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ON-SITE REDESIGNED AIR BAG REPORT

CASE NUMBER - IN97-065
LOCATION - TEXAS
VEHICLE - 1998 HONDA ACCORD EX
CRASH DATE - December, 1997

Submitted:

September 16, 1998

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Contract Number: DTNH22-94-D-17058

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National Highway Traffic Safety Administration
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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 deployment investigation involving a 1998 Honda Accord EX, four-door sedan, equipped with manual belts and dual front air bags, which impacted three trees, a wall, and a utility pole			
16. *Abstract* This report covers an on-site investigation of an air bag deployment crash that involved a 1998 Honda Accord EX (case vehicle) and three trees, a noise abatement wall, and a wooden utility pole. This crash is of special interest because the case vehicle was equipped with redesigned air bags that deployed as a result of the crash events, and the vehicle's restrained driver (34-year-old male) sustained only moderate injuries during the crash. The case vehicle was traveling north on a one-lane, one-way, urban tollway exit ramp. As the case vehicle entered the exit ramp from the tollway, the roadway curved to the right. The case vehicle came close to or struck the barrier curb along the ramp's west side; either way, the driver over corrected to the right, steering the case vehicle into a clockwise yaw. The yaw increased as the case vehicle diagonally crossed the ramp's entire width and exited the roadway onto the east roadside where the crash occurred. The case vehicle had rotated approximately 75 degrees clockwise when the left side impacted a tree [9 centimeter (3.5 inch) diameter] in the left front door (impact #1). The case vehicle continued ahead and struck a second tree [27 centimeter (10.6 inch) diameter] with its front (impact #2), causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. This second impact increased the case vehicle's clockwise rotation. Almost instantaneously, a third tree [10 centimeter (3.9 inch) diameter] was impacted by the left front door (impact #3). The case vehicle continued its clockwise rotation until it struck a brick noise abatement wall with its left quarter panel (impact #4) and began traveling backwards (i.e., the case vehicle had rotated approximately 165 degrees from its initial travel path), scraping the wall for approximately 6 meters (19.7 feet). The case vehicle continued its backwards trajectory for another 11 meters (36.1 feet) and struck a 30 centimeter (11.8 inch) wooden utility pole with its back bumper (impact #5). The case vehicle's driver was seated with his seat track located between its middle and rearmost positions, and the tilt steering wheel was located in its middle position. He was restrained by his available, active, three-point, lap and shoulder belt and sustained, according to his interview, moderate injuries which included: a blunt head injury with loss of consciousness, two left rib fractures, a fractured left clavicle, and a lacerated forehead on the right side.			
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BACKGROUND

IN97-065

This on-site report was brought to NHTSA's attention on December 30, 1997, by CDS sampling activities. This crash involved a 1998 Honda Accord EX (case vehicle), three trees, a noise abatement wall, and a wooden utility pole. The crash occurred in December, 1997, at 1:27 a.m., in Texas, and was investigated by the applicable municipal police department. This crash is of special interest because the case vehicle was equipped with redesigned air bags and its driver (34-year-old male) allegedly sustained non-incapacitating injuries from his deploying driver air bag. This contractor's investigative consultant inspected the scene on March 4, 1998 and the case vehicle on January 5, 1998. The case vehicle's driver was interviewed on July 3, 1998. This report is based on the Police Crash Report, an interview with the case vehicle's driver, scene and vehicle inspections, occupant kinematic principles, and this contractor's evaluation of the evidence.

CRASH CIRCUMSTANCES

Figure 1: Case vehicle's northbound travel path on exit ramp; Note: white van on right is near crash scene (case photo #01)

The case vehicle was traveling north on a one-lane, one-way, urban tollway exit ramp, and intended to continue exiting the tollway in a northerly travel path. The exit ramp was estimated to be wide enough for two passenger vehicles, side-by-side, at its mouth, but it narrowed to a one-lane width as it merged with another ramp (**Figure 1**). A 15.2 centimeter (6.0 inch) concrete barrier curb was present on the west side of the ramp and a 0.9 meter (3.0 foot) asphalt shoulder on the east side. The pavement was concrete, with an estimated coefficient of friction of 0.60, wet. At the time of the crash the light condition was dark, but illuminated by overhead street lamps at the area of impact, the atmospheric condition was cloudy (no precipitation), and the road pavement was wet (i.e., it had been raining). The roadway was undivided. It initially curved to the right at the ramp's mouth, but began a slight left curve perpendicular to the tree impacts. The ramp had a negative slope that varied from -4.3% pre-crash to -2.2% between the tree impacts and the final rest position. There were no reported view obstructions, traffic controls, or roadway defects. It is not known if an advisory exit speed sign (W13-2 or W-13-3) was present on the tollway, somewhere along the exit ramp's deceleration lane, or if such a sign was present, what reduced speed was advised. The driver admitted to a pre-impact travel speed on the tollway in excess of 113 km.p.h. (70 m.p.h.), but has no memory of an impact speed. The posted speed limit on the tollway was 89 km.p.h. (55 m.p.h.).

Figure 2: Case vehicle deposited clockwise yaw marks leaving roadway; Note: center cone shows first impact, right cone shows second impact, and left cone shows third impact (case photo #04)

As the case vehicle entered the exit ramp from the tollway, the ramp curved to the right. The case vehicle's driver reportedly has no memory of the crash sequence and is unsure if he made any avoidance maneuvers prior to the crash. Available evidence suggests that the case vehicle most likely came close to or struck the barrier curb along the ramp's west side; either way, the driver over corrected to the right, steering the case vehicle into a clockwise yaw (**Figure 2** above). The yaw increased as the case vehicle diagonally crossed the ramp's entire width and exited the east side of the roadway. The crash occurred on the east roadside of the tollway exit ramp.

The case vehicle had rotated approximately 75 degrees clockwise when the left side impacted a 9 centimeter (3.5 inch) diameter tree immediately rearward of the left front door's forward door seam (impact #1, **Figure 3**). As a result of the initial impact, the case vehicle's rotation was likely unaffected prior to impacting a second tree, but its side-to-side stability was disrupted as the overridden trunk of the first tree caused the case vehicle to tilt slightly–with the leading left side marginally lower than the right side.

Figure 3: Case vehicle's damaged left front door from first impact; Note: contact near forward seam of door panel and on "A" pillar (case photo #25)

The second tree, with a 27 centimeter (10.6 inch) diameter, was impacted by the front of the case vehicle (impact #2, **Figure 4**), causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. This contact with the largest of the three impacted trees (i.e., second impact) resulted in the case vehicle continuing its clockwise rotation, with the degree of clockwise rotation increasing. Almost instantaneously, a third tree, with a 10 centimeter (3.9 inch) diameter, was impacted by the center of the case vehicle's left front door (impact #3, see **SELECTED PHOTOGRAPHS**, **Figure 13** below). The case vehicle continued its clockwise rotation until it struck the brick, noise abatement wall (impact #4, see **SELECTED PHOTOGRAPHS**, **Figures 14** and **15** below) with the rear portion of its left quarter panel and, almost simultaneously, it began traveling backwards (i.e., the case vehicle had rotated approximately 165 degrees from its initial path of travel down the exit ramp), scraping the wall for approximately 6 meters (19.7 feet). The case vehicle's left side scraping damage extended forward from the back of the left quarter

Figure 4: Case vehicle's frontal damage from the second tree (deployment) impact (case photo #18)

panel to the rear seam of the left front door (impact #4, see **SELECTED PHOTOGRAPHS**, **Figure 14** below). The case vehicle continued its backwards trajectory for another 11 meters (36.1 feet) and struck a 30 centimeter (11.8 inch), wooden utility pole with its back bumper (impact #5--the highest Delta V impact, **Figure 5**).

Figure 5: Case vehicle's back damage from utility pole (fifth) impact; Note: pole was highest Delta V impact (case photo #32)

CASE VEHICLE

The 1998 Honda Accord EX was a front wheel drive, five-passenger, four-door sedan (VIN: 1HGCG5656WA------) equipped with a 2.3 L, I-4, 16 valve VTEC engine and a four-speed automatic transmission with its shift lever located at the console. Braking was achieved by a power-assisted, front and rear disc system. Four wheel anti-lock brakes are an option for this model, but it is unknown if the case vehicle was so equipped. The case vehicle's wheelbase was 272 centimeters (106.9 inches), and the odometer reading at inspection is unknown because the case vehicle was equipped with an electronic odometer.

Inspection of the vehicle's interior revealed electronic window and door locks; adjustable front bucket seats; a non-adjustable rear bench seat; and three-point lap and shoulder belts at the front outboard positions and all three back seating positions. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a driver air bag and a front right passenger air bag. Both front seat air bags deployed as a result of the largest tree impact (impact #2 of the five in this crash sequence).

Figure 6: Case Vehicle's backlite and deck damage; Note: trunk lid intrusion into lower glazing (case photo #31)

The first of five impacts involved contact with a 9 centimeter (3.5 inch) diameter tree that creased the forward seam of the left front door from the left rocker panel to the lower third of the left "A" pillar. There was also a small 15.2 centimeter (6.0 inch) splintering of the windshield's left seam with the left "A" pillar and contact to the left outside rearview mirror (see **Figure 3** above). The second impact (air bag deployment, **Figure 4** above) occurred with a 27 centimeter (10.6 inch) diameter tree, largest of the three trees contacted. The second impact caused direct damage to the case vehicle's front bumper,

front splash guard, front grille, radiator and brackets, front right headlight/turn signal assembly, and the left half of the front hood. Direct damage began 30 centimeters (11.8 inches) right of the front left corner and extended right 58 centimeters (22.8 inches). The third impact occurred with a 10 centimeter (3.9 inch) diameter tree and dented the left rocker panel, the middle of the left front door, the top of the left front door window glass frame, and the left roof rail above the middle of the left front door (see **SELECTED PHOTOGRAPHS**, **Figure 13** below). Impact four involved a brick, noise abatement wall. The rear of the case vehicle's left quarter panel contacted the wall, and the vehicle began sliding backwards along the wall, damaging the left quarter panel, the back left taillight assembly, the left seam of the trunk lid, the rear seam of the left rear door, the rear seam of the left front door, the left rocker panel, and the left rear wheel and tire (see **SELECTED PHOTOGRAPHS**, **Figure 14** below). The highest Delta V impact (see **Figure 5** above) was the fifth, and last, of the five crash sequence impacts. The back of the case vehicle struck a wooden utility pole. Direct damaged components include the back bumper, the back left taillight assembly, the trunk lid, the trunk floor, the back deck rearward of the backlite, the lower frame of the backlite, and the back glazing (see **Figure 6** above). In addition, there was direct damage to the forward roof rail and front right corner of the roof from contact with tree limbs; it is unknown which of the three tree impacts caused this damage. Also, the window glazing from both left side doors was missing post-crash. Tree limbs or contact with the wall by the rear door seams of the left side doors are possible causes of the missing glazing. Indirect damage included the front corners of both front fenders and the back corners of both quarter panels. No undercarriage damage was documented by this contractor's investigative consultant.

Based on the vehicle inspection, the CDC for the highest severity impact (impact #5, wooden utility pole) was determined to be: **06-BCEW-6 (180)** [maximum crush was 87 centimeters (34.3 inches)]. A CDC for the second highest impact (impact #2, deployment impact and largest tree) was determined to be: **10-FDEW-2 (305)** [maximum crush was 27 centimeters (10.6 inches)]. The CDCs for the case vehicle's first, third, and fourth impacts were determined to be, respectively: **09-LPAN-2 (280)**, **09-LPAN-2 (270)**, and **07-LZEW-1 (220)**. The WinSMASH reconstruction program, barrier algorithm, was used for the highest and the second highest severity impacts sustained by the case vehicle during this five-impact crash sequence. The Total, Longitudinal, and Lateral Delta Vs for the highest severity impact are, respectively: 53.3 km.p.h. (33.1 m.p.h.), +53.3 km.p.h. (+33.1 m.p.h.), and 0 km.p.h. (0 m.p.h.); similarly, the totals for the second highest severity impact are, respectively: 18.7 km.p.h. (11.6 m.p.h.), -10.7 km.p.h. (-6.6 m.p.h.), and +15.4 km.p.h. (+9.6 m.p.h.). This contractor believes that the determined results for the deployment impact are low.

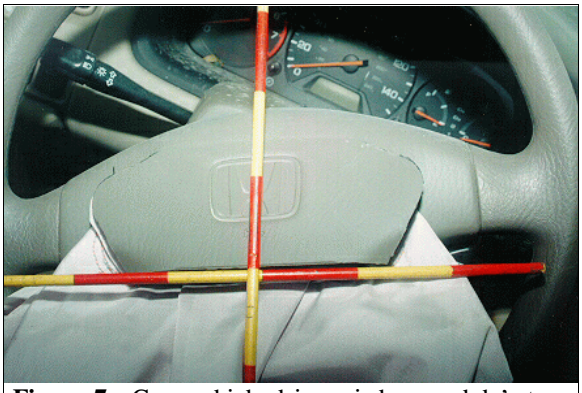

Figure 7: Case vehicle driver air bag module's top cover flap; Note: absence of occupant contact evidence (case photo 46)

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained frontal air bags at the driver and front right passenger positions. Both air bags deployed as a result of the frontal impact with the tree (i.e.,

second of five crash sequence impact). The case vehicle's driver air bag was located in the steering wheel hub. The module's seams were in an asymmetrical, "H" configuration, with the larger, top cover flap measuring 13 centimeters (5.1 inches) along the horizontal seam, 19 centimeters (7.5 inches) at its maximum width, and 7.6 centimeters (3.0 inches) at its maximum height (see **Figure 7** above). The smaller, lower cover flap measured 10 centimeters (3.9 inches) along the horizontal seam, 14 centimeters (5.5 inches) at its maximum width, and 4 centimeters (1.6 inches) at its maximum height (see **Figure 8**).

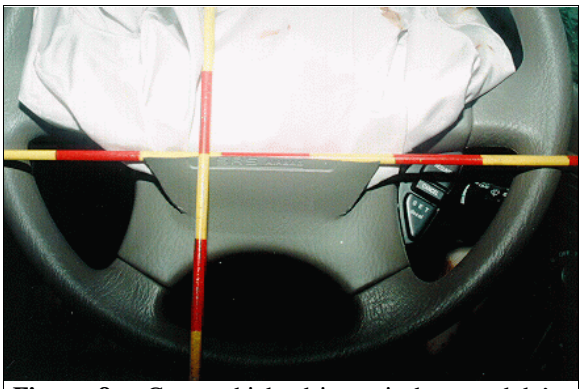

Figure 8: Case vehicle driver air bag module's bottom cover flap; Note: absence of occupant contact evidence (case photo #47)

An inspection of the air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with two cloth tethers, each 3 centimeters (1.2 inches) wide. The driver's air bag had two vent ports, approximately 4 centimeters (1.6 inches) in diameter, located at the 3 and 9 o'clock positions. The deployed driver's air bag was round with a diameter of 64 centimeters (25.2 inches). On the upper right quadrant of the air bag fabric (**Figure 9**) there was a possible cloth transfer located approximately 10.2 centimeters (4.0 inches) right of the longitudinal axis and 12.7 centimeters (5.0 inches) up from the lateral axis. In addition, there were three groups of blood stains: one at 15.2 centimeters (6.0 inches) right and 2.5 centimeters (1.0 inch) up, a second at 27.9 centimeters (11 inches) right and 5.1 centimeters (2.0 inches) up, and a third at 25.4 centimeters right (10.0 inches) and 12.7 centimeters (5.0 inches) up. On the lower right quadrant of the driver's air bag there was a blood stain centered at 17.8 centimeters (7.0 inches) right of the longitudinal axis and 2.5 centimeters (1.0 inches) down from the lateral axis. There was also a blood stain at the bottom of the fabric that straddled the longitudinal axis. On the reverse side of the driver's air bag (**Figure 10**), at the top (approximate 2 o'clock position), there was a blood stain on the seam. In addition, an unmeasured series of blood stains were located along the right vertical surface of the fabric, extending outwards from the circumferential seam.

Figure 9: Case vehicle's driver air bag; Note: blood stains and scuffs to right third of fabric (case photo #58)

Figure 10: Case vehicle's driver air bag; Note: blood stains on bottom, back side of fabric (case photo #64)

The front right passenger air bag also deployed on the case vehicle's second impact (i.e., with the largest of the three contacted trees). The front right passenger's air bag was located in the top of the instrument panel. The module cover consisted of slightly asymmetrical "H"-configuration cover flaps made of thick vinyl with overall dimensions of 26 centimeters (10.2 inches) at the horizontal seam and 4 centimeters (1.6 inches) vertically for the upper flap and 6 centimeters (2.4 inches) vertically for the lower flap. The profile of the case vehicle's instrument panel resulted in a 20 centimeter (7.9 inch) setback of the leading edge of the cover flap relative to the protruding right instrument panel. An inspection of the front right air bag module's cover flaps and air bag revealed that both the upper and lower cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. It is not known whether the top cover flap contacted the windshield. The front right passenger's air bag was designed without any tethers. The front right air bag had two vent ports, approximately 6 centimeters (2.4 inches) in diameter, located at the 3 and 9 o'clock positions. The deployed front right air bag was rectangular with a height of approximately 55 centimeters (21.7 inches) and a width of approximately 76 centimeters (29.9 inches). There was no evidence of occupant contact to the front right passenger air bag, but there were three blood splotches located at the top right quadrant of the fabric (**Figure 11**).

Figure 11: Case vehicle's front right passenger air bag; Note: three blood splatters on top right quadrant of the fabric (case photo #67)

Inspection of the case vehicle's interior revealed other evidence of the driver's contact on the interior surfaces. Specifically, there was a blood stain on the bottom of the steering wheel rim, a possible skin transfer on the upper right steering wheel spoke, a significant blood stain to the middle instrument panel just left of the stereo (see **SELECTED PHOTOGRAPHS**, **Figure 16** below), and blood and hair transfers within the spider web-shaped damage to the windshield's glazing above the steering wheel.

CASE VEHICLE OCCUPANT

Immediately prior to the crash, the case vehicle's driver [183 centimeters and 79 kilograms (72 inches, 175 pounds)] was seated upright with his back against the seat back, his left and right feet at undescribed locations, and both hands on the steering wheel. His seat track was located between its middle and rearmost positions, his seat back was upright, and the tilt steering wheel was located in its middle position.

The case vehicle's driver was restrained by his available, active, three-point, lap-and-shoulder safety belt system. There was, however, no reported evidence of belt pattern bruising and/or abrasions to his body. Inspection of his seat belt webbing, "D"-ring, and latch plate showed no reportable evidence of loading.

As stated previously, the case vehicle's driver recalls nothing of the crash sequence and, thus, the exact totality of his avoidance maneuvers prior to the crash are unknown; although, he did attempt a right steering input that resulted in an overcorrection sufficient to cause the case vehicle to begin a clockwise rotation. This pre-crash clockwise rotation likely caused the driver's weight to shift and his body to lean to the left. The crash sequence's first impact with the small tree likely had a negligible effect on the driver's positioning; although, the slight downward tilt to the left side may have caused the driver's body to lean a little further left. The second impact (air bag deployment) of the crash sequence, involving the largest of the three struck trees, most likely moved the driver further forward and to his left in the direction of the left "A" pillar. This second impact increased the clockwise rotation. Almost instantaneously the third tree was impacted. The third tree was nearly identical in size to the first impacted tree and not large enough to have much of an effect on the driver's positioning. The fourth impact of the crash sequence occurred when the case vehicle's left rear corner contacted the brick, noise abatement wall and began sliding along the wall. This fourth impact was of sufficient magnitude to shift the driver's body rearward along the left front door panel toward his seat back. The fifth and final impact, and the one with the highest Delta V, occurred as the case vehicle struck a large, wooden utility pole with its back bumper and came to rest. This last impact caused the driver's body to move further rearward, loading the left side of his seat back with sufficient force to cause the failure of the seat back's folding lock (**Figure 12**). The case vehicle's driver then rebounded forward and upward, striking a partially deflated air bag, rolling over the air bag into the windshield, and rebounding rearward and downward into his seat, allegedly unconscious.

Figure 12: Case vehicle's driver seat; Note: seat back angle caused by folding lock failure (case photo #54)

The case vehicle's driver was transported by ambulance to a medical facility and was treated and released. He sustained the following self-reported injuries: a blunt head injury with loss of consciousness, two left rib fractures, a fractured left clavicle, and a lacerated forehead on the right side.

CASE VEHICLE DRIVER INJURIES

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Blunt head trauma	115099.7 unknown	Left "A"-pillar	Possible	Interviewee (driver)
2	Fractured two left ribs, ribs unspecified	450220.2 moderate	Interior surface of driver's door	Probable	Interviewee (driver)

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
3	Fracture left clavicle	752200.2 moderate	Left front window frame	Possible	Interviewee (driver)
4	Laceration right forehead	290600.1 minor	Windshield	Certain	Interviewee (driver)

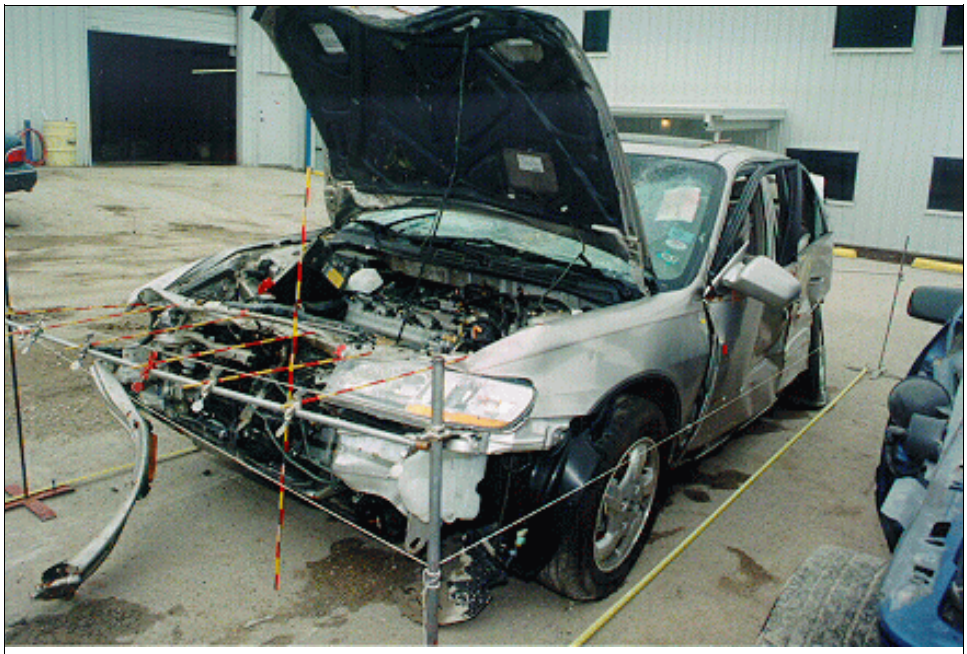

Figure 13: Case Vehicle's damaged left side; Note: left front door forward seam and mid-panel damage (case photo #23)

Figure 14: Case vehicle's left side damage; Note: first impact at left front door's forward seam, third impact at mid-left front door, and fourth impact goes forward from left rear corner to left front door's rear seam (case photo #28)

Figure 15: Case vehicle's five impacts; Note: center cone shows impact #1, right cone shows impact #2, left cone shows impact #3, cone at wall shows #4, and utility pole was impact #5 (case photo #06)

Figure 16: Case vehicle's lower dash just right of the steering column; Note: yellow tape marks area of significant blood stain (case photo #52)