

**TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER**

Veridian Engineering
Buffalo, New York 14225

**VERIDIAN ON-SITE AIR BAG RELATED
CHILD PASSENGER FATALITY INVESTIGATION**

VERIDIAN CASE NO. CA00-009

VEHICLE - 1995 FORD THUNDERBIRD LX

LOCATION - STATE OF FLORIDA

CRASH DATE - FEBRUARY, 2000

Contract No. DTNH22-94-D-07058

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 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 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.

TECHNICAL REPORT STANDARD TITLE PAGE

1. <i>Report No.</i> CA00-009	2. <i>Government Accession No.</i>	3. <i>Recipient's Catalog No.</i>	
4. <i>Title and Subtitle</i> Veridian On-Site Air Bag Related Child Passenger Fatality Investigation Vehicle - 1995 Ford Thunderbird LX Location - State of Florida		5. <i>Report Date:</i> April, 2000	
		6. <i>Performing Organization Code</i>	
7. <i>Author(s)</i> Crash Research Section		8. <i>Performing Organization Report No.</i>	
9. <i>Performing Organization Name and Address</i> Veridian Engineering Transportation Sciences Crash Data Research Center P.O. Box 400 Buffalo, New York 14225		10. <i>Work Unit No.</i> C01115.0271.(0000-0009)	
		11. <i>Contract or Grant No.</i> DTNH22-94-D-07058	
12. <i>Sponsoring Agency Name and Address</i> U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		13. <i>Type of Report and Period Covered</i> Technical Report Crash Date - February, 2000	
		14. <i>Sponsoring Agency Code</i>	
15. <i>Supplementary Notes</i> On-site investigation of an obtuse angle collision that involved a 1995 Ford Thunderbird LX equipped with frontal air bags.			
16. <i>Abstract</i> <p>This on-site investigation focused on the injury mechanisms that caused the death of a 3 year old male front right passenger of a 1995 Ford Thunderbird LX. The Ford was equipped with frontal air bags for the driver and right passenger positions which deployed as a result of an obtuse angle collision with a 1996 Chevrolet Blazer sport utility vehicle. The Chevrolet made an abrupt lane change (to the right) across the path of the Ford in an attempt to enter a parking area. The driver of the Ford steered right/braked in avoidance as the vehicle's right front wheel/tire impacted the right (west) barrier curb resulting in minor damage. The Ford's front left area subsequently struck the right rear area of the Chevrolet which resulted in minor damage to both vehicles.</p> <p>The unrestrained 26 year old male driver of the 1995 Ford Thunderbird LX initiated a forward trajectory in response to the 12 o'clock impact force as the expanding driver air bag contacted the anterior aspect of his left forearm resulting in a contusion. The driver refused treatment. The unrestrained front right child passenger was seated in an upright posture and initiated a forward trajectory in response to pre-crash braking. The curb impact further displaced the child in a forward direction as he loaded the right mid-instrument panel. At impact with the Chevrolet, he was forward within the path of the expanding air bag which struck the anterior neck and torso resulting in multiple abrasions. The air bag expansion hyper-extended the head resulting in a complete transection of the skull base from the first cervical vertebra with a transection of the underlying cervical cord and vertebral arteries. Associated brain trauma included a subarachnoid hemorrhage and cerebral edema. Expansion of the air bag membrane continued against the face and torso of the child which resulted in additional soft tissue injuries, a liver laceration, and a complete transection of the spleen. At this point, the child was accelerated rearward and struck the front right seat back support resulting in a scalp contusion. He came to rest on the center console between the front seat back supports. The child passenger was transported by ambulance to a local trauma center for treatment and expired later that day.</p>			
17. <i>Key Words</i> Mid-mount passenger air bag module Collision Deformation Classification (CDC): 12-FLEE-3 WinSMASH damage algorithm - borderline reconstruction Transection of the skull base from the first cervical vertebra		18. <i>Distribution Statement</i> General Public	
19. <i>Security Classif. (of this report)</i> Unclassified	20. <i>Security Classif. (of this page)</i> Unclassified	21. <i>No. of Pages</i> 8	22. <i>Price</i>

TABLE OF CONTENTS

BACKGROUND	1
SUMMARY	
Crash Site	1
Pre-Crash	2
Crash	2
Post-Crash	3
VEHICLE DATA	3
EXTERIOR VEHICLE DAMAGE	
1995 Ford Thunderbird LX	3
1996 Chevrolet Blazer	4
INTERIOR VEHICLE DAMAGE	
1995 Ford Thunderbird LX	4
MANUAL RESTRAINT SYSTEMS	5
SUPPLEMENTAL RESTRAINT SYSTEMS	5
DRIVER DEMOGRAPHICS	6
Driver Injuries	6
Driver Kinematics	6
FRONT RIGHT PASSENGER DEMOGRAPHICS	6
Front Right Passenger Injuries	7
Front Right Passenger Kinematics	7
SCENE DIAGRAM	8

**VERIDIAN ON-SITE AIR BAG RELATED
CHILD PASSENGER FATALITY INVESTIGATION
VERIDIAN CASE NO. CA00-009
VEHICLE - 1995 FORD THUNDERBIRD LX
LOCATION - STATE OF FLORIDA
CRASH DATE - FEBRUARY, 2000**

BACKGROUND

This on-site investigation focused on the injury mechanisms that caused the death of a 3 year old male front right passenger of a 1995 Ford Thunderbird LX. The Ford was equipped with frontal air bags for the driver and right passenger positions which deployed as a result of an obtuse angle collision with a 1996 Chevrolet Blazer sport utility vehicle. The Chevrolet made an abrupt lane change (to the right) across the path of the Ford in an attempt to enter a parking area. The driver of the Ford steered right/braked in avoidance as the vehicle's right front wheel/tire impacted the right (west) barrier curb resulting in minor damage. The Ford's front left area subsequently struck the right rear area of the Chevrolet which resulted in minor damage to both vehicles.

The unrestrained 26 year old male driver of the 1995 Ford Thunderbird LX initiated a forward trajectory in response to the 12 o'clock impact force as the expanding driver air bag contacted the anterior aspect of his left forearm resulting in a contusion. The driver refused treatment. The unrestrained front right child passenger was seated in an upright posture and initiated a forward trajectory in response to pre-crash braking. The curb impact further displaced the child in a forward direction as he loaded the right mid-instrument panel. At impact with the Chevrolet, he was forward within the path of the expanding air bag which struck the anterior neck and torso resulting in multiple abrasions. The air bag expansion hyper-extended the head resulting in a complete transection of the skull base from the first cervical vertebra with a transection of the underlying cervical cord and vertebral arteries. Associated brain trauma included a subarachnoid hemorrhage and cerebral edema. Expansion of the air bag membrane continued against the face and torso of the child which resulted in additional soft tissue injuries, a liver laceration, and a complete transection of the spleen. At this point, the child was accelerated rearward and struck the front right seat back support resulting in a scalp contusion. He came to rest on the center console between the front seat back supports. The child passenger was transported by ambulance to a local trauma center for treatment and expired later that day.

The crash notification was provided to NHTSA on Thursday, March 2, 2000 and immediately assigned to the Veridian SCI team as an on-site investigative effort. The on-site investigator departed on March 6 and conducted the investigation on Tuesday, March 7, 2000.

SUMMARY

Crash Site

This two vehicle crash occurred during the afternoon hours of February, 2000. At the time of the crash, it was daylight with no adverse conditions as the roads were dry. The crash occurred in the southbound lanes of a straight and level north/south five lane (asphalt) roadway (see **Figure 13 - page 8**) which was bordered by 4.5 cm (1.8 in) high barrier curbs. The posted speed limit was 72 km/h (45 mph) with a 4-leg intersection located 41.0 meters (134.5 feet) south of the crash site.

Pre-Crash

The 26 year old female driver of the 1996 Chevrolet Blazer was operating the vehicle northbound when she entered a parking area and initiated a U-turn to proceed south. She re-entered the roadway and began a diagonal trajectory towards another parking area adjacent to the southbound lanes (**Figure 1**) while reportedly using a cellular phone (to the right ear). This apparently obstructed the driver's peripheral view as she maneuvered the Chevrolet into the southbound lanes. The 26 year old male driver of the 1995 Ford Thunderbird was operating the vehicle southbound in the outboard lane (**Figure 2**) when he observed the Chevrolet Blazer cross his path of travel. Upon recognition of the impending harmful event, he steered right/braked with sufficient force to lock the wheels of the vehicle. This trajectory was evidenced by 10.2 meters (33.5 feet) of pre-impact brake marks documented at the scene.



Figure 1. Southwest approach for the 1996 Chevrolet Blazer.



Figure 2. Southbound approach for the 1995 Ford Thunderbird LX.

Crash

As the driver of the Ford steered right/braked in avoidance of the encroaching Chevrolet, the vehicle's right front wheel/tire impacted the right (west) barrier curb resulting in minor damage. The Collision Deformation Classification (CDC) for this initial impact to the Ford Thunderbird was 12-FRWN-3. The Ford's trajectory was not altered by the curb impact as it continued 1.6 meters (5.2 feet) to impact with the Chevrolet. Initial contact involved the front left bumper area of the Ford and right rear tire of the Chevrolet. The corner area continued into the right door and sill area of the Chevrolet which produced a sufficient longitudinal deceleration to deploy the Ford's frontal air bag system. It should also be noted that the protrusion of the Ford's front left bumper corner slightly underrode the sill with no engagement identified to the undercarriage of the Chevrolet. The minor severity crash probably resulted in a late deployment of the frontal air bag system due to the sheet metal engagement against the side surface of the Chevrolet. Although classified as a borderline reconstruction (*based on the damage extent and type of engagement*), the WinSMASH damage algorithm computed velocity changes of 11.5 km/h (7.1 mph) for the subject vehicle and 10.3 km/h (6.4 mph) for the struck Chevrolet. Respective longitudinal components were -11.3 km/h (-7.0 mph) and 5.2 km/h (3.2 mph). The CDC for this impact to the Ford Thunderbird was 12-FLEE-3 with a principal direction of force of (-)10 degrees. The CDC for this impact to the Chevrolet Blazer was 04-RPLW-2 with a principal direction of force of (+)120 degrees. The Chevrolet Blazer was driven to a controlled stop in the adjacent parking area facing west (**Figure 3**). The Ford Thunderbird came to rest over the west curblines facing southwest (**Figure 4**).



Figure 3. Police photograph (view northeast) showing vehicle final rest positions.



Figure 4. Police photograph (view south) showing vehicle final rest positions.

Post-Crash

Following the crash, the driver of the Chevrolet Blazer exited the vehicle under her own power and called for police/emergency assistance on her cellular phone. The driver of the Ford Thunderbird crawled over his injured child and exited the vehicle through the right door. He placed the unconscious child on the sidewalk adjacent to the final rest position of the vehicle until rescue personnel arrived on-scene within ten minutes of the crash. Treatment was rendered at the scene by fire department personnel and emergency medical technicians (EMTs). The 3 year old child passenger of the Ford was transported by ambulance (accompanied by his father) to a local trauma center for treatment and expired later that day. The driver of the Chevrolet was reported by police as uninjured. The Ford Thunderbird was towed from the scene with disabling damage as the Chevrolet Blazer was impounded by police with non-disabling damage.

VEHICLE DATA

The 1995 Ford Thunderbird LX was manufactured on 2/95 and identified by the vehicle identification number (VIN): 1FALP62W0SH (production number deleted). The driver was reported by police as the owner of the vehicle. The vehicle was a 2-door sedan equipped with rear wheel drive and a 4.6 liter, V-8 engine. The Ford was also equipped with power windows, door locks, steering and front disc/rear drum brakes. At the time of the crash, the odometer had recorded 162,095 km (100,724 miles). The seating was configured with front bucket seats and a rear bench. The driver reported no previous crashes or maintenance on the Ford's air bag system. No cell phone was present or in use at the time of the collision.

VEHICLE DAMAGE

Exterior - 1995 Ford Thunderbird LX

The Ford sustained minor frontal damage as a result of the impact with the Chevrolet Blazer (**Figure 5**). The direct contact damage began at the front left bumper corner and extended 28.0 cm (11.0 in) inboard. The combined direct and induced damage length (Field L) measured 152.0 cm (59.8 in). Although no crush was identified at any of the six *bumper level* measurements, a secondary profile was obtained at the level of the radiator support [11.0 cm (4.3 in) above the level of the bumper] resulting in an



Figure 5. Frontal damage to the 1995 Ford Thunderbird LX.

averaged profile of: C1= 7.0 cm (2.8 in), C2= 0 cm, C3= 0 cm, C4= 0 cm, C5= 0 cm, C6= 0 cm. A rubber transfer was noted to the front left bumper corner which was attributed to the right rear tire of the Chevrolet. The height variance between the vehicles at impact resulted in minor hood displacement with 78.0 cm (30.7 in) of direct contact damage documented rearward along the left side surface of the vehicle. The right front wheel/tire was deflated (not restricted) with notable rim damage attributed to the barrier curb impact. The windshield fractured from interior occupant contact (only).

Exterior - 1996 Chevrolet Blazer

The Chevrolet sustained minor right side damage as a result of the impact with the Ford Thunderbird (Figures 6 & 7). The direct contact damage began 40.0 cm (15.7 in) forward of the right rear axle and extended 64.0 cm (25.2 in) forward. The combined direct and induced damage length (Field L) began 15.0 cm (5.9 in) forward of the right rear axle and extended 93.0 cm (36.6 in) forward. The damage was concentrated below the level of the frame. A scuff mark was noted to the right rear tire (not deflated/restricted) attributed to the front left bumper corner of the Ford. Induced lateral buckling was identified to the upper right rear (door) window frame which measured 7.0 cm (2.8 in). All glazing was undamaged.



Figure 6. Right side damage to the 1996 Chevrolet Blazer.



Figure 7. Close-up view of the impact damage.

Interior - 1995 Ford Thunderbird LX

Interior damage to the Ford identified through the vehicle inspection was moderate and was attributed to occupant contact (Figure 8). A scuff mark was documented on the left knee bolster (rigid plastic type). The rear-view mirror separated from the windshield which was fractured and heavily scratched. In addition, a fracture site was identified on the windshield to the left of the rear-view mirror mounting bracket along with a small fracture site to the right mid-windshield area. Light blood spattering was noted along the windshield header and right sunvisor area. A large indentation was documented to the right mid-instrument panel along with multiple scuff marks to the surrounding area. No column compression or loading to the steering wheel rim was identified (tilt column set between the full up and center position). No intrusion of interior components were found in the vehicle.



Figure 8. Interior view of the 1995 Ford Thunderbird LX.

MANUAL RESTRAINT SYSTEMS

The interior of the Ford Thunderbird LX consisted of a five passenger seating configuration with front bucket seats and a rear bench which accommodates three individual seating positions. The front 3-point manual lap and shoulder belt systems were removed by police shortly after the crash and were unavailable for SCI inspection. A follow-up interview was conducted with the lead police investigator who reported no loading evidence on the restraint webbings; confirmed by lab analysis. The rear outboard seated positions were equipped with 3-point manual lap and shoulder belt systems which consisted of continuous loop belt webbings with sliding latchplates. The rear center seating position was equipped with a 2-point manual lap belt system with a locking latchplate.

SUPPLEMENTAL RESTRAINT SYSTEMS

The Ford Thunderbird was equipped with frontal air bags for the driver and right passenger positions. The air bags deployed as a result of the crash (**Figure 9**). The driver air bag module was identified by the Ford part number: F5SB-63043B13-AAJABO with a bar coded lot number of: *1PZ6033I10102*. The air bag was housed in the center of the steering wheel (**Figure 10**) with a horizontally oriented flap tear seam (H-configuration). The flaps were asymmetrical in shape as the upper flap measured 23.5 cm (9.3 in) in width along the upper portion, 17.5 cm (6.9 in) along the lower portion and 12.0 cm (4.7 in) in height. The lower flap measured 17.5 cm (6.9 in) along the upper/lower portion and 7.0 cm (2.8 in) in height. The driver air bag was not available for SCI inspection as it was removed by police for analysis shortly after the crash, however, the police investigator reported no visible contacts on the face of the air bag.



Figure 10. Driver air bag module (bag removed by police).



Figure 9. Police photo showing 1995 Ford Thunderbird LX deployed frontal air bags.



Figure 11. Passenger air bag module (bag removed by police).

The front right passenger air bag deployed from the right mid-instrument panel area (**Figure 11**) with a horizontally oriented flap tear seam (H-configuration). The cover flaps were asymmetrical in shape as the upper flap measured 37.5 cm (14.8 in) in width and 6.0 cm (2.4 in) in height as the lower flap measured 37.5 cm (14.8 in) in width and 7.5 cm (3.0 in) in height. No contact evidence was found on the exterior surface of the module cover flap. The passenger air bag was not available for SCI inspection as it was removed by police for analysis shortly after the crash, however, the police investigator reported multiple tissue and fabric transfers on the face of the air bag.

DRIVER DEMOGRAPHICS

Age/Sex: 26 year old male
Height: 178 cm (70 in)
Weight: 82 kg (180 lb)
Seat Track Position: Full rearward position [22.0 cm (8.7 in) aft of the full forward position]
Manual Restraint Use: None
Usage Source: Driver interview, police report
Eyeware: None
Type of Medical Treatment: Refused treatment

Driver Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
*Contusion anterior left forearm (5.0 in)	Minor (790402.1,2)	Expanding driver air bag
*Contusion left shoulder	Minor (790402.1,2)	Door panel

* Source - driver

Driver Kinematics

The 26 year old male driver of the 1995 Ford Thunderbird LX was unrestrained (3-point manual lap and shoulder belt system available), seated in an upright posture with the seat track adjusted to the full rearward position. His hands were placed at the 10 o'clock and 2 o'clock positions on the steering wheel rim. The driver reported that he was unrestrained, further evidenced by the police report data. At impact with the Chevrolet, he initiated a forward trajectory in response to the 12 o'clock impact force as the expanding air bag contacted the anterior aspect of his left forearm resulting in a 12.7 cm (5.0 in) contusion. This injury mechanism was evidenced by the size and location of the injury relative to the pre-crash placement of the hands on the steering wheel rim. He subsequently loaded the knee bolster as evidenced by the scuff mark documented to this component, with no resulting injury reported. At this point, the vehicle was re-directed to the southwest as the driver struck the door panel which resulted in a contusion to the lateral aspect of the left shoulder. Following the collision, he exited the vehicle under his own power through the right door and directed his attention to the injured front right child passenger. The driver refused treatment, however, he accompanied his injured child to the trauma center.

FRONT RIGHT PASSENGER DEMOGRAPHICS

Age/Sex: 3 year old male
Height: 104 cm (41 in)
Weight: 16 kg (36 lb)
Seat Track Position: Full rearward position [22.0 cm (8.7 in) aft of the full forward position]
Manual Restraint Use: None
Usage Source: Vehicle inspection, driver interview, police report
Eyeware: None
Type of Medical Treatment: Transported to a trauma center and admitted (expired later that day)

Front Right Passenger Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
*Complete transection of the skull base from the first cervical vertebra (with transection of the cervical cord)	Maximum (640270.6,6)	Expanding front right air bag
*Pooling at the base with bilateral uncus and cerebellar tonsillar grooving	Critical (140202.5,8)	Expanding front right air bag
*Transection of the right vertebral artery	Critical (122802.5,1)	Expanding front right air bag
*Transection of the left vertebral artery	Critical (122802.5,2)	Expanding front right air bag
*Subarachnoid hemorrhage - cerebrum	Serious (140684.3,9)	Expanding front right air bag
*Cerebral edema (not further specified)	Serious (140660.3,9)	Expanding front right air bag
*Complete transection of the spleen	Moderate (544222.2,2)	Expanding front right air bag
*Liver laceration (capsule-superficial)	Moderate (541822.2,1)	Expanding front right air bag
*Contusion posterior scalp	Minor (190402.1,6)	Front right seat back support
*Friction abrasion left temporal area	Minor (190202.1,2)	Expanding front right air bag
*Compression abrasion mandibular region (horseshoe shaped)	Minor (290202.1,8)	Expanding front right air bag
*Friction abrasion anterior neck (bilateral)	Minor (390202.1,5)	Expanding front right air bag
*Friction abrasion right shoulder	Minor (790202.1,1)	Expanding front right air bag
*Friction abrasion right chest (7x2.5 in)	Minor (490202.1,1)	Expanding front right air bag

* Source - autopsy report

Front Right Passenger Kinematics

The 3 year old male passenger of the 1995 Ford Thunderbird LX was unrestrained (3-point manual lap and shoulder belt system available), seated in an upright posture against the front right seat back support. The seat back support was reclined to 23 degrees with the seat track adjusted to the full rearward position. Lack of restraint usage was determined by the trajectory of the child and contact points within the vehicle.

The child passenger was displaced in a forward direction by the pre-crash braking actions of the driver. The barrier curb impact further displaced the child forward as the mid-torso loaded the right mid-instrument panel. This trajectory was evidenced by the indentation and surrounding scuff marks documented to this component (**Figure 12**). This trajectory and contact sequence positioned his head/neck within a close proximity to the mid-mount air bag module. At impact with the Chevrolet, he was forward within the path of the expanding passenger air bag which struck the



Figure 12. Right instrument panel area.

anterior neck and torso resulting in multiple “friction” abrasions. The expansion of the air bag hyper-extended the head resulting in a complete transection of the skull base from the first cervical vertebra with a transection of the underlying cervical cord and vertebral arteries. Associated brain trauma included a subarachnoid hemorrhage and cerebral edema. Expansion of the air bag membrane continued against the face and torso of the child resulting in additional soft tissue injuries, a liver laceration and a complete transection of the spleen. Contact evidence to the air bag reported by police included tissue and fabric transfers. At this point, the child was accelerated rearward and struck the front right seat back support which resulted in a contusion to the posterior scalp.

The child passenger came to rest with his head/upper torso faced forward on the center console (between the front seat back supports) and his lower extremities across the front right seat cushion. The driver subsequently removed the child passenger from the vehicle and laid him on the sidewalk adjacent to the final rest position of the vehicle until rescue personnel arrived on-scene within ten minutes of the crash. He was transported by ambulance to a local trauma center for treatment and expired later that day.

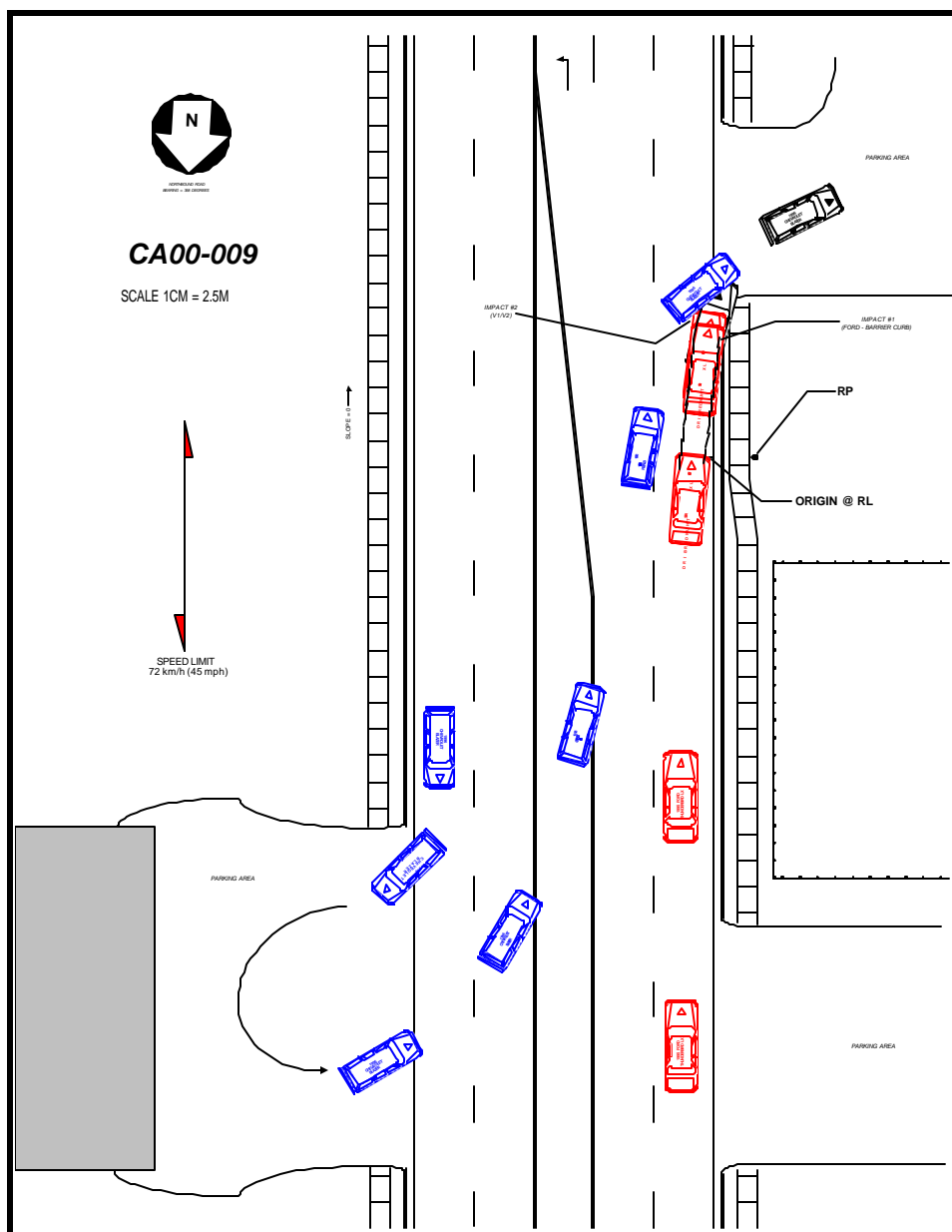


Figure 13. Scene Diagram