On-Scene / Vehicle versus Fixed Object (Brick Building)
Dynamic Science, Inc. / Case Number: DS9719
1993 Chevrolet Corsica LT 4-Door
Washington
July/1997

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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 crash worthiness performance of the involved vehicle(s) or their safety systems.

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15. Supplemental Notes

This was a single vehicle collision which occurred in a small private parking lot of a furniture store. Vehicle 1, a 1993 Chevrolet Corsica LT 4-door, was being driven by a properly restrained 77-year-old female (160 cm, 63 in/68.5 kg, 151 lb). Vehicle 1 was originally parked facing west. The driver backed out of the parking space and struck a light standard/pole with its left rear end. A witness inside the store related that she saw the driver of Vehicle 1 enter the vehicle and begin to back up. When she struck the light standard/pole she stopped and sat there for about one minute. All of the sudden the tires started spinning and Vehicle 1 moved forward and into the front of the store. On impact with the building, the driver's air bag deployed. The investigating police officer arrived at the scene almost immediately. He saw heavy smoke coming out of the driver's side window. The driver was lying back, partially out of the open driver's side window. The fire department arrived and they took over medical attention, and they extracted her from Vehicle 1. She was transported to a trauma center via ground ambulance arriving there at 1205 hours. Two days later she was withdrawn from life support and she expired at 0110 hours. Vehicle 1 sustained minor rear end damage when it struck the standard light/pole; it was minor scratching to the bumper surface. There was minor damage to the front right tire rim. There was moderate damage to the entire front end; the highest Delta-V. A CDC of 12FDEW1 has been coded for the impact, and a total Delta-V of 21.1 km (13.1 mph) was calculated using the barrier portion of WinSmash.

On impact with the brick wall, the air bag in the steering wheel hub deployed and struck the right side of the driver's head and face area. There are contusions and abrasions about the face and head that are typically air bag associated type injuries. There are also contact points on the air bag that appear to be makeup transfer. Examination of the driver by the county medical examiner led to the following pathological diagnoses: blunt force injury to the head consisting of abrasions of the right face area and contusion to the left forehead. A scalp contusion of the left parietal area. Acute bilateral subdural hematomas (AIS-5) and acute subdural and subarachnoid hemorrhages (AIS 5 & 3). There were also small intra-ventricular hemorrhages (AIS 4). The source of these injuries is the air bag.

16. Abstract

17. Key Words	18. Distribution Statement
Air bag, deployment, injury, collision, driver, fatality	

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Dynamic Science, Inc.
Accident Investigation
Case Number: DS9719

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BACKGROUND:

Description:	This case was initiated in response to a report of a fatality to the driver as a result of the deployment of the air bag. This collision occurred in the state of Washington in July, 1997 at 1104 hours. This case was originally to be conducted as a remote investigation, but problems with cooperation with CIREN caused it to be changed to an on-site investigation.
Investigation Type:	On-Scene
Crash Location:	Washington
Crash Date:	July, 1997
Notification Date:	September 3, 1997
Field Work Completed:	September 19, 1997

SUMMARY:

This was a single vehicle collision which occurred in a small private parking lot of a furniture store. Vehicle 1, a 1993 Chevrolet Corsica LT 4-door, was being driven by a properly restrained 77-year-old female (160 cm, 63 in/68.5 kg, 151 lb). Vehicle 1 was originally parked facing west. The driver backed out of the parking space and struck a light standard/pole with its left rear end; this caused minor damage to the rear bumper. There are contradicting accounts from two witnesses as to the body position of the driver of Vehicle 1. A witness inside the store related that she saw the driver of Vehicle 1 enter the vehicle and begin to back up. When she struck the light standard/pole she stopped and sat there for about one minute. All of the sudden the tires started spinning and Vehicle 1 moved forward and into the front of the store. A second witness indicated that the driver slumped forward just prior to the car accelerating forward.

For an unknown reason the driver accelerated forward towards the front of the store building. The two front tires ran into and over a 16.5 cm (6.5 in) concrete parking curb causing minor damage to the front right tire rim. The front of Vehicle 1 then collided with the front of the building, a brick wall store front, causing damage to the wall and breaking the store front's glass windows. On impact with the building, the driver's air bag deployed. The tires kept spinning forward, the driver's foot was apparently stuck on the accelerator. One of the store's employees came out and turned off Vehicle 1.

The investigating police officer arrived at the scene almost immediately. He saw heavy smoke coming out of the driver's side window. The driver was lying back, partially out of the open driver's side window. He felt for a pulse and began verbal stimulation and the driver started lunging forward and making sounds. He tried to stabilize her and to keep her from hurting herself. He saw that the correctly worn seat belt was hampering his efforts, and he instructed a bystander to undo the seat belt. The officer then noticed that the air bag was still releasing burnt gases. The fire department arrived and they took over medical attention, and they extracted her from Vehicle 1. She was transported to a trauma

center via ground ambulance arriving there at 1205 hours. Two days later she was withdrawn from life support and she expired at 0110 hours.

Vehicle 1 sustained minor rear end damage when it struck the standard light/pole; it was minor scratching to the bumper surface. There was minor damage to the front right tire rim. There was moderate damage to the entire front end resulting in the highest Delta-V. A CDC of 12FDEW1 has been coded for the impact, and a total Delta-V of 21.1 km (13.1 mph) was calculated using the barrier portion of WinSmash. Travel speed at impact was calculated using acceleration from stop formula, and an acceleration rate of 4 ft/sec/sec was assumed since there were no obvious tire marks left in the parking lot. The pavement was bare and dry with no obvious signs of oil or other slippery substances.

$$S_2 = \sqrt{s_i^2 + (2aD)}$$

Where S_2 = *Velocity after acceleration*, s_i = *initial Velocity*
a = *acceleration rate*

D = *distance*
(*Acceleration point / building*)

$$S_2 = \sqrt{0 + (2(4(24.7)} = 14.05 \; ft/\sec$$

$$S_2 = \frac{14.05}{1.467} = 9.58 \; MPH = 15.42 \; KPH$$

Vehicle 1 was towed from the scene, and was salvaged by the insurance company.

On impact with the brick wall, the air bag in the steering wheel hub deployed and struck the right side of the driver's head and face area. There are contusions and abrasions about the face and head that are typically air bag associated type injuries. There are also contact points on the air bag that appear to be makeup transfer.

Examination of the driver by the county medical examiner led to the following pathological diagnoses: blunt force injury to the head consisting of abrasions of the right face area and contusion to the left forehead. A scalp contusion of the left parietal area. Acute bilateral subdural hematomas (AIS-5) and acute subdural and subarachnoid hemorrhages (AIS 5 & 3). There were also small intra-ventricular hemorrhages (AIS 4). The source of these injuries is the air bag.

The driver had reported dizziness and ringing in her ears for two weeks prior to the collision. She was taking one librium[1] a day. No other medical problems were reported.

[1] Librium is indicated for the management of anxiety disorders or for the short-term relief of symptoms of anxiety. Precaution is noted for the elderly due to reports of drowsiness, ataxia, and confusion, *Physician's Desk Reference, 41th Edition 1987.*

DETAILED INFORMATION

Vehicle

Vehicle 1

Description:	1993 Chevrolet Corsica LT 4-door
VIN:	1G1LT53TPY2XXXXXX
Odometer:	25,987 km (16148 miles)
Engine:	3.1L, 6 cyl
Manual Restraints:	Three point manual lap/shoulder restraints at LF, RF, LR, and RR seating positions.
Automatic Restraints:	Driver's steering wheel hub mounted air bag
Reported Defects:	None
Cargo:	None
Damage Description:	Moderate damage across the front bumper, and grille area.
CDC:	Impact #1: 06BLLN1 Impact #2: 12FRWN3 Impact #3: 12FDEW1 -Highest Delta-V / air bag deployment event

Figure 1. Front end damage.

Delta V[2]:	Total	21.1 km/h (13.1 MPH)

[2] Highest Delta V of Impact #3, Barrier routine of WinSmash

Longitudinal	-21.1 km/h (-13.1 MPH)
Latitudinal	0.0 km/h (0.0 MPH)
Energy	21,817 Joules (16,103 ft-lbs)

The results fit the collision model, but this is a border line reconstruction since the collision involved a yielding object. It appears however, that the Delta-V was at around the deployment threshold of the air bag system (which is assumed to be 16 km/h - 10 MPH).

Occupant

Vehicle 1	Occupant 1
Age/Sex:	77/Female
Seated Position:	Left front
Seat Type:	Bucket
Height:	160 cm (63 in.)
Weight:	68.5 kg (151 lbs.)
Occupation:	Retired Registered Nurse
Pre-existing Medical Condition:	Complained of dizziness and ringing in her ears two weeks prior to her death. She was on medication of one librium a day. The autopsy also revealed subendocardial fibrosis of the heart, and mild atherosclerosis of the coronary artery.
Alcohol/Drug Involvement:	None
Driving Experience:	. 61 years
Body Posture:	Contradicting witnesses indicated she was slumped over as well as sitting upright.
Hand Position:	Unknown, right hand appears to have been on steering wheel due to injuries.
Foot Position:	Right foot on accelerator .
Restraint Usage:	Lap and shoulder belts used correctly
	Air bag deployment (frontal)

Injuries and Injury Mechanisms

Vehicle 1

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	Acute subdural hemorrhage	140654.5,3	852.25	Air bag
	Acute bilateral subdural hematomas	140654.5,3	852.25	Air bag
	Small intra-ventricular hemorrhages, occipital horn of the left lateral ventricle	140678.4,2	852.25	Air bag
	Acute Subarachnoid hemorrhage	140684.3,3	852.25	Air bag
	Subgaleal hemorrhage /Scalp contusion approximately 4" in diameter over left parietal region	190402.1,6	920	Unknown Source
	Abrasion to right side of face/cheek area	290202.1,1	910.0	Air bag
	Periobital ecchymosis of both eyelids	297099.1,1 297099.1,2	921.1 921.1	Air bag Air bag
	Contusion < 1" over left forehead	290402.1,7	920.0	Air bag
	Ecchymosis over right anterior shoulder	790402.1,1	923.00	Probably air bag
	Ecchymosis/abrasion over right breast	790402.1,1 790202.1,1	922.1 911.1	Seat belt Seat belt
	Contusion left breast–upper, outer, and inner quadrant	790402.1,2	922.1	Possibly air bag
	Ecchymosis 4"x3" right forearm	790402.1,1	923.10	Probably air bag
	Ecchymosis 4" posterior right hand	790402.1,1	923.20	Probably air bag

Ecchymosis 3"x4" over right upper arm	790402.1,1	923.03	Probably air bag
Ecchymosis/contusion left shoulder	790402.1,2	923.00	Probably air bag
Contusion to right knee	890402.1,1	924.11	Instrument panel
Slight contusion to left knee	890402.1,2	924.11	Instrument panel

Air bag System:

Vehicle 1 was equipped with a driver's air bag that was installed in the steering wheel hub. It measured 54 cm (21.3 in) diameter. There were two asymmetrical module cover flaps that opened in a H-configuration. The upper cover measured 19.7 cm (7.8) x 8.5 cm (3.4 in), and the lower cover measured 18 cm (7.1 in) x 7 cm (2.8 in). Both of the module covers had powder residue about them. There were two vent ports at the 09 and 03 O'clock positions. The air bag had a maximum deployed excursion of 47 cm (18.5 in).

There was makeup transfer on the center of the front part of the air bag. There was also makeup transfer on the right front quadrant that extended to the back part of the air bag **(See Figure 2)**. There were no contacts or damage noted to the module covers.

Figure 2. Makeup transfer on driver's air bag.

Occupant Kinematics

The driver's seat is a bucket type seat with an adjustable head restraint. The driver's seat track was adjusted between the forward most and middle track positions. The seatback was in an upright position. There was no visible seat or head restraint damage.

As indicated previously, there were contradictory statements by witnesses as to the position of the driver prior to the collision. One witness indicated that the driver was slumped forward, while a second indicated that she was in an upright position. It appears that the driver had her right hand on the steering wheel, due to the injuries that may have been caused by the air bag; that her right foot was on the accelerator, and she was properly restrained by the lap and shoulder belts.

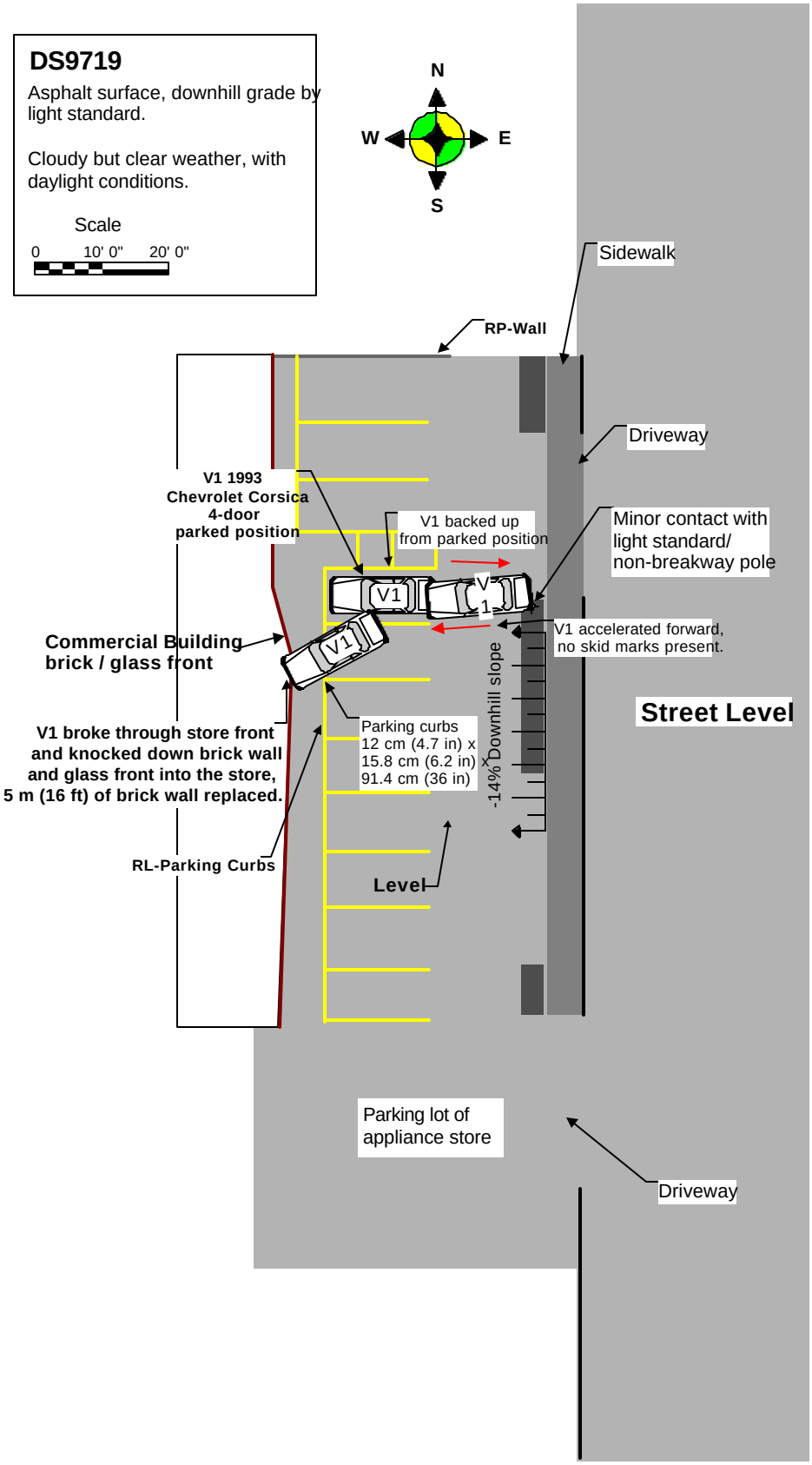
On impact with the brick wall/building, the driver was moving forward into the deploying air bag. The right side of the driver's face struck the air bag, as is indicated by the makeup transfer about the air bag. The driver's head was then thrown backwards and to the left. The Ciren investigator indicated that the driver may have struck the B-pillar or the head restraint and that caused the subgaleal hemorrhage/scalp contusion over the left parietal region. Contact tape was found by the SCI investigator at the time of the vehicle inspection that had

been left by the Ciren investigator. This contact is however being ruled out. The seat was adjusted too far forward to have allowed the head of the driver to contact the B-pillar **(See Figures 3 & 4)**. It is possible that the back of the driver's head struck some part of the window frame. The Police report indicated *"...an elderly female lying back, partially out the open driver's side window."* There were no visible contact points around the window frame area.

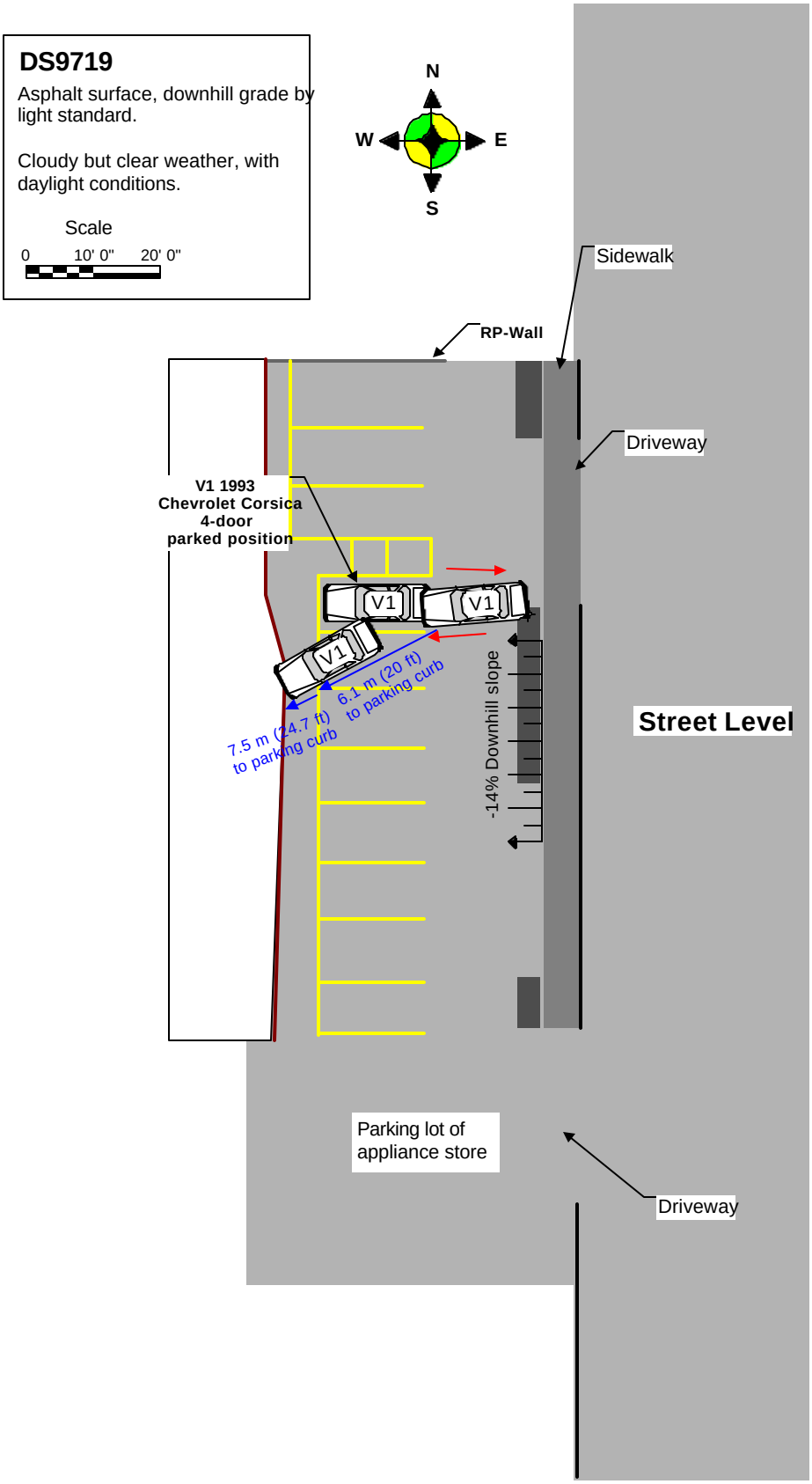
Figure 3. Driver's seat adjustment.

Figure 4. Ciren contact tape.

Scene diagram - Page 1



Scene diagram - Page 2



Collision Measurements (Field Measurements)

COLLISION MEASUREMENTS

Reference Point: Concrete wall on North edge of parking lot	Reference Line: Parking curbs	
ITEM	Distance and Direction from RP	Distance and Direction from RL
Final rest position of V1 R/F	13.5m (44.4ft) S	1.4m (4.7ft) W
Final rest position of V1 L/F	14.7m (48.3ft) S	0.3m (0.9ft) W
Final rest position of V1 L/R	13.4m (44.1ft) S	1.8m (5.8ft) E

Photo Index

Photo no.	Vehicle No.	Direction of Picture	Subject Matter
01-04	1	West	Looking towards impact area, and area where Vehicle 1 was parked.
05	1	East	Looking back from where Vehicle 1 was parked.
06	1	East	Approach to light standard, as Vehicle 1 backed up.
07-08	1	East	Light standard impact with back bumper.
09-11	1	West	Original parking space Vehicle 1 parked; area from Vehicle 1 accelerated forward towards building. No skid marks present.
12-14	1	West	Parking curbs Vehicle 1's LF and RF tires went over. Photographs also indicated final rest area of LR, RF, and LF. Building brick wall that was damaged.
15-16	1	West	Rubber transfer on building from spinning LF tire.
17	1	West	Repaired brick wall damaged by impact.
18-35	1	---	Exterior damage to vehicle.
36-37	1	---	Driver's seat.
38-40	1	—	Driver's side B pillar. Occupant contact tape left by Ciren investigator. This was discounted as driver's contact since driver's seat was adjusted forward of the B pillar. The head rest would not have allowed the driver's head to strike the B pillar.
41-46	1	---	Driver's seat belt D-ring, and lower seat belt retractor.
47-49	1	---	Cloth transfer to left instrument panel.
50-58	1	—	Driver's air bag with what appears to be makeup transfer to the front and back of the air bag.
59-62	1	—	Upper and lower module cover, and vent ports.
63-69	1	—	Head liner area, no visible contacts.
7073	1	—	Front right passenger compartment area.

74-75	1	—	Rear seats.