CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION

CASE NO: CA08002

VEHICLE: 2000 HONDA CIVIC LX

LOCATION: VIRGINIA

CRASH DATE: JANUARY 2008

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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BACKGROUND

This on-site investigation focused on the installation of an Evenflo Tribute Child Safety Seat (CSS) in a 2000 Honda Civic and the injury sources for a 2-year old female child seated therein. The CSS was installed in a forward facing orientation in the second row right position of the vehicle. The Honda **(Figure 1)** was involved in multiple impacts with fixed objects and a one-quarter turn rollover. A 39-year old female was driving the vehicle and realized that the child's internal harness clip of the CSS was not latched. She reached into the rear seat to fasten the clip and the vehicle drifted off the right roadside. The driver overcorrected by steering left and lost directional control of the vehicle. The Honda departed the left roadside while rotating counterclockwise (CCW) and struck a small diameter tree with the right fender. The vehicle continued rotating CCW and struck a 64 cm (25") diameter tree with the right rear door. The second tree impact induced a rapid change of rotation to clockwise (CW) leading to a subsequent trip-over onto its left side. As the vehicle overturned, the left side of the vehicle struck a third tree. The vehicle sustained disabling damage and was deemed a total loss by the insurance agency. The child was removed from the vehicle by emergency personnel and transported via helicopter to a regional trauma center. She sustained multiple skull fractures, a brain edema and hemorrhage, and soft-tissue injuries and expired five hours after admission. The female driver of the Honda sustained minor injuries and refused medical attention.

Figure 1 - Damaged 2000 Honda Civic.

The crash was identified by the Calspan Special Crash Investigation (SCI) team through an Internet news search. The notification of the crash was forwarded to the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA). The Calspan SCI team located the vehicle and established cooperation with the investigating police agency. The case was assigned on January 22, 2008. The vehicle was located at a salvage yard in Virginia with the CSS confirmed as still being inside the vehicle. The vehicle, CSS, and scene inspections were conducted on January 25, 2008. A detailed phone interview with the mother of the child (the driver) was completed on January 22, 2008.

SUMMARY

Vehicle Data – 2000 Honda Civic LX

The 2000 Honda Civic was designed as a four-door sedan and identified by the Vehicle Identification Number (VIN): 1HGEJ6678YL (production number omitted). The

vehicle's date of manufacture was 9/99 and the odometer registered 110,128 km (68,432 miles). The Gross Vehicle Weight Rating (GVWR) was 1,510 kg (3,330 lb) with 798 kg (1,760 lb) distributed to the front axle and 730 kg (1,610 lb) distributed to the rear. The front-wheel drive vehicle was equipped with 1.6 liter, 4-cylinder engine linked to an automatic transmission. The braking system consisted of front disc and rear drum brakes. The Honda was equipped with Lexington ES-335 tires. All four tires were size P185/65R14 and contained the DOT number 025328 E11. The manufacturer's recommended tire pressure was 207 kPa (30 PSI) for the front tires and 200 kPa (29 PSI) for the rear tires. The specific tire information at the time of the SCI inspection was as follows:

Position	**Measured Pressure**	**Measured Tread**	**Restricted**	**Damage**
LF	179 kPa (26 PSI)	3 mm (4/32")	No	None
LR	172 kPa (25 PSI)	4 mm (5/32")	No	None
RF	179 kPa (26 PSI)	4 mm (5/32")	No	Dirt embedded in wheel
RR	172 kPa (25 PSI)	2 mm (3/32")	No	Dirt embedded in wheel

The 2000 Honda Civic was configured with two front bucket seats with adjustable head restraints. The driver's head restraint was adjusted to 5 cm (2") above the seatback and the front right head restraint was adjusted to 3 cm (1") above the seatback. The front seats exhibited 20 cm (8") of total track travel. Both seats were at the mid-track position with the driver's seat 11 cm (4.5") rear of full forward and the front right seat 6 cm (2.5") rear of the same. The rear seating positions in the Civic were configured with a split bench seat with folding backs and integral head restraints. The intruding second row rear door panel and C-pillar deformed the right rear bench seat.

Crash Site

This single vehicle crash occurred during daylight hours of January 2008 in the state of Virginia. At the time of the crash, the weather was clear and the asphalt roadway surface was dry. The east/west roadway consisted of one lane in each direction and was devoid of lane markings. The roadside environment consisted of a grassy embankment area that ran contiguous to agricultural fields on the south roadside and an undeveloped tree line on the north roadside. Beyond the immediate tree line on the north roadside was steep decline. A drainage ditch was present along the south roadside 1.5 m (5 ft) outboard of the road edge. The rural roadway was windy in configuration and experienced a 281 m (923 ft) radius of curvature to the left at the area of the crash. The posted speed limit for the east/west roadway was 64 km/h (40 mph). The Crash Schematic is included as **Figure 14** at the end of the narrative report.

Crash Sequence

Pre-Crash

The female driver of the Honda was operating the vehicle in an eastbound direction on the two-lane roadway and was negotiating the 281 m (923 ft) radius left curve **(Figure 2)**. She had recently left her home, which was located approximately 1 km (1/2 mile) from the crash site, and was traveling on an errand with her 2-year old daughter. The driver related during the SCI interview that she allowed her daughter to strap herself into the CSS in the right rear position of the vehicle, who then informed her mother when she was done. After realizing that the child never acknowledged that she was done, the driver looked into the second row, noticed that the internal harness was not latched, and then reached into the second row to assist the child. As the driver was attempting to latch the harness, the Honda drifted off the right roadside and began tracking along the grassy shoulder. The driver overcorrected by initiating a left steering input and the vehicle began to rotate CCW into a full broadside yaw and off the left roadside. The vehicle rotated CCW approximately 90 degrees and traveled toward the tree line. The right side tires dug into the dirt and grass and created yaw marks leading to the point of impact. A 7 m (23 ft) long yaw mark, attributable to the right rear tire, and a 3.7 m (9.5 ft), attributable to the front right tire, were documented during the SCI scene inspection. Both marks were slightly curved in orientation and dissipated near the point of impact. **Figure 3** is an overall view of the crash location.

Figure 2 - Eastbound approach of the Honda.

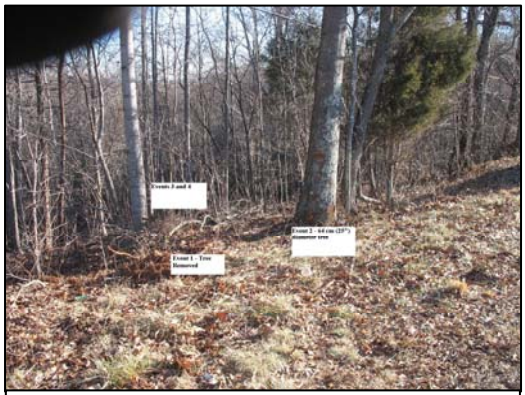

Figure 3 - Overall view of crash site (events encapsulated).

Crash

The right fender of the 2000 Honda Civic struck a small diameter tree located 5 m (16.5 ft) off the south road edge (Event 1). The small diameter tree yielded as it snapped at the ground level. The direction of force for this impact was in the 3 o'clock sector. The barrier algorithm of the WinSMASH program computed a velocity change of 12 km/h (7.5 mph). After the initial impact, the Honda continued rotating CCW and the right rear door struck a 64 cm (25") diameter tree located .5 m (1.5 ft) south and 3 m (8 ft) east of the first tree (Event 2). The direction of force for this impact was in the 2 o'clock sector. The impact was sufficient to deploy the frontal air bags in the Honda. The damage algorithm of the WinSMASH program computed a total delta V of 22 km/h (13.7 mph) with longitudinal and lateral velocity changes of -11 km/h (-6.8 mph) and -19 km/h (-11.8

mph), respectively. The force of the impact resulted in moderate right rear door panel and C-pillar intrusion.

After striking the second tree, the Honda reversed its rotation to CW. After rotating approximately 90 degrees, the vehicle tripped over the soft soil and overturned left side leading one-quarter turn (Event 3). As the vehicle was in the process of overturning, the left side of the vehicle contacted a 46 cm (16") diameter tree (Event 4). The tree was positioned 4.6 m (15 ft) south and 2.6 (6.6 ft) east of the original struck tree. The vehicle came to final rest on its left side against the tree.

Post-Crash

The 39-year old female driver of the 2000 Honda Civic exited her vehicle and attempted to administer aid to the child prior to the arrival of emergency personnel. The driver reported that her memory of the post-crash events was unclear. Emergency personnel arrived on scene and removed the child from the vehicle. The child sustained massive head trauma and was transported via helicopter to a regional trauma center where she expired shortly after admission. The driver sustained minor bruising to the left hand and shoulder as a result of the crash. She declined medical treatment. The Honda was removed from the scene and deemed a total loss.

Vehicle Damage

Exterior Damage – 2000 Honda Civic

Figure 4 - Right side of Honda Civic.

The 2000 Honda Civic sustained moderate damage to its right side as a result of multiple tree impacts. The initial impact **(Figure 4)** was to the right fender where the direct damage began at the bumper corner and extended 56 cm (22") rearward. The combined direct and induced damage extended from the same point to 61 cm (24") rearward. The maximum crush was located 49 cm (19.3") rear of the bumper corner and was 25 cm (10") in depth. Six equidistant crush measurements were documented along the vehicle's mid-door level and were as follows: C1 = 5 cm (2"), C2 = 25 cm, (10"), C3 = 21 cm (7.5"), C4 = 19 cm (7.5"), C5 = 20 cm (7.9"), C6 = 13 cm (5"). The Collision Deformation Classification (CDC) for this impact was 03-RFEW-3.

The secondary tree impact to the right side resulted in moderate damage to the Honda's right side in the area of the right rear door and C-pillar **(Figure 5)**. The direct contact damage began 70 cm (27.5") aft of the front right axle and extended rearward 77 cm (30.3"). The combined direct and induced damage began 68 cm (26.8") rear of the front right axle and extended rearward a distance of 99 cm (39").

Figure 5 - Damage to right rear door area.

The maximum crush was located 149 cm (58.6”) aft of the front left axle and measured 40 cm (15.7”) in depth. The impact fractured the right rear window and resulted in the intrusion of the door panel and the C-pillar. The intrusion subsequently fractured the backlight glazing and caused the roof to deflect upwards. Six equidistant measurements were taken along the vehicle’s mid-door level and were as follows: C1 = 0 cm, C2 = 12 cm (4.7”), C3 = 38 cm (15”), C4 = 37 cm (14.6”), C5 = 29 cm (11.4”), C6 = 20 cm (7.9”). The CDC for this secondary impact was 02-RPAW-3.

After the Honda was redirected from the second tree, the vehicle rotated CW approximately 90 degrees and the left side tires dug into the soft soil, which caused the vehicle to overturn. The rollover was classified as trip-over due to the ground yielding to the tires. As the Honda overturned, the left side roof side rail, rear door panel, and window glazing struck a third tree. The abrasions on the left roof side rail **(Figure 6)** began 118 cm (46.5”) forward of the left rear axle and extended forward 33 cm (13”). The maximum crush on the roof side rail was 1 cm (1.5”) and was located 118 cm (46.5”) forward of the left rear axle. The abrasions on the door panel began 76 cm (30”) forward of the left rear axle and were 11 cm (4.5”) in length. The abrasions on the left rear glazing were found 74–86 cm (29-34”) forward of the left rear axle and were 18-33 cm (7-13”) above the beltline.

Figure 6 - Damage to left roof side rail.

Additional patterns of abrasions, attributable to the rollover, were noted on the left fender, along the forward edge of the left front door, and vertically from the base to the top of the A-pillar. The CDC’s for the rollover event and non-horizontal tree impact were 00-LYEO-1 and 00-LPHN-3.

Interior Damage – 2000 Honda Civic

The 2000 Honda Civic sustained moderate interior damage as a result of passenger compartment intrusion and occupant contact. The intrusion was centered in the region of the right rear seating position. The most prominent intrusion was to the right roof side rail, which intruded 37 cm (14.5”) laterally and 7 cm (2.75”) vertically. The intrusions documented during the SCI inspection are listed by their magnitude in the following table:

Position	**Component**	**Magnitude**	**Direction**
Second row right	Roof side rail	37 cm (14.5”)	Lateral
Second row right	Door panel (right upper quadrant)	36 cm (14”)	Lateral
Second row right	C-pillar	34 cm (13.4”)	Lateral
Second row right	Quarter window frame	34 cm (13.4”)	Lateral
Second row right	Side panel – rear of B-pillar	14 cm (5.5”)	Lateral

Position	Component	Magnitude	Direction
Second row right	B-pillar	9 cm (3.5”)	Lateral
Front right	B-pillar	9 cm (3.5”)	Lateral
Second row right	Roof side rail	7 cm (2.75”)	Vertical
Second row right	Roof	7 cm (2.75”)	Vertical

Figure 7 - Areas of probable occupant contact.

Three areas of probable occupant contact were documented during the SCI inspection in the region of the second row door panel **(Figure 7).** The most notable was an area of whitish substance transfer along the beltline that was 8 cm (3”) longitudinally and 8 cm (3”) vertically and began 45 cm (17.7”) aft of the rear aspect of the B-pillar. The transfer was coarse in nature and was likely a result of the shell of the CSS compressing against the intruded panel. The triangular quarter window frame in the second row right position contained a blood transfer and a black substance transfer. The transfer was 53-58 cm (21-23”) in length and was located 5 cm (2”) below the framing for the backlight header. A small scuff was located at the beltline further rear of the whitish transfer; however, considering the intrusion and the presence of the CSS, the source of this potential contact point was not determined.

Manual Restraint Systems

The manual restraint systems in the 2000 Honda Civic consisted of three-point lap and shoulder belts in the four outboard seating positions and a lap belt for the second row center position. The driver’s belt consisted of continuous loop webbing, a sliding latch plate, an adjustable D-ring, and an Emergency Locking Retractor (ELR). Examination of the belt webbing revealed minor waffling with no distinct loading evidence; however, an analysis of the latch plate revealed distinct loading patterns on the latch plate housing and historical usage striations on the metallic latch plate itself.

The second row outboard belts consisted of continuous loop webbing, a sliding latch plate, and a switchable ELR/Automatic Locking Retractor (ALR). The second row right restraint was used to install a forward facing CSS. The belt was routed through the forward belt path designed into the CSS and the latch plate was buckled. The second row right belt was partially restricted by the intruding door panel and C-pillar. However, a 111 cm (44”) area of the belt was free from the intrusion and was used to secure the CSS into position. The shoulder aspect of the webbing leading to the latch plate was 66 cm (26”) in length and the lap aspect was 46 cm (18”) in length. Besides minor waffling of the belt webbing, the second row right belt system was unremarkable in terms of loading evidence. The latch plate exhibited minor striations indicative of historical usage and the immediate plastic housing revealed no loading evidence.

Frontal Air Bag System

The 2000 Honda Civic was equipped with a redesigned frontal air bag system that deployed as a result of the second impact with the 64 cm (25") diameter tree. The driver's air bag deployed from the steering hub though H-configuration module cover flaps. The upper flap measured 14 cm (5.5") horizontally and 7 cm (2.5") vertically. The lower flap measured 14 cm (5.5") horizontally and 4 cm (1.75") vertically. The deployed driver's air bag measured 56 cm (22") in diameter in its deflated state. There was no discernable loading evidence on the air bag or cover flaps.

The front right passenger's air bag deployed from a top-mount module configured with symmetrical H-configuration cover flaps. Both cover flaps measured 23 cm (9") horizontally and 5 cm (2") vertically. The deployed front right air bag measured 50 cm (20") horizontally and 76 cm (30") vertically in its deflated state. The top aspect of the deployed air bag had small pieces of glass embedded within the membrane as a result of contacting and fracturing the windshield. There was no discernable loading evidence on the air bag.

Child Safety Seat

Figure 8 is a front view of the forward facing CSS installed and in use at the time the crash. A second forward facing CSS was installed in the left rear position of the vehicle. The CSS was not being utilized at the time of the crash. It should be noted that the position of the CSS in relation to its location and its installation by the belt system, was not altered by the emergency personnel after the crash. The CSS was an Evenflo Tribute 5 DLX Model No.: 2573018, manufactured in August 2005. The CSS **(Figure 9)** was installed in the second row right position of the Honda by the vehicle's 3-point lap and shoulder belt. The CSS was labeled for use by children in the following circumstances:

Figure 8 - Post-crash position of CSS.

Figure 9 - Overhead view of CSS.

Rear Facing Only

- 2.3 - 13.6 kg (5 – 30 lb)
- At least 48 cm (19") tall
- Top of head is at least 2.5 cm (1") below the top of the CSS seatback
- Less than one year of age

Rear or Forward Facing

- 9 – 13.6 kg (20 – 30 lb)
- At least one year of age

Forward Facing Only
-13.6 – 18 kg (30 – 40 lb)
- Less than 101 cm (40”)
- At least one year of age

The manufacture’s labels were intact and legible. The instruction manual was present and the locking clip was in place on the back of the shell. **Figure 10** illustrates the CSS in its post-impact position.

The CSS was configured with a 5-point harness system. The harness was routed through the top slots and the harness straps were in good condition. The length of the right and left straps was 24 cm (9.5”) and 23 cm (9.25”), respectively. The CSS was designed with a 13 x 5 cm (5.5 x 2”) chest retainer clip. The right harness strap was threaded through the clip. The left harness strap was not threaded at the time of the inspection, refer to **Figure 10**. There was no loading evidence on the harness straps or retainer clip.

Figure 10 - View of intrusion against CSS shell (chest retainer clip encapsulated).

The shell of the CSS sustained severe damage as a result of the intrusion of the right rear door panel and the C-pillar, both of which compressed and fractured the CSS. The width of the CSS seatback was compressed 9.5 cm (3.75”) from its original design specifications. In addition, the shell sustained multiple fractures and stress marks down its right side. The damage began 19 cm (7.5”) below the top aspect of the CSS and extended downward 50 cm (20”) to the footer area, refer to **Figures 11 and 12**.

Figure 11 - Frontal view of damaged CSS.

Figure 12 - Right side view of damaged CSS.

Occupant Demographics

Driver

Age/Sex:	39-year old/Female
Height:	160 cm (63”)
Weight:	59 kg (130 lb)
Seat Track Position:	11 cm (4.5”) rear of full forward
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Eyewear:	None
Type of Medical Treatment:	None

Driver Injuries

Injury	Injury Severity (AIS90/Update 98)	Injury Source
Left hand contusion (4^{th} and 5^{th} fingers)	Minor (790402.1,2)	Steering wheel rim
Right shoulder contusion	Minor (790402.1,1)	Front right seatback
Thoracic spine strain	Minor (640478.1,6)	Impact forces

Source: Interview

Driver Kinematics

The 39-year old driver was seated in an upright position and was turned to her right and reaching into the second row attempting to adjust her child’s chest harness clip. The driver, accompanied by her 2-year old daughter, had just departed her place of residence and was traveling on an errand. As the distracted driver attempted to fix the child’s harness clip, the vehicle drifted off the right side of the roadway. In response, the driver stated that she used her left hand to steer to the Honda to the left. In so doing, she lost directional control and the vehicle departed the left roadside. As the vehicle contacted the two trees with its right side, the driver responded to the 2 o’clock direction of force by moving to the right. She loaded the front right seatback and sustained a contusion to her right shoulder. As she was gripping the wheel, she also sustained contusions to the fourth and fifth fingers of her left hand. She suffered a strain to the thoracic back region due to the impact forces. After striking the second tree, the vehicle reversed its rotation to CW and its left side tires tripped over the soft soil. The vehicle overturned and came to rest on its left side. The driver exited the vehicle with assistance from passers-by; however, she indicated that she did not recall the post-crash events clearly. She stated that she began assisting the child; although, the level of assistance could not be discerned. The driver declined medical treatment, but she accompanied her daughter to a regional trauma center.

Second Row Right Passenger

Age/Sex:	2-year old/Female
Height:	91 cm (36”)
Weight:	10 kg (22 lb)
Seat Track Position:	Not adjustable
Manual Restraint Use:	Seated within a FFCSS with a manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Eyewear:	None
Type of Medical Treatment:	Transported to a regional trauma center and expired a short time after admission.

Second Row Right Passenger Injuries

Injury	Injury Severity (AIS90/Update 98)	Injury Source
Multiple foci of hemorrhage in cerebrum	Severe (140629.4,9)	Quarter window frame
Cerebral edema	Serious (140660.3,9)	Quarter window frame
Bilateral comminuted vault skull fractures	Serious (150404.3,1) (150404.3,2)	Quarter window frame
Anterior basilar skull fracture	Serious (150200.3,8)	Quarter window frame
Dicing lacerations to forehead and right scalp	Minor (290602.1,7) (190602.1,1)	Quarter window frame
Minor abrasions to dorsum left hand	Minor (790202.1,2)	Child safety seat shell
Contusion to anterior left thigh	Minor (890402.1,2)	Child safety seat shell

Source: Autopsy – external only

Second Row Right Passenger Kinematics

The 2-year old child was seated upright within a forward facing CSS. This system included a 5-point harness and an adjustable harness retainer clip. The driver of the vehicle stated that she allowed the child to latch herself into the CSS so that the child could learn the practice. In past instances, the child would alert the mother when she latched herself into the CSS. However, as the driver began traveling on this occasion, she recalled that the child had not mentioned that she had completed the latching process. The driver noticed that the harness clip was not fully threaded and she reached into the second row and began to thread the internal harness system into the retainer clip.

After departing the roadway, the vehicle struck a small diameter tree and then a larger 64 cm (25”) diameter tree with its right side. The right side structure in the area of the door panel and C-pillar intruded into the occupant space and the child responded to the 2 o’clock direction of force by moving slightly right in her CSS. The child’s head struck the intruded triangular quarter window frame **(Figure 13)**. From the contact to the window frame, the child sustained bilateral vault skull fractures, an anterior basilar skull

fracture, a cerebral edema and hemorrhage, and dicing lacerations to her forehead and scalp. The vehicle rebounded off the second tree and overturned onto its left side where it came to rest. During the rollover, the child's left hand and left thigh loaded the CSS shell resulting in additional minor soft-tissue injuries. The child remained seated within the CSS during the subsequent impacts. She was removed by emergency personnel and airlifted to a regional trauma center. She expired five hours after admission.

Figure 13 - Intruded door panel and quarter window frame against CSS shell.

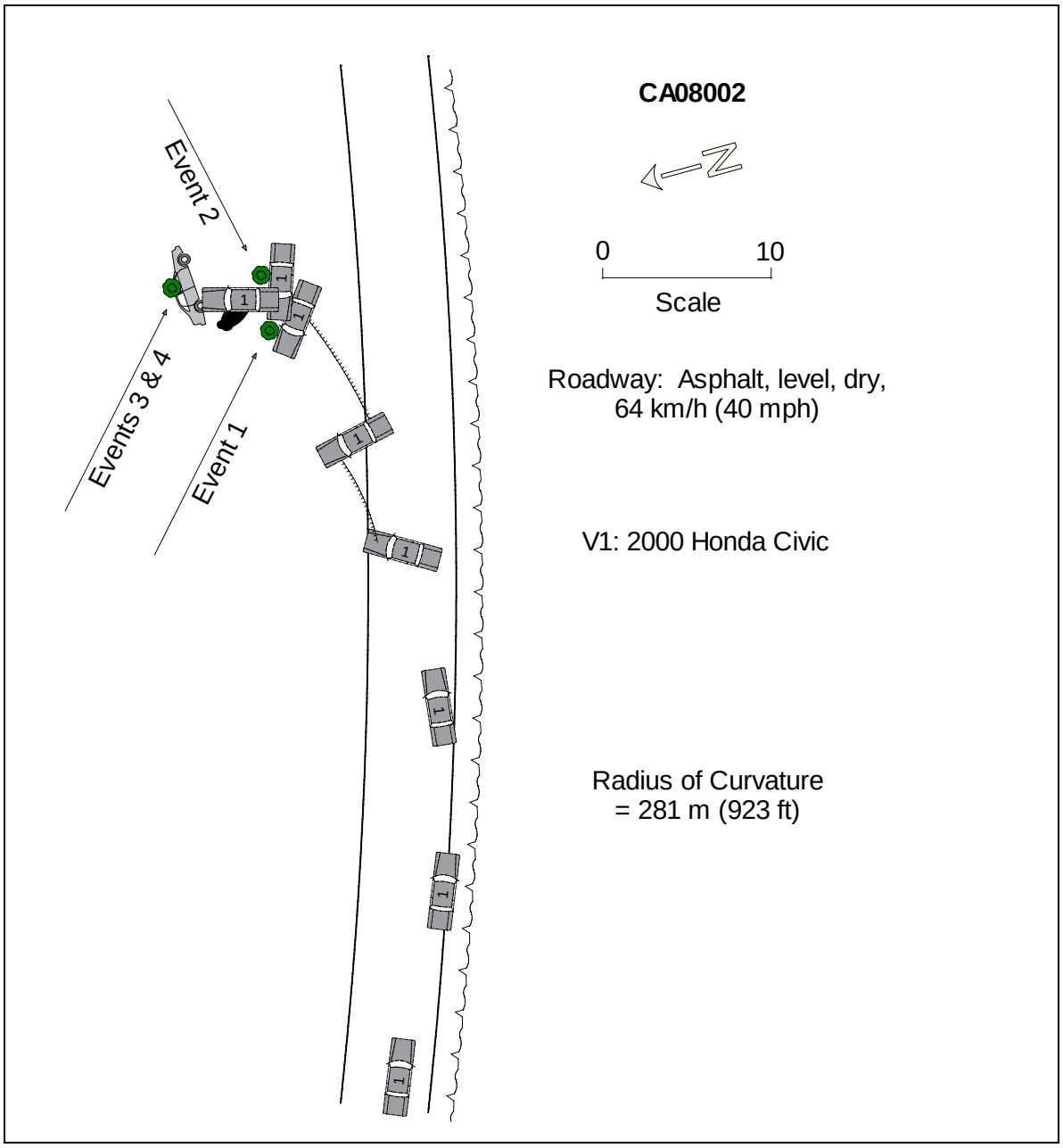

Figure 14 – SCI Crash Schematic