

Rollover/Infant Safety Seat Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS07012
2006 Kia Spectra5
Nevada
February 2007

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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.

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Background

This on site rollover/infant safety seat investigation focused on the performance of a rear-facing infant seat that was installed in the left rear position of a 2006 Kia Spectra5 (**Figure 1**). The Kia Spectra5 was occupied by a 21-year-old female restrained driver, a 25-year-old male front right seat passenger, and an 8-month-old female rear left seat passenger. The 8-month-old female rear left seat passenger was restrained in the rear facing infant seat. The infant seat was secured within the vehicle by the manual 3-point lap and shoulder belt. The belt was routed through the rear-facing belt path. The Kia struck on the left side of a 2005 Cadillac Escalade in an intersection crash. The Kia was deflected laterally, contacted a concrete median, and overturned onto its roof. The driver stated that there were no injuries. All three occupants of the Kia were transported to a local hospital for evaluation. The driver of the Escalade was not injured.



Figure 1. Case vehicle. 2006 Kia Spectra5

This Rollover/Child Safety Seat case was identified by NHTSA from an online news article. DSI was notified of the crash on February 28, 2007. DSI obtained a police report and then located the case vehicle. On March 21, 2007, the driver was located and it was determined that the family still had the child safety seat in their possession. The vehicle and child safety seat inspections were conducted on April 3, 2007.

Summary

Crash Site

This two-vehicle crash occurred at a four-leg intersection of two local roadways in February 2007 at 1813 hours. At the time of the crash, there were no adverse weather conditions and the asphalt roadway was dry. The north/south roadway was configured with two lanes in each direction that were separated by a 20.3 cm (8.0 in) high raised concrete median (**Figure 2**). Within the confines of the intersection, the median decreases in width to accommodate a left hand turn lane for northbound travel. The east/west roadways are physically separated from one another by a cement median. The westbound roadway is configured with a single lane in each direction (**Figure 3**). The westbound roadway is controlled by a stop sign. The speed limit is 56 km/h (35 mph) for both roadways.



Figure 2. Approach to area of impact (south)

Pre-Crash

The 2006 Kia Spectra5 was traveling southbound at an unknown speed in the second lane from the right approaching the four-leg intersection. The other vehicle was a 2005 Cadillac Escalade that was being driven by a 67-year-old male. The front right seat of the Cadillac was occupied by a 59-year-old female. The 2005 Cadillac Escalade was initially stopped at the intersection facing west. Traffic was heavy at this time. The Cadillac pulled into the intersection and attempted to merge into southbound traffic. The driver of the Kia Spectra5 indicated that the Escalade was initially in the right hand lane and then continued on into the adjacent lane. The driver of the Kia began braking while honking her horn.



Figure 3. Approach to area of impact (west)

Crash

The front of the Kia struck the left front of the Escalade. The Kia was deflected laterally and struck the concrete median with its left side tires. The Kia tripped at this point and overturned left side leading. Following two quarter turns, the Kia came to rest on its roof.

Post-Crash

The driver stated that there were no injuries. The driver and the front right passenger were held in place by their lap and shoulder belts. They were able to exit the vehicle under their own power. The front right passenger opened the left rear door. The child was still in the infant seat and was suspended upside down. He initially tried to remove the child seat but did not understand that it was being held in place by the vehicle's lap and shoulder belt. He was eventually able to remove the child from the infant seat by unfastening the infant seat harness. All three occupants of the Kia were transported to a local hospital for evaluation. The driver of the Escalade was not injured. The Kia Spectra5 was towed from the scene due to damage and was later declared a total loss by the insurance company.

Vehicle Data - 2006 Kia Spectra5

The Kia Spectra5 was identified by the Vehicle Identification Number (VIN): KNAFE162X65xxxxxx. The vehicle's odometer could not be read, as there was no power to the instrument panel when the ignition was actuated. The Kia Spectra5 was a five-door hatchback that was equipped with a 2.0 liter, four-cylinder engine, front wheel drive, an automatic transmission, front/rear disc brakes, and rack and pinion steering. The Kia was configured with Goodyear Eagle P205/50R16 tires. The vehicle manufacturer's recommended cold tire pressure is 207 kPa (30 psi). The tire manufacturer's recommended maximum tire pressure is 303 kPa (44 psi). The specific tire information is as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	214 kPa (31 psi)	6 mm (8/32 in)	No	None
LR	255 kPa (37 psi)	6 mm (8/32 in)	No	None
RR	200 kPa (29 psi)	6 mm (8/32 in)	No	None
RF	193 kPa (28 psi)	7 mm (9/32 in)	Yes	None

The seating in the Kia Spectra5 was configured with fabric covered front bucket seats with adjustable head restraints and a rear 60/40 split folding bench seat with adjustable headrests. The front seats were covered with aftermarket seat covers. The driver's seat was located one setting forward of the rear most track position. The front right seat was located in the rear most track position.

Vehicle Damage

Exterior Damage - 2006 Kia Spectra5

The 2006 Kia Spectra5 sustained minor frontal damage as a result of the impact with the Cadillac Escalade (**Figure 4**). The direct damage began at the right front bumper corner and extended 26 cm (10.2 in) laterally along the frontal plane. The damage extended 59 cm (23.2) down the right side of the vehicle. The right side wheelbase was compressed by 8 cm (3.1 in) and the front right tire was restricted. The Collision Deformation Classification (CDC) for the impact with the Escalade as 01FREE3.



Figure 4. Front right damage

The Spectra5 also sustained moderate top and left side damage as a result of the rollover (**Figure 5**). The direct damage to the top began at the hood line and measured 152 cm (59.8 in) wide by 96 cm (37.8 in) rearward on the hood. There was also direct damage beginning at the windshield header area that measured 120 cm (47.2 in) wide by 26 cm (10.2 in) rearward on the roof. There was also direct contact along the left side plane that began 14 cm (5.5 in) forward of the rear axle and extended forward 296 cm (116.5 in) along the left side plane. The maximum vertical crush (**Figure 6**) was located at the right A pillar and measured 2 cm (0.8 in). The CDC for the rollover was 00TYDO2.



Figure 5. Rollover damage

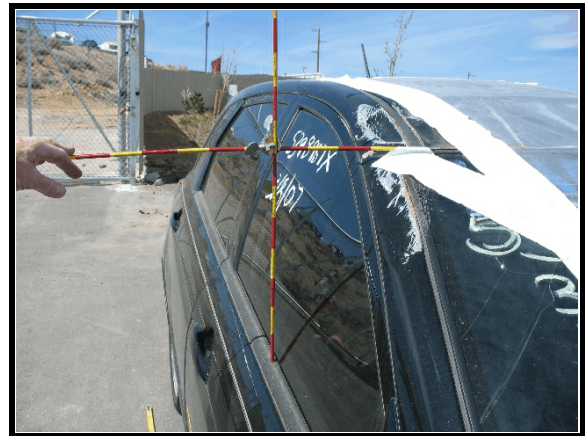


Figure 6. Maximum rollover crush

Interior Damage - 2006 Kia Spectra5

The Kia Spectra5 sustained minor interior damage as a result of passenger compartment intrusion. There was 2 cm (0.8 in) of vertical intrusion from the roof at the second row left seat position. The intrusion appeared to be as a result of compression from the side forcing the roof downward rather than direct downward crush.

Manual Restraint Systems - 2006 Kia Spectra5

The 2006 Kia Spectra5 was configured with manual 3-point lap and shoulder belts for all five seat positions. Both front seat safety belts were equipped with retractor pretensioners with force limiters and adjustable shoulder anchorages. The driver's shoulder anchorage was in the mid position; the front right passenger's anchorage was in the full down position. The driver's safety belt was configured with a sliding latch plate and an Emergency Locking Retractor (ELR). The remaining safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractors (ALR).

The second row outboard seating positions were equipped with the lower anchor points that are part of this vehicle's Lower Anchors and Tethers for Children (LATCH) system. All three second row seating positions were equipped with child safety seat top tether anchor points located behind the second row seat backs.

Both front seat belt exhibited indications of historical usage and were used during this crash. The rear left safety belt was used to secure a rear facing infant seat.

Supplemental Restraint System - 2006 Kia Spectra5

The Kia Spectra5 was equipped with advanced occupant protection systems including multistage Certified Advanced 208-Compliant driver and front right passenger air bags. The multistage air bags were certified by the manufacturer to meet the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The Kia was also equipped with front seat back mounted side air bags and front/rear side head curtain air bags. There were no air bag deployments.

Infant Safety Seat

Baby Trend Flex Loc

A rear facing Baby Trend Flex Loc infant seat was positioned in the left rear seat of the Kia Spectra5 (**Figure 7**). The model number was 6306 and the date of manufacture was April 5, 2006. The infant seat was purchased new by the current owner for the child involved in this crash. The infant seat was configured with a five-point harness system and an A-lock harness buckle. The seat was also configured with a level indicator that helps ensure that the seat is installed at the optimal angle (**Figure 8**). The seat is designed with a stay-in-vehicle base that is LATCH compliant. The base and LATCH system was not used in this crash. The manufacturer recommends that the seat be used rear facing for children weighing 2-10 kg (5-22 lbs). The child in this case met the weight recommendation (8 kg/17 lbs).

The infant seat was installed by the driver. She had received some instruction about installation from the hospital when taking the child home. She had not read any manuals and was unaware of how the belt system worked. The seat was secured to the vehicle using the lap and shoulder belt. The webbing was routed through the rear facing slots. The retractor was in the ELR mode and a locking clip was not used. The harness clip was near the arm pit level. The driver described the space between the child and the harness as being approximately two fingers wide. The carrying handle was in the UP position. There was some light scuffing to the belt guide on the right side of the seat (**Figure 9**).



Figure 7. Baby Trend Flex Loc infant seat



Figure 8. Seat angle indicator



Figure 9. Scuffing, right seat belt guide 6

VEHICLE DATA - 2005 Cadillac Escalade

Description:	2005 Cadillac Escalade 4x4 sport utility vehicle
VIN:	3GYFK66N75GXXXXXX
Odometer:	Unknown
Engine:	6.0L, V8
Reported Defects:	None
Cargo:	Unknown
Damage Description:	Minor contact damage to left front, per police report
CDC:	Unknown

OCCUPANT DEMOGRAPHICS - 2006 Kia Spectra5

	Driver	Occupant 2
Age/Sex:	21/Female	25/Male
Seated Position:	Front left	Front right
Seat Type:	Bucket	Bucket
Height:	168 cm (66 in)	173 cm (68 in)
Weight:	91 kg (200 lbs)	82 kg (180 lbs)
Occupation:	None	Unknown
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	NA
Driving Experience:	5 years	NA
Body Posture:	Normal, upright	Normal, upright
Hand Position:	Both hands on steering wheel, 11 and 1 o'clock position	Unknown
Foot Position:	Right foot on brake, left on floor	Both feet on floor
Restraint Usage:	Lap and shoulder belt available, used	Lap and shoulder belt available, used
Air bag:	Steering wheel mounted frontal air bag available, did not deploy. Seat back mounted side air bag available, did not deploy. Side air curtain available, did not deploy.	Top instrument panel mounted frontal air bag available, did not deploy. Seat back mounted side air bag available, did not deploy. Side air curtain available, did not deploy.

	Occupant 3
Age/Sex:	8 month/Female
Seated Position:	Second row left
Seat Type:	Split bench
Height:	61 cm (24 in)
Weight:	8 kg (17 lbs)
Occupation:	NA
Pre-existing Medical Condition:	None
Alcohol/Drug Involvement:	NA
Driving Experience:	NA
Body Posture:	Normal, reclined in infant seat
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt used with rear facing infant seat
Air bag:	Side air curtain available, did not deploy.

OCCUPANT DEMOGRAPHICS - 2005 Cadillac Escalade

	Driver	Occupant 2
Age/Sex:	67/Male	59/Female
Seated Position:	Front left	Front right
Seat Type:	Unknown	Unknown
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Occupation:	Unknown	Unknown
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	None
Driving Experience:	Unknown	NA
Body Posture:	Unknown	Unknown
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt used, per police report	Lap and shoulder belt used, per police report

Occupant Injuries -2006 Kia Spectra5

There were no injuries in this crash.

Occupant Kinematics - 2006 Kia Spectra5

Driver Kinematics

The 21-year-old female driver was seated in an upright posture and was restrained by the 3-point lap and shoulder belt. The shoulder belt anchorage was in the mid position. The seat track was positioned one setting forward of the rear most track position. The bucket seat was covered by an after-market seat cover. The driver's seat back had been moved post-crash. At impact with the Escalade, the driver initiated a slight forward trajectory to the right. She was held in place by the lap and shoulder belt. As the Kia was redirected to the left, the left side tires contacted the concrete median and the vehicle began a left side leading rollover. This appears to have been a fairly low speed event. The Kia rolled onto its left side and then onto the roof. The driver was displaced to the left as the vehicle engaged the median and tripped. As the vehicle rolled, the driver remained in place and came to rest still restrained in an upside down position. The driver was able to unlatch her seat belt and get out of the vehicle on her own. She did not report any injuries. She was transported by ground ambulance to a local hospital for evaluation.

Front Right Row Occupant Kinematics

The 26-year-old male front right occupant was seated in an upright posture and was restrained by the 3-point lap and shoulder belt. The shoulder belt anchorage was in the full down position. The seat track was positioned at the rear most track position. The bucket seat was covered by an after-market seat cover. At impact with the Escalade, the front right occupant initiated a slight forward trajectory to the right. He was held in place by the lap and shoulder belt. As the Kia was redirected to the left, the left side tires contacted the concrete median and the vehicle began a left side leading rollover. The Kia rolled onto its left side and then onto the roof. The front right occupant was displaced to the left as the vehicle engaged the median and tripped. As the vehicle rolled, the front right occupant remained in place and came to rest still restrained in an upside down position. The front right occupant was able to unlatch his seat belt and get out of the vehicle on his own. The front right passenger opened the left rear door. The child was still in the infant seat and was suspended upside down. He initially tried to remove the child seat but did not understand that it was being held in place by the vehicle's lap and shoulder belt. He was eventually able to remove the child from the infant seat by unfastening the infant seat harness. The front right occupant did not report any injuries. He was transported by ground ambulance to a local hospital for evaluation.

Second Row Left Occupant Kinematics

The 8-month-old female child was restrained in the rear-facing infant seat by the five-point harness (**Figure 10**). The infant seat was installed in the left rear position of the Kia Spectra5 with the vehicle's 3-point lap and shoulder safety belt. The retractor was in the ELR mode and a locking clip was not used. The harness clip was near the arm pit level. The driver described the space between the child and the harness as being approximately two fingers wide. The carrying handle was in the UP position. At impact with the Escalade, the left rear occupant initiated a slight forward trajectory to the right. She engaged to the infant seat back in some minimal fashion. As the Kia was redirected to the left, the left side tires contacted the concrete median and the vehicle began a left side leading rollover. The Kia rolled onto its left side and then onto the roof. The left rear occupant would have been displaced somewhat to her right (vehicle left) as the vehicle engaged the median and tripped. As the vehicle rolled, the left rear occupant remained in place and came to rest still restrained in the infant seat in an upside down position. She was removed from the vehicle by the front right occupant. There were no visible injuries to the child. She was transported by ground ambulance to a local hospital for evaluation.



Figure 10. Second row left seat position

Attachment 1. Scene Diagram

