

**CRASH DATA RESEARCH CENTER**

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**CALSPAN ON-SITE CHILD AIR BAG RELATED FATALITY CRASH  
INVESTIGATION**

**CASE NO: CA02-038**

**VEHICLE: 1995 TOYOTA TERCEL**

**LOCATION: SOUTH CAROLINA**

**CRASH DATE: SEPTEMBER 2002**

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 ON-SITE CHILD AIR BAG RELATED FATALITY CRASH  
INVESTIGATION**

**SCI CASE NO.: CA02-038**

**VEHICLE: 1995 TOYOTA TERCEL**

**LOCATION: SOUTH CAROLINA**

**CRASH DATE: SEPTEMBER 2002**

**BACKGROUND**

This on-site investigation focused on the injury sources and cause of death of a 3-month old male who was positioned in a rear facing child safety seat (RFCSS) in the front right seat of a 1995 Toyota Tercel (**Figure 1**). The Tercel was equipped with frontal air bags for the driver and front right passenger positions that deployed as a result of a moderate severity frontal crash with a utility pole. The RFCSS was driver reported as secured by the vehicle's 3-point manual lap and shoulder belt system;



**Figure 1 - View of the damaged 1995 Toyota Tercel.**

however, the child was not restrained within the RFCSS by the internal harness system. The right front air bag expanded against the RFCSS, displacing the RFCSS in a rearward direction. As the air bag expanded against the shell of the RFCSS, momentum was transmitted through the RFCSS resulting in multiple head and brain injuries along with bilateral lung lacerations. Specifically, the child's head injuries included an 11 cm (4.5") vault fracture, a subdural hematoma, lacerations to the right temporal lobe, left frontal lobe, and right cerebellum, bilateral subarachnoid hemorrhages, and multiple soft-tissue injuries. The infant was displaced from the RFCSS and was found post-crash in the left rear seat area of the vehicle. The child was crying and was placed into a relative's private vehicle that transported the child to a local hospital. The child was triaged and immediately transferred to a regional trauma center by helicopter where he expired while in-transport. The 18-year old female driver also sustained injuries and was transported to a local hospital in a separate private vehicle for treatment and then released.

The investigating officer notified the National Highway Traffic Safety Administration (NHTSA) of this crash through their online crash notification system in September 2002. The notification was subsequently forwarded to the Calspan Special Crash Investigations (SCI) team who initiated the investigation. Cooperation was established with the investigating officer and the on-site investigation commenced on October 1, 2002. The Calspan SCI team received a detailed crash report from the South Carolina state police and the autopsy for the child passenger.

**SUMMARY**

***Crash Site***

This single vehicle crash occurred on the roadside of a two-lane north/south roadway in the state of South Carolina in September 2002. The roadway was delineated by double

yellow painted centerlines and white painted fog lines. Both lanes were 3.4 m (11 ft) in width and the shoulders were 0.3 m (1 ft) wide. The roadway was surfaced with asphalt and the roadside environment consisted of grassy areas and natural growth. The roadway was curved to the right for southbound traffic and the radius of curvature was 166.85 meters (547.8'). The roadway also experienced a 3.5 percent incline in the southbound direction. Both roadsides experienced a significant change in gradient. The west roadside had a 45 degree decline and the east roadside experienced a 15 degree decline. The posted speed limit for the roadway was 72 km/h (45 mph). The SCI Crash Schematic is included as **Figure 13** at the end of this narrative report.

**Vehicle Data**

**1995 Toyota Tercel**

The subject vehicle in this crash was a 1995 Toyota Tercel four-door sedan. The Tercel was manufactured in 12/94 and was identified by the Vehicle Identification Number: JT2EL56E5S7014895. The vehicle’s mileage was 229,411 km (142,549 miles) and had a Gross Vehicle Weight Rating of 1,374 kg (3,030 lbs) which distributed 767 kg (1,690 lbs) to the front axle and 631 kg (1,390 lbs) to the rear. The Tercel was powered by a 1.5-liter transverse mounted 4-cylinder gasoline engine linked to a 4-speed automatic transmission with a console mounted transmission selector. The service brakes consisted of front ventilated disc and rear drum brakes. The Tercel was configured with 33 cm (13”) steel wheels and Concorde Premium Metric P175/70R13 tires. The specific tire information at the time of the SCI investigation is outlined in the following table:

Position	Measured Tire Pressure	Measured Tread Depth	Tire/Wheel Damage
Left Front	152 kPa (22 PSI)	4 mm (5/32”)	None
Left Rear	172 kPa (25 PSI)	6 mm (8/32”)	None
Right Front	152 kPa (22 PSI)	4 mm (5/32”)	None
Right Rear	172 kPa (25 PSI)	6 mm (8/32”)	None

The interior of the Tercel was configured with bucket seats with integral head restraints for the front passenger positions and a fixed bench seat for the three rear seat positions. The safety systems included manual lap and shoulder belts for the four outboard positions and a fixed length lap belt for the second row center position.

**Crash Sequence**

**Pre-Crash**

The 18-year old female driver of the 1995 Toyota Tercel had just departed her place of employment and picked up the 3-month old child at a relative’s home. En route to her home, she had traveled approximately 3 km (2 miles) prior to the crash. The driver was traveling southbound on a two-lane curved roadway (**Figure 2**) and reportedly fell asleep as she approached the crash site. As the



**Figure 2 - Southbound approach of the Tercel.**

roadway curved to the right, the vehicle drifted off the left roadside and traveled approximately 25 m (80') on the grassy roadside. The vehicle approached a utility pole and an advertising sign secured by two wooden sign posts.

### ***Crash***

The front right area of the Tercel impacted the utility pole resulting in moderate damage. The direction of force for the impact with the pole was in the 12 o'clock sector and the impact was sufficient to command a deployment of the vehicle's frontal air bag system. The damage algorithm of the WinSMASH program calculated a total delta V of 32 km/h (19.8 mph). The specific longitudinal and lateral components were -32 km/h (-19.8 mph) and 6 km/h (3.7 mph).

Following the initial impact, the Tercel rotated clockwise approximately 80 degrees and its left side impacted a wooden sign post. The post was designed to hold a roadway advertisement sign in place. The secondary impact resulted in minor damage to the forward aspect of the vehicle's left front door near the A-pillar. The direction of force for this impact was 280 degrees. The damage algorithm of the WinSMASH program calculated a total delta-V of 10 km/h (6.2 mph) for this secondary impact. The specific longitudinal and lateral components were -2 km/h (-1.2 mph) and 10 km/h (6.2 mph). The vehicle came to rest near the second impact and was facing in southwest direction. **Figures 3 and 4** are close-up views of the struck roadside objects.



**Figure 3 - Impacted utility pole (Event 1).**



**Figure 4 - Impacted wooden sign post (Event 2).**

### ***Post-Crash***

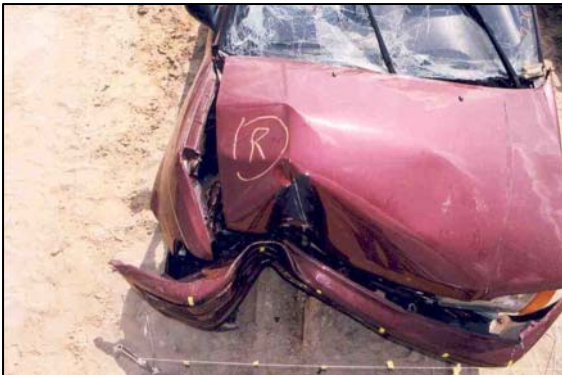
The driver of the Tercel exited the vehicle under her own power and called her mother to report the crash. The 3-month old child, who was crying and found in the left rear of the vehicle post-crash, was removed from the vehicle. The child's mother placed the child and the RFCSS into a relative's vehicle who transported the child to a local hospital for treatment. After arrival at the hospital, the child was transferred to a regional trauma center where he died en-route. The 18-year old female driver was transported to a local hospital by a separate private vehicle where she was treated and released.



## ***Vehicle Damage***

### ***Exterior Damage – 1995 Toyota Tercel***

The 1995 Toyota Tercel sustained moderate damage as a result of the impact with the utility pole (**Figure 5**). The direct contact damage began 18 cm (7") right of the vehicle's centerline and extended 20 cm (8") to the right. The combined direct and induced damage encompassed the vehicle's front bumper beam and measured 117 cm (46"). The maximum crush was located at C5, 31 cm (12.4") right of the vehicle's centerline and measured 44 cm (17.5") in depth. The vehicles rebar mounting bracket separated due to lateral right frame rail displacement and the impact compressed the right side wheelbase by 7 cm (2.75"). The Collision Deformation Classification (CDC) for the frontal impact with the utility pole was 12-FREN-3. Six equidistant crush measurements were documented across the front bumper and were as follows: C1 = 3 cm (1.2"), C2 = 13 cm (5.1"), C3 = 24 cm (9.4"), C4 = 35 cm (13.8"), C5 = 44 cm (17.3") and C6 = 16 cm (5.9").



**Figure 5 - Frontal damage to the 1995 Toyota Tercel.**



**Figure 6 - Left side damage to the 1995 Toyota Tercel.**

Following the impact with the utility pole, the Tercel rotated clockwise and its left side and impacted a wooden post resulting in minor damage (**Figure 6**). The direct contact damage was concentrated on the forward aspect of front left door near the A-pillar. The direct contact damage began 134 cm (52.8") forward of the left rear axle and extended forward 34 cm (13.4"). The combined direct and induced damage began 94 cm (37") forward of the left rear axle and extended forward 100 cm (39.4"). The maximum crush was located at C5 and was 8 cm (3.1") in depth. The CDC for the left side impact was 09-LPAN-1. Six equidistant measurements were documented along the mid-door level and were as follows: C1 = 0 cm, C2 = 2 cm (0.8"), C3 = 3 cm (1.2"), C4 = 6 cm (2.4"), C5 = 8 cm (3") and C6 = 0 cm.

### ***Interior Damage – 1995 Toyota Tercel***

The 1995 Toyota Tercel sustained minor interior damage as a result of intrusion and occupant contact. Longitudinal intrusion of the front right instrument panel and upper toe pan reduced occupant space by 8 cm (3.1"). The intrusion resulted in substantial damage to the glove compartment area and the compartment door was displaced from the instrument panel. Pronounced scuff marks and component damage was present on the



left side of the steering column and onto the top aspect knee bolster. Laterally, the scuffs began 39 cm (15.5") left of the vehicle's centerline and extended left 7 cm (2.75"). Vertically, they began 25 cm (11") below the top of the instrument panel's brow and extended downward 8 cm (3.1"). This contact point was attributed to the driver's left knee. A second prominent scuff was located on the right aspect of the driver's knee bolster in proximity to the driver's right knee. The scuff contained associated fabric embedded within the panel. Laterally, the contact to the right bolster began 15 cm (6") left of the vehicle's centerline and extended left 8 cm (3"). Vertically, the scuff began 28 cm (11") below the instrument panel's brow and extended downward 6 cm (2.4"). **Figure 7** illustrates the damage resulting from the driver's lower extremity contact. Less prominent contact points were located on the front left interior door panel. Although faint, scuffing to the top aspect of the left door attributable to the driver's left shoulder and scuffing to the left armrest attributable to the driver's left hip were documented. Based on the 9 o'clock direction of force of the secondary impact, the trajectory of the driver probably placed her at this location. No discernable contact points to interior components were located in the area front right passenger's seating position. However, loading evidence to the front right air bag was identified and is discussed in greater detail in the Frontal Air Bag section of this report.



**Figure 7 - Contact damage to knee bolster from driver's knees.**

### ***Manual Safety Belt Systems – 1995 Toyota Tercel***

The Tercel was equipped with manual 3-point lap and shoulder belts for the two frontal seating positions. The driver's belt was configured with continuous loop webbing, a sliding latch plate, and a belt sensitive Emergency Locking Retractor (ELR). Frictional abrasions were present on the sliding latch plate housing as a result of occupant loading. The abrasions were located on both surfaces of contact with the belt webbing and were 5 cm (2") in width. The webbing also sustained damage from occupant loading. The loading marks were located 70 – 81 cm (27.5 – 32") above the floor anchor, 15 – 26 cm (5.75 – 10.25") above the stop button (**Figure 8**). The left front webbing was also twisted when stowed reorienting the latch plate to face outside the vehicle.



**Figure 8 - Loading evidence on the driver's belt webbing.**

The front right safety system was configured with a single energy management loop positioned 10 cm (4") above the floor anchor and housed within a vinyl sleeve. The management loop was not deployed. The front right belt was also configured with a

sliding latch plate and switchable ELR/Automatic Locking Retractor. There was no discernable loading evidence on the belt's webbing or the sliding latch plate.

The rear seats were configured with manual 3-point lap and shoulder belts for the two outboard positions and a fixed length lap belt for the center position. The outboard belts had sliding latch plates and swithable ELR/ALR retractors. The center lap belt had a locking latch plate. The rear seat was unoccupied during the crash and the safety belts revealed limited historical usage.

***Frontal Air Bag System – 1995 Toyota Tercel***

The 1995 Toyota Tercel was equipped with first generation frontal air bags for the driver and front right passenger positions. The driver's air bag (**Figure 9**) deployed from the steering wheel hub through H-configuration module cover flaps. The upper flap measured 13 cm (5.25") in width and 9 cm (3.6") in height. The lower flap measured 13 cm (5.25") in width and 7 cm (2.75") in height. The deployed driver's air bag measured 66 cm (26") in diameter in its deflated state. The air bag was tethered by two 16 cm (6.25") straps with associative tether stitching on the face of the bag.



**Figure 9 - View of driver's air bag.**

The air bag was vented by dual 3 cm (1.25") ports. There was no discernable contact evidence on the air bag membrane. The following nomenclature was stamped at the forward aspect on the top of the deployed air bag:

45164-16030-A  
BBNF008  
4SS94Y070  
051294  
S  
N4L40188

The front right passenger's air bag deployed from a top-mount module configured with a single rectangular cover flap hinged at the forward aspect. The cover flap measured 32 cm (12.75") in width and 22 cm (8.75") in height. The cover flap sustained abrasions due to contact with the laminated windshield (**Figure 10**). The abrasions were to the cover flap's leading edge and were 30 cm (12") in length and 5 cm (2") in height. The deployed front right air bag (**Figure 11**) measured 48 cm in width and 56 in height in its deflated state and had an excursion of 56 cm (22") from the instrument panel and 64 cm (25") from the



**Figure 10 - Front right cover flap and windshield interaction.**

leading edge of the module. The air bag contained no internal tethers. The air bag was vented by two 7 cm (2.75”) ports located in the 3 and 9 o’clock sectors of the air bag. Contact evidence in the form of black scuffs with brown substance transfers were documented on the front right air bag (**Figure 12**). These scuffs were located 5 – 17 cm (2 – 6.5”) right of the air bag’s center and 36 – 43 cm (14 – 17”) below the top horizontal seam. The following nomenclature was stamped on the top of the right front air bag adjacent to the inflator:

B500 23594FC6



**Figure 11 - View of the right front deployed air bag.**



**Figure 12 - Close-up of transfer evidence on front right air bag.**

### ***Rear Facing Child Safety Seat***

The 3-month old male right front passenger was seated in a rear facing child safety seat that was held in place with the manual 3-point lap and shoulder belt. The RFCSS was equipped with an internal harness; however, the harness was reportedly not used during the crash. The specific type of RFCSS was not reported.

### ***Occupant Demographics***

#### ***Driver***

Age/Sex:	18-year old female
Height:	Not reported
Weight:	Not reported
Seat Track Position:	Full-rear
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Eyewear:	Not Reported
Type of Medical Treatment:	Transported to hospital by private vehicle and treated and released

#### ***Driver Kinematics***

The 18-year old driver was seated in a presumed upright attitude and was restrained by the manual 3-point lap and shoulder belt. The driver of the vehicle had just left her place of employment and after picking up the child at a relative’s home. She fell asleep and drifted off the left side of the roadway.

At impact with the utility pole, the air bag deployed and the restrained driver initiated a forward and slightly left trajectory toward the instrument panel. The driver loaded the manual safety belt evidenced by marks on the belt’s webbing and the sliding latch plate. The driver’s lower extremities contacted and scuffed the knee bolster in two locations as described in the Interior Damage section of this report. After loading the knee bolster and safety belt, the driver was displaced to the left from the clockwise rotation of the vehicle and subsequent left side impact with the wooden sign post. The driver loaded the interior of the front left door and the left armrest. This is supported by faint scuff marks on these components and the kinematical principals of occupant motion. The driver reportedly sustained minor injuries and was transported by a private vehicle to a local hospital. She was evaluated, treated, and then released the same day.

***Front Right Passenger***

Age/Sex: 3-month old Male  
 Height: 67 cm (26.4”)  
 Weight: 8 kg (18 lb)  
 Seat Track Position: Full-rear  
 Manual Restraint Use: Placed in rear facing CSS installed incorrectly and without internal harness  
 Usage Source: Police reported  
 Eyewear: None  
 Type of Medical Treatment: Transported to hospital by private vehicle and transferred to regional trauma center; expired en-route

***Front Right Passenger Injuries***

<b>Injury</b>	<b>Injury Severity (AIS90/Update 98)</b>	<b>Injury Source</b>
Subdural hematoma (10 ml) to right temporal lobe	Severe (140652.4,1)	Expanding air bag against shell of RFCSS
Cerebral laceration to right temporal lobe	Severe (140688.4,1)	Expanding air bag against shell of RFCSS
Right cerebellar laceration	Severe (140474.4,6)	Expanding air bag against shell of RFCSS
Left frontal lobe hemorrhage, NFS	Severe (140629.4,2)	Expanding air bag against shell of RFCSS
Bilateral lung lacerations – right lung included upper and middle lobe [3 x 3 cm (1.2 x 1.1”) area] – left lung included upper and lower lobe [2 x 1 cm (0.8 x 0.5”) area]	Severe (441410.4,3)	Expanding air bag against shell of RFCSS

<b>Injury</b>	<b>Injury Severity (AIS90/Update 98)</b>	<b>Injury Source</b>
Right and left subarachnoid hemorrhages	Serious (140684.3,1) (140684.3,2)	Expanding air bag against shell of RFCSS
Vault fracture [11 cm (4.5'')] to right temporal skull with two associative perpendicular fractures	Moderate (150402.2,1)	Expanding air bag against shell of RFCSS
Scalp abrasions to left side of head – 1 x 0.3 cm (0.5 x 0.1'') area.	Minor (190202.1,2)	Unknown
Right side diffuse subgaleal hemorrhage	Minor (190402.1,1)	Expanding air bag against shell of RFCSS

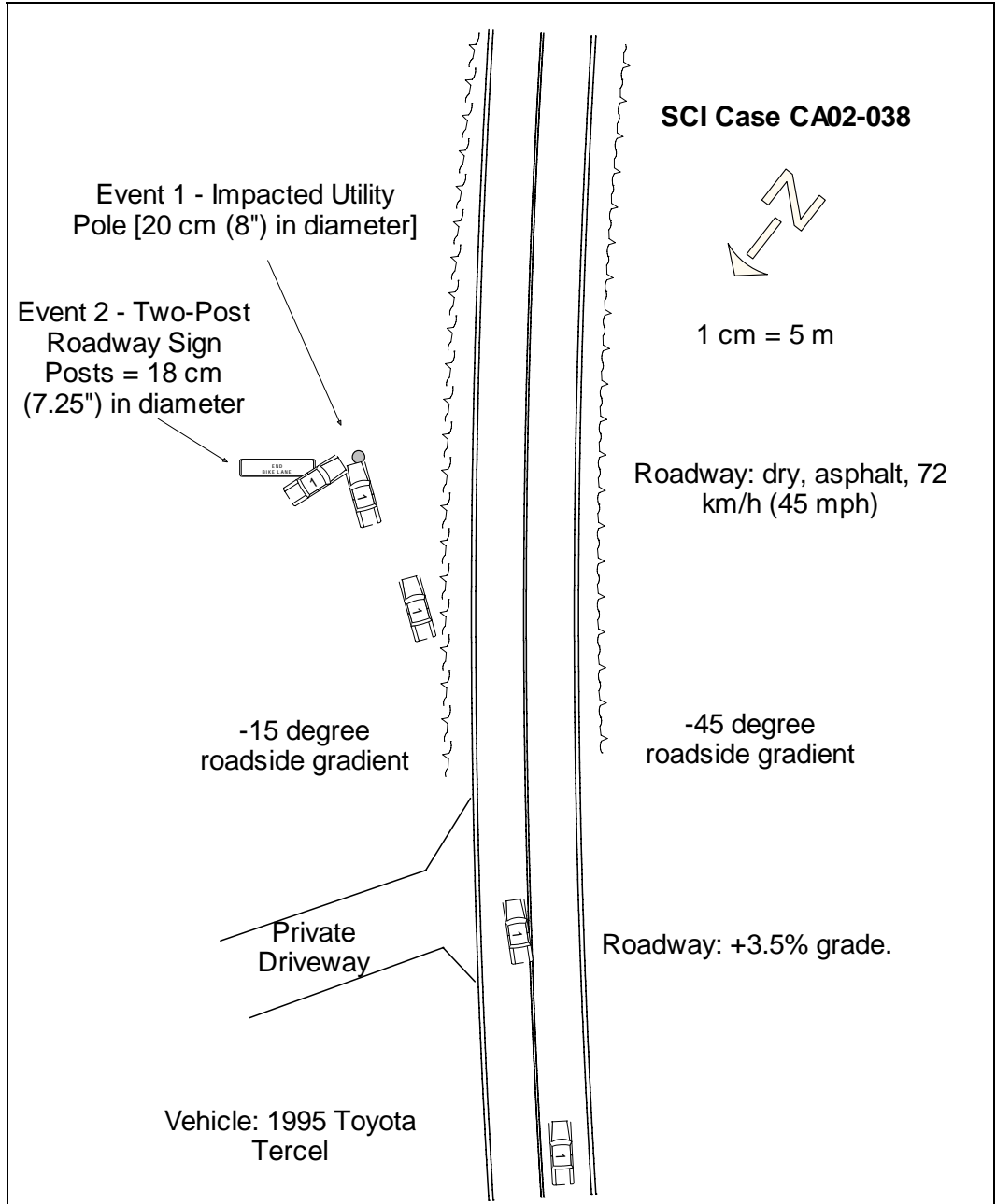
*Source: Autopsy*

### ***Front Right Passenger Kinematics***

The 3-month old male child was placed within a RFCSS without use of the internal harness. The RFCSS was reportedly secured within the vehicle by the manual 3-point lap and shoulder belt. At impact, the frontal air bag deployed and the child and RFCSS initiated a forward and slightly left trajectory toward the instrument panel. The air bag reportedly expanded against the rear facing RFCSS, displacing the same in a rearward direction. The air bag contained transfer evidence in the form of black scuffs and a brownish material imbedded within the scuff. It is probable the scuff was the result of the air bag expanding against the shell of the RFCSS and the brownish material was possibly a fabric within the RFCSS.

As the air bag expanded against the shell of the RFCSS, momentum was transmitted through the RFCSS resulting in multiple head and brain injuries along with bilateral lung lacerations. Specifically, the child's head injuries included an 11 cm (4.5'') vault fracture, a subdural hematoma, lacerations to the right temporal lobe, left frontal lobe, and right cerebellum, bilateral subarachnoid hemorrhages, and multiple soft-tissue injuries.

The infant was displaced from the RFCSS and thrust into the rear seat of the vehicle where he sustained multiple abrasions to his left scalp. The child was heard to be crying and was removed from the left rear seat of the vehicle by the driver. A relative of the driver responded to the scene and transported the child to a local hospital. The child was evaluated and was then transferred to a regional trauma center. The child sustained police-reported severe brain damage and expired while en-route to the trauma center.



**Figure 13 – SCI Crash Schematic**