On-Site Certified Advanced 208-Compliant Air Bag Investigation
Dynamic Science, Inc. (DSI), Case Number DS09017
2005 Honda Odyssey
California
January 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.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient Catalog No.
DS09017		

4. Title and Subtitle	5. Report Date
On-Site Certified Advanced 208-Compliant Air Bag Investigation	September 24, 2009
	6. Performing Organization Report No.

7. Author(s)	8. Performing Organization Report No.
Dynamic Science, Inc.	

9. Performing Organization name and Address	10. Work Unit No. (TRAIS)
Dynamic Science, Inc. 299 West Cerritos Avenue Anaheim, CA 92805	11. Contract or Grant no. DTNH22-07-00045

12. Sponsoring Agency Name and Address	13. Type of report and period Covered [Report Month, Year]
U.S. Dept. of Transportation (NVS-411) National Highway Traffic Safety Administration 1200 New Jersey Ave, SE Washington, DC 20590	14. Sponsoring Agency Code

15. Supplemental Notes

16. Abstract

This on-site investigation focused on both the Certified Advanced 208-Compliant (CAC) air bag system in a 2005 Honda Odyssey and the vehicle's Advanced Compatibility Engineering (ACE) body structure. The multi-stage air bags were certified by the manufacturer to be compliant with the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. According to Honda literature, the ACE front-end frame structure reduces the force of an impact by dispersing and absorbing crash energy over a larger area. It also helps minimize the potential for under-ride or over-ride during head-on or offset frontal collisions with a larger or smaller vehicle. This two-vehicle crash occurred within a four-leg intersection. The Honda was being driven southbound by a 45-year-old male. The other vehicle was a 2009 Mazda Tribute that was being driven northbound by an 18-year-old male. The front right seat of the Mazda was occupied by an 18-year-old female. The Mazda entered a left hand turn lane, then initiated a left turn. The front end of the Mazda impacted the left front of the Honda. Both vehicles were redirected in a southwest direction. The Honda continued in a southwest direction and impacted a concrete curb and a metal pole with its front end. The driver sustained contusions to his torso and extremities and a neck strain. He was transported to a local hospital due to chest pains and hospitalized overnight.

17. Key Words	18. Distribution Statement
Certified Advanced 208-Compliant (CAC), Advanced Compatibility Engineering (ACE), driver air bag, deployment, injury	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No of pages	22. Price

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BACKGROUND

This on-site investigation focused on both the Certified Advanced 208-Compliant (CAC) air bag system in a 2005 Honda Odyssey and the vehicle's Advanced Compatibility Engineering (ACE) body structure (**Figure 1**). The multi-stage air bags were certified by the manufacturer to be compliant with the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. According to Honda literature, the ACE front-end frame structure reduces the force of an impact by dispersing and absorbing crash energy over a larger area. It also helps minimize the potential for under-ride or over-ride during head-on or offset frontal collisions with a larger or smaller vehicle. This two-vehicle crash occurred within a four-leg intersection. The Honda was being driven southbound by a 45-year-old male. The other vehicle was a 2009 Mazda Tribute that was being driven northbound by an 18-year-old male. The front right seat of the Mazda was occupied by an 18-year-old female. The Mazda entered a left hand turn lane, then initiated a left turn. The front end of the Mazda impacted the left front of the Honda. Both vehicles were redirected in a southwest direction. The Honda continued in a southwest direction and impacted a concrete curb and a metal pole with its front end. The driver sustained contusions to his torso and extremities and a neck strain. He was transported to a local hospital due to chest pains and hospitalized overnight.

Figure 1. Subject vehicle, 2005 Honda Odyssey

On March 18, 2009 the National Highway Traffic Safety Administration (NHTSA) forwarded vehicle data and photographs from an auction facility to DSI with instructions to obtain cooperation. DSI obtained permission to inspect the subject vehicle on March 23, 2009 and the case was assigned on March 24, 2009. Permission to remove the vehicle's Event Data Recorder (EDR) was also obtained. The vehicle inspection took place on March 25, 2009. The EDR was removed and submitted to the NHTSA Crash Investigation Division (CID) on March 26, 2009. CID submitted the EDR to Honda for the purposes of imaging any crash data. The investigating police agency was contacted and a copy of the crash report was received on April 23, 2009. Field work was completed on April 24, 2009. Data from the EDR was obtained on August 27, 2009.

Figure 2. Southbound approach, subject vehicle

SUMMARY

Crash Site

This two-vehicle crash occurred in January 2009 at 1650 hours. The crash occurred within a four-leg intersection that was controlled by three-phase

traffic signals. The north leg of the intersection was comprised of three southbound through lanes, a left turn lane, a raised divider, and three northbound through lanes (**Figure 2**). The through lanes were divided by dashed white stripes. The left turn lane was divided from the through lanes by a 2.1 m (7 ft) white painted divider. The south leg of the intersection was comprised of two northbound through lanes, a left turn lane, a raised shrub-covered divider, and three southbound through lanes (**Figure 3**). The roadways were of asphalt composition and were wet; there was a 1% positive grade in the northbound direction. The posted speed limit was 72 km/h (45 mph).

Figure 3. Northbound approach, other vehicle

Pre-Crash

The Honda was traveling southbound in the second lane from the right at an unknown speed. The Mazda was traveling northbound in the left turn lane. As the Honda entered the intersection, the Mazda began a left turn to travel west. The driver of the Honda saw the Mazda and began braking and steering to the right.

Crash

The front of the Mazda impacted the left front of the Honda. The driver's air bag in the Honda deployed during the impact. The Mazda was displaced in a southwest direction. The Honda was redirected clockwise and continued forward in a southwest direction. The Honda traveled southwest until impacting a 21 cm (8.3 in) high concrete curb and a 28 cm (11.0 in) diameter metal light pole with its front end (**Figure 4**). Left front tire marks were located on the curb and sidewalk. The marks began at the curb edge and extended approximately 40 cm (15.7 in) toward the pole. To the right of the tire marks, there was an area of scraping that was probably caused by the vehicle undercarriage. A right side tire mark was located 73 cm (28.7 in) to the right of the area of scraping. The pole was located 104 cm (40.9 in) from the curb edge, as measured along the path the vehicle traveled. The damage to the pole measured 100 cm (39.3 in) from the base of the pole upward. For the Honda's initial impact, the Missing Vehicle algorithm of the WinSMASH program computed a Total Delta-V of 18 km/h (11.2 mph) based on the final appearance of the damage. The longitudinal and lateral components were -18 km/h (-11.0 mph) and 3 km/h (1.9 mph), respectively. For the Mazda, the program computed a Total Delta-V of 26 km/h (16.2 mph). The longitudinal and lateral components were -24 km/h (-15.2 mph) and -9 m/h

Figure 4. Points of impact with curb and pole

(-5.5 mph), respectively. The results should be considered borderline due to the overlapping damage.

Post-Crash

The Honda came to rest against the metal pole facing southwest. The Mazda came to rest in the intersection facing west. The driver of the Honda was able to exit the vehicle under his own power through the driver's door. He complained of neck and chest pain and was transported by ground ambulance to a local hospital where he was admitted overnight. During transport, the driver's Glasgow Coma Scale (GCS) score was 15, indicative of a minor brain injury. The driver of the Mazda did not report any injuries. The front right passenger in the Mazda sustained a concussion and an abrasion to the right side of his head. He was transported by helicopter to a local trauma center.

Both vehicles were towed from the scene due to damage. The Honda was later declared a total loss by the insurance company. The Mazda was declared a total loss by the insurance company and was sold to a private buyer. Efforts to locate the buyer were unsuccessful and the Mazda was not inspected.

Vehicle Data - 2005 Honda Odyssey

The 2005 Honda Odyssey was identified by the Vehicle Identification Number (VIN): 5FNRL38795Bxxxxxx. The Honda's date of manufacture was February 2005. The vehicle was equipped with a 3.5 liter, 6-cylinder engine, 5-speed automatic transmission, front wheel drive, antilock 4-wheel disc brakes with brake assist, traction control, power steering, and a tilt steering wheel. Based on the auction facility's photographs, the vehicle mileage was 63,087 miles (101,753 km). The Honda was equipped with General Altimax RT 235/65R16 tires. The tire manufacturer's recommended maximum pressure was 303 kPa (44 psi); the vehicle manufacturer's recommended cold pressure for the front and rear tires was 241 kPa (35 psi). The specific tire information was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damaged
LF	Tire flat	5 mm (6/32 in)	Yes	Yes
LR	262 kPa (38 psi)	6 mm (7/32 in)	No	None
RR	Tire flat	6 mm (7/32 in)	No	None
RF	179 kPa (26 psi)	5 mm (6/32 in)	No	None

The left front tire was damaged during the crash. The tire was debeaded and there was a 13 cm (5.1 in) piece of plastic embedded between the rim and the tire. There was a 2 cm (0.8 in) hole in the side wall and a 10 x 12 cm (3.9 x 4.7 in) abrasion on the side wall.

The seating in the Honda was configured with bucket seats with adjustable head restraints for the first and second rows. The third row was configured with a 60/40 bench seat with folding backs.

The third row seats were in the stowed position at the time of the vehicle inspection. The driver's seat back was at a 27 degree angle from vertical and the seat cushion was a 14 degree angle from horizontal. The seat was adjusted to mid track position and was located 20 cm (7.9 in) rearward of the A-pillar. The front right, second row left, and second row right seat were adjusted to the mid-track position.

Exterior Damage - 2005 Honda Odyssey

The Honda sustained moderate damage due to the impact with the Mazda and the subsequent impact with the metal pole (**Figure 5**). The direct damage began at the left front bumper corner and extended 45 cm (17.7 in) to the right. The damage between the two impacts overlapped. The pole damage included direct contact along the outboard edge of the hood and the pocketing in the left fender. The left bumper fascia was broken away and the damage bypassed the bumper backing bar. There was 195 cm (76.8 in) of direct contact along the left side of the vehicle that extended to the front row door and vertically to the A-pillar. The wheelbase on the left side was shortened by 17 cm (6.7 in). Six crush measurements were documented at bumper level; the C1 measurement was a projected point and was averaged with the above bumper crush. The crush measurements were as follows: C1 = 30 cm (11.8 in), C2 = 2 cm (0.8 in), C3 = 2 cm (0.8 in), C4 = 3 cm (1.2 in), C5 = 5 cm (2.0 in), C6 = 0 cm.

Figure 5. Left front corner damage

The Collision Deformation Classification (CDC) for the impact with Mazda was 12FLEW4, the CDC for the pole impact was 12FLEE4, and the CDC for the wheel to curb impact was 12FLWN3.

ACE

According to Honda literature, the ACE body structure provides enhanced occupant protection in a frontal collision by reducing cabin intrusion and minimizing the potential for misalignment of the vehicle's energy-absorbing safety structure in an offset collision or in a collision between vehicles of differing size or ride height (**Figure 6**). By reducing the potential for misalignment, the ACE body helps to optimize the performance of the vehicle's safety structures while dispersing collision forces through more load paths compared to a traditional front frame structure.

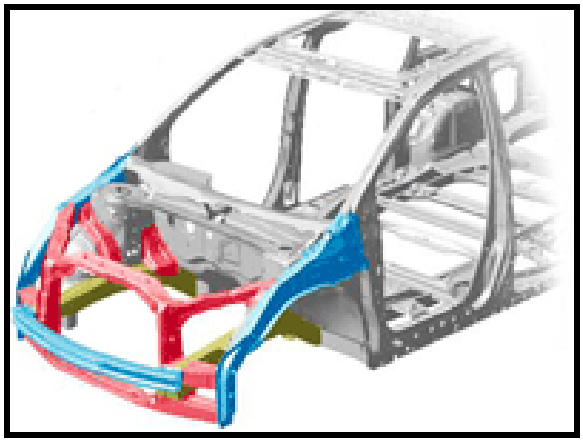

Figure 6. ACE body structure. Source: http://automobiles.honda.com/certified-used/2005/odyssey/safety.aspx

Measurements were taken to compare the damaged upper bulkhead frame on the left to the relatively undamaged upper bulkhead frame on the right (**Figures 7-8**). The frame was displaced 6 cm (2.4 in) laterally to the right at the forward aspect and 11 cm (4.3 in) at the midpoint and 17 cm (6.7 in) rearward.

Figure 7. Right upper frame

Figure 8. Left upper frame

Measurements were taken to the lower frame. The left edge of the frame was fractured and displaced 14 cm (5.5 in) rearward and 12 cm (4.7 in) laterally to the right (**Figure 9**).

Figure 9. Lower frame

Interior Damage - 2005 Honda Odyssey

The Honda sustained minor interior damage due to intrusion and occupant contacts (**Figure 10**). There was 2 cm (0.8 in) of longitudinal intrusion to the left lower kick panel. A 4 x 6 cm (1.6 x 2.4) scuff was located 9 cm (3.5 in) left of the left instrument panel (IP) and 11 cm (4.3 in) above the bottom of the IP, a 3 x 2 cm (1.2 x 0.8 in) scuff was located right of the steering wheel column, and a 2 x 1 cm (0.8 x 0.4 in) scuff was located along the bottom edge of the IP. There was also a 2 x 4 cm (0.8 x 1.6 in) scuff located on the glove box and a 5 x 2 cm (1.9 x 0.8 in) scuff on the forward aspect of the right seat cushion.

Figure 10. Contacts to lower instrument panel

Supplemental Restraint Systems (SRS)

The Honda was equipped with dual-stage dual threshold frontal air bags, seat-mounted side air bags; 1st, 2nd, and 3rd row side inflatable curtain (IC) combination rollover/side impact air bags; and front row seat belt retractor pretensioners. The

front right seat position was configured with an Occupant Position Detection System (OPDS) for the right seat mounted side air bag. The OPDS utilizes a 7-segment antenna system built into the backrest to signal the electronic control unit to deactivate the air bag in the event a child (or a small-statured adult) leans in the deployment path of the bag. Air bag deployment for the front passenger's air bag was regulated by crash severity, seatbelt usage, and the weight of the occupant. Sensors under the seat gauge occupant weight and if the total weight does not meet the specification will not deploy.

During this crash, the driver's air bag deployed and the front left seat belt pretensioner actuated.

The driver's air bag deployed from the center of the steering wheel hub through H-configuration module cover flaps (**Figure 11**). The top flap measured 15 cm (6.7 in) in width and 8 cm (3.1 in) in height; the lower flap measured 15 cm (6.7 in) in width and 7 cm (2.8 in) in height. The deployed air bag measured 52 cm (20.4 in) in width in its deflated state. The air bag was tethered by two internal straps. The tethers were attached to a stitched 10 cm (3.9 in) diameter circle in the center of the air bag face. Two vent ports that measured 4 cm (1.6 in) in diameter were located at the 11 and 1 o'clock aspects on the rear of the air bag. There were areas of grease smears and scuffs over the entire upper half the air bag. There was a 33 x 9 cm (12.9 x 3.5 in) area of light scuffing on the bottom of the air bag face that was probably a result of occupant contact.

Figure 11. Driver's air bag

The EDR was removed and submitted to Honda. The EDR report from Honda indicated the following:

	Left side	**Right side**
Seat Belt Status:	Buckled	Unbelted
Pretensioner Fire:	ON	OFF
Seat Weight Sensor (Front A/B):	N/A	Empty
OPDS Status (Side A/B):	N/A	Empty
Front Air Bag Deploy Status:	ON	OFF
Side Air Bag Deploy Status:	OFF	OFF
Curtain Air Bag Deploy Status:	OFF	OFF
Safing "ON" Time (Side):	OFF	OFF
Delta T "ON" Time (Side):	OFF	OFF

Front Crash Sensor "ON" Time:	1.024 ms	1.024 ms
SRS ECU "ON" Time (Front):	31.744 ms	OFF

In summary, the following describes the stored data:

- Driver pretensioner and air bag were deployed.
- Driver air bag deployed 31.7 ms after system wake-up.
- At the front impact detection, the driver's seat belt was buckled and the Seat Position Sensor was in the far position.
- The passenger's seat belt was unbuckled, and the Seat Weight Sensor was responding that the passenger seat was empty, which made the SRS not fire passenger's pretensioner or front air bag.
- The left side impact triggered a side recording but no side air bag deployment decision was made.
- No rollover recording was triggered.

Manual Restraints

The Honda was configured with 3-point manual lap and shoulder belts for all seven seating positions. The Honda was equipped with driver and front right passenger safety belt retractor pretensions. The safety belt anchorage for the driver's seat belt, front right passenger's seat belt, and second row right passenger's seat belt were in the full-down position. The anchorage for the second row left safety belt was in the mid-position. The driver's safety belt was configured with a sliding latch plate and an Emergency Locking Retractor (ELR). The belt was locked in the used position at the time of the vehicle inspection (**Figure 12**). A scuff measuring 4 x 1 cm (1.6 x 0.4 in) was located on the belt webbing where it contacted the D-ring. Based on the evidence found during the vehicle inspection, it was determined that the safety belt was in use during the crash.

Figure 12. Driver safety belt

Vehicle Data - 2009 Mazda Tribute

The 2009 Mazda Tribute was identified by the VIN: 4F2CZ02709Kxxxxxx. The Mazda was a 4-door, 5-passenger sport utility vehicle was equipped with a 2.3-liter, 4-cylinder engine, automatic transmission, front wheel drive, anti-lock 4-wheel disc brakes, and a tilt steering wheel. The vehicle sustained major frontal damage and was towed from the scene. It was later declared a total loss by the insurance company and sold to a private buyer.

OCCUPANT DEMOGRAPHICS

	Driver
Age/Sex:	45/Male
Seated Position:	Front left
Seat Type:	Bucket
Seat track position:	Mid-track
Height:	178 cm (70 in)
Weight:	66 kg (145 lbs)
Alcohol/Drug Involvement:	None
Body Posture:	Normal, upright
Hand Position:	Both hands on steering wheel, o'clock positions not known.
Foot Position:	Right foot on brake, left on floor.
Restraint Usage:	Lap and shoulder belt
Air bags:	Driver's air bag deployed

OCCUPANT INJURIES

Driver Injuries: Injuries obtained from fire department transport records, radiology reports, emergency room reports, and the interviewee.

Injury	OIC Code	Injury Mechanism	Confidence Level
Cervical strain	640278.1,6	Impact forces	Certain
Left shoulder contusion	790402.1,2	Seat belt webbing	Certain
Center chest contusion (linear)	490402.1,4	Seat belt webbing	Certain
Center chest contusion (circular)	490402.1,4	Driver air bag	Certain
Abdominal contusion	590402.1,0	Seat belt webbing	Certain
Right hand contusion	790402.1,1	Steering wheel rim	Probable
Right knee contusion	890402.1,1	Lower instrument panel	Certain

Injury	OIC Code	Injury Mechanism	Confidence Level
Bilateral ankle contusions	890402.1,3	Foot controls	Possible

OCCUPANT KINEMATICS

Driver Kinematics

The 45-year-old male driver was restrained and seated in an upright posture. His right foot was on the accelerator and his left on the floor board. Both hands were on the steering wheel. The driver noticed the other vehicle turning in front of him and began braking and steering to the right. The left front of the Honda impacted the right front of the Mazda. At impact, the driver's air bag deployed and the driver's safety belt pretensioner actuated. The driver initiated a forward trajectory and loaded the safety belt, causing chest, shoulder, and abdominal contusions. The driver contacted the deployed air bag with his torso; his lower extremities contacted the lower IP and he sustained a contusion to the right knee. The vehicle continued in a southwest direction and struck a concrete curb with its wheel and a metal pole with its front end. The driver was displaced forward but was held in place by the pretensioned safety belt. The driver was able to exit the vehicle under his own power. He was transported by ground ambulance to a local hospital where he was admitted overnight.

Attachment 1. Scene Diagram