TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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

NASS CDS CASE NO. 1998-45-046C

VEHICLE - 1997 KIA SPORTAGE SPORT UTILITY VEHICLE

LOCATION - STATE OF TENNESSEE

CRASH DATE - APRIL, 1998

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. *Abstract* This remote investigation focused on a two vehicle crash involving a 1997 Kia Sportage 4-door sport utility vehicle (subject vehicle) and a 1986 Honda Civic 2-door hatchback. The Kia Sportage was equipped with a driver knee bolster and frontal air bag which deployed as a result of an offset head-on collision with the Honda Civic. The driver of the Honda was operating the vehicle southbound on a 2-lane rural roadway and negotiating a right curve on wet pavement when she allowed the vehicle to cross the centerline into the path of the northbound Kia. As the Honda entered the northbound lane, the front left area impacted the front left area of the Kia resulting in moderate damage to both vehicles. The restrained 59 year old male driver of the Kia Sportage initiated a forward trajectory in response to the 11 o'clock impact force and loaded the manual restraint and deployed driver knee bolster/frontal air bag. Loading of the manual restraint resulted in a contusion to the left shoulder and central abdominal area. Contact to the knee bolster air bag resulted in a contusion to the left knee. He also sustained a laceration of the posterior scalp from contact to the left front window glazing. The driver of the Kia was transported to a local hospital for treatment and released.			
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TABLE OF CONTENTS

VERIDIAN REMOTE KNEE BOLSTER AIR BAG INJURY INVESTIGATION
SCI TECHNICAL SUMMARY REPORT
NASS CDS CASE NO. 1998-45-046C
VEHICLE - 1997 KIA SPORTAGE
CRASH DATE - APRIL, 1998

BACKGROUND

This remote investigation focused on a two vehicle crash involving a 1997 Kia Sportage 4-door sport utility vehicle (subject vehicle) and a 1986 Honda Civic 2-door hatchback. The Kia Sportage was equipped with a driver knee bolster and frontal air bag which deployed as a result of an offset head-on collision with the Honda Civic. The driver of the Honda was operating the vehicle southbound on a 2-lane rural roadway and negotiating a right curve on wet pavement when she allowed the vehicle to cross the centerline into the path of the northbound Kia. As the Honda entered the northbound lane, the front left area impacted the front left area of the Kia resulting in moderate damage to both vehicles. The restrained 59 year old male driver of the Kia Sportage initiated a forward trajectory in response to the 11 o'clock impact force and loaded the manual restraint and deployed driver knee bolster/frontal air bag. Loading of the manual restraint resulted in a contusion to the left shoulder and central abdominal area. Contact to the knee bolster air bag resulted in a contusion to the left knee. He also sustained a laceration of the posterior scalp from contact to the left front window glazing. The driver of the Kia was transported to 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 98-45-046C. 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 morning hours of April, 1998. At the time of the crash, it was daylight with rainy conditions as the roads were wet. The crash occurred in the northbound lane of a 2-lane rural roadway **(see Figure 10 - page 5)** which curved left with a positive grade for northbound traffic. No traffic control was present at the scene which had a posted speed limit of 48 km/h (30 mph).

Pre-Crash

The 18 year old female driver of the 1986 Honda Civic was operating the vehicle southbound **(Figure 1)** and negotiating a right curve on wet pavement when the vehicle began to rotate clockwise and subsequently crossed the centerline into the northbound lane. The Honda driver steered right/braked in avoidance of the Kia. The 59 year old male driver of the 1997 Kia Sportage was operating the vehicle northbound **(Figure 2)** and proceeding straight when he observed the southbound Honda enter his lane of travel. Upon recognition of the impending harmful event, the Kia driver steered right in avoidance.

Figure 1. Southbound approach for the 1986 Honda Civic.

Figure 2. Northbound approach for the 1997 Kia Sportage.

Crash

As the Honda entered the northbound lane of the 2-lane rural roadway, the front right area impacted the front left area of the Kia resulting in moderate damage to both vehicles. The damage algorithm of the WinSMASH program computed velocity changes of 20.0 km/h (12.4 mph) for the subject vehicle and 35.0 km/h (21.7 mph) for the striking Honda. Respective longitudinal components were -18.0 km/h (-11.2 mph) and -30.0 km/h (-18.6 mph). The impact induced deceleration was sufficient to deploy the Kia's driver knee and frontal air bag system. At this point, both vehicles rotated counterclockwise as the Honda Civic came to rest perpendicular to the center divider line facing northeast as the Kia Sportage came to rest off the east pavement edge facing northwest.

Post-Crash

Both drivers were removed from their vehicles by rescue personnel due to perceived serious injuries. 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 a local hospital for treatment and released as the driver of the Honda was transported by ambulance and admitted for one day. Both vehicles were towed from the scene due to disabling damage.

VEHICLE DATA

The 1997 Kia Sportage was identified by the Vehicle Identification Number (VIN): KNDJA7232V5 (production sequence deleted). The vehicle was a 4-door sport utility vehicle equipped with four-wheel drive and a 2.0 liter, 4-cylinder engine. The vehicle's odometer reading was 20,704 km (12,865 miles) at the time of the crash. The police report did not specify the owner of the vehicle. 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

Figure 3. Front left damage to the 1997 Kia Sportage.

The 1997 Kia Sportage sustained moderate frontal damage as a result of the impact with the Honda Civic **(Figure 3)**. The direct contact damage began at the front left bumper corner and extended 48.0 cm (18.9 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 130.0 cm (51.2 in). Six crush measurements were documented at the level of the bumper: C1= 41.0 cm (16.1 in), C2= 16.0 cm (6.3 in), C3= 9.0 cm (3.5 in), C4= 6.0 cm (2.4 in), C5= 2.0 cm (0.8 in), C6= 0 cm. The Collision Deformation Classification (CDC) for this impact to the Kia was 11-FYEW-2 with a principal direction of force of (-)30 degrees. The left fender was displaced rearward which restricted/deflated the left front wheel/tire. The hood was deformed up and rearward from the impact force. Reduction in the left side wheelbase measured 16.0 cm (6.3 in). The windshield was fractured from exterior impact forces (only).

Figure 4. Front left damage to the 1986 Honda Civic.

The 1986 Honda Civic sustained moderate frontal damage as a result of the impact with the Kia Sportage **(Figure 4)**. The direct contact damage began at the front left bumper corner and extended 63.0 cm (24.8 in) inboard. The impact deformed the full end width resulting in a combined direct and induced damage length (Field L) of 108.0 cm (42.5 in). The CDC for this impact to the Honda was 01-FYEW-4 with a principal direction of force of (+)30 degrees. The hood was deformed up and rearward from the impact force. The left fender was displaced rearward which restricted/deflated the left front wheel/tire and jammed the left door. Induced buckling was noted to the roof at the left B-pillar area along with outward bowing of the upper left door frame. Reduction in the left side wheelbase measured 24.0 cm (9.4 in). The windshield was fractured from (exterior) impact forces and (interior) occupant contact. The left front glazing was disintegrated by the impact force.

Interior Damage

Figure 5. Interior view.

Damage to the interior surfaces of the Kia Sportage were minimal and attributed to occupant contact **(Figure 5)**. Scuff marks were documented on the left portion of the driver air bag, knee bolster air bag, and lower right portion of the steering wheel rim. The left front glazing was disintegrated. No intrusions were found in the vehicle.

SUPPLEMENTAL RESTRAINT SYSTEMS

The 1997 Kia Sportage was equipped with a driver knee bolster and frontal air bag which deployed as a result of the crash. The driver air bag was housed in the center of the steering wheel **(Figure 6)** with a horizontally oriented flap tear seam (H-configuration). Although no contact evidence was identified on the exterior surface of the module cover flaps, scuff marks were documented on the left portion of the bag face. The flaps were asymmetrical in shape. The bag was tethered by four internal straps and vented by two ports located at the 11 o'clock and 1 o'clock sectors on the rear aspect of the air bag.

Figure 6. 1997 Kia Sportage driver frontal air bag.

The Kia was also equipped with a driver knee bolster air bag that deployed from the left lower instrument panel area **(Figure 7)**. The module cover flap was rectangular in shape. This design provides protection to the driver's lower extremities by allowing the bag to expand against the module cover panel. A tear was identified on the right side of the bag from snagging against the lower steering column/instrument panel **(Figures 8 & 9)**.

Figure 7. 1997 Kia Sportage driver knee bolster air bag.

Figure 8. Damage to the driver knee bolster air bag.

Figure 9. Tear to the driver knee bolster air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	59 year old male
Height:	173 cm (68 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:	Prescription glasses
Type of Medical Treatment:	Treatment later at a medical facility

Driver Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
Contusion left shoulder	Minor (790402.1,2)	Shoulder belt webbing
Contusion left chest	Minor (490402.1,2)	Shoulder belt webbing
Contusion central/lower abdomen	Minor (590402.1,4)	Lap belt webbing
Contusion left knee	Minor (890402.1,2)	Knee bolster air bag
Laceration posterior scalp	Minor (190600.1,6)	Left front window glazing

Driver Kinematics

The 59 year old male driver of the 1997 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 the type of injuries sustained relative to the driver's reported placement of the restraint harness. At impact, he initiated a forward trajectory in response to the 11 o'clock impact force and loaded the manual restraint and deployed driver knee/frontal air bag. Loading of the manual restraint resulted in contusions to the left shoulder, chest and central abdominal area. Contact to the knee bolster air bag resulted in a contusion to the left knee as evidenced by the scuff mark documented on the left side of the bag face. At this point, the vehicle was re-directed to the northeast as the driver contacted the left front window glazing which resulted in a laceration of the posterior scalp. This trajectory was evidenced by the disintegrated glazing in conjunction with the lack of exterior direct/induced contact damage at the left front door area. The driver was transported by ambulance to a local hospital for treatment and released. The combination of restraint options provided protection against further contact to the steering wheel hub/rim and potential serious injury.

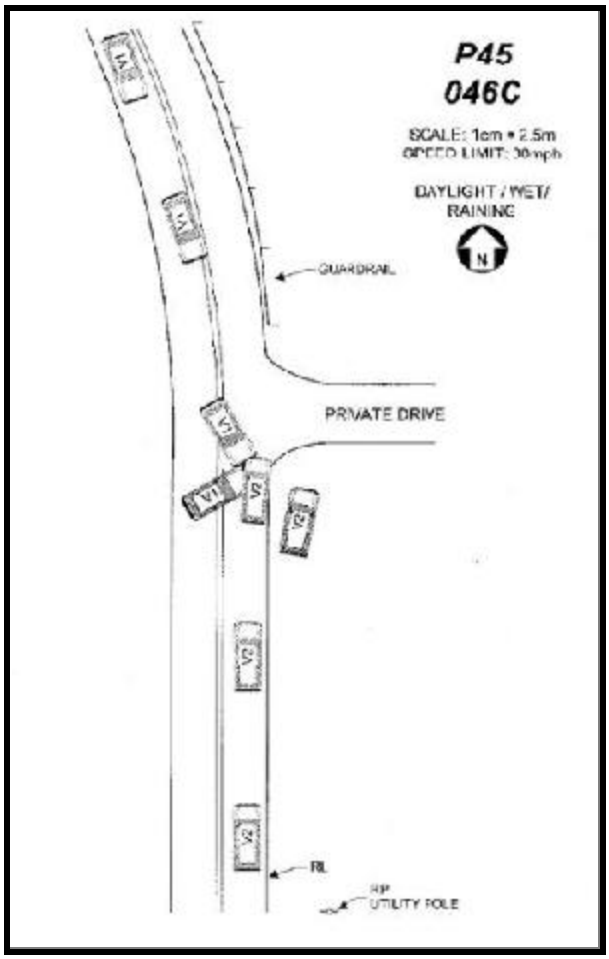

Figure 10. NASS Scene Diagram.