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ON-SITE AIR BAG INVESTIGATION

CASE NUMBER - IN00-016
LOCATION - MISSOURI
VEHICLE - 1999 CHRYSLER CONCORD LX
CRASH DATE - July, 2000

Submitted:

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Prepared for:

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National Highway Traffic Safety Administration
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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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15. *Supplementary Notes*
On-site air bag deployment investigation involving a 1999 Chrysler Concorde LX, four-door sedan, with manual belts and dual front air bags, a 1995 Ford Windstar GL, and a 1999 International straight truck

16. *Abstract*
This report covers an on-site investigation of an air bag deployment crash that involved a 1999 Chrysler Concord LX (case vehicle), a 1995 Ford Windstar GL (1st other vehicle), and a 1999 International 4700 straight truck (2nd other vehicle). This crash is of special interest because the case vehicle was equipped with redesigned air bags and the case vehicle's unrestrained, front right passenger [75-year-old, White (non-Hispanic) female] sustained multiple left lower leg fractures from contact by the deploying front right passenger air bag module's cover flap. The case vehicle was traveling north in outside through lane of a seven-lane, undivided, state roadway and was approaching a controlled four-leg intersection with an interstate frontage road (i.e., on the south leg of the intersection there were two through lanes for both north and southbound traffic; the northbound direction also had both right and left-hand turn lanes, and the southbound direction had an additional lane used for either merging into one of the through lanes or right-hand turns further southward). The Ford had been traveling south in the left-hand turn lane of the same state roadway and turned left (i.e., there were six-lanes on the north leg of the intersection, including two through lanes for both north and southbound directions and southbound right and left-hand turn lanes). The straight truck was stopped heading west on the east leg of the four-leg intersection in the left-hand turn lane of the three-lane, undivided, interstate frontage road. The crash occurred within the intersection, in the outside northbound through lane. The front left of the case vehicle was impacted by the front of the Ford, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. As a result of this impact, the case vehicle was subsequently redirected in a northeasterly direction where its front right impacted the straight truck's left front corner. The front right passenger (i.e., mother of driver) was seated with her seat track located in its forward-most position and was not wearing her available, active, three-point, lap-and-shoulder, safety belt system. She sustained, according to the case vehicle's driver and her medical records, moderate injuries which included: a trimalleolar fracture to her left ankle and a segmented fracture of her left fibula. The driver (56-year-old male) was seated with his seat track located in its rearmost position, and the 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 his interview, a large abrasion and a small laceration to his left forearm.

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This on-site investigation was brought to NHTSA's attention on July 27, 2000 by an a police officer with the investigating police agency. This crash involved a 1999 Chrysler Concord LX (case vehicle), a 1995 Ford Windstar GL (1st other vehicle), and a 1999 International 4700 straight truck with cherry picker attachment (2nd other vehicle). The crash occurred in July, 2000, at 3:20 p.m., in Missouri and was investigated by the applicable city police department. This crash is of special interest because the case vehicle was equipped with redesigned air bags and the case vehicle's unrestrained, front right passenger [75-year-old, White (non-Hispanic) female] sustained multiple left lower leg fractures from contact by the deploying front right passenger air bag module's cover flap. This contractor inspected the scene and vehicles on July 31, 2000. This contractor interviewed the driver of the case vehicle on August 1, 2000. This report is based on the Police Crash Report, interviews with the case vehicle's driver and the investigating police officer, scene and vehicle inspections, occupant kinematic principles, occupant medical records, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling north in outside through lane of a seven-lane, undivided, state roadway and was approaching a controlled four-leg intersection with an interstate frontage road, intending to continue straight ahead through the intersection and turn right on an entrance ramp to the interstate at the next northern intersection (i.e., on the south leg of the intersection there were two through lanes for both north and southbound traffic; the northbound direction also had both right and left-hand turn lanes, and the southbound direction had an additional lane used for either merging into one of the through lanes or right-hand turns further southward). The Ford had been traveling south in the left-hand turn lane of the same, undivided, state roadway and turned left, intending to travel east on the interstate frontage road (i.e., there were six-lanes on the north leg of the intersection; the north and southbound directions had two through lanes while the southbound direction also had both right and left-hand turn lanes). The straight truck was stopped heading west on the east leg of the four-leg intersection in the left-hand turn lane of the three-lane, undivided, interstate frontage road and intended to turn left and travel southward (i.e., the east leg of the intersection had one through lane in both the east and west directions and a left-hand turn lane). The case vehicle's driver made no avoidance maneuvers prior to the crash. The crash occurred within the intersection, in the outside northbound through lane; see **CRASH DIAGRAM** below.

The front left of the case vehicle was impacted by the front of the Ford, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. As a result of this impact, the case vehicle was subsequently redirected in a northeasterly direction where its front right impacted the straight truck's front right corner; however, the straight truck was not inspected. The case vehicle came to rest in the westbound left-hand turn lane on the east leg of the intersection, heading northeast. The Ford came to rest in the intersection heading east in the outside northbound through lane. The straight truck remained essentially in its pre-crash position.

The state roadway was straight and level at the area of impact. The pavement was concrete for both the outside northbound through lane and the southbound left-hand turn lane. The width

of the outside northbound through lane was approximately 3.4 meters (12 feet). The width for the southbound left-hand turn lane was 3.6 meters (11.9 feet). The shoulders were improved (i.e., bituminous) and measured 1.6 meters (5.3 feet) wide on both the east and west sides of the south leg. No curbs were present. Pavement markings consisted of a double solid yellow centerline for both north and southbound traffic, and solid white lane lines separated the turning lanes from the through lanes while the through lanes were divided by dashed white line. In addition, no edge lines were present. The estimated coefficient of friction was 0.70. On-colors, pre-timed, vertically mounted traffic control signals (i.e., six in all) were located so as to control each of the left-hand turn lanes and for all four of the through lanes. The posted speed limit was 64 km.p.h. (40 m.p.h.) for the north and south roadway. At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the road pavement was dry. Traffic density was heavy, and the site of the crash was urban commercial.

The case vehicle was a front wheel drive 1999 Chrysler Concorde LX, four-door sedan (VIN: 2C3HD46R3XH------). The case vehicle was equipped with four-wheel, anti-lock brakes. Based on the vehicle inspection the CDCs for the case vehicle were determined to be: **11-FLEW-1** (**340** degrees) and **01-FRME-1** (**30** degrees). The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 13.9 km.p.h. (8.6 m.p.h.), -13.1 km.p.h. (-8.1 m.p.h.), and +4.8 km.p.h. (+3.0 m.p.h.). This contractor believes these Delta V results to be borderline but reasonable. No reconstruction program was used on the case vehicle's second impact because the impact was out of scope (i.e., override with a vehicle that was out of scope); however, this contractor's visually estimated Delta V is between 5 km.p.h. (3 m.p.h.) and 11 km.p.h. (7 m.p.h.). The case vehicle was towed due to damage.

The case vehicle's initial contact was with the Ford and involved the front left corner. Direct damage began 18 centimeters (7.1 inches) to the left of the vehicle's center and extended, a measured distance of 55 centimeters (21.7 inches), along the front bumper toward the front left bumper corner. The case vehicle's front bumper sustained induced damage (Field L) from the vehicle's initial impact and the damage extended, a measured distance of 145 centimeters (57.1 inches) toward the front right bumper corner. Maximum crush was measured as 8 centimeters (3.1 inches) at C_1. The direct damage also extended down the case vehicle's left side, a measured distance of 108 centimeters (42.5 inches) to the left front hub cap. The case vehicle's secondary impact with the straight truck was an underride type impact to the front right corner above the bumper at the hood level. Direct damage began 67 centimeters (26.4 inches) to the right of the vehicle's center and extended, a measured distance of 18 centimeters (7.1 inches) to the front right bumper corner. The maximum crush from this impact was approximately 7 centimeters (2.8 inches). The wheelbase on the case vehicle's left side was possibly shortened 1 centimeters (0.4 inches) while the right side was neither shortened nor extended. The case vehicle's front bumper fascia, hood, and right and left fenders were directly damaged and crushed rearward. The case vehicle's left front tire was physically restricted and deflated from the initial impact. Both the right and left headlight and turn signal assemblies sustained induced damage as well as both the right and left fenders. The left front wheel cover was directly damage as well.

The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module's cover flaps and air bag fabric revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with four tethers, each 10 centimeters (3.9 inches) wide, and sewn interiorly to the center at the 11, 1 5, and 7 o'clock positions. The driver's air bag had no vent ports. The deployed driver's air bag was round with a diameter 63 centimeters (24.8 inches). An inspection of the air bag's fabric revealed blood spots near the one and three o'clock positions and a large area of skin transfer, measuring approximately 18 x 8 centimeters (7.1 x 3.1 inches), readily apparent on the driver's air bag in the lower right quadrant angled obliquely toward the 4:30 o'clock position.

The front right passenger's air bag was located in the top of the instrument panel. An inspection of the front right air bag module's cover flap and air bag fabric revealed that the cover flap opened at the designated tear points, and there was evidence of damage during the deployment to the module's cover flap (i.e., deformed by contact with the front right passenger's left leg. Furthermore, there were several areas of black scuffs and streaks beginning on the top surface of the air bag's fabric indicating that the air bag's deployment path had been restricted from the front right passenger's left leg. The front right passenger's air bag was designed with two tethers, each 7.5 centimeters (3.0 inches) wide, sewn into the center of the front surface near the 3 and 9 o'clock positions. The front right air bag had two vent ports, approximately 5 centimeters (2.0 inches) in diameter, located at the 10 and 2 o'clock positions. The deployed front right air bag was rectangular with a height of approximately 62 centimeters (24.4 inches) and a width of approximately 47 centimeters (18.5 inches). An inspection of the front right air bag's fabric did not reveal any obvious evidence of occupant contact to the air bag's front surface.

Inspection of the case vehicle's interior revealed a blood spot on the armrest of the driver's door, which does not appear to be contact related; scuffs to the right windshield's glazing and right "A"-pillar from contact by the driver's left and right feet, respectively; and a contact to the case vehicle's fold-down center armrest/console from the front right passenger's torso.

The 1995 Ford Windstar GL was a front wheel drive, 4 x 2, three-door minivan (VIN: 2FMDA5141SB------). Based on the vehicle inspection, the CDC for the Ford was determined to be: **01-FDEW-2** (**40** degrees). The Ford was towed due to damage.

The Ford's contact with the case vehicle involved its entire front. Direct damage began 40 centimeters (15.7 inches) to the left of the Ford's center and extended, a measured distance of 117 centimeters (46.1 inches), along the front to the front right bumper corner. Residual maximum crush was measured as 20 centimeters (7.9 inches) between C_2 and C_3. The wheelbase on the Ford's left side was shortened 5centimeters (2.0 inches) while the right side was possibly extended 1 centimeter (0.4 inches). The Ford's front bumper, bumper fascia, grille, right turn signal assembly, and hood were directly damaged and crushed rearward. None of the Ford's tires were physically restricted or deflated from the crash. The right headlight and the left headlight and turn signal assemblies sustained induced damage as well as the hood and both the right and left fenders.

The 1999 International Harvester 4700 was a rear wheel drive straight truck with a cherry picker attachment (VIN: 1HTSCAAN0XH------). With no available photographs of its damage, the TDC for the straight truck is unknown. The straight truck was driven from the scene.

Immediately prior to the crash the case vehicle's front right passenger [i.e., mother of driver; 163 centimeters and 59 kilograms (64 inches, 130 pounds)] was seated in a reclined posture with her back angled against the seat back and center arm rest, both legs atop the instrument panel angled toward the right "A"-pillar, and both hands on her lap. According to the case vehicle's driver (i.e., son), her seat track was located in its forward-most position, and the seat back was sightly reclined. During the vehicle inspection, the front right seat was position at its rearmost position but had most likely been moved rearward during this occupant's extrication.

The case vehicle's front right passenger was not wearing her available, active, three-point, lap-and-shoulder, safety belt system. In addition, there was no evidence of belt pattern bruising and/or abrasions to the front right passenger's body, and the inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading.

The case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the nonuse of her available safety belts, the front right passenger's pre-impact body position did not change just prior to impact. The case vehicle's impact with the Ford enabled the front right passenger's torso continued forward and to the left, towards the **340** degree Direction of Principal Force, as the case vehicle decelerated. Because of her pre-crash posture (i.e., her left foot atop the right edge of the air bag module's cover flap, right foot just to the right of the cover flap), the impact caused the passenger's left leg to slide slightly upwards and to the left, directly atop and slightly to the right of center of the front right air bag module's cover flap, just prior to deployment. The deploying air bag module's cover flap lifted her left leg upwards and leftwards, and her right leg was redirected by the deploying air bag's fabric to the right against the right "A"-pillar. In essence, the deploying air bag spread the front right passenger's legs as it expanded. As the case vehicle was redirected to the northeast (i.e., rightward), the unrestrained, front right passenger moved leftward. The combination of the **340** degree Direction of Principal Force on the front right occupant's position, the leftward movement of the front right passenger in response to the case vehicle's rightward redirection, and possibly the rotation effect on her torso of her right leg being redirected toward the right "A"-pillar caused the front right passenger to load and dislodge the center arm rest. Upon impacting the left front corner of the straight truck, the front right passenger's pelvic area moved forwards (i.e., probably submarining, upper torso moving backwards) and slightly to her right. At final rest, the front right passenger's pelvic area and torso remained in her seat with her legs spread apart, still atop the dash, with the air bag module's cover flap and deployed air bag between them.

The front right occupant was transported by ambulance to the hospital. She sustained moderate injuries and was hospitalized for 5 days post-crash. According to the case vehicle's driver and her medical records, the injuries sustained by the front right passenger included: a trimalleolar fracture to her left ankle and a segmented fracture of her left fibula.

The case vehicle's driver [56-year-old, White (non-Hispanic) male; 175 centimeters and 77 kilograms (69 inches, 170 pounds)] was seated in an upright posture with his back against the seat back, his left foot on the floor, his right foot on the accelerator, and both hands on the steering wheel. His seat track was located in its rearmost position, the seat back was upright, and the 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. However, there was no evidence of belt pattern bruising and/or abrasions to the driver's body, but the inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed evidence that was consistent with usage during this crash.

The driver was transported by ambulance to the hospital, primarily for the purpose of accompanying the front right passenger (i.e., mother). He sustained minor injuries and was treated and released. According to the case vehicle's driver, his self-reported injuries included: a large abrasion and a small laceration to his left forearm.

An inspection of the Ford's interior revealed that both of its frontal air bags deployed during the impact with the case vehicle. In addition, there was contact evidence readily apparent on the Ford's driver air bag. The Ford's driver [89-year-old, White (non-Hispanic) female; unknown height and weight] was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The driver was transported by ambulance to the hospital. She sustained non-incapacitating-evident ("B") injuries but her treatment status and injuries are unknown.

CRASH CIRCUMSTANCES

Figure 1: Case vehicle's northbound travel path in outside lane approaching intersection; Note: turning vehicle represents the Ford and stopped vehicle heading westbound on east leg of intersection represents the straight truck (case photo #02)

The case vehicle was traveling north in outside through lane of a seven-lane, undivided, state roadway and was approaching a controlled four-leg intersection with an interstate frontage road, intending to continue straight ahead through the intersection and turn right on an entrance ramp to the interstate at the next northern intersection (i.e., on the south leg of the intersection there were two through lanes for both north and southbound traffic; the northbound direction also had both right and left-hand turn lanes (**Figure 1**), and the southbound direction had an additional lane used for either merging into one of the through lanes or right-hand turns further southward). The Ford had been traveling south in the left-hand turn lane of the same, undivided, state roadway and turned left, intending to travel east on the interstate frontage road (i.e., there were six-lanes on the north leg of the intersection; the north and southbound directions had two through lanes while the southbound direction also had both right and left-hand turn lanes). The straight truck was stopped heading west on the east leg of the four-leg intersection in the left-hand turn lane of the three-lane, undivided, interstate frontage road and intended to turn left and travel southward (i.e., the east leg of the intersection had one through lane in both the east and west directions and

a left-hand turn lane). The case vehicle's driver made no avoidance maneuvers prior to the crash. The crash occurred within the intersection, in the outside northbound through lane; see **CRASH DIAGRAM** below.

The state roadway was straight and level at the area of impact. The pavement was concrete for both the outside northbound through lane and the southbound left-hand turn lane. The width of the outside northbound through lane was approximately 3.4 meters (12 feet). The width for the southbound left-hand turn lane was 3.6 meters (11.9 feet). The shoulders were improved (i.e., bituminous) and measured 1.6 meters (5.3 feet) wide on both the east and west sides of the south leg. No curbs were present. Pavement markings consisted of a double solid yellow centerline for both north and southbound traffic, and solid white lane lines separated the turning lanes from the through lanes while the through lanes were divided by dashed white line. In addition, no edge lines were present. The estimated coefficient of friction was 0.70. On-colors, pre-timed, vertically mounted traffic control signals (i.e., six in all) were located so as to control each of the left-hand turn lanes and for all four of the through lanes. The posted speed limit was 64 km.p.h. (40 m.p.h.) for the north and south roadway. At the time of the crash the light condition was daylight, 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 2: Elevated view of case vehicle's damaged front with tapes indicating start of direct damage; Note: tape at front right corner shows impact with straight truck while tape toward front left side shows impact with the Ford (case photo #15)

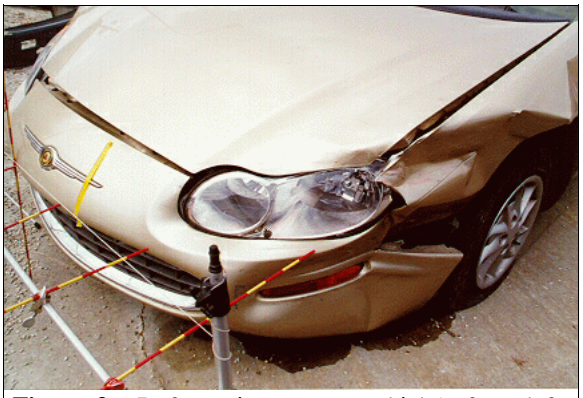


Figure 3: Deformation to case vehicle's front left corner from impact with the Ford; Note: yellow tape on bumper indicates start of direct damage (case photo #20)

Figure 4: Ford's damaged front from impact with case vehicle; Note: yellow tape indicates end of direct damage that extended from the Ford's right (case photo #62)

The front left of the case vehicle (**Figures 2** and **3**) was impacted by the front of the Ford (**Figure 4**), causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. As a result of this impact, the case vehicle was subsequently redirected in a northeasterly direction where its front right (**Figure 2** above and **Figure 5** below) impacted the

straight truck's left front corner (i.e., most likely left front rather than front left; however, the straight truck was not inspected). The case vehicle came to rest in the westbound left-hand turn lane on the east leg of the intersection, heading northeast. The Ford came to rest in the intersection heading east in the outside northbound through lane. The straight truck remained essentially in its pre-crash position.

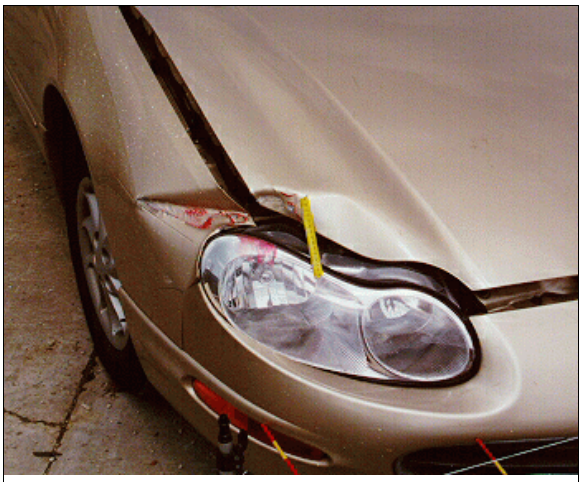


Figure 5: Close-up of underride damage to case vehicle's front right corner from impacting stopped the straight truck (case photo #32)

CASE VEHICLE

The 1999 Chrysler Concorde LX was a front wheel drive, five-passenger, four-door sedan (VIN: 2C3HD46R3XH------) equipped with a 2.7L, V-6 engine and a four-speed automatic transmission. Braking was achieved by a power-assisted, front disc and rear drum, four-wheel, anti-lock system. The case vehicle's wheelbase was 287 centimeters (113.0 inches), and the odometer reading at inspection was 30,644 kilometers (19,041 miles).

Inspection of the vehicle's interior revealed adjustable front bucket seats with adjustable head restraints; a non-adjustable back bench seat with separate back cushions and integral head restraints for the back outboard seating positions; continuous loop, three-point, lap-and-shoulder, safety belt systems at the front and back outboard positions; and a two-point, lap belt system at the back center position. The front seat belt systems were equipped with manually operated height adjusters for the "D"-rings, and the driver's adjuster was in the full-up position and the front right passenger's was in the full-down 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.

CASE VEHICLE DAMAGE

The case vehicle's initial contact was with the Ford and involved the front left corner. Direct damage began 18 centimeters (7.1 inches) to the left of the vehicle's center and extended, a measured distance of 55 centimeters (21.7 inches), along the front bumper toward the front left bumper corner. The case vehicle's front bumper sustained induced damage (Field L) from the vehicle's initial impact and the damage extended, a measured distance of 145 centimeters (57.1 inches) toward the front right bumper corner.

Figure 6: Case vehicle's left front corner showing direct damage extending back to hubcap of left front tire (case photo #25)

Maximum crush was measured as 8 centimeters (3.1 inches) at C_1. The direct damage also extended down the case vehicle's left side, a measured distance of 108 centimeters (42.5 inches) to the left front hub cap (**Figure 6** above). The case vehicle's secondary impact with the straight truck was an underride type impact to the front right corner above the bumper at the hood level (**Figure 5** above). Direct damage began 67 centimeters (26.4 inches) to the right of the vehicle's center and extended, a measured distance of 18 centimeters (7.1 inches) to the front right bumper corner. The maximum crush from this impact was approximately 7 centimeters (2.8 inches). The wheelbase on the case vehicle's left side was possibly shortened 1 centimeters (0.4 inches) while the right side was neither shortened nor extended. The case vehicle's front bumper fascia, hood, and right and left fenders were directly damaged and crushed rearward. The case vehicle's left front tire was physically restricted and deflated from the initial impact. Both the right and left headlight and turn signal assemblies sustained induced damage as well as both the right and left fenders. The left front wheel cover was directly damage as well.

Figure 7: Vertical view of case vehicle's front right passenger seating area showing deployed air bag; Note: highlighted contacts on right "A"-pillar and scuff on windshield (case photo #40)

Inspection of the case vehicle's interior revealed a blood spot on the armrest of the driver's door, which does not appear to be contact related; scuffs to the right windshield's glazing and right "A"-pillar from contact by the driver's left and right feet, respectively (**Figure 7**); and a contact to the case vehicle's fold-down center armrest/console from the front right passenger's torso (**Figure 8**). The rearview mirror was also askew possibly from contact with the front right passenger's left foot. The energy absorbing steering column showed no evidence of compression. The case vehicle's left and right back seat armrests were dented from being contacted by the luggage stacked in the vehicle's back seat.

Figure 8: Case vehicle's damaged center arm rest which was bent towards driver's seat from contact by front right passenger's torso (case photo #39)

Based on the vehicle inspection the CDCs for the case vehicle were determined to be: **11-FLEW-1** (**340** degrees) and **01-FRME-1** (**30** degrees). The WinSMASH reconstruction program, damage only algorithm, was used on the

case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 13.9 km.p.h. (8.6 m.p.h.), -13.1 km.p.h. (-8.1 m.p.h.), and +4.8 km.p.h. (+3.0 m.p.h.). This contractor believes these Delta V results to be borderline but reasonable. No reconstruction program was used on the case vehicle's second impact because the impact was out of scope (i.e., override with a vehicle that was out of scope); however, this contractor's visually estimated Delta V is between 5 km.p.h. (3 m.p.h.) and 11 km.p.h. (7 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 frontal impact with the Ford. The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of two irregular-shaped cover flaps made of thick vinyl. The top cover flap resembled a rounded rectangle with a horizontal dimension of 18 centimeters (7.1 inches) and a vertical dimension of 10 centimeters (3.9 inches). The bottom cover flap was trapezoidal in shape with overall dimensions of 13 centimeters (5.1 inches) at the top horizontal seam, 12 centimeters (4.7 inches) at the bottom horizontal seam, and 6 centimeters (2.4 inches) vertically. An inspection of the air bag module's cover flaps and air bag fabric revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with four tethers, each 10 centimeters (3.9 inches) wide, and sewn interiorly to the center at the 11, 1 5, and 7 o'clock positions. The driver's air bag had no vent ports. The deployed driver's air bag was round with a diameter 63 centimeters (24.8 inches). An inspection of the air bag's fabric revealed blood spots near the one and three o'clock positions and a large area of skin transfer, measuring approximately 18 x 8 centimeters (7.1 x 3.1 inches), readily apparent on the driver's air bag in the lower right quadrant angled obliquely toward the 4:30 o'clock position (**Figure 9**), both coming from the driver's left forearm.

Figure 9: Skin transfer centered on right lower quadrant of case vehicle's driver air bag from contact by driver's left forearm (case photo #50)

The front right passenger's air bag was located in the top of the instrument panel. There was a single, essentially rectangular, modular tethered cover flap. The cover flap was made of a thick vinyl over a thick cardboard type frame. The flap's dimensions were: 28 centimeters (11.0 inches) at the forward horizontal seam and 18 centimeters (7.1 inches) along both vertical seams. 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 flap and air bag fabric revealed that the cover flap opened at the designated tear points, and there was evidence of damage during the deployment to the module's cover flap (i.e., deformed by contact with the front right passenger's left leg–**Figure 10** below). The deformation was located 11 centimeters (4.3 inches) inward from

Figure 10: Deformation to case vehicle front right air bag module's cover flap from contact with front right passenger's left leg (case photo #56)

the right edge of the cover flap, and the deformation was approximately 9 centimeters (3.5 inches) wide. Furthermore, there were several areas of black scuffs and streaks beginning on the top surface of the air bag's fabric indicating that the air bag's deployment path had been restricted from the front right passenger's left leg. The front right passenger's air bag was designed with two tethers, each 7.5 centimeters (3.0 inches) wide, sewn into the center of the front surface near the 3 and 9 o'clock positions (i.e., 7 centimeters (2.8 inches) inward from the side edges and 32 centimeters (12.6 inches) down from the top stitching). The front right air bag had two vent ports, approximately 5 centimeters (2.0 inches) in diameter, located at the 10 and 2 o'clock positions. The deployed front right air bag was rectangular with a height of approximately 62 centimeters (24.4 inches) and a width of approximately 47 centimeters (18.5 inches). An inspection of the front right air bag's fabric did not reveal any obvious evidence of occupant contact to the air bag's front surface (**Figure 7** above).

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

Immediately prior to the crash the case vehicle's front right passenger [i.e., mother of driver; 163 centimeters and 59 kilograms (64 inches, 130 pounds)] was seated in a reclined posture with her back angled against the seat back and center arm rest, both legs atop the instrument panel angled toward the right "A"-pillar, and both hands on her lap. According to the case vehicle's driver (i.e., son), her seat track was located in its forward-most position, and the seat back was sightly reclined. During the vehicle inspection, the front right seat was position at its rearmost position but had most likely been moved rearward during this occupant's extrication.

The case vehicle's front right passenger was not wearing her available, active, three-point, lap-and-shoulder, safety belt system. In addition, there was no evidence of belt pattern bruising and/or abrasions to the front right passenger's body, and the inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading.

The case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the nonuse of her available safety belts, the front right passenger's pre-impact body position did not change just prior to impact. The case vehicle's impact with the Ford enabled the front right passenger's torso continued forward and to the left, towards the **340** degree Direction of Principal Force, as the case vehicle decelerated. Because of her pre-crash posture (i.e., her left foot atop the right edge of the air bag module's cover flap, right foot just to the right of the cover flap), the impact caused the passenger's left leg to slide slightly upwards and to the left, directly atop and slightly to the right of center of the front right air bag module's cover flap, just prior to deployment. The deploying air bag module's cover flap lifted her left leg upwards and leftwards,

and her right leg was redirected by the deploying air bag's fabric to the right against the right "A"-pillar. In essence, the deploying air bag spread the front right passenger's legs as it expanded. As the case vehicle was redirected to the northeast (i.e., rightward), the unrestrained, front right passenger moved leftward. The combination of the **340** degree Direction of Principal Force on the front right occupant's position, the leftward movement of the front right passenger in response to the case vehicle's rightward redirection, and possibly the rotation effect on her torso of her right leg being redirected toward the right "A"-pillar caused the front right passenger to load and dislodge the center arm rest (**Figure 8** above). Upon impacting the left front corner of the straight truck, the front right passenger's pelvic area moved forwards (i.e., probably submarining, upper torso moving backwards) and slightly to her right. At final rest, the front right passenger's pelvic area and torso remained in her seat with her legs spread apart, still atop the dash, with the air bag module's cover flap and deployed air bag between them.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right occupant was transported by ambulance to the hospital. She sustained moderate injuries and was hospitalized for 5 days post-crash. According to the case vehicle's driver and her medical records, the injuries sustained by the front right passenger included: a trimalleolar fracture to her left ankle and a segmented fracture of her left fibula. Both of these fractures were caused from contact by the front right passenger air bag module's cover flap.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Fracture, trimalleolar, left ankle, not further specified	851612.2 moderate	Front right module's cover flap	Certain	Hospitalization records
2	Fracture, segmented, left fibula, not further specified	851605.2 moderate	Front right module's cover flap	Probable	Emergency room records

CASE VEHICLE DRIVER KINEMATICS

The case vehicle's driver [56-year-old, White (non-Hispanic) male; 175 centimeters and 77 kilograms (69 inches, 170 pounds)] was seated in an upright posture with his back against the seat back, his left foot on the floor, his right foot on the accelerator, and both hands on the steering wheel. His seat track was located in its rearmost position, the seat back was upright, and the 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. However, there was no evidence of belt pattern bruising and/or abrasions to the driver's body, but the inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed evidence that was consistent with usage during this crash.

The case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the use of his available safety belts, the driver's pre-impact body position did not change just prior to impact. The case vehicle's impact with the Ford enabled the driver continued forward and to the left, towards the **340** degree Direction of Principal Force, as the case vehicle decelerated. The initial impact resulted in the case vehicle being redirected to the northeast and, as a result, the steering wheel rotated rapidly to the right allowing the right lower quadrant of the deploying air bag's fabric to contact the driver's left forearm. As the case vehicle was redirected to the northeast (i.e., rightward), the air bag knocked the restrained driver backwards toward his seat back while the redirection caused the driver to moved leftward toward the interior surface of the driver's door. Upon impacting the left front corner of the straight truck, the driver moved forwards and slightly to his right. At final rest, the driver remained in his seat near his original seating position.

CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to the hospital, primarily for the purpose of accompanying the front right passenger (i.e., mother). He sustained minor injuries and was treated and released. According to the case vehicle's driver, his self-reported injuries included: a large abrasion and a small laceration to his left forearm.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Abrasion left forearm, not further specified	790202.1 minor	Air bag, driver's	Probable	Interviewee (same person)
2	Laceration {cut}, small, left forearm	790602.1 minor	Air bag, driver's	Probable	Interviewee (same person)

1ST OTHER VEHICLE

The 1995 Ford Windstar GL was a front wheel drive, 4 x 2, seven-passenger, three-door minivan (VIN: 2FMDA5141SB------) equipped with a 3.8L, V-6 engine and a four-speed automatic transmission. Braking was achieved by a power-assisted, front disc and rear drum, four-wheel, anti-lock system. The Ford's wheelbase was 307 centimeters (120.7 inches), and the odometer reading at inspection was 18,691 kilometers (11,614 miles).

Inspection of the vehicle's interior revealed an adjustable front bucket seats with integral head restraint for the driver and an adjustable box-mounted bucket seat with integral head restraint for the driver. There was a two seat bench for the center row and a three seat, a non-adjustable, back bench seat for the back row. Neither of the bench seats had head restraints. Continuous loop, three-point, lap-and-shoulder, safety belt systems were provided for the front, center, and back outboard positions, and a two-point, lap belt system at the back center position. The vehicle was equipped with knee bolsters for both the driver and front right passenger. Automatic restraint

was provided by a Supplemental Restraint System (SRS) that consisted of a frontal air bag for the driver and front right passenger seating positions. Both frontal air bags deployed as a result of this vehicle's frontal impact with the case vehicle.

The Ford's contact with the case vehicle involved its entire front. Direct damage began 40 centimeters (15.7 inches) to the left of the Ford's center (**Figure 4** above) and extended, a measured distance of 117 centimeters (46.1 inches), along the front to the front right bumper corner. Residual maximum crush was measured as 20 centimeters (7.9 inches) between C_2 and C_3. The wheelbase on the Ford's left side was shortened 5centimeters (2.0 inches) while the right side was possibly extended 1 centimeter (0.4 inches). The Ford's front bumper (**Figure 11**), bumper fascia, grille, right turn signal assembly, and hood were directly damaged and crushed rearward (**Figure 4** above). None of the Ford's tires were physically restricted or deflated from the crash. The right headlight and the left headlight and turn signal assemblies sustained induced damage as well as the hood and both the right and left fenders.

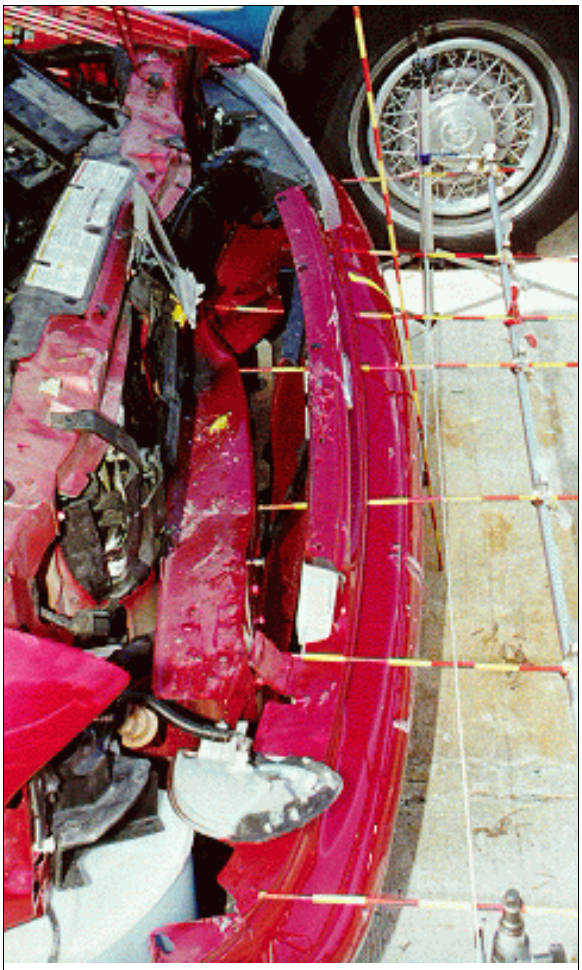


Figure 11: Elevated reference line view of deformation to the Ford's front reinforcement bar (case photo #67)

Figure 12: Vertical view of Ford's driver seating area showing deployed air bag with evidence (i.e., blood) of contact (case photo #75)

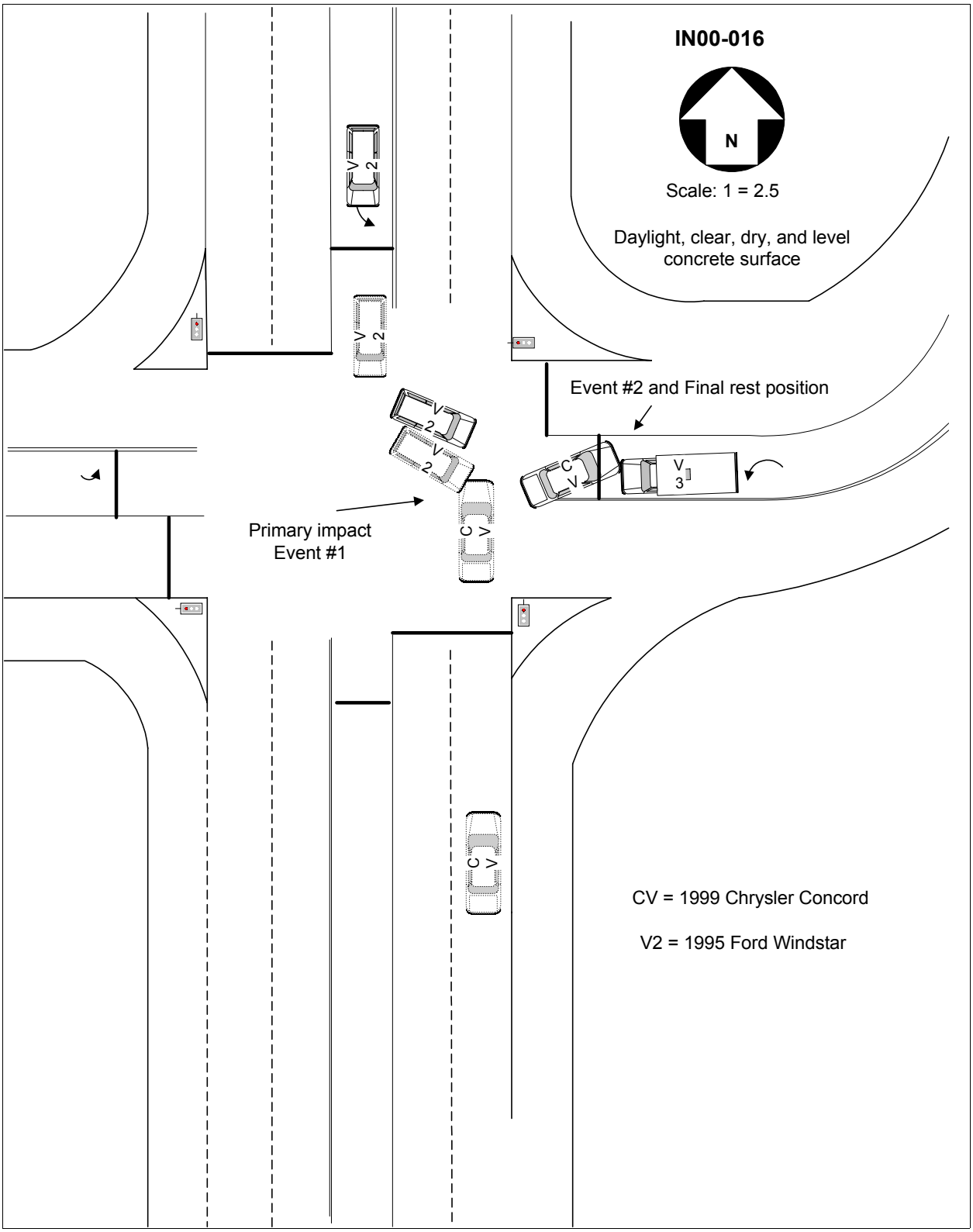
Based on the vehicle inspection, the CDC for the Ford was determined to be: **01-FDEW-2** (**40** degrees). The WinSMASH reconstruction program, damage only algorithm, was used on the Ford's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively:

13.8 km.p.h. (8.6 m.p.h.), -10.6 km.p.h. (-6.6 m.p.h.), and -8.9 km.p.h. (-5.5 m.p.h.). The Ford was towed due to damage.

An inspection of the Ford's interior revealed that there was contact evidence (**Figure 12** above) readily apparent on the Ford's driver air bag. The Ford's driver [89-year-old, White (non-Hispanic) female; unknown height and weight] was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The driver was transported by ambulance to the hospital. She sustained non-incapacitating-evident ("B") injuries but her treatment status and injuries are unknown.

2ND OTHER VEHICLE

The 1999 International 4700 was a rear wheel drive, unknown-passenger, two-door straight truck (VIN: 1HTSCAAN0XH------) equipped with a 7.6L, IL-6 engine and a unknown-speed manual or automatic transmission. The straight truck was equipped with a cherry picker attachment. The straight truck's braking system, wheelbase, and odometer are unknown because the truck was not inspected. With no available photographs of its damage, the TDC for the straight truck is unknown. The straight truck was driven from the scene.


IN00-016
N
Scale: 1 = 2.5
Daylight, clear, dry, and level concrete surface
Event #2 and Final rest position
Primary impact
Event #1
CV = 1999 Chrysler Concord
V2 = 1995 Ford Windstar