



# INDIANA UNIVERSITY

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### **ON-SITE ADVANCED OCCUPANT PROTECTION SYSTEM INVESTIGATION**

CASE NUMBER - IN-02-005  
LOCATION - TEXAS  
VEHICLE - 2003 TOYOTA COROLLA LE  
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.

## Technical Report Documentation Page

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| <p>16. <i>Abstract</i><br/>This report covers an on-site investigation of an air bag deployment crash that involved a 2003 Toyota Corolla LE and 1983 Ford F-150, 4x2, regular cab pickup truck (other vehicle). This crash is of special interest because the case vehicle was equipped with multiple Advanced Occupant Protection Systems as well as an <b>E</b>vent <b>D</b>ata <b>R</b>ecorder (EDR) and the case vehicle's driver (18-year-old male) did not sustain any injuries as a result of the crash. The case vehicle was traveling east in the center through lane of the eastbound roadway which was part of a six-lane, divided, city trafficway and was approaching a Tee intersection (i.e., both the east and westbound roadways had three through lanes). The Ford was traveling north in the northbound lane of a two-lane, undivided, city roadway and attempted to cross the eastbound roadway to make a left-hand turn and proceed westward. The crash occurred in the eastbound roadway within the intersection of the two trafficways. The front of the case vehicle collided with and underrode the left side of the Ford, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle most likely continued forward a short distance while rotating slightly counterclockwise before coming to rest in the inside through lane, heading east-northeastward. The Ford rotated counterclockwise and rolled onto its right side. The Ford came to rest in the median cut between the eastbound and westbound roadways on its right side heading northwestward. The case vehicle's driver was seated with his seat track located in its rearmost position, and tilt steering wheel was located in its middle position. He was restrained by his available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to the driver's mother, a minor neck strain.</p> |   |   |  |
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This on-site investigation was brought to NHTSA's attention on August 27, 2002 by GES sampling activities. This crash involved a 2003 Toyota Corolla LE (case vehicle) and a 1983 Ford F-150 pick-up truck (other vehicle). The crash occurred in July 2002 at 1:45 a.m. in Texas and was investigated by the applicable city police. This crash is of special interest because the case vehicle was equipped with multiple Advanced Occupant Protection Systems as well as an **E**vent **D**ata **R**ecorder (EDR) and the case vehicle's driver [18-year-old, Black (non-Hispanic) male] sustained only a minor neck strain as a result of the crash. This contractor inspected the case vehicle on August 29, 2002, and permission to harvest the **E**lectronic **C**ontrol **U**nit, which houses the EDR technology, was denied by the insurance company on the same day. The other vehicle and the scene were inspected on August 30, 2002. This contractor had a conversation with the mother of the case vehicle's driver on August 30, 2002. This report is based on the Police Crash Report, a conversation with the driver's mother, scene and vehicle inspections, occupant kinematic principles, and this contractor's evaluation of the evidence.

## SUMMARY

The case vehicle was traveling east in the center through lane of the eastbound roadway which was part of a six-lane, divided, city trafficway and was approaching a Tee intersection, intending to continue straight ahead (i.e., both the east and westbound roadways had three through lanes). The Ford was traveling north in the northbound lane of a two-lane, undivided, city roadway and attempted to cross the eastbound roadway to make a left-hand turn and proceed westward. Given the absence of physical evidence at the scene and lack of cooperation from the family of the case vehicle's driver, it is unknown if the driver made any avoidance maneuvers. The crash occurred in the eastbound roadway within the intersection of the two trafficways; see **CRASH DIAGRAM** below.

The front of the case vehicle collided with and underrode the left side of the Ford, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The exact final rest locations of both vehicles are unknown, but the case vehicle most likely continued forward a short distance while rotating slightly counterclockwise before coming to rest in the inside through lane, heading east-northeastward. The Ford rotated counterclockwise and rolled onto its right side. The Ford came to rest in the median cut between the eastbound and westbound roadways on its right side heading northwestward. The driver of the Ford fled the scene before police arrived.

The 2003 Toyota Corolla LE was a front wheel drive, four-door sedan (VIN: 1NXBR32E93Z-----). The case vehicle was equipped with multi-stage frontal air bags and seat belt pretensioners with force limiters. In addition, the case vehicle was equipped with an **E**lectronic **C**ontrol **U**nit. The insurance company for the owner of the case vehicle refused to allow this contractor to remove the **E**CU during our vehicle inspection. Based on vehicle inspection, the CDC for the case vehicle was determined to be: **01-FDEW-3 (20 degrees)**. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's impact. The Total, Longitudinal, and Lateral Delta V's are, respectively: 29.0 km.p.h.(18. 0

m.p.h.), -27.3 km.p.h. (-17.0 m.p.h.), and -9.9 km.p.h. (-6.2 m.p.h.). The case vehicle was towed from the scene due to damage.

The case vehicle's contact with the Ford involved its entire front surface. The bumper fascia was not available, so crush measurements were taken on the actual metal bumper and there is damage across the entire front. Furthermore, the case vehicle underrode the Ford necessitating a second set of C-measurements above the front bumper. These measurements were averaged where applicable, producing a residual maximum averaged crush of 17 centimeters (6.7 inches) at C<sub>1</sub>. The case vehicle's front bumper, bumper fascia, grille, hood, radiator, right and left headlight and turn signal assemblies, and the right and left fenders were directly damaged and crushed rearward. The greater portion of the crush occurred above the bumper, including the hood. The case vehicle's wheelbase was unaltered from the crash, and none of the tires were damaged, deflated, or physically restricted. The case vehicle's windshield was cracked from the impact as well. No obvious induced damage or remote buckling was noted to the remainder of the case vehicle's exterior.

The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with two very wide tethers, each measuring 11 centimeters (4.3 inches). The driver's air bag had two vent ports, approximately 3.5 centimeters (1.4 inches) in diameter, located at the 1 and 11 o'clock positions. The driver's air bag was round with a diameter of 63 centimeters (24.8 inches). An inspection of the driver's air bag fabric revealed some possible evidence of contact to the air bag's fabric in the form of scuffing, but this is more likely due to the rapid deployment out of the module.

The front right passenger's air bag was located in the top of the instrument panel. An inspection of the front right air bag module's cover 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 tethers. The front right air bag had two vent ports, approximately 5.5 centimeters (2.2 inches) in diameter, located at the 9:30 and 2:30 o'clock positions. The deployed front right air bag was rectangular with a height of approximately 57 centimeters (22.4 inches) and a width of approximately 40 centimeters (15.7 inches). An inspection of the front right passenger's air bag fabric revealed that there was some discoloration on the front left portion of the air bag, but this was again due to flap scuffing incurred during deployment.

Inspection of the case vehicle's interior revealed no major contacts to the vehicle though a small possible right knee scuff was found on the right portion of the knee bolster. In addition, there was no evidence of intrusion to the case vehicle's interior and no deformation to the steering wheel rim.

The 1983 Ford F-150 was a rear wheel drive, 4x2, regular cab, extended bed, pick up truck (VIN: 2FTDF15Y0DCA-----). Based on the vehicle inspection, the CDCs for the Ford were determined to be: **10-LZEW-3 (290 degrees)** for the impact with the case vehicle (1<sup>st</sup> event), and

**00-RDAO-2** for the rollover impact (2<sup>nd</sup> event). Maximum crush was measured as 44 centimeters (17.3 inches) and was located 19 centimeters (7.5 inches) rearward of C<sub>4</sub>. The WinSMASH reconstruction program, damage only algorithm, was used on the Ford's highest severity impact (1<sup>st</sup> event). The Total, Longitudinal, and Lateral Delta Vs are, respectively: 21.0 km.p.h. (13.0 m.p.h.), -7.2 km.p.h. (-4.5 m.p.h.), and + 19.7 km.p.h. (+ 12.2 m.p.h.). The Ford was towed due to damage after being abandoned at the crash scene.

The exact posture of the case vehicle's driver [155 centimeters and 59 kilograms (61 inches, 130 pounds)] immediately prior to the crash is unknown but, based on the vehicle inspection, he was seated in a significantly reclined posture with his back against the seat back, his left foot on the floor, his right foot presumably on one of the foot controls, and at least one of his hands on the steering wheel, in an unknown position. His seat track was located in its rearmost position, the seat back was reclined at least 45 degrees, and tilt steering wheel was located in its middle position.

The case vehicle's driver was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. Although there were no interviewee reported belt pattern bruises and/or abrasions to the driver's body, the inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed a significant friction burn/scuff to the belt webbing and "D"-ring, indicating a clear sign of loading.

It is unknown if the case vehicle's driver made any pre-crash avoidance maneuvers, so it cannot be determined if the driver moved forward prior to impact. The case vehicle's impact with the Ford enabled the case vehicle's driver to continue forward and slightly rightward towards the case vehicle's 20 degree Direction of Principal Force as the case vehicle decelerated. As a result, the driver loaded onto his safety belts and most likely contacted his deploying driver air bag. As the case vehicle continued forward while rotating slightly counterclockwise post-crash, the case vehicle's driver rebounded backwards from the combination of his safety belts and the deploying air bag. The exact posture of the case vehicle's driver at final rest is unknown, but because of his use of the available safety belts, he was most likely near his pre-crash position at final rest.

Based on the conversation with the mother of the case vehicle's driver, he was not transported to a medical facility. He sustained a minor injury but did not seek any medical treatment. According to the driver's mother, he sustained a neck strain and had a headache.

**CRASH CIRCUMSTANCES**

The case vehicle was traveling east in the center through lane of the eastbound roadway (Figure 1) which was part of a six-lane, divided, city trafficway and was approaching a Tee



**Figure 1:** Case vehicle eastward travel path in center through lane of eastbound roadway approaching impact area at roadway's junction with Tee intersection (case photo #02)



intersection, intending to continue straight ahead (i.e., both the east and westbound roadways had three through lanes). The Ford was traveling north in the northbound lane of a two-lane, undivided, city roadway and attempted to cross the eastbound roadway to make a left-hand turn and proceed westward (**Figure 2**). Given the absence of physical evidence at the scene and lack of cooperation from the family of the case vehicle's driver, it is unknown if the driver made any avoidance maneuvers. The crash occurred in the eastbound roadway within the intersection of the two trafficways; see **CRASH DIAGRAM** below.



**Figure 2:** Southward view of south leg of "Tee" intersection from which Ford pickup traveled northward, across eastbound roadway, during pickup's attempted left-hand turn (case photo #11)

The eastbound roadway of the case vehicle's city trafficway was straight and essentially level (i.e., there was a very slight incline, positive to the east) at the area of impact (**Figure 1** above). The pavement was bituminous but "traveled," and the width of all three eastbound lanes was 3.1 meters (10.2 feet). The eastbound roadway was bordered by barrier curbs with the curb on the north associated with a raised, unprotected, grassy median. The grassy median was approximately 4.6 meters (15.1 feet) wide, separating the east and westbound roadways. Pavement markings consisted of single, dash white lane lines that separated the three eastbound through lanes. In addition, no edge lines were present on either the north or south sides of the roadway. There was a narrow concrete shoulder/rain gutter just prior to the south curb. The coefficient of friction was estimated to be 0.65. There were no visible traffic controls in the immediate area of the crash. The posted speed limit was 56 km.p.h. (35 m.p.h.).

The other vehicle's city roadway was straight and level (i.e., there was a very slight incline, positive to the north as a result of the crown of the eastbound roadway) at the area of impact (**Figure 2**). The pavement on the south leg of the intersection was concrete but "traveled" and became bituminous where it intersected the roadway of the case vehicle. The width of the roadway measured 8 meters (26.2 feet). The roadway was bordered by barrier curbs on both the east and west sides. There were no pavement markings, and no edge lines were present. The estimated coefficient of friction was 0.65. Traffic controls consisted of a regulatory **STOP** sign (Manual on Uniform Traffic Control Devices, R1-1) located on the southeast corner of the "Tee" intersection. The statutory speed limit was 48 km.p.h. (30 m.p.h.). No regulatory speed limit sign was posted near the crash site.



**Figure 3:** Case vehicle's frontal damage with contour gauge set at bumper level; Note: case vehicle underrode left side of Ford pickup (case photo #18)

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 most likely light because of the time of the crash and the site of the crash was a combination of urban residential and commercial.

The front (**Figure 3** above) of the case vehicle collided with and underrode the left side of the Ford (**Figure 4**), causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The exact final rest locations of both vehicles are unknown, but the case vehicle most likely continued forward a short distance while rotating slightly counterclockwise before coming to rest in the inside through lane, heading east-northeastward. The Ford rotated counterclockwise and rolled onto its right side. The Ford came to rest in the median cut between the eastbound and westbound roadways on its right side heading northwestward. The driver of the Ford fled the scene before police arrived.



**Figure 4:** Ford pickup's left side damage—with contour gauge at sill level, resulting from impact with case vehicle; Note: case vehicle's front underrode left side of pickup (case photo #72)

**CASE VEHICLE**

The 2003 Toyota Corolla LE was a front wheel drive, five-passenger, four-door sedan (VIN: 1NXBR32E93Z-----) equipped with a 1.8L, I-4 engine and a four-speed automatic transmission. In addition, the case vehicle was equipped with multi-stage frontal air bags and retractor-mounted, seat belt pretensioners with force limiters. In addition, the case vehicle was equipped with an **Electronic Control Unit**. Braking was achieved by a power-assisted, front disc and rear drum, four-wheel, anti-lock system. The case vehicle's wheelbase was 260 centimeters (102.4 inches), and the odometer reading at inspection is unknown because the case vehicle was equipped with an electronic odometer.

Inspection of the vehicle's interior revealed adjustable front bucket seats with adjustable head restraints; a non-adjustable back bench seat with folding seat backs and adjustable head restraints for the back outboard seating positions; and continuous loop, three-point, lap-and-shoulder, safety belt systems at the front and all three back seating positions. The front seat belt systems were equipped with manually operated, upper anchorage adjusters for the "D"-rings. Both the driver and front right passenger had their upper anchorage adjusters located in the upmost positions. The vehicle was equipped with knee



**Figure 5:** Overhead view of case vehicle's frontal damage from impact with Ford pickup—contour gauge set above bumper (case photo #17)

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 an advanced 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.

**CASE VEHICLE DAMAGE**

The case vehicle's contact with the Ford involved its entire front surface. The bumper fascia was not available, so crush measurements were taken on the actual metal bumper and there is damage across the entire front (**Figure 5** above). Furthermore, the case vehicle underrode the Ford necessitating a second set of C-measurements above the front bumper. These measurements were averaged where applicable, producing a residual maximum averaged crush of 17 centimeters (6.7 inches) at C<sub>1</sub>. The case vehicle's front bumper, bumper fascia, grille, hood, radiator, right and left headlight and turn signal assemblies, and the right and left fenders were directly damaged and crushed rearward (**Figure 3** above). The greater portion of the crush occurred above the bumper, including the hood (**Figure 5** above). The case vehicle's wheelbase was unaltered from the crash, and none of the tires were damaged, deflated, or physically restricted. The case vehicle's windshield was cracked from the impact as well. No obvious induced damage or remote buckling was noted to the remainder of the case vehicle's exterior.



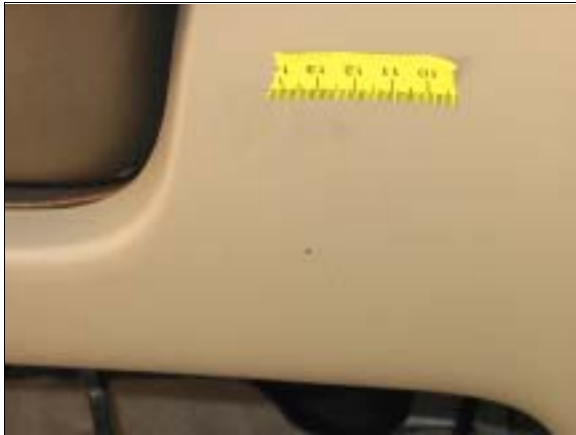
**Figure 6:** Case vehicle's driver seating and greenhouse areas showing steering wheel-mounted deployed air bag module and no obvious contact evidence to left "A"-pillar, sun visor/windshield header, and/or roof (case photo #44)



**Figure 7:** Case vehicle's front instrument panel, center console, sun visors, roof, and windshield's header and glazing; Note: only obvious contact occurred to driver's knee bolster (yellow tape), right of steering column (case photo #45)



Inspection of the case vehicle's interior revealed no major contacts to the vehicle (**Figures 6 and 7** above) though a small possible right knee scuff was found on the right portion of the knee bolster (**Figure 8**). In addition, there was no evidence of intrusion to the case vehicle's interior and no deformation to the steering wheel rim (**Figure 9**).



**Figure 8:** Close-up of scuff mark on case vehicle's driver knee bolster, right of steering column (case photo #48)



**Figure 9:** Case vehicle's driver seating area viewed from right showing no deformation to steering wheel or other obvious occupant contact evidence (case photo #51)

Based on vehicle inspection, the CDC for the case vehicle was determined to be: **01-FDEW-3 (20 degrees)**. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's impact. The Total, Longitudinal, and Lateral Delta V's are, respectively: 29.0 km.p.h.(18. 0 m.p.h.), -27.3 km.p.h. (-17.0 m.p.h.), and -9.9 km.p.h. (-6.2 m.p.h.). The case vehicle was towed from the scene 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. It is unknown whether more than one stage of the multi-stage air bags was activated. The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of an inverted, triangular, curvilinear-shaped cover that contained three asymmetrical flaps made of thick vinyl. The top and largest flap was somewhat semicircular in design while the left and right lower flaps were obliquely oriented. The top cover flap had overall dimensions of 15.5 centimeters (6.1 inches) horizontally and 8 centimeters (3.1 inches) vertically at its widest point. The two bottom flaps were mirror imaged and each measured 7 centimeters (2.8 inches) horizontally to the hub and had an overall height of 6 centimeters (2.4 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 two very wide tethers, each measuring 11 centimeters (4.3 inches). The driver's air bag had two vent ports, approximately 3.5 centimeters (1.4 inches) in diameter, located at the 1 and 11 o'clock positions. The driver's air bag was round with a diameter of 63 centimeters (24.8 inches). An inspection of the driver's air bag fabric revealed some possible evidence of

contact to the air bag's fabric in the form of scuffing, but this is more likely due to the rapid deployment out of the module (**Figure 10**).

The front right passenger's air bag was located in the top of the instrument panel. There were two, symmetrical, "H"-configuration, modular cover flaps. The cover flaps were made of thick vinyl with overall dimensions of 20.5 centimeters (8.1 inches) at the horizontal seam and 6 centimeters (2.4 inches) vertically for both the upper and lower flaps. The profile of the case vehicle's instrument panel resulted in a 15 centimeter (5.9 inch) setback of the leading edge of the cover flap relative to the protruding right instrument panel. An inspection of the front right air bag module's cover 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 tethers. The front right air bag had two vent ports, approximately 5.5 centimeters (2.2 inches) in diameter, located at the 9:30 and 2:30 o'clock positions. The deployed front right air bag was rectangular with a height of approximately 57 centimeters (22.4 inches) and a width of approximately 40 centimeters (15.7 inches). An inspection of the front right passenger's air bag fabric revealed that there was some discoloration on the front left portion of the air bag, but this was again due to flap scuffing incurred during deployment (**Figure 11**).

#### **ELECTRONICS CONTROL UNIT**

The insurance company for the owner of the case vehicle refused to allow this contractor to remove the **ECU** during our vehicle inspection.

#### **CASE VEHICLE DRIVER KINEMATICS**

The exact posture of the case vehicle's driver [18-year-old, Black (non-Hispanic) male; 155 centimeters and 59 kilograms (61 inches, 130 pounds)] immediately prior to the crash is unknown but, based on the vehicle inspection, he was seated in a significantly reclined posture with his back



**Figure 10:** Case vehicle's deployed driver air bag showing no apparent evidence of occupant contact (case photo #52)



**Figure 11:** Case vehicle's deployed front right passenger air bag showing no occupant contact evidence (case photo #59)

against the seat back, his left foot on the floor, his right foot presumably on one of the foot controls, and at least one of his hands on the steering wheel, in an unknown position. His seat track was located in its rearmost position, the seat back was reclined at least 45 degrees, and tilt steering wheel was located in its middle position.

The case vehicle's driver was restrained by his available, active, three-point, lap-and-shoulder, safety belt system; the belt system was equipped with a retractor-mounted pretensioner with force limiters, housed within the "B"-pillar. Although there were no interviewee reported belt pattern bruises and/or abrasions to the driver's body, the inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed a significant friction burn/scuff to the belt webbing and "D"-ring (**Figure 12**), indicating a clear sign of loading.



**Figure 12:** Close-up view of scuffing/friction burn on seat belt of case vehicle's driver (case photo #36)

It is unknown if the case vehicle's driver made any pre-crash avoidance maneuvers, so it cannot be determined if the driver moved forward prior to impact. The case vehicle's impact with the Ford enabled the case vehicle's driver to continue forward and slightly rightward towards the case vehicle's 20 degree Direction of Principal Force as the case vehicle decelerated. As a result, the driver loaded onto his safety belts and most likely contacted his deploying driver air bag. As the case vehicle continued forward while rotating slightly counterclockwise post-crash, the case vehicle's driver rebounded backwards from the combination of his safety belts and the deploying air bag. The exact posture of the case vehicle's driver at final rest is unknown, but because of his use of the available safety belts, he was most likely near his pre-crash position at final rest.

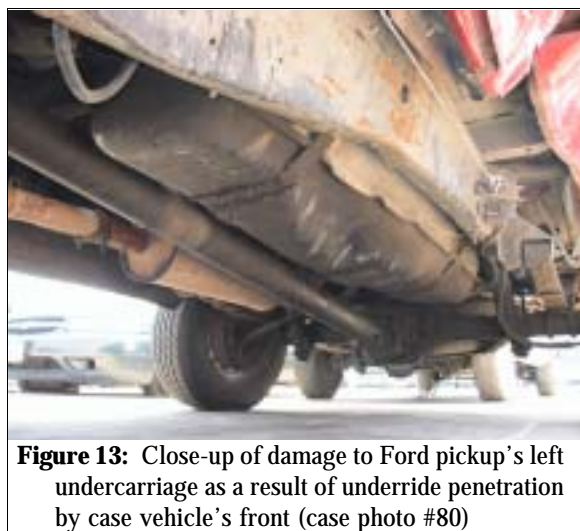
**CASE VEHICLE DRIVER INJURIES**

Based on the conversation with the mother of the case vehicle's driver, he was not transported to a medical facility. He sustained a minor injury but did not seek any medical treatment. According to the driver's mother, he sustained a neck strain and had a headache.

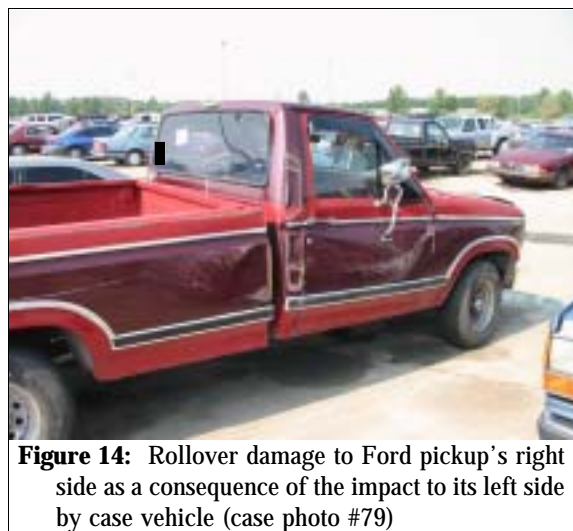
| Injury Number | Injury Description (including Aspect) | NASS Injury Code & AIS 90 | Injury Source (Mechanism) | Source Confidence | Source of Injury Data  |
|---------------|---------------------------------------|---------------------------|---------------------------|-------------------|------------------------|
| 1             | Strain neck, not further specified    | 640278.1 minor            | Air bag, driver's         | Possible          | Interviewee (relative) |

The 1983 Ford F-150 was a rear wheel drive, 4x2, three-passenger, two door, regular cab, extended bed, pick-up truck (VIN: 2FTDF15Y0DCA-----) equipped with a 4.9L, I-6 engine and a three-speed automatic transmission. Braking was achieved by a power-assisted, front disc and rear drum system. The case vehicle's wheelbase was 338 centimeters (133.0 inches), and the odometer reading is unknown because the Ford's interior was not inspected.

The Ford's contact with the case vehicle (1<sup>st</sup> event) involved the left side between its wheels. Direct damage began 78 centimeters (30.7 inches) rearward of the left front axle and extended 204 centimeters (80.3 inches), along the left side toward the left rear axle. Maximum crush was measured as 44 centimeters (17.3 inches) and was located 19 centimeters (7.5 inches) rearward of C<sub>4</sub>. The wheelbase on the Ford's left side was shortened 5 centimeters (2.0 inches) while the right side was unaltered from the crash. The pickup's left front door and the left side of the truck bed were directly damaged and crushed inward. Because the case vehicle underrode the pickup, there was direct contact to the left frame rail and gas tank areas (**Figure 13**). None of the Ford's tires were damaged, deflated, or physically restricted. The pickup's truck bed sustained induced damage as it was shifted rightward as a result of the left side impact. As a result of the rollover impact (2<sup>nd</sup> event), the entire right side of the Ford, rearward of the right front axle, was directly damaged (**Figure 14**).



**Figure 13:** Close-up of damage to Ford pickup's left undercarriage as a result of underride penetration by case vehicle's front (case photo #80)



**Figure 14:** Rollover damage to Ford pickup's right side as a consequence of the impact to its left side by case vehicle (case photo #79)

Based on the vehicle inspection, the CDCs for the Ford were determined to be: **10-LZEW-3 (290 degrees)** for the impact with the case vehicle (1<sup>st</sup> event), and **00-RDAO-2** for the rollover impact (2<sup>nd</sup> event). The WinSMASH reconstruction program, damage only algorithm, was used on the Ford's highest severity impact (1<sup>st</sup> event). The Total, Longitudinal, and Lateral Delta Vs are, respectively: 21.0 km.p.h. (13.0 m.p.h.), -7.2 km.p.h. (-4.5 m.p.h.), and + 19.7 km.p.h. (+ 12.2 m.p.h.). The Ford was towed due to damage after being abandoned at the crash scene.

