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SCI/NASS COMBINATION 208-COMPLIANT VEHICLE INVESTIGATION

CASE NUMBER - NASS-2004-74-280J
LOCATION - Nebraska
VEHICLE - 2005 Ford Escape
CRASH DATE - December 2004

Submitted:
August 24, 2005
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Contract Number: DTNH22-01-C-07002

Prepared for:

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator' s expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

Technical Report Documentation Page

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SCI/NASS combination investigation of an air bag deployment crash involving a 2005 Ford Escape, equipped with a CAC frontal air bag system, that was hit by a 1995 Ford Windstar

16. *Abstract*
This report covers a SCI/NASS combination investigation of an air bag deployment crash involving a 2005 Ford Escape (case vehicle) and a 1995 Ford Windstar (other vehicle). This crash is of special interest because the case vehicle's manufacturer has certified that it meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The case vehicle's restrained driver (47-year-old female) was hospitalized with severe and critical brain injuries. The case vehicle was stopped, heading southward in the inside southbound lane of a three-lane roadway that was part of a divided local trafficway, within an interchange area. The Windstar was traveling northwestward down a one-lane, one-way entrance ramp that curved to the right and merged into the northbound lanes of the same divided trafficway where the case vehicle was traveling. The Windstar's driver failed to negotiate the right curve and continued essentially straight, off the left edge of the ramp, across the gore and the northbound travel lanes. The first harmful event occurred when the Windstar's front wheels impacted and vaulted over the curbed median. The case vehicle's left front and driver's door areas were impacted by the Windstar's front, causing the case vehicle's driver and front right passenger frontal air bags to deploy. The case vehicle was pushed to the west and rotated approximately 45 degrees clockwise, coming to rest straddling the inside and center lanes, heading southwestward. The Windstar came to rest straddling the curbed median, heading northwestward. Because the Windstar vaulted upward as a result of its impact with the curbed median, its frontal structures penetrated through the case vehicle driver's door window, striking the case vehicle driver's head. The case vehicle driver sustained multiple severe and critical brain injuries, plus fractures of the mandible bilaterally, the alveolar ridge and the maxilla, and other injuries, and was hospitalized. The case vehicle's restrained front right passenger (19-year-old female) sustained minor injuries and was treated and released at a hospital emergency department. There were no other occupants in the case vehicle.

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TABLE OF CONTENTS NASS-2004-74-280J

BACKGROUND

NASS-2004-74-280J

This SCI/NASS combination investigation was brought to the NHTSA's attention in January 2005 by NASS-CDS sampling activities and was designated for SCI on January 14, 2005. This crash involved a 2005 Ford Escape SUV (case vehicle, NASS vehicle #2) and a 1995 Ford Windstar minivan (other vehicle, NASS vehicle #1). The crash occurred in December 2004, at 4:35 p.m., in Nebraska, and was investigated by the applicable municipal police department. This crash is of special interest because the case vehicle's manufacturer has certified that it meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The case vehicle's restrained driver (47-year-old female, white, non-Hispanic) was hospitalized with severe and critical brain injuries. The case vehicle's front right passenger (19-year-old female, white, non-Hispanic) sustained minor injuries and was treated and released at a hospital emergency department. There were no other occupants in the case vehicle. This report is based on the coded NASS case, occupant kinematic principles, and this contractor's evaluation of the available evidence.

CRASH CIRCUMSTANCES

The case vehicle had been traveling southward and was stopped for an automatic traffic signal, heading southward, in heavy traffic, in the inside southbound lane of a three-lane roadway that was part of a divided local trafficway, within an interchange area, intending to continue south (**Figure 1**). The other vehicle (Windstar) was traveling generally northwestward down a one-lane, one-way entrance ramp that curved to the right and merged into the northbound lanes of the same divided trafficway where the case vehicle was traveling. It was daylight, the weather was clear, the concrete road surface was dry and with no apparent defects, and the speed limit for both vehicles was 64 km.p.h. [40 m.p.h.]. The Windstar's driver failed to negotiate the right curve and continued essentially straight, off the left edge of the ramp, across the gore and the northbound travel lanes (**Figure 2**). The case vehicle's driver did not attempt any avoidance actions.

Figure 1: Case vehicle's southbound approach toward impact area

Figure 2: Lookback along the other vehicle's northwestward approach (view from the case vehicle's location at impact)

The first harmful event occurred when the Windstar's front wheels impacted and vaulted over the curbed median. The vehicle-to-vehicle crash occurred in the inside southbound through lane. The case vehicle's left front and driver's door areas were impacted by the Windstar's front,

causing the case vehicle's driver and front right passenger frontal air bags to deploy. The Windstar's dual frontal air bags also deployed. The case vehicle was pushed to the west and rotated approximately 45 degrees clockwise, coming to rest straddling the inside and center lanes, heading southwestward. The Windstar came to rest straddling the curbed median, heading northwestward.

CASE VEHICLE

The case vehicle was a 2005 Ford Escape XLS front wheel drive, four-door, five passenger sport utility vehicle (VIN: 1FMYU02Z35D------), equipped with a 2.3 liter four cylinder gasoline engine and an automatic transmission with a console-mounted selector lever. Four-wheel anti-lock brakes were standard for this model. The case vehicle was fitted with dual-stage frontal air bags, with a driver's seat track sensor and a front right passenger seat weight sensor, and manual, three-point, lap-and-shoulder safety belts with buckle sensors and with buckle stalk pretensioners for the two front seat positions. Its wheelbase was 262 centimeters [103.1 inches]. The odometer reading is not known. The case vehicle was towed due to disabling damage.

Figure 3: Case vehicle's front and left side

Figure 4: Case vehicle's left side, front portion

The case vehicle sustained direct contact damage extending from the left front corner nearly to the left B-pillar (**Figures 3** and **4**). The Windstar had impacted and vaulted over the curbed median and its front was up, off the ground, such that its bumper contacted the case vehicle at approximately the level of the top of the left front tire. The Windstar's frontal structures above the bumper engaged the case vehicle along the midline and above on the left side, including direct contact to the case vehicle's left upper A-pillar, windshield and driver's door window. The case vehicle's left fender and hood were crushed inward, downward and slightly rearward. The upper left A-pillar and driver's door window frame were bent inward and rearward with a sharp crease a short distance above the belt line (**Figures 4** and **5**). The left side of the windshield was heavily cracked and crushed inward due to direct contact with the Windstar, and the trailing edge of the hood contacted the lower portion of the windshield across its entire width, with additional heavy cracking on the right (**Figure 6**). The left roof rail over the driver's door was buckled upward due to rearward displacement of the left A-pillar, and the driver's door opening was distorted. In

addition to the heavy damage to the windshield, the driver's door window glazing was completely shattered, and there was no other glazing damage. The front left axle/suspension was damaged, with the left front wheel visibly displaced inward at the top and restricted due to being pressed against the deformed body panels (**Figure 5**), but the tire was not damaged or deflated. The left rear wheel rim was dented but the tire was not damaged, and there was no other wheel/tire damage. The wheelbase was shortened by 13 centimeters [5.1 inches] on the left and stretched by 2 centimeters [0.8 inches] on the right. The force of the impact on the left side caused induced damage on the right side, with the right front door and/or door opening distorted (**Figure 6**).

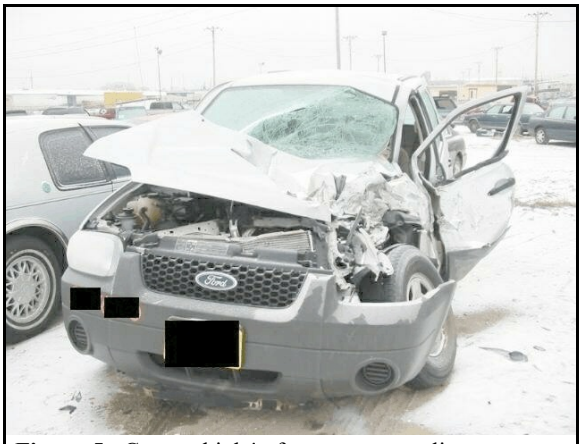


Figure 5: Case vehicle's front; note, no direct contact on the front plane

Figure 6: Case vehicle's front and right side; note, induced damage on right from impact on left

The CDC for the case vehicle's single impact was determined to be **11-LYAW-3 (320 degrees)**. The WinSMASH reconstruction program, damage-only algorithm based on the measured crush profile for both vehicles, was used. The total, longitudinal and lateral delta-Vs are, respectively: 28 km.p.h. [17.4 m.p.h.], -21 km.p.h. [-13.0 m.p.h.] and + 18 km.p.h. [+ 11.2 m.p.h.]. These results are somewhat low due to the impact configuration, with the Windstar vaulting and engaging the case vehicle above the frame. This was a crash of moderate severity (24-40 km.p.h. [15-25 m.p.h.]) for the case vehicle.

The driver's seat area sustained numerous specific intrusions, including: the windshield (44 cms. [17.3 inches] longitudinal); the left upper A-pillar (35 cms. [13.8 inches] longitudinal); the driver's door panel (14 cms. [5.5 inches] lateral); and the roof side rail above the driver's door opening (4 cms. [1.6 inches] lateral). The most significant intrusion, however, was from the Windstar's grille and hood, which penetrated into the case vehicle driver's seat area through the shattered driver's door window as it crushed the A-pillar and door structures inward. The magnitude of the lateral intrusion by the Windstar could not be measured. The Windstar's intruding frontal structures impacted the left side of the case vehicle driver's head.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with driver and front right passenger Certified Advanced 208-Compliant (CAC) frontal air bags. There were seat belt buckle sensors for the two front

seats. The driver's position had a seat track sensor, the passenger's position had a seat weight sensor, and both air bags had multi-stage inflators. Both air bags deployed.

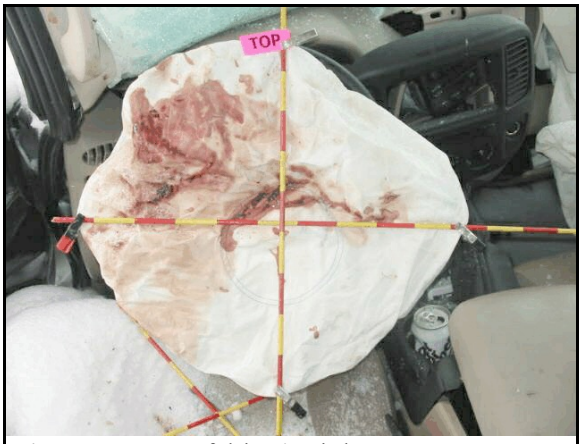


Figure 7: Front of driver's air bag

The driver's air bag was mounted in the steering wheel hub with the module cover flaps in the H-configuration. The cover flaps opened at the tear points and there was no evidence of damage to the cover flaps or the adjacent structures. The upper flap measured 15 cms. [5.9 inches] horizontally and 7 cms. [2.8 inches] vertically and the lower flap measured 13 cms. [5.1 inches] horizontally and 5 cms. [2.0 inches] vertically. The driver's air bag was round with a diameter of 50 cms. [19.7 inches]. There were two vent ports on the back surface of the fabric, of unknown diameter, at the 10:00 and 2:00 o'clock positions. There was no evidence of damage to the air bag. The driver's air bag fabric was smeared with copious amounts of blood on both the front and the back surfaces (**Figure 7**).

Figure 8: Front of front right passenger's air bag

The front right passenger's air bag was mounted in the middle of the instrument panel on the right. The single cover flap opened at the tear points and there was no evidence of damage to the cover flap or the adjacent structures. The cover flap measured 33 cms. [13.0 inches] horizontally and 22 cms. [8.7 inches] vertically. The front right passenger's air bag was rectangular, measuring 70 cms. [27.6 inches] vertically and 36 cms. [14.2 inches] horizontally. There were two vent ports of unknown diameter, located in the left and right side panels of the air bag fabric. There was no evidence of occupant contact or damage on the front right passenger's air bag fabric (**Figure 8**).

CASE VEHICLE DRIVER'S KINEMATICS

The case vehicle's driver (47-year-old female, white, non-Hispanic, 170 centimeters, 61 kilograms [67 inches, 134 pounds]) was restrained by the available manual, three-point, lap-and-shoulder safety belt system. She was seated in an upright posture, with her feet on the floor and both hands on the steering wheel. Her seat track was adjusted between the middle and the forward positions, the bucket seat back was upright and the bottom of the adjustable head restraint was positioned approximately 5 centimeters [2 inches] above the top of the seat back. The case vehicle was stopped in traffic, waiting for a traffic signal and intending to continue straight ahead.

The case vehicle's driver did not attempt any avoidance maneuvers and her posture did not change immediately prior to the impact. The Windstar came down the ramp, crossed the opposing lanes and its front wheels impacted the curbed median, causing it to vault upward. The Windstar's front impacted the case vehicle's left fender and the driver's door, causing the case vehicle's driver and front right passenger air bags to deploy. The Windstar's front bumper engaged the case vehicle approximately at the level of the top of the case vehicle's left front tire, with the Windstar's grille and the leading edge of the hood impacting the case vehicle's windshield, left upper A-pillar and the driver's door window glazing. The case vehicle driver moved forward and leftward, toward the 11:00 o'clock direction of force and, as the Windstar's frontal structures penetrated into the case vehicle's front seat row, the case vehicle driver was hit on the left side of her head by the leading edge of the Windstar's engine hood. She sustained several critical and severe brain injuries, discussed below, plus fractures of the left and right mandibles, the alveolar ridge and the maxilla bilaterally. The driver's door panel intruded against her thorax and she sustained a fracture of the left fourth rib. She also sustained lacerations and abrasions on her face, and various contusions. Her position at final rest is not known. She was knocked unconscious and remained unconscious during her removal from the wrecked vehicle, during transport, and during initial evaluation at the hospital.

DRIVER'S INJURIES

The case vehicle's driver was transported via ambulance to a hospital, where she was admitted for 21 days.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1.	Unconscious on initial observation, GCS = 7	serious 160806.3,0	other vehicle's engine hood	certain	emergency room records
2.	Cerebrum, left, subarachnoid hemorrhage	serious 140684.3,2	other vehicle's engine hood	certain	hospitalization records
3.	Cerebrum, right, subarachnoid hemorrhage	serious 140684.3,1	other vehicle's engine hood	certain	hospitalization records
4.	Cerebrum, bilateral, diffuse axonal injury (white matter shearing)	critical 140628.5,3	other vehicle's engine hood	certain	hospitalization records
5.	Cerebrum (frontal-temporal), bilateral, multiple small contusions	serious 140622.3,3	other vehicle's engine hood	certain	hospitalization records
6.	Cerebrum, right, subdural hematoma	severe 140652.4,1	other vehicle's engine hood	certain	hospitalization records

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
7.	Cerebral edema, mild, right parietal-occipital	serious 140662.3,1	other vehicle's engine hood	certain	hospitalization records
8.	Cerebrum, left, intraventricular hemorrhage	severe 140678.4,2	other vehicle's engine hood	certain	hospitalization records
9.	Fracture, right mandible, subcondylar	moderate 250608.2,1	other vehicle's engine hood	certain	hospitalization records
10.	Fracture, left mandible, body	minor 250604.1,2	other vehicle's engine hood	certain	hospitalization records
11.	Fracture, alveolar ridge	moderate 250200.2,8	other vehicle's engine hood	certain	hospitalization records
12.	Fracture, maxilla, bilateral	moderate 250800.2,3	other vehicle's engine hood	certain	hospitalization records
13.	Fracture, left 4th rib	minor 450212.1,2	left side interior surface	certain	hospitalization records
14.	Laceration, minor, chin	minor 290602.1,8	other vehicle's engine hood	certain	emergency room records
15.	Abrasion, left eyelid	minor 297202.1,2	other vehicle's engine hood	certain	emergency room records
16.	Contusion(s), unknown region(s)	minor 990400.1,9	unknown	unknown	interviewee

CASE VEHICLE FRONT RIGHT PASSENGER'S KINEMATICS

The case vehicle's front right passenger (19-year-old female, white, non-Hispanic, 168 centimeters, 48 kilograms [66 inches, 106 pounds]) was restrained by the available manual, three-point, lap-and-shoulder safety belt system. She was probably seated in an forward-facing posture, with the position of her hands and feet not known. The seat track was adjusted between the middle and rear, the bucket seat back was slightly reclined and the bottom of the adjustable head restraint was positioned approximately 3 centimeters [1.2 inches] above the top of the seat back.

The case vehicle's driver did not attempt any avoidance maneuvers and the front right passenger's posture did not change immediately prior to the crash. The Windstar impacted the case vehicle's left side, causing the case vehicle's driver and front right passenger air bags to deploy, and causing the front right passenger to move forward and leftward, toward the 11:00 o'clock direction of force. The front right passenger was held in place by her manual safety belts and she probably encountered the deployed front right air bag with her face and chest. Her legs flailed, striking the knee bolster on the right, and she sustained contusions on both lower legs, and no other injuries. Her posture at final rest is not known, but the safety belt system probably held her in place.

The front right passenger was transported via ambulance to a hospital, where she was treated and released at the emergency department.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1.	Bilateral lower leg contusions	890402.1,3	Knee Bolster	certain	Interviewee

OTHER VEHICLE

The other vehicle was a 1995 Ford Windstar GL front wheel drive, three-door, seven-passenger minivan (VIN: 2FMDA5143SB------), equipped with a 3.8 liter V6 gasoline engine. Four-wheel anti-lock brakes were standard for this model. The Windstar was equipped with dual frontal air bags, both of which deployed. Its wheelbase was 307 centimeters [120.7 inches]. The Windstar was towed due to damage.

Figure 9: Windstar's front and right side

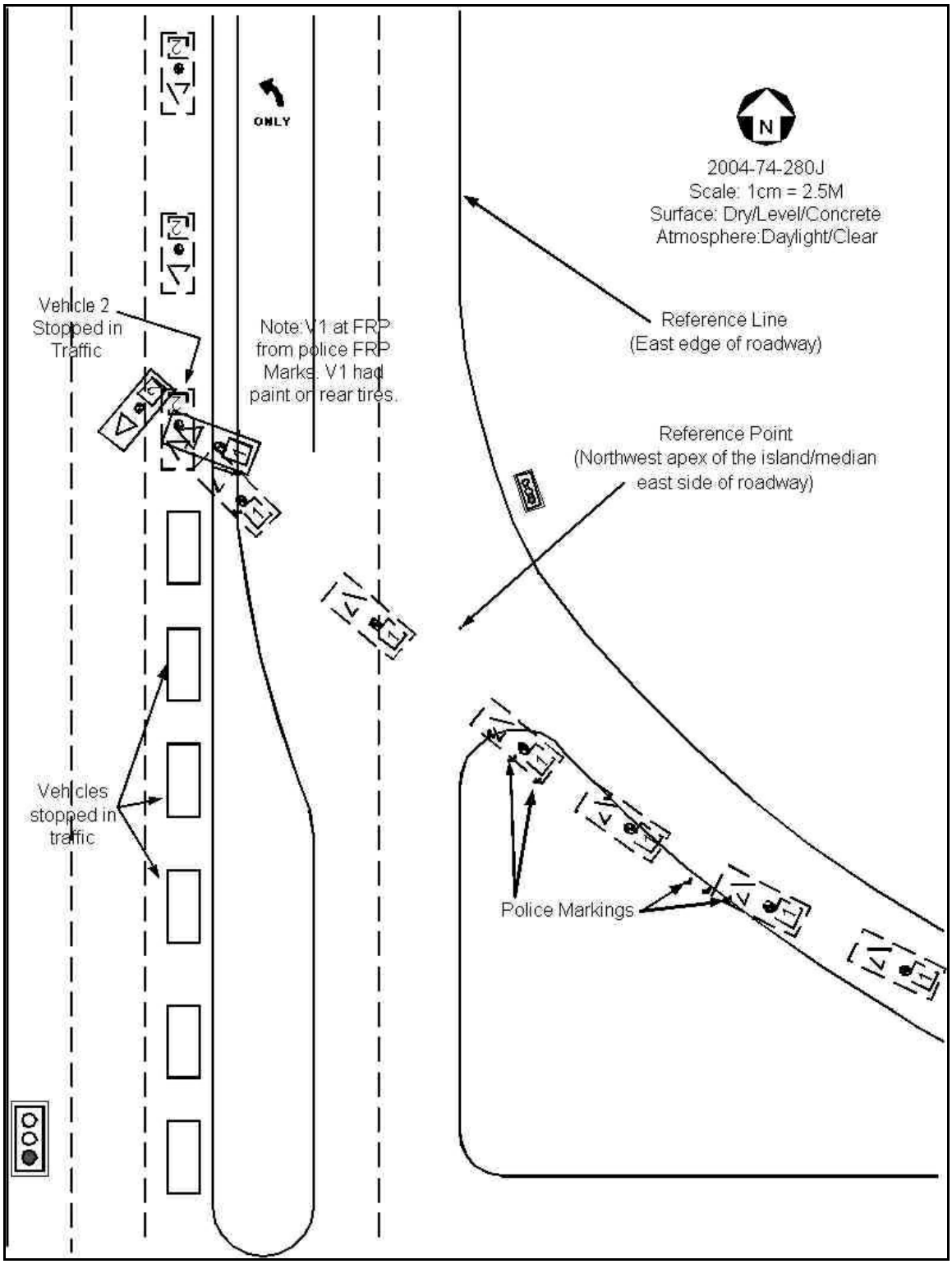
Figure 10: Windstar's front and left side

The Windstar sustained moderate direct contact damage across the lower portion of the front plane, with lesser direct and induced damage over almost the entire front (**Figures 9** and **10**). The bumper cover was torn off and the steel bumper was crushed rearward. The grille and the left headlamp/turn signal assembly were broken away, but the right headlamp/turn signal was intact. The finish panel was torn off the hood. There was no glazing damage. The wheel base was shortened by 16 centimeters [6.3 inches] on the left and stretched 5 centimeters [2.0 inches] on the right. The left front wheel rim was damaged and displaced rearward and the tire was torn and deflated. The investigator indicated that it was not possible to separate left front wheel damage due to the curb impact from the frontal impact. The left rear wheel rim was dented, with no damage to the tire, and there was no other wheel/tire damage.

The first harmful event was the Windstar's impact with the curbed median and a CDC for the left rear wheel's curb impact was written as **12-FLWN-9 (0 degrees)**. The CDC for the

Windstar's most severe impact, with the case vehicle, was determined to be **12-FDEW-2 (0 degrees)**. The WinSMASH reconstruction program, damage only algorithm based on the measured crush profile of both vehicles, was used on the Windstar's most severe impact. The total, longitudinal and lateral delta-Vs are, respectively: 26 km.p.h. [16.2 m.p.h.], -26 km.p.h. [-16.2 m.p.h.] and 0 km.p.h. [0 m.p.h.]. These results are somewhat low, due to the configuration of the two vehicles at impact. This was a crash of moderate severity (24-40 km.p.h. [15-25 m.p.h.]) for the Windstar.

The other vehicle's driver (16-year-old female) was restrained by the available manual, three-point, lap-and-shoulder safety belt system and the driver's steering wheel-mounted air bag deployed. The driver did not sustain any injury and did not seek medical attention. There was no other occupant in the Windstar.


ONLY
N
2004-74-280J
Scale: 1cm = 2.5M
Surface: Dry/Level/Concrete
Atmosphere:Daylight/Clear
Vehicle 2
Stopped in
Traffic
Note:V1 at FRP
from police FRP
Marks. V1 had
paint on rear tires.
Reference Line
(East edge of roadway)
Reference Point
(Northwest apex of the island/median
east side of roadway)
Vehicles
stopped in
traffic
Police Markings