in) diameter abrasion of the left elbow	Minor (790202.1,2)	Unknown
Small contusions to the left thumb and fourth finger	Minor (790402.1,2)	Possible fling injury to left door glass/panel
Superficial transverse laceration over the ventrolateral aspect of the left wrist	Minor (790602.1,2)	Possible fling injury to left door glass/panel
Three superficial avulsive lacerations over the dorsolateral aspect of the right wrist	Minor (790802.1,1)	Unknown

The cause of death was listed as: Blunt impact injuries to the head and neck with basilar skull fracture and high cervical injury.

*Note: The above injuries were identified in the driver's Autopsy Report.*

### ***DRIVER KINEMATICS***

Immediately prior the crash, the unrestrained female driver was seated in a forward track position consistent with her stature. This seat track position placed her in-close proximity to the driver air bag module. It was probable the driver became distracted and moved out-of-position to her right. Her head was turned in that direction, as well. She relinquished directional control of the vehicle, causing the roadside departure and frontal impact. The driver air bag deployed as a result of an above-threshold impact with a 15 cm (6 in) hardwood tree.

The driver responded to the 12 o'clock direction of the impact by exhibiting a forward trajectory. The deploying driver air bag contacted the left side of the driver's face and her chest. This contact was evidenced by large abrasions to those body regions. The air bag fractured the driver's eyeglass frames which in-turn caused minor facial lacerations. The combination of the driver's forward kinematic pattern and the expanding air bag deformed the steering wheel rim and displaced the steering column from the shear capsules.

The air bag expanded under the driver's chin forcing the head upward and rearward. This rapid hyper-extension of the neck resulted in the fatal basilar skull fracture, brain hemorrhages, and the distraction of the atlanto-occipital and atlanto-axial membranes. The expansion of the bag forced the driver rearward into contact with the seat back and head restraint. The police inspection noted an unspecified contact to the head restraint consistent with this kinematic pattern. This contact resulted in the posterior fracture, of the (already) compromised, skull, and the subscalpular/subgaleal hemorrhages. The driver then came to rest within her seat where she was found.