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ON-SITE CHILD AIR BAG-RELATED SERIOUS INJURY INVESTIGATION

CASE NUMBER - IN-02-021
LOCATION - MINNESOTA
VEHICLE - 1995 VOLKSWAGEN JETTA III GL
CRASH DATE - December 2002

Submitted:

April 19, 2006

Contract Number: DTNH22-01-C-07002

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
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Washington, D.C. 20590-0003

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

Technical Report Documentation Page

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15. *Supplementary Notes*
On-site air bag deployment investigation involving a 1995 Volkswagen Jetta III GL, four-door sedan, with manual safety belts and dual front air bags, and a 2000 Honda CR-V EX, four-door sport utility

16. *Abstract*
This report covers an on-site investigation of an air bag deployment crash that involved a 1995 Volkswagen Jetta III GL (case vehicle) and a 2000 Honda CR-V EX (other vehicle). This crash is of special interest because the case vehicle's, unrestrained, front right passenger (6-year-old, male) sustained a critical spinal cord and brain injuries as a result of impacting his deploying front right passenger air bag. The trafficway on which both vehicles were traveling was a four-lane, divided, state highway, traversing in an east-west direction. Both the east and west roadways had two through lanes. The case vehicle was traveling east in the inside through lane of the eastern roadway. The Honda had also been traveling east in the same lane and had come to a stop just prior to the crash. The crash occurred within an interchange area, in the inside through lane of the eastbound roadway. The front of the case vehicle impacted the back of the Honda, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle's front right passenger was seated but most likely turned slightly toward the driver with his seat track located in its middle position and was not using his available, active, three-point, lap-and-shoulder, safety belt system. He sustained, according to the interview with the case vehicle's driver and his medical records, critical injuries which included: a contusion of his spinal cord at C_1 with complete cord syndrome, quadriplegia, and an atlanto-occipital dislocation. Furthermore, he sustained a critical nonanatomic injury, a contusion of his inferior medulla oblongata, and pulmonary contusions. In addition, he sustained facial, neck, and right clavicular abrasions. This occupant's primary cervical and brain injuries were caused by his contact with the case vehicle's front right passenger air bag. The case vehicle's driver (52-year-old, female) was seated with her seat track located in its middle position, and the tilt steering wheel was located in its upmost position. She was restrained by her available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to her interview, a large bruise on her right chest and breast areas as well as back and neck soreness.

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This on-site investigation was brought to NHTSA's attention on December 19, 2002 by the Minnesota Department of Public Safety. This crash involved a 1995 Volkswagen Jetta III GL (case vehicle) and a 2000 Honda CR-V EX (other vehicle). The crash occurred in December 2002 at 4:57 p.m. in Minnesota and was investigated by the state police department. This crash is of special interest because the case vehicle's front right passenger [6-year-old, Black (non-Hispanic) male] sustained a critical injury from his deploying front right passenger air bag, resulting in his hospitalization. This contractor inspected the scene and vehicles on 9-10 January 2003. This contractor interviewed the driver for the case vehicle on 10 January 2003. This summary is based on the Police Crash Report, an interview with the case vehicle's driver, scene and vehicle inspections, occupant kinematic principles, driver-reported occupant injury information, and this contractor's evaluation of the evidence.

SUMMARY

Crash Environment: The trafficway on which both vehicles were traveling was a four-lane, divided, state highway, traversing in an east-west direction. Both the east and west roadways had two through lanes. At the time of the crash the light condition was dark, the atmospheric condition was clear, and the roadway pavement was dry. Traffic density was heavy and "stop and go" at the time of the crash, and the site of the crash was essentially urban residential; see **CRASH DIAGRAM** at end.

Pre-Crash: The case vehicle was traveling east in the inside through lane of the eastern roadway and intended to continue straight ahead. The Honda was also traveling east in the inside through lane and, according to the Police Crash Report, had come to a stop just prior to the crash, intending to continue straight ahead. According to the case vehicle's driver, she made no avoidance maneuvers prior to the crash. However, based upon the underride damage pattern on the case vehicle's front, the driver applied the brakes prior to the collision. Furthermore, based on the slight offset nature of the impact configuration, the driver most likely steered slightly to the right just prior to impact. The crash occurred within an interchange area, in the inside through lane of the eastbound roadway.

Crash: The front of the case vehicle impacted the back of the Honda, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy.

Post-Crash: According to the case vehicle's driver, the case vehicle came to rest at impact. Based on the available information, the case vehicle and the Honda both moved slightly forward before coming to rest in the inside eastbound lane, heading east.

Case Vehicle: The 1995 Volkswagen Jetta III GL was a front wheel drive, four-door sedan (VIN: 3VWWC81H1SM------). The case vehicle was equipped with driver and front right passenger air bags.

Vehicle Exterior: Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **12-FDEW-1** (**0** degrees). The WinSMASH reconstruction program, missing vehicle

algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 17.0 km.p.h. (10.6 m.p.h.), -17.0 km.p.h. (-10.6 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The case vehicle was towed due to damage.

Exterior Damage: The case vehicle's contact with the Honda involved the entire front with the damage distributed all the way across. Direct damage began at the front left bumper corner and extended 108 centimeters (42.5 inches) inward along the front bumper. Crush measurements were taken at the bumper level and at the top of the radiator support, and values were averaged where appropriate. Residual maximum crush along the bumper was measured as 2 centimeters (0.8 inches) at all six "C" locations. Above the bumper (i.e., along the radiator support) the residual maximum crush was measured as 21 centimeters (8.3 inches) at C_3. The average residual maximum crush at C_3 was 12 centimeters (4.7 inches). The case vehicle's wheelbase was unaltered from the crash. The case vehicle's front bumper, bumper fascia, grille, hood, radiator, and left fender and headlight assembly were directly damaged and crushed rearward. Both the right and left headlight and turn signal assemblies sustained induced damage as well as the hood and both the right and left fenders. No obvious induced damage or remote buckling was noted to the remainder of the case vehicle's exterior. The recommended tire size was: P185/60R14, but tire size: P195/60R14, was optional; the case vehicle was equipped with tire size: P185/65R14. The case vehicle's tire data are shown in the table below. In addition, none of the case vehicle's tires were damaged, deflated, or physically restricted.

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	165	24	228	33	6	8	None	No	No
RF	172	25	228	33	7	9	None	No	No
LR	165	24	214	31	7	9	None	No	No
RR	186	27	214	31	7	9	None	No	No

Vehicle Interior: Inspection of the case vehicle's interior revealed that there was no evidence of occupant contact on the interior surfaces of the case vehicle. Furthermore, 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.

Supplemental Restraints: The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module's cover flaps and 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 four tethers, each approximately 7 centimeters (2.8 inches) in width. The driver's air bag had two vent ports, approximately 3.5 centimeters (1.4 inches) in diameter, located at the 10 and 2 o'clock positions. The deployed driver's air bag was round with a diameter of 66 centimeters (26.0 inches). An

inspection of the driver's air bag fabric revealed no contact evidence readily apparent on the air bag's fabric.

The front right passenger's air bag was located in the middle of the instrument panel. An inspection of the front right 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 front right passenger's air bag was designed without any tethers. The front right air bag had no vent ports. The deployed front right air bag was rectangular with a height of approximately 72 centimeters (28.3 inches) and a width of approximately 45 centimeters (17.7 inches). An inspection of the front right passenger's air bag fabric revealed obvious contact evidence on the front right air bag's fabric. Specifically, on the front surface there was large vertically oriented skin transfer measuring 8 x 21 centimeters (3.1 x 8.3 inches) near the middle of the left upper quadrant. The transfer was located 7 centimeters (2.8 inches) to the right of the bag's left edge and 4 centimeters (1.6 inches) below the top edge. In addition, on the top surface there was a round skin transfer measuring approximately 5 centimeters (2.0 inches) in diameter located near the 6 o'clock position. This transfer was located 18 centimeters (7.1 inches) from the left edge and 22 centimeters (8.7 inches) from the right edge of the air bag's top surface.

Other Vehicle: The 2000 Honda CR-V EX was an all wheel drive, four-door, sport utility vehicle (VIN: JHLRD176XYS------). Two wheel, anti-lock brakes are standard on this vehicle and four wheel, anti-locks brakes are an option. The Honda was equipped with redesigned driver and front right passenger air bags which did not deploy as a result of this vehicle's impact.

Exterior Damage: With only limited vehicle photographs available, the CDC for the Honda was not estimable. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the Honda's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 15.0 km.p.h. (9.3 m.p.h.), +15.0 km.p.h. (+9.3 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The Police Crash Report indicates that this vehicle was towed, but it is not known if the towing was due to damage.

Case Vehicle's Front Right Passenger: Immediately prior to the crash the case vehicle's front right passenger [6-year-old, Black (non-Hispanic) male; 117 centimeters and 25 kilograms (46 inches, 55 pounds)] was seated in an upright posture but most likely turned slightly toward the driver with his left shoulder against the seat back and his feet hanging down over the front edge of the seat's cushion–just above the floor, and one hand was possibly holding a juice container. Exactly which hand had the juice container is unknown, and the exact positions of his hands are also unknown. His seat track was located in its middle position, and the seat back was upright.

Based on this contractor's vehicle inspection and supported by this occupant's medical records, the case vehicle's front right passenger was not using his available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, there was no indication of belt pattern bruising and/or abrasions to the front right passenger's body, and the inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading.

In this contractor's opinion, the case vehicle's driver braked and steered slightly to her right, attempting to avoid the crash. As a result of these attempted avoidance maneuvers and the nonuse of his available safety belts, the front right passenger most likely moved slightly forward and to his left just prior to impact. The case vehicle's impact with the Honda enabled the case vehicle's front right passenger to continue forward and slightly upward along a path opposite the case vehicle's **0** degree Direction of Principal Force as the case vehicle decelerated. Based on the occupant contact evidence on the air bag's fabric and the driver's interview, the front right passenger contacted the deploying air bag with the right side of his face near the front portion of the air bag's top surface. The top of the front surface most likely contacted this occupant's chin and anterior neck areas. As a result, this occupant's cervical area was hyper-extended. As the air bag continued to expand, the front right passenger was driven backwards into his seat back. The exact posture of the front right passenger at final rest is unknown. According to the Police Crash Report, the driver of the Honda observed the case vehicle's driver holding the head and upper torso of the front right passenger across her lap trying to wake him up. The front right passenger had to be removed from the vehicle because of his injuries.

The front right occupant was transported by ambulance to the hospital. He sustained critical injuries and was hospitalized on a respirator for life support. According to the case vehicle's driver and this occupant's medical records, the primary injuries sustained by the front right passenger included a contusion of his spinal cord at C_1 and included a complete cord syndrome, quadriplegia, and an atlanto-occipital dislocation. Furthermore, this occupant sustained a critical nonanatomic injury (i.e., unconscious greater than six hours), a contusion of his inferior medulla oblongata, and pulmonary contusions. In addition, he sustained an abrasion over his right clavicle and an abrasion which began on his upper right cheek and extended underneath–involving his chin and neck, and over to his left jaw and/or face. This occupant's primary cervical and brain injuries were caused by his contact with the case vehicle's front right passenger air bag.

Case Vehicle's Driver: The case vehicle's driver [52-year-old, Black (non-Hispanic) female; 163 centimeters and 86 kilograms (64 inches, 190 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 at least one hand on the steering wheel. The exact position of her hands is unknown. Her seat track was located in its middle position, the seat back was upright, and the tilt steering wheel was located in its upmost position.

Based on this contractor's vehicle inspection, the case vehicle's driver was most likely restrained by her available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, there were no reports of belt pattern bruising and/or abrasions to the driver's body, but the inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed trace evidence of loading (i.e., slight waving on the belt's webbing).

The driver was transported by ambulance to the hospital for the purposes of a medical-legal blood draw. Subsequently, she sought treatment later at an emergency room. She sustained minor injuries and was treated and released. According to her interview, she sustained a large bruise on her right chest and breast areas as well as back and neck soreness.

Honda's Occupants: According to the Police Crash Report, the driver of the Honda [25-year-old, (unknown race and/or ethnic origin) male; of unknown height and weight] was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. The driver was not transported by ambulance to the hospital and did not sustain any injuries as a result of this crash.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which both vehicles were traveling was a four-lane, divided, state highway, traversing in an east-west direction (**Figure 1**). Both the east and west roadways had two through lanes. The state highway was straight and had a 4.0% grade positive to the east, at the area of impact (i.e., an upgrade in the case vehicle's and Honda's directions of travel–**Figure 1**). The pavement was bituminous, but traveled, and the width of the inside eastbound travel lane–for both vehicles, was approximately 3.7 meters (12 feet) and was most likely the same for the outside eastbound lane. The shoulders were improved (i.e., bituminous), with an unknown width paved shoulder on the south side of the eastbound roadway and a narrower unknown width shoulder on the north side of the roadway prior to the longitudinal barrier (i.e., concrete) which separated, protected, and was in the median between the east and westbound roadways, respectively (**Figure 1**). At the location of the crash, the roadway was not bordered by curbs. Pavement markings for the eastbound roadway consisted of a solid yellow edge line on the north side and a solid white edge line on south side. In addition, the through lanes were divided by a dashed white line. The estimated coefficient of friction was 0.70. There were no visible traffic controls prior to the crash site; however, a warning **MERGE** sign (Manual on Uniform Traffic Control Devices, W4-1) was located further downstream from the crash site, advising motorists of the traffic merging from an entrance ramp (**Figure 1**). The statutory speed limit was 89 km.p.h. (55 m.p.h.). No regulatory speed limit sign was posted near the crash site. At the time of the crash the light condition was dark, the atmospheric condition was clear, and the roadway pavement was dry. Traffic density was heavy and "stop and go" at the time of the crash, and the site of the crash was essentially urban residential; see **CRASH DIAGRAM** at end.

Figure 1: Case vehicle's eastward travel path in inside eastbound lane; Note: arrow indicates approximate impact location (case photo #03)

Figure 2: On-scene police photo of case vehicle and Honda at final rest in inside eastbound lane (case photo #59)

Pre-Crash: The case vehicle was traveling east in the inside through lane of the eastern roadway and intended to continue straight ahead. The Honda was also traveling east in the inside through lane and, according to the Police Crash Report, had come to a stop just prior to the crash, intending to

continue straight ahead. According to the case vehicle's driver, she made no avoidance maneuvers prior to the crash. However, based upon the underride damage pattern on the case vehicle's front, the driver applied the brakes prior to the collision. Furthermore, based on the slight offset nature of the impact configuration, the driver most likely steered slightly to the right just prior to impact (**Figure 2** above). The crash occurred within an interchange area, in the inside through lane of the eastbound roadway.

Crash: The front (**Figure 3**) of the case vehicle impacted the back of the Honda, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy.

Post-Crash: According to the case vehicle's driver, the case vehicle came to rest at impact (**Figure 2** above). Based on the available information, the case vehicle and the Honda both moved slightly forward before coming to rest in the inside eastbound lane, heading east.

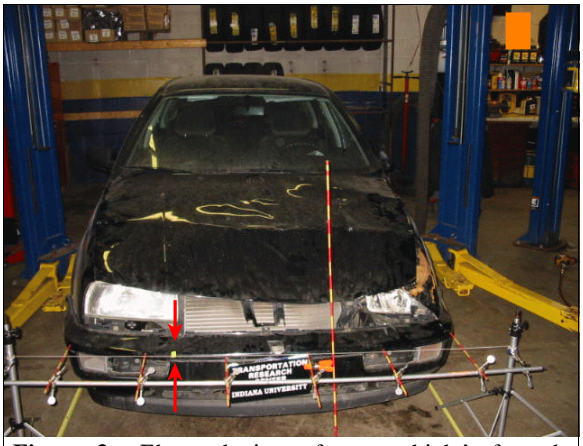


Figure 3: Elevated view of case vehicle's frontal damage with contour gauge present at bumper level; Note: yellow tape (arrows) indicates width of direct damage on bumper (case photo #07)

CASE VEHICLE

The 1995 Volkswagen Jetta III GL was a front wheel drive, five-passenger, four-door sedan (VIN: 3VWWC81H1SM------) equipped with a 2.0L, I-4 engine and a five-speed manual transmission. Braking was achieved by a power-assisted, front disc and rear drum system. The case vehicle's wheelbase was 247 centimeters (97.3 inches), and the odometer reading at inspection was 120,279 kilometers (74,738 miles), and the case vehicle was equipped with driver and front right passenger air bags.

Inspection of the vehicle's interior revealed adjustable front bucket seats with adjustable head restraints; a non-adjustable back bench seat with adjustable head restraints for the back outboard seating positions; continuous loop, three-point, lap-and-shoulder, safety belt systems at the front and back outboard positions; and a two-point, lap belt system at the back center position. The front seat belt systems were equipped with manually operated, upper anchorage adjusters for the "D"-rings. The driver's upper anchorage adjuster was located in the middle position, but the front right passenger's adjuster was located in the down-most position. The vehicle was equipped with knee bolsters for both the driver and front right passenger, neither of which showed evidence of

Figure 4: Case vehicle's frontal damage viewed along reference line from left with contour gauge present at bumper level; Note: ridge line (arrows) on hood shows above bumper deformation (case photo #09)

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

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle's contact with the Honda involved the entire front with the damage distributed all the way across. Direct damage began at the front left bumper corner and extended 108 centimeters (42.5 inches) inward along the front bumper (**Figure 3** above). Crush measurements were taken at the bumper level (**Figure 4** above) and at the top of the radiator support (**Figure 5**), and values were averaged where appropriate. Residual maximum crush along the bumper was measured as 2 centimeters (0.8 inches) at all six "C" locations. Above the bumper (i.e., along the radiator support) the residual maximum crush was measured as 21 centimeters (8.3 inches) at C_3. The average residual maximum crush at C_3 was 12 centimeters (4.7 inches). The table below shows the case vehicle's crush profile (**Figure 6**).

Figure 5: Case vehicle's frontal damage viewed along reference line from left with contour gauge positioned above bumper at upper radiator support brackets (case photo #12)

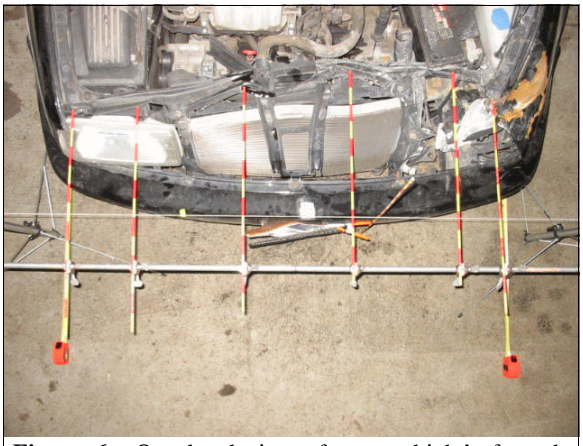


Figure 6: Overhead view of case vehicle's frontal damage with hood raised and contour gauge position above bumper along radiator support (case photo #13)

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	108	12	148	2	11	12	2	2	2	-22	0
in		42.5	4.7	58.3	0.8	4.3	4.7	0.8	0.8	0.8	-8.7	0.0

The case vehicle's wheelbase was unaltered from the crash. The case vehicle's front bumper, bumper fascia, grille, hood, radiator, and left fender and headlight assembly were directly damaged and crushed rearward. Both the right and left headlight and turn signal assemblies sustained induced damage as well as the hood and both the right and left fenders. No obvious

induced damage or remote buckling was noted to the remainder of the case vehicle's exterior. The recommended tire size was: P185/60R14, but tire size: P195/60R14, was optional; the case vehicle was equipped with tire size: P185/65R14. The case vehicle's tire data are shown in the table below. In addition, none of the case vehicle's tires were damaged, deflated, or physically restricted.

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	165	24	228	33	6	8	None	No	No
RF	172	25	228	33	7	9	None	No	No
LR	165	24	214	31	7	9	None	No	No
RR	186	27	214	31	7	9	None	No	No

Vehicle Interior: Inspection of the case vehicle's interior (**Figures 7** and **8**) revealed that there was no evidence of occupant contact on the interior surfaces of the case vehicle. Furthermore, 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.

Figure 7: Case vehicle's driver seating area showing deployed driver air bag and no apparent evidence of occupant contact to steering wheel, instrument panel, or greenhouse areas (case photo #30)

Figure 8: Case vehicle's front right passenger seating area showing deployed front right passenger air bag and no apparent occupant contact evidence to mid and right instrument panels or greenhouse areas (case photo #32)

Damage Classification: Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **12-FDEW-1** (**0** degrees). The WinSMASH reconstruction program, missing vehicle algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 17.0 km.p.h. (10.6 m.p.h.), -17.0 km.p.h. (-10.6 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The case vehicle was towed due to damage.

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained frontal air bags at the driver and front right passenger positions. Both frontal air bags deployed as a result of the frontal impact with the Honda. The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module's cover flaps and 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 four tethers, each approximately 7 centimeters (2.8 inches) in width. The driver's air bag had two vent ports, approximately 3.5 centimeters (1.4 inches) in diameter, located at the 10 and 2 o'clock positions. The deployed driver's air bag was round with a diameter of 66 centimeters (26.0 inches). An inspection of the driver's air bag fabric revealed no contact evidence readily apparent on the air bag's fabric (**Figure 9**).

Figure 9: Case vehicle's deployed driver air bag showing no apparent evidence of occupant contact (case photo #44)

The front right passenger's air bag was located in the middle of the instrument panel. An inspection of the front right 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 front right passenger's air bag was designed without any tethers. The front right air bag had no vent ports. The deployed front right air bag was rectangular with a height of approximately 72 centimeters (28.3 inches) and a width of approximately 45 centimeters (17.7 inches). An inspection of the front right passenger's air bag fabric revealed obvious contact evidence on the front right air bag's fabric. Specifically, on the front surface there was large vertically oriented skin transfer measuring 8 x 21 centimeters (3.1 x 8.3 inches) near the middle of the left upper quadrant (**Figure 10**). The transfer was located 7 centimeters (2.8 inches) to the right

Figure 10: Front surface of case vehicle's deployed front right passenger air bag showing vertically oriented contact area approximately midline within left upper quadrant (case photo #48)

Figure 11: Top surface of case vehicle's deployed front right passenger air bag showing occupant contact evidence near 6 o'clock position (case photo #50a)

of the bag's left edge and 4 centimeters (1.6 inches) below the top edge. In addition, on the top surface there was a round skin transfer measuring approximately 5 centimeters (2.0 inches) in diameter located near the 6 o'clock position (**Figure 11** above). This transfer was located 18 centimeters (7.1 inches) from the left edge and 22 centimeters (8.7 inches) from the right edge of the air bag's top surface.

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

Immediately prior to the crash the case vehicle's front right passenger [6-year-old, Black (non-Hispanic) male; 117 centimeters and 25 kilograms (46 inches, 55 pounds)] was seated in an upright posture but most likely turned slightly toward the driver with his left shoulder against the seat back and his feet hanging down over the front edge of the seat's cushion–just above the floor, and one hand was possibly holding a juice container. Exactly which hand had the juice container is unknown, and the exact positions of his hands are also unknown. His seat track was located in its middle position, and the seat back was upright.

Based on this contractor's vehicle inspection and supported by this occupant's medical records, the case vehicle's front right passenger was not using his available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, there was no indication of belt pattern bruising and/or abrasions to the front right passenger's body, and the inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading.

In this contractor's opinion, the case vehicle's driver braked and steered slightly to her right, attempting to avoid the crash. As a result of these attempted avoidance maneuvers and the nonuse of his available safety belts, the front right passenger most likely moved slightly forward and to his left just prior to impact. The case vehicle's impact with the Honda enabled the case vehicle's front right passenger to continue forward and slightly upward along a path opposite the case vehicle's **0** degree Direction of Principal Force as the case vehicle decelerated. Because the damage on the case vehicle was primarily above the bumper and produced an underride impact pattern, this underride type damage resulted in the air bag deploying late during the sequence of the impact. This delayed deployment occurred due to the prolonged change in time (Delta T) relative to the change in speed (magnitude of Delta V–i.e., ramp versus spike). Based on the occupant contact evidence on the air bag's fabric and the driver's interview, the front right passenger contacted the deploying air bag with the right side of his face near the front portion of the air bag's top surface. The top of the front surface most likely contacted this occupant's chin and anterior neck areas. As a result, this occupant's cervical area was hyper-extended. As the air bag continued to expand, the front right passenger was driven backwards into his seat back. The exact posture of the front right passenger at final rest is unknown. According to the Police Crash Report, the driver of the Honda observed the case vehicle's driver holding the head and upper torso of the front right passenger across her lap trying to wake him up. The front right passenger had to be removed from the vehicle because of his injuries.

The front right occupant was transported by ambulance to the hospital. He sustained critical injuries and was hospitalized on a respirator for life support. According to the case vehicle's driver and this occupant's medical records, the primary injuries sustained by the front right passenger included a contusion of his spinal cord at C_1 and included a complete cord syndrome, quadriplegia, and an atlanto-occipital dislocation. Furthermore, this occupant sustained a critical nonanatomic injury (i.e., unconscious greater than six hours), a contusion of his inferior medulla oblongata, and pulmonary contusions. In addition, he sustained an abrasion over his right clavicle and an abrasion which began on his upper right cheek and extended underneath–involving his chin and neck, and over to his left jaw and/or face. This occupant's primary cervical and brain injuries were caused by his contact with the case vehicle's front right passenger air bag.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion {hematoma} cervical spinal cord at C_1 including complete cord syndrome, quadriplegia, and atlanto-occipital dislocation[1], with complications of fusion occiput to C_3, ventilator dependency, SIADA (syndrome of inappropriate anti-diuretic hormones), neurogenic bowel and bladder, and autonomic dysregulation	maximum 640234.6,6	Air bag, front right passenger's	Certain	Hospitalization records
2	Nonanatomic brain injury with unconscious greater than 6 hours (i.e., one calendar day) with neurologic deficit, including GCS=3 initially, unresponsive to painful stimuli, visual field deficit, and seizures	critical 160212.5,0	Air bag, front right passenger's	Certain	Hospitalization records
3	Contusion {hematoma} inferior medulla oblongata	critical 140204.5,8	Air bag, front right passenger's	Certain	Hospitalization records
4	Contusions pulmonary, more marked on right than left, not further specified–resolved	severe 441410.4,3	Air bag, front right passenger's	Certain	Hospitalization records
5	Abrasions left face, not further specified	minor 290202.1,2	Air bag, front right passenger's	Certain	Hospitalization records
6	Abrasions, large, right face {cheek}, not further specified	minor 290202.1,1	Air bag, front right passenger's	Certain	Hospitalization records

[1] Additional medical observations include: severe extension-distraction injury to cervical spine; some distance between atlas and occipital condyles; and ligaments connecting C_1 and skull and C_1 and ring of C_2 were completely disrupted.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
7	Abrasions chin and under over to left jaw, not further specified	minor 290202.1,8	Air bag, front right passenger's	Certain	Hospitalization records
8	Abrasions neck, not further specified	minor 390202.1,9	Air bag, front right passenger's	Certain	Hospitalization records
9	Abrasion right clavicle area, not further specified	minor 790202.1,1	Air bag, front right passenger's	Certain	Emergency room records

CASE VEHICLE DRIVER KINEMATICS

The case vehicle's driver [52-year-old, Black (non-Hispanic) female; 163 centimeters and 86 kilograms (64 inches, 190 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 at least one hand on the steering wheel. The exact position of her hands is unknown. Her seat track was located in its middle position, the seat back was upright, and the tilt steering wheel was located in its upmost position.

Based on this contractor's vehicle inspection, the case vehicle's driver was most likely restrained by her available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, there were no reports of belt pattern bruising and/or abrasions to the driver's body, but the inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed trace evidence of loading (i.e., slight waving on the belt's webbing–**Figure 12**).

Figure 12: Case vehicle's driver safety belt showing slight waving in the lap portion of the belt indicating probable restraint use (case photo #33)

In this contractor's opinion, the case vehicle's driver braked and steered slightly to her right, attempting to avoid the crash. As a result of these attempted avoidance maneuvers and the use of her available safety belts, the driver most likely moved slightly forward and to her left just prior to impact. The case vehicle's impact with the Honda enabled the case vehicle's driver to continue forward and slightly upward along a path opposite the case vehicle's **0** degree Direction of Principal Force as the case vehicle decelerated. As a result, she most likely loaded her safety belts and, based on her interview, she contacted her deploying air bag with the right side of her chest. As the air bag continued to expand, the driver was driven backwards into her seat back. The exact posture of the driver at final rest is unknown. According to the Police Crash Report, the driver of the Honda observed this occupant sitting in her seat, holding the head and upper torso of the front right passenger across her lap trying to wake him up. The driver was able to exit her vehicle without assistance.

The driver was transported by ambulance to the hospital for the purposes of a medical-legal blood draw. Subsequently, she sought treatment later at an emergency room. She sustained minor injuries and was treated and released. According to her interview, she sustained a large bruise on her right chest and breast areas as well as back and neck soreness.

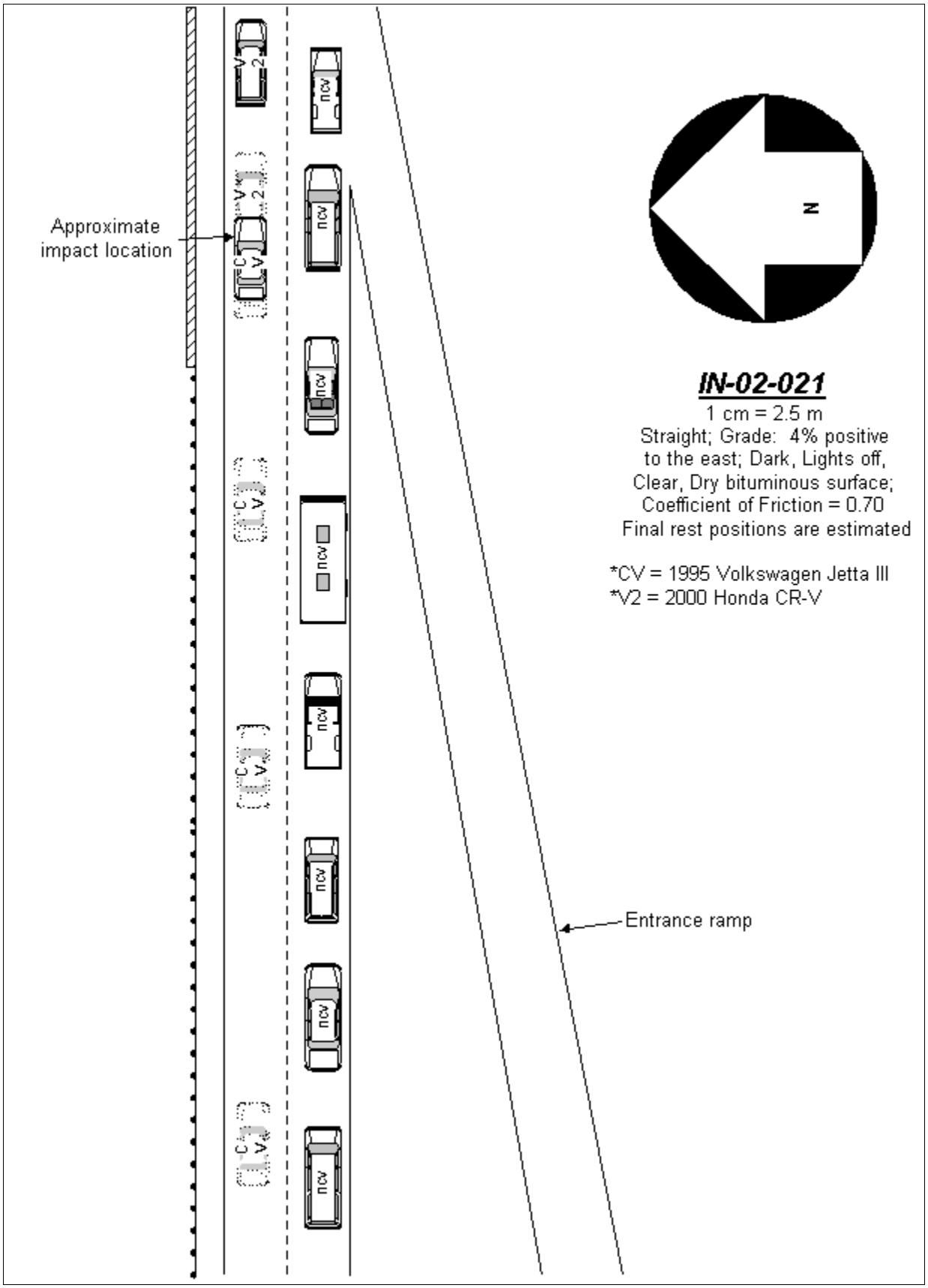
Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion {bruise} 15.2 to 20.3 cm (6 to 8 in) right central chest	minor 490402.1,1	Air bag, driver's	Probable	Interviewee (same person)

OTHER VEHICLE

Based on the VIN and manufacturer's specifications, the 2000 Honda CR-V EX was an all wheel drive, four-passenger, four-door, sport utility vehicle (VIN: JHLRD176XYS------) equipped with a 2.0L, I-4 engine and a five-speed manual transmission. Two wheel, anti-lock brakes are standard on this vehicle and four wheel, anti-locks brakes are an option. The Honda's wheelbase was 262 centimeters (103.2 inches), and the odometer reading is unknown because the Honda's interior was not inspected. Furthermore, the Honda was equipped with redesigned driver and front right passenger air bags and manual, three-point, lap-and-shoulder, safety belt systems for the front and back outboard seating positions. The Honda's air bags did not deploy as a result of this vehicle's impact.

Exterior Damage: With only limited vehicle photographs available, the CDC for the Honda was not estimable. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the Honda's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 15.0 km.p.h. (9.3 m.p.h.), +15.0 km.p.h. (+9.3 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The Police Crash Report indicates that this vehicle was towed, but it is not known if the towing was due to damage.

Honda's Occupants: According to the Police Crash Report, the driver of the Honda [25-year-old, (unknown race and/or ethnic origin) male; of unknown height and weight] was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. The driver was not transported by ambulance to the hospital and did not sustain any injuries as a result of this crash.


Approximate impact location
N
IN-02-021
1 cm = 2.5 m
Straight; Grade: 4% positive to the east; Dark, Lights off, Clear, Dry bituminous surface; Coefficient of Friction = 0.70
Final rest positions are estimated
*CV = 1995 Volkswagen Jetta III
*V2 = 2000 Honda CR-V
Entrance ramp