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**Special Crash Investigations:
Possible Advanced Air Bag
Fatality Crash Investigation;
Vehicle: 2010 Kia Soul;
Location: California;
Crash Date: April 2019**

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16. Abstract This report documents the on-site investigation of a possible advanced air-bag-related fatality in a 2010 Kia Soul. This two-vehicle, head-on crash occurred in April 2019 at night on a curved 6-lane divided roadway in an urban area of California. The Kia Soul was traveling eastbound, driven by an unbelted 33-year-old female. The front row right seat was occupied by a belted 10-year-old male. A Kia Sorrento was traveling westbound, driven by a 34-year-old male who was operating as a transportation network company driver and had six passengers on board. The police report indicated that the occupants were belted. The driver of the Kia Soul reported that she had fallen asleep while driving home. The Kia Soul traveled to the left, struck the median, and then entered the left westbound travel lane. The front of the Kia Soul struck the front of the Kia Sorrento head-on, and both frontal air bags in the Kia Soul deployed. The driver of the Kia Soul sustained "A" (incapacitating) injuries. She was transported from the scene by ambulance. The 10-year-old front right occupant of the Kia Soul sustained fatal injuries. He was transported from the scene by ambulance. He was hospitalized and died four days after the crash. Based on the vehicle inspection and medical data obtained, it was determined that the air bag was not the source of the fatal injuries to the 10-year-old Kia Soul passenger.			
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Special Crash Investigations
Possible Advanced Air Bag Fatality Crash Investigation
Case Number: DS19013
Vehicle: 2010 Kia Soul
Location: California
Crash Date: April 2019

BACKGROUND

This report documents the on-site investigation of a possible advanced air-bag-related fatality in a 2010 Kia Soul (**Figure 1**). The vehicle was involved in a head-on crash with a 2013 Kia Sorrento. The investigation was intended to determine the crash events, occupant restraint usage, demographics, and possible injury mechanisms. The crash was identified during a review of Fatality Analysis Reporting System (FARS) crash reports. The Special Crash Investigations (SCI) group of the National Highway Traffic Safety Administration assigned the case to Dynamic Science, Inc., in June 2019. The vehicle inspection was completed in June 2019. The vehicle was not supported by the Bosch Crash Data Retrieval (CDR) system, and the vehicle's Event Data Recorder (EDR) was not imaged during the inspection. Based on the vehicle inspection and medical data obtained, it was determined that the air bag was not the source of the fatal injuries to the 10-year-old Kia Soul passenger.



Figure 1. The 2010 Kia Soul.

This two-vehicle crash occurred in April 2019 at night on a curved, 6-lane, divided roadway in an urban area of California. The Kia Soul was traveling eastbound, driven by an unbelted 33-year-old female. The front row right seat was occupied by a belted 10-year-old male. The Kia Sorrento was traveling westbound, driven by a 34-year-old male who was operating as a transportation network company driver. The vehicle had six passengers on board. The front right seat was occupied by a 28-year-old male, the second row left seat was occupied by a 20-year-old male, the second row middle seat was occupied by a 21-year-old male, the second row right seat was occupied by a 23-year-old male, the third row left seat was occupied by a 24-year-old female, and the third row right seat was occupied by a 20-year-old female. The police report indicated that the occupants were belted.

The driver of the Kia Soul reported that she had fallen asleep while driving home. The Kia Soul traveled to the left, struck the median, and then entered the left westbound travel lane. The front plane of the Kia Soul struck the front plane of the Kia Sorrento head-on. Both frontal air bags in the Kia Soul deployed during the crash. The driver of the Kia Soul sustained "A" (incapacitating) injuries. She was transported from the scene by ambulance. The 10-year-old front right occupant of the Kia Soul sustained fatal injuries. He was transported from the scene by ambulance. He was hospitalized and passed away four days after the crash. Four of the occupants of the Kia Sorrento

were transported from the scene by ambulance. Both vehicles were towed from the scene due to damage.

SUMMARY

Crash Site

The crash site was a curved 6-lane divided roadway in an urban area. The roadway was asphalt paved with three lanes of travel for westbound traffic and three lanes of travel for eastbound traffic. The lanes of travel were separated by a raised median and the roadway was bordered by raised concrete curbs. The eastbound approach had a positive 4 percent grade and the westbound approach had negative 2 percent grade. It was dark at the time of the crash and the roadway was lit by dual-arm street lights positioned in the median. The weather at the nearest reporting station was 22 °C (72 °F), 72 percent humidity, calm winds, and cloudy. The posted speed limit was 72 km/h (45 mph).

Pre-Crash

The Kia Soul was traveling eastbound in the third lane from the right (**Figure 2**), driven by an unbelted 33-year-old female. The front row right seat was occupied by a belted 10-year-old male. The Kia Sorrento was traveling westbound in the third lane from the right (**Figure 3**), driven by a 34-year-old male who was operating as a transportation network company driver. The driver of the Kia Sorrento reported that he was traveling at approximately 64 km/h (40 mph). The driver of the Kia Soul reported that she was on her way home and had fallen asleep.

Crash

The driver of the Kia Soul was asleep as the vehicle traveled through the apex of the left curve and departed the roadway to the left. The vehicle struck the south curb of the center median with its left front wheel/tire (Event 1). The vehicle traveled over the median and the north curb and entered the left westbound travel lane. The driver of the Kia Sorrento reported that he saw the Kia Soul enter his lane, but that there was insufficient time to react. The front plane of the Kia Soul struck the front plane of the Kia Sorrento (Event 2) head-on. Both frontal air bags in the Kia Soul deployed during the crash. The CDC-only algorithm of the WinSMASH program calculated a total delta V of 72 km/h (45 mph) for the Kia Soul. The longitudinal and lateral components were -71 km/h (-44 mph) and -13 km/h (-8 mph), respectively. The barrier equivalent speed



Figure 2. Eastbound approach for the 2010 Kia Soul.



Figure 3. Westbound approach for the 2013 Kia Sorrento.

(BES) was 73 km/h (45 mph). The results fit the model and appear reasonable. The WinSMASH program calculated a total delta V of 56 km/h (35 mph) for the Kia Sorrento. The longitudinal and lateral components were -56 km/h (-35 mph) and 0 km/h, respectively. The BES was 55 km/h (34 mph). Both vehicles came to rest in the westbound travel lane (**Figure 4**).

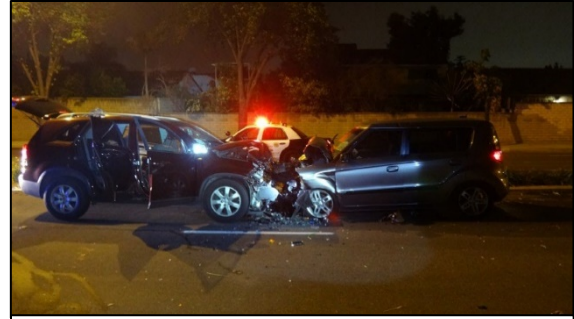


Figure 4. Final rest, looking south, the Kia Sorrento on left, Kia Soul on right (police image).

Post-Crash

The driver of the Kia Soul sustained “A” (incapacitating) injuries. She was transported from the scene by ambulance to a local trauma center where she was treated and released. The front right occupant of the Kia Soul was transported by ambulance to a local trauma center. According to hospital records, he reported that he was having a hard time breathing and had abdominal pain. A “focused assessment with sonography in trauma” (FAST) scan showed a right hemothorax and fluid in the abdomen. He was transferred to the pediatric intensive care unit in critical condition and went into surgery. At 1645 hours, it was reported that he became hypertensive, had tachycardia, and was noted to have dilated, non-reactive pupils. A CT scan showed severe diffused cerebral edema from large infarcts. He remained on supportive care and eventually progressed to brain death four days after the crash. Four of the occupants of the Kia Sorrento were transported from the scene by ambulance. Both vehicles were towed from the scene due to damage.

2010 KIA SOUL

Description

The Kia Soul was a 5-door, 5-passenger, subcompact crossover sport utility vehicle (SUV). The vehicle was identified by the Vehicle Identification Number KNDJT2A22A7xxxxxx and was manufactured in August 2009. The vehicle was equipped with a 2.0-liter, 4-cylinder, gasoline engine, had front-wheel drive, and 5-speed manual transmission. The vehicle manufacturer’s recommended tire size was P205/55R16 tires with a cold pressure of 228 kPa (33 psi). The vehicle was equipped with Arroyo Grand Sport A/S tires of the recommended size for the front and rear. The specific tire information was as follows:

Position	Measured Tread Depth	Restricted	Damage
LF	6 mm (7/32 in)	Yes	De-beaded
LR	5 mm (6/32 in)	No	None
RR	5 mm (6/32 in)	No	None
RF	4 mm (5/32 in)	No	None

The Kia was configured with seating for five occupants. The front row was equipped with bucket seats with adjustable head restraints. The second row was equipped with a 60/40 split bench with folding backs.

Exterior Damage

The Kia sustained minor damage to the left front wheel from the impact with the median. The Collision Deformation Classification (CDC) was 12FLWN3. The vehicle sustained severe front plane damage from the impact to the front plane of the Kia Sorento (**Figure 5**). The direct damage began at the left front bumper corner and extended 104 cm (40.9 in) to the right. The Field L extended from bumper corner to bumper corner. Thirteen measurements were taken at bumper backing bar level by the Nikon Total Station and the Faro Blitz program computed crush measurement in six increments as follows: $C_1 = 47$ cm (18.5 in), $C_2 = 48$ cm (18.8 in), $C_3 = 51$ cm (20.0 in), $C_4 = 51$ cm (20.0 in), $C_5 = 48$ cm (18.5 in), and $C_6 = 17$ cm (6.6 in). The maximum crush was located 83 cm (32.6 in) from the left front bumper corner and measured 51 cm (20.0 in). The CDC was 12FDEW3.

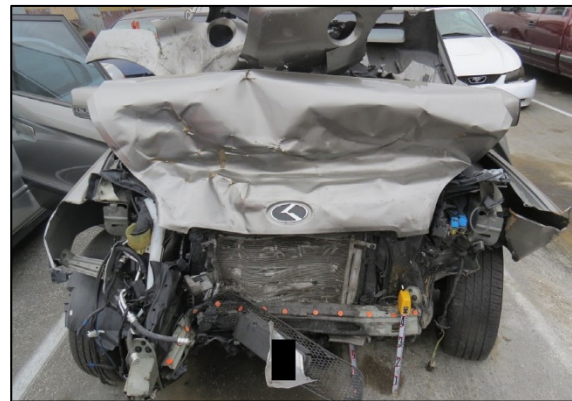


Figure 5. The 2010 Kia Soul.

NHTSA Recalls and Investigations

There was one unrelated recall associated with the VIN for this vehicle (13V114). This was related to the brake-shift interlock mechanism. The most recent query to the recall database was made in September 2020.

Interior Damage

The Kia sustained moderate interior damage as a result of occupant contacts, intrusion, and air bag deployments. There was longitudinal intrusion to the left toe pan. The foot controls were deformed. The steering wheel column was collapsed and the base of the column at the instrument panel was fractured. The glove compartment was contacted and fractured by occupant contact. The front right seat back was deformed forward. The windshield was fractured from hood contact and a displaced center mirror. There was no other glazing damage. The left door was jammed shut. All the other doors remained closed and operational.

Manual Restraint Systems

The front row was equipped with driver and front right passenger lap and shoulder seat belts. The driver's belt was equipped with continuous loop belt webbing, a sliding latch plate, an emergency locking retractor (ELR), and an adjustable upper anchor that was adjusted to the full-up position. The front right passenger's seat belt was equipped the same as the driver's, but had a switchable ELR/automatic locking retractor. The adjustable upper anchor was adjusted to the full-up position. The driver's seat belt did not exhibit any indications of use in this crash. The pretensioner did not actuate. The front right passenger's seat belt was used in this crash and the pretensioner actuated. The belt webbing was trapped in the sliding latch plate 33 cm (12.9 in) above the stop button and showed signs of loading (**Figures 6–7**).



Figure 6. Front right seat belt, the 2010 Kia Soul.

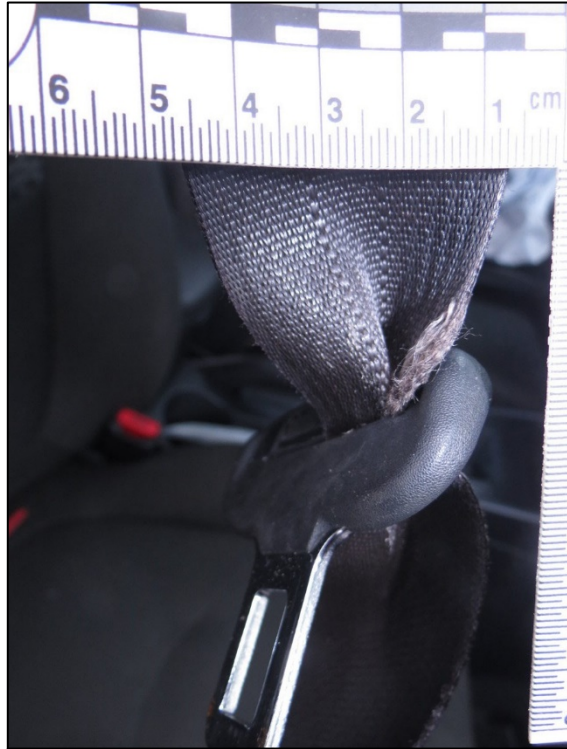


Figure 7. Front right seat belt, the 2010 Kia Soul.

Supplemental Restraint Systems

The Kia Soul was equipped with six air bags for supplemental restraint. The Soul was equipped with dual-stage driver's and passenger's frontal air bags, front row seat-mounted side air bags, and side impact inflatable curtain (IC) air bags for the front and second row seats. The frontal air bags did deploy during the impact to the Kia Sorrento.

The driver's frontal air bag deployed from an H-configuration module cover located in the hub of the steering wheel rim. The air bag was circular and measured 46 cm (18.1 in) in diameter in its deflated state (**Figure 8**). The air bag was configured with rear panel vent ports and was tethered. There were make-up contacts identified on the air bag face. The right passenger's frontal air bag deployed from the top of the instrument panel. The air bag was rectangular in shape and measured 41 cm (16.1 in) seam to seam and 51 cm (20.0 in) top to



Figure 8. Driver's frontal air bag, the 2010 Kia Soul.

bottom (**Figure 9**). There were no indications of occupant contact.

Passenger’s Frontal Air Bag Occupant Interaction Discussion

This investigation was initiated in response to the death of the 10-year-old male during a frontal crash and the occupant’s possible interaction with the passenger’s frontal air bag. Based on the vehicle inspection and medical data obtained, it was determined that the air bag was not the source of the fatal injuries. This occupant’s injuries were to the torso and abdomen and were attributed to interaction between the seat back and seat belt. This conclusion was based on multiple factors.

During the vehicle inspection, it was determined that the seat was at the rear most track position, there was no evidence of occupant contact to the air bag, there was evidence of knee contact to the glove compartment, there was interaction between the occupant and the rear seat back due to possible cargo movement, and the seat belt showed evidence of loading and was trapped in the sliding latch plate. This suggested that the occupant engaged and loaded the lap and shoulder seat belt with his torso and abdomen.



Figure 9. Passenger’s frontal air bag, the 2010 Kia Soul.

2010 KIA SOUL OCCUPANTS

Driver Demographics

Age/sex:	33 years/female
Height:	155 cm (61 in)
Weight:	57 kg (125 lbs)
Eyewear:	Unknown
Seat type:	Bucket
Seat track position:	Forward most
Manual restraint usage:	Lap and shoulder not used
Usage source:	Vehicle inspection
Air bags:	Frontal air bag deployed; side-impact and IC air bags not deployed
Alcohol/drug data:	None
Egress from vehicle:	Extricated by emergency personnel
Transport from scene:	Ambulance
Type of medical treatment:	Transported and released

Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Open wound, right knee	810600.1	Low instrument panel	Certain
2	Chest abrasion	410202.1	Driver's air bag	Probable

Source: police report.

Driver Kinematics

The 33-year-old driver was seated in a forward-most track position with the seat back slightly reclined and the head restraint adjusted to the mid position. She was not restrained by the manual seat belt system. There was no loading evidence on the belt system at the hard points of the D-ring and latch plate. Based on contact evidence in the vehicle, the Kia driver was positioned in line with the steering assembly. Her vertical posture is unknown but she did report being asleep prior to the crash.

The front left wheel struck the median curb. This was a relatively minor impact. As the vehicle entered the westbound left travel lane, the front of the Kia Soul struck the front plane of the Kia Sorrento, resulting in an impact force of 12 o'clock. The driver's frontal air bag deployed. The retractor pretensioner of the unbuckled seat belt did not actuate. The unbelted driver initiated a forward trajectory in response to the frontal crash forces. Her right knee struck the lower instrument panel. Her face and torso engaged the deployed air bag. The driver continued forward and compressed the steering wheel/column. Her feet and legs likely engaged and deformed the brake and accelerator pedals. The driver was removed from the vehicle by emergency personnel and was transported by ambulance to a local trauma center where she was treated and released.

Front Row Right Occupant Demographics

Age/sex: 10 years/male
Height: 145 cm (57 in)
Weight: 42 kg (93 lbs)
Eyewear: Unknown
Seat type: Bucket
Seat track position: Rear most
Manual restraint usage: Lap and shoulder used
Usage source: Vehicle inspection
Air bags: Frontal air bag deployed; side-impact and IC air bags not deployed
Egress from vehicle: Extricated by emergency personnel
Transport from scene: Ambulance
Type of medical treatment: Hospitalized for 4 days before death

Front Row Right Occupant Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Rib fractures, posterior 8-10, right	450203.3	ICS 1-Event 2; Seat back and shoulder belt	Probable
1	Rib fractures, posterior 8-10, right	450203.3	ICS 2-Event 2; Seat back	Possible
2	Hemothorax, right and left	442200.3	ICS 1-Event 2 Shoulder belt	Probable
2	Hemothorax, right and left	442200.3	ICS 2-Event 2; Seat back and shoulder belt	Possible
3	Bilateral lung contusions	441410.3	ICS 1-Event 2 Shoulder belt	Probable
3	Bilateral lung contusions	441410.3	ICS 2-Event 2; Seat back and shoulder belt	Possible
4	Lung laceration, right	441430.3	ICS 1-Event 2 Shoulder belt	Probable
4	Lung laceration, right	441430.3	ICS 2-Event 2; Seat back and shoulder belt	Possible
5	Splenic laceration	544220.2	Lap belt	Certain
6	Right chest wall contusion	410402.1	Shoulder belt	Probable
7	Abrasion, left chest	410202.1	Shoulder belt	Probable
8	Multiple injuries to abdominal organs	500099.9	ICS 1-Event 2 Shoulder belt	Certain
8	Multiple injuries to abdominal organs	500099.9	ICS 2-Event 2; Seat back and shoulder belt	Certain Possible
	Hemoperitoneum	Not codeable		

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
	Cerebral edema, cerebral infarction, shock	Not codeable, not related to head injury		

Source: ER report, autopsy report.

Front Row Right Occupant Kinematics

The 10-year-old front right occupant was seated in the rear most track position. He was restrained by the manual seat belt system. There was loading evidence to the latch plate and it was entrapped in the webbing. His vertical posture is not known but given the time of night and his age it was possible that he was asleep.

The front left wheel struck the median curb. This was a relatively minor impact. As the vehicle entered the westbound left travel lane, the front of the Kia Soul struck the front plane of the Kia Sorrento resulting in an impact force of 12 o'clock. The passenger's frontal air bag deployed. There were no indications that this occupant contacted the air bag. He engaged and loaded the lap and shoulder seat belt with his torso and abdomen. He submarined under the system and his knees struck the glove compartment (**Figures 10–11**). The front right passenger's seat back was deformed forward. The seat back deformation may have been due to cargo being displaced during the crash. At the time of the vehicle inspection, the second row seat back was in the down position and there may have been some type of cargo in the trunk. This occupant was removed from the vehicle by emergency personnel and was transported by ambulance to a local trauma center. He was hospitalized for four days before passing away.

2013 KIA SORRENTO

Description

The 2013 Kia Sorrento was a 5-door SUV. It was identified by the Vehicle Identification Number 5XYKT4A28DGxxxxxx. The vehicle was equipped with a 6-cylinder, 3.5-liter, gasoline engine coupled to a 6-speed, automatic transmission, ABS and front-wheel drive.



Figure 10. Contacts to glove compartment, the 2010 Kia Soul.



Figure 11. Contact to glove compartment, the 2010 Kia Soul.

Exterior Damage

The Kia Sorrento sustained major front plane damage from the impact with the Kia Soul (Figure 12). There was damage to the front bumper, hood, and both front fenders. The estimated CDC based on police images of the damaged vehicle was 12FDEW2. The vehicle was towed due to damage.

Occupant Data

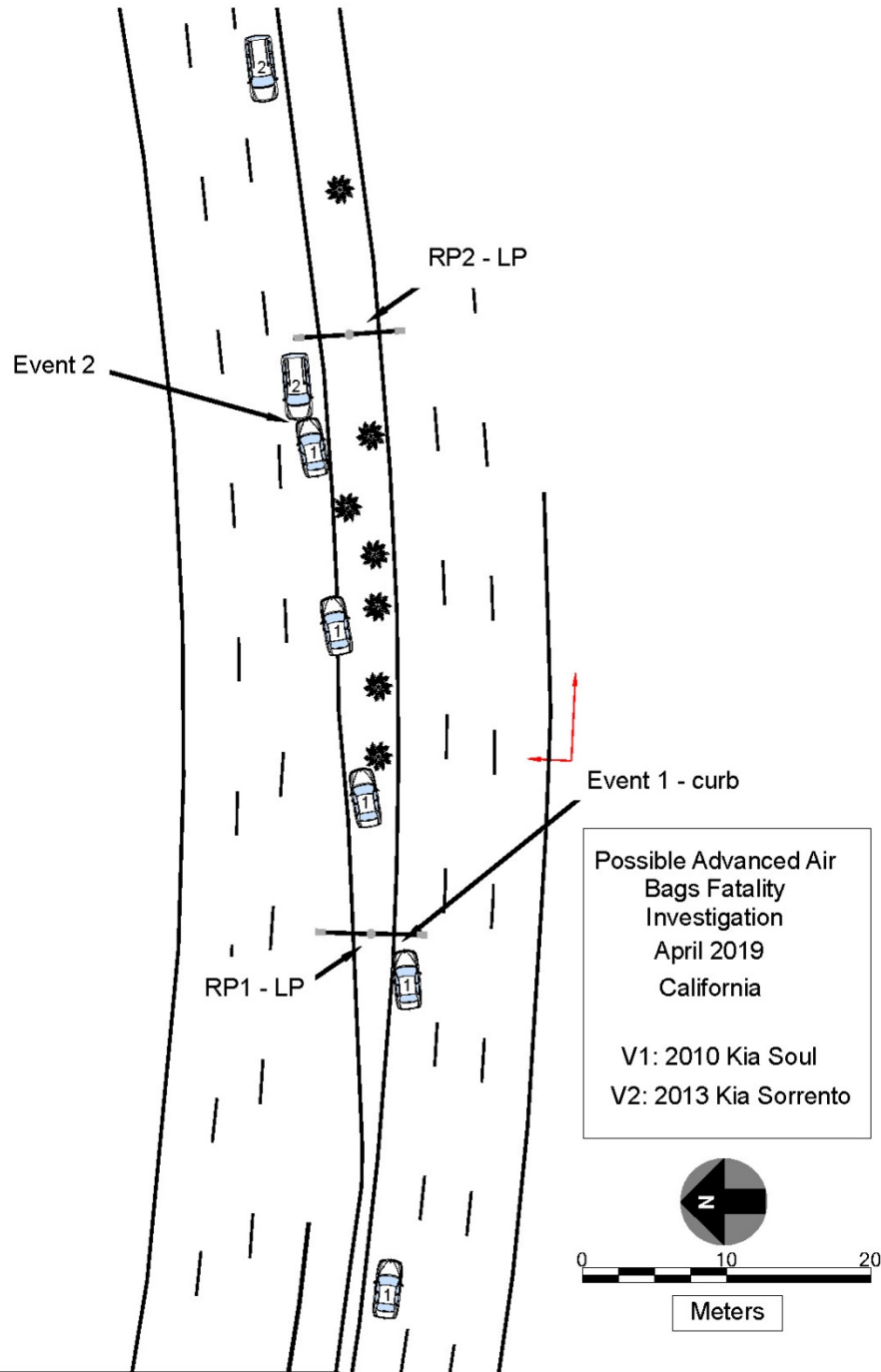
The Kia Sorrento was driven by a 34-year-old male who was operating as a transportation network company driver. The vehicle had six passengers on board. The front right seat was occupied by a 28-year-old male, the second row left seat was occupied by a 20-year-old male, the second row middle seat was occupied by a 21-year-old male, the second row right seat was occupied by a 23-year-old male, the third row left seat was occupied by a 24-year-old female, and the third row right seat was occupied by a 20-year-old female. The police report indicated that the occupants were belted. It is not known how the occupants exited the vehicle.



Figure 12. The 2013 Kia Sorrento (police image).

The driver sustained “A” (incapacitating) injuries and was transported to a local hospital by ambulance. The front right occupant sustained “B” (non-incapacitating) injuries and was transported to a local hospital by ambulance. The second row left occupant sustained “C” (possible) injuries. He indicated that he would seek treatment later on his own. The second row middle occupant sustained “B” (non-incapacitating) injuries and was transported to a local hospital by ambulance. The second row right occupant did not report any injuries. The third row left occupant sustained “A” (incapacitating) injuries and was transported to a local trauma center by ambulance. The third row right occupant sustained “C” possible injuries. She indicated that she would seek treatment later on her own.

CRASH DIAGRAM



	
Case Number:	DS19013

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