

On-Site Side Air Bag Investigation
Dynamic Science, Inc. (DSI), Case Number DS09032
2007 Honda Accord
Washington
September 2009

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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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16. Abstract This on-site investigation focused on the deployed side air bags in a 2007 Honda Accord that was involved in a crash with another vehicle. The crash occurred in September 2009 in the state of Washington in a four-leg intersection. The Honda was being driven by a restrained 35-year-old female. The other vehicle was a 2004 Toyota Highlander that was being driven by a 43-year-old female. The Honda was traveling southbound and the Toyota was traveling northbound. As the Honda traversed the intersection, the Toyota initiated a left turn across its path and the front end of the Toyota impacted the left side of the Honda. Both vehicles came to rest in the west leg of the intersection. The Honda was equipped with advanced dual-stage frontal air bags, front seat-mounted side air bags, and side impact inflatable curtain (IC) air bags. At impact, the Honda's left seat-mounted side air bag and left IC air bag deployed. The driver of the Honda sustained minor injuries to her back and hip. She was transported to a local hospital where she was treated and released. The Honda was towed due to damage to an auto repair facility and was later repaired.				
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Background

This on-site investigation focused on the deployed side air bags in a 2007 Honda Accord that was involved in a crash with another vehicle. The crash occurred in September 2009 in the state of Washington in a four-leg intersection. The Honda (**Figure 1**) was being driven by a restrained 35-year-old female. The other vehicle was a 2004 Toyota Highlander that was being driven by a 43-year-old female. The Honda was traveling southbound and the Toyota was traveling northbound. As the Honda traversed the intersection, the Toyota initiated a left turn across its path and the front end of the Toyota impacted the left side of the Honda. Both vehicles came to rest in the west leg of the intersection.



Figure 1. Subject vehicle, 2007 Honda Accord

The Honda was equipped with advanced dual-stage frontal air bags, front seat-mounted side air bags, and side impact inflatable curtain (IC) air bags. At impact, the Honda's left seat-mounted side air bag and left IC air bag deployed.

The driver of the Honda sustained minor injuries to her back and hip. She was transported to a local hospital where she was treated and released. The Honda was towed due to damage to an auto repair facility and was later repaired.

This on-site side air bag investigation was initiated by the National Highway Traffic Safety Administration (NHTSA) during a review of National Automotive Sampling System (NASS) General Estimates System (GES) police reports. On October 23, 2009, Dynamic Science, Inc. (DSI) was forwarded the police report with instructions to obtain cooperation. DSI obtained permission to inspect the subject vehicle and the case was assigned on October 28, 2009. The vehicle inspection took place at the repair facility on November 2, 2009. DSI obtained the vehicle's Event Data Recorder (EDR) from the repair facility on December 29, 2009 and sent it to NHTSA on December 31, 2009 for OEM imaging of the crash data. The EDR was forwarded to the manufacturer for imaging but as of this writing the imaged data had not yet been received.

Summary

Crash Site

The crash occurred in a four-leg intersection consisting of a divided north/south roadway and an undivided east/west roadway (**Figure 2**). The north/south roadway was configured with two through lanes and one left turn lane for each direction of travel and was divided by two light rail train tracks on a raised center median. All northbound and southbound lanes approaching the intersection measured 3.4 m (11.0 ft) in width. The through lanes were separated by dashed white stripes and

the left turn lanes were separated by solid white stripes. The concrete roadway was straight and level. Outboard of the through lanes were raised concrete curbs and paved sidewalks. Inboard of the left turn lanes was a raised concrete median consisting of a paved surface and two light rail train tracks aligned parallel to the north/south roadway.

The east/west roadway consisted of one lane for each direction of travel separated by solid double yellow stripes. The east leg intersected the northbound roadway at a 110-degree angle. The west leg intersected the southbound roadway at a 100-degree angle.



Figure 2. Crash site, looking east

The intersection was controlled by three-phase traffic signals that utilized leading green arrows for the left turn lanes. Additionally, illuminated signs signaled the approach of trains for the northbound and southbound travel lanes. At the time of the crash the weather was clear, light conditions were daylight, and the roadway was dry. The posted speed limit at this location was 56 km/h (35 mph).

Pre-Crash

The Honda was traveling in the inboard southbound lane with the flow of traffic at a driver-estimated speed of 40 km/h (25 mph). As she entered the intersection other vehicles were ahead of her in the inboard lane. She did not recall the position of her right foot, or if she was accelerating or braking prior to impact. The driver stated she did not observe the opposing vehicle prior to impact, and she did not initiate an evasive maneuver. She was observing the vehicles traveling ahead of her and was not distracted prior to the impact. The police report indicated that both drivers claimed to enter the intersection with a green signal.

The Toyota was traveling northbound at an unknown speed in the left turn lane. The driver initiated a left turn, crossed over the railroad tracks, and then crossed into the inboard southbound lane.

Crash

The crash consisted of a single event. The front end of the Toyota impacted the left side of the Honda between its B-pillar and rear axle, aft of its longitudinal center of gravity. The Honda then initiated a post-impact counterclockwise rotation and was displaced to the right. It came to rest facing north in the outboard southbound lane (**Figure 3**) approximately 8.0 m (26.0 ft) from the point of impact.

The Toyota initiated a post-impact, counterclockwise rotation and came to rest in the southbound lanes. The vehicle's at-rest heading angle was not determined. The driver of the Honda stated during the interview that the Toyota came to rest on the roadway within the intersection and that it did not sustain a secondary impact.

For the Honda, the Missing Vehicle algorithm of the WinSMASH program computed a Total Delta-V of 13.0 km/h (8.1 mph). The longitudinal and lateral components were -8.4 km/h (-5.2 mph) and 10.0 km/h (6.2 mph), respectively. The WinSMASH results appear reasonable based on the vehicle's left side crush profile.

For the Toyota, the program computed a Total Delta-V of 12.0 km/h (7.5 mph). The longitudinal and lateral components were -11.3 km/h (-7.0 mph) and -4.1 km/h (-2.5 mph), respectively. The WinSMASH results for the Toyota should be considered a borderline reconstruction.

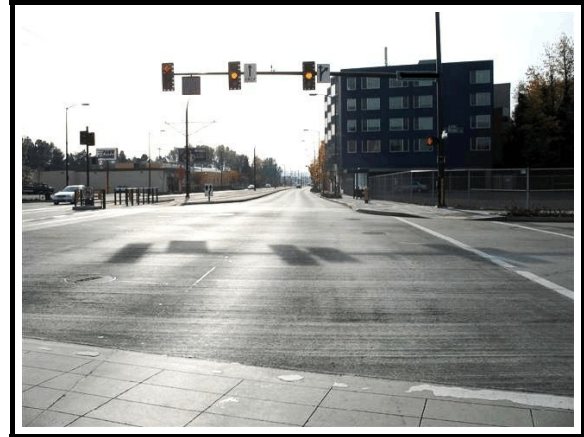


Figure 3. Area of impact and path to final rest for subject vehicle, looking south

Post-Crash

The driver of the Honda unbuckled her safety belt and remained seated until assisted by on-scene responders. She stated during the interview that following the crash the front left door was jammed shut and she felt disoriented and dizzy. The vehicle inspection later revealed the driver's door to be operational. The police arrived, opened the door, and assisted the driver from the vehicle. She was treated on-scene, and then was transported to a local hospital where she arrived at 1615 hours with a Glasgow Coma Score (GCS) of 15. She was treated in the emergency room and then was discharged at 1840 hours. She sustained cervical and thoracic muscle strains, a hip contusion, and complained of pain to the left shoulder. The driver missed seven days of work due to injury and did not seek follow-up treatment. The Honda was towed to a repair facility due to damage and was later repaired.

The driver of the Toyota was treated at the scene and the vehicle was driven from the scene. The police report indicated that the vehicle sustained damage distributed across the front end. The vehicle was not inspected.

Vehicle Data - 2007 Honda Accord

The Honda was identified by the Vehicle Identification Number (VIN): 1HGCM567X7Axxxxxx and the vehicle's date of manufacture was November 2006. The odometer reading obtained during the inspection was 42,669 km (26,513 mi). Standard equipment included a 2.4-liter, 4-cylinder engine, automatic transmission, front wheel drive, 4-wheel disc brakes, 4-wheel Assisted Braking System (ABS), power steering with tilt and telescopic column functionality, and daytime running lights.

The vehicle manufacturer recommended P205/60R16 tires for the front and rear with a recommended pressure of 221 kPa (32 psi) for the front and 207 kPa (30 psi) for the rear. The Honda was equipped with Michelin Energy MXV4 tires of the recommended size that were manufactured in November 2006. The specific tire information was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	262 kPa (38 psi)	6 mm (7/32 in)	No	None
LR	255 kPa (37 psi)	7 mm (9/32 in)	Yes	None
RR	248 kPa (36 psi)	6 mm (7/32 in)	No	None
RF	255 kPa (37 psi)	6 mm (7/32 in)	No	None

The Honda's interior was configured with leather-covered five-passenger seating. The front bucket seats were equipped with adjustable head restraints and were separated by a center console. The driver's head restraint was adjusted between the mid- and full-down position and was 2.0 cm (0.8 in) above the seat back. The seat cushion was adjusted to mid-track and the seat back was slightly reclined. Second row seating consisted of a 60/40 split bench seat with folding backs and adjustable head restraints for the outboard seats.

Vehicle Damage - 2007 Honda Accord

Exterior Damage

The Honda sustained direct and induced damage to the left side. Direct damage began 38.0 cm (15.0 in) forward of the left rear bumper corner, extended forward 194.0 cm (76.4 in), and ended 140.0 cm (55.1 in) aft of the front axle. The Field L began at the left rear bumper corner, extended forward 210.0 cm (82.7 in), and ended 162.0 cm (63.8 in) aft of the front axle (**Figure 4**). Vertically, the direct damage began at the sill, extended upward 59.0 cm (23.2 in), and ended above mid-door level. Six crush measurements were taken at mid-door level as follows: $C_1 = 0$, $C_2 = 0$, $C_3 = 11.0$ cm (4.3 in), $C_4 = 19.0$ cm (7.5 in), $C_5 = 13.0$ cm (5.1 in), $C_6 = 0$. Maximum crush was located at C_4 and measured 19.0 cm (7.5 in). The Collision Deformation Classification (CDC) for Event 1 was 10LZEW2.



Figure 4. Subject vehicle showing left side crush profile measurement

The Honda sustained direct damage to the left rear door panel. The vehicle's sill height measured 29.0 cm (11.4 in), the height of maximum door crush measured 57.0 cm (22.4 in), and the Door Sill Differential (DSD) measured 8.0 cm (3.1 in). Additionally, the vehicle's left rear tire was restricted and the rim was deformed to a 15 degree inboard cant.

The vehicle inspection revealed minor damage to the right side of the vehicle resulting from a previous non-deployment event not related to this crash.

Interior Damage - 2007 Honda Accord

The Honda sustained minor interior damage resulting from intrusions, occupant loading and contacts, and post-crash salvage activity. Lateral intrusion was located in the second row at the armrest and the rearward lower quadrant of the left door panel. Evidence of occupant loading and contacts were located on the front left door panel, left seat-mounted side air bag, left IC air bag, the driver's seat back, and the driver's safety belt webbing and latch plate. The left IC air bag was cut by the repair facility to facilitate access to the front row. The vehicle's glazing remained intact and the vehicle sustained no integrity loss.

Manual Restraints - 2007 Honda Accord

The front row seating positions were equipped with 3-point manual lap and shoulder safety belts with continuous loop webbing, sliding latch plates, adjustable D-ring anchorages, and retractor pretensioners. The driver's safety belt had an Emergency Locking Retractor (ELR) and the front right passenger's safety belt had a switchable ELR/Automatic Locking Retractor (ALR).

The driver's safety belt D-ring anchorage was in the full-up position. The latch plate was scratched and the shoulder belt webbing revealed wear marks indicating historical usage. The safety belt retractor pretensioner had actuated during the crash and the safety belt webbing was locked in the used position. The safety belt latch plate was scuffed indicating occupant loading where the webbing was routed through the latch plate (**Figure 5**). Two scuffs measuring less than 1.0 cm (0.4 in) each were located 11.0 cm (4.3 in) above the stop button, and an abraded section measuring 9.0 cm (3.5 in) in length began 3.0 cm (1.2 in) below the stop button and extended downward. Based on the vehicle inspection, the driver's safety belt was determined to have been used to restrain the driver during the crash.



Figure 5. Scuff to safety belt latch plate resulting from occupant loading

The front right safety belt retractor pretensioner did not actuate during the crash. The safety belt webbing was equipped with an aftermarket Custom brand comfort pad measuring 20.0 cm (7.8 in) in length. The latch plate revealed scratches indicating historical usage.

The second row safety belts were configured with sliding latch plates and ELR/ALR retractors. The outboard seats were configured with Lower Anchors and Tethers for Children (LATCH) and the center seat was equipped with tether hardware.

Supplemental Restraint System - 2007 Honda Accord

The vehicle's Supplemental Restraint System (SRS) included an air bag control module (ACM), driver and passenger frontal air bags, front seat-mounted side air bags, side impact IC air bags, and safety belt retractor pretensioners for the front row. During the crash, the left seat-mounted side air bag and the left IC air bag deployed (**Figure 6**) and the driver's safety belt retractor pretensioner actuated.

The Honda was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system. A CAC vehicle is certified by the manufacturer to be compliant with the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The Honda's advanced dual-stage frontal air bags were designed to deploy according to impact severity. The frontal air bags did not deploy in this crash.

The left seat-mounted side air bag deployed from the outboard aspect of the left seat-back. The air bag was hexagonal in shape with a rectangular tab at the leading edge. It measured 35.0 cm (13.8 in) in height, 30.0 cm (11.0 in) in width, and covered the upper rear quadrant of the left door panel. The air bag's lower edge was level with the bottom of the arm rest and the upper edge extended to the side glass. The air bag was configured with two vent ports and did not have internal tethers.

The seat-mounted side air bag exhibited evidence of occupant loading on the outboard panel. The outboard panel revealed a 2.0 cm (0.8 in) scuff located near the leading edge resulting from occupant loading which in turn caused the air bag to load the left door panel. A scuff measuring 5.0 x 5.0 cm (2.0 x 2.0 in) on the door panel's rear upper quadrant was consistent with the evidence on the air bag.

The left IC air bag deployed from the left roof side rail above the front and second rows. The IC air bag measured 184.0 cm (72.4 in) in length x 40.0 cm (15.7 in) in height. The air bag was configured with 20 folded pleats that were oriented horizontally. The IC air bag was configured with three 2.0 cm (0.8 in) vent ports and several smaller vent ports. Two sections of the IC air bag had been cut out by the repair facility to allow easier access to the vehicle's interior. The displaced sections were located in the vehicle during the inspection. The DSI investigator reattached the sections to their original positions and the inboard panel revealed a hair and skin oil transfer measuring 8.0 x 8.0 cm (3.1 x 3.1 in). The transfer was located near the vertical center of the inboard panel and approximately 32.0 cm (12.6 in) from the leading edge of the panel (**Figure 7**). Based on the

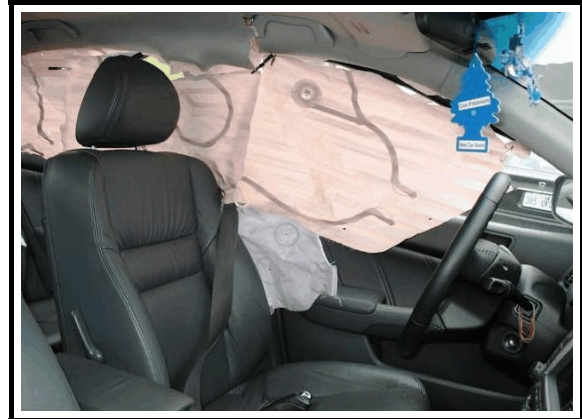


Figure 6. Deployed seat-mounted side air bag and IC air bag



Figure 7. Location of hair and skin oil transfer on the left IC air bag

driver's kinematics and injuries, her head and hair were determined to be the source of the transfer.

Vehicle Data - 2004 Toyota Highlander

The other vehicle was a 2004 Toyota Highlander sport utility vehicle identified by the VIN: JTEEP21A740xxxxxx. Standard equipment for this model included a 3.3-liter, 6-cylinder engine, automatic transmission, all-wheel drive, and 4-wheel anti-lock brakes.

Occupant Demographics - 2007 Honda Accord

Driver

Age/Sex:	35 years/Female
Height:	165.0 cm (65.0 in)
Weight:	82.0 kg (180.0 lb)
Seat type:	Bucket with adjustable head restraint
Seat track position:	Middle track
Manual restraint usage:	Lap and shoulder belt used
Usage source:	Vehicle inspection
Air bags:	IC air bag and seat-mounted side air bag, deployed; frontal air bag, not deployed
Alcohol, drug involvement:	None present
Type of medical treatment:	Transported, treated and released

Occupant Kinematics - 2007 Honda Accord

Driver

The 35-year-old female driver was seated in an upright posture and was restrained by the vehicle's lap and shoulder belt. Her seat back was slightly reclined and her seat cushion was set to mid-track. She was actively steering the vehicle with both hands on the steering wheel and her left foot was on the floor. She could not recall the position of her right foot or whether she was accelerating or braking prior to impact. The driver was not wearing eyewear and the front row left side glass was completely open.

At impact with the Toyota, the driver's safety belt retractor pretensioner actuated and the left seat-mounted side air bag and IC air bag deployed. The driver was displaced left in response to the direction of force. She loaded the safety belt and sustained thoracic and lumbar muscle strains. She

contacted the seat back in the lower left quadrant depositing scuffs to the leather. The driver's left shoulder and flank loaded the seat-mounted side air bag, depositing scuffs and transfers to the rear upper door panel just below the bottom of the side glass (**Figure 8**). Her left hip loaded the rear lower quadrant of the left door panel and sustained a contusion.



Figure 8. Scuff to door panel resulting from occupant loading

The driver's head and possibly her left face loaded the IC air bag, depositing a hair and skin oil transfer to the inboard panel and resulting in post-impact dizziness and disorientation. The window opening allowed the IC air bag some space in which to move laterally when it was loaded by the driver. The driver did not sustain a facial injury but possibly sustained a minor closed head injury after loading the IC air bag.

The impact to the Honda was rearward of the vehicle's lateral center of gravity and consequently the vehicle initiated a counterclockwise rotation. During the vehicle's post-impact movement, the driver was displaced first left and then right by the rotational forces but was held in place in her seat by the vehicle's lap and shoulder safety belt. The driver remained seated until on-scene responders opened her door and assisted her from the vehicle. Following the crash, the driver complained of pain and stiffness to the left shoulder although no lesions were present.

Occupant Injuries - 2007 Honda Accord

Driver

The injury data was obtained from the driver's medical records and the interview.

<u>Injury</u>	<u>Injury Severity</u> <u>AIS 1990 / Update 1998</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Thoracic muscle strain	640478.1,7	Impact forces	Probable
Lumbar muscle strain	640678.1,7	Impact forces	Probable
Hip contusion, left	890402.1,2	Side door panel, rear lower quadrant	Probable

Attachment 1. Scene Diagram

