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# ON-SITE CHILD AIR BAG-RELATED FATALITY INVESTIGATION

CASE NUMBER - IN98-001
LOCATION - MISSISSIPPI
VEHICLE - 1994 PONTIAC GRAND PRIX
CRASH DATE - January, 1998

Submitted:

March 21, 2003


Contract Number: DTNH22-94-D-17058

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
National Center for Statistics and Analysis
Washington, D.C. 20590-0003

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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.

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15. *Supplementary Notes*
On-site air bag deployment investigation involving a 1994 Pontiac Grand Prix SE, two-door coupe, with automatic, three-point, safety belts and dual front air bags and a large tree

16. *Abstract*

This report covers an on-site investigation of an air bag deployment crash that involved a 1994 Pontiac Grand Prix (case vehicle) and a large tree. This crash is of special interest because the case vehicle's, unrestrained, front right passenger (4-year-old male) sustained facial and head injuries from contacting his deploying front right air bag, resulting in his death. The case vehicle was traveling east, approaching the top of a hill crest, in the center of a two-lane, undivided, county roadway. As the case vehicle crested the hill, the case vehicle's driver swerved to the right, attempting to avoid an oncoming, noncontact vehicle. The case vehicle subsequently went off the south edge of the roadway. The crash occurred off the south side of the road. Initially the right fender of the case vehicle sideswiped a fence post and the barbed wire the post supported. Subsequently, the front center of the case vehicle impacted the large tree, causing the case vehicle's driver and front right supplemental restraints (air bags) to deploy. The case vehicle rotated slightly counterclockwise before coming to rest near the large tree. The case vehicle's front right passenger was seated with his seat track located between its middle and forward-most positions. He was not wearing his available, passive, three-point, lap-and-shoulder, safety belt system and sustained, according to the county coroner, a traumatic brain injury (alleged to be a cerebral edema), a separation/dislocation at $C_2$, a large abrasion to the right side of his face and abrasions to his right orbital area, nose, and upper lip. The case vehicle driver (46-year-old female) was seated, with her seat track located in its forward-most position, and the tilt steering wheel was located in its up-most position. She was not using the available, passive, three-point, lap-and-shoulder, safety belt system and sustained, according to the county coroner, bilateral patellar fractures.

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**TABLE OF CONTENTS** IN98-001

## BACKGROUND

IN98-001

This on-site investigation was brought to NHTSA's attention on January 5, 1998 by a trooper with the Mississippi Highway Patrol Safety Department. This crash involved a 1994 Pontiac Grand Prix SE (case vehicle) and a large tree. The crash occurred in January, 1998, at 4:17 p.m., in Mississippi and was investigated by the applicable county sheriff department. This crash is of special interest because the case vehicle's front right passenger [4-year-old, Black (unknown if Hispanic) male] sustained facial and head injuries from contacting his deploying front right air bag, resulting in his death. This contractor inspected the scene and vehicles on 8-9 January, 1998. This contractor was unable to locate or interview the case vehicle's driver. This report is based on the Police Crash Report, interviews with the county coroner and the investigating police officer, scene and vehicle inspections, occupant kinematic principles, and this contractor's evaluation of the evidence.

## SUMMARY

The case vehicle was traveling east, approaching the top of a hill crest, in the center of a two-lane, undivided, county roadway and intended to continue traveling eastward. As the case vehicle crested the hill, the case vehicle's driver swerved to the right, attempting to get back into the eastbound lane and avoid an oncoming, noncontact vehicle that was traveling westbound. As a result of this attempted avoidance maneuver, the case vehicle departed the south edge of the roadway. There is no evidence that the case vehicle's driver made any further avoidance maneuvers just prior to the crash; however, she may have attempted to steer leftward as the case vehicle was departing the roadway. The crash occurred off the south side of the road (see **CRASH DIAGRAM** below).

Initially the right fender of the case vehicle sideswiped a fence post and the barbed wire the post supported. Subsequently, the front center of the case vehicle impacted the large tree, causing the case vehicle's driver and front right supplemental restraints (air bags) to deploy. The case vehicle rotated slightly counterclockwise before coming to rest near the large tree.

The case vehicle's front right passenger (son; unknown height and weight) was not using the available, passive, three-point, lap-and-shoulder, safety belt system, which was located in the right front door. In addition, there was no evidence of belt pattern bruising and/or abrasions to the front right passenger's body. The inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading.

The case vehicle's driver steered rightward to avoid the oncoming, noncontact vehicle. As a result of this rightward steering maneuver, the downward orientation of the case vehicle (i.e., the case vehicle had just crested a hill), and the nonuse of his available safety belts, the front right passenger moved slightly forward and to his left just prior to impact. The case vehicle's driver may have attempted to steer leftward as the case vehicle was departing the roadway. As a result, the unrestrained child passenger would have move slightly back to the right, towards his original seating position. The case vehicle's impact with the fence post had little effect on the posture or position of the front right passenger. On the other hand, the case vehicle's impact with the tree enabled front right passenger to move upward and forward into the deploying air bag as the case

vehicle decelerated. The deploying air bag struck the passenger on the right side of his face, redirecting him leftward, backward and downward toward the case vehicle's center console. The console's flip-top cover was broken off during the crash. After striking the center console, the passenger rebounded forward, and at final rest, his lower torso was in the front right floor pan area with his back and upper torso on the front right seat cushion, facing upwards.

The front right occupant was transported by ambulance to the hospital. He sustained fatal injuries and was pronounced dead at the hospital unknown minutes post-crash. The injuries sustained by the case vehicle's front right passenger included: a traumatic brain injury (alleged to be a cerebral edema), a separation/dislocation at $C_2$, a large abrasion to the right side of his face and abrasions to his right orbital area, nose, and upper lip.

The case vehicle was a front wheel drive 1994 Pontiac Grand Prix SE, two-door coupe (VIN: 1G2WJ12M5RF------). The case vehicle was equipped with anti-lock brakes. The case vehicle was towed due to damage. Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **12-RDES-1**, for the initial impact and **12-FDEW-3 (-10)**, for the tree impact [maximum crush was 85 centimeters (33.5 inches)]. The WinSMASH reconstruction program, barrier algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta V's are respectively: 45.4 km.p.h. (28.2 m.p.h.), -44.7 km.p.h. (-27.8 m.p.h.), and + 7.9 km.p.h. ( + 4.9 m.p.h). The front of the case vehicle's uni-body frame was bent upwards approximately 18 centimeters (7.1 inches).

The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed without any tethers. The driver's air bag had two vent ports, approximately 3 centimeters (1.2 inches) in diameter, located at the 9 and 3 o'clock positions. The deployed driver's air bag was round with diameter 60 centimeters (23.6 inches). An inspection of the driver air bag revealed a lipstick imprint and a blood smear to the upper right portion.

The front right passenger's air bag was located in the top of the instrument panel. An inspection of the front right air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag. There was, however, evidence on the front right air bag module's cover flap of contact during the deployment to the windshield (i.e., scratches and slicing), but there was no evidence of contact with the front right passenger on the module's cover flap. The front right passenger's air bag was designed with two tethers, each 8 centimeters (3.1 inches) wide. The front right air bag had two vent ports, approximately 5 centimeters (2.0 inches) in diameter, located at the 10 and 2 o'clock positions. The deployed front right air bag was rectangular with a height of approximately 50 centimeters (19.7 inches) and a width of approximately 64 centimeters (25.2 inches). An inspection of the front right air bag revealed dark skin to the left center portion of the air bag. The interior inspection of the case vehicle also showed moderate intrusion to the whole dash, toe pan, and floor pan. In addition, there was complete separation of the steering column's shear capsule.

Immediately prior to the crash, the exact posture of the case vehicle's front right passenger is unknown. Presumably, he was seated upright with his back against the seat back, his buttocks toward the left edge of the seat cushion, his legs outstretched in front of him with his feet hanging off the front edge of the seat cushion, his left arm on the center arm rest, and his right arm/hand on his lap or possibly trying to hold onto the center arm rest. Based on the vehicle inspection, his seat track was located between its middle and forward-most positions, and the seat back was upright.

The exact posture of the case vehicle's driver [46-year-old, Black (unknown if Hispanic) female] just prior to the crash is unknown. Presumably, the case vehicle's driver was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot off the accelerator reaching for the brake, and both hands on the steering wheel. Based on the vehicle inspection, her seat track was located in its forward-most position, the seat back was upright, and the tilt steering wheel was located in its up-most position. The case vehicle's driver (unknown height and weight) was not using the available, passive, three-point, lap-and-shoulder, safety belt system, which was located in the driver's door. The driver was transported by ambulance to the hospital. She sustained moderate injuries and was hospitalized for eight days post-crash. The injuries sustained by the case vehicle's driver included: bilateral patellar fractures.

**Figure 1:** On-scene view of case vehicle's eastbound travel path, while cresting a hill, in middle of roadway (case photo #02)

**Figure 2:** On-scene view of case vehicle's eastbound travel path onto south roadside and into barbed wire fence and tree; Note: fence had been repaired (case photo #03a)

## CRASH CIRCUMSTANCES

The case vehicle was traveling east, approaching the top of a hill crest (i.e., slope was -4% in a westerly direction), in the center of a two-lane, undivided, unmarked (i.e., no lane lines), rural, county roadway and intended to continue traveling eastward. As the case vehicle crested the hill (i.e., slope was +5% in a westerly direction), the case vehicle's driver swerved to the right, attempting to get back into the eastbound lane and avoid an oncoming, noncontact vehicle that was traveling westbound (**Figure 1**). As a result of this attempted avoidance maneuver, the case vehicle departed the south edge of the roadway. Although the case vehicle was equipped with anti-lock brakes, there is no evidence that the case vehicle's driver made any further avoidance maneuvers just prior to the crash. The crash occurred off the south side of the road; see **CRASH DIAGRAM** below.

Initially the right fender of the case vehicle sideswiped a fence post and the barbed wire the post supported, bending several metal fence posts (**Figure 2** above). Subsequently, the front center of the case vehicle (**Figures 3**, **4**, and **5**) impacted the large tree [66 centimeters in diameter (26.0 inches)], causing the case vehicle's driver and front right supplemental restraints (air bags) to deploy. The case vehicle rotated slightly (approximately 10 degrees) counterclockwise before coming to rest near the large tree, heading primarily eastward. The case vehicle was towed from the scene due to damage. The roadway was straight, bituminous, had no shoulders, and was dry at the time of the crash. There were no visible traffic controls, and the estimated coefficient of friction was 0.70%.

**Figure 3:** Case vehicle's frontal damage from tree impact, viewed from left of front with contour gauge present (case photo #13)

**Figure 4:** Case vehicle's frontal damage from tree impact, viewed from right of front with contour gauge present; Note: vertical yellow tape outlines direct contact area case photo #18)

**Figure 5:** Overhead view of case vehicle's frontal damage from tree impact; Note: vertical yellow tape outline direct damage area (case photo #11)

## CASE VEHICLE

The case vehicle was a front wheel drive 1994 Pontiac Grand Prix SE, five-passenger, two-door coupe (VIN: 1G2WJ12M5RF------) equipped with power-assisted rack-and-pinion steering, a 3.1L, SFI-OHV, V-6 engine, and a four-speed automatic transmission. Braking was achieved by a power-assisted, front disc and rear drum, four-wheel, anti-lock system. The case vehicle's wheel base was 273 centimeters (107.5 inches), and the odometer reading at inspection was 134,903 kilometers (83,825 miles).

The interior of the case vehicle had front bucket seats with folding backs and adjustable head restraints. The back seat was a bench seat without head restraints. The case vehicle was equipped with automatic, passive, three-point, lap-and-shoulder, safety belt systems, located in the door in the front outboard seating positions (**Figure 6** below). The case vehicle was not equipped with manually operated height adjusters for the "D"-rings on the front belt systems. The back seat had

manual, three-point, lap-and-shoulder, safety belt systems in the outboard seating positions with a manual, two-point, lap belt only in the back center seat. The case vehicle was equipped with knee bolsters for the driver and front right passenger. The driver's knee bolster showed significant contact evidence (deformation with scuffing). Additional automatic restraint was provided by a Supplemental Restraint System (**SRS**) that consisted of frontal air bags for the driver and front right passenger positions.

**Figure 6:** Case vehicle's driver seating area showing deployed driver and front right air bags; Note: three-point passive belt in driver's door (case photo #21)

## CASE VEHICLE DAMAGE

The initial contact with the fence post and barbed wire involved the right side of the case vehicle. Direct contact with the post and wire began at the right front bumper corner and extended rearwards 437 centimeters (172.0 inches) to just behind the right rear axle. The field L also started at the right front bumper corner and extended rearwards 451 centimeters (177.6 inches). Maximum crush was measured at 1 centimeter (0.4 inches).

**Figure 7:** Right side of the case vehicle's windshield which was damaged by front right air bag module's tethered cover flap (case photo #20)

The direct damage for the case vehicle's primary impact with the tree began 19 centimeters (7.5 inches) in from the front right bumper and extended 68 centimeters (26.8 inches) to the left (**Figure 5** above). The impact pulled in both front corners of the case vehicle resulting in a 78 centimeter (30.7 inches) field L. Maximum crush was measured as 85 centimeters (33.5 inches) near the $C_3$ position. The front bumper fascia, grille, hood, and radiator were crushed rearward. Both of the front tires were physically restricted from the front end damage (**Figures 3** and **4** above) and only the right front tire was deflated, possibly from interaction with the barbed wire fence. The case vehicle's impact with the large tree altered (i.e., shortened) the wheelbase 3 centimeters (1.2 inches) on the right side and 9 centimeters (3.5 inches) on the left side. The roof was buckled on the driver's side just behind the "B"-pillar, and both the right and left fenders sustained induced damage from the frontal impact.

**Figure 8:** Case vehicle front right air bag module's tethered cover flap showing glass scratches from contacting and damaging right windshield (case photo #36)

An examination of the case vehicle's interior revealed that the windshield was fractured on the passenger side (**Figure 7** above) from contact by the deploying front right passenger air bag module's cover flap (**Figure 8** above). The energy absorbing steering column sustained complete separation of the steering column's shear capsule (**Figure 9**), with separation measured at 9 centimeters (3.5 inches). The steering wheel rim showed total collapse from interaction with the case vehicle driver's chest. The padded cover on the floor-mounted, center console was broken off and had blood on it from contact by the front right passenger's head (**Figures 10** and **11**). The interior inspection also showed moderate intrusion to the entire front instrument panel, toe pan, and floor pan.

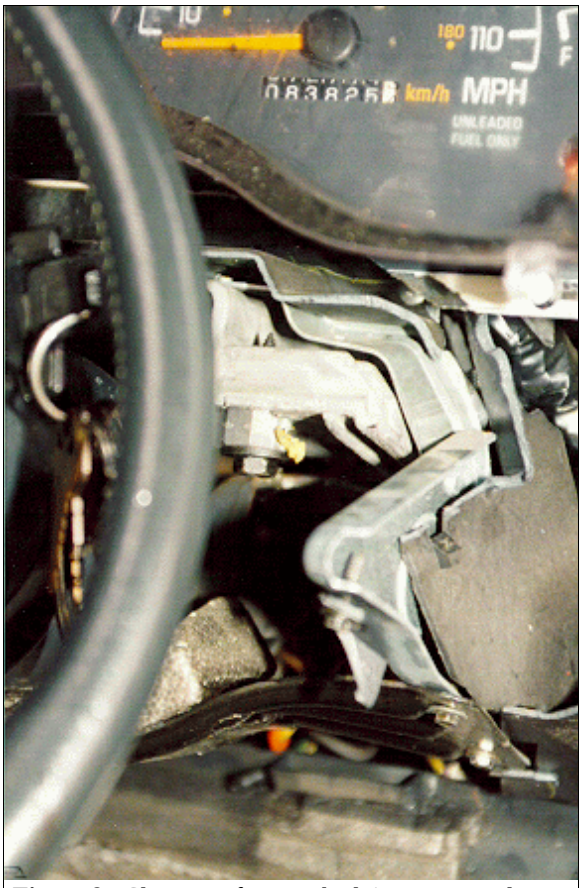



**Figure 9:** Close-up of case vehicle's steering column showing shear capsule separation (case photo #24)

Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **12-RDES-1**, for the initial impact and **12-FDEW-3 (-10)**, for the tree impact. The WinSMASH reconstruction program, barrier algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta V's are respectively: 45.4 km.p.h. (28.2 m.p.h.), -44.7 km.p.h. (-27.8 m.p.h.), and +7.9 km.p.h. (+4.9 m.p.h). The front of the case vehicle's unibody frame was bent upwards approximately 18 centimeters (7.1 inches).

**Figure 10:** Case vehicle's front right passenger seating area showing deployed driver and front right air bags; Note: broken hinge (arrow) from center console's covered storage box and collapsed steering wheel rim (case photo #26)

**Figure 11:** Case vehicle's padded center console cover, broken off by front right passenger's head; Note: arrow marks blood spot (case photo #26a)

As previously mentioned, the case vehicle was equipped with a SRS that consisted of frontal air bags at the driver and front right passenger seat position. The SRS deployed as a result of the case vehicle's frontal impact with the tree. The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of "I"-configuration cover flaps made of thick vinyl with overall dimensions of 18 centimeters (7.1 inches) at the upper and lower horizontal seams and 10 centimeters (3.9 inches) vertically. An inspection of the air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed without any tethers. The driver's air bag had two vent ports, approximately 3 centimeters (1.2 inches) in diameter, located at the 9 and 3 o'clock positions. The deployed driver's air bag was round with diameter 60 centimeters (23.6 inches). An inspection of the driver air bag revealed an area of blood drainage toward the center portion of the upper left quadrant along the top edge (and continuing onto the back top of the air bag) and a lipstick imprint and a blood smear to the upper right portion (**Figure 12**).

The front right passenger's air bag was located in the top of the right dash. There was a single, asymmetrical, modular cover flap. The cover flap was made of a thick vinyl over a thick cardboard type frame. The flap's dimensions were: 53 centimeters (20.9) at the forward horizontal seam, 38 centimeters (15.0 inches) at the rear (i.e., toward the windshield) horizontal seam, 25 centimeters (9.8 inches) along the right vertical seam, and 32 centimeters (12.6 inches) along the angled left vertical seam. The profile of the case vehicle's instrument panel/dash resulted in a 5 centimeter (2.0 inch) setback of the leading edge of the cover flap relative to the protruding right instrument panel. An inspection of the front right air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag. However, the front right corner and right side of the cover flap contacted the windshield fracturing it (**Figure 7** above), and abrading the right side of the flap (**Figure 8** above) and cracking the stiff cardboard frame. Inspection of the cover flap revealed no visible evidence of contact with the front right passenger. The front right passenger's air bag was designed with two tethers, each 8 centimeters (3.1 inches) wide. Both tethers were sewn to the interior face of the air bag at a point

**Figure 12:** Close-up of case vehicle's driver air bag showing lipstick (i.e., upper right) and blood (i.e., upper center) smears (case photo #28)

**Figure 13:** Close-up of case vehicle's front right passenger air bag showing area (i.e., taped) of skin transfer (case photo #32)

**Figure 14:** Closer-up of case vehicle's front right air bag showing dark skin transfer to middle front left area of air bag (case photo #33a)

that was 19 centimeters (7.5 inches) above the bottom edge. The front right air bag had two vent ports, approximately 5 centimeters (2.0 inches) in diameter, located at the 10 and 2 o'clock positions. The deployed front right air bag was rectangular with a height of approximately 50 centimeters (19.7 inches) and a width of approximately 64 centimeters (25.2 inches). An inspection of the front right passenger air bag revealed a dark skin transfer to the front left center portion of the air bag (**Figure 13** above and **Figure 14**). The skin transfer started approximately 10 centimeters (3.9 inches) down from the top edge of the air bag and extended downwards 10 centimeters (3.9 inches). The skin transfer was 10 centimeters wide and started 4 centimeters (1.6 inches) in from the left edge. The bottom of the skin transfer was 11 centimeters (4.3 inches) above the tether stitching.

After this contractor's on-scene investigation, a General Motors (GM) analyst inspected the case vehicle and downloaded information that was recorded on the case vehicle's Sensing Diagnostic Module (SDM). The SDM revealed that the system was clean (i.e., no faults or warning codes) at the time of the deployment. According to the GM analyst responsible for decoding the encrypted printout, it appears that the case vehicle's air bags were commanded to deploy 30.0 milliseconds into the event. The SDM recorded a maximum change in velocity of 44.9 km.p.h. (27.9 m.p.h.). The SDM also recorded a **near deployment** event that happened on the same ignition cycle and the maximum change in velocity was 2.1 km.p.h. (1.3 m.p.h.). It should be noted that an "event" by GM's definition is any deceleration occurrence that is greater than "**2g's**"and is recorded on the vehicle's SDM. The SDM is located under the carpet of the front right passenger's seat with the data retrieval port located under the lower instrument panel on the driver side. The SDM indicated that the driver's seat belt was un latched at the time the deployment occurred. For additional information, see the **SENSING AND DIAGNOSTIC MODULE** section below.

## CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

Immediately prior to the crash the exact posture of the front right passenger [son; 4-year-old, Black (unknown if Hispanic) male] is unknown. Presumably, he was seated upright with his back against the seat back, his buttocks toward the left edge of the seat cushion, his legs outstretched in front of him with his feet hanging off the front edge of the seat cushion, his left arm on the center arm rest, and his right arm/hand on his lap or possibly trying to hold onto the center arm rest. Based on the vehicle inspection, his seat track was located between its middle and forward-most positions, and the seat back was upright.

The front right passenger (unknown height and weight) was not using the available, passive, three-point, lap-and-shoulder, safety belt system, which was located in the right front door. In

addition, there was no evidence (i.e., based on the photographs obtained from the county coroner) of belt pattern bruising and/or abrasions to the front right passenger's body. The inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading.

The case vehicle's driver steered rightward to avoid the oncoming, noncontact vehicle. As a result of this rightward steering maneuver, the downward orientation of the case vehicle (i.e., the case vehicle had just crested a hill), and the nonuse of his available safety belts, the front right passenger moved slightly forward and to his left just prior to impact. The case vehicle's driver may have attempted to steer leftward as the case vehicle was departing the roadway. As a result, the unrestrained child passenger would have move slightly back to the right, towards his original seating position. The case vehicle's impact with the fence post had little effect on the posture or position of the front right passenger. On the other hand, the case vehicle's impact with the tree enabled front right passenger to move upward and forward into the deploying air bag as the case vehicle decelerated. The deploying air bag struck the passenger on the right side of his face, redirecting him leftward, backward, and downward toward the case vehicle's floor-mounted, center console as the front of the case vehicle climbed the tree. The console's flip-top cover was broken off during the crash (**Figures 10** and **11** above). The passenger's interaction with the deploying air bag most likely resulted in his traumatic brain injury and $C_2$ separation/dislocation. After striking the center console, the passenger rebounded forward, and at final rest, his lower torso was in the front right floor pan area with his back and upper torso on the front right seat cushion, facing upwards.

## CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right occupant was transported by ambulance to the hospital. He sustained fatal injuries and was pronounced dead at the hospital unknown minutes post-crash. The injuries sustained by the case vehicle's front right passenger included: a traumatic brain injury (alleged to be a cerebral edema), a separation/dislocation at $C_2$, a large abrasion to the right side of his face and abrasions to his right orbital area, nose, and upper lip.

| Injury Number | Injury Description (including Aspect) | NASS Injury Code & AIS 90 | Injury Source (Mechanism) | Source Confidence | Source of Injury Data |
|---|---|---|---|---|---|
| 1 | Traumatic brain injury {alleged to be cerebral edema} | 115299.7 unknown | Air bag, front right passenger's | Probable | Other: County Coroner |
| 2 | Dislocation of $C_2$ | 650204.2 moderate | Air bag, front right passenger's | Probable | Other: County Coroner |
| 3 | Abrasions right face: including right orbital area and cheek | 290202.1 minor | Air bag, front right passenger's | Certain | Other: Coroner's photos |
| 4 | Abrasions nasal area | 290202.1 minor | Air bag, front right passenger's | Certain | Other: Coroner's photos |
| 5 | Abrasion upper lip | 290202.1 minor | Air bag, front right passenger's | Certain | Other: Coroner's photos |

The case vehicle's impact with the tree deployed the driver's air bag. The exact posture of the case vehicle's driver [46-year-old, Black (unknown if Hispanic) female] just prior to the crash is unknown. Presumably, the case vehicle's driver was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot off the accelerator reaching for the brake, and both hands on the steering wheel. Based on the vehicle inspection, her seat track was located in its forward-most position, the seat back was upright, and the tilt steering wheel was located in its up-most position. The case vehicle's driver (unknown height and weight) was not using the available, passive, three-point, lap-and-shoulder, safety belt system, which was located in the driver's door. An inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading.

The case vehicle's driver steered rightward to avoid the oncoming, noncontact vehicle. As a result of this rightward steering maneuver, the downward orientation of the case vehicle (i.e., the case vehicle had just crested a hill), and the nonuse of her available safety belts, the driver moved slightly forward and to her left just prior to impact. The case vehicle's driver may have attempted to steer leftward as the case vehicle was departing the roadway. Based on the available information, she most likely leaned to the right and may have brace her arms against the steering wheel as she approached the barbed wire fence and post. The case vehicle's impact with the fence post had little effect on the posture or position of the driver. On the other hand, the case vehicle's impact with the tree enabled the driver to move upward and forward into the deploying air bag as the case vehicle decelerated. The case vehicle's driver may have moved slightly downwards and the case vehicle tried to climb up the tree. There was evidence (i.e., lipstick and blood) of driver contact on the air bag (**Figure 12** above), compression to the energy absorbing shear capsules in the base of the steering column, and complete collapse of the steering wheel rim. The driver rebounded straight back off the collapsed steering wheel rim into her seat back. As the case vehicle came to rest the driver most likely remained in her seat.

## CASE VEHICLE DRIVER INJURIES

The case vehicle's driver was transported by ambulance to the hospital. Based on the interview with the investigating officer, she sustained moderate injuries and was hospitalized for eight days post-crash. According to the **county coroner**, the injuries sustained by the case vehicle's driver included: bilateral patellar fractures.

| Injury Number | Injury Description (including Aspect) | NASS Injury Code & AIS 90 | Injury Source (Mechanism) | Source Confidence | Source of Injury Data |
|---|---|---|---|---|---|
| 1 | Fracture left patella | 852400.2 moderate | Knee bolster, driver's side | Probable | Other: County Coroner |
| 2 | Fracture right patella | 852400.2 moderate | Knee bolster, driver's side | Probable | Other: County Coroner |

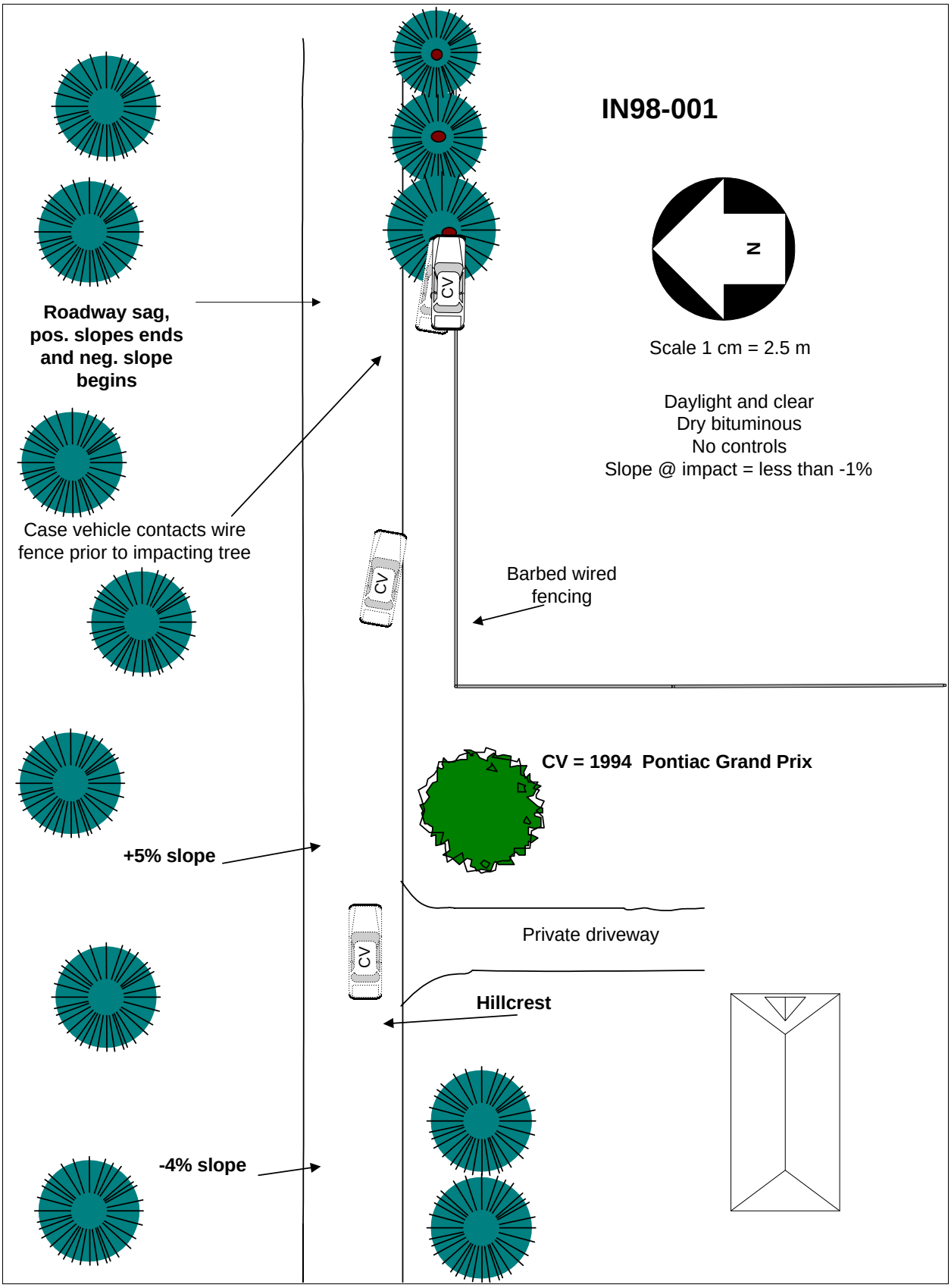
Forty-five (45) days following this investigator's on-site investigation, General Motors had a person from the ESIS GM Claims Unit inspect the case vehicle. This person was familiar with obtaining and deciphering stored information in GM vehicles equipped with an SDM (Sensing and Diagnostic Module).

According to the GM analysis, the SDM is able to record any near deployment events the case vehicle has incurred throughout its driving lifetime. These near deployment events would include anything from a 5 m.p.h. fender bender to an impact just below the vehicle's threshold or higher, the latter causing deployment. Essentially the recording is taken at any deceleration event the case vehicle incurs higher than **"2gs"**. The SDM also is capable of recording the driver's seat belt status at the last recorded event, any recorded air bag warnings that have been detected (pre- or post-crash), and when the warnings first appeared. Another important item of information the SDM is capable of retaining is the maximum Delta V the case vehicle sustained during its deployment event (crash).

The SDM recorded and stored a CRASH EVENT which contains the following information:

- The SIR Warning Light was OFF at the time of the deployment (i.e., no malfunctions).
- The SIR Warning Light was not ON prior to the crash (i.e., no malfunctions).
- The air bags deployed 30.0 milliseconds after the collision was first detected by the SDM.
- The maximum change in velocity (Delta V) the SDM recorded was 44.9 km.p.h. (27.9 m.p.h). The maximum Delta V the SDM is capable of recording is 44.9 km.p.h. (27.9 m.p.h.). It reached this maximum value at 80 milliseconds after the crash was first detected.
- Normal criteria were met which triggered the SDM to command the deployment of the air bags.
- The crash occurred on ignition cycle number 14656. This is one (1) cycle prior to when the SDM was read on February 23, 1998 (14657).
- The driver's seat belt was unlatched at the time the deployment occurred.

In addition to the Deployment Crash Event, the SDM also stored a Near-Deployment Event that occurred sometime during the same ignition cycle (14656) as the crash in question. The maximum Delta V for this event was 2.1 km.p.h. (1.3 m.p.h.). The driver seat belt was also unlatched during this event.


IN98-001
N
Scale 1 cm = 2.5 m
Daylight and clear
Dry bituminous
No controls
Slope @ impact = less than -1%
Roadway sag, pos. slopes ends and neg. slope begins
Case vehicle contacts wire fence prior to impacting tree
Barbed wired fencing
CV = 1994 Pontiac Grand Prix
+5% slope
Private driveway
Hillcrest
-4% slope
CV