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CALSPAN ON-SITE ROLLOVER CRASH INVESTIGATION
SCI CASE NO: CA09006

VEHICLE: 2007 HONDA CR-V
LOCATION: PENNSYLVANIA
CRASH DATE: DECEMBER 2008

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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 are 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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<i>15. Supplementary Note</i> An investigation of a rollover crash involving a 2007 Honda CR-V.			
<i>16. Abstract</i> <p>This on-site investigative effort focused on the crash dynamics and injury sources surrounding the rollover crash of a 2007 Honda CR-V. The Honda was driven by a 31-year-old restrained female. The Honda CR-V was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system, front seat back mounted side impact air bags and roof-rail mounted inflatable side curtains with rollover sensing. A CAC vehicle is certified by the manufacturer to be compliant to the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC safety system consisted of dual stage frontal air bags, an occupant presence sensor for the front right seat, seat track position sensors, and safety belt buckle switch sensors to monitor belt usage. The Honda's front safety belts were equipped with both buckle and retractor mounted pretensioners. The crash occurred when a 2004 Mercedes-Benz ML350, driven by a 26-year-old female, changed lanes to its right and entered the path of the Honda CR-V. The front aspect of the Honda impacted the right front side of the Mercedes. This contact induced a counterclockwise (CCW) rotation of the Honda. The Honda subsequently tripped into a single quarter-turn right side leading rollover event. The driver's frontal air bag and the inflatable side curtains in the Honda deployed as a result of the crash. The driver of the Honda was not injured.</p>			
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BACKGROUND

This on-site investigative effort focused on the crash dynamics and injury sources surrounding the rollover crash of a 2007 Honda CR-V (**Figure 1**). The Honda was driven by a 31-year-old restrained female. The Honda CR-V was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system, front seat back mounted side impact air bags and roof-rail mounted inflatable side curtains with rollover sensing. A CAC vehicle is certified by the manufacturer to be compliant to the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC safety system consisted of dual stage frontal air bags, an occupant presence sensor for the front right seat, and safety belt buckle switch sensors to monitor belt usage. The Honda's front safety belts were equipped with both buckle and retractor mounted pretensioners. The crash occurred when a 2004 Mercedes-Benz ML350, driven by a 26-year-old female, changed lanes to the right and entered the path of the Honda CR-V. The front aspect of the Honda impacted the right front side of the Mercedes. This contact induced a counterclockwise (CCW) rotation of the Honda. The Honda subsequently tripped into a single quarter-turn right side leading rollover event. The driver's frontal air bag and both inflatable side curtains in the Honda deployed as a result of the crash. The driver of the Honda was not injured.



Figure 1: 2007 Honda CR-V.

This crash was identified during routine sampling of Police Accident Reports by the General Estimates System (GES) of the National Highway Traffic Safety Administration (NHTSA). The Crash Investigation Division (CID) of the NHTSA forwarded the notification to the Special Crash Investigations (SCI) team at Calspan on February 6, 2009. Calspan SCI initiated follow-up investigation and established cooperation with the insurance carrier for the Honda. It was determined that the Honda was available for inspection at an insurance auction facility. A request to remove the Honda's Event Data Recorder for analysis was denied by the insurance carrier. The CID subsequently assigned an on-site investigation on February 9, 2009 due to the Agency's interest in rollover crashes involving late model year vehicles. The on-site portion of the investigation was conducted on February 10, 2009. The Mercedes-Benz was repaired prior to the SCI notification of the crash and was not inspected.

SUMMARY

Crash Site

This crash occurred during the nighttime hours of December 2008. At the time of the crash, the weather conditions were clear and the asphalt road surface was dry. The crash occurred in the northbound left lane of a seven-lane divided north/south roadway. The area of impact was approximately 55 meters (180 feet) south of a four-leg intersection. The northbound lanes consisted of three through traffic lanes and a left turn only lane. The right northbound lane branched off into a right turn lane. The northbound lanes were 3.3 meters (10.8 feet) wide and contained a slight left curve leading to the intersection. The traffic lanes were separated by a raised concrete median which tapered from 3.9 meters (12.8 feet) wide prior to the crash site to 0.9 meters (2.8 feet) wide in the vicinity of the impact area. The posted speed limit for the north/southbound roadway was 64 km/h (40 mph). The scene schematic is included as **Figure 10** of this report.

Vehicle Data – 2007 Honda CR-V

The 2007 Honda CR-V was a sport utility vehicle that was identified by the Vehicle Identification Number (VIN): 5J6RE48527L (production number omitted) and was manufactured in 05/07. The electronic odometer reading at the time of the SCI inspection was unknown due to the expended vehicle battery. The Honda was equipped with a 2.4-liter, four-cylinder engine, five-speed automatic transmission, all-wheel drive, power-front and rear disc brakes with anti-lock, and a tilt steering wheel. Electronic Stability Control (ESC) and traction control were standard features for the Honda CR-V. The Honda was equipped with Continental 4x4 Contact tires, size P225/65R17, mounted on seven-spoke OEM alloy wheels. The vehicle manufacturer recommended front and rear tire pressure was 207 kPa (30 PSI). The specific tire data at the time of the SCI inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Damage
Left Front	193 kPa (28 PSI)	5 mm (6/32")	None
Left Rear	186 kPa (27 PSI)	4 mm (5/32")	None
Right Front	Tire Flat	5 mm (6/32")	De-beaded
Right Rear	193 kPa (28 PSI)	4 mm (5/32")	None

The seating positions in the Honda were configured with cloth upholstered front bucket seats with height adjustable head restraints. At the time of the SCI inspection, the front head restraints were adjusted to the full-down position. The second row was configured with a three-passenger split bench seat (60/40) with height adjustable head restraints. The rear head restraints were adjusted to the full-down position.

Vehicle Data – 2004 Mercedes-Benz ML 350

The 2004 Mercedes-Benz ML 350 was repaired and returned to service prior to the initiation of this SCI case and was not inspected.

Crash Sequence

Pre-Crash

The female driver of the Honda was operating the vehicle northbound in the left through lane approaching the intersection (**Figure 2**). The driver of the Mercedes-Benz was operating the vehicle northbound in the left turn lane. While traveling in the left turn lane, the driver of the Mercedes-Benz initiated a lane change maneuver to the right.



Figure 2: Northbound approach of the Honda.

Crash

The front left corner of the Honda impacted the right front aspect of the Mercedes-Benz in the left through lane (**Figure 3**). The engagement to the Honda began at the front left corner and extended down the left fender 95 cm (37.4”). The impact fractured the Honda’s left front suspension. This corner impact configuration resulted in a 12 o’clock impact force to the Honda. The corner engagement was outside the scope of the WINSMASH program; therefore, a delta-V could not be calculated for this impact. This frontal impact sequence actuated the driver’s dual safety belt pretensioners and deployed the driver’s frontal air bag.



Figure 3: Area of impact from the Mercedes-Benz approach.

The Honda separated from the impact with the Mercedes-Benz to the right with counterclockwise rotation. As the vehicle rotated, the right front tire rolled under the rim exposing the rim edge to the asphalt surface. This interaction tripped the Honda into a right side leading single quarter-turn rollover event. The Honda travelled approximately 12 meters (39 feet) from the trip point to final rest (**Figure 4**). As a result of the rollover event, the rollover sensors triggered the deployment of the Honda’s left and right inflatable side curtains.



Figure 4: Approximate final rest area of the Honda.

Post-Crash

Police and emergency medical personnel responded to the crash site. The driver of the Honda was police reported as not injured and was not transported to a hospital. Although the driver of the Mercedes-Benz was reportedly not injured, she was transported to a hospital. The Honda sustained disabling damage and was towed from the crash site. The Mercedes-Benz was not towed.

Vehicle Damage

Exterior Damage

The 2007 Honda CR-V sustained moderate severity damage from this multiple event crash sequence. The direct contact damage for the impact with the Mercedes-Benz began 55 cm (21.8”) left of the centerline and extended 39 cm (15.2”) to the left bumper corner. The front bumper beam exhibited no residual crush from this impact. Due to the corner impact configuration, the direct contact damage extended 95 cm (37.4”) down the left fender. The left side engagement snagged the left front tire and wheel resulting in damage to the suspension components. The suspension damage consisted of a fractured lower control arm. The Collision Deformation Classification (CDC) for this impact was 12-FLEE-5. **Figure 5** is an overall view of the front and left side damage from the impact with the Mercedes-Benz.

The rollover event resulted in minor severity damage to the right side of the Honda (**Figure 6**). The direct contact damage consisted of surface abrasions to the right front wheel rim and right side plane. Vertically, the direct contact damage extended from the right front wheel to the front right window frame. There was no crush to the side or roof of the Honda. The CDC for this impact was 00-RDAO-2.

The four doors remained closed during the crash and were operational at the time of the SCI inspection. The windshield, left side, backlight, roof, and right rear glazing were not damaged during the crash. The right front glazing was disintegrated from contact with the ground.



Figure 5: Overall view of the residual damage from the impact with the Mercedes-Benz.



Figure 6: Front oblique view of the rollover damage.

Interior Damage

The interior of the Honda sustained minor damage that was attributed to air bag deployment. The passenger compartment was free of occupant contact points.

Certified Advanced 208-Compliant Frontal Air bag System

The Honda CR-V was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system. A CAC vehicle is certified by the manufacturer to be compliant to the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC safety system consisted of dual stage frontal air bags, an occupant presence sensor for the front right seat, seat track position sensors, pretensioners, and safety belt buckle switch sensors to monitor belt usage.

As a result of the crash, the driver's frontal air bag deployed. The driver's air bag was conventionally located in the center of the steering wheel hub and was concealed by three cover flaps. The top cover flap measured 13 cm (5") in height and 8 cm (3") in width. The total width of the lower cover flaps measured 13 cm (5") with a height of 9 cm (3.5"). The centers of the lower cover flap contained a circular cutout for the Honda insignia. The driver's air bag membrane measured 56 cm (22") in diameter in its deflated state. The air bag contained two tethers at the 3 and 9 o'clock positions and was vented by two vent ports at the 11 and 1 o'clock positions. There was no damage or occupant contact points present on the air bag membrane. The air bag membrane contained several areas of dirt from post-crash handling.

The front right passenger air bag was a top-mount design in the right instrument panel. The CAC system identified the front right position as unoccupied and suppressed air bag deployment.

Side Impact Air Bag System and Rollover Crash Protection System

The Honda was equipped with front seat back mounted side impact air bags and roof side rail mounted inflatable side curtains with rollover sensing. The left and right seat back air bags did not deploy in this crash. The left and right inflatable curtains deployed during rollover crash sequence



Figure 7: Deployed driver's frontal and left curtain air bags.

The side curtains deployed from the roof side rails. The air bag membranes measured 183 cm (72") in length. At the front seating positions, the membrane measured 44 cm (17.5") in height and 41 cm (16") in height at the right rear position. The air bags were tethered at the A- and D-pillars. The A-pillar tether measured 24 cm (9.5") and the D-pillar tether measured 23 cm (9"). The A-pillar tethers

were cut post-crash. **Figure 7** depicts the deployed left curtain and driver's frontal air bag.

Vertically, the curtain air bags extended below the beltline at the first and second rows. At the first row, the air bag extended 4 cm (1.5") below the belt line and 3 cm (1") below the beltline at the rear position. A triangular shaped void was present at the A-pillar. This void was approximately 23 cm (9") in height and 23 cm (9") in width. The inflatable side curtains were free of occupant contact points and damage.

Manual Safety Belt Systems

The 2007 Honda CR-V was equipped with manual 3-point lap and shoulder safety belts for the five seating positions. The driver's safety belt was configured with continuous loop webbing, a sliding latch plate, a height adjustable D-ring that was in the full-down position at the time of the SCI inspection, an Emergency Locking Retractor (ELR), and dual pretensioners. The pretensioners were both buckle mounted and retractor mounted. The driver utilized the safety belt during the crash as evidenced by frictional abrasions on the latch plate and actuation of the dual pretensioners. The actuation of the retractor pretensioner locked the safety belt webbing in the used position (**Figure 8**). The total amount of restricted webbing measured 141 cm (55.5"). The buckle stalk was compressed 5 cm (1.8") from the actuation of the buckle mounted pretensioner (**Figure 9**).

The front right safety belt was configured with continuous loop webbing, sliding latch plate, height adjustable D-ring, dual pretensioners, and a switchable ELR/Automatic Locking Retractor (ALR). The front right seat was not occupied during the crash; therefore, the pretensioners did not actuate.

The second row safety belts were configured with continuous loop webbing, sliding latch plates and switchable ELR/ALR retractors.



Figure 8: Driver's safety, restricted in the used position.

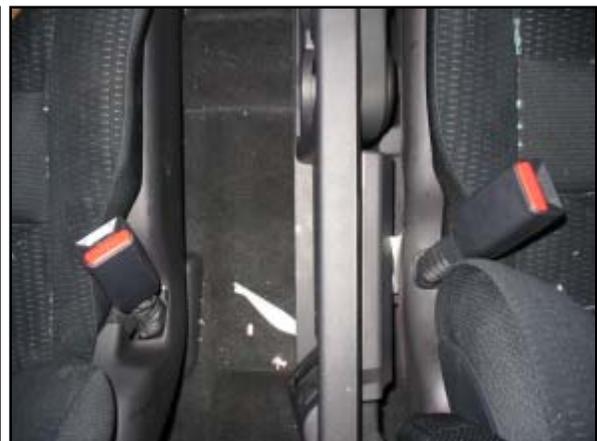


Figure 9: Actuated driver's buckle pretensioner (left in image).

Occupant Demographics/Data

Driver

Age/Sex: 31-year-old/Female
Height: Unknown
Weight: Unknown
Seat Track Position: Unknown track position
Eyewear: Unknown
Safety Belt Usage: 3-point manual lap and shoulder safety belt
Usage Source: Vehicle inspection
Egress from Vehicle: Unknown
Mode of Transport from Scene: Not transported
Type of Medical Treatment: None, not injured

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Not injured	N/A	N/A

Source – Police report

Driver Kinematics

The 31-year-old female driver was seated in an unknown track position and was restrained by the lap and shoulder belt. At impact with the Mercedes-Benz, the driver’s dual pretensioners actuated and the CAC frontal air bag deployed. The driver initiated a forward trajectory in response to the 12 o’clock direction of force and loaded the safety belt. The combination of safety belt usage and the deployed air bag prevented potential face/head contact with the steering wheel.

As the Honda separated from the impact with the Mercedes-Benz, it rotated counterclockwise and tripped into a right side leading single-quarter turn rollover event. At the on-set of the rollover event, the rollover sensors triggered the deployment of the left and right curtain air bags. The driver was displaced to the right during the right side leading rollover event and continued loading the belt system. She remained positioned within the left front seating and did not interact with either curtain air bag. She was not injured during the crash.

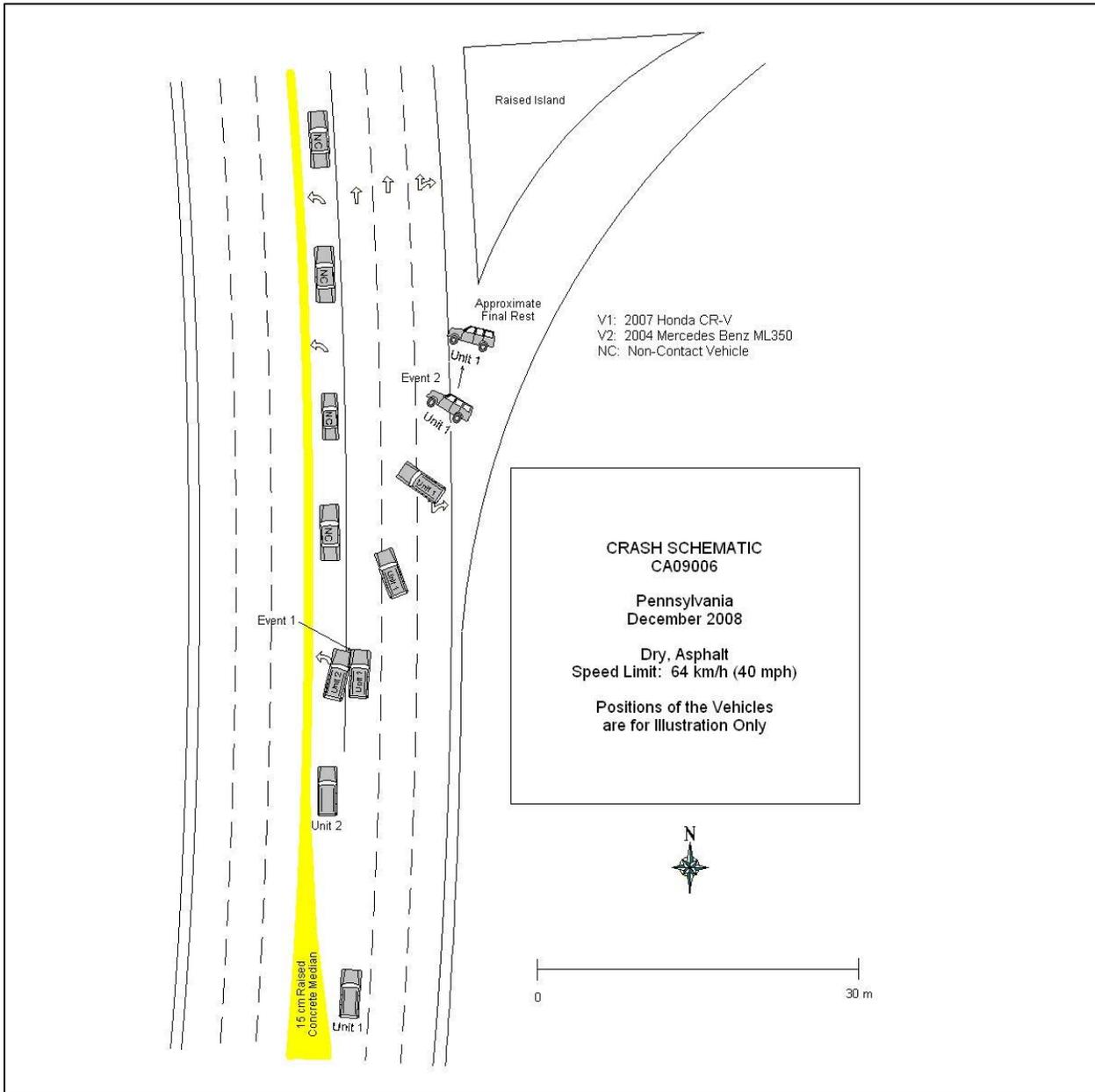


Figure 10: Scene Schematic