CRASH DATA RESEARCH CENTER

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CALSPAN REMOTE CHILD AIR BAG RELATED FATAILITY INVESTIGATION

CASE NO: CA05-022

VEHICLE: 1997 SATURN SL1

LOCATION: FLORIDA

CRASH DATE: APRIL 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.

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CALSPAN REMOTE CHILD AIR BAG RELATED FATALITY INVESTIGATION
SCI CASE NO.: CA05-022
VEHICLE: 1997 SATURN SL1
LOCATION: FLORIDA
CRASH DATE: APRIL 2005

BACKGROUND

This remote investigation focused on the source of injury and cause of death for a 2-month old infant male who was positioned in a rear-facing child safety seat (CSS) in a 1997 Saturn SL1. The Saturn was equipped with frontal air bags for the driver and front passenger position that deployed as a result of a three-vehicle, front-to-rear crash sequence. The Saturn SL1 was being operated by a 19-year old female driver who was southbound in the center lane of a 3-lane state roadway. The Saturn impacted the back of a stopped 1995 Pontiac Trans Am in a front-to-rear configuration **(Figure 1)**. The Pontiac was subsequently pushed forward and its front impacted the rear of a 2003 Chevrolet Tracker which was stopped ahead of the Pontiac in the same lane. The Saturn then impacted the back of the Pontiac a second time. The CSS was installed in the front right position of the Saturn and was contacted by the front right air bag cover flap and the deploying air bag membrane that resulted in structural damage to the CSS and multiple skull fractures with subdural and subarachniod hemorrhage. The child was removed from the CSS by the driver and was transported to a regional trauma center where he expired approximately 12 hours following the crash. The driver of the Saturn was not injured. Both the Saturn and the Pontiac sustained moderate damage and were towed from the crash scene. The Chevrolet Tracker sustained minor back plane damage and was driven from the scene.

Figure 1 - Impact area between Saturn and Pontiac.

This crash was identified on April 4, 2005 by the Calspan Special Crash Investigations (SCI) team through an Internet news search. The notification was forwarded to the Crash Investigations Division of the National Highway Traffic Safety Administration (NHTSA) and it was assigned for an on-site investigation. Cooperation was established with the Vehicle Homicide Squad of the County Sherriff's Department and an on-site investigation was tentatively scheduled for the first week in May 2005. The status of the case was changed from an on-site investigation to a remote investigation after learning from the Sergeant in Charge of the squad that the vehicle was being held in evidence by the State Attorney's Office until the legal aspects of the case were finalized. The remote investigation included the acquisitions of the Police Accident Report (PAR), photographic images from the investigative agency, and the infant's autopsy report.

SUMMARY

Crash Site

This three-vehicle crash occurred on a well-traveled asphalt state highway during daylight hours in April 2005. The crash occurred in the center southbound lane of a three-lane divided highway. At the time of the crash, the weather was clear and the roadway was dry. The outboard curb lane was utilized to distribute the flow of traffic and then merge traffic from the right lane into the center lane. The lane displayed large white painted arrows and the word "merge." The lanes were delineated by painted white broken lane lines and white painted fog lines. A curbed grassy center median separated north and southbound traffic. The roadside environment consisted of sporadic dwellings and natural growth. The roadway led to an intersection approximately 0.2 km (1/8 mile) further south. Construction signs and orange cones were located in the center median warning motorists of an approaching active work zone. Shortly after the approaching intersection, only the right lane was open to traffic as a police vehicle blocked off the center and left lanes. The north/south roadway had a police-reported posted speed limit of 72 km/h (45 mph). Speed reduction signs due to construction were not reported or viewed through the provided photographic images. An SCI conceptual crash schematic is included as **Figure 14** at the end of this narrative report.

Vehicle Data – 1997 Saturn SL1

The 1997 Saturn SL1 was identified by the Vehicle Identification Number (VIN): 1G8ZH528XVZ (production number omitted). The vehicle was a four-door sedan with an automatic transmission linked to a console-mounted selector. The Saturn had front wheel drive and was equipped with a transverse-mounted inline 4-cylinder, 1.9 liter engine.

The interior of the 1997 Saturn SL1 was configured with front bucket seats and a rear bench seat designed with a 50/50 split folding back that allowed access to the trunk. The front seats had integrated head restraints and there were no head restraints for rear seated occupants. The front seat tracks were manually adjusted.

Vehicle Data – 1995 Pontiac Trans Am

The 1995 Pontiac Trans-Am was identified by the VIN: 2G2FV22P7S2 (production number omitted). The vehicle was a two-door coupe with a rear hatch. The rear-wheel drive vehicle was equipped with a 5.7-liter, 8-cylinder engine linked to an automatic transmission with a console mounted selector. The service brakes consisted of front disc and rear drum with anti-lock (ABS).

Vehicle Data – 2003 Chevrolet Tracker

The 2003 Chevrolet Tracker was identified by the VIN: 2CNBE13C836 (production number omitted). The vehicle was four-door sport utility vehicle with a rear hatch. The four-wheel drive vehicle was equipped with an inline 2.0-liter, 4-cylinder engine. The service brakes consisted of front disc and rear drum brakes.

Crash Sequence

Pre-Crash

The 19-year old female driver of the 1997 Saturn SL1 was traveling in a southerly direction on a three-lane roadway and was approaching stopped traffic **(Figures 2 and 3)**. She was police reported as unlicensed and this trip was her third experience as a driver of a vehicle. The 1995 Pontiac Trans Am was stopped behind the 2003 Chevrolet Tracker in a line of traffic leading to a construction work zone. No physical evidence indicative of pre-impact avoidance maneuvers was reported and nothing to that effect was visible in the photographic images.

Figure 2 - Southbound approach of the Saturn.

Figure 3 - Area of impact with gouging on the asphalt roadway.

Crash

The frontal area of the Saturn impacted the back plane of the Pontiac in the center southbound travel lane. The impact was slightly off-set with the center and right aspects of the Saturn's front bumper engaging the center and left aspects of the Pontiac's rear bumper. Five linear gouges were present on the asphalt roadway at the initial point of impact **(Figure 3)**. The direction of force for the Saturn was in the 12 o'clock sector and in the 6 o'clock sector for the Pontiac. The impact resulted in moderate damage to both vehicles. An estimated crush profile from the photographic images was used to compute an anecdotal damage algorithm of the WinSMASH program. The program computed a total delta-V of 28 km/h (17 mph) for the Saturn and 20 km/h (12 mph) for the Pontiac. The specific longitudinal and lateral velocity changes were -28 km/h (-17 mph) and 0 km/h for the Saturn and 20 km/h (12 mph) and 0 km/h for the Pontiac.

The Pontiac was displaced forward and to the right from the force of the initial impact and it contacted and partially underrode the back of the Chevrolet Tracker with its front bumper. The Saturn continued forward following the initial impact and impacted the Pontiac a second time based on the distances traveled and the final rest positions. The Saturn and Pontiac came to final rest approximately 10 m (30') forward of the initial point of impact. A large reddish fluid transfer was present on the roadway emanating from the Saturn's engine compartment. At final rest, the Saturn was facing southbound and the Pontiac was angled approximately 30 degrees off southbound.

Post Crash

The 19-year old female driver of the Saturn was not injured. Immediately following the crash, she exited the vehicle and removed the infant from the Saturn. The infant became unresponsive and was transported by helicopter to a regional trauma center where he was admitted for treatment of his closed head injuries where he expired 12 hours later. The Saturn and Pontiac were towed from the crash scene due to damage. The driver of the Chevrolet maneuvered off the roadway post-crash and parked on the west shoulder. The Chevrolet was later driven from the scene

Vehicle Damage

Exterior Damage – 1997 Saturn SL1

The 1997 Saturn sustained moderate frontal damage as a result of the impact with the Pontiac Trans Am **(Figure 4)**. The direct contact damage was estimated to extend across the front right and center aspects of the front bumper, a distance of approximately 80 cm (32”). The hood was buckled uniformly with a crease about its center aspect. The composite structure of the right fender was fractured while the left fender was undamaged. The Field L was estimated to be the full length of the damaged bumper approximately 120 cm (47”). An estimated crush profile was generated from the post-crash photographic images provided by the investigative agency and was as follows: C1 = 0 cm, C2 = 15 cm (6”), C3 = 20 cm (8”), C4 = 15 cm (6”), C5 = 8 cm (3”), C6 = 5 cm (2”). The Collision Deformation Classification (CDC) for the impact with the Pontiac was 12-FZEW-2.

Figure 4 - Frontal damage to the Saturn.

A secondary impact with the rear of the Pontiac resulted as the vehicles tracked to their final rest positions. The damage to the Saturn from the secondary impact was minimal and the CDC was 12-FDEW-1.

Interior Damage – 1997 Saturn SL1

The 1997 Saturn sustained minor interior damage due primarily to the expansion of the front right passenger’s air bag against the back aspect of the shell of the safety seat. The CSS was positioned approximately 5 cm (2”) rearward of the air bag’s mid-mount module cover flap which impeded the deployment of the front right air bag. Energy from the upper flap and expanding air bag was translated back into the instrument panel causing a partial separation of the instrument panel cover at both front seating positions. No further interior damage could be discerned from the photographic images of the interior.

Exterior Damage - 1995 Pontiac Trans Am

The 1995 Pontiac Trans Am sustained moderate damage as a result of the impact with the Saturn SL1 **(Figure 5)**. The direct contact damage began at the left rear bumper corner and was estimated to extend approximately 110 cm (43”) to the right. The combined

direct and induced encompassed the entire front end of approximately 160 cm (63”). A crush profile was estimated using photographic images provided by the investigating agency and was as follows: C1 = 30 cm (12”), C2 = 27 cm (11”), C3 = 25 cm (10”), C4 = 20 cm (8”), C5 = 15 cm (6”), C6 = 10 cm (4”). The CDC for the impact with the Saturn was 06-BDEW-3.

Following the initial impact, the Pontiac was displaced forward into the back of the 2003 Chevrolet Tracker. The low profile front bumper of the Pontiac partially underrode the back bumper of the Chevrolet resulting in minor damage. The damage was limited to surface scratching with a large whitish transfer located primarily on the Pontiac’s left front corner **(Figure 6)**. The CDC for this impact was 12-FYEW-1.

A secondary impact occurred with the Saturn after the Pontiac’s forward momentum ended with the impact to the Chevrolet Tracker. The Saturn continued to track forward while dissipating energy en route to final rest and impacted the back bumper of the Pontiac a second time. The CDC for this impact was 06-BZEW-1.

Figure 5 - Damage to back of the Pontiac.

Figure 6 - Damage to front of the Pontiac.

Exterior Damage - 2003 Chevrolet Tracker

The 2003 Chevrolet Tracker sustained minor damage as a result of the impact with the Pontiac Trans Am. The damage pattern was minor consisting primarily of surface scratching and approximately 2 cm of narrow crush located 30 cm to the left of the back right bumper corner **(Figure 7)**. The CDC for this impact was 06-BREE-1.

Figure 7 - Damage to back of the Chevrolet.

Frontal Air Bag System – 1997 Saturn SL1

The 1997 Saturn was equipped with first generation frontal air bags for the driver and front right passenger positions. The air bag system deployed as a result of the frontal impact sequence with the back of the Pontiac Trans Am **(Figure 8)**. The driver's air bag was module was conventionally mounted within the four-spoke steering wheel rim and concealed by I-configuration module cover flaps. The air bag deployed through the cover flaps and no damage or driver contact evidence was visible on the bag membrane. It should be noted that an aftermarket cover was fitted on the steering wheel rim and remained in place during the crash and deployment event.

Figure 8 - Deployed frontal air bags in the Saturn.

The front right passenger air bag was mounted in the right mid instrument panel and concealed by a single oval cover flap. The vertically oriented cover flap was hinged at the top with a brow protrusion of the upper instrument panel extending over the flap. Based on an exemplar vehicle, the cover flap was 30 cm (12") horizontally and 12 cm (4.75") vertically and the brow protruded 4 cm (1.5") from the instrument panel. At deployment, the cover flap opened at the designated tear points and impacted the back of the CSS. The air bag membrane subsequently expanded against the leading edge of the shell of the rear-facing CSS and engaged the back of the CSS shell as the CSS was rotated rearward. There was no visible damage to the air bag or the cover flap associated with the deployment event.

Manual Restraint Systems – 1997 Saturn SL1

The Saturn was equipped with continuous loop, 3-point lap and shoulder safety belt systems for the four outboard positions. All belt systems utilized sliding latch plates. The driver's safety belt retractor was an Emergency Locking Retractor (ELR) while the remaining retractors were switchable to an Automatic Locking Retractor (ALR) mode. It was unknown if the front right safety belt system was used at the time of the crash.

The center rear position was equipped with a lap belt that buckled to the right side of the center position. There were no rear seat passengers in the Saturn at the time of the crash.

Child Safety Seat

The 2-month old infant front right passenger was positioned in a Cosco/Dorel rear-facing infant seat **(Figure 9)**. Although the Model Number and the Date of Manufacturer was unknown, the infant seat appeared to be a Designer 22 model. The rear-facing infant seat was positioned on the front right seat cushion of the Saturn and restrained by the manual 3-point

Figure 9 - Damaged CSS.

lap and shoulder belt system. The exact routing of the safety belt system and the tautness of the belt was not specified by the investigating officer. Based on the supplied images, the CSS was used without the detachable base. The carrying handle appeared to be adjusted to the mid position over the child, a position used to carry the seat. A hard plastic toy with swivel beads was attached to the carrying handle with four Velcro straps. A sunshade was also present with the CSS, but was not attached to the seat in the supplied images. This shield probably separated from the CSS during the crash sequence as a result of interaction with the front right deployed air bag components.

The integral 3-point harness system was routed through the back of the safety seat shell and appeared to be positioned in the mid to lower slots (3rd row from the top). A removable pad with a head support was fitted over the harness straps. This padding concealed the latch plates, the chest positioning clip (if equipped), and the adjusted position of the integral harness.

The front right seat was adjusted to a mid track position approximately 9 cm (3.5") forward of full rear and 8 cm (3") rear of full forward based on the images and the inspection of an exemplar vehicle **(Figure 10)**. In this position, the leading edge of an exemplar rear-facing CSS was in close proximity, approximately 5 cm (2") aft of the mid mount front right passenger air bag module **(Figure 11)**.

At deployment, the cover flap impacted the leading edge of the shell of the CSS **(Figure 12)**. The air bag membrane subsequently expanded against the shell of the CSS. The fabric cover at the top left aspect of the infant was torn and the plastic shell at the same location was fractured **(Figure 13)**. It could not be determined if additional damage occurred to the CSS. The carry handle remained upright and attached to the sides of the shell and the toy remained attached to the handle.

Figure 10 - Front right seat track position.

Figure 11 - View of an exemplar CSS in exemplar Saturn and distance from the air bag cover flap to the CSS.

Figure 12 - Close-up of the gap between the CSS and instrument panel mid-mount cover flap.

Figure 13 - View of damage to upper back aspect of the CSS.

Driver Demographics – 1997 Saturn SL1

Age/Sex:	19-year old/Female
Height:	Not reported
Weight:	Not reported
Eyewear:	Unknown
Seat Track Position:	Mid-to-rear based on police images
Manual Safety Belt Usage:	None
Usage Source:	Police Accident Report
Egress from Vehicle:	Exited vehicle unassisted through left front door
Mode of Transport From Scene:	Not reported

Driver Injuries – 1997 Saturn SL1

Injury	Injury Severity AIS90/Update 98)	Injury Source
Not injured	N/A	N/A

Source – PAR

Driver Kinematics – Saturn SL1

The driver of the 1997 Saturn was seated in a mid-to-rear track position and was unrestrained as reported by the investigating officer. The driver was unlicensed and it was police reported that this trip was his third time driving a vehicle.

At impact, the frontal air bag system deployed. The driver responded to the frontal crash forces by initiating a forward trajectory and loading the deployed driver's air bag. There was no contact evidence or damage to the driver's air bag. The driver was not injured in the crash.

Front Right Infant Passenger Demographics

Age/Sex:	2-months/Male
Length:	58 cm (23”)
Weight:	6 kg (12.5 lb)
Seat Track Position:	Mid-track
Safety Systems:	Positioned in a rear-facing infant seat, unknown if properly restrained
Mode of Transport From Scene:	Helicopter transport
Type of Medical Treatment:	Transported to a regional trauma center where he expired 12 hours post-crash

Front Right Infant Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Small residual subdural hematoma underneath the right temporal and frontal lobes	Severe (140652.4,1)	Front right air bag cover flap and expanding air bag membrane
Multiple focal areas of subarachnoid hemorrhage	Serious (140684.3,9)	Front right air bag cover flap and expanding air bag membrane
Fracture of the midline of the occipital skull with fractures that extend into the left parietal and frontal skull	Moderate (150402.2,8)	Front right air bag cover flap and expanding air bag membrane
Bilateral temporal skull fractures	Moderate (150402.2,1; 150402.2,2)	Front right air bag cover flap and expanding air bag membrane
Scattered pericardial petechiae (NFS) with endocardial hemorrhage of the left ventricle	Moderate (441699.2,4)	Expanding front right air bag

Source – Autopsy Report

Front Right Infant Passenger Kinematics

The 2-month old male infant passenger was positioned in the rear-facing infant safety which was placed in the front right seating position on the Saturn. Based on the limited information for this remote level investigation, it was unknown if the child was restrained by the integral harness system, or if the safety seat was restrained by the vehicle’s manual safety belt system. A supplement to the autopsy report indicated that the safety belt system was not used. The front right seat track was adjusted to a mid track position based on the available police provided images of the vehicle. The safety seat was used at the time of the crash without the base. In this adjusted seat track position, the leading

edge of the infant seat was in close proximity to the mid mount front right air bag module. For this remote investigation, the Calspan SCI team placed an exemplar rear-facing child safety seat in an exemplar 1997 Saturn with the front right seat adjusted to the mid track position, similar to the position of the seat in the subject vehicle. The top aspect of the infant seat was 5 cm (2") rearward of the mid mount cover flap.

At impact, the frontal air bag system deployed. Due to the narrow distance of the safety seat in relation to the cover flap, the cover flap contacted and fractured the shell of the seat in the area of the infant's head. The cover flap accelerated the rear-facing child safety seat in a rearward direction. Subsequent to this contact, the expanding air bag membrane contacted the shell of the safety seat during the expansion phase of the air bag. There was no additional damage evident in the available images or contact damage. Although unconfirmed by contact evidence within the vehicle, it was likely that the expanding air bag rotated and accelerated the child restraint rearward into the front right seat back. As a result of the cover flap contact and the expanding air bag, the child sustained a fracture of the occipital skull with a fracture line that extended into the left parietal and frontal skull, bilateral temporal skull fractures, a small right subdural hematoma, and multiple focal areas of subarachniod hemorrhage. In addition, he sustained scattered pericardial petechiae with endocardial hemorrhage of the left ventricle from the expanding air bag membrane against the back of the safety seat.

Medical Treatment

Immediately following the crash, the driver removed the child from the safety seat and cradled the child. He became unresponsive at the scene and was transported by helicopter to a regional trauma center where he was admitted for treatment of his closed head injuries. The child underwent surgical intervention to alleviate swelling of the brain; however, he expired 12 hours following the crash. An autopsy was performed on the body.

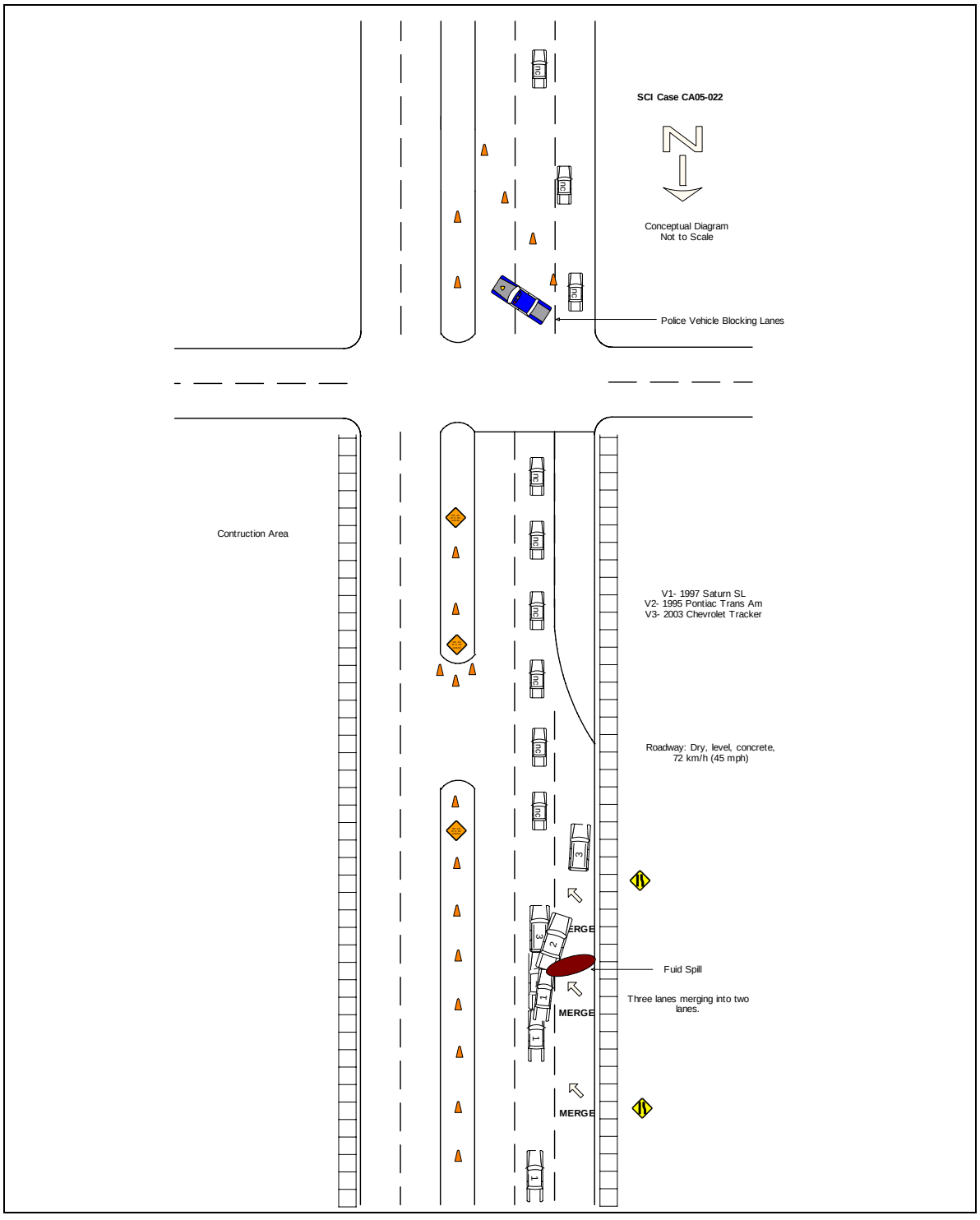

Figure 14 – Conceptual SCI Crash Schematic