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ON-SITE OTHER INFLATABLE OCCUPANT PROTECTION INVESTIGATION

CASE NUMBER - IN-05-026
LOCATION - OHIO
VEHICLE - 2005 HONDA ACCORD EX
CRASH DATE - July 2005

Submitted:

July 24, 2006

Contract Number: DTNH22-01-C-07002

Prepared for:

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

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

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

Technical Report Documentation Page

1. *Report No.* IN-05-026	2. *Government Accession No.*	3. *Recipient's Catalog No.*	
4. *Title and Subtitle* On-Site Other Inflatable Occupant Protection Investigation Vehicle - 2005 Honda Accord EX Location - Ohio		5. *Report Date:* July 24, 2006 6. *Performing Organization Code*	
7. *Author(s)* Special Crash Investigations Team #2		8. *Performing Organization Report No.*	
9. *Performing Organization Name and Address* Transportation Research Center Indiana University 222 West Second Street Bloomington, Indiana 47403-1501		10. *Work Unit No. (TRAIS)* 11. *Contract or Grant No.* DTNH22-01-C-07002	
12. *Sponsoring Agency Name and Address* U.S. Department of Transportation (NPO-122) National Highway Traffic Safety Administration National Center for Statistics and Analysis Washington, D.C. 20590-0003		13. *Type of Report and Period Covered* Technical Report Crash Date: July 2005 14. *Sponsoring Agency Code*	
15. *Supplementary Notes* On-site air bag investigation involving a 2005 Honda Accord EX with manual safety belts and dual front certified advanced 208-compliant air bags, side curtain air bag and side impact air bags.			
16. *Abstract* This report covers an on-site investigation of an air bag deployment crash that involved a 2005 Honda Accord EX (case vehicle), which ran-off-road and rolled over. 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, as well as side curtain and front seat back-mounted side impact air bags, and the case vehicle's driver [56-year-old, White (non-Hispanic) female sustained a police reported “C” (possible) injury as a result of the crash. The case vehicle was traveling north in the outside northbound lane of a four-lane, divided Interstate highway. The case vehicle’s driver was changing lanes to the left and steered right to avoid a non-contact vehicle. The driver then steered left and lost control of the case vehicle. The case vehicle rotated counterclockwise across both northbound lanes, departed the left side of the roadway and rolled over, passenger side leading in the median four quarter rolls. The case vehicle’s left side curtain air bag and driver’s side impact air bag deployed when the case vehicle landed hard on its left roof side rail and “C”-pillar at the beginning of the third quarter roll. The case vehicle came to rest on its wheels in the median heading southeast. The driver was restrained by her manual, three-point, lap-and-shoulder safety belt. She sustained a cervical strain due to impact with the left roof side rail as well as multiple contusions and abrasions due to contact with her safety belt system and side impact air bag. The driver was transported to a local hospital and treated and released.			
17. *Key Words* Advanced Air Bag Deployment, Rollover Motor Vehicle Traffic Crash Injury Severity		18. *Distribution Statement* General Public	
19 *Security Classif. (of this report)* Unclassified	20. *Security Classif. (of this page)* Unclassified	21. *No. of Pages* 10	22. *Price* $6,500

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This investigation was brought to NHTSA's attention on or before August 18, 2005 by the Nationwide Insurance Company. This crash involved a 2005 Honda Accord EX (case vehicle) that ran-off-road and rolled over. The crash occurred in July, 2005 at 2: 58 p.m., in Ohio and was investigated by the applicable city police department. 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, as well as side curtain and front seat back-mounted side impact air bags, and the case vehicle's driver [56-year-old, White (non-Hispanic) female sustained a police reported "C" (possible) injury as a result of the crash. This contractor inspected the scene and vehicle on September 12, 2005. The case vehicle driver's interview was conducted on November 21, 2005. This report is based on the police crash report, on-scene police photographs, scene and vehicle inspections, driver medical records, case vehicle driver's interview, occupant kinematic principles, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling north in the outside northbound lane of a four-lane, divided Interstate highway. The case vehicle's driver was changing lanes to the left and steered right to avoid a non-contact vehicle. The driver then steered left and lost control of the case vehicle. The case vehicle rotated counterclockwise across both northbound lanes, departed the left side of the roadway and entered the median in an increasing counterclockwise yaw. The case vehicle traveled down into the median and the right side tires furrowed into the ground. The case vehicle tripped and rolled over, passenger side leading, four quarter turns. The case vehicle's left side curtain air bag and driver's seat back-mounted side impact air bag deployed when the case vehicle landed hard on its left roof side rail and "C"-pillar at the beginning of the third quarter roll. The case vehicle came to rest on its wheels in the median heading southeast.

The CDC for the case vehicle was determined to be: **00-TDDO-3**. The maximum residual roof crush was approximately 16 centimeters (6.3 inches) occurring at the back of the left rear door. No reconstruction program was used on this crash because rollover's are out-of-scope for the WinSMASH reconstruction program. Based on the extent of roof crush, the rollover crash severity was determined to be moderate. The case vehicle was towed due to damage.

Immediately prior to the crash, the case vehicle's driver was seated in an upright position with her back against the seat back, both hands on the steering wheel, her left foot on the floor and her right foot on the brake. Her seat was located in its middle track position, and the seat back was slightly reclined. The steering column was adjusted to its center position. The driver was restrained by her manual, three-point, lap-and-shoulder safety belt system. The driver was wearing glasses at the time of the crash.

As the case vehicle rotated counterclockwise across both northbound lanes, the driver's safety belt retractor most likely locked, and she moved to the right within her seat and safety belt. As the case vehicle began to roll over, the driver continued to move to the right and toward the roof and continued loading her safety belt. The driver then moved left and toward the roof as the case vehicle impacted the left roof side rail and "C"-pillar on the ground. The impact caused the

driver's seat back-mounted side impact air bag and left side curtain air bag to deploy. She loaded her safety belt system causing contusions to her abdomen and ribs, and her left upper arm and left flank impacted the deployed side impact air bag abrading her arm and flank. Her head also impacted the deployed side curtain air bag and then the left roof side rail causing a scalp contusion and cervical strain. As the case vehicle completed its forth quarter roll and returned to it's wheels, the driver most likely moved off the left side and back to the right before settling back into the her seat. The driver exited the vehicle under her own power following the crash.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the case vehicle was traveling was a four-lane, divided, Interstate highway, traversing in a north-south direction. Each travel lane was approximately 3.7 meters (12 feet) in width. Each roadway was bordered by bituminous shoulders. The outside shoulders were approximately 3 meters (9.8 feet) in width. The inside shoulders were approximately 1.2 meters (4 feet) in width. The trafficway was divided by a grass median approximately 24 meters (78.7 feet) in width. Roadway markings consisted of solid white outside edge lines, broken white center lines and a solid yellow median edge lines. There were no traffic controls in the immediate area of the crash. The speed limit was 105 km.p.h. (65 m.p.h.). No regulatory speed limit sign was 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 level, dry, travel polished bituminous with an estimated coefficient of friction of 0.65. Traffic density was moderate, and the site of the crash was rural. See the Crash Diagram at end of this summary.

Pre-Crash: The case vehicle was traveling north in the outside northbound lane (**Figure 1**). The driver began to change lanes to the left and was startled by a non-contact car in the inside lane. The case vehicle's driver steered right to avoid the non-contact vehicle, and the case vehicle traveled onto the right shoulder. The case vehicle's driver then steered left in an attempt to return to the roadway. As a result, she lost control of the vehicle and it began to rotate counterclockwise. The case vehicle rotated counterclockwise across both northbound lanes, departed the left side of the roadway and entered the median in an increasing counterclockwise yaw. The crash occurred in the median of the two roadways.

Figure 1: Police on-scene photo showing case vehicle's yaw marks (arrows); from left to right, yaw marks are right rear, left rear, right front and left front, photo view is to southeast

Crash: As the case vehicle's counterclockwise yaw increased and it traveled down into the median, the right side tires furrowed into the ground (**Figure 2** below), tripped the vehicle and it rolled over, passenger side leading, four quarter turns. The case vehicle's left side curtain air bag and driver's seat back-mounted side impact air bag deployed when the case vehicle landed hard on its left roof side rail and "C"-pillar (**Figure 3** below) at the beginning of the third quarter roll.

Figure 2: View northwest along approach of case vehicle to trip point (arrows), from left to right tire marks are right front and right rear

Figure 3: Damage to case vehicle's left roof side rail and left "C"-pillar from ground impact, each increment on rods is 5 cm (2 in)

Post-Crash: The case vehicle came to rest on its wheels in the median heading southeast (**Figure 4**).

Figure 4: View southeast to case vehicle's rest position, arrows show case vehicle's tire furrows in grass

CASE VEHICLE

The 2005 Honda Accord EX (**Figure 5**) was a front wheel drive, four-door sedan (VIN: 1HGCM56835A------) equipped with a four cylinder, 2.4L engine; five-speed automatic transmission and power assisted, four wheel anti-lock disc brakes. The front seating row was equipped with bucket seats with adjustable head restraints, tilt and telescoping steering column, dual stage driver and front right passenger air bags, a front right passenger occupant detection system, seat back-mounted side impact air bags with front right passenger "Occupant Position Detection System" (OPDS), side curtain air bags; driver and front right passenger manual, three-point, lap-and-shoulder safety belt systems with adjustable upper anchors and retractor mounted safety belt pretensioners with safety belt usage sensors. The back bench seat was equipped with three-point, lap-and-shoulder safety belt systems in all three seat positions, adjustable head restraints in the outboard seat positions and side curtain air bags. In addition, the case vehicle was equipped with a LATCH system for securing child safety seats. The case vehicle's wheelbase was 274 centimeters (107.9 inches). The odometer reading at the time of the inspection was unknown because the case vehicle was equipped with an electronic odometer. However, the driver

Figure 5: Front view of case vehicle

estimated that the odometer reading was approximately 7,886 kilometers (4,900 miles) at the time of the crash.

The various sensors in the case vehicle's advanced occupant restraint system analyze a combination of factors including the predicted crash severity, safety belt usage and presence of a front right passenger to determine the front air bag inflation level appropriate for the severity of the crash. The OPDS monitors the position of the front right passenger. If a small statured person is in the deployment path of the seat back-mounted side impact air bag, the system suppresses deployment of the side impact air bag.

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle's rollover involved direct ground contact to the right quarter panel, right "C"-pillar, roof, trunk lid, left roof side rail, left "C"-pillar, left side door window frames, left fender and left front door (**Figures 6-9**). In addition, the beads on the right side tires were broken, and there was grass jammed in the beads of the left side tires. The maximum residual roof crush was approximately 16 centimeters (6.3 inches) occurring at the back of the left rear door.

Figure 6: Overview of back and right side showing rollover damage to right quarter panel and left "C"-pillar, roof and left roof side rail

Figure 7: Back view of crush to left "C"-pillar and roof side rail

Figure 8: Rollover damage to left fender and left front door

Figure 9: Rollover damage to left front and left rear doors

The case vehicle's left side wheelbase was unaltered while the right side wheelbase was shortened 2 centimeters (0.8 inches). Induced damaged involved the roof, left rear door, left quarter panel, left fender, front bumper fascia, right quarter panel and the trunk lid. In addition, the backlight was broken out.

The case vehicle's recommended tire size was: P205/60R16, and the vehicle was equipped with tires of this size. The case vehicle's tire data are shown in the table below. The right front wheel was not present at the inspection. A spare tire had been mounted in its place.

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kpa	psi	kpa	psi	milli-meters	32nd of an inch			
LF	200	29	221	32	7	9	No damage, but grass in bead	No	No
RF	0	0	221	32	?	?	Police photos show bead broken, tire flat	No	Yes
LR	193	28	207	30	7	9	None	No	No
RR	0	0	207	30	7	9	Bead broken	No	Yes

Vehicle Interior: Inspection of the case vehicle's interior (**Figure 10**) revealed some reddish brown scuff marks on the roof nap along the left roof side rail just below the grab handle. These marks appeared to be possible makeup transfers from the driver. In addition, there were several scuff marks on the left side curtain air bag oriented in a line with the scuff mark on the roof side rail. The driver also loaded her lap-and-shoulder safety belt. The safety belt webbing would not retract at the time of inspection indicating actuation of the pretensioner. There was intrusion of the left roof side rail, roof and left C-pillar. The most severe intrusion involved the roof. It intruded vertically 16 centimeters (6.3 inches) into the back left seating position. Lastly, there was no evidence of deformation of the steering wheel or energy absorbing steering column (**Figure 11** below).

Figure 10: Overview of driver's door, steering wheel , left instrument panel and left portion of windshield, arrow shows reddish brown scuff mark on roof side rail.

Damage Classification: Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **00-TDDO-3**. No reconstruction program was used on this crash because

rollover's are out-of-scope for the WinSMASH reconstruction program. Based on the extent of roof crush, the rollover crash severity was determined to be moderate. The case vehicle was towed due to damage.

ROLLOVER SPEED RECONSTRUCTION

A range of speeds at rollover initiation was calculated for the case vehicle using the approximate rollover distance and a range of rollover deceleration values from the reconstruction literature. The reconstructed speed range at rollover initiation was approximately 31 to 39 km.p.h. (19 to 24 m.p.h.). The time duration during the rollover was approximately 2.4 to 1.9 seconds. The average rotational velocity of the case vehicle during the rollover was approximately 150 to 189 degrees/second.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with certified advanced 208-compliant front air bags at the driver and front right passenger positions. Neither of these air bags deployed in this crash. The case vehicle was also equipped with side curtain air bags and front seat back-mounted side impact air bags. The left side curtain air bag and the driver's seat back-mounted side impact air bags deployed as a result of the crash.

Figure 12: Driver's seat back mounted side impact air bag

The driver's seat back-mounted side impact air bag (**Figure 12**)was located in the left side of the driver's seat back (**Figure 13**). The deployed side impact air bag was approximately oval in shape and was constructed with a fabric loop on its leading edge that was separated from the body of the air bag by stitching. The dimensions of the air bag were approximately 30 centimeters (11.8 inches) in height and 26 centimeters (10.2 inches) in width. The air bag was designed without tethers and had two small holes in the upper and lower portions of the air bag. These holes were not vent ports. They were sections of the air bag where both side were stitched together. It appeared they were designed to control the width of the air bag during inflation. Each hole was 5 millimeters (0.2 inch) in diameter, and the diameter of the circular stitching was 6

Figure 13: Opening in driver's seat back for the side impact air bag

centimeters (2.4 inches). There was no module flap on the side of the seat back. The air bag deployed through a tear-seam in the side of the seat back. There was no evidence of damage to the air bag, but there were some yellowish discolorations on both the inboard and outboard sides of the air bag, which appeared to be moisture stains.

The left side curtain air bag was located along the left roof side rail, inside the head liner. The air bag extended along the roof side rail from the middle of the left A-pillar, across the front left and back left seat positions to the top of the left C-pillar (**Figures 14** and **15**). The left side curtain air bag was approximately 170 centimeters (67 inches) in length and 40 centimeters (15.7 inches) in height. It was constructed with three main inflation chambers, two at the driver's head area and one at the left rear passenger's head area. Each of these chambers had a 2 centimeter (0.80 inches) circular opening through the center surrounded by double circular stitching 6 centimeters (2.4 inches) in diameter that extended through both inboard and outboard sides of the air bag. Based on crash test videos, this appears to aid in shaping the air bag during inflation and to control the width of the air bag during deployment. While there were no obvious vent ports, the perimeter stitching of the front and rear inflation chambers did not meet. There was an opening approximately 4 centimeters (1.8 inches) wide, presumably to allow the inflation gases to escape the inflation chambers. Several scuff marks were observed on the side curtain air bag adjacent to the driver's seated position (**Figure 14**). They were oriented in a line below the probable driver's head contact mark on the roof side rail.

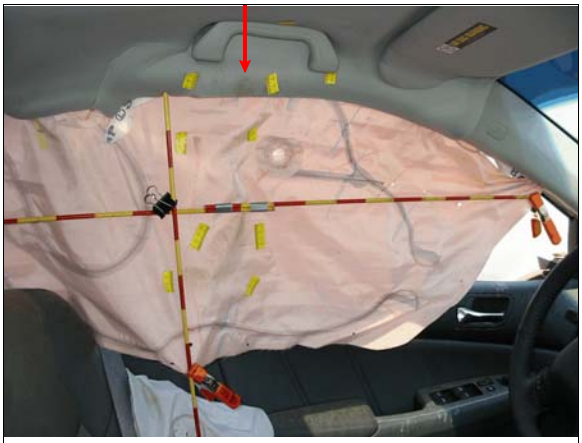


Figure 14: Driver's side curtain air bag, yellow tape shows areas of probable driver contact, arrow shows probable driver head contact on roof rail

Figure 15: Back left passenger, side curtain air bag

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash the case vehicle's driver [56-year-old, White (non-Hispanic) female, 168 centimeters and 66 kilograms (66 inches, 145 pounds)] was seated in an upright posture with her back against the seat back, both hands on the steering wheel, her left foot on the floor and her right foot on the brake. Her seat was located in its middle track position, and the seat back was slightly reclined. The steering column was adjusted to its center position. The driver was wearing glasses at the time of the crash.

Based on this contractor's vehicle inspection, the case vehicle's driver was restrained by her manual, three-point, lap-and-shoulder safety belt system. The upper anchor was adjusted to its full up position. The safety belt system was equipped with a retractor-mounted pretensioner housed within the "B"-pillar. Inspection of the safety belt assembly revealed that the pretensioner had activated indicating that the driver was using the restraint system. The front right safety belt pretensioner did not activate.

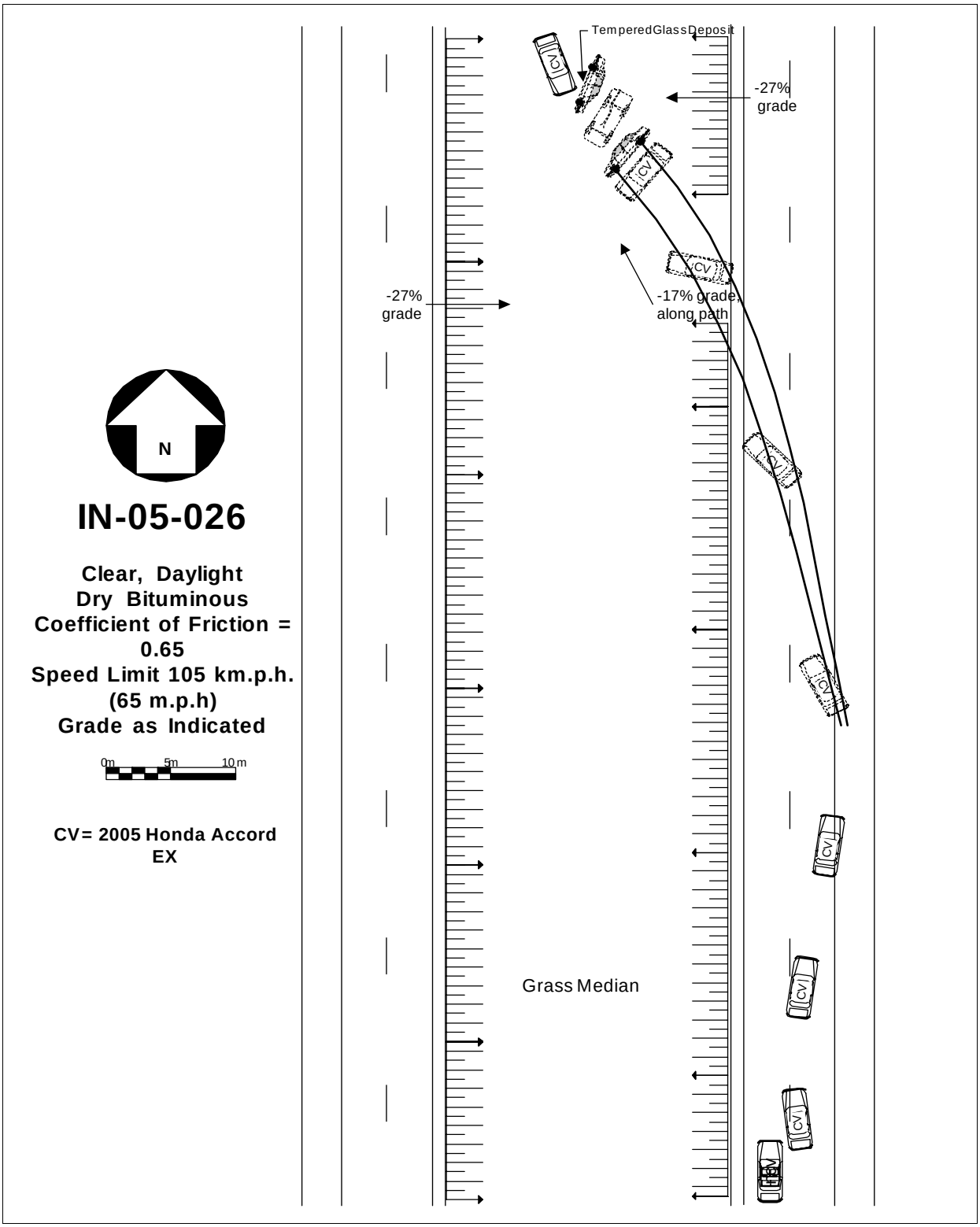
The case vehicle driver's left steer following the right side roadway departure caused the case vehicle to rotate counterclockwise and most likely locked the driver's safety belt retractor. As the case vehicle rotated counterclockwise across both northbound lanes, the driver most likely moved to the right within her seat and safety belt. As the case vehicle's rotation increased, the case vehicle entered the median, the right side tires furrowed into the ground, and the case vehicle began to rollover passenger side leading. As the case vehicle rolled over, the driver continued to move to the right and toward the roof and continued loading her safety belt. The driver then moved left and toward the roof as the case vehicle impacted the left roof side rail and "C"-pillar on the ground. The impact caused the driver's seat back-mounted side impact air bag and left side curtain air bag to deploy. She loaded her safety belt system causing contusions to her abdomen and ribs, and her left upper arm and left flank impacted the deployed side impact air bag abrading her arm and flank. Her head also impacted the deployed side curtain air bag and then the left roof side rail causing a scalp contusion and cervical strain. As the case vehicle completed its forth quarter roll and returned to it's wheels, the driver most likely moved off the left side and back to the right before settling back into the her seat. The driver exited the vehicle under her own power following the crash.

CASE VEHICLE DRIVER INJURIES

The case vehicle's driver sustained a police reported "C" (possible) injury and was transported by ambulance to a local hospital. She was treated and released from the emergency room. The driver reported that she received follow-up treatment for neck and back pain. The driver had not yet returned to work at the time of her interview. The case vehicle driver's injuries and injury mechanisms are presented in the following table.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion {hematoma} scalp, not further specified	minor 190402.1,9	Roof, left front side rail	Probable	Emergency room records
2	Strain, cervical, acute, with complications of degenerative disc disease and end plate spurring with canal and foraminal narrowing between C_4-C_5 through C_6-C_7	minor 640278.1,6	Roof, left front side rail	Probable	Emergency room records

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
3	Contusion, ribs, multiple, not further specified	minor 450202.1,9	Torso portion of safety belt system	Possible	Emergency room records
4	Abrasion left flank, not further specified	minor 590202.1,2	Air bag, driver's side impact	Probable	Emergency room records
5	Contusion abdomen, not further specified	minor 590402.1,9	Lap portion of safety belt system	Possible	Emergency room records
6	Abrasion left upper arm, not further specified	minor 790202.1,2	Air bag, driver's side impact	Probable	Emergency room records


N
IN-05-026
Clear, Daylight
Dry Bituminous
Coefficient of Friction = 0.65
Speed Limit 105 km.p.h. (65 m.p.h)
Grade as Indicated
0m
5m
10 m
CV= 2005 Honda Accord EX
TemperedGlassDeposit
-27% grade
-27% grade
-17% grade along path
Grass Median
CV
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