

CRASH DATA RESEARCH CENTER

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**CALSPAN ON-SITE SIDE IMPACT AIR BAG DEPLOYMENT INVESTIGATION
SCI TECHNICAL SUMMARY REPORT**

CASE NO. CA03-050

VEHICLE – 2003 HYUNDAI SANTA FE

LOCATION - STATE OF FLORIDA

CRASH DATE – AUGUST 2003

Contract No. DTNH22-01-C-17002

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 are 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.

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16. <i>Abstract</i> This on-site investigative effort focused on the crash severity, the performance of the deployed Side Impact Inflatable Occupant Protection System, and the resulting injury mechanisms for a 48-year-old female restrained driver of a 2003 Hyundai Santa Fe. The Santa Fe was involved in an intersection collision and subsequent sideslap with a 1985 Chevrolet Camaro. The crash resulted in the deployment of the driver's side air bag in the Santa Fe. The damage to the Santa Fe was limited to the left side exterior of the vehicle, and there were no intrusions into the passenger compartment. The driver of the Santa Fe initiated a lateral trajectory and she loaded the lap belt and deployed side impact air bag. Her left elbow was compressed between the deployed side impact air bag and her left upper abdomen, which resulted in an occult spleen injury. She had a complaint of rib pain and was transported by ambulance to a local hospital and admitted. Initial evaluation demonstrated a contused rib and the driver was otherwise seemingly uninjured. However, while in the Hospital Emergency Department, the driver developed abdominal pain, which rapidly evolved into a change in skin color and abdominal tenderness. A CT scan revealed a ruptured spleen, which required surgery.		13. <i>Type of Report and Period Covered</i> Technical Report Crash Date: August 2003	
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**GENERAL DYNAMICS ON-SITE SIDE IMPACT AIR BAG DEPLOYMENT
INVESTIGATION
SCI SUMMARY TECHNICAL REPORT
CASE NO. – CA03-050
SUBJECT VEHICLE – 2003 HYUNDAI SANTA FE
LOCATION - STATE OF FLORIDA
CRASH DATE – AUGUST 2003**

BACKGROUND

This on-site investigative effort focused on the crash severity, the performance of the deployed Side Impact Inflatable Occupant Protection System, and the resulting injury mechanisms for a 48-year-old female restrained driver of a 2003 Hyundai Santa Fe (**Figure 1**). The Santa Fe was involved in an intersection collision and subsequent sideslap with a 1985 Chevrolet Camaro. The crash resulted in the deployment of the driver's side air bag in the Santa Fe. The damage to the Santa Fe was limited to the left side exterior of the vehicle, and there were no intrusions into the passenger compartment. The driver of the Santa Fe initiated a lateral trajectory and she loaded the lap belt and deployed side impact air bag. Her left elbow was compressed between the deployed side impact air bag and her left upper abdomen, which resulted in an occult spleen injury. She had a complaint of rib pain and was transported by ambulance to a local hospital and admitted. Initial evaluation demonstrated a contused rib and the driver was otherwise seemingly uninjured. However, while in the Hospital Emergency Department, the driver developed abdominal pain, which rapidly evolved into a change in skin color and abdominal tenderness. A CT scan revealed a ruptured spleen, which required surgery.



Figure 1. Post-crash photograph of damaged 2003 Hyundai Santa Fe

This crash was identified by the driver's physician who forwarded the crash information to the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) due to the potential side impact air bag-related injuries that the driver of the Santa Fe sustained. An on-site investigation was assigned to the General Dynamics SCI team on September 4, 2003. The vehicle was under repair at a local body shop, and was partially disassembled at the time of the vehicle inspection. The Camaro was driven from the scene and could not be located for inspection, after repeated attempts.

VEHICLE DATA – 2003 HYUNDAI SANTA FE

The Hyundai Santa Fe was identified by the Vehicle Identification Number (VIN) KM8SC13D23U (production sequence omitted). At the time of the vehicle inspection, the vehicle did not have power and the electronic odometer could not be read. The Santa Fe was a four-door sport-utility vehicle that was equipped with a 2.7 liter, V-6 engine, front-wheel-drive, a four-speed automatic transmission, power windows, power door locks, power four-wheel disc brakes with ABS, power steering, and a tilt steering wheel. The Santa Fe was configured with

OEM alloy rims and BF Goodrich Radial Long Trail T/A P225/70R16 tires. The vehicle manufacturer's recommended tire pressure for each tire with up to two occupants was 207 kpa (30 psi) and 221 kpa (32 psi) for up to the maximum vehicle load. The specific tire data is as follows:

Tire	Measured Pressure	Maximum Pressure	Tread Depth	Restricted	Damage
LF	227.5 kpa (33.0 psi)	379.2 kpa (55.0 psi)	9 mm (11/32")	No	None
LR	227.5 kpa (33.0 psi)	379.2 kpa (55.0 psi)	9 mm (11/32")	No	None
RF	227.5 kpa (33.0 psi)	379.2 kpa (55.0 psi)	9 mm (11/32")	No	None
RR	227.5 kpa (33.0 psi)	379.2 kpa (55.0 psi)	9 mm (11/32")	No	None

The front seating positions in the Hyundai Santa Fe were configured with bucket seats with adjustable head restraints. The driver's seat had been moved post-crash, and the seat track position at the time of the crash could not be determined. The rear seating positions were configured with a bench seat with a 60/40 split fold-down, reclining seat back. The rear seat had been removed at the time of the vehicle inspection.

Santa Fe also had an automatic inertial fuel cut-off switch in the event of a severe crash, which activated as a result of the side impacts. The vehicle could not be re-started post-crash until the reset switch was activated.

VEHICLE DATA – 1985 CHEVROLET CAMARO

The 1985 Chevrolet Camaro was identified by the VIN listed on the police report as follows: 1G1FP87S5FN (production sequence omitted). The vehicle was a two-door hardtop coupe that was equipped with a 2.8 liter, V-6 engine, front disc/rear drum brakes, and power steering. The vehicle was driven from the scene, subsequently sold after the crash, and could not be located for inspection after numerous attempts.

CRASH SITE

This two-vehicle crash occurred at a four-leg intersection during the daylight hours of August 2003 in the state of Florida. At the time of the crash, the weather was clear and the asphalt roadway surface was dry. The divided north/south roadway was configured with two travel lanes in each direction. The north and south travel lanes were separated by a raised curbed median on the south leg, and a raised median on the north aspect, on which a service station was located. On approach to the intersection, the north/south roadway widened to accommodate right turn lanes and left turn lanes to direct traffic through the intersection. The northbound left turn lane was separated from the northbound travel lanes by a raised concrete gore. The southbound lanes on the south leg also widened to accommodate a right turn lane, beyond the intersection. All lanes at the north and south legs of the intersection were separated by solid white lines and marked with appropriate painted arrows. The east/west roadway was configured with one traffic lane in each direction separated by a double-yellow centerline on each leg. Traffic flow through the intersection was controlled by overhead three-phase traffic signals. In addition, three-phase left-

turn arrow signals were also present to control north/south traffic initiating left turns into the intersection. The posted speed limit for the north/south roadway was 48 km/h (30 mph) and the posted speed for the east/west roadway was 40 km/h (25 mph). The scene schematic is included as **Figure 14** of this report.

CRASH SEQUENCE

Pre-Crash

The 48-year-old female driver of the Santa Fe was operating the vehicle eastbound on the two-lane roadway on approach to the four-leg intersection. She stated that prior to the crash, all of the windows were closed and the air conditioning was in use. The traffic signal was in the red phase for eastbound traffic, and the driver of the Santa Fe brought the vehicle to a controlled stop on the west leg of the intersection (**Figure 2**). She intended to travel into the intersection and initiate a left turn onto the northbound travel lanes when the signal changed to the green phase. A 31-year-old male driver of a 1985 Chevrolet Camaro was operating the vehicle in the outboard southbound lane on approach to the intersection (**Figure 3**). As the traffic light cycled to the green phase for the Santa Fe, the driver entered the intersection and began to initiate the left turn. The driver of the Camaro appeared to be distracted and did not detect the traffic signal change to the red phase for northbound traffic. As the Camaro approached the intersection, the driver realized the signal had changed and noticed the Santa Fe entering the intersection. He applied the brakes and steered left in an attempt to avoid the collision. Although there were no visible tire marks on the roadway within the vehicle's trajectory at the time of the scene documentation, police documented pre-impact skid marks from the Camaro on the PAR.



Figure 2. Eastbound approach for the Santa Fe



Figure 3. Southbound approach for the Camaro

Crash

The front right corner of the Camaro struck the left front corner of the Santa Fe. The impact resulted in minor damage to both vehicles. Due to the location of the impact being well forward of the Santa Fe's center of gravity, the impact induced in a counterclockwise (CCW) rotation of the Camaro and a clockwise (CW) rotation of the Santa Fe. The initial CW deflection of the Santa Fe resulted in a CW tire scuff on the roadway surface. The rotation of the vehicles resulted in a subsequent sideslap. Based on the damage pattern on the Santa Fe, the sideslap event was probably of sufficient severity to deploy the driver's side impact air bag, although, it could not be confirmed without analysis of an Event Data Recorder. The Santa Fe was deflected to the right and came to final rest in the center of the intersection adjacent to the northbound left turn lane.

The Camaro was also deflected slightly to the left and came to rest in the center of the intersection.

Post-Crash

The driver of the Camaro drove the vehicle onto to a controlled stop onto the east leg of the intersection prior to the arrival of police. The driver of the Santa Fe stated that the vehicle's engine stopped after the crash and she remained in the vehicle until rescue personnel arrived. She used a cellular telephone to call a family member and exited the Santa Fe under her own power. Rescue personnel advised her to seek medical treatment, and she was transported by ambulance to a local hospital. In the Hospital Emergency Department, the driver developed abdominal pain, which rapidly evolved into a change in skin color and abdominal tenderness. A CT scan revealed a ruptured spleen, which required surgery. She was released from the hospital seven days after the crash.

VEHICLE DAMAGE

Exterior Damage – 2003 Hyundai Santa Fe

The 2003 Hyundai Santa Fe sustained minor left side damage as a result of the impacts with the Chevrolet Camaro. At the time of the vehicle inspection, both left side exterior door panels had been removed from the vehicle. In addition, the left rear quarter panel and both bumper fascias were removed. All of the dismantled components were available for inspection.

The direct damage on the left front aspect included white paint transfers and minor crush damage on the bumper fascia. The direct damage began at the left front corner of the bumper fascia and extended 35.6 cm (14.0") rearward to the left rear edge of the fascia (**Figure 4**). The maximum crush on the left aspect of the fascia was located 19.1 cm (7.5") rear of the left front corner and measured 3.8 cm (1.5"). The left front corner of the bumper fascia was slightly displaced from the initial contact and subsequent snagging as a result of the secondary sideslap event. The left corner of the metal bumper beam was deflected slightly forward as a result of the initial contact and rotation of the vehicles. The Collision Deformation Classification (CDC) for the initial impact was 10-LFEE-1.

The secondary sideslap event resulted in minor damage to the left side aspect of the Santa Fe (**Figure 5**). The direct damage began at the leading edge of the left front door and extended 289.0 cm (113.7") rearward.



Figure 4. Left front view of damaged bumper fascia



Figure 5. View of left side sideslap damage

White paint transfers were present on the driver's door and were located 40.6 cm (16.0") aft of the leading edge of the left front door and 24.1 cm (9.5") below the beltline. The transfer measured 7.0 cm (2.8") in height and 10.2 cm (4.0") in width. Additional light paint transfers were located on the center aspect of the left rear door. A white paint transfer and rubber transfer from the right rear tire of the Camaro was located on the aft edge of the Santa Fe's left rear door below the door handle, which measured 10.2 cm (4.0") in length. White paint transfers were also present along the contour of the left rear wheel on the left rear quarter panel. As illustrated in **Figure 6**, lateral deformation and minor crush was present on both left side doors and the left rear quarter panel from direct contact with the Camaro.



Figure 6. View of deformation to both removed left side doors and left quarter panel

The combined direct and induced damage began at the left front axle and extended 343.0 cm (135.0") rearward to the left rear bumper corner. The maximum crush on the driver's door that resulted from the sideslap was located in the area of the white paint transfer, 43.1 cm (17.0") aft of the leading edge of the left front door and 24.1 cm (9.5") below the beltline. The maximum lateral crush on the left front door measured 3.8 cm (1.5"). The removed status of the left side components negated any significant crush measurements, as additional deformation was incurred by the removal process. There was no damage to the door structures. Six crush measurements were estimated from photographs provided from the insurance company, and were as follows: C1 = 0.0 cm, C2 = 3.0 cm (1.2"), C3 = 3.0 cm (1.2"), C4 = 1.0 cm (0.4"), C5 = 3.0 cm (1.2"), C6 = 0.0 cm. The CDC for the sideslap event was 09-LDEW-1.

Interior Damage – 2003 Hyundai Santa Fe

The interior of the Santa Fe sustained minor damage as a result of the side impact air bag interaction against the interior B-pillar trim and interior left front door surface. The windshield and vehicle glazing were undamaged and all of the doors were operational. There were no occupant contacts or passenger compartment intrusions. The interior was partially disassembled as a result of the repairs in progress.

Figure 7 illustrates the interior damage to the left front door and left B-pillar trim. The forward aspect of the plastic B-pillar trim was scuffed and fractured at the beltline. The lower panel was removed from the vehicle at the time of the inspection. The top forward aspect of the removed panel was fractured. The fracture measured 7.0 cm (2.8") in height and radiated forward 3.2 cm (1.3"). The scuffed area around the fracture measured 17.8 cm (7.0") in height and 8.9 cm (3.5") in width.



Figure 7. Damaged interior left front door panel and left B-pillar trim

The rear aspect of the left front door interior and armrest was also scuffed from interaction with the left side impact air bag. The aft edge above the armrest was scuffed, heavier near the beltline. The scuff mark measured 16.5 cm (6.5”) in height and 7.6 cm (3.0”) in width at the beltline, and measured 2.5 cm (1.0”) in width at the bottom aspect. The distance between the beltline and the top aspect of the armrest measured 19.1 cm (7.5”) in height. A second scuff mark was located below the top plane of the armrest. The scuff mark began at the top of the armrest and extended downward 11.1 cm (4.4”). The scuff mark measured 10.2 cm (4.0”) in width.

Exterior Damage – 1985 Chevrolet Camaro

The 1985 Chevrolet Camaro was driven from the scene and subsequently sold after the crash. The vehicle could not be located after repeated attempts through the insurance company. There were no available photographs of the damaged Camaro.

MANUAL RESTRAINT SYSTEMS – 2003 HYUNDAI SANTA FE

The Santa Fe was configured with manual 3-point lap and shoulder belts for each front seat position. The driver’s safety belt (**Figure 8**) was configured with a sliding latch plate and an Emergency Locking Retractor (ELR) and the front right passenger’s safety belt was configured with a sliding latch plate and a switchable/Automatic Locking Retractor (ALR). At the time of the inspection, the lower anchor on the driver’s safety belt had been disconnected from the vehicle in anticipation of replacement. The driver’s adjustable D-ring was located one detent, or 2.5 cm (1.0”), below the full-up position. The plastic-coated D-ring and plastic-coated latch plate cover did not exhibit any abrasions. Minor historical use abrasions were present on the latch plate. The driver’s safety belt exhibited faint stretching from occupant loading that began 66.0 cm (26.0”) above the anchor and extended 78.7 cm (31.0”) upward along the webbing.



Figure 8. Driver's safety belt

The rear outboard seating positions were configured with manual 3-point lap and shoulder belts with sliding latch plates and switchable/ALR’s. The center rear position was configured with a 2-point lap belt with a locking latch plate.

FRONTAL AIR BAG SYSTEM – 2003 HYUNDAI SANTA FE

The Santa Fe was equipped with dual stage frontal air bags for the driver and front right passenger positions. The frontal air bag system did not deploy in this crash.

The Santa Fe was also equipped with retractor safety belt pretensioners for both front seat positions that did not actuate as a result of the crash.

SIDE IMPACT AIR BAG SYSTEM – 2003 HYUNDAI SANTA FE

The Santa Fe was equipped with seat back-mounted side impact air bags for the driver and front right passenger positions. A warning label was present on the outboard aspect of the left instrument panel that alerted occupants to the presence of the side air bags. The label also advised against the use of aftermarket seat covers, against installing any accessories on the sides or near the air bags, and against using excessive force on the side of the seat. The side impact air bags offered both head and torso protection for the front seat positions. **Figure 9** was present on the Hyundai website, and illustrated the proximities of the frontal and side impact air bags, relative to the interior of the vehicle. The side impact sensors were located on the forward aspects of the outboard bases of the B-pillars. The owner's manual (**Figure 10**) identified the location of the air bags, sensors, and general operation of the system.



Figure 9. View from the Hyundai website showing proximity of deployed frontal and side impact air bags

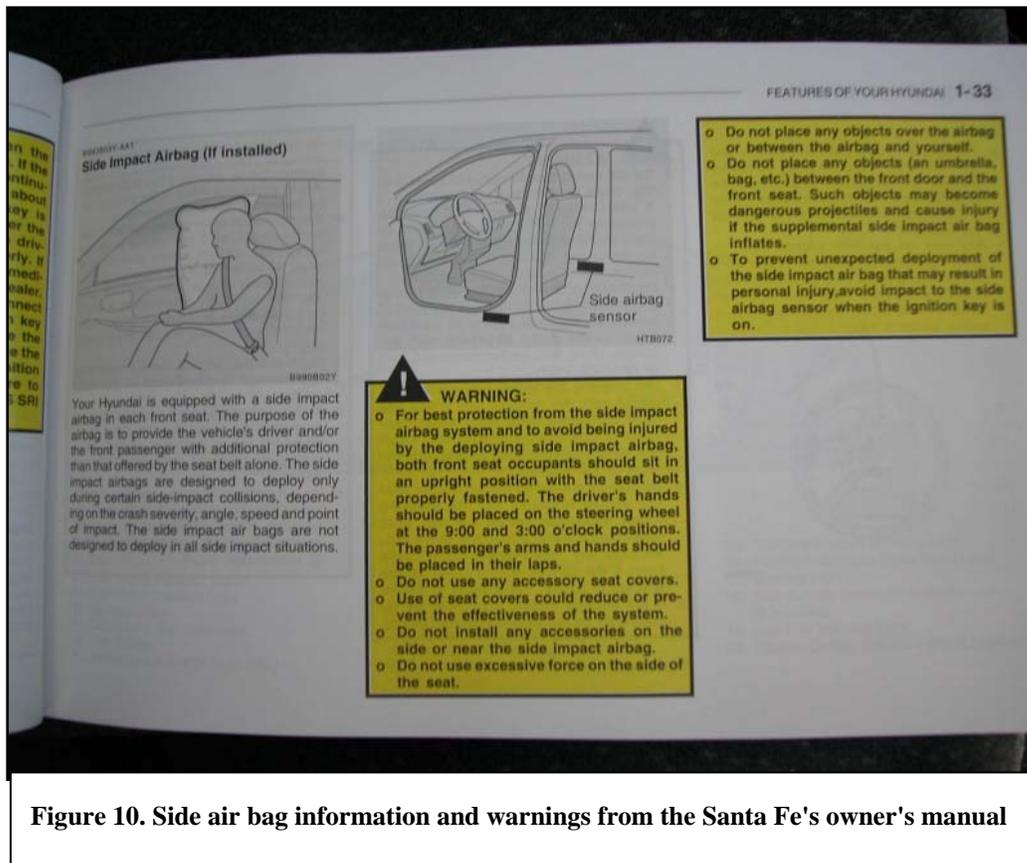


Figure 10. Side air bag information and warnings from the Santa Fe's owner's manual

The driver's side impact air bag probably deployed as a result of the secondary sideslap event. The air bag tear seam on the outboard aspect of the seat back measured 40.6 cm (16.0") in length and began at the top aspect of the seat back. The module in the seat back measured 20.3 cm (8.0") in height. The bottom of the module was located 20.3 cm (8.0") above the seat cushion and the top of the module was located 12.1 cm (4.8") below the top of the seat back. A Styrofoam layer was present between the exterior seat fabric and the air bag module. The foam thickness on the outboard aspect of the seat measured 3.8 cm (1.5") in thickness and the foam on the inboard/forward aspect measured 2.5 cm (1.0") in thickness. The vertical tear in the foam measured 25.4 cm (10.0"). A clear plastic sleeve surrounded the air bag module, and measured 22.9 cm (9.0") in height, 10.2 cm (4.0") in depth at the inboard aspect, and 5.1 cm (2.0") in depth on the outboard aspect. The interior aspect of the seat fabric adjacent to the air bag module was lined with rectangular air bag fabric. The liners were stitched at the front and rear aspects to the interior aspect of the seat fabric. Both liners were located 8.3 cm (3.5") below the top aspect of the seat back and measured 28.6 cm (11.3") in height. The inboard liner measured 15.2 cm (6.0") in depth and the outboard liner measured 12.7 cm (5.0") in depth. The liners ensured a smooth deployment out of the seat back and prevented the air bag from snagging on the seat back tear seam as it expanded. **Figure 11** illustrates the tear seam, foam, and liners on the outboard aspect of the driver's seat back.

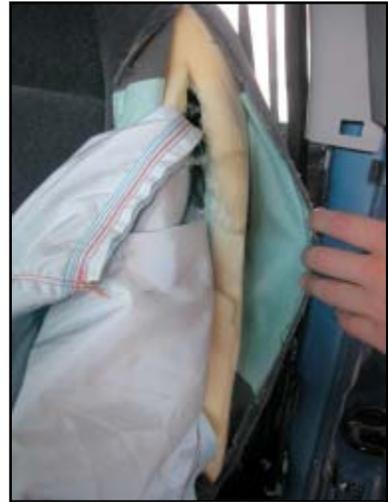


Figure 11. View of the outboard seat back and tear seam showing foam and interior liners

The air bag (**Figures 12 and 13**) deployed forward and upward from the outboard aspect of the seat back. The driver's side impact air bag measured 72.4 cm (28.5") in height, 44.5 cm (17.5") in width at the top aspect, and 16.5 cm (6.5") in width at the bottom aspect. The air bag extended vertically to the roof side rail and exhibited stitching along the entire perimeter located 1.9 cm (0.8") from the edge of the air bag. A full-width angular horizontal line of stitching was located 34.3 cm (13.0") below the top aspect of the air bag. A single 5.1 cm (2.0") vertical vent port in the air bag fabric was located on the outboard panel 47.0 cm (18.5") from the top of the air bag and 30.5 cm (12.0") aft of the forward aspect of the air bag.



Figure 12. Inboard view of deployed driver's side impact air bag



Figure 13. Outboard view of deployed driver's side impact air bag

Faint scuff marks were present on the bottom outboard aspect from contact with the interior aspect of the seat back during the deployment and contact with the interior panel and armrest of the left front door. The area of scuffing on the bottom of the air bag measured 22.9 cm (9.0") in width and 15.2 cm (6.0") in height. A triangular area of scuffing was present on the rear outboard aspect and located 25.4 cm (10.0") below the top aspect of the air bag. The area of scuff marks measured 18.1 cm (7.1") in height and 15.9 cm (6.3") in width and resulted from contact with the interior lower B-pillar trim, evidenced by corresponding scuff marks and fractured plastic. Two additional small faint scuff marks were present on the outboard panel from contact with the top aspect of the left front door interior. The scuff marks were located 6.4 cm (2.5") and 16.5 cm (6.5") aft of the forward seam of the air bag, and 44.5 cm (17.5") and 47.0 cm (18.5") from the top of the air bag, respectively. A square scuff mark was located on the forward aspect of the outboard panel that measured 8.9 cm (3.5") in height and width. The scuff mark was located 7.6 cm (3.0") aft of the forward seam and 17.9 cm (11.0") from the top aspect of the air bag. It appeared to be from contact with the seat back during the deployment. A 5.1 cm (2.0") square scuff mark was present on the aft aspect of the outboard panel above the module. It was located 17.8 cm (7.0") below the top of the air bag and 11.4 cm (4.5") forward of the rear aspect. The scuff mark was from contact with the interior door frame adjacent to the window. A 3.8 cm (1.5") square scuff mark was also located on the top center aspect of the outboard panel from contact with the roof side rail.

The inboard panel of the driver's side impact air bag exhibited faint scuff marks that resulted from contact with the seat fabric during the deployment. The scuffed area measured 8.9 cm (3.5") in width, 11.4 cm (4.5") in height, and was located 29.2 cm (11.5") above the bottom aspect of the air bag and 6.4 cm (2.5") forward of the rear seam. A square area of dark transfers that measured 5.1 cm (2.0") in length and width was located on the top inboard aspect of the air bag, 17.8 cm (7.0") rear of the forward aspect. The dark transfers appeared to be from post-crash handling of the air bag. There was no occupant contact evidence present on the air bag.

OCCUPANT DEMOGRAPHICS – 2003 HYUNDAI SANTA FE

Driver

Age/Sex:	48-year-old/Female
Height:	163 cm (64")
Weight:	66 kg (145 lb)
Seat Track Position:	Mid-track (per driver)
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection, interview
Eyewear:	Prescription contact lenses
Type of Medical Treatment:	Transported by ambulance to a local hospital, admitted for seven days, and released

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Splenic rupture, NFS	Serious (544240.3,2)	Compression of left elbow between the air bag and the driver's left upper abdomen
Contused left rib	Minor (450202.1,2)	Compression of left elbow between the air bag and the driver's left upper abdomen
Left upper abdominal contusion	Minor (590402.1,2)	Compression of left elbow between the air bag and the driver's left upper abdomen

Injury source: Telephone interview with attending ER physician, driver interview

Driver Kinematics

Difficulty had been encountered in obtaining official medical records. The driver had retained an attorney who was unwilling to release medical data for the driver, and the hospital refused to release any medical information without an authorization and release from the patient. Injury sources reflect specific injuries obtained from a verbal interview with the patient's physician.

The 48-year-old female driver was seated in an upright posture with the seat track adjusted to a mid-track position. She was restrained by the manual 3-point lap and shoulder belt. She stated that her hands were positioned at the 3 and 9 o'clock positions on the steering wheel rim and her arms were bent at the elbows in her normal driving posture. In this posture, her left elbow would have been positioned against the lower left aspect of the rib cage, in the vicinity of her spleen. She was wearing a sleeveless dress constructed of rayon fabric that was black in color with a white pattern. The dress was inspected by the SCI investigator during the in-person interview, and showed no evidence of abrasion or damage.

At the initial impact with the Camaro, the driver initiated a slightly forward and lateral trajectory to the left. She rebounded slightly to the right as the vehicle rotated in a CW direction, although the use of the safety belt mitigated substantial movement. The secondary sideslap was probably sufficient to deploy the driver's side air bag which offered both torso and head protection. The female driver was redirected laterally to the left and loaded the deployed side impact air bag. Given the driver's posture and the probability that the driver's hands were still placed on the steering wheel rim, the expansion of the air bag may have displaced her left arm slightly toward her torso. The combination of the driver's lateral motion and the slight displacement of her left arm resulted in the compression of her left arm and elbow between the deployed air bag and her left side. The compression of her elbow into her left rib area resulted in a left upper abdominal contusion, a left rib contusion, and a splenic rupture. The driver rebounded to the right and came to rest upright in the driver's seat. The Santa Fe was deflected in slight CW direction, and rolled to final rest in the intersection.

The lateral nature of the injury, lack of contact evidence on the air bag membrane, lack of damage to the driver's clothing, and lack of abrasions on the driver's arm suggested that the injuries were not related to the inflation/expansion of the side impact air bag. Air bag expansion from a seat back-mounted module would most likely produce injury more prominent in the posterior regions of the torso and likely result in soft-tissue injuries (such as swiping-type

abrasions) on the driver's left side and fabric abrasions from the forward and vertical expansion against the driver and the driver's clothing. Interaction with the deploying side impact air bag would probably produce a soft-tissue type injury on the driver's exposed left arm. In addition, it was not likely that the crash forces were sufficient for the driver to load through the side impact air bag and engage the left door armrest. Given the confirmed restraint usage, minor crash severity, and lack of passenger compartment intrusion, it was unlikely that she loaded through the deployed side impact air bag.

The driver stated that after the vehicle came to rest, she noticed foam fragments in the passenger compartment, which alerted her to the deployed driver's side impact air bag. She stated that she did not detect the deployment of the air bag until after the crash.

The driver had a complaint of mild rib pain and was transported to a local hospital under the encouragement of rescue personnel. Upon arrival at the hospital, initial evaluation demonstrated a contused left rib. After the initial evaluation, the driver began to experience mild abdominal pain and tenderness. She was re-evaluated and a CT scan revealed a ruptured spleen, which was surgically removed. She was released from the hospital seven days following the crash.

