INDIANA UNIVERSITY
TRANSPORTATION RESEARCH CENTER
School of Public and Environmental Affairs
222 West Second Street
Bloomington, Indiana 47403-1501
(812) 855-3908 Fax: (812) 855-3537

ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE INVESTIGATION

CASE NUMBER - IN-03-037
LOCATION - OKLAHOMA
VEHICLE - 2003 GMC YUKON XL
CRASH DATE - July 2001

Submitted:

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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.

Technical Report Documentation Page

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16. *Abstract*

This report covers an on-site investigation of an air bag deployment crash that involved a 2003 GMC Yukon XL (case vehicle) and a 2000 Kia Sportage (other vehicle). This crash is of special interest because the case vehicle was equipped with multiple **A**dvanced **O**ccupant **P**rotection **S**ystem (**AOPS**) features, including certified advanced 208-compliant air bags, as well as an **E**vent **D**ata **R**ecorder (**EDR**) and the case vehicle's driver (23-year-old, female) sustained only a minor soft tissue injury from her deploying driver air bag. The trafficway on which both vehicles were traveling was a four-lane, undivided, city street, traversing in an east-west direction, and both the case vehicle and the Kia were approaching a four-leg intersection. On both the eastern and western legs of the intersection, the east-west roadway had two through lanes in both the east and westbound directions. The case vehicle was traveling east in the outside lane. The Kia had been traveling west in the inside through lane and was making a left-hand turn onto the intersecting roadway. The crash occurred in the outside eastern through lane, within the four-leg intersection of the two roadways. The front right of the case vehicle impacted the right back half of the Kia, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle's driver was seated with her seat track located in its rearmost position, and the tilt steering wheel was located in its center position. She was not using her available, active, three-point, lap-and-shoulder, integral safety belt system and sustained, according to her interview and her medical records, minor injuries that included: a cervical strain, sprains to her left shoulder and elbow joints, an abrasion on the medial side of her left forearm and a contusion to the dorsal surface of her left hand. The front right passenger (55-year-old, female) was seated with her seat track located in its middle position and was not using her available, active, three-point, integral lap-and-shoulder, safety belt system. She sustained, according to her interview and her medical records, minor contusions to her lower central chest and the right upper quadrant of her abdomen. The second seat left passenger (52-year-old, male) was seated on a non-adjustable bench seat and was not using his available, active, three-point, lap-and-shoulder, safety belt system. He did not sustain any injuries as a result of this crash. The second seat right passenger (81-year-old, female) was seated on a non-adjustable bench seat and was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. She sustained, according to the interview with the front right passenger and her medical records, minor soft tissue injuries which included: abrasions on the right side of her neck and on her lower right arm and minor contusions over her right mandible and right abdomen.

17. *Key Words* Advanced Air Bag Deployment: EDR Motor Vehicle Traffic Crash Injury Severity		18. *Distribution Statement* General Public	
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This investigation was brought to NHTSA's attention on August 1, 2003 by NASS GES sampling activities. This crash involved a 2003 GMC Yukon XL (case vehicle) and a 2000 Kia Sportage (other vehicle). The crash occurred in July 2003 at 5:45 p.m., in Oklahoma and was investigated by the applicable city police department. This crash is of special interest because the case vehicle was equipped with multiple **A**dvanced **O**ccupant **P**rotection **S**ystem (**AOPS**) features, including certified advanced 208-compliant air bags, as well as an **E**vent **D**ata **R**ecorder (**EDR**) and the case vehicle's driver [23-year-old, White (non-Hispanic) female] sustained only a minor soft tissue injury from her deploying driver air bag. This contractor inspected the scene and vehicles on August 19, 2003 and downloaded the data from the onboard **EDR**. This contractor interviewed the driver and front right passenger for the case vehicle between 12-16 September 2003. This report is based on the Police Crash Report, interviews with the case vehicle's driver and front right passenger, scene and vehicle inspections, occupant kinematic principles, occupant medical records, and this contractor's evaluation of the evidence.

SUMMARY

Crash Environment: The trafficway on which both vehicles were traveling was a four-lane, undivided, city street, traversing in an east-west direction, and both the case vehicle and the Kia were approaching a four-leg intersection. On both the eastern and western legs of the intersection, the east-west roadway had two through lanes in both the east and westbound directions. At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the roadway pavement was dry. Traffic density was not determined, and the site of the crash was a combination of urban residential and commercial; see **CRASH DIAGRAM** at end.

Pre-Crash: The case vehicle was traveling east in the outside lane and was approaching a partially controlled four-leg intersection, intended to proceed straight ahead. The Kia had been traveling west in the inside through lane and was making a left-hand turn onto the intersecting roadway, intending to travel south. According to the case vehicle's driver, no avoidance maneuvers were made prior to the crash. Based on the data downloaded from the case vehicle's **EDR**, the case vehicle's driver activated the brake pedal just prior to the crash. The crash occurred in the outside eastern through lane, within the four-leg intersection of the two roadways.

Crash: The front right of the case vehicle impacted the right back half of the Kia, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. Based on the downloaded **EDR** data, only one stage of the multi-stage air bags was activated.

Post-Crash: The case vehicle continued eastward while rotating approximately 20 degrees clockwise before coming to rest in the intersection, heading east-southeast. The Kia moved southward while rotating approximately 160 degrees clockwise before coming to rest on the southern leg of the intersection, heading in a north-northwesterly direction.

Case Vehicle: The 2003 GMC Yukon XL was a rear wheel drive (4x2), four-door sport utility vehicle (VIN: 1GKEC16Z43J------)and was **CERTIFIED ADVANCED 208-COMPLIANT**. The case vehicle was equipped with four wheel, anti-lock brakes, dual stage driver and front right passenger

air bag inflators, driver and front right passenger seat belt buckle switch sensors, and an occupant sensing system for the front right seating position. Front seat back-mounted side impact air bags and power-adjustable pedals were optional for this model, but this vehicle was not so equipped.

Vehicle Exterior: Based on the available insurance company photographs (i.e., front bumper and other components were removed prior to this contractor's vehicle inspection), the CDC for the case vehicle is estimated as: **11-FZEW-1** (**340** degrees). The WinSMASH reconstruction program, CDC-only algorithm–based on the measured crush profile for the Kia and the photo-estimated CDC for the case vehicle, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 11.0 km.p.h. (6.8 m.p.h.), -10.3 km.p.h. (-6.4 m.p.h.), and +3.8 km.p.h. (+2.4 m.p.h.). According to the case vehicle's **EDR**, the case vehicle was going approximately 66.0 km.p.h. (41 m.p.h.) just prior to the crash. The case vehicle was towed due to damage.

Exterior Damage: The case vehicle's contact with the Kia involved the front with the damage distributed on approximately the right half. Direct damage began at the front right bumper corner and, based on the available photographs, extended approximately 60 centimeters (23.6 inches) inward toward the driver's side. Residual crush measurements were not obtained because the bumper fascia, bumper, grille, hood, and right fender were removed prior to this contractor inspection but, based on the available photographs, maximum crush occurred at C_6. The case vehicle's wheelbase was unaltered from the crash. The case vehicle's front bumper, bumper fascia, grille, hood, right fender, and right headlight and turn signal assemblies were directly damaged and crushed rearward. The left and right fenders, left headlight and turn signal assemblies, right outside rear view mirror, right front door, right "A"-pillar, and the right side of the windshield's glazing sustained induced damage. No obvious induced damage or remote buckling was noted to the remainder of the case vehicle's exterior.

The vehicle manufacturer's recommended tire size was: P265/70R16, and the case vehicle tires were the recommended size. The case vehicle's tire data are shown in the table below. In addition, the side wall of the case vehicle's right front tire was damage (i.e., cut) and deflated.

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	221	32	241	35	8	10	None	No	No
RF	0	0	241	35	9	11	Cut sidewall	No	Yes
LR	228	33	241	35	9	11	None	No	No
RR	214	31	241	35	9	11	None	No	No

Vehicle Interior: Inspection of the case vehicle's interior revealed that there was no evidence of occupant contact on the interior surfaces of the case vehicle. Finally, there was no evidence of

intrusion to the case vehicle's interior, no evidence of compression to the energy absorbing shear capsules in the steering column, and no deformation to the steering wheel rim.

Supplemental Restraints: The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module's cover flaps and the air bag's fabric revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with two tethers, each approximately 13 centimeters (5.1 inches) in width. The driver's air bag had two vent ports, approximately 3 centimeters (1.2 inches) in diameter, located at the 11 and 1 o'clock positions. The deployed driver's air bag was round with a diameter of 63 centimeters (24.8 inches). An inspection of the driver's air bag fabric revealed very slight smudges, possibly makeup, on the fabric of the air bag's front surface in the lower left quadrant toward the 7 o'clock position.

The front right passenger's air bag was located in the middle of the instrument panel. An inspection of the front right air bag module's cover flap and the air bag's fabric revealed that the cover flap opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The front right passenger's air bag was designed with one tether, approximately 46 centimeters (18.1 inches) in width. The front right air bag had two vent ports, approximately 3.5 centimeters (1.4 inches) in diameter, located at the 2:30 and 9:30 clock positions. The deployed front right air bag was rectangular with a height of approximately 53 centimeters (20.9 inches) and a width of approximately 50 centimeters (19.7 inches). An inspection of the front right passenger's air bag fabric revealed no contact evidence readily apparent on the air bag's fabric.

Crash Data Recording: The data downloaded from the case vehicle's **EDR** showed the vehicle's SIR warning lamp status, driver's seat belt buckle status, brake switch status for the five recorded sample periods preceding the **ALGORITHM ENABLE**, ignition cycles at deployment, time from algorithm enable to deployment (i.e., air bag deployments) for both of the system's first and second stages, and velocity change (i.e., Delta V). Downloaded data of interest indicated the following. The case vehicle was traveling at a speed of 66 km.p.h. (41 m.p.h.), the driver's seat belt status showed it was not buckled, the second stage of the multi-stage air bags was not activated, and the Delta V reached a value of 10.0 km.p.h. (6.2 m.p.h.) at the 110 millisecond mark of recorded data; see **EVENT DATA RECORDER DATA**. This contractor believes that the recorded Delta V seems reasonable considering the amount of deformation to the case vehicle's front.

Other Vehicle: The 2000 Kia Sportage was a rear wheel drive (4x2), four-door sport utility vehicle (VIN: KNDJB723XY5------). The Kia was equipped with redesigned driver and front right passenger air bags and a driver side only knee air bag, none of which deployed as a result this vehicle's right side impact. Two-wheel, anti-lock brakes were standard equipment on this vehicle, and four-wheel, anti-lock brakes were optional.

Vehicle Exterior: Based on the vehicle inspection, the CDC for the Kia was determined to be: **02-RZAW-2** (**70** degrees). The WinSMASH reconstruction program, missing vehicle algorithm, was used on the Kia's highest severity impact. The Total, Longitudinal, and Lateral

Delta Vs are, respectively: 19.0 km.p.h. (11.8 m.p.h.), -6.5 km.p.h. (-4.0 m.p.h.), and -17.9 km.p.h. (-11.1 m.p.h.). The Kia was towed due to damage.

Exterior Damage: The Kia's contact with the case vehicle involved its right side with the damage distributed on approximately the back half. Direct damage began 202 centimeters (79.5 inches) rearward of the front right axle and extended 122 centimeters (48.0 inches) rearward along the right side. The field L began 166 centimeters (65.4 inches) rearward of the front right axle and extended 165 centimeters (65.0 inches) rearward as well. Residual maximum crush was measured as 17 centimeters (6.7 inches) at C_4. The wheelbase on the Kia's left side was shortened 4 centimeters (1.6 inches) while the right side was extended 4 centimeters (1.6 inches). The Kia's right rear door and right quarter panel were directly damaged and crushed inward. There was induced damage to the right front door, right "C" and "D"-pillars, and the back right stop/tail light and turn signal assemblies. In addition, both the right rear glazing and the second right glazing were disintegrated.

The vehicle manufacturer's recommended tire size was: P205/75R15, and the Kia's tires were the recommended size. The Kia's tire data are shown in the table below. In addition, the Kia's right rear tire was damaged (i.e., cut) and deflated from the crash.

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	248	36	179	26	4	5	None	No	No
RF	228	33	179	26	4	5	None	No	No
LR	241	35	179	26	5	6	None	No	No
RR	0	0	179	26	5	6	Cut sidewall	No	Yes

Case Vehicle's Driver: Immediately prior to the crash, the case vehicle's driver [23-year-old, White (non-Hispanic) female; 175 centimeters and 145 kilograms (69 inches and 320 pounds)] was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot on the brake, and her right hand on the center armrest. Furthermore, according to the driver's interview, her left hand was crossing the steering wheel's hub, gripping the rim at the "2 o'clock" position. Her seat track was located in its rearmost position, the seat back was upright, and the tilt steering wheel was located in its center position.

Based on this contractor's inspection of the case vehicle's driver safety belt system and substantiated by the **EDR** data, the driver was not using her available, active, three-point, lap-and-shoulder, integral safety belt system; the belt system was not equipped with a pretensioner. There was no mention by the driver of belt pattern bruising and/or abrasions to the driver's body, and the inspection of the driver's seat belt webbing, shoulder belt guide, and latch plate showed no evidence of loading.

Based on the **EDR** data, the case vehicle's brake switch circuit had been activated, indicating that she had her (right) foot on the brake pedal; however, the vehicle's recorded speed did not change just prior to the crash. The case vehicle's driver made no other known pre-crash avoidance maneuvers prior to the crash. As a result and independent of the nonuse of her available safety belt, the driver's pre-impact body position did not change just prior to impact. The case vehicle's impact with the Kia enabled the case vehicle's driver to continue forward and slightly upward and leftward along a path opposite the case vehicle's **340** degree Direction of Principal Force as the case vehicle decelerated. As a result of the impact, the driver loaded her deploying driver air bag, depositing smudges in the lower left quadrant of the air bag's front surface. In addition, the air bag's fabric abraded her left forearm and strained her left shoulder as her arm was driven backwards as the air bag expanded. As the case vehicle continued forward, while rotating approximately 20 degrees clockwise, the driver rebounded from her air bag contact and moved backwards and to her right toward the right side of her seat back as the vehicle came to final rest. The driver's exact posture at final rest is unknown, but she was most likely near her original pre-crash position and was able to exit the vehicle without assistance.

The driver refused transport to a medical facility from the scene but went to the hospital later to be examined. She sustained minor injuries and was treated and released. According to her interview and her medical records, the injuries sustained by the case vehicle's driver included: a cervical strain and sprains to her left shoulder and elbow joints. In addition, she sustained an abrasion (i.e., friction burn) on the medial side of her left forearm and a contusion to the dorsal surface of her left hand. The forearm abrasion, her neck strain, and her shoulder sprain resulted from the air bag. Her elbow sprain and hand contusion most likely occurred when the deploying air bag redirected her left arm toward the interior surface of her door.

Case Vehicle's Front Right Passenger: The case vehicle's front right passenger [55-year-old, (White, non-Hispanic) female; 173 centimeters and 104 kilograms (68 inches, 230 pounds)] was seated in an upright posture with her back against the seat back, her feet on the floor, and her right hand/arm on the right front door's armrest; however, the exact position of her left hand is unknown. Her seat track was located in its middle position, and the seat back was upright.

Based on this contractor's vehicle inspection, the case vehicle's front right passenger was not using her available, active, three-point, integral lap-and-shoulder, safety belt system; the belt system was not equipped with a pretensioner. There was no mention by the front right passenger of belt pattern bruising and/or abrasions to her body and the inspection of the front right passenger's seat belt webbing, shoulder belt guide, and latch plate showed no evidence of loading.

The front right passenger was not transported by ambulance to the hospital, but she sought treatment at a hospital emergency room later. She sustained minor soft tissue injuries and was treated and released. According to her interview and her medical records, she sustained contusions to her lower central chest and the right upper quadrant of her abdomen from contacting her deploying air bag.

Case Vehicle's Second Seat Left Passenger: The case vehicle's second seat left passenger [52-year-old, White (non-Hispanic) male; 175 centimeters and 109 kilograms (69 inches, 240 pounds)]

was seated in an upright posture with his back against the seat back and his feet on the floor. However, the exact position of his hands is unknown. There was no seat track, and the seat back was not adjustable.

Based on this contractor's vehicle inspection, the second seat left passenger was not using his available, active, three-point, lap-and-shoulder, safety belt system. There was no mention by the front right passenger that the second seat left passenger had any belt pattern bruising and/or abrasions to the his body, and the inspection of the second seat left passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading.

The second seat left passenger was not transported by ambulance to the hospital and did not seek subsequent medical treatment. Furthermore, he did not sustain any injuries as a result of this crash.

Case Vehicle's Second Seat Right Passenger: The case vehicle's second seat right passenger [81-year-old, White (non-Hispanic) female; 157 centimeters and 77 kilograms (62 inches, 170 pounds)] was seated in an upright posture with her back against the seat back and her feet on the floor. However, once again, the exact position of her hands is unknown. There was no seat track, and the seat back was not adjustable.

Based on the front right passenger's interviewee-reported injury information, the case vehicle's second seat right passenger was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The front right passenger indicated in her interview that the second seat right passenger sustained a belt pattern abrasion to her right neck. However, the inspection of the second seat right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading. Given the relatively minor [2-13 km.p.h. (1-8 m.p.h.)] nature of the case vehicle's Delta V, the lack of specific loading evidence is inconclusive.

The second seat right passenger was transported by ambulance to the hospital. She sustained minor injuries and was treated and released. According to the interview with the front right passenger and her medical records, the injuries sustained by the case vehicle's second seat right passenger included: abrasions on the right side of her neck and on her lower right arm and minor contusions over her right mandible and right abdomen. Her face, neck, and abdominal injuries were caused by her safety belts.

Kia's Occupants: According to the Police Crash Report, the Kia's driver [26-year-old, (unknown race and/or ethnic origin) male] was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. The driver was not transported by ambulance to the hospital, and he did not sustain any injuries as a result of this crash.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which both vehicles were traveling was a four-lane, undivided, city street, traversing in an east-west direction, and both the case vehicle (**Figure 1** below) and the Kia (**Figure 2** below) were approaching a four-leg intersection. On both the

eastern and western legs of the intersection, the east-west roadway had two through lanes in both the east and westbound directions. The city roadway was straight and level at the area of impact. The pavement was bituminous but traveled, and the width of the outside eastbound lane was 3.5 meters (11.5 feet) and the inside westbound lane was 3.3 meters (10.8 feet). The shoulders were improved (i.e., concrete rain gutters) and measured approximately 0.2 meters (6-8 inches) wide on both the north and south sides of the roadway prior to the curbs which protected the north and south roadsides, respectively. The roadway was bordered by barrier curbs. Pavement markings consisted of a double solid yellow centerline for both east and westbound traffic, and the lanes were divided by dashed white lines. In addition, no edge lines were present. The estimated coefficient of friction was 0.60 for the case vehicle's travel lane and 0.70 for the Kia's travel lane. There were no visible traffic controls located on roadway for the east and west legs. For the north and south legs of the four leg intersection, traffic controls consisted of regulatory **STOP** signs (Manual on Uniform Traffic Control Devices, R1-1) located on the applicable quadrants of the intersection. The speed limit was 64 km.p.h. (40 m.p.h.). No regulatory speed limit sign was posted near the crash site. At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the roadway pavement was dry. Traffic density was not determined, and the site of the crash was a combination of urban residential and commercial; see **CRASH DIAGRAM** at end.

Pre-Crash: The case vehicle was traveling east in the outside lane and was approaching a partially controlled four-leg intersection, intended to proceed straight ahead (**Figure 1**). The Kia had been traveling west in the inside through lane (**Figure 2**) and was making a left-hand turn onto the intersecting roadway, intending to travel south (**Figure 3**). According to the case vehicle's driver, no avoidance maneuvers were made prior

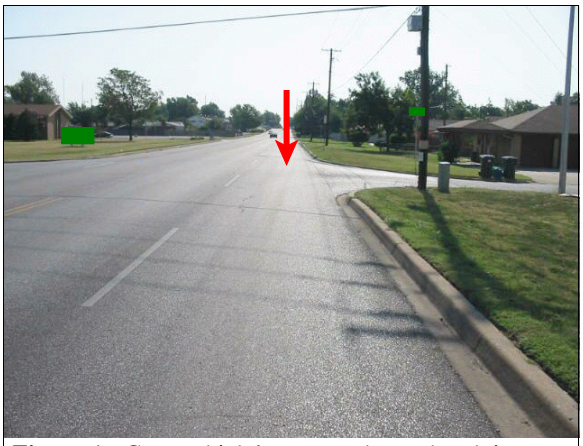


Figure 1: Case vehicle's eastward travel path in outside eastbound lane approaching four-leg intersection; Note: arrow indicates approximate area of impact (case photo #01a)

Figure 2: Kia's westward travel path in inside westbound lane prior to making left-hand turn; Note: arrow indicates approximate point of impact in outside eastbound lane (case photo #04)

Figure 3: Southwesterly view of Kia's travel path across eastbound lanes during left-hand turn; Note: arrow indicates approximate point of impact (case photo #05)

to the crash. Based on the data downloaded from the case vehicle's **EDR**, the case vehicle's driver activated the brake pedal just prior to the crash. The crash occurred in the outside eastern through lane, within the four-leg intersection of the two roadways (**Figure 4**).

Figure 4: Westward view from beyond impact (arrow) of case vehicle's eastward travel path in outside eastbound lane (case photo #03)

Crash: The front right (**Figure 5**) of the case vehicle impacted the right back half (**Figure 6**) of the Kia, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. Based on the downloaded **EDR** data, only one stage of the multi-stage air bags was activated.

Post-Crash: The case vehicle continued eastward while rotating approximately 20 degrees clockwise before coming to rest in the intersection, heading east-southeast. The Kia moved southward while rotating approximately 160 degrees clockwise before coming to rest on the southern leg of the intersection, heading in a north-northwesterly direction.

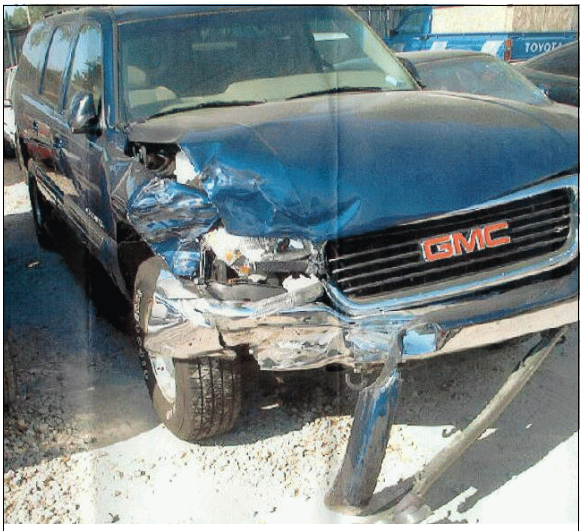


Figure 5: Insurance company photo of case vehicle's front right and corner damage (case photo #14)

Figure 6: Damage to rear portion of Kia's right side with contour gauge present (case photo #43)

CASE VEHICLE

The 2003 GMC Yukon XL was a rear wheel drive (4x2), nine-passenger, four-door sport utility vehicle (VIN: 1GKEC16Z43J------) equipped with a 5.3L, V-8 engine and a four-speed automatic transmission with overdrive. Braking was achieved by a power-assisted, front and rear disc, four-wheel, anti-lock system. The case vehicle's wheelbase was 330 centimeters (130.0 inches), and the odometer reading at inspection is unknown because the case vehicle was equipped with an electronic odometer.

The case vehicle was **CERTIFIED ADVANCED 208-COMPLIANT** and was equipped with dual stage driver and front right passenger air bag inflators, driver and front right passenger seat belt buckle switch sensors, and LATCH system features for the second seating area. Furthermore, there was an occupant detection and automatic air bag suppression system for the front right

passenger seating position. The various sensors in the case vehicle's advanced occupant restraint system analyze a combination of factors including the predicted crash severity and driver and front right passenger seat belt usage to determine the front air bag inflation level appropriate for the severity of the crash. For the front right seating position, an occupant pressure sensor and a seat belt tension sensor provide data to the electronic control module. The electronic control module (a) compares the seat pressure and seat belt tension data to threshold values, (b) determines if the front right air bag should be suppressed or enabled, and ©) communicates the decision to the air bag control module. The air bag will be suppressed when the seat pressure is at or below the established threshold ***or*** there is above normal tension on the safety belt (e.g., a secured child seat). The air bag will be enabled if the pressure is above the threshold ***and*** the seat belt tension is normal (e.g., a restrained adult occupant) or below (e.g., unrestrained occupant). Front seat back-mounted side impact air bags and power-adjustable pedals were optional for this model, but this vehicle was not so equipped. Finally, the case vehicle was also equipped with an **E**vent **D**ata **R**ecorder (**EDR**).

Inspection of the vehicle's interior revealed an adjustable front 40/20/40 split bench seat with adjustable head restraints for the outboard positions–the front center seat was not adjustable and had no head restraint; a non-adjustable second row 60/40 split bench seat with folding backs and adjustable head restraints for the back outboard seating positions and an integral head restraint for the second center seating position; a non-adjustable back bench seat that had been removed (i.e., most likely prior to the crash); continuous loop, three-point, integral lap-and-shoulder, safety belt systems at the front outboard positions; continuous loop, three-point, lap-and-shoulder, safety belt systems at the back outboard positions; a two-point, lap belt system at the front center position; and a continuous loop, three-point, integral lap-and-shoulder, safety belt system at the second center seating position. The case vehicle was not equipped with any manually operated, upper anchorage adjusters for the "D"-rings. The vehicle was equipped with knee bolsters for both the driver and front right passenger, neither of which showed evidence of occupant contact or deformation. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a frontal air bag for the driver and front right passenger seating positions. Both frontal air bags deployed as a result of the case vehicle's frontal impact with the Kia.

Figure 7: Insurance company photo of induced damage to case vehicle's left front corner (case photo #13)

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle's contact with the Kia involved the front with the damage distributed on approximately the right half (**Figure 5** above). Direct damage began at the front right bumper corner and, based on the available photographs, extended approximately 60 centimeters (23.6 inches) inward toward the driver's side. Residual crush measurements were not obtained because the bumper fascia, bumper,

grille, hood, and right fender were removed prior to this contractor inspection but, based on the available photographs, maximum crush occurred at C_6. The case vehicle's wheelbase was unaltered from the crash. The case vehicle's front bumper, bumper fascia, grille, hood, right fender, and right headlight and turn signal assemblies were directly damaged and crushed rearward. The left and right fenders, left headlight and turn signal assemblies (**Figure 7** above), right outside rear view mirror, right front door, right "A"-pillar, and the right side of the windshield's glazing sustained induced damage (**Figure 8**). No obvious induced damage or remote buckling was noted to the remainder of the case vehicle's exterior.

Figure 8: Close-up of induced damage to case vehicle's right fender, right outside rearview mirror, right "A"-pillar, and the right side of the windshield's glazing (case photo #08)

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	221	32	241	35	8	10	None	No	No
RF	0	0	241	35	9	11	Cut sidewall	No	Yes
LR	228	33	241	35	9	11	None	No	No
RR	214	31	241	35	9	11	None	No	No

The vehicle manufacturer's recommended tire size was: P265/70R16, and the case vehicle tires were the recommended size. The case vehicle's tire data are shown in the table above. In addition, the side wall of the case vehicle's right front tire was damage (i.e., cut) and deflated.

Vehicle Interior: Inspection of the case vehicle's interior revealed that there was no evidence of occupant contact on the interior surfaces of the case vehicle (**Figure 9** and **Figures 10** through **13** below). Finally, there was no evidence of intrusion to the case vehicle's interior, no evidence of compression to the energy absorbing shear capsules in the steering column, and no deformation to the steering wheel rim.

Figure 9: Case vehicle's front seating area viewed from outside driver's door showing deployed front air bags and no contact evidence on driver's knee bolster or instrumental panel or left "A"-pillar (case photo #16)

Figure 10: Case vehicle's driver seating area showing deployed driver air bag and no apparent evidence of occupant contact to left or center instrument panels or greenhouse area (case photo #19)

Figure 11: Case vehicle's front right passenger seating area showing deployed front right passenger air bag and no apparent evidence of occupant contact to either center or right instrument panel or greenhouse area (case photo #21)

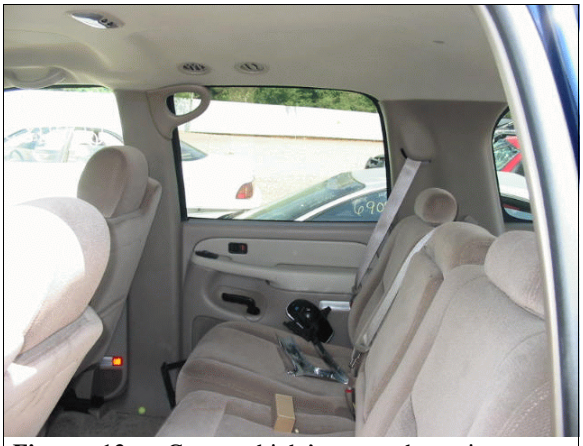


Figure 12: Case vehicle's second seating area viewed from left showing no obvious occupant contact evidence (case photo #35)

Figure 13: Case vehicle's second seating area viewed from right showing no obvious occupant contact evidence (case photo #36)

Damage Classification: Based on the available insurance company photographs (i.e., front bumper and other components were removed prior to this contractor's vehicle inspection), the CDC for the case vehicle is estimated as: **11-FZEW-1** (**340** degrees). The WinSMASH reconstruction program, CDC-only algorithm–based on the measured crush profile for the Kia and the photo-estimated CDC for the case vehicle, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 11.0 km.p.h. (6.8 m.p.h.), -10.3 km.p.h. (-6.4 m.p.h.), and +3.8 km.p.h. (+2.4 m.p.h.). According to the case vehicle's **EDR**, the case vehicle was going approximately 66.0 km.p.h. (41 m.p.h.) just prior to the crash. The case vehicle was towed due to damage.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained dual stage frontal air bags at the driver and front right passenger positions. Both frontal air bags

deployed as a result of the frontal impact with the Kia. Only one stage of the multi-stage air bags was activated. The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of asymmetrical, essentially, "I"-configuration cover flaps made of medium thickness vinyl. Both the left and right flaps were trapezoidal in shape with overall dimensions of 15 centimeters (5.9 inches) at the top horizontal seam, 10.5 centimeters (4.1 inches) at the bottom horizontal seam, and 12 centimeters (4.7 inches) vertically along the seam that separated the two flaps. An inspection of the air bag module's cover flaps and the air bag's fabric revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with two tethers, each approximately 13 centimeters (5.1 inches) in width. The driver's air bag had two vent ports, approximately 3 centimeters (1.2 inches) in diameter, located at the 11 and 1 o'clock positions. The deployed driver's air bag was round with a diameter of 63 centimeters (24.8 inches). An inspection of the driver's air bag fabric revealed very slight smudges, possibly makeup, on the fabric of the air bag's front surface in the lower left quadrant toward the 7 o'clock position (**Figures 14** and **15**).

Figure 14: Case vehicle's deployed driver air bag showing occupant contact evidence (i.e., arrows) on air bag's front surface in lower left quadrant near 7 o'clock position (case photo #25)

Figure 15: Close-up of contact evidence (i.e., smudges) near 7 o'clock position of case vehicle's deployed driver air bag (case photo #26)

The front right passenger's air bag was located in the middle of the instrument panel. There was a single, essentially rectangular, modular cover flap. The cover flap was made of a thick semi-pliable vinyl, thicker than the vinyl on the driver's module. The flap's dimensions were 39 centimeters (15.4 inches) at the lower horizontal seam and 15 centimeters (5.9 inches) along both vertical seams. The profile of the case vehicle's instrument panel was flush with the leading edge of the cover flap. An inspection of the front right air bag module's cover flap and the air bag's fabric revealed that the cover flap opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The front right passenger's air bag was designed with one tether, approximately 46 centimeters (18.1 inches) in width. The front right air bag had two vent ports, approximately 3.5 centimeters (1.4 inches) in diameter, located at the 2:30 and 9:30 clock positions. The deployed front right air bag was rectangular with a height of approximately 53 centimeters (20.9 inches) and a width of approximately 50 centimeters (19.7 inches). An inspection of the front right passenger's air bag fabric revealed no contact evidence readily apparent on the air bag's fabric (**Figure 16** below).

Figure 16: Case vehicle's deployed front right passenger bag showing no apparent contact evidence on air bag's front surface (case photo #30)

The data downloaded from the case vehicle's **EDR** showed the vehicle's SIR warning lamp status, driver's seat belt buckle status, brake switch status for the five recorded sample periods preceding the **ALGORITHM ENABLE**, ignition cycles at deployment, time from algorithm enable to deployment (i.e., air bag deployments) for both of the system's first and second stages, and velocity change (i.e., Delta V). Downloaded data of interest indicated the following. The case vehicle was traveling at a speed of 66 km.p.h. (41 m.p.h.), the driver's seat belt status showed it was not buckled, the second stage of the multi-stage air bags was not activated, and the Delta V reached a value of 10.0 km.p.h. (6.2 m.p.h.) at the 110 millisecond mark of recorded data; see **EVENT DATA RECORDER DATA** (**Figures 19** through **21**) below. This contractor believes that the recorded Delta V seems reasonable considering the amount of deformation to the case vehicle's front.

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash, the case vehicle's driver [23-year-old, White (non-Hispanic) female; 175 centimeters and 161 kilograms (69 inches and 355 pounds)] was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot on the brake, and her right hand on the center armrest. Furthermore, according to the driver's interview, her left hand was crossing the steering wheel's hub, gripping the rim at the "2 o'clock" position. Her seat track was located in its rearmost position, the seat back was upright, and the tilt steering wheel was located in its center position.

Based on this contractor's inspection of the case vehicle's driver safety belt system and substantiated by the **EDR** data, the driver was not using her available, active, three-point, lap-and-shoulder, integral safety belt system; the belt system was not equipped with a pretensioner. There was no mention by the driver of belt pattern bruising and/or abrasions to the driver's body, and the inspection of the driver's seat belt webbing, shoulder belt guide, and latch plate showed no evidence of loading.

Based on the **EDR** data, the case vehicle's brake switch circuit had been activated, indicating that she had her (right) foot on the brake pedal; however, the vehicle's recorded speed did not change just prior to the crash. The case vehicle's driver made no other known pre-crash avoidance maneuvers prior to the crash. As a result and independent of the nonuse of her available safety belt, the driver's pre-impact body position did not change just prior to impact. The case vehicle's impact with the Kia enabled the case vehicle's driver to continue forward and slightly upward and leftward along a path opposite the case vehicle's **340** degree Direction of Principal Force as the case vehicle decelerated. As a result of the impact, the driver loaded her

deploying driver air bag, depositing smudges in the lower left quadrant of the air bag's front surface. In addition, the air bag's fabric abraded her left forearm and strained her left shoulder as her arm was driven backwards as the air bag expanded. As the case vehicle continued forward, while rotating approximately 20 degrees clockwise, the driver rebounded from her air bag contact and moved backwards and to her right toward the right side of her seat back as the vehicle came to final rest. The driver's exact posture at final rest is unknown, but she was most likely near her original pre-crash position and was able to exit the vehicle without assistance.

CASE VEHICLE DRIVER INJURIES

The driver refused transport to a medical facility from the scene but went to the hospital later to be examined. She sustained minor injuries and was treated and released. According to her interview and her medical records, the injuries sustained by the case vehicle's driver included: a cervical strain and sprains to her left shoulder and elbow joints. In addition, she sustained an abrasion (i.e., friction burn) on the medial side of her left forearm and a contusion to the dorsal surface of her left hand. The forearm abrasion, her neck strain, and her shoulder sprain resulted from the air bag. Her elbow sprain and hand contusion most likely occurred when the deploying air bag redirected her left arm toward the interior surface of her door.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Strain, acute, cervical with minimal tenderness, not further specified	minor 640278.1,6	Air bag, driver's	Probable	Emergency room records
2	Sprain left shoulder[1], not further specified	minor 751020.1,2	Air bag, driver's	Probable	Interviewee (same person)
3	Sprain {strain}, minor, left elbow, not further specified	minor 750620.1,2	Left side interior hardware and/or armrest {air bag-related}	Possible	Emergency room records
4	Contusion, minor, left dorsal hand	minor 790402.1,2	Left side interior surface, excluding hardware and/or armrest {air bag-related}	Probable	Emergency room records
5	Abrasion {friction burn}, 17.8 cm x 0.6 cm (7 x 0.25 in), left medial forearm, not further specified	minor 790202.1,2	Air bag, driver's	Probable	Interviewee (same person)

[1] In this contractor's opinion, it is likely that this lesion and the one above are actually the same lesion, described differently by two separate sources.

The case vehicle's front right passenger [55-year-old, (White, non-Hispanic) female; 165 centimeters and 104 kilograms (65 inches, 230 pounds)] was seated in an upright posture with her back against the seat back, her feet on the floor, and her right hand/arm on the right front door's armrest; however, the exact position of her left hand is unknown. Her seat track was located in its middle position, and the seat back was upright.

Based on this contractor's vehicle inspection, the case vehicle's front right passenger was not using her available, active, three-point, integral lap-and-shoulder, safety belt system; the belt system was not equipped with a pretensioner. There was no mention by the front right passenger of belt pattern bruising and/or abrasions to her body and the inspection of the front right passenger's seat belt webbing, shoulder belt guide, and latch plate showed no evidence of loading.

The case vehicle's driver had just started to brake prior to the crash (i.e., based on the **EDR** data, the brake switch circuit had been activated but the vehicle's speed had not yet changed). As a result of this attempted avoidance maneuver and independent of the nonuse of her available safety belt, the front right passenger's pre-impact body position did not change just prior to impact. The case vehicle's impact with the Kia enabled the case vehicle's front right passenger to continue forward and slightly upward and leftward along a path opposite the case vehicle's **340** degree Direction of Principal Force as the case vehicle decelerated. As a result of the impact, the front right passenger loaded her deploying front right air bag with at least her chest and right upper abdomen. Although, no evidence of occupant contact was deposited on the air bag's front surface, the front right passenger distinctly recalls the interaction in her interview. As the case vehicle continued forward, while rotating approximately 20 degrees clockwise, the front right passenger rebounded from her air bag contact and moved backwards and to her right toward the right side of her seat back as the vehicle came to final rest. The driver's exact posture at final rest is unknown, but she was most likely near her original pre-crash position and was able to exit the vehicle without assistance.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right passenger was not transported by ambulance to the hospital, but she sought treatment at a hospital emergency room later. She sustained minor soft tissue injuries and was treated and released. According to her interview and her medical records, she sustained contusions to her lower central chest and the right upper quadrant of her abdomen from contacting her deploying air bag.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion {bruise}, large, 25.4 cm (10 in) diameter, from under breasts to stomach	minor 490402.1,4	Air bag, front right passenger's	Certain	Interviewee (same person)
2	Contusion {ecchymosis} right upper abdominal quadrant	minor 590402.1,1	Air bag, front right passenger's	Certain	Emergency room records

The case vehicle's second seat left passenger [52-year-old, White (non-Hispanic) male; 175 centimeters and 109 kilograms (69 inches, 240 pounds)] was seated in an upright posture with his back against the seat back and his feet on the floor. However, the exact position of his hands is unknown. There was no seat track, and the seat back was not adjustable.

Based on this contractor's vehicle inspection, the second seat left passenger was not using his available, active, three-point, lap-and-shoulder, safety belt system. There was no mention by the front right passenger that the second seat left passenger had any belt pattern bruising and/or abrasions to the his body, and the inspection of the second seat left passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading.

The case vehicle's driver had just started to brake prior to the crash (i.e., based on the **EDR** data, the brake switch circuit had been activated but the vehicle's speed had not yet changed). As a result of this attempted avoidance maneuver and independent of the nonuse of his available safety belt, the second seated left passenger's pre-impact body position did not change just prior to impact. The case vehicle's impact with the Kia enabled the case vehicle's second seated left passenger to continue forward and slightly upward and leftward along a path opposite the case vehicle's **340** degree Direction of Principal Force as the case vehicle decelerated. As a result of the impact, the second seated left passenger may have contacted the back of the driver's seat and/or the left "B"-pillar area; however because of the relatively minor [2-13 km.p.h. (1-8 m.p.h.)] nature of the case vehicle's Delta V, this occupant may have slowed his forward momentum by bracing (i.e., with his outstretched arms) himself against the driver's seat back and/or left "B"-pillar. Because there is no loading evidence on his safety belts or contact evidence on the case vehicle's interior, coupled with the lack of specific knowledge regarding his movements by the interviewees, his exact movements cannot be determined. As the case vehicle continued forward, while rotating approximately 20 degrees clockwise, the second seated left passenger rebounded backwards and to his right toward the right side of his seat back as the vehicle came to final rest. The second seated left passenger's exact posture at final rest is unknown, but he was most likely near his original pre-crash position and was able to exit the vehicle without assistance.

CASE VEHICLE SECOND SEAT LEFT PASSENGER INJURIES

The second seat left passenger was not transported by ambulance to the hospital and did not seek subsequent medical treatment. Furthermore, he did not sustain any injuries as a result of this crash.

CASE VEHICLE SECOND SEAT RIGHT PASSENGER KINEMATICS

The case vehicle's second seat right passenger [81-year-old, White (non-Hispanic) female; 157 centimeters and 77 kilograms (62 inches, 170 pounds)] was seated in an upright posture with her back against the seat back and her feet on the floor. However, once again, the exact position of her hands is unknown. There was no seat track, and the seat back was not adjustable.

Based on the front right passenger's interviewee-reported injury information, the case vehicle's second seat right passenger was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The front right passenger indicated in her interview that the second seat right passenger sustained a belt pattern abrasion to her right neck. However, the inspection of the second seat right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading. Given the relatively minor [2-13 km.p.h. (1-8 m.p.h.)] nature of the case vehicle's Delta V, the lack of specific loading evidence is inconclusive.

The case vehicle's driver had just started to brake prior to the crash (i.e., based on the **EDR** data, the brake switch circuit had been activated but the vehicle's speed had not yet changed). As a result of this attempted avoidance maneuver and the use of her available safety belt, the second seated right passenger's pre-impact body position did not change just prior to impact. The case vehicle's impact with the Kia enabled the case vehicle's second seated right to continue forward and slightly upward and leftward along a path opposite the case vehicle's **340** degree Direction of Principal Force as the case vehicle decelerated. As a result of the impact, the second seat right passenger loaded her lap and shoulder safety belts, which limited her forward momentum. As the case vehicle continued forward, while rotating approximately 20 degrees clockwise, the second seated right passenger rebounded from loading her safety belts and moved backwards and to her right toward the right side of her seat back as the vehicle came to final rest. The second seat right passenger's exact posture at final rest is unknown, but she was most likely near her original pre-crash position and was able to exit the vehicle with some assistance.

CASE VEHICLE SECOND SEAT RIGHT PASSENGER INJURIES

The second seat right passenger was transported by ambulance to the hospital. She sustained minor injuries and was treated and released. According to the interview with the front right passenger and her medical records, the injuries sustained by the case vehicle's second seat right passenger included: abrasions on the right side of her neck and on her lower right arm and minor contusions over her right mandible and right abdomen. Her face, neck, and abdominal injuries were caused by her safety belts.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion {ecchymosis} right mandibular angle	minor 290402.1,1	Torso portion of safety belt system	Probable	Emergency room records
2	Abrasion, 7.6 cm (3 in) on right side of neck, not further specified	minor 390202.1,1	Torso portion of safety belt system	Probable	Interviewee (other occupant)
3	Contusion right abdominal wall, not further specified	minor 590402.1,1	Lap portion of safety belt system	Possible	Emergency room records
4	Wound {abrasion} right arm below right elbow, not further specified	minor 790202.1,1	Right side interior hardware and/or armrest	Possible	Emergency room records

Based on the VIN, manufacturer's specifications, and our exterior inspection of the vehicle, the 2000 Kia Sportage was a rear wheel drive (4x2), five-passenger, four-door sport utility vehicle (VIN: KNDJB723XY5------) equipped with a 2.0L, I-4 engine, and the standard five-speed manual transmission. Two-wheel, anti-lock rear brakes are standard equipment on this vehicle. The Kia's wheelbase was 265 centimeters (104.3 inches), and the odometer reading is unknown because the Kia's interior was not inspected.

The vehicle was equipped with **ADVANCED OCCUPANT PROTECTION SYSTEM** features including redesigned driver and front right passenger air bags, pretensioners, and a driver side only knee air bag. None of the Kia's air bags deployed as a result this vehicle's right side impact. Furthermore, the Kia was equipped with manual, three-point, lap-and-shoulder, safety belt systems for the front and back outboard seating positions. The back center seat had a manual, two-point, lap belt. The interior was equipped with bucket seats for the driver and front right passenger, and the back bench seat was non-adjustable.

Figure 17: Reference line view from back showing Kia's right side damage with contour gauge positioned above sill level (case photo #40)

Exterior Damage: The Kia's contact with the case vehicle involved its right side with the damage distributed on approximately the back half (**Figure 6** above and **Figure 17**). Direct damage began 202 centimeters (79.5 inches) rearward of the front right axle and extended 122 centimeters (48.0 inches) rearward along the right side. The field L began 166 centimeters (65.4 inches) rearward of the front right axle and extended 165 centimeters (65.0 inches) rearward as well. Residual maximum crush was measured as 17 centimeters (6.7 inches) at C_4 (**Figure 18**). The table below shows the case vehicle's crush profile.

Figure 18: Overhead view of damage to rear portion of Kia's right side (case photo #45)

Units	Event	Direct Damage		Field L	C_1	C_2	C_3	C_4	C_5	C_6	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	122	17	165	11	10	13	17	6	0	-131	-119
in		48.0	6.7	65.0	4.3	3.9	5.1	6.7	2.4	0.0	-51.6	-46.9

The wheelbase on the Kia's left side was shortened 4 centimeters (1.6 inches) while the right side was extended 4 centimeters (1.6 inches). The Kia's right rear door and right quarter panel were directly damaged and crushed inward. There was induced damage to the right front door, right "C" and "D"-pillars, and the back right stop/tail light and turn signal assemblies. In addition, both the right rear glazing and the second right glazing were disintegrated.

The vehicle manufacturer's recommended tire size was: P205/75R15, and the Kia's tires were the recommended size. The Kia's tire data are shown in the table below. In addition, the Kia's right rear tire was damaged (i.e., cut) and deflated from the crash.

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	248	36	179	26	4	5	None	No	No
RF	228	33	179	26	4	5	None	No	No
LR	241	35	179	26	5	6	None	No	No
RR	0	0	179	26	5	6	Cut sidewall	No	Yes

Damage Classification: Based on the vehicle inspection, the CDC for the Kia was determined to be: **02-RZAW-2** (**70** degrees). The WinSMASH reconstruction program, CDC-only algorithm–based on the measured crush profile for the Kia and the photo-estimated CDC for the case vehicle, was used on the Kia's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 19.0 km.p.h. (11.8 m.p.h.), -6.5 km.p.h. (-4.0 m.p.h.), and -17.9 km.p.h. (-11.1 m.p.h.). The Kia was towed due to damage.

Kia's Occupants: According to the Police Crash Report, the Kia's driver [26-year-old, (unknown race and/or ethnic origin) male] was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. The driver was not transported by ambulance to the hospital, and he did not sustain any injuries as a result of this crash.

1GKEC16Z43J	System Status At Deployment
SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Ignition Cycles At Deployment	695
Ignition Cycles At Investigation	700
Maximum SDM Recorded Velocity Change (MPH)	-6.65
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	135
Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	12.5
Driver Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	N/A
Passenger First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	12.5
Passenger Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	N/A
Time Between Non-Deployment And Deployment Events (sec)	N/A
Frontal Deployment Level Event Counter	1
Event Recording Complete	Yes
Multiple Events Associated With This Record	No
One Or More Associated Events Not Recorded	No

Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-0.31	-1.55	-2.79	-4.03	-4.96	-5.89	-6.20	-6.20	-6.20	-6.20	-6.20	N/A	N/A	N/A	N/A

PRE-CRASH DATA				
Seconds Before AE	**Vehicle Speed (MPH)**	**Engine Speed (RPM)**	**Percent Throttle**	**Brake Switch Circuit Status**
-5	40	1152	20	OFF
-4	40	1216	20	OFF
-3	40	1216	20	OFF
-2	41	1216	20	OFF
-1	41	1344	0	ON

Figure 19: Case vehicle's at deployment data including: pre-crash speed, brake switch status, restraint system status, and activation data for vehicle's dual inflation air bags, and the case vehicle's change in velocity (Delta V) over the first 110 milliseconds post deployment

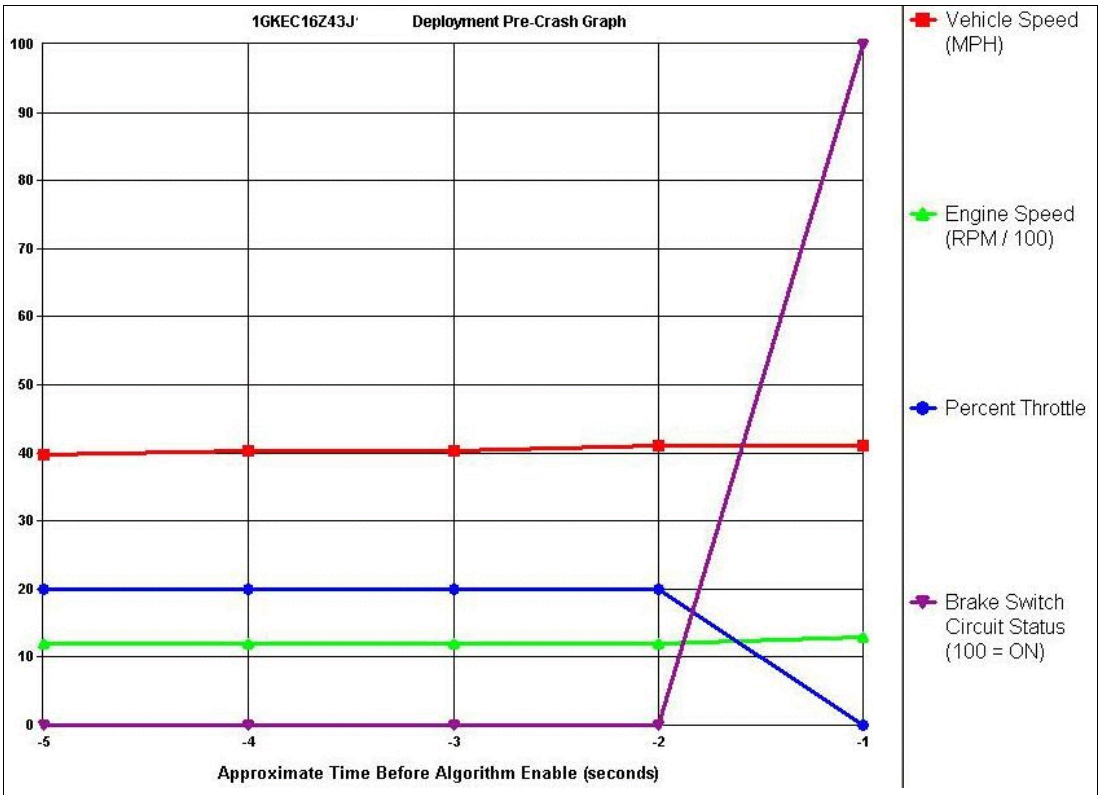


Figure 20: Case vehicle's pre-crash speed and brake switch circuit status showing that the vehicle's speed was recorded at 66 km.p.h. (41 m.p.h.) when the brake was activated approximately 2 seconds prior to algorithm enable.

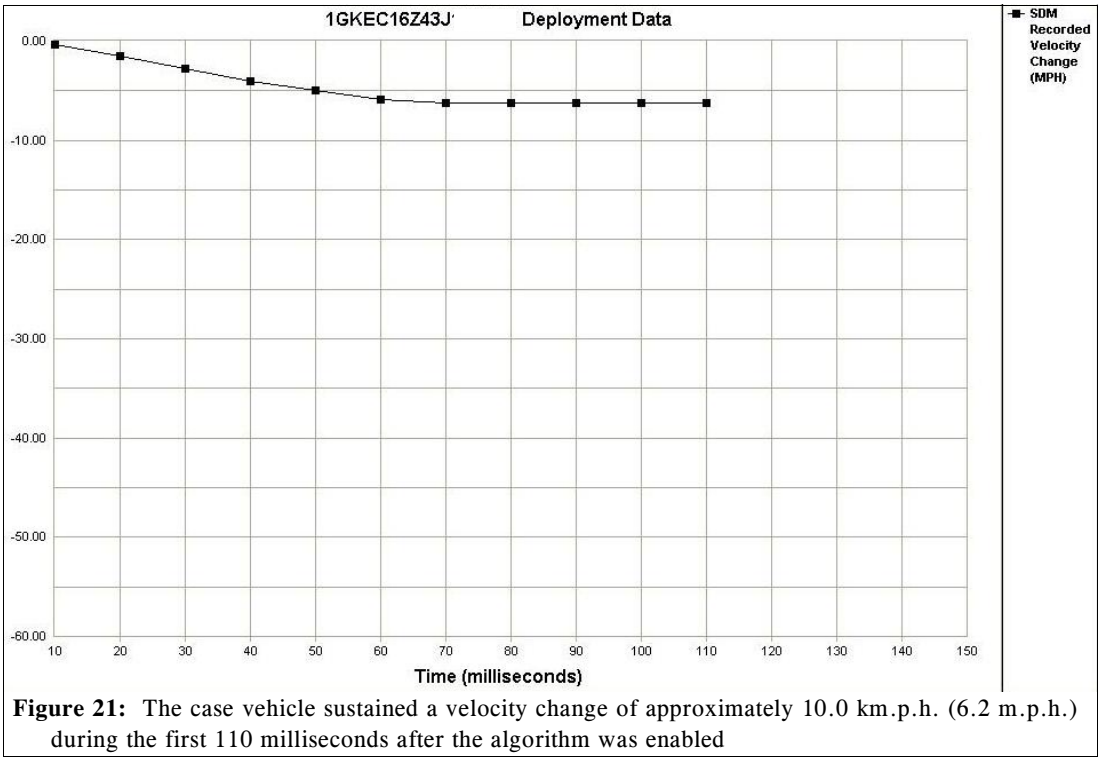
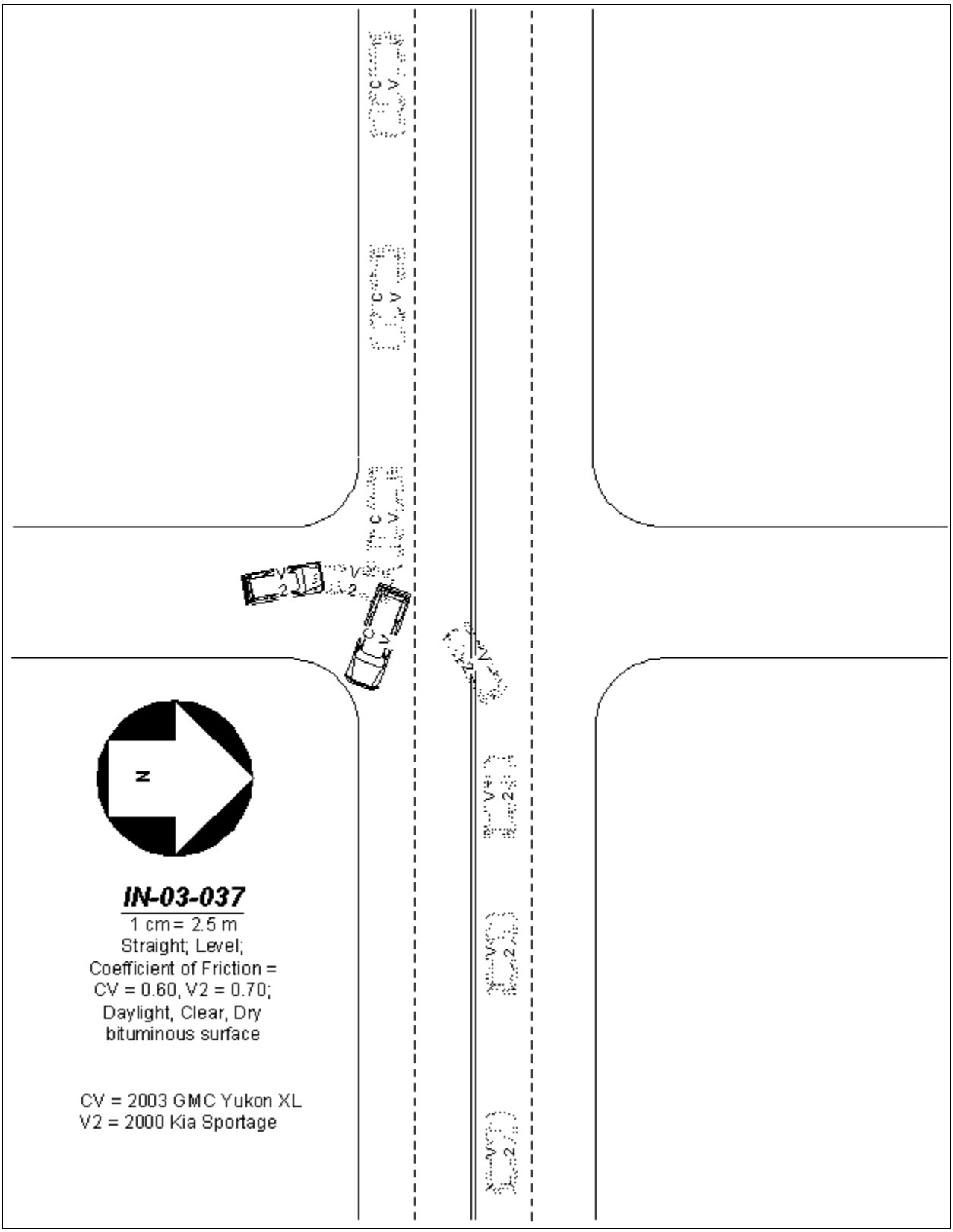


Figure 21: The case vehicle sustained a velocity change of approximately 10.0 km.p.h. (6.2 m.p.h.) during the first 110 milliseconds after the algorithm was enabled


N
IN-03-037
1 cm = 2.5 m
Straight; Level;
Coefficient of Friction =
CV = 0.60, V2 = 0.70;
Daylight, Clear, Dry
bituminous surface
CV = 2003 GMC Yukon XL
V2 = 2000 Kia Sportage