INDIANA UNIVERSITY

TRANSPORTATION RESEARCH CENTER
School of Public and Environmental Affairs
501 South Morton Street Suite 105
Bloomington, Indiana 47403-2452
(812) 855-3908 Fax: (812) 855-3537

ON-SITE CHILD RESTRAINT SYSTEM INVESTIGATION

CASE NUMBER - IN10016
LOCATION - ALABAMA
VEHICLE - 1995 PONTIAC GRAND AM GT
CRASH DATE - May 2010

Submitted:

October 14, 2010

Contract Number: DTNH22-07-C-00044

Prepared for:

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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 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 performance of the involved vehicle(s) or their safety systems.

Technical Report Documentation Page

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16. *Abstract*

This on-site investigation focused on the 23-month-old female second row right passenger of a 1995 Pontiac Grand Am GT, and the Cosco/Dorel High Back Booster Child Restraint System (CRS) in which she was seated. The unrestrained 24-year-old female driver was traveling west on a 2-lane rural roadway during clear and dry weather conditions. The crash scene evidence showed that the vehicle was traveling west in the eastbound lane when it yawed clockwise and departed the north side of the roadway. The vehicle entered a shallow ditch and became airborne as it traveled up the back slope of the ditch at the edge of a residential gravel driveway. The vehicle crossed the driveway and the left side plane impacted a 104 cm (41 in) diameter tree (event 1). The vehicle rotated counterclockwise off the tree and rolled over (event 2) with the right side leading 6 quarter turns. The driver's frontal air bag deployed during the crash. The driver's door came open during the rollover and the driver was ejected. The second row right passenger remained restrained in the CRS throughout the crash sequence, but sustained a fatal head injury from contacting the intruding roof and was pronounced deceased at the crash scene. The CRS was damaged by intrusion of the second row seat back. The driver was transported by ambulance to a hospital and admitted. A blood test was given and the driver's blood alcohol level was 0.16 mg/dl.

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This on-site investigation focused on the 23-month-old female second row right passenger of a 1995 Pontiac Grand Am GT (**Figure 1**), and the Cosco/Dorel High Back Booster Child Restraint System (CRS) in which she was seated. This crash was brought to the National Highway Traffic Safety Administration's (NHTSA) attention on May 5, 2010 through an on-line new report. This investigation was assigned on May 27, 2010. The crash involved the Pontiac, which departed the roadway and impacted a tree and rolled over. This crash occurred in May 2010, at 1810 hours in Alabama and was investigated by the city police department. The Pontiac and the crash scene were inspected on June 2-3, 2010. A passerby (the driver's father in-law) was interviewed on June 7, 2010. This report is based on the police crash report, vehicle inspection, crash scene inspection, an interview with the driver's father in-law, occupants medical records, occupant kinematic principles, and evaluation of the evidence.

Figure 1: The damaged 1995 Pontiac Grand Am GT

CRASH CIRCUMSTANCES

Crash Environment: The crash occurred on the north roadside of a two-lane, undivided rural roadway during daylight hours and clear weather conditions. There was one travel lane in each direction. Each lane was 3.3 m (10.8 ft) in width. The roadway was bordered by grass shoulders and shallow ditches. The grade for the Pontiac just prior to roadway departure was positive 3.3%. The roadway was dry bituminous and the speed limit was 89 km/h (55 mph). The site of the crash was rural residential and the traffic density was light. The Crash Diagram is on page 12 of this report.

Pre-Crash: The Pontiac was occupied by an unrestrained 24-year-old female driver and a 23-month-old female second row right passenger who was restrained in the CRS. The driver of the Pontiac was traveling west in the eastbound lane when the vehicle began to yaw clockwise (**Figure 2**) toward the north side of the roadway. Witnesses reported to the police that the Pontiac was traveling at a high rate of speed. A subsequent blood test of the driver revealed a blood alcohol content of 0.16 mg/dl. The vehicle rotated clockwise approximately 40 degrees from its initial westerly heading and departed the roadway (**Figure 3**). The vehicle entered a shallow ditch and became airborne as it traveled

Figure 2: Approach of the Pontiac to roadway departure, white marks on roadway are police marks highlighting yaw marks from the Pontiac

up the back slope of the ditch at the edge of a residential gravel driveway. There was no evidence of yaw marks on the driveway during the SCI inspection. The police crash schematic also showed no yaw marks on the driveway, which suggested that the vehicle was airborne as it crossed the driveway.

Figure 3: Approach to impact with the tree; orange flags show yaw marks in the grass; yaw mark on left is left rear tire; yaw mark on right is left front tire

Crash: The vehicle was airborne a distance of 14 m (46 ft) when the left side plane (**Figure 4**) impacted a 104 cm (41 in) diameter tree (**Figure 5**, event 1). The vehicle rotated counterclockwise off the tree and rolled over (event 2) with the right side leading 6 quarter turns. The driver's door came open during the rollover and the unrestrained driver was ejected. The driver's frontal air bag deployed during the crash. The Pontiac came to final rest on its top heading west 22 m (72.2 ft) northwest of the impacted tree.

Figure 4: Damage on the left side plane of the Pontiac from the impact with the tree

Post-Crash: The police were notified of the crash at 1812 hours and arrived on scene at 1821 hours. Emergency rescue and medical personnel also responded to the crash scene. Prior to the arrival of emergency responders, a passerby (the driver's father-in-law) cut the left harness strap of the CRS and removed the child from the vehicle. A second passerby, who was a nurse, began Cardio-Pulmonary Resuscitation (CPR) on the child. The driver was transported by ambulance to a hospital and admitted. The child was pronounced deceased at the crash scene. The Pontiac was towed from the crash scene due to damage.

Figure 5: The impacted tree

ROLLOVER DISCUSSION

The Pontiac was rotating clockwise when its left side plane impacted the tree. The center of the damage was located 138 cm (54.3 in) rear of the center of the wheelbase, which caused the vehicle to rotate counterclockwise off the tree. As the vehicle separated from the tree, it rolled over right side leading. The overlapping scratches were oriented in two primary directions on the roof and right side plane, and the extent of the roof crush suggested that the vehicle rolled over 6 quarter turns. The vehicle traversed a distance of approximately 21 m (68.9 ft) during the

rollover. It came to final rest on its top heading west with the front end on a brush pile. The driver came to final rest approximately 8.5 m (27.9 ft) northwest of the point of impact with the tree.

CASE VEHICLE

The 1995 Pontiac Grand Am GT was a front-wheel drive, 2-door coupe (VIN: 1G2NW15M3SC------) equipped with a 3.1L, 6-cylinder engine, automatic transmission, and 4-wheel anti-lock brakes. The front row was equipped with bucket seats with folding backs, adjustable head restraints, door-mounted automatic lap-and-shoulder safety belts, and a driver frontal air bag. The second row was equipped with a bench seat, lap-and-shoulder safety belts in the outboard seating positions, a lap belt in the center seating position, and integral head restraints in the outboard seating positions. The odometer reading at the time of the SCI inspection was 256,020 miles (412,025 kilometers). The vehicle's specified wheelbase was 263 cm (103.5 in).

CASE VEHICLE DAMAGE

Exterior Damage Event 1: The vehicle sustained direct damage on the rear edge of the left front door, quarter panel, B- and C-pillars, trunk lid, and left rear wheel during the impact with the tree. The left rear axle was broken and the wheel was separated from the axle. The direct damage began 131 cm (51.6 in) rear of the left front axle and extended rearward 155 cm (61 in). The crush measurements were taken at the upper-door level and the maximum residual crush was 35 cm (13.8 in), occurring 16 cm (6.3 in) to the left of C_3 (**Figure 6**). The left side wheelbase was extended 10 cm (5 in), while the right side wheelbase was extended 5 cm (2 in). The quarter panel, trunk lid, and roof sustained indirect damage. The table below presents the left side plane crush profile.

Figure 6: Crush on the left side plane of the Pontiac from the impact with the tree

Units	Event	Direct Damage		Field L	C_1	C_2	C_3	C_4	C_5	C_6	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	155	35	155	0	16	23	34	25	12	-138	-138
in		61.0	13.8	61.0	0.0	6.3	9.1	13.4	9.8	4.7	-54.3	-54.3

Damage Classification Event 1: The Collision Deformation Classification was 00LZAW3 for the tree impact. A non-horizontal principal direction of force was assigned since the vehicle was airborne when it impacted the tree. The WinSMASH program could not be used since non-

horizontal impacts are out of scope for the program. Based on the extent of the crush on the left side plane, the severity of the damage was moderate.

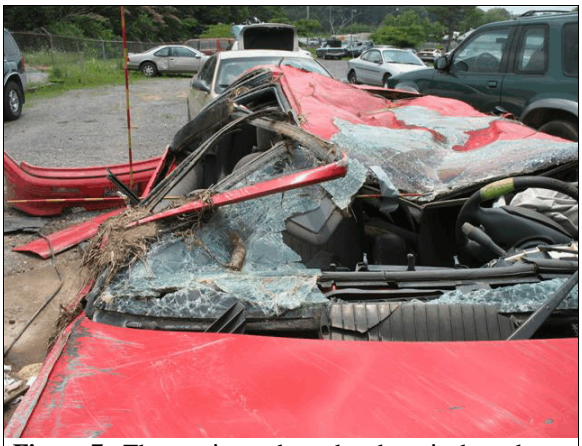

Figure 7: The maximum lateral and vertical crush on the roof of the Pontiac

Exterior Damage Event 2: The Pontiac sustained damage on the top and both side planes during the rollover. The direct damage on the left side plane began at the front of the fender, 62 cm (24.4 in) forward of the left front axle, and extended 246 cm (97 in) rearward along the left side palne. The direct damage on the top plane began at the front of the hood, 82 cm (32.3 in) forward of the left front axle, and extended 323 cm (127 in) rearward on the hood and the right portion of the roof. The direct damage on the right side plane began at the front of the fender, 76 cm forward of the right front axle, and extended 290 cm (114 in) rearward along the right side. The maximum residual vertical crush (**Figure 7**) was 43 cm (16.9 in) and occurred at the center left windshield header, 103 cm (40.6 in) rear of the right front axle. The maximum lateral crush (**Figure 7**) was 37 cm (14.6 in) and occurred at the top of the right A-pillar, 73 cm (28.7 in) rear of the right front axle.

Damage Classification Event 2: The The CDC for the rollover (event 2) was 00TDDO5. The WinSMASH program could not be used since a rollover is out of scope for the program. Based on the extent of the crush on the roof, the severity of the damage from the rollover was severe.

The manufacturer's recommended tire size was P205/55R16. The Pontiac was equipped with the recommended size tires. The vehicle's tire data are presented in the table below.

Tire	*Measured Pressure*		*Vehicle Manufacturer's Recommended Cold Tire Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	Flat	Flat	207	30	6	8	None	No	Yes
LR	34	5	207	30	9	11	None	No	Yes
RR	255	37	207	30	8	10	None	No	No
RF	262	38	207	30	7	9	None	No	No

Vehicle Interior: The inspection of the interior in the front seating row did not reveal any discernable evidence of occupant contact. A body fluid transfer was present on the roof above the second row right seating position from head contact by the second row right passenger.

The right front door was jammed shut. The striker on the left front door was deformed out of the latch during the tree impact and the door came open during the rollover. The left front window glazing was closed at the time of the crash while the right front window glazing was fully open. The remaining glazings were fixed. The windshield was in place and holed by impact forces and the remainder of the glazings were disintegrated.

The passenger compartment sustained numerous intrusions due to the left side plane impact and rollover. The most severe intrusions into the driver's space involved the roof, windshield header, and the left roof side rail,. These components intruded vertically 51 cm (20.1 in), 44 cm (17.3 in), and 42 cm (16.5 in), respectively. The most severe intrusions into the second row right passenger's space involved the right roof side rail, backlight header, and roof which intruded vertically 21 cm (8.3 in), 21 cm (8.3 in), and 15 cm (5.9 in), respectively.

AUTOMATIC RESTRAINT SYSTEM

The Pontiac was equipped with a driver's frontal air bag, which deployed during the crash. The vehicle also was equipped with door-mounted 3-point automatic safety belts in the front row.

The driver's frontal air bag was located within the steering wheel hub and the module cover was a two-flap configuration with a vertical tear seam and constructed of pliable vinyl. Each flap was 8 cm (3.1 in) wide and 10 cm (3.9 in) in height. An inspection of the air bag module cover flaps revealed that they opened at the designated tear points and were undamaged. The deployed air bag was 63 cm (24.8 in) in diameter and had two 1.5 cm (0.6 in) diameter vent ports located at the 3 and 9 o'clock positions. There were no tethers. Inspection of the air bag revealed no discernable evidence of occupant contact or damage.

The driver and front right passenger automatic lap-and-shoulder safety belts consisted of continuous loop belt webbing with a sewn-on latch plate and dual Emergency Locking Retractors (ELR) in the doors. When the safety belt was buckled and the door was opened, the safety belt would extend and then be positioned on the person when they sat in the seat and closed the door.

The inspection of the driver's safety belt assembly revealed heavy historical usage scratches on the latch plate and aged webbing. The top retractor was jammed with the belt in the retracted position. The belt webbing was not stretched and the buckle was not damaged suggesting the safety belt was not in use when the door came open during the crash.

MANUAL RESTRAINT SYSTEM

The second row outboard seating positions were equipped with manual lap-and-shoulder safety belts, while the second row center seat position was equipped with a lap belt. The outboard safety belts were equipped with continuous loop belt webbing, locking latch plates, ELRs, and fixed upper anchors. The lap belt webbing for the center seat position had been cut and removed. Only the buckle remained in the vehicle.

At the SCI inspection, the second row right passenger's CRS was found secured in the vehicle (**Figure 8**) by the lap-and-shoulder safety belt. The safety belt webbing was routed through the forward facing belt path on the back of the CRS and the belt was buckled. No locking clip was present and there was no evidence that one had been used on the safety belt. The belt webbing was not snug, which allowed approximately 10 cm (2 in) of lateral and 5 cm (1 in) of longitudinal movement of the CRS on the seat.

Figure 8: The CRS was found secured in the second row right seating position of the Pontiac at the SCI inspection

CHILD RESTRAINT SYSTEM

The Pontiac's second row right passenger [23-month-old female, 76 cm (30 in) and 16 kg (35 lbs)] was seated in a Cosco/Dorel High Back Booster CRS (**Figure 9**). There were no labels on the CRS that identified the date of manufacture or the model number. The CRS's weight and height restrictions when the 5-point harness was in use were 9-18 kg (20-40 lbs) and 86 cm-109 cm (34-43 in), respectively. A warning was molded into the plastic shell, which stated that the CRS should not be used after December 2009.

Figure 9: The Cosco/Dorel High Back Booster CRS

The CRS was equipped with a 5-point harness, lower anchor straps and buckles, and a harness retainer clip. Based on the SCI interview with the driver's father-in-law (the passer-by who removed the child from the vehicle), the harness retainer clip was positioned at the child's chest/armpit level. No tether was present. The CRS was constructed of a one-piece plastic shell and had a 1 cm (0.4 in) thick padded fabric cover. There was a sliding harness strap adjustment with 2 positions. The harness straps were adjusted to the lowest position.

The inspection of the CRS revealed a crack 23 cm (9 in) in length on the bottom of the shell immediately to the right of the harness strap adjuster (**Figure 10**). Stress marks on the shell were also present near the crack. A crack 15 cm (5.9 in) in length was present on the left portion of the upper shell. There were corresponding stress marks, 28 cm (11 in) in length, that joined to the crack and curved up to the top right portion of the shell (**Figure 11**). Heavy abrasions were also present on the top left of the shell (**Figure 12**). The crack and curved stress marks

corresponded with the intruded shape of the second row seat back (**Figure 13**). The left harness strap had been cut at the crash scene.

Figure 10: Yellow tape highlights crack and stress marks in shell of CRS

Figure 11: Crack and stress mark on upper left portion of the shell of the CRS

Figure 12: Abrasions on the top left portion of the shell of the CRS

Figure 13: CRS and deformed second row seat back of the Pontiac

CASE VEHICLE DRIVER KINEMATICS

The unrestrained driver [24-year-old female, 160 cm (63 in) and 68 kg (150 lbs)] was seated in an unknown posture. At the time of the vehicle inspection, the seat track was adjusted to between the middle and forward positions and the seat back was slightly reclined. The steering column was adjusted to the middle tilt position.

The Pontiac was rotating clockwise as it approached the impact with the tree. The driver was displaced to the left as the vehicle rotated and decelerated during the yaw. The left side plane impact with the tree displaced the driver to the left and she contacted the left front door. The tree impact separated the left front door striker from the latch and the unrestrained driver was ejected through the door as the vehicle rolled over right side leading. The left side plane and roof of the vehicle rolled on the driver and she sustained multiple head, chest, abdomen, and spinal injuries including subdural hemorrhage, cerebral edema, intraventricular hemorrhage, multiple fractured

ribs with pneumothoraces and pneumomediastinum, liver laceration, spleen laceration, and fractures of the cervical, thoracic, and lumbar vertebra.

CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to a hospital where she was admitted. She was hospitalized for 24 days. The table below presents the driver's injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
	Concussive injury loss of consciousness and unresponsive to deep stimuli	Not coded	Exterior of occupant's motor vehicle: roof	Probable	Hospitalization records
1	Hemorrhage, subdural, left frontoparietal (holohemispheric) with 8 mm left-to-right midline shift, subfalcine herniation[1]	serious 140650.3,2	Exterior of occupant's motor vehicle: roof	Probable	Hospitalization records
2	Hemorrhage, subdural along the cerebellar tentorial leaflets with left greater than right	moderate 140440.2,6	Exterior of occupant's motor vehicle: roof	Probable	Hospitalization records
3	Cerebral edema with paucity of sulci throughout hemispheres; effacement frontal, occipital, and temporal horns of left lateral ventricle; low lying cerebellar tonsils–down to foramen magnum	serious 140670.3,2	Exterior of occupant's motor vehicle: roof	Probable	Hospitalization records
4	Hemorrhage, intraventricular, region of foramen of Monro[2] and 3rd ventricle	severe 140677.4,9	Exterior of occupant's motor vehicle: roof	Probable	Hospitalization records
5	Pneumothoraces, apical, bilaterally, not further specified	moderate 442202.2,3	Exterior of occupant's motor vehicle: side surface	Probable	Hospitalization records

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[1] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
falcial (fal′shal): pertaining to a falx.
falx (falks) pl. ***fal′ces***: a sickle-shaped organ or structure; used as a general term in anatomical nomenclature to designate such a structure.
f. ce′rebri, f. of cerebrum: the sickle-shaped fold of dura mater that extends downward in the longitudinal cerebral fissure and separates the two cerebral hemispheres.
herniation (her"ne-a′shen): the abnormal protrusion of an organ or other body structure through a defect or natural opening in a covering, membrane, muscle, or bone.
subfalcial h.: not defined in Dorland's, but it means below a falx (i.e., see falcial above)

[2] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
foramen (fo-ra′men): a natural opening or passage; a general term for such a passage, especially one into or through a bone.
f of Monro: *f. interventriculare*.
interventricular foramen, foramen interventricular′re: a passage through which the lateral and third ventricles communicate.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
6	Pneumomediastinum, not further specified	moderate 442209,2,9	Exterior of occupant's motor vehicle: side surface	Probable	Emergency room records
7	Fractured ribs: right 1st - 3rd, and 8th; left[3] 1st - 5th, not further specified with	critical 450214.5,3	Exterior of occupant's motor vehicle: side surface	Probable	Hospitalization records
	flail chest on both right and left				Emergency room records
8	Contusions, pulmonary, bilaterally, not further specified	serious 441410.3,3	Exterior of occupant's motor vehicle: side surface	Probable	Emergency room records
9	Laceration, liver, grade 3, involving dome, right anterior, and left medial hepatic segments, largest 3.2 x 2.4 cm (1.3 x 0.9 in)	serious 541824.3,1	Exterior of occupant's motor vehicle: side surface	Probable	Hospitalization records
10	Laceration, several, spleen, grade 2, largest 2.0 x 1.5 cm (0.8 x 0.6 in)	moderate 544222.2,2	Exterior of occupant's motor vehicle: side surface	Probable	Hospitalization records
11	Fracture, minimally displaced, left occipital condyle	serious 150200.3,8	Exterior of occupant's motor vehicle: roof	Probable	Hospitalization records
12	Fracture right nasal bone, not further specified	minor 251000.1,4	Exterior of occupant's motor vehicle: roof	Probable	Hospitalization records
13	Fracture, nondisplaced, right orbital floor	moderate 251221.2,1	Exterior of occupant's motor vehicle: roof	Probable	Hospitalization records
14 15 16	Fractures left cervical transverse processes–C_5, C_6, and C_7, with extension into transverse foramina	moderate 650220.2,6 650220.2,6 650220.2,6	Exterior of occupant's motor vehicle: roof	Probable	Hospitalization records
17	Fracture right transverse process C_7, not further specified	moderate 650220.2,6	Exterior of occupant's motor vehicle: roof	Probable	Emergency room records
18 19 20 21	Fractures left thoracic transverse processes: T_1 and T_5 - T_7, not further specified	moderate 650420.2,7 650420.2,7 650420.2,7 650420.2,7	Exterior of occupant's motor vehicle: side surface	Probable	Hospitalization records

[3] The left 3rd and 4th ribs were fractured posteriorly.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
22 23 24 25	Fractures, minimally displaced, left lumbar transverse processes: L_2 - L_4, and right L_5, not further specified	moderate 650620.2,8 650620.2,8 650620.2,8 650620.2,8	Exterior of occupant's motor vehicle: side surface	Probable	Hospitalization records
26	Contusion, moderate, left parietal scalp, not further specified	minor 110402.1,2	Exterior of occupant's motor vehicle: roof	Probable	Emergency room records
27	Contusion left face, not further specified	minor 210402.1,2	Exterior of occupant's motor vehicle: roof	Probable	Emergency room records
28	Lacerations left face, not further specified	minor 210600.1,2	Exterior of occupant's motor vehicle: roof	Probable	Emergency room records
29	Contusion right infraorbital area, not further specified	minor 210402.1,1	Exterior of occupant's motor vehicle: roof	Probable	Hospitalization records
30	Contusion left chin, not further specified	minor 210402.1,8	Exterior of occupant's motor vehicle: roof	Probable	Hospitalization records
31	Contusion left neck, not further specified	minor 310402.1,2	Exterior of occupant's motor vehicle: roof	Probable	Hospitalization records
32	Contusion (soft tissue injury[4]) left chest wall, not further specified	minor 410402.1,2	Exterior of occupant's motor vehicle: side surface	Probable	Hospitalization records
33	Abrasion left lateral (back), not further specified	minor 410202.1,2	Left front door panel, rear upper quadrant	Probable	Hospitalization records
34	Abrasion left flank, not further specified	minor 510202.1,2	Left front door panel, rear upper quadrant	Probable	Hospitalization records

[4] Lesion was described as a seat belt sign.

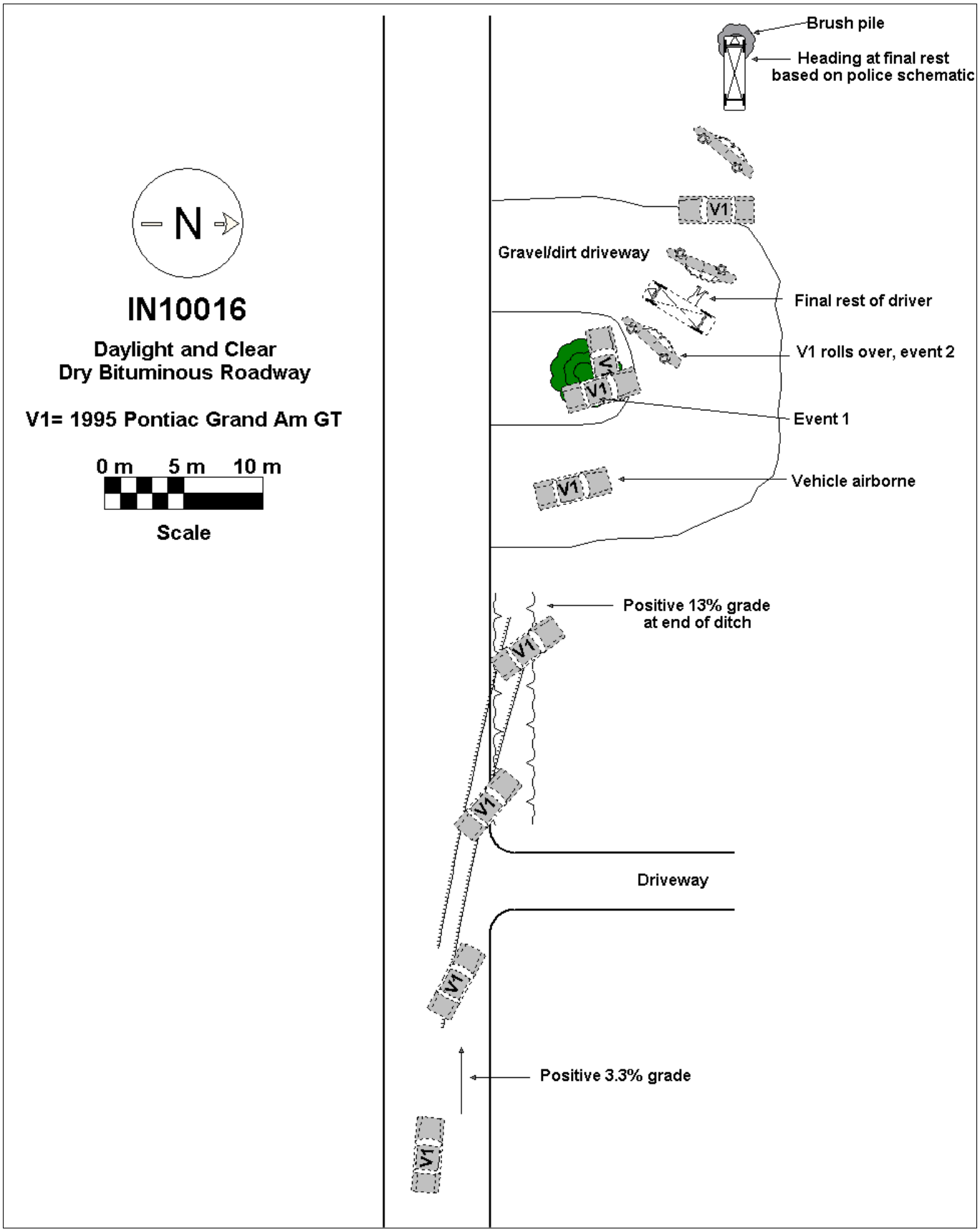
The second row right passenger [23-month-old female, 76 cm (30 in) and 16 kg (35 lbs)] was seated in the CRS in an unknown posture and was restrained by the 5-point harness.

The Pontiac's left side impact with the tree displaced the child to the left within the CRS. The second row seat back was buckled by the impact and deformed the back of the CRS. There was no discernable evidence of occupant contact on the CRS. As the vehicle rolled over and the roof was crushed, the CRS and the child were redirected toward the roof. The deposits of body fluid on the roof above the child's seating position indicated that the child contacted her head on the roof. The police crash report stated that the child sustained a severe head injury, which was caused by contact with the intruding roof during the rollover. The child was declared deceased at the crash scene.

CASE VEHICLE SECOND ROW RIGHT PASSENGER INJURIES

The table below presents the second row right passenger's injury and injury source. An autopsy was not performed.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
1	Blunt head trauma to posterior superior (top of head toward back) head	unknown 100999.9,0	Roof	Certain	Other: police officer


N
IN10016
Daylight and Clear
Dry Bituminous Roadway
V1= 1995 Pontiac Grand Am GT
0 m 5 m 10 m
Scale
Brush pile
Heading at final rest based on police schematic
V1
Gravel/dirt driveway
Final rest of driver
V1 rolls over, event 2
V1
Event 1
V1
Vehicle airborne
Positive 13% grade at end of ditch
V1
V1
Driveway
V1
Positive 3.3% grade
V1