CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE SIDE IMPACT PROTECTION SYSTEM CRASH INVESTIGATION

CASE NO: CA06-011

VEHICLE: 2006 HONDA CR-V

LOCATION: NEW YORK

CRASH DATE: APRIL 2006

Contract No. DTNH22-01-C-17002

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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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SCI CASE NO: CA06-011

VEHICLE: 2006 HONDA CR-V
LOCATION: NEW YORK
CRASH DATE: APRIL 2006

BACKGROUND

This investigation focused on the crash dynamics, the injury sources, and the inflatable side impact protection of a 2006 Honda CR-V that was involved in a side impact crash with a 1994 BMW 740i. The Honda CRV was equipped with a Certified Advanced 208 Compliant (CAC) frontal air bag system and an inflatable side impact protection system. The CAC system in the Honda was comprised of dual-stage frontal air bags, seat track position sensors, front safety belt buckle switches, front safety belt buckle pretensioners, and a front right occupant detection sensor. 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 inflatable side impact protection system consisted of front seatback mounted side impact (thorax) air bags and roof-rail mounted inflatable side curtains. The Honda was also equipped with a rollover sensor that controlled the deployment of the side curtains in the event of the rollover. The BMW was equipped with frontal air bags for the driver and front right passenger.

Figure 1: Honda CRV front view.

The crash occurred when the eastbound Honda CR-V turned left directly across the path of the westbound BMW. The front plane of the BMW struck the right side plane of the Honda in an 11/2 o'clock impact configuration. The force of the impact fired the Honda's front safety belt pretensioners and caused the right thorax air bag and right side curtain to deploy. The frontal air bags in the BMW deployed. The momentum of the BMW displaced the Honda to the northwest and caused it to depart the north side of the road. The down slope of the north road side caused the Honda to fall-over its left side into a three quarter turn rollover. During the initial stage of the rollover sequence, the left side curtain deployed. The Honda was occupied by a 56 year old restrained male driver and a 28 year old restrained male front right passenger. The BMW was occupied by a 65 year old restrained male driver. The front right passenger of the Honda and the driver of the BMW sustained police reported minor injuries and were transported by ground ambulance to a medical facility. The driver of the Honda was not injured in the event.

This crash was identified by the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) and subsequently assigned as an on-site investigation to the Calspan Special Crash Investigations team on May 17, 2005. Calspan SCI initiated follow-up investigation and established cooperation with the respective insurance agencies. The vehicles

were available for inspection at an insurance auction facility. The on-site portion of the investigation took place May 22, 2006.

SUMMARY

Vehicle Data

2006 Honda CR-V

The 2006 Honda CR-V sport utility vehicle was identified by the Vehicle Identification Number (VIN): JHLRD78866C (production sequence deleted). **Figure 2** is a right side view of the Honda. The vehicle was manufactured in the Japan in September 2005. The insurance records indicated that the odometer had registered 4,990 km (3,100 miles). The digital odometer could not be read at the time of the inspection. The four-door, five passenger sport utility vehicle was equipped with EX level trim. The *"Real-time"* four-wheel drive power train consisted of a 2.4 liter/I4 engine linked to a five-speed automatic transmission. The service brakes were four-wheel disc with ABS. The vehicle was also equipped with vehicle stability assist with traction control and a rollover sensor. The manual restraint system consisted of three-point lap and shoulder belts in all five seat positions. The front safety belts utilized buckle pretensioners. The dual-stage frontal air bags were a manufacturer certified FMVSS 208-compliant system. The inflatable side impact protection consisted of front seatback mounted thorax bags and roof-rail mounted side curtains. The Honda was equipped with Bridgestone Dueler HT P215/65R16 98 M&S tires on OEM alloy wheels. The recommended tire pressure was 200 kPa (29 PSI) front and rear. The specific measured tire data at the time of the SCI inspection was as follows:

Figure 2: Right side view of the Honda.

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	214 kPa (31 PSI)	7 mm (9/32)	No	None
LR	0 kPa (0 PSI)	7 mm (9/32)	No	Debeaded
RF	228 kPa (33 PSI)	7 mm (9/32)	No	None
RR	124 kPa (18 PSI)	8 mm (10/32)	No	Debris embedded In the bead

1994 BMW 740i

The 1994 BMW 740i, **Figure 3**, was identified by the Vehicle Identification Number (VIN): WBAGD8321RD (production sequence deleted). The rear-wheel drive, four-door sedan was manufactured in Germany in February 1994. The vehicle was configured with the 293 cm (115.4 in) wheelbase. The power train consisted of a 4.0 liter/V8 engine linked to a five-speed automatic transmission with overdrive. The vehicle was equipped with power-assist four wheel disc brakes with ABS. The manual restraint systems consisted of three-point lap and shoulder belts for the four outboard positions and a center rear lap belt. The BMW was equipped with air bags for the driver and front right passenger that deployed as a result of the crash. The BMW was equipped with Fuzion HRI P225/60R15 tires on OEM alloy wheels. The recommended tire pressure was 241 kPa (35 PSI) front and 269 kPa (39 PSI) rear. The specific measured tire data at the time of the SCI inspection was as follows:

Figure 3: Left front view of the BMW 740i.

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	221 kPa (32 PSI)	7 mm (9/32)	No	None
LR	228 kPa (33 PSI)	6 mm (8/32)	No	None
RF	228 kPa (33 PSI)	6 mm (8/32)	No	None
RR	234 kPa (34 PSI)	6 mm (8/32)	No	None

Crash Site

This two-vehicle crash occurred during the daylight hours of April 2006. At the time of the crash, it was raining and the asphalt road surface was wet. The crash occurred in a straight section of a two-lane east/west road approximately 33.5 m (110 ft) west of the exit of a right curve for westbound traffic. The 3.4 m (11.3 ft) wide traffic lanes were separated by a double yellow centerline. The outboard edges of the respective travel lanes were delineated by solid white lines. Improved shoulders bordered the travel lanes and measured 1.1 m (3.8 ft) in width. At the crash site, a 6.3 m (20.7 ft) wide driveway was located on the north side of the road and a hill crest was located approximately 9.1 m (30 ft) west of the center of the driveway. The grade of the road, 42.7 m (140 ft) east of the driveway, was positive nine percent in the westbound direction. The eastbound road grade measured positive five percent, 36.6 m (120 ft) west of the driveway. Due to the grade of the road in the respective directions, the hillcrest was a vision obstruction. The terrain north of the road shoulder had a negative slope of 22 percent in the area where the Honda left the pavement and was the major factor contributing to the fall-over of the Honda. The area of the Honda's final rest location was approximately 1.1 m (3.5 ft) below the elevation of the road. The speed limit in the area of the crash was 89 km/h (55 mph). A warning sign with a recommended 72 km/h (45 mph) speed limit was posted due to the presence of a

four-leg intersection approximately 244 m (800 ft) west of the crash site. **Figure 4** is an eastbound trajectory view of the Honda approximately 61 m (200) ft west of the impact. **Figure 5** is a westbound trajectory view of the BMW approximately 61 m (200 ft) east of the impact. **Figure 6** is a view looking southeastward from the Honda's approximate final rest location denoted by the disintegrated side glazing toward the point of impact.

Figure 4: Honda's eastbound trajectory view.

Figure 5: BMW's westbound trajectory view.

Figure 6: View looking from the Honda's final rest toward the point of impact.

Crash Sequence

Pre-Crash

The 2006 Honda CR-V was eastbound was driven by a 56 year old restrained male. A 28 year old restrained male was the Honda's front right passenger. The crash occurred when the driver of the Honda turned left directly across the path of a westbound 1994 BMW 740i. The BMW was driven by a 65 year old restrained male. It was the Honda driver's intension to enter the

driveway located on the north side of the road. The reader is encouraged to refer to the crash schematic attached to the end of this narrative report, **Figure 17**.

Crash

The front plane of the BMW struck the right side plane of the Honda in an 11/2 o'clock impact configuration. The right front window glazing disintegrated in the impact. The westbound momentum of the BMW displaced the vehicles to the northeast and both vehicles began to rotate clockwise. The impact force caused the Honda's front safety belt pretensioners to fire and deployed the vehicle's inflatable right side occupant protection system. This protection system included a front seatback mounted thorax bag and a right side curtain mounted in the right roof rail. The force of the impact also caused the frontal air bags in the BMW to deploy. The severity (delta V) of the impact was calculated using the Damage Algorithm of the WINSMASH collision model. The total delta V of the Honda was 24 km/h (15.0 mph) with an estimated 50 degree Principle Direction of Force (PDOF). The Honda's longitudinal and lateral delta V components were -16 km/h (-9.6 mph) and -18 km/h (-11.4 mph), respectively. The total delta V of the BMW was 20 km/h (12.5 mph) with an estimated 340 degree PDOF. Its corresponding longitudinal and lateral components were -19 km/h (-11.7 mph) and 7 km/h (4.3 mph), respectively.

The Honda separated from the BMW sliding to the northwest and rotating counterclockwise. The Honda traveled across the mouth of the driveway and departed the north side of the road 4.3 m (14.1 ft) from the impact. Due to the negative slope of the roadside, the Honda began to fall-over its left side. The Honda's rollover sensor assessed the change in the vehicle's roll rate and attitude and deployed the left side curtain. The weight shift to the left rear of the vehicle overloaded the left rear tire and caused the tire to air out. The Honda rolled three-quarter turns over its left side and came to rest on its right side approximately 10.6 m (35 ft) northeast of the impact. Two pools of disintegrated window glazing were identified along the vehicle's roll trajectory and established the area of the Honda's final rest. These two defined areas related to the disintegrated glazing of the left front and right rear windows, respectively. The BMW rotated approximately 190 degrees clockwise and slid to rest on the north shoulder of the road approximately 21 m (69 ft) from the impact.

Post-Crash

The police and ambulance personnel responded to the crash. Reportedly, the occupants exited their respective vehicles under their own power. The Honda's 28 year old restrained male front right passenger had a police reported complaint of lower extremity pain. He was transported by ground ambulance to a local hospital for evaluation. The BMW's 65 year old restrained male driver had a police reported compliant of back pain. This individual was also transported to a local hospital. The 56 year old restrained male driver of the Honda was not injured and did not request transport. Both vehicles sustained disabling damage and were towed.

2006 Honda CR-V

Exterior Damage

The inspection of the vehicle revealed two distinct damage patterns directly associated to the two events experienced by the Honda in this crash. The right side plane exhibited direct and induced lateral damage associated to the impact with the BWM. The body panels of the left, top, and

right side planes exhibited rollover damage consisting of abrasions and minor buckling. The rollover damage was consistent with a "soft" three-quarter turn roll.

Figure 7 is a close-up view of the right side impact damage. The direct contact began 28 cm (11.0 in) aft of the right front axle and extended rearward 206 cm (81 in). The direct contact ended on the rear aspect of the right rear door 27 cm (10.5 in) forward of the right rear axle. The combined length of the direct and induced damage measured 226 cm (89 in). The induced damage extended 20 cm (8.0 in) aft of the direct contact pattern and ended 6 cm (2.5 in) forward of the right rear axle. The crush profile was measured along the mid-door elevation which was the level of maximum deformation. The maximum lateral crush was located 118 cm (46.6 in) aft of the right front axle on the mid aspect of the left front door at C4. The residual crush profile measured as follows: C1 = 1 cm (0.4 in), C2 = 13 cm (5.1 in), C3 = 20 cm (7.9 in), C4 = 25 cm (9.8 in), C5 = 20 cm (7.9 in), C6 = 0. The right side doors were jammed shut by the deformation and were shifted rearward. The front right window glazing was disintegrated. The right wheelbase was reduced 2 cm (0.8 in) due to bending of the vehicle's unibody. The left wheelbase was unchanged. The Collision Deformation Classification of the impact was 02-RYEW3.

Figure 7: Right side impact damage.

Figures 8 and 9 are views of the Honda's left side damage. The left rear tire was debeaded and the face of the wheel rim was abraded. This occurred in the early stage of the rollover when the Honda encountered the side slope and began to fall-over. The weight shift to the left rear overloaded the tire and caused it to air out. The left plane contacted the ground exhibited by the longitudinal abrasions at the C-pillar and the debris embedded in the body seams. The left exterior mirror was fractured and separated from the vehicle. The left A-pillar was abraded and the left front window glazing disintegrated by subsequent ground contact. Both left doors were operational. The abrasion pattern extended forward onto the upper aspect of the left front fender and then wrapped onto the hood. The entire surface of the hood was abraded.

Figure 8: Left side view of the Honda.

Figure 9: Abrasions at the left A-pillar.

The left A-pillar area of the roof exhibited a small area of abrasions localized to its forward left aspect. There was no noted left A-pillar deformation. There was no other damage to the roof. The plastic trim covering the respective roof-rails was not damaged. As the vehicle rolled through two-quarter turns, the right side plane contacted the ground. The abrasion pattern of the hood wrapped onto the right front fender. The right A-pillar, **Figure 10**, was abraded and debris was embedded in the door frame. There was no deformation of the pillar. The right exterior mirror was fractured and separated. As the vehicle came to final rest the right rear quarterpanel and D-pillar area contacted the ground, **Figure 11**. The ground contact caused a buckling of the body panel. The right rear window glazing disintegrated and the right rear taillight lens was fractured. Grass debris was embedded into the bead of the right rear tire indicative of ground contact. The Collision Deformation Classification of the rollover event was 00-TDDO1.

Figure 10: Right A-pillar abrasions.

Figure 11: Right rear quarterpanel damage.

1994 BMW 740i
Exterior Damage

Figure 13 is the front view of the BMW damage. The BMW sustained direct contact damage to the frontal plane that extended across the vehicle's entire 157 cm (62 in) front end width as a result of the impact with the Honda. The deformation was biased to the right indicative of the 11 o'clock direction of the impact force. The damage components included the front bumper structure, center grille, hood, right headlamp assembly, and right front fender. The maximum crush was located at the right front bumper corner (C6). The residual crush measured at the bumper elevation was as follows: C1 = 8 cm (3.1 in), C2 = 14 cm (5.5 in), C3 = 15 cm (5.9 in), C4 = 18 cm (7.1 in), C5 = 22 cm (8.7 in), C6 = 25 cm (9.8 in). There was no change in the wheelbase measurements. All the doors remained closed during the crash and were operational at the SCI inspection. The windshield was fractured from contact by the cover flap of the deployed front right passenger air bag. All the glazing of the side windows

Figure 12: Front view of the BMW.

and the backlight were intact. The Collision Deformation Classification of the impact was 11-FDEW1.

2006 Honda CR-V

Interior Damage

The interior damage to the Honda CR-V consisted of the deployment of the vehicle's air bag systems and the intrusion of the right side structure as a result of the impact with the BMW. The intrusion of the forward aspect of the right front door measured 1 cm (0.7 in). The intrusion increased to 8 cm (3.0 in) at the aft aspect of the front door measured above the aft aspect of the arm rest. The door panel was in contact with the outboard aspect of the seat. The right B-pillar intrusion measured 9 cm (3.5 in) at the belt line. The intrusion of the right rear door measured 8 cm (3.0 in) at its forward aspect and tapered to zero at its aft aspect

There was no identified evidence of contact from the restrained occupants to the hard structures of the interior. The lack of significant contact evidence was consistent with the lack of reported injury, the use of the manual restraint systems, the occupant protection supplemented by the inflatable restraint systems, and to the relatively "soft" nature of the rollover event.

The manual driver seat was adjusted to a full rear track position. The total seat track travel measured 22 cm (8.75 in). The seat back was reclined 15 degrees. The horizontal distance from the center of the steering wheel hub/driver air bag module to the seat back measured 56 cm (22 in). This horizontal distance was measured 38 cm (15 in) above the seat bight. The four-spoke steering wheel rim was not deformed and there was no displacement of the shear capsules. The tilt steering column was in the full up position.

The front right passenger seat could not be moved due to deformation of the floor pan and the right side structure. The seat was found to be adjusted to the full rear track position through a comparison with the driver seat. The seat back was reclined 35 degrees from horizontal. The horizontal distance from the seat back to the rearward protrusion of the instrument panel measured 99 cm (39 in).

Manual Restraint Systems

The manual restraint systems in the Honda CR-V consisted of 3-point lap and shoulder safety belts in all five seat positions. The driver's restraint, **Figure 13**, consisted of a continuous loop webbing, a sliding latch plate, an adjustable D-ring, and an Emergency Locking Retractor (ELR). The outboard anchor was attached to the floor. The inboard buckle was attached to the seat and was equipped with a pretensioner. The pretensioner fired as a result of the impact. The height of the buckle reduced approximately 5 cm (2 in) to the level of the seat cushion. Upon initial inspection, the driver's restraint was in the extended position. The ELR retractor was locked and the webbing would not retract. The length of the extended webbing measured 180 cm (71.0 in). Examination of the webbing revealed it was creased in the area of the latch plate. The crease was located 76

Figure 13: Driver's restraint.

cm to 83 cm (30.0 in to 32.5 in) from the outboard anchor. Examination of the latch plate revealed indicators of historical use. Additionally, the friction surface of the latch plate belt path was abraded indicative of loading. The D-ring was adjusted to the full up position. The surface of the D-ring did not reveal loading evidence. The evidence identified during the examination of the driver's restraint indicated the restraint was in use at the time of the crash.

Figure 14: Front right passenger safety belt.

The front right passenger manual safety belt consisted of a continuous loop webbing, a sliding lath plate, an adjustable D-ring and a switchable Emergency Locking/Automatic Locking Retractor (ELR/ALR). The inboard buckle stalk was equipped with a pretensioner that fired as a result of the crash. Upon inspection, the webbing was extended and the retractor was locked due to the right B-pillar deformation. The length of the extended webbing measured 170 cm (67.0 in). The webbing was creased in the area of the latch plate. The location of the crease measured 67 cm to 75 cm (26.5 in to 29.5 in) from the outboard anchor. Examination of the latch plate revealed abrasions to the friction surface of the belt guide consistent with this loading. Minor historical use indicators were present on the tongue consistent with its use. The adjustable D-ring was in the full-down position. The surface of the D-ring was not abraded. The physical evidence identified during the course of the inspection confirmed the front right passenger was restrained at the time of the crash.

Air Bag Systems

The Honda CRV was equipped with a Certified Advanced 208 Compliant (CAC) frontal air bag system that consisted of advanced dual stage/dual threshold air bags for the driver and front right passenger, seat track position sensors, front safety belt buckle switches, front safety belt buckle pretensioners and a front right occupant detection sensor. 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 system was controlled and monitored by a control module located under the center console. The frontal air bags were not commanded to deploy in this angular side impact crash.

The vehicle's inflatable side impact protection system consisted of front seatback mounted thorax air bags and roof-rail mounted side curtains. An array of five impact sensors and a rollover sensor controlled the deployment of these air bags dependent on crash type and severity. For example in a side impact crash of sufficient severity, the seat back mounted thorax air bag and the roof rail side curtain on the affected side of the vehicle would be commanded to deploy. In a rollover crash, the rollover sensor would command the deployment of both roof rail mounted side curtains. The thorax bags would not be commanded to deploy in a rollover crash. In the subject crash, the right side impact of the BMW resulted in the deployment of the right thorax air bag and the right side curtain. Then as the Honda departed the road and initiated the rollover, the

rollover sensor commanded the deployment of the left side curtain in response to the changing roll attitude. The left thorax air bag was not commanded to deploy (refer to **Figure 13** above).

The thorax bag was housed in a module in the outboard bolster of the front seat back and expanded forward to offer a measure of inflatable protection between the occupant's chest and the door panel. The module measured 23 cm (9 in) in height and the base of the module was 20 cm (8 in) above the seat bight. The deployed bag was rectangular in shape and measured 33 cm x 27 cm (13 in x 10.5 in), length x height respectively. The referenced length dimension was measured to the module recessed within the seat bolster. The deployed bag extended 24 cm (9.5 in) forward of the seat bolster. The bag was tethered by a 5 cm (2 in) wide strap. It was vented by two 3.8 cm (1.5 in) ports located on the bag's forward vertical seam. There was no evidence of occupant contact to the right thorax bag.

The inflatable side curtain deployed downward from its mounting in the vehicle's roof rail. The rectangular curtain provided coverage that extended from the A- to the C-pillars. Upon deployment, the curtain was inflated by compressed helium stored in a canister located in the roof-rail behind the C-pillar. The gross overall dimensions of the curtain measured 160 cm x 46 cm (63 in x 18 in), length by height, respectively. The curtain was tethered at the A-pillar and to the roof rail between the C- and D- pillars. **Figure 15** is a view of the deployed right side curtain and thorax air bag. **Figure 16** is a view of the deployed left side curtain. There was no residual evidence of occupant contact to the deployed side curtains.

Figure 16: Deployed right side impact protection.

Figure 16: Deployed left side protection.

Occupant Demographics
2006 Honda CR-V

	Driver	***Front Right Passenger***
Age/Sex:	56 year old / Male	28 year old / Male
Height:	Not Reported	180 cm (71 in)
Weight:	Not Reported	125 kg (276 lb)
Seat Track Position:	Full rear track	Full rear track
Restraint Use:	3-point lap and shoulder belt	3-point lap and shoulder belt
Usage Source:	SCI inspection	SCI inspection
Medical Treatment:	None, not injured	Transported via ground ambulance, treated and released

Driver Injuries
2006 Honda CR-V
The Honda driver was not injured in the crash and declined medical transport. He could not be reached for an interview.

Driver Kinematics
2006 Honda CR-V
Prior to the crash, the 56 year old male driver was seated in a full rear track position with a presumed normal posture. He was restrained by the vehicle's manual 3-point lap and shoulder belt. The driver initiated a left turn directly across the path of the BMW precipitating the crash.

Upon impact, the seat belt's ELR retractor locked and the buckle pretensioner fired. The seat belt buckle compressed and tightened the seat belt about the driver's pelvis. The driver responded to the 2 o'clock direction of the impact force by initiating a forward and rightward trajectory. The driver loaded the seat belt with his chest and pelvis and began to ride down the crash. The driver's rearward seat position and use of the manual restraint minimized his interaction with the hard structures of the interior.

As the vehicle departed the road and began to rollover, the driver initiated a vertical and rightward trajectory in response to the rollover dynamics. The left side curtain deployed at this time. The driver was positioned the further inboard of his initial seated posture at this time and was positioned away from the deploying curtain. As the vehicle rolled inverted the effective use of the seat belt protected the driver from significant interaction with the roof. As the Honda rolled through the three-quarter turn event, the driver continued to load the locked safety belt and ride down the force of the crash. The driver came to rest within the confines of the front left interior.

Front Right Occupant Injuries
2006 Honda CR-V

Injury	**Injury Severity (AIS 98 update)**	**Source**
Right lower leg contusion, NFS	Minor (890402.1,1)	Right kick panel (possible)

Source: Emergency Room Records

Front Right Occupant Kinematics
2006 Honda CR-V

The 28 year old front right male passenger was seated in a full rear track position with a presumed upright posture prior to the crash. He was restrained by the vehicle's 3-point lap and shoulder belt. Upon impact with the BMW, the right side inflatable occupant protection system deployed, the seat belt buckle pretensioner fired, and the ELR/ALR retractor locked. The fired pretensioner compressed the seat belt buckle and tightened the seat belt about the occupant's pelvis.

The occupant responded to the 2 o'clock direction of the impact by initiating the forward and right trajectory. He loaded the locked seat belt with his chest and pelvis and began to ride down the force of the crash. He loaded the deployed thorax air bag with the right lateral aspect of his chest. His right shoulder and right flank loaded the deployed right side curtain. Coincident to this kinematic pattern, the right side structures of the Honda intruded laterally and the front window glazing disintegrated. The deployed side curtain and seat belt helped to maintain the occupant's position within the vehicle and prevented ejection.

As the Honda departed the road side and began to rollover, the occupant exhibited a downward and rightward trajectory. He continued to load the locked seat belt system, the deployed thorax bag and the deployed side curtain. As the vehicle rolled inverted, the use of the seat belt mitigated the occupant's interaction with the roof. As the vehicle came to rest on its right side, the occupant came to rest against the right door panel and side curtain. His right lower leg possibly contacted the right kick panel resulting in the identified contusion.

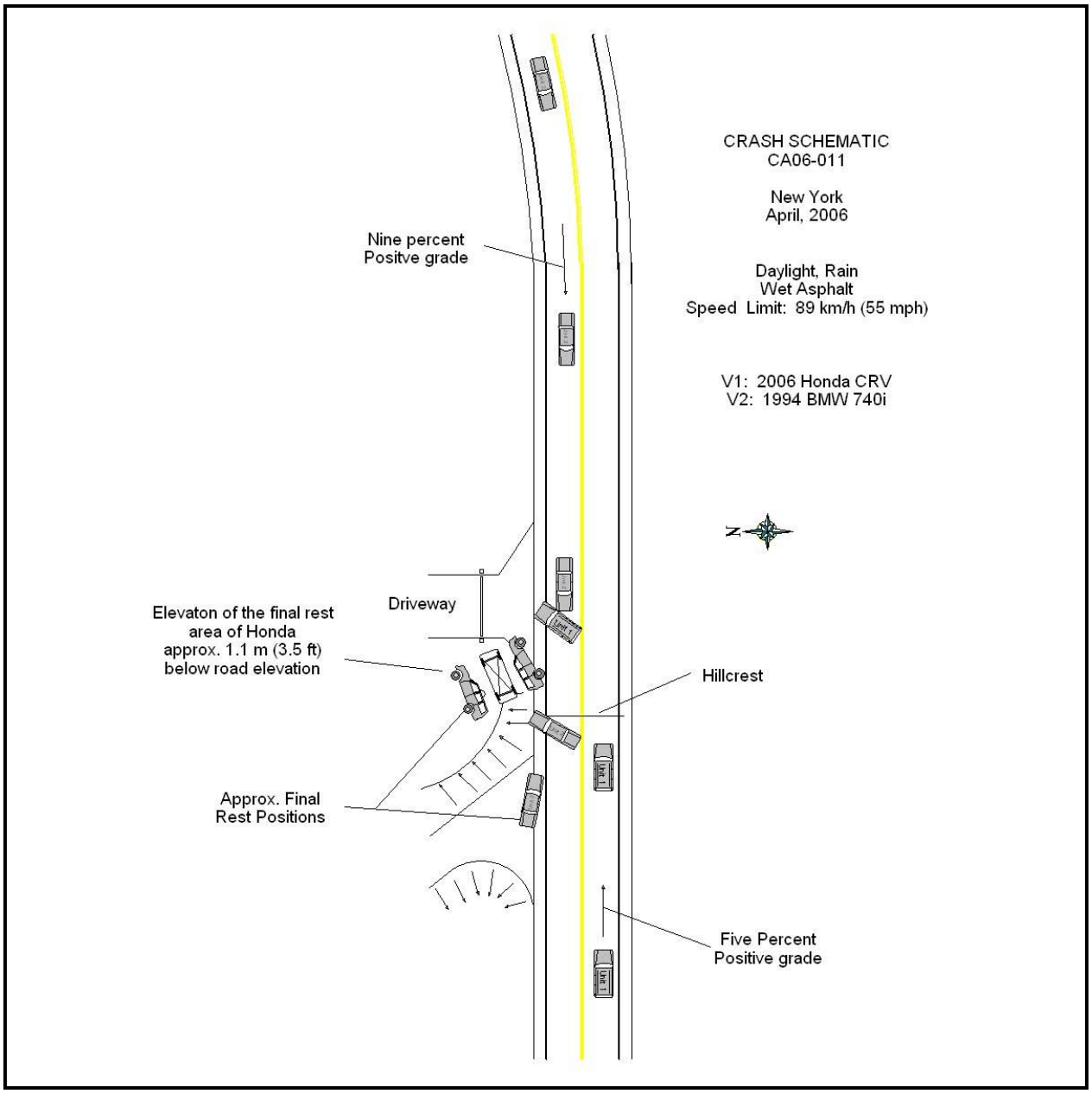

Figure 17 - Crash Schematic