CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION SYSTEM CRASH INVESTIGATION

SCI CASE NO: – CA09019

VEHICLE – 2008 HONDA ACCORD

LOCATION – VIRGINIA

CRASH DATE – 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 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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LOCATION – VIRGINIA
CRASH DATE – JANUARY 2009

BACKGROUND

This on-site investigation focused on the side impact inflatable occupant protection system of a 2008 Honda Accord **(Figure 1)**, the Honda Advanced Compatibility Engineering (ACE) frame structure, and the injury sources for the 52-year-old male driver. The ACE structure is a design that utilizes a network of connected structural elements to distribute crash energy more evenly throughout the front of the vehicle. The Honda was equipped with front seat back-mounted side impact air bags and Inflatable Curtain (IC) air bags for the four outboard positions. Additionally, the Honda was equipped with a Certified Advanced 208-Complaint (CAC) frontal air bag system that consisted of dual stage driver and passenger air bags, seat track positioning sensors, a front right occupant presence detection sensor, retractor pretensioners, and safety belt buckle switch sensors. The manufacturer of the Accord has certified that the vehicle was compliant to the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The 2008 Honda was involved in an offset frontal collision with a 1994 Honda Accord. As a result of the crash, the retractor pretensioners actuated, the driver's front air bag, the left seat back mounted side impact air bag, and both IC air bags deployed in the 2008 Honda Accord. The driver of the 2008 Honda Accord sustained a sternum fracture and multiple soft tissue injuries. He was transported to a local hospital where he hospitalized for two days.


Figure 1. 2008 Honda Accord, case vehicle.

This crash was identified by the Crash Investigation Division (CID) of the National Highway Traffic Safety Administration (NHTSA) during a review of images of total loss vehicles that were located at a salvage facility. Due to the resultant corner type impact configuration and the deployment of the multiple air bag systems, the 2008 Honda Accord's location was forwarded to the Calspan Special Crash Investigations (SCI) team for follow-up on March 18, 2009. The vehicle was located and cooperation was established with the insurance company and the salvage facility to inspect the vehicle. An on-site investigation was assigned to the Calspan SCI team on March 18, 2009. The on-site investigation was conducted on March 20, 2009.

SUMMARY

Crash Site

The crash occurred during the daylight hours of January 2009. At the time of the crash, the weather was clear and the road surfaces were dry. The crash occurred within the eastbound lane of a two-lane east/west roadway in a rural area. There was a moderate left curve for westbound traffic. **Figure 2** is a westbound trajectory view of the 2008 Honda Accord. The curve was posted with a cautionary speed limit of 48 km/h (30 mph). The respective travel lanes measured 2.8 m (9.2 ft) in width and were separated by a double-yellow centerline. The north road side consisted of grass and gravel that sloped away from the pavement to a hedgerow and fence line. The fence line was located 2.7 m (8.9 ft) from the pavement edge. A 0.8 m (2.6 ft) wide ditch/depression bordered the south road edge. A 4.5 m (14.8 ft) wide north/south roadway intersected the primary road from the north at the end of the left curve. **Figure 3** is an eastbound trajectory view of the 1994 Honda Accord.

Figure 2: Westbound trajectory view of the 2008 Honda Accord.

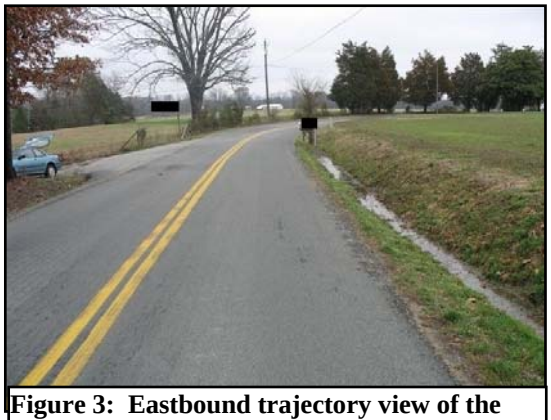

Figure 3: Eastbound trajectory view of the 1994 Honda Accord.

Pre-Crash

The 52-year-old male driver of the 2008 Honda Accord was operating the vehicle westbound negotiating the left curve. The 1994 Honda Accord was driven eastbound by a 21-year-old male driver on a straight section of the road. As the 1994 Honda entered the (eastbound right) curve, the driver of the 2008 Honda allowed his vehicle to cross the centerline and enter the eastbound travel lane. A schematic of the crash is included at the end of report as **Figure 14**.

Crash

The left frontal area of the 2008 Honda Accord struck the left frontal area of the 1994 Honda Accord in a head-on, offset configuration. The front left structures of both vehicles deformed and the vehicle engagement continued down the left side plane of each vehicle. The directions of force were in the 12 o'clock sector for both vehicles. The force of the impact caused the driver's safety belt pretensioner to actuate and deployed the driver's frontal air bag, the left side impact air bag and both IC air bags in the 2008 Honda Accord. The frontal air bags in the 1994 Honda Accord also deployed. The Collision Deformation Classification Algorithm of the WinSMASH program was used to calculate the severity (delta-V) of the crash. The total delta-V of the 2008 Honda Accord was 15 km/h (9.3 mph). The longitudinal and lateral components were -15 km/h (-9.3

mph) and 0, respectively. The total delta-V of the 1994 Honda Accord was 19 km/h (11.8 mph). The longitudinal and lateral components were -19 km/h (-11.8 mph) and 0, respectively.

The offset impact configuration induced a counterclockwise rotation to both vehicles. The 2008 Honda Accord rotated CCW and slid to rest, west of the impact area. The 1994 Honda Accord rotated CCW and slid to rest, east of the impact. The physical evidence of the crash had eroded due to the passage of time between the crash date and SCI scene inspection.

Post-Crash

Police and emergency medical personnel were summoned to the crash site. Based of the severity of damage to both vehicles it appears that the drivers were assisted with their egress. The driver of the 2008 Honda Accord sustained a sternum fracture and multiple soft tissue injuries. He was transported to a local hospital where he hospitalized for two days.

Vehicle Data – 2008 Honda Accord

The case vehicle in this crash was the 2008 Honda Accord EX-L four-door sedan. The Honda was manufactured in 07/08 and was identified by Vehicle Identification Number (VIN): 1HGCP368X8A (production number deleted). The Honda was powered by a 3.5-liter, transverse mounted 6-cylinder engine linked to a 5-speed automatic transmission with a console mounted shift lever. The service brakes were power-assisted front and rear disc with antilock, electronic brake force distribution, and brake assist. The Honda was also equipped with Electronic Stability Control (ESC) and traction control. The tires were Michelin Pilot HX MXM4, size P225/50R17 mounted on OEM alloy wheels. The vehicle manufacturer recommended cold tire pressure was 221 kPa (32 PSI) for the front and rear. The tire data at the time of the SCI inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Damage
Left Front	Tire Flat	6 mm (8/32 in)	Cut sidewall
Right Front	255 kPa (37 PSI)	7 mm (9/32 in)	None
Left Rear	241 kPa (35 PSI)	7 mm (9/32 in)	None
Right Rear	207 kPa (30 PSI)	7 mm (9/32 in)	None

The interior safety systems consisted of 3-point lap and shoulder belts for the five positions, a CAC frontal air bag system, front seat back-mounted side impact air bags, and roof side rail-mounted curtain air bags.

Vehicle Data – 1994 Honda Accord

The second vehicle in this crash was a 1994 Honda Accord. This vehicle could not be located at the time of the case assignment and was not inspected by the SCI investigator. Images of the vehicle were obtained from the salvage facility. The Honda was identified by the VIN: 1HGCD7136RA (production number omitted). The 1994 Honda Accord was equipped with a 2.2-liter inline 4-cylinder engine linked to a 5-speed manual transmission with front-wheel drive, manual safety belts, and a frontal air bag system.

Vehicle Damage

Exterior – 2008 Honda Accord

The 2008 Honda Accord sustained moderate damage to the front and left side planes as a result of the impact with the 1994 Honda Accord **(Figure 4)**. The damaged components included but were not limited to the bumper fascia, bumper beam, hood, left fender, and the left front wheel and suspension components. All four doors remained closed during the crash and were operational post-crash. The windshield fractured during the crash. The remaining side, rear, and roof glass were intact. The direct contact damage began 29 cm (11.4 in) left of the centerline and extended 52 cm (20.5 in) to the left bumper corner. The combined direct and induced damage extended across the entire front end width. Due to the prolonged engagement, the direct contact damage extended 95 cm (37.4 in) down the left fender. The left front wheel was directly involved as the vehicles crushed, resulting in a separation of the left wheel and brake assembly from the suspension. The maximum crush measured 11 cm (4.3 in) and was located on the left end of the bumper beam. A crush profile was documented along the bumper beam which was as follows: C1 = 11 cm (4.3 in), C2 = 8 cm (3.1 in), C3 = 3 cm (1.2 in), C4 = 0 cm, C5 = 0 cm, C6 = 0 cm. The Collision Deformation Classification (CDC) for this impact was 12-FLEW-1. **Figures 5 - 7** depict the damage to the ACE structure:

Figure 4. Overall view of the frontal damage.

Figure 5. Front left ACE frame damage.

Figure 6. Lateral view of the front ACE frame damage.

Figure 7. Front right view of the undamaged ACE frame structure.

Interior – 2008 Honda Accord

The interior of the 2008 Honda Accord sustained moderate severity damage as a result of driver contact and deployment of the inflatable safety systems. The interior of the Accord was configured for five-passenger seating with front bucket seats and a rear bench seat with split folding backs. The seat surfaces consisted of black leather. The seating positions were equipped with height adjustable head restraints. The front left head restraints was adjusted to 4 cm (1.6 in) above the seat back. The front left seat back was adjusted to a measured angle of 20 degrees aft of vertical with the seat track adjusted to a rear position. **Figure 8** is an overall view of the driver's area.

The driver's contact points consisted of two knee impacts to the knee bolster which were evidenced by the fractured rigid plastic panel **(Figure 9)**. The turn signal stalk was fractured and the rear view mirror was deflected downward. These contacts were attributed to the driver's left and right hands, respectively. The driver loaded the deployed air bag which resulted in 1 cm (0.5 in) of steering column compression. There was no intrusion into the passenger compartment.

Figure 8. Overall view of the driver's area.

Figure 9. Knee bolster contact points.

Exterior – 1994 Honda Accord

The 1994 Honda Accord sustained severe frontal and left side damage as a result of the crash **(Figures 10 – 11)**. The damage assessment was based on the images obtained from the salvage facility; no actual measurements were obtained. The direct damage began left of the centerline and extended to the front left bumper corner. The direct damage continued down left side of the vehicle onto the front left door. The maximum crush was estimated at 20 cm (8 in). The impact configuration and severity resulted in a near vertical deformation of the left A-pillar.

Figure 10. Front left oblique view of the damage.

Figure 11. Direct damage extending onto the left door.

Certified Advanced 208-Compliant Frontal Air Bag System – 2008 Honda Accord

The 2008 Honda Accord was equipped with a CAC frontal air bag system for the driver and front right passenger positions. This system consisted of dual-stage air bags, seat track position sensors, safety belt buckle switch sensors, a front right occupant presence detection sensor, and front safety belt retractor pretensioners. The driver's air bag was concealed in the center hub of the 4-spoke steering wheel by three cover flaps design. The top flap was 13 cm (5 in) in width at the horizontal tear seam and 10 cm (3.9 in) in height. The lower flaps were 7 cm (2.8 in) in width and height. The air bag measured 53 cm (21 in) in diameter in its deflated state and was tethered internally by two straps. The air bag was vented by two ports located at the 11 and 1 o'clock positions. The driver's air bag contained body fluid spatter at the left aspect near the center. There were no occupant contact points or damage to the frontal air bag.

The front right air bag was a mid-mount design incorporated into the right instrument panel. The front right seat was not occupied during the crash; therefore, the CAC system suppressed the deployment of the air bag.

Event Data Recorder – 2008 Honda Accord

The 2008 Honda Accord was equipped with an air bag control module that had Event Data Recording (EDR) capabilities. Permission to remove the EDR from the vehicle was denied by the insurance company.

Side Impact Air Bag System – 2008 Honda Accord

The 2008 Honda Accord was equipped with front seat back-mounted side impact air bags and roof side rail-mounted IC air bags. The left seat back-mounted side impact air bag and both IC air bags deployed during the crash. **Figure 12** depicts the deployed front, seat back mounted, and the left IC air bag in the Honda.

Figure 12. Overall view of the deployed front, seat back mounted, and the IC air bags.

The left seat back-mounted air bag was concealed within the outboard aspect of the seat back. The air bag deployed through a tear seam at the forward aspect of the outboard seat bolster. The air bag measured 47 cm (18.5 in) in height and 28 cm (11 in) in width at the top and 20 cm (8 in) in width at the bottom. The air bag consisted of two panels sewn together at the forward edge. The air bag contained a single 3 cm (1 in) diameter vent port at the top forward aspect. The air bag contained a rectangular-shaped cut out that measured 10 cm (4 in) in height and 8 cm (3.1 in) in width. This cut out was located 18 cm (7 in) above the bottom and 9 cm (3.5 in) rear of the forward edge. The air bag was designed to inflate around this cut forming two chambers. Black-colored expansion transfers were noted on the upper outboard aspect of the air bag. The air bag was not damaged and did not contain occupant contact points.

The left and right IC air bags deployed from the roof side rails. The air bag measured 207 cm (81.5 in) in length. At the front seating positions, the air bag measured 46 cm (18.1 in) in height extending 8 cm (3.1 in) below the beltline. The height of the curtain air bag at the rear positions was 41 cm (16.1 in) and extended 7 cm (2.8 in) below the beltline. The height of the IC air bags provided head protection from the roof side rail to belt line of the vehicle. The IC air bags provided full longitudinal coverage across the side glazing. Occupant contact points or damage did not occur to the curtain air bag.

Manual Safety Belt Systems – 2008 Honda Accord

The safety belt systems consisted of continuous loop webbing and sliding latch plates for all five positions. The front belts were equipped with adjustable D-rings and retractor mounted pretensioners. The driver's D-ring was adjusted to the full-down position. The driver's belt system was equipped with an Emergency Locking Retractor (ELR).

Figure 13. D-ring transfer evidence on the belt webbing.

The driver utilized the safety belt during the crash which was supported by loading evidence on the lap and shoulder portions of the webbing and the latch plate. As a result of the crash, the retractor pretensioner actuated which retracted a portion of the safety belt. During this motion, the belt webbing was pulled through the D-ring and the latch plate resulting in frictional transfers to the webbing from these components. The driver loaded the safety belt which pulled the webbing through the D-ring in a forward motion. The combination of the actuating pretensioner and the driver loading resulted in a 25 cm (9.8 in) transfer from the D-ring. This transfer began 177 cm (69.7 in) above the anchor. A transfer occurred from the latch plate interaction and was located from 86 – 89 cm (33.9 – 35 in) above the anchor. Additionally, the latch plate exhibited full-width frictional abrasions across the plastic surface.

The front right safety belt system utilized a switchable ELR and Automatic Locking Retractor (ALR) and a retractor pretensioner. The front right safety belt system was not used during crash and the retractor pretensioner did not actuate. The three rear belt systems utilized switchable ELR/ALR. These positions were unoccupied at the time of the crash.

Driver Demographics – 2008 Honda Accord

Age/Sex:	52-year-old/Male
Height:	178 cm (70 in)
Weight:	117 kg (257 lbs)
Seat Track Position:	Rear-track position
Safety Belt Usage:	3-point manual lap and shoulder safety belt
Usage Source:	SCI vehicle inspection
Egress from Vehicle:	Assisted by first responders
Mode of Transport from Scene:	Ambulance
Type of Medical Treatment:	Hospitalized for two days

Driver Injuries – 2008 Honda Accord

Injury	**Injury Severity (AIS 90/ Update 98)**	**Injury Source**
Sternal body fracture, nondisplaced with miniscule retrosternal hematoma	Moderate (450804.2,4)	Safety belt
Right anterior chest wall contusion	Minor (490402.1,1)	Safety belt
Lower abdominal contusion	Minor (590402.1,8)	Safety belt
Lower abdominal abrasion	Minor (590202.1,8)	Safety belt
Contusion to the left anterolateral proximal thigh	Minor (890402.1,2)	Safety belt
Left knee laceration, approximately 6cm (2.4 in)	Minor (890602.1,2)	Knee bolster

Source: Medical records

Driver Kinematics– 2008 Honda Accord

The 52-year-old male driver of the 2008 Honda Accord was seated in a rear-track position with the seat back reclined 20 degrees aft of vertical. He was restrained by the manual lap and shoulder safety belt system. At impact, the safety belt pretensioner actuated and the front air bag, left seat back-mounted side impact air bag, and both curtain air bags deployed. The driver's hands were deflected from the steering wheel rim as he responded to the 12 o'clock direction of force by initiating a forward trajectory. The driver's left hand contact and fractured the turn signal stalk that was mounted on the left side of the steering column and his right hand contacted and deflected the windshield mounted rear view mirror. The driver's knee's contacted and fractured the knee bolster as he translated forward resulting in the left knee laceration. His torso and pelvic area loaded the safety belt evidenced by the loading abrasions on the webbing. The loading of the safety belt resulted in the sternum fracture, chest wall contusion, abdominal contusion and abrasion, and the left thigh contusion. The loading of the air bag was translated through to the steering column. There was 1 cm (0.5 in) of steering column compression noted. The driver was transported to a local hospital where he was hospitalized for two days.

Driver Demographics – 1994 Honda Accord

Age/Sex:	21-year-old/Male
Height:	180 cm (71 in)
Weight:	104 kg (230 lbs)
Seat Track Position:	Mid to rear-track position
Safety Belt Usage:	None used
Usage Source:	Medical records
Egress from Vehicle:	Assisted by first responders
Mode of Transport from Scene:	Ambulance
Type of Medical Treatment:	Hospitalized for ten days

Driver Injuries – 1994 Honda Accord

Injury	**Injury Severity (AIS 90/ Update 98)**	**Injury Source**
Extensive comminuted fractures involving the left posterior acetabulum and the roof of the acetabulum extending to the iliac bone, fracture also extends to involve the left ischium. With posterior hip displacement	Serious (852604.3,2)	Intruding knee bolster (Indirect)
Left patella fracture, open and severely comminuted (inferior pole aspect)	Moderate (852400.2,2)	Intruding knee bolster
Left patellar tendon rupture, (with disruption of the extensor mechanism) and complex laceration, 10 cm (3.9 in) in length, transversely oriented, with a 1 cm (0.4 in) transverse laceration just superior to larger wound	Moderate (841002.2,2)	Intruding knee bolster
Bilateral knee abrasions	Minor (890202.1,3)	Intruding knee bolster
Left hip (extensive pelvic sidewall) hematoma and proximal thigh intramuscular hematoma	Minor (890402.1,2)	Left door panel
Left knee ecchymosis	Minor (890402.1,2)	Intruding knee bolster
Left lower abdominal hematoma, (groin area)	Minor (590402.1,8)	Steering wheel rim
Right abdominal abrasion	Minor (590202.1,1)	Steering wheel rim
Left lower abdominal superficial laceration	Minor (590602.1,8)	Steering wheel rim

Injury	Injury Severity (AIS 90/ Update 98)	Injury Source
Nose abrasion	Minor (290202.1,4)	Air bag
Nose contusion	Minor (290402.1,4)	Air bag

Source: Medical records

Driver Kinematics– 1994 Honda Accord

The 21-year-old male driver of the 1994 Honda Accord was positioned in the driver's seat and was unrestrained. At impact, the frontal air bags deployed and the driver initiated a forward trajectory in response to the frontal crash forces. The driver's face contacted the frontal air bag resulting in the contusion and abrasion to his nose. His knees contacted and loaded the intruding knee bolster resulting in the fracture to the left patella, laceration and rupture of the left patella tendon, bilateral knee abrasions, left knee ecchymosis, and the extensive comminuted fractures of the acetabulum. During the forward motion, his abdomen contacted and deformed the steering wheel rim. As a result of this contact, the driver sustained abdominal abrasions, hematoma, and a superficial laceration. As the vehicles rotated, the driver's left hip contacted the left door panel resulting in a hematoma to his hip. The driver was transported to a local hospital where he was hospitalized for ten days.

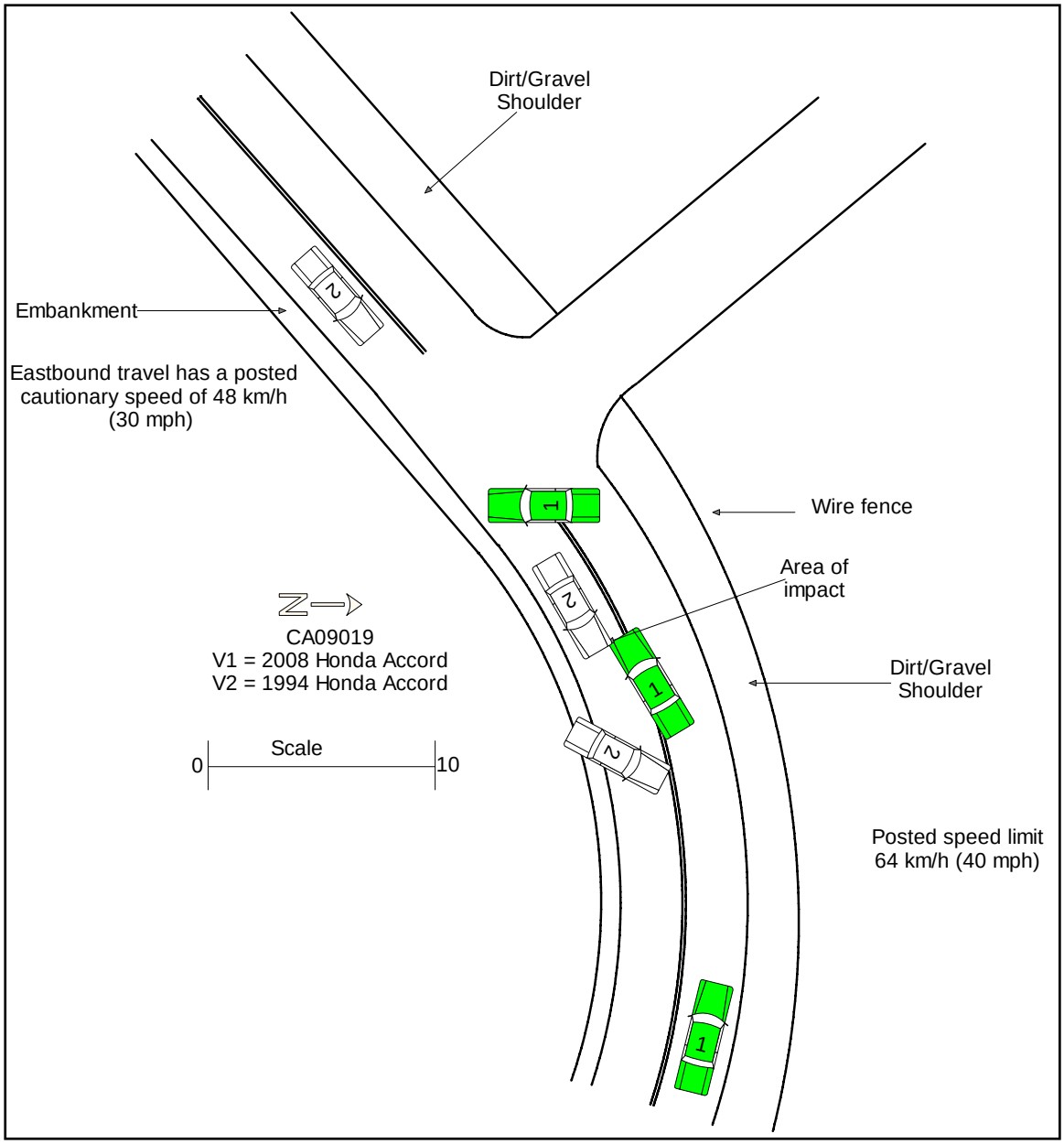

Figure 14: Scene Schematic