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CALSPAN REMOTE CHILD AIR BAG RELATED FATALITY CRASH INVESTIGATION

NASS/SCI COMBO CASE NO.: 2007-48-274B

VEHICLE: 1997 MERCURY SABLE

LOCATION: ALABAMA

CRASH DATE: DECEMBER 2007

Contract No. DTNH22-07-C-00043

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 passenger contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and passenger kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and passengers.

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

1. Report No. 2007-48-274B	*2. Government Accession No.*	*3. Recipient's Catalog No.*	
4. Title and Subtitle Calspan Remote Child Air Bag Related Fatality Crash Investigation Vehicle: 1997 Mercury Sable Location: State of Alabama		*5. Report Date*: June 2008 *6. Performing Organization Code*	
7. Author(s) Crash Data Research Center		*8. Performing Organization Report No.*	
9. Performing Organization Name and Address Crash Data Research Center Calspan Corporation P.O. Box 400 Buffalo, New York 14225		*10. Work Unit No.* C0500.0000.0052 *11. Contract or Grant No.* DTNH22-07-C-00043	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		*13. Type of Report and Period Covered* Technical Report Crash Date: December 2007 *14. Sponsoring Agency Code*	
15. Supplementary Note This NASS/SCI combo case focused on the severity of the crash and the source of injury that contributed to the death of an unrestrained 4-year-old male front right passenger of a 1997 Mercury Sable.			
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17. Key Words Unrestrained child passenger Pre-crash braking Air bag cover flap		*18. Distribution Statement* General Public	
19. Security Classif. (of this report) Unclassified	*20. Security Classif. (of this page)* Unclassified	*21. No. of Pages* 12	*22. Price*

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NASS/SCI COMBO CASE NO.: 2007-48-274B
VEHICLE: 1997 MERCURY SABLE
LOCATION: ALABAMA
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BACKGROUND

This NASS/SCI combo case focused on the severity of the crash and the source of injury that contributed to the death of an unrestrained 4-year-old male front right passenger of a 1997 Mercury Sable. The Sable was equipped with first generation driver and passenger frontal air bags. The Sable was occupied by a 27-year old female driver, the front right child passenger, and an 11-year-old female seated in the rear left position. The passengers of the Sable were not restrained by the vehicle's manual safety belt systems. The front of the Mercury **(Figure 1)** struck the rear of a stopped 2005 Chevrolet Cobalt which resulted in the deployment of the Sable's frontal air bag system. Immediately prior to the impact, the driver suddenly applied the brakes which displaced the 4-year-old male forward. At impact with the Chevrolet, the front right air bag deployed with the 4-year-old male positioned with his head positioned over the front right air bag cover flap. As the cover flap opened, it contacted and lacerated his chin. The expanding air bag membrane propelled the 4-year-old male into the right roof area. His head impacted the roof resulting in multiple AIS 3, AIS 4, and AIS 5 level brain injuries.

Figure 1. 1997 Mercury Sable.

The child was transported to a hospital and was then transferred to a pediatric trauma center where he expired the following day. The driver and the rear seat passenger of the Sable sustained minor injuries.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS). The NASS researcher located and inspected the Mercury Sable and the crash scene, and interviewed the driver of the Sable. The Chevrolet was repaired prior to the assignment of the case; therefore a partial inspection of the repaired Chevrolet was obtained. The researcher notified NASS Zone Center personnel of the crash, who in-turn forwarded the notification to the Crash Investigation Division of the NHTSA. The notification and several images of the Sable were forwarded to the Calspan Special Crash Investigations (SCI) team. Subsequently, this case was assigned as a remote NASS/SCI combo investigation on January 9, 2008. This remote investigation involved a review of the NASS CDS case file, hospital records, and the autopsy.

SUMMARY

Crash Site

This crash occurred in the southbound lane of a two-lane roadway approximately 20 meters (66 feet) north of a T-intersection during the evening hours of December 2007. The light conditions were dark and the roadway was lighted by overhead luminaries. At the time of the crash, the asphalt road surface was dry. The north/south roadway was configured with one traffic lane in each direction; these lanes were separated by double yellow center lines. The travel lanes measured approximately 4.5 meters (15 feet) in width and were bordered by concrete curbs. Driveways to private residences intersected the roadway on the east road edge. Lawns extended beyond the curbs and contained mailboxes and wooden utility poles. The posted speed limit for the north/south roadway was 40 km/h (25 mph). The east/west roadway consisted of two asphalt surfaced lanes that were bordered by concrete curbs. The NASS schematic of the crash site is included in this report as **Figure 9**.

Vehicle Data

1997 Mercury Sable

The 1997 Mercury Sable was manufactured in 11/96 and was identified by Vehicle Identification Number (VIN) 1MELM53S2VG (production number deleted). The odometer reading at the time of the NASS inspection was 317,104 kilometers (197,039 miles). The vehicle was a four-door sedan that was equipped with a 3.0-liter, V-6 engine linked to a four-speed automatic transmission, front-wheel drive, and a center console mounted transmission shifter. The vehicle was equipped with OEM multi-spoke alloy wheels with P205/60R15 tires. The vehicle manufacturer recommended cold front and rear tire pressure was 228 kPa (33 PSI). The specific tire data at the time of the NASS inspection was as follows:

Position	Make/Model	Measured Tire Pressure	Measured Tread Depth	Damage
Left Front	Response ST/ Touring 2000	103 kPa (15 PSI)	3 mm (4/32”)	None
Left Rear	Sumitomo/ Srixon 4	124 kPa (18 PSI)	2 mm (3/32”)	None
Right Front	BFGoodrich/ Premier	186 kPa (27 PSI)	4 mm (5/32”)	None
Right Rear	BFGoodrich/ Touring T/A	172 kPa (25 PSI)	6 mm (8/32”)	None

The interior of the Mercury was equipped with cloth and leather accented front bucket seats and a rear split bench with forward folding seat backs (70/30). The front seating positions were designed with height adjustable head restraints that were in the full-down positions at the time of the NASS inspection. Additionally, the vehicle was equipped with a tilt steering wheel that was adjusted to the full-down position at the time of the NASS inspection.

2005 Chevrolet Cobalt

The 2005 Chevrolet Cobalt was identified by VIN: 1G1AK52F957 (production number omitted). The Cobalt was a four-door sedan that was powered by a 2.2-liter I-4 engine linked to a four-

speed automatic transmission with front wheel drive. The vehicle was equipped with steel wheels with five spoke plastic hub caps with P205/60R15 tires. The vehicle manufacturer recommended cold front and rear tire pressure was 207 kPa (30 PSI). The specific tire data at the time of the NASS inspection was as follows:

Position	Make/Model	Measured Tire Pressure	Measured Tread Depth	Damage
Left Front	Bridgestone/ Potenza G009	172 kPa (25 PSI)	6 mm (8/32”)	None
Left Rear	Bridgestone/ Potenza G009	172 kPa (25 PSI)	6 mm (8/32”)	None
Right Front	Bridgestone/ Potenza G009	345 kPa (50 PSI)	5 mm (6/32”)	None
Right Rear	Bridgestone/ Potenza G009	179 kPa (26 PSI)	5 mm (6/32”)	None

Crash Sequence

Pre-Crash

The driver of the Mercury was operating the vehicle southbound on the north/south roadway. The driver of the Chevrolet was operating the vehicle on the same roadway in front of the Mercury. **Figure 2** is a view of both vehicles’ travel path. As the Chevrolet approached the T-intersection, the driver applied a braking input as traffic ahead began to slow. During the NASS interview, the driver of the Mercury stated that she was engaged in a conversation with the front right passenger. Additionally, she stated that she was reaching for food within the vehicle. At this point, the Chevrolet had come to a stop approximately 23 meters (75 feet) north of the intersection. The conversation with the front right passenger and reaching for food distracted the driver of the Mercury. As the Mercury neared the intersection, the driver observed the Cobalt and spiked the brakes which displaced the front right passenger forward against the instrument panel.

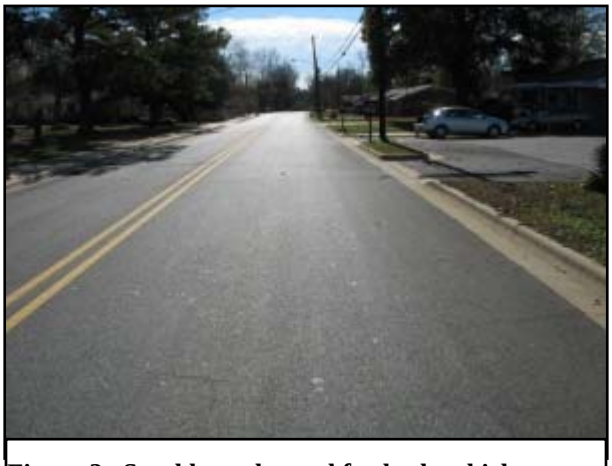

Figure 2. Southbound travel for both vehicles.

Crash

The full frontal aspect of the Mercury impacted the back plane of the Chevrolet. The resultant directions of force were 12 o’clock for the Mercury and 6 o’clock for the Chevrolet. The Chevrolet was repaired prior to the NASS case assignment; therefore, the WINSMASH missing vehicle algorithm was used to calculate the delta-V’s. The total delta-V for Mercury was 13 km/h (8 mph). The total delta-V for the Chevrolet was 17 km/h (10.5 mph). The longitudinal and lateral components for the Mercury were -13 km/h (8 mph) and 0 km/h, respectively. The longitudinal component for the Chevrolet was 17 km/h (10.5 mph) with a lateral component of 0 km/h. The impact resulted in the frontal air bag deployment in the Mercury. As a result of the

front right passenger's close proximity to the instrument panel, interaction occurred with the deploying front right air bag and the cover flap. This interaction is discussed in the *Air Bag* and the *Front Right Passenger Kinematics* sections of this report.

The impact displaced the Chevrolet forward approximately 13 meters (43 feet) where it came to rest 7 meters (22.9 feet) north of the T-intersection. The Mercury continued its southbound trajectory and came to a controlled stop approximately 5 meters (16 feet) south of the area of impact.

Post-Crash

Following the crash, police and Emergency Medical Technicians (EMTs) arrived on-scene. The EMT evaluated the condition of the child passenger and began medical treatment at the crash site. The 4-year-old male was transported to a local hospital where treatment continued for approximately two hours. He was then transferred to a pediatric trauma center where he expired approximately one day post-crash. The driver of the Mercury sustained a minor hand injury was not medically treated. The 11-year-old female rear left passenger sustained minor injuries and was transported to a local hospital at a later time after the crash for treatment. The Mercury was towed from the crash site to a nearby tow-yard. The Chevrolet was driven from the crash site and was subsequently repaired prior to the NASS inspection.

Vehicle Damage

Exterior – 1997 Mercury Sable

The Mercury Sable sustained minor severity frontal damage as result of the crash with the Chevrolet **(Figures 3 and 4)**. The damaged components included the bumper fascia, bumper beam, the hood, and the headlight assemblies. The direct contact damage on the bumper fascia measured 147 cm (57.9") which began at the front left corner and extended to the right bumper corner. The maximum crush measured 4 cm (1.6") and was located at the left bumper corner. The direct contact damage and crush profiles were documented at the level of the bumper. The crush profile documented at the bumper level was follows: C1 = 4 cm (1.6"), C2 = 3 cm (1.2"), C3 = 1 cm (0.4"), C4 = 0 cm, C5 = 0 cm, C6 = 0 cm. The Collision Deformation Classification (CDC) for this impact was 12-FDEW-1.

Figure 3. Resultant frontal damage and crush profile.

Figure 4. Oblique view of the frontal damage.

The doors remained closed during the crash and were operational post-crash. There was no damage to the side and rear glazing. Fractures were noted to the left and right aspects of the windshield.

Exterior – 2005 Chevrolet Cobalt

The 2005 Chevrolet Cobalt sustained minor damage as result of the impact with the Mercury **(Figures 5 and 6)**. The Chevrolet was repaired prior to the NASS case assignment; therefore, the damage was based on police on-scene images of the vehicle. A partial inspection of the repaired Cobalt was obtained for this investigation.

Direct contact damage in the form of abrasions was apparent on the rear bumper fascia. There did not appear to be crush damage to the rear plane of the vehicle. Lateral views of the rear of the Cobalt showed that the bumper fascia was not displaced from its mounting points. Based on the residual damage, the SCI revised CDC for this impact was 06-BDEW-1.

Figure 5. Police on-scene image of the damage to the Chevrolet.

Figure 6. Chevrolet in its repaired state.

Interior – 1997 Mercury Sable

The interior of the Mercury sustained moderate damage that was attributed to air bag deployment and occupant contact points. This minor severity crash did not produce intrusion of the passenger compartment.

The windshield was fractured (spider-webbed) above the steering wheel. Although the fracture was initially attributed to contact from the driver's head, a resultant injury did not occur. This damage probably occurred due to a fling contact from the driver's left hand. It was observed that the center mirror was displaced. This was linked to a probable fling contact from the driver's right hand. However, the displacement of the mirror most likely occurred from the deploying front right air bag. Body fluid was noted on the driver's air bag membrane at the 2 o'clock sector and on the center console.

The front right passenger contact points were identified as a head strike to the right aspect of the windshield, the sun visor/roof area, the right instrument panel, the floor, and the front right air

bag components. **Figure 7** is an overall view of the front right position. The front right air bag contacts are discussed in the Air Bag section of this report.

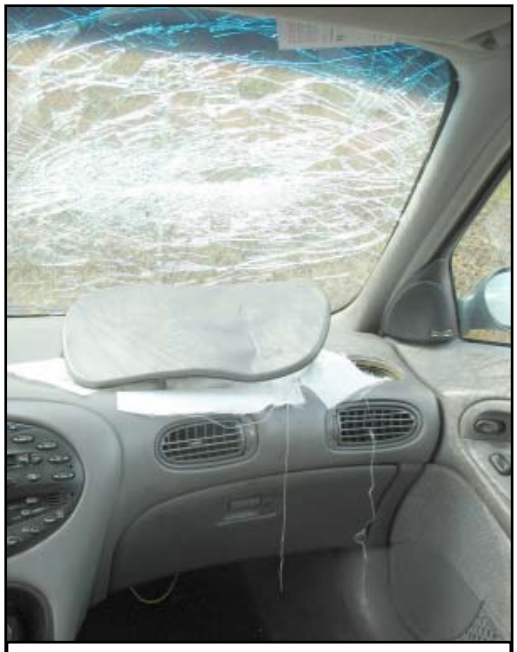

Figure 7. Right front passenger space.

The windshield fracture was initially attributed to a head strike from the front right passenger. However, the exhibited fracture pattern was consistent with contact from the front right air bag cover flap. A skin transfer and body fluid evidenced the sun visor/roof area contacts points. Both of these contacts were linked to the front right passengers head. The right instrument panel contained a red colored transfer centered between the air vents; this contact was initially attributed to the passenger's chest. However, the air bag membrane was positioned between the passenger and the instrument panel; therefore, this transfer was not likely a result from contact by the passenger.

It was also noted that the fins on the left air vent on the right instrument panel were fractured. It could not be determined if this was previous damage or contact from the front right passenger lower extremities. Pooled body fluid was noted on the floor in the front right position. This was listed as a possible occupant contact point; however, the body fluid appeared to have occurred from the 4-year-old passenger post-crash.

A single passenger contact point was noted for the rear left passenger. This consisted of a scuff mark to the rear of the front left seat back.

Frontal Air Bag System – 1997 Mercury Sable

The Mercury was equipped with a first generation frontal air bag system for the driver and front right positions. The air bag system deployed as a result of the front-to-rear impact sequence with the Chevrolet.

Figure 8. Deployed driver's air bag.

The driver's air bag was contained within the four-spoke steering wheel and was concealed by two symmetrical H-configuration cover flaps **(Figure 8)**. Body fluid was noted on the air bag membrane at the 2 o'clock sector from possible contact by the driver. No damage or malfunctions were noted to the driver's air bag system.

The front right passenger air bag was a top-mount design, incorporated into the right instrument panel. A single cover flap tethered to the instrument panel concealed the front right air bag. The

cover flap was constructed of a vinyl top with a steel backer panel. The lower right corner of the cover flap **(Figure 9)** was deformed in a V-shaped crease. A tissue transfer was noted on the leading edge of the flap within the deformation. The deformation occurred as a result of an interaction with the unrestrained front right passenger during the early stages of the deployment sequence.

Figure 9. Damaged front right air bag cover flap.

Figure 10. Front right air bag membrane.

The front right air bag membrane was rectangular in shape **(Figure 10)**. Tissue transfers were noted on the left aspect of the bottom panel of the air bag. In addition, a dark colored fabric transfer was also noted on the left aspect of the bottom panel. Body fluid was present on the face of the membrane above the center seam left of the center line and on the bottom panel right of the center line. The numerous transfers were indicative of occupant contact during the air bag expansion.

Manual Safety Belt Systems – 1997 Mercury Sable

The Mercury Sable was equipped with manual three-point lap and shoulder belt systems for the four outboard-seated positions. A lap only belt was present for the rear center seating position.

The driver's belt was configured with continuous loop webbing, sliding latch plate, and a height adjustable D-ring that was in the full-up position at the time of the NASS inspection. The driver's safety belt retracted onto an Emergency Locking Retractor (ELR). The driver did not use the safety belt in this crash.

The front right safety belt system retracted onto a switchable ELR/Automatic Locking Retractor (ALR) and was equipped with a sliding latch plate, and a height adjustable D-ring that was in the full-up position at the time of the NASS inspection. The 4-year-old male front right passenger did not use the safety belt in the crash. The lack of belt usage was supported by the out-of-position status and the interaction with front right air bag system.

The outboard second row safety belts were equipped with switchable ELR/ALR and sliding latch plates. The 11-year-old female did not use the available safety belt which was supported by her contact with the rear of the front left seat back. The second row center and right seating positions were not occupied during the crash; therefore, the safety belts were not used.

Demographics/Data

Driver

Age/Sex:	27- year-old/Female
Height:	163 cm (64”)
Weight:	98 kg (216 lbs)
Seat Track Position:	Between middle and full-rear track position
Eyewear:	None
Manual Safety Belt Usage:	None used
Usage Source:	Vehicle inspection
Egress from vehicle:	Exited under own power
Mode of Transport from Scene:	None
Type of Medical Treatment:	None

Driver Injuries

Injury	Injury Severity AIS90/Update 98	Injury Source
8 cm (3”) abrasion to inner left hand	Minor (790202.1,2)	Driver air bag

Source – Interview

Driver Kinematics

The 27-year-old female driver of the Mercury Sable was seated in an unknown posture and was not restrained by the manual belt system.

Prior to the impact, the driver was reaching for food in the passenger compartment and was conversing with the front right passenger. Her reaching may have resulted in her leaning to the right. The driver suddenly applied the brakes immediately prior to the crash, which displaced her slightly forward. At impact, the frontal air bags deployed and the driver initiated a forward trajectory in response to the 12 o’clock direction of force. The deploying air bag contacted the inner aspect of her left hand resulting in the abrasion. A fracture site was located on the windshield forward and above the steering wheel that possibly resulted from a fling contact from the driver’s left hand. A resulting injury did not occur from this possible contact. The driver loaded the air bag with her head and chest. Body fluid was noted on the driver’s air bag membrane from the probable interaction. The driver was not treated at medical facility for her injury.

Front Right Passenger

Age/Sex:	4-year-old/Male
Height:	144 cm (41”)
Weight:	35 kg (77 lbs)
Seat Track Position:	Between middle and full-rear track position
Manual Safety Belt Usage:	None used
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Egress from vehicle:	Removed from vehicle by an unknown person(s)
Mode of Transport from Scene:	Transported by ambulance
Type of Medical Treatment:	Resuscitative efforts by the EMTs and in the emergency room, transferred to a pediatric trauma center where he expired approximately one day post-crash

Front Right Passenger Injuries

Injury	Injury Severity (AIS 90, Update 98)	Injury Source
Tonsillar and uncal herniation of the brain stem	Critical (140202.5,8)	Right sun visor/reinforced by windshield header * Air bag related
Left subdural hematoma of the posterior compartment of the left cerebellum	Severe (140438.4,6)	Right sun visor/reinforced by windshield header * Air bag related
0.8 cm (0.3”) wide left subdural hematoma in the frontal and temporal regions	Severe (140652.4,2)	Right sun visor/reinforced by windshield header * Air bag related
Small intraventricular hemorrhage in the right occipital horn of the lateral ventricle	Severe (140678.4,1)	Right sun visor/reinforced by windshield header * Air bag related
Brain edema	Serious (140660.3,9)	Right sun visor/reinforced by windshield header * Air bag related
Left greater subarachnoid hemorrhage and right subarachnoid hemorrhage	Serious (140684.3,1 140684.3,2)	Right sun visor/reinforced by windshield header * Air bag related
Right temporal scalp lacerations, NFS	Minor (190600.1,1)	Right roof rail area
Right temporal scalp hematoma	Minor (190402.1,1)	Right roof rail area
Left eyelid contusion	Minor (297402.1,2)	Right sun visor/reinforced by windshield header * Air bag related
Minor laceration of the chin	Minor (290602.1,8)	Air bag cover flap

Abrasion to the bridge of the nose, left cheek, forehead, and the right side of the lip	Minor (290202.1,0)	Air bag membrane
Abrasions on the left side of the inner and outer lower lip	Minor (243204.1,8)	Air bag membrane

Source– Autopsy and emergency room records from the initial hospital. Secondary hospital is a non-cooperating facility and records will not be obtained.

Front Right Passenger Kinematics

The 4-year-old male front right passenger was seated in a mid to rear-track position. He was not restrained by the 3-point lap and shoulder belt. Prior to the impact, the driver suddenly applied a level of braking which displaced him forward.

At impact with the Chevrolet, the front right air bag deployed with the 4-year-old male against the instrument panel with his head positioned over the front right air bag cover flap. As the cover flap opened, it contacted his chin resulting in the laceration to this area. This interaction was evidenced by a tissue transfer on the leading edge of the cover flap and deformation of the vinyl flap and steel backer panel. The deformation of the vinyl top and steel backer panel formed a V-shaped crease that was located on the leading edge right of center.

As the cover flap rotated open, the expanding air bag membrane propelled the child passenger upward into the right roof area. The top of his head impacted the roof which resulted in the 0.8 cm (0.3”) wide left subdural hematoma in the frontal and temporal regions, the small intraventricular hemorrhage in the right occipital horn of the lateral ventricle, the brain edema, left and right subarachnoid hemorrhage, and compression of the brain stem (tonsillar and uncal herniation). The air bag membrane continued to expand against his face. The air bag contact resulted in the multiple facial soft tissue injuries evidenced by the skin transfers to the air bag membrane. The expanding air bag displaced the child to the right and rearward. During this motion, he contacted the right roof side rail resulting in the right temporal scalp lacerations and the right temporal scalp hematoma. The 4-year-old male the came to rest within the front right foot well as evidenced by the pooled body fluid.

Following the crash, the child passenger was transported to a hospital where treatment for his injuries began. He was transferred to a pediatric trauma center for further treatment; however, he expired approximately one day post-crash. His body was taken to the Medical Examiner’s Office where an autopsy was performed. The emergency room records from the initial treating hospital have been received and the listed injuries are included in this report. The secondary hospital records could not be obtained.

Rear Left Passenger

Age/Sex:	11-year-old/Female
Height:	155 cm (61”)
Weight:	94 kg (207 lbs)
Seat Track Position:	Not adjustable
Manual Safety Belt Usage:	None used
Usage Source:	Vehicle inspection
Eyewear:	None
Passenger Mobility:	Exited under own power
Mode of Transport from Scene:	Not transported from scene
Type of Medical Treatment:	Sought treatment later at a Children’s Hospital

Rear Left Passenger Injuries

Injury	Injury Severity (AIS 90, Update 98)	Injury Source
Fractured finger on the right hand	Minor (790402.1,1)	Rear of front left seat back

Rear Left Passenger Kinematics

The 11-year-old female rear left passenger was seated in an unknown posture. She was not restrained by the 3-point lap and shoulder belt. Prior to the impact, the driver applied a level of braking which displaced her forward.

At impact with the Chevrolet, the 11-year-old female was displaced forward into the rear of the front left seat back which arrested her forward motion and resulted in a fractured finger on the right hand. This was evidenced by a scuff mark on the seat back. She was police reported as sustaining possible injury; however, she was not immediately transported to a hospital. Based on the NASS case file, this passenger was transported at a later time to a pediatric hospital for treatment. Additional information regarding her possible injuries was unavailable.

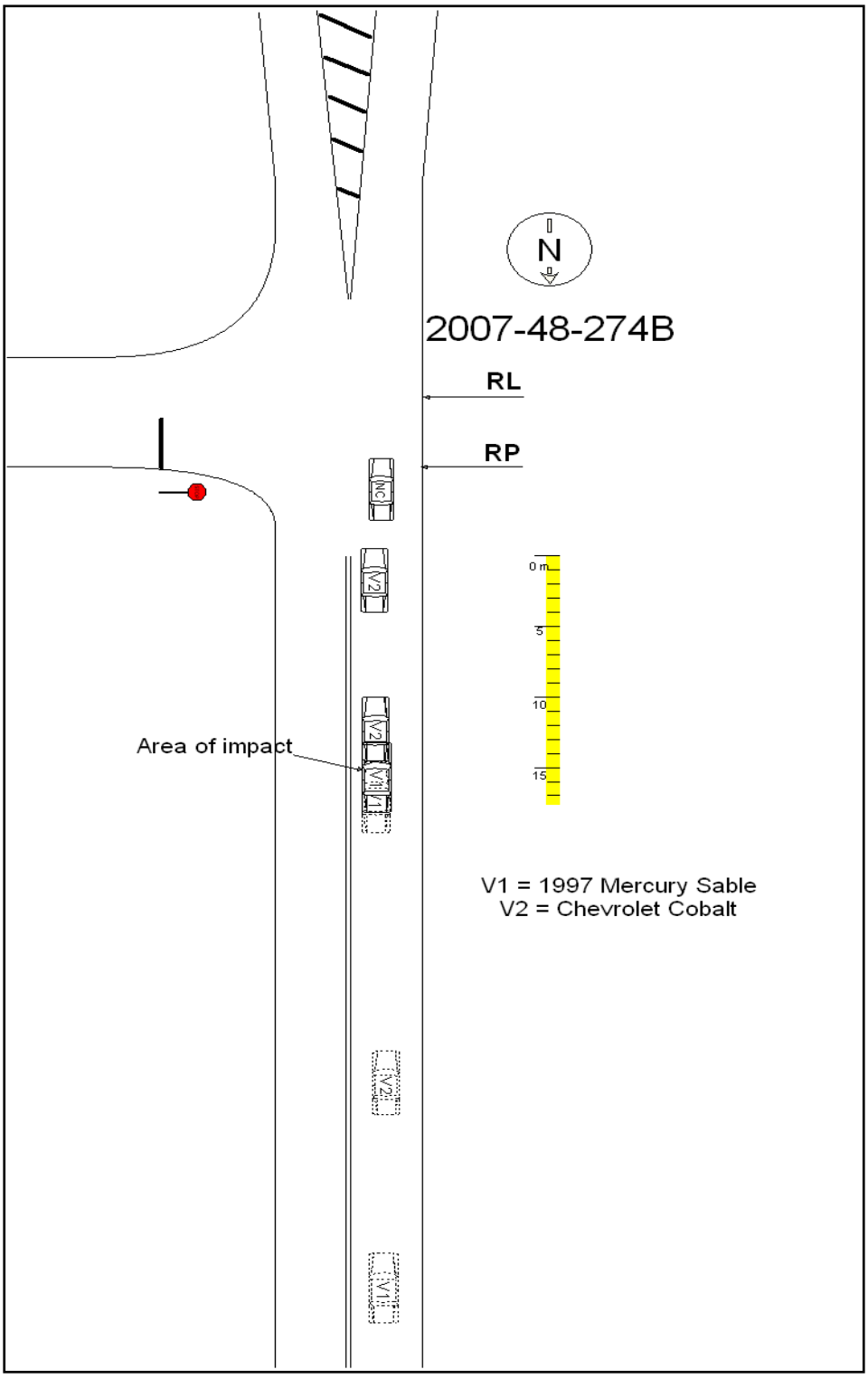

Figure 9: NASS Scene Schematic