

CRASH DATA RESEARCH CENTER

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**VERIDIAN REMOTE KNEE BOLSTER AIR BAG INJURY
INVESTIGATION
SCI TECHNICAL SUMMARY REPORT**

NASS/SCI COMBO CASE NO. 2000-09-033C

VEHICLE - 1999 KIA SPORTAGE SPORT UTILITY VEHICLE

LOCATION - STATE OF MARYLAND

CRASH DATE - MARCH, 2000

Contract No. DTNH22-94-D-07058

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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 remote investigation focused on a two vehicle crash involving a 1999 Kia Sportage 4-door sport utility vehicle (subject vehicle) and a 1982 Crane roll-off truck. The Kia Sportage was equipped with a driver knee bolster and redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of a frontal collision with the Crane truck. The driver of the Kia was operating the vehicle eastbound on the inboard lane of a multi-lane interstate highway when he allowed the vehicle to depart the north shoulder as the left side surface impacted the median guardrail resulting in minor damage. The Kia re-entered the eastbound lanes and across the path of the eastbound Crane truck. As the Kia entered the outboard lane, the front right area struck the left side surface of the Crane which resulted in moderate damage. The Kia's right side surface subsequently impacted the left side surface of the Crane resulting in minor damage. At this point, the Kia was re-directed across the eastbound lanes as the front left area struck the median guardrail a second time resulting in moderate damage. At first impact with the Crane truck, the restrained 30 year old male driver of the 1999 Kia Sportage initiated a forward and slightly lateral trajectory in response to the 1 o'clock impact force and loaded the manual restraint and deployed redesigned driver frontal and knee bolster air bag. Loading of the manual restraint resulted in contusions to the left upper chest and shoulder. Contact to the deployed knee bolster air bag resulted in a contusion to the right anterior shin. The Kia driver was transported to the emergency room of a local hospital for treatment and released.			
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**VERIDIAN REMOTE KNEE BOLSTER AIR BAG INJURY
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SCI TECHNICAL SUMMARY REPORT
NASS/SCI COMBO CASE NO. 2000-09-033C
VEHICLE - 1999 KIA SPORTAGE
CRASH DATE -MARCH, 2000**

BACKGROUND

This remote investigation focused on a two vehicle crash involving a 1999 Kia Sportage 4-door sport utility vehicle (subject vehicle) and a 1982 Crane roll-off truck. The Kia Sportage was equipped with a driver knee bolster and redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of a frontal collision with the Crane truck. The driver of the Kia was operating the vehicle eastbound on the inboard lane of a multi-lane interstate highway when he allowed the vehicle to depart the north shoulder as the left side surface impacted the median guardrail resulting in minor damage. The Kia re-entered the eastbound lanes and across the path of the eastbound Crane truck. As the Kia entered the outboard lane, the front right area struck the left side surface of the Crane which resulted in moderate damage. The Kia's right side surface subsequently impacted the left side surface of the Crane resulting in minor damage. At this point, the Kia was re-directed across the eastbound lanes as the front left area struck the median guardrail a second time resulting in moderate damage. At first impact with the Crane truck, the restrained 30 year old male driver of the 1999 Kia Sportage initiated a forward and slightly lateral trajectory in response to the 1 o'clock impact force and loaded the manual restraint and deployed redesigned driver frontal and knee bolster air bag. Loading of the manual restraint resulted in contusions to the left upper chest and shoulder. Contact to the deployed knee bolster air bag resulted in a contusion to the right anterior shin. The Kia driver was transported to the emergency room of a local hospital for treatment and released.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 00-09-033C. The Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) assigned the Special Crash Investigation (SCI) team at Veridian the task of case review and final report preparation.

SUMMARY

Crash Site

This two vehicle crash occurred during the afternoon hours of March, 2000. At the time of the crash, it was daylight with no adverse conditions as the roads were dry. The crash occurred in the eastbound lanes of a straight 10-lane interstate highway with a negative grade for eastbound traffic (**see Figure 11 - page 7**). The asphalt roadway was bordered by 3.0 meter (9.8 feet) wide paved shoulders and divided by a W-beam guardrail located 5.8 meters off the north shoulder. No traffic control was present at the scene which had a posted speed limit of 89 km/h (55 mph).

Pre-Crash

The 30 year old male driver of the 1999 Kia Sportage was operating the vehicle eastbound (**Figure 1**) in the inboard lane at a driver reported speed of 92 km/h (57 mph) when he was reportedly cutoff by a (non-contact) vehicle in the adjacent lane and forced to enter the left (north) shoulder into the center median area.

Crash

As the Kia departed the north pavement edge, the left side surface impacted the center median W-beam guardrail (**Figure 2**) resulting in minor damage. The Kia re-entered the eastbound lanes in a southeasterly direction and across the path of the eastbound Crane roll-off truck. As the Kia entered the outboard #2 lane, the front right area struck the left side surface of the Crane truck resulting in moderate damage. The impact induced deceleration was sufficient to deploy the Kia's driver knee and frontal air bag system. *Contrary to the NASS case file*, a barrier equivalent velocity change for this impact could not be computed due to the overlapping nature of subsequent impacts. The right rear side surface of the Kia subsequently sideslapped the left rear side surface of the Crane which resulted in minor damage. At this point, the Kia was re-directed across the eastbound lanes and into the center median area. As the Kia departed the north pavement edge, the front left area impacted the W-beam guardrail resulting in moderate damage. The Kia rotated approximately 30 degrees counterclockwise and came to rest in close proximity to the final impact perpendicular to the north shoulder facing northwest. The Crane truck was driven to final rest on the south shoulder.



Figure 1. East view of travel lanes.



Figure 2. Impacted W-beam guardrail.

Post-Crash

The driver of the Kia exited the vehicle with some assistance from rescue personnel as subsequent treatment was rendered at the scene by fire department personnel and emergency medical technicians (EMTs). The driver of the Kia was transported by ambulance to the emergency room at a local hospital for treatment and released. The Kia Sportage was towed from the crash site due to disabling damage as the Crane truck was driven from the scene with non-disabling damage.

VEHICLE DATA

The 1999 Kia Sportage was identified by the Vehicle Identification Number (VIN): KNDJA7235X5 (production sequence deleted). The vehicle was a 4-door sport utility equipped with four-wheel drive and a 2.0 liter, 4-cylinder engine. The police report listed the driver as the owner of the vehicle. The vehicle's odometer reading was 23,884 km (14,841 miles) at the time of the crash. The seating was configured with front bucket and rear split bench seats (with folding backs). The driver reported no previous crashes or maintenance on the air bag system (original equipment). No cell phone was present or in-use at the time of the collision.

Exterior Damage

The 1999 Kia Sportage sustained moderate frontal damage as a result of the impact with the Crane truck (**Figures 3 & 4**). The direct contact damage began at the front right bumper corner and extended 45.0 cm (17.7 in) inboard. The impact deformed the full frontal end width resulting in a combined direct and induced damage length (Field L) of 101.0 cm (39.8 in). Six crush measurements were documented at the level of the reinforcement bar (*bumper fascia separation*): C1= 25.0 cm (9.8 in), C2= 25.0 cm (9.8 in), C3= 14.0 cm (5.5 in), C4= 9.0 cm (3.5 in), C5= 9.0 cm (3.5 in), C6= 0 cm. The Collision Deformation Classification (CDC) for this impact to the Kia was 01-FREW-2 with a principal direction of force of (+)30 degrees. Direct contact damage was also identified to the front left area attributed to the secondary W-beam guardrail impact. The direct contact damage began at the front left bumper corner and extended 50.0 cm (19.7 in) inboard. The CDC for this final impact to the Kia was 12-FLEW-2 with a principal direction of force of (-)10 degrees. Two substantial impacts along the front end structure resulted in overlapping damage, therefore, NASS Delta-V calculations were invalidated. The hood and fenders were displaced rearward from the impact force. Reduction in the right side wheelbase measured 6.0 cm (2.4 in) as the left wheelbase was elongated 3.0 cm (1.2 in). The windshield was fractured from exterior impact forces only. No wheels/tires were restricted or flat. All left side tempered glazing remained undamaged.



Figure 3. Frontal (overlapping) damage to the 1999 Kia Sportage.



Figure 4. Impact damage to the (left side surface) hydraulic box of the 1982 Crane roll-off truck.

Additional contact damage was identified to the left side surface attributed to the initial W-beam guardrail impact (**Figure 5**). The direct contact damage began 16.0 cm (6.3 in) aft of the front left bumper corner and extended rearward 340.0 cm (133.9 in). A maximum crush value of 4.0 cm (1.6 in) was approximated just forward of the left A-pillar area. No engagement was noted to the end structure for this initial impact, therefore, a CDC of 12-LDES-1 was assigned to the side surface. Contact damage was also documented to the right rear side surface attributed to the secondary (sideslap) impact with the Crane truck (**Figure 6**). The direct contact damage began 6.0 cm (2.4 in) forward of the rear right bumper corner and extended forward 32.0 cm (12.6 in). Four crush measurements were documented at the level of the mid-door: C1= 2.0 cm (0.8 in), C2= 6.0 cm (2.4 in), C3= 5.0 cm (2.0 in), C4= 0 cm. A maximum crush value of 8.0 cm (3.1 in) was documented between the C2 and C3 position. The CDC for this impact to the Kia was 03-RBAN-1. The rear right tail light was fractured

with rubber transfers surrounding the damaged area and attributed to the 3rd axle (tire) on the Crane truck. The right rear quarter window tempered glazing was disintegrated.



Figure 5. W-beam guardrail damage to the left side surface.

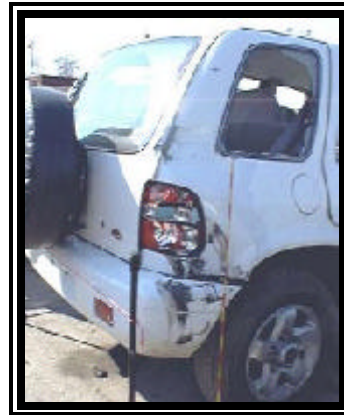


Figure 6. Sideslap damage to the right rear side surface.

Interior Damage

Damage to the interior surfaces of the Kia Sportage was minimal and attributed to occupant contact. Scuff marks were documented on the left knee bolster, center (lower) instrument panel and roof area. No intrusions were found in the vehicle.

SUPPLEMENTAL RESTRAINT SYSTEMS

The 1999 Kia Sportage was equipped with a driver knee bolster air bag and redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of the impact with the Crane truck. The driver air bag was housed in the center of the steering wheel with a horizontally oriented flap tear seam (H-configuration). The flaps were asymmetrical in shape as the upper flap measured 15.0 cm (5.9 in) in width and 7.0 cm (2.8 in) in height while the lower flap measured 15.0 cm (5.9 in) in width and 6.0 cm (2.4 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, black vinyl transfers were noted to the right centered portion of the bag from expansion within the module. The NASS researcher measured the diameter of the driver bag at 61.0 cm (24.0 in) in its deflated state (**Figure 7**). No internal tether straps were present. The bag was vented by two ports located at the 11 o'clock and 1 o'clock sectors on the rear aspect of the air bag.

The front right passenger air bag deployed from the right mid-instrument panel area with a single cover flap design hinged at the top aspect. The passenger air bag was identified by the part number: P119455-02M with a bar coded lot number of: TAW365M10135. No contact evidence was identified on the air bag or exterior surface of the module cover flap. The cover flap was rectangular in shape and measured 24.0 cm (9.4 in) in width and 12.0 cm (4.7 in) in height. The NASS researcher measured the passenger air bag at 40.0 cm (15.7 in) in width and 76.0 cm (29.9 in) in height in its deflated state (**Figure 8**). The bag was tethered by one internal strap. No vent ports or cutoff switch were reported for the front right passenger air bag.



Figure 7. 1999 Kia Sportage deployed redesigned driver air bag.



Figure 8. 1999 Kia Sportage deployed redesigned passenger air bag.

The Kia was also equipped with a driver knee bolster air bag that deployed from the left lower instrument panel area. The air bag was identified by the part number: P118959-016 with a bar coded lot number of: TAW015N10433. The module cover flap was “U” shaped and measured 31.0 cm (12.2 in) in width and 30.0 cm (11.8 in) in height (**Figure 9**). This design provides protection to the driver’s lower extremities by allowing the bag to expand against the (tethered) module cover panel. The rear aspect of the air bag was attached to a metal reinforcement plate below the steering column. No contact evidence was identified to the air bag membrane. The NASS researcher measured the knee bolster air bag at 47.0 cm (18.5 in) in width and 33.0 cm (13.0 in) in height in its deflated state (**Figure 10**). No vent ports were present. The front outboard restraint systems also included buckle pretensioners mounted longitudinally alongside the seat cushions. The activation of the driver side pretensioner pulls a cable which lowered the height of the buckle assembly, reducing slack in both the lap and shoulder belt webbing.



Figure 9. 1999 Kia Sportage driver knee bolster air bag module cover.



Figure 10. 1999 Kia Sportage deployed driver knee bolster air bag.

DRIVER DEMOGRAPHICS

Age/Sex: 30 year old male
Height: 180 cm (71 in)
Weight: 109 kg (240 lb)
Seat Track Position: Mid-to-rear position
Manual Restraint Use: 3-point lap and shoulder belt system
Usage Source: NASS vehicle inspection, driver interview, police report
Eyeware: None
Type of Medical Treatment: Transported to the emergency room of a local hospital for treatment and released

Driver Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
*Acute concussion (with no prior unconsciousness)	Minor (160402.1,0)	Non-contact injury
*Cervical spine strain	Minor (640278.1,6)	Non-contact injury (flexion)
*Contusion left shoulder	Minor (790402.1,2)	Shoulder belt webbing
*Contusion left upper chest	Minor (490402.1,2)	Shoulder belt webbing
*Contusion right anterior shin	Minor (890402.1,1)	Left knee bolster

*source - ER report**

Driver Kinematics

The 30 year old male driver of the 1999 Kia Sportage was restrained by the available 3-point manual lap and shoulder belt system, seated in an upright posture with the seat track adjusted to the mid-to-rear position. Belt usage was confirmed by lack of substantial interior contacts and injury relative to the deployment of the driver side belt pretensioner.

At first impact with the guardrail, the driver probably remained in his pre-impact posture as this minor collision offered no resistance to the vehicle nor produce any occupant kinematic response. At impact with the Crane truck, he initiated a forward and slightly lateral trajectory in response to the 1 o'clock impact force and loaded the manual restraint, deployed redesigned driver frontal and knee bolster air bag. Loading of the manual restraint resulted in contusions to the left upper chest and shoulder. Contact to the deployed knee bolster air bag resulted in a contusion to the right anterior shin as evidenced by the scuff marks documented to the module cover panel. He also sustained a cervical strain which was a result of sudden forward head movement as the body loaded the belt system (flexion). The driver reported a loss of consciousness during the crash sequence, however, no specific head trauma was sustained which could be linked to this injury. Following the crash, the driver exited the vehicle with some assistance from rescue personnel and was subsequently transported by ambulance to the emergency room of a local hospital for treatment and released. The redesigned driver frontal and knee bolster air bag provided additional protection against further contact to frontal components, and potential serious injury.

