

**TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER**

**Veridian Engineering
Buffalo, New York 14225**

ON-SITE AIR BAG RELATED CHILD FATALITY INVESTIGATION

VERIDIAN CASE NO: CA98-070

VEHICLE: 1995 PONTIAC SUNFIRE

LOCATION: SOUTH CAROLINA

CRASH DATE: DECEMBER 1998

Contract No. DTNH22-94-07058

Prepared for:

**U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, DC 20590**

DISCLAIMER

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be 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 of the involved vehicle(s) or their safety systems.

TECHNICAL REPORT STANDARD TITLE PAGE

<p>1. <i>Report No.</i> CA98-070</p>	<p>2. <i>Government Accession No.</i></p>	<p>3. <i>Recipient's Catalog No.</i></p>	
<p>5. <i>Title and Subtitle</i> On-site Air Bag Related Child Fatality Investigation Vehicle: 1995 Pontiac Sunfire Location: South Carolina</p>		<p>4. <i>Weights</i></p>	
		<p>6. <i>Report Date:</i> May 2002</p>	
<p>8. <i>Author(s)</i> Crash Data Research Center</p>		<p>7. <i>Performing Organization Code</i></p>	
		<p>9. <i>Performing Organization Report No.</i></p>	
<p>10. <i>Performing Organization Name and Address</i> Transportation Sciences Crash Data Research Center Veridian Engineering P.O. Box 400 Buffalo, New York 14225</p>		<p>11. <i>Work Unit No.</i> CO1115.0000.(9170-9179)</p>	
		<p>12. <i>Contract or Grant No.</i> DTNH22-94-D-07058</p>	
<p>13. <i>Sponsoring Agency Name and Address</i> U.S. Department of Transportation National Highway Traffic Safety Administration Washington, DC 20590</p>		<p>14. <i>Type of Report and Period Covered</i> Technical Report Crash Date: December 1998</p>	
		<p>15. <i>Sponsoring Agency Code</i></p>	
<p>16. <i>Supplementary Notes:</i> On-site investigation of the injury mechanism of a 3 year old child seated on the lap on the front right passenger in a 1995 Pontiac Sunfire.</p>			
<p>17. <i>Abstract</i></p> <p>This on-site investigation focused on the fatal injury mechanism of a 3 year old male seated in the lap of the front right passenger in a 1995 Pontiac Sunfire. The Pontiac was involved in an intersection crash with a 1992 Volkswagen Fox. The Pontiac Sunfire was equipped with a Supplemental Restraint System that consisted of driver and front right passenger air bags that deployed as a result of the crash. The lap seated child was in-close proximity to the passenger air bag module and was contacted by the deploying air bag early in its deployment sequence. The expansion of the air bag caused abrasions about the child's head, neck and under the chin and resulted in hyper-extension of the head. The child was pronounced deceased with a C1-C2 cervical fracture with a 2 cm distraction.</p> <p>The Medical Examiner's office of North Carolina informed the Special Crash Investigations team at Veridian Engineering of this crash. The medical examiner noted the similarity in injury patterns between the 3 year old male in this crash to two previous child fatalities. The Crash Investigations Division of the National Highway Traffic Safety Administration subsequently assigned an on-site investigation of the crash.</p>			
<p>18. <i>Key Words</i> Supplemental Restraint System Unrestrained Seated on the lap Cervical fracture</p>		<p>19. <i>Distribution Statement</i> General Public</p>	
<p>20. <i>Security Classif. (of this report)</i> Unclassified</p>	<p>21. <i>Security Classif. (of this page)</i> Unclassified</p>	<p>22. <i>No. of Pages</i> 11</p>	<p>23. <i>Price</i></p>

TABLE OF CONTENTS

BACKGROUND	1
SUMMARY	
Crash Site	1
Pre-Crash	2
Crash	2
Post-crash	2
1995 PONTIAC SUNFIRE	
Exterior Damage	3
Interior Damage	4
Manual Restraint System	6
Supplemental Restraint System	6
1992 VOLKSWAGEN FOX	
Exterior Damage	5
OCCUPANT DEMOGRAPHICS	8
DRIVER INJURY	9
RIGHT FRONT ADULT PASSENGER INJURY	9
LAP SEATED CHILD PASSENGER INJURY	9
LAP SEATED CHILD PASSENGER KINEMATICS	10
CRASH SCHEMATIC	11

**ON-SITE AIR BAG RELATED CHILD FATALITY INVESTIGATION
VERIDIAN CASE NO: CA98-070**

**VEHICLE: 1995 PONTIAC SUNFIRE
LOCATION: SOUTH CAROLINA
CRASH DATE: DECEMBER 1998**

BACKGROUND

This on-site investigation focused on the fatal injury mechanism of a 3 year old male seated on the lap of the front right passenger in a 1995 Pontiac Sunfire. The Pontiac was involved in an intersection crash with a 1992 Volkswagen Fox. The Pontiac Sunfire was equipped with a Supplemental Restraint System that consisted of driver and front right passenger air bags that deployed as a result of the crash. The lap seated child was in-close proximity to the passenger air bag module and was contacted by the deploying air bag early in its deployment sequence. The expansion of the air bag caused abrasions about the child's head, neck, and submental area and resulted in hyper-extension of the neck. The child was pronounced deceased with a C1-C2 cervical fracture with a 2 cm (1 in) distraction.

The Medical Examiner's office of North Carolina informed the Special Crash Investigations team at Veridian Engineering of this crash. The Medical Examiner noted the similarity in the injury patterns between the 3 year old male in this crash to two previous child fatalities. The Crash Investigations Division of the National Highway Traffic Safety Administration subsequently assigned an on-site investigation of the crash. Both vehicles were located in the police impound pending this SCI inspection.

SUMMARY

Crash Site

This two-vehicle crash occurred during the afternoon hours of December 1998. At the time of the crash, it was daylight and raining. The road surfaces were wet. The crash occurred within the intersection of a five lane east/west road and five lane north/south road. The east/west road consisted of two lanes passing through the intersection and opposing left turn lanes. The respective travel lanes of the east/west road were separated by a grass median. The west median (relative to the intersection) measured 1.5 m (5.0 ft) in width and was protected by a 15 cm (6 in) barrier curb. The intersection was controlled by operational overhead (red/amber/green) traffic signals. **Figure 1** is a westbound trajectory view of the Pontiac Sunfire.



Figure 1. Pre-crash trajectory of the Pontiac Sunfire

Pre-Crash

The 1995 Pontiac Sunfire was westbound in the inboard through lane intending to pass through the intersection. The vehicle was operated by a 22 year old female. A 21 year old male was the front right passenger. A 3 year old male was seated on the lap of the front right passenger. He was eating a hot dog at the time of the crash. The 1992 Volkswagen Fox was eastbound in the left turn intending to turn. The Volkswagen was driven by an 18 year old male. Another 18 year old male was the front right passenger. The Volkswagen proceeded to turn left across the path of the Pontiac, precipitating the crash. Pre-crash braking evidence was not identified nor attributed to either vehicle. Witnesses indicated the traffic light was in the yellow to red phase when the crash occurred.

Crash

The central and right aspects of the Pontiac front plane struck the right side of the Volkswagen in an 11/2 o'clock impact configuration. The impact damage to the Volkswagen began at the right B-pillar location and extended rearward into the right rear suspension. The force of the impact caused the frontal air bags on the Pontiac to deploy. **Figure 11**, page 11, is a schematic of the crash.

The westward momentum and its impact rearward of the Volkswagen's center of gravity caused the Volkswagen to rotate clockwise (CW) as the vehicle's disengaged from the collision. The Volkswagen rotated approximately 200 degrees as it slid to its final rest position in the mouth of the northbound lanes. The Volkswagen came to rest facing west approximately 15 m (50 ft) northeast of the point of impact (POI).

The Pontiac continued on its westward trajectory after separating from the Volkswagen. The front undercarriage of the Pontiac then impacted and overrode the barrier curb protecting the center median located west of the intersection. Inspection of the curb face identified contact damage which was subsequently linked to the Pontiac's undercarriage damage. The vehicle then came to rest straddling the median approximately 24 m (79 ft) from the POI. **Figure 2** is a view of the median and the area of the vehicle's final rest.



Figure 2: View of the barrier curb and the area of the Pontiac's final rest.

Post-Crash

The police and ambulance personnel responded to the crash scene. The child was found in the arms of the front right passenger and was unresponsive. The emergency responders applied life supportive measures and transported him to a local hospital. This facility in-turn immediately transferred him via mercy flight to a regional trauma center. He arrived in the trauma unit 2 hours and 33 minutes post-crash. Efforts to save the child's life were unsuccessful due to the seriousness of his injuries and he was removed from life support 6 hours and 33 minutes post-crash.

The occupants of the Pontiac reportedly told the police investigators that at the time of the crash the child was restrained by the lap belt in the center rear seat of the vehicle. They indicated that due to the forces of the crash, the child came forward and contacted the air bag and then rebounded into the front right passenger's arms. The police inspected the vehicle and found the lap belt inaccessible under the rear bench seat. The police investigators concluded the occupant was in the right front seat location.

1995 PONTIAC SUNFIRE

The 1995 Pontiac Sunfire was identified by the Vehicle Identification Number (VIN): 1G2JB5242S7 (production sequence deleted). The Pontiac Sunfire was equipped with the SE trim level. The power train consisted of a 2.2 liter/I4 engine linked to a 4-speed automatic transmission. The vehicle's date of manufacture was November 1994. The odometer read 82,816 miles at the time of the inspection. The driver purchased the pre-owned vehicle from an unknown source on May 27, 1998. The vehicle's prior history was not known.

Exterior Damage

Figures 3 through 5 are the front, right side and right lateral views depicting the Pontiac's damage. The front plane of the vehicle sustained 80.0 cm (31.5 in) of direct contact damage. The direct contact began 15 cm (6 in) left of center and extended to the right corner of the front bumper. The combined width of the direct and induced damage extended across the full 125 cm (49 in) frontal end width of the Pontiac. The crush profile measured along the bumper was follows: C1 = 6.0 cm (2.4 in), C2 = 6.0 cm (2.4 in), C3 = 7.0 cm (2.8 in), C4 = 10.0 cm (3.9 in), C5 = 15.0 cm (5.9 in), C6=20.0 cm (7.9 in). There was no measurable change in the either wheelbase



Figure 3: Pontiac front view.

dimension. The hood and right front fender were buckled. All the doors remained shut during the crash and were operational upon inspection. The Collision Deformation Classification was 11-FZEW-1. The total delta V calculated by the damage algorithm of the WINSMASH model was 17.0 km/h (10.6 mph). The longitudinal and lateral delta V components were -16.0 km/h (9.9 mph) and 5.8 km/h (3.6 mph). The Principle Direction of Force (PDOF) was an estimated 20 degrees. The vehicle's impact speed calculated by the trajectory model was 40.0 km/h (24.9 mph). The WINSMASH analysis was a borderline speed reconstruction because of the violation of the common velocity assumption.

The central aspect of the Pontiac's undercarriage sustained minor contact damaged, during its post crash trajectory, as it impacted and overrode the barrier curb protecting the center median. The CDC of the damage was 12-UFCW-2.



Figure 4: Pontiac right side view.



Figure 5: Right lateral view of the frontal damage.

Interior Damage

The interior damage of the Pontiac was consistent with the deployment of the vehicle's frontal air bag system and occupant contacts within the forward interior. There was no intrusion or interior damage associated with the exterior forces of the crash.

The driver's seat was adjusted to a full rear track position. The total seat track adjustment measured 18 cm (7 in). The seat back was reclined 26 degrees aft of vertical. The anti-submarine angle measured 15 degrees. The horizontal distance from the driver air bag module to the seat back measured 71 cm (28 in). There was no displacement of the steering column's shear capsules. No driver contacts were identified within the front left interior.

The front passenger seat was also adjusted to the full rear position. The total seat track adjustment measured 18 cm (7 in). The seat back was reclined 45 degrees aft of vertical. The anti-submarine angle of the seat cushion measured 15 degrees. The horizontal distance from the seat back to the passenger air bag module measured 122 cm (48 in). It was possible (although unverified) that this was the at-crash position of the seat. The reclined seat back would have allowed greater interior space for the front right and lap seated passengers.

The interior surface of the windshield's right aspect was fractured from direct contact with the cover flap of the passenger air bag module. The fracture pattern measured 33 cm (13 in) in width and was located 16.5 cm (6.5 in) above the instrument panel.

The right aspect of the center instrument panel and inboard aspect of the right knee bolster exhibited a crescent shaped scuff mark attributed to contact from the left lower extremity of the adult front right passenger. The elevation of this contact measured 36 cm (14 in) above the floor. A 5 cm x 2 cm (2 in x 1 in) scuff located 39.4 cm (15.5 in) right of center along the lower aspect of the knee bolster was attributed to the right lower extremity of the adult passenger. A 8 cm (3 in) wide contact scuff, located 56

cm (22 in) right of center along the upper aspect of the bolster, was attributed to contact from the lap seated child's right lower extremity.

Two vertically oriented, swiping contacts were identified on the interior surface of the windshield. The contacts were located 38 cm (15 in) and 44.4 cm (17.5 in) right of center respectively. Immediately above the contacts, a small depression was noted in the leading edge of the headliner. These contacts were attributed to probable contact from the child's head.

Several large areas of food particles were noted throughout the right front interior. The particles were emitted from the child passenger post-crash. Reportedly, he was eating a hot dog at the time of the impact. It was noted on the autopsy report, the child had also aspirated some of the food during the crash sequence.

1992 VOLKSWAGEN FOX

The 1992 Volkswagen Fox was identified by the Vehicle Identification Number (9BWGA2300NP (production sequence deleted). The vehicle was manufactured in December 1991. The power train consisted of a 1.8 liter/I4 engine linked to a 4-speed manual transmission. The vehicle's restraint system consisted of a 2-point automatic shoulder belt and a 2-point manual lap for the front seated occupants. The vehicle was not equipped with a Supplemental Restraint System (SRS).

Exterior Damage

The right side of the Volkswagen sustained a combined width of direct contact and induced damage that measured 196.3 cm (77.3 in), **Figure 6**. The induced damage began 58 cm (23 in) rear of the right front axle location and extended rearward. The direct contact damage width measured 146.1 cm (57.5 in) and began 89 cm (35 in) rear of the right front axle (in the area of the right B-pillar). The maximum crush measured 29.2 cm (11.5 in) and was located 155 cm (61 in) rear of the right front axle on the mid-aspect of the right rear door. The crush profile measured along the trim elevation was as follows: C1 = 0, C2 = 17.8 cm (7.0 in), C3 = 26.7 cm (10.5 in), C4 = 16.5 cm (6.5 in), C5 = 8.9 cm (3.5 in), C6=1.0 cm (0.4 in). The right doors were jammed shut due to deformation. All the side window glazings were intact. The right rear wheel rim was bent due to impact damage. However, there was no measurable change in the wheelbase dimension. The Collision Deformation Classification (CDC) of this vehicle was 02-RPEW-03. The total delta V calculated by the damage algorithm of the WINSMASH model was 21.0 km/h (13.0 mph). The longitudinal and lateral delta V components were -13.5 km/h (-8.4 mph) and -16.1 km/h (-10.0 mph). The vehicle's impact speed calculated by the trajectory model was 43.6 km/h (27.1 mph).



Figure 6: Right rear view of the Volkswagen Fox.

The WINSMASH analysis was a borderline speed reconstruction because the vehicles did not attain a common velocity during the crash. The common velocity assumption is a basic principle of the model.

Manual Restraint System - Pontiac Sunfire

The Sunfire was equipped with 3-point lap and shoulder belts in the four outboard seat positions. The outboard restraints utilized continuous loop webbings, sliding latch plates and inertial locking retractors. The D-rings for the front restraints were adjustable. The center rear position was equipped with a lap belt. The latch plate for this belt was tucked under the rear seat cushion and was not accessible to a potential occupant.

The driver's restraint was stowed within its retractor at the time of the inspection and was operational. The adjustable D-ring was in a mid-position. Examination of the latch plate revealed evidence of historical use. However, given the vehicle was purchased used approximately six months prior to the crash, this evidence was not an indicator of this driver's habits. Inspection of the webbing and friction surfaces of the hardware was unremarkable; no crash related usage evidence was identified. However, given the minor severity of the crash, usage evidence would not be expected. It was probable the driver was not restrained at the time of the crash considering the lack of restraint used by the two front right passengers.

The front right passenger restraint was stowed at inspection and operational. The adjustable D-ring was in the full up position. Examination of the latch plate revealed signs of historical use. Inspection of the webbing and hardware surfaces did not identify any indicators of use during the crash. Food particles were observed on the plastic casing of the inboard buckle. Given their location, had the restraint been in use at the time of the crash, food particles would also be expected on the latch plate and/or webbing. However, none were identified. Given the evidence, it is unlikely that the front right restraint was in use at the time of the crash.

Inspection of the center rear position revealed the lap belt latch plate was tucked into the rear seat bight and was not available for use. The child passenger was not in this seat position and restrained at the time of the crash, as stated by the vehicle's occupants. Furthermore, had he been seated in this position, the lap belt could not have been used.

Supplemental Restraint System

The Supplemental Restraint System in the 1995 Pontiac Sunfire consisted of first generation frontal air bags for the driver and front right passenger. The system was controlled by a control module located in the center aspect of the instrument panel and utilized three external sensors. The frontal air bags had deployed as a result of the above-threshold intersection crash.

The driver air bag module was located in the center of the steering wheel. The I-configuration module cover flaps opened as designed along the tear seams. The flaps were symmetrical and measured 8 cm x 10 cm (3 in x 4 in), width by height. The deployed driver air bag, **Figure 7**, measured 66 cm (26 in) in diameter and was not tethered. The bag was vented by two 1.3 cm (0.5 in) diameter ports located in the

3/9 o'clock sectors on the back side. On the face of the air bag, three areas of vinyl transfers were noted in the 12 o'clock, central, and 6 o'clock aspects. The transfers measured approximately 20 cm (8 in) in length and were attributed to contact with the cover flaps during the deployment. These transfers were considered typical for this air bag. No evidence of occupant contact was observed on the driver air bag. The driver air bag was identified by the following manufacturers nomenclature:

PUT12323-01C
TAC279H30367



Figure 7: Driver air bag.

The front right passenger air bag module was a top mount design located in the right aspect of the instrument panel. The module cover flap was rectangular in shape and measured 33 cm x 20 cm (13 in x 8 in). The flap was constructed of 1.6 mm (1/16 in) hard plastic. The interior surface was backed by a thin-gauge metal plate. The exterior surface of the flap was abraded as a result of its contact to the windshield.

The face of the passenger air bag measured 48 cm x 56 cm (19 in x 22 in), width by height and extended rearward 56 cm (22 in) in its deflated state, **Figure 8**. The air bag was tethered by a 46 cm (18 in) wide strap sewn to the mid to upper aspect of the face of the bag. The membrane was not externally vented. The following nomenclature identified the passenger air bag:

P116753275
TBI425620175

The deploying passenger air bag contacted and abraded the face and neck of the lap seated child early in the deployment sequence. This contact resulted in a large tissue transfer to the horizontal top surface and vertical face of the bag, **Figures 9 and 10**. The tissue transfer measured 43.2 cm x 12.2 cm (17.0 in x 4.8 in), length by width, and



Figure 8: Front right passenger air bag.

was located within the central aspect of the bag's width. The transfer began on the air bag's top surface approximately 25 cm (10 in) from the inflator, extended rearward 30 cm (12 in) and wrapped 12 (5 in) onto the face of the bag.



Figure 9: View of the tissue transfer to the top surface of the PAB.



Figure 10: Profile view of the PAB and tissue transfer.

OCCUPANT DEMOGRAPHICS

	<i>Driver</i>	<i>Front Right Adult Passenger</i>	<i>Lap Seated Child Passenger</i>
Age/Sex:	22 years old/Female	21 year old/Male	3 year old/Male
Height:	170 cm (67 in)	193 cm (76 in)	94 cm (37 in)
Weight:	98 kg (215 lb)	136 kg (300 lb)	20 kg (45 lb)
Manual Restraint Use:	Unrestrained	Unrestrained	Unrestrained
Usage Source:	SCI inspection	SCI inspection	SCI inspection/ occupant kinematics
Medical Treatment:	None	None	Fatally Injured

DRIVER INJURY

<i>Injury</i>	<i>Severity (AIS 98 update)</i>	<i>Injury Mechanism</i>
None reported	N/A	N/A

FRONT RIGHT PASSENGER INJURY

<i>Injury</i>	<i>Severity (AIS 98 update)</i>	<i>Injury Mechanism</i>
None reported	N/A	N/A

LAP SEATED CHILD ADULT PASSENGER INJURY

<i>Injury</i>	<i>Severity (AIS 98 update)</i>	<i>Injury Mechanism</i>
Large area of abrasion about the right anterior and left neck, chin, and extending into the left post-auricular region	Minor (390202.1,1,2,5) (290202.1,8) (290202.1,2)	Expanding front right passenger air bag
1.5 cm fracture separation at C1/C2 of the cervical vertebra with traumatic disruption of the cervical spinal cord	Maximum (640276.6,6)	Expanding front right passenger air bag
Subarachnoid hemorrhage most prominent at the base of the brain, brain stem hemorrhage and edema	Critical (140210.5,8)	Expanding front right passenger air bag
Tonsillar and uncal herniation	Critical (140202.5,8)	Expanding front right passenger air bag
Hemorrhage within the white matter of the cerebral cortex	Severe (140629.4,9)	Expanding front right passenger air bag
Right superior subarachnoid hemorrhage	Serious (140684.3,1)	Expanding front right passenger air bag
6 cm area of hemorrhage in the right parieto-occipital area in the subgalea	Minor (190402.1,1)	Rebound contact with the front right adult occupant
Laceration of the lower lip and mucosal	Minor (290602.1,8)	Self inflicted

<i>Injury</i>	<i>Severity (AIS 98 update)</i>	<i>Injury Mechanism</i>
Laceration of the spleen	Moderate (544222.2,2)	Physically restrained by front right adult occupant
Laceration of the mesentery at the gastroduodenal junction and small intestines, approx. 1000 cc of clotted and unclotted blood in the peritoneal cavity	Serious (542024.3,8)	Physically restrained by front right adult occupant

Note: the above injuries were identified in the Coroner's Autopsy Report.

LAP SEATED CHILD PASSENGER KINEMATICS

Immediately prior to the crash, the 3 year old child was seated on the lap of the front right passenger. He had a upright posture and reportedly was eating a hot dog. The adult occupant had his arms around the child's waist providing some support and stability to his position. Seated in this position, the child was in a forward position seated in-close proximity to the front right air bag module.

Upon impact with the Volkswagen, the frontal air bag system in Pontiac deployed. The deploying air bag contacted and abraded the child in the face and about the neck. The neck abrasions extended into the left post-auricular region and indicated the child turned his head to the right and/or was seated facing slightly rightward. The air bag expanded under the child's chin causing a hyper-extension of the neck resulting in the C1/C2 fracture and cervical spine disruption (AIS 6). The expanding bag lifted the child vertically causing the (probable) swipes across the windshield. The child's head and/or arms contacted the leading edge of the headliner noted by the depressed fabric. The lifting kinematic coupled with the restraint provided by the adult passenger's arms caused the lacerations of the spleen and mesentery. As the child rebounded toward the adult occupant, the right parieto-occipital region of his head contacted the adult's head resulting in the scalp contusion. The child rebounded and came to rest in the lap of the front right adult passenger. During the course of the crash sequence, the child bit his lower lip and aspirated some of the hot dog.

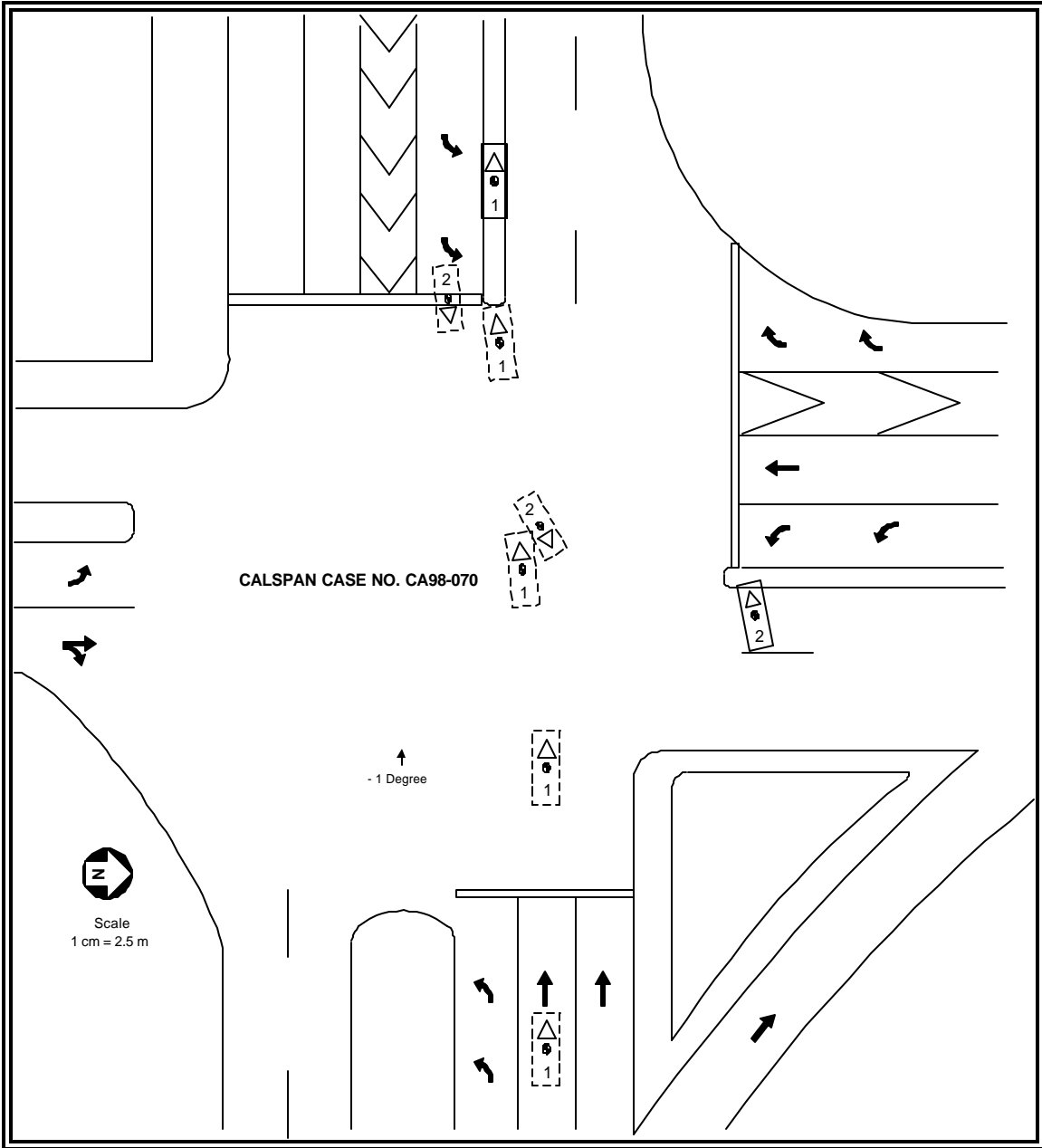


Figure 11: Crash Schematic.