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ON-SITE CHILD AIR BAG-RELATED FATALITY INVESTIGATION

CASE NUMBER - IN00-019
LOCATION - TEXAS
VEHICLE - 1996 FORD CONTOUR GL
CRASH DATE - December, 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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16. <i>Abstract</i> This report covers an on-site investigation of an air bag deployment crash that involved a 1996 Ford Contour GL (case vehicle) and a 1973 Chevrolet Custom-10 pickup truck (other vehicle). This crash is of special interest because the case vehicle's unrestrained, front right passenger (5-year-old male) sustained critical brain injuries in a crash in which he was redirected by his deploying front right passenger air bag, resulting in his death. The case vehicle was traveling south in outside southbound lane of a five-lane, divided, state highway (i.e., both the north and southbound roadways had two through lanes while the southbound roadway had a left-hand, turn lane). The Chevrolet pickup was traveling east in the eastbound through lane of a four-lane, undivided, city roadway (i.e., the east-west roadway had one through lane and one left-hand, turn lane in the eastbound direction). The crash occurred in the southbound roadway, in the four-leg intersection of the two trafficways. The front of the case vehicle impacted and underrode the left side of the Chevrolet pickup, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. In addition both vehicle's side slapped. The front right passenger was seated with his seat track located between its middle and forward-most positions and was not using his available, active, three-point, lap-and-shoulder, safety belt system. He sustained, according to his medical records, critical injuries which included: a critical nonanatomic brain injury, severe cerebral edema, a left subdural hematoma, injuries to his cerebral veins (sinuses), a subarachnoid hemorrhage, bilateral pulmonary contusions, and lacerations to his spleen and the right posterior side of his head. This occupant's primary brain and head injuries were caused by his contact with the case vehicle's windshield glazing. This contractor believes that the deploying front right passenger air bag altered this passenger's trajectory toward the windshield and, as a result, the apex and posterior portion of the passenger's head struck the windshield rather than the passenger's forehead. The case vehicle's driver (25-year-old female) was seated with her seat track located between its middle and forward-most positions, and the vehicle was not equipped with a tilt steering wheel. She was not using her available, active, three-point, lap-and-shoulder, safety belt system and sustained only minor facial abrasions and a contused abdomen. The case vehicle's back left and back right passengers (7-year-old male and 9-year-old female, respectively) were seated and their seat track was not adjustable. Neither back seat passenger was using their available, active, three-point, lap-and-shoulder, safety belt system nor did either sustain any injuries as a result of this crash.					
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TABLE OF CONTENTS

IN00-019

Page No.

BACKGROUND 1

SUMMARY 1

CRASH CIRCUMSTANCES 5

CASE VEHICLE: 1996 FORD CONTOUR GL 7

 CASE VEHICLE DAMAGE 8

 AUTOMATIC RESTRAINT SYSTEM 10

 CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS 11

 CASE VEHICLE FRONT RIGHT PASSENGER INJURIES 12

 CASE VEHICLE DRIVER KINEMATICS 14

 CASE VEHICLE DRIVER INJURIES 15

 CASE VEHICLE BACK LEFT PASSENGER KINEMATICS 15

 CASE VEHICLE BACK LEFT PASSENGER INJURIES 16

 CASE VEHICLE BACK RIGHT PASSENGER KINEMATICS 16

 CASE VEHICLE BACK RIGHT PASSENGER INJURIES 17

OTHER VEHICLE: 1973 CHEVROLET CUSTOM-10 PICKUP TRUCK 17

CRASH DIAGRAM 19

SELECTED PHOTOGRAPHS

 Figure 1: Case vehicle’s southward travel path in inside through lane of southbound roadway 5

 Figure 2: Chevrolet pickup’s eastward travel path into intersection 5

 Figure 3: On-scene view looking north in southbound roadway at final rest positions of case vehicle and Chevrolet pickup 5

 Figure 4: Westward view of Chevrolet pickup’s eastward travel path 6

 Figure 5: On-scene westerly view of case vehicle and Chevrolet pickup at final rest 6

 Figure 6: On-scene southeasterly view of case vehicle and Chevrolet pickup at final rest 6

 Figure 7: On-scene view of case vehicle’s deployed front air bags 7

SELECTED PHOTOGRAPHS (Continued)

Figure 8:	South-southeast view of gouges in case vehicle's southbound roadway	7
Figure 9:	On-scene view looking south-southeast at final rest positions of case vehicle and Chevrolet pickup	7
Figure 10:	Case vehicle's frontal damage viewed at bumper level	8
Figure 11:	Case vehicle's frontal damage viewed from right of front	8
Figure 12:	Damage to case vehicle's right front door and right outside rear view mirror	9
Figure 13:	Vertical view of case vehicle's front right seating area	9
Figure 14:	Close-up of spider web-type impact to case vehicle's front right windshield glazing	9
Figure 15:	Case vehicle's deployed driver air bag showing lipstick imprint	10
Figure 16:	Close-up of case vehicle front right passenger air bag module's cover flap	11
Figure 17:	Front surface of case vehicle's deployed front right passenger air bag	11
Figure 18:	Case vehicle's back seating area	15
Figure 19:	Back surface of case vehicle's driver seat back	16
Figure 20:	Chevrolet pickup's damage left side from front of left	17
Figure 21:	Chevrolet pickup's damaged left side from left viewed at frame level	17
Figure 22:	Close up direct damage to Chevrolet pickup's left frame rail	18

This on-site investigation was brought to NHTSA's attention on December 21, 2000 by a detective with the applicable police department. This crash involved a 1996 Ford Contour GL (case vehicle) and a 1973 Chevrolet Custom-10 pickup truck (other vehicle). The crash occurred in December, 2000, at 10:29 a.m., in Texas and was investigated by the applicable city police department. This crash is of special interest because the case vehicle's unrestrained, front right passenger [5-year-old, White (Hispanic) male] sustained critical brain injuries in a crash in which he was redirected by his deploying front right passenger air bag, resulting in his death. This contractor inspected the scene and vehicles on 27-28 December, 2000. This contractor interviewed the driver for the case vehicle on January 5, 2001. This summary is based on the Police Crash Report, interviews with the driver of the case vehicle and the investigating police officer, scene and vehicle inspections, occupant kinematic principles, occupant medical records, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling south in outside southbound lane of a five-lane, divided, state highway and was approaching a controlled four-leg intersection, intending to continue traveling southbound (i.e., both the north and southbound roadways had two through lanes while the southbound roadway had a left-hand, turn lane). In addition, there were one-way, multi-lane, access roads adjacent to the highway. The Chevrolet pickup was traveling east in the eastbound through lane of a four-lane, undivided, city roadway and was also intending to travel through the intersection (i.e., the east-west roadway had one through lane and one left-hand, turn lane in the eastbound direction). The case vehicle's driver attempted to avoid the crash by braking and steering leftward just prior to impact. The crash occurred in the southbound roadway, in the four-leg intersection of the two trafficways (see **CRASH DIAGRAM** below).

The front of the case vehicle impacted the left side of the Chevrolet pickup, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. Upon impact the case vehicle's front underrode the Chevrolet pickup's left side directly contacting the left side frame rail. At maximum engagement the undercarriage of the case vehicle contacted the bituminous surface resulting in two gouges. This underriding action also resulted in the case vehicle simultaneously lifting and pushing the Chevrolet pickup in a southeasterly direction post-crash. Because of the Chevrolet pickup's forward momentum, the case vehicle rotated approximately 10 degrees counterclockwise resulting in both vehicles side slapping. The case vehicle's right outside rearview mirror and right front door panel contacted the left rear wheel well and left rear wheel, respectively, of the Chevrolet pickup. The two vehicles became intertwined. The case vehicle came to rest, primarily in the inside through lane of the southbound roadway, heading in a south-southeasterly direction. The Chevrolet pickup rotated approximately 45 degrees clockwise as a result of the impact and came to rest straddling the two southbound through lanes, heading southeast. Because the damage on the case vehicle was primarily above the bumper and produced an underride impact pattern, this underride type damage resulted in the air bags deploying late during the sequence of the impact. This delayed deployment occurred due to the prolonged change in time (Delta T) relative to the change in speed (magnitude of Delta V--i.e., ramp versus spike).

The 1996 Ford Contour GL was a front wheel drive, four-door sedan (VIN: 1FALP6535TK-----). The case vehicle was not equipped with anti-lock brakes. Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **01-FDEW-3 (20 degrees)** and **03-RPMW-1 (90 degrees)**. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 20.4 km.p.h. (12.7 m.p.h.), -19.1 km.p.h. (-11.9 m.p.h.), and -7.0 km.p.h. (-4.3 m.p.h.). The case vehicle was towed due to damage.

The case vehicle's initial contact with the Chevrolet pickup involved approximately three-fourths of its front. Because of the underride type impact, the direct damage began at the right bumper corner and extended, a measured distance of 102 centimeters (40.2 inches), towards the left bumper corner, ending 28 centimeters (11.0 inches) leftward of the case vehicle's center. For the frontal impact the residual maximum crush to the bumper was only 1 centimeter (0.4 inches), but as a result of the underride impact, the residual maximum crush above the bumper was measured as 44 centimeters (17.3 inches) at C₆. However, the actual above bumper crush was 71 centimeters (28.0 inches) at C₆. The case vehicle's wheelbase was unaltered from the crash. As a result of the initial impact, the case vehicle's front bumper fascia, grille, hood, front right headlight and turn signal assemblies, and right fender were directly damaged and crushed rearward. The case vehicle's hood was shifted slightly to the left because of the counterclockwise rotation while the hood was partially under the left side of the Chevrolet pickup. During the side slap impact, the right front door panel and right outside rearview mirror were directly contacted and crushed inward. None of the case vehicle's tires were damaged, deflated, or physically restricted. No obvious induced damage or remote buckling was noted to the remainder of the case vehicle's exterior.

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 fabric 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 driver's air bag was designed with two tethers, each 7.5 centimeters (3.0 inches) in width. The driver's air bag had two vent ports, approximately 2 centimeters (0.8 inches) in diameter, located at the 11:30 and 12:30 o'clock positions. The deployed driver's air bag was round with a diameter of 57 centimeters (22.4 inches). An inspection of the air bag's fabric revealed a lipstick imprint upward from and to the right of center in the upper right quadrant. In addition, there was a possible blood spot near the outer edge of the front surface at approximately the 4:30 o'clock position.

The front right passenger's air bag was located in the top of the instrument panel. An inspection of the front right air bag module's cover flap and air bag fabric revealed that the cover flap opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag. However, there were slight abrasions to the front portion of the cover flap that most likely resulted from the air bag's fabric being partially redirected back against the cover flap during its deployment as a result of occupant loading. The front right passenger's air bag was designed with two tethers, each 7.5 centimeters (3.0 inches) wide and sewn interiorly at the 12 and 6 o'clock positions. The front right air bag had one vent port, approximately 7 centimeters (2.8 inches) in diameter, located at the 10 o'clock position on the front surface. The

deployed front right air bag was rectangular with a height of approximately 50 centimeters (19.7 inches) and a width of approximately 70 centimeters (27.6 inches). An inspection of the air bag's fabric revealed no contact evidence readily apparent on the front surface of the air bag. However, there was a small area of oil/skin and blood on the lower right side surface of the front right air bag at its seam with the front surface and a blood spot on the bottom surface of the front right air bag.

Inspection of the case vehicle's interior revealed that right side of the windshield's glazing sustained a spider web-type impact, with skin/hair present from the front right passenger. Furthermore, there was a few small blood spots on the roof over the front right seat and a blood spot on the front right seat's cushion from where the front right passenger came to rest. In addition, there was no integrity loss or intrusion to the interior of the case vehicle.

The 1973 Chevrolet Custom-10 was a rear wheel drive, 4x2, two-door, pickup truck equipped with camper cap (VIN: CCX143A-----). Based on the vehicle inspection, the CDCs for the Chevrolet pickup were determined to be: **10-LZLW-3 (290)** and **09-LBMW-1 (270)** [maximum crush for the primary left side impact was 15 centimeters (5.9 inches)]. The Chevrolet pickup was towed, but not due to damage.

Immediately prior to the crash the case vehicle's front right passenger [102 centimeters and 27 kilograms (40 inches, 60 pounds)] was seated in an upright posture with his back against the seat back and his feet dangling over the front edge of the seat's cushion, but the exact position of his hands is unknown. His seat track was located between its middle and forward-most positions, and the seat back was slightly reclined. During the vehicle inspection, the front right seat was located at its rearmost position, but this positioning was most likely a result of extrication efforts.

The case vehicle's front right passenger was not using his available, active, three-point, lap-and-shoulder, safety belt system. The inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading. The case vehicle's driver indicated in the interview that the front right passenger was not restrained at the time of the crash.

The case vehicle's driver steered slightly leftward and braked (to some degree) just prior to impact. As a result of these attempted avoidance maneuvers and the nonuse of his available safety belts, the front right passenger moved forward and slightly upward, with his head and upper torso leading, just prior to impact. The case vehicle's impact with the Chevrolet pickup enabled the case vehicle's front right passenger to continue forward and upward toward the **20** degree Direction of Principal Force as the case vehicle decelerated and underrode the side of the Chevrolet pickup. The underride caused the back end of case vehicle to pitch upwards. As previously mentioned, the underride type damage resulted in the air bag deploying late during the sequence of the impact. The vehicle's deceleration combined with the front end dipping downward most likely resulted in the front right passenger continuing forward, head first, over the air bag module. Based on the injury information, the case vehicle's front right passenger air bag deployed as the passenger was passing over causing the top surface of the air bag's fabric to strike the front right passenger in his torso and lifting it slightly upwards. As the passenger continued forward his face was tilted downward, causing the top and back portion of his scalp to impact the windshield's glazing and

deposit hair and skin. As the air bag continued to expand, the deploying air bag lifted the front right passenger upwards into the roof near the front sun visor and then backwards along the roof and into the front right seat back. The case vehicle's 10 degree counterclockwise rotation had little affect on the front right passenger since the rotation occurred while he was moving within the vehicle's interior. At most, the rotation would have caused the front right passenger to rebound back toward the right side of the front right seat back as opposed to the center of the front right seat back. After striking the seat back, the front right passenger rebounded forward and, according to the driver, at final rest the front right passenger's lower torso was on the floor board, with his legs straight out, his upper torso laying back against the front of the seat, and his head arched backwards onto the seat's cushion (i.e., a blood spot supports the driver's description of this occupant's final rest position).

The front right occupant was transported by ambulance to the hospital. He sustained critical injuries, was hospitalized, and subsequently pronounced dead 30 hours and 15 minutes post-crash. Based on his medical records, the injuries sustained by the case vehicle's front right passenger included: a critical nonanatomic brain injury, severe cerebral edema, a left subdural hematoma, injuries to his cerebral veins (sinuses), a subarachnoid hemorrhage, bilateral pulmonary contusions, and lacerations to his spleen and the right posterior side of his head. This occupant's primary brain and head injuries were caused by his contact with the case vehicle's windshield glazing. This occupant's lung injuries were most likely caused by the front right passenger air bag. This contractor believes that the deployment of the front right passenger air bag altered (as mentioned above) the front right passenger's trajectory toward the windshield and, as a result, the apex and posterior portion of the passenger's head struck the windshield rather than the passenger's forehead. It should be noted that the medical information made no mention of soft tissue injuries to the front right passenger's neck, chin, mid-face, or forehead.

The case vehicle's driver [25-year-old, White (Hispanic) female; 165 centimeters and 68 kilograms (65 inches, 150 pounds)] was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot on the brake, and both hands on the steering wheel. Her seat track was located between its middle and forward-most positions, the seat back was upright, and the vehicle was not equipped with a tilt steering wheel.

The case vehicle's driver was not using her available, active, three-point, lap-and-shoulder, safety belt system. The driver was transported by ambulance to the hospital but only to be with her son and not because of injury. Based on her interview, she sustained minor facial abrasions and a contused abdomen as a result of this crash.

The case vehicle's back left passenger [7-year-old, White (Hispanic) male; 122 centimeters and 25 kilograms (48 inches, 55 pounds)] was seated in an upright posture with his back against the seat back and his feet hanging down over the front edge of the seat's cushion; however, the exact position of his hands is unknown. His seat track and seat back were not adjustable. The case vehicle's back left passenger was not using his available, active, three-point, lap-and-shoulder, safety belt system. The back left passenger was not transported by ambulance to the hospital; instead, he left the scene with a relative. According to the interview with the case vehicle's driver, he did not sustain any injuries as a result of this crash.

The case vehicle's back right passenger [9-year-old, White (Hispanic) female; 137 centimeters and 27 kilograms (54 inches, 60 pounds)] was seated in an upright posture with her back against the seat back and her feet hanging down over the front edge of the seat's cushion; however, the exact position of her hands is unknown. Her seat track and seat back were not adjustable. The case vehicle's back right passenger was not using her available, active, three-point, lap-and-shoulder, safety belt system. The back right passenger was not transported by ambulance to the hospital; instead, she left the scene with a relative. Once again, according to the driver's interview, she did not sustain any injuries as a result of this crash.

CRASH CIRCUMSTANCES

The case vehicle was traveling south in outside southbound lane of a five-lane, divided, state highway (**Figure 1**) and was approaching a controlled four-leg intersection, intending to continue traveling southbound (i.e., both the north and southbound roadways had two through lanes while the southbound roadway had a left-hand, turn lane). In addition, there were one-way, multi-lane, access roads adjacent to the highway. The Chevrolet pickup was traveling east in the eastbound through lane of a four-lane, undivided, city roadway (**Figure 2**) and was also intending to travel through the intersection (i.e., the east-west roadway had one through lane and one left-hand, turn lane in the eastbound direction). The case vehicle's driver attempted to avoid the crash by braking and steering leftward just prior to impact. The crash occurred in the southbound roadway (**Figure 3**), in the four-leg intersection of the two trafficways (see **CRASH DIAGRAM** below).

The state highway was straight and level at the area of impact. The pavement was bituminous but traveled, and the width of the case vehicle's outside southbound travel lane was 3.7 meters (12.3 feet). The west side of the southbound road had a 3.2 meter (10.6 foot) wide paved (i.e., bituminous) shoulder. The west shoulder was adjacent to a grass median that separated the state highway from the highway's access road. At the area of impact, there was no shoulder on the east side of the road because the left-hand turn lane



Figure 1: Case vehicle's southward travel path in inside through lane of southbound roadway prior to entering intersection; Note: frontage road on right (case photo #02)



Figure 2: Chevrolet pickup's eastward travel path across first, southbound frontage road, and second, across southbound roadway of state highway (case photo #08)



Figure 3: On-scene view looking north in southbound roadway at final rest positions of case vehicle and Chevrolet pickup; Note: case vehicle is hidden behind pickup (case photo #79)

was adjacent to the paved unprotected median that separated the north and southbound roadways. On the north leg of the intersection, the median was 5.0 meters (16.5 feet) wide. The two southbound lanes were divided by a dashed white line, and a single solid white line separated the inside southbound lane from the left-hand turn lane (**Figure 1** above). In addition, a single solid yellow “no passing” line, augmented by raised pavement markers was present along left side of the roadway at the median’s edge and a single solid white edge line separated the outside through lane from the west shoulder. The estimated coefficient of friction was 0.70. The legal speed limit was 64 km.p.h. (40 m.p.h.). No regulatory speed limit sign was posted near the crash site.

The city street was straight and level at the area of impact. The pavement was bituminous but traveled, and the width of the two eastbound lanes was approximately 6.2 meters (20.3 feet). No shoulders were present. The south side of the city street was flush with a barrier curb while the north side was adjacent to a grassy area (**Figure 4**). Pavement markings consisted of a painted but faded single solid yellow line separating the eastbound and westbound lanes. The estimated coefficient of friction was 0.70. The legal speed limit was 48 km.p.h. (30 m.p.h.).

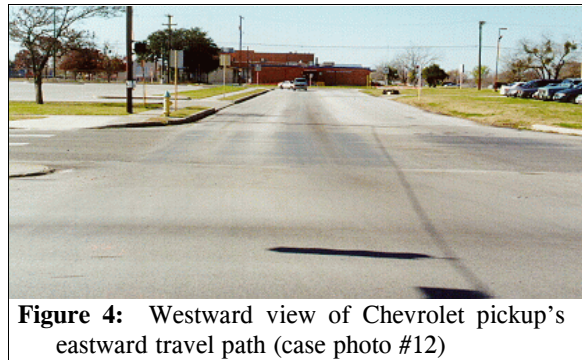


Figure 4: Westward view of Chevrolet pickup’s eastward travel path (case photo #12)

The intersection was controlled by multiple, on-colors, pre-timed, vertically mounted traffic control signals in the immediate area of the crash. At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the road pavement was dry. According to the case vehicle’s driver, traffic density was light, and the site of the crash was primarily urban commercial.



Figure 5: On-scene westerly view of case vehicle and Chevrolet pickup at final rest (case photo #78)



Figure 6: On-scene southeasterly view of case vehicle and Chevrolet pickup at final rest; Note: pickup tilted from being underridden by case vehicle (case photo #76)

The front of the case vehicle impacted the left side of the Chevrolet pickup (**Figures 5 and 6**), causing the case vehicle’s driver and front right passenger supplemental restraints (air bags) to deploy (**Figure 7** below). Upon impact the case vehicle’s front underrode the Chevrolet

pickup's left side directly contacting the left side frame rail. At maximum engagement the undercarriage of the case vehicle contacted the bituminous surface resulting in two gouges (**Figure 8**). This underriding action also resulted in the case vehicle simultaneously lifting and pushing the Chevrolet pickup in a southeasterly direction post-crash (**Figure 9**). Because of the Chevrolet pickup's forward momentum, the case vehicle rotated approximately 10 degrees counterclockwise resulting in both vehicles side slapping. The case vehicle's right outside rearview mirror and right front door panel contacted the left rear wheel well and left rear wheel, respectively, of the Chevrolet pickup. The two vehicles became intertwined (**Figure 5** above). The case vehicle came to rest, primarily in the inside through lane of the southbound roadway, heading in a south-southeasterly direction (**Figure 9**). The Chevrolet pickup rotated approximately 45 degrees clockwise as a result of the impact and came to rest straddling the two southbound through lanes, heading southeast (**Figure 3** above). Because the damage on the case vehicle was primarily above the bumper and produced an underride impact pattern, this underride type damage resulted in the air bags deploying late during the sequence of the impact. This delayed deployment occurred due to the prolonged change in time (Delta T) relative to the change in speed (magnitude of Delta V—i.e., ramp versus spike).



Figure 7: On-scene view of case vehicle's front seating area showing deployed air bags; Note: front right passenger's air bag was cutout and removed prior to inspection (case photo #80)



Figure 8: South-southeastward view of gouges in roadway's bituminous surface made by case vehicle's undercarriage as a result of its maximum engagement with Chevrolet pickup (case photo #04)

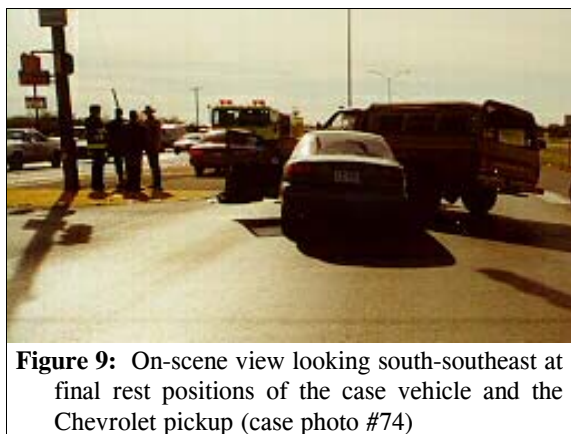


Figure 9: On-scene view looking south-southeast at final rest positions of the case vehicle and the Chevrolet pickup (case photo #74)

CASE VEHICLE

The 1996 Ford Contour GL was a front wheel drive, five-passenger, four-door sedan (VIN: 1FALP6535TK-----) equipped with a 2.0L, I-4 engine and a four-speed automatic transmission. Braking was achieved by a power-assisted, front disc and rear drum system and, although four-wheel, anti-lock brakes were an option for this model, the case vehicle was not so equipped. The case vehicle's wheelbase was 271 centimeters (106.5 inches), and the odometer reading at inspection was 103,281 kilometers (64,176 miles).

Inspection of the vehicle's interior revealed adjustable front bucket seats with adjustable head restraints; a non-adjustable back bench seat with separate back cushions but without head restraints for the back outboard seating positions; 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 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, neither of which showed any evidence of deformation. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a frontal air bag for the driver and front right passenger seating positions. Both front air bags deployed as a result of the case vehicle's frontal impact with the Chevrolet pickup.

CASE VEHICLE DAMAGE

The case vehicle's initial contact with the Chevrolet pickup involved approximately three-fourths of its front (**Figure 10**). Because of the underride type impact, the direct damage began at the right bumper corner and extended, a measured distance of 102 centimeters (40.2 inches), towards the left bumper corner, ending 28 centimeters (11.0 inches) leftward of the case vehicle's center (**Figure 11**). For the frontal impact the residual maximum crush to the bumper was only 1 centimeter (0.4 inches), but as a result of the underride impact, the residual maximum crush above the bumper was measured as 44 centimeters (17.3 inches) at C₆. However, the actual above bumper crush was 71 centimeters (28.0 inches) at C₆. The case vehicle's wheelbase was unaltered from the crash. As a result of the initial impact, the case vehicle's front bumper fascia, grille, hood, front right headlight and turn signal assemblies, and right fender were directly damaged and crushed rearward. The case vehicle's hood was shifted slightly to the left because of the counterclockwise rotation while the hood was partially under the left side of the Chevrolet pickup (**Figure 10**). During the side slap impact, the right front door panel and right outside rearview mirror were directly contacted and crushed inward (**Figure 12** below). None of the case vehicle's tires were damaged, deflated, or physically restricted. No obvious induced damage or remote buckling was noted to the remainder of the case vehicle's exterior.



Figure 10: Case vehicle's frontal deformation with contour gauge present; Note: vertical yellow tape marks end of direct damage and damage is primarily above the bumper (case photo #13)



Figure 11: Case vehicle's front right deformation viewed from right of front; Note: underride type damage to hood and right fender (case photo #23)

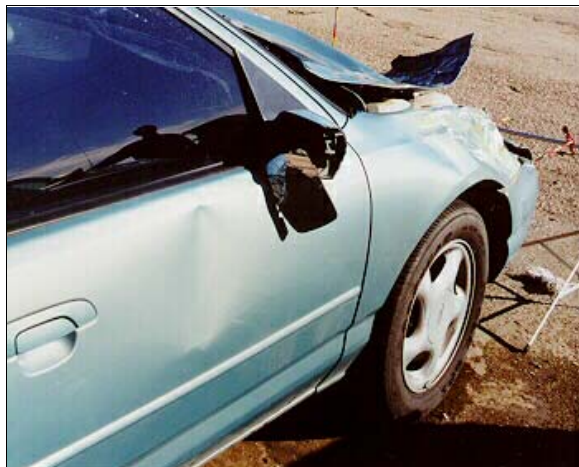


Figure 12: Damage to case vehicle's right front door and outside rearview mirror from side slap type impact with Chevrolet pick-up's left rear wheel, viewed from back of right (case photo #19)

Inspection of the case vehicle's interior revealed that right side of the windshield's glazing sustained a spider web-type impact, with skin/hair present from the front right passenger, and there was associated scuffing to the right "A"-pillar (**Figures 13 and 14**). Furthermore, there was a few small blood spots on the roof over the front right seat and a blood spot on the front right seat's cushion from where the front right passenger came to rest. In addition, there was no integrity loss. Finally, there was no evidence of intrusion to the case vehicle's interior, no evidence of compression to the energy absorbing shear capsules in the steering column, and no deformation to the steering wheel rim.

Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **01-FDEW-3** (20 degrees) and **03-RPMW-1** (90 degrees). The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 20.4 km.p.h. (12.7 m.p.h.), -19.1 km.p.h. (-11.9 m.p.h.), and -7.0 km.p.h. (-4.3 m.p.h.). These results appear reasonable to this contractor. The case vehicle was towed due to damage.



Figure 13: Case vehicle's front right seating area showing residue of deployed front right passenger air bag (cutout prior to inspection), air bag module's cover flap, spider web-type impact to right windshield's glazing, and blood spots on right roof (case photo #36)

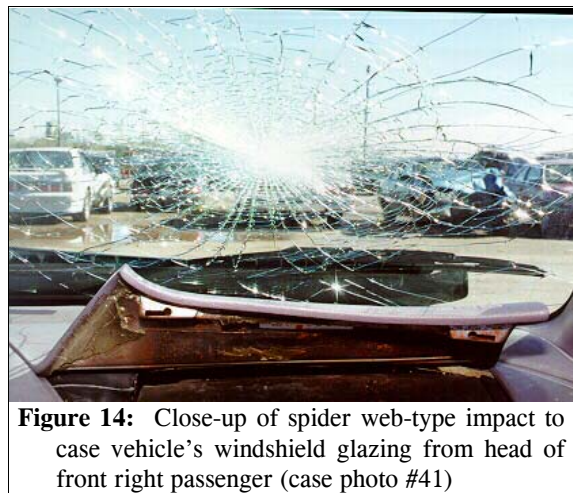


Figure 14: Close-up of spider web-type impact to case vehicle's windshield glazing from head of front right passenger (case photo #41)

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained frontal air bags at the driver and front right passenger positions. Both air bags deployed as a result of the frontal impact with the left side of the Chevrolet pickup. The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of asymmetrical, hexagonal, essentially "H"-configuration cover flaps made of thick vinyl and at least two sides of each flap was curved. The upper cover flap had a curvilinear top with an overall width of 26 centimeters (10.2 inches) while the bottom horizontal seam measured 19.5 centimeters (7.7 inches). The upper flap was curved vertically and measured 12 centimeters (4.7 inches) along its surface [i.e., there was a 5 centimeter (2.0 inch) distance from the apex of the curved surface to the top curvilinear seam and a 7 centimeter (2.8 inch) distance from the apex to the bottom horizontal seam]. The bottom cover flap measured 19.5 centimeters (7.7 inches) at its top horizontal seam, 21.5 centimeters (8.5 inches) at its bottom horizontal seam, and 7 centimeters (2.8 inches) vertically. An inspection of the air bag module's cover flaps and air bag fabric 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 driver's air bag was designed with two tethers, each 7.5 centimeters (3.0 inches) in width. The driver's air bag had two vent ports, approximately 2 centimeters (0.8 inches) in diameter, located at the 11:30 and 12:30 o'clock positions. The deployed driver's air bag was round with a diameter of 57 centimeters (22.4 inches). An inspection of the air bag's fabric revealed a lipstick imprint upward from and to the right of center in the upper right quadrant (**Figure 15**). In addition, there was a possible blood spot near the outer edge of the front surface at approximately the 4:30 o'clock position.



Figure 15: Case vehicle's deployed driver air bag showing imprint (highlighted) of driver's lipstick (case photo #32)

The front right passenger's air bag was located in the top of the instrument panel. There was a single, asymmetrical, quadrilateral, modular cover flap. The cover flap was made of a thick vinyl over a preformed frame and had a pre-shaped fold that angled horizontally across the cover flap, designed to the contour of the case vehicle's instrument panel. The flap's dimensions were: 37 centimeters (14.6 inches) at the forward horizontal seam, 45 centimeters (17.7 inches) at the above mentioned angular fold line (i.e., toward the windshield but not a seam), 21 centimeters (8.3 inches) along the right vertical seam, and 33 centimeters (13.0 inches) along the angled left vertical seam. The top horizontal seam was curvilinear but its length was not measured. The distance from the bottom horizontal seam to the angular fold was measured as 17 centimeters (6.7 inches) at each of the two vertical seams. The profile of the case vehicle's instrument panel resulted in a 13 centimeter (5.1 inch) setback of the leading edge of the cover flap relative to the protruding right instrument panel. An inspection of the front right air bag module's cover flap and air bag fabric revealed that the cover flap opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag. However, there were

slight abrasions to the front portion of the cover flap that most likely resulted from the air bag's fabric being partially redirected back against the cover flap during its deployment as a result of occupant loading. The abrasion started 12 centimeters (4.7 inches) in from the left lower corner and measured 19 centimeters (7.5 inches) across the leading edge of the cover flap (**Figure 16**). The front right passenger's air bag was designed with two tethers, each 7.5 centimeters (3.0 inches) wide and sewn interiorly at the 12 and 6 o'clock positions. The front right air bag had one vent port, approximately 7 centimeters (2.8 inches) in diameter, located at the 10 o'clock position on the front surface. The deployed front right air bag was rectangular with a height of approximately 50 centimeters (19.7 inches) and a width of approximately 70 centimeters (27.6 inches). An inspection of the air bag's fabric revealed no contact evidence readily apparent on the front surface of the air bag (**Figure 17**). However, there was a small area of oil/skin and blood on the lower right side surface of the front right air bag at its seam with the front surface [i.e., 34 centimeters (13.4 inches) below the top surface of the air bag] and a blood spot on the bottom surface of the front right air bag [i.e., 36 centimeters (14.2 inches) behind the front surface and 29 centimeters (11.4 inches) inward from the left side surface of the air bag]. These blood spots most likely resulted from contact with the occupant after the occupant and the case vehicle came to final rest.

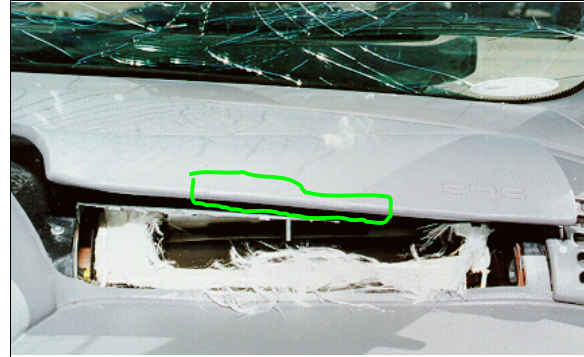


Figure 16: Close-up of case vehicle's front right air bag module's cover flap showing small abrasions (highlighted) on flap (case photo #39)



Figure 17: Frontal surface of case vehicle's front right passenger air bag showing no visible evidence of contact (case photo #44)

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

Immediately prior to the crash the case vehicle's front right passenger [102 centimeters and 27 kilograms (40 inches, 60 pounds)] was seated in an upright posture with his back against the seat back and his feet dangling over the front edge of the seat's cushion, but the exact position of his hands is unknown. His seat track was located between its middle and forward-most positions, and the seat back was slightly reclined. During the vehicle inspection, the front right seat was located at its rearmost position, but this positioning was most likely a result of extrication efforts.

The case vehicle's front right passenger was not using his available, active, three-point, lap-and-shoulder, safety belt system. The inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading. The case vehicle's driver indicated in the interview that the front right passenger was not restrained at the time of the crash.

The case vehicle's driver steered slightly leftward and braked (to some degree) just prior to impact. As a result of these attempted avoidance maneuvers and the nonuse of his available safety belts, the front right passenger moved forward and slightly upward, with his head and upper torso leading, just prior to impact. The case vehicle's impact with the Chevrolet pickup enabled the case vehicle's front right passenger to continue forward and upward toward the **20** degree Direction of Principal Force as the case vehicle decelerated and underrode the side of the Chevrolet pickup. The underride caused the back end of case vehicle to pitch upwards. As previously mentioned, the underride type damage resulted in the air bag deploying late during the sequence of the impact. The vehicle's deceleration combined with the front end dipping downward most likely resulted in the front right passenger continuing forward, head first, over the air bag module. Based on the injury information, the case vehicle's front right passenger air bag deployed as the passenger was passing over causing the top surface of the air bag's fabric to strike the front right passenger in his torso and lifting it slightly upwards. As the passenger continued forward his face was tilted downward, causing the top and back portion of his scalp to impact the windshield's glazing and deposit hair and skin. As the air bag continued to expand, the deploying air bag lifted the front right passenger upwards into the roof near the front sun visor and then backwards along the roof and into the front right seat back. The case vehicle's 10 degree counterclockwise rotation had little affect on the front right passenger since the rotation occurred while he was moving within the vehicle's interior. At most, the rotation would have caused the front right passenger to rebound back toward the right side of the front right seat back as opposed to the center of the front right seat back. It is also possible that the front right passenger's right upper or lower extremity may have scuffed the right "A"-pillar as a result of the counterclockwise rotation as she was rebounding backwards from the air bag's deployment. After striking the seat back, the front right passenger rebounded forward and, according to the driver, at final rest the front right passenger's lower torso was on the floor board, with his legs straight out, his upper torso laying back against the front of the seat, and his head arched backwards onto the seat's cushion (i.e., a blood spot supports the driver's description of this occupant's final rest position).

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right occupant was transported by ambulance to the hospital. He sustained critical injuries, was hospitalized, and subsequently pronounced dead 30 hours and 15 minutes post-crash. Based on his medical records, the injuries sustained by the case vehicle's front right passenger included: a critical nonanatomic brain injury, severe cerebral edema, a left subdural hematoma, injuries to his cerebral veins (sinuses), a subarachnoid hemorrhage, bilateral pulmonary contusions, and lacerations to his spleen and the right posterior side of his head. This occupant's primary brain and head injuries were caused by his contact with the case vehicle's windshield glazing. This occupant's lung injuries were most likely caused by the front right passenger air bag. This contractor believes that the deployment of the front right passenger air bag altered (as mentioned above) the front right passenger's trajectory toward the windshield and, as a result, the apex and posterior portion of the passenger's head struck the windshield rather than the passenger's forehead. It should be noted that the medical information made no mention of soft tissue injuries to the front right passenger's neck, chin, mid-face, or forehead.

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 loss of consciousness, GCS=5, decerebrate posturing, unresponsive to stimuli; complications ¹ included the onset of central diabetes insipidus and brain herniation ² —not further specified	160824.5 critical	Front right windshield's glazing {air bag-related}	Probable	Hospitalization records
2	Edema, cerebral, diffuse with effacement of cisterns ³ ; complications included uncontrollable intracranial pressures reaching into the 100s (e.g., ICP=113 just prior to this patient being declared brain dead)	140666.5 critical	Front right windshield's glazing {air bag-related}	Probable	Hospitalization records
3	Hematoma, 8 mm (0.3 in), subdural, left, with rightward midline shift of # 1 cm (0.4 in)	140652.4 severe	Front right windshield's glazing {air bag-related}	Probable	Hospitalization records
4	Injury {NFS}, large, superior longitudinal (sagittal) sinus	122499.4 severe	Front right windshield's glazing {air bag-related}	Probable	Hospitalization records
5	Injury {NFS}, large, vein {sinus} of Labbé ⁴	122299.3 serious	Front right windshield's glazing {air bag-related}	Probable	Hospitalization records

¹ The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:

diabetes (*di"e-be'tez*): a general term referring to disorders characterized by excessive urine excretion (polyuria), as in diabetes mellitus and diabetes insipidus. When used alone, the term refers to diabetes mellitus.

d. insipidus, central: a metabolic disorder due to injury of the neurohypophyseal system, which results in a deficient quantity of antidiuretic hormone being released or produced, and thus in failure of tubular reabsorption of water in the kidney. As a result, a large amount of urine of low specific gravity is excreted, followed by voracious appetite, loss of strength, and emaciation. It may be inherited, acquired, or idiopathic.

herniation (*her"ne-a'shen*): the abnormal protrusion of an organ or other body structure through a defect or natural opening in a covering, membrane, muscle, or bone.

idiopathic (*id"e-o-path'ik*): of the nature of an idiopathy; self-originated; of unknown causation.

idiopathy (*id"e-op'e-the*): a morbid state of spontaneous origin; one neither sympathetic or traumatic.

² This lesion description was listed as a diagnosis in the discharge summary but no further specific information was provided.

³ The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:

cistern (*sis'tern*): a closed space serving as a reservoir for fluid; see also *cisterna*.

cisterna (*sis-ter'na*) **pl. cister'nae**: a cistern -- a closed space serving as a reservoir for lymph or other body fluid, especially one of the enlarged subarachnoid spaces containing cerebrospinal fluid.

⁴ The following term is defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:

Labbe's triangle, vein (*lah-baz'*): see *vena anastomotica superior*.

v. anastomo'tica supe'rior: superior anastomotic vein; a vein that interconnects the superficial middle cerebral vein and the superior sagittal sinus.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
6	Hemorrhage, subarachnoid, location not specified [Aspect = Unknown]	140684.3 serious	Front right windshield's glazing {air bag-related}	Probable	Hospitalization records
7	Contusions bilateral lungs {pulmonary} without hemothorax or pneumothorax, locations not specified	441410.4 severe	Air bag, front right passenger's	Probable	Hospitalization records
8	Laceration spleen, not further specified	544220.2 moderate	Seat back support, front right	Possible	Hospitalization records
9	Laceration(s), large, right parietal {posterior} scalp	190600.1 minor	Front right windshield's glazing {air bag-related}	Probable	Hospitalization records

CASE VEHICLE DRIVER KINEMATICS

The case vehicle's driver [25-year-old, White (Hispanic) female; 165 centimeters and 68 kilograms (65 inches, 150 pounds)] was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot on the brake, and both hands on the steering wheel. Her seat track was located between its middle and forward-most positions, the seat back was upright, and the vehicle was not equipped with a tilt steering wheel.

The case vehicle's driver was not using her available, active, three-point, lap-and-shoulder, safety belt system. The inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed evidence of recent usage but no conclusive evidence of loading during this crash.

The case vehicle's driver steered slightly leftward and braked (to some degree) just prior to impact. As a result of these attempted avoidance maneuvers and the nonuse of her available safety belts, the driver moved forward and slightly upward just prior to impact. The case vehicle's impact with the Chevrolet pickup enabled the driver to continue forward and slightly upward toward the 20 degree Direction of Principal Force as the case vehicle decelerated and underrode the side of the Chevrolet pickup. The underride caused the back end of case vehicle to pitch upwards. As previously mentioned, the underride type damage resulted in the air bag deploying late during the sequence of the impact. The vehicle's deceleration combined with the front end dipping downward most likely resulted in the driver continuing forward, head first, over the steering wheel hub. The deploying air bag contacted the driver in the face [i.e., lipstick mark on air bag (**Figure 15** above)] and head knocking her backwards into her seat back. The case vehicle's 10 degree counterclockwise rotation had little affect on the driver since the rotation occurred while he was rebounding backwards from the air bag's deployment. At most, the rotated would have caused the driver to rebound back toward the right side of her seat back as opposed to the center of her seat back. After striking the seat back, the driver rebounded forward and at

final rest she most likely remained near her original seating position. According to the case vehicle’s driver, she has no recollection of her exact posture at final rest.

CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to the hospital but only to be with her son and not because of injury. Based on her interview, she sustained minor facial abrasions and a contused abdomen as a result of this crash.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Abrasion left cheek, not further specified	290202.1 minor	Air bag, driver’s	Certain	Interviewee (same person)
2	Abrasion right cheek, not further specified	290202.1 minor	Air bag, driver’s	Certain	Interviewee (same person)
3	Contusions {bruises} abdomen, not further specified [Aspect = Unknown]	590402.1 minor	Steering wheel rim	Probable	Interviewee (same person)

CASE VEHICLE BACK LEFT PASSENGER KINEMATICS

The case vehicle’s back left passenger [7-year-old, White (Hispanic) male; 122 centimeters and 25 kilograms (48 inches, 55 pounds)] was seated in an upright posture with his back against the seat back and his feet hanging down over the front edge of the seat’s cushion; however, the exact position of his hands is unknown. His seat track and seat back were not adjustable (**Figure 18**).

The case vehicle’s back left passenger was not using his available, active, three-point, lap-and-shoulder, safety belt system. The inspection of the back left passenger's seat belt webbing and latch plate showed no evidence of loading. In addition, the case vehicle's driver indicated in the interview that the back left passenger was not restrained at the time of the crash.



Figure 18: Case vehicle’s back seating area viewed from outside right rear door showing where back left (7-year-old) and back right (9-year-old) passengers were seated; Note: front right seat was positioned at rearmost location at time of inspection (case photo #55)

The case vehicle’s driver steered slightly leftward and braked (to some degree) just prior to impact. As a result of these attempted avoidance maneuvers and the nonuse of his available safety

belts, the back left passenger moved forward and slightly upward, with his head and upper torso leading, just prior to impact. The case vehicle's impact with the Chevrolet pickup enabled the case vehicle's back left passenger to continue forward and slightly upward toward the **20** degree Direction of Principal Force as the case vehicle decelerated and underrode the side of the Chevrolet pickup. The underride caused the back end of case vehicle to pitch upwards. The vehicle's deceleration combined with the front end dipping downward most likely resulted in the back left passenger continuing forward, head first, into the back of the case vehicle's driver seat back (**Figure 19**). The case vehicle's 10 degree counterclockwise rotation had little affect on the back left passenger since the rotation occurred while he was moving within the vehicle's interior. After striking the seat back, the back left passenger most likely fell onto the floor board. At final rest he was in an unknown position on the back seat floor.



Figure 19: Back surface of case vehicle's driver seat back showing no visible evidence of contact on seat back (case photo #56)

CASE VEHICLE BACK LEFT PASSENGER INJURIES

The back left passenger was not transported by ambulance to the hospital; instead, he left the scene with a relative. According to the interview with the case vehicle's driver, he did not sustain any injuries as a result of this crash.

CASE VEHICLE BACK RIGHT PASSENGER KINEMATICS

The case vehicle's back right passenger [9-year-old, White (Hispanic) female; 137 centimeters and 27 kilograms (54 inches, 60 pounds)] was seated in an upright posture with her back against the seat back and her feet hanging down over the front edge of the seat's cushion; however, the exact position of her hands is unknown. Her seat track and seat back were not adjustable.

The case vehicle's back right passenger was not using her available, active, three-point, lap-and-shoulder, safety belt system. The inspection of the back right passenger's seat belt webbing and latch plate showed no evidence of loading. In addition, the case vehicle's driver indicated in the interview that the back right passenger was not restrained at the time of the crash.

The case vehicle's driver steered slightly leftward and braked (to some degree) just prior to impact. As a result of these attempted avoidance maneuvers and the nonuse of her available safety belts, the back right passenger moved forward and slightly upward, with her head and upper torso leading, just prior to impact. The case vehicle's impact with the Chevrolet pickup enabled the case vehicle's back right passenger to continue forward and slightly upward toward the **20** degree Direction of Principal Force as the case vehicle decelerated and underrode the side of the Chevrolet pickup. The underride caused the back end of case vehicle to pitch upwards. The

vehicle's deceleration combined with the front end dipping downward most likely resulted in the back right passenger continuing forward, head first, into the back of the front right passenger's seat back. The case vehicle's 10 degree counterclockwise rotation had little effect on the back right passenger since the rotation occurred while she was moving within the vehicle's interior. After striking the seat back, the back right passenger most likely fell onto the floor board. At final rest she was in an unknown position on the back seat floor.

CASE VEHICLE BACK RIGHT PASSENGER INJURIES

The back right passenger was not transported by ambulance to the hospital; instead, she left the scene with a relative. Once again, according to the driver's interview, she did not sustain any injuries as a result of this crash.

OTHER VEHICLE

The 1973 Chevrolet Custom C-10 was a rear wheel drive, 4x2, three-passenger, two-door, regular cab, standard bed, pickup truck (VIN: CCX143A-----) equipped with a camper cap, a 5.0L, V-8 engine and an five-speed manual transmission. Braking was achieved by a front and rear drum system. Four-wheel, anti-lock brakes were not an option for this model. The Chevrolet pickup's wheelbase was 334 centimeters (131.5 inches), and the odometer reading at inspection is unknown.

The Chevrolet pickup's initial contact with the case vehicle involved the left side between the front and rear axles (**Figure 20**). Direct damage began 59 centimeters (23.2 inches) behind the left front axle and extended, a measured distance of 249 centimeters (98.0 inches), along the left side (**Figure 21**). Residual maximum crush was measured as 15 centimeters (5.9 inches) between C_2 and C_4 . Because the case vehicle underrode the Chevrolet pickup, there was direct damage to the left frame rail (**Figure 22** below). The case vehicle's penetration resulted in a residual direct damage of 43 centimeters (16.9 inches) at C_4 . The wheelbase on the Chevrolet pickup's left side was extended 2 centimeters (0.8 inches) while the right side remained unchanged. The Chevrolet pickup's left fender, left front door, and left quarter panel were directly damaged and crushed inward. None of the Chevrolet pickup's tires were damaged, deflated, or physically restricted. No obvious induced damage or remote buckling was noted to the remainder of the Chevrolet pickup's exterior.



Figure 20: Chevrolet pickup's damaged left side with contour gauge present viewed from front of left (case photo #59)

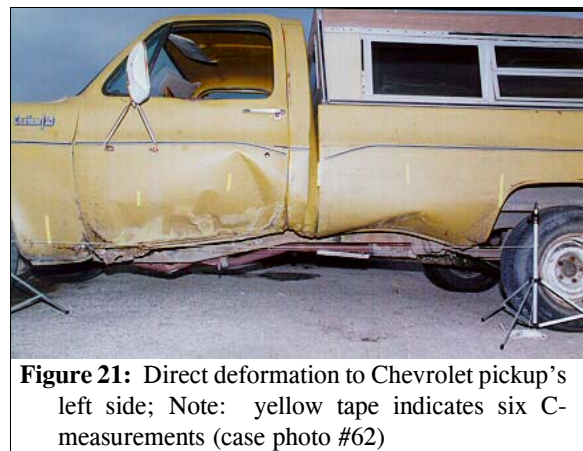


Figure 21: Direct deformation to Chevrolet pickup's left side; Note: yellow tape indicates six C-measurements (case photo #62)

Other Vehicle (Continued)

IN00-019

Based on the vehicle inspection, the CDCs for the Chevrolet pickup were determined to be: **10-LZLW-3 (290)** and **09-LBMW-1 (270)** [maximum crush for the primary left side impact was 15 centimeters (5.9 inches)]. The WinSMASH reconstruction program, damage only algorithm, was used on the Chevrolet pickup's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 14.7 km.p.h. (9.1 m.p.h.), -5.0 km.p.h. (-3.1 m.p.h.), and +13.8 km.p.h. (+8.6 m.p.h.). The Chevrolet pickup was towed, but not due to damage.

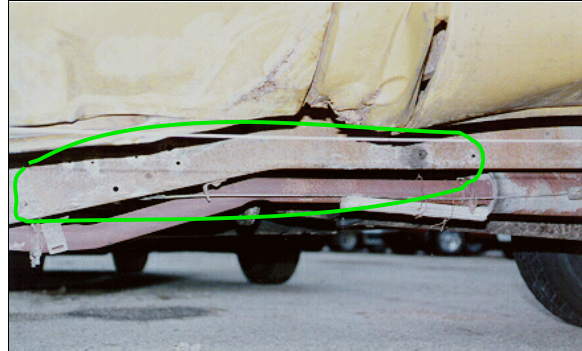


Figure 22: Close-up of direct damage to Chevrolet pickup's left frame rail from front bumper of case vehicle (case photo #64)

