CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION

CASE NO: CA05-007

VEHICLE: 1993 OLDSMOBILE CUTLASS SUPREME

LOCATION: PENNSYLVANIA

CRASH DATE: JANUARY 2005

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.

TECHNICAL REPORT STANDARD TITLE PAGE

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CALSPAN ON-SITE CHILD SAFETY SEAT INVESTIGATION
CASE NO.: CA05-007
LOCATION: STATE OF PENNSYLVANIA
VEHICLE: 1993 OLDSMOBILE CUTLASS SUPREME
CRASH DATE: JANUARY 2005

BACKGROUND

This investigation focused on the crash dynamics and injury mechanisms of an unrestrained 30-year-old female driver of a 1993 Oldsmobile Cutlass Supreme **(Figure 1)**, and two restrained children in the rear seat. A 10-year-old male child was restrained by the vehicle's lap belt in the rear center position, and a 3-year-old female was restrained in a forward-facing convertible Child Safety Seat (CSS) in the vehicle's rear right position. The female driver of the Cutlass Supreme was operating the vehicle on a local roadway during nighttime hours. She lost control of the vehicle while negotiating a left curve on a hillcrest, and over-steered to the left. The vehicle initiated a counterclockwise (CCW) yaw, departed the left roadside, struck a roadside ditch and rolled over with the right side leading. The vehicle rolled six quarter-turns and came to rest on its roof in a roadside field. The unrestrained driver was ejected from the vehicle during the rollover and was trapped under the vehicle's roof at final rest. The driver sustained fatal injuries and did not receive medical treatment. The children remained restrained in the vehicle during the crash. The 10-year-old male self-extricated himself and rescue personnel found the 3-year-old female suspended upside down from the CSS. The children did not sustain injury, but were transported by ambulance to a local hospital for evaluation and released.

Figure 1. Damaged 1993 Cutlass Supreme

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 news article that reported the crash. Cooperation with the family was established and the Oldsmobile Cutlass Supreme was located at a local salvage yard. Permission to inspect the CSS and the vehicle was obtained, and an on-site investigation was assigned by NHTSA on January 28, 2005. The on-site investigation was completed on February 3, 2005, and a copy of the Police Accident Report (PAR) was obtained from the investigating agency.

SUMMARY

Vehicle Data - 1993 Oldsmobile Cutlass Supreme

The 1993 Oldsmobile Cutlass Supreme was identified by the Vehicle Identification Number (VIN): 1G3WH14M4PD (production sequence omitted). At the time of the vehicle inspection, the vehicle's odometer read 187,443 km (116,475 miles), and the family indicated that the driver purchased the vehicle used. The vehicle was a two-door coupe that was equipped with a 3.1 liter, V-6 engine, front wheel drive, automatic three-speed transmission, power brakes, power steering,

and a tilt steering wheel. The Cutlass Supreme was also configured with alloy wheels and the manufacturer's recommended tire pressure was unknown. The specific tire information at the time of the vehicle inspection was as follows:

Position	Tire Manufacturer	Size	Measured Pressure	Measured Tread
LF	Cooper Lifeliner	P215/60R16	0.0 kPa	3.2 mm (4/32")
LR	Douglas Touring	P225/60R16	68.9 kPa (10.0 PSI)	3.2 mm (4/32")
RF	Cooper Lifeliner	P215/60R16	0.0 kPa	2.4 mm (3/32")
RR	Douglas Touring	P225/60R16	0.0 kPa	3.2 mm (4/32")

The Cutlass Supreme was configured with front bucket seats with folding backs and adjustable head restraints. The driver's head restraint was adjusted 1.3 cm (0.5") above the seat back and the front right passenger's head restraint was in the full-down position at the time of the vehicle inspection. The driver's seat was adjusted 17.8 cm (7.0") rear of the full-forward track position and 2.5 cm (1.0") forward of the full-rear position. The front right seat was adjusted to the full forward position, although it was not known if it had been moved post-crash. Both front seat backs moved fore and aft freely and did not lock in the rear position. It was unknown if the vehicle was equipped with inertial locking seat backs at the time of this inspection. The second row was configured with a bench seat. The rear seat was not configured with head restraints.

Crash Site

This single-vehicle crash occurred during nighttime hours in the state of Pennsylvania in January 2005. At the time of the crash, police reported that no adverse weather conditions were present and that the asphalt roadway surface was dry. The crash occurred on a rural two-lane roadway where the roadway exited a southbound left curve with a negative grade from a hillcrest. The north/south roadway was configured with one travel lane in each direction, separated by a double-yellow centerline. The roadway at the crash site, was bordered by grassy fields and a shallow drainage ditch on the east roadside that measured 2.4 m (7.9') in width and 1.0 m (3.3") in depth. The roadway exhibited an approximate 3 percent positive and negative southbound grade on both sides of the hillcrest, respectively. The hillcrest was located at the apex of the left southbound curve 63.7 m (209.0'), north of the roadside departure. The curve passed through a cutout in a hill, which restricted southbound visibility. The earth walls on either side of the cutout measured 3.5 m (11.5') in height at the hillcrest and were located 1.0 m (3.2') from either road edge. At the crash site, the negative southbound grade approached a sag in the roadway, located 24.1 m (79.1') south of the point of roadside departure. A cable guardrail was present on the east roadside at the roadway sag. The guardrail exhibited damage from a previous unrelated crash. The posted speed limit for the north/south roadway was 64 km/h (40 mph). The scene schematic is included as **Figure 14** of this narrative report.

Crash Sequence

Pre-Crash

The 30-year-old female driver of the 1993 Oldsmobile Cutlass Supreme was operating the vehicle in a southbound direction on the two-lane rural roadway during nighttime hours. The police report indicated that the driver was operating the vehicle under the influence of alcohol, and family members suggested that the driver might have been unfamiliar with the roadway. The vehicle's pre-crash speed was unknown. Due to the driver's potential unfamiliarity with the roadway, the unlighted nature of the roadway, and the roadway character, she may not have anticipated the left curve and hillcrest **(Figure 2)**. As she crested the hill **(Figure 3)**, it appeared that she over-steered to the left as she negotiated the left curve. As the Cutlass Supreme exited the curve onto the negative grade, the vehicle initiated a CCW yaw on the roadway and crossed the centerline **(Figure 4)**. The right rear wheel gouged the asphalt road surface, evidenced by a 0.5 m (1.6') gouge and significant scuff marks on the right rear alloy wheel. The vehicle continued to rotate and departed the left roadside into the roadside ditch with the right front aspect leading, evidenced by significant dirt and debris on the right front wheel.

Figure 2. Southbound approach to the hillcrest and left curve

Figure 3. Southbound approach at hillcrest and left curve

Figure 4. Southbound approach after exiting the left curve

Crash

The Cutlass Supreme rotated into the ditch, and the right front fender struck the ditch bank, which tripped a rollover with the right side leading. The vehicle rolled six quarter-turns onto the roadside field and came to rest on its roof approximately 9 m (30') east of the roadside. The unrestrained driver was ejected out of the right front window opening during the rollover, and the vehicle followed her ejection trajectory. The vehicle rolled onto the ejected driver and came to final rest upside down facing east. The driver's lower torso and extremities were trapped under the vehicle at final rest.

Post-Crash

The driver was found trapped under the vehicle. The 10-year-old male child unbuckled the safety belt and exited the overturned vehicle under his own power. Rescue personnel removed the 3-year-old female from the child safety seat. Neither child sustained injury, but both were transported by ambulance to a local hospital for observation and released. The 30-year-old female driver expired at the scene after the vehicle was elevated to free her.

Vehicle Damage

Exterior Damage – 1993 Oldsmobile Cutlass Supreme

The 1993 Oldsmobile Cutlass Supreme sustained minor damage on the right rear alloy wheel as a result of the pre-crash CCW yaw. The outboard aspect of the alloy wheel sustained scuff marks and minor gouging from engagement with the asphalt road surface.

The Cutlass Supreme sustained moderate damage as a result of the rollover **(Figure 5)**. The right front fender and right door sustained minor deformation as a result of the ditch bank rollover initiation. The direct contact damage began at the leading edge of the right fender and extended 167.6 cm (66.0”) rearward to 43.2 cm (17.0”) rear of the leading edge of the right front door. The deformation began at the beltline and extended 36.8 cm (14.5”) downward. The maximum lateral deformation measured 2.2 cm (0.9”) and was located 12.7 cm (5.0”) below the beltline and 36.8 cm (14.5”) rear of the leading edge of the right door. The right front wheel exhibited large amounts of dirt and grass from engagement with the ditch and ditch bank. In addition, dirt had accumulated between the top aspect of the right fender and the right side aspect of the hood from contact with the ditch bank during the first quarter turn. The right side mirror was fractured and separated. The right front door window was disintegrated. Diagonally oriented vertical abrasions were present on the face of the right fender and on the forward aspect of the right door, above the plastic body cladding. The lower cladding aft of the right side door was partially separated forward of the right rear wheel. A minor dent was present 55.0 cm (21.7”) rear of the right rear axle on the right rear quarter panel.

Figure 5. Right side damage to the Cutlass Supreme

The roof sustained moderate damage as a result of the rollover. Vertical deformation was present primarily over the left front aspect and minor scuff marks were visible across the entire roof surface. The windshield header and left roof side rail were both crushed vertically due to the rollover **(Figure 6)**. The maximum roof crush was located at the top of the left A-pillar and measured 12.4 cm (4.9”). Six vertical crush measurements were documented along the windshield header. The distance across the damaged windshield header measured 118.1 cm (46.5”) and the crush measurements were as follows: C1 = 12.4 cm (4.9”), C2 = 6.7 cm (2.6”), C3 = 5.7 cm (2.3”), C4 = 3.8 cm (1.5”), C5 = 2.5 cm (1.0”), C6 = 0.0 cm. Six additional crush measurements were documented along the left roof side rail. The distance across the damaged left roof side rail measured 116.9 cm (46.0”) and the vertical crush measurements were as

Figure 6. Windshield header showing vertical deformation

follows: C1 = 0.0 cm, C2 = 0.0 cm, C3 = 1.3 cm (0.5”), C4 = 5.1 cm (2.0”), C5 = 11.4 cm (4.5”), C6 = 12.4 cm (4.9”). The windshield exhibited two holed areas as a result of the crash. A large hole on the left aspect began 10.2 cm (4.0”) left of the centerline and 10.2 cm (4.0”) below the windshield header. The hole radiated the entire height of the windshield and laterally to the left A-pillar. The maximum width of the hole measured 55.9 cm (22.0”) over the steering wheel. A second hole was located on the right side of the windshield that began 45.1 cm (17.8”) right of center and extended 38.1 cm (15.0”) diagonally downward to the right A-pillar.

The left side plane sustained minor damage **(Figure 7)**. The left front fender was deformed along its entire length. The maximum lateral deformation was located 34.9 cm (13.8”) forward of the left front axle and measured 5.1 cm (2.0”). The left side door was slightly displaced, and the left front window was displaced in the window frame, although it remained intact. The top forward aspect of the left front door sustained minor outward displacement, possibly from rescue personnel forcing the door open.

Figure 7. Left side damage

The Collision Deformation Classification (CDC) for the rollover event was 00-TYDO-3.

Interior Damage – 1993 Oldsmobile Cutlass Supreme

The Oldsmobile Cutlass Supreme sustained moderate interior damage as a result of passenger compartment intrusion and occupant contact. There was no evidence of occupant contact on the instrument panel or steering wheel rim. The top aspect of the center console was displaced 1.3 cm (0.5”) to the right as a result of loading from the driver as she initiated her lateral trajectory to the right **(Figure 8)**. Both sun visors were displaced from the plastic clasps and the rear view mirror was displaced as a result of the windshield fracture.

Figure 8. Displaced center console

The rear right seat back face exhibited a linear abrasion from probable contact with the rear aspect of the CSS. The abrasion began 13.3 cm (5.3”) right of the centerline and extended 9.5 cm (3.8”) to the right and measured 1.9 cm (0.8”) in height.

Specific intrusions were documented as follows:

Position	Intruded Component	Magnitude of Intrusion	Direction
Front Left	Left A-pillar	7.6 cm (3.0”)	Vertical
Front Left	Left A-pillar	3.8 cm (1.5”)	Lateral
Front Left	Left roof side rail	11.4 cm (4.5”)	Vertical
Front Left	Left roof side rail	7.6 cm (3.0”)	Lateral
Front Left	Roof	8.9 cm (3.5”)	Vertical
Front Left	Windshield header	8.9 cm (3.5”)	Vertical
Front Right	Roof	3.2 cm (1.3”)	Vertical
Front Right	Windshield header	2.5 cm (1.0”)	Vertical

Safety Systems

Automatic Safety Belts – 1993 Oldsmobile Cutlass Supreme

The Cutlass Supreme was equipped with door-mounted 3-point automatic safety belts for the driver and front right passenger positions. Each safety belt was configured with Emergency Locking Retractors (ELR) and a sewn-on latch plate. The driver’s safety belt **(Figure 9)** exhibited 1.5 twists in the webbing between the sewn-on latch plate and the door-mounted D-ring. The driver’s safety belt was not used in this crash. Due to the “used” nature of the vehicle, faint historical use abrasions on the latch plate could not be attributed to the driver in the crash. A crease in the webbing was present at the D-ring in the stowed position, which suggested lack of historical use.

Figure 9. Driver's door-mounted automatic safety belt

The front right automatic lap and shoulder belt was found in the stowed position at the time of the vehicle inspection. Minor creases were present on the shoulder belt webbing above the latch plate, but were not attributed to this crash. A minor vertical fracture line was present on the forward outboard aspect of the D-ring above the webbing slot.

Manual Safety Belts – 1993 Oldsmobile Cutlass Supreme

The Cutlass Supreme was configured with manual 3-point lap and shoulder belts for the rear outboard seat positions. The outboard safety belts were configured with ELR’s and locking latch plates. The buckles extended 16.5 cm (6.5”) from the seat bight.

The rear right safety belt **(Figure 10)** was used to install the forward-facing convertible CSS in the vehicle. A lateral crease was present on the safety belt webbing from the latch plate loading, and was located 51.4 cm (20.3”) above the lower anchor. Faint plastic transfers were present on the bottom aspect of the webbing and were located 17.1 cm (6.8”) above the lower anchor and extended 4.8 cm (1.9”) along the webbing. Based on the post-crash installation of the CSS, the plastic transfers appeared to have been a result of engagement of the safety belt webbing with the outboard aspect of the CSS belt path.

Figure 10. Rear right safety belt

The rear center lap belt **(Figure 11)** was configured with a fixed-length section of webbing and a locking latch plate. At the time of the inspection, the plastic latch plate cover was separated from the latch plate. It was unknown if the latch plate cover was present at the time of the crash, and it should be noted that the missing cover did not compromise the integrity of the locking latch plate. At the time of the vehicle inspection, the lap belt webbing exhibited a lateral crease from latch plate loading located 44.5 cm (17.5”) above the anchor. The total fixed-length lap belt measured 100.3 cm (39.5”).

Figure 11. View of rear center lap belt

Child Safety Seat

Child Safety Seat Installation – Century Convertible CSS

A convertible Century CSS was positioned in the rear right seat and secured by the manual 3-point lap and shoulder belt with the locking latch plate **(Figure 12)**. The CSS appeared to be consistent with a Century STE model, but it could not be confirmed. The CSS was configured with a five-point harness system. Most of the labeling on the CSS had been removed, and the model number was unknown. The date of manufacture was August 2001. A warning on the plastic shell stated: “Do not use this car seat after December 2007.” A family member stated that the CSS was purchased new approximately three years ago and was used habitually to restrain the 3-year-old female.

Figure 12. View of CSS, installed post-crash

A family member described the installation as “tight”, but could not offer additional information as to how the CSS was specifically installed. The family member stated that post-crash, the CSS remained secure on the vehicle’s bench seat with the lap belt.

Based on an exemplar CSS in a rear-facing orientation, the CSS was rated for children who weighed less than 9 kg (20 lb) and measured less than 71 cm (28”) in height. In a forward-facing orientation, the CSS was rated for children who weighed 9 – 18 kg (20 – 40 lb) and whose height was 69 – 102 cm (27 – 40”). Based on the 3-year-old’s height and weight of 11 kg (25 lb) and 76 cm (30”), respectively, she was within the manufacturer’s recommended height and weight guidelines.

At the time of the CSS inspection, the kickstand was engaged for forward facing use. The family indicated that the kickstand was down at the time of the crash. The shoulder harnesses were routed through the second set of rear-facing harness slots, versus the top set of forward-facing slots. All of the harnesses were folded in half. The length of the left and right harness straps between the slots and the buckle measured 30.5 cm (12.0”) and 27.9 cm (11.0”), respectively. The adjustment tab on the front of the CSS was extended 22.9 cm (9.0”). The harness retainer clip was present on the right harness straps 2.5 cm (1.0”) above the buckle, however, it was unknown if it the left harness strap was engaged with the locking tab on the retainer clip at the time of the crash. At the time of the CSS inspection, the left harness was not engaged with the retainer clip and there was no deformation or historical use marks consistent with regular use. The harness system is shown in **Figure 13**. The CSS was equipped with a tether strap. The tether strap was found in a stowed position on the rear aspect of the CSS, and was not used to install the CSS in the vehicle.

Figure 13. View of harness system

Child Safety Seat Damage – Century Convertible CSS

The Century convertible CSS sustained minor damage as a result of the crash. The right second harness slot plastic cover disengaged from the front aspect of the CSS fabric as a result of loading to the harness system by the 3-year-old. The right harness was gathered and jammed in the right latch plate slot as a probable result of occupant loading, as well. The left outboard aspect of the forward-facing belt path sustained abrasions and minor gouges from the engagement against the locking latch plate and buckle, due to the height of the buckle webbing. The right outboard aspect of the forward-facing belt path sustained minor abrasions from loading against the lap belt.

Occupant Demographics –1993 Oldsmobile Cutlass Supreme

Driver

Age/Sex:	30-year-old/Female
Height:	173 cm (68”)
Weight:	63 kg (138 lb)
Seat Track Position:	17.8 cm (7.0”) rear of full-forward and 2.5 cm (1.0”) forward of full-rear
Safety Belt Use:	Unrestrained
Usage Source:	Vehicle inspection, ejection, injury data, interview with family members
Eyewear:	Unknown
Type of Medical Treatment:	Expired at the scene and did not receive medical treatment

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Blunt traumatic chest injury, NFS	Unknown (415999.7,0)	Exterior roof side rail
Blunt traumatic abdominal injury, NFS	Unknown (515999.7,0)	Exterior roof side rail
Traumatic lower extremity injury, NFS	Unknown (815999.7,0)	Exterior roof side rail
Fractured right arm, NFS	Moderate (751800.2,1)	Ground
Fractured left arm, NFS	Moderate (751800.2,2)	Ground
Nose fracture, NFS	Minor (251000.1,4)	Ground
Right facial abrasions, NFS	Minor (290202.1,1)	Ground

Source: Discussion with Coroner – No Autopsy Performed.

Driver Kinematics

The 30-year-old female driver was unrestrained and was presumed to have been seated in an upright posture. She was displaced to the left as the vehicle began to yaw in a CCW direction across the roadway. She was deflected to the right as the Cutlass Supreme entered the ditch, and loaded the top aspect of the center console, which was displaced to the right. She continued to be deflected inside the vehicle during the rollover, and traveled over the center console into the front right position. It was not known if she was partially ejected through the right front window. As the vehicle entered its fifth quarter turn onto the right side, the driver was completely ejected through the right front window. The Cutlass Supreme continued to roll onto its roof, and pinned the driver under the right roof side rail. The driver was positioned longitudinally with respect to the vehicle at rest, and was trapped in a supine position under the right roof side rail. She sustained blunt traumatic abdominal injuries, a traumatic lower extremity injury, and blunt traumatic chest injuries as a result of the roof side rail position on top her of her at final rest. She also sustained right and left arm fractures, right facial abrasions, and a nose fracture, most likely from contact with the ground as she was ejected from the vehicle. She expired at the scene shortly after she was extricated from under the vehicle. She did not receive medical treatment

and was not transported to any medical facility. The coroner advised that an autopsy was not performed.

Rear Center Child Passenger

Age/Sex:	10-year-old/Male
Height:	122 cm (48”)
Weight:	27 kg (60 lb)
Seat Track Position:	Fixed
Manual Restraint Use:	Lap belt
Usage Source:	Vehicle inspection, interview with family members
Eyewear:	None
Type of Medical Treatment:	Did not sustain injury, was transported by ambulance to a local hospital for evaluation and released.

Rear Center Child Passenger Kinematics

The 10-year-old rear center male child passenger was restrained by the two-point lap belt. His upper torso was displaced slightly to the left as the vehicle began to yaw in a CCW direction, and was redirected to the right over the lap belt as the Cutlass Supreme entered the ditch. Although the use of the lap belt prevented the ejection and significant displacement of the child, his upper torso most likely jackknifed over the lap belt to a certain extent during the rollover sequence. He came to rest upside down, suspended by the lap belt as the vehicle came to rest. He released the buckle and exited the overturned vehicle under his own power. He did not sustain injury and was transported by ambulance to a local hospital for observation and released.

Rear Right Child Passenger

Age/Sex:	3-year-old/Female
Height:	76 cm (30”)
Weight:	11 kg (25 lb)
Seat Track Position:	Fixed
Manual Restraint Use:	Forward-facing CSS with a 5-point harness, installed with a manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection, CSS inspection, interview with family member
Eyewear:	None
Type of Medical Treatment:	Did not sustain injury, was transported by ambulance to a local hospital for evaluation and released.

Rear Right Child Passenger Kinematics

The 3-year-old rear right female was restrained in a forward-facing convertible CSS that was installed in the rear right position of the Cutlass Supreme. A family member reported that at the time of the crash, she was wearing a bulky winter coat and jeans. The child initiated a lateral trajectory to the left in the CSS as the vehicle began to yaw in a CCW direction, and was redirected to the right as the Cutlass Supreme impacted the ditch. The tight adjustment of the 5-point harness system prevented significant movement of the child in the CSS. As the vehicle began to rollover, the CSS loaded the lap and shoulder belt, evidenced by minor abrasions on the

plastic rear-facing belt path. The female child loaded the harness straps, which mitigated significant displacement throughout the rollover sequence, and prevented ejection from the CSS and from the vehicle. The 3-year-old child was suspended upside down from the CSS as the vehicle came to rest on the roadside. The child did not sustain injury, and rescue personnel removed the child from the CSS. She was transported by ambulance to a local hospital for observation and released.

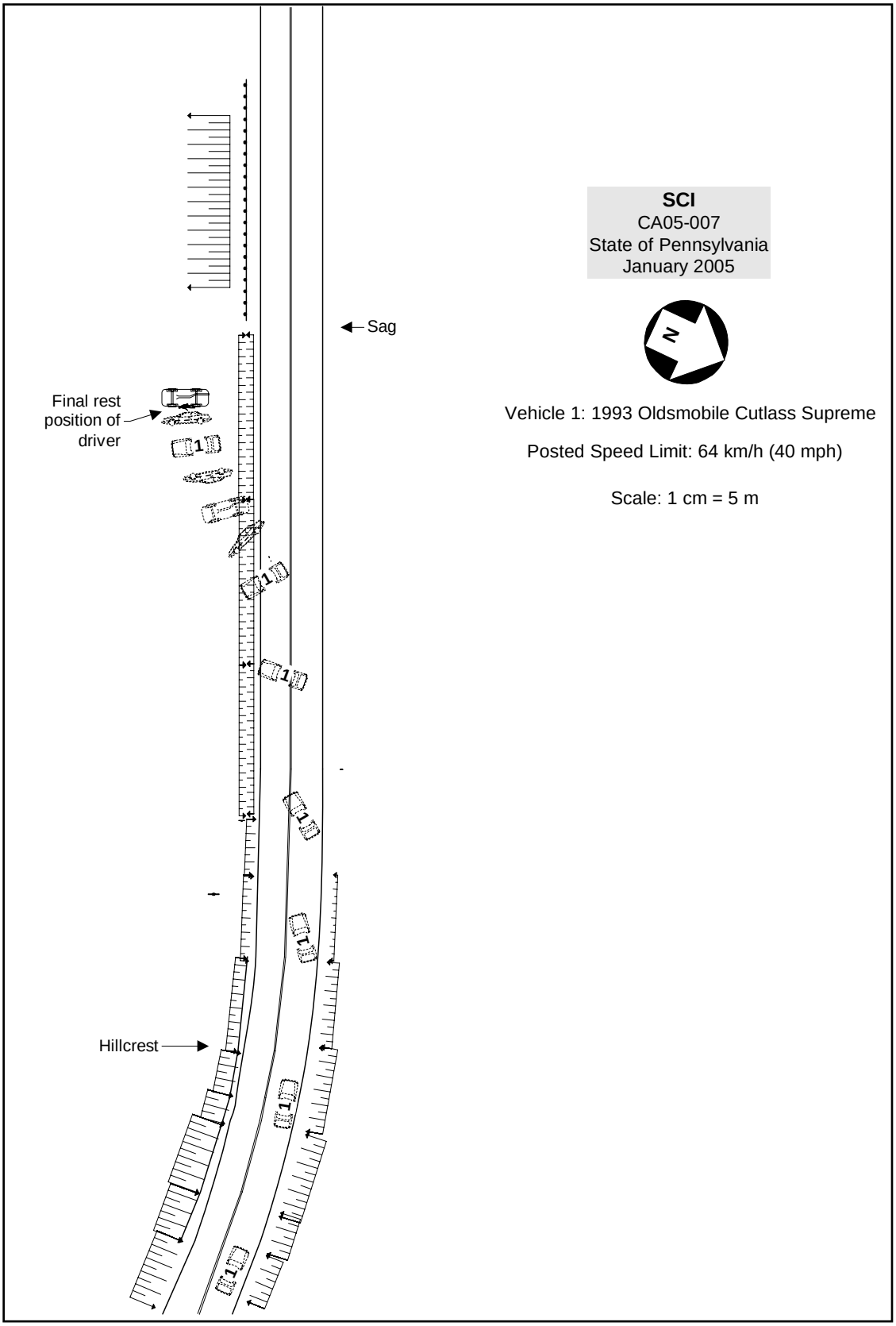

Figure 14. Scene schematic