



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 CHILD SAFETY SEAT INVESTIGATION

CASE NUMBER - IN-03-018
LOCATION - ALABAMA
VEHICLE - 2001 HONDA CIVIC EX
CRASH DATE - March 2003

Submitted:

May 24, 2007



Contract Number: DTNH22-01-C-07002

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
National Center for Statistics and Analysis
Washington, D.C. 20590-0003

DISCLAIMERS

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

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

1. <i>Report No.</i> IN-03-018	2. <i>Government Accession No.</i>	3. <i>Recipient's Catalog No.</i>	
4. <i>Title and Subtitle</i> On-Site Child Safety Seat Investigation Vehicle - 2001 Honda Civic EX Location - Alabama		5. <i>Report Date:</i> May 24, 2007	
		6. <i>Performing Organization Code</i>	
7. <i>Author(s)</i> Special Crash Investigations Team #2		8. <i>Performing Organization Report No.</i>	
9. <i>Performing Organization Name and Address</i> Transportation Research Center Indiana University 222 West Second Street Bloomington, Indiana 47403-1501		10. <i>Work Unit No. (TRAIS)</i>	
		11. <i>Contract or Grant No.</i> DTNH22-01-C-07002	
12. <i>Sponsoring Agency Name and Address</i> U.S. Department of Transportation (NPO-122) National Highway Traffic Safety Administration National Center for Statistics and Analysis Washington, D.C. 20590-0003		13. <i>Type of Report and Period Covered</i> Technical Report Crash Date: March 2003	
		14. <i>Sponsoring Agency Code</i>	
15. <i>Supplementary Notes</i> On-site child safety seat investigation involving a 2001 Honda Civic EX, four-door sedan, with manual safety belts, dual advanced front air bags, and a child safety seat which ran-off-road and impacted a tree			
16. <i>Abstract</i> <p>This report covers an on-site investigation of an air bag deployment crash that involved a 2001 Honda Civic EX (case vehicle) which ran-off-road and impacted a tree. This crash is of special interest because the back right passenger (8-month-old, male) was seated in a child safety seat and did not sustain any injuries as a result of the crash. The trafficway on which the case vehicle was traveling was a two-lane, undivided, county road, traversing in a north-northeasterly and south-southwesterly direction. The north-south roadway had one through lane in each direction. The case vehicle had been traveling south-southwest and was negotiating a left-hand curve. The case vehicle's driver apparently lost control of the vehicle in the curve and may have briefly drifted off the right side of the roadway. The driver returned to the roadway and crossed both travel lanes before running off the southeast side of the roadway. The case vehicle continued on the road's southeast roadside where the crash occurred. The front of the case vehicle impacted a medium sized tree, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle's back right passenger was seated in a reclined posture, facing rearward in his infant child safety seat. The back seat was not adjustable. The back right passenger (i.e., son of driver) was restrained in the rear-facing child safety seat which was secured by the available, active, three-point, lap-and-shoulder, safety belt system for this position. The back right passenger did not sustain any injuries as a result of the crash. The case vehicle's driver (20-year-old, female) was seated with her seat track located between its middle and forward-most positions, and the tilt steering wheel was located in its down-most position. She was restrained by her available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to her interview and her medical records, minor injuries which included: abrasions to her left ear area, across the top of both hands, and to her right knee. In addition, she sustained contusions near her left ear area and to both knees.</p>			
17. <i>Key Words</i> Child Safety Seat Motor Vehicle Traffic Crash Air Bag Deployment Injury Severity		18. <i>Distribution Statement</i> General Public	
19. <i>Security Classif. (of this report)</i> Unclassified	20. <i>Security Classif. (of this page)</i> Unclassified	21. <i>No. of Pages</i> 17	22. <i>Price</i> \$8,200

TABLE OF CONTENTS

IN-03-018

	<u>Page No.</u>
BACKGROUND	1
SUMMARY	1
CRASH CIRCUMSTANCES	5
CASE VEHICLE: 2001 HONDA CIVIC EX	7
CASE VEHICLE DAMAGE	8
AUTOMATIC RESTRAINT SYSTEM	10
CHILD SAFETY SEAT	11
CASE VEHICLE BACK RIGHT PASSENGER KINEMATICS	13
CASE VEHICLE BACK RIGHT PASSENGER INJURIES	14
CASE VEHICLE DRIVER KINEMATICS	14
CASE VEHICLE DRIVER INJURIES	15
CRASH DIAGRAM	17
SELECTED PHOTOGRAPHS	
Figure 1: Case vehicle’s uphill, south-southwesterly travel path at entrance to left-hand curve	5
Figure 2: Case vehicle’s south-southwesterly travel path after cresting top of hill in left-hand curve	5
Figure 3: Case vehicle’s southerly travel path obliquely across leftward curving road toward eastern (left) roadside	6
Figure 4: Case vehicle’s off-road, southerly travel path along eastern roadside toward impact with tree	6
Figure 5: Case vehicle’s frontal damage with bumper fascia placed in approximate post-crash position	6
Figure 6: Case vehicle’s frontal damage with contour gauge set at bumper level	7
Figure 7: Tree on eastern side of road impacted by case vehicle	7
Figure 8: Elevated view of case vehicle’s frontal damage with contour gauge set at bumper level	7

SELECTED PHOTOGRAPHS (Continued)		<u>Page No.</u>
Figure 9:	Overhead view of case vehicle’s frontal damage pocket from tree impact	8
Figure 10:	Vertical view of case vehicle’s driver seating area showing deployed driver air bag and no evidence of occupant contact	9
Figure 11:	Case vehicle’s front right seating area showing no occupant contact evidence	9
Figure 12:	Close-up of contact damage to underneath surface of case vehicle’s steering column and driver’s knee bolster	9
Figure 13:	Case vehicle’s driver seating area showing loading to steering column and steering wheel	10
Figure 14:	Case vehicle’s deployed driver air bag with yellow tape highlighting area of occupant contact	10
Figure 15:	Close-up of occupant contact evidence on case vehicle’s driver air bag	10
Figure 16:	Case vehicle’s deployed front right passenger air bag showing no occupant contact evidence	11
Figure 17:	Overhead view of front of Evenflo Discovery infant seat used by case vehicle’s back right passenger	11
Figure 18:	Back surface of Evenflo Discovery infant child seat used by case vehicle’s back right passenger	12
Figure 19:	Left (inboard) side of Evenflo Discovery infant seat used in rear-facing position by case vehicle’s back right passenger	12
Figure 20:	Close-up of manufacturer’s labels on right side of Evenflo Discovery infant seat used by case vehicle’s back right passenger	13
Figure 21:	Case vehicle’s back right seating area showing no obvious contact evidence	13
Figure 22:	Case vehicle’s back right safety belt showing loading evidence	13
Figure 23:	Loading evidence on latch plate of Evenflo Discovery infant seat used by case vehicle’s back right passenger	14

This on-site investigation was brought to NHTSA's attention on April 25, 2003 by NASS CDS sampling activities. This crash involved a 2001 Honda Civic EX (case vehicle) which ran-off-road and impacted a tree. The crash occurred in March 2003, at 9:00 a.m., in Alabama and was investigated by the applicable state police department. This crash is of special interest because the back right passenger [8-month-old, White (non-Hispanic) male] was seated in a child safety seat and did not sustain any injuries as a result of the crash. This contractor inspected the vehicle on May 6, 2003 and the scene on May 7, 2003. This contractor interviewed the driver for the case vehicle on May 7, 2003. This report is based on the Police Crash Report, an interview with the case vehicle's driver, scene and vehicle inspections, occupant kinematic principles, occupant medical records, and this contractor's evaluation of the evidence.

SUMMARY

Crash Environment: The trafficway on which the case vehicle was traveling was a two-lane, undivided, county road, traversing generally in a north-northeasterly and south-southwesterly direction. The north-south roadway had one through lane in both the northern and southern directions. At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the roadway pavement was dry. Traffic density was not determined, and the site of the crash was rural undeveloped; see **CRASH DIAGRAM** at end.

Pre-Crash: The case vehicle had been traveling south-southwest and was in the process of negotiating a left-hand curve in the roadway, intending to proceed in a southerly travel path. The case vehicle's driver apparently lost control of the vehicle somewhere in the curve and may have briefly drifted off the right side of the roadway. The driver returned to the roadway and crossed both travel lanes before running off the southeast side of the roadway. The case vehicle's driver steered to the right and braked (without lock-up) as corrective action, attempting to avoid the crash. The case vehicle continued in a south-southeasterly direction on the road's southeast roadside. The crash occurred on the southeast side of the road.

Crash: The front of the case vehicle impacted a medium sized tree, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. It is unknown whether more than one stage of the multi-stage air bags was activated.

Post-Crash: The case vehicle rotated counterclockwise post-impact and came to rest on the southeast roadside heading in an easterly direction.

Case Vehicle: The 2001 Honda Civic EX was a front wheel drive, four-door sedan (VIN: 1HGES26711L-----) was equipped with **ADVANCED OCCUPANT PROTECTION SYSTEM** features. The case vehicle was equipped with four wheel, anti-lock brakes, dual-stage air bag inflators, three-point seat belts for all five occupants, and LATCH system features. In addition, front seat back-mounted side impact air bags were optional for this model, but this vehicle was not so equipped.

Vehicle Exterior: Based on the vehicle inspection the CDC for the case vehicle was determined to be: **01-FZEW-3 (20 degrees)**. The WinSMASH reconstruction program, barrier, damage only, algorithm was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 35.0 km.p.h. (21.7 m.p.h.), -32.9km.p.h. (-20.4 m.p.h.), and -12.0 km.p.h. (-7.5 m.p.h.). The case vehicle was towed due to damage.

Exterior Damage: The case vehicle's contact with the tree involved its front, just to the right of center. Direct damage began 24 centimeters (9.4 inches) inward from the front right bumper corner and extended 66 centimeters (26.0 inches) along the front bumper, toward the left. Residual maximum crush was measured as 45 centimeters (17.7 inches) at C₅. The wheelbase on the case vehicle's left side was shortened approximately 4 centimeters (1.6 inches) while the right side was possibly shortened approximately 1 centimeter (0.4 inches). The case vehicle's front bumper, bumper fascia, grille, hood, radiator, and right headlight and turn signal assemblies were directly damaged and crushed rearward. In addition, there was leftward lateral movement by the hood. The left headlight and turn signal assemblies sustained induced damage as well as the hood. No obvious induced damage or remote buckling was noted to the remainder of the case vehicle's exterior. The vehicle manufacturer's recommended tire size was: P185/65R15, and the case vehicle tires were the recommended size. 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	32 nd of an inch			
LF	248	36	207	30	6	8	None	No	No
RF	228	33	207	30	6	8	None	No	No
LR	338	49	207	30	7	9	None	No	No
RR	248	36	207	30	6	8	None	No	No

Vehicle Interior: Inspection of the case vehicle's interior revealed a fairly significant contact to the knee bolster and/or instrument panel just to the right side of the steering column. Furthermore, the left side of the steering wheel rim was bent toward the left instrument panel approximately 3 centimeters (1.2 inches). Finally, there was no evidence of intrusion to the case vehicle's interior but it could not be determined whether there was compression to the energy absorbing shear capsules in the steering column.

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 two tethers, each approximately 7.5 centimeters (3.0 inches) in width. The driver's air bag had two vent ports,

approximately 4 centimeters (1.6 inches) in diameter, located near the center of the back surface but oriented toward the 11 and 1 o'clock positions. The deployed driver's air bag was round with a diameter of 62 centimeters (24.4 inches). An inspection of the driver's air bag fabric revealed slight contact on the upper left quadrant of the air bag's fabric. This consisted of an obliquely oriented skin scuff, most likely from either the top of her left hand or from her left ear area.

The front right air bag was located in the top 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 two vent ports, approximately 6.5 centimeters (2.6 inches) in diameter, located at the 9:30 and 2:30 clock positions. The deployed front right air bag was essentially, rectangularly shaped with a height of approximately 48 centimeters (18.9 inches) and a width of approximately 50 centimeters (19.7 inches). An inspection of the front right passenger's air bag fabric revealed no contact evidence readily apparent on the front right air bag's fabric, which is consistent with no passenger present in this seating position.

Child Safety Seat: The back right passenger was seated in an infant child safety seat that was positioned rear-facing. The child safety seat was manufactured by Evenflo on May 24, 2002 and was identified by Model name "Discovery" and Model number **2121012 P1**. The infant seat was designed with a three-point harness which attached between the child's legs into a recessed buckle. The seat did not have a top tether, and there were two sets of slots to thread the harness through. The harness straps were threaded through the top slots, which is in accordance with the manufacturer's instructions. The child seat was in the reclined position.

The infant child safety seat consisted of a plastic one-piece shell. According to the case vehicle's inspection, the latch plate for this seating position's safety belt was the "sliding" type. The case vehicle's safety belt system had a switchable retractor. The case vehicle's driver indicated that she had read the child seat's instruction manual but not the vehicle's manual on installation of a child safety seat using the vehicle's seat belts. The driver indicated that she had installed the child seat and had placed the child in the seat prior to the crash. The driver recalls locking the vehicle's seat belt while securing the child restraint. According to the case vehicle's driver, the safety belt was in the **Automatic Locking Retractor (ALR)** mode as it should have been when used to secure a child safety seat. The driver indicated that the child seat was "tight" and that no "locking clip" was used on this passenger's safety belt.

A close inspection of the child safety seat revealed no apparent damage, stress evidence, or fractures to the shell. In addition, no damage or fractures were noted along either side of the seat's path for the vehicle's safety belt. At the time of the crash the exact position of the child seat's carrying handle is unknown.

A manufacturer's label was affixed to the left side (i.e., inboard side for rear-facing) of the child safety seat which provided general warnings about the placement of this child seat in non-vehicular circumstances and information about how to register the child seat. This label was dated March 2001.

There was a manufacturer's label affixed to the right side (i.e., outboard side for rear-facing) stressing the importance of securing the child restraint with a vehicle's safety belt as specified in the vehicle manufacturer's instructions and giving the child seat's limitations [i.e., between 2.3-9 kilograms (5-20 pounds) and 48-66 centimeters (19-26 inches)]. This label was dated March 2001. In addition, there was another label on the right side that illustrated the proper way to install the vehicle's safety belts when the child safety seat was rear-facing. This label was dated November 2001.

There were two yellow warning labels—one on each side of the shell, warning the user/parent to not place this child seat in a vehicle's front right seat when the vehicle is equipped with a front right passenger air bag. The warning labels were bright yellow with black writing, advising that serious injury or death could occur if an air bag inflated against this child restraint. This yellow warning label was dated 5/95. The manufacturer's instructions for this child safety seat were not available on the back of the seat at the time of this contractor's inspection.

Case Vehicle's Back Right Passenger: Immediately prior to the crash, the case vehicle's back right passenger [8-month-old, White (non-Hispanic) male; 66 centimeters and 8.6 kilograms (26 inches, 19 pounds)] was seated in a reclined posture, facing rearward in his infant child safety seat. The exact position of his hands is unknown. There was no seat track, and the seat back was not adjustable.

The case vehicle's back right passenger (i.e., son of driver) was restrained in the rear-facing child safety seat which was secured by the available, active, three-point, lap-and-shoulder, safety belt system for this position. There was no mention by the driver or any other evidence indicating the presence of harness belt pattern bruising and/or abrasions to the passenger's body, and the inspection of the passenger's seat belt webbing and latch plate showed only trace evidence of loading on the webbing.

After returning to the roadway, the case vehicle's driver steered to the right and braked (without lock-up) as corrective action, attempting to avoid running off the left side of the roadway. As a result of these attempted avoidance maneuvers in combination with the child being restrained in a child safety seat and secured by the vehicle's available safety belts, the back right passenger's pre-impact body position most likely shifted to his right and then left just prior to impact. The case vehicle's impact with the tree caused the back right passenger to continue backward (i.e., his rear-facing child safety seat moved forward) and slightly rightward along a path opposite the case vehicle's 20 degree Direction of Principal Force as the case vehicle decelerated. As a result of the tree impact, the case vehicle rotated slightly counterclockwise post-impact. As a consequence, the child safety seat and back right passenger most likely moved to his right, loading his child seat harness, child seat, and the vehicle's safety belts prior to stabilizing near his original pre-crash travel position. According to the interview with the case vehicle's driver (i.e., mother), the back right passenger was able to exit the vehicle with her assistance.

The back right passenger was not transported by ambulance to the hospital. According to the interview with the case vehicle driver, he did not sustain any injuries as a result of the crash.

Case Vehicle's Driver: The case vehicle's driver [20-year-old, White (non-Hispanic) female; 168 centimeters and 54 kilograms (66 inches, 120 pounds)] had been 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 on the steering wheel. However, just prior to the crash, the driver indicated that she moved her hands from the steering wheel and covered her face. According to the case vehicle's driver her seat track was located between its middle and forward-most positions, the seat back was upright, and the tilt steering wheel was located in its down-most position. At the time of the vehicle inspection, the driver's seat track was located between its middle and rearmost positions, her seat was slightly reclined, and the tilt steering wheel was located in its down-most position. In this contractor's opinion, the seat track had most likely been moved post-crash.

According to the driver's interview and her medical records, she was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. However, there was no evidence of belt pattern bruising and/or abrasions to the driver's body, and the inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading.

The driver was not transported by ambulance to the hospital, but she was examined in an emergency room later in the day. She sustained minor injuries and was treated and released. According to her interview and her medical records, the injuries sustained by the case vehicle's driver included: abrasions to her left ear area, across the top of both hands, and to her right knee. In addition, she sustained contusions near her left ear area and to both knees. Her head and hand lesions were most likely caused by her deploying driver air bag while her knee injuries resulted from contacting the driver knee bolster.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the case vehicle was traveling was a two-lane, undivided, county road, traversing generally in a north-northeasterly and south-southwesterly direction. The north-south roadway had one through lane in both the northern and southern directions (**Figure 1**). The county roadway was curved to the left for southerly traffic (**Figure 1**) and for the pre-crash segment of the roadway there was a 2.5% grade positive to the south-southwest (i.e., an upgrade in the case vehicle's direction of travel). Near the area of impact the roadway was level (i.e., actual slope was less than



Figure 1: Case vehicle's uphill, south-southwesterly travel path at entrance to left-hand curve (case photo #01)



Figure 2: Case vehicle's south-southwesterly travel path after cresting top of hill in left-hand curve; Note: arrow indicates point of impact with tree (case photo #02)

2%, negative to the south—**Figure 2** above). The pavement was bituminous but traveled, and the width of the southern travel lane was 3.1 meters (10.2 feet) and the northern travel lane was 3.0 meters (9.8 feet). The shoulders were essentially not improved (i.e., dirt and grass). The roadway was not bordered by curbs. Pavement markings consisted of a double solid yellow “no passing” centerline for both northern and southern traffic (**Figure 2** above). In addition, solid white edge lines were present. The estimated coefficient of friction was 0.70. There were no visible traffic controls in the immediate area of the crash. No regulatory speed limit sign was posted near the crash site. At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the roadway pavement was dry. Traffic density was not determined, and the site of the crash was rural undeveloped; see **CRASH DIAGRAM** at end.

Pre-Crash: The case vehicle had been traveling south-southwest and was in the process of negotiating a left-hand curve in the roadway, intending to proceed in a southerly travel path. The case vehicle’s driver apparently lost control of the vehicle somewhere in the curve and may have briefly drifted off the right side of the roadway. The driver returned to the roadway and crossed both travel lanes before running off the southeast side of the roadway (**Figure 3**). The case vehicle's driver steered to the right and braked (without lock-up) as corrective action, attempting to avoid the crash. The case vehicle continued in a south-southeasterly direction on the road’s southeast roadside (**Figure 4**). The crash occurred on the southeast side of the road.

Crash: The front (**Figure 5** and **Figure 6** below) of the case vehicle impacted a medium sized tree (**Figure 7** below), causing the case vehicle’s driver and front right passenger supplemental restraints (air bags) to deploy. It is unknown whether more than one stage of the multi-stage air bags was activated.



Figure 3: Case vehicle’s southerly travel path, obliquely across leftward curving road toward eastern (left) roadside and impact (arrow) with tree (case photo #03)



Figure 4: Case vehicle’s off-road, southerly travel path along eastern roadside toward impact (arrow) with tree (case photo #04)



Figure 5: Case vehicle’s frontal damage with bumper fascia placed in approximate post-crash position (case photo #09)

Post-Crash: The case vehicle rotated counter-clockwise post-impact and came to rest on the southeast roadside heading in an easterly direction.

CASE VEHICLE

The 2001 Honda Civic EX was a front wheel drive, five-passenger, four-door sedan (VIN: 1HGES26711L-----) equipped with a 1.7L, I-4 engine and a four-speed automatic transmission. Braking was achieved by a power-assisted, front and rear disc, four-wheel, anti-lock system. In addition, the case vehicle was equipped with ADVANCED OCCUPANT PROTECTION SYSTEM features, including dual-stage air bag inflators, three-point seat belts for all five occupants, and LATCH system features. Furthermore, front seat back-mounted side impact air bags were optional for this model, but this vehicle was not so equipped. The case vehicle's wheelbase was 262 centimeters (103.1 inches), and the odometer reading at inspection is unknown because the case vehicle was equipped with an electronic odometer.

Inspection of the vehicle's interior revealed adjustable front bucket seats with adjustable head restraints; a non-adjustable back bench seat with folding backs and integral head restraints for the back outboard seating positions; and continuous loop, three-point, lap-and-shoulder, safety belt systems at all five front and back positions. 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 down-most position, but the adjuster was located in upmost position for the front right seating position. The vehicle was equipped with knee bolsters for both the driver and front right seating positions. The driver's knee bolster was scuffed and deformed to the right of the steering column. There was no evidence of occupant contact or deformation to the front right knee bolster. 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



Figure 6: Case vehicle's frontal damage with contour gauge set at bumper level (case photo #10)



Figure 7: Tree on eastern side of road impacted by case vehicle's front (case photo #05)



Figure 8: Elevated view of case vehicle's frontal damage with contour gauge set at bumper level, viewed from right of front (case photo #21a)

frontal air bags deployed as a result of the case vehicle’s frontal impact with the tree.

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle’s contact with the tree involved its front, just to the right of center (**Figure 8** above). Direct damage began 24 centimeters (9.4 inches) inward from the front right bumper corner and extended 66 centimeters (26.0 inches) along the front bumper, toward the left. Residual maximum crush was measured as 45 centimeters (17.7 inches) at C₅ (**Figure 9**). The table below shows the case vehicle’s crush profile.



Figure 9: Overhead view of case vehicle’s frontal damage pocket from tree impact and crush profile measured at bumper level (case photo #10a)

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	66	45	154	0	12	25	42	45	11	27	0
in		26.0	17.7	60.6	0.0	4.7	9.8	16.5	17.7	4.3	10.6	0.0

The wheelbase on the case vehicle’s left side was shortened approximately 4 centimeters (1.6 inches) while the right side was possibly shortened approximately 1 centimeter (0.4 inches). The case vehicle’s front bumper, bumper fascia, grille, hood, radiator, and right headlight and turn signal assemblies were directly damaged and crushed rearward. In addition, there was leftward lateral movement by the hood. The left headlight and turn signal assemblies sustained induced damage as well as the hood. No obvious induced damage or remote buckling was noted to the remainder of the case vehicle’s exterior.

The vehicle manufacturer’s recommended tire size was: P185/65R15, and the case vehicle tires were the recommended size. 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	32 nd of an inch			
LF	248	36	207	30	6	8	None	No	No
RF	228	33	207	30	6	8	None	No	No
LR	338	49	207	30	7	9	None	No	No

Tire	Measured Pressure		Recommend Pressure		Tread Depth		Damage	Restricted	Deflated
	kPa	psi	kPa	psi	milli-meters	32 nd of an inch			
RR	248	36	207	30	6	8	None	No	No



Figure 10: Vertical view of case vehicle's driver seating area showing deployed driver air bag and no obvious contact evidence to greenhouse area (case photo #27)

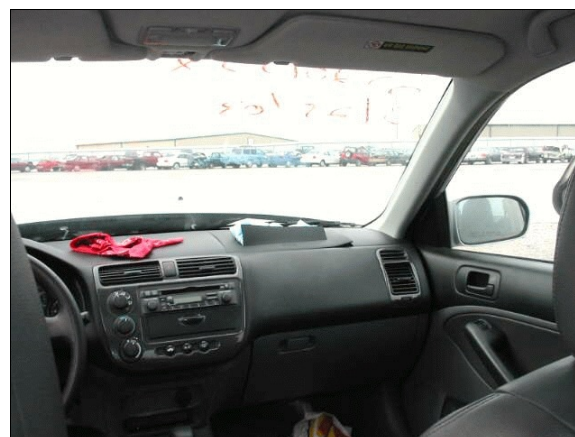


Figure 11: Case vehicle's front right seating area showing no occupant contact evidence to center or right instrument panels or greenhouse areas (case photo #40)

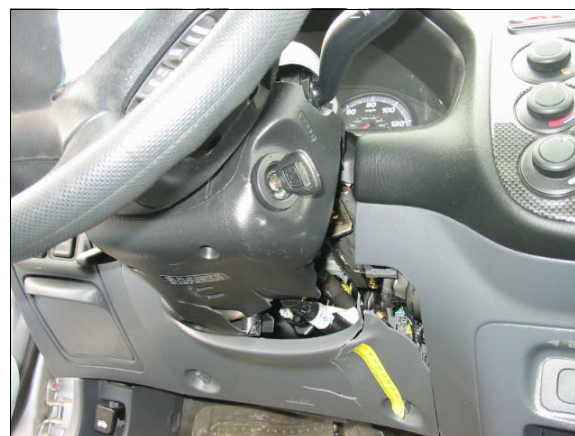


Figure 12: Close-up of contact damage to underneath surface of case vehicle's steering column and right side of driver's knee bolster (case photo #35)

Vehicle Interior: Inspection of the case vehicle's interior (**Figures 10** and **11**) revealed a fairly significant contact to the knee bolster and/or instrument panel just to the right side of the steering column (**Figure 12**). Furthermore, the left side of the steering wheel rim was bent toward the left instrument panel, approximately 3 centimeters (1.2 inches—**Figure 13** below), as a result of the driver loading the air bag, momentarily blocking the air bag's forward expansion, and causing the air bag to expand against and bend the steering wheel rim. Finally, there was no evidence of intrusion to the case vehicle's interior but it could not be determined whether there was compression to the energy absorbing shear capsules in the steering column.

Damage Classification: Based on the vehicle inspection the CDC for the case vehicle was determined to be: **01-FZEW-3 (20 degrees)**. The WinSMASH reconstruction program, barrier algorithm was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 35.0 km.p.h. (21.7 m.p.h.), -32.9km.p.h. (-20.4 m.p.h.), and -12.0 km.p.h. (-7.5 m.p.h.). The case vehicle was towed due to damage.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained dual stage frontal air bags at the driver and front right passenger positions. Both frontal air bags deployed as a result of the frontal impact with the tree. It is unknown whether more than one stage of the multi-stage air bags was activated. The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of asymmetrical, essentially, "H"-configuration cover flaps made of a medium thickness vinyl. The top cover flap was essentially rectangular with overall dimensions of 16 centimeters (6.3 inches) at the bottom horizontal seam, and 8 centimeters (3.1 inches) vertically. The bottom cover flap was trapezoidal with overall dimensions of 16 centimeters (6.3 inches) at the top horizontal seam, 7.5 centimeters (3.0 inches) at the bottom horizontal seam, and 8 centimeters (3.1 inches) vertically. An inspection of the air bag module's cover flaps and the air bag's fabric revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with two tethers, each approximately 7.5 centimeters (3.0 inches) in width. The driver's air bag had two vent ports, approximately 4 centimeters (1.6 inches) in diameter, located near the center of the back surface but oriented toward the 11 and 1 o'clock positions. The deployed driver's air bag was round with a diameter of 62 centimeters (24.4 inches). An inspection of the driver's air bag fabric revealed



Figure 13: Case vehicle's driver seating area, viewed from driver's door, showing loading to steering column (case photo #25)



Figure 14: Case vehicle's deployed driver air; Note: yellow tape highlights area of occupant contact (case photo #28a)



Figure 15: Close-up of occupant contact evidence on case vehicle's driver air bag (case photo #29)

slight contact on the upper left quadrant of the air bag's fabric (**Figure 14** above). This consisted of an obliquely oriented skin scuff (**Figure 15** above), most likely from either the top of her left hand or from her left ear area.

The front right air bag was located in the top of the instrument panel. There were two symmetrical, "H"-configuration, modular cover flaps made of a thick semi-pliable vinyl—thicker than the vinyl on the driver's module, with overall dimensions of 22 centimeters (8.7 inches) at the top and bottom horizontal seams and 4.5 centimeters (1.8 inches) vertically for the cover flaps. The profile of the case vehicle's instrument panel resulted in a 12 centimeter (4.7 inch) setback of the leading edge of the cover flap relative to the protruding right 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 two vent ports, approximately 6.5 centimeters (2.6 inches) in diameter, located at the 9:30 and 2:30 clock positions. The deployed front right air bag was essentially, rectangularly shaped with a height of approximately 48 centimeters (18.9 inches) and a width of approximately 50 centimeters (19.7 inches). An inspection of the front right passenger's air bag fabric revealed no contact evidence readily apparent on the front right air bag's fabric (**Figure 16**), which is consistent with no passenger present in this seating position.

CHILD SAFETY SEAT

The back right passenger was seated in an infant child safety seat that was positioned rear-facing. The child safety seat was manufactured by Evenflo on May 24, 2002 and was identified by Model name "Discovery" and Model number **2121012 P1**. The infant seat was designed with a three-point harness which attached between the child's legs into a recessed buckle (**Figure 17**). The seat did not have a top tether, and there were two sets of slots to thread the harness through.



Figure 16: Case vehicle's deployed front right passenger air bag showing no occupant contact evidence (case photo #41)



Figure 17: Overhead view of front of Evenflo Discovery infant seat used by case vehicle's back right passenger (case photo #49)

The harness straps were threaded through the top slots, which is in accordance with the manufacturer’s instructions. The child seat was in the reclined position.

The infant child safety seat consisted of a plastic one-piece shell. According to the case vehicle’s inspection, the latch plate for this seating position’s safety belt was the “sliding” type. The case vehicle’s safety belt system had a switchable retractor. The case vehicle’s driver indicated that she had read the child seat’s instruction manual but not the vehicle’s manual on installation of a child safety seat using the vehicle’s seat belts. The driver indicated that she had installed the child seat and had placed the child in the seat prior to the crash. The driver recalls locking the vehicle’s seat belt while securing the child restraint. According to the case vehicle’s driver, the safety belt was in the **Automatic Locking Retractor (ALR)** mode as it should have been when used to secure a child safety seat. The driver indicated that the child seat was “tight” and that no “locking clip” was used on this passenger’s safety belt.

A close inspection of the child safety seat revealed no apparent damage, stress evidence, or fractures to the shell (**Figure 18**). In addition, no damage or fractures were noted along either side of the seat’s path for the vehicle’s safety belt (**Figure 19**). At the time of the crash the exact position of the child seat’s carrying handle is unknown.

A manufacturer’s label was affixed to the left side (i.e., inboard side for rear-facing) of the child safety seat which provided general warnings about the placement of this child seat in non-vehicular circumstances and information about how to register the child seat. This label was dated March 2001.

There was a manufacturer’s label affixed to the right side (i.e., outboard side for rear-facing) stressing the importance of securing the child restraint with a vehicle’s safety belt as specified in the vehicle manufacturer’s instructions (**Figure 20** below) and giving the child seat’s limitations



Figure 18: Back surface of Evenflo Discovery infant child seat used by case vehicle’s back right passenger; Note: no visible evidence of damage (case photo #52)



Figure 19: Left (inboard) side of Evenflo Discovery infant safety seat used in rear-facing position by case vehicle’s back right passenger; Note: arrow marks safety belt path (case photo #51)

[i.e., between 2.3-9 kilograms (5-20 pounds) and 48-66 centimeters (19-26 inches)]. This label was dated March 2001. In addition, there was another label on the right side that illustrated the proper way to install the vehicle's safety belts when the child safety seat was rear-facing. This label was dated November 2001.

There were two yellow warning labels—one on each side of the shell (Figure 19 above), warning the user/parent to not place this child seat in a vehicle's front right seat when the vehicle is equipped with a front right passenger air bag. The warning labels were bright yellow with black writing, advising that serious injury or death could occur if an air bag inflated against this child restraint. This yellow warning label was dated 5/95. The manufacturer's instructions for this child safety seat were not available on the back of the seat at the time of this contractor's inspection.

CASE VEHICLE BACK RIGHT PASSENGER KINEMATICS

Immediately prior to the crash, the case vehicle's back right passenger [8-month-old, White (non-Hispanic) male; 66 centimeters and 8.6 kilograms (26 inches, 19 pounds)] was seated in a reclined posture, facing rearward in his infant child safety seat (Figure 21). The exact position of his hands is unknown. There was no seat track, and the seat back was not adjustable.

The case vehicle's back right passenger (i.e., son of driver) was restrained in the rear-facing child safety seat which was secured by the available, active, three-point, lap-and-shoulder, safety belt system for this position. There was no mention by the driver or any other evidence indicating the presence of harness belt pattern bruising and/or abrasions to the passenger's body, and the inspection of the passenger's seat belt webbing and latch plate showed only trace evidence of loading on the webbing (Figure 22).

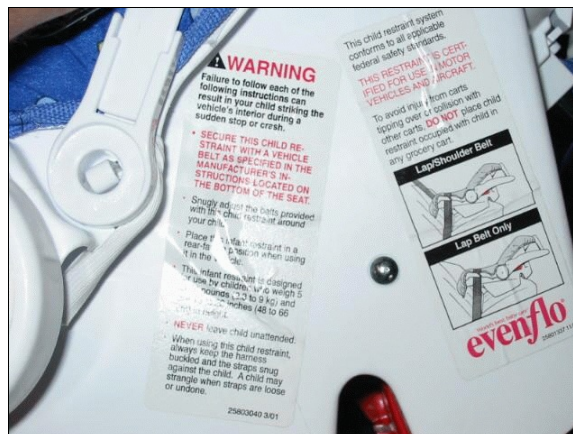


Figure 20: Close-up of manufacturer's labels on right side of Evenflo Discovery infant safety seat used by case vehicle's back right passenger (case photo #56)



Figure 21: Case vehicle's back right seating area, view from left rear door, showing no obvious contact evidence from infant child seat (case photo #45)

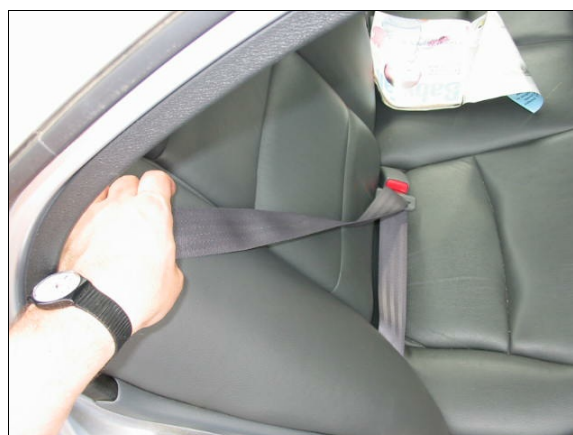


Figure 22: Case vehicle's back right safety belt showing loading evidence on webbing of torso portion (case photo #46)

After returning to the roadway, the case vehicle's driver steered to the right and braked (without lock-up) as corrective action, attempting to avoid running off the left side of the roadway. As a result of these attempted avoidance maneuvers in combination with the child being restrained in a child safety seat and secured by the vehicle's available safety belts, the back right passenger's pre-impact body position most likely shifted to his right and then left just prior to impact. The case vehicle's impact with the tree caused the back right passenger to continue backward (i.e., his rear-facing child safety seat moved forward) and slightly rightward along a path opposite the case vehicle's 20 degree Direction of Principal Force as the case vehicle decelerated. As a result of the tree impact, the case vehicle rotated slightly counterclockwise post-impact. As a consequence, the child safety seat and back right passenger most likely moved to his right, loading his child seat harness (**Figure 23**), child seat, and the vehicle's safety belts prior to stabilizing near his original pre-crash travel position. According to the interview with the case vehicle's driver (i.e., mother), the back right passenger was able to exit the vehicle with her assistance.



Figure 23: Loading evidence on latch plate of Evenflo Discovery infant child safety seat used by case vehicle's back right passenger (case photo #55)

CASE VEHICLE BACK RIGHT PASSENGER INJURIES

The back right passenger was not transported by ambulance to the hospital. According to the interview with the case vehicle driver, he did not sustain any injuries as a result of the crash.

CASE VEHICLE DRIVER KINEMATICS

The case vehicle's driver [20-year-old, White (non-Hispanic) female; 168 centimeters and 54 kilograms (66 inches, 120 pounds)] had been 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 on the steering wheel. However, just prior to the crash, the driver indicated that she moved her hands from the steering wheel and covered her face. According to the case vehicle's driver her seat track was located between its middle and forward-most positions, the seat back was upright, and the tilt steering wheel was located in its down-most position. At the time of the vehicle inspection, the driver's seat track was located between its middle and rearmost positions, her seat was slightly reclined, and the tilt steering wheel was located in its down-most position. In this contractor's opinion, the seat track had most likely been moved post-crash.

According to the driver's interview and her medical records, she was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. However, there was no evidence of belt pattern bruising and/or abrasions to the driver's body, and the inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading.

After returning to the roadway, the case vehicle's driver steered to the right and braked (without lock-up), attempting to avoid running off the left side of the roadway. As a result of these attempted avoidance maneuvers and the use of her available safety belts, the driver's pre-impact body position most likely shifted to her right and then left just prior to impact. The case vehicle's impact with the tree enabled the case vehicle's driver to continue forward and slightly rightward along a path opposite the case vehicle's 20 degree Direction of Principal Force as the case vehicle decelerated. As a result of the tree impact, the driver's face and chest contacted her deploying air bag and her chest loaded the steering column and rim. Furthermore, because of her close proximity to the air bag module at the time of the air bag's deployment, the resistance caused by the driver to the air bag's expansion most likely caused the air bag to expand towards the left instrument panel and deform the a portion of the steering wheel rim. In addition, the driver loaded the case vehicle's driver knee bolster, scuffing and deforming it and causing her knee lesions. After impacting the tree, the case vehicle rotated slightly counterclockwise post-impact. As a result, the driver most likely moved to her right, loading her safety belts prior to stabilizing near her original pre-crash travel position. According to the interview with the case vehicle's driver, she was able to exited the vehicle without assistance.

CASE VEHICLE DRIVER INJURIES

The driver was not transported by ambulance to the hospital, but she was examined in an emergency room later in the day. She sustained minor injuries and was treated and released. According to her interview and her medical records, the injuries sustained by the case vehicle's driver included: abrasions to her left ear area, across the top of both hands, and to her right knee. In addition, she sustained contusions near her left ear area and to both knees. Her head and hand lesions were most likely caused by her deploying driver air bag while her knee injuries resulted from contacting the driver knee bolster.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Abrasion left ear {posterior auricular area}	minor 290202.1,2	Air bag, driver's	Probable	Emergency room records
2	Contusion left ear {posterior auricular area}	minor 290402.1,2	Air bag, driver's	Possible	Emergency room records
3	Abrasion {burn} top of right hand	minor 790202.1,1	Air bag, driver's	Probable	Emergency room records
4	Abrasion {burn}, 10 cm (4 in), diagonally across dorsum {back} left hand	minor 790202.1,2	Air bag, driver's	Probable	Interviewee (same person)
5	Abrasion right knee, not further specified	minor 890202.1,1	Knee bolster, driver's, right of steering column	Certain	Emergency room records

Case Vehicle Driver Injuries (Continued)

IN-03-018

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
6	Contusion, 15 cm (6 in), left knee, not further specified	minor 890402.1,2	Knee bolster, driver's, left of steering column	Probable	Interviewee (same person)
7	Contusion, 15 cm (6 in), right knee, not further specified	minor 890402.1,1	Knee bolster, driver's, right of steering column	Certain	Emergency room records

