

**TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION**

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**VERIDIAN ON-SITE REDESIGNED AIR BAG DEPLOYMENT/
CHILD PASSENGER FATALITY INVESTIGATION**

VERIDIAN CASE NO. CA99-25

**VEHICLES - 1998 PONTIAC GRAND PRIX SE
1999 FORD RANGER XLT**

LOCATION - STATE OF OHIO

CRASH DATE - JULY, 1999

Contract No. DTNH22-94-D-07058

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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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16. <i>Abstract</i> <p>This on-site investigation focused on the injury mechanisms that caused the death of a 7 year old male front right passenger of a 1998 Pontiac Grand Prix SE. The Pontiac was equipped with redesigned frontal air bags for the driver and passenger positions. The Pontiac was westbound on approach to a 4-leg intersection when an eastbound 1999 Ford Ranger XLT initiated a left turn across the path of the Pontiac. As the Ford crossed the westbound lanes of the intersection, the front left area of the Pontiac struck the front center area of the Ford resulting in moderate damage to both vehicles.</p> <p>The 36 year old female driver of the 1998 Pontiac Grand Prix was unrestrained (3-point manual lap and shoulder belt system available) and initiated a forward trajectory in response to the 12 o'clock impact force. She loaded the redesigned driver air bag and knee bolster. The driver was not reported by police as injured. The child passenger of the Pontiac was also unrestrained and initiated a forward trajectory in response to pre-crash braking. His face was positioned against or within close proximity to the top mounted front right air bag module cover flap. The flap struck the child in the chin area which resulted in a fractured mandible. He was accelerated vertically into the windshield and windshield header. His contact to the header resulted in a left parietal depressed skull fracture (with an underlying subdural and subarachnoid hemorrhage). In addition, he sustained a multitude of brain injuries to include a diffuse axonal injury to the corpus callosum and brain stem, edema and petechial hemorrhages of the cerebrum and cerebellum. The child passenger was transported to a local hospital for treatment and expired five days following the crash. The Ford Ranger was also equipped with redesigned frontal air bags which deployed during the crash. Both adult male occupants were belted and not injured in the collision.</p>			
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**VERIDIAN ON-SITE REDESIGNED AIR BAG DEPLOYMENT/
CHILD PASSENGER FATALITY INVESTIGATION
VERIDIAN CASE NO. CA99-25
VEHICLES - 1998 PONTIAC GRAND PRIX SE
1999 FORD RANGER XLT
LOCATION - STATE OF OHIO
CRASH DATE - JULY, 1999**

BACKGROUND

This on-site investigation focused on the injury mechanisms that caused the death of a 7 year old male front right passenger of a 1998 Pontiac Grand Prix SE. The Pontiac was equipped with redesigned frontal air bags for the driver and passenger positions. The Pontiac was westbound on approach to a 4-leg intersection when an eastbound 1999 Ford Ranger XLT initiated a left turn across the path of the Pontiac. As the Ford crossed the westbound lanes of the intersection, the front left area of the Pontiac struck the front center area of the Ford resulting in moderate damage to both vehicles.

The 36 year old female driver of the 1998 Pontiac Grand Prix was unrestrained (3-point manual lap and shoulder belt system available) and initiated a forward trajectory in response to the 12 o'clock impact force. She loaded the redesigned driver air bag and knee bolster. The driver was not reported by police as injured. The child passenger of the Pontiac was also unrestrained and initiated a forward trajectory in response to pre-crash braking. His face was positioned against or within close proximity to the top mounted front right air bag module cover flap. The flap struck the child in the chin area which resulted in a fractured mandible. He was accelerated vertically into the windshield and windshield header. His contact to the header resulted in a left parietal depressed skull fracture (with an underlying subdural and subarachnoid hemorrhage). In addition, he sustained a multitude of brain injuries to include a diffuse axonal injury to the corpus callosum and brain stem, edema and petechial hemorrhages of the cerebrum and cerebellum. The child passenger was transported to a local hospital for treatment and expired five days following the crash. The Ford Ranger was also equipped with redesigned frontal air bags which deployed during the crash. Both adult male occupants were belted and not injured in the collision.

The crash was identified by NHTSA through a media search on Monday, August 9, 1999 and immediately assigned to the Veridian SCI team as an on-site investigative effort. The Veridian SCI team departed on August 9 and conducted the investigation on Tuesday, August 10, 1999.

SUMMARY

Crash Site

The crash occurred at a 4-leg intersection of a minor arterial roadway and a local street in a residential area during the evening hours of July, 1999. It was dark with the roadway illuminated by overhead halogen lamps. The arterial roadway consisted of four travel lanes that were straight with a negative grade to the west (see **Figure 13 - page 11**). The asphalt surface was wet due to rain and the posted speed limit was 56 km/h (35 mph). Traffic flow through the intersection was controlled by an overhead traffic signal system.

Pre-Crash

The 36 year old female driver of the 1998 Pontiac Grand Prix was transporting her 7 year old son to purchase ice cream. The driver was traveling in a westerly direction on the inboard lane of the minor arterial roadway. As she approached the signalized intersection, a westbound non-contact vehicle was stopped on the inboard travel lane waiting to turn left onto the local street. The driver of the Pontiac maneuvered the vehicle into the curb lane to proceed straight through the intersection (**Figure 1**). The overhead signal system was in a green phase for east/westbound traffic flow.



Figure 1. Westbound approach for the 1998 Pontiac Grand Prix SE.



Figure 2. Eastbound approach for the 1999 Ford Ranger XLT pickup truck.

The driver of the 1999 Ford Ranger XLT pickup truck was traveling in an easterly direction on the minor arterial roadway and was decelerating in preparation for a left turn onto the local street (**Figure 2**). The stopped non-contact westbound vehicle apparently obstructed the driver's view of the approaching Pontiac as he initiated his turn across the path of the Pontiac at a (passenger reported) speed of 8.0 km/h (5.0 mph). The driver of the ABS equipped Pontiac Grand Prix braked in an attempt to avoid the crash.

Crash

As the Ford crossed the westbound lanes of the 4-leg intersection, the front left area of the Pontiac struck the front center area of the Ford. Impact resulted in moderate damage to each vehicle. The vehicles crushed to maximum engagement as the Ford overrode the Pontiac which allowed the structure under the bumper to engage the bumper on the Pontiac. The impact produced sufficient longitudinal decelerations which deployed the redesigned frontal air bag systems in both vehicles. The WinSMASH damage and trajectory algorithm computed an impact speed of 41.6 km/h (25.9 mph) for the Pontiac and 7.5 km/h (4.7 mph) for the struck Ford. Computed velocity changes were 19.7 km/h (12.2 mph) for the subject vehicle and 20.7 km/h (12.9 mph) for the Ford. Respective longitudinal components were -19.4 km/h (-12.1 mph) and -15.9 km/h (-9.9 mph). The Pontiac's Sensing and Diagnostic Module (SDM) recorded an overall velocity change of 25.7 km/h (16.0 mph) based on static crush only (underride damage/residual crush not factored). The Collision Deformation Classification (CDC) for this impact to the Pontiac Grand Prix was 12-FYEW-1 with a principal direction of force of (-)10 degrees. The CDC for this impact to the Ford Ranger was 81-FDEW-2 (PDOF incremented for lateral shifting to the left) with a principal direction of force of (+)40 degrees.

The Ford was displaced rearward by the impact and rotated 49 degrees counterclockwise as the Pontiac continued its trajectory towards the northwest sector of the intersection. The side aspect of the Ford's right bumper apex sideswiped the left quarter panel of the Pontiac resulting in minor side

damage to both vehicles. The CDC for this secondary impact to the Pontiac Grand Prix was 12-LBES-1 and 03-RFEN-1 for the Ford Ranger. The Ford came to rest perpendicular to the westbound travel lanes facing in a northerly direction. The Pontiac continued forward 8.0 meters (26.2 ft) and sideswiped a utility pole which resulted in minor right side damage. The CDC for this third and final impact to the Pontiac Grand Prix was 12-RFES-1. The Pontiac came to rest (against the utility pole) parallel to the north curbline in the northwest sector of the intersection.

Post-Crash

Following the crash, the driver of the Ford Ranger assisted the driver of the Pontiac out of her vehicle. Both individuals removed the front right passenger from the Pontiac and laid the child on the sidewalk adjacent to the final rest position of the vehicle. Treatment was rendered at the scene by fire department personnel and emergency medical technicians (EMT). The 7 year old male front right passenger of the Pontiac was transported to a local hospital for treatment and expired five days after the crash. The driver of the Pontiac and both occupants of the Ford were reported by police as uninjured. Both vehicles were towed from the scene.

VEHICLE DATA

1998 Pontiac Grand Prix SE

The 1998 Pontiac Grand Prix SE was manufactured on 12/97 and identified by the vehicle identification number (VIN): 1G2WJ52M3WF (production number deleted). The Pontiac was a company provided vehicle for the driver. The vehicle was a 4-door sedan equipped with front wheel drive and a 3.1 liter, V-6 engine. At the time of the crash, the odometer had recorded 79,464 km (49,378 miles). The seating was configured with front bucket seats and a rear bench. Previous crashes or maintenance on the Pontiac's air bag system were unknown. No cell phone was present or in use at the time of the collision.

1999 Ford Ranger XLT

The 1999 Ford Ranger XLT pickup truck was manufactured on 3/99 and identified by the vehicle identification number (VIN): 1FTYR10C0XT (production number deleted). The police report listed the driver as the owner of the vehicle. The vehicle was a regular cab pickup truck equipped with rear wheel drive and a 3.0 liter, V-6 engine. At the time of the crash, the odometer had recorded 7,944 km (4,936 miles). The seating was configured with a split bench (with folding backs). The surrogate reported no previous crashes or maintenance on the Ford's air bag system (original equipment). No cell phone was present or in use at the time of the collision.

EXTERIOR VEHICLE DAMAGE

Exterior - 1998 Pontiac Grand Prix SE

The Pontiac sustained moderate frontal damage as a result of the impact with the Ford Ranger pickup truck (**Figure 3**). The direct contact damage began at the front left bumper corner and extended 66.0 cm (26.0 in) inboard. The combined direct and induced damage length measured 154.0 cm (60.6 in). Six crush measurements were documented at the level of the bumper:



Figure 3. Frontal damage to the 1998 Pontiac Grand Prix SE.

C1= 0 cm, C2= 7.0 cm (2.8 in), C3= 5.0 cm (2.0 in), C4= 0 cm, C5= 0 cm, C6= 0 cm. Crush measurements were also documented 10.0 cm (3.9 in) above the level of the bumper to capture the underride damage which resulted in an *averaged* profile of: C1= 8.0 cm (3.1 in), C2= 16.0 cm (6.3 in), C3= 12.0 cm (4.7 in), C4= 0 cm, C5= 0 cm, C6= 0 cm. Paint transfers were documented along the hood and bumper fascia. The windshield fractured at the left lower A-pillar from exterior impact forces and the right mid-windshield fractured from (interior) front right passenger contact and the air bag module cover flap. Direct contact damage was documented to the left quarter panel from the secondary impact which began 42.0 cm (16.5 in) forward of the rear left bumper corner and extended 13.0 cm (5.1 in) forward. Direct contact damage was also documented to the right fender from the utility pole impact which began 34.0 cm (13.4 in) aft of the front right bumper corner and extended 38.0 cm (15.0 in) rearward.

Exterior - 1999 Ford Ranger XLT

The Ford Ranger pickup truck sustained moderate frontal damage as a result of the impact with the Pontiac Grand Prix (**Figure 4**). The direct contact damage began at the front right bumper corner and extended 108.0 cm (42.5 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 141.0 cm

(55.5 in). Six crush measurements were documented at the level of the bumper: C1= 26.0 cm (10.2 in), C2= 23.0 cm (9.1 in), C3= 30.0 cm (11.8 in), C4= 33.0 cm (13.0 in), C5= 17.0 cm (6.7 in), C6= 1.0 cm (0.4 in). The end structure was displaced approximately 28.0 cm (11.0 in) to the left from the impact force. An indentation was documented to the center portion of the bumper from the front left bumper corner of the Pontiac. A circular imprint was also documented to the right portion of the bumper from the left front wheel of the Pontiac which occurred during sustained contact between the vehicles during spinout. The windshield was undamaged with all tempered glazing intact. Superficial scratch marks were documented to the side aspect of the front right bumper apex which was attributed to the secondary impact.



Figure 4. Frontal damage to the 1999 Ford Ranger XLT.

INTERIOR VEHICLE DAMAGE

Interior - 1998 Pontiac Grand Prix SE

Interior damage to the Pontiac identified through the vehicle inspection was moderate and was attributed to occupant contact. Multiple scuff marks were documented on the left knee bolster (rigid plastic type). Although no contact evidence was found on the driver air bag, a scuff mark and possible skin transfer were identified on the exterior surface of the (left) air bag module cover flap. No column compression or loading to the steering wheel rim was identified (tilt column set to the center position). An indentation was documented on the passenger air bag module cover flap along with glass fragments and tissue transfers. Tissue transfers were also documented on the face of the passenger air bag. The windshield was fractured from front right occupant contact and the passenger air bag module cover flap. A small fracture was noted to the upper/center windshield area from rear-view mirror displacement. A spider-web type fracture was documented to the right mid-windshield area with hair strands embedded into the glazing above the fracture site. This contact pattern began at the right windshield header area and extended 10.2 cm (4.0 in) downward. Passenger contact damage was also

found along the leading edge of the right headliner which was torn with hair/skin transfers embedded into the tears. No intrusion of interior components were found in the vehicle.

Interior - 1999 Ford Ranger XLT

Interior damage to the Ford identified through the vehicle inspection was minor and was attributed to occupant contact. No contact evidence was identified to the redesigned air bags or exterior surface of the module cover flaps. Scuff marks were documented to the right knee bolster (rigid plastic type) and glove compartment door. No column compression or loading to the steering wheel rim was identified (fixed column). A 3.0 cm (1.2 in) longitudinal toepan intrusion was documented to the driver space.

MANUAL RESTRAINT SYSTEMS

1998 Pontiac Grand Prix SE

The interior of the Pontiac Grand Prix consisted of a five passenger seating configuration with front bucket seats and a rear bench which accommodates three individual seating positions. The outboard seating positions were equipped with 3-point manual lap and shoulder belt systems with continuous loop webbing and a sliding latchplate. There was no loading evidence on the belt systems and the systems yielded minimal routine usage indicators for the high vehicle mileage. The rear center seating position was equipped with a 2-point manual lap belt.

1999 Ford Ranger XLT

The interior of the Ford Ranger consisted of a three passenger seating configuration with a split bench (with folding backs). The outboard seating positions were equipped with 3-point manual lap and shoulder belt systems with continuous loop webbing and a sliding latchplate. Superficial routine wear marks were documented to the latchplates of the outboard 3-point manual lap and shoulder restraints, which supports frequent use. Stretched stitching was noted at the lower attachment point of the front left restraint along with loading marks to the adjustment ring. The center seating position was equipped with a 2-point manual lap belt.

SUPPLEMENTAL RESTRAINT SYSTEMS

1998 Pontiac Grand Prix SE

The Pontiac was equipped with redesigned frontal air bags for the driver and right passenger positions. The air bags deployed as a result of the crash. The driver air bag module was identified by the General Motors part number: *16760359* with a bar coded lot number of *TCAP70553904*. The driver air bag was housed in the center of the steering wheel with a vertically oriented flap tear seam (I-configuration). The flaps were symmetrical in shape and measured 8.0 cm (3.1 in) in width and 10.5 cm (4.1 in) in height. A scuff mark and possible skin transfer which measured 4.0 cm x 3.5 cm (1.6 in x 1.4 in) were documented on the exterior surface of the left cover flap. Although no contact evidence was identified on the air bag, multiple black vinyl transfers were noted to the face of the air bag from expansion within the module. The diameter of the driver air bag measured 61.5 cm (24.2 in) in its deflated state (**Figure 5**). No internal tether straps



Figure 5. 1998 Pontiac Grand Prix redesigned driver air bag.

were present. The bag was vented by two ports located at the 10 o'clock and 2 o'clock (centered) sectors on the rear aspect of the air bag.

The front right passenger air bag deployed from the right top instrument panel area with a single cover flap design hinged at the forward aspect which opened in an upward direction towards the windshield. The cover flap was asymmetrical in shape and measured 33.0 cm (13.0 in) in width along the rear aspect of the flap and 40.6 cm (16.0 in) along the forward aspect. The flap measured 27.9 cm (11.0 in) in height along the left edge of the flap and 24.1 cm (9.5 in) along the right edge. Glass fragments were noted to the right section of the cover flap with a 1.0 cm (0.4 in) deep indentation attributed to the passenger's chin contact (**Figure 6**). Tissue transfers and white scuff marks were also documented on the cover flap which began left of the centerline and extended onto the face of the flap. The right mid-windshield area was fractured with a scuff mark (attributed to the module cover flap) surrounding the damage.



Figure 6. Passenger contact damage to the front right air bag module cover flap.



Figure 7. 1998 Pontiac Grand Prix redesigned passenger air bag.

The passenger air bag module was identified by the General Motors part number: *16757542-57* with a bar coded lot number of: *TRA170019154*. The passenger air bag measured 63.5 cm (25.0 in) in width and 58.4 cm (23.0 in) in height in its deflated state (**Figure 7**). The bag was tethered by two internal straps sewn to the top seam and vented by two ports located at the 10 o'clock and 2 o'clock sectors on the side aspect of the air bag. Tissue transfers were identified on the left side of the bag and below the right vent port which measured 3.2 cm (1.3 in) in length. A series of light brown tissue transfers were also documented along the right vertical seam of the air bag. Numerous loose "cut" hair strands were identified along the top of the air bag and instrument panel. Black vinyl transfers were found on the top and side aspects of the air bag from expansion within the module.

1999 Ford Ranger XLT

The Ford was equipped with redesigned frontal air bags for the driver and right passenger positions. The air bags deployed as a result of the crash. The driver air bag was housed in the center of the steering wheel with a horizontally oriented flap tear seam (H-configuration). The flaps were asymmetrical in shape as the upper flap measured 17.5 cm (6.9 in) in width and 8.0 cm (3.1 in) in height while the lower flap measured 17.5 cm (6.9 in) in width and 4.0 cm (1.6 in) in height. No contact evidence was identified on the air bag or exterior surface of the module cover flaps. The diameter of the driver air bag measured 63.5 cm (25.0 in) in its deflated state (**Figure 8**). The bag was tethered by two internal straps and vented by two ports located at the 11 o'clock and 1 o'clock sectors



Figure 8. 1999 Ford Ranger XLT redesigned driver air bag.

on the rear aspect of the air bag.

The front right passenger air bag deployed from the right mid-instrument panel area with a single cover flap design hinged at the top aspect. The cover flap was rectangular in shape and measured 37.0 cm (14.6 in) in width and 17.5 cm (6.9 in) in height. No contact evidence was identified on the air bag or exterior surface of the module cover flap. The passenger air bag measured 66.0 cm (26.0 in) in width and 56.0 cm (22.0 in) in height in its deflated state (**Figure 9**). No internal tether straps were present. The bag was vented by two ports located at the 10 o'clock and 2 o'clock sectors on the side aspect of the air bag.



Figure 9. 1999 Ford Ranger XLT redesigned passenger air bag.

DRIVER DEMOGRAPHICS

1998 Pontiac Grand Prix SE

Age/Sex: 36 year old female
Height: 175 cm (69 in)
Weight: 61 kg (135 lb)
Seat Track Position: 17.0 cm (6.7 in) aft of the full forward position, 6.0 cm (2.4 in) forward of the full rearward position
Manual Restraint Use: None
Usage Source: Vehicle inspection
Eyeware: Unknown
Type of Medical Treatment: None reported

Driver Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
None reported	N/A	N/A

Driver Kinematics

The 36 year old female driver of the 1998 Pontiac Grand Prix was unrestrained and presumed to be in an upright posture with the seat track adjusted 17.0 cm (6.7 in) aft of the forward most position. At impact, she initiated a forward trajectory in response to the 12 o'clock impact force and loaded the deployed redesigned driver air bag and knee bolster (**Figure 10**). There was no loading evidence on the driver air bag, however, the knee bolster yielded several scuff marks from knee contact. Following the collision, she was assisted from the vehicle by the driver of the Ford Ranger. She was not reported by police as injured.



Figure 10. Scuff marks to the driver knee bolster.

FRONT RIGHT PASSENGER DEMOGRAPHICS

Age/Sex: 7 year old male
Height: 132 cm (52 in)
Weight: 21 kg (46 lb)

Seat Track Position: Full rearward position
Manual Restraint Use: None
Usage Source: Vehicle inspection
Eyeware: None
Type of Medical Treatment: Transported to a local hospital and admitted (expired after 5 days)

Front Right Passenger Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
Unconscious at scene (GCS=4/unresponsive to painful stimuli with posturing)	Critical (160824.5,0)	Windshield header
Diffuse axonal injury-corpora callosa	Critical (140628.5,2)	Windshield header
Petechial hemorrhage-cerebrum	Critical (140646.5,3)	Windshield header
Diffuse axonal injury-brain stem	Critical (140206.5,8)	Windshield header
Hemorrhage mid-brain	Critical (140210.5,8)	Windshield header
Bilateral uncal herniation and grooving of both cerebellar tonsils	Critical (140202.5,8)	Windshield header
Subdural hemorrhage-cerebrum	Critical (140656.5,2)	Windshield header
Petechial hemorrhage-cerebellum	Severe (140426.4,6)	Windshield header
Fracture-left parietal bone (vault) (4x1cm: linear/depressed/comminuted)	Serious (150404.3,5)	Windshield header
Hemorrhage and edema-pituitary gland	Serious (140799.3,8)	Windshield header
Cerebral edema	Serious (140668.3,2)	Windshield header
Subarachnoid hemorrhage-left parietal and occipital cerebrum	Serious (140684.3,2)	Windshield header
Contusions-left frontal/parietal lobe with contra-coup contusions to right inferior temporal lobe	Serious (140620.3,3)	Windshield header
Brain swelling-right cerebrum	Serious (140660.3,1)	Windshield header
Brain swelling-left cerebrum	Serious (140660.3,2)	Windshield header
Alveolar hemorrhage-right lower lobe lung	Serious (441406.3,1)	Front right air bag
Vault fracture (left parietal) (2.2cm & 3.0cm linear)	Moderate (150400.2,5)	Windshield header
Fracture-mandible @ midline (displaced)	Moderate (250612.2,3)	Front right air bag module cover flap

Laceration/rupture-spleen (1.5cm/0.2cm deep)	Moderate (544222.2,2)	Front right air bag
Laceration-left parietal scalp (11 cm)	Moderate (190604.2,2)	Windshield header
Avulsion-both lower incisors	Minor (251406.1,8)	Indirect contact injury (front right air bag module cover flap)
Contusion-right chin (15x2cm “green”)	Minor (290402.1,1)	Front right air bag module cover flap
Contusions-abdomen (along lower quads)	Minor (590402.1,0)	Front right air bag
Laceration-chin (5.5cm @ midline)	Minor (290602.1,8)	Front right air bag module cover flap

Front Right Passenger Kinematics

The 7 year old male passenger of the 1998 Pontiac Grand Prix was unrestrained and presumed to be seated in an upright posture (out-of-position) forward on the seat cushion. The seat track was adjusted to the full rearward position with the seat back support reclined to 23 degrees from vertical. The lack of belt usage was determined by the trajectory of the child and contact points within the vehicle. In addition, there was no loading evidence on the belt system and the system yielded minimal routine usage indicators for the high vehicle mileage.

The child passenger was displaced in a forward direction by the pre-crash braking actions of the driver. At impact, the child was forward against the instrument panel with his face against or within close proximity to the top mounted front right air bag module cover flap. As the air bag system deployed, the cover flap impacted the chin of the child which resulted in a 15.0 x 2.0 cm (5.9 x 0.8 in) “green” contusion to the right chin, a 5.5 cm (2.2 in) laceration and a fractured mandible. Contact evidence to the cover flap consisted of tissue transfers to the cover flap and a 1.0 cm (0.4 in) deep dent to the aluminum reinforced flap. The expanding air bag membrane probably contacted the anterior neck and torso of the child, resulting in contusions along the lower quadrants of the abdomen and an alveolar hemorrhage to the right lower lobe of the lung. This was evidenced by the tissue transfers noted to the upper mid-point area of the bag.

The cover flap contact and the expanding air bag displaced the unrestrained child vertically into the windshield. His head fractured the laminated glazing which contained hair strands. This pattern continued vertically into the windshield header area. During this upward movement, the child passenger’s head rotated in a counterclockwise direction. The upper left parietal area of his scalp impacted the header (**Figure 11**) which resulted in a 11.0 cm (4.3 in) laceration and a linear/depressed skull fracture that measured 4.0 x 1.0 cm



Figure 11. Passenger contact damage to the right windshield header.

(1.6 x 0.4 in) . The child sustained additional brain trauma to include an underlying cerebral subdural and subarachnoid hemorrhage, diffuse axonal injury to the corpus callosum and brain stem, cerebral and cerebellar petechial hemorrhages, contusions of the left frontal/parietal lobes and contra-coup contusions to the right inferior temporal lobe.

The child came to rest on the front right floor of the vehicle. The driver subsequently removed the child passenger from the vehicle and laid him on the ground adjacent to the final rest position of the Pontiac. He was transported to a local hospital where he was admitted for treatment. The child was hospitalized for five days before succumbing to his injuries. Treatment at the hospital included surgical repair of the mandible fracture and the placement of an ICP to monitor cranial pressure.

DRIVER DEMOGRAPHICS

1999 Ford Ranger XLT

Age/Sex: 19 year old male
 Height: 180 cm (71 in)
 Weight: 82 kg (180 lb)
 Seat Track Position: Full rearward position
 Manual Restraint Use: 3-point lap and shoulder belt
 Usage Source: Vehicle inspection, passenger interview
 Eyewear: Prescription glasses
 Type of Medical Treatment: None



Figure 12. Loading marks to the sliding latchplate.

Driver Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
None	N/A	N/A

Driver Kinematics

The 19 year old male driver of the 1999 Ford Ranger XLT was properly restrained by the 3-point manual lap and shoulder belt system, seated in an upright posture with the seat track adjusted to the full rearward position. Belt usage was confirmed by the loading marks documented to the sliding latchplate (**Figure 12**) and stretched webbing noted at the lower attachment point. At impact, he initiated a forward/lateral trajectory in response to the 1 o'clock impact force and loaded the manual belt and deployed redesigned driver air bag. The driver was not injured in the collision. The combination of restraint options prevented contact with frontal components and possible injury.

FRONT RIGHT PASSENGER DEMOGRAPHICS

Age/Sex: 20 year old male
 Height: 185 cm (73 in)
 Weight: 80 kg (177 lb)
 Seat Track Position: Full rearward position
 Manual Restraint Use: 3-point lap and shoulder belt
 Usage Source: Vehicle inspection, passenger interview

Eyewear: None
Type of Medical Treatment: None

Front Right Passenger Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
None	N/A	N/A

Front Right Passenger Kinematics

The 20 year old male front right passenger of the 1999 Ford Ranger XLT was properly restrained by the 3-point manual lap and shoulder belt system, seated in an upright posture with the seat track adjusted to the full rearward position. Belt usage was confirmed by the loading marks documented to the webbing of the front right manual restraint in conjunction with the lack of significant interior contact points and injury. At impact, he initiated a forward/lateral trajectory in response to the 1 o'clock impact force and loaded the manual belt and deployed redesigned passenger air bag. His lower extremities contacted the knee bolster as evidenced by the scuff marks noted to this component. The passenger was not injured in the collision.

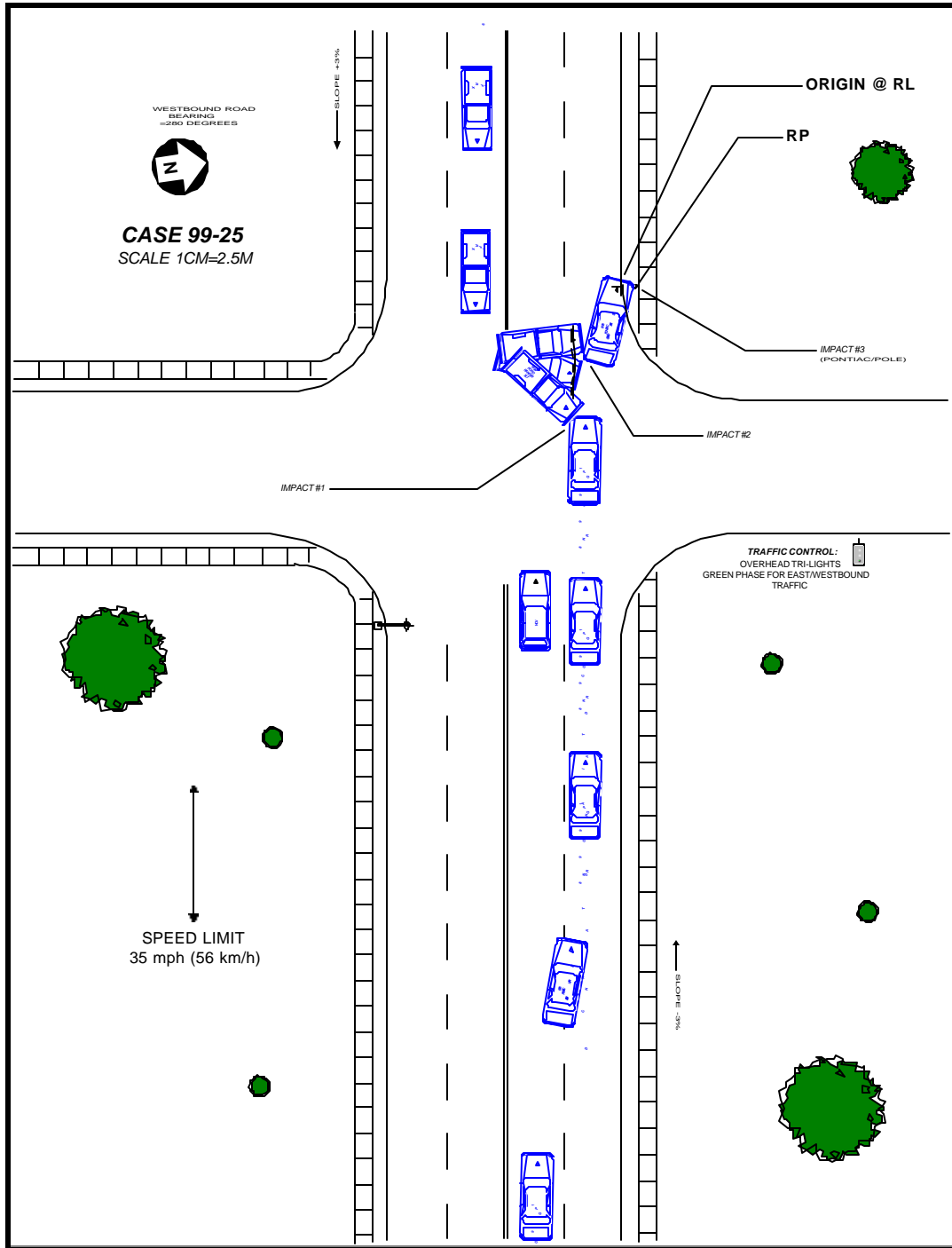


Figure 13. Scene Diagram