

CRASH DATA RESEARCH CENTER
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ON-SITE CHILD SAFETY SEAT INVESTIGATION
CALSPAN CASE NO: CA05-013

VEHICLE – 2000 FORD EXPEDITION
COSCO EDDIE BAUER CONVERTIBLE SEAT

LOCATION – MARYLAND
CRASH DATE – JANUARY 2005

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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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<p>16. Abstract</p> <p>This on-site investigation focused on the performance of a Cosco Eddie Bauer Child Safety Seat (CSS) installed in a forward facing mode in the center rear position of a 2000 Ford Expedition. The Ford Expedition was involved in an intersection crash with a 1990 Chrysler New Yorker. The Cosco CSS was occupied by a 4 year old male at the time of the crash. The 36 year old female driver of the Ford failed to yield the right-of-way at the intersection resulting in the impact. The restrained driver of the Ford sustained police reported possible injuries and the child passenger sustained reported non-incapacitating injuries. Both occupants were transported to a local hospital. The 23 year old unrestrained male driver of the Chrysler sustained a police reported disabling injury and was transported to a local hospital.</p> <p>This crash was identified from a selection of police reported crashes obtained by PSU 9 of the National Automotive Sampling System and subsequently forwarded to the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA). In turn, the Crash Investigation Division forwarded the police report to the Special Crash Investigation team at Calspan for follow-up investigation and case assignment. Cooperation was obtained by the SCI team with the salvage yard holding the vehicles and an inspection was scheduled for February 14, 2005. The CSS was still located in the Ford and was available for inspection.</p>			
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CALSPAN CASE NO: CA05-013
VEHICLE: 2000 FORD EXPEDITION
COSCO EDDIE BAUER CHILD SAFETY SEAT

LOCATION: MARYLAND
CRASH DATE: JANUARY, 2005

BACKGROUND

This on-site investigation focused on the performance of a Cosco Eddie Bauer Child Safety Seat (CSS) installed in a forward facing mode in the center rear position of a 2000 Ford Expedition, **Figure 1**. The Ford Expedition was involved in an intersection crash with a 1990 Chrysler New Yorker. The Cosco CSS was occupied by a 4 year old male at the time of the crash. The 36 year old female driver of the Ford failed to yield the right-of-way at the intersection resulting in the impact. The restrained driver of the Ford sustained police reported possible injuries and the child passenger sustained reported non-incapacitating injuries. Both occupants were transported to a local hospital. The 23 year old unrestrained male driver of the Chrysler sustained a police reported disabling injury and was transported to a local hospital.



Figure 1: Front view of the Cosco child safety seat.

This crash was identified from a selection of police reported crashes obtained by PSU 9 of the National Automotive Sampling System and subsequently forwarded to the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA). In turn, the Crash Investigation Division forwarded the police report to the Special Crash Investigation team at Calspan for follow-up investigation and case assignment. Cooperation was obtained by the SCI team with the salvage yard holding the vehicles and an inspection was scheduled for February 14, 2005. The CSS was still located in the Ford and was available for inspection.

SUMMARY

Crash Site

This two-vehicle crash occurred during the daylight hours in January 2005 at a four-leg intersection in a residential setting. The intersection was laid out north/south and east/west in direction. Each road was configured with two travel lanes separated by double yellow centerlines. The width of the north/south road measured 11.5 m (37.7 ft). The width of the east/west road measured 9.1 m (29.9 ft). The northeast and northwest quadrants of the intersection were bordered by 15 cm (6 in) barrier curbs. A utility pole was located outboard of the northeast intersection quadrant and was involved in the crash. The traffic flow through the intersection was controlled by stop signs for north/south traffic. There were no obstructions in the respective intersection quadrants that would have impaired the visibility of the respective

drivers. The speed limit in the area of the crash was 48 km/h (30 mph). **Figures 2 and 3** are northbound and eastbound trajectory views approaching the intersection, respectively.



Figure 2: Northbound trajectory view.



Figure 3: Eastbound trajectory view.

Vehicle Data

2000 Ford Expedition

The 2000 Ford Expedition was identified by the Vehicle Identification Number (VIN): 1FMRU1569YL (production sequence deleted). The 4x2, four-door sport utility vehicle was configured for eight passenger seating and had a Gross Vehicle Weight Rating of 3,039 kg (6,700 lb). The power train consisted of a 4.6 liter, V6 engine linked to a four-speed automatic transmission with overdrive. The foot controls were adjustable. The service brakes were power-assisted four-wheel disc with a four-wheel antilock system. The manual restraint system consisted of 3-point lap and shoulder restraints in the six outboard seat positions. The center positions in rows 2 and 3 were lap belt equipped. The vehicle was equipped with redesigned air bags for the driver and front right passenger. The vehicle’s date of manufacture was May 2000. The electronic odometer could not be read due to a lack of battery power. The Ford was equipped with Goodyear Wrangler RT/4S P255/70R16 tires at all four positions. The specific tire data measured during the SCI inspection was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	83.0 kPa (12.0 PSI)	8.7 mm (11/32)	No	None
LR	193.0 kPa (28.0 PSI)	8.7 mm (11/32)	No	None
RF	193.0 kPa (27.5 PSI)	8.7 mm (11/32)	No	None
RR	193.0 kPa (28.0 PSI)	8.7 mm (11/32)	No	None

1990 Chrysler New Yorker

The 1990 Chrysler New Yorker was identified by the Vehicle Identification Number (VIN): 1C3XC66R7LD (production sequence deleted). The four-door, front wheel drive sedan was equipped with a 3.3 liter, V6 engine linked to a four-speed automatic transmission. The service brakes were a front disc/rear drum system with four-wheel ABS. The manual restraint system consisted of 3-point lap and shoulder belts in the four outboard positions and center lap belts. The vehicle was also equipped with a driver (only) air bag that had deployed as a result of the crash. The vehicle's date of manufacture was June 1990.

CRASH SEQUENCE

Pre-Crash

The 2000 Ford Expedition was occupied by a 36 year old restrained female driver and by a 4 year old male restrained in a child safety seat installed forward facing in the vehicle's center rear position. The Ford was facing north, stopped at the intersection intending to turn left. Coincident to this, the 1990 Chrysler New Yorker was eastbound driven by a 23 year old unrestrained male. The crash occurred when the Ford failed to yield the right-of-way and accelerated forward directly into the path of the Chrysler. There was no evidence at the crash site to support pre-crash avoidance maneuvers.

Crash

The front right corner of the Chrysler struck the front left corner of the Ford in an L-configuration impact. The directions of impact force were in the 1 and 10 o'clock for the Chrysler and Ford, respectively. The force of the impact caused the driver (only) air bag of the Chrysler to deploy. The frontal air bags of the Ford did not deploy. The lateral momentum of the Chrysler, relative to the Ford, redirected the Expedition to the northeast and caused it to rotate rapidly clockwise during the engagement. The Chrysler was deflected to its left and began to rotate counterclockwise. During the initial stage of the rotation, the forward left right side of the Chrysler contacted the forward left side of the Ford in sustained contact. The delta V's of the frontal impact calculated by the Damage Algorithm of the WINSMASH model were 8.7 km/h (5.4 mph) and 12.4 km/h (7.7 mph) for the Ford and Chrysler, respectively. The calculated values underestimated the severity of the crash due to limitations of the model analyzing a non-central (right angle) crash configuration.

After separation from the initial impact, the vehicles continued to rotate in their respective directions. As the vehicles translated toward the northeast, the left rear quarterpanel of the Ford impacted the right rear bumper corner of the Chrysler in a sideslap configuration. The force direction of the impact was in the 9 and 3 o'clock sectors for the Ford and Chrysler, respectively. This impact stopped the Chrysler's counterclockwise rotation and induced a clockwise rotation to the vehicle. The Ford decelerated from this impact and separated from the Chrysler coming to rest facing southward in the westbound lane of the intersecting road approximately 13.6 m (44.4 ft) from the initial impact.

The Chrysler separated from the Ford with a clockwise rotation and northeast trajectory. The Chrysler's left side tire impacted the barrier curb in the northeast intersection quadrant, identified by two tire scuffs observed during the SCI scene inspection. The left side tires of the Chrysler

were deflated. **Figure 4** is a view of the northeast quadrant of the intersection. The vehicle mounted the curb and the left rear tire/axle and quarterpanel area of the Chrysler impacted a 23 cm (9 in) diameter utility pole located 1.4 m (4.6 ft) north of the curb edge. This impact, rearward of the vehicle center of gravity, redirected the vehicle's momentum into a clockwise rotation. The contact to the utility pole was evidenced by an 18 cm (7 in) scuff from the Chrysler's Landau roof (upper C-pillar area) that was located 110.5 cm (43.5 in) above the ground. The Chrysler then came to rest facing northeast in-close proximity to the pole (approximately 18.6 m (61.0 ft) from the initial impact). A schematic of the crash sequence is attached to the end of this report as **Figure 15**.



Figure 4: View of the northeast intersection quadrant.

Post-Crash

The police and ambulance personnel responded to the scene. The driver and child passenger of the Ford exited the vehicle under their own power and were both transported to a local hospital for evaluation. The unrestrained driver of the Chrysler was transported to a local hospital with a police reported disabling injury. Both vehicles sustained disabling damage and were towed from the scene.

2000 FORD EXPEDITION

Exterior Damage

The front and left side planes of the Ford Expedition sustained contact damages consistent with the initial frontal impact and secondary side slap crash sequence. The left aspect of the Ford's front plane sustained 29.2 cm (11.5 in) of direct contact damage that began 56.9 cm (22.0 in) left of center and extended to the left corner, **Figure 5**. The combined width of the direct and induced damage extended across the 142 cm (56 in) end width of the vehicle. The left end of the front bumper deformed rearward and inboard as a result of the 2 o'clock direction of the impact force. The measured residual crush profile at the bumper level was as follows: C1 = 18.0 cm (7.1 in), C2 = 2.0 cm (0.8 in), C3 = 0, C4 = 2.0 cm (0.8 in), C5 = 3.0 cm (1.2 in), C6 = 0. The direct contact from the frontal engagement wrapped around the left corner due to the induced clockwise rotation of the Ford. The direct contact on the left front fender ended 6.4 cm (2.5 in) rearward of the left front axle. The fender was displaced rearward and buckled due to the contact. The left



Figure 5: Front view of the Ford.

wheelbase was reduced 2.8 cm (1.1 in). The right wheelbase was unchanged. The right front door was jammed shut due to the body deformation. Both left doors and right rear door were operational. The Collision Deformation Classification (CDC) was 10-FLEE-3. The delta V calculated by the damage algorithm of the WINSMASH program was 8.7 km/h (5.4 mph). The longitudinal and lateral components were -4.4 km/h (-2.7 mph) and 7.6 km/h (4.7 mph), respectively.

The left quarterpanel of the Ford sustained moderate damage as a result of the sideslap, **Figure 6**. The direct damage measured 71.1 cm (28.0 in), began 37.5 cm (14.75 in) forward of the left rear axle and extended rearward. The maximum crush measured 21.0 cm (8.3 in) and was attributed to contact from the right end of the Chrysler's rear bumper corner. The maximum crush was located 25.4 cm (10.0 in) aft of the left rear axle and 19.1 cm (7.5 in) above the wheel opening. Within the region of maximum crush, two 8.9 cm (3.5 in) long horizontal abrasions were observed. The abrasions were separated 6.4 cm (2.5 in) vertically. This contact pattern was directly attributed to contact with the right corner of the Chrysler's rear bumper. The combined width of the direct and induced damage measured 218.4 cm (86.0 in), began at the left B-pillar and extended to the left rear corner. The measured residual crush profile was as follows: C1 = 0, C2 = 6.0 cm (2.4 in), C3 = 24.0 cm (9.4 in), C4 = 4.0 cm (1.6 in), C5 = 1.0 cm (0.4 in), C6 = 0. The impact caused the left rear window glazing to disintegrate. The CDC of this impact was 09-LZAW-3.



Figure 6: View of the left rear quarterpanel.

1990 CHRYSLER NEW YORKER

Exterior Damage

The front, right, and left side planes of the Chrysler sustained three distinct regions of damage directly related to the vehicle's multiple crash sequence. The right aspect of the Chrysler's frontal plane sustained 30 cm (12 in) of direct contact damage that began 45.0 cm (17.75 in) right of center and extended to the right corner. Refer to **Figure 7**. The direct contact then wrapped around the right front corner due to the vehicles' rotation and ended 5.1 cm (2.0 in) rearward of the right front axle. The residual crush profile measured along the bumper was as follows: C1 = 0, C2 = 0, C3 = 2.0 cm (0.8 in), C4 = 5.0 cm (2.0 in), C5 = 8.0 cm (3.1 in), C6 = 12.0 cm (4.7 in). The right wheelbase was reduced 12.4 cm (4.9 in). The windshield and side



Figure 7: Front right oblique view of the Chrysler.

window glazings remained intact and all the doors were operational post-crash. The CDC of the frontal impact was 01-FREE-3. The delta V calculated by the damage algorithm of the WINSMASH program was 12.4 km/h (7.7 mph). The longitudinal and lateral components were -10.8 km/h (-6.7 mph) and -6.2 km/h (-3.9 mph), respectively.

The right corner of the Chrysler's rear bumper impacted the left quarterpanel of the Ford during the sideslap. Inspection of the rear structures of the Chrysler revealed that the entire aft aspect, rearward of the C-pillars deformed to the left as a unit. Note, the exposure of the right rear tire from the wheel opening due to the left deformation in **Figure 8**, as compared to the enclosure of the left rear tire within the wheel opening of **Figure 9**. The left shift of the rear structures was an estimated 15 cm (6 in), measured at the rear bumper corner. The CDC of the contact was 83-RBEW-2. Note the 3 o'clock principle direction of the impact force was incremented by 80 to denote the left end shift.

As the Chrysler slid to final rest, the left tires struck and mounted the curb at the northeast intersection quadrant. These impacts caused deformation to both wheel rims and both tires to debeat. The CDC's were 09-LFWN-1 and 09-LBWN-1. The left quarterpanel of the Chrysler then struck the utility pole. The direct contact measured 66.0 cm (26.0 in) and was centered on the left rear axle. The maximum residual crush measured 8.4 cm (3.3 in). The Landau roof at the left C-pillar was abraded and torn. This damage was consistent with the scuff observed on the pole during the scene inspection. The CDC of this contact was 09-LZAW-2. Refer to **Figure 9**.



Figure 8: Right rear view of the Chrysler.



Figure 9: Left side view of the Chrysler.

2000 FORD EXPEDITION

Interior Damage

The interior damage to the Ford consisted of probable minor occupant interior contacts. There was no intrusion into the occupant compartment related to the exterior force of the crash. The severity of the crash was below the threshold required for frontal air bag deployment.

The driver seat was adjusted to the full rear track position at the time of the inspection. The seat back angle measured 18 degrees aft of vertical. There was no damage or deformation to the two-spoke steering wheel rim. There was no displacement of the steering column shear capsules.

The only identified interior contact was a probable left lower extremity contact to the knee bolster. The contact was identified by the displacement of the trim panel concealing the fuse panel at the outboard aspect of the bolster, **Figure 10**. The trim panel was not in the vehicle.



Figure 10: Ford interior view.

The CSS was buckled in the center of the Row 2 at the time of the inspection. Refer to the Child Safety Seat section of the report below for details regarding the installation. The second row seat consisted of a 60/40 split bench seat. The seat back angle measured at the center position was 25 degrees aft of vertical and matched the angle of the CSS.

Manual Restraint System

The manual restraint system in the Ford consisted of 3-point lap and shoulder belts in the six outboard positions. The driver restraint was configured with continuous loop webbing, sliding latch plate and an Emergency Locking Retractor (ELR). The five outboard passenger restraints were configured with continuous loop webbing sliding latch plates and switchable ELR/Automatic Locking Retractors (ALR). The center position of Row 2 was equipped with a lap belt. This restraint was configured with a sewn-on latch plate attached to webbing that spooled from an ALR. The center position of Row 3 was configured with a lap belt that consisted of fixed-length webbing and a locking latch plate.

The driver's restraint was stowed within the retractor at inspection. The adjustable D-ring was in the full-up position. There was no crash related evidence on the D-ring surface. Examination of the driver's restraint revealed evidence of historical use consistent with the age of the vehicle. There was no crash related evidence identified on the restraint. However, given the magnitude severity of the frontal deceleration, crash related usage evidence would not be expected.



Figure 11: Right view of the CSS in Row 2.

The CSS was restrained in a forward facing mode by the lap belt in the center position of Row 2 at the time of the crash. The CSS was still buckled in that position at the time of the SCI vehicle inspection, **Figure 11**. The latch plate was inserted in the buckle and the ALR retractor was locked. Inspection revealed the restraint webbing

was routed through the proper belt path. In its restrained condition, the CSS had approximately 5 cm (2 in) of lateral movement and 3.8 cm (1.5 in) of fore/aft movement when grasped at the belt path. During the inspection, the restraint was unlatched and examined. The webbing spooled in and out of the retractor properly and the retractor locked as designed. Examination of the webbing was unremarkable. There was no crash related evidence identified.

Frontal Air Bag System

The Supplemental Restraint System in the Ford Expedition consisted of redesigned frontal air bags for the driver and front right passenger positions. The driver air bag was located in the center of the steering wheel rim. The front right passenger air bag was located in the right aspect of the instrument panel. The frontal air bags were not commanded to deploy in the right angle impact.

CHILD SAFETY SEAT

Cosco Eddie Bauer Child Safety Seat

The 4 year old male was restrained in a Cosco Eddie Bauer CSS in the center position of the Ford's second row. **Figure 12** is a front view of the Cosco CSS, Model No: 02-537-MET. The seat was manufactured on January 19, 2002. The seat's labeling was intact. The labels indicated the seat was for use by children with a weight and height of 2.3 kg to 36.3 kg (5.0 lb to 80.0 lb) and 48.3 cm to 129.5 cm (19 in to 51 in). The CSS was to be used in a rear-facing mode for infants up to 10 kg (22 lb), forward facing for toddlers 10 kg to 18 kg (22 lb to 40 lb), and as a belt positioning booster seat for a child 13.6 kg to 36.3 kg (30 to 80 lb). The seat's instruction manual was not present.



Figure 12: Front view of the CSS.

The CSS was designed with a three position adjustable base and a 5-point harness. The seat was adjusted to the middle position at the time of inspection. The angle of the seat measured 30 degrees. The shell would not lock into the most upright adjustment position. The 5-point harness consisted of two shoulder straps, a two piece chest clip, two upper thigh straps, and a crotch buckle. The height of the shoulder straps had a five position adjustment located on the back of the shell, **Figure 13**. The shoulder straps were adjusted to the mid-position. This adjustment also controlled the height of the head restraint. The seat was not equipped with a tether strap. The harness straps were roped throughout its path and were roped through the chest clips, **Figure 14**. There was no loading evidence identified on the harness straps. The location of the chest clips measured 25 cm (10 in) below the harness slots. Referring to **Figure 16**, the right (male) chest clip appeared to be have been reversed from its designed orientation at a time when the harness straps were rethreaded. When clipped together, the chest clip formed an “S” shape. By reversing the orientation of the right clip, the buckled clip would form a symmetrical arc, the more typical design.



Figure 13: Back view of the CSS.



Figure 14: Close-up view the roped harness straps and chest clip.

OCCUPANT DEMOGRAPHICS
2000 Ford Expedition

	<i>Driver</i>	<i>Rear Center Passenger</i>
Age/Sex:	36 year old/Female	4 year old/Male
Height:	Not reported	Not reported
Weight:	Not reported	Not reported
Seat Position:	Rear track	Fixed bench
Restraint Use:	3-point lap and shoulder harness	CSS with 5-pt harness
Usage Source:	SCI inspection, First responder	SCI inspection, First responder
Medical Treatment:	Not injured	Not injured

DRIVER INJURY

2000 Ford Expedition

The driver sustained a police reported possible injury and was transported via ground ambulance to a local hospital. The medical records indicated the driver's chief complaint was soreness of the left shoulder. She did not sustain any AIS codeable injuries. She was released from the hospital four hours post-crash.

DRIVER KINEMATICS

2000 Ford Expedition

The 36 year old driver was seated in a presumed upright posture and was restrained at the time of the crash. At impact, the driver responded to the 10 o'clock direction of the collision by exhibiting a left and forward trajectory. The driver's left shoulder, chest and pelvis contacted the locked restraint system and she began to ride down the force of the impact. The source of the driver's shoulder pain was attributed to her loading of the safety belt. The driver's left lower extremity possibly contacted the outboard aspect of the knee bolster. This possible contact did not produce an injury. As the vehicle began to rotate clockwise, she possibly contacted the left door panel. As the vehicle decelerated and came to rest, the driver rebounded back into her seat. The use of the manual restraint system mitigated the driver's interior contact and potential injury.

REAR CENTER PASSENGER INJURY

2000 Ford Expedition

The 4 year old child passenger sustained a police reported non-incapacitating injury and was transported via ground ambulance to a local hospital. The medical records for this child indicated he was not injured in the crash. He was released from the emergency room with the driver (his mother) four hours post-crash.

REAR CENTER PASSENGER KINEMATICS

2000 Ford Expedition

The 4 year old child passenger was seated in a forward facing mode in a CSS that was restrained in the vehicle's center rear position. The child was restrained within the CSS by the child seat's 5-point harness.

At impact, the child responded to the 10 o'clock direction of the event by exhibiting a left and forward trajectory. The child contacted and loaded the harness system of the CSS. As the Ford rotated clockwise, the child loaded the left side of the child seat shell. The combined use of the child safety seat's harness system and vehicle belt system restraining the CSS allowed the child to ride down the forces of the impact sequence. The child rebounded back into the CSS and was not injured in the crash.

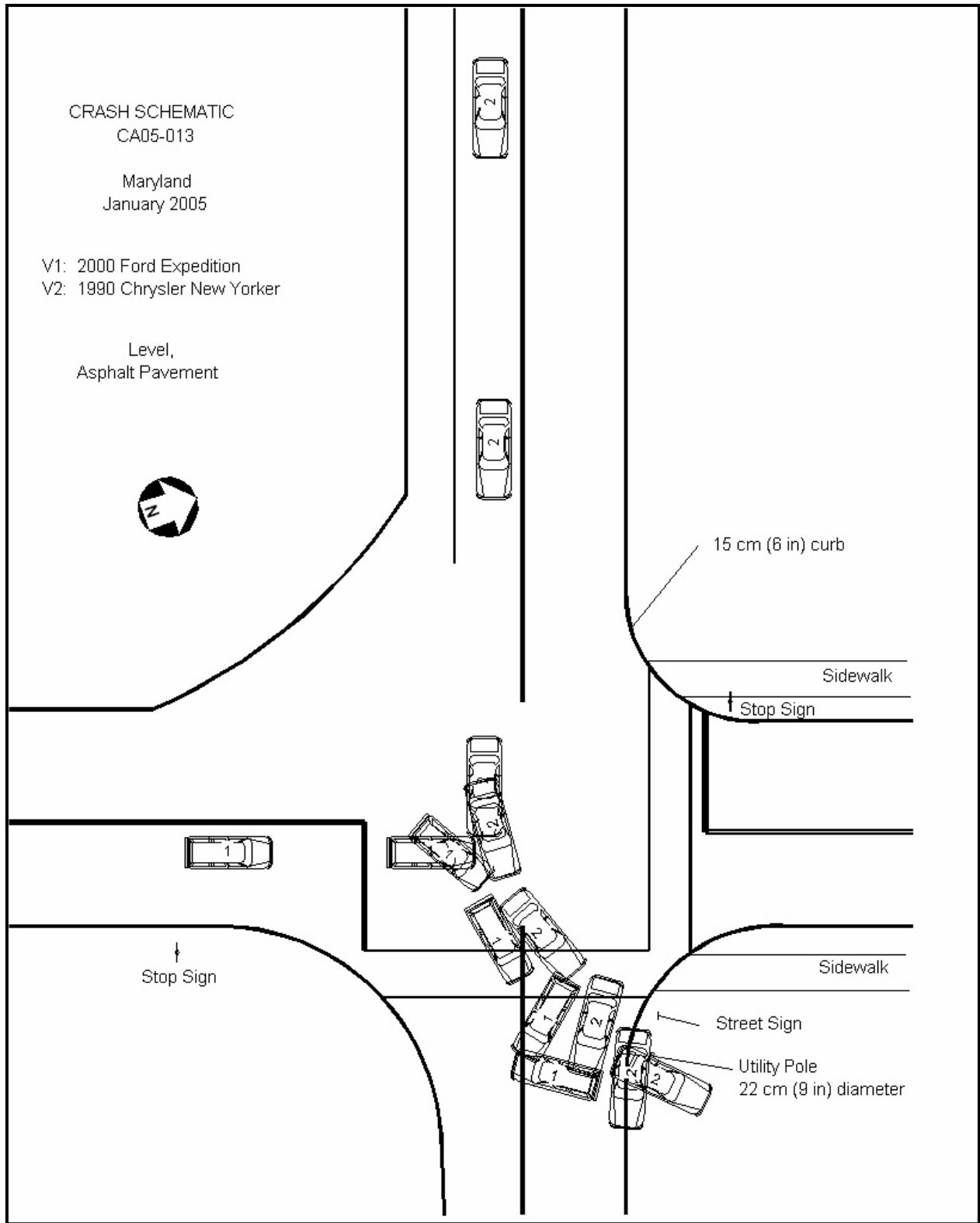


Figure 15: Crash schematic.