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## ON-SITE AIR BAG INVESTIGATION

CASE NUMBER - IN99-078  
LOCATION - TEXAS  
VEHICLE - 1995 FORD MUSTANG  
CRASH DATE - December, 1998

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 1995 Ford Mustang (case vehicle) and an unknown year black Ford Ranger pickup truck (other vehicle). This crash is of special interest because the case vehicle's front right passenger (11-month-old female) who was improperly restrained in a forward facing child safety seat, sustained a critical spinal cord injury (i.e., quadriplegia) from her deploying front right passenger air bag. The case vehicle had been traveling in the outside through lane of a three-lane westbound roadway which was part of a divided, six-lane, state freeway, when the case vehicle entered an associated exit ramp in an Interchange area. The case vehicle was traveling west-northwest in the outside lane of the two-lane, exit ramp when the Ford pickup, which was traveling ahead of the case vehicle in the same outside lane, unexplainably came to a complete stop. The crash occurred in the Interchange area in the outside lane of the exit ramp. The front of the case vehicle impacted, and subsequently underrode the back of the Ford 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 in an upright posture in a convertible child safety seat, that was used in its forward facing configuration, and her seat track located in its rearmost position. The front right passenger was improperly restrained in her child safety seat and, in addition, the child safety seat was improperly secured by the available, active, three-point, lap-and-shoulder, safety belt system. She sustained, according to her medical records, critical injuries which included: a laceration of the spinal cord at C <sub>3</sub> -C <sub>4</sub> with dislocation and fracture at that level, compression of the brain stem, a critical nonanatomic brain injury, intraventricular and subarachnoid hemorrhages, and abrasions and contusions about her face and neck from the nose level downward. The case vehicle's driver (28-year-old female) was seated with her seat track located in its middle position, and the tilt steering wheel was located in its middle position. She was restrained by her available, active, three-point, lap-and-shoulder, safety belt system and, according to her interview, sustained no reported injuries but was treated the next day for soreness to her neck and back.					
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This on-site investigation was brought to NHTSA's attention on July 14, 1999 by an attorney representing the family of the front right passenger. This crash involved a 1995 Ford Mustang (case vehicle), and an unknown model year Ford Ranger pickup truck (other vehicle). The crash occurred in December, 1998, at 8:25 p.m., in Texas and was investigated by the applicable city police department. This crash is of special interest because the case vehicle's front right passenger [11-month-old, White (Hispanic) female] who was improperly restrained in a forward facing child safety seat, sustained a critical spinal cord injury (i.e., quadriplegia) from her deploying front right passenger air bag. This contractor inspected the scene and case vehicle on July 21, 1999. This contractor interviewed the driver for the case vehicle on July 27, 1999. This summary is based on the Police Crash Report, an interview with the case vehicle's driver, inspections of the scene and case vehicle, occupant kinematic principles, occupant medical records, and this contractor's evaluation of the evidence.

## SUMMARY

The case vehicle had been traveling in the outside through lane of a three-lane westbound roadway which was part of a divided, six-lane, state freeway, when the case vehicle entered an associated exit ramp in an Interchange area. The case vehicle was traveling west-northwest in the outside lane of the two-lane, exit ramp, intending on merging into the northbound roadway of an Interstate trafficway. The Ford pickup had also entered the exit ramp and was traveling ahead of the case vehicle in the outside lane when the Ford pickup unexplainably came to a complete stop. The case vehicle's driver braked, attempting to avoid the crash. The crash occurred in the Interchange area in the outside lane of the exit ramp; see **CRASH DIAGRAM** below.

The front of the case vehicle impacted, and subsequently underrode the back of the Ford pickup, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle came to rest heading west-northwest in the outside lane of the interchange ramp. The driver of the Ford pickup drove from the scene without rendering assistance or exchanging information.

The 1995 Ford Mustang was a rear wheel drive, two-door coupe (VIN: 1FALP4046SF-----). The case vehicle was equipped with four-wheel, anti-lock brakes. Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **12-FDEW-2 (0 degrees)**. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 19.6 km.p.h. (12.2 m.p.h.), -19.6 km.p.h. (-12.2 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The case vehicle was towed due to damage.

The case vehicle's contact with the Ford pickup involved the entire front end. Based on the damage pattern on the case vehicle, the case vehicle's front bumper underrode the Ford pickup's back bumper, and the majority of the case vehicle's damage occurred above the bumper as a result of the underide type impact. Direct damage began at the front left bumper corner and extended, a measured distance of 154 centimeters (60.6 inches), from bumper corner to bumper corner. Actual maximum deformation occurred above the bumper at C<sub>1</sub> and was 38 centimeters (15.0

inches). Maximum residual crush also occurred above the bumper and was 24 centimeters (9.4 inches) at C<sub>3</sub> and C<sub>4</sub>. Maximum average residual crush was 13 centimeters (5.1 inches) at C<sub>3</sub> and C<sub>4</sub>. The case vehicle's wheelbases were not shortened. The case vehicle's front bumper fascia, grille, hood, radiator, right and left headlight and turn signal assemblies, and both the right and left fenders were directly damaged and crushed rearward. The fiberglass hood had been partially torn away, exposing the inner hood structure, and was not available to be viewed. None of the case vehicle's tires were physically restricted or deflated. Both the right and left fenders sustained induced damage as well and the left fender was pushed rearwards partially obstructing the opening of the driver's door.

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 three tethers, each 8 centimeters (3.1 inches) in width and sewn interiorly to the bag's center at the 12, 8 and 4 o'clock positions. 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 clock positions. The deployed driver's air bag was round with a diameter of 63 centimeters (24.8 inches). There was no contact (i.e., skin or blood) evidence readily apparent on the driver's air bag; although, there was an unknown fluid stain, measuring 21 x 23 centimeters (8.3 x 9.1 inches), located on the right upper quadrant of the air bag's fabric.

The front right passenger's air bag module 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 cover flaps; however, there were several small snags to the top portion of the air bag. The front right passenger's air bag was designed without any tethers. The front right air bag had one vent port, approximately 5 centimeters (2.0 inches) in diameter, located near the 10 o'clock position along the left edge of the front surface. The deployed front right air bag was rectangular with a height of approximately 53 centimeters (20.9 inches) and a width of approximately 83 centimeters (32.7 inches). The forward-most edge of the air bag's top surface extended 61 centimeters (24.0 inches) rearwards towards the front right passenger seat. When completely extended rearwards, the air bag's fabric could touch the seat back of the forward facing child safety seat that was used in the front right seating position. The distance from the cover flaps in the instrument panel to the forward-most part of the forward facing child safety seat's pullover shield was only 40 centimeters (15.7 inches). An inspection of the front right passenger air bag revealed contact evidence readily apparent (e.g., an area of oil/skin transfer) on the top and front surfaces of air bag. In addition, there was a blue cloth transfer from the bag's interaction with the child safety seat located on the top surface of the air bag towards the front right edge.

The front right passenger was seated in a convertible child safety seat that was used in its forward facing configuration. The child safety seat was manufactured by Evenflo, on July 20, 1998, and was identified by Model name "Ultara I" and Model number **235115 P1**. The convertible seat was designed with a three-point harness connected to a pullover shield which buckled between the toddler's legs. The seat was also equipped with a three position recline

mechanism and a three position pullover shield. The child seat was in the upright position, and the shield was in the middle position.

The convertible child safety seat consisted of a plastic one-piece shell and pullover shield. The shell had a cloth covered foam padding on the back support, the seating portion, and the pullover shield portion. The foam provided a soft surface for the child. A close inspection of the child safety seat revealed no apparent damage or fractures to the tilt base, shell, or shield. There were two yellow warning labels—one on each side of the shell, warning the user parent to not place this child seat in a vehicle's front right seat when the vehicle is equipped with a front right passenger air bag. The warning labels were bright yellow with black writing, advising that serious injury or death could occur if an air bag inflated against this child restraint. In addition, this yellow label advised that the seat should be placed in the rear facing position when the child weighted less than 9 kilograms (20 pounds). This yellow warning label was dated 11/96. There was also a manufacturers label affixed to the left side (inboard) giving the child seat's height and weight limitations [i.e., approximately 2.3 - 18 kilograms and 48-102 centimeters (5-40 pounds, 19-40 inches)]. This label's date had been torn off.

Another manufacturers label was affixed to the right side (i.e., outboard side when used in the forward facing position) of the child safety seat which illustrated the proper way to install the vehicle's safety belts when the child safety seat is in a rear center seat or front passenger seat. The warning continues to explain the importance of securing the child restraint with a vehicle's safety belt as specified in the vehicle manufacturer's instructions. The manufacturer's instructions for this child safety seat were not available on the back of the seat at the time of this contractor's inspection.

Inspection of the case vehicle's interior revealed contact evidence on the driver's knee bolster to the left side of the steering wheel. In addition, the rearview mirror had been contacted most likely by the deploying front right air bag and rotated into the windshield cracking the glazing towards the driver's side.

The Ford pickup is either a rear or four-wheel drive, unknown model year, Ford Ranger pickup (VIN: Unknown). The driver of the Ford pickup drove from the scene without rendering assistance or exchanging information. Because the Ford pickup fled the scene, its CDC is unknown. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the Ford pickup's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 20.8 km.p.h. (12.9 m.p.h.), +20.8 km.p.h. (+12.9 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.).

Immediately prior to the crash the case vehicle's front right passenger [11-month-old, White (Hispanic) female; 76 centimeters and 12 kilograms (30 inches, 27 pounds)] was seated in an upright posture in a convertible child safety seat, that was used in its forward facing configuration, with her back against the child safety seat's back, her feet hanging down, and both hands resting atop the shield portion of the child safety seat. Her seat track was located in its rearmost position, and the seat back was upright and flush with the seat back of the child safety seat. Upright means

that the seat back was located at a measured angle of 21.5 degrees rearward of perpendicular to the case vehicle's floor.

The case vehicle's front right passenger was improperly restrained in her forward facing child safety seat and, in addition, the child safety seat was improperly secured by the available, active, three-point, lap-and-shoulder, safety belt system. The child safety seat was being used improperly at the time of the crash because, when used as a forward facing child safety seat, the shoulder straps should be slotted through the uppermost slots. The lower slots are only used when the convertible child seat is being used in the rearward facing configuration. In addition, the three-point harness attached to the child safety seat showed no conclusive evidence of loading. According to the case vehicle's driver, the child safety seat was positioned in the front right seat with the seat track in the full rearward position because it did not fit in either of the two rear seat positions.

The front right child passenger's child seat was improperly secured. The case vehicle's seat belt system (i.e., a manual, continuous loop, three-point, lap-and-shoulder, safety belt system) had a switchable retractor which, at the time of the crash, was in the Emergency Locking Retractor (ELR) mode instead of the proper Automatic Locking Retractor (ALR) mode as it should have been when used to secure a child safety seat. In the ELR mode, the belts lock up through inertia and braking ("g"-loads). The ELR mode allows for some "spooling out" of the webbing and the possibility of the child safety seat tipping forward. To switch into the ALR mode, the belt webbing is extended completely out the retractor, buckled, and then slowly released back into the retractor housing. The ALR mode eliminates the slack, and the retractor remains in the locked position. Once the safety belt is completely released into the housing it returns to the ELR mode. The inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no conclusive evidence of loading.

The case vehicle's driver braked, attempting to avoid the crash. As a result of this attempted avoidance maneuver and independent of the use of the front right passenger's available safety belt systems, the front right passenger most likely moved slightly forward just prior to impact. The case vehicle's impact with the Ford pickup enabled the front right passenger's momentum to continue forward and slightly upward as the case vehicle decelerated and prior to the improperly positioned child safety seat harness restraining her.

As mention above, the case vehicle's front right passenger air bag was designed without any tethers. Because of the untethered bag's rearward excursion [73 centimeters (28.4 inches ) from instrument panel], the front right passenger was contacted across the lower half of her face, primarily to the right side. As a result, her head was accelerated upward and her torso rearward into the back of her child safety seat. Based on previously investigated SCI crashes, the facial injury pattern sustained by the case vehicle's front right child passenger is a strong indication that the forward facing child safety seat remained upright (vertical) and did not tip forward. At final rest the front right passenger remained in the child safety seat, slumped to the side (unknown), with her arms still over the top of the safety seat's shield.

The front right occupant was transported by ambulance to the hospital. She sustained critical injuries and was hospitalized for at least 143 days post-crash (i.e., including 68 days in a children's hospital and the remainder in a pediatric long-term care facility in ventilator-dependency). Based on her medical records, the injuries sustained by the case vehicle's front right passenger included: a laceration of the spinal cord at C<sub>3</sub>-C<sub>4</sub> with dislocation and fracture at that level, compression of the brain stem, a critical nonanatomic brain injury, intraventricular and subarachnoid hemorrhages, and abrasions and contusions about her face and neck from the nose level downward.

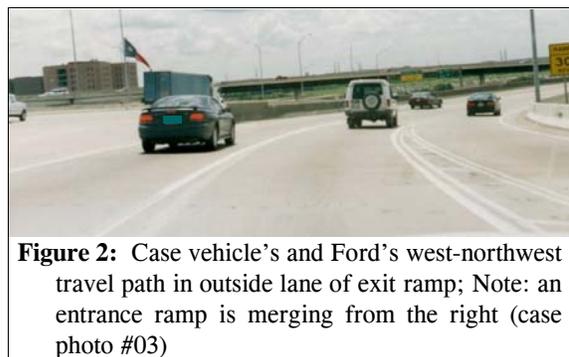
The case vehicle's driver [28-year-old, White (Hispanic) female; 165 centimeters and 79 kilograms (65 inches, 175 pounds)] was seated in a slightly reclined posture with her back against the seat back, her left foot on the clutch, her right foot on the brake, and both hands on the steering wheel. Her seat track was located in its middle position, and the tilt steering wheel was located in its middle position.

The case vehicle's driver was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The driver was transported by ambulance only for the purpose of accompanying her daughter to the hospital. She sustained no reported injuries but was treated the next day for soreness to her neck and back.

### CRASH CIRCUMSTANCES

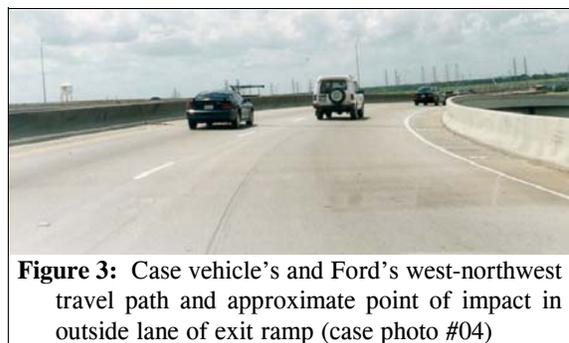


**Figure 1:** Case vehicle's and Ford's westward travel path in outside lane of exit ramp (case photo #01)



**Figure 2:** Case vehicle's and Ford's west-northwest travel path in outside lane of exit ramp; Note: an entrance ramp is merging from the right (case photo #03)

The case vehicle had been traveling in the outside through lane of a three-lane westbound roadway which was part of a divided, six-lane, state freeway, when the case vehicle entered an associated exit ramp in an Interchange area (**Figure 1**). The case vehicle was traveling west-northwest in the outside lane of the two-lane, exit ramp (**Figure 2**), intending on merging into the northbound roadway of an Interstate trafficway. The Ford pickup had also entered the exit ramp and was traveling ahead of the case vehicle in the outside lane when the Ford pickup unexplainably came to a complete stop. The case vehicle's driver braked, attempting to avoid the crash. The crash occurred in the Interchange area in the outside lane of the exit ramp (**Figure 3**); see **CRASH DIAGRAM** below.



**Figure 3:** Case vehicle's and Ford's west-northwest travel path and approximate point of impact in outside lane of exit ramp (case photo #04)

The two-lane, one-way, exit ramp of the state freeway was curved to the right for west-to-northbound traffic and had an approximate 2% grade negative to the northwest at the area of impact (i.e., a downgrade in the case vehicle's direction of travel). The pavement was concrete, and the width of the outside travel lane for both vehicles is unknown. The shoulders were improved (i.e., concrete), with a 1.2 meter (4 foot) wide shoulder adjacent to the respective concrete longitudinal barriers on both the northeast and southwest sides of the ramp roadway that protected each roadside. Pavement markings consisted of a single broken white lane line that separated the two west-to-northbound traffic lanes. In addition, the roadway was bordered by a solid yellow edge line on the left-hand side and a solid white edge line on right-hand side. The estimated coefficient of friction was 0.85. A warning advisory **RAMP** speed limit sign (MUTCD, W13-3) was located prior to crash site (**Figure 2** above). The speed limit was 80 km.p.h. (50 m.p.h.). At the time of the crash the light condition was dark, but illuminated by overhead street lamps at the area of impact, the atmospheric condition was clear, and the road pavement was dry. Traffic density was heavy, and the site of the crash was urban commercial.

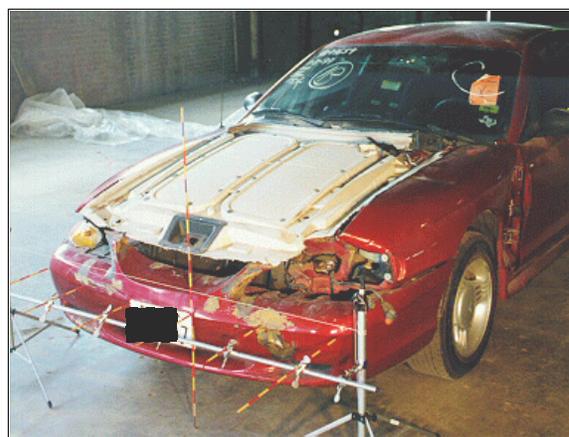


**Figure 4:** Elevated view of case vehicle's front under-ride damage with contour gauge at bumper level; Note: exposed inner hood structure and damaged headlight and turn signal assemblies (case photo #05)

The front (**Figure 4**) of the case vehicle impacted, and subsequently underrode (**Figure 5**) the back of the Ford pickup, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle came to rest heading west-northwest in the outside lane of the interchange ramp. The driver of the Ford pickup drove from the scene without rendering assistance or exchanging information.

#### CASE VEHICLE

The 1995 Ford Mustang was a rear wheel drive, four-passenger, two-door coupe (VIN: 1FALP4046SF-----) equipped with a 3.8L, V-6 engine and a five-speed manual transmission. Braking was achieved by a power-assisted, four-wheel, anti-lock system. The case vehicle's wheelbase was 257 centimeters (101.3 inches), and the odometer reading at inspection was 185,210 kilometers (115,084 miles).



**Figure 5:** Case vehicle's frontal damage viewed from left of center showing under-ride damage pattern; Note: contour gauge at bumper level (case photo #07)

Inspection of the vehicle's interior revealed adjustable front bucket seats with adjustable head restraints; a non-adjustable back bench seat with separate backs but without head restraints for the

back outboard seating positions; and continuous loop, three-point, lap-and-shoulder, safety belt systems at the front and back outboard positions. The front seat belt systems were not equipped with manually operated height adjusters for the “D”-rings. The vehicle was equipped with knee bolsters for both the driver and front right passenger but only the driver’s knee bolster was scuffed and 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.

### CASE VEHICLE DAMAGE

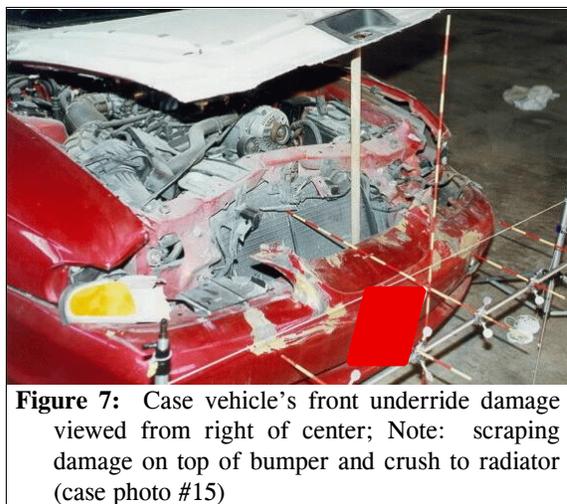
The case vehicle’s contact with the Ford pickup involved the entire front end (**Figures 4 and 5** above). Based on the damage pattern on the case vehicle, the case vehicle’s front bumper underrode the Ford pickup’s back bumper, and the majority of the case vehicle’s damage occurred above the bumper as a result of the underride type impact (**Figures 6 and 7**).

Direct damage began at the front left bumper corner and extended, a measured distance of 154 centimeters (60.6 inches), from bumper corner to bumper corner. The most severe crush occurred above bumper to the center (i.e., radiator area) of the case vehicle (**Figure 7**). Actual maximum deformation occurred above the bumper at C<sub>1</sub> and was 38 centimeters (15.0 inches). Maximum residual crush also occurred above the bumper and was 24 centimeters (9.4 inches) at C<sub>3</sub> and C<sub>4</sub>. Maximum average residual crush was 13 centimeters (5.1 inches) at C<sub>3</sub> and C<sub>4</sub>. The case vehicle’s wheelbase was unaltered from the crash. The case vehicle’s front bumper fascia, grille, hood, radiator, right and left headlight and turn signal assemblies, and both the right and left fenders were directly damaged and crushed rearward. The fiberglass hood had been partially torn away, exposing the inner hood structure, and was not available to be viewed. None of the case vehicle’s tires were physically restricted or deflated. Both the right and left fenders sustained induced damage as well and the left fender was pushed rearwards partially obstructing the opening of the driver’s door.

Inspection of the case vehicle’s interior revealed contact evidence on the driver’s knee bolster to the left side of the steering wheel (**Figure 8** below). In addition, the rearview mirror



**Figure 6:** Reference line view from left of case vehicle’s front underride damage; Note: contour gauge shows above bumper damage (case photo #09)



**Figure 7:** Case vehicle’s front underride damage viewed from right of center; Note: scraping damage on top of bumper and crush to radiator (case photo #15)

had been contacted most likely by the deploying front right air bag and rotated into the windshield cracking the glazing towards the driver's side. The energy absorbing steering column showed no evidence of compression. The interior inspection showed no evidence of intrusion.

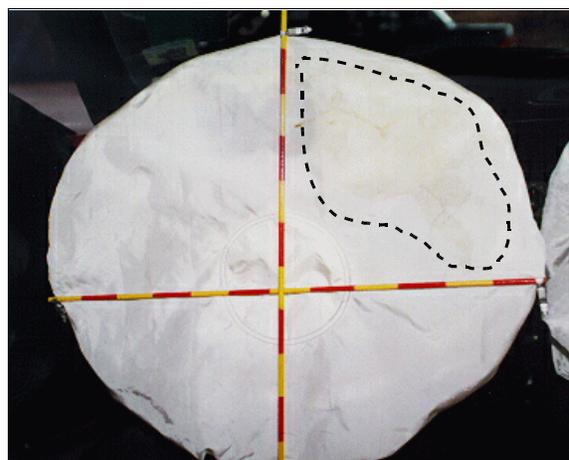
Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **12-FDEW-2 (0 degrees)**. Because the damage on the case vehicle was primarily above the bumper and produced an underride impact pattern, this underride type damage resulted in the air bag deploying late during the sequence 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 WinSMASH reconstruction program, missing vehicle algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 19.6 km.p.h. (12.2 m.p.h.), -19.6 km.p.h. (-12.2 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The case vehicle was towed 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 air bags deployed as a result of the front underride impact with the Ford pickup. The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of asymmetrical, essentially, "H"-configuration cover flaps made of thick vinyl. The top cover flap was hexagonal, except that two of the top sides were "S-curve"-shaped with overall dimensions of 15 centimeters (5.9 inches) at the bottom horizontal seam, and 8 centimeters (3.1 inches) vertically. The bottom cover flap was trapezoidal with overall dimensions of 14 centimeters (5.5 inches) at the top horizontal seam and 4 centimeters (1.6 inches) vertically. 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 three tethers, each 8 centimeters (3.1 inches) in width and sewn interiorly to the bag's center at the 12, 8 and 4 o'clock positions. 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 clock positions. The deployed



**Figure 8:** Case vehicle's driver seating area showing deployed driver air bag and contact evidence on driver's knee bolster, left of the steering column (case photo #20)



**Figure 9:** Case vehicle's deployed driver air bag with highlighted fluid stain of unknown origin (case photo #23)

driver's air bag was round with a diameter of 63 centimeters (24.8 inches). There was no contact (i.e., skin or blood) evidence readily apparent on the driver's air bag; although, there was an unknown fluid stain, measuring 21 x 23 centimeters (8.3 x 9.1 inches), located on the right upper quadrant of the air bag's fabric (**Figure 9** above).

The front right passenger's air bag module was located in the middle of the instrument panel. There were two asymmetrical modular cover flaps made of a thick vinyl over a thick cardboard type frame (**Figure 10**). The upper flap was shaped like a quarter-moon and the flap's dimensions were 48 centimeters (18.9 inches) at the lower horizontal seam and 7.5 centimeters (3.0 inches) at the middle ordinate. The lower flap was trapezoidal and the flap's dimensions were: 48 centimeters (18.9 inches) at the top horizontal seam, 51 centimeters (20.1 inches) at the bottom horizontal seam, and 7.5 centimeters (3.0 inches) vertically between the seams. The profile of the case vehicle's instrument panel resulted in a 5 centimeter (2.0 inch) setback of the leading edge of the cover flap relative to the protruding right instrument panel.



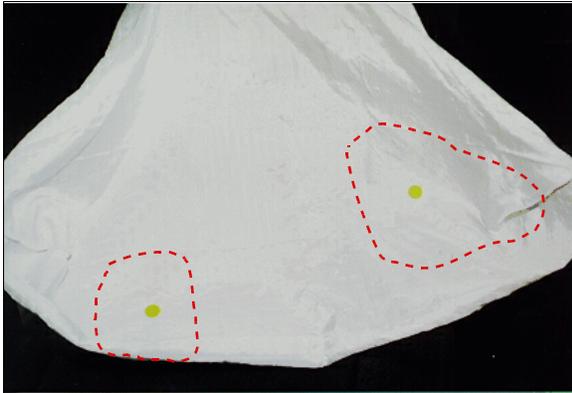
**Figure 10:** Case vehicle front right passenger air bag module's irregularly shaped cover flaps (case photo #36)

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 cover flaps; however, there were several small snags to the top portion of the air bag. The front right passenger's air bag was designed without any tethers, but it had one vent port which was approximately 5 centimeters (2.0 inches) in diameter near the 10 o'clock position along the left edge of the front surface of the air bag. The deployed front right air bag was rectangular with a height of approximately 53 centimeters (20.9 inches) and a width of approximately 83 centimeters (32.7 inches). The forward-most edge of the air bag's top surface extended 61 centimeters (24.0 inches) rearwards towards the front right passenger seat. When completely extended rearwards, the air bag's fabric could touch the seat back of the forward facing child safety seat that was used in the front right seating position (**Figure 11**). The distance from the cover flaps in the instrument panel to the forward-most part of the forward facing child safety seat's pullover shield was only 40 centimeters (15.7 inches). An inspection of the front right passenger air bag revealed contact evidence readily apparent (e.g., an area of oil/skin transfer) on the top and front surfaces of air bag (**Figures 12 and 13** below). In addition, there was a blue cloth transfer from the bag's interaction

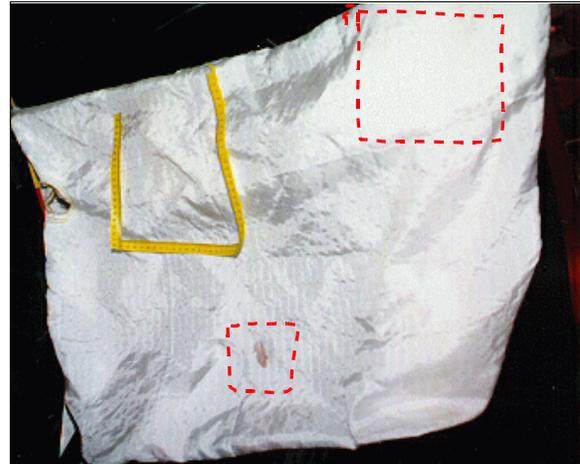


**Figure 11:** Case vehicle's outstretched, untethered, front right passenger air bag; Note: air bag's rearward excursion is capable of touching the seat back of this convertible, forward facing configured, child safety seat (case photo #34)

with the child safety seat located on the top surface of the air bag towards the front right edge (Figure 12).



**Figure 12:** Skin transfer (left) and blue cloth transfer (right) on top surface of the case vehicle's front right passenger air bag (case photo #28)



**Figure 13:** Front surface of case vehicle's front right passenger air bag showing two skin transfers along top and a blood smear toward bottom center portion of air bag (case photo #27)

### CHILD SAFETY SEAT

The front right passenger was seated in a convertible child safety seat that was used in its forward facing configuration (Figure 14). The child safety seat was manufactured by Evenflo, on July 20, 1998, and was identified by Model name "Ultara I" and Model number **235115 P1**. The convertible seat was designed with a three-point harness connected to a pullover shield which buckled between the toddler's legs. The seat was also equipped with a three position recline mechanism and a three position pullover shield. The child seat was in the upright position, and the shield was in the middle position.

The convertible child safety seat consisted of a plastic one-piece shell and pullover shield. The shell had a cloth covered foam padding on the back support, the seating portion, and the pullover shield portion. The foam provided a soft surface for the child. A close inspection of the child safety seat revealed no apparent damage or fractures to the tilt base, shell, or shield. There were two yellow warning labels—one on each side of the shell, warning the user parent to not place this child seat in a vehicle's front right seat when the vehicle is equipped with a front right passenger air bag. The warning labels were bright yellow with black writing, advising that serious



**Figure 14:** Front of case vehicle's undamaged Evenflo "Ultara I" convertible child safety seat; Note: harness straps improperly located when seat used in forward facing mode (case photo #40)

injury or death could occur if an air bag inflated against this child restraint. In addition, this yellow label advised that the seat should be placed in the rear facing position when the child weighted less than 9 kilograms (20 pounds). This yellow warning label was dated 11/96. There was also a manufacturers label affixed to the left side (inboard) giving the child seat's height and weight limitations [i.e., approximately 2.3 - 18 kilograms and 48-102 centimeters (5-40 pounds, 19-40 inches)]. This label's date had been torn off.

Another manufacturers label was affixed to the right side (i.e., outboard side when used in the forward facing position) of the child safety seat which illustrated the proper way to install the vehicle's safety belts when the child safety seat is in a rear center seat or front passenger seat. The warning continues to explain the importance of securing the child restraint with a vehicle's safety belt as specified in the vehicle manufacturer's instructions. The manufacturer's instructions for this child safety seat were not available on the back of the seat at the time of this contractor's inspection.

The NHTSA recommends that a child have a weight of 9 kilograms (20 pounds) or greater and be one year of age to be placed in a forward facing child safety seat. Thus, this child should have been in a rear facing child safety seat because the child was less than one year old. The convertible child safety seat which contained this child was not designed to handle a child over 9 kilograms (20 pounds) in a rear facing configuration. Therefore, the ideal situation would have this child in a rear facing seat that was designed to handle a child of this weight and the child seat secured in the back seat of this vehicle. In essence, the child seat used in this crash could not properly provide the needed occupant protection.

#### **CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS**

Immediately prior to the crash the case vehicle's front right passenger [11-month-old, White (Hispanic) female; 76 centimeters and 12 kilograms (30 inches, 27 pounds)] was seated in an upright posture in a convertible child safety seat, that was used in its forward facing configuration, with her back against the child safety seat's back, her feet hanging down, and both hands resting atop the shield portion of the child safety seat. Her seat track was located in its rearmost position, and the seat back was upright and flush with the seat back of the child safety seat. Upright means that the seat back was located at a measured angle of 21.5 degrees rearward of perpendicular to the case vehicle's floor.

The case vehicle's front right passenger was improperly restrained in her forward facing child safety seat and, in addition, the child safety seat was improperly secured by the available, active, three-point, lap-and-shoulder, safety belt system. The child safety seat was being used improperly at the time of the crash because, when used as a forward facing child safety seat, the shoulder straps should be slotted through the uppermost slots. The lower slots are only used when the convertible child seat is being used in the rearward facing configuration (**Figure 14** above). In addition, the three-point harness attached to the child safety seat showed no conclusive evidence of loading. According to the case vehicle's driver, the child safety seat was positioned in the front right seat with the seat track in the full rearward position because it did not fit in either of the two rear seat positions.

The front right child passenger's child seat was improperly secured. The case vehicle's seat belt system (i.e., a manual, continuous loop, three-point, lap-and-shoulder, safety belt system) had a switchable retractor which, at the time of the crash, was in the Emergency Locking Retractor (ELR) mode instead of the proper Automatic Locking Retractor (ALR) mode as it should have been when used to secure a child safety seat. In the ELR mode, the belts lock up through inertia and braking ("g"-loads). The ELR mode allows for some "spooling out" of the webbing and the possibility of the child safety seat tipping forward. To switch into the ALR mode, the belt webbing is extended completely out the retractor, buckled, and then slowly released back into the retractor housing. The ALR mode eliminates the slack, and the retractor remains in the locked position. Once the safety belt is completely released into the housing it returns to the ELR mode. The inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no conclusive evidence of loading.

The case vehicle's driver braked, attempting to avoid the crash. As a result of this attempted avoidance maneuver and independent of the use of the front right passenger's available safety belt systems, the front right passenger most likely moved slightly forward just prior to impact. The case vehicle's impact with the Ford pickup enabled the front right passenger's momentum to continue forward and slightly upward as the case vehicle decelerated and prior to the improperly positioned child safety seat harness restraining her.

As mention above, the case vehicle's front right passenger air bag was designed without any tethers. Because of the untethered bag's rearward excursion [73 centimeters (28.4 inches ) from instrument panel–**Figure 11** above], the front right passenger was contacted across the lower half of her face (**Figure 15**), primarily to the right side. As a result, her head was accelerated upward and her torso rearward into the back of her child safety seat. Based on previously investigated SCI crashes, the facial injury pattern sustained by the case vehicle's front right child passenger is a strong indication that the forward facing child safety seat remained upright (vertical) and did not tip forward. At final rest the front right passenger remained in the child safety seat, slumped to the side (unknown), with her arms still over the top of the safety seat's shield.



**Figure 15:** Angled close-up of case vehicle's forward facing child safety seat secured in front right seating position showing close proximity [8 cm (3.1 in)]-between arrows] of skin transfer (i.e., taped area) on front portion of air bag in relation to center of safety seat's back (case photo #35)

## CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right occupant was transported by ambulance to the hospital. She sustained critical injuries and was hospitalized for at least 143 days post-crash (i.e., including 68 days in a children's hospital and the remainder in a pediatric long-term care facility in ventilator-dependency). Based on her medical records, the injuries sustained by the case vehicle's front right passenger included: a laceration of the spinal cord at C<sub>3</sub>-C<sub>4</sub> with dislocation and fracture at that

level, compression of the brain stem, a critical nonanatomic brain injury, intraventricular and subarachnoid hemorrhages, and abrasions and contusions about her face and neck from the nose level downward.

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 persistent coma, non-responsive, flaccid, pupils fixed and dilated; disconjugate gaze, GCS = 3, with complications including neurogenic bladder and Rancho II <sup>1</sup> , Rappaport 2.6 to 2.0	160824.5 critical	Air bag, front right passenger's	Certain	Hospitalization records
2	Compression {herniation of brain through foremen magnum} including subsequent ischemia <sup>2</sup> of brainstem and/or anoxic <sup>2</sup> brain injury with complications including hydrocephalus—a ventriculoperitoneal shunt <sup>3</sup> was placed between +68 and +95 days post-crash	140202.5 critical	Air bag, front right passenger's	Certain	Hospitalization records
3	Hemorrhage, intraventricular, not further specified as to ventricle [Aspect = Unknown]	140678.4 severe	Air bag, front right passenger's	Certain	Hospitalization records
4	Hemorrhage, subarachnoid, basal, not further specified [Aspect = Unknown]	140684.3 serious	Air bag, front right passenger's	Certain	Hospitalization records

<sup>1</sup> According to the Rancho Los Amigos Scale of Levels of Cognitive Functioning this patient is a Level II which indicates she has a **Generalized Response**. According to the scale a Generalized Response is: *Patient reacts inconsistently and non-purposefully to stimuli in a non-specific manner. Responses are limited in nature and are often the same regardless of stimulus presented. Responses may be physiological changes, gross body movements, and/or vocalization. Often, the earliest response is to deep pain. Responses are likely to be delayed.*

<sup>2</sup> The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:  
*anoxic (a-nok'sik)*: pertaining to or characterized by anoxia.  
*anoxia (a-nok'se-a)*: a total lack of oxygen; often used interchangeably with *hypoxia* to mean a reduced supply of oxygen to the tissues.  
*ischemia (is-ke'me-a)*: deficiency of blood in a part, usually due to functional constriction or actual obstruction of a blood vessel.

<sup>3</sup> The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:  
*shunt (shunt')*: 1. to turn to one side; to divert; to bypass. 2. a passage or anastomosis between two natural channels, especially between blood vessels. Such structures may be formed physiologically (e.g., to bypass a thrombosis), or they may be structural anomalies. 3. a surgically created anastomosis; also, the operation of forming a shunt.  
*ventriculoperitoneal s.*: the most common shunting procedure for the relief of hydrocephalus, consisting of the creation of a channel between a cerebral ventricle and the peritoneum by means of plastic tubing.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
5	Laceration {transection and/or disruption <sup>4</sup> } cervical spinal cord and fracture <sup>5</sup> /dislocation {separation, distraction <sup>4</sup> , disassociation} of 3-4 cm (1.2-1.6 in) at C <sub>3</sub> -C <sub>4</sub> with quadriplegia/quadruparesis <sup>6</sup> and complete cord syndrome	640268.5 critical	Air bag, front right passenger's	Certain	Hospitalization records
6	Abrasion {friction burn} to nose	290202.1 minor	Air bag, front right passenger's	Certain	Emergency room records
7	Abrasion {friction burn}, severe, to chin	290202.1 minor	Air bag, front right passenger's	Certain	Emergency room records
8	Abrasion {friction burn} to cheek, not further specified	290202.1 minor	Air bag, front right passenger's	Certain	Emergency room records
9	Abrasion {friction burn}, severe, across neck	390202.1 minor	Air bag, front right passenger's	Certain	Emergency room records
10	Contusions {ecchymoses} on face, not further specified	290402.1 minor	Air bag, front right passenger's	Certain	Emergency room records
11	Contusion {ecchymosis} over trachea	390402.1 minor	Air bag, front right passenger's	Certain	Emergency room records

## CASE VEHICLE DRIVER KINEMATICS

The case vehicle's driver [28-year-old, White (Hispanic) female; 165 centimeters and 79 kilograms (65 inches, 175 pounds)] was seated in a slightly reclined posture with her back against the seat back, her left foot on the clutch, her right foot on the brake, and both hands on the steering wheel. Her seat track was located in its middle position, and the tilt steering wheel was located in its middle position.

<sup>4</sup> The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:

**disruption** (*dis-rup'shen*): [L *diruptio* a bursting apart] a morphologic defect of an organ or larger region of the body, resulting from the extrinsic breakdown of, or interference with, an originally normal developmental process.

**distraction** (*dis-trak'shen*): a form of dislocation in which the joint surfaces have been separated without rupture of their binding ligaments and without displacement.

<sup>5</sup> One medical source described the fracture as an "end plate" fracture.

<sup>6</sup> The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:

**quadriplegia** (*kwod"ri-pare'sis*): tetraparesis.

**quadriplegia** (*kwod"ri-ple'ja*): paralysis of all four limbs; called also *tetraplegia*.

**tetraparesis** (*tet"ra-pa-re'sis*): muscular weakness affecting all four extremities.

**tetraplegia** (*tet"ra-ple'ja*): quadriplegia.

The term quadriplegia was used during the period of +95 through +143 days post-crash. The term quadriplegia was used prior to that period.

The case vehicle's driver was restrained by 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 no conclusive evidence of loading.

The case vehicle's driver braked, attempting to avoid the crash. As a result of this attempted avoidance maneuver the use of her available safety belts, she most likely moved slightly forward, loading her manual, three-point, lap-and-shoulder, safety belts just prior to impact. The case vehicle's impact with the Ford pickup enabled the driver to continue forward and slightly upward before coming to an abrupt halt as her safety belts locked up restricting her forward movement as the case vehicle decelerated. The deploying driver's air bag impacted her chest and, in combination with her safety belts, causing the driver to move backwards into her seat back. At final rest the driver remained in her seat near her original seat position.

#### **CASE VEHICLE DRIVER INJURIES**

The driver was transported by ambulance only for the purpose of accompanying her daughter to the hospital. She sustained no reported injuries but was treated the next day for soreness to her neck and back.

#### **OTHER VEHICLE**

The Ford pickup is either a rear or four-wheel drive, unknown model year, Ford Ranger pickup (VIN: Unknown). The driver of the Ford pickup drove from the scene without rendering assistance or exchanging information. Because the Ford pickup fled the scene, its CDC is unknown. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the Ford pickup's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 20.8 km.p.h. (12.9 m.p.h.), +20.8 km.p.h. (+12.9 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.).

