

**CRASH DATA RESEARCH CENTER**

Calspan Corporation  
Buffalo, NY 14225

**CALSPAN ON-SITE ROLLOVER CRASH INVESTIGATION**

**SCI CASE NO.: CA09047**

**VEHICLE: 2007 HONDA CR-V**

**LOCATION: NORTH CAROLINA**

**CRASH DATE: JULY 2009**

Contract No. DTNH22-07-C-00043

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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>16. Abstract</i> <p>This on-site investigation focused on the intersection crash and subsequent rollover of a 2007 Honda CR-V. The Honda was equipped with four-wheel anti-lock brakes, Electronic Stability Control (ESC), a Certified Advanced 208-Compliant (CAC) frontal air bag system, seat-mounted side impact air bags, and roll-sensing Inflatable Curtain (IC) air bags. The manufacturer of the vehicle has certified that the Honda CR-V is compliant to the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) 208. The CAC system includes dual-stage frontal air bags for the driver and right front passenger positions, seat track positioning sensors, retractor and buckle mounted pretensioners, and a front right occupant presence sensor. The rear aspect of the Honda CR-V's right plane was impacted by the front of a 1999 Honda Odyssey in an intersection crash. The Honda CR-V then rotated clockwise, tripped and initiated a 3-quarter turn left side leading rollover. The left and right IC air bags and the driver seat-mounted side impact air bag deployed during the crash. The 38-year-old restrained female driver of the Honda sustained minor injuries. The driver was transported by ground ambulance to a local hospital where she was treated in the emergency department and released.</p>			
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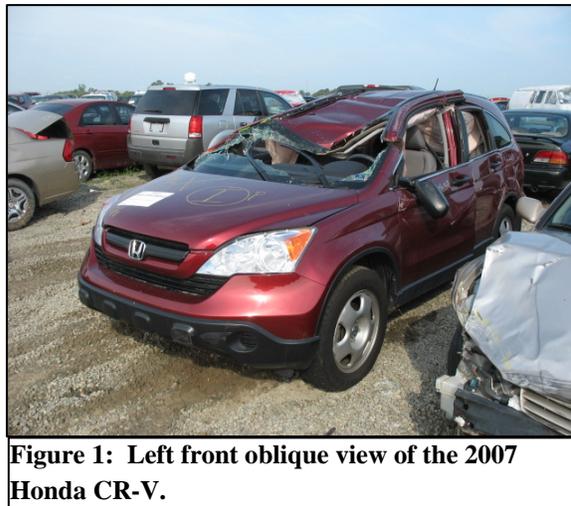
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**CALSPAN ON-SITE ROLLOVER CRASH INVESTIGATION  
SCI CASE NO.: CA09047**

**VEHICLE: 2007 HONDA CR-V  
LOCATION: NORTH CAROLINA  
CRASH DATE: JULY 2009**

***BACKGROUND***

This on-site investigation focused on the intersection crash and subsequent rollover of a 2007 Honda CR-V (**Figure 1**). The Honda was equipped with four-wheel anti-lock brakes, Electronic Stability Control (ESC), a Certified Advanced 208-Compliant (CAC) frontal air bag system, seat-mounted side impact air bags, and roll-sensing Inflatable Curtain (IC) air bags. The manufacturer of the vehicle has certified that the Honda CR-V is compliant to the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) 208. The CAC system includes dual-stage frontal air bags for the driver and right front passenger positions, seat track positioning sensors, retractor and buckle mounted pretensioners, and a front right occupant presence sensor. The rear aspect of the Honda CR-V's right plane was impacted by the front of a 1999 Honda Odyssey in an intersection crash. The Honda CR-V then rotated clockwise, tripped and initiated a 3-quarter turn left side leading rollover. The left and right IC air bags and the driver seat-mounted side impact air bag deployed during the crash. The 38-year-old restrained female driver of the Honda sustained minor injuries. The driver was transported by ground ambulance to a local hospital where she was treated in the emergency department and released.



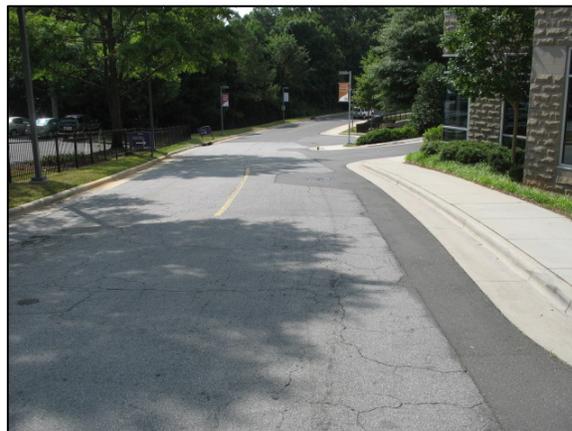
**Figure 1: Left front oblique view of the 2007 Honda CR-V.**

The crash was identified through a visit to a regional vehicle salvage facility on July 17, 2009. An image of the Honda CR-V was forwarded to Calspan Special Crash Investigations (SCI) team for review on the same day. Based on the rollover of the late model year vehicle and the deployment of the IC air bags, this case was assigned for an on-site investigation on July 20, 2009. The on-site investigation was initiated on July 21, 2009 and involved the inspections of the involved vehicles, interviews with the drivers of both vehicles and documentation of the crash scene.

## **SUMMARY**

### ***Crash Site***

This crash occurred during daylight hours of July 2009 at the 3-leg intersection of two 2-lane roadways (**Figure 2**). The weather conditions were dry and clear. The traffic lanes were surfaced with asphalt. The southbound approach to the intersection had a negative grade of -4.9 percent transitioning to -3.2 percent nearing the intersection. This roadway configuration was an “S” curve beginning to the left and transitioning to the right as the roadway approached the intersection. The eastbound approach to the intersection had a level grade and a shallow right curve. The eastbound travel was controlled by a



**Figure 2: Pre-crash trajectory view of the Honda CR-V.**

stop sign. The roadsides were bordered by concrete curbs that were 16 cm (6.3 in) in height. On the north/south roadway, the travel lanes were 4.2 m (13.8 ft) in width. The east/west travel lanes measured 3.7 m (12.1 ft) in width. Beyond the curb on the west roadside, south of the intersection, was a 1.7 m (5.6 ft) wide concrete sidewalk. The posted speed limit was 16 km/h (10 mph) for both roadways. The Crash Schematic is included as **Figure 11** of this report.

### ***Vehicle Data***

#### ***2007 Honda CR-V***

The 2007 Honda CR-V was manufactured in May 2007 and was identified by the Vehicle Identification Number (VIN) 5J6RE48357L (production sequence deleted). The odometer read 48,971 km (30,436 mi) at the time of the SCI inspection. The vehicle had been purchased new by the driver/owner in the fall of 2007.

The front-wheel drive Honda was powered by a 2.4-liter, inline four-cylinder engine linked to a five-speed automatic transmission. The braking system consisted of power-assisted front and rear disc with four-wheel antilock, brake assist, and electronic brake force distribution. The vehicle was also equipped with Electronic Stability Control (ESC), traction control, and an indirect Tire Pressure Monitoring System (TPMS). Per the driver interview, the TPMS warning light was not on prior to the crash. The side windows were closed at the time of the crash. The vehicle was equipped with Continental 4x4 Contact tires, Tire Identification Number (TIN) FDF5 3AH 1007 in tire size P225/65R17. The tires were mounted on OEM five-spoke alloy wheels. The vehicle manufacturer recommended tire size was P225/65R17 with a cold tire pressure of 207 kPa (32 PSI) for the front and rear. The specific tire data at the time of the SCI inspection was as follows:

<b>Position</b>	<b>Measured Tire Pressure</b>	<b>Measured Tread Depth</b>	<b>Tire/Wheel Damage</b>
Left Front	131 kPa (19 PSI)	2 mm (2/32 in)	None
Left Rear	145 kPa (31 PSI)	2 mm (3/32 in)	None
Right Front	179 kPa (26 PSI)	2 mm (3/32 in)	None
Right Rear	179 kPa (26 PSI)	2 mm (2/32 in)	None

The interior of the Honda was configured with cloth-surfaced five-passenger seating. The front bucket seats were separated by a folding center console and equipped with adjustable head restraints. The left head restraint was located 2 cm (0.8 in) above the full-down position, and the right head restraint was in the full-down position at the time of the SCI inspection. The driver seat track was adjusted to a mid-track position. The driver seat back angle measured 23 degrees aft of vertical. The front right seat was in the full-rear position with a seat back angle of 27 degrees aft of vertical. The second row consisted of a split bench seat (60/40) with forward folding seat backs. The three rear positions all had adjustable head restraints in the full-down position.

The interior occupant safety systems consisted of 3-point lap and shoulder belt systems for all five designated seating positions, front retractor and buckle mounted pretensioners, CAC frontal air bags, front seat-mounted side impact air bags, and roll sensing IC air bags.

### ***1999 Honda Odyssey***

The 1999 Honda Odyssey was identified by the VIN 2HKRL1856XH (production sequence deleted). The front-wheel drive Honda Odyssey was powered by a 3.5-liter, V-6 engine linked to a four-speed automatic transmission. The braking system consisted of power-assisted front and rear disc brakes with four-wheel antilock. All windows were closed at the time of the crash. The vehicle was equipped with Kumho Solus KH16 tires, size P215/60R16. The manufacturer recommended tire size was P215/60R16. The tires were mounted on OEM steel wheels with plastic wheel covers. The vehicle manufacturer recommended cold tire pressure was 221 kPa (32 PSI) for the front and rear. The complete tire data was not obtained as the driver refused a complete inspection. The partial tire data was as follows:

<b>Position</b>	<b>Measured Tire Pressure</b>	<b>Measured Tread Depth</b>	<b>Tire/Wheel Damage</b>
Left Front	Unknown	6 mm (7/32 in)	None
Left Rear	Unknown	4 mm (5/32 in)	None
Right Front	Unknown	4 mm (5/32 in)	None
Right Rear	Unknown	6 mm (7/32 in)	None

## ***Crash Sequence***

### ***Pre-Crash***

The 38-year-old restrained female driver of the Honda CR-V was operating this vehicle in a southbound direction while negotiating an “S” curve, which transitioned from a right to left arc, as she approached a three-legged intersection. The vehicle was traveling at a driver estimated speed of 48 km/h (30 mph). The driver of the Honda CR-V was on her way home from work within her routine path of travel. The 31-year-old female driver of the Honda Odyssey was operating her vehicle eastbound towards the same intersection when she came to a stop at the designated stop sign intending to turn left. She indicated that she did not see the Honda CR-V when she stopped and proceeded through the intersection. As she removed her foot from the brake pedal, she detected the Honda CR-V entering the intersection. The Honda Odyssey driver attempted to stop but mistakenly pressed the accelerator pedal instead of the brake pedal. The Honda Odyssey accelerated forward into the intersection. The driver of the Honda CR-V detected the Honda Odyssey entering the intersection and initiated a left steering input in an attempt to avoid the collision.

### ***Crash***

The left aspect of the Honda Odyssey’s front plane impacted the rear aspect of the Honda CR-V’s right side at its right rear door and wheel area (Event 1). The direction of force was within the 2 o’clock sector for the Honda CR-V and the 11 o’clock sector for the Honda Odyssey. The Missing Vehicle algorithm of the WinSMASH program was used to calculate the severity of the crash (delta-V). The total delta-V of Honda CR-V was 9.0 km/h (5.6 mph). The longitudinal and lateral delta-V components were -3.1 km/h (-1.9 mph) and -8.5 km/h (-5.3 mph). The total delta-V of the Honda Odyssey was 7.0 km/h (4.3 mph) with a longitudinal component of -6.6 km/h (-4.1 mph) and a lateral component of 2.4 km/h (1.5 mph).

The force of the impact rearward of the Honda CR-V’s center of gravity caused the vehicle to initiate a clockwise (CW) rotation. The Honda CR-V rotated approximately 125 degrees CW and deposited yaw marks on the roadway attributed to the left front and left rear tires. The left front yaw mark measured 3.2 m (10.5 ft) and the left rear yaw mark measured 5 m (16.4 ft) in length. The Honda rolled, left side leading, over the left front tire as the left front rim contacted the pavement resulting in a trip-over (Event 2). A scratch mark was observed on the pavement at the end of the front left tire mark. The vehicle rolled 3-quarter turns and departed the west road side. The Honda CR-V came to rest on its right side facing north, partially on the sidewalk and partially in the southbound travel lane. The (uninterrupted) distance from trip to final rest was approximately 7 m (23 ft). The Honda Odyssey traveled east across the intersection and impacted a steel information sign on the east road side (Event 3). The vehicle came to rest facing east with its front wheels contacting the east curb in contact with the sign.

### *Post-Crash*

Witnesses to the crash placed calls to the 9-1-1 emergency response system. Police, fire, emergency medical, and tow personnel responded to the crash site. The 38-year-old female driver of the Honda CR-V had to be assisted from her vehicle. The first responders cut out the windshield, cut the A-pillars, B-pillars and the roof side rails aft of the B-pillars and folded the roof rearward. The driver of the Honda CR-V was removed from the vehicle and immobilized on a backboard for transport to a local hospital. She was transported by ground ambulance to a local hospital, treated for soft tissue injuries to the left elbow and shoulder and was released. The driver of the Honda Odyssey and its two child passengers were not injured.

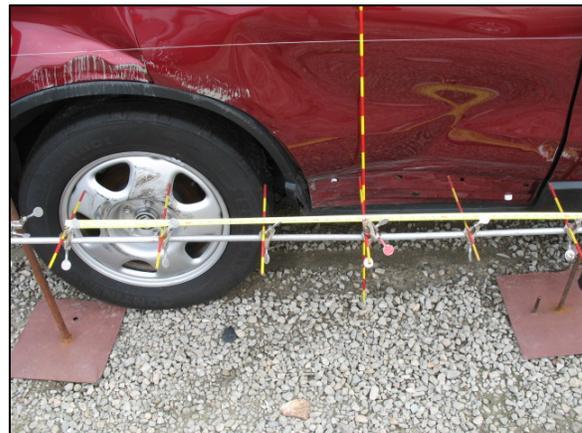
### *2007 Honda CR-V*

#### *Exterior Damage*

The right, top and left planes of the Honda CR-V were damaged in this multiple event crash. The initial impact involved moderate-severity damage to the right side of the Honda. The doors remained closed during the crash and were operational post-crash. The direct contact damage began on the right side 156 cm (61.4 in) rearward of the right front axle and extended rearward 121 cm (47.6 in) to just aft of the right rear wheel well. The combined direct and induced damage (Field L) began and ended in the same locations. Lateral crush was present to the right rear door, C-pillar and quarter panel. Vertically, the direct damage extended from the sill level to the mid-door level. The residual crush profile was measured at the lower door level and was as follows: C1 = 0 cm, C2 = 3 cm (1.2 in), C3 = 6 cm (2.4 in), C4 = 7 cm (2.8 in), C5 = 6 cm (2.4 in), C6 = 0 cm. The maximum crush was located at C4, 205 cm (80.7 in) rearward of the right front axle. The elevation of the maximum crush was 44 cm (17.3 in), consistent with the front bumper height of the Honda Odyssey. The Door Sill Differential (DSD) measured 3 cm (1.2 in) at the right rear door. The Collision Deformation Classification (CDC) assigned for this impact was 02RZEW1. The right side impact damage is depicted in **Figures 3 and 4**.



**Figure 3: Right side impact damage to the Honda CR-V.**



**Figure 4: Close-up view of the right side crush profile and DSD of the Honda CR-V.**

As a result of the rollover event, the Honda sustained moderate severity damage to the left, top and right planes (**Figure 5**). The surface abrasions on both side planes were oriented vertically, and the abrasions on the roof were oriented laterally consistent with the direction of the rollover and indicated that the vehicle did not roll beyond 3-quarter turns. The direct contact extended 333 cm (131.1 in) from the top of the backlight header forward to the hood and extended 112 cm (44.1 in) from roof side rail to roof side rail. The roof deformed in a V-pattern consistent with probable contact with the curb during the rollover sequence. The maximum vertical crush measured 38 cm (15 in) and was located on the windshield header 60 cm (23.6 in) inboard of the right A-pillar. The maximum lateral crush was 10 cm (3.9 in) and was located on the left roof side rail 15 cm (5.9 in) aft of the windshield header. The A-pillars, B-pillars and roof side rails were cut by the first responders during the removal of the driver. The windshield was fractured in the crash, but was also cut and removed. The left and right door glazing disintegrated as a result of this multiple impact crash sequence. The left and right rear quarter windows and the backlight were intact. The CDC assigned for the rollover event was 00TDDO5.



**Figure 5: Rollover damage to the Honda CR-V.**

### ***Interior Damage***

The Honda CR-V sustained moderate severity damage that was attributed to passenger compartment intrusion and occupant contact. There was a scuff mark attributed to the driver's head on the headliner that extended 39 to 52 cm (15.4 to 20.9 in) rear of the windshield header and 30 to 41 cm (11.8 to 16.1 in) inboard of the left roof side rail. There was a scuff mark on the left door located on the window sill 21 to 30 cm (8.3 to 11.8 in) forward of the B-pillar that was attributed to the driver's left elbow. The intrusion to the Honda is listed on the following table:

<b>Position</b>	<b>Component</b>	<b>Direction</b>	<b>Magnitude</b>
Row 1 Left	Windshield header	Vertical	22 cm (8.7 in)
Row 1 Left	Roof	Vertical	28 cm (11 in)
Row 1 Left	Roof side rail	Lateral	6 cm (2.4 in)
Row 1 Left	B-pillar (upper)	Lateral	6 cm (2.4 in)
Row 1 Center	Windshield header	Vertical	28 cm (11 in)
Row 1 Center	Roof	Vertical	34 cm (13.4 in)
Row 1 Right	Windshield header	Vertical	23 cm (9.1 in)
Row 1 Right	Roof	Vertical	27 cm (10.6 in)
Row 1 Right	Roof side rail	Lateral	4 cm (1.6 in)

<b>Position</b>	<b>Component</b>	<b>Direction</b>	<b>Magnitude</b>
Row 1 Right	B-pillar (upper)	Lateral	4 cm (1.6 in)
Row 2 Left	Roof	Vertical	11 cm (4.3 in)
Row 2 Center	Roof	Vertical	11 cm (4.3 in)
Row 2 Right	Roof	Vertical	9 cm (3.5 in)

### ***Manual Restraint Systems***

The Honda CR-V was equipped with 3-point manual lap and shoulder belts for the five designated seating positions. All belt systems utilized continuous loop webbing. The driver's belt retracted onto an Emergency Locking Retractor (ELR). The driver's belt system utilized a sliding latch plate and retractor and buckle mounted pretensioners, both of which actuated during the crash. The buckle stalk, fastened to the inboard aspect of the driver seat, was compressed. The actuated retractor pretensioner locked the safety belt in the used position. The total length of extended webbing measured 181 cm (71.3 in). The front left upper D-ring was height adjustable and found in the mid-position 2 cm (0.8 in) below the upper setting. The driver used the safety belt at the time of the crash, which was supported by loading evidence on the belt webbing. This evidence consisted of a frictional abrasion on the belt webbing near the latch plate. Specifically, the latch plate abrasion was located 69 to 72 cm (27.2 to 28.3 in) above the lower anchor. The driver's belt webbing had been cut by EMS post-crash during the removal of the driver. This cut was located 161 cm (63.4 in) above the floor anchor.

The front right safety belt system utilized a switchable ELR/Automatic Locking Retractor (ALR), a sliding latch plate and retractor and buckle pretensioners. The front right pretensioners did not actuate during the crash. Each second row belt system consisted of an ELR/ALR retractor and sliding latch plate. The second row center retractor was located in the roof of the vehicle.

### ***Frontal Air Bag System***

The Honda CR-V was equipped with a CAC frontal air bag system. The manufacturer of the Honda CR-V has certified that the vehicle is compliant to the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC system includes dual-stage frontal air bags for the driver and right front passenger positions, seat track positioning sensors, retractor and buckle mounted pretensioners, and a front right occupant weight sensor. The driver's air bag was concealed within the center hub of the three-spoke steering wheel. The front right passenger's air bag was concealed within the top aspect of the right instrument panel. The frontal air bags did not deploy in this crash.

### ***Rollover and Side Impact Air Bag System***

The Honda CR-V was equipped with roof side rail mounted IC air bags with rollover sensing. Both curtain air bags deployed during the rollover sequence. The curtain air bags were

rectangular in shape and measured 172 cm (67.7 in) in length. At both the front and rear seating positions, the IC air bag measured 48 cm (18.9 in) in height and extended vertically to below the beltline at each outboard seating position. The IC provided head protection from the C-pillar forward to a point located 56 cm (22.0 in) forward of the B-pillar. A triangular shaped void was present forward of the IC at the front seating position. The void measured 28 cm (11 in) in length along the window sill, 36 cm (14.2 in) in height along the rear edge and 16 cm (6.3 in) in height at the forward most aspect. The air bag was tethered to the A-pillar by a 32 cm (12.6 in) long strap. The tether straps on both sides were cut by EMS during the removal of the driver. There was a scuff mark from contact with the ground on the outboard side of the left IC at the left front window opening. This scuff mark was located 2 to 23 cm (0.8 to 9.1 in) aft of the front edge of the air bag, and 6 to 40 cm (2.4 to 15.7 in) above the lower edge of the air bag. **Figures 6 and 7** depict the IC air bags.



**Figure 6: Left curtain air bag of the Honda CR-V.**



**Figure 7: Honda CR-V's right curtain air bag.**

The inboard side of the right IC had food particles adhered to the air bag near the B-pillar. The food was consistent with a plate of food found in the rear right seat at the time of the inspection. The right curtain had been cut vertically at the top of the air bag extending down 14 cm (5.5 in) by a first responder cutting the right roof side rail. This cut was 46 cm (18.1 in) forward of the C-pillar.

The Honda CR-V was equipped with side impact air bags located in the outboard aspect of the front seat backs. The left side air bag deployed as a result of the contact with the ground during the rollover. The right side air bag did not deploy. The left side air bag measured 33 cm (13 in) in height and 28 cm (11 in) in width. This air bag contained two vent ports at the 2 and 4 o'clock positions at the front edge of the bag. The left side air bag (**Figure 8**) was free from occupant contact points and damage.



**Figure 8: Honda CR-V's driver side seatback mounted air bag.**

## ***1999 Honda Odyssey***

### ***Exterior Damage***

The front of the Honda Odyssey sustained minor-severity damage as a result of the multiple impact crash. The owner refused to fully participate and only allowed a visual exterior inspection and photographs, no exterior measurements were obtained from the vehicle. The Event 1 impact damage was located on the left half of the vehicle's front bumper and had a direction of force within the 11 o'clock sector. The direct damage began at the approximate center of the bumper fascia and extended to the left bumper corner. The CDC assigned for the initial impact was 11FYEW1. The Event 1 damage was overlapped by the secondary impact damage with the steel sign at the roadside. The CDC assigned to the secondary impact was 12FLEN99. **Figures 9 and 10** depict the frontal damage sustained by the Odyssey.



**Figure 9: Overall view of the frontal damage to the Odyssey.**



**Figure 10: Front left bumper fascia damage to the Odyssey.**

## ***2007 Honda CR-V Occupant Demographics***

### ***Driver Data***

Age/Sex:	38-year-old/Female
Height:	163 cm (64 in)
Weight:	73 kg (160 lb)
Eyewear:	None
Seat Track Position:	Mid-track, 8 cm (3.1 in) forward of full-rear
Manual Safety Belt Use:	Lap and shoulder belt
Usage Source:	Vehicle Inspection
Egress from Vehicle:	Assisted by EMS
Mode of Transport from Scene:	Ground ambulance
Type of Medical Treatment:	Treated in emergency department and released

### *Driver Injuries*

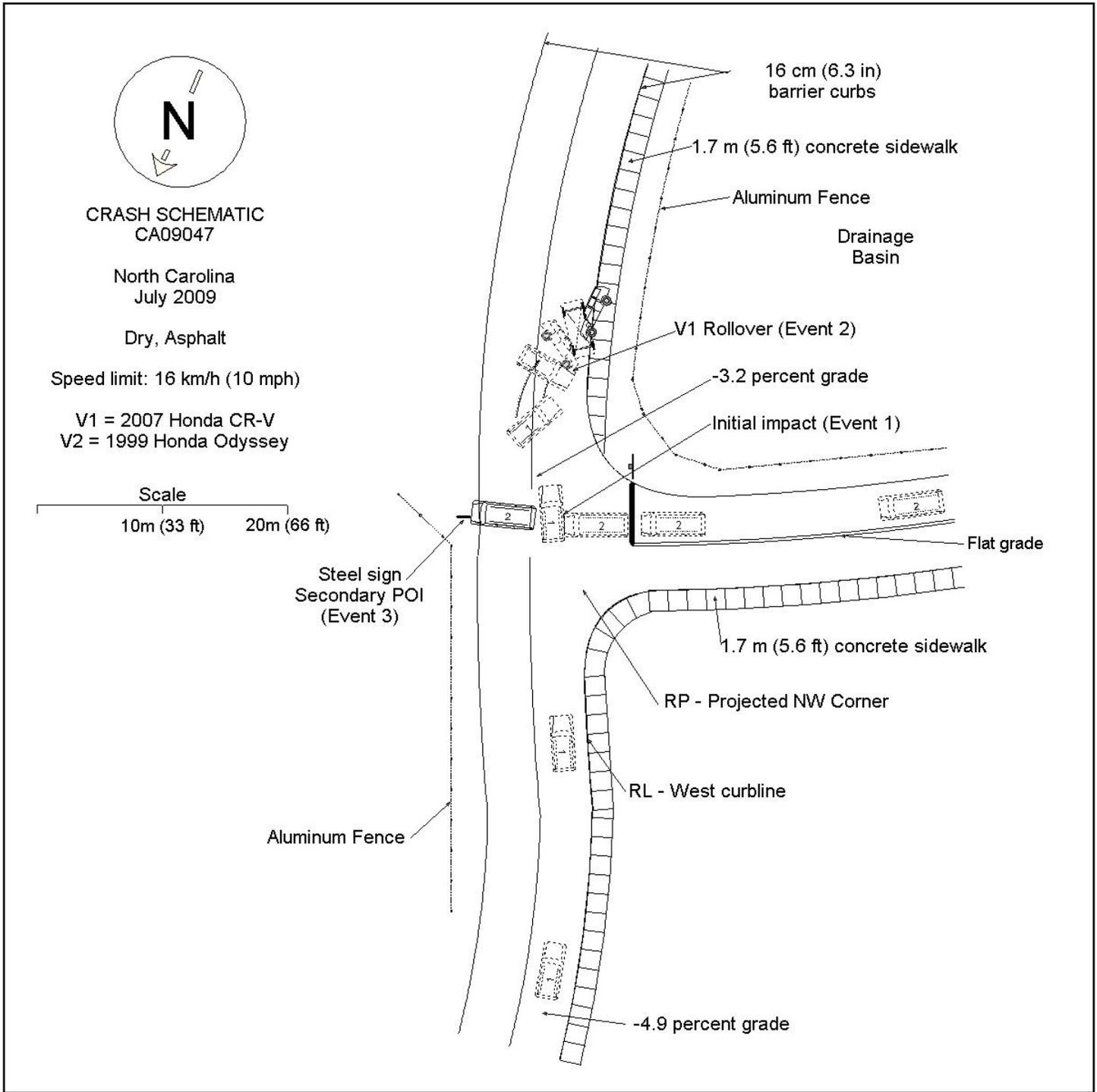
<b>Injury</b>	<b>Injury Severity (AIS 90/Update 98)</b>	<b>Injury Source</b>
Left shoulder contusion, NFS (1)	Minor (790402.1,2)	Ground
Left elbow contusion (1)	Minor (790402.1,2)	Left door rear upper quadrant
Central chest contusion (2)	Minor (490402.1,4)	Safety belt webbing
Left hip contusion (2)	Minor (890402.1.2)	Left door arm rest rear lower quadrant

*Source = Emergency room records (1) and driver interview (2)*

### *Driver Kinematics*

The 38-year-old female driver was seated in a mid-track position and was restrained by the manual 3-point lap and shoulder belt system. When the initial impact occurred, the driver initiated a right trajectory within the front left seating position and loaded the lap belt. The Honda CR-V separated from the initial impact with a CW rotation. The vehicle tripped and began to roll to the left. The IC air bags deployed. During the first quarter turn the left plane of the Honda impacted the ground which resulted in the deployment of the left side impact air bag. In response to the ground impact and rollover, the driver initiated a trajectory to the left within the front left seating position. The driver's shoulder loaded the ground through the left IC, which resulted in the left shoulder contusion. The driver's left elbow contacted the rear upper quadrant of the left door resulting in the left elbow contusion. Additionally, her left hip loaded the rear lower arm rest/door panel through the left side impact air bag resulting in the left hip contusion. As the rollover continued, the roof intruded vertically towards the driver. The driver initiated a vertical trajectory upward and contacted the headliner with her head. This contact did not result in an injury. During the crash sequence, the driver loaded the belt system with her upper body resulting in the contusion to the center of her chest.

The Honda CR-V came to rest on its right side. The driver was hanging in the front left safety belt and was unable to open the left door to exit the vehicle. She was removed from the vehicle by EMS and was transported by ground ambulance to a local hospital where she was treated in the emergency department and released.



**Figure 11: Crash Schematic**