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ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE INVESTIGATION

CASE NUMBER - IN-05-032
LOCATION - ARKANSAS
VEHICLE - 2005 HONDA ACCORD EX
CRASH DATE - August 2005

Submitted:

May 14, 2006
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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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15. *Supplementary Notes* On-site air bag investigation involving a 2005 Honda Accord with manual safety belts and dual front certified advanced 208-compliant 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 impacted a metal fence, the roadway pavement and two trees. 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, and the case vehicles' driver (45 year-old, female) did not sustain any police reported injuries as a result of the crash. The case vehicle was traveling east on a two-lane county roadway in a right curve at a driver estimated speed of approximately 72 km.p.h. (45 m.p.h.). The driver stated she fell asleep. The case vehicle departed the north side of the roadway and entered a ditch. The driver steered right in an attempt to avoid the crash, and the case vehicle's left rear wheel and quarter panel sideswiped a metal fence post. The case vehicle then traveled back through the ditch and became airborne as it reentered the roadway. The vehicle's front undercarriage bottomed-out and gouged the roadway as it touched down in the eastbound lane. The case vehicle then departed the south side of the roadway. The front right impacted a tree causing the driver's air bag to deploy. The case vehicle's right fender and right front wheel then immediately sideswiped a second tree. The case vehicle traveled a short distance and came to rest facing southeast. Just prior to the tree impact, the driver was seated in an upright position with both hands on the steering wheel. Her seat track was adjusted to its middle position, the seat back was slightly reclined, the tilt steering column was adjusted to between its center and full up position, and she was restrained by her three-point, lap-and-shoulder safety belt system. As a result of the tree impact, the driver loaded her safety belt system and her face, upper chest and both arms contacted her deployed air bag. In addition, her right hand impacted and broke off the rearview mirror. The driver was transported to a medical clinic by private vehicle and treated and released. She sustained a laceration (i.e., scratch) and two contusions on her arms from the air bag and fractured her right little finger on the rearview mirror.			
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TABLE OF CONTENTS

Page No.

This investigation was brought to NHTSA's attention on or about September 20, 2005 by the Nationwide Insurance Company. This crash involved a 2005 Honda Accord EX (case vehicle) that ran-off-road and impacted a metal fence, the roadway pavement and two trees. The crash occurred in August, 2005, at 8:39 a.m., in Arkansas and was investigated by the county sheriff's 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 an Event Data Recorder (EDR) and the case vehicle's driver [45-year-old, White (non-Hispanic) female] did not sustain any police reported injury as a result of the crash. This contractor inspected the case vehicle and the scene on October 5, 2005. The case vehicle's driver was interviewed on October 17, 2005. In addition, what was thought to be the air bag Electronic Control Unit (ECU), which contains the EDR, was harvested from the case vehicle and sent to Washington D.C. for subsequent transfer to the manufacturer and download of the EDR data. However, the harvested unit was not the ECU, so no EDR data was obtained from the case vehicle. This report is based on the police crash report, scene and vehicle inspections, driver interview, occupant kinematic principles and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling east on a two-lane county roadway in a right curve at a driver estimated speed of approximately 72 km.p.h. (45 m.p.h.). The driver stated she fell asleep. The case vehicle departed the north side of the roadway and entered a ditch. The driver steered right in an attempt to avoid the crash, and the case vehicle's left rear wheel and quarter panel sideswiped a metal fence post. The case vehicle then traveled back through the ditch and became airborne as it reentered the roadway. The vehicle's front undercarriage bottomed-out and gouged the roadway as it touched down in the eastbound lane. The case vehicle then departed the south side of the roadway, traveled through a shallow ditch, and the front right impacted a tree uprooting it and causing the driver's air bag to deploy. The case vehicle's right fender and right front wheel then immediately sideswiped a second tree. The case vehicle traveled a short distance and came to rest facing southeast.

The CDCs for the case vehicle were determined to be: **12-LBES-1** (**0** degrees) for the sideswipe impact to the metal fence post, **00-UFDN-1** for the undercarriage impact, **12-FREN-1** (**0** degrees) for the first tree impact and **12-RFES-1** (**0** degrees) for the right front wheel and right fender impact to the second tree. The maximum residual bumper crush due to the first tree impact was 19 centimeters (7.5 inches).

The WinSMASH reconstruction program could not be used to reconstruct the case vehicle's Delta V from to the first tree impact because the tree was uprooted. Yielding object impacts are out-of-scope for the program. However, the WinSMASH program, barrier algorithm was used to determine a Barrier Equivalent Speed (BES) for the first tree impact based on the damage to the front bumper. The BES was calculated as: 16.9 km.p.h. (10.5 m.p.h). Based on the damage to the case vehicle the BES appeared to be low. 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 both hands on the steering wheel, her right foot on the accelerator and her left foot on the floor. The driver's seat track was located in the middle position, her seat back was slightly reclined and the tilt steering column was adjusted to between its center and full-up position. The driver was restrained by her manual, three-point, lap-and-shoulder safety belt system.

Following the fence impact and after reentering the roadway, the driver was still seated upright in her seat and was bracing for the impact as the case vehicle departed the south side of the roadway and approached the trees. The case vehicle's front impact with the first tree caused the driver to continue forward opposite the case vehicle's 0 degree direction of principal force as the case vehicle decelerated. She loaded her safety belt and her face, upper chest and both arms contacted her deployed air bag. The contact with the air bag caused a 25 to 30 centimeters (10 to 12 inches) long contusion and 12.7 centimeters (5 inches) long laceration (i.e., scratch) on the inside of her right forearm, as well as a 10 centimeter (4 inch) diameter contusion on the inside of her left wrist. The driver's right arm continued forward and upward off the air bag, and her right hand impacted the rearview mirror and broke it off the windshield. The driver sustained a fracture of her right little finger due to this contact. She also complained of neck, back and shoulder pain due to the crash. The driver remained restrained in her seat as the case vehicle continued forward, sideswiped the second tree and came to final rest. The driver stated she was able to exit the vehicle under her own power following the crash. She was taken to a local medical clinic in a private vehicle and was treated and released. The driver's use of her three-point, lap-and-shoulder safety belt and the deployment of her air bag mitigated her interaction with the steering wheel and instrument panel and reduced her injury potential.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the case vehicle was traveling was a curved, two-lane county roadway traversing in an east and west direction (**Figure 1**). Each travel lane was 3.2 meters (10.5 feet) in width. The roadway was bordered by shallow ditches on each side. The ditch on the south side of the roadway was approximately 3.5 meters (11.5 feet) in width while the ditch on the north side of the roadway was approximately 4.5 meters (14.8 feet) in width. A metal farm fence was located adjacent to the ditch on the north side of the roadway. A woods was adjacent to the ditch on the south side of the roadway. The case vehicle's approach to the crash location was controlled by double yellow no-passing lines, and the speed limit was 72 km.p.h. (45 m.p.h.). At the time of the crash the light condition was daylight, the weather was clear, the roadway pavement was dry bituminous and the roadway had an approximate positive 4% grade on the case vehicle's approach. Traffic density was light and the site of the crash was rural residential.

Figure 1: Approach of case vehicle eastbound to area of left side roadway departure

Pre-Crash: The case vehicle was traveling east in a right curve at a driver estimated speed of approximately 72 km.p.h. (45 m.p.h.). The driver was on her way home and was intending to continue eastbound. The driver stated she fell asleep. The case vehicle departed the north side of the roadway and entered a ditch. The driver steered right in an attempt to avoid the impact with the fence. The first impact occurred on the north side of the roadway with a metal farm fence.

Figure 2: Overview of damage to left quarter panel (arrows) due to impact with metal fence

Crash: Following the driver's right steer, the case vehicle's left rear wheel and quarter panel (**Figure 2**) sideswiped a metal fence post (**Figure 3**). The case vehicle then traveled back through the ditch and up the front slope of the ditch (**Figure 4**) and became airborne as it reentered the roadway. The vehicle's front undercarriage bottomed-out and gouged the roadway (**Figure 5** below) as it touched down in the eastbound lane. The case vehicle then departed the south side of the roadway, traveled through a shallow ditch, and the front right (**Figure 6** below) impacted a tree (**Figure 7** below) causing the driver's air bag to deploy. The case vehicle's right fender and right front wheel then immediately sideswiped a second tree. The front right air bag did not deploy in this crash because there was no front right passenger seated in the case vehicle at the time of the crash. The case vehicle's advanced occupant protection system properly determined the absence of a front passenger and suppressed deployment of the front right passenger air bag.

Figure 3: Overview of ditch and metal fence sideswiped by case vehicle

Post-Crash: The case vehicle did not appear to have rotated due to the tree impacts. It uprooted the first impacted tree, traveled a short distance and came to rest facing southeast (**Figure 7** below).

Figure 4: Area where case vehicle became airborne and reentered roadway, arrow shows gouges in roadway

The 2005 Honda Accord EX was a four-door, front wheel drive sedan (VIN: 1HGCM66575A------) equipped with a V-6 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, dual stage driver and front right passenger air bags, a front right passenger occupant detection system, seat back-mounted side impact air bags, side curtain air bags and driver and front right passenger manual, three-point, lap-and-shoulder safety belts with adjustable upper anchors and retractor mounted safety belt pretensioners with safety belt usage sensors. The front right passenger seat was also equipped with an "Occupant Position Detection System" (OPDS). The back seating row was equipped with a bench seat with adjustable head restraints in the outboard seat position; manual, three-point, lap-and-shoulder safety belts in all three back 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 (109.9 inches). The odometer reading at the time of the inspection is unknown because the case vehicle was equipped with an electronic odometer. However, the driver estimated the mileage was 28,967 kilometers (18,000 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, and 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.

Figure 5: Gouges in roadway (three white circles in foreground) where case vehicle touched down, arrow shows area of tree impacts

Figure 6: Overview of damage to front of case vehicle due to tree impact

Figure 7: Case vehicle's impact to trees, arrow shows right front wheel damage to large tree, front impacted and uprooted tree on left. Increments on tape measure are in tenths of meter

Exterior Damage: The case vehicle's impact with the metal fence involved the left quarter panel and left rear wheel. The direct quarter panel damage began 21 centimeters (8.3 inches) rear of the left rear axle and extended rearward 76 centimeters (29.9 inches). Maximum residual crush was approximately 2 centimeters (0.8 inch) occurring at C_3. The direct damage also involved the rim flange of the left rear wheel, and red paint transfer from a fence post was observed on the flange and sidewall of the tire. The case vehicle's first tree impact involved the right portion of the front bumper, grille and hood. These components were directly damaged and crushed rearward. Direct damage began 26 centimeters (10.2 inches) left of the front right bumper corner and extended 36 centimeters (14.1 inches) along the bumper. Crush measurements were taken at the bumper bar. The maximum residual crush was measured as 19 centimeters (7.5 inches) occurring 14 centimeters (5.5 inches) left of C_6 (**Figure 8**). The case vehicle's second tree impact involved the right front wheel and most likely the right fender (the right fender had been removed from the case vehicle and was not inspected). The sidewall was cut and wood was jammed in the tire bead. The first table below shows the case vehicle's crush profile for the fence impact. The second table below shows the case vehicle's crush profile for the first tree impact.

Figure 8: Top view of front crush, measurements taken to bumper bar, front bumper cover was off vehicle, each increment on rods in 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	76	2	97	0	1	2	2	2	1	-199	-186
in		29.9	0.8	38.2	0.0	0.4	0.8	0.8	0.8	0.4	-78.3	-73.2

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	3	36	19	114	0	4	5	9	15	0	42	0
in		14.2	7.5	44.9	0.0	1.6	2.0	3.5	5.9	0.0	16.5	0.0

The right side wheelbase was reduced 3 centimeters (1.2 inches) while the left side wheelbase was unchanged. Induced damage involved the front bumper, grille, hood and left quarter panel. Induced damaged also involved the radiator and most likely the right fender.

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.

Tire	*Measured Pressure*		*Recommended Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kpa	psi	kpa	psi	milli-meters	32nd of an inch			
LF	241	35	234	34	5	6	No damage but grass in bead	No	No
RF	0	0	248	36	5	6	Wood in bead, two cuts in sidewall	No	No
LR	234	34	269	39	4	5	Scuff on sidewall, abrasion on rim flange	No	No
RR	234	34	241	35	4	5	None	No	No

Vehicle Interior: Inspection of the case vehicle's interior (**Figure 9**) revealed that the rearview mirror was broken off its mount. The mirror was cracked and there was a scuff on the left edge of the mirror frame. No other evidence of occupant contact to any interior surfaces or components was observed. There was no intrusion of the passenger compartment, no evidence of compression of the energy absorbing steering column, and no deformation of the steering wheel rim (**Figure 10**).

Figure 9: Overview of steering wheel, instrument panel and windshield

Figure 10: Right side view of steering wheel and steering column showing lack of deformation

Damage Classification: Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **12-LBES-1** (**0**-degrees) for the sideswipe impact to the metal fence post, **00-UFDN-1** for the undercarriage impact, **12-FREN-1** (**0** degrees) for the first tree impact and **12-RFES-1** (**0** degrees) for the right front wheel and right fender impact to the second tree.

The WinSMASH reconstruction program could not be used to reconstruct the case vehicle's Delta V from to the first tree impact because the tree was uprooted. Yielding object impacts are out-of-scope for the program. However, the WinSMASH program, barrier algorithm was used to determine a Barrier Equivalent Speed (BES) based on the damage to the front bumper. The BES was calculated as: 16.9 km.p.h. (10.5 m.p.h). Based on the damage to the case vehicle the BES appeared to be low. The case vehicle was towed due to damage.

Figure 11: Case vehicle driver's air bag module cover flaps

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with certified advanced 208-compliant air bags at the driver and front right passenger positions, as well as front seat back-mounted side impact air bags and side curtain air bag. The driver's air bag deployed as a result of the case vehicle's first tree impact. The front right passenger's air bag did not deploy in this crash. In addition, the seat back-mounted side impact air bags and side curtain air bags did not deploy in this crash.

Figure 12: Case vehicle's driver air bag

The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module cover flaps (**Figure 11**) 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; however, a few scuffs were observed on the air bag that appeared related to the deployment. The module cover consisted of two asymmetrical flaps made of pliable vinyl. The top flap was approximately rectangle in shape with a manufacturer's emblem located in the center of the flap. A portion of the emblem, which was also approximately rectangular-shaped, extended from the bottom of the flap and fit into a cut-out at the center top of the bottom flap. The upper flap was 13.5 centimeters (5.3 inches) in width and 6 centimeters (2.4 inches) in height. The lower flap was approximately hexagonal-shaped and was

Figure 13: Arrows show case vehicle's driver air bag vent ports

13.5 centimeters (5.3 inches) in width and 6 centimeters (2.4 inches) in height. The deployed driver's air bag (**Figure 12**) was round with a diameter of approximately 59 centimeters (23.2 inches). The air bag was designed with two tethers, each approximately 7 centimeters (2.8 inches) in width and had two vent ports (**Figure 13** above), each approximately 5 centimeters (2 inches) in diameter, located near the center of the air bag at the approximate 10 and 2 o'clock positions. The distance between the mid-center of the driver's seat back, as positioned at the time of the vehicle inspection (i.e., seat at middle track position, seat back slightly reclined), and the front surface of the air bag's fabric at approximate full excursion was approximately 39 centimeters (15.4 inches).

Figure 14: Overview of instrument panel, front right passenger air bag located in top of right instrument panel

The front right passenger air bag was located in the top of the instrument panel (**Figure 14** below). 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 passenger in the case vehicle at the time of the crash. In addition, the seat back-mounted side impact air bags and side curtain air bags did not deploy because there was no side impact severe enough to require their deployment.

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash, the case vehicle's driver [45-year-old, White (non-Hispanic) female; 173 centimeters and 82 kilograms (68 inches, 180 pounds)] had fallen asleep. The driver recalls that when she woke up, as the vehicle was departing the roadway, she was seated in an upright position with both hands on the steering wheel, her right foot on the accelerator and her left foot on the floor. The driver's seat track was located in the middle position and her seat back was slightly reclined. The tilt steering column was adjusted to between its center and full-up position.

The driver stated she was restrained by her manual, three-point, lap-and-shoulder safety belt system. The evidence observed during the vehicle inspection supported the driver's statement. While the inspection of the safety belt assembly revealed no evidence of loading, the safety belt pretensioner had activated indicating the safety belt was buckled.

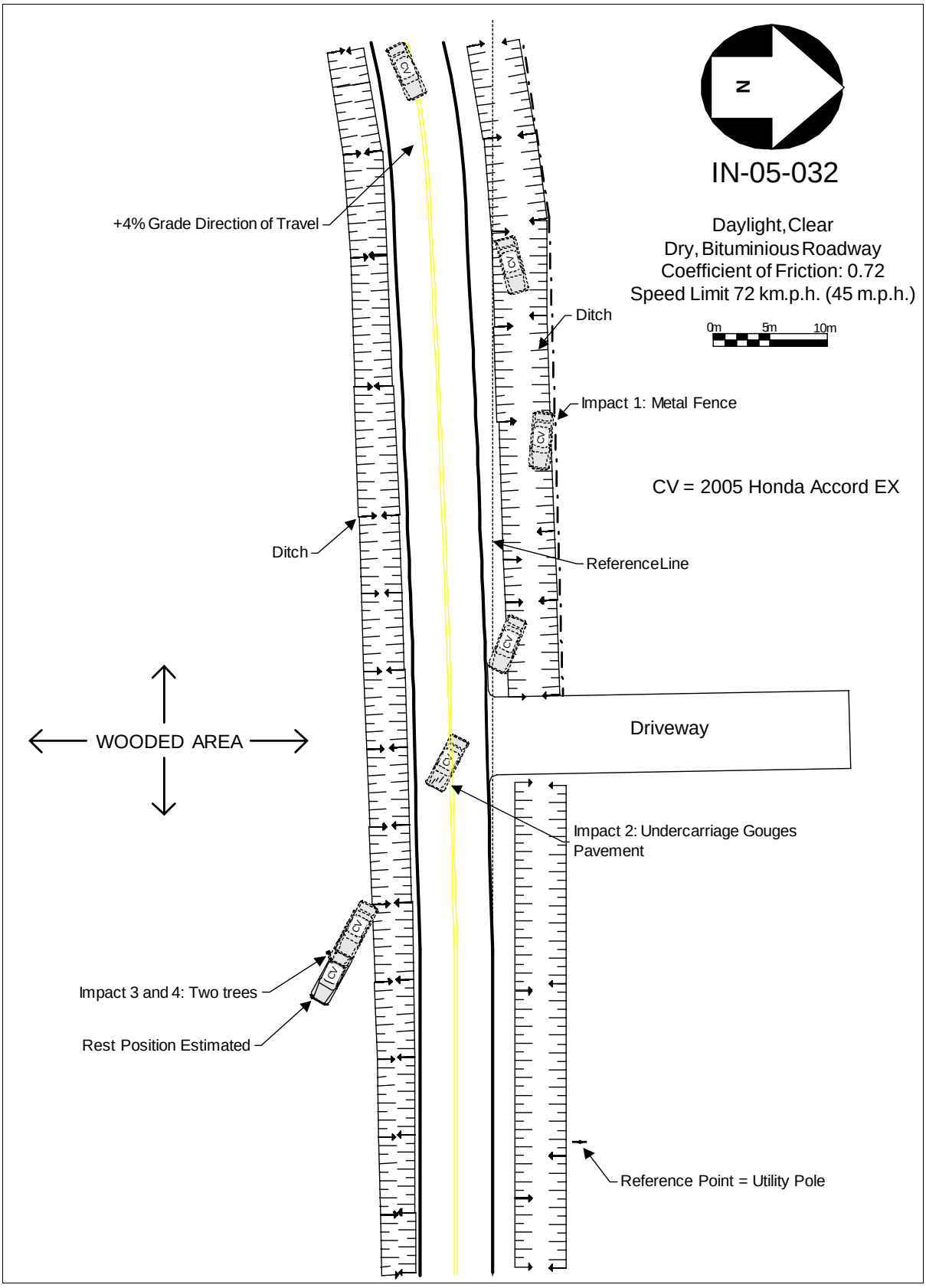
As the case vehicle departed the north side of the roadway and entered the ditch, the driver's safety belt retractor most likely locked. The driver's right steer maneuver caused her to move slightly to the left. The driver's seating position did not change due to the sideswipe impact with the left quarter panel, and she most likely moved down in her seat as the case vehicle traveled up the front slope of the ditch, became airborne and reentered the roadway. The driver moved down into her seat cushion and forward as the front undercarriage bottomed out on the roadway as the

vehicle touched down. The driver was still seated upright in her seat and bracing for the impact as the case vehicle departed the south side of the roadway and approached the tree impacts. The driver stated she did not apply the brakes prior to the impact. The case vehicle's front impact with the first tree caused the driver to continue forward opposite the case vehicle's 0 degree direction of principal force as the case vehicle decelerated. She loaded her safety belt and her face, upper chest and both arms contacted her deployed air bag. The contact with the air bag caused a 25 to 30 centimeters (10 to 12 inches) long contusion and 12.7 centimeters (5 inches) long laceration (i.e., scratch) on the inside of her right forearm, as well as a 10 centimeter (4 inch) diameter contusion on the inside of her left wrist. The driver's right arm continued forward and upward off the air bag, and her right hand impacted the rearview mirror and broke it off the windshield. The driver sustained a fracture of her right little finger due to this contact. She also complained of neck, back and shoulder pain due to the crash. The driver remained restrained in her seat as the case vehicle continued forward and the right fender and right front wheel sideswiped the second tree, and the case vehicle came to final rest. The driver stated she was able to exit the vehicle under her own power following the crash. The driver's use of her three-point, lap-and-shoulder safety belt and the deployment of her air bag mitigated her interaction with the steering wheel and instrument panel and reduced her injury potential.

CASE VEHICLE DRIVER INJURIES

The driver sustained no police reported injury as a result of the crash; however, she was transported to a local medical clinic subsequent to the crash in a private vehicle. She was treated at the clinic and released. The driver received one follow-up visit to her doctor. No additional injuries were identified. The driver stated that she lost no work days as a result of the crash. The table below shows the driver'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	Fracture, small, right 5th phalanx {digit}, not further specified	minor 752404.1,1	Rearview mirror	Probable	Interviewee (same person)
	Pain, neck, shoulder, back, not further specified	Not coded			Interviewee (same person)
2	Contusions {bruise} on inside of right arm, 25.4 to 30.5 cm (10-12 in) **and** near inside of left wrist, 10.2 cm (4 in)	minor 790402.1,3	Air bag, driver's	Probable	Interviewee (same person)
3	Laceration {scratch}, 12.7 cm (5 in) on inside of right arm from elbow	minor 790602.1,1	Air bag, driver's	Probable	Interviewee (same person)


N
IN-05-032
Daylight, Clear
Dry, Bituminious Roadway
Coefficient of Friction: 0.72
Speed Limit 72 km.p.h. (45 m.p.h.)
0m 5m 10m
+4% Grade Direction of Travel
Ditch
Impact 1: Metal Fence
CV = 2005 Honda Accord EX
Ditch
Reference Line
WOODED AREA
Driveway
Impact 2: Undercarriage Gouges Pavement
Impact 3 and 4: Two trees
Rest Position Estimated
Reference Point = Utility Pole