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ON-SITE REDESIGNED AIR BAG INVESTIGATION

CASE NUMBER - IN99-090

LOCATION - ILLINOIS

VEHICLE - 1999 CHEVROLET SILVERADO 1500

CRASH DATE - September, 1999

Submitted:

July 28, 2000



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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 performance of the involved vehicle(s) or their safety systems.

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15. <i>Supplementary Notes</i> On-site air bag deployment investigation involving a 1999 Chevrolet Silverado 1500, pickup truck, with manual safety belts and dual redesigned front air bags, and a concrete bridge support			
16. <i>Abstract</i> This report covers an on-site investigation of an air bag deployment crash that involved a 1999 Chevrolet Silverado 1500, pickup truck (case vehicle), and a concrete bridge support. This crash is of special interest because the case vehicle was equipped with redesigned air bags and the case vehicle's restrained driver (26-year-old male) and restrained front right passenger (26-year-old female) both sustained moderate injuries. The driver air bag deployed, but the front right passenger air bag did not deploy because the activation switch was in the "off" position. The case vehicle was traveling south in the outside, southbound lane of a four-lane, undivided, U.S. highway. The case vehicle drifted off the right side of the roadway, and the crash occurred on the west roadside of the trafficway. The front of the case vehicle impacted a concrete railroad bridge support, causing the case vehicle's driver supplemental restraint (air bag) to deploy. The case vehicle's driver was seated, leaning to his right, with his seat track located in its rearmost position, and the tilt steering wheel was located between its middle and upmost positions. He was restrained by his available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to his interview and his medical records, moderate injuries which included: a nonanatomic brain injury; fractures to his maxillary and mandibular alveolar ridges, with multiple teeth avulsed and dislocated; multiple mandibular fractures; lacerations to his lower lip, under his chin, and to his tongue; abrasions to his left jaw and right knee; and contusions to his lower abdomen, bilateral upper arms, right medial knee, and posterior right leg. The front right passenger (i.e., girlfriend) was seated with her seat track located between its middle and rearmost positions, and she was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. She sustained, according to the interview with the case vehicle's driver, moderate injuries which included: a fractured right orbit, a laceration along the right side of her nose that curved around the right naris, a contusion across her lower abdomen, a contused right upper arm, and an abraded left lower leg.			
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This on-site investigation was brought to NHTSA's attention on October 5, 1999, by the mother of the case vehicle's driver. This crash involved a 1999 Chevrolet Silverado, 1500 pickup truck (case vehicle) and a concrete support for a railroad bridge. The crash occurred in September, 1999, at 3:54 a.m., in Illinois, and was investigated by the applicable city police department. This crash is of special interest because the case vehicle was equipped with redesigned air bags and the case vehicle's restrained driver [26-year-old, White (non-Hispanic) male] and restrained front right passenger [26-year-old, White (non-Hispanic) female] both sustained moderate injuries. The driver air bag deployed, but the front right passenger air bag did not deploy because the activation switch was in the "off" position. This contractor inspected the scene and the case vehicle on October 11, 1999. This contractor interviewed the driver on 10 October and the front right passenger on 11 October. This report is based on the Police Crash Report; interviews with the case vehicle's driver, front right passenger, and the investigating police officer; scene and case vehicle inspections; occupant kinematic principles; occupant medical records and interviewee-reported injuries; and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling south in the outside, southbound lane of a four-lane, undivided, U.S. highway and intended to continue in its southerly travel path underneath a railroad overpass. The case vehicle's driver made no avoidance maneuvers prior to the crash, according to the driver, the front right passenger, and the investigating officer. The case vehicle's driver was internally distracted and did not notice the vehicle drifting off the right side of the roadway. The crash occurred on the west roadside of the trafficway (see **CRASH DIAGRAM**).

The front of the case vehicle impacted a concrete railroad bridge support, causing the case vehicle's driver supplemental restraint (air bag) to deploy. The front right passenger supplemental restraint (air bag) did not deploy because the activation switch was in the "off" position. The case vehicle most likely rebounded slightly backwards prior to coming to rest heading southward.

The case vehicle's driver [198 centimeters and 100 kilograms (78 inches, 220 pounds)] was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. In addition, the front right passenger [180 centimeters and 59 kilograms (71 inches, 130 pounds)] was also restrained by her available, active, three-point, lap-and-shoulder, safety belt system. There was no self-reported evidence of belt pattern bruising and/or abrasions to the driver's body; however, the front right passenger reported a contusion across her lower abdomen. Inspection of the driver's seat belt webbing indicated fabric waffling, but the "D"-ring and latch plate showed no clear evidence of loading. There were, however, several blood-stained areas on the torso portion of the webbing. Inspection of the front right seat belt webbing also indicated fabric waffling and a diagonal crimp near where the inboard connection would have been made. The front right "D"-ring and latch plate showed no evidence of loading but, similar to the driver's safety belt, there were several blood-stained areas on the fabric.

The case vehicle's driver, who was leaning to his right prior to the crash, made no known pre-crash avoidance maneuvers. As a result and independent of their use of the available safety belts, the driver's

and front right passenger's pre-impact body positions did not change prior to impact. The case vehicle's impact with the concrete railroad bridge support enabled the case vehicle's driver and front right passenger to continue forward and upward as rapid deceleration was experienced. Although the driver loaded his safety belt and deploying air bag, the driver's large stature (see above) caused him to load and compress [approximately 5 centimeters (2.0 inches)] the steering column against the left instrument panel and strike the left side of his face against the steering wheel rim (through the compressed air bag's fabric). Because the case vehicle's final rest position was only slightly backward of maximum engagement, coupled with the driver's rightward pre-crash posture, the driver rebound backward and rightward toward the left portion of the case vehicle's center console. The posterior right part of the driver's right leg struck and uplifted (i.e., tilted toward the right side of the vehicle) the center console's cover. Although the case vehicle's driver does not recall his exact final rest position, he was most likely leaning to the right against the center console with his back straddling the space between the front bucket seats and his head near the front right seat back.

The front right passenger, likewise, continued her forward movement, loading her safety belt. The front right passenger's face contacted the oblong hand rail atop of the front right air bag module, fracturing her right orbit. She then rebounded back into her seat and back forward again, against her safety belt prior to coming to rest essentially in her pre-crash position.

The driver was transported by ambulance to the hospital. He sustained moderate injuries and was hospitalized. According to his medical records and his interview, the injuries sustained by the case vehicle's driver included: a nonanatomic brain injury; fractures to his maxillary and mandibular alveolar ridges, with multiple teeth avulsed and dislocated; multiple mandibular fractures; lacerations to his lower lip, under his chin, and to his tongue; abrasions to his left jaw and right knee; and contusions to his lower abdomen, bilateral upper arms, right medial knee, and posterior right leg.

The case vehicle's front right passenger was also transported by ambulance to the hospital. She sustained moderate injuries and was hospitalized. Her self-reported injuries included: a fractured right orbit, a laceration along the right side of her nose that curved around the right naris, a contusion across her lower abdomen, a contused right upper arm, and an abraded left lower leg.

The case vehicle was an four wheel drive, 1999 Chevrolet Silverado, 4x4, 1500, Z71, LS, extended cab, short box, three-door pickup truck (VIN: 1GCEK19T0XZ-----). The case vehicle was equipped with four-wheel, anti-lock brakes. It was towed due to disabling damage. Based on the vehicle inspection, the CDC was determined to be: **12-FDEW-3 (360)** [maximum crush was 59 centimeters (23.2 inches)]. The WinSMASH reconstruction program, barrier algorithm, was used on the case vehicle's highest severity impact. The preliminary Total, Longitudinal, and Lateral Delta Vs are, respectively: 46.5 km.p.h. (28.9 m.p.h.), -46.5 km.p.h. (-28.9 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The crash severity to the case vehicle was high [greater than 40 km.p.h. (greater than 25 m.p.h.)].

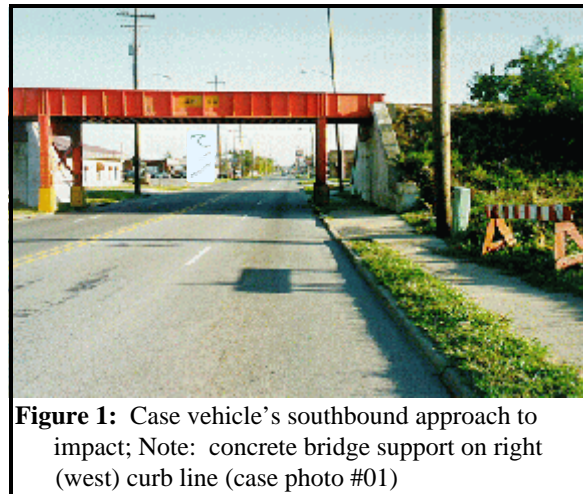
The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The front right passenger's air bag was located in the middle of the instrument panel. Again, it did not deploy because the activation switch was in the "off" position. The driver's air bag was designed with two tethers and two vent ports, approximately 3 centimeters (1.2 inches) in diameter, located at the 11 and 1 o'clock positions. The deployed driver's air bag was rectangular, with a height of approximately 60 centimeters (23.6 inches) and a width of approximately 54 centimeters (21.3 inches). There were copious blood stains on the right half of the air bag's fabric, and there were two body fluid stains at the top of the bag.

Immediately prior to the crash, the case vehicle's driver was seated, leaning to his right with his back against the seat back, his left foot on the floor, his right foot on one of the foot controls, his left hand on the steering wheel rim, and his right arm extending across the inboard armrest. His seat track was located in its rearmost position, and the seat back was slightly reclined. The tilt steering wheel was located between its middle and upmost positions. The front right passenger (i.e., girlfriend) was seated in an upright posture with both feet on the floor, but the location of her arms and hands is unknown. Her seat track was located between its middle and rearmost positions, and the seat back was upright.

CRASH CIRCUMSTANCES

The case vehicle was traveling south in the outside, southbound lane of a four-lane, undivided, city street and intended to continue in its southerly travel path underneath a railroad overpass (**Figure 1**). The case vehicle's driver made no avoidance maneuvers prior to the crash, according to the driver, the front right passenger, and the investigating officer. The case vehicle's driver was internally distracted and did not notice the vehicle drifting off the right side of the roadway. The crash occurred on the west roadside of the trafficway (see **CRASH DIAGRAM**).

The U.S. highway was straight in the vicinity of the crash and level (i.e., actual slope was 1.6%, negative to the south) near the area of impact. The pavement was bituminous, but traveled and worn, and the width of the outside southbound lane was 2.8 meters (9.2 feet). There were no shoulders adjacent to the 9 centimeter (3.5 inch) barrier curbs on either the east or west sides of the roadway. Pavement markings consisted of a double solid yellow centerline for both north and southbound traffic, and the lanes were divided by a dashed white line. The estimated coefficient of friction was 0.65 when dry. There were no visible traffic controls present. No regulatory speed limit sign was posted near the crash site. At the time of the crash the light condition was dark, but illuminated by overhead street lamps at the area of impact, the atmospheric condition was raining, and the road pavement was wet. Traffic density was light, the site of the crash was primarily urban commercial.



The front (**Figures 2 and 3**) of the case vehicle impacted a concrete railroad bridge support (**Figure 4**), causing the case vehicle's driver supplemental restraint (air bag) to deploy. The front right passenger supplemental restraint (air bag) did not deploy because the activation switch was in the "off" position. The case vehicle most likely rebounded slightly backwards prior to coming to rest heading southward.



Figure 2: Case vehicle's front center damage; Note: yellow tape defines direct damage

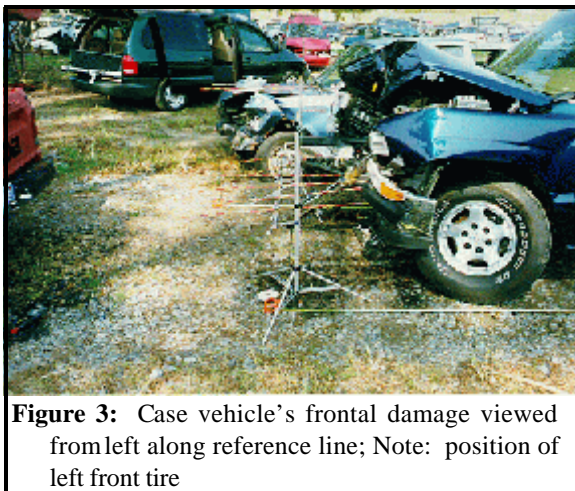


Figure 3: Case vehicle's frontal damage viewed from left along reference line; Note: position of left front tire

CASE VEHICLE

The case vehicle was a four wheel drive, 1999 Chevrolet Silverado 1500, 4x4, five-passenger, three-door, extended cab pickup truck (VIN: 1GCEK19T0XZ-----) equipped with power-assisted rack-and-pinion steering, a 5.3L, Vortec SCPFI, V-8 engine, and a four-speed automatic transmission. Braking was achieved by a power-assisted, front and rear disc, four-wheel anti-lock system. The case vehicle's wheelbase was 364 centimeters (143.5 inches), and the odometer reading at inspection is unknown because the case vehicle was equipped with an electronic odometer.

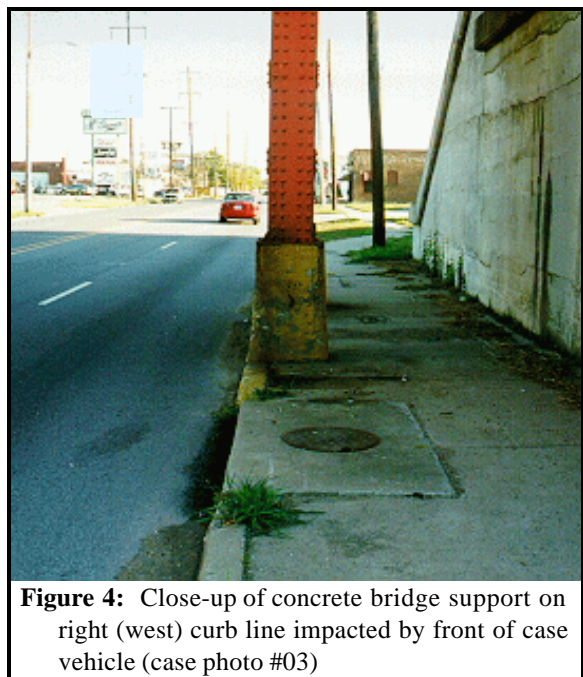


Figure 4: Close-up of concrete bridge support on right (west) curb line impacted by front of case vehicle (case photo #03)

Inspection of the vehicle's interior revealed electronic window and door locks; adjustable front bucket seats with adjustable head restraints; a nonadjustable back bench seat with adjustable head restraints for the back outboard seating positions; and continuous loop, three-point, lap-and-shoulder, safety belt systems at the front and back outboard positions; and a two-point, lap belt system at the back center position. The front seat belt systems were not equipped with manually operated height adjusters for the "D"-rings. The vehicle was equipped with knee bolsters for both the driver and front right passenger. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of redesigned frontal air bags for the driver and front right passenger seating positions. The front right passenger air bag

was controlled by an activation switch that was located in the center instrument panel. The driver's air bag deployed as a result of the case vehicle's impact with the bridge support. The front right passenger's air bag did not deploy because the activation switch was in the "off" position (Figure 5).

CASE VEHICLE DAMAGE

The case vehicle's contact with the railroad bridge support involved the front center of the front bumper. Direct damage began 40.7 centimeters (16.0 inches) inward from the front left bumper corner and extended a measured distance of 90 centimeters (35.4 inches) along the front bumper. Maximum crush was measured as 59 centimeters (23.2 inches) at C₃. The wheelbase on the case vehicle's left side was shortened only 2 centimeters (0.8 inches) while the right side was shortened 5 centimeters (2.0 inches). The case vehicle's front bumper, bumper fascia, grille, hood, and radiator were directly damaged and crushed rearward. The case vehicle's left front tire was physically restricted, and the front of the tire was rotated inward (Figure 3 above) from the crash. Both the right and left headlight and turn signal assemblies sustained induced damage, as did both the right and left fenders. Remote buckling was also found on the left portion of the case vehicle's extended cab (Figure 6) behind the driver's door and in front of the regular truck bed.

Based on the vehicle inspection, the CDC was determined to be: **12-FDEW-3 (360)**. The WinSMASH reconstruction program, barrier algorithm, was used on the case vehicle's highest severity impact. The preliminary Total, Longitudinal, and Lateral Delta Vs are, respectively: 46.5 km.p.h. (28.9 m.p.h.), -46.5 km.p.h. (-28.9 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The crash severity to the case vehicle was high [greater than 40 km.p.h. (greater than 25 m.p.h.)]. It was towed due to disabling damage.



Figure 5: Case vehicle's center instrument panel showing passenger air bag activation switch (arrow) in "off" position; Note: distorted center console's cover (case photo #23)



Figure 6: Case vehicle's frontal damage viewed from left of front; Note: induced damage to left fender and left side of extended cab (case photo #08)



Figure 7: Evidence of occupant contact on case vehicle's left knee bolster and center instrument panel (case photo #19)

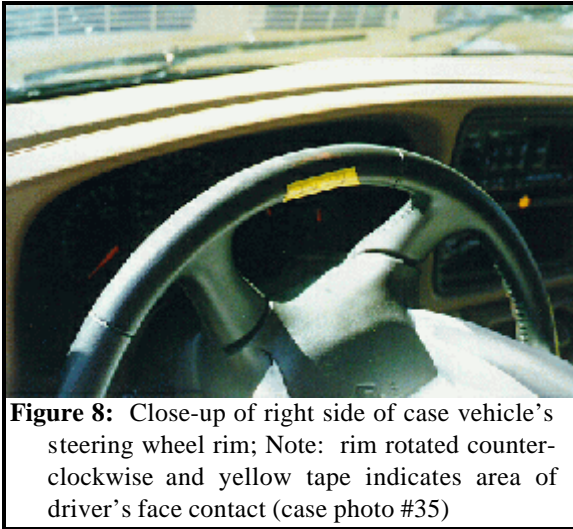


Figure 8: Close-up of right side of case vehicle's steering wheel rim; Note: rim rotated counter-clockwise and yellow tape indicates area of driver's face contact (case photo #35)



Figure 9: Close-up of lower right portion of case vehicle's steering wheel rim showing blood spots; Note: behind rim, transmission selector lever is jammed against instrument panel (case photo #37)

An examination of the case vehicle's interior revealed contact and blood evidence readily apparent throughout the front seating area. The area below the left instrument panel/knee bolster showed contact evidence most likely from impact by the case vehicle's driver (**Figure 7** above). The case vehicle's steering wheel rim showed evidence of contact (**Figure 8**) by the driver's face, as well as blood evidence (**Figure 9**). There was also blood evidence present on the interior surface of the driver's door (**Figure 10**), but this blood most likely resulted when the case vehicle's driver exited the vehicle and not as a result of direct contact. However, the driver's impact with the steering wheel, compressed the steering column such that the steering wheel rim was compressed against the instrument panel (**Figure 11**). The center console showed evidence of occupant contacts (i.e., scrubs) on both its left (driver's) and right (front right passenger's) sides, and there was contact evidence (i.e., scrub) on the center instrument panel (**Figure 12** below). In addition, there was blood on the center console and it had been distorted (**Figure 11** and **Figure 12** below), either as a result of occupant contacts or the crash itself. There was a suspected occupant contact on the glove box (**Figure 13** below), and there were contacts on the right instrument panel and on an oblong hand rail atop the front right passenger's air bag module from impact by the front right passenger's face (**Figure 14** below).

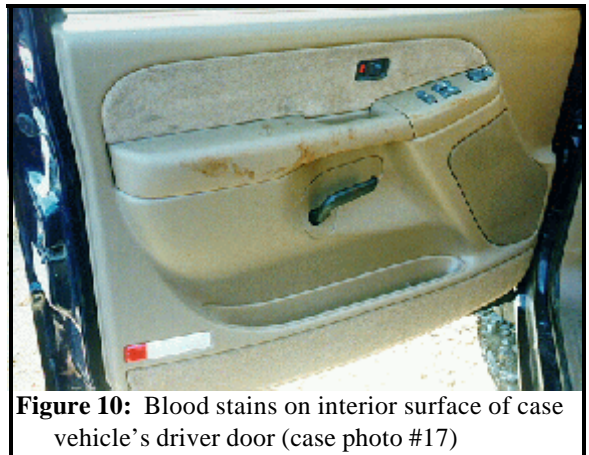


Figure 10: Blood stains on interior surface of case vehicle's driver door (case photo #17)



Figure 11: Case vehicle's front seating area showing steering column compressed against instrument panel and distorted center console cover (case photo #26)

Based on the blood evidence, both the case vehicle's driver and front right passenger were using their available, manual, three-point, lap-and-shoulder, safety belt systems. Both safety belts showed blood stains on the portion of the webbing that would have been strapped across the torsos of their respective occupants (**Figure 15** and **Figure 16** below).



Figure 13: Case vehicle's front right seating area showing suspected occupant contacts to glove box door and oblong hand rail atop of front right air bag module; Note: arrows highlight rail contact and air bag cutoff switch (case photo #25)

AUTOMATIC RESTRAINT SYSTEM

As previously mentioned, the 1999 Chevrolet Silverado 1500 pickup truck was equipped with a SRS that consisted of redesigned frontal air bags at both the driver and front right passenger seating positions. However, the front right air bag was controlled by an activation switch, and the activation switch was set in the "off" position. The driver's SRS deployed as a result of the case vehicle's frontal impact with the bridge support pillar.

The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of symmetrical "T"-configuration cover flaps made of thick vinyl with overall dimensions of 7.5 centimeters (3.0 inches) at the left and right horizontal seams and 10.5 centimeters (4.1 inches) vertically. An inspection of



Figure 12: Case vehicle's driver seating area showing compressed steering wheel, driver's blood stained right armrest, and distorted center console cover (case photo #22)



Figure 14: Close-up of contact evidence on oblong hand rail atop of case vehicle's front right air bag module (case photo #27)



Figure 15: Case vehicle's driver safety belt showing blood stains on torso portion of webbing (case photo #29)

the air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The front right passenger's air bag was located in the middle of the instrument panel. Again, it did not deploy because the activation switch was in the "off" position (**Figure 10** above). The driver's air bag was designed with two tethers, each 10 centimeters (3.9 inches) wide, and two vent ports, approximately 3 centimeters (1.2 inches) in diameter, located at the 11 and 1 o'clock positions. The deployed driver's air bag was elliptical, with a height of approximately 60 centimeters (23.6 inches) and a width of approximately 54 centimeters (21.3 inches). There were scattered, copious blood stains on the right half of the air bag's fabric (**Figure 17**), and there were two body fluid stains at the top of the bag.

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash, the case vehicle's driver [26-year-old, White (non-Hispanic) male] was seated, leaning to his right with his back against the seat back, his left foot on the floor, his right foot on one of the foot controls, his left hand on the steering wheel rim, and his right arm extending across the inboard armrest. His seat track was located in its rearmost position, and the seat back was slightly reclined. The tilt steering wheel was located between its middle and upmost positions.

The case vehicle's driver [198 centimeters and 100 kilograms (78 inches, 220 pounds)] was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. There was no self-reported evidence of belt pattern bruising and/or abrasions to the driver's body. Inspection of the driver's seat belt webbing indicated fabric waffling, but the "D"-ring and latch plate showed no clear evidence of loading. There were, however, several blood-stained areas on the torso portion of the webbing (**Figure 15** above).

The case vehicle's driver, who was leaning to his right prior to the crash, made no known pre-crash avoidance maneuvers. As a result and independent of his use of the available safety belts, the driver's pre-impact body position did not change prior to impact. The case vehicle's impact with the concrete railroad bridge support enabled the case vehicle's driver to continue forward and upward as rapid deceleration was experienced. Although the driver loaded his safety belt and deploying air bag, the driver's large stature (see



Figure 16: Case vehicle's front right safety belt showing blood stains on torso portion of webbing (case photo #31)

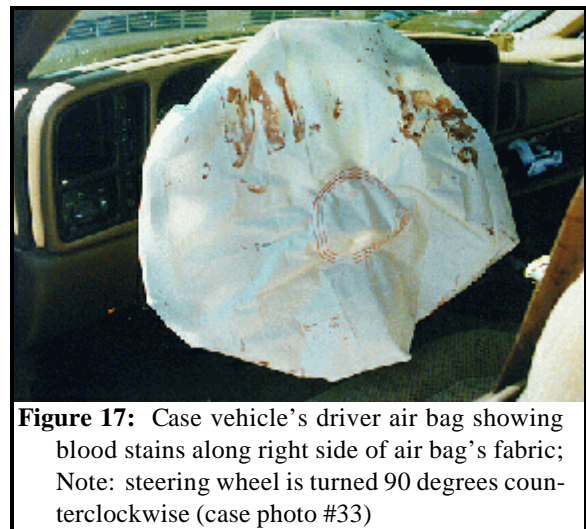


Figure 17: Case vehicle's driver air bag showing blood stains along right side of air bag's fabric; Note: steering wheel is turned 90 degrees counterclockwise (case photo #33)

above) caused him to load and compress [approximately 5 centimeters (2.0 inches)] the steering column against the left instrument panel (**Figure 11** above) and strike the left side of his face against the steering wheel rim (through the compressed air bag’s fabric--**Figures 8 and 9** above). Because the case vehicle’s final rest position was only slightly backward of maximum engagement, coupled with the driver’s rightward pre-crash posture, the driver rebound backward and rightward toward the left portion of the case vehicle’s center console. The posterior right part of the driver’s right leg struck and uplifted (i.e., tilted toward the right side of the vehicle) the center console’s cover (**Figures 11 and 12** above). Although the case vehicle’s driver does not recall his exact final rest position, he was most likely leaning to the right against the center console with his back straddling the space between the front bucket seats and his head near the front right seat back.

CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to the hospital. He sustained moderate injuries and was hospitalized. According to his medical records and his interview, the injuries sustained by the case vehicle's driver included: a nonanatomic brain injury; fractures to his maxillary and mandibular alveolar ridges, with multiple teeth avulsed and dislocated; multiple mandibular fractures; lacerations to his lower lip, under his chin, and to his tongue; abrasions to his left jaw and right knee; and contusions to his lower abdomen, bilateral upper arms, right medial knee, and posterior right leg.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Nonanatomic brain injury with brief loss of consciousness and amnesia (i.e., no recollection of event); GCS=15 in ER	160410.2 moderate	Steering wheel rim	Possible	Hospitalization records
2	Laceration, complex, 3 cm (1.2 in) anterior, dorso-lateral tongue	243404.2 moderate	Steering wheel rim	Certain	Hospitalization records
3	Fracture anterior maxillary alveolar ridge	250200.2	Steering wheel rim	Certain	Hospitalization records
4	Fracture mandibular alveolar ridge with avulsed teeth #: 8, 9, 11, and 26 and dislocated {deformed} teeth #: 10, 24, and 25; teeth #: 8, 9, 10, 11, 24, and 25 were not salvageable and extracted	250200.2 moderate			
5	Fractures, multiple, mandible including left mandibular body, right angle, right ramus, and right subcondylar with mal-occlusion	250608.2 moderate	Steering wheel rim	Certain	Hospitalization records

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
6	Laceration, through and through, 5 cm (2.0 in) left lower lip <u>and</u> laceration, complex, 3 cm (1.2 in) chin	290602.1 minor	Steering wheel rim	Certain	Hospitaliza-tion records
7	Laceration lower mucosa	243204.1 minor	Steering wheel rim	Certain	Emergency room records
8	Abrasions left jaw	290202.1 minor	Air bag, driver's	Possible	Emergency room records
9	Contusion {bruising} to lower abdomen, not further specified	590402.1 minor	Safety belt webbing, driver's	Probable	Emergency room records
10	Contusions {bruises} upper arms, bilaterally; left more than right	790402.1 minor	Steering wheel rim	Possible	Emergency room records
11	Abrasion right medial knee	890202.1 minor	Knee bolster, driver's	Probable	Hospitaliza-tion records
12	Contusion right medial knee with swelling	890402.1 minor	Knee bolster, driver's	Probable	Hospitaliza-tion records
13	Contusion whole right leg, posterior aspect	890402.1 minor	Center console	Probable	Interviewee (same person)

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

The case vehicle's front right passenger [i.e., girlfriend; 26-year-old, White (non-Hispanic) female] was seated in an upright posture with both feet on the floor, but the location of her arms and hands is unknown. Her seat track was located between its middle and rearmost positions, and the seat back was upright.

The case vehicle's front right passenger [180 centimeters and 59 kilograms (71 inches, 130 pounds)] was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The front right passenger reported a contusion across her lower abdomen. Inspection of the front right seat belt webbing indicated fabric waffling and a diagonal crimp near where the inboard connection would have been made. The front right "D"-ring and latch plate showed no evidence of loading but, similar to the driver's safety belt, there were several blood-stained areas on the fabric (**Figure 16** above).

The case vehicle's driver, who was leaning to his right prior to the crash, made no known pre-crash avoidance maneuvers. As a result and independent of her use of the available safety belts, the front right passenger's pre-impact body position did not change prior to impact. The case vehicle's impact with the concrete railroad bridge support enabled the case vehicle's front right passenger to continue forward and upward as rapid deceleration was experienced. Although the front right passenger loaded her safety belt, the front right passenger's relatively large stature (see above) caused her face to contact the oblong hand rail atop of the front right air bag module (**Figure 14** above), fracturing her right orbit. Because the case vehicle's final rest position was only slightly backward of maximum engagement, she rebounded back into her seat and back forward again, against her safety belt prior to coming to rest essentially in her pre-crash position.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The case vehicle's front right passenger was transported by ambulance to the hospital. She sustained moderate injuries and was hospitalized. According to the case vehicle's driver, her injuries included: a fractured right orbit, a laceration along the right side of her nose that curved around the right naris, a contusion across her lower abdomen, a contused right upper arm, and an abraded left lower leg.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Fracture right orbit, not further specified	251200.2 moderate	Oblong hand rail attached to front right instrument panel	Certain	Interviewee (driver)
2	Laceration along right side of nose, curving under right naris	290602.1 minor	Oblong hand rail attached to front right instrument panel	Certain	Interviewee (driver)
3	Contusion lower abdomen, not further specified	590402.1 minor	Safety belt webbing, front right passenger's	Probable	Interviewee (driver)
4	Contusion right upper arm	790402.1 minor	Interior surface right front door	Possible	Interviewee (driver)
5	Abrasion left lower leg	890202.1 minor	Glove compartment door	Probable	Interviewee (driver)

CRASH DIAGRAM

IN99-090

