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SCI/NASS COMBINATION SIDE IMPACT INFLATABLE OCCUPANT PROTECTION REPORT

CASE NUMBER - NASS-2003-72-078K
LOCATION - Illinois
VEHICLE - 2003 AUDI QUATTRO
CRASH DATE - July 2003

Submitted:
June 29, 2004

Revised:
September 20, 2005

Contract Number: DTNH22-01-C-07002

Prepared for:

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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

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SCI/NASS combination investigation of an air bag deployment crash involving a 2003 Audi Quattro equipped with frontal air bags, seat back-mounted side air bags and roof rail-mounted inflatable curtain air bags, and a 1998 Ford Contour

16. *Abstract*
This report covers a SCI/NASS combination investigation of an air bag deployment crash involving a 2003 Audi Quattro (case vehicle) and a 1998 Ford Contour (other vehicle). This crash is of special interest because the case vehicle was equipped with frontal air bags and seat back-mounted side impact air bags for the two front seats, and roof rail-mounted inflatable curtain air bags. The two frontal air bags, the right seat back-mounted side impact air bag and the right inflatable curtain deployed as a result of the collision events. The restrained case vehicle driver (53-year-old male) and the restrained front right passenger (29-year-old male) both sustained minor soft tissue injuries and both were treated and released. The restrained back right passenger (25 year-old female) sustained minor head, neck and extremity injuries and was hospitalized for two days. The case vehicle was traveling east in the eastbound lane of a two-lane local street, approaching a four-leg intersection and intending to continue east. The other vehicle was traveling north in the inside northbound through lane of the intersecting two-lane roadway that was part of a divided trafficway, and was intending to continue north. The case vehicle entered the intersection across the other vehicle' s path. The case vehicle' s right side was impacted by the front of the other vehicle, causing the case vehicle' s front right seat back-mounted side air bag and the right roof rail-mounted inflatable curtain to deploy. The other vehicle was equipped with frontal air bags that did not deploy. The case vehicle ran up onto the sidewalk at the northeast corner of the intersection. Its left front area impacted a non-breakaway luminaire support pole, causing the driver and front right passenger frontal air bags to deploy. The case vehicle came to rest on the sidewalk heading slightly east of north. The other vehicle came to rest within the intersection, heading northeast. Both vehicles were towed due to damage.

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BACKGROUND

This SCI/NASS combination investigation was brought to the NHTSA's attention in July 2003 by NASS/CDS sampling activities and was designated for SCI on February 13, 2004. This crash involved a 2003 Audi A6 Quattro sedan (case vehicle) and a 1998 Ford Contour sedan (other vehicle). The crash occurred in July 2003, at 5:30 p.m., in Illinois, and was investigated by the applicable municipal police department. This crash is of special interest because the case vehicle was equipped with frontal air bags, side impact air bags and inflatable curtain air bags. Both frontal air bags, the front right side impact air bag and right inflatable curtain air bag deployed. The case vehicle driver (52-year-old male, white, non-Hispanic) and the front right passenger (29-year-old male, white, non-Hispanic) were both transported via ambulance to a hospital, where they were both treated and released for minor injuries. The back right passenger (25-year-old female, white, non-Hispanic) was transported via ambulance and was hospitalized for two days. There were no other occupants in the case vehicle. This report is based on the coded NASS case, medical data, occupant kinematic principles and this contractor's evaluation of the evidence.

CRASH CIRCUMSTANCES

The case vehicle was traveling east in the eastbound lane of a two-lane local street, approaching a four-leg intersection and intending to continue east (**Figure 1**). The other vehicle was traveling north in the inside northbound through lane of the intersecting two-lane roadway that was part of a divided trafficway, and was intending to continue north (**Figure 2**). It was daylight, the weather was clear, the road surface was dry and with no apparent defects. The speed limit on both roadways was 56 km.p.h. [35 m.p.h.]. There was a stop sign for the case vehicle and no traffic control for the other vehicle. The case vehicle entered the intersection across the other vehicle's path. The case vehicle driver observed the other vehicle and braked at the last moment.

Figure 1: Case vehicle's eastbound approach; final rest was against the pole at the upper left

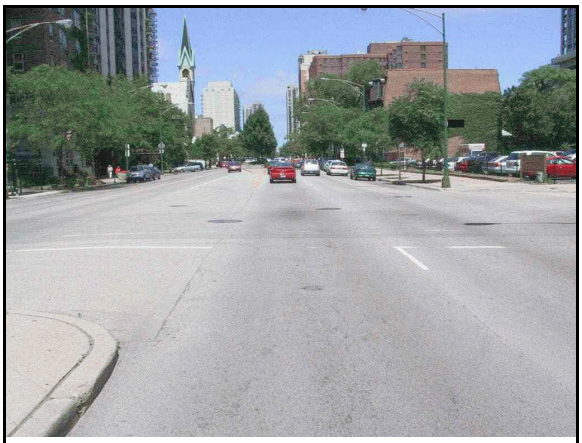


Figure 2: Other vehicle's northbound approach

The crash occurred within the intersection. The case vehicle's right side was impacted by the front of the other vehicle, causing the case vehicle's front right seat back-mounted side air bag and the right roof rail-mounted inflatable curtain air bag to deploy. The other vehicle was equipped with frontal air bags that did not deploy. The case vehicle was redirected and ran up onto the sidewalk at the northeast corner of the intersection. Its left front area impacted a non-breakaway luminaire support pole, causing the

driver and front right passenger frontal air bags to deploy. The case vehicle rotated a few degrees counterclockwise and came to rest on the sidewalk heading slightly east of north. The other vehicle rotated clockwise and came to rest within the intersection, heading northeast. Both vehicles were towed due to damage.

CASE VEHICLE

The case vehicle was a 2003 Audi A6 Quattro all-wheel drive, four-door, five-passenger sedan (VIN: WAULT64B93N------), equipped with a 3.0 liter V6 gasoline engine and an automatic transmission with a console-mounted selector lever. Four-wheel anti-lock brakes, traction control and stability control were standard for this model. The case vehicle was equipped with dual stage frontal air bags, seat back-mounted side impact air bags for the front outboard seat positions, and left and right roof rail-mounted inflatable curtain air bags that provided protection for the front and rear outboard seat positions. This vehicle was also equipped with safety belt buckle pretensioners in all five seat positions. The odometer reading is not known due to the non-functional electronic instrument cluster. Its wheelbase was 276 centimeters [108.7 inches]. The case vehicle was towed due to disabling damage.

The case vehicle was hit on the right side (**Figures 3** and **5**) by the full width of the other vehicle' s front, centered approximately on the right B-pillar, with direct damage on both right doors. The crush profile was measured as 179 centimeters [70.5 inches] long, with maximum crush of 39 centimeters [15.4 inches] slightly forward of the B-pillar on the lower right front door. In addition to the two right doors, the right door sill sustained direct damage, and there was minor induced buckling on the right roof rail. The right back door window glazing and the fixed glazing rearward of the right back door was shattered, and there was no other glazing damage.

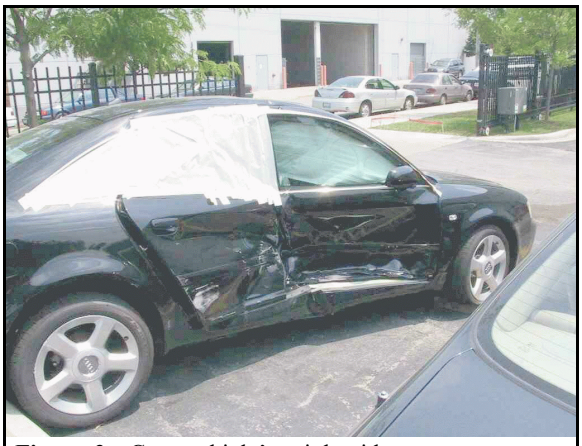


Figure 3: Case vehicle' s right side

Figure 4: Case vehicle' s left front area

The case vehicle' s left front area (**Figures 4** and **6**) impacted the base of a non-breakaway, heavy steel pole. The left fender was crushed inward and rearward, with abrading and paint transfers from the pole. The rearward movement of the left fender pulled the left end of the front bumper cover rearward and tore it off. The headlamp assembly was displaced but otherwise undamaged, and the engine compartment was exposed, but the hood was not damaged. The left front wheel was restricted by the damaged fender, the two front tires were both flat and there was no other wheel/tire damage.

The CDC for the first impact was determined to be **02-RPEW-3 (50 degrees)**. The WinSMASH reconstruction program, missing vehicle algorithm based on the measured crush profile of the case vehicle and partial data from the other vehicle, was used. The total, longitudinal and lateral deltaVs are, respectively: 16 km.p.h. [9.9 m.p.h.], -10 km.p.h. [-6.2 m.p.h.], and -12 km.p.h. [-7.5 m.p.h.]. These results appear reasonable. The first impact was the second most severe for the case vehicle, and this was of low severity (14-23 km.p.h. [9-14 m.p.h.]). The CDC for the second impact was determined to be **11-LFEW-3 (330 degrees)**. The WinSMASH reconstruction program, barrier algorithm, was used. The total, longitudinal and lateral deltaVs are, respectively: 15 km.p.h. [9.3 m.p.h.], -13 km.p.h. [-8.1 m.p.h.] and + 8 km.p.h. [+ 5.0 m.p.h.]. These results appear somewhat low but reasonable and the second impact was also of low severity.

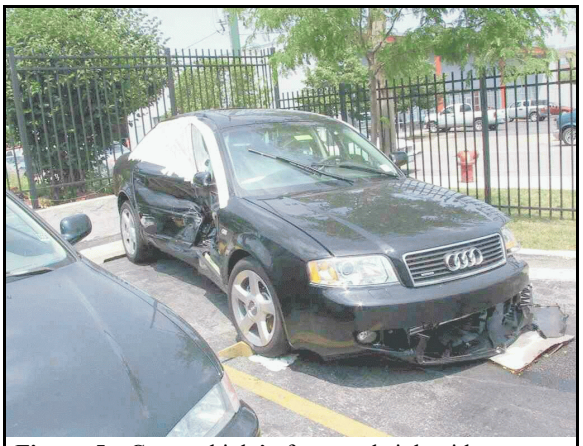


Figure 5: Case vehicle' front and right side

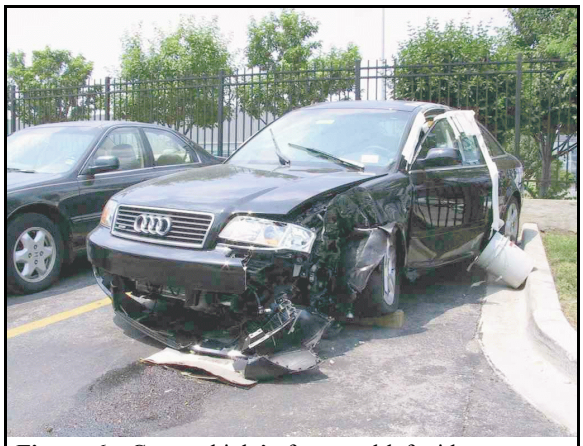


Figure 6: Case vehicle' front and left side

Inspection of the case vehicle interior revealed numerous areas of intrusion. The front right door intruded into the front right seat area 25 centimeters [9.8 inches], causing substantial deformation of the seat back and seat cushion, and also pushing the front right seat back laterally into the center and longitudinally such that it intruded into the second row right seat area. The right B-pillar intruded 15 centimeters [5.9 inches] into the front right seat area and the right roof rail intruded slightly into both the front and back seat areas. The back right door intruded 11 centimeters [4.3 inches] into the right back seat. The sills of the two right doors intruded into the right seat areas, 8 centimeters [3.1 inches] in the front and 10 centimeters [3.9 inches] in the back.

The interior inspection also revealed evidence of occupant contact on the interior surfaces. There was scuffing on the left door, left instrument panel, steering column and center console from the driver, and on the right door from the front right passenger. The back right passenger' s motion resulted in scuffing on the right back door surface and the back seat fold down center console. In addition, the back right passenger left evidence of contact on the back of the front right seat, which intruded into the back right seat area.

The case vehicle was equipped with frontal air bags and seat back-mounted side impact air bags for the two front outboard positions plus roof rail-mounted inflatable curtain air bags that provided protection for the front and back outboard seat positions, for a total of six air bags in this vehicle. The two frontal air bags, the front right seat back-mounted side impact air bag and the right roof rail-mounted inflatable curtain air bags deployed.

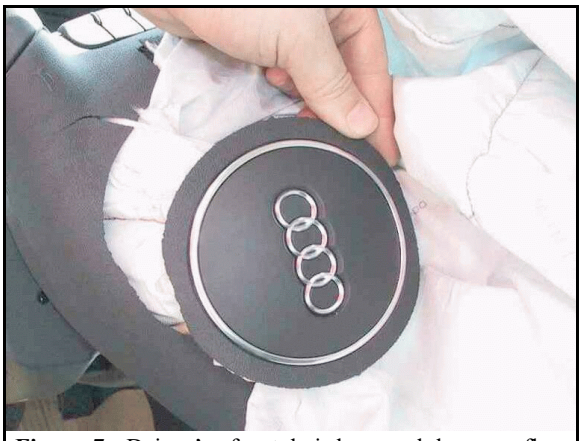


Figure 7: Driver's frontal air bag module cover flap

Figure 8: Front of driver's frontal air bag

The driver's frontal air bag was located in the steering wheel hub. The module's single cover flap was circular, with a diameter of 13 centimeters [5.1 inches] (**Figure 7**). The cover flap opened at the designated points and there was no evidence of damage to the cover flap or the air bag, but the vinyl-like covering on the hub had tears radiating out from the circular flap opening. The air bag was round with a diameter of 60 centimeters [23.6 inches] (**Figure 8**). There were four tethers and one vent port, of unknown size, at the 12 o'clock position on the back of the air bag. There was a faint yellow fluid stain and a scuff near the center on the front of the air bag fabric and no other evidence of contact.

Figure 9: Passenger's frontal air bag module cover flap, viewed from left

Figure 10: Front of passenger's frontal air bag

The front right passenger' s frontal air bag was located in the top of the right instrument panel. The single cover flap was rectangular and measured 26 centimeters [10.2 inches] horizontally and 13 centimeters [5.1 inches] vertically (**Figure 9**). The flap was hinged at the top and opened at the tear points with no apparent damage to the air bag, the flap or the adjacent structures. The air bag was approximately rectangular (**Figure 10**), but its measurements are not known. The air bag had one tether and one vent port, of unknown size, located at the 12:00 o' clock position on the top surface of the air bag.

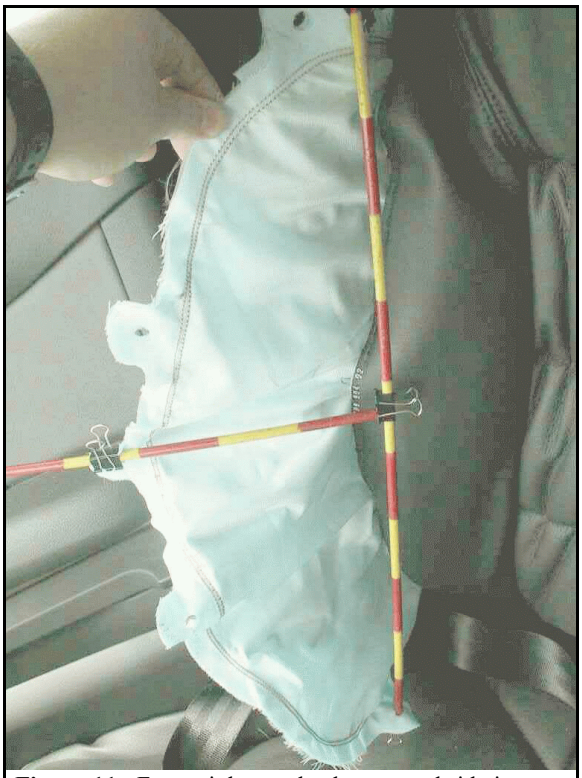


Figure 11: Front right seat back-mounted side impact air bag

The front right passenger' s seat back-mounted side impact air bag was mounted in the outboard edge of the front right seat back. The module was covered by the fabric of the seat' s upholstery and this came open along pre-stressed seams (**Figure 11**). There was no evidence of damage to the air bag, the flap or the adjacent structures. The air bag was semi-circular in shape, approximately 48 centimeters [18.9 inches] vertically and 20 centimeters [7.9 inches] horizontally. There were no tethers or vent ports. There was no evidence of occupant contact, nor any other marks, on the air bag.

The right inflatable curtain air bag was mounted in the right roof rail, behind a trim panel that runs along the upper A-pillar rearward to the C-pillar and spans the junction where the roof headliner meets the side. This panel comes open along the outboard edge, allowing the air bag to emerge. There was no evidence of damage to the air bag, the trim panel or the adjacent structures. The deployed curtain covered the entire length of the right side of the passenger compartment, from the point where the A-pillar meets the instrument panel (**Figure 12**) rearward

Figure 12: Front seat portion of right curtain wall

Figure 13: Back seat portion of right curtain wall

to just beyond the C-pillar (**Figure 13**). The deployed curtain was rectangular, measuring approximately 140 centimeters [55.1 inches] from front to rear and 36 centimeters [14.2 inches] from top to bottom. There was a scuff on the curtain's fabric in the back seat area that appeared to be the result of occupant contact, and no other marks on the inflatable curtain.

CASE VEHICLE DRIVER'S KINEMATICS

The case vehicle driver (53-year-old male, white, non-Hispanic, 175 centimeters, 100 kilograms [69 inches, 220 pounds]) was restrained by the available, manual, three-point, lap-and-shoulder safety belt system. His posture is not known but he was probably in a normal driving posture. His bucket seat back was adjusted at the upright position and the seat track was adjusted at the middle position. The tilt steering wheel was adjusted between the full up and center positions.

The driver braked just prior to the first impact and he moved slightly forward in response to the braking deceleration. The case vehicle's right side was impacted by the other vehicle, causing the case vehicle's right side impact air bag and right inflatable curtain air bag to deploy. The driver moved rightward and slightly forward, toward the 2:00 o'clock direction of force, but was held in place by the safety belt system. The case vehicle was redirected with slight counterclockwise rotation, ran off the road and the left front corner impacted a pole, causing the driver's and front right passenger's frontal air bags to deploy. His safety belt system was equipped with a pretensioner in the buckle stalk. It appears that the pretensioner did not actuate, but the NASS case is coded "unknown if actuated". The driver moved forward, toward the 11:00 o'clock direction of force. He probably encountered the deployed air bag with his face and chest sustained a cervical strain as a result of the rapid deceleration. His posture at final rest is not known, but he probably rebounded back into the driver's seat.

CASE VEHICLE DRIVER'S INJURIES

The case vehicle driver was transported via ambulance to a hospital, where he was treated and released in the emergency department.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Cervical spine strain	minor 640278.1,6	Non-contact: impact force	Certain	Interviewee

CASE VEHICLE FRONT RIGHT PASSENGER'S KINEMATICS

The case vehicle front right passenger (29-year-old male, white, non-Hispanic, 185 centimeters, 95 kilograms [73 inches, 209 pounds]) was restrained by the available, manual, three-point, lap-and-shoulder safety belt system. His posture is not known, but he was probably seated in a normal posture. His bucket seat back was adjusted in a slightly reclined position and his seat track was adjusted at the middle position.

The case vehicle driver braked immediately prior to the first impact and the front right passenger moved slightly forward in response to the braking deceleration. The case vehicle' s right side was impacted by the front of the other vehicle, causing the case vehicle' s front right seat back-mounted side impact air bag and the right roof rail-mounted inflatable curtain air bag to deploy. The front right passenger moved slightly forward and to the right, toward the 2:00 o' clock direction of force, but was held in place by the safety belt system. The right front door intruded laterally, his seat back was deformed and he sustained a contusion on his right elbow from the deploying seat back-mounted side impact air bag. The case vehicle ran off the road and its left front corner impacted a non-breakaway pole, causing the driver' s and front right passenger' s frontal air bags to deploy. His safety belt system was equipped with a pretensioner in the buckle stalk. It appears that the pretensioner did not actuate, but the NASS case is coded " unknown if actuated". The front right passenger moved forward and leftward, toward the 11:00 o' clock direction of force, loading against the safety belt webbing and sustaining contusions on his right shoulder and chest. His posture at final rest is not known, but he probably rebounded into his now-deformed seat.

CASE VEHICLE FRONT RIGHT PASSENGER' S INJURIES

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

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion, right shoulder	minor 790402.1,1	Belt restraint system	Certain	Emergency Room
2	Contusion, right elbow	minor 790402.1,1	Seat back-mounted side air bag	Certain	Emergency Room
3	Contusion, chest, not further specified (aspect unknown)	minor 490402.1,9	Belt restraint system	Certain	Emergency Room

CASE VEHICLE BACK RIGHT PASSENGER' S KINEMATICS

The case vehicle' s back right passenger (25-year-old female, white, non-Hispanic, 155 centimeters, 54 kilograms [61 inches, 119 pounds]) was restrained by the available, manual, three-point, lap-and-shoulder safety belt system. Her posture is not known, but she was probably seated in a normal posture. Her seat back and seat track were not adjustable.

The case vehicle driver braked immediately prior to the first impact and the back right passenger moved forward in response to the braking deceleration. The case vehicle' s right side was impacted by the front of the other vehicle, causing the case vehicle' s roof rail-mounted

inflatable curtain air bag to deploy and causing the back right passenger to move forward and rightward, toward the 2:00 o' clock direction of force. The right side of her head contacted the curtain, leaving a scuff, but she did not sustain any injury from this contact. The case vehicle ran off the road and its left front corner impacted a non-breakaway pole, causing the back right passenger to more forward and slightly leftward, toward the 11:00 o' clock direction of force. Her safety belt system was equipped with a pretensioner in the buckle stalk that actuated. She loaded against the safety belt webbing and sustained an abrasion on her right shoulder. The front right seat back intruded rearward approximately 3-8 centimeters [1.2-3.1 inches] and her head impacted the seat back, causing contusions on her left frontal scalp and left eyelid, and causing a cervical strain. Her position at final rest is not known, but she probably rebounded into her now-deformed seat.

CASE VEHICLE BACK RIGHT PASSENGER' S INJURIES

The back right passenger was transported via ambulance to a hospital, where she was admitted for two days.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Abrasion, right shoulder	minor 790202.1,1	Belt restraint system	Certain	Emergency Room
2	Contusion, left eyelid	minor 297402.1,2	Seat, back support	Certain	Emergency Room
3	Scalp contusion/subgaleal hematoma, left frontal	minor 190402.1,5	Seat, back support	Certain	Emergency Room
4	Cervical spine strain	minor 640278.1,6	Seat, back support	Certain	Emergency Room

OTHER VEHICLE

The other vehicle was a 1998 Ford Contour front-wheel drive, four-door, five passenger sedan (VIN: 1FAFP6639WK------), equipped with a 2.0 liter four cylinder gasoline engine. Four-wheel anti-lock brakes were an option for this model, but it is not known if this vehicle was so equipped. The odometer reading was 159,744 kilometers [99,263 miles]. Its wheelbase was 271 centimeters [106.5 inches]. The Contour was towed due to damage.

The other vehicle was under repair and partially disassembled at the time of inspection (**Figures 14** and **15**). The bumper cover, grille, headlamp/turn signal assemblies and the left fender were removed. Based on an examination of the damaged parts, it was determined that the Contour sustained direct contact across the entire front. The engine hood was slightly displaced and there was an area of induced damage on the left edge, probably from crush damage on the left

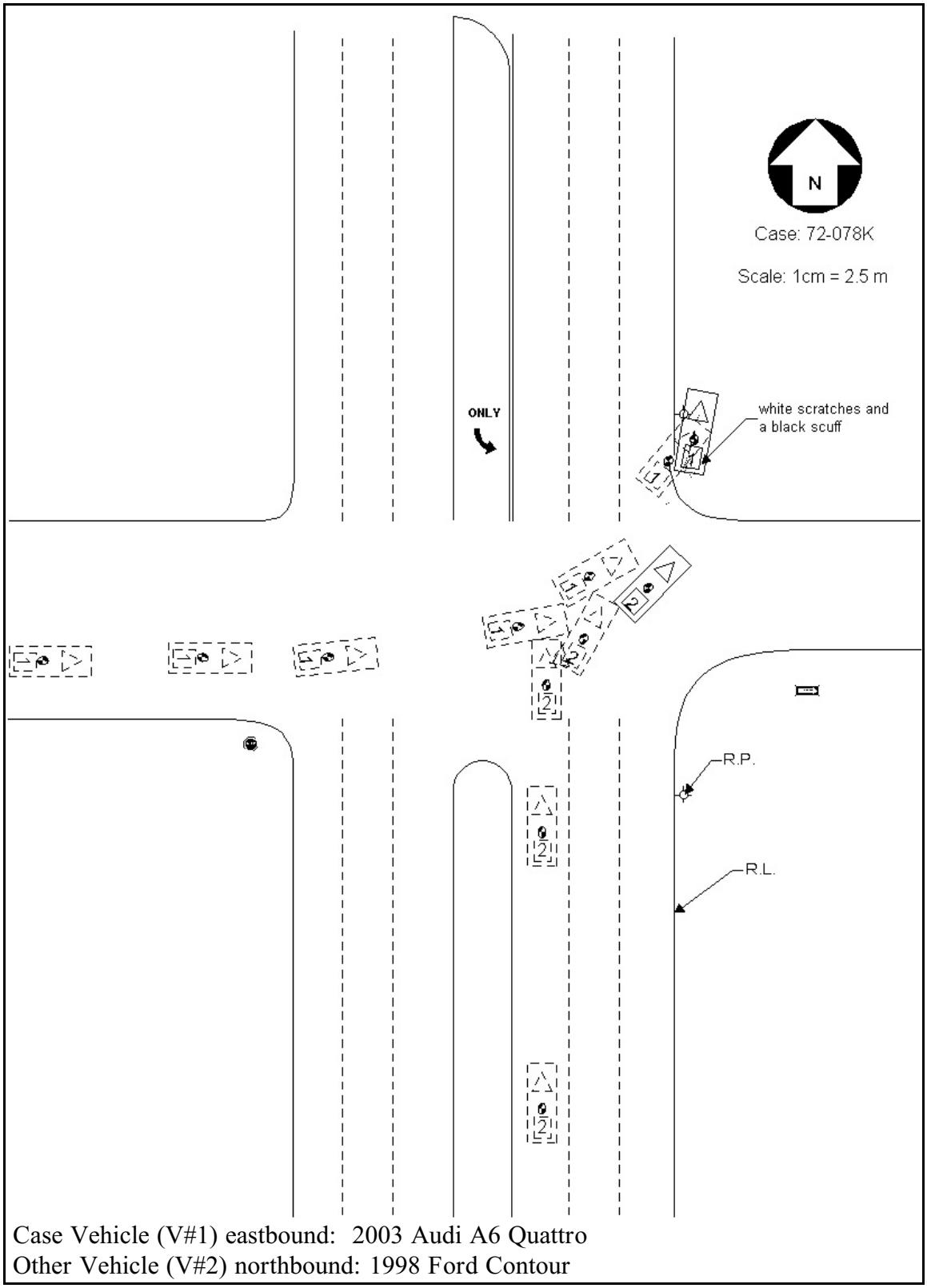
fender. The wheelbase was shortened by 1 centimeter [0.4 inches] on both sides. None of the tires were damaged or restricted, and there was no glazing damage.

Figure 14: Other vehicle' s front and right side

Figure 15: Other vehicle' s front and left side

A partial CDC was assigned as **10-FDEW-? (310)**, with extent zone unknown due to the removal of damaged parts. The WinSMASH reconstruction program, missing vehicle algorithm based on the measured profile of the case vehicle, was used. The total, longitudinal and lateral deltaVs are, respectively: 21 km.p.h. [13.0 m.p.h.], -14 km.p.h. [-8.7 m.p.h.] and + 16 km.p.h. [+ 9.9 m.p.h.]. This is a borderline reconstruction but the results appear reasonable. This was a crash of low severity (14-24 km.p.h. [9-14 m.p.h.]) for the Contour.

The other vehicle' s driver (41-year-old male) was police-reported as not injured and was not transported via ambulance. There was no other occupant in the Contour.



Case Vehicle (V#1) eastbound: 2003 Audi A6 Quattro
Other Vehicle (V#2) northbound: 1998 Ford Contour