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### ON-SITE CERTIFIED ADVANCED 208- COMPLIANT VEHICLE INVESTIGATION

CASE NUMBER - IN-03-048  
LOCATION - TEXAS  
VEHICLE - 2003 CHEVROLET K1500 SUBURBAN Z71  
CRASH DATE - October 2003

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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. <i>Supplementary Notes</i> On-site air bag deployment investigation involving a 2003 Chevrolet K1500 Suburban Z71, four-door utility vehicle, with manual safety belts and dual front advanced air bags, and a 1997 Ford Contour GL, four-door sedan					
16. <i>Abstract</i> This report covers an {on-site/remote} investigation of an air bag deployment crash that involved a 2003 Chevrolet Suburban Z71 (case vehicle) and a 1997 Ford Contour GL (other vehicle). This crash is of special interest because the case vehicle was equipped with multiple <b>A</b> dvanced <b>O</b> ccupant <b>P</b> rotection <b>S</b> ystem ( <b>AOPS</b> ) features, including certified advanced 208-compliant air bags, as well as an <b>E</b> vent <b>D</b> ata <b>R</b> ecorder ( <b>EDR</b> ) and case vehicle's driver (43-year-old, male) sustained only a minor injury from his deploying driver air bag. The trafficway on which both vehicles were traveling was essentially an eight-lane, divided, state highway, traversing in an east-southeasterly and west-northwesterly direction. On the western leg of the intersection, both the eastern and western roadways had three through lanes while the eastern roadway had one left-hand and one right-hand turn lane. On the eastern leg of the intersection, both the eastern and western roadways had three through lanes while the western roadway had one left-hand turn lane. Both roadways were curved. The case vehicle was navigating a left-hand curve in the inside eastern through lane and was approaching a controlled three-leg intersection. The Ford had been navigating a right-hand curve in the left-hand turn lane prior to the Tee intersection, and was making a left-hand turn. The crash occurred in the inside eastern through lane, within the three-leg intersection of the two trafficways. The front of the case vehicle impacted the right front of the Ford, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. As a result of the impact, the case vehicle was redirected approximately 15 degrees to the right while the Ford rotated approximately 150 degrees counterclockwise and side slapped the left side of the case vehicle with its right rear corner. The case vehicle's driver was seated with his seat track located in its rearmost position, and the tilt steering wheel was located in its upmost position. The front right passenger (interviewee; 40-year-old, female) was seated with her seat track located in its middle position. Both front occupants were restrained by their available, active, three-point, integrated lap-and-shoulder, safety belt system. The second seat passengers (left-8-year-old, male; right-10-year-old, male) were seated on a non-adjustable bench seat and were restrained by their available, active, three-point, lap-and-shoulder, safety belt systems. According to the interviewee, the driver sustained an abrasion to his left wrist and a contusion to his left knee. The front right passenger sustained a left hip bruise, and neither second seat passenger sustained any injuries as a result of this crash.					
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This investigation was brought to NHTSA's attention on November 26, 2003 by NASS GES sampling activities. This crash involved a 2003 Chevrolet Suburban Z71 (case vehicle) and a 1997 Ford Contour GL (other vehicle). The crash occurred in October 2003 at an unknown time but prior to 1:36 p.m., in Texas and was investigated by the applicable city police department. This crash is of special interest because the case vehicle was equipped with multiple Advanced Occupant Protection System (AOPS) features, including certified advanced 208-compliant air bags, as well as an Event Data Recorder (EDR) and case vehicle's driver [43-year-old, White (non-Hispanic) male] sustained only a minor injury from his deploying driver air bag. This contractor inspected case vehicle on December 2, 2003 and downloaded the data from the onboard **EDR**. The scene inspection was completed on December 3, 2003. This contractor interviewed the case vehicle's front right passenger (i.e., wife of driver and mother of back seat occupants) on December 29, 2003. This report is based on the Police Crash Report, an interview with the case vehicle's front right passenger, scene and vehicle inspections, occupant kinematic principles, interviewee-reported injury information, and this contractor's evaluation of the evidence.

## SUMMARY

### *Crash Environment:*

The trafficway on which both vehicles were traveling was essentially an eight-lane, divided, state highway, traversing in an east-southeasterly and west-northwesterly direction, and the case vehicle was approaching a three-leg (i.e., Tee) intersection. On the western leg of the intersection, both the eastern and western roadways had three through lanes while the eastern roadway had one left-hand and one right-hand turn lane. On the eastern leg of the intersection, both the eastern and western roadways had three through lanes while the western roadway had one left-hand turn lane. Both roadways were curved. The trafficway into which the other vehicle was turning was a five-lane, undivided, city street, traversing in a generally north-south direction. At the time of the crash the light condition was daylight, the atmospheric condition was clear and/or cloudy, and the road pavement was dry; see **CRASH DIAGRAM** at end.

### *Pre-Crash:*

The case vehicle was navigating a left-hand curve, traveling east-southeastward in the inside eastern through lane, and was approaching a controlled three-leg intersection. The Ford had been navigating a right-hand curve, traveling west-northwestward in the left-hand turn lane prior to the Tee intersection, and was making a left-hand turn. The case vehicle's driver steered slightly to the right, attempting to avoid the crash. The crash occurred in the inside eastern through lane, within the three-leg intersection of the two trafficways.

### *Crash:*

The front of the case vehicle impacted the right front of the Ford, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. Based on the downloaded **EDR** data only one stage of the multi-stage air bags was activated.

***Post-Crash:***

As a result of the impact, the case vehicle was redirected approximately 15 degrees to the right while the Ford rotated approximately 150 degrees counterclockwise and side slapped the left side of the case vehicle (i.e., primarily to its left rear door area) with its right rear corner. After the side slap event, the case vehicle continued in a southeastward direction, rolling to a stop near the eastern corner of the intersection, heading in a southeastern direction. The Ford continued to rotate counterclockwise, a total of approximately 310 degrees from its heading during its initial impact with the case vehicle and came to a rest facing west-northwest in the intersection of the two trafficways. The case vehicle and the Ford were **both** towed due to damage.

***Case Vehicle:***

The 2003 Chevrolet Suburban Z71 was a four wheel drive (4x4), four-door utility vehicle (VIN: 3GNFK16Z83G-----) and was **CERTIFIED ADVANCED 208-COMPLIANT**. The case vehicle was equipped with four wheel, anti-lock brakes, dual stage driver and front right passenger air bag inflators, and a driver seat belt sensing system. Furthermore, there was an occupant detection and automatic air bag suppression system for the front right passenger seating position. Front seat back-mounted side impact air bags were optional for this model, but this vehicle was not so equipped. This vehicle was equipped with LATCH system features and power-adjustable pedals, with controls on the left front door panel. Because there was no electrical power to the vehicle, the exact position of the pedals could not be determined. Finally, the case vehicle was also equipped with an **Event Data Recorder (EDR)**. The case vehicle's driver and front right passenger supplemental restraints (air bags) deployed as a result of the frontal impact.

***Vehicle Exterior:***

Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **11-FDEW-2 (340 degrees)** for its initial impact with the Ford and **09-LPEW-1 (270 degrees)** for the side slap impact. The WinSMASH reconstruction program, missing vehicle algorithm, was used on both of the case vehicle's impacts. For the highest severity impact to the case vehicle, the Total, Longitudinal, and Lateral Delta Vs are, respectively: 20.0 km.p.h. (12.4 m.p.h.), -18.8 km.p.h. (-11.7 m.p.h.), and +6.8 km.p.h. (+4.2 m.p.h.). For the second highest severity (i.e., side slap) impact to the case vehicle, the Total, Longitudinal, and Lateral Delta Vs are, respectively: 3.0 km.p.h. (1.9 m.p.h.), 0.0 km.p.h. (0.0 m.p.h.), and +3.0 km.p.h. (+1.9 m.p.h.). Based on the vehicle inspection and the data from the **EDR**, this collision fits the reconstruction model, but the results appear to be high.

***Crash Data Recording:***

The data downloaded from the case vehicle's **EDR** showed that the driver's seat belt buckle status was buckled, the second stage of the multi-stage air bags was not activated, and the Delta V reached a value of 14.47 km.p.h. (8.99 m.p.h.) at the 110 millisecond mark of recorded data.

***Other Vehicle:***

The 1997 Ford Contour GL was a front wheel drive, four-door sedan (VIN: 3FALP6531VM-----). The Ford was equipped with driver and front right passenger air bags and, according to the Police Crash Report, they deployed during this vehicle's crash sequence.

**Case Vehicle's Driver:**

The driver of the crash the case vehicle's driver (43-year-old, male) was seated with his seat track located in its rearmost position and, during the vehicle inspection, the tilt steering wheel was located in its upmost position. He was also restrained by his available, active, three-point, integrated lap-and-shoulder, safety belt system; the belt system was not equipped with a pretensioner. The driver sustained, according to the interview with the front right passenger (i.e., wife), only minor injuries which included: an abrasion [i.e., friction burn-7-10 centimeters in diameter (3-4 inch)] to the inside of his left wrist from his deploying air bag and a contusion to his left knee, most likely caused by contact to the knee bolster.

**Case Vehicle's Front Right Passenger:**

The case vehicle's front right passenger (i.e., wife of driver and mother of second seat passengers; 40-year-old, White female) was seated with her seat track located in its middle position and was restrained by her available, active, three-point, integrated lap-and-shoulder, safety belt system; the belt system was not equipped with a pretensioner. She sustained, according to her interview, minor injuries which consisted of a left hip bruise as well as neck and back pain.

**Case Vehicle's Second Seat Left Passenger:**

The second seated left passenger (i.e., son; 8-year-old, male) was seated, but the seat track was not adjustable. Furthermore, he was restrained by his available, active, three-point, lap-and-shoulder, safety belt system; the belt system was not equipped with a pretensioner. According to the interview with the front right passenger, the second seat left passenger did not sustain any injuries as a result of this crash.

**Case Vehicle's Second Seat Right Passenger:**

The second seated right passenger (i.e., son; 10-year-old, male) was seated, but the seat track was not adjustable. Likewise, he was restrained by his available, active, three-point, lap-and-shoulder, safety belt system; the belt system was not equipped with a pretensioner. According to the front right passenger, he also did not sustain any injuries as a result of this crash.

**CRASH CIRCUMSTANCES**

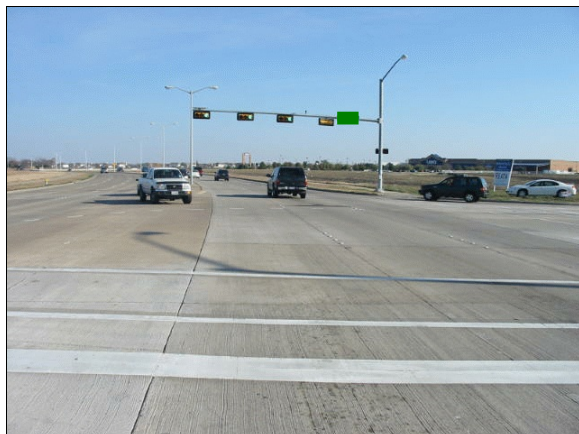
**Crash Environment:** The trafficway on which both vehicles were traveling was essentially an eight-lane, divided, state highway, traversing in an east-southeasterly and west-northwesterly direction (**Figure 1**), and the case vehicle was approaching a three-leg (i.e., Tee) intersection (**Figure 2** below). On the western leg of the intersection, both the eastern and western roadways had three through lanes while the eastern roadway had one left-hand and one right-hand turn lane (**Figure 1**). On the eastern leg of the intersection, both the



**Figure 1:** Case vehicle's east-southeasterly travel path in inside through lane of eastern roadway, approaching four-leg intersection; Note: left-hand curvature, beginning of left-hand turn lane, and beginning (arrow) of right-hand turn lane (case photo #01)



eastern and western roadways had three through lanes (**Figure 2**) while the western roadway had one left-hand turn lane (**Figure 3**). Both roadways were curved (**Figure 1**).



**Figure 2:** Case vehicle's east-southeasterly travel path in inside through lane of eastern roadway into impact area with Ford which was turning left similar to vehicle shown above (case photo #03)



**Figure 3:** Ford's west-northwesterly travel path in right-hand curve just prior to entering four-leg intersection; Note: arrow indicates approximate area of impact with case vehicle (case photo #08)

The trafficway into which the other vehicle was turning was a five-lane, undivided, city street, traversing in a generally north-south direction. The state highway was curved slightly to the left for east-southeastbound traffic and was level near the area of impact. The pavement was concrete, and the width of the inside east-southeasterly lane was 3.4 meters (11.2 feet) while the width of the west-northwesterly left-hand turn lane was approximately 3.3 meters (10.8 feet). On both the eastern and western legs of the intersection, the eastern and western roadways were bordered by barrier curbs and, as a result, the shoulders were not improved (i.e., grass). On both eastern and western legs of the intersection, the roadways were separated by an unprotected raised paved concrete median which measured approximately 1.9 meter (6.2 feet) in width. Pavement markings for the easterly roadway on the western leg of the intersection consisted only of raised pavement markers which were used to separate the three through lanes and the right-hand turn lane. The left-hand turn lane was brand-new concrete and no lane markings had yet been added (**Figure 1** above). Furthermore, traffic in the left-hand turn lane had nowhere to turn, except for a U-turn, because no northern leg of the intersection currently existed.

Pavement markings for the westerly roadway on the eastern leg of the intersection consisted only of raised pavement markers which were also used to separate the three through lanes and the left-hand turn lane (**Figure 2**). In addition, no painted center lines or edge lines were present. The estimated coefficient of friction was 0.70 for the case vehicle's travel lane and 0.80 for the Ford's left-hand turn lane. Traffic controls consisted of three, on-colors, pre-timed, horizontal mounted traffic control signals located across the intersection for each of the respective directions of travel (i.e., on the southeastern quadrant of the intersection for easterly travel and on the northwestern quadrant for westerly travel). The statutory speed limit was 64 km.p.h. (40 m.p.h.). No regulatory speed limit sign was posted near the crash site. At the time of the crash the light condition was daylight, the atmospheric condition was clear and/or cloudy, and the road pavement was dry. Traffic density was not determined, and the site of the crash was primarily urban undeveloped; see **CRASH DIAGRAM** at end.

**Pre-Crash:** The case vehicle was navigating a left-hand curve, traveling east-southeastward in the inside eastern through lane (**Figure 1** above), and was approaching a controlled three-leg intersection, intending to continue in its eastern direction of travel (**Figure 2** above). The Ford had been navigating a right-hand curve, traveling west-northwestward in the left-hand turn lane prior to the Tee intersection (**Figure 3** above), and was making a left-hand turn, intending to travel south on the intersecting trafficway. The case vehicle's driver steered slightly to the right, attempting to avoid the crash. The crash occurred in the inside eastern through lane, within the three-leg intersection of the two trafficways.

**Crash:** The front (**Figure 4** and **Figure 5**) of the case vehicle impacted the right front of the Ford, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. Based on the downloaded **EDR** data only one stage of the multi-stage air bags was activated.

**Post-Crash:** As a result of the impact, the case vehicle was redirected approximately 15 degrees to the right while the Ford rotated approximately 150 degrees counterclockwise and side slapped the left side of the case vehicle (i.e., primarily to its left rear door area—**Figure 6**) with its right rear corner. After the side slap event, the case vehicle continued in a southeastward direction, rolling to a stop near the eastern corner of the intersection, heading in a southeastern direction. The Ford continued to rotate counterclockwise, a total of approximately 310 degrees from its heading during its initial impact with the case vehicle and came to a rest facing west-northwest in the intersection of the two trafficways.

#### CASE VEHICLE

The 2003 Chevrolet Suburban Z71 was a four wheel drive (4x4), eight-passenger, four-door utility vehicle (VIN: 3GNFK16Z83G-----) equipped with a 5.3L, V-8 engine and a four-speed automatic transmission. Braking was achieved by a power-assisted, front and rear disc, four-wheel, anti-lock system. The case vehicle's



**Figure 4:** Case vehicle's frontal damage from impact with Ford; Note: contour gauge positioned at bumper level (case photo #11)



**Figure 5:** Case vehicle's frontal damage from impact with Ford viewed from left of front with contour gauge set at bumper level (case photo #13)



**Figure 6:** Case vehicle's side slap damage, primarily to left rear door (case photo #16)

wheelbase was 330 centimeters (130.0 inches), and the odometer reading at inspection is unknown because the case vehicle was equipped with an electronic odometer. The case vehicle was **CERTIFIED ADVANCED 208-COMPLIANT** and was equipped with dual stage driver and front right passenger air bag inflators, and a driver seat belt sensing system. Furthermore, there was an occupant detection and automatic air bag suppression system for the front right passenger seating position. Front seat back-mounted side impact air bags were optional for this model, but this vehicle was not so equipped. The various sensors in the case vehicle's advanced occupant restraint system analyze a combination of factors including the predicted crash severity and driver and front right passenger seat belt usage to determine the front air bag inflation level appropriate for the severity of the crash. For the front right seating position, an occupant pressure sensor and a seat belt tension sensor provide data to the electronic control module. The electronic control module (a) compares the seat pressure and seat belt tension data to threshold values, (b) determines if the front right air bag should be suppressed or enabled, and (c) communicates the decision to the air bag control module. The air bag will be suppressed when the seat pressure is at or below the established threshold *or* there is above normal tension on the safety belt (e.g., a secured child seat). The air bag will be enabled if the pressure is above the threshold *and* the seat belt tension is normal (e.g., a restrained adult occupant) or below (e.g., unrestrained occupant). This vehicle was equipped with LATCH system features and power-adjustable pedals, with controls on the left front door panel (**Figure 7**). Because there was no electrical power to the vehicle, the exact position of the pedals could not be determined (**Figure 8**). Finally, the case vehicle was also equipped with an **Event Data Recorder (EDR)**.



**Figure 7:** Buttons on interior surface of case vehicle's driver door controlling adjustable foot pedals (case photo #45)



**Figure 8:** Adjustable foot controls for case vehicle's driver—exact position of pedals is unknown (case photo #46)

Inspection of the vehicle's interior revealed adjustable front bucket seats with adjustable head restraints; a non-adjustable second row split bench seat with folding backs and adjustable head restraints for the second row outboard seating positions and an integral head restraint for the second seat center position; a non-adjustable back bench seat with folding backs and adjustable head restraints for the back outboard seating positions; continuous loop, three-point, lap-and-shoulder, integrated safety belt systems at the front and second seat center seating positions; continuous loop, three-point, lap-and-shoulder, safety belts at the second row and back outboard seating positions; and a two-point, lap belt system at the back center position. The case vehicle



was not equipped with any upper anchorage adjusters. The vehicle was equipped with knee bolsters for both the driver and front right passenger, neither of which showed evidence of occupant contact or deformation. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of dual stage frontal air bags 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**

**Exterior Damage:** The case vehicle’s initial contact with Ford involved its front (Figures 4 and 5 above). Direct damage began at the front left bumper corner and extended inward 116 centimeters (45.7 inches), along the front bumper. Residual maximum crush was measured as 31 centimeters (12.2 inches) at C<sub>3</sub> (Figure 9). The table below shows the case vehicle’s crush profile.



Figure 9: Overhead view of frontal damage to case vehicle from impact with Ford (case photo #23)

Units	Event	Direct Damage		Field L	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	C <sub>5</sub>	C <sub>6</sub>	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	116	31	176	1	14	31	12	0	0	-20	0
in		45.7	12.2	69.3	0.4	5.5	12.2	4.7	0.0	0.0	-7.9	0.0
cm	2	42	5	103	2	3	3	5	3	2	-19	-50
in		16.5	2.0	40.6	0.8	1.2	1.2	2.0	1.2	0.8	-7.5	-19.7

The wheelbase on the case vehicle’s left side was shortened by approximately 1 centimeter (0.4 inches) while the right side was extended approximately 2 centimeters (0.8 centimeters). The case vehicle’s side slap contact with the Ford involved its left side (Figure 6 above). Direct damage began 125 centimeters (49.2 inches) forward from the left rear axle and extended 42 centimeters (16.5 inches) forward along the left side. The Field L began 64 centimeters (25.2 inches) forward from the left rear axle and extended 103 centimeters (40.6 inches) forward along the left side. Residual maximum crush was measured as 5 centimeters (2.0 inches) at C<sub>4</sub> (Figure 10). The table above shows the case vehicle’s crush profile.

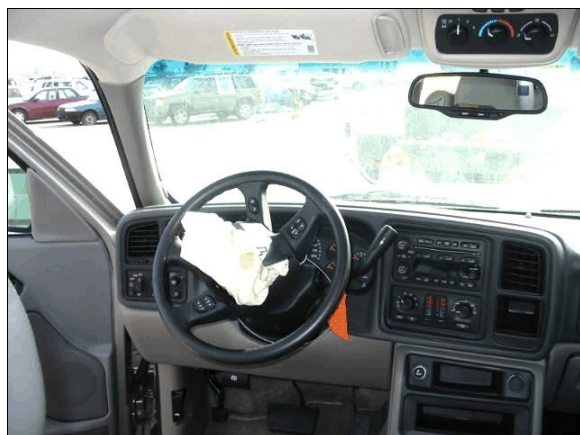


Figure 10: Overhead view of side slap damage, primarily to case vehicle’s left rear door (case photo #15a)

From the frontal impact, the case vehicle’s front bumper, bumper fascia, grille, hood, and right headlight and turn signal assemblies were directly damaged and crushed rearward. For the side impact, the left rear door was directly damaged and crushed inward. In addition, for the frontal impact, there was induced damage to the left headlight and turn signal assemblies as well as the hood, and both the right and left fenders. For the side slap impact, there was induced damage to the left front and left rear doors. No obvious induced damage or remote buckling was noted to the remainder of the case vehicle’s exterior.

The case vehicle manufacturer’s recommended tire size was: P265/70R17; the case vehicle was equipped with tire size: P265/70R17. The case vehicle’s tire data are shown in the table below.

Tire	Measured Pressure		Recommend Pressure		Tread Depth		Damage	Restricted	Deflated
	kpa	psi	kpa	psi	milli-meters	32 <sup>nd</sup> of an inch			
LF	159	23	207	30	11	14	None	Yes	No
RF	152	22	207	30	10	13	None	No	No
LR	152	22	207	30	10	13	None	No	No
RR	152	22	207	30	10	13	None	No	No



**Figure 11:** Case vehicle’s driver seating area showing deployed driver air bag and no apparent evidence of occupant contact (case photo #27)



**Figure 12:** Case vehicle’s front right seating area showing deployed front right passenger air bag and no apparent occupant contact evidence (case photo #29)

**Interior Damage:** Inspection of the case vehicle’s interior revealed that there was no evidence of occupant contact on the interior surfaces of the case vehicle (**Figures 11 and 12 and Figure 13** below). Finally, there was no evidence of intrusion to the case vehicle’s interior, no evidence of compression to the energy absorbing shear capsules in the steering column, and no deformation to the steering wheel rim.

**Damage Classification:** Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **11-FDEW-2 (340 degrees)** for its initial impact with the Ford and **09-LPEW-1 (270 degrees)** for the side slap impact. The WinSMASH reconstruction program, missing vehicle algorithm, was used on both of the case vehicle's impacts. For the highest severity impact to the case vehicle, the Total, Longitudinal, and Lateral Delta Vs are, respectively: 20.0 km.p.h. (12.4 m.p.h.), -18.8 km.p.h. (-11.7 m.p.h.), and +6.8 km.p.h. (+4.2 m.p.h.). For the second highest severity (i.e., side slap) impact to the case vehicle, the Total, Longitudinal, and Lateral Delta Vs are, respectively: 3.0 km.p.h. (1.9 m.p.h.), 0.0 km.p.h. (0.0 m.p.h.), and +3.0 km.p.h. (+1.9 m.p.h.). Based on the vehicle inspection and the data from the **EDR**, this collision fits the reconstruction model, but the results appear to be high. The case vehicle was towed due to damage.



**Figure 13:** Case vehicle's second seating area viewed from right showing no apparent evidence of occupant contact and second seat center's integrated three-point lap and shoulder safety belt system (case photo #51)

#### AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained dual stage 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. Based on the **EDR** data, only 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 asymmetrical, essentially, "I"-configuration cover flaps made of thick vinyl. Both the left and right flaps were trapezoidal in shape with overall dimensions of 14.5 centimeters (5.7 inches) at the top horizontal seam, 10 centimeters (3.9 inches) at the bottom horizontal seam, and 12 centimeters (4.7 inches) vertically along the seam that separated the two flaps. An inspection of the air bag module's cover flaps and the air bag's fabric revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with two tethers, each approximately 11 centimeters (4.3 inches) in width. The driver's air bag had two vent ports, approximately 3 centimeters (1.2 inches) in diameter, located at the 10 and 2 o'clock positions. The deployed driver's air bag was round with a diameter of 65 centimeters (25.6 inches). The distance between the mid-center of the driver's seat back, as

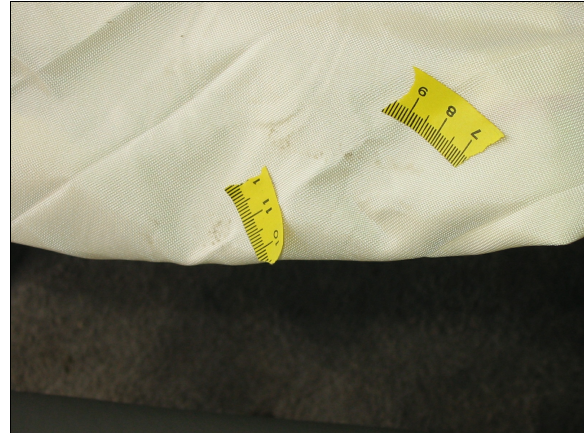


**Figure 14:** Case vehicle's deployed driver air bag showing only slight scuff near 1 o'clock position; Note: air bag rotated approximately 140 degrees clockwise (case photo #33)



positioned at the time of the vehicle inspection, and the front surface of the air bag's fabric at full excursion was 43 centimeters (16.9 inches). An inspection of the driver's air bag fabric revealed a slight transfer on the upper right portion of the air bag's fabric, near the 1 o'clock position (**Figure 14** above and **Figure 15**).

The front right passenger's air bag was located in the middle of the instrument panel. There was a single, essentially rectangular, modular cover flap. The cover flap was made of a thick vinyl over a thick cardboard type frame. The flap's dimensions were 38.5 centimeters (15.2 inches) at the lower horizontal seam and 14.5 centimeters (5.7 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 the air bag's fabric revealed that the cover flap opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flap. The front right passenger's air bag was designed with one wide tether, approximately 47 centimeters (18.5 inches) in width. The front right air bag had two vent ports, approximately 3 centimeters (1.2 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 68 centimeters (26.8 inches) and a width of approximately 49 centimeters (19.3 inches). The distance between the mid-center of the front right seat back, as positioned at the time of the vehicle inspection, and the front surface of the air bag's fabric at full excursion was 40 centimeters (15.7 inches). An inspection of the front right passenger's air bag fabric revealed no contact evidence readily apparent on the front right air bag's fabric (**Figure 16**).



**Figure 15:** Close-up of scuff on case vehicle's deployed driver air bag near 1 o'clock position (case photo #34)



**Figure 16:** Case vehicle's deployed front right passenger air bag showing no apparent evidence of occupant contact on front surface (case photo #38)

## CRASH DATA RECORDING

The data downloaded from the case vehicle's **EDR** showed the vehicle's SIR warning lamp status, driver's seat belt buckle status, ignition cycles at deployment, time from algorithm enable to deployment (i.e., air bag deployments) for both of the system's first and second stages, and the vehicle's speed and brake switch status for the five recorded sample periods preceding the **ALGORITHM ENABLE**. In addition, the vehicle's velocity change (i.e., Delta V) is reported. Downloaded data of interest indicated the following. The case vehicle was traveling at a speed of 72 km.p.h. (45 m.p.h.), the driver's seat belt status showed it was buckled, the second stage

of the multi-stage air bags was not activated, and the Delta V reached a value of 14.47 km.p.h. (8.99 m.p.h.) at the 110 millisecond mark of recorded data; see **EVENT DATA RECORDER DATA (Figures 21 through 23)** below. This contractor believes that the recorded Delta V seems reasonable considering the collision dynamics and amount of deformation to the case vehicle's front.

#### CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash the case vehicle's driver [43-year-old, White (non-Hispanic) male; 185 centimeters and 113 kilograms (73 inches, 250 pounds)] was seated in an upright posture with his back against the seat back, his left foot on the floor, his right foot between the accelerator and brake, and both hands on the steering wheel. His seat track was located in its rearmost position and the seat back was slightly reclined. During the vehicle inspection, the tilt steering wheel was located in its upmost position.

Based on this contractor's interview with the front right passenger and substantiated by the **EDR** data, the case vehicle's driver was restrained by his available, active, three-point, integrated lap-and-shoulder, safety belt system; the belt system was not equipped with a pretensioner. However, there was no mention by the interviewee of belt pattern bruising and/or abrasions to the driver's body, and the inspection of the driver's seat belt webbing, shoulder belt guide, and latch plate showed little, if any, evidence of usage during the crash (**Figure 17**). On the other hand, a low speed frontal impact would not necessarily have produced evidence of belt webbing usage (i.e., scuffs, friction burns) and is not inconsistent with our vehicle inspection.

The case vehicle's driver steered to the right, attempting to avoid the crash. As a result of this attempted avoidance maneuver and the use of his available safety belts, he most likely moved slightly to the left just prior to impact. The case vehicle's primary impact with the Ford enabled the case vehicle's driver to continue forward and slightly leftward along a path opposite the case vehicle's **340** degree Direction of Principal Force as the case vehicle decelerated. As a result, the driver loaded his safety belts, contacted his deploying driver air bag, and contacted the driver's knee bolster to the left of the steering column with his left knee. According to the front right passenger, the driver sustained a large bruise to his left knee from the "instrument panel". As a result of maximum engagement, the case vehicle was redirected approximately 15 degrees to its right and the driver most likely rebounded backwards—from his safety belts and deploying air bag,



**Figure 17** Case vehicle's driver seat and integrated safety belts showing no apparent loading evidence on webbing (case photo #42)



and slightly to his left—from the case vehicle’s redirection. The side slap impact between the Ford’s right rear corner and the case vehicle’s left rear door most likely had very little effect on the vehicle’s post-crash trajectory or the movement of the driver. The driver most likely moved back forwards, toward the steering wheel, as the case vehicle came to final rest. The exact posture of the driver at final rest is unknown, but he was able to exit the vehicle without assistance.

#### CASE VEHICLE DRIVER INJURIES

The driver was not transported by ambulance to the hospital and did not seek any additional medical treatment. According to the interview with the front right passenger (i.e., wife), he sustained only minor injuries. The injuries sustained by the case vehicle's driver included: an abrasion [i.e., friction burn—7-10 centimeters in diameter (3-4 inch)] to the inside of his left wrist from his deploying air bag and a contusion to his left knee, most likely caused by contact to the knee bolster; although, the vehicle inspection did not reveal any contact to this area (**Figure 11** above).

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Abrasion {friction burn}, 7.6-10.2 cm (3-4 inches) anterior {inside} left wrist	minor 790202.1,2	Air bag, driver’s	Probable	Interviewee (other occupant)
2	Contusion {bruise}, large, left knee with swelling	minor 890402.1,2	Knee bolster, driver’s, left of steering column	Probable	Interviewee (other occupant)

#### CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

The case vehicle's front right passenger [i.e., wife of driver and mother of second seat passengers; 40-year-old, White (non-Hispanic) female; 160 centimeters and 61 kilograms (63 inches, 135 pounds)] was seated in a slightly reclined posture with her back against the seat back, her feet on the floor, and both hands holding some books. Her seat track was located in its middle position, and the seat back was slightly reclined.

The case vehicle's front right passenger was restrained by her available, active, three-point, integrated lap-and-shoulder, safety belt system; the belt system was not equipped with a pretensioner. Furthermore, there was mention by this occupant of belt pattern bruising to the her left hip, but the inspection of the front right passenger's seat belt webbing, shoulder belt guide, and latch plate showed little, if any, evidence of usage during the crash (**Figure 18** below). Once again, a low speed frontal impact would not necessarily have produced evidence of belt webbing usage (i.e., scuffs, friction burns) and is not inconsistent with our vehicle inspection.

The case vehicle's driver steered to the right, attempting to avoid the crash. As a result of this attempted avoidance maneuver and the use of her available safety belts, the front right

passenger most likely moved slightly to the left just prior to impact. The case vehicle's primary impact with the Ford enabled the case vehicle's front right passenger to continue forward and slightly leftward along a path opposite the case vehicle's 340 degree Direction of Principal Force as the case vehicle decelerated. As a result, the front right passenger loaded her safety belts and contacted her deploying front right passenger air bag. Because her seat track was located in its middle position, she also may have contacted the front right knee bolster and/or glove box door with one or both of her knees; however, no contact evidence was noted during this contractor's vehicle inspection. According to the front right passenger, she sustained a bruise to her left hip from loading the lap portion of her safety belts. As a result of maximum engagement, the case vehicle was redirected approximately 15 degrees to its right and the front right passenger most likely rebounded backwards—from her safety belts and deploying air bag, and slightly to her left—from the case vehicle's redirection. The side slap impact between the Ford's right rear corner and the case vehicle's left rear door most likely had very little effect on the vehicle's post-crash trajectory or the movement of the front right passenger. The front right passenger most likely moved back forwards, toward her deflating front right passenger air bag, as the case vehicle came to final rest. The exact posture of the front right passenger at final rest is unknown, but she was able to exit the vehicle without assistance.

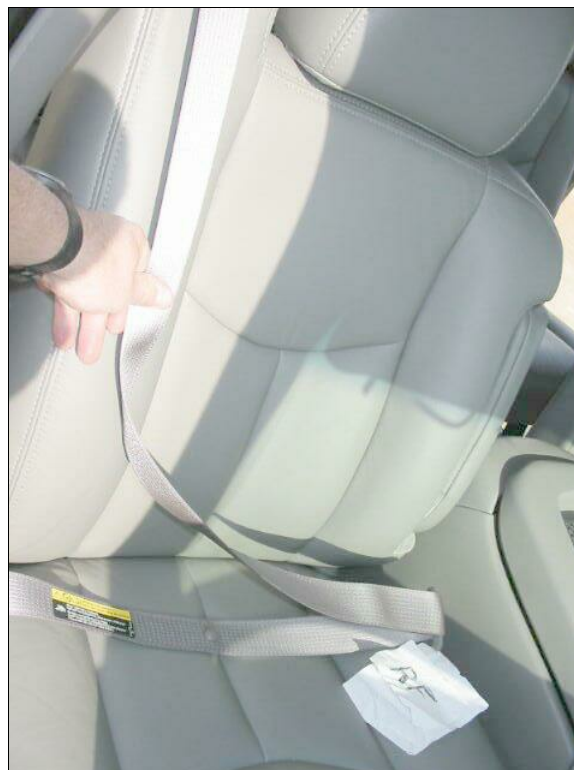


Figure 18: Case vehicle's front right seat and integrated safety belts showing no apparent loading evidence on webbing (case photo #47)

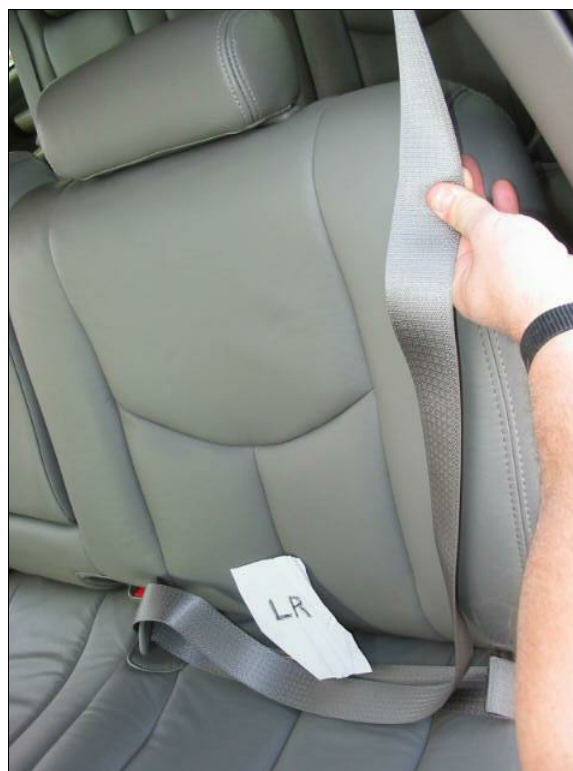
**CASE VEHICLE FRONT RIGHT PASSENGER INJURIES**

The right front passenger was not transported by ambulance to the hospital and did not seek any additional medical treatment. She sustained minor injuries and was released at the crash scene. Her self-reported injuries consisted of a left hip bruise as well as neck and back pain.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion {bruise} left hip, not further specified	minor 890402.1,2	Lap portion of safety belt system	Probable	Interviewee (other occupant)

The case vehicle's second seated left passenger [i.e., son; 8-year-old, White (non-Hispanic) male; 122 centimeters and 25 kilograms (48 inches and 55 pounds)] was seated in an upright posture with his back against the seat back and his feet dangling over the front edge of the seat's cushion, angled downward. However, the exact position of his hands is unknown. There was no seat track, and the seat back was not adjustable.

Based on this contractor's interview with the front right passenger, the case vehicle's second seated left passenger was restrained by his available, active, three-point, lap-and-shoulder, safety belt system; the belt system was not equipped with a pretensioner. However, there was no mention by the front right passenger of belt pattern bruising and/or abrasions to the second seat left passenger's body, and the inspection of this passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading (**Figure 19**). Given the age and stature of this child [8-years-old; 122 centimeters (48 inches)], it is unlikely that the torso portion of the safety belt system was snugly fitted against this occupant's left shoulder to begin with and, as a result, he most likely did not load the torso portion of his safety belt. In this contractor's opinion, the lack of loading evidence is not inconsistent with the crash sequence.



**Figure 19:** Case vehicle's second left seat cushion, adjustable head restraint, and safety belts; Note: no apparent loading evidence on webbing (case photo #52)

The case vehicle's driver steered to the right, attempting to avoid the crash. As a result of this attempted avoidance maneuver and the use of his available safety belts, the second seat left passenger most likely moved slightly to the left just prior to impact. The case vehicle's primary impact with the Ford enabled the case vehicle's the second seat left passenger to continue forward and slightly leftward along a path opposite the case vehicle's **340** degree Direction of Principal Force as the case vehicle decelerated. As a result, the second seat left passenger loaded the lap portion of his safety belts and probably the torso portion as well. He also may have contacted the interior surface of the left rear door, but no contact evidence resulted. According to the front right passenger, the second seat left passenger did not sustained any injuries during the crash. As a result of maximum engagement, the case vehicle was redirected approximately 15 degrees to its right and the second seat left passenger most likely rebounded backwards—from his safety belts, and slightly to his left—from the case vehicle's redirection. The side slap impact between the Ford's right rear corner and the case vehicle's left rear door most likely had very little effect on the vehicle's post-crash trajectory and at most enabled the second seat left passenger to contact and/or re-contact the left rear door's interior surface. The second seat left passenger most likely

moved forwards, toward the back surface of the driver's seat back, as the case vehicle came to final rest. The exact posture of the second seat left passenger at final rest is unknown, but he was able to exit the vehicle without assistance.

#### **CASE VEHICLE SECOND SEAT LEFT PASSENGER INJURIES**

The second seat left passenger was not transported by ambulance to the hospital, and did not seek any additional treatment. According to the front right passenger, he did not sustain any injuries as a result of this crash.

#### **CASE VEHICLE SECOND SEAT RIGHT PASSENGER KINEMATICS**

The case vehicle's second seated right passenger [i.e., son; 10-year-old, White (non-Hispanic) male; 124 centimeters and 39 kilograms (49 inches and 85 pounds)] was seated in an upright posture with his back against the seat back and his feet hanging down over the front edge of the seat's cushion. In addition, the exact position of his hands is unknown. His seat track and seat back were not adjustable.

The case vehicle's second seated right passenger was restrained by his available, active, three-point, lap-and-shoulder, safety belt system; the belt system was not equipped with a pretensioner. Once again, there was no mention by the front right passenger of belt pattern bruising and/or abrasions to the second seat right passenger's body, and the inspection of this passenger's seat belt webbing, "D"-ring, and latch plate showed little, if any, evidence of usage during the crash (**Figure 20**). Given the age and stature of this child [10-years-old; 124 centimeters (49 inches)], it is unlikely that the torso portion of the safety belt system was snugly fitted against this occupant's right shoulder to begin with and, as a result, he most likely did not load the torso portion of his safety belt. Once again, the lack of loading evidence is not inconsistent with the crash sequence.



**Figure 20:** Case vehicle's second right seat cushion, adjustable head restraint, and safety belts showing no apparent loading evidence on webbing (case photo #55)

#### **CASE VEHICLE SECOND SEAT RIGHT PASSENGER INJURIES**

The second seat right passenger was not transported by ambulance to the hospital, and did not seek any additional treatment. According to the front right passenger, he also did not sustain any injuries as a result of this crash.

Based on the VIN and manufacturer's specifications, the 1997 Ford Contour GL was a front wheel drive, five-passenger, four-door sedan (VIN: 3FALP6531VM-----) equipped with a 2.0L, I-4 engine and either the standard five-speed manual or an optional four-speed automatic transmission. Braking was achieved by a power-assisted, front disc and rear drum system. Four-wheel, anti-lock brakes were an option for this model, but it is unknown if the Ford was so equipped. The Ford's wheelbase was 271 centimeters (106.5 inches), and the odometer reading is unknown because the Ford's interior was not inspected. Furthermore, the Ford was equipped with driver and front right passenger air bags and, according to the Police Crash Report, they deployed during this vehicle's crash sequence. Based on the available information, the vehicle was equipped with manual, three-point, lap-and-shoulder, safety belt systems for the front and back outboard seating positions. The back center seat had a manual, two-point, lap belt. Standard interior equipment included bucket seats for the driver and front right passenger, and a non-adjustable back bench seat.

**Damage Classification:** With no available vehicle photographs, the CDCs for the Ford are not estimable. The WinSMASH reconstruction program, missing vehicle algorithm, was used on both of the Ford's impacts. For the Ford's highest severity impact, the Total, Longitudinal, and Lateral Delta Vs are, respectively: 39.0 km.p.h. (24.2 m.p.h.), -33.8 km.p.h. (-21.0 m.p.h.), and -19.5 km.p.h. (-12.1 m.p.h.). For the Ford's second highest severity (i.e., side slap) impact, the Total, Longitudinal, and Lateral Delta Vs are, respectively: 5.0 km.p.h. (3.1 m.p.h.), +3.2 km.p.h. (+2.0 m.p.h.), and -3.8 km.p.h. (-2.4 m.p.h.). The Ford was towed due to damage.

**Ford's Occupants:** According to the Police Crash Report, the Ford's driver [16-year-old, White (non-Hispanic) male], right front passenger [38-year-old, White (non-Hispanic) female], and back right passenger [15-year-old, White (non-Hispanic) male] were all restrained by their available, active, three-point, lap-and-shoulder, safety belt systems. None of the occupants were transported by ambulance to the hospital for medical treatment, and they did not sustain any injuries as a result of this crash.

3GNFK16Z83G System Status At Deployment															
SIR Warning Lamp Status	OFF														
Driver's Belt Switch Circuit Status	BUCKLED														
Ignition Cycles At Deployment	435														
Ignition Cycles At Investigation	446														
Maximum SDM Recorded Velocity Change (MPH)	-9.49														
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	127.5														
Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	12.5														
Driver Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	N/A														
Passenger First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	12.5														
Passenger Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	N/A														
Time Between Non-Deployment And Deployment Events (sec)	N/A														
Frontal Deployment Level Event Counter	1														
Event Recording Complete	Yes														
Multiple Events Associated With This Record	No														
One Or More Associated Events Not Recorded	No														
◀															
Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-0.62	-1.66	-3.41	-4.96	-6.20	-7.44	-8.06	-8.68	-8.68	-8.68	-8.99	N/A	N/A	N/A	N/A
PRE-CRASH DATA															
Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status											
-5	46	1344	9	OFF											
-4	46	1344	9	OFF											
-3	45	1344	9	OFF											
-2	45	1280	4	OFF											
-1	45	1280	0	OFF											

**Figure 21:** Case vehicle's at deployment data including: pre-crash speed, brake switch status, restraint system status, and activation data for vehicle's dual inflation air bags, and the case vehicle's change in velocity (Delta V) over the first 110 milliseconds post deployment



