INDIANA UNIVERSITY
TRANSPORTATION RESEARCH CENTER
School of Public and Environmental Affairs
222 West Second Street
Bloomington, Indiana 47403-1501
(812) 855-3908 Fax: (812) 855-3537

ON-SITE CHILD AIR BAG-RELATED FATALITY INVESTIGATION

CASE NUMBER - IN-06-011
LOCATION - NORTH CAROLINA
VEHICLE - 1995 FORD WINDSTAR GL
CRASH DATE - May 2006

Submitted:

February 9, 2007
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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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15. *Supplementary Notes* On-site child air bag-related fatality investigation involving a 1995 Ford Windstar with manual safety belts and driver and front right passenger air bag system.			
16. *Abstract* This report covers an on-site investigation of a child air bag-related fatality investigation that involved a 1995 Ford Windstar that rolled down a hill on private property and impacted a tree. This crash is of special interest because the case vehicle's front left occupant [6-year-old, female] was fatally injured due to contact with the case vehicle's driver air bag module cover flap and the driver air bag. The case vehicle was parked on a negative grade near the end of a driveway on private property heading northwest. The case vehicle rolled down the hill with the unrestrained 6-year-old behind the steering wheel. The case vehicle entered a wooded area and the left corner of the case vehicle's front bumper impacted a tree, the left fender swiped against the tree and the left front wheel engaged the tree causing the case vehicle's front air bags to deploy. The case vehicle came to rest adjacent to the tree heading northwest. The 6-year-old front left occupant became positioned over the air bag module during the crash and was fatally injured by the deploying air bag.			
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BACKGROUND

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This investigation was brought to NHTSA's attention on June 6, 2006 by a North Carolina newspaper article. This crash involved a 1995 Ford Windstar GL (case vehicle), which was parked on private property and rolled down a hill and impacted a tree. The crash occurred in May 2006, at 5:00 p.m., in North Carolina and was investigated by the North Carolina Highway Patrol. This crash is of special interest because the case vehicle's front left occupant [6-year-old, White (non-Hispanic) female] was fatally injured due to contact with the case vehicle's driver air bag module cover flap and the driver air bag. This contractor inspected the case vehicle and scene on June 19, 2006. Interviews with the occupant's father was conducted on June 16, 2006 and August 29, 2006. This report is based on the police crash report, scene and vehicle inspections, interviews with the occupant's father, occupant medical records, occupant kinematic principles and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was parked on a negative grade near the end of a driveway on private property heading northwest with the transmission reportedly in park and no keys in the ignition. The case vehicle owner's two young daughters were reportedly outside playing near the case vehicle. The owner stated he was preparing to leave for work and went inside his house to get the case vehicle's ignition key. While he was in the house, the case vehicle rolled down the hill with the unrestrained 6-year-old female behind the steering wheel. The case vehicle entered a wooded area and the left corner of the case vehicle's front bumper impacted a tree, the left fender swiped against the tree and the left front wheel engaged the tree causing the case vehicle's front air bags to deploy. Due to the displacement of the left front wheel, the crash severity was estimated to be in a range of 18-24 km.p.h. (12-15 m.p.h). The case vehicle came to rest adjacent to the tree heading northwest. The 6-year-old front left occupant was found in the driver's seat on her knees leaning to the left of the steering wheel.

The front left occupant's head and chest became positioned over the driver's air bag module during the initial bumper corner and left fender engagement with the tree as the case vehicle decelerated. The front left occupant's head and chest were directly impacted by the air bag module cover flap and the air bag as the air bag deployed when the left front wheel engaged the tree. The front left occupant was transported to a local hospital and died in the emergency room shortly after her arrival.

Figure 1: On-scene police photo showing area where case vehicle was parked, arrows show left and right tire marks in grass and rest position of case vehicle at bottom of hill

CRASH CIRCUMSTANCES

Crash Environment: The case vehicle was parked heading northwest near the end of a driveway on private property (**Figure 1**). The driveway was

sloped downhill approximately 13% negative. The slope of the hill became steeper beyond the end of the driveway increasing to a negative 17% across a distance of approximately 23 meters (74.4 feet). At this point the hill became covered with weeds, brush and small trees. The hill maintained the negative 17% slope across an additional 35 meters (114.8 feet) then changed to a positive 7% slope approximately 3 meters (9.8 feet) prior to the impacted tree. At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the surface condition was dry. The site of the crash was rural residential. See the Crash Diagram at the end of this report.

Pre-Crash: The case vehicle was parked on a negative 13% grade near the end of the driveway heading northwest with the transmission reportedly in park and no keys in the ignition. The owner stated that his two daughters were outside playing near the case vehicle. He stated he was preparing to leave for work and went inside his house to get the case vehicle's ignition key. Shortly after entering the house, his youngest daughter entered the house and told him the van was gone. The owner exited the house and saw that the case vehicle had rolled down the hill (**Figure 2**). The crash occurred near the bottom of the hill in a wooded area.

Crash: The left corner of the case vehicle's front bumper (**Figure 3**) impacted a tree (**Figure 4**). There was only minor engagement to the bumper. As the case vehicle swiped past the tree, the left fender (**Figure 5** below) engaged the tree and then the left front wheel engaged the tree causing the case vehicle's front air bags to deploy. The impact crushed the left front wheel rearward 11 centimeters (4.3 inches) and crushed the left fender inward. The case vehicle then separated slightly from the tree and the case vehicle's left side view mirror impacted the tree rotating the side view mirror inward (**Figure 6** below).

Figure 2: Overview of path of case vehicle down hill to impact with tree, arrow shows impacted tree, line shows approximate path to tree impact

Figure 3: Overview front of case vehicle, arrow shows direct damage to front left bumper corner due to impact with tree

Figure 4: Tree impacted by case vehicle, numbers on scale are tenths of meter

Figure 5: Damage to left corner of front bumper and left fender due to impact with the tree

Figure 6: Arrow shows displacement of left side view mirror and bark transfer on mirror due to impact with the tree

Post-Crash: The case vehicle came to rest adjacent to the tree (**Figure 7**). The 6-year-old occupant was found in the driver's seat on her knees leaning to the left of the steering wheel.

Figure 7: Police on-scene photo showing rest position of case vehicle adjacent to impacted tree

CASE VEHICLE

The 1995 Ford Windstar was a front wheel drive, three-door minivan (VIN: 2FMDA5146SB------) equipped with a 3.8L, V6 engine; four-speed automatic transmission and four-wheel, anti-lock brakes. The front seating row was equipped with bucket seats with adjustable head restraints, tilt steering column, driver and front right passenger air bags and driver and front right passenger manual, three-point, lap-and-shoulder safety belt systems. The case vehicle's owner stated that he bought the vehicle from the original owner in 2005. He stated that the previous owner had replaced the case vehicle's transmission. He stated that he had experienced no problems with the transmission or engine, and had never experienced a problem with the vehicle coming out of park or gear. The owner stated that the case vehicle's transmission selector was in park following the crash. The police also indicated that the vehicle was in park with no keys in the ignition. The case vehicle's owner also stated the front wheels rolled while the transmission selector was in park as the vehicle was towed away from the tree. This contractor's vehicle inspection determined that the case

vehicle would in fact roll with the transmission selector in park. It is unlikely that this condition was the result of the crash damage. In addition, it was determined that the ignition could not be actuated without the keys placed in the ignition.

It is this contractors understanding that the air bag system will not deploy the air bags if the ignition is not on. An alternate crash scenario could be that the case vehicle was parked and running. The owner's 6-year-old daughter was either in the vehicle or entered the vehicle when the owner went into the house. Possibly due to some action by the child (such as releasing the parking brake or putting the transmission in gear)or the condition of the transmission, the vehicle rolled down the hill resulting in the crash.

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle's impact with the tree involved 9 centimeters (3.5 inches) of direct contact to the front left bumper corner. The left fender and left front wheel then engaged the tree producing 73 centimeters (28.7 inches) of direct damage down the side of the fender and crushing the left front wheel rearward 11 centimeters (4.3 inches). The left front wheel was not jammed against the back of the wheelhouse at the inspection. However, a tire scuff mark was found on the back of the wheelhouse indicating the wheel had been dynamically crushed into the back of the wheelhouse during the crash. Crush measurements were taken at the bumper. The maximum residual crush was measured as 3 centimeters (1.2 inches) occurring at C_1 (**Figure 8**). The left fender was also crushed rearward approximately 5 centimeters (2 inches). In addition to the 11 centimeters (4.3 inches) reduction of the left side wheelbase, the right side wheelbase was reduced 5 centimeters (2 inches). Induced damage involved the front bumper and left fender, as well as the left headlamp/turn signal assembly and grille. The table below shows the case vehicle's front crush profile.

Figure 8: Top view of crush to case vehicle's front bumper [baseline placement subsequently reduced 10 centimeters (4 inches) to establish case vehicle's specification overall length, each increment on rods is 5 cm (2 in)]

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	9	3	156	3	1	0	0	0	0	-76	0
in		3.5	1.2	61.4	1.2	0.4	0.0	0.0	0.0	0.0	-29.9	0.0

The case vehicle's recommended tire size was: P215/70R15, and the vehicle was equipped with tires of this size. The case vehicle's tire data are shown in the table below.

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kpa	psi	kpa	psi	milli-meters	32nd of an inch			
LF	172	25	221	32	6	8	None	No	No
RF	234	34	221	32	6	8	None	No	No
LR	179	26	221	32	6	8	None	No	No
RR	83	12	221	32	2	3	None	No	No

Vehicle Interior: Inspection of the case vehicle's interior (**Figure 9**) revealed probable occupant contact evidence on the driver's air bag, upper air bag module cover flap, the driver's head restraint, and the rearview mirror was found knocked off its mounting bracket. In addition, two semi-circular black scuffs were observed on the driver's air bag, which appeared to be caused by interaction of the deploying air bag against the steering wheel. There was no deformation of the steering wheel and no compression of the energy absorbing steering column (**Figure 10**). Lastly, there was no intrusion of the case vehicle's passenger compartment.

Figure 9: Overview of case vehicle's steering wheel windshield, and instrument panel (Note: rearview mirror placed back on bracket during inspection)

Figure 10: Left side view of case vehicle's steering wheel showing lack of deformation

Damage Classification: Based on the vehicle inspection, the CDC for the initial impact with the tree was determined to be: **12-FLEE-5** (**0** degrees). The CDC for the impact with the same tree to the left side view mirror following separation from the initial impact was determined to be **12-FLMS-6** (**0** degrees) The WinSMASH reconstruction program could not be used to reconstruct the case vehicle's Delta V due to the swiping nature of the impact and the snagging of the left front wheel (i.e., stiffness coefficients have not been determined for wheel engagements). Based on the overall damage to the case vehicle and the displacement of the left front wheel, this contractor estimates the crash severity to be in a range of 18-24 km.p.h. (12-15 m.p.h). The case vehicle was towed due to damage.

The case vehicle was equipped with driver and front right passenger air bags. Both air bags deployed as a result of the case vehicle's impact with the tree.

The case vehicle's driver air bag was located in the steering wheel hub. The air bag module cover consisted of an approximate "H"-configuration cover flaps. The upper cover flap was constructed of firm plastic with a pliable vinyl cover. The lower cover flap was constructed of pliable, medium thick vinyl. The upper flap's overall dimensions were 20 centimeters (7.9 inches) in width and 12 centimeters (4.7 inches) in height. The lower flap's overall dimensions were 20 centimeters (7.9 inches) in width and 6 centimeters (2.4 inches) in height. An inspection of the air bag module cover flaps revealed that they opened at the designated tear points; however, the vinyl cover of the top flap was heavily deformed (**Figure 11**). In addition, linear black scuff marks were observed on the back of the air bag adjacent to the top cover flap (**Figure 12**) that were clearly due to interaction with of the back of the top cover flap. Other black scuff marks were also observed on the upper and lower half of the back of the air bag that appeared to be related to interaction with the steering wheel. Inspection of the front of the air bag also revealed two semi-circular black scuff marks on the air bag's upper right quadrant (**Figure 13**). These marks also appeared to be due to interaction of the deploying air bag with the steering wheel. The deployed driver's air bag (**Figure 13**) was round with a diameter of approximately 62 centimeters (24.4 inches). The air bag was designed with two tethers, each approximately 12 centimeters (4.7 inches) in width and had two vent ports (**Figure 12**), each approximately 1.5 centimeters (0.6 inch) in diameter, located at the 11 and 1 o'clock positions.. The distance between the mid-center of the driver's seat back, as positioned as the time of the vehicle inspection (i.e., seat between the middle and forward-most track position, seat back

Figure 11: Deformation to top cover flap due to interaction with front left occupant during air bag deployment

Figure 12: Arrows show linear black scuff marks on back of driver's air bag due to contact with back of top cover flap

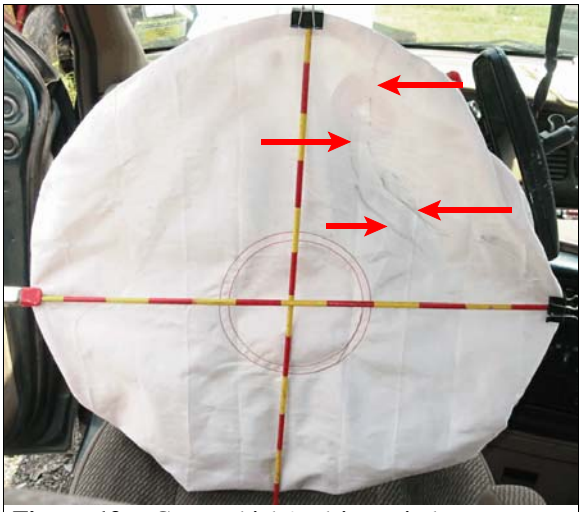


Figure 13: Case vehicle's driver air bag, arrows shows semi-circular black scuffs on air bag

slightly reclined), and the front surface of the air bag's fabric at approximate full excursion was 23 centimeters (9.1 inches).

The evidence indicated that the front left occupant was positioned over the air bag module at the moment of deployment and interacted with the air bag components during the deployment. The top cover flap impacted the occupant as the air bag deployed deforming the cover flap. The occupant's body interfered with air bag deployment causing the air bag to interact forcefully with the back of the top cover flap and the steering wheel causing the observed black scuff marks on the front and back of the air bag.

The front right passenger air bag was located in the middle of the instrument panel (**Figure 14** below). The air bag module cover consisted of a single rectangular cover flap constructed of medium thickness, pliable vinyl. The cover flap was 33.5 centimeters (13.1 inches) in width and 12.5 centimeters (4.9 inches) in height. Inspection of the air bag module cover flap and the air bag fabric revealed that the cover flap opened at the designated tear points. There was no damage due to deployment to the cover flap or the air bag. The front right passenger air bag (**Figure 15**) was rectangular in shape and was approximately 71 centimeters (27.9 inches) in width and 64 centimeters (25.2 inches) in height. The air bag was designed without tethers had two vent ports, each 4.5 centimeters (1.8 inches) in diameter located at the 9:30 and 2:30 o'clock positions.

Figure 14: Overview of case vehicle's front right passenger air bag located in middle of right instrument panel

Figure 15: Case vehicle's front right passenger air bag

CASE VEHICLE FRONT LEFT OCCUPANT KINEMATICS

Immediately prior to the crash, the case vehicle's front left occupant [6-year-old, White (non-Hispanic) female; 110 centimeters and 20 kilograms (43 inches, 44 pounds)] was in an unknown position in the driver's seat. The driver's seat track was located between the middle and forward-most position. The driver's seat back was slightly reclined. The tilt steering column was adjusted to between its center and full down position. The front left occupant was not restrained by the manual, three-point, lap-and-shoulder safety belt system.

The case vehicle was parked on a 13% negative slope and for an unknown reason, the vehicle began to roll down the hill. The initial impact with the front left bumper corner and left

fender caused the front left occupant to continue forward opposite the case vehicle's 0 degree direction of principal force as the case vehicle swiped the tree and decelerated. As the occupant moved forward, she became positioned over the driver's air bag module at the time of air bag deployment when the tree engaged the left front wheel. She most likely had her torso and head turned to the left. As the air bag deployed, the upper air bag module cover flap (**Figure 16**) scrapped along the passenger's upper chest, right shoulder, neck and submandibular areas causing contusions and abrasion to these areas. The deploying air bag then impacted the right side of her face causing a transection of her spinal cord and facial abrasions and contusions. The deployment of the air bag projected her upward and rearward, and she may have impacted the rearview mirror with her right arm knocking it off its bracket (**Figure 17**). Her back then impacted the driver's seat back, and her head impacted the head restraint (**Figure 18**) leaving a transfer of her hair on the left portion of the head restraint. She sustained a left subdural and subscalpular hematoma and fractures to her posterior right 1st, 7th, and 9th ribs due to these contacts. She then rebounded off the seat back and came to rest with her knees on the driver's seat cushion and her upper torso on the left side of the steering wheel.

Figure 16: Deformation to case vehicle driver's top air bag module cover flap due to contact with front left occupant

Figure 17: Case vehicle's rearview mirror was knocked from it mounting bracket due to contact by front left occupant

Figure 18: Yellow tape outlines area of hair transfer found on driver's seat head restraint

The police crash report indicated that the front left occupant was fatally injured as a result of the crash. The front left occupant was transported by ambulance to a local hospital and died in the emergency room 91 minutes following the crash. The table below shows the front left occupant's injuries and injury mechanisms.

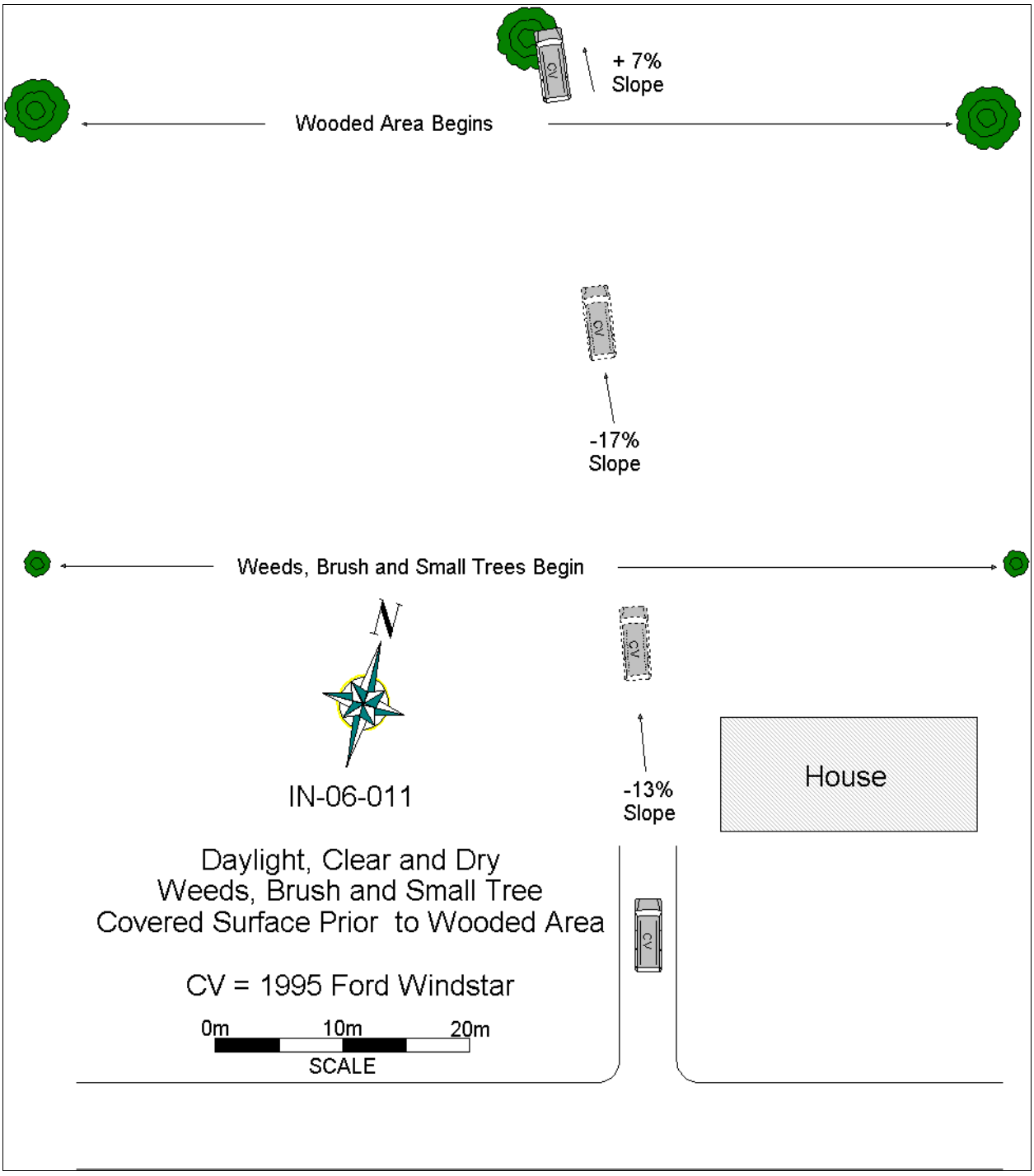
Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Nonanatomic brain with loss of consciousness, pupils fixed and dilated, no pulse, no respirations, asystole[1] followed by PEA; unresponsive, GCS=3	critical 160824.5,0	Air bag, driver's	Certain	Emergency room records
2	Laceration {transection} of cervical spinal cord underlying atlanto-occipital junction with transverse fracture and atlanto-occipital dislocation	maximum 640276.6[2],6	Air bag, driver's	Certain	Autopsy
3	Hematoma, subdural, 10 ml, left temporal region	severe 140652.4,2	Head restraint, driver's seat {air bag-related}	Probable	Autopsy
4	Fracture, posterior right 1st, 7th, and 9th ribs	moderate 450220.2,1	Seat back, driver's {air bag-related}	Probable	Autopsy
5	Hematoma, 6.4 x 5.1 cm (2.5 x 2 in) left subscalpular	minor 190402.1,2	Head restraint, driver's seat {air bag-related}	Certain	Autopsy
6	Injury with hemorrhage middle left eye, not further specified	minor 240499.1,2	Air bag, driver's	Certain	Autopsy
7	Abrasion, 6.4 x 3.8 cm (2.5 x 1.5 in) left cheek	minor 290202.1,2	Air bag, driver's	Certain	Autopsy
8	Contusion, 6.4 x 3.8 cm (2.5 x 1.5 in) left cheek	minor 290402.1,2	Air bag, driver's	Certain	Autopsy

[1] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
asystole (a-sis'to-le): cardiac standstill or arrest; absence of a heartbeat.
asystolic (a"sis-tol'ik): asystole.
PEA: pulseless electrical activity
pulseless electrical activity: continued electrical rhythmicity of the heart in the absence of effective mechanical function; it may be due to uncoupling of ventricular muscle contraction from electrical activity or may be secondary to cardiac damage with respiratory failure and cessation of cardiac venous return. Called also *electromechanical dissociation*.

[2] The choice of injury code is difficult because the NASS CDS Injury Coding manual presumes that one knows whether there was a complete or an incomplete cord syndrome. Because the only available medical record is an autopsy, the syndrome issue is not discernable (i.e., you cannot determine the difference in a deceased person). In the absence of protocol, this contractor chooses to assume that the syndrome was complete.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
9	Abrasion on chin and on submandibular area, 16.5 x 7.6 x 7.6 cm (6.5 x 3 x 3 in), with bleeding[3]	minor 290202.1,8	Driver module's cover flap	Certain	Autopsy
10	Contusion {ecchymoses} on chin and on submandibular area, 16.5 x 7.6 x 7.6 cm (6.5 x 3 x 3 in), with subcutaneous emphysema and swelling[3]	minor 290402.1,8	Driver module's cover flap	Certain	Autopsy
11	Abrasion {bleeding[3]} on lower right neck, 12.7 x 8.9 cm (5 x 3.5 in)	minor 390202.1,1	Driver module's cover flap	Certain	Autopsy
12	Contusion {ecchymoses[3]} on lower right neck, 12.7 x 8.9 cm (5 x 3.5 in) with subcutaneous emphysema and swelling[3]	minor 390402.1,1	Driver module's cover flap	Certain	Autopsy
13	Contusion, 20.3 x 15.2 cm (8 x 6 in) upper right chest	minor 490402.1,1	Driver module's cover flap	Certain	Autopsy
14	Abrasion, 11.4 x 7.6 cm (4.5 x 3 in) upper right shoulder	minor 790202.1,1	Driver module's cover flap	Certain	Autopsy
15	Contusion, 11.4 x 7.6 cm (4.5 x 3 in) upper right shoulder	minor 790402.1,1	Driver module's cover flap	Certain	Autopsy

[3] Emergency room records


+ 7%
Slope
Wooded Area Begins
-17%
Slope
Weeds, Brush and Small Trees Begin
N
IN-06-011
-13%
Slope
House
Daylight, Clear and Dry
Weeds, Brush and Small Tree
Covered Surface Prior to Wooded Area
CV = 1995 Ford Windstar
0m
10m
20m
SCALE