



INDIANA UNIVERSITY

TRANSPORTATION RESEARCH CENTER

School of Public and Environmental Affairs

222 West Second Street

Bloomington, Indiana 47403-1501

(812) 855-3908 Fax: (812) 855-3537

ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE INVESTIGATION

CASE NUMBER - IN-05-006

LOCATION - TEXAS

VEHICLE - 2004 JEEP LIBERTY SPORT

CRASH DATE - January 2005

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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 investigation involving a 2004 Jeep Liberty Sport with manual safety belts and dual front certified advanced 208-compliant air bags.					
16. <i>Abstract</i> This report covers an on-site investigation of an air bag deployment crash that involved a 2004 Jeep Liberty Sport (case vehicle), which ran-off-road and impacted a concrete bridge support. 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, and the case vehicles' front right passenger (7 year-old, female) sustained police reported "B" (non-incapacitating-evident) injuries as a result of the crash, and her air bag did not deploy. The case vehicle was traveling north in a right curve in the outside lane of a four-lane, divided city street at a driver estimated speed of 48 km.p.h. (30 m.p.h). The case vehicle was approaching an overpass bridge that traversed over the case vehicle's trafficway. The driver attempted to change lanes to the left and lost control of the case vehicle on the wet roadway. The case vehicle slid on the pavement and traveled toward the median. The driver locked the brakes. The case vehicle traveled over the concrete curbed median, and the front of the case vehicle impacted a concrete bridge support causing the case vehicle driver's air bag to deploy. The case vehicle's front right air bag did not deploy. The sensor in the front right seat most likely determined that the weight on the seat by the restrained, 28 kilogram (62 pound), 7-year-old passenger was below the front right air bag's enable threshold and suppressed deployment of the air bag. Following the impact, the case vehicle rotated counterclockwise a few degrees and came to rest against the concrete bridge support. The front right passenger was restrained by her manual, three-point, lap and shoulder belt. She sustained multiple abrasions and contusions from loading her safety belt. She was transported from the scene and treated and released. The driver was also restrained by her manual, three-point, lap-and-shoulder safety belt. The impact caused her to load her safety belt and her face and upper chest contacted her deployed air bag. She sustained multiple contusions, an abrasion and a laceration from her air bag, safety belt, knee bolster and foot controls. She refused treatment at the scene. However, she visited the emergency room later and was treated and released.					
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This investigation was brought to NHTSA's attention on or about January 26, 2005 by NASS CDS/GES sampling activities. This crash involved a 2004 Jeep Liberty Sport (case vehicle), which ran-off-road and impacted a concrete bridge support. The crash occurred in January, 2005, at 7:30 a.m., in Texas and was investigated by the applicable city police department. This crash is of special interest because the case vehicle's front right passenger [7-year-old, White (non-Hispanic) female] sustained a police reported "B" (non-incapacitating-evident) injury as a result of the crash, and her air bag did not deploy. In addition, the manufacturer of the case vehicle has certified that it meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. This contractor inspected the case vehicle and scene on February 10, 2005 and interviewed the case vehicle's driver on February 14, 2005. This report is based on the police crash report, scene and vehicle inspections, emergency room records, an interview with the case vehicle's driver, occupant kinematic principles and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling north in a right curve in the outside lane of a four-lane, divided city street at a driver estimated speed of 48 km.p.h. (30 m.p.h). The case vehicle was approaching an overpass bridge that traversed over the case vehicle's trafficway. The driver attempted to change lanes to the left and lost control of the case vehicle on the wet roadway. The case vehicle slid on the pavement and traveled toward the median. The driver locked the brakes. The case vehicle traveled over the concrete curbed median, and the front of the case vehicle impacted a concrete bridge support causing the case vehicle driver's air bag to deploy. The case vehicle's front right air bag did not deploy. The sensor in the front right seat most likely determined that the weight on the seat produced by the restrained, 28 kilogram (62 pound), 7-year-old passenger was below the front right air bag's enable threshold and suppressed deployment of the air bag. Following the impact, the case vehicle rotated counterclockwise a few degrees and came to rest against the concrete bridge support. At the time of the crash the light condition was daylight, the atmospheric condition was light rain, and the roadway pavement was wet concrete.

The CDC for the case vehicle was determined to be: **12-FDEW-2 (0-degrees)**. The maximum residual crush was measured as 40 centimeters (15.7 inches). The WinSMASH reconstruction program, barrier algorithm, calculated the case vehicle's Total, Longitudinal, and Lateral Delta Vs respectively as: 32.0 km.p.h. (19.9 m.p.h.), -32.0 km.p.h. (-19.9 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The case vehicle was towed due to damage.

Immediately prior to the crash, the case vehicle's front right passenger was seated in an upright position with her back forward of the seat back and both feet on the floor. Her seat track was located in its full rear position, and the seat back was slightly reclined. She was restrained by her manual, three-point, lap-and-shoulder safety belt system.

The driver's pre-impact braking most likely locked the front right passenger's safety belt retractor. She moved forward against her safety belt as the case vehicle decelerated and the left front wheel mounted the concrete median. The case vehicle's impact with the concrete bridge

support then caused the passenger to continue forward opposite the case vehicle's 0 degree direction of principal force as the case vehicle decelerated, and she loaded her safety belt. The front right passenger rebounded back into her seat following the impact and remained in her seat as the case vehicle came to final rest against the concrete bridge support. The front right passenger was removed from the case vehicle through the right front door by emergency medical personnel. The front right passenger's use of her manual, three-point, lap-and-shoulder safety belt mitigated her interaction with the front right instrument panel and reduced her injury potential.

The front right passenger was transported by ambulance to a local children's hospital for treatment and was treated and released from the emergency room. She sustained multiple abrasions and contusions from her safety belt.

Immediately prior to the crash, the case vehicle's driver (29-year-old, female) was seated in an upright driving position. She had both hands on the steering wheel, her right foot on the brake pedal, her left foot on the floor and her back against the seat back. Her seat track was located between its middle and full-forward position and her seat back was slightly reclined. She was restrained by her manual, three-point, lap-and-shoulder safety belt system.

The driver's pre-impact braking most likely locked her safety belt retractor and she moved forward against her safety belt as the case vehicle decelerated and the left front wheel mounted the concrete median. The case vehicle's impact with the concrete bridge support then caused the driver to continue forward opposite the case vehicle's 0 degree direction of principal force as the case vehicle decelerated. The driver loaded her safety belt, her face and upper chest contacted her deployed air bag, her knees contacted the knee bolster and her right foot wedged between the accelerator and brake pedal. The driver rebounded back into her seat following the impact and remained in her seat as the case vehicle came to final rest against the concrete bridge support. The driver exited the vehicle under her own power through the driver's door. The driver's use of her three-point, lap-and-shoulder safety belt system and the deployment of her air bag mitigated her interaction with the steering wheel and instrument panel and reduced her injury potential.

The police crash report indicated the driver sustained a "C" (possible) injury as a result of the crash and refused transport from the scene. The driver stated she went to the emergency room later and was treated and released. She sustained multiple contusions, an abrasion and a laceration from her air bag, safety belt, knee bolster and foot controls. The driver stated she lost 3 work days as a result of the crash.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the case vehicle was traveling was a curved two-way, four-lane, divided, city street, traversing in a north-south direction and under an overpass bridge. Each travel direction contained two travel lanes and was divided by a painted and raised, curbed, concrete median. The case vehicle's roadway curved to the right. Each travel lane was approximately 3.5 meters (11.5 feet) in width. The median was approximately 5.5 meters (18 feet) in width tapering to approximately 3.1 meters (10.2 feet) in width in the area of the impact. Pavement markings consisted of broken white lane lines, solid white outside edge lines and yellow

median edge lines. The painted portion of the median contained diagonal yellow lines extending from the median edge line to the raised, curbed portion of the median. There were also “Bots Dots” in the painted portion of the median. The case vehicle’s approach to the crash location was controlled by chevron alignment signs posted in the curved portion of the median. The speed limit was 56 km.p.h. (35 m.p.h.). At the time of the crash the light condition was daylight, the atmospheric condition was light rain, and the roadway pavement was wet concrete with a 2.9% positive grade in the case vehicle’s travel direction. Traffic density was heavy and the site of the crash was urban commercial.

Pre-Crash: The case vehicle was traveling north in the outside lane of the right curve (**Figure 1**) approaching an overpass at a driver estimated speed of 48 km.p.h. (30 m.p.h.). The driver was intending to continue northbound. The driver attempted to change lanes to the left and lost control of the case vehicle on the wet roadway. The case vehicle began to slide toward the median. The driver locked the brakes in an attempt to avoid the crash. The crash occurred in the median on the south side of the overpass.

Crash: The case vehicle traveled over the concrete curbed median (**Figure 2**) and the front of the case vehicle (**Figure 3**) impacted the concrete bridge support of the overpass (**Figure 4** below) causing the case vehicle driver’s air bag to deploy. The case vehicle’s front right air bag did not deploy. The sensor in the front right seat most likely determined that the weight on the seat produced by the restrained, 28 kilogram (62 pound), 7-year-old passenger was below the front right air bag’s enable threshold and suppressed deployment of the air bag.

Post-Crash: The case vehicle rotated counterclockwise a few degrees and came to rest against the concrete bridge support (**Figure 4** below).



Figure 1: Case vehicle’s approach, northbound in outside lane, to impact with concrete bridge support (indicated by arrow)



Figure 2: Case vehicle’s approach to impact with the concrete bridge support, arrow shows left front skid mark

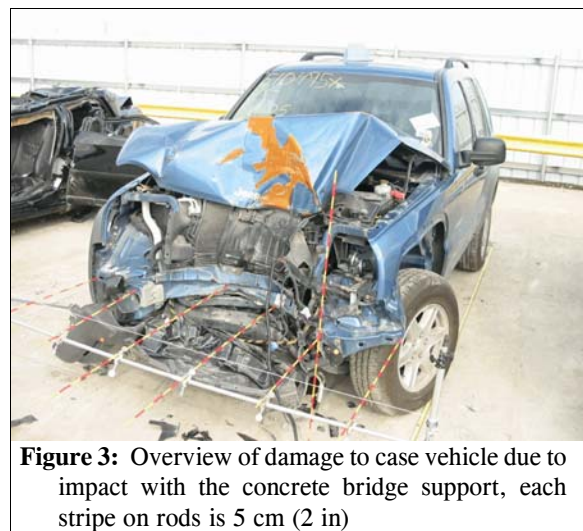


Figure 3: Overview of damage to case vehicle due to impact with the concrete bridge support, each stripe on rods is 5 cm (2 in)

The 2004 Jeep Liberty Sport was a four-door, rear wheel drive, sport utility vehicle (VIN: 1J4GK48K44W-----) equipped with a 3.7L, V6 engine; four speed automatic transmission and four-wheel disc brakes. The front seating row was equipped with bucket seats with integral head restraints, driver and front right air bags with multi-stage inflators; driver and front right passenger manual, three point, lap-and-shoulder safety belt systems with safety belt buckle switch sensors, adjustable upper anchors, constant force retractors and a retractor-mounted pretensioner at the driver's position. The front right seat was equipped with a seat position sensor and a weight sensor to detect the presence of an occupant. The back seat was equipped with a split bench seat with adjustable head restraints in the outboard positions; manual, three point, lap-and-shoulder safety belt systems in all three seat positions and a LATCH system for securing child safety seats. Four-wheel, anti-lock brakes and side-curtain air bags were an option, but the case vehicle was not so equipped. The case vehicle's wheelbase was 265 centimeters (104.3 inches). The case vehicle's odometer reading at the time of the crash is unknown because the vehicle was equipped with an electronic odometer.



Figure 4: Case vehicle's impact and final rest location

The various sensors in the case vehicle's advanced occupant restraint system analyze a combination of factors including the predicted crash severity, front safety belt usage and presence of a front right seat occupant 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.

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle's impact with the concrete bridge support involved the front plane of the vehicle. The front bumper, grille and hood were directly damaged and crushed rearward (**Figure 5**). Direct damage began 28 centimeters (11 inches) left of the front right bumper corner and extended 105 centimeters (41.3 inches) along the bumper. Crush measurements were taken at the bumper. The maximum residual crush was measured as 40 centimeters (15.7 inches) occurring at C₃ and C₄ (**Figure 6** below). The table below shows the case vehicle's front crush profile.

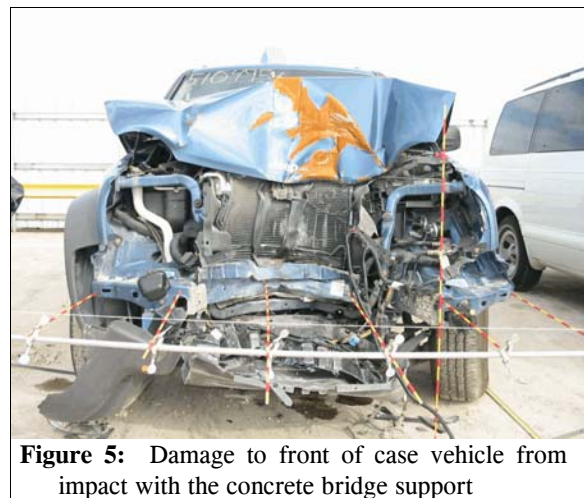


Figure 5: Damage to front of case vehicle from impact with the concrete bridge support

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	105	40	153	10	9	40	40	2	0	-9	0
in		41.3	15.7	60.2	3.9	3.5	15.7	15.7	0.8	0.0	-3.5	0.0



Figure 6: Top view of crush to front of case vehicle from impact with bridge support



Figure 7: Left front view of damage to front of case vehicle, each increment on rods is 5 cm (2 in)

The case vehicle’s left side wheelbase was reduced 7 centimeters (2.8 inches) while the right side wheelbase was extended 1 centimeter (0.4 inch). Induced damage also involved the front bumper, grille and hood as well as both fenders and both headlamp/turn signal assemblies (**Figure 7**).

The case vehicle’s recommended tire size was: P215/75R16, 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	179	26	228	33	8	10	None	No	No
RF	172	25	228	33	7	9	None	Yes	Yes
LR	179	26	228	33	7	9	None	No	No
RR	172	25	228	33	7	9	None	No	No

Vehicle Interior: Inspection of the case vehicle’s interior revealed an occupant contact scuff on the driver’s left knee bolster (**Figure 8** below) and a possible occupant contact scuff on the right

front door and arm rest (**Figures 8 and 9**). There were also several dust smears on the interior that may have been related to the air bag deployment. There were no passenger compartment intrusions. In addition, no evidence of compression of the energy absorbing steering column or deformation of the steering wheel rim was observed (**Figure 10**).



Figure 8: Overview of steering wheel and instrument panel, arrows show driver knee scuff on knee bolster and scuff on right front door

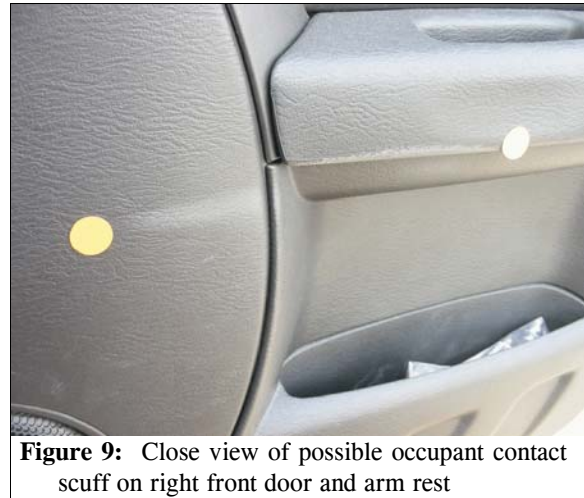


Figure 9: Close view of possible occupant contact scuff on right front door and arm rest

Damage Classification: Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **12-FDEW-2 (0-degrees)**. The WinSMASH reconstruction program, barrier algorithm, was used to reconstruct the case vehicle's Delta V. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 32.0 km.p.h. (19.9 m.p.h.), -32.0 km.p.h. (-19.9 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The case vehicle was towed due to damage.



Figure 10: Case vehicle's steering column and steering wheel showing lack of deformation

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with certified advanced 208-compliant air bags at the driver and front right passenger positions. The driver's air bag deployed as a result of the case vehicle's front impact with the concrete bridge support. The case vehicle's front right air bag did not deploy.

The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module cover flaps and the air bag fabric revealed that the cover flaps opened at the designated tear points (**Figure 11** below). There was no evidence of damage during the deployment to the air bag or the air bag module cover flaps. The air bag module cover consisted of two cover flaps. The left module cover flap was constructed of pliable vinyl with a circular center portion that contained the Jeep emblem. The left cover flap was 14 centimeters in width

while the circular emblem within the flap was 10 centimeters (3.9 inches) in diameter. Half of the emblem mated to a semi-circular contour in the right module cover flap. The deployed driver's air bag (Figure 12 below) was round with a diameter of approximately 61 centimeters (24 inches). The air bag was designed with two tethers, each approximately 13 centimeters (5.1 inches) in width and had two vent ports (Figure 13), each approximately 3 centimeters (1.2 inches) in diameter, located at the 11 and 1 o'clock positions. No evidence of occupant contact was observed on the driver's air bag.



Figure 11: Case vehicle's driver air bag module flap



Figure 12: Case vehicle's driver air bag



Figure 13: Top back portion of driver's air bag showing vent ports, indicated by arrows

The front right passenger air bag was located in the middle of the instrument panel (Figure 14) above the grab handle. This air bag did not deploy in the crash. The air bag deployment was most likely suppressed by the case vehicle's advanced occupant protection



Figure 14: Front right passenger air bag located in middle of instrument panel above grab handle

system. The sensor in the front right seat most likely determined that the weight on the seat produced by the restrained, 28 kilogram (62 pound), 7-year-old passenger was below the air bag’s enable threshold (the specific threshold is not known) and suppressed deployment of the air bag.

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

Immediately prior to the crash, the case vehicle's front right passenger [7-year-old, White (non-Hispanic) female; 122 centimeters and 28 kilograms (48 inches and 62 pounds)] was seated in an upright position with her back forward of the seat back and both feet on the floor. Her seat track was located in its full rear position, and the seat back was slightly reclined.

Based on the case vehicle’s driver interview, the front right passenger was properly restrained by her manual, three-point, lap-and-shoulder safety belt system. In addition, the passenger sustained belt pattern bruising indicating she was restrained in the crash. Inspection of the safety belt assembly revealed some slight wavy appearance to the shoulder belt, but no other evidence of loading was observed.

The driver’s pre-impact braking most likely locked the front right passenger’s safety belt retractor and she moved forward against her safety belt as the case vehicle decelerated and the left front wheel mounted the concrete median. The case vehicle’s impact with the concrete bridge support then caused the passenger to continue forward along a path opposite the case vehicle’s 0 degree direction of principal force as the case vehicle decelerated and she loaded her safety belt. The front right passenger rebounded back into her seat following the impact and remained in her seat as the case vehicle came to final rest against the concrete bridge support. The front right passenger was removed from the case vehicle through the right front door by emergency medical personnel. The front right passenger’s use of her manual, three-point, lap-and-shoulder safety belt mitigated her interaction with the front right instrument panel and reduced her injury potential.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The police crash report indicated the front right passenger sustained a “B” (non-incapacitating-evident) injury as a result of the crash and was transported by ambulance to a local children’s hospital for treatment. She was treated and released from the emergency room. The front right passenger did not receive any follow up treatment and missed two school days as a result of the crash. The front right passenger’s injuries and injury mechanisms are shown 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	Abrasion left anterior chest, not further specified	minor 490202.1,2	Torso portion of safety belt system	Certain	Emergency room records
2	Contusion {bruise}, 20.3 cm (8 in), left anterior chest, obliquely oriented	minor 490402.1,2	Torso portion of safety belt system	Certain	Interviewee (driver)

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
3	Abrasion inferior abdomen, greater on left side	minor 590202.1,8	Lap portion of safety belt system	Certain	Emergency room records
4	Contusion {bruising} across abdomen, not further specified	minor 590402.1,8	Lap portion of safety belt system	Certain	Interviewee (driver)
5	Contusion, not further specified	minor 990400.1,9	Unknown contact mechanism	Unknown	Emergency room records

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash, the case vehicle's driver [29-year-old, White (non-Hispanic) female; 165 centimeters and 56 kilograms (65 inches and 123 pounds)] was seated in an upright driving position. She had both hands on the steering wheel, her right foot on the brake pedal, her left foot on the floor and her back against the seat back. Her seat track was located between its middle and full-forward position and her seat back was slightly reclined.

Based on the driver's interview and the vehicle inspection, the driver was restrained by her manual, three-point, lap-and-shoulder safety belt system. Inspection of the safety belt assembly revealed some light scuffs on the shoulder belt webbing. In addition, the retractor was jammed indicating the pretensioner had activated, and a length of the driver's safety belt was found spooled out of the retractor consistent with the belt being worn by the driver (**Figure 15**).

The driver's pre-impact braking most likely locked the driver's safety belt retractor, and she moved forward against her safety belt as the case vehicle decelerated and the left front wheel mounted the concrete median. The case vehicle's impact with the concrete bridge support then caused the driver to continue forward opposite the case vehicle's 0 degree direction of principal force as the case vehicle decelerated. The driver loaded her safety belt, her face and upper chest contacted her deployed air bag, her knees contacted the knee bolster and her right foot wedged between the accelerator and brake pedal. The



Figure 15: Case vehicle driver's safety belt in buckled position, retractor was jammed with length of belt spooled out of the retractor consistent with safety belt usage in the crash

driver rebounded back into her seat following the impact and remained in her seat as the case vehicle came to final rest against the concrete bridge support. The driver stated she was able to exit the vehicle under her own power through the driver's door. The driver's use of her three-point, lap-and-shoulder safety belt system and the deployment of her air bag mitigated her interaction with the steering wheel and instrument panel and reduced her injury potential.

CASE VEHICLE DRIVER INJURIES

The police crash report indicated the driver sustained a "C" (possible) injury as a result of the crash and refused transport from the scene. The driver stated she went to the emergency room later and was treated and released. The driver stated she lost 3 work days as a result of the crash. The table below shows the driver's injuries and injury mechanisms.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion {bruise}, <2.5 cm (<1 in) in diameter, on face under right eye	minor 290402.1,1	Air bag, driver's	Probable	Interviewee (same person)
2 3	Contusion {bruise} hips, 10.2 cm (4 in) on right, 2.5 cm (1 in) on left; not further specified	minor 890402.1,1 890402.1,2	Lap portion of safety belt system	Certain	Interviewee (same person)
4	Contusion {bruise} bilateral knees just below knee cap, including left proximal shin	minor 890402.1,3	Knee bolster, driver's, left and right of steering column	Certain	Interviewee (same person)
5	Abrasion, 10.2 to 20.3 cm (4-8 in), left proximal shin	minor 890202.1,2	Knee bolster, driver's, left of steering column	Certain	Interviewee (same person)
6	Laceration {cut}, 1.9 cm (0.75 in) left proximal shin within abrasion cited above	minor 890602.1,2	Knee bolster, driver's, left of steering column	Certain	Interviewee (same person)
7	Contusion {bruise}, 12.7 cm (5 in) in diameter on lateral side of right ankle	minor 890402.1,1	Floor, foot controls (i.e., wedged between)	Probable	Interviewee (same person)

