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ON-SITE CHILD AIR BAG-RELATED FATALITY INVESTIGATION

CASE NUMBER - IN-02-004
LOCATION - INDIANA
VEHICLE - 1994 VOLKSWAGEN JETTA GL
CRASH DATE - July 2002

Submitted:

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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 1994 Volkswagen Jetta GL (case vehicle), a 1993 Ford Tempo GL (1 st other vehicle), and a 1998 Ford F-150 pickup truck (2 nd other vehicle). This crash is of special interest because of the case vehicle's front right passenger (7-year-old female) sustained critical cervical injuries from her deploying front right passenger air bag, resulting in her death. The case vehicle was stopped, heading east in the outside lane of a four-lane, divided, U.S. highway and intended to continue eastward (i.e., both the east and westbound roadways had two through lanes). The case vehicle was stopped behind several other eastbound vehicles at a traffic light. The Ford F-150 was also stopped, directly in front of the case vehicle. The Ford Tempo was traveling eastbound in the same lane and was approaching the stopped vehicles. The crash occurred in the outside through lane of the eastbound roadway. The back of the case vehicle was contacted by the front of the Tempo. As a result the case vehicle was pushed forward and the front of the case vehicle impacted the back of the pickup, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle's front right passenger was seated with her seat track located between its middle and forward-most positions and was restrained by her available, active, three point, lap-and-shoulder, safety belt system. However, given this occupant's height, it is likely that the shoulder belt did not fit snugly across this occupant's right shoulder. According to the driver's (i.e., mother) interview and her medical records, she sustained a critical nonanatomic brain injury. In addition, she sustained a clinical basilar skull fracture, an atlanto-occipital dislocation (and probable spinal cord injury), and multiple abrasions, contusions, and lacerations about her face, neck, chest, and arms. This occupant's primary brain, skull, and cervical injuries were caused by her contact with the case vehicle's front right passenger air bag. The case vehicle's driver (25-year-old female) was seated with her seat track located between its center and forward-most positions, and the tilt steering wheel was located in its down-most position. She was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. According to her interview, she sustained minor abrasions on her arms and contusions under both eyes. The back left passenger (3-year-old female) was seated, but her seat track was non-adjustable. She was restrained by her available, active, three-point, lap-and-shoulder, safety belt system and, according to the driver's interview and her medical records, did not sustain any injuries as a result of this crash.					
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This on-site investigation was brought to NHTSA's attention on July 17, 2002 through a newspaper article in a nearby local paper. This crash involved a 1994 Volkswagen Jetta GL (case vehicle), a 1993 Ford Tempo GL (1st other vehicle), and a 1998 Ford F-150 pickup truck (2nd other vehicle). The Crash occurred in July 2002 at 4:53 p.m., in Indiana and was investigated by the applicable city police department. This crash is of special interest because of the case vehicle's front right passenger [7-year-old, White (non-Hispanic) female] sustained critical cervical injuries from her deploying front right passenger air bag, resulting in her death. This contractor inspected the scene and vehicles on July 22, 2002. This contractor interviewed the driver for the case vehicle on July 22, 2002. This summary is based on the Police Crash Report, interviews with the case vehicle's driver and the investigating police officers, scene and vehicle inspections, occupant kinematic principles, occupant medical records, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was stopped, heading east in the outside lane of a four-lane, divided, U.S. highway and intended to continue eastward (i.e., both the east and westbound roadways had two through lanes). The case vehicle was stopped behind several other eastbound vehicles at a traffic light that regulated a four-leg intersection. The Ford F-150 was also stopped, directly in front of the case vehicle. The Ford Tempo was traveling eastbound in the same lane of the same roadway and was approaching the line of stopped vehicles. The Tempo's driver attempted to stop, depositing 10.3 meters (33.8 feet) of straight line skid marks prior to impact. The driver of the case vehicle stated that she saw the Tempo approaching and thought about accelerating and steering to the right but did not take any evasive action. The crash occurred in the outside through lane of the eastbound roadway; see **CRASH DIAGRAM** at end.

The back of the case vehicle was contacted by the front of the Tempo. As a result the case vehicle was pushed forward and the front of the case vehicle impacted the back of the pickup, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. All three vehicles moved forward slightly in the outside eastbound lane from their respective points of impact.

The 1994 Volkswagen Jetta GL was a front wheel drive, four-door sedan (VIN: 3VWRA81H6RM-----). Based on vehicle inspection, the CDCs for the case vehicle were determined to be: **06-BDEW-1 (180 degrees)** for its initial impact, and **12-FREN-1 (0 degrees)** for its second (deployment) impact. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's first impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 13.0 km.p.h. (8.1 m.p.h.), +13.0 km.p.h. (+8.1 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The WinSMASH reconstruction program, missing vehicle algorithm, was used on the case vehicle's second impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 13.0 km.p.h. (8.1 m.p.h.), -13.0 km.p.h. (-8.1 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). Based on this contractor's experience, the two separate Delta V results are reasonable, given the modest amounts of crush that the case vehicle sustained in each of its impacts. However, it must be noted that the presence of the Ford pickup's trailer hitch qualifies the pickup as an "altered" vehicle for

the purposes of the crash reconstruction program, but what effect the hitch had on the reported Delta Vs is unclear. The case vehicle was towed from the scene but not due to damage.

The case vehicle's contact with the Ford Tempo involved the majority of the back bumper. Direct damage began at the back right bumper corner and extended 134 centimeters (52.8 inches) leftward along the back bumper. Residual maximum crush was measured as 2 centimeters (0.8 inches) at C₆. All measurements were taken at bumper level. The case vehicle's contact with the Ford pickup involved only the small portion of the front right bumper which struck a trailer ball hitch on the back of the pickup. Direct damage began 18 centimeters (7.1 inches) from the front right bumper corner and extended leftward 18 centimeters (7.1 inches) along the bumper. The case vehicle's wheelbase was unaltered from the crash. The case vehicle's front and back bumper fascia as well as the right fog lamp, directly under the front bumper, were directly damaged and crushed rearward. None of the case vehicle's tires were damaged, deflated, or physically restricted. The case vehicle's front bumper fascia and grille sustained induced damage as a result of the direct contact with the pickup's trailer hitch. No other 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 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 four tethers, each with a width of 7 centimeters (2.8 inches). The driver's air bag had two vent ports, approximately 4 centimeters (1.6 inches) in diameter, located at the 10 and 2 o'clock positions. The deployed driver's air bag was round with a diameter of 68 centimeters (26.8 inches). An inspection of the driver's air bag fabric revealed very faint smudges in the left lower quadrant, one near the edge just below the 9 o'clock position and the other smudge just left of and below center toward the 7 o'clock position.

The front right passenger's air bag was located in the middle of the instrument panel. An inspection of the front right 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 designed without any tethers or vent ports. The deployed front right air bag was rectangular with a height of approximately 60 centimeters (23.6 inches) and a width of approximately 46 centimeters (18.1 inches). An inspection of the front right passenger's air bag fabric revealed significant contact readily apparent on the front and top surfaces of the air bag in the form of a large skin scuff. On the front surface, the scuff extended from just left-of-center to the top of the air bag. On the top surface, there was a small bloodstained area on the top of the air bag, again just left-of-center.

Inspection of the case vehicle's interior revealed that there was no other evidence of occupant contact on the interior surfaces of the case vehicle. In addition, there were no intrusions or glazing damage.

The 1993 Ford Tempo GL was a front wheel drive, two-door coupe (VIN: 1FAPP31X9PK-----). Based on the vehicle inspection, the CDC for the Tempo was determined to be: **12-FDEW-1 (0 degrees)**. Residual maximum crush was measured as 4 centimeters (1.6

inches) at C_1 and C_6 . The WinSMASH reconstruction program, damage only algorithm, was used on the Tempo's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 14.0 km.p.h. (8.6 m.p.h.), -14.0 (-8.6 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The Tempo was towed from the scene but not due to damage.

The 1998 Ford F-150 was a one-quarter ton, 4x4, four wheel drive, two-door, extended cab pickup truck (VIN: 1FTRX08L5WK-----). The pickup was equipped with front wheel, anti-lock brakes. Based on available on-scene photographs, the CDC for the Ford pickup was estimated as: **06-BCEN-1 (180 degrees)**. The WinSMASH reconstruction program, missing vehicle algorithm was used on the pickup's highest severity impact. The Total, Longitudinal, and Lateral Delta V's are, respectively: 8.0 km.p.h. (5.0 m.p.h.), +8.0 km.p.h. (+5.0 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). It should be noted that, according to the interviews with the responding police officers and the on-scene photography, the only contact to the pickup involved its rear trailer "ball-type" hitch that was connected to the back. The pickup was driven from the scene.

Immediately prior to the crash the case vehicle's front right passenger [137 centimeters and 25 kilograms (54 inches and 55 pounds)] was seated in an upright posture with her back against the seat back, her feet dangling over the front edge of the seat's cushion angled downward, and her hands were in her lap, clutching an unknown object. Her seat track was located between its middle and forward-most positions, and the seat back was slightly reclined. Furthermore, the front edge of seat cushion was 51 centimeters (20.1 inches) forward of the right "B"-Pillar.

The case vehicle's front right passenger (i.e., the driver's daughter) was restrained by her available, active, three point, lap-and-shoulder, safety belt system. However, given this occupant's height, it is likely that the shoulder belt portion of the belt system did not fit snugly across this occupant's right shoulder. Furthermore, the front right seat had the upper anchorage adjuster located in the upmost position. The inspection of the front right passenger's seat belt webbing, latch plate, and "D"-Ring showed light evidence of loading and signs of bodily fluid on the lap belt portion of the webbing. In addition, it should be noted that the distance between air bag's excursion and the seat back was only 19 centimeters (7.5 inches).

The case vehicle was stopped, and the case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the use of her available safety belts, the front right passenger's pre-impact body position did not change just prior to the initial back impact. The case vehicle's impact by the Tempo caused the front right passenger to move directly backwards and most likely slightly upwards, loading her seat back. The front right passenger then rebounded and moved directly forward, loading the lap portion of her safety belt. Whether she also loaded the torso portion of her safety belt or, more likely, slipped out from underneath it, is unknown. The case vehicle impacted the Ford pickup, most likely causing this occupant to move slightly upwards while jackknifing over the lap portion of her safety belt and enabling her head to move forward and slightly downward where it was struck by the deploying air bag. The deploying front right passenger air bag most likely hyper-extended this occupant's neck and knocked her backwards into her seat back. This occupant's exact posture at final rest is unknown, but based on the physical evidence she was most likely slumped to the left with her head on or near the center console.

The right front passenger was transported by helicopter to a trauma center. She sustained critical injuries and was pronounced brain dead approximately 7 hours post-crash; however, organ harvesting services were requested approximately 1 hour and 45 minutes post-crash. According to the driver's interview and her medical records, the injuries sustained by the front right passenger included: a critical nonanatomic brain injury; a clinical basilar skull fracture; an atlanto-occipital dislocation (and probable spinal cord injury); abrasions to her eyes, whole face, neck, superior chest, and bilateral arms; contusions to her whole face, neck, superior chest, left shoulder, bilateral arms, and right upper thigh; and superficial lacerations to her nose and both cheeks. This occupant's primary brain, skull, and cervical injuries were caused by her contact with the case vehicle's front right passenger air bag.

The case vehicle's driver [25-year-old, White (non-Hispanic) female; 168 centimeters and 50 kilograms (66 inches, 110 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, her left hand on the steering wheel (i.e., unknown position), and her right arm extended laterally to the right, attempting to restrain the front right passenger. Her seat track was located between its center and forward-most positions with the seat back slightly reclined, and the tilt steering wheel was located in its down-most position. The front edge of the driver's seat cushion was positioned 51 centimeters (20.1 inches) forward of the left "B"-Pillar.

The case vehicle's driver was restrained by her available, active, three-point, lap-and-shoulder, safety belt system; however, there were no self-reported belt pattern bruising and/or abrasions to the driver's body, and the inspection of the driver's seat belt webbing, latch plate, and "D"-Ring showed no evidence of loading.

The driver accompanied the front right passenger to the trauma center but did not seek any medical treatment. She sustained minor injuries. Her self-reported injuries included an abrasion on the anterior surface of her right arm, from her biceps to her wrist, most likely caused by the passenger air bag as she was extending it to the right to restrain the front right occupant. In addition, she also had bruises under both eyes and a small abrasion on the anterior surface of her left arm above the elbow. The contusions and left arm abrasion most likely resulted from contact with her deploying air bag.

The case vehicle's back left passenger [3-year-old, white (non-Hispanic) female; 107 centimeters and 16 kilograms (42 inches, 35 pounds) was seated in an upright posture with her back against the seat back and her feet dangling 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 non-adjustable.

Based on the available evidence, interviews, and the Police Crash Report, the case vehicle's back left passenger was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. Once again, the inspection of the back left passenger's seat belt webbing and latch plate showed no evidence of loading. However, given the size (i.e., height and weight) of the occupant and the minor to low severity of the case vehicle's frontal impact, the lack of loading evidence is not unusual.

This occupant was also not transported to a medical facility but was, according to the driver, briefly “checked out” in the waiting room of the hospital which received her sister (i.e., the front right passenger). According to the driver’s interview and her medical records, she did not sustain any injuries from this crash.

According to the Police Crash Report, the Ford Tempo's driver [20-year-old, (unknown race and/or ethnic origin) female] was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The driver was not transported by ambulance to the hospital, and she did not sustain any injuries as a result of this crash.

According to the Police Crash Report, the Ford pickup's driver [55-year-old, (unknown race and/or ethnic origin) female] was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The driver was not transported by ambulance to the hospital, and she did not sustain any injuries as a result of this crash.

CRASH CIRCUMSTANCES

The case vehicle was stopped, heading east in the outside lane of a four-lane, divided, U.S. highway and intended to continue eastward (i.e., both the east and westbound roadways had two through lanes). The case vehicle was stopped behind several other eastbound vehicles at a traffic light that regulated a four-leg intersection. The Ford F-150 was also stopped, directly in front of the case vehicle. The Ford Tempo was traveling eastbound in the same lane of the same roadway and was approaching the line of stopped vehicles. The Tempo’s driver attempted to stop, depositing 10.3 meters (33.8 feet) of straight line skid marks prior to impact (**Figure 1**).

The driver of the case vehicle stated that she saw the Tempo approaching and thought about accelerating and steering to the right but did not take any evasive action. The crash occurred in the outside through lane of the eastbound roadway; see **CRASH DIAGRAM** at end.

The U.S. highway was straight and level (i.e., actual slope was 1.2%, negative to the east—in the case vehicle’s direction of travel), at the area of impact. The pavement was bituminous, but traveled, and the width of the outside eastbound lane was 3.5 meters (11.5 feet) and the inside eastbound lane was 3.9 meters (12.8 feet). The shoulders were improved (i.e., bituminous), and the south side of the eastbound road had a 2.5 meter (8.2 foot) paved shoulder prior to a W-beam guardrail and the north side had a 1.4 meter (4.6 foot) paved shoulder, prior to a W-beam guardrail. Each guardrail protected a supporting column for a railroad overpass. Pavement markings for the roadway consisted of a solid yellow edge line on the north side and a solid white edge line on south side. In addition, the through lanes were divided by a dashed white line (**Figure 1**). The estimated coefficient of friction was 0.70 for the case vehicle and the Ford pickup



Figure 1: Southward travel path of Ford pickup, case vehicle, and Ford Tempo in outside lane of southbound roadway, showing Tempo’s straight line, pre-crash skid marks (case photo #01)

but only 0.65 for the Ford Tempo. Traffic controls consisted of a regulatory **SPEED LIMIT** sign (MUTCD, R2-1), located west of the crash site, and on-colors, pre-timed, vertically mounted traffic control signals were located east of the area of the crash in the four-leg intersection that the vehicular traffic was stopped for. The posted speed limit was 80 km.p.h. (50 m.p.h.). At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the road pavement was dry. Traffic density is unknown, and the site of the crash was urban commercial.



Figure 2: Damage to case vehicle's back bumper from impact (1st event) by Tempo; Note: contour gauge present at bumper level (case photo #23)



Figure 3: Ford Tempo's frontal damage from impact (1st event) to back of case vehicle; Note: contour gauge present a bumper level (case photo #67)

The back of the case vehicle (**Figure 2**) was contacted by the front of the Tempo (**Figure 3**). As a result the case vehicle was pushed forward and the front of the case vehicle impacted the back of the pickup (**Figure 4**), causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. All three vehicles moved forward slightly in the outside eastbound lane from their respective points of impact and came to rest heading eastward in the outside through lane (**Figure 5** below).

CASE VEHICLE

The 1994 Volkswagen Jetta GL was a front wheel drive, five-passenger, four-door sedan (VIN: 3VWRA81H6RM-----) 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. The case vehicle's wheelbase was 274 centimeters (97.4 inches), and the odometer reading at inspection was 214,379 kilometers (133,209 miles).



Figure 4: On-scene view of final rest positions of case vehicle and Ford pickup (2nd event), showing rear-end impact configuration; Note: trailer hitch on pickup's back bumper damaged case vehicle's front (case photo #12)

Inspection of the vehicle’s interior revealed adjustable front bucket seats with adjustable head restraints; a non-adjustable back bench seat with folding backs and adjustable 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 exact position of any of the head restraints was not determined. The front seat belt systems were equipped with manually operated, upper anchorage adjusters for the “D”-rings. The driver had her upper anchorage adjuster located in the middle position and front right seat had the upper anchorage adjuster located in the upmost position. The vehicle was equipped with knee bolsters for both the driver and front right passenger, neither of which were deformed. 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 frontal air bags deployed as a result of the case vehicle’s frontal impact with the Ford pickup.



Figure 5: On-scene view from southern roadside of Ford Tempo, case vehicle (arrow), and Ford F-150 at final rest in outside lane of eastbound roadway (case photo #13)



Figure 6: Vertical view of case vehicle’s driver seating area showing deployed driver air bag and no apparent occupant contact evidence on steering wheel rim or greenhouse areas (case photo #36)



Figure 7: Vertical view of case vehicle’s front right passenger seating area showing deployed front right passenger air bag and underneath surface of air bag module’s cover flap; Note: no contact evidence on windshield’s glazing or on right “A”-pillar, sun visor, or roof (case photo #65)

Inspection of the case vehicle's interior revealed that there was no other evidence of occupant contact on the interior surfaces of the case vehicle, including the two front seat backs. Furthermore, there was no glazing damage (Figures 6 and 7 above). 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.

CASE VEHICLE DAMAGE

The case vehicle's contact with the Ford Tempo involved the majority of the back bumper (Figure 2 above). Direct damage began at the back right bumper corner and extended 134 centimeters (52.8 inches) leftward along the back bumper. Residual maximum crush was measured as 2 centimeters (0.8 inches) at C_6 (Figure 8). All measurements were taken at bumper level. The case vehicle's contact with the Ford pickup involved only the small portion of the front right bumper (Figures 9 and 10) which struck a trailer ball hitch on the back of the pickup (Figure 4 above). Direct damage began 18 centimeters (7.1 inches) from the front right bumper corner and extended leftward 18 centimeters (7.1 inches) along the bumper (Figure 9). The case vehicle's wheelbase was unaltered from the crash. The case vehicle's front and back bumper fascia as well as the right fog lamp, directly under the front bumper, were directly damaged and crushed rearward. None of the case vehicle's tires were damaged, deflated, or physically restricted. The case vehicle's front bumper fascia and grille sustained induced damage as a result of the direct contact with the pickup's trailer hitch. No other obvious induced damage or remote buckling was noted to the remainder of the case vehicle's exterior.

Based on vehicle inspection, the CDCs for the case vehicle were determined to be: **06-BDEW-1 (180 degrees)** for its initial impact, and

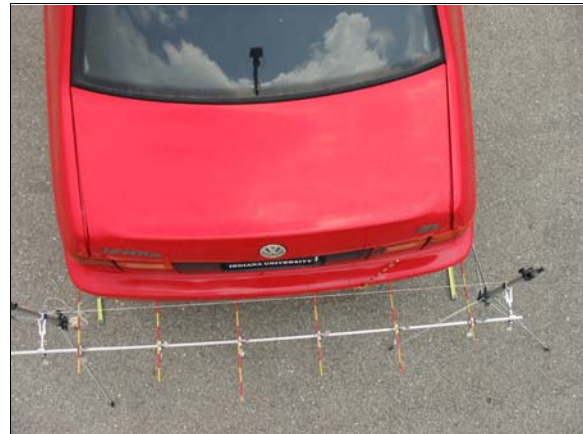


Figure 8: Overhead view of case vehicle's back damage from impact with Ford Tempo (1st event) with contour gauge positioned at bumper level (case photo #26)



Figure 9: Case vehicle's frontal damage with contour gauge present at bumper level; Note: arrow indicates impact location of pickup's trailer hitch (case photo #15)

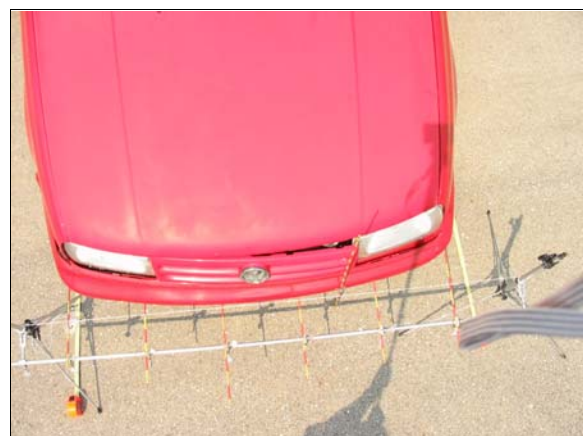


Figure 10: Overhead view of case vehicle's frontal damage from impact with Ford F-150 (2nd event) with contour gauge positioned at bumper level (case photo #14)

12-FREN-1 (0 degrees) for its second (deployment) impact. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's first impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 13.0 km.p.h. (8.1 m.p.h.), +13.0 km.p.h. (+8.1 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The WinSMASH reconstruction program, missing vehicle algorithm, was used on the case vehicle's second impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 13.0 km.p.h. (8.1 m.p.h.), -13.0 km.p.h. (-8.1 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). Based on this contractor's experience, the two separate Delta V results are reasonable, given the modest amounts of crush that the case vehicle sustained in each of its impacts. However, it must be noted that the presence of the Ford pickup's trailer hitch qualifies the pickup as an "altered" vehicle for the purposes of the crash reconstruction program, but what effect the hitch had on the reported Delta Vs is unclear. The case vehicle was towed from the scene but not due to damage.

AUTOMATIC RESTRAINT SYSTEM

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 frontal air bags deployed as a result of the frontal impact with the Ford pickup. The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of symmetrical "H"-configuration cover flaps made of thick vinyl with overall dimensions of 16.5 centimeters (6.5 inches) at the horizontal seam and 6 centimeters (2.8 inches) vertically for both the upper and lower flaps. 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 driver's air bag was designed with four tethers, each with a width of 7 centimeters (2.8 inches). The driver's air bag had two vent ports, approximately 4 centimeters (1.6 inches) in diameter, located at the 10 and 2 o'clock positions. The deployed driver's air bag was round with a diameter of 68 centimeters (26.8 inches). An inspection of the driver's air bag fabric revealed very faint smudges in the left lower quadrant, one near the edge just below the 9 o'clock position and the other smudge just left of and below center toward the 7 o'clock position (**Figure 11**). The distance between the mid-center of the driver's seat back, as positioned at the time of the vehicle inspection, and the front surface of the air bag's fabric at full excursion was 30 centimeters (11.8 inches).



Figure 11: Case vehicle's deployed driver air bag showing faint smudges (i.e., yellow tape); Note: steering wheel has been rotated approximately 170 degrees clockwise (case photo #46)

The front right passenger's air bag was located in the middle of the instrument panel. There were two asymmetrical, "H"-configuration, modular cover flaps made of a thin vinyl over a thick foam encased sheet metal frame/liner which acted as the hinge point for the deploying flaps. The flap's dimensions were 37 centimeters (14.6 inches) at the top and bottom horizontal seams, 8

centimeters (3.1 inches) vertically for the upper flap, and 10 centimeters (3.9 inches) vertically for the lower flap. The profile of the case vehicle's instrument panel was flush with the leading edge of the cover flap. An inspection of the front right 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 designed without any tethers or vent ports. The deployed front right air bag was rectangular with a height of approximately 60 centimeters (23.6 inches) and a width of approximately 46 centimeters (18.1 inches). An inspection of the front right passenger's air bag fabric revealed significant contact readily apparent on the front and top surfaces of the air bag in the form of a large skin scuff. On the front surface, the scuff extended from just left-of-center to the top of the air bag (**Figure 12**). On the top surface, there was a small bloodstained area on the top of the air bag, again just left-of-center (**Figure 13**). The distance between the mid-center of the front right seat back, as positioned at the time of the vehicle inspection, and the front surface of the air bag's fabric at full excursion was 19 centimeters (7.5 inches).



Figure 12: Case vehicle's deployed front right passenger air bag showing skin smudges in upper left quadrant of bag's front surface (case photo #53)



Figure 13: Top surface of case vehicle's deployed front right air bag; Note: blood and scuff marks (case photo #60)

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

Immediately prior to the crash the case vehicle's front right passenger [7-year-old, White (non-Hispanic) female; 137 centimeters and 25 kilograms (54 inches and 55 pounds)] was seated in an upright posture with her back against the seat back, her feet dangling over the front edge of the seat's cushion angled downward, and her hands were in her lap, clutching an unknown object. Her seat track was located between its middle and forward-most positions, and the seat back was slightly reclined. Furthermore, the front edge of seat cushion was 51 centimeters (20.1 inches) forward of the right "B"-Pillar.

The case vehicle's front right passenger (i.e., the driver's daughter) was restrained by her available, active, three point, lap-and-shoulder, safety belt system. However, given this occupant's height, it is likely that the shoulder belt portion of the belt system did not fit snugly across this occupant's right shoulder. Furthermore, the front right seat had the upper anchorage adjuster located in the upmost position. The inspection of the front right passenger's seat belt

webbing, latch plate, and “D”-Ring showed light evidence of loading and signs of bodily fluid on the lap belt portion of the webbing (**Figure 14**).

The case vehicle was stopped, and the case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the use of her available safety belts, the front right passenger's pre-impact body position did not change just prior to the initial back impact. The case vehicle's impact by the Ford Tempo caused the front right passenger to move directly backwards and most likely slightly upwards, loading her seat back. The front right passenger then rebounded and moved directly forward, loading the lap portion of her safety belt. Whether she also loaded the torso portion of her safety belt or, more likely, slipped out from underneath it, is unknown. The case vehicle impacted the Ford pickup, most likely causing this occupant to move slightly upwards while jackknifing over the lap portion of her safety belt and enabling her head to move forward and slightly downward where it was struck by the deploying air bag. The deploying front right passenger air bag most likely hyper-extended this occupant's neck and knocked her backwards into her seat back. This occupant's exact posture at final rest is unknown, but based on the physical evidence she was most likely slumped to the left with her head on or near the center console (**Figures 15 and 16**).



Figure 14: Close-up of case vehicle's front right seat belt webbing showing wear marks and body fluids (case photo #44)



Figure 15: Overhead view of case vehicle's front right seat showing vomit and blood evidence on seat's cushion (case photo #40)



Figure 16: Overhead close-up view of case vehicle's parking brake lever and center console showing vomit on parking brake and vomit and blood evidence on center console (case photo #41)

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The right front passenger was transported by helicopter to a trauma center. She sustained critical injuries and was pronounced brain dead approximately 7 hours post-crash; however, organ harvesting services were requested approximately 1 hour and 45 minutes post-crash. According

to the driver's interview and her medical records, the injuries sustained by the front right passenger included: a critical nonanatomic brain injury; a clinical basilar skull fracture; an atlanto-occipital dislocation (and probable spinal cord injury); abrasions to her eyes, whole face, neck, superior chest, and bilateral arms; contusions to her whole face, neck, superior chest, left shoulder, bilateral arms, and right upper thigh; and superficial lacerations to her nose and both cheeks. This occupant's primary brain, skull, and cervical injuries were caused by her contact with the case vehicle's front right passenger air bag.

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, unresponsive to painful stimuli, flaccid, pupils fixed and dilated, GCS=3 with complications that include: neurogenic shock and brain death	160824.5 critical	Air bag, front right passenger's	Certain	Hospitalization records
2	Fracture ¹ basilar skull, not further specified as to location, with cerebrospinal fluid drainage	150204.3 serious	Air bag, front right passenger's	Probable	Hospitalization records
3	Dislocation, atlanto-occipital ² , with 1 cm (0.4 inch) separation {distraction} between occiput and C ₁ most likely spinal cord trauma	650208.2 moderate	Air bag, front right passenger's	Certain	Hospitalization records
4 5	Abrasions, periorbital, bilaterally	297202.1 297202.1 minor	Air bag, front right passenger's	Certain	Hospitalization records
6	Abrasions whole face, including right and left cheeks (i.e., under eyes), nose, and chin	290202.1 minor	Air bag, front right passenger's	Certain	Hospitalization records
7	Contusions whole face, including right and left cheeks, nose, and chin	290402.1 minor	Air bag, front right passenger's	Certain	Hospitalization records
8 9 10	Lacerations, superficial, below eyes bilaterally and over nose	290602.1 290602.1 290602.1 minor	Air bag, front right passenger's	Certain	Emergency room records

¹ This lesion was diagnosed clinically based upon the presence of cerebrospinal fluid coming from the nose (i.e., CSF rhinorrhea) and the likely (i.e., conflicting observations) presence of bloody fluid coming from this occupant's right ear (i.e., CSF otorrhea and/or hemotympanum). No imaging records substantiate this lesion, in part because the child's mother requested the cessation of medical intervention and, as a result, a planned CT scan of the brain was aborted.

² This lesion was described in the medical records as a "mortal lesion" and as "not compatible with life".

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
11	Abrasions neck with massive swelling of neck tissues	390202.1 minor	Air bag, front right passenger's	Certain	Hospitalization records
12	Abrasions superior chest with swelling	490202.1 minor	Air bag, front right passenger's	Certain	Hospitalization records
13	Contusions superior chest with swelling	490402.1 minor	Air bag, front right passenger's	Certain	Hospitalization records
14	Abrasions bilateral arms, not further specified	790202.1 minor	Air bag, front right passenger's	Certain	Hospitalization records
15	Contusions bilateral arms, not further specified	790402.1 minor	Air bag, front right passenger's	Certain	Hospitalization records
16	Contusions {ecchymoses} left shoulder with swelling	790402.1 minor	Air bag, front right passenger's	Certain	Emergency room records
17	Contusion {ecchymosis} right upper thigh	890402.1 minor	Lap portion of safety belt system	Possible	Emergency room records

CASE VEHICLE DRIVER KINEMATICS

The case vehicle's driver [25-year-old, White (non-Hispanic) female; 168 centimeters and 50 kilograms (66 inches, 110 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, her left hand on the steering wheel (i.e., unknown position), and her right arm extended laterally to the right, attempting to restrain the front right passenger. Her seat track was located between its center and forward-most positions with the seat back slightly reclined, and the tilt steering wheel was located in its down-most position. The front edge of the driver's seat cushion was positioned 51 centimeters (20.1 inches) forward of the left "B"-Pillar.

The case vehicle's driver was restrained by her available, active, three-point, lap-and-shoulder, safety belt system; however, there were no self-reported belt pattern bruising and/or abrasions to the driver's body, and the inspection of the driver's seat belt webbing, latch plate, and "D"-Ring showed no evidence of loading.

The case vehicle was stopped, and the case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the use of her available safety belts, the driver's pre-impact body position did not change just prior to the initial back impact. The case vehicle's impact by the Ford Tempo caused the driver to move directly backwards and possibly slightly upwards, loading her seat back. The driver then rebounded and moved directly forward, possibly coming into contact with her safety belts. The case vehicle impacted the Ford pickup, possibly causing this occupant to load her safety belts and enabling her to move forward where she was struck by her deploying air bag. The deploying driver air bag most likely contacted this

occupant's face and arms and knocked her backwards into her seat back. This occupant's exact posture at final rest is unknown, but she was able to exit the case vehicle under her own power.

CASE VEHICLE DRIVER INJURIES

The driver accompanied the front right passenger to the trauma center but did not seek any medical treatment. She sustained minor injuries. Her self-reported injuries included an abrasion on the anterior surface of her right arm, from her biceps to her wrist, most likely caused by the passenger air bag as she was extending it to the right to restrain the front right occupant. In addition, she also had bruises under both eyes and a small abrasion on the anterior surface of her left arm above the elbow. The contusions and left arm abrasion most likely resulted from contact with her deploying air bag.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1 2	Contusion {bruise} under both eyes, more severe under left eye [Aspect = left & right]	297402.1 297402.1 minor	Air bag, driver's	Certain	Interviewee (same person)
3	Abrasion, 5 cm (2 in) long, anterior left upper arm, above elbow	790202.1 minor	Air bag, driver's	Certain	Interviewee (same person)
4	Abrasions anterior {inside} right arm from shoulder to wrist	790202.1 minor	Air bag, front right passenger's	Certain	Interviewee (same person)

CASE VEHICLE BACK LEFT PASSENGER KINEMATICS

The case vehicle's back left passenger [3-year-old, white (non-Hispanic) female; 107 centimeters and 16 kilograms (42 inches, 35 pounds) was seated in an upright posture with her back against the seat back and her feet dangling 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 non-adjustable.

Based on the available evidence, interviews, and the Police Crash Report, the case vehicle's back left passenger was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. However, given this occupant's height, it is almost certain that the shoulder belt portion of the belt system did not fit snugly across this occupant's left shoulder. The inspection of the back left passenger's seat belt webbing and latch plate showed no evidence of loading. However, given the size (i.e., height and weight) of the occupant and the minor to low severity of the case vehicle's frontal impact, the lack of loading evidence is not unusual.

The case vehicle was stopped, and the case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the use of her available safety belts, the

back left passenger's pre-impact body position did not change just prior to the initial back impact. The case vehicle's impact by the Ford Tempo caused the back left passenger to move directly backwards and most likely slightly upwards, loading her seat back. The back left passenger then rebounded and moved directly forward, loading the lap portion of her safety belt. Whether she also loaded the torso portion of her safety belt or, more likely, slipped out from underneath it, is unknown. The case vehicle impacted the Ford pickup, most likely causing this occupant to move slightly upwards while jackknifing over the lap portion of her safety belt and enabling her head to move forward and slightly downward. There is no evidence that this occupant came into contact with the back surface of the driver's seat back. Given the location of the driver's seat track, it is questionable as to whether she could even reach the driver's seat back had she put her hands forward, attempting to brace herself against the seat back. As the case vehicle came to rest, this occupant most likely rebounded backwards into her seat back as a result of her safety belt usage. This occupant's exact posture at final rest is unknown, but she was able to exit the case vehicle with some assistance.

CASE VEHICLE BACK LEFT PASSENGER INJURIES

This occupant was also not transported to a medical facility but was, according to the driver, briefly "checked out" in the waiting room of the hospital which received her sister (i.e., the front right passenger). According to the driver's interview and her medical records, she did not sustain any injuries from this crash.

1ST OTHER VEHICLE

The 1993 Ford Tempo GL was a front wheel drive, five-passenger, two-door coupe (VIN: 1FAPP31X9PK-----) equipped with a 2.3L, I-4 engine and a three-speed automatic transmission. The case vehicle's wheelbase was 254 centimeters (99.9 inches), and the odometer reading at inspection is unknown because the Tempo's interior was not inspected.

The Ford Tempo's contact with the case vehicle involved the entire front. Direct damage began at the front left bumper corner and extended, a measured distance of 147 centimeters (57.9 inches), to the front right bumper corner. Residual maximum crush was measured as 4 centimeters (1.6 inches) at C₁ and C₆ (**Figure 3** above and **Figure 17**).



Figure 17: Overhead view of Ford Tempo's frontal damage from impact with case vehicle (1st event) with contour gauge positioned at bumper level (case photo #70)

Based on the vehicle inspection, the CDC for the Tempo was determined to be: **12-FDEW-1 (0 degrees)**. The WinSMASH reconstruction program, damage only algorithm, was used on the Tempo's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 14.0 km.p.h. (8.6 m.p.h.), -14.0 (-8.6 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The Tempo was towed from the scene but not due to damage.

According to the Police Crash Report, the Ford Tempo's driver [20-year-old, (unknown race and/or ethnic origin) female] was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The driver was not transported by ambulance to the hospital, and she did not sustain any injuries as a result of this crash.

2ND OTHER VEHICLE

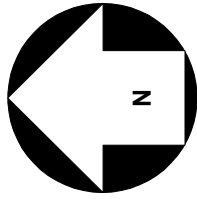
The 1998 Ford F-150 was a one-quarter ton, 4x4, five-passenger, four wheel drive, two-door, extended cab pickup truck (VIN: 1FTRX08L5WK-----) equipped with a 5.4L, V-8 engine and a four-speed automatic transmission. The pickup was equipped with front wheel, anti-lock brakes. The case vehicle's wheelbase was 353 centimeters (138.8 inches), and the odometer reading is unknown because the Ford pickup was not inspected.

Based on available on-scene photographs, the CDC for the Ford pickup was estimated as: **06-BCEN-1 (180 degrees)**. The WinSMASH reconstruction program, missing vehicle algorithm was used on the pickup's highest severity impact. The Total, Longitudinal, and Lateral Delta V's are, respectively: 8.0 km.p.h. (5.0 m.p.h.), +8.0 km.p.h. (+5.0 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). It should be noted that, according to the interviews with the responding police officers and the on-scene photography (**Figure 18**), the only contact to the pickup involved its rear trailer "ball-type" hitch that was connected to the back. The pickup was driven from the scene.



Figure 18: On-scene view of back of Ford pickup showing no obvious damage to back bumper but damage to trailer hitch (case photo #11a)

According to the Police Crash Report, the Ford pickup's driver [55-year-old, (unknown race and/or ethnic origin) female] was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The driver was not transported by ambulance to the hospital, and she did not sustain any injuries as a result of this crash.



IN-02-004

1 cm = 2.5 m

Straight; Level (i.e., actual grade at impact = 1.2% negative to East);
 Coefficient of Friction:
 CV/V3 = 0.70; V2 = 0.65;
 Daylight; Clear; Dry bituminous surface

*Final Rest positions approximated
 *CV = 1993 Volkswagen Jetta GL
 *V2 = 1993 Ford Tempo GL
 *V3 = 1998 Ford F-150, 4x4, Extd Cab

