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**TRANSPORTATION RESEARCH GROUP
CRASH RESEARCH SECTION**

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**ON-SITE SIDE IMPACT AIR BAG DEPLOYMENT
FATAL DRIVER INVESTIGATION**

VERIDIAN ENGINEERING CASE NO. CA99-75

**VEHICLE #1 - 2000 CADILLAC SEVILLE SLS
VEHICLE #2 - 1994 FORD ECONOLINE E350 CARGO VAN**

LOCATION: STATE OF NEW JERSEY

CRASH DATE - DECEMBER, 1999

Contract No. DTNH22-94-D-07058

Prepared for:

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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

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| 15. <i>Supplementary Notes</i> On-site investigation of a front to side crash that resulted in the deployment of a side impact air bag and subsequent fatal injuries suffered by the 88 year old male driver. | | | |
| 16. <i>Abstract</i> <p>The crash occurred on a straight roadway when the driver of 2000 Cadillac Seville SLS equipped with side impact air bags attempted to make a "U" turn from a parked position and was struck on the left side plane by the front of the 1994 Ford Econoline E350 cargo van. The Cadillac sustained a maximum crush of 62.9 cm (24.75") to the left side resulting in the deployment of the driver's side air bag. The Collision Deformation Classification (CDC) code assigned to the Cadillac was 09-LPEW-4 and 12-FDEW-1 for the Ford. The WinSMASH computed the total delta V as 38.9 km/h (24.2 mph) for the Cadillac and 25.1 km/h (15.6 mph) for the Ford.</p> <p>The unrestrained 88 year old male driver of the Cadillac suffered fractures of the pelvis (AIS-3), fracture of the left ribs (AIS-2), fracture of the thoracic spine with cord damage (AIS-5), lung contusions (AIS-4), and lacerations of the liver (AIS-2) from contact with the intruding front left door surface and an atlanto-occipital dislocation with complete laceration of the spinal cord (AIS-6) from striking his head on the front right door surface. His vital signs were sent via telecommunications to a trauma facility where it was determined that the driver was deceased. He was subsequently transported to the morgue where an autopsy was performed.</p> <p>The side impact air bag was designed in a "J" deployment configuration which jutted forward 33.0 cm (13.0") and vertically 58.4 cm (23.0") from the forward leading edge of the seat back support during the deployment sequence. There were no visible driver contact points noted on the surface of the air bag.</p> <p>The driver of the Ford, a 58 year old male, was not restrained and suffered minor facial injuries from contact with the windshield. He was transported to a local treatment facility where was treated and released.</p> | | | |
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Final Case Report
Veridian Engineering Case No. CA99-75
On-site Side Impact Air Bag Deployment
Fatal Driver Investigation
Vehicle #1 - 2000 Cadillac Seville SLS
Vehicle #2 - 1994 Ford Econoline E350 Cargo Van
State of New Jersey
December, 1999

BACKGROUND

The Crash Investigation Division (CID) of the National Highway Traffic Safety Administration (NHTSA) was informed of a crash involving a 2000 Cadillac Seville SLS and a 1994 Ford Econoline E350 cargo van by the local police department. It was reported that a 88 year old male driver of the Cadillac suffered fatal injuries as the result of a side impact. The Cadillac was equipped with side impact air bags which deployed in the crash. The SCI team was requested by the CID to pursue this crash as an on-site investigation. The local police department was instrumental in establishing cooperation with all parties in this investigation. An on-site inspection of both vehicles and the scene was conducted within four days of notification.

SUMMARY

The crash occurred on a straight roadway when the driver of 2000 Cadillac Seville SLS equipped with side impact air bags attempted to make a “U” turn from a parked position and was struck on the left side plane by the front of the 1994 Ford Econoline E350 cargo van. The Cadillac sustained a maximum crush of 62.9 cm (24.75”) to the left side resulting in the deployment of the driver’s side air bag. The WinSMASH computed the total delta V as 38.9 km/h (24.2 mph) for the Cadillac and 25.1 km/h (15.6 mph) for the Ford. The unrestrained 88 year old male driver of the Cadillac suffered an atlanto-occipital dislocation with complete laceration of the spinal cord (AIS-6) as the result of striking his head on the front right door surface. His vital signs were sent via telecommunications to a trauma facility where it was determined that the driver was deceased. He was subsequently transported to the morgue where an autopsy was performed.

This crash occurred during traffic rush hours in the late afternoon hours. The ambient condition was light rain resulting in a wet roadway surface. The north/south roadway was undivided and consisted of one travel lane northbound and two travel lanes southbound (**Figure 1**). The roadway was marked with a double yellow solid barrier painted centerline and broken white lane lines southbound which were in good condition. There was a parking lane on the east side of the roadway which began 14.5m (47.5') south of the crash. The area speed limit was listed by police as 40 km/h (25 mph). The asphalt roadway surface had a 1.7 percent



Figure 1 View of the Ford's northbound trajectory 30 m (100') from the POI

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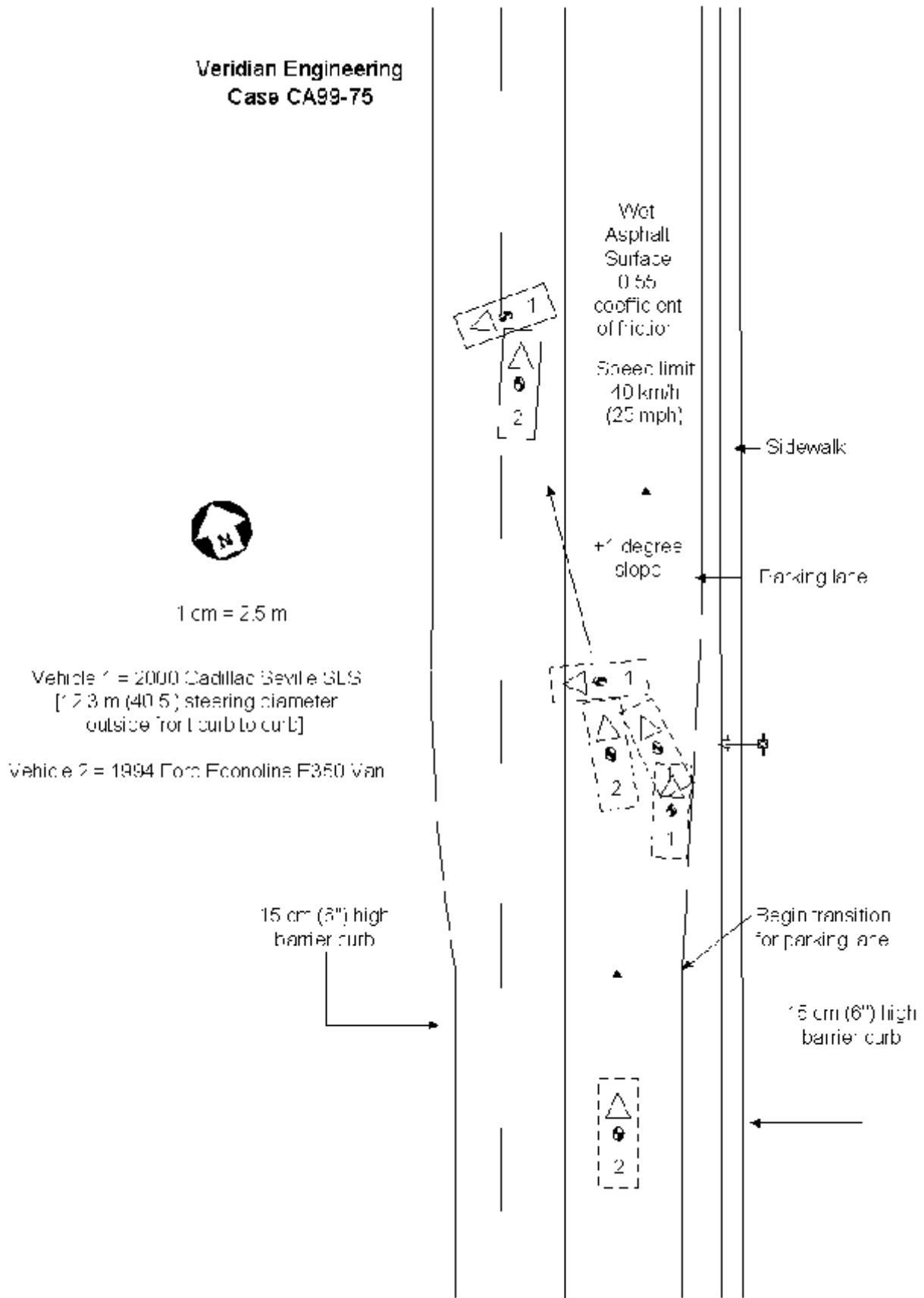


Figure 2 Scaled Scene Schematic

positive slope northbound at the point of impact (POI) with an estimated coefficient of 0.75 (dry)/0.55 (wet). The Cadillac was parked adjacent to the east curb within the transition area for the parking lane (**Figure 2**) prior to the crash.

The 88 year old male driver of the Cadillac, who was 170.2 cm (67.0") tall and weighed 81-84 kg (180-185 lb.), had departed a club moments prior to the crash. According to relatives, the driver was probably en route to his residence which was south of the club. The driver initiated a left U-turn and was perpendicular to the northbound travel lane at the time of impact.

The driver of the Ford, a 58 year old male who was 177.8 cm (70.0") tall and weighed 81.6 kg (180.0 lb.), described the traffic flow as medium density. He indicated that he was the lead vehicle while traveling northbound at an estimated speed of 40 km/h (25 mph). As he approached the parking lane area, he observed the Cadillac suddenly veer into his lane. He attempted to apply full brakes and steer to the left in an effort to avoid the impending crash. The driver estimated that he had only 1-2 vehicle lengths in which to respond.

The frontal plane of the Ford (**Figure 3**) struck the left side plane of the Cadillac (**Figure 4**) at a WinSMASH computed impact speed of 64.7 km/h (40.2 mph) which resulted in a 38.9 km/h (24.2 mph) lateral delta V to the Cadillac. The Collision Deformation Classification (CDC) code assigned to the Ford was 12-FDEW-1 and 09-LPEW-4 for the Cadillac. Both vehicles traveled 20.6 m (67.6') from the POI to the final rest positions (FRP) in the southbound travel lanes where they remained locked together by damage. The location of the POI was determined by the police from the side glass debris field observed at the scene.



Figure 3 Frontal plane of the Ford Econoline



Figure 4 View of the left side impact damage to the Cadillac

The Cadillac was equipped with a supplemental restraint system (SRS) which included dual front air bags and side impact air bags in restraint towers that were located along the outboard aspects of the front seat back supports. The driver's side air bag was the only air bag which deployed during the crash sequence (**Figure 5**). The side impact air bag was designed in a "J" deployment configuration which jutted forward 33.0 cm (13.0") and vertically 58.4 cm (23.0") from the forward leading edge of the seat back support during the deployment sequence. The longitudinal width of the vertical segment of the air bag measured 30.5 cm (12.0"). The air bag was not tethered or designed with external vent ports. There were no visible driver contact points noted on the surface of the air bag, however, there was a fabric artifact transfer field which measured 15.2 x 17.8 cm (6.0 x 7.0") along the inboard lower leading area of the air bag. This artifact was the result of contact with the fabric covered lower B-pillar during the air bag expansion sequence (**Figure 6**).



Figure 5 Lateral view of the front seat row of the Cadillac showing the “J” design left front side impact air bag



Figure 6 Close-up view of the fabric transfer from contact with the fabric covered lower left B-pillar during the air bag expansion sequence and located along the lower inboard leading area of the side impact air bag surface

The driver of the Cadillac was not restrained by the three point manual lap and shoulder belt prior to the crash. The intruding front left door panel contacted the driver’s left hip and lower left lateral torso area resulting in multiple fractures of the pelvis, fractures of the 8th and 9th ribs, and fracture of the thoracic spine with spinal cord compression/pulification. The driver was then propelled to the right by the intruding components where his head contacted the front right door armrest and door surface as denoted by the bodily fluid transfer (**Figure 7**). This contact resulted in a dislocation of the atlanto-occipital with complete transection of the spinal cord (AIS-6).

The driver’s body at final rest was oriented in a lateral position across the front seat cushions with his head against the front right door surface, his lower chest over the center console area, and his hips and upper legs on the front left seat cushion with his feet angled toward the front left instrument panel. The police indicated that the driver’s legs were wedged under the left instrument panel.

Rescue reportedly arrived within ten minutes and proceeded to check for vital signs of the Cadillac driver. After establishing a telecommunication link with the trauma hospital, it was determined by the trauma physician that driver was deceased at the scene.



Figure 7 View of the bodily fluid transfer on the front right door armrest and door panel from contact by the driver’s head

The unrestrained driver of the Ford exited his vehicle unassisted following the crash. He suffered facial lacerations from contact with the windshield and was transported to a local treatment facility where he was treated and released.

Both vehicles were towed from the scene and stored at storage facilities. The Cadillac was housed in a dealership building and covered by a plastic tarp. It appeared that interior of the vehicle had not been tampered with following rescue activities. The electrical system had been rendered inoperative by rescue who

cut the power cable both at the relay/fuse panel under the hood and at the battery located under the rear right seat.

VEHICLE DATA

2000 Cadillac Seville SLS - Exterior

The 2000 Cadillac Seville SLS four door sedan was a new leased vehicle with an estimated 1,600 km (1,000 miles) on the odometer. The vehicle was equipped with a Supplemental Restraint System (SRS) which included dual frontal air bags and front seat mounted side impact air bags. The driver’s side air bag deployed as the result of the impact with the 1994 Ford Econoline E350 cargo van. Exterior damage to the Cadillac involved the left A-pillar, left front door, left front door glazing, the left B-pillar, the left rear door, the left rear quarter panel, and the windshield. The maximum crush of 62.9 cm (24.75") was located at mid level of the left rear door and 96.5 cm (38.0") forward of the left rear axle center. The direct contact damage length measured 182.9 cm (72.0") with the rear most end of the contact located 35.6 cm (14.0") forward from the left rear axle center. The left side crush profile is listed in the following table:

| Cadillac Crush Profile | | | |
|-------------------------------|----------------------------------|-----------------------------------|------------------------------------|
| Impact with the Ford | C ₁ = 15.9 cm (6.25") | C ₂ = 59.1 cm (23.25") | C ₃ = 61.3 cm (24.125") |
| | C ₄ = 55.9 cm (22.0") | C ₅ = 42.5 cm (16.75") | C ₆ = 0 cm |

Collision Deformation Classification (CDC)

The collision deformation classification (CDC) code for the left side impact was assigned as follows: 09-LPEW-4.

2000 Cadillac Seville SLS - Interior

Interior damage to the 2000 Cadillac Seville SLS was attributed to the extensive lateral vehicle intrusion from the impact sequence with the Ford Econoline E350 cargo van (**Figures 8&9**) and the deployment of the Supplemental Restraint System (SRS). Intruded components included: the front left door panel and armrest; the B-pillar; the left front seat; the left floor sill; the front left kick panel; and the rear left door panel.



Figure 8 Overhead view of the driver’s seat and the left side intrusion looking rearward from the front of the Cadillac



Figure 9 Another overhead view of the left side intrusion looking from the rear of the vehicle forward

The following table lists the intruded values for these components.

| Component | Intruded Value | Intruded direction |
|--|------------------|--------------------|
| Left front door armrest adjacent to the lower B-pillar | 41.3 cm (16.25") | Lateral |
| Left front door panel adjacent to the lower B-pillar above the left front door armrest | 41.3 cm (16.25") | Lateral |
| Outboard surface of the front left driver seat back support | 46.4 cm (18.25") | Lateral |
| Left lower B-pillar | 36.8 cm (14.5") | Lateral |
| Left kick panel | 7.6 cm (3.0") | Lateral |
| Rear left door panel (separated from door substructure) | 72.4 cm (28.5") | Lateral |
| Rear left door substructure | 43.2 cm (17.0") | Lateral |

The motorized adjustable light color gray leather driver seat was deformed laterally by the intruded front left door structure. The pre-impact seat cushion dimensions measured 52.1 cm (20.5") longitudinally and 47.0 cm (18.5") laterally. The vertical height of the seat back support measured 57.2 cm (22.5") with a 50.8 cm (20.0") width. The vertically motorized adjustable head restraint was in the full down position and measured 22.9 cm (9.0") laterally and 17.8 cm (7.0") vertically with a 2.5 cm (1.0") gap between the bottom of the head restraint and the top of the seat back support.

The bucket front seats were designed with a unique restraint tower mounted to the outboard vertical surface of the seat back support which was designed to maintain a spacial relationship between the various restraints and the occupant regardless of the seat track position (**Figures 10 & 11**). Contained in the restraint tower were the head restraint; the seat-integrated manual three point lap and torso restraint belts, the "D-ring", restraint belt retractors; and the side impact air bag.

The top portion of the restraint tower which measured 20.3 cm (8.0") vertically and 14.0 cm (5.5") laterally was vertically adjustable via a motorized adjustment mechanism. By incorporating the head restraint and restraint belt D-ring into this section, both safety features were simultaneously adjustable for the occupant's torso height.

The lower portion of the tower which measured 53.3 cm (21.0") vertically and 10.2 cm (4.0") laterally with the top edge located 8.9 cm (3.5") below the top of the seat back support contained restraint belt retractors, the restraint belt pretensioner, and the side impact air bags. The three point manual restraint belt was designed with a dual mode webbing sensitive/inertia force locking mechanism with locking retractors for the torso and lap belts. The belt latching mechanism was mounted to the inboard aspect of the seat structure.

The front left restraint belt was fully retracted into the restraint tower and resisted unspooling efforts during the inspection. The driver was not using the restraint belt at the time of the crash.



Figure 10 View of the front right seat back support showing the restraint tower incorporating the head restraint, manual belt restraint, and side impact air bag located along the outboard surface of the seat back support



Figure 11 Closer view of the adjustable portion of the restraint tower

During the impact event, the left side impact air bag began the actuation sequence and exerted pressure against the inside wall of the restraint tower housing resulting in a separation of the vinyl adjacent to the seat fabric. As the air bag expanded, the leading lower edge contacted the intruding lower B-pillar resulting in a 15.2 cm (6.0") vertical abraded surface of the B-pillar cover and a fabric transfer on the air bag (**Figure 12**). The air bag deployed in a forward and upward direction as designed. The driver's side air bag was mounted in the restraint tower located along the outboard aspect of the driver seat back support.



Figure 12 View of the abraded area along the lower left B-pillar from contact by the expanding left front side impact air bag



Figure 13 View of contact evidence to the front right door panel and armrest

There was a 5 cm (2") diameter dark smudge mark on the front left door armrest located 15.0 cm (6.0") forward of the rear edge of the door. This contact was attributed to contact by the driver's lower left torso area during the impact sequence.

The center console was deformed to the right as the result of contact by the driver who was displaced to the right by the intruding left side structure. The front right door surface and armrest exhibited copious bodily fluid deposits as the result of contact by the driver's head area (**Figure 13**). The transfer on the door surface measured 5 cm (2") in diameter and was located 5 cm (2") above the armrest. The horizontal width of the armrest measured 8.9 cm (3.5"). Both transfers were located 66.0 cm (26.0") rearward from the instrument panel.

The steering wheel rim was rotated 90 degrees counterclockwise and deformed along the normal top portion of the rim by the intruding front left door panel. The rim remained in contact with the door panel at final rest and was located 40.6 cm (16.0") forward from the rear edge of the door and 11.4 cm (4.5") below the belt line.

There was no visible driver contact evidence noted to the front left instrument panel or knee bolster. The roof structure was removed by rescue to facilitate first aid activities and the removal of the driver. The roof head liner along the windshield header and the leading edge of the left sunvisor were abraded as the result of removal actions. There were no driver related contact artifacts noted to the roof area. The windshield was cracked by impact forces along the left upper A-pillar. There was no evidence of contact by the driver during the crash.

1994 Ford Econoline E350 Cargo Van- Exterior

The 1994 Ford Econoline E350 cargo van which was used as a commercial vehicle struck the left side of the 2000 Cadillac as the driver of the Cadillac was attempting to make a U-turn from a parking lane. Direct damage to the front bumper measured 177.8 cm (70.0") across the entire frontal plane. The maximum crush of 9.5 cm (3.75") was located 20.3 cm (8.0") right of the vehicle centerline (**Figure 14**). The vehicle was towed from the scene as the result of damage to the transmission. The van was empty of cargo at the time of the crash. Crush values are listed in the following table:



Figure 14 Left corner view of the impact damage to the frontal plane of the 1994 Ford Econoline cargo van

| 1994 Ford Econoline E350 Cargo Van - Crush Profile | | | |
|---|---------------------------------|--------------------------------|---------------------------------|
| Impact with the 2000 Cadillac | C ₁ = 8.3 cm (3.25") | C ₂ = 3.8 cm (1.5") | C ₃ = 3.8 cm (1.5") |
| | C ₄ = 9.5 cm (3.75") | C ₅ = 3.8 cm (1.5") | C ₆ = 9.5 cm (3.75") |

1994 Ford Econoline E350 Cargo Van- Interior

The windshield exhibited a spider web pattern crack with a tissue oil transfer surrounding the fracture site. The crack was located 47.0 cm (18.5") left of the vehicle centerline and 17.8 cm (7.0") below the windshield header (**Figure 15**). This artifact was directly in front of the driver seat and was attributed to contact by the driver's facial area. There was a 7.6 cm (3.0") diameter fabric transfer along the lower

instrument panel located 38.1 cm (15.0") left of the vehicle centerline which was attributed to contact by the driver's right knee. The manual lap and torso restraint belt indicated wear marks on the latch plate, but the wear indicator did not appear to represent a frequent usage pattern with respect to the vehicle mileage [228,078 km (141,725 miles) on the odometer] (**Figure 16**). Although the driver indicated he was wearing the restraint belt at the time of the crash, the contact pattern to the windshield and the lower instrument panel along with a laceration of the face was indicative that he was not using the restraint system.



Figure 15 View of the contact pattern to the windshield of the 1994 Ford Econoline cargo van



Figure 16 View of the latch plate for the front left 3 point manual lap and torso restraint belt

Collision Deformation Classification (CDC)

The collision deformation classification (CDC) code for the frontal damage was assigned as follows: 12-FDEW-1.

SPEED RECONSTRUCTION

The WinSMASH speed reconstruction algorithm was used to compute relative delta V and impact speed values. The output from the damage and trajectory routines indicated that the Cadillac experienced a lateral delta V of 38.9 km/h (24.2 mph) as shown in the following table. This value appeared to be consistent with the damage profile of the vehicle and was sufficient to deploy the left side impact air bag.

| WinSMASH 1.02.001 | | 2000 Cadillac Seville SLS | 1994 Ford Econoline E350 |
|--------------------------|------------|----------------------------------|---------------------------------|
| Impact Speed | | 6.4 km/h (4.0 mph) | 64.7 km/h (40.2 mph) |
| Total delta V | Damage | 38.9 km/h (24.2 mph) | 25.1 km/h (15.6 mph) |
| | Trajectory | 38.9 km/h (24.2 mph) | 25.1 km/h (15.6 mph) |
| Longitudinal delta V | Damage | 0 km/h (0 mph) | -25.0 km/h (-15.5 mph) |
| | Trajectory | -0.1 km/h (-0.1 mph) | -25.0 km/h (-15.5 mph) |
| Lateral delta V | Damage | 38.9 km/h (24.2 mph) | -2.2 km/h (-1.4 mph) |
| | Trajectory | 38.9 km/h (24.2 mph) | -2.2 km/h (-1.4 mph) |

| | | |
|--------------------------|--------------------------------|-------------------------------|
| Energy dissipated | 159,074 joules (117,385 ft-lb) | 23,1215 joules (17,062 ft-lb) |
| Barrier equivalent speed | 46.4 km/h (28.9 mph) | 14.2 km/h (8.8 mph) |

SUPPLEMENTAL RESTRAINT SYSTEM (SRS)

The 2000 Cadillac Seville SLS was equipped with an event data recorder (EDR) which has the capability of recording precrash related data such as brake application, throttle position, engine speed, and vehicle speed over a 5 second pre-impact time period. However, this data could not be retrieved due to the severity of the damage.

The supplemental restraint system (SRS) comprised of dual front air bags (steering wheel mounted and top mounted front right passenger air bag), two side impact air bags which were concealed inside restraint towers mounted along the outboard aspects of the front seat back supports, and a Sensing and Diagnostic Module (SDM). The vehicle was struck on the left side in a 270 degree impact force vector which resulted in the deployment of the left front side impact air bag. The air bag performed as designed given the lateral delta V computed by the WinSMASH program of 38.9 km/h (24.2 mph). Neither front air bag deployed.

Driver's Side Air Bag

The driver's side air bag was mounted in a restraint tower which also housed the seat back head restraint, the manual three point lap and torso belt, and the restraint belt pretensioner. As the air bag began to expand, the leading edge of the tower wall adjacent to the seat back support separated to allow the excursion of the air bag (**Figure 17**).

The side impact air bag was designed in a "J" configuration where the bottom portion of the air bag measured a static travel distance of 38.1 cm (15.0") in a forward direction from the restraint tower (**Figure 18**). The air bag then extended in a vertical direction which had a static measured distance of 58.4 cm (23.0"). The vertical segment of the air bag had a longitudinal measurement of 30.5 cm (12.0") near the base which tapered slightly to a longitudinal dimension of 27.8 cm (11.0") at the top of the air bag.



Figure 17 View of the top outboard aspect of the front left seat back support partially showing the air bag deployment area



Figure 18 View of the left front side impact air bag

The side impact air bag was not tethered and there were no visible vent ports. The material of the air bag appeared to be a medium denier density with a fine mesh weave. The air bag identification number ink printed on the surface of the air bag was recorded as follows: 312267 630d. There was no visible driver related contact evidence detected on the surface of the air bag. There was a fabric transfer noted along the bottom inboard surface of the air bag which was attributed to contact with the lower B-pillar during the deployment sequence. This area measured 17.8 cm (7.0") vertically and 15.2 cm (6.0") longitudinally.

INJURY DATA

The driver in the Cadillac was unrestrained at the time of the crash and came to rest diagonally across the front seat row with his head against the front right door surface and his feet in front of the driver's seat. His demographic data as reported in the autopsy report is listed in the following table:

| Seat Position | Age (years) | Sex | Height | Weight | Restrained |
|---------------|-------------|------|------------------|-------------------------|----------------------------------|
| Driver | 88 | Male | 170.2 cm (67.0") | 81-84 kg (180-185 lbs.) | Not using the lap and torso belt |

The driver according to the autopsy report was wearing a hunter green jacket over a green vest over a green short sleeved dress shirt. He was wearing brown plaid pants and burgundy shoes (one shoe remained in the front left seating area of the vehicle).

Rescue personal attached EKG patches to the driver's upper torso and transmitted vital sign data to the trauma hospital where it was determined that the driver had expired. The body was subsequently transported to the morgue where an autopsy was performed.

The following tables list the injuries of the driver as described in the autopsy report.

| INJURY 88 Year Old Male Driver of the Cadillac | AIS-90 | INJURY SOURCE | |
|---|------------|--------------------------|-----------|
| | | Component | Certainty |
| 1. Atlanto-occipital dislocation associated with spinal cord compression/laceration (pulpifaction) of the spinal cord without disruption of the dura mater underlying the posterior atlanto-occipital membrane. | 640274.6,6 | Front right door surface | Certain |
| Supplemental Discussion: <i>There was patchy hemorrhage of the deep muscle layers of the back of the neck and disruption of the posterior atlanto-occipital membrane (the anterior membrane is lax but without disruption). There was subarachnoid hemorrhage at the level of the posterior atlanto-occipital membrane</i> | | | |

| INJURY 88 Year Old Male Driver of the Cadillac | AIS-90 | INJURY SOURCE | |
|---|--|--------------------------|-----------|
| | | Component | Certainty |
| Additional Discussion: <i>NECK - The subcutaneous tissue reveals no hemorrhage. The strap muscles of the anterior cervical region reveals no evidence of injury. The neurovascular structures were intact. The hyoid bone, thyroid, and cricoid cartilages were atraumatic. The laryngeal and tracheal lumens were patent and of normal caliber. The thyroid gland is unremarkable. No abnormality was noted in the cervical muscles, hyoid bone, laryngeal cartilages, trachea, or the cervical vertebral column</i> | | | |
| 2. Fracture of the thoracic spine with compression of the spinal cord between the 8 th and 9 th vertebrae | 640462.5,7 | Front left door armrest | Certain |
| Supplemental discussion: <i>Fracture diastasis of the intervertebral disc (extremely calcified) in between the 8th and 9th thoracic vertebrae. This complete separation exposes the spinal canal where the spinal cord is compressed and pulpified. There is abundant epidural and subdural hemorrhage</i> | | | |
| 3. Bilateral fracture of both superior pubic ramus and the left sacroiliac joint | 852600.2,2 852600.2,1 852800.3,6 | Front left door armrest | Certain |
| 4. Fracture diastasis of the pubic symphysis | 853000.3,5 | Front left door armrest | Certain |
| 5. Lateral fracture of the 9 th and 10 th left ribs | 450220.2,2 | Front left door armrest | Certain |
| 6. Pulmonary contusions of posterolateral aspect of the left lung and hilum of the right lung | 441410.4,3 | Front left door armrest | Certain |
| 7. Two irregular superficial lacerations of the left hepatic lobe of the liver which range from 2" to 0.5" in length and a maximum depth of 0.25") | 541822.2,1 | Front left door armrest | Certain |
| Supplemental discussion: <i>Extensive soft tissue hemorrhage that includes the left retroperitoneum, peritoneal cavity contains approximately 150 cc of unclotted blood</i> | | | |
| 8. Abrasion of the forehead which was described as depressed and irregular measuring 0.5"x0.375" and located over the top center area of the forehead | 290202.1,7 | Front right door surface | Certain |

| INJURY 88 Year Old Male Driver of the Cadillac | AIS-90 | INJURY SOURCE | |
|---|------------|--------------------------------|-----------|
| | | Component | Certainty |
| 9. Superficial abrasions of the right auricle over the superior aspect of the helix measuring 0.5"x0.25" | 290202.1,1 | Front right door armrest | Probable |
| 10. Abrasions of the right temporoparietal area | 190202.1,1 | Front right door surface | Certain |
| 11. Contusions of the right temporoparietal area | 190402.1,1 | Front right door surface | Certain |
| 12. Laceration of the right temporoparietal area | 190602.1,1 | Front right door surface | Certain |
| Supplemental discussion: Multiple small dicing-type abrasions over the right temporoparietal area measuring 4"x3", dicing abrasions with faint abrasions and ecchymosis of the right temple covering an area of 2"x1", contusions of the right temporoparietal area, superficial oblique laceration of the right temporoparietal area measuring 1.5" | | | |
| 13. Superficial abrasions over the left frontoparietal area measuring 1"x0.5" | 190202.1,2 | Left front side impact air bag | Probable |
| 14. Ecchymosis over the left frontoparietal area measuring 1"x0.5" | 190402.1,2 | Left front side impact air bag | Probable |
| 15. Superficial laceration immediately below the right lower eyelid which measured 0.5" | 290602.1,1 | Driver's right hand | Probable |
| 16. Contusion immediately below the right lower eyelid which measured 0.5" | 290402.1,1 | Driver's right hand | Probable |
| 17. Faint bruising over the center of the right upper eyelid measuring 0.25" in diameter, scanty petechial hemorrhages over the right upper and lower eyelids | 297402.1,1 | Driver's right hand | Probable |
| 18. Hemorrhage of the right subconjunctive over the lateral aspect of the right eye globe measuring 0.25" | 240416.1,1 | Driver's right hand | Probable |
| 19. Superficial laceration of the left auricle over the superior aspect measuring 0.75". A prosthetic hearing device was present in the left ear at the time of the autopsy | 290602.1,2 | Left front side impact air bag | Probable |

| INJURY 88 Year Old Male Driver of the Cadillac | AIS-90 | INJURY SOURCE | |
|---|------------|------------------------------|-----------|
| | | Component | Certainty |
| 20. Contusions of the left ipsilateral wrist which measured 1.5"x0.25" and located above an area of band-like hyperpigmentation of the skin that possibly corresponded to wristwatch band | 790402.1,2 | Front left door side surface | Probable |
| 21. Ecchymosis over the back of the right hand which measured 2.25"x1.5" | 790402.1,1 | Driver's facial area | Probable |
| 22. Superficial abrasion over the posterolateral aspect of the left thigh which measured 2" and averages 0.125" in width | 890202.1,2 | Front left seat cushion | Certain |

OCCUPANT KINEMATICS

Driver Of The Cadillac

The driver of the Cadillac was in the process of making a U-turn from a parking lane when his vehicle was struck on the left side plane by the front of the Ford Econoline E350 cargo van. The collision resulted in a 9 o'clock principal direction of force and a WinSMASH computed lateral delta V of 38.9 km/h (24.2 mph). The Cadillac was pushed laterally a distance of 20.6 m (67.6') to the final rest position.

The driver was not using the manual three point lap and torso restraint belt prior to the crash. During the impact sequence, the driver moved laterally to the left and contacted the deploying side impact air bag with the left side of his upper torso and head. This contact resulted in superficial abrasions and ecchymosis of the left frontoparietal area and a superficial laceration of the left auricle. The driver was wearing hearing aids in both ears.

The left lower portion of the driver's upper torso and the left hip then contacted the front left door armrest as it was intruding into the occupant space. This contact resulted in fractures of the 9th and 10th ribs (AIS-2) with contusions of both lungs (AIS-4), fracture between the 8th and 9th thoracic vertebrae with pulpified spinal cord (AIS-5), lacerations of the liver (AIS-2), and multiple fractures of the pelvis (AIS-3).

The driver was then pushed to the right by the intruding door panel where his right hip area contacted the center console armrest. This interaction resulted in a rapid rotation of his upper body where his head struck the front right door armrest resulting in an atlanto-occipital dislocation with a complete laceration of the spinal cord (AIS-6). His head then overrode the door armrest and struck the door panel resulting in superficial lacerations and dicing abrasions from the presence of shattered solid tempered side glazing. His right hearing

aid became dislodged and came to rest on the horizontal surface of the front right door armrest adjacent to the bodily fluid transfer.

The driver came to rest with his body oriented in a lateral position across the front seat cushions with his head against the front right door surface, his lower chest over the center console area, and his hips and upper legs on the front left seat cushion with his feet angled toward the front left instrument panel. The police indicated that the driver's legs were wedged under the left instrument panel.

Driver Of The Ford

The driver of the Ford indicated that he was wearing the three point manual lap and torso belt restraint belt at the time of the crash. However, contact evidence to the windshield and instrument panel along with a facial laceration suggested that he was not restrained at the time of the crash. Additionally, the police investigation report also concluded that he was not wearing the belt at the time of the crash.

The driver attempted to apply the brakes and steer to the left prior to the crash when the Cadillac encroached into his travel path. The driver moved forward in response to impact forces and contacted the lower instrument panel with his knees. His upper torso continued forward and struck the windshield with his face resulting in a laceration below the nose which required stitches. The driver exited the vehicle through the front left door without assistance.