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ON-SITE AIR BAG INVESTIGATION

CASE NUMBER - IN97-034
LOCATION - TEXAS
VEHICLE - 1997 HYUNDAI ACCENT L
CRASH DATE - October, 1997

Submitted:

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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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On-site air bag deployment investigation involving a 1997 Hyundai Accent L, three-door hatchback, with manual safety belts and dual front air bags, and a 1993 Chrysler New Yorker Fifth Avenue, four-door sedan

16. *Abstract*

This report covers an on-site investigation of an air bag deployment crash that involved a 1997 Hyundai Accent L (Case Vehicle) and a 1993 Chrysler New Yorker Fifth Avenue (vehicle #2). This crash is of special interest because the case vehicle's front right passenger (4-year-old female) sustained fatal cervical injuries from her deploying front right passenger air bag. The case vehicle was traveling east in the eastbound lane of a two-lane, undivided, city street. Vehicle #2 had been traveling west in the westbound lane of the same roadway and was making a left-hand turn into a private driveway. The crash occurred in the eastbound lane of the roadway, within the three-leg junction of the driveway. The front of the case vehicle impacted the front right corner of vehicle #2, causing the case vehicle's driver and front right supplemental restraints (air bags) to deploy. The case vehicle's front right passenger was seated upright with her seat track located between its middle and forward-most positions,. She was not wearing her available, active, three-point, lap-and-shoulder safety belt system and sustained, according to her medical records, fatal injuries which included: a fracture of the C_2 vertebral body with a transection and severe compression of her spinal cord; a nonanatomic brain injury; a cerebellar hemorrhage; bilateral cerebral contusions; mild cerebral edema; intraventricular hemorrhages; extensive subarachnoid hemorrhages; abrasions and contusions to her anterior neck and chin, forearms and hands, and bilateral anterior thighs; and an avulsion (evulsion) to the palmar surface of her left thumb. The case vehicle's driver (20 year-old female) was seated upright with her seat track located between its middle and forward-most positions, and the vehicle was not equipped with a tilt steering wheel. The case vehicle's driver was restrained by her available, active, three-point, lap-and-shoulder safety belt system. She sustained, according to her interview, minor injuries which included: a cervical strain, a sprained right wrist, and contusions to her whole chest and right wrist.

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BACKGROUND

IN97-034

This on-site investigation was brought to NHTSA's attention in October, 1997 by NASS Zone #2 personnel. This crash involved a 1997 Hyundai Accent L (case vehicle) and a 1993 Chrysler New Yorker (vehicle #2). The crash occurred in October, 1997, at 5:29 p.m., in Texas and was investigated by the applicable city police. This crash is of special interest because the case vehicle's front right passenger [4-year-old, White (Hispanic) female] sustained fatal cervical injuries from her deploying front right passenger air bag. A NASS Zone person inspected the scene and vehicles in October, 1997. This contractor interviewed the driver for the case vehicle in April, 1998. This report is based on the Police Crash Report, an interview with the case vehicle's driver, scene and vehicle inspections, medical records (autopsy), occupant kinematic principles, and this contractor's evaluation of the evidence that the Zone Center #2 personnel collected.

SUMMARY

The case vehicle was traveling east in the eastbound lane of a two-lane, undivided, city street and intended to continue traveling eastbound. Vehicle #2 had been traveling west in the westbound lane of the same roadway and was making a left-hand turn into a private driveway. The case vehicle's driver braked, attempting to avoid the crash. The crash occurred in the eastbound lane of the roadway, within the three-leg junction of the driveway (see **CRASH DIAGRAM** below). It should be noted that the vision of vehicle #2's driver was obscured due to the setting sun.

The front of the case vehicle impacted the front right corner of vehicle #2, causing the case vehicle's driver and front right supplemental restraints (air bags) to deploy. At maximum engagement the case vehicle rotated approximately 15 degrees clockwise and continued eastward a few feet, while remaining in contact with vehicle #2. The case vehicle came to rest in the eastbound lane heading east-southeast. Vehicle #2 initially continued southward after the impact, but at maximum engagement it was redirected eastward and rotated counterclockwise striking and dislodging some brick landscape edging, adjacent to the southeast edge of the roadway and the private drive. Vehicle #2 came to rest with its left front wheel on the curb of the eastbound lane heading south-southwest.

The case vehicle's front right passenger [niece, 111 centimeters and 13 kilograms (44 inches, 28 pounds)] was not wearing her available, active, three-point, lap and shoulder belt. In addition, there was no evidence of belt pattern bruising and/or abrasions to the front right passenger's body, and the inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading.

According to the case vehicle's driver, she had no time to attempt any avoidance maneuvers, but based on the scene evidence (i.e., faint anti-lock braking system tire skids from the case vehicle) this contractor believes that the case vehicle's driver braked, attempting to avoid the crash. As a result of this attempted avoidance maneuver and the nonuse of her available safety belts, the front right passenger moved forward, putting her forward location close to the air bag module, just prior to impact. The case vehicle's impact with vehicle #2 enabled the front right passenger to continue forward, upward, and slightly leftward, toward the -10 degree Direction of Principal Force, as the case vehicle decelerated. The front right passenger may have contacted the deploying air bag module's cover flap with her left hand as she most

likely reached out to stop her forward movement. But this occupant's injuries clearly indicate that as she moved forward and upwards, the thrust of the deploying air bag contacted her in her chest, neck, and undersurface of her chin. The passenger's interaction with the deploying air bag resulted in her being driven backwards toward the right side of the front right seat back where she subsequently rebounded down to the left as the case vehicle rotated clockwise. According to the case vehicle's driver, at final rest the front right passenger was sitting upright in her seat with her head tilted back against the seat back, her chin pointed toward the windshield, and her chest raised upwards. It is this contractor's opinion that the passenger's interaction with the deploying air bag caused the fatal injuries.

The front right occupant was transported by ambulance to the hospital. She sustained fatal injuries and was pronounced dead three and ½ hours post-crash. According to her autopsy report, the injuries sustained by the case vehicle's front right passenger included: a fracture of the C_2 vertebral body with a transection and severe compression of her spinal cord, an infra foliar hemorrhage in the cerebellum, bilateral cerebral contusions, mild cerebral edema, intraventricular hemorrhages involving the occipital horns of both lateral ventricles and the third and fourth ventricles, extensive subarachnoid hemorrhages involving the entire base of brain, abrasions and contusions to her anterior neck and chin, abrasions to her bilateral distal forearms and hands, contusions to her right mid-forearm and hand, an avulsion (evulsion) to the palmar surface of her left thumb, and abrasions to her bilateral anterior thighs. The cause of death was listed as neck fracture due to air bag deployment. According to the initial medical facility that treated her, she also sustained a nonanatomic brain injury and a contusion to her right thigh.

The case vehicle was a 1997 Hyundai Accent L, three-door hatchback (VIN: KMHVD14N3VU------). The case vehicle was equipped with anti-lock brakes. Vehicle #2 is a front wheel drive 1993 Chrysler New Yorker Fifth Avenue, four-door sedan (VIN: 1C3XV66R9PD------). The case vehicle and vehicle #2 were both towed due to damage. Based on the vehicle inspections, the CDCs were determined to be: **12-FYEW-2 (-10)** for the case vehicle [maximum crush was 24 centimeters (9.4 inches)] and **01-FZEW-1 (+30)** for vehicle #2 [maximum crush was 5 centimeters (2.0 inches)]. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta V's are, respectively: 18.2 km.p.h. (11.3 m.p.h.), -17.9 km.p.h. (-11.1 m.p.h.), and +3.2 km.p.h. (+2.0 m.p.h).

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 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 flap opened at its designated tear points. Furthermore, there appeared to be an oil smudge on the front right air bag module's cover flap. Both air bags were designed with three tethers sewn internally. The driver's air bag had two vent ports, of unknown diameter, located at the 10 and 2 o'clock positions. The deployed driver's air bag was round with a diameter of 60 centimeters (23.6 inches). The front right air bag had one vent port, approximately 5 centimeters (2.0 inches) in diameter, located between the 9 and 10 o'clock positions. The deployed front right air bag was rectangular with a height of approximately 47 centimeters (18.5 inches) and a width of approximately 43 centimeters (16.9 inches). There was a 0.5 centimeter (0.2 inch) black transfer (possibly

mascara) on the driver's air bag near the 11 o'clock position. There was an area of contact (i.e., skin, hair, cloth transfers, and an oil smear) on the upper front portion of the front right air bag between the 12 and 1 o'clock positions that extended onto the top portion. An inspection of the case vehicle's other interior surfaces revealed that there was scuffing on the instrument panel just below the steering column and to the driver's knee bolster to the left of the steering column.

Immediately prior to the crash the case vehicle's front right passenger was in the process of attempting to latch the buckle of her seat belt. The passenger was seated upright, with her back against the seat back, both hands grasping the seat belt (one on the buckle the other on the latch), and both feet sticking out forward, beyond the seat cushion. The case vehicle's driver recalled that the front right seat track was located between its middle and forward-most positions, and the seat back was slightly reclined. The on-scene police photos and the vehicle inspection showed that the front right seat track was located in the middle position, with the seat back slightly reclined. In this contractor's opinion, the front right passenger's seat track position had most likely been moved by rescue personnel.

The case vehicle's driver [20 year-old, White (Hispanic) female] was seated upright with her back against the seat back, her left foot on the floor, her right foot on the brake, and both hands on the steering wheel. Her seat track was located between its middle and forward-most positions, and the vehicle was not equipped with a tilt steering wheel. The case vehicle's driver [160 centimeters and 82 kilograms (63 inches, 180 pounds)] was restrained by her available, active, three-point, lap-and-shoulder safety belt system. The driver was transported by ambulance to the hospital for the purpose of accompanying the front right passenger (niece). She sustained minor injuries but did not seek treatment until the following day. The self-reported injuries sustained by the case vehicle's driver included: a cervical strain, a sprained right wrist, and contusions to her whole chest and right wrist.

CRASH CIRCUMSTANCES

The case vehicle was traveling east in the eastbound lane of a two-lane, undivided, city street (**Figure 1**) and intended to continue traveling eastbound. Vehicle #2 had been traveling west in the westbound lane of the same residential roadway and was making a left-hand turn into a private driveway (see **CRASH DIAGRAM** below). It should be noted that the vision of vehicle #2's driver was obscured due to the setting sun. The case vehicle's driver braked, attempting to avoid the crash. The case vehicle deposited approximately 7.3 meters (24 feet) of faint skid marks prior to impact (**Figure 2**). The crash occurred in the eastbound lane of the roadway, within the three-leg junction of the driveway.

Figure 1: Case vehicle's eastbound travel path; Note: arrow indicates approximate point of impact (case photo #01)

Both the case vehicle and vehicle #2 were traveling on a dry, bituminous roadway that was straight and level at the area of impact (**Figure 1** above). The width of the travel lanes for both vehicles was 4.5 meters (14.9 feet). There were no lane markings (e.g., painted yellow center line) or traffic controls present. The roadway is bordered by mountable curbs. The estimated coefficient of friction for the roadway is 0.75%. The posted speed limit was 48 km.p.h. (30 m.p.h.). The surrounding area is residential.

Figure 2: On-scene view of case vehicle and vehicle #2 at final rest positions; Note: highlighted faint tire scrub marks leading to case vehicle's final rest position (case photo #53)

The front of the case vehicle impacted the front right corner of vehicle #2, causing the case vehicle's driver and front right supplemental restraints (air bags) to deploy. At maximum engagement the case vehicle rotated approximately 15 degrees clockwise and continued eastward a few feet, while remaining in contact with vehicle #2. The case vehicle came to rest in the eastbound lane heading east-southeast resting against the side of vehicle #2 (**Figure 3**). Vehicle #2 initially continued southward after the impact, but at maximum engagement it was redirected eastward and rotated approximately 35 degrees counterclockwise. While rotating to final rest the bottom of vehicle #2's front bumper struck and dislodged some brick landscape edging at the southeast corner of the private drive and the south edge of the roadway. Vehicle #2 came to rest, atop the edging, with its left front wheel on the curb of the eastbound lane heading south-southwest.

Figure 3: On-scene view of case vehicle (left) and vehicle #2 (right) at final rest; Note: struck brick landscape edging underneath vehicle #2's front bumper (case photo #54)

CASE VEHICLE

The case vehicle was a front wheel drive 1997 Hyundai Accent L, five-passenger, three-door hatchback (VIN: KMHVD14N3VU------) equipped with power-assisted rack and pinion steering, a 1.5L, SOHC MPEFI, L-4 engine, and a five-speed manual 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 240 centimeters (94.5 inches), and the odometer reading at inspection was 398 kilometers (247 miles).

The interior of the case vehicle was equipped with adjustable front bucket seats with folding backs, adjustable head restraints, and three-point, lap-and-shoulder, safety belt systems in the four outboard

seating positions. The vehicle was equipped with rigid plastic knee bolsters for the driver and front right passenger. The back seat was a bench seat with a lap belt only in the rear center seating position. The front belt systems were equipped with manually operated height adjusters for the "D"-rings. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of frontal air bags for both the driver and front right passenger positions. The examination of the SRS is discussed below. An inspection of the case vehicle's other interior surfaces revealed that there was contact evidence (i.e., scuffing) on the instrument panel just below the steering column and to the driver's knee bolster to the left of the steering column. In addition, there was a brush abrasion to the passenger side of the floor-mounted center console as a result of the front right air bag's deployment. The left front door glazing was disintegrated during the impact.

CASE VEHICLE DAMAGE

The case vehicle's initial contact with vehicle #2 involved the left **b** of the front bumper and began with the case vehicle's front bumper fascia impacting against the front right bumper corner of vehicle #2 (**Figure 4**). Direct contact damage consisted of a lateral abrasive pattern that began at the front left bumper corner and extended 92 centimeters (36.2 inches) to the right (**Figure 5**). The left fender, hood, bumper fascia, and bumper reinforcement bar were deformed rearward. The residual deformation to the bumper reinforcement bar was relatively minor. The damage pattern suggests an obtuse angle impact such as occurred with vehicle #2 turning left into the case vehicle's travel path. The case vehicle's crush was uneven with the deformation above bumper (i.e., hood--**Figure 5**) being greater than at bumper level. This uneven crush profile is indicative of the case vehicle underriding vehicle #2's front bumper during its braking maneuver. The maximum deformation above bumper was 24 centimeters (9.4 inches) while only 12 centimeters (4.7 inches) maximum at bumper level. The field L was measured at 133 centimeters (52.4 inches). The wheelbase on the left (drivers) side was shortened 3 centimeters (1.2 inches). None of the case vehicle's tires were deflated or physically restricted. There was no evidence of intrusion to the case vehicle's interior. The CDC was determined to be: **12-FYEW-2 (-10)**.

Figure 4: Case vehicle's front with contour gauge present showing damage from impact with vehicle #2; Note: vehicle #2's front right bumper corner impacted case vehicle's front left (case photo #11)

Figure 5: Close-up of direct damage (between yellow tape) to case vehicle's front bumper and left hood and corner area (case photo #22)

The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's

highest severity impact. The Total, Longitudinal, and Lateral Delta V's are, respectively: 18.2 km.p.h. (11.3 m.p.h.), -17.9 km.p.h. (-11.1 m.p.h.), and +3.2 km.p.h. (+2.0 m.p.h). The case vehicle was towed due to damage.

Figure 6: On-scene view of case vehicle's front seating area showing deployed front air bags and close proximity of seats to air bags (case photo #23)

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a SRS that consisted of frontal air bags at the driver and front right passenger positions. The SRS deployed as a result of the case vehicle's frontal impact with the front right corner of vehicle #2 (**Figure 6**).

The driver's 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 module's cover consisted of two nearly symmetrical cover flaps, each with a width of 15 centimeters (5.9 inches) and heights of 7 centimeters (2.8 inches) for the upper flap and 5 centimeters (2.0 inches) for the lower flap.

Figure 7: Case vehicle's deployed driver air bag showing area (yellow tape) of mascara transfer near 11 o'clock position; Note: steering wheel has been rotated clockwise (case photo #29)

The driver's air bag had three tethers sewn to the interior center face of the air bag, two vent ports--of unknown diameter, located at the 10 and 2 o'clock positions, and was round with a diameter of 60 centimeters (23.6 inches). There was a 0.5 centimeter (0.2 inch) black transfer (possibly mascara) on the driver's air bag near the 11 o'clock position (**Figure 7**).

The front right passenger's air bag was mounted in the top of the instrument panel. The air bag deployed from a single forward hinged cover flap. The cover flap opened in an upward direction. The cover flap was made of a vinyl skin over a sheet metal frame/liner which acted as hinge points for the deploying flap. An inspection of the front right air bag module's cover flaps and air bag revealed that the cover flap opened at its designated tear points along the leading and outer edges of the flap. The module's

Figure 8: Case vehicle's deformed front right air bag module's cover flap, positioned against and viewed through windshield (case photo #35)

cover flap was 35 centimeters (13.8 inches) wide and 15 centimeters (5.9 inches) high. The hinged flap did contacted the windshield, resulting in the scuffing but no cracking to the windshield. The cover flap was deformed during the air bags deployment (**Figure 8** above). Furthermore, the flap showed evidence of contact [3 x 1.5 centimeter (1.2 x 0.6 inch) oil smudge] to the leading edge near its center (**Figure 9**). The profile of the case vehicle's instrument panel resulted in an approximate 3 centimeter (1.2 inch) setback of the leading edge of the cover flap from the protruding mid instrument panel.

Figure 9: Suspected oil smudge on case vehicle's front right air bag module's cover flap (case photo #34)

Figure 10: Skin transfer to front portion of case vehicle's front right air bag; Note: cross stitching indicates tether attachments (case photo #38)

Figure 11: Overhead view of skin transfer to top portion of case vehicle's front right air bag from contact with front right passenger's neck/chin (case photo #37)

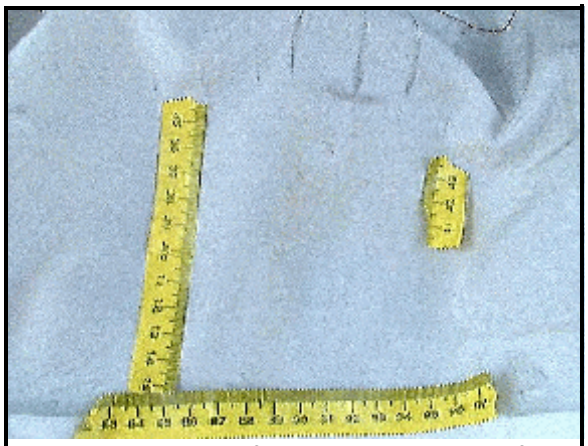

Figure 12: Close-up of skin evidence on top surface of case vehicle's front right passenger air bag (case photo #36)

The front right passenger air bag was tethered by three internal tether straps (exact location and size not documented). The tethers were interiorly sewn to the passenger's air bag (**Figure 10**). The front right air bag had one vent port, approximately 5 centimeters (2.0 inches) in diameter, located on the left side of the air bag between the 9 and 10

o'clock positions. The deployed front right air bag was rectangular with a height of approximately 47 centimeters (18.5 inches) and a width of approximately 43 centimeters (16.9 inches). Examination of the front right passenger air bag revealed a heavy skin transfer and a red cloth transfer to the top and front portions of the air bag (**Figure 11** above). Also found on the top portion of the air bag was a long strand of black hair. The skin evidence on the top of the air bag started approximately 12 centimeters (4.7 inches) behind the top horizontal edge and 12 centimeters (4.7 inches) in from the left edge of the air bag (**Figure 12**). The skin contact continued down onto the front of the air bag for a distance of 25 centimeters (9.8 inches) and was 6 centimeters (2.4 inches) wide. The red cloth transfer paralleled the skin transfer on the top and extended down the front 8 centimeters (3.2 inches).

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

The case vehicle's front right passenger [4-year-old, White (Hispanic) female] was not wearing her available, active, three-point, lap-and-shoulder safety belt system. In addition, there was no evidence of belt pattern bruising and/or abrasions to the front right passenger's body, and the inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading. According to the driver (aunt), the front right passenger [niece, 111 centimeters and 13 kilograms (44 inches, 28 pounds)] was in the process of buckling her seat belt when the crash occurred. This statement is suspect since the case vehicle was only a few hundred feet from arriving at the front right passenger's residence.

Immediately prior to the crash the case vehicle's front right passenger was seated upright, with her back against the seat back, both hands grasping the seat belt (one on the buckle the other on the latch), and both feet sticking out forward, beyond the seat cushion. The case vehicle's driver recalled that the front right seat track was located between its middle and forward-most positions, and the seat back was slightly reclined. The on-scene police photos and the vehicle inspection showed that the front right seat track was located in the middle position [82 centimeters (32.3 in) from the dash to seat back's center], with the seat back slightly reclined. There are two scenarios to explain this discrepancy between the driver's reported recollection and the information recorded in the on-scene photographs and observed during the vehicle inspection. In the first scenario, the driver's recollection is mistaken, and the front right passenger's seat track was actually located in its middle position. In the second scenario, rescue personnel moved the seat backwards during the occupant's extrication. Although EMS personnel normally reposition an occupied seat all the way rearward in order to maximize access to an injured occupant, the amount of rearward seat adjustment required to remove a small child is much less than an adult. In this contractor's opinion, the front right passenger's seat track position had most likely been moved by rescue personnel.

According to the case vehicle's driver, she had no time to attempt any avoidance maneuvers, but based on the scene evidence (i.e., faint anti-lock braking system tire skids from the case vehicle--**Figure 2** above) this contractor believes that the case vehicle's driver braked, attempting to avoid the crash. As a result of this attempted avoidance maneuver and the nonuse of her available safety belts, the front right passenger moved forward, putting her forward location close to the air bag module, just prior to impact. The case vehicle's impact with vehicle #2 enabled the front right passenger to continue forward, upward, and slightly leftward, toward the -10 degree Direction of Principal Force, as the case vehicle decelerated.

The front right passenger may have contacted the deploying air bag module's cover flap with her left hand as she most likely reached out to stop her forward movement. But this occupant's injuries clearly indicate that as she moved forward and upwards, the thrust of the deploying air bag contacted her in her chest, neck, and undersurface of her chin. The passenger's interaction with the deploying air bag resulted in her being driven backwards toward the right side of the front right seat back where she subsequently rebounded down to the left as the case vehicle rotated clockwise. According to the case vehicle's driver, at final rest the front right passenger was sitting upright in her seat with her head tilted back against the seat back, her chin pointed toward the windshield, and her chest raised upwards. It is this contractor's opinion that the passenger's interaction with the deploying air bag caused the fatal injuries.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right occupant was transported by ambulance to the hospital. She sustained fatal injuries and was pronounced dead three and ½ hours post-crash. According to her autopsy report, the injuries sustained by the case vehicle's front right passenger included: a fracture of the C_2 vertebral body with a transection and severe compression of her spinal cord, an infra foliar hemorrhage in the cerebellum, bilateral cerebral contusions, mild cerebral edema, intraventricular hemorrhages involving the occipital horns of both lateral ventricles and the third and fourth ventricles, extensive subarachnoid hemorrhages involving the entire base of brain, abrasions and contusions to her anterior neck and chin, abrasions to her bilateral distal forearms and hands, contusions to her right mid-forearm and hand, an avulsion (evulsion) to the palmar surface of her left thumb, and abrasions to her bilateral anterior thighs. The cause of death was listed as neck fracture due to air bag deployment. According to the initial medical facility that treated her, she also sustained a nonanatomic brain injury and a contusion to her right thigh.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Laceration {transection and severe compression} of spinal cord @ C_2 with fracture of the C_2 vertebral body	640272.6 untreatable	Air bag, front right passenger's	Certain	Autopsy
2	Nonanatomic brain injury, unconscious, GCS=3, pupils fixed and dilated, flaccid	160824.5 critical	Air bag, front right passenger's	Certain	Emergency room records
3	Hemorrhage, infra-foliar[1], in cerebellum	140426.4 severe	Air bag, front right passenger's	Probable	Autopsy

[1] The following term is defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
folium (fo■le-am) pl. folia: a general term for a leaflike structure, especially one of the leaflike subdivisions of the cerebellar cortex. ***folia cerebelli, folia of cerebellum***: the numerous long narrow folds of the cerebellar cortex, separated by sulci and supported by white laminae; they are aggregated into the various subdivisions of the cerebellum. Called also ***gyri cerebelli***

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
4	Contusions, bilateral cerebral, in gyri[2] recti and hippocampal gyri[2]	140620.3 serious	Air bag, front right passenger's	Certain	Autopsy
5	Edema, mild, cerebral–generalized location	140670.3[3] serious	Air bag, front right passenger's	Certain	Autopsy
6	Hemorrhages, intraventricular involving the occipital horns of both lateral ventricles and the third and fourth ventricles	140678.4 severe	Air bag, front right passenger's	Certain	Autopsy
7	Hemorrhage, extensive, subarachnoid involving the entire base of the brain and ventrally over the occipital and temporal-parietal lobes, bilaterally	140684.3 serious	Air bag, front right passenger's	Certain	Autopsy
8	Abrasion chin involving the underneath surface and extending onto the anterior surface	290202.1 minor	Air bag, front right passenger's	Certain	Autopsy
9	Contusions chin, right and left sides extending from abrasion above	290402.1 minor	Air bag, front right passenger's	Certain	Autopsy
10	Abrasion anterior base of neck	390202.1 minor	Air bag, front right passenger's	Certain	Autopsy

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[2] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:

fissure (fish■ar): any cleft or groove, normal or otherwise; especially a deep fold in the cerebral cortex which involves the entire thickness of the brain wall. Compare *sulcus.*

gyrus (ji■ras) pl. ***gyri (ji■ri)***: one of the convolutions of the surface of the brain caused by infolding of the cortex; see ***gyri cerebri***.

- ***g. cerebell■li***: folia cerebelli.
- ***g. cerebra■les***: cerebral gyri; the tortuous convolutions of the surface of the cerebral hemisphere, caused by infolding of the cortex and separated by the fissures or sulci. Many are constant enough that they have been given special names. Called also *gyri cerebri* and *gyri of cerebrum.*
- ***g. ce■rebri, gyri of cerebrum***: gyri cerebrales.
- ***g. hippocam■pi, hippocampal gyrus***: gyrus of hippocampus; a convolution on the inferior surface of each cerebral hemisphere, lying between the hippocampal and collateral sulci; called also *parahippocampal g.* and *g. parahippocampalis*.
- ***g. parahippocampalis, parahippocampal g.***: alternative for *g. hippocampi.*
- ***g. rec■tus***: a convolution on the orbital surface of the frontal lobe, medial to the olfactory sulcus and continuous with the medial frontal gyrus on the medial surface.

sulcus (sul■kas) pl. ***sul■ci (sul■si)***: a groove, trench, or furrow; a general term for such a depression, especially one of those on the surface of the brain, separating the gyri. Compare *fissure.*

[3] Because the NASS CDS Injury Coding protocol does not allow the use of the most appropriate Aspect code (i.e., **Whole**"), the Aspect "**Unknown**" is used here because all aspects of the brain were injured and the contact mechanism is identical (i.e., the air bag).

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
11	Abrasions, bilateral[4], distal forearms and hands	790202.1 minor	Air bag, front right passenger's	Certain	Autopsy
12	Contusions right mid-forearm and posterior right hand	790402.1 minor	Air bag, front right passenger's	Probable	Autopsy
13	Avulsion {evulsion[5]} palmar surface left thumb	790802.1 minor	Front right module's cover flap	Possible	Autopsy
14	Abrasions, bilateral, central anterior thighs	890202.1 minor	Air bag, front right passenger's	Probable	Autopsy
15	Contusion {bruise} right thigh, not further specified	890402.1 minor	Air bag, front right passenger's	Probable	Emergency room records

CASE VEHICLE DRIVER KINEMATICS

The case vehicle's driver [20 year-old, White (Hispanic) female] was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The driver's adjustable "D"-ring was located in the full down position. An inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed apparent evidence of loading (i.e., a minor crease was found on the torso portion of the seat belt webbing from the "D"-ring). In addition, the case vehicle's driver reported contusions to her whole chest, some of which may have been seat belt-related.

Immediately prior to the crash the case vehicle's driver [aunt, 160 centimeters and 82 kilograms (63 inches, 180 pounds)] was seated upright with her back against the seat back, her left foot on the floor, her right foot on the brake, and both hands on the steering wheel. Her seat track was located between its middle and forward-most positions, and the vehicle was not equipped with a tilt steering wheel.

The case vehicle's driver braked, attempting to avoid the crash. As a result of this attempted avoidance maneuver and the use of her available safety belts, the driver moved slightly forward, closer to her air bag module, just prior to impact. The case vehicle's impact with vehicle #2 enabled the driver to continue forward, loading her safety belts, and slightly leftward, toward the -10 degree Direction of Principal Force, as the case vehicle decelerated. The driver's seat belt inertia system presumably locked-up, keeping the driver's forward excursion from getting too close to the deploying air bag module, preventing serious injury. There was also no evidence of compression to the energy absorbing shear capsules in the base of the steering column. The driver's interaction with the deploying air bag resulted in

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4 Specifically, the abrasions were located on the ventral, right distal forearm [i.e., two: one 3 x 5 cm (1.2 x 2.0 in), and the other 6 cm (2.4 in), linearly], the base of the right thumb, the distal left forearm–just above the wrist, and the posterior left hand, including the base of the left fourth finger.

5 According to the autopsy this lesion was an evulsion. According to the RANDOM HOUSE WEBSTER'S UNABRIDGED DICTIONARY, an evulsion is a plucking or pulling out or a forcible extraction of the object (i.e., skin), whereas an avulsion is a tearing away.

her being driven backwards toward the right side of the driver's seat back. At final rest the driver was still seated essentially in her pre-crash posture.

CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to the hospital for the purpose of accompanying the front right passenger (niece). She sustained minor injuries but did not seek treatment until the following day. The self-reported injuries sustained by the case vehicle's driver included: a cervical strain, a sprained right wrist, and contusions to her whole chest and right wrist.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Strain, cervical	640278.1 minor	Air bag, driver's	Probable	Interviewee (same person)
2	Contusion {bruise} whole chest	490402.1 minor	Air bag, driver's[6]	Possible	Interviewee (same person)
3	Sprain right wrist	751420.1 minor	Air bag, driver's	Possible	Interviewee (same person)
4	Contusion {bruise} right wrist	790402.1 minor	Air bag, driver's	Probable	Interviewee (same person)

VEHICLE #2

Vehicle #2 is a front wheel drive 1993 Chrysler New Yorker Fifth Avenue, six-passenger, four-door sedan (VIN: 1C3XV66R9PD------) equipped with a 3.3L, OHV SMPI, V-6 engine, and a four-speed automatic transmission. It is unknown if the vehicle was equipped with an anti-lock brake system. Vehicle #2's wheel base was 278 centimeters (109.6 inches), and the odometer reading at inspection was 105,698 kilometers (65,678 miles).

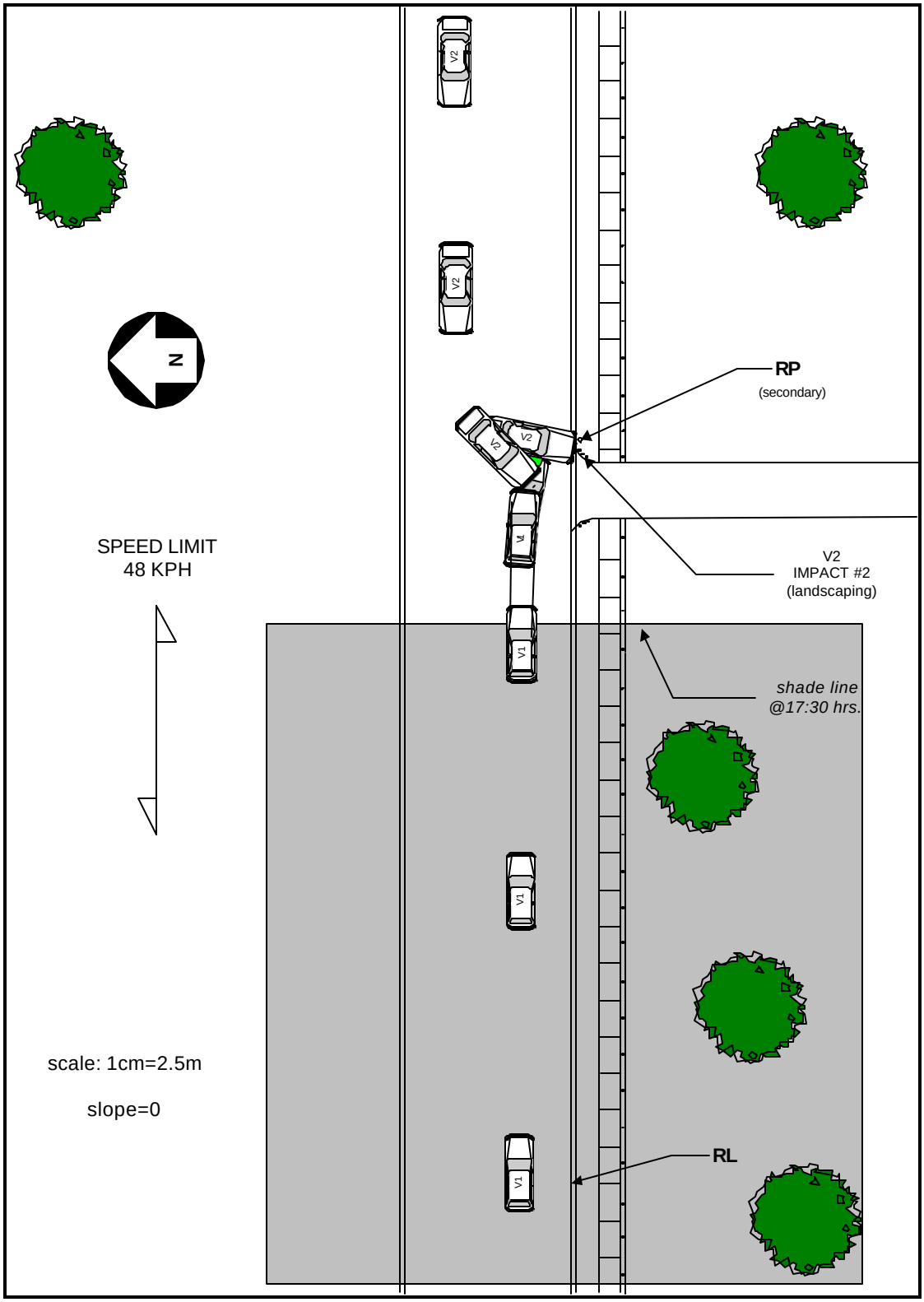
Vehicle #2's front seating area was equipped with a split bench with separate back cushions and adjustable head restraints. The front and rear outboard seats had available, active, three-point, lap-and-shoulder, safety belt systems. Vehicle #2 was equipped with a driver supplemental restraint system (air bag) which deployed in the crash. The rear seat was a bench seat without head restraints. The front and rear center seating positions were equipped with active, two-point, lap-belts only.

The vehicle inspection showed that the direct damage extended from the front right bumper corner

[6] In her interview the case vehicle's driver reported contusions to her whole chest, without being more specific as to their exact location. The vehicle inspection found evidence of loading on the driver's safety belt and contact evidence on the driver's deployed air bag. Given the lack of specificity regarding the location of the contusions and the known contact from the air bag, this contractor assigned the air bag as the primary injury source mechanism even though some of the contusions may have been caused by the torso portion of the driver's safety belt.

Figure 13: Vehicle #2's damaged front right corner with contour gauge present viewed from right of front (case photo #46)

to the left 53 centimeters (20.9 inches). Direct damage extended vertically from the bumper to the hood. The bumper assembly on the right side was shifted downward, giving the appearance of an underride/override type collision (**Figure 13**). As the vehicle rotated counterclockwise the vehicle sustained direct damage down the right side. The direct damage extended from the front right bumper corner rearwards 46 centimeters (18.1 inches). The right front tire was restricted, and the wheelbase on the right side was shortened 1 centimeter (0.4 inches). The CDC was determined to be: **01-FZEW-1 (+30)** [maximum crush was 5 centimeters (2.0 inches)]. The WinSMASH reconstruction program, damage only algorithm, was used on vehicle #2's highest severity impact. The Total, Longitudinal, and Lateral Delta V's are, respectively: 12.0 km.p.h. (7.5 m.p.h.), -10.4 km.p.h. (-6.5 m.p.h.), and -6.0 km.p.h. (-3.7 m.p.h). Vehicle #2 was towed due to damage.


V2
V2
N
RP
(secondary)
V2
V2
V1
SPEED LIMIT
48 KPH
V2
IMPACT #2
(landscaping)
shade line
@17:30 hrs.
V1
scale: 1cm=2.5m
slope=0
V1
RL