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ON-SITE CERTIFIED ADVANCED 208- COMPLIANT VEHICLE INVESTIGATION

CASE NUMBER - IN-04-003
LOCATION - Texas
VEHICLE - 2003 Chevrolet Silverado
CRASH DATE - December 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.

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15. <i>Supplementary Notes</i> On-site air bag non-deployment investigation involving a 2003 Chevrolet Silverado with integral manual safety belts and dual front advanced air bag system and a 1994 Honda Accord EX, two-door coupe.					
16. <i>Abstract</i> This report covers an on-site investigation of an air bag non-deployment crash involving a 2003 Chevrolet Silverado (case vehicle) and a 1994 Honda Accord EX (other vehicle). This crash is of special interest because the supplemental restraint (air bag) system in the case vehicle, which did not deploy, is certified by the manufacturer to be compliant to the Advanced Air Bag portion of the Federal Motor Vehicle Standard (FMVSS) No. 208. The case vehicle was equipped with multiple Advanced Occupant Protection System (AOPS) features, and the case vehicle's driver (18 year-old female) sustained only minor injuries while the front right passenger (16-year-old female) sustained no injury as a result of the crash. The case vehicle was traveling east in the inside lane of a five-lane divided city street. The Honda had been traveling west in the left turn lane and was in the process of executing a left turn through a median cut and across eastbound traffic. The case vehicle's driver stated she applied the brakes just as the impact occurred. The front of the case vehicle impacted the front of the Honda. The impact caused the Honda to rotate counterclockwise and the case vehicle to rotate slightly clockwise. Both vehicles came to rest in the eastbound travel lanes. The impact did not cause the case vehicle's driver or front right passenger air bags to deploy. Both driver and passenger were restrained by their integral, three-point, lap-and-shoulder safety belts. It is this contractor's opinion that, due to the occupants' usage of their safety belt systems, the case vehicle's crash sensing algorithm determined that the crash would not be severe enough to require deployment of the air bags. Neither the driver or front right passenger were reported as injured on the police crash report and were not transported from the scene. The case vehicle's driver sought medical treatment later, and reported that she sustained a contusion to her left shoulder from her safety belt and a "whiplash" due to impact force. The front right passenger was not injured. Both driver and passenger were able to exit the case vehicle without assistance following the crash.					
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This on-site investigation was brought to NHTSA's attention on January 14, 2004 by NASS CDS sampling activities. This crash involved a 2003 Chevrolet K1500 Silverado pickup truck (case vehicle) and a 1994 Honda Accord EX (other vehicle). The crash occurred in December 2003, at 9:20 p.m., in Texas and was investigated by the applicable city police department. This crash is of special interest because the supplemental restraint (air bag) system in the case vehicle, which did not deploy, is certified by the manufacturer to be compliant to the Advanced Air Bag portion of the Federal Motor Vehicle Standard (FMVSS) No. 208. The case vehicle was equipped with multiple Advanced Occupant Protection System (AOPS) features, as well as an Event Data Recorder (EDR), and the case vehicle's driver [18-year-old, White (Hispanic) female] sustained only minor injuries and the front right passenger [16-year-old, White (Hispanic) female] was not injured as a result of the crash. This contractor inspected the scene, both vehicles and downloaded the data from the onboard EDR on January 26, 2004. This contractor interviewed the case vehicle's driver on January 28, 2004. This summary is based on the police crash report, scene and vehicle inspections, an interview with the case vehicle's driver, occupant kinematic principles and this contractor's evaluation of the evidence.

SUMMARY

Crash Environment: The trafficway on which both vehicles were traveling was a five-lane, divided, city street, traversing in an east-west direction and curved to the north. A one-way undivided city street intersected the trafficway from the southwest to form a "Y" intersection. The westbound roadway had two through lanes with a left turn lane through the median to the intersecting city street. The eastbound roadway had two through lanes. At the time of the crash, the light condition was dark, but illuminated by overhead luminaires at the area of impact, the atmospheric condition was clear; and the roadway pavement was dry, traffic polished concrete. Traffic density was light and the site of the crash was a combination of residential and commercial. See the Crash Diagram at the end of this report.

Pre-Crash: The case vehicle was traveling east in the inside through lane, and the driver was intending to proceed straight ahead. The Honda had been traveling west in the left turn lane and was in the process of traveling through the median cut and executing a left turn across eastbound traffic to continue southwestbound on another city street. The case vehicle's driver stated she braked just as the case vehicle impacted the Honda. The crash occurred in the "Y" intersection in the inside eastbound lane.

Crash: The front of the case vehicle impacted the front of the Honda. The case vehicle's driver and front right passenger air bags did not deploy. The Honda's driver and front right passenger air bags did deploy.

Post-Crash: As a result of the impact, the case vehicle rotated slightly clockwise and came to an estimated final rest position in the outside eastbound lane facing southeast. The Honda rotated counterclockwise and came to an estimated final rest position in the inside eastbound lane of the roadway facing northeast.

Case Vehicle: The 2003 Chevrolet Silverado (VIN: 2GCEK19N631-----) was a four-wheel drive (4x4), four-door pickup truck equipped with four wheel, anti-lock brakes; dual stage driver and front right passenger air bags; integrated, three-point lap-and-shoulder safety belt systems in the driver and front right seats; three-point, lap-and-shoulder safety belt systems in the outboard back seat positions and a lap belt in the center back seat position. The case vehicle was also equipped with an air bag suppression switch for the front right passenger air bag, which was found in the “Auto” position, an occupant weight sensor in the front right passenger seat and an EDR contained within the case vehicle’s Sensing and Diagnostic Module (SDM).

Vehicle Exterior: Based on the vehicle inspection and post-crash photographs provided by the insurance company, the CDC for the case vehicle was determined to be: **12-FYEW-1 (350 degrees)**.

The WinSMASH reconstruction program, missing vehicle algorithm, was used to reconstruct the case vehicle's Delta V. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 14 km.p.h. (8.7 m.p.h.), -13.8 km.p.h. (-8.6 m.p.h.), and 2.4 km.p.h. (1.5 m.p.h.). The collision fit the model, but the results appeared to be low based on the extent of damage to the case vehicle’s front bumper. The downloaded EDR data indicated the longitudinal component of Delta-V was -22.51 km.p.h. (-13.99 m.p.h.). The case vehicle was towed due to damage.

Exterior Damage: The case vehicle’s contact with the Honda involved the front bumper, bumper fascia, left headlamp/turn lamp assembly and the grille. Direct damage began at the left front bumper corner and extended 88 centimeters (34.6 inches), along the front bumper. No crush measurements were taken at the time of inspection because the repair process had started and the front bumper had been removed. The case vehicle’s front bumper, bumper fascia, left turn lamp assembly and grille were directly damaged and crushed rearward. There was slight induced damage to the left headlamp/turn lamp assemblies, grille and left fender. No obvious induced damage or remote buckling was noted to the remainder of the case vehicle’s exterior. There was no damage or restriction to any of the case vehicle’s tires, and the wheelbase was unaltered from the crash.

The case vehicle’s recommended tire size was: P275/55R20, and it was equipped with tires of this size. 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 nd of an inch			
LF	207	30	207	30	9	11	None	No	No
RF	200	29	207	30	9	11	None	No	No
LR	207	30	207	30	9	11	None	No	No
RR	207	30	207	30	8	10	None	No	No

Vehicle Interior: Inspection of the case vehicle's interior revealed slight evidence of occupant contact on the knee bolster on each side of the steering column. No other evidence of occupant contact was observed on any the case vehicle's interior surfaces or components. Finally, there was no evidence of intrusion of the case vehicle's interior, and no evidence of compression of the energy absorbing steering column or deformation to the steering wheel rim was observed.

Supplemental Restraints: The case vehicle's driver air bag was located in the steering wheel hub, and the front right passenger's air bag was located in the middle of the instrument panel. Neither of these air bags deployed as a result of the crash. It is this contractor's opinion that, due to the occupants' usage of their safety belt systems, the case vehicle's crash sensing algorithm determined that the crash would not be severe enough to require deployment of the air bags.

Crash Data Recording: The download of the case vehicle's EDR was done during the vehicle inspection by direct connection to the SDM. The downloaded data indicated the case vehicle sustained a single non-deployment event. The system status report at non-deployment recorded the vehicle's SIR warning lamp status as off, the driver's seat belt switch circuit as buckled, and the maximum recorded velocity change (Delta-V) as 22.51 km.p.h. (-13.99 m.p.h.) occurring at 292.5 milliseconds (0.2925 seconds) after algorithm enable. At one second prior to the crash (i.e., algorithm enable), the pre-crash data indicated the case vehicle was traveling 74 km.p.h. (46 m.p.h) and the brake switch was off.

Other Vehicle: The 1994 Honda Accord EX was a front wheel drive, two-door coupe (VIN: 1HGCD7154RA-----). The Honda was equipped with driver and front right passenger air bags which deployed as a result this vehicle's impact. Based on the vehicle inspection, the CDC for the Honda was determined to be: **01-FDEW-2 (30 degrees)**.

The WinSMASH reconstruction program, missing vehicle algorithm, was used to reconstruct the Honda's Delta V. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 25 km.p.h. (15.5 m.p.h.), -21.7 km.p.h. (-13.5 m.p.h.), and -12.5 km.p.h. (-7.8 m.p.h.). The collision fits the model, but based on the damage to the front of the Honda, the results appeared to be low. The Honda was towed due to damage.

Exterior Damage: The Honda's impact with the case vehicle involved the front bumper, grille, hood and left headlamp/turn lamp assembly. The direct damage began at the left bumper corner and extended 135 centimeters (53.1 inches) along the front bumper. The maximum residual crush to the front bumper was 33 centimeters (13 inches) occurring at C₃. The Honda's left side wheelbase was reduced 6 centimeters (2.4 inches), and the right side wheelbase was extended 5 centimeters (2 inches). The Honda's front bumper, grille, hood, and front of the left fender were directly damage and crushed rearward. Induced damage involved the front bumper, hood, left and right fenders, left front wheel, left front door and the windshield.

The Honda's recommended tire size was: P195/60R16, and the vehicle was equipped with tires of this size. The Honda'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 nd of an inch			
LF	214	31	221	32	4	5	No	Yes	No
RF	221	32	221	32	4	5	No	No	No
LR	200	29	221	32	4	5	No	No	No
RR	193	28	221	32	3	4	No	No	No

Case Vehicle's Driver: Immediately prior to the crash the case vehicle's driver [18-year-old, White (Hispanic) female; 155 centimeters and 46 kilograms (61 inches, 102 pounds)] was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot on the brake, and both hands bracing on the steering wheel. Her seat track was located between its middle and forward-most positions, the seat back was slightly reclined, and the tilt steering wheel was located in its center position.

Based on this contractor's vehicle inspection and supported by the EDR data, the case vehicle's driver was restrained by her three-point, integral, lap-and-shoulder safety belt system. In addition, the driver stated she sustained a small bruise on her left shoulder from the safety belt.

The case vehicle's driver stated she braked just as impact occurred with the Honda. As a result, the braking likely did not cause any appreciable change in her pre-impact posture. The case vehicle's impact with the Honda locked the driver's safety belt retractor and caused the driver to move forward and slightly leftward along a path opposite the case vehicle's 350 degree direction of principal force as the case vehicle decelerated. As a result, the driver loaded her safety belt causing a bruise on her left shoulder and "whiplash" pain to her neck, and she contacted the knee bolster with her knees. The driver most likely rebounded back into her seat following the impact and remained in her seat as the case vehicle came to final rest. The driver exited her vehicle without assistance following the crash.

The police crash report indicated that the driver was not injured as a result of the crash and was not transported from the crash scene. The driver indicated in her interview that she sought treatment later at a private medical clinic. She described her injuries as a "whiplash", a 2.5 centimeter (1 inch) bruise on her left shoulder from her shoulder belt, and complained of pain to her left shoulder. The driver stated she lost no work days as a result of the crash.

Case Vehicle's Front Right Passenger: The case vehicle's front right passenger [16-year-old, White (Hispanic) female; 155 centimeters and 46 kilograms (61 inches, 102 pounds)] was seated in an upright posture with her back against the seat back, her feet on the floor, her left arm on the armrest, and her right hand and arm on her lap. Her seat track was located in its forward-most position, and the seat back was slightly reclined.

The case vehicle's front right passenger was most likely restrained by her three-point, integral lap-and-shoulder safety belt system. The driver reported that the front right passenger was properly restrained by her lap-and-shoulder belt.

The case vehicle driver's brake application approximately at the moment of impact likely did not cause any appreciable change in front right passenger's pre-impact posture. The case vehicle's impact with the Honda locked the passenger's safety belt retractor and caused the passenger to move forward and slightly leftward along a path opposite the case vehicle's 350 degree direction of principal force as the case vehicle decelerated and she loaded her safety belt. The passenger most likely rebounded back into her seat following the impact and remained in her seat as the case vehicle came to final rest. The passenger was able to exit the vehicle without assistance following the crash.

The police crash report indicated the front right passenger was not injured and was not transported from the scene. The driver indicated the passenger sustained no injury and lost no work days as a result of the crash.

Honda's Occupant: According to the police crash report, the Honda's driver [33-year-old, Black (unknown if Hispanic) male] was restrained by his three-point, lap-and-shoulder safety belt system. The driver was not transported from the scene, and the police crash report indicated he sustained no injury as a result of the crash.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which both vehicles were traveling was a five-lane, divided, city street, traversing in an east-west direction and curved to the north. A one-way undivided city street intersected the trafficway from the southwest to form a "Y" intersection. The westbound roadway had two through lanes with a left turn lane through the median to the intersecting city street. The eastbound roadway had two through lanes. The roadway surface for both vehicles consisted of traffic polished concrete with a coefficient of friction of approximately 0.65 for the case vehicle and 0.70 for the Honda. Each of the westbound travel lanes was approximately 3.7 meters (12 feet) wide. The inside eastbound travel lane was 4 meters (13 feet) wide, and the outside eastbound travel lane was 4.4 meters (14.4 feet) wide. The roadway was divided by a raised, curbed, grass median that was 4.5 meters (14.8 feet) wide west of the intersection and approximately 1.6 meters (5.2 feet) wide east of the intersection. The roadway grade for the case vehicle's approach was approximately 0.6% positive, while the grade for the Honda's approach was approximately 1.4% negative. Pavement markings for both vehicles consisted of broken, raised, reflective, lane line markers. In addition, a double-arrow warning sign was posted at the end of the median on the Honda's approach in the left turn lane. The speed limit for both vehicles was 64 km.p.h. (40 m.p.h); however, there was no regulatory speed limit sign posted near the crash site. At the time of the crash, the light condition was dark, but illuminated by overhead luminaires at the area of impact, the atmospheric condition was clear, and the roadway pavement was dry. Traffic density was light and the site of the crash was a combination of residential and commercial. See the Crash Diagram at the end of this report.

Pre-Crash: The case vehicle was traveling east in the inside lane (**Figure 1**), and the driver was intending to proceed straight ahead. The Honda had been traveling west in the left turn lane. Its driver was in the process of traveling through the median cut (**Figure 2**) and executing a left turn across eastbound traffic to continue southwestbound on another city street. The case vehicle's driver stated she braked just as the case vehicle impacted the Honda. The crash occurred in the "Y" intersection in the inside eastbound lane.



Figure 1: Case vehicle's eastbound approach to impact area (arrow) in inside lane(case photo #02)



Figure 2: Honda's southwestbound approach in left turn lane to impact area (case photo #07)

Crash: The front of the case vehicle (**Figure 3**) impacted the front of the Honda (**Figure 4**). The left portion of the case vehicle's front bumper was the primary component of engagement to the Honda's bumper, grille and hood. The case vehicle's driver and front right passenger air bags did not deploy as a result of the impact. The Honda's driver and front right passenger air bags did deploy.



Figure 3: Insurance photo of case vehicle's front damage from impact with Honda (case photo #12a)



Figure 4: Honda's front damage from impact with the case vehicle (case photo #34)

Post-Crash: As a result of the impact, the case vehicle rotated slightly clockwise and came to an estimated final rest position in the outside eastbound lane facing southeast (**Figure 5** below). The Honda rotated counterclockwise, but its extent of rotation is not known. Its final rest position was

estimated to be in the inside eastbound lane of the roadway facing northeast (**Figure 5**).

CASE VEHICLE

The 2003 Chevrolet K1500 Silverado (VIN: 2GCEK19N631-----) was a four-wheel drive (4x4), four-door, pickup truck equipped with a 6.0L, V8 gasoline engine; four-speed automatic transmission and power-assisted, four wheel, anti-lock brakes. The case vehicle's wheelbase was 364 centimeters (143.3 inches), and the odometer reading at the time of inspection was 3,286 kilometers (2,042 miles).



Figure 5: Double head arrow shows estimated final rest of case vehicle, single head arrow shows estimated final rest of Honda (case photo #04)

The case vehicle was equipped with multiple AOPs features including dual stage driver and front right passenger air bags and safety belt usage sensors for the driver and front right passenger. In addition, the vehicle was equipped with knee bolsters, bucket seats with adjustable head restraints and integrated, three-point, lap-and-shoulder safety belt systems in the driver and front right passenger positions, as well as a back bench seat with adjustable head restraints and three-point, lap-and-shoulder safety belt systems in the outboard back seat positions. In addition, the center back seat position was equipped with a two-point lap belt. The case vehicle was also equipped with an air bag suppression switch (**Figure 6**) for the front right passenger air bag, which was found in the “Auto” position, an occupant weight sensor in the front right passenger seat and an EDR contained within the case vehicle's SDM.



Figure 6: Front right air bag suppression switch, found in the “Auto” position (case photo #27)

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 seat position, an occupant weight sensor in the seat cushion determines if an occupant is on the seat and enables or suppresses deployment of the air bag based on the amount of weight on the seat.



Figure 7: Insurance photo showing case vehicle's front damage from impact with Honda (case photo #12a)

Exterior Damage: The case vehicle’s contact with the Honda involved the bumper, bumper fascia, left headlamp/turn lamp assembly and the grille (**Figure 7** above). Direct damage began at the left front bumper corner and extended 88 centimeters (34.6 inches), along the front bumper. No crush measurements were taken at the time of inspection because the repair process had started and the front bumper and other damage components had been removed from the vehicle. The left portion of the case vehicle’s front bumper, bumper fascia, left turn lamp assembly and grille were all directly damaged and crushed rearward.

The case vehicle’s wheelbase was unchanged as a result of the crash. There was slight induced damage to the left headlamp/turn lamp assemblies, grille and left fender. No obvious induced damage or remote buckling was noted to the remainder of the case vehicle’s exterior.

The case vehicle’s recommended tire size was: P275/55R20, and the vehicle was equipped with tires of this size. 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 nd of an inch			
LF	207	30	207	30	9	11	None	No	No
RF	200	29	207	30	9	11	None	No	No
LR	207	30	207	30	9	11	None	No	No
RR	207	30	207	30	8	10	None	No	No

Interior Damage: Inspection of the case vehicle’s interior revealed slight evidence of occupant contact on the knee bolster on each side of the steering column. A light scuff in the rigid plastic of the knee bolster was observed on each side of the steering column (**Figure 8**). No other evidence of occupant contact was observed on any the case vehicle’s interior surfaces or components. Finally, there was no evidence of intrusion of the case vehicle’s interior, and no evidence of compression of the energy absorbing steering column or deformation to the steering wheel rim was observed (**Figure 9** below).



Figure 8: Yellow tape shows occupant contact scuffs on driver’s knee bolster (case photo #22)

Damage Classification: Based on the vehicle inspection and photographs of the damage to the case vehicle provided by the insurance company, the CDC for the case vehicle was determined to be: **12-FYEW-1 (350 degrees)**.

The WinSMASH reconstruction program, missing vehicle algorithm, was used to reconstruct the case vehicle's Delta V. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 14 km.p.h. (8.7 m.p.h.), -13.8 km.p.h. (-8.6 m.p.h.), and 2.4 km.p.h. (1.5 m.p.h.). The collision fit the model, but the results appeared to be low based on the extent of damage to the case vehicle's front bumper. The case vehicle's downloaded EDR data indicated a maximum longitudinal component of Delta-V of -22.51 km.p.h. (-13.99 m.p.h) for this impact. Using the EDR recorded Delta V and the assigned direction of principal force angle of 350 degrees, the total and lateral components of the EDR reported Delta-V were calculated respectively as: 22.85 km.p.h (14.20 m.p.h) and 3.97 km.p.h. (2.47 m.p.h). The case vehicle was towed due to damage.



Figure 9: Left side view of steering wheel and steering column showing lack of deformation (case photo #18)

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with certified advanced 208-compliant front air bags at the driver and front right passenger positions. The driver air bag was located in the steering wheel hub (**Figure 10**), and the front right passenger air bag was located in the middle of the right instrument panel (**Figure 11**). Neither of these air bags deployed as a result of the crash. It is this contractor's opinion that due to the occupants' usage of their safety belt systems, the case vehicle's crash sensing algorithm determined that the crash would not be severe enough to require deployment of the air bags.



Figure 10: Overview of instrument panel and steering wheel (case photo #19)

CRASH DATA RECORDING

The download of the case vehicle's EDR was done during the vehicle inspection by direct connection to the SDM. The downloaded data indicated the case vehicle sustained a single non-deployment event. The system status report at non-deployment recorded the vehicle's SIR warning lamp status as off, the driver's seat belt switch circuit as buckled, and the maximum recorded velocity change (Delta-V) as 22.51



Figure 11: Overview of right instrument panel, arrow shows location of front right air bag (case photo #25)

km.p.h. (-13.99 m.p.h.) occurring at 292.5 milliseconds (0.2925 seconds) after algorithm enable. The pre-crash data indicated the case vehicle was traveling 71 km.p.h. (44 m.p.h) to 72 km.p.h. (45 m.p.h.) at 21% throttle with the brake switch off from five to two seconds prior to the crash (i.e., algorithm enable). At one second prior to the crash, the vehicle's speed is recorded as 74 km.p.h. (46 m.p.h) and percent throttle falls to 2% indicating the driver has removed her foot from the throttle, and supports the driver's interview statement that she applied the brakes at about the time of the impact. The EDR reports are presented in **Figures 16-18** at the end of this report.

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash the case vehicle's driver [18-year-old, White (Hispanic) female; 155 centimeters and 46 kilograms (61 inches, 102 pounds)] was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot on the brake, and both hands bracing on the steering wheel. Her seat track was located between its middle and forward-most positions, the seat back was slightly reclined, and the tilt steering wheel was located in its center position.

Based on this contractor's vehicle inspection and supported by the EDR data, the case vehicle's driver was restrained by her three-point, integral, lap-and-shoulder safety belt system. Also, the driver stated she sustained a small bruise on her left shoulder from the safety belt. A small area of rippling was also found in the shoulder belt webbing (Figure 12). It appeared to correspond to the location of the shoulder belt guide when the belt was configured in the approximate restrained position. In addition, the shoulder belt guide was pulled out of the seat (Figure 13).

The case vehicle's driver stated she braked just as impact occurred with the Honda. As a result, the braking likely did not cause any appreciable change in her pre-impact posture. The case vehicle's impact with the Honda locked the driver's safety belt retractor and caused the driver to move forward and slightly leftward along a path opposite the case vehicle's 350 degree direction of principal force as the case vehicle decelerated. As a result, the driver loaded her safety belt causing a bruise on her left shoulder and "whiplash" pain to her neck, and she contacted the knee bolster with both of her knees. The driver most likely rebounded back into her seat following the impact and remained in her seat as the case vehicle came to final rest. The driver exited her vehicle without assistance following the crash.

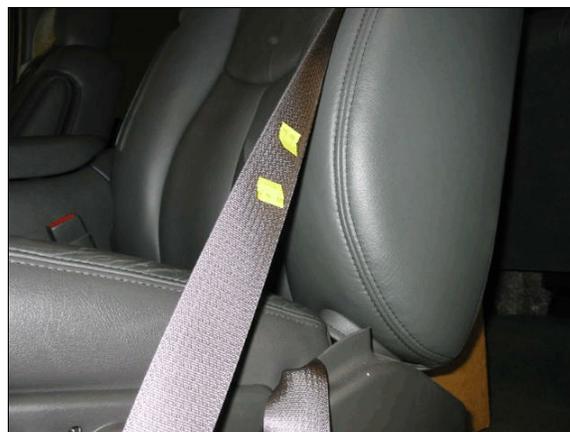


Figure 12: Ripple in driver's shoulder belt webbing between the pieces of yellow tape (case photo #30)



Figure 13: Driver's shoulder belt guide pulled out of the seat (case photo #33)

The police crash report indicated that the driver was not injured as a result of the crash and was not transported from the crash scene. However, the driver stated in her interview that she sought treatment later at a private medical clinic. She also stated that she lost no work days as a result of the crash. The driver reported injuries and injury mechanisms are presented in the table below.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Strain {whiplash} acute cervical, not further specified	minor 640278.1,6	Noncontact injury: impact forces	Probable	Interviewee (same person)
2	Contusion, 2.5 cm (1 in) wide, left shoulder, not further specified	minor 790402.1,2	Torso portion of safety belt system	Certain	Interviewee (same person)

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

The case vehicle's front right passenger [16-year-old, White (Hispanic) female; 155 centimeters and 46 kilograms (61 inches, 102 pounds)] was seated in an upright posture with her back against the seat back, her feet on the floor, her left arm on the armrest, and her right hand and arm on her lap. Her seat track was located in its forward-most position, and the seat back was slightly reclined.

The case vehicle's front right passenger was most likely restrained by her three-point, integral, lap-and-shoulder safety belt system. No evidence of loading was found on her safety belt assembly; however, the driver reported that the front right passenger was properly restrained by her lap-and-shoulder safety belt. In addition, inspection of the case vehicle revealed no evidence of occupant contact on the instrument panel or windshield.

The case vehicle driver's reported brake application approximately at the moment of impact likely did not cause any appreciable change in front right passenger's pre-impact posture. The case vehicle's impact with the Honda locked the passenger's safety belt retractor and caused the passenger to move forward and slightly leftward along a path opposite the case vehicle's 350 degree direction of principal force as the case vehicle decelerated, and she loaded her safety belt. The passenger most likely rebounded back into her seat following the impact and remained in her seat as the case vehicle came to final rest. The passenger was able to exit the vehicle without assistance following the crash.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The police crash report indicated the front right passenger was not injured and was not transported from the scene. The driver indicated the passenger sustained no injury and lost no work days as a result of the crash.

The 1994 Honda Accord EX was a front wheel drive, two-door coupe (VIN: 1HGCD7154RA-----) equipped with a five-speed manual transmission and a four-cylinder engine of unknown displacement. In addition, the Honda was equipped with three-point, lap-and-shoulder safety belt systems in the driver and front right passenger positions and driver and front right passenger air bags, which deployed as a result this vehicle’s impact with the case vehicle. The Honda was not equipped with anti-lock brakes, and its wheelbase was 272 centimeters (107.1 inches). The odometer reading is not known because the interior was not inspected.

Exterior Damage: The Honda’s impact with the case vehicle involved the front bumper, grille, hood and left headlamp/turn lamp assembly (Figure 14). The direct damage began at the left bumper corner and extended 135 centimeters (53.1 inches) along the front bumper. The maximum residual crush to the front bumper was 33 centimeters (13 inches) occurring at C₃ (Figure15). The table below shows the Honda’s crush profile.

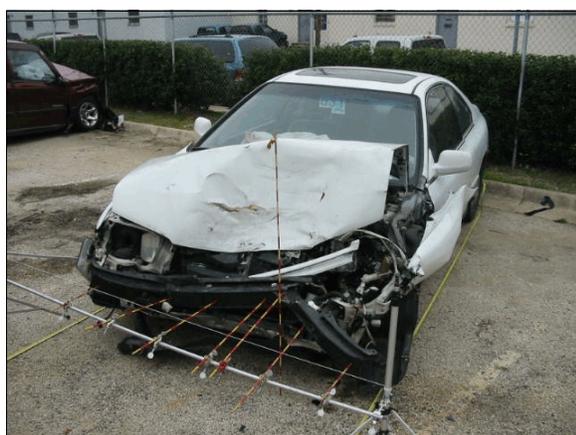


Figure 14: Damage to front of Honda from impact with case vehicle, each stripe on rods is 5 cm (2 in) (case photo #35)

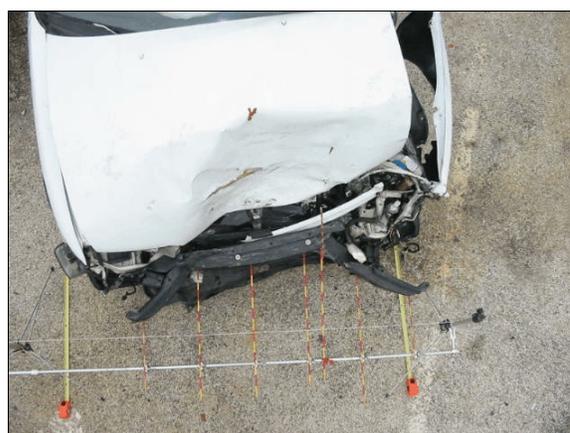


Figure 15: Top view of Honda’s front crush (case photo #40)

Units	Event	Direct Damage		Field L	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	135	33	124	0	15	33	29	23	0	-12	0
in		53.2	13.0	48.8	0.0	5.9	13.0	11.4	9.1	0.0	-4.7	0.0

The Honda’s left side wheelbase was reduced 6 centimeters (2.4 inches) by the impact, and the right side wheelbase was extended 5 centimeters (2 inches). The Honda’s front bumper, grille, hood, and front of the left fender were directly damaged and crushed rearward. Induced damage involved the front bumper, hood, left and right fenders, left front wheel, left front door and the windshield. Sideswipe type damage was noted to the Honda’s right quarter panel; however, no corresponding damage was found on the left side of the case vehicle. This damage was therefore determined to be unrelated to this crash.

The Honda's recommended tire size was: P195/60R15, and the it was equipped with tires of this size. The Honda's tire data are shown in the table below:

<i>Tire</i>	<i>Measured Pressure</i>		<i>Recommend Pressure</i>		<i>Tread Depth</i>		<i>Damage</i>	<i>Restricted</i>	<i>Deflated</i>
	kpa	psi	kpa	psi	milli-meters	32 nd of an inch			
LF	214	31	221	32	4	5	None	Yes	No
RF	221	32	221	32	4	5	None	No	No
LR	200	29	221	32	4	5	None	No	No
RR	193	28	221	32	3	4	None	No	No

Damage Classification: Based on the vehicle inspection, the CDC for the Honda was determined to be: **01-FDEW-2 (30 degrees)**.

The WinSMASH reconstruction program, missing vehicle algorithm, was used to reconstruct the Honda's Delta V. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 25 km.p.h. (15.5 m.p.h.), -21.7 km.p.h. (-13.5 m.p.h.), and -12.5 km.p.h. (-7.8 m.p.h.). The collision fits the model, but based on the damage to the front of the Honda, the results appeared to be low. The Honda was towed due to damage.

Honda's Occupant: According to the police crash report, the Honda's driver [33-year-old, Black (unknown if Hispanic) male] was restrained by his three-point, lap-and-shoulder safety belt system. The driver was not transported from the scene, and the police crash report indicated he sustained no injury as a result of the crash.

