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 CERTIFIED ADVANCED 208-COMPLIANT VEHICLE INVESTIGATION

CASE NUMBER - IN-04-034
LOCATION - Texas
VEHICLE - 2004 MAZDA 3
CRASH DATE - September 2004

Submitted:

April 6, 2005
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Prepared for:

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National Center for Statistics and Analysis
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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 air bag investigation involving a 2004 Mazda 3, four-door sedan with manual safety belts and dual front advanced air bag system.			
16. *Abstract* This report covers an on-site investigation of an air bag deployment crash that involved a 2004 Mazda 3 (case vehicle), which ran-off-road and impacted a concrete longitudinal barrier and concrete median barrier. This crash is of special interest because the case vehicle was equipped with multiple Advanced Occupant Protection System (AOPS) features, including certified advanced 208-compliant air bags, the driver's air bag deployed as a result of the crash, and the case vehicle's restrained driver (32-year-old, female) sustained a police reported "C" (possible) injury. The case vehicle was traveling north in the middle northbound lane of a six-lane divided tollway. A non-contact vehicle was northbound in the inside lane and changed lanes to the right and crossed in front of the case vehicle. The case vehicle's driver braked and steered right to avoid the non-contact vehicle, and the case vehicle traveled to the right across the outside lane. The driver then steered left, the case vehicle entered the outside shoulder, and the right rear wheel and quarter panel sideswiped the longitudinal barrier. The case vehicle then rotated counterclockwise across all three northbound travel lanes, and the front impacted a concrete median barrier causing the case vehicle's driver air bag to deploy. The case vehicle's driver was most likely seated in an upright position with both hands on the steering wheel. Her seat track was located in its rear-most position, the seat back was slightly reclined, and the tilt steering column was adjusted to its full-up position.. The case vehicle's driver was restrained by her lap and shoulder safety belt system, and the buckle-mounted pretensioner activated during the crash. The driver refused medical treatment at the scene. It is not known if she subsequently sought medical treatment or lost any work days as a result of the crash.			
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BACKGROUND

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This on-site investigation was brought to NHTSA's attention on or about October 8, 2004 by NASS CDS/GES sampling activities. This crash involved a 2004 Mazda 3 (case vehicle), which ran-off-road and impacted a concrete longitudinal barrier and a concrete median barrier. The crash occurred in September, 2004, at 10:45 a.m., in Texas and was investigated by the Texas Highway Patrol. This crash is of special interest because the case vehicle was equipped with multiple Advanced Occupant Protection System (AOPS) features, including certified advanced 208 compliant air bags, the driver's air bag deployed as a result of the crash, and the case vehicle's driver [32-year-old, Black (unknown if Hispanic) female] sustained a police-reported "C" (Possible) injury. This contractor inspected the case vehicle on October 8, 2004, and inspected the crash scene on October 12, 2004. This contractor was unable to contact the case vehicle's driver. This summary is based on the police crash report, scene and vehicle inspections, occupant kinematic principles and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling north in the middle northbound lane of a six-lane divided tollway. A non-contact vehicle was northbound in the inside northbound lane and changed lanes to the right and crossed in front of the case vehicle. The case vehicle's driver braked and steered right to avoid the non-contact vehicle and traveled to the right across the outside lane. The driver then steered left, the case vehicle entered the outside shoulder and the right rear wheel and quarter panel sideswiped a concrete longitudinal barrier. The case vehicle then rotated counterclockwise across all three northbound travel lanes, and the front impacted a concrete median barrier causing the case vehicle's driver air bag to deploy. The case vehicle then spun counterclockwise off the barrier, rotated approximately 390 degrees and came to rest facing southwest with the front of the vehicle in the inside lane and the back of the vehicle in the middle lane. The case vehicle's driver was restrained by her lap and shoulder safety belt system, and the buckle mounted pretensioner activated during the crash. The driver refused medical treatment at the scene.

The CDCs for the case vehicle were determined to be: **12-RZES-1** (**0** degrees) for the initial impact with the concrete longitudinal barrier and **02-FDEW-2** (**70**-degrees) for the front impact with the concrete median barrier. The WinSMASH reconstruction program, barrier option, calculated the case vehicle's Total, Longitudinal and Lateral Delta Vs for the highest severity impact (i.e., front impact with the longitudinal barrier) as: 22 km.p.h. (13.7 m.p.h.), -7.5 km.p.h. (-4.7 m.p.h.), -20.7 km.p.h. (12.9 m.p.h.). The collision fit the reconstruction model but the results appeared to be low. The case vehicle was towed due to damage.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the case vehicle was traveling was a straight, six-lane, divided tollway, traversing in a north and south direction (**Figure 1** below). Each travel direction contained three travel lanes, and the trafficway was divided by a concrete median barrier. Each travel lane was approximately 3.7 meters (12 feet) wide. Both outside shoulders were bituminous and approximately 3 meters (10 feet) wide. Both inside shoulders were also bituminous and were approximately 1 meter (3.3 feet) wide. The case vehicle's travel lanes were

traffic polished bituminous with an estimated coefficient of friction of 0.65 and an approximate 3% positive grade. The roadway pavement markings consisted of single broken white lane lines, a yellow median line and white edge line. The case vehicle's approach to the crash location was uncontrolled and the speed limit was 88 km.p.h. (55 m.p.h.). There was no regulatory speed limit sign posted near the crash site. At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the roadway pavement was dry. Traffic density was moderate, the site of the crash was urban, and the crash occurred within an interchange area. See the Crash Diagram at the end of this report.

Figure 1: Overview of trafficway and approach of case vehicle northbound in middle lane (case photo #01)

Pre-Crash: The case vehicle was traveling north in the center lane, and the driver was intending to continue northbound (**Figure 1**). A non-contact vehicle was northbound in the inside lane and changed lanes to the right and crossed in front of the case vehicle. The case vehicle's driver braked and steered right to avoid the non-contact vehicle, and the case vehicle traveled to the right across the outside lane. The driver steered left and the case vehicle entered the outside shoulder heading toward the concrete longitudinal barrier. The initial impact of the crash sequence occurred on the outside shoulder of the roadway.

Figure 2: Damage to right quarter panel and right rear wheel due to sideswiping the concrete longitudinal barrier (case photo #15)

Crash: As the case vehicle's driver steered to the left, the case vehicle's right rear wheel and quarter panel (**Figure 2**) sideswiped the concrete longitudinal barrier (**Figure 3**). As the case vehicle separated from the barrier, it began to rotate counterclockwise and continued to rotate counterclockwise approximately 95 degrees as it traveled to the left across all three northbound travel lanes. The front of the case vehicle (**Figure 4** below) then impacted the concrete median barrier (**Figure 5** below) causing the case vehicle's driver air bag to deploy. The case vehicle's front right air bag did not deploy because there was no front right occupant in the case vehicle. The occupant weight sensor in the front right seat properly determined the absence of an

Figure 3: View to northeast to area of case vehicle's sideswipe impact with the concrete longitudinal barrier (case photo #02)

occupant and suppressed deployment of the front right air bag.

Post-Crash: The case vehicle rotated counterclockwise off the median barrier approximately 390 degrees, traveled approximately 24 meters (78.7 feet) and came to final rest facing southwest with the front of the vehicle in the inside lane and the back of the vehicle in the middle lane.

Figure 4: Damage to front of case vehicle [each stripe on rods is 5 cm (2 in)] from impact with the median barrier (case photo #08)

Figure 5: View to northwest to case vehicle's front impact location (arrow) on concrete median barrier, note case vehicle's yaw marks (case photo #05)

CASE VEHICLE

The 2004 Mazda 3 was a front wheel drive, four-door sedan (VIN: JM1BK323141------) equipped with four wheel, anti-lock brakes; dual stage driver and front right passenger air bags, front seat back-mounted side impact air bags, front and rear side curtain air bags, driver seat position sensor; driver and front right passenger, height adjustable, three point lap and shoulder safety belts with belt usage sensors, belt pretensioners, and belt force limiters. The front right seat was also equipped with a weight sensor to detect the presence of an occupant. In addition, the case vehicle was equipped with a LATCH system for securing child safety seats, and a brake pedal that was designed to pivot away from the driver during a severe crash.

The various sensors in the case vehicle's advanced occupant restraint system analyze a combination of factors including the predicted crash severity, the driver's safety belt usage and the seat track position to determine the front air bag inflation level appropriate for the severity of the crash. For the front right seat position, an occupant weight sensor determines first, if an occupant is on the seat and, second, if the weight on the seat is at or below 30 kilograms (66 pounds). If no occupant is seated, or the weight on the seat is at or below 30 kilograms (66 pounds), then the deployment of the air bag is suppressed.

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle's initial impact with the concrete longitudinal barrier involved the right quarter panel and right rear wheel (**Figure 2** above). A few scratches were also observed on the back portion of the right rear door. Direct damage began 198 centimeters (78 inches) rear of the right front axle and extended 124 centimeters (48.8) inches along the right rear door, sill, quarter panel, right rear wheel and right side of the rear bumper cover. The maximum crush to

the right quarter panel was about 1.0 centimeter (0.4 inch) occurring at C_2, and the right rear wheel was bent inward at the bottom. The case vehicle's impact with the concrete median barrier involved the front bumper, right fender, right headlamp/turn lamp assembly, grille and hood. (**Figure 6**). Direct damage began at the right corner of the front bumper and extended 118 centimeters (46.5 inches) across the front of the case vehicle. Crush measurements were taken at the bumper and maximum crush was measured as 31 centimeters (12.2 inches) occurring at C_2 and C_3 (**Figure 7**). The table below shows the case vehicle's crush profile.

Figure 6: Overview of damage to front of case vehicle from impact with the concrete median barrier (case photo #10)

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	138	22	118	20	31	31	30	27	15	20	0
in		54.3	8.7	46.5	7.9	12.2	12.2	11.8	10.6	5.9	7.9	0.0

The right side wheelbase was extended 1.0 centimeter (0.4 inch). The left side wheelbase was unchanged. Induced damage involved the front bumper, grille, hood, right fender and left fender.

The recommended tire size was: P205/55R16; however, the case vehicle was equipped P205/50R17 size tires. The maximum tire pressure for these tires was 303 kpa (44 psi) The case vehicle's tire data are shown in the table below.

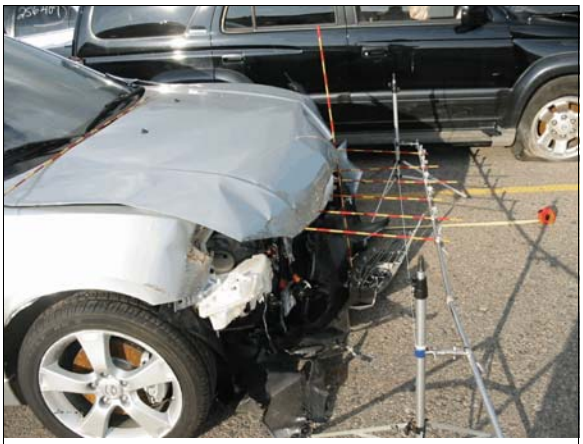


Figure 7: Right side view of crush to front of case vehicle (case photo #16)

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	186	27	221	32	6	8	None	No	No

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kpa	psi	kpa	psi	milli-meters	32nd of an inch			
LR	179	26	221	32	6	8	None	No	No
RR	179	26	221	32	6	8	None	No	No

Vehicle Interior: Inspection of the case vehicle's interior revealed a possible occupant contact on the left center portion of the air bag (**Figure 8**). The contact appeared to be a stain in the air bag material. It did not appear to be a transfer of lip stick or make-up. No other evidence of occupant contact was noted on the case vehicle's interior. In addition, there was a heavy abrasion noted on the driver's shoulder belt, and her buckle-mounted pretensioner had activated. No occupant compartment intrusions were observed, and there was no compression of the energy absorbing steering column or deformation of the steering wheel rim (**Figure 9**).

Figure 8: Case vehicle's driver air bag, arrow shows stain in the air bag material (case photo #25)

Figure 9: Overview of steering wheel and steering column showing lack of deformation (case photo #38)

Damage Classification: Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **12-RZES-1** (**0** degrees) for the initial impact with the concrete longitudinal barrier and **02-FDEW-2** (**70**-degrees) for the front impact with the concrete median barrier.

The WinSMASH reconstruction program, barrier option, was used to reconstruct the Delta V for the case vehicle's front impact. The Total, Longitudinal and Lateral Delta Vs are, respectively: 22 km.p.h. (13.7 m.p.h.), -7.5 km.p.h. (-4.7 m.p.h.), -20.7 km.p.h. (12.9 m.p.h.). The collision fits the reconstruction model but the results appear to be low. The case vehicle was towed due to damage.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a certified advanced 208-compliant air bag system including dual stage frontal air bags at the driver and front right passenger positions, front seat back-mounted side impact air bags and front and rear side curtain air bags. The driver's air bag

deployed as a result of the case vehicle's front impact with the concrete median barrier. The cae vehicle's other air bags did not deploy because there was no front right passenger in the vehicle, and the vehicle did not sustain a side impact severe enough to require deployment of the side air bags.

The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module cover flaps and the air bag fabric revealed that the cover flaps opened at the designated tear points. There was no evidence of damage during the deployment to the air bag module cover flaps or the air bag. The deployed driver's air bag (**Figure 8** above)was round with a diameter of approximately 58 centimeters (22.8 inches). The air bag was designed without tethers and had two vent ports (**Figure 10**), each approximately 4 centimeters (1.6 inches) in diameter, located at the 11 and 1 o'clock positions. There were two air bag module cover flaps (**Figure 11**). The top portion of the top flap was rectangular in shape with a semi-circular center portion that mated with the semi-circular center portion of the bottom flap. The top flap was 11 centimeters (4.3 inches) in width at the top, and the bottom flap was 8.5 centimeters (3.3 inches) in width at the bottom. The distance between the mid-center of the driver's seat back and the front surface of the air bag's fabric at full excursion was 20 centimeters (7.9 inches).

The front right passenger air bag was located in the middle of the instrument panel (**Figure 12**). The deployment of the front right air bag was properly suppressed by the case vehicle's advanced occupant protection system because there was no front right occupant in the case vehicle at the time of the crash.

Figure 10: Case vehicle's driver air bag vent ports (case photo # 27)

Figure 11: Overview of air bag module flaps (case photo # 22)

Figure 12: Front right air bag located in top of instrument panel above glove box door (case photo #35)

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash, the case vehicle's driver [32-year-old, Black (unknown if Hispanic) female; unknown height and weight] was most likely seated in an upright posture with

both hands on the steering wheel. Her right foot was likely off the accelerator, but it is not known if she applied the brakes just prior to the impact. The driver's seat track was located in its rear-most position, the seat back was slightly reclined, the tilt steering column was adjusted to its full up position and her head restraint was adjusted to its full up position. Finally, the driver's shoulder belt anchor was adjusted to its full up position.

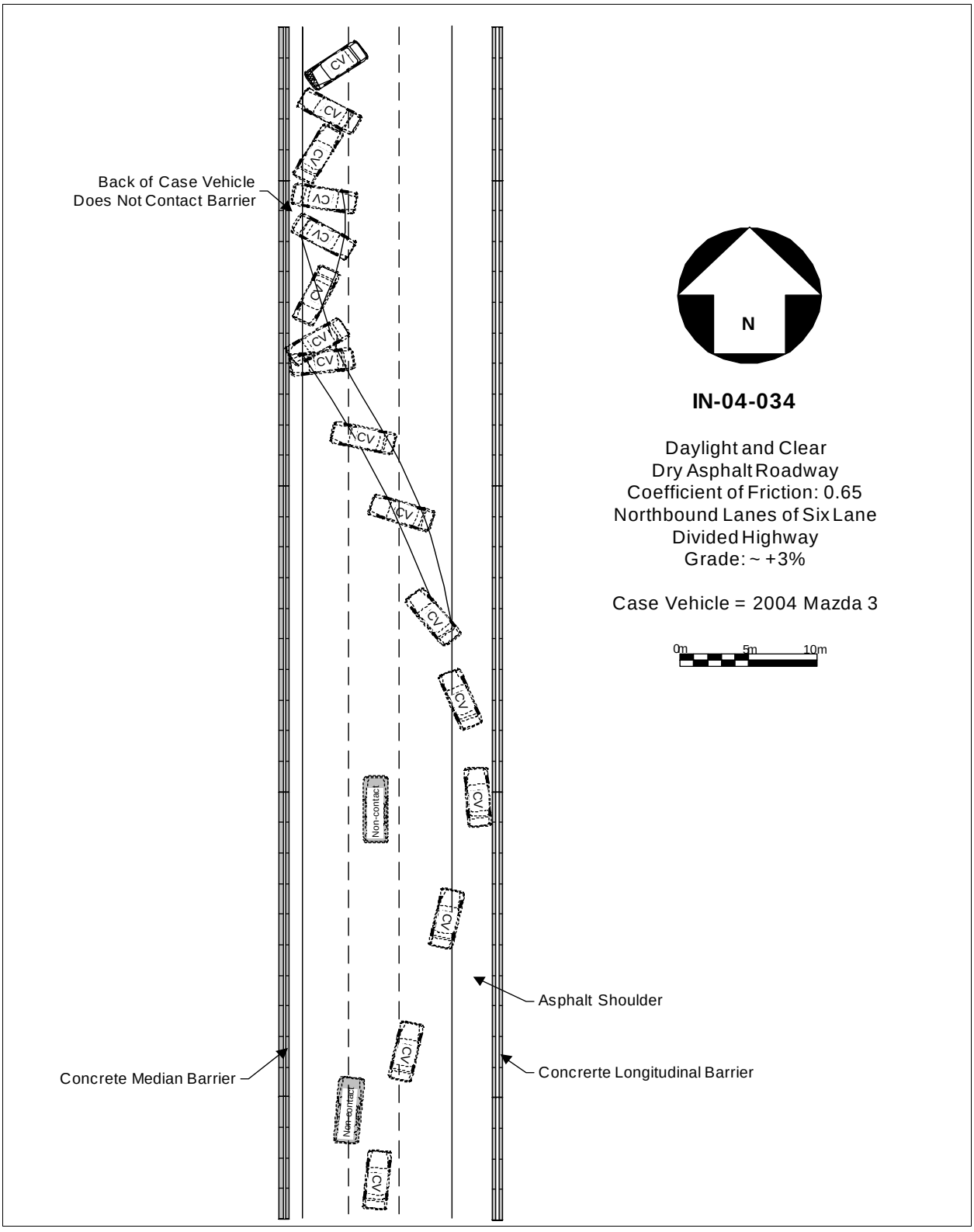
Figure 13: Load mark on driver's shoulder belt (case photo #30)

The evidence observed during the vehicle inspection indicates the case vehicle's driver was using her active, three-point, lap-and-shoulder safety belt system. Inspection of the safety belt assembly revealed a heavy abrasion on the shoulder belt (**Figure 13** above) due to loading on the D-ring during the crash. In addition, the buckle-mounted pretensioner had activated during the crash. The safety belt buckle stalk was observed to be compressed (**Figure 14**), and the pretensioner piston was flush with the end of the cylinder, a movement of approximately 8 centimeters (3.1 inches).

Figure 14: Compression of driver's seat belt buckle stalk due to activation of the seat belt pretensioner (case photo # 31)

The driver initially braked and steered to the right to avoid the non-contact vehicle. The evidence indicates the driver then steered to the left to avoid the impact with the concrete longitudinal barrier on the right side of the roadway. The case vehicle's sideswipe impact with the longitudinal barrier most likely caused the driver to move forward and to the right along a path opposite the case vehicle's 10 degree direction of principal force, and locked her seat belt retractor. The driver then moved to the right in her seat as the case vehicle rotated counterclockwise and traveled across the roadway. The driver's seat belt retractor would have remained locked during this rotation. The case vehicle's impact with the concrete median barrier deployed the driver's air bag and her buckle mounted pretensioner, and caused the driver to move forward and to the right along a path opposite the case vehicle's 70 degree direction of principal force and load her safety belt. The driver's face and chest most likely contacted her deployed air bag. The driver remained in her seat, and her safety belt remained locked as the vehicle rotated counterclockwise off the median barrier and came to final rest. The driver's upper body most likely moved to the right and left during the post-impact rotation. It is likely the driver was able to exit the case vehicle without assistance.

The police crash report indicated the driver sustained a “C” (possible) injury as a result of the crash and refused treatment at the scene. It is not known if the driver subsequently sought medical treatment or lost any work days as a result of the crash.


Back of Case Vehicle
Does Not Contact Barrier
CV
Non-contact
N
IN-04-034
Daylight and Clear
Dry Asphalt Roadway
Coefficient of Friction: 0.65
Northbound Lanes of Six Lane
Divided Highway
Grade: ~ +3%
Case Vehicle = 2004 Mazda 3
0m
5m
10m
Asphalt Shoulder
Concrete Median Barrier
Concrerte Longitudinal Barrier