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Special Crash Investigations: On-Site Alleged Air Bag Non-Deployment Crash Investigation; Vehicle: 2017 Kia Forte; Location: Illinois; Crash Date: July 2017

DISCLAIMER

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15. Supplementary Notes

Each crash represents a unique sequence of events, and generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicles or their safety systems. This report and associated case data are based on information available to the Special Crash Investigation team on the date this report was published.

16. Abstract

This report documents the on-site investigation of a head-on crash involving a 2017 Kia Forte and a 2009 GMC Sierra 1500. A belted 37-year-old male driver and a belted 36-year-old male front row right passenger in the Kia sustained fatal injuries. A person reported the crash to the National Highway Traffic Safety Administration and alleged that the seat belt systems did not lock and that no air bags deployed. The Kia was equipped with a Certified Advanced 208-Compliant frontal air bag system for the driver and front passenger positions, front-seat-mounted and inflatable curtain side impact air bags, and front lower anchor and retractor pretensioners.

Through the course of this SCI investigation, it was concluded that at the time of the crash both Kia occupants were belted, all of the front lower anchor and retractor pretensioner systems actuated, and inflatable supplemental restraints deployed. This included the driver's and passenger's frontal air bags, the left IC air bag, and the left front seat-mounted air bag. The allegations made by the individual who reported the crash were inconsistent with the findings of this SCI investigation.

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Special Crash Investigations
On-Site Alleged Air Bag Non-Deployment Crash Investigation
Office of Defects Investigation
Case Number: CR18028
Vehicle: 2017 Kia Forte
Location: Illinois
Crash Date: July 2017

BACKGROUND

This report documents the on-site investigation of a head-on crash involving a 2017 Kia Forte (**Figure 1**) and a 2009 GMC Sierra 1500. A belted 37-year-old male driver and a belted 36-year-old male front row right passenger in the Kia sustained fatal injuries in the crash. A person reported the crash to the National Highway Traffic Safety Administration and alleged that the seat belt systems did not lock and that no air bags deployed. The Kia was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system for the driver and front passenger positions, front seat-mounted and inflatable curtain (IC) side impact air bags, and front lower anchor and retractor pretensioners. Through the course of this SCI investigation, it was concluded that at the time of the crash, both Kia occupants were belted, all of the front lower anchor and retractor pretensioner systems actuated, and inflatable supplemental restraints deployed. This included the driver's and passenger's frontal air bags, the left IC air bag, and the left front-seat-mounted air bag. The allegations made by the person who reported the crash were inconsistent with the findings of this SCI investigation.

Figure 1. Front left oblique view of the 2017 Kia Forte.

The crash was reported to NHTSA in August 2018. Notification was forwarded to the Crash Investigation Division and assigned for on-site investigation by the Special Crash Investigations (SCI) team at Crash Research & Analysis, Inc. in October 2018. The on-site portion of this investigation took place in October 2018, and consisted of an inspection of the Kia to document the exterior and interior damage, identify occupant contact/loading, and assess the vehicle's manual and supplemental restraint systems. The inspection of the Kia was attended by legal and technical representatives, including the Kia's manufacturer. No inspection of the GMC could be conducted, as it was sold at auction months prior to notification of the crash to NHTSA. The Kia was equipped with an air bag control unit (ACU) that had Event Data Recorder (EDR) capabilities, but it had been removed by the investigating law enforcement agency and retained as evidence.

Verbal and written requests to the law enforcement agency for copies of on-scene images and any EDR data retrieved from the involved vehicles remained unanswered as of the date of this report. No EDR data from either vehicle was available to the SCI investigator. Additional on-site activities included the documentation of the crash site using photographs and a total station mapping system. Medical record data was received from the local coroner's office.

CRASH SUMMARY

Crash Site

The crash occurred in the eastbound portion of a divided, limited-access roadway during the evening hours in July 2017. According to the National Weather Service, conditions in the locale at the time of the crash included mostly cloudy skies with a temperature of 23 °C (73 °F), a northwesterly breeze of 5 km/h (3 mph), and relative humidity of 74 percent. The SCI investigator documented the crash site using photographs and a Nikon Nivo 5+M total station mapping system.

The limited-access roadway consisted of a westbound and eastbound portion, divided by a depressed grass median. The eastbound portion consisted of two travel lanes, delineated by a broken white center lane line; a single, solid yellow median line; and a single, solid white fog line. A 1.9 m (6.2 ft) shoulder supported the left lane along the median, while a 2.2 m (7.2 ft) wide shoulder supported the right lane. The left lane measured 3.7 m (12.1 ft) wide, and the right lane was 3.6 m (11.8 ft) wide. There were tactile rumble strips cut into each shoulder parallel to the solid lane markings. A W-beam guardrail system paralleled the right road edge along a ravine in the vicinity of the crash. Speed of traffic was regulated by a posted limit of 89 km/h (55 mph). **Figure 2** depicts an eastbound view of the roadway for the Kia's pre-crash approach trajectory. A crash diagram is included at the end of this technical report.

Figure 2. Eastbound view of the roadway for the Kia's pre-crash travel trajectory.

Pre-Crash

The Kia was occupied by the belted 37-year-old male driver and belted 36-year-old male front row right passenger as it traveled east on the limited-access roadway. The two occupants were traveling back to their residence. The driver operated the Kia in the left lane along the dark roadway.

The GMC entered the eastbound lanes at an unknown location and began traveling westbound in the eastbound lanes (in the wrong direction). The GMC was operated by a belted 54-year-old male driver. It should be noted that the GMC's driver was later criminally charged with aggravated driving under the influence of alcohol.

A witness to the crash traveling west in the westbound portion observed the GMC pass them as it traveled west in the left lane of the eastbound portion. This witness placed a cellular telephone

call to the emergency response system and reported the wrong-way driver. Law enforcement units were dispatched to the area, when a follow-up call was received from the witness reporting that the GMC had crashed head-on into an eastbound sedan.

Crash

The crash (Event 1) occurred as the front plane/ left aspect of the GMC struck the front plane of the Kia head-on in the left eastbound lane. Directions of force were in the 12 o'clock sector for both vehicles. There was no evidence of any avoidance action by either driver documented by the law enforcement investigation of the crash, nor was there any visible evidence present at the time of the SCI inspection. Impact forces induced a counterclockwise rotation to both vehicles, and the greater momentum of the GMC reversed the Kia's trajectory. The Kia was displaced toward the southwest, while the GMC continued eastward. The vehicles experienced prolonged engagement and rotated counterclockwise about each other, before separating on their redirected trajectories. The Kia completed approximately 250 degrees of total rotation and came to final rest facing southwest on the south shoulder of the roadway. The GMC completed approximately 80 degrees of total rotation and came to final rest facing southwest on the median shoulder. **Figure 3** is an on-scene image that depicts the vehicles in their respective final rest positions.

Figure 3. East-facing view of the Kia and GMC at final rest (on-scene image obtained from an online news source).

During the crash, the occupants of the Kia exerted severe loading forces on the belt systems that tore the webbing of both systems. Additionally, the separation/severe deformation to the Kia resulted in the separation of the left front door structure. The combination of these circumstances resulted in the complete ejection of the Kia's driver as the vehicle slid to rest, as well as the displacement of the front right occupant from his seat position.

Post-Crash

Law enforcement, emergency medical services personnel, and fire department personnel responded to the crash scene. According to law enforcement documentation of the crash site, the Kia driver's body was found lying in the roadway immediately east of the Kia's final rest position, absent of vital life signs. The Kia's front row right occupant was displaced to the floor area beneath the right instrument panel, also absent of vital life signs. Both men were ultimately pronounced deceased at the crash scene. The GMC driver was found unresponsive in the vehicle. He was flown by helicopter to a regional trauma center, where he recovered. The GMC driver was criminally charged with felonious DUI and two counts of reckless homicide.

A local towing service recovered the Kia from the crash site and transferred it to a local yard. It was later deemed a total loss and transferred to a regional vehicle salvage facility, where it was being held under legal impound at the time of the SCI vehicle inspection. The GMC was also recovered from the crash scene and towed to a local facility, deemed a total loss by its insurer,

and transferred to a regional vehicle salvage facility. It was sold at auction prior to notification of the crash to NHTSA and unavailable for inspection.

2017 KIA FORTE

Description

The Kia (**Figure 4**), manufactured in February 2017, was identified by the vehicle identification number (VIN) 3KPFK4A76HExxxxxx. It was a 4-door sedan built on a 270 cm (106.3 in) wheelbase with a 2.0 liter, inline, 4-cylinder gasoline engine. The Kia's electronic odometer reading could not be obtained during the SCI inspection due to electrical system inoperability and complete destruction of the instrument cluster. The Kia had a gross vehicle weight rating of 1,760 kg (3,880 lb). Front and rear axle ratings were 980 kg (2,161 lb) and 910 kg (2,006 lb), respectively. The curb weight was 1,272 kg (2,804 lb). Placarding on the frame of the left front door declared that the vehicle manufacturer's recommended tire size and cold tire pressure for all four axle positions were P195/65R15 at 230 kPa (33 PSI). At the time of the SCI inspection, the vehicle was equipped with Nexen NPriz AH8 tires of the recommended size at all four axle positions. All tires had ample tread. Both rear tires remained inflated without damage or restriction. However, both front tires were flat. The left front tire had a large cut in the tread and sidewall, and was restricted. The right front was not damaged. All four tires had tire identification numbers that began with the nomenclature "UA8T."

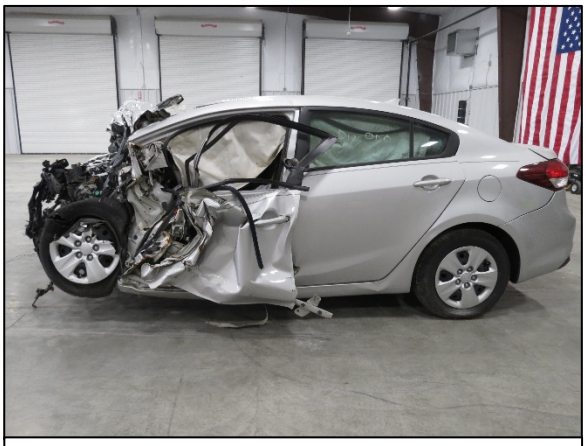


Figure 4. Left plane view of the 2017 Kia Forte at the time of the SCI vehicle inspection.

The interior of the Kia was configured for the seating of up to five occupants (2/3). The front row consisted of forward-facing bucket seats with adjustable head restraints. The front seats had manual seat track and seatback recline adjustments.

At the time of the SCI inspection, both the Kia's front seats were adjusted to their rearmost track positions. The driver's head restraint was positioned 5 cm (2.0 in) upward, while the front right head restraint was 11 cm (4.3 in) upward. Both the Kia's front seats were deformed by a combination of occupant loading and vehicle deformation related to the crash. The second row consisted of a non-adjustable bench seat. Manual restraint features in the Kia included 3-point lap and shoulder seat belts for all five seat positions. Supplemental restraint systems included the frontal, front-seat-mounted side impact, and side impact IC air bags.

Exterior Damage

Damage to the exterior of the Kia was located on the front plane (**Figure 5**), associative to the frontal crash event with the GMC. Direct contact began 50 cm (19.7 in) right of center and extended 135 cm (53.1 in) to the left front bumper corner of the Kia. The bumper fascia, front headlight assemblies, and grille were completely fractured and separated from the vehicle. Additionally, the bumper beam, radiator, and radiator support were also separated from the vehicle. Major longitudinal crush was observed to the front plane. The entire hood was deformed rearward and pushed onto the top of the instrument panel, with direct contact damage to the left

A-pillar. Severe longitudinal deformation significantly compressed the left front door, which separated the upper hinge from the A-pillar and released the latch from the striker. The left front door then swung open as the Kia rotated to final rest.

A residual crush profile was documented to the front plane of the Kia (**Figure 6**). Measurements were obtained at a high and low level to remaining vehicle structure, using a Field-L width of 130 cm (51.2 in) from the outside edges of the exposed frame rail ends. The averaged results of this profile included C1 = 107 cm (42.1 in), C2 = 99 cm (39.0 in), C3 = 94 cm (37.0 in), C4 = 89 cm (35.0 in), C5 = 82 cm (32.3 in), and C6 = 67 cm (26.4 in). Maximum crush in the profile was observed to the upper left of the front plane, above the left front bumper, and measured 118 cm (46.5 in). The left wheelbase was reduced by 31 cm (12.2 in). Based on the observed damage to the Kia, the collision deformation classification (CDC) assigned for the Event 1 impact was 12FDAW6.

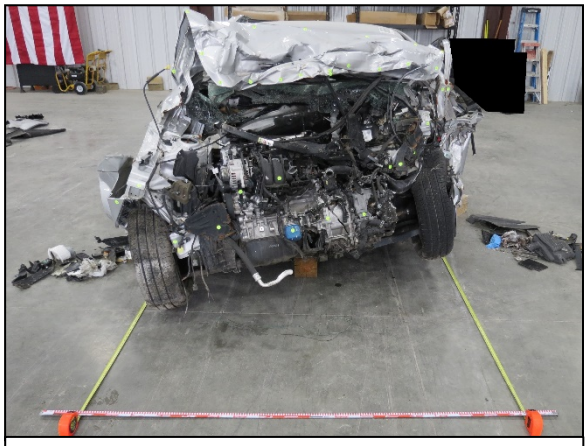


Figure 5. View of the Kia's front plane crush profile as documented during the SCI inspection.

The missing vehicle algorithm of the WinSMASH model was used to calculate a vehicle velocity change (delta V) reconstruction of the crash. The calculated total delta V of the Kia for the Event 1 impact with the GMC was 118 km/h (73 mph). Longitudinal and lateral components of the calculated delta V were -117 km/h (73 mph) and 21 km/h (13 mph), respectively. These results appeared reasonable, based on SCI expertise, the observed damage profile, and the circumstances of the crash.

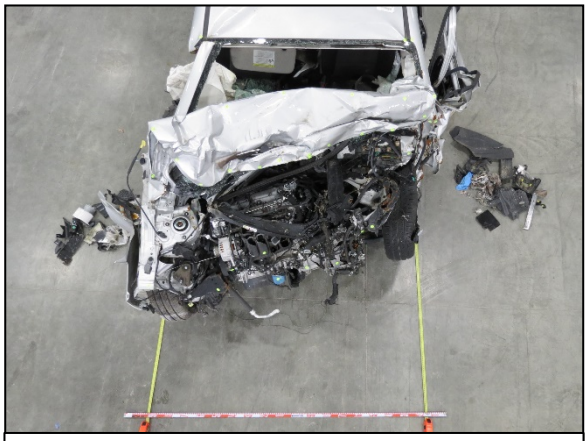


Figure 6. Overhead view of the front crush profile to the Kia.

Event Data Recorder

The Kia was equipped with an air bag control unit (ACU) that had EDR capabilities. However, the ACU had been removed from the Kia by the investigating law enforcement agency and retained as evidence. It was, therefore, unavailable to the SCI investigator or any other party for imaging during the joint vehicle inspection. The SCI investigator made multiple verbal and written requests to the investigating law enforcement agency for an electronic (CDRx or PDF) copy of the imaged data (if any) and/or access to the ACU for data retrieval, but did not receive any response as of the date of this report.

Interior Damage

The interior of the Kia was inspected for crash-related damage, including intrusion and occupant contact. There was major occupant compartment intrusion observed to the front row of the vehicle's interior associated with the severe frontal crash. The left A-pillar and the entire

instrument panel were displaced longitudinally into the occupant compartment by exterior deformation. There was also vertical and longitudinal intrusion of the floor/toe pan. Documented intrusions included the following:

Component	Magnitude	Direction
Left lower A-pillar	30 cm (11.8 in)	Longitudinal
Left instrument panel	26 cm (10.2 in)	Longitudinal
Left floor/toe pan	20 cm (7.9 in)	Longitudinal
Center instrument panel	14 cm (5.5 in)	Longitudinal
Left floor/toe pan	10 cm (3.9 in)	Vertical
Right instrument panel	5 cm (2.0 in)	Longitudinal

More than one year had passed between the date of the crash and the date of crash notification to NHTSA. Due to the passage of time and storage of the vehicle, a significant layering of dust, dirt, mold, and mildew covered the various surfaces of the vehicle's interior and components. This masked the visibility of surface contact evidence and hindered the investigator's ability to discern and document occupant contact. However, due to physical damage, the SCI investigator successfully identified driver loading to the seat belt system, deployed driver's frontal air bag, steering wheel/assembly/column, and left front door. Similarly, the SCI investigator also identified front passenger loading to the seat belt system, deployed frontal air bag, and right lower instrument panel. The contact and loading of the occupants to the seat belt systems and air bags are described in subsequent sections of this report.

The driver overloaded the seat belt system and deployed driver air bag, and in conjunction with the rearward intrusion of frontal components, he loaded the steering wheel and column. This contact and loading resulted in the complete fracture and separation of the steering wheel assembly, inclusive of the driver's frontal air bag module, from the steering column. It also sheared a section of the steering wheel rim from the assembly.

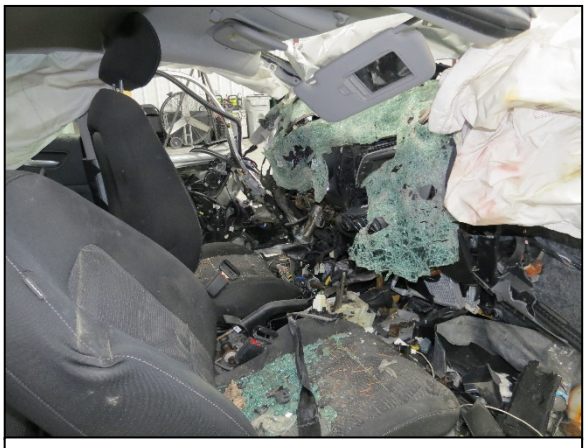


Figure 7. Left-facing view of the Kia's front row and the visible longitudinal intrusion of the instrument panel.

Figure 8. Sheared steering wheel and fractured assembly resultant from loading by the Kia's driver.

During his ejection through the opened left front door as the vehicle slid to final rest, the driver contacted the door's interior polymer paneling. This deposited blood residue and body tissue onto the panel's surface. **Figure 7** depicts the intrusion of the instrument panel and frontal components into the occupant compartment, while **Figure 8** depicts the fractured and separated steering wheel assembly that resulted from driver contact.

The front passenger also overloaded the seat belt system and deployed frontal air bag, and, in conjunction with the rearward intrusion of the instrument panel, he loaded and deformed the lower instrument panel.

Manual Restraint Systems

The Kia was equipped with 3-point lap and shoulder seat belt systems for all five seating positions. The front seat belt systems used continuous loop webbing with lightweight locking latch plates and adjustable D-rings. The driver's system retracted onto an emergency locking retractor (ELR), while the front passenger's seat belt utilized an ELR/automatic locking retractor (ALR). The front seat belt systems were also equipped with retractor and lower anchor pretensioners, which all actuated as a result of the crash. All three second-row systems were equipped with ELR/ALR retractors.

Due to identical loading characteristics and resulting damage, both the driver and front passenger seat belt systems are discussed in this report concurrently. At the time of the SCI inspection, the driver's D-ring was adjusted fully upward, and the front passenger's was adjusted fully downward.

The latch plates of both systems remained engaged in their respective buckles, and the webbing of both systems was broken into two sections. Both latch plates were missing their respective lightweight locking mechanisms, and the webbing breaks both appeared frayed and stretched. As for the webbing, the driver's system had a 94 cm (37.0 in) lower portion and a 118 cm (46.5 in) upper section, while the front passenger's had a 74 cm (29.1 in) lower section and a 111 cm (43.7 in) upper section.

Figure 9. Webbing of the driver seat belt system in the Kia with blue fabric transfer from the driver's clothing.

Figure 10. Latch plate of the Kia's driver seat belt system with the lightweight locking portion missing.

The driver's system had 24 cm (9.4 in) of evidence from load limiter release, while the front passenger's had 17 cm (6.7 in) of evidence from load limiter release. Creasing and overloading were apparent to the webbing of both systems, with bright blue fabric transferred onto the driver's system. **Figure 9** depicts the webbing and blue fabric transfer on the driver's system, while **Figure 10** depicts the broken webbing.

Figures 11 and **12** depict the broken latch plates of the driver's and front passenger's seat belt systems.

Figure 11. Latch plate of the Kia's driver seat belt system with the lightweight locking portion missing.

Figure 12. Latch plate of the front passenger's seat belt system with the lightweight locking portion missing.

It was apparent to the SCI investigator that the Kia's occupants were restrained prior to the crash. Both occupants overloaded their respective seat belt system, evidenced by the creasing of the webbing and load limiter release. The combination of the high severity of the crash and their loading ultimately exceeded the tensile strength and broke the webbing of both systems. Both webbing breaks occurred in the belt path of the latch plate of both systems, and resulted in the separation of the lightweight locking inserts. The SCI investigator and other parties extensively searched the vehicle's interior for the separated lightweight locking inserts, without success in locating them.

Supplemental Restraint Systems

The Kia was equipped with front lower anchor and retractor pretensioners, as well as a CAC frontal air bag system, front-seat-mounted side impact air bags, and side impact IC air bags. All systems except for the right seat-mounted and right IC air bags actuated/deployed. The frontal air bag system consisted of frontal air bags for the driver and front passenger positions, with seat belt buckle switch sensors, seat track position sensors, and a front right occupant presence (weight) sensor. The front-seat-mounted and IC air bags were all side-impact systems. The Kia did not have rollover-sensing IC air bags.

According to a commercially available vehicle history report, the Kia was purchased new by its current owner just 2 months prior to the crash. It was not involved in any prior crashes. The supplemental restraint systems were original equipment, and had not required or received any specific service or maintenance.

The driver's frontal air bag deployed from the steering wheel hub-mounted module through the cover flaps without damage. It measured 58 cm (22.8 in) in overall diameter in its deflated state, and was internally tethered via a 25 cm (9.8 in) diameter circular center stitch pattern. A pair of 2 cm (0.8 in) diameter vents were located on the back of the air bag at the 11 and 1 o'clock positions. On the left side of the face of the air bag was a 5 cm (2.0 in) long tear. Although this tear did not appear to be related to occupant contact, the SCI investigator was unable to determine if the tear was related to the crash or had occurred post-crash. However, a 6 cm (2.4 in) long tear in the outer circumference of the deployed air bag at the 9 o'clock position, as well as a diagonal 38 cm (15.0 in) long tear on the back of the air bag were attributed to the driver's overloading of the air bag during the crash. These tears were the result of over-pressurization of the inflated bag as it was loaded and compressed between the driver as he was displaced forward and the steering wheel hub/column as it intruded rearward. The large tear in the back was located in the vicinity of where a section of the steering wheel sheared, which likely contributed to the size of the tear. **Figure 13** depicts the deployed Kia driver's frontal air bag, with the two small tears highlighted by yellow masking tape. **Figure 14** depicts the large tear. A visual inspection of the driver's frontal air bag module confirmed that the inflator was intact.

Figure 13. Deployed Kia driver's frontal air bag.

Figure 14. Tear on the back of the Kia driver's air bag.

The passenger's frontal air bag deployed from the top instrument panel-mounted module through the H-configuration cover flaps without damage. The air bag's overall measurements were 58 cm (22.8 in) tall by 36 cm (14.2 in) wide in its deflated state. It was vented by a 4 cm (1.6 in) diameter vent and a 6 cm (2.4 in) diameter vent on each side. Similar to the driver's frontal air bag, it had an 11 cm (4.3 in) long tear in the upper right aspect of its face, as well as a 23 cm (9.1 in) tear along its left side. Despite the lack of discernable occupant contact, like the driver's frontal air bag, it was evident that the passenger's frontal air bag had burst as a result of the combination of front row right occupant loading and rearward occupant compartment intrusion. **Figure 15** depicts the Kia's deployed passenger's frontal air bag, while **Figure 16** depicts the large burst tear. A visual inspection of the passenger's frontal air bag module confirmed that the inflator was intact.

Figure 15. Deployed passenger's frontal air bag in the Kia.

Figure 16. Large tear on the left side of the Kia's passenger's frontal air bag.

The left front seat-mounted side impact air bag deployed from the driver's seatback through the outer seam. It measured 60 cm (23.6 in) tall and 25 cm (9.8 in) wide in its deflated state. There was a 6 cm (2.4 in) vent on the leading edge near the center aspect of the air bag. No discernable occupant contact or loading was visible to the driver's side impact air bag (**Figure 17**).

The Kia's left IC air bag deployed from the left roof side rail through the edge of the headliner. It provided 50 cm (19.7 in) of vertical coverage and measured 175 cm (68.9 in) in overall length when deflated. It was tethered at the A-pillar by a piece of fabric. There was no discernable occupant contact to the Kia's left IC air bag (**Figure 18**).

Figure 17. Deployed Kia driver's seat-mounted side-impact air bag.

Figure 18. Deployed left IC air bag in the Kia.

NHTSA Recalls and Investigations

A query of the 2017 Kia Forte's VIN on www.safercar.gov identified that there were no open recalls and no investigations concerning this specific vehicle as of September 2020, the date this report was submitted.

Air Bag Non-Deployment Allegation Discussion

The person who reported this crash to NHTSA alleged that the seat belt systems did not lock and that the air bag systems did not deploy. As discussed, these allegations were inconsistent with the findings of this SCI investigation. The seat belt systems were in use at the time of the crash, their respective pretensioners actuated, and they did provide restraint for both belted occupants of the Kia. However, the severe forces of the crash and occupant loading exerted extreme tension on both systems. The webbing of both front seat belt systems broke in the belt path of the latch plate during the crash. Additionally, the allegation of no air bag deployment was inaccurate. The SCI investigator observed that both the driver and passenger frontal air bags were deployed, as well as the left IC and left front seat-mounted side impact air bags. The right front seat-mounted side impact and the right IC air bags did not deploy in the crash, and their deployment would not be commanded under the circumstances of this crash. The forces of the crash were from the 11 o'clock direction, associated with a left lateral force component. Absent a right lateral force component, the right-side impact air bags would not be commanded to deploy. There was no evidence to support the allegations reported to NHTSA.

2017 KIA FORTE OCCUPANT DATA

Driver Demographics

Age/sex:	37 years/male
Height:	191 cm (75 in)
Weight:	179 kg (395 lb)
Eyewear:	Eyeglasses/sunglasses
Seat type:	Bucket
Seat track position:	Seat at rear-most track position
Manual restraint usage:	Lap and shoulder belt
Usage source:	Vehicle inspection
Air bags:	Frontal, IC, and seat back (outboard) air bags available; all deployed (as a result of impact)
Alcohol/drug data:	.017 g/dL; drugs not found in specimen
Egress from vehicle:	Occupant fully ejected
Transport from scene:	None
Type of medical treatment:	No treatment; pronounced deceased at crash scene

Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Heart (myocardium) laceration-> perforation, either ventricular or atrial, with or without tamponade-> multiple lacerations; >50% tissue loss of a chamber, Atria	441016.6	Tandem IPC Initial: Interior – Shoulder portion of belt restraint Secondary: Left Air Bag – Steering wheel hub Tertiary: Front – Steering wheel hub/spoke	Certain Certain Certain
2	Heart (myocardium) laceration-> perforation, either ventricular or atrial, with or without tamponade-> multiple lacerations; >50% tissue loss of a chamber, Ventricle	441016.6	Tandem IPC Initial: Interior – Shoulder portion of belt restraint Secondary: Left Air Bag – Steering wheel hub Tertiary: Front – Steering wheel hub/spoke	Certain Certain Certain
3	Aorta, thoracic stated otherwise] laceration; perforation; puncture-> major; rupture; transection; segmental loss; blood loss >20% by volume, No Further Specificity	420210.5	Tandem IPC Initial: Interior – Shoulder portion of belt restraint Secondary: Left Air Bag – Steering wheel hub Tertiary: Front – Steering wheel hub/spoke	Certain Certain Certain

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
4	Thoracic spinal cord injury incomplete spinal cord injury with preservation of some motor and/or sensory function [includes anterior cord, central cord, lateral or posterior/Brown-Sequard syndromes, ASIA Grade B, C or D]-> with fracture, Vertebrae T4	610414.4	Tandem IPC Initial: Interior – Shoulder portion of belt restraint Secondary: Left Air Bag – Steering wheel hub Tertiary: Front – Steering wheel hub/spoke	Certain Certain Certain
5	Cerebrum hematoma (hemorrhage)-> subdural NFS	140650.3	Isolated Roof – Front header	Certain
6	Cerebrum subarachnoid hemorrhage NFS; no LOC	140693.2	Isolated Roof – Front header	Certain
7	Base (basilar) fracture NFS; dura intact	150200.3	Isolated Roof – Front header	Certain
8	Vault fracture closed; simple; undisplaced; diastatic; linear, Multiple, NFS	150402.2	Isolated Roof – Front header	Certain
9	Facial bone(s) fracture, NFS	250400.1	Unknown	Unknown
10	Scalp contusion; subgaleal hematoma, individual >6 months old, NFS	110402.1	Isolated Roof – Front header	Certain
11	Larynx laceration; puncture-> perforation; full thickness; 'fracture', NFS	340208.3	Isolated Front – Steering wheel rim	Probable
12	Trachea injury in Neck laceration; tear, NFS	341604.2	Isolated Front – Steering wheel rim	Probable

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
13	Sternum fracture [OIS II, III], No Further Specificity	450804.2	Tandem IPC Initial: Interior – Shoulder portion of belt restraint Secondary: Left Air Bag – Steering wheel hub Tertiary: Front – Steering wheel hub/spoke	Certain Probable Probable
14	Rib Cage fracture(s) without flail, any location unilateral or bilateral-> >=3 ribs [OIS II], Right Rib 1, Left Rib 1, Right Rib 2, Left Rib 2, Right Rib 3, Left Rib 3, Right Rib 4, Left Rib 4, Right Rib 5, Left Rib 5, Right Rib 6, Left Rib 6, Right Rib 7, Left Rib 7, Right Rib 8, Left Rib 8, Right Rib 9, Left Rib 9, Left Rib 10, Left Rib 11, Left Rib 12	450203.3	Tandem IPC Initial: Interior – Shoulder portion of belt restraint Secondary: Left Air Bag – Steering wheel hub Tertiary: Front – Steering wheel hub/spoke	Certain Certain Certain
15	Pleura laceration, Right, NFS	441800.2	Isolated Front – Steering wheel hub/spoke	Certain
16	Pleura laceration, Left, NFS	441800.2	Isolated Front – Steering wheel hub/spoke	Certain
17	Kidney laceration-> >1cm parenchymal depth of renal cortex, no collecting system, Right, NFS	541624.3	Tandem IPC Initial: Interior – Lap portion of belt restraint Secondary: Left Air Bag – Steering wheel hub Tertiary: Front – Steering wheel rim	Probable Probable Probable

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
18	Colon laceration, NFS	540820.2	Isolated Front – Steering wheel rim	Probable
19	Mesentery laceration-> minor; superficial, Multiple, NFS	542022.2	Tandem IPC Initial: Interior – Lap portion of belt restraint Secondary: Left Air Bag – Steering wheel hub Tertiary: Front – Steering wheel rim	Probable Probable Probable
20	Liver laceration, NFS	541820.2	Isolated Front – Steering wheel rim	Probable
21	Spleen laceration, NFS	544220.2	Isolated Front – Steering wheel rim	Probable
22	Femur fracture, NFS, Right	853000.3	Isolated Front – Left lower instrument panel (includes knee bolster)	Certain
23	Ulna fracture, NFS, Left	753200.2	Isolated Left Door Panel – Unknown/multiple quadrant	Possible
24	Humerus fracture, NFS, Right	751100.2	Isolated Front – Left instrument panel	Possible
25	Knee joint dislocation-> with articular cartilage involvement-> open, Left, NFS	874035.2	Isolated Front – Left lower instrument panel (includes knee bolster)	Certain
26	Pelvic ring fracture NFS [includes pelvic ring dislocation]	856100.2	Isolated Front – Left lower instrument panel (includes knee bolster)	Certain

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
27	Scattered abrasions to face, up to 10 cm, No Further Specificity	210202.1	Isolated Roof – Front header	Possible
28	Skin/subcutaneous/muscle abrasion, Superior/Upper Lip	210202.1	Unknown	Unknown
29	Skin/subcutaneous/muscle abrasion, Inferior/Lower Lip	210202.1	Unknown	Unknown
30	Skin/subcutaneous/muscle contusion; hematoma, Left Eye	210402.1	Isolated Roof – Front header	Possible
31	Skin/subcutaneous/muscle (Thorax) abrasion, Left Chest	410202.1	Isolated Interior – Shoulder portion of belt restraint	Certain
32	Skin/subcutaneous/muscle (Thorax) abrasion, Right Chest, up to 4 cm	410202.1	Isolated Front – Steering wheel rim	Probable
33	Scattered abrasions to torso, up to 20 cm, No Further Specificity	410202.1	Isolated Front – Steering wheel hub/spoke	Probable
34	Skin/subcutaneous/muscle laceration-> minor; superficial, Left Forearm, up to 13 cm	710602.1	Isolated Left Door Panel – Unknown/multiple quadrant	Probable
35	Skin/subcutaneous/muscle abrasion, Ventral Surface of Right Forearm, up to 5 cm	710202.1	Isolated Front – Left instrument panel	Probable
36	Skin/subcutaneous/muscle abrasion, Right Fingers, up to 0.2 cm	710202.1	Isolated Front – Left instrument panel	Probable
37	Skin/subcutaneous/muscle abrasion, Left Hand, up to 7 cm	710202.1	Isolated Left Door Panel – Unknown/multiple quadrant	Probable

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
38	Scattered lacerations to lower right extremity up to 30 cm, Not Further Specified	810602.1	Isolated Front – Left lower instrument panel (includes knee bolster)	Probable
39	Scattered lacerations to lower left extremity up to 30 cm, Not Further Specified	810602.1	Isolated Front – Left lower instrument panel (includes knee bolster)	Probable
40	Skin/subcutaneous/muscle abrasion, Left Hip, up to 16 cm	810202.1	Isolated Left Door Panel – Left rear lower quadrant	Probable
41	Skin/subcutaneous/muscle abrasion, Left Thigh, up to 9 cm	810202.1	Isolated Left Door Panel – Unknown/multiple quadrant	Probable

Source: autopsy reports.

Driver Kinematics

The 37-year-old male driver was positioned in the Kia's driver seat, with the seatback slightly reclined and the track in a rearmost position. He used the available 3-point lap and shoulder seat belt system for manual restraint, evidenced by the severe loading and post-crash condition of the system as observed by the SCI investigator during inspection.

The driver operated the Kia eastbound on the limited-access roadway. He did not detect the wrong-way driving GMC prior to the crash. At impact with the GMC, the driver initiated a forward trajectory. His body loaded the seat belt system, with the shoulder portion across his chest and the lap portion across his lower abdomen. Due to the severe nature of the crash forces, his loading of the system exceeded the tensile strength of the belt webbing. The webbing broke in the belt path of the latch plate, releasing his body and allowing unrestricted displacement. The driver's loading of the seat belt system contributed to numerous chest injuries, including multiple rib fractures, internal heart and lung injuries, and internal abdominal organ injuries.

As the crash forces continued to increase, the driver loaded through the deployed CAC frontal air bag. In conjunction with the rearward intrusion of the steering column and frontal components associated with the severe frontal crash, the driver compressed the inflated air bag with such force that the fabric burst in multiple locations. His body loaded and deformed the steering wheel rim and fractured the entire steering wheel assembly from the column. The combination of the driver's loading of the steering wheel and the rearward intrusion of the assembly/column resulted in and/or exacerbated numerous injuries to the driver's chest, including rib fractures, internal heart and lung injuries, and internal abdominal organ injuries.

Simultaneously, the driver loaded the intruding instrument panel with his lower extremities, which resulted in soft tissue injures, a right femur fracture, left knee dislocation, and pelvic ring fracture. His left arm contacted the intruding left door panel, resulting in an ulna fracture and soft tissue injuries. The driver's head contacted and engaged the windshield header, evidenced by a bloody skin transfer to the driver's sun visor and headliner, as well as deformation to the driver's sun visor and displacement of the hands-free microphone in the headliner. Loading of the windshield header by the driver's head resulted in multiple head injuries, including a basilar skull fracture, vault fracture, subdural hematoma, cerebral hemorrhage, and soft tissue injuries.

The driver was directed toward his left as the Kia rotated counterclockwise and was displaced toward the southwest. Deformation from the crash had compressed the left front door and caused the release of the left front door latch from the striker. This allowed the driver's door to swing open as the vehicle slid toward final rest. Subsequently, the driver fell out of the vehicle as it continued sliding toward final rest, which resulted in his complete ejection. He contacted the left door panel and roadway/ground during his ejection, probably resulting in/exacerbating multiple soft tissue injuries. The driver's body was found by the first arriving emergency personnel immediately east of the opened left front door, lying in the roadway. His body was absent of vital life signs, and he was pronounced deceased at the crash scene.

Front Row Right Occupant Demographics

Age/sex:	36 years/male
Height:	177 cm (70 in)
Weight:	120 kg (265 lb)
Eyewear:	Unknown
Seat type:	Bucket
Seat track position:	Seat at rear-most track position
Manual restraint usage:	Lap and shoulder belt
Usage source:	Vehicle Inspection
Air bags:	Frontal, seat-mounted, and IC air bags available; frontal deployed
Alcohol/drug data:	.155 g/dL; drugs not found in specimen
Egress from vehicle:	Occupant fatal before removed from vehicle
Transport from scene:	None
Type of medical treatment:	No treatment; pronounced deceased at crash scene

Front Row Right Occupant Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Heart (myocardium) laceration-> perforation, either ventricular or atrial, with or without tamponade-> multiple lacerations; >50% tissue loss of a chamber, Atria	441016.6	Tandem IPC Initial: Interior – Shoulder portion of belt restraint Secondary: Right Air Bag – Right top instrument panel Tertiary: Front – Right instrument panel	Certain Certain Certain
2	Heart (myocardium) laceration-> perforation, either ventricular or atrial, with or without tamponade-> multiple lacerations; >50% tissue loss of a chamber, Ventricle	441016.6	Tandem IPC Initial: Interior – Shoulder portion of belt restraint Secondary: Right Air Bag – Right top instrument panel Tertiary: Front – Right instrument panel	Certain Certain Certain
3	Aorta, thoracic stated otherwise] laceration; perforation; puncture-> major; rupture; transection; segmental loss; blood loss >20% by volume, No Further Specificity	420210.5	Tandem IPC Initial: Interior – Shoulder portion of belt restraint Secondary: Right Air Bag – Right top instrument panel Tertiary: Front – Right instrument panel	Certain Certain Certain
4	Trachea injury laceration-> avulsion; rupture; transection; massive destruction; crush, No Further Specificity	341610.4	Tandem IPC Initial: Interior – Shoulder portion of belt restraint Secondary: Right Air Bag – Right top instrument panel Tertiary: Front – Right instrument panel	Certain Certain Certain

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
5	Thoracic spinal cord injury complete spinal cord injury motor and sensory complete injury, includes complete spinal cord transection syndrome, [ASIA Grade A]-> with fracture, Vertebrae T2	610424.5	Tandem IPC Initial: Interior – Shoulder portion of belt restraint Secondary: Right Air Bag – Right top instrument panel Tertiary: Front – Right instrument panel	Certain Certain Certain
6	Mesentery laceration-> massive; avulsion; complex; tissue loss; devascularized or devitalized small bowel or colon, NFS	542026.4	Tandem IPC Initial: Interior – Lap portion of belt restraint Secondary: Right Air Bag – Right top instrument panel Tertiary: Front – Right instrument panel	Certain Probable Certain
7	Thoracic cavity injury Hemothorax, Right, NFS	442200.3	Tandem IPC Initial: Interior – Shoulder portion of belt restraint Secondary: Right Air Bag – Right top instrument panel Tertiary: Front – Right instrument panel	Certain Certain Certain
8	Thoracic cavity injury Hemothorax, Left, NFS	442200.3	Tandem IPC Initial: Interior – Shoulder portion of belt restraint Secondary: Right Air Bag – Right top instrument panel Tertiary: Front – Right instrument panel	Certain Certain Certain

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
9	Lung laceration-> unilateral-> minor; small; scattered, Right Lung Lobe 1	441431.3	Tandem IPC Initial: Interior – Shoulder portion of belt restraint Secondary: Right Air Bag – Right top instrument panel Tertiary: Front – Right instrument panel	Certain Certain Certain
10	Lung laceration-> unilateral-> minor; small; scattered, Right Lung Lobe 2	441431.3	Tandem IPC Initial: Interior – Shoulder portion of belt restraint Secondary: Right Air Bag – Right top instrument panel Tertiary: Front – Right instrument panel	Certain Certain Certain
11	Cerebrum hematoma (hemorrhage)-> subdural NFS	140650.3	Isolated Front – Center instrument panel	Probable
12	Cerebrum pneumocephalus directly related to head trauma, NFS	140682.3	Isolated Front – Center instrument panel	Probable
13	Cerebrum intraventricular hemorrhage NFS; no LOC, Right	140678.2	Isolated Front – Center instrument panel	Probable
14	Cerebrum intraventricular hemorrhage NFS; no LOC, Left	140678.2	Isolated Front – Center instrument panel	Probable
15	Cerebrum subarachnoid hemorrhage NFS; no LOC	140693.2	Isolated Front – Center instrument panel	Probable

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
16	Diaphragm laceration Left with herniation of the spleen	440610.4	Tandem IPC Initial: Interior – Shoulder portion of belt restraint Secondary: Right Air Bag – Right top instrument panel Tertiary: Front – Right instrument panel	Certain Certain Certain
17	Spleen laceration-> simple capsular tear <=3cm parenchymal depth and no trabecular vessel involvement; minor; superficial [OIS I, II], NFS	544222.2	Tandem IPC Initial: Interior – Lap portion of belt restraint Secondary: Right Air Bag – Right top instrument panel Tertiary: Front – Right instrument panel	Certain Certain Certain
18	Liver laceration-> simple capsular tears; <=3cm parenchymal depth; <=10cm long; minor; superficial [OIS I, II], NFS	541822.2	Tandem IPC Initial: Interior – Lap portion of belt restraint Secondary: Right Air Bag – Right top instrument panel Tertiary: Front – Right instrument panel	Certain Certain Certain
19	Esophagus injury in Thorax contusion; hematoma [OIS I], NFS	440802.2	Isolated Front – Right instrument panel	Probable
20	Adrenal gland contusion; hematoma NFS [OIS I], Right	540210.1	Isolated Front – Right instrument panel	Probable
21	Base (basilar) fracture NFS; dura intact, Central/ Middle/Medial	150200.3	Isolated Front – Center instrument panel	Probable

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
22	Rib Cage fracture(s) without flail, any location unilateral or bilateral-> >=3 ribs [OIS II], Right Rib 1, Left Rib 1, Right Rib 2, Left Rib 2, Right Rib 3, Left Rib 3, Right Rib 4, Left Rib 4, Right Rib 5, Left Rib 5, Right Rib 6, Left Rib 6, Right Rib 7, Left Rib 7, Right Rib 8, Left Rib 8, Right Rib 9	450203.3	Tandem IPC Initial: Interior – Lap portion of belt restraint Secondary: Right Air Bag – Right top instrument panel Tertiary: Front – Right instrument panel	Certain Certain Certain
23	Sternum fracture [OIS II, III], NFS	450804.2	Tandem IPC Initial: Interior – Lap portion of belt restraint Secondary: Right Air Bag – Right top instrument panel Tertiary: Front – Right instrument panel	Certain Probable Probable
24	Femur fracture NFS, Left	853000.3	Right lower instrument panel	Certain
25	Pelvic ring fracture posterior arch intact; isolated fracture not destroying the integrity of the pelvic ring, Right Illium Bone, Right Ischium Bone, Left Ischium Bone, Right Pubic Rami, Left Pubic Rami	856151.2	Isolated Front – Right lower instrument panel (includes knee bolster)	Certain
26	Tibia fracture NFS, Right	854000.2	Isolated Front – Right lower instrument panel (includes knee bolster)	Certain
27	Fibula [malleoli] fracture NFS, Right	854441.2	Isolated Front – Right lower instrument panel (includes knee bolster)	Certain

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
28	Clavicle fracture NFS, Left	750500.2	Isolated Front – Center instrument panel	Certain
29	Humerus fracture NFS, Left	751100.2	Isolated Front – Center instrument panel	Certain
30	Scalp contusion; subgaleal hematoma, individual >6 months old, Right, 3.0 cm	110402.1	Isolated Front – Center instrument panel	Probable
31	Skin/subcutaneous/muscle laceration-> minor; superficial, Left Eye, 2.0 cm	210602.1	Isolated Front – Center instrument panel	Probable
32	Skin/subcutaneous/muscle abrasion, Right Cheek, 5.0 cm	210202.1	Isolated Front – Center instrument panel	Probable
33	Skin/subcutaneous/muscle (Thorax) abrasion, Left lateral chest, 7.0 cm	410202.1	Isolated Front – Center instrument panel	Probable
34	Skin/subcutaneous/muscle (Thorax) abrasion, Right Chest up to 8.0 cm	410202.1	Isolated Interior – Shoulder portion of belt restraint	Certain
35	Skin/subcutaneous/muscle (Thorax) abrasions near anterior surface of left torso that measures 30.0 x 33.0 cm	410202.1	Isolated Front – Center instrument panel	Probable
36	Skin/subcutaneous/muscle [except closed abdominal muscle injuries] (Abdomen) abrasion, Right Abdomen, up to 30 cm	510202.1	Isolated Interior – Lap portion of belt restraint	Probable
37	Skin/subcutaneous/muscle abrasion, Right Hip	810202.1	Isolated Interior – Lap portion of belt restraint	Probable
38	Scattered lacerations to upper left arm up to 2.0 cm	710602.1	Isolated Front – Center instrument panel	Probable

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
39	Scattered lacerations to left forearm, up to 3.0 cm	710602.1	Isolated Front – Center instrument panel	Probable
40	Skin/subcutaneous/muscle contusion; hematoma, Right Wrist, 5.0 cm	710402.1	Isolated Front – Right instrument panel	Probable
41	Skin/subcutaneous/muscle abrasion, Left Hand, 13.0 x 9.0 cm	710202.1	Isolated Front – Center instrument panel	Probable
42	Skin/subcutaneous/muscle laceration-> minor; superficial, Left Knee, 7.0 cm	810602.1	Isolated Front – Right lower instrument panel (includes knee bolster)	Certain
43	Scattered lacerations on lower right extremity up to 4.0 cm	810602.1	Isolated Front – Right lower instrument panel (includes knee bolster)	Probable
44	Scattered lacerations on lower left extremity up to 4.0 cm	810602.1	Isolated Front – Right lower instrument panel (includes knee bolster)	Probable
45	Scattered abrasions on lower right extremity up to 9.0 cm	810202.1	Isolated Front – Right lower instrument panel (includes knee bolster)	Probable
46	Scattered abrasions on lower left extremity up to 9.0 cm	810202.1	Isolated Front – Right lower instrument panel (includes knee bolster)	Probable

Source: autopsy reports.

Front Row Right Occupant Kinematics

The 36-year-old male front row right occupant was positioned in the Kia's front passenger seat, with the seatback slightly reclined and the track in a rearmost position. He used the available 3-point lap and shoulder seat belt system for manual restraint, evidenced by the severe loading and post-crash condition of the seat belt system as observed during the SCI inspection.

At impact with the GMC, the occupant initiated a forward trajectory. His body loaded the seat belt system, while his head and face contacted the deployed frontal air bag. He exerted intense loading force on the seat belt system, resulting in numerous soft tissue and internal injuries to his

chest and abdomen. Due to the severe associated forces, his loading of the system exceeded the tensile strength of the seat belt webbing. The webbing broke in the belt path of the latch plate, releasing his body and allowing unrestricted displacement. As the crash forces continued to increase, the occupant loaded the deployed frontal air bag. In conjunction with the rearward intrusion of the instrument panel and frontal components associated with the severe frontal crash, the occupant compressed the inflated air bag. His body loaded through the air bag, which deformed the instrument panel as it intruded rearward. Corresponding compression of the air bag by the front right occupant's body caused the fabric to burst in multiple locations. The occupant loaded the instrument panel with his chest and abdomen, resulting in the exacerbation of and additional injuries to his chest and abdomen. These injuries included numerous rib fractures, injuries to his heart and aorta, numerous thoracic injuries, and lacerations to his lungs, spleen, and liver.

During his forward loading, the occupant loaded the right lower instrument panel with his lower extremities. This resulted in multiple lower extremity fractures, a pelvic fracture, and numerous soft tissue injuries. His left arm contacted and engaged the intruding center instrument panel, which resulted in injuries to his left hand, left arm, and left shoulder. His torso contorted and extended on top of the instrument panel, which caused his head/face to engage the top aspect of the intruding center instrument panel. This resulted in extensive internal head injuries and soft tissue injuries. The occupant remained in the vehicle as it slid to final rest. Arriving emergency response personnel used hydraulic rescue tools to remove both right-side doors and extricate his body, but found him absent of vital life signs and pronounced him deceased.

2009 GMC SIERRA 1500

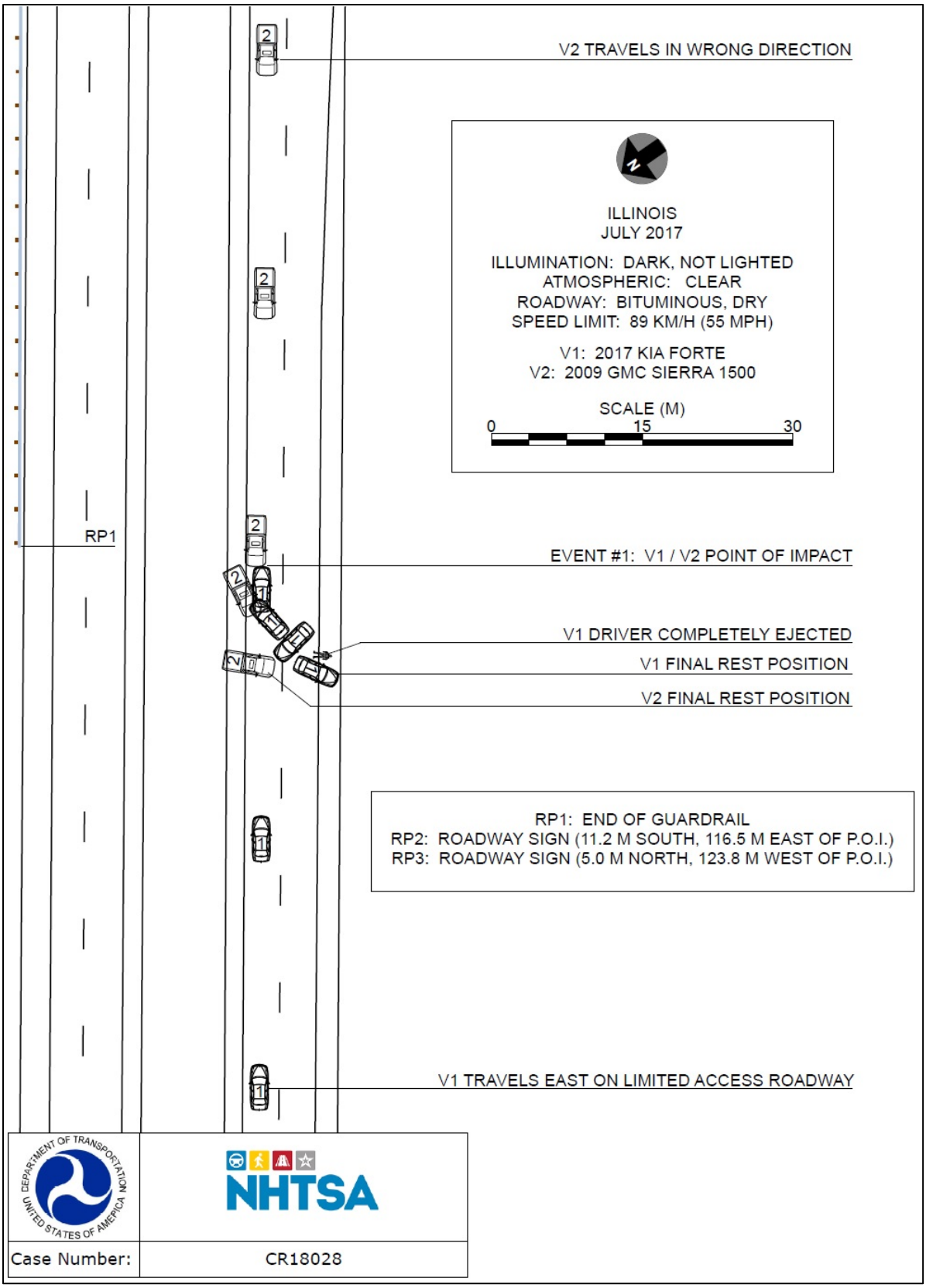
Description

The GMC was identified by the VIN 1GTEK24059Zxxxxxx. It was a single cab, standard bed-length pickup truck built on a 302 cm (119.0 in) wheelbase with a 5.3 liter, V-8, gasoline engine. The GMC was towed from the crash scene, deemed a total loss by its insurer, and sold at auction prior to notification of the crash to NHTSA. It was not available for inspection. The SCI investigator was unable to locate any further information concerning the GMC. Multiple verbal and written requests were made to the investigating law enforcement agency for an electronic (CDRx or PDF) copy of the imaged data (if any) and/or access to the GMC's ACU (if available) for data retrieval, but no response was received as of the date of this report.

Occupant Data

The GMC was operated by a belted 54-year-old male driver. According to a police crash report documenting the crash, the driver's frontal air bag in the GMC deployed in the crash. The driver was removed from the vehicle while unconscious/unresponsive and flown by helicopter to a regional trauma center. He ultimately recovered from his injuries and was subsequently arrested and charged with felonious aggravated DUI resulting in death and two counts of reckless homicide. Official reports stated that the GMC driver's blood toxicology results revealed that his blood alcohol content at the time of the crash was more than three times the legal limit.

CRASH DIAGRAM



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**National Highway
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