

CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION

CASE NO: CA05-015

VEHICLE: 1997 HONDA CIVIC

LOCATION: VIRGINIA

CRASH DATE: JANUARY 2005

Contract No. DTNH22-01-C-17002

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

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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.

TECHNICAL REPORT STANDARD TITLE PAGE

<p>1. <i>Report No.</i> CA05-015</p>	<p>2. <i>Government Accession No.</i></p>	<p>3. <i>Recipient's Catalog No.</i></p>	
<p>4. <i>Title and Subtitle</i> Calspan On-Site Child Safety Seat Crash Investigation Vehicle: 1997 Honda Civic Location: State of Virginia</p>		<p>5. <i>Report Date:</i> March 2006</p>	
		<p>6. <i>Performing Organization Code</i></p>	
<p>7. <i>Author(s)</i> Crash Data Research Center</p>		<p>8. <i>Performing Organization Report No.</i></p>	
<p>9. <i>Performing Organization Name and Address</i> Crash Data Research Center Calspan Corporation P.O. Box 400 Buffalo, New York 14225</p>		<p>10. <i>Work Unit No.</i> C00410.0000.0273</p>	
		<p>11. <i>Contract or Grant No.</i> DTNH22-01-C-17002</p>	
<p>12. <i>Sponsoring Agency Name and Address</i> U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590</p>		<p>13. <i>Type of Report and Period Covered</i> Technical Report Crash Date: January 2005</p>	
		<p>14. <i>Sponsoring Agency Code</i></p>	
<p>15. <i>Supplementary Note</i> This investigation focused on the crash dynamics and injury sources of an unrestrained 22-year-old female driver of a 1997 Honda Civic, and a 3-month-old male child who was restrained in a rear-facing CSS (with a detachable base) in the rear left position.</p>			
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<p>17. <i>Key Words</i> Rear-facing child safety seat Rollover with ejection Fatal injuries to the driver</p>		<p>18. <i>Distribution Statement</i> General Public</p>	
<p>19. <i>Security Classif. (of this report)</i> Unclassified</p>	<p>20. <i>Security Classif. (of this page)</i> Unclassified</p>	<p>21. <i>No. of Pages</i> 11</p>	<p>22. <i>Price</i></p>

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CALSPAN ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION
CASE NO.: CA05-015
LOCATION: STATE OF VIRGINIA
VEHICLE: 1997 HONDA CIVIC
CRASH DATE: JANUARY 2005

BACKGROUND

This on-site investigation focused on the crash dynamics and injury sources of an unrestrained 22-year-old female driver of a 1997 Honda Civic, and a 3-month-old male child who was restrained in a rear-facing Child Safety Seat (CSS) with a detachable base in the rear left position. The female driver of the Civic lost control of the vehicle on the inboard lane of a four-lane divided highway. She departed the left roadside and over-steered right in an attempt to re-enter the travel lane. The over-steer maneuver caused the Civic to initiate a clockwise (CW) yaw across the travel lane. The front right aspect of the Civic struck the rear left axles of the trailer of a tractor semi-trailer that was traveling in the outboard lane. The Civic rotated rapidly from the front right impact and engaged the trailer tires with the full width of the bumper fascia. The Civic deflected from the truck in a CW direction on the inboard lane as it rotated to a near broadside attitude. The lateral forces on the left side tires resulted in a turnover (un-tripped rollover) with the left side leading. The Civic rolled six quarter-turns and came to rest on its roof in the center of the northbound travel lanes, facing south (**Figure 1**). The unrestrained driver was ejected during the rollover and came to rest in the travel lanes. The 3-month-old male child remained restrained in the rear-facing CSS and sustained only a minor abrasion to his forehead. A passerby found the child suspended upside-down from the CSS and removed him from the vehicle. The child was transported by ambulance to a local hospital for observation and released. The driver of the Civic sustained fatal injuries and expired at the scene.



Figure 1. On-scene news photograph showing final rest of the Honda Civic

The Special Crash Investigations team at Calspan was notified of this crash by the Crash Investigation Division of the National Highway Traffic Safety Administration, who forwarded an Internet newspaper article that reported the crash. Cooperation with the family was established and the Honda Civic was located at a local tow yard. Permission to inspect the CSS and the vehicle was obtained, and an on-site investigation was assigned by NHTSA on February 14, 2005. The on-site investigation was completed on February 16, 2005, and a copy of the Police Accident Report (PAR) was obtained from the investigating agency. The tractor semi-trailer was driven from the scene and was not available for inspection.

SUMMARY

Vehicle Data – 1997 Honda Civic

The 1997 Honda Civic was identified by the Vehicle Identification Number (VIN) 1HGEJ8141VL (production sequence omitted). The Civic's odometer read 386,531 km (240,186 miles) at the time of the SCI inspection. Family members reported that the vehicle was purchased used and had not been involved in any prior crashes. It was also reported that the windshield had been replaced approximately two years prior to the crash. The vehicle was a two-door coupe that was configured with 1.6 liter, 4-cylinder engine, front disc/rear drum power brakes, front wheel-drive, a 5-speed manual transmission, and a tilt steering wheel. The Civic was also configured with a retractable sunroof, which was opened 10.2 cm (4.0") at the time of the SCI inspection. The Civic was equipped with steel 36 cm (14") wheels and the manufacturer's recommended tire pressure was 210 kPa (30 PSI) for the front wheels and 200 kPa (29 PSI) for the rear wheels. The specific tire information at the time of the inspection was as follows:

Position	Tire Manufacturer	Size	Measured Pressure	Measured Tread	Damage
LF	Uniroyal Tiger Paw	185/65R14	0 kPa	6 mm (7/32")	None
LR	Douglas Xtra-Trac	185/65R14	210 kPa (30 PSI)	6 mm (7/32")	None
RF	Uniroyal Tiger Paw	185/65R14	210 kPa (30 PSI)	6 mm (7/32")	None
RR	Douglas Xtra-Trac	185/65R14	0 kPa	6 mm (7/32")	Sidewall tear

The Honda Civic was configured with front bucket seats with folding backs and adjustable head restraints. Both head restraints were located 5 cm (2.0") above the front seat backs. At the time of the SCI inspection, the driver's seat was adjusted to the full-rear position with a total track travel of 23 cm (9.1"). The front right seat was positioned 4 cm (1.5") forward of full-rear and 19 cm (7.5") rear of full-forward. The second row was configured with a rear bench seat with folding backs.

Crash Site

This two-vehicle crash occurred on the northbound lanes of a divided highway in the state of Virginia in February 2005. At the time of the crash, the weather was clear and the asphalt roadway surface was dry. The roadway was configured with two travel lanes in each direction separated by a depressed grass median (**Figure 2**). The roadway was straight and level. The northbound and southbound travel lanes were bordered by asphalt shoulders, Continuous Shoulder Rumble Strips (CSRS), yellow fog lines on the inboard aspects, and white fog lines on the outboard aspects. At the area of the crash, W-beam guardrails bordered each side of



Figure 2. Overhead view of northbound lanes and crash site

the travel lanes. The posted speed limit for the divided highway was 105 km/h (65 mph). The scene schematic is included as **Figure 13** at the end of this report.

Crash Sequence

Pre-Crash

The 22-year-old female driver was operating the Honda Civic on the inboard northbound lane (**Figure 3**). The investigating agency reported that she was attempting to pass a tractor semi-trailer that was traveling on the outboard northbound lane. As she attempted to overtake the truck, she lost directional control of the vehicle. Police reported that the Civic traveled to the left onto the shoulder and grassy median. The driver steered right in an attempt to regain control and re-enter the roadway. The driver over-corrected to the right as the Civic re-entered the inboard travel lane, adjacent to the passing truck.



Figure 3. Northbound approach for the Honda Civic

Crash

The Civic continued across the inboard travel lane in a CW yaw and the front right aspect struck the left rear axles of the trailer as the tractor semi-trailer continued northbound in the outboard lane. The direction of force was in the 1 o'clock sector for the Civic, and the impact was sufficient to deploy the Civic's frontal air bag system. The damage algorithm of the WinSMASH program computed a total delta-V of 15 km/h (9.3 mph) based on the frontal crush profile. The Civic continued to rotate CW against the outboard aspect of the left wheels of the trailer, evidenced by significant scuffing and rubber transfers on the full width front bumper fascia. The Civic was deflected from the trailer wheels in a CW yaw. The lateral forces on the left side tires resulted in a turnover (un-tripped rollover) with the left side leading. Based on the vehicle damage, the Civic most likely rolled six quarter-turns and came to rest on its roof in the center of the northbound travel lanes, facing south. The vehicle damage did not exhibit heavy abrasions consistent with extended sliding on any vehicle plane. Several gouges were visible on the roadway surface within the Civic's rollover trajectory, but their relationship to this crash could not be confirmed. The unrestrained driver was ejected through the open front left window area during the rollover, and came to rest in the travel lanes. Based on the rollover dynamics and driver injuries, it appeared the driver might have been partially ejected during the initial stages of the rollover, and fully ejected as the Civic completed the fifth quarter-turn. The vehicle came to rest beyond the driver's final rest position, which supported a "fall-out" type of ejection versus being thrown from the vehicle.

Post-Crash

The 3-month-old child was found suspended upside down in the CSS, which remained secured in the vehicle during the crash. A passerby removed the child from the CSS and the vehicle. The child sustained a minor injury and was transported by ambulance to a local hospital for evaluation and released. The driver expired at the scene.

Vehicle Damage

Exterior Damage – 1997 Honda Civic

The 1997 Honda Civic sustained moderate frontal damage as a result of the frontal impact with the left rear aspect of the tractor semi-trailer. The rubber tire marks on the front bumper fascia began 62 cm (24.5”) right of center and extended 117 cm (46.1”) to the left across the fascia (**Figure 4**). The maximum crush was located 41 cm (16.3”) right of the vehicle’s centerline and measured 41 cm (16.3”) in depth. The combined direct and induced damage involved the entire frontal width of the vehicle and measured 104 cm (41.0”). The front bumper fascia and bumper beam were separated at the time of the SCI inspection. The upper and lower radiator supports were crushed rearward (**Figure 5**). Six crush measurements were documented along the lower



Figure 4. Separated front bumper fascia



Figure 5. Frontal damage to the 1997 Honda Civic

radiator support and were as follows: C1 = 0 cm, C2 = 0 cm, C3 = 4 cm (1.5”), C4 = 9 cm (3.5”), C5 = 13 cm (5.1”), C6 = 10 cm (3.9”). The Collision Deformation Classification (CDC) for the frontal impact was 01-FDEW-1.

The Civic sustained severe damage as a result of the rollover event. The left front tire was debanded and the left front wheel was deformed and abraded. Heavy abrasions were present on the left upper fender, left roof side rail, left C-pillar, roof, hood, and entire right side plane. Both side mirrors were separated. The left and right rear axles were deformed causing the rear wheels to be out of camber. The right front wheel was abraded. The right and left side planes sustained minor lateral deformation and both side doors were slightly displaced (**Figures 6 and 7**). The



Figure 6. Left side rollover damage



Figure 7. Right side rollover damage

roof, right roof side rail, and windshield header were crushed as a result of contact with the ground. The maximum crush was located at the top aspect of the right A-pillar and measured 15 cm (5.9"). Six vertical crush measurements were documented along the right roof side rail as follows: C1 = 0 cm, C2 = 1 cm (0.4"), C3 = 3 cm (1.2"), C4 = 8 cm (3.1"), C5 = 13 cm (5.1"), C6 = 15 cm (5.9"). Six vertical crush measurements were also documented along the windshield header as follows: C1 = 1 cm (0.4"), C2 = 3 cm (1.2"), C3 = 6 cm (2.5"), C4 = 10 cm (3.9"), C5 = 11 cm (4.3"), C6 = 15 cm (5.9"). The CDC for the rollover event was 00-TDDO-3.

During the rollover, the windshield sustained severe damage (**Figure 8**). The windshield was fractured, holed, and sustained bond separation. The bond separated along the entire length of the left A-pillar and the separation extended along the windshield header 86 cm (33.9"). Bond separation was also present on the right A-pillar, which began at the top aspect and extended vertically 48 cm (18.9"). The outer gasket on the perimeter of the windshield sustained heavy abrasions from the rollover.



Figure 8. Windshield damage from left side

Interior Damage – 1997 Honda Civic

The 1997 Honda Civic sustained moderate interior damage as a result of occupant contact and passenger compartment intrusion during the crash. A 24 cm (9.5") wide fracture was present on the left aspect of the knee bolster from probable contact with the driver's left knee. The entire knee bolster was displaced. The driver's interior door was slightly deformed, and the plastic trim on the top aspect of the armrest was deformed and displaced as a result of occupant loading (**Figure 9**). The door panel above the door handle was also damaged. The outboard aspect of the driver's seat back exhibited tears and scuff marks from contact with the driver's safety belt latch plate during the rollover. The latch plate, in the stowed position, engaged the seat back in a longitudinal orientation. The roof crush resulted in moderate passenger compartment intrusion.



Figure 9. Damaged driver's interior door panel

The specific intrusions were documented as follows:

Position	Intruded Component	Magnitude of Intrusion	Direction
11	Windshield header	6 cm (2.5")	Vertical
11	Roof	8 cm (3.1")	Vertical
11	Left roof side rail	14 cm (5.5")	Vertical
13	Windshield header	14 cm (5.5")	Vertical
13	Roof	15 cm (5.9")	Vertical
13	Right A-pillar	20 cm (7.9")	Vertical
13	Right A-pillar	5 cm (2.0")	Lateral
13	Right roof side rail	13 cm (5.3")	Vertical
13	Right roof side rail	8 cm (3.1")	Lateral
13	Right front door interior	7 cm (2.8")	Lateral
23	Headliner	17 cm (6.8")	Vertical
23	Right roof side rail	3 cm (1.2")	Vertical

Manual Restraint System

The 1997 Honda Civic was equipped with manual 3-point lap and shoulder belts for the front seat positions. The driver's safety belt was configured with continuous loop webbing, a sliding latch plate, and an Emergency Locking Retractor (ELR). The driver's safety belt was not used in this crash and was found in the stowed position at the time of the SCI inspection. The plastic stop button was separated at the time of the inspection, but it was unknown if the separation was a result of the crash. The front right safety belt was configured with continuous loop webbing, a sliding latch plate, and a switchable ELR/Automatic Locking Retractor (ALR).

The rear seat was equipped with manual 3-point lap and shoulder belts for the outboard positions. Each was configured with continuous loop webbing, a sliding latch plate, and a switchable ELR/ALR. The center rear position was equipped with a fixed-length lap belt and a locking retractor.

The left rear safety belt (**Figure 10**) was used to secure the detachable base of the rear-facing CSS. Minor deformation was present on the webbing that began 13 cm (5.1") above the anchor and extended 84 cm (33.1") up the webbing. A minor puncture



Figure 10. Rear left safety belt

was located 67 cm (26.4”) above the anchor on the outboard aspect of the shoulder belt webbing.

Child Safety Seat

Child Safety Seat Installation – Graco Snug Ride

The Graco Snug Ride was a rear-facing CSS with a detachable base (**Figure 11**). The Model Number was 7320UVB and the Date of Manufacture was 08/09/04 on the CSS and on the base. The CSS was designed for rear-facing use only, and for children weighing 9 kg (20 lb) or less and whose height was 66 cm (26”) or less. The 3-month-old male child was within the manufacturer’s height and weight range for this CSS.

The CSS was removed from the vehicle post-crash by a family member and was inspected at the family’s residence, independently from the vehicle inspection.

The CSS was purchased new four days prior to the crash. The family stated that the driver had purchased a different CSS but experienced difficulty with the harnesses remaining secure, and therefore, exchanged the previous CSS. The detachable base was configured with Lower Anchors and Tethers for Children (LATCH) hooks attached to a section of webbing. The CSS was configured with a 3-point harness system and a two-piece, locking harness retainer clip. The harness straps were routed through the bottom set of harness slots, and were properly secured. Each harness strap measured 37 cm (14.5”) in length between the harness slot and the buckle.



Figure 11. Graco Snug Ride rear-facing CSS

Family members reported that the driver received guidance from a Certified Child Safety Seat Technician who provided CSS information to local first responders. The CSS was installed rear-facing with the detachable base. The height/angle adjustment was full-down on the detachable base (configured with 3 positions) to achieve the recommended 45-degree angle for rear-facing CSS’s. The 1997 Honda Civic was not equipped with LATCH anchors; therefore, the CSS was installed with the rear left manual 3-point lap and shoulder belt. The safety belt was routed through the rear-facing slots of the detachable base. Family members reported that the switchable ELR/ALR retractor was not engaged in the ALR mode, but that the installation of the CSS was tight. The child was restrained tightly in the CSS. Family members reported that the harness straps were tight, at the level of the child’s shoulders, and nothing was placed between the child and the harness straps. The harness retainer clip was positioned at armpit level and remained engaged during the crash. The family reported that it was likely that the carrying handle on the CSS was in the upright position at the time of the crash, but it could not be confirmed.

Child Safety Seat Damage – Graco Snug Ride

The Graco Snug Ride CSS sustained minor damage as a result of the crash. The CSS remained secured in the detachable base. The detachable base exhibited abrasions on the right aspect of the rear-facing belt path from engagement with the vehicle’s safety belt. Stress marks in the plastic were present above the left aspect of the belt path (**Figure 12**). There was no damage to the bottom aspect of the base. Minor damage was noted on the CSS. Minor abrasions and scuff marks were present on both outboard side aspects of the CSS. A minor lateral crease was present on the left harness strap as a result of loading. The crease was located 13 cm (5.1”) below the left harness slot. The harness retainer clip did not exhibit any abrasions, and there was no damage present on the harness slots.



Figure 12. Left side (with respect to installation in vehicle) showing stress mark in base

Frontal Air Bag System – 1997 Honda Civic

The 1997 Honda Civic was equipped with frontal air bags for the driver and front right passenger positions that deployed as a result of the frontal impact with the tractor semi-trailer. The driver’s air bag deployed from the center of the steering wheel through H-configuration module cover flaps. The top cover flap measured 13 cm (5.1”) in width and 10 cm (3.9”) in height. The bottom cover flap measured 11 cm (4.3”) in width and 6 cm (2.4”) in height. The driver’s air bag measured 66 cm (26.0”) in diameter in its deflated state. The air bag was vented by two circular ports located at the 11 and 1 o’clock aspects on the rear of the air bag. Each vent port measured 4 cm (1.6”) in diameter. The air bag was tethered by two 8 cm (3.1”) wide straps located at the 12 and 6 o’clock positions on the air bag. A makeup transfer was present on the lower left quadrant of the air bag at the circumferential seam. The transfer began 6 cm (2.4”) left of the vertical centerline and extended 14 cm (5.5”) to the left along the seam.

The front right passenger’s air bag deployed from a top-mount module configured with symmetrical H-configuration cover flaps. Each flap measured 26 cm (10.3”) in width and 5 cm (2.0”) in height. The air bag measured 51 cm (20.0”) in width and 56 cm (22.0”) in height in its deflated state. The air bag was not tethered and was configured with two circular vent ports on the inboard and outboard side panels. Each vent port measured 6 cm (2.4”) in diameter and was located 23 cm (9.0”) aft of the forward seam.

Occupant Demographics

Driver

Age/Sex: 22-year-old/Female
Height: 163 cm (64")
Weight: 64 kg (140 lb)
Seat Track Position: Full rear
Safety Belt Use: Unrestrained
Usage Source: Vehicle inspection, ejection, interview with family members
Eyewear: Unknown
Type of Medical Treatment: Expired at the scene and was transported to hospital morgue

Driver Injuries

Injury	Injury Severity (AIS90/Update 98)	Injury Source
Blunt force head injury	Injured, unknown severity (115999.7,0)	Ground

Source: Surrogate interview – no autopsy performed.

Driver Kinematics

The 22-year-old female driver of the Honda Civic was presumed to have been seated in an upright posture. She was not restrained by the available lap and shoulder belt. At impact with the tractor semi-trailer, the frontal air bag system deployed and she initiated a forward and lateral trajectory to the right. Her knees struck the knee bolster and her face contacted the deployed driver's air bag, evidenced by a makeup transfer on the lower seam of the air bag. She was re-directed to the left as the vehicle initiated the rollover with the left side leading. She loaded the interior aspect of the driver's door, evidenced by the deformation to the armrest and interior door and continued her movement in the vehicle as it rolled. As the vehicle rolled onto its wheels, she was completely ejected through the driver's open window. The Civic rolled an additional two quarter-turns and came to rest on its roof. The ejected driver came to rest in the travel lanes. The driver sustained critical injuries and expired at the scene. According to the driver's father, the driver sustained severe head trauma, but specific injury information is not known as no official autopsy was performed.

Rear Left Child Passenger

Age/Sex: 3-month-old/Male
Height: 58 cm (23")
Weight: 6 kg (13.5 lb)
Seat Track Position: Fixed
Manual Restraint Use: Rear-facing CSS with a 3-point harness, installed with a manual 3-point lap and shoulder belt
Usage Source: Vehicle inspection, CSS inspection, interview with family
Eyewear: None
Type of Medical Treatment: Transported by ambulance to a local hospital for evaluation and released

Rear Left Child Passenger Injuries

Injury	Injury Severity (AIS90/Update 98)	Injury Source
Small abrasion of forehead	Minor (290202.1,7)	Flying glass

Source: Medical records.

Rear Left Child Passenger Kinematics

The 3-month-old male child was seated in a reclined posture in the rear-facing CSS. The family reported that the CSS was installed to achieve a 45-degree rear-facing angle. The 3-month-old was wearing a one-piece outfit, and was not wearing any bulky clothing. The CSS was installed with the vehicle's manual 3-point lap and shoulder belt in the rear left position of the Civic. The child was restrained by the 3-point harness of the CSS, which was adjusted tightly. At impact with the tractor semi-trailer, the child and CSS initiated a forward and lateral trajectory to the right. The rear right safety belt's ELR engaged, and the CSS base loaded the safety belt. The CSS loaded the detachable base, and remained fully engaged throughout the crash. The rear-facing child loaded the shell of the CSS, which distributed the frontal crash forces. As the vehicle rotated CW, the child rebounded and was redirected laterally to the right (with respect to the vehicle). The rebound was probably minimal, due to the snug harness strap adjustment. As the Civic initiated the rollover with the left side leading, the child was initially deflected to the right. He loaded the CSS harness straps, the left harness (with respect to the CSS) more severely than the right, evidenced by a minor crease on the left harness strap. He continued to load the harness straps as the Civic rolled over, and the proper adjustment of the harness straps prevented significant displacement of the child. The child came to rest upside down, suspended from the harness straps as the vehicle came to rest. A passerby removed the child from the CSS and the vehicle, and the child was transported by ambulance to a local hospital. The child sustained a minor abrasion to his forehead likely from flying glass from the disintegrated backlight during the roll sequence. The child was evaluated at a local hospital and then released.

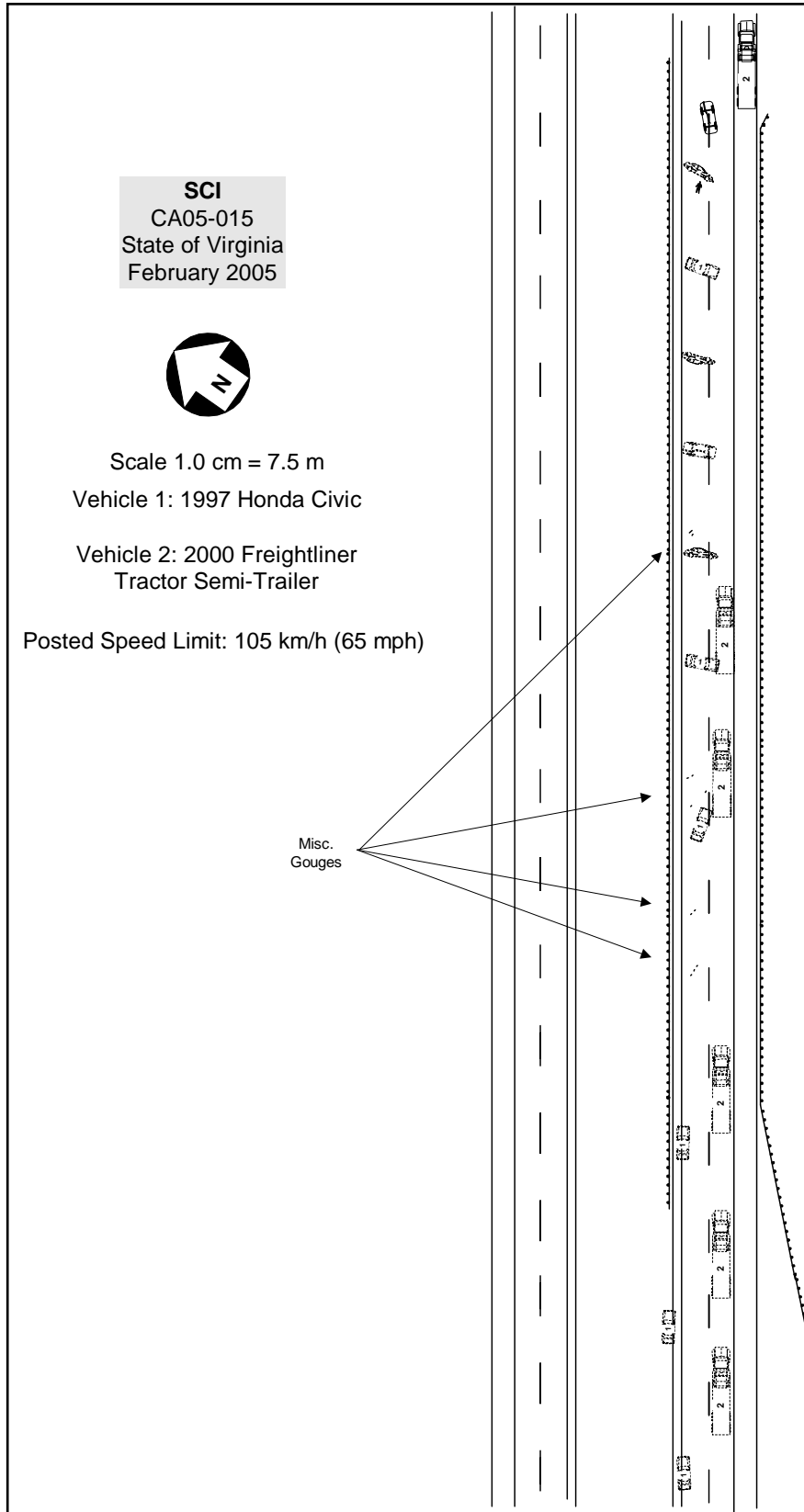


Figure 13. Scene Schematic