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ON-SITE OFFICE OF DEFECTS INVESTIGATION SIDE AIR BAG NON-DEPLOYMENT INVESTIGATION

CASE NUMBER - IN10039
LOCATION - MISSISSIPPI
VEHICLE - 2010 HYUNDAI SONATA GLS
CRASH DATE - October 2010

Submitted:

May 16, 2011

Contract Number: DTNH22-07-C-00044

Prepared for:

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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 on-site investigation focused on a 2010 Hyundai Sonata GLS and the non-deployment of the driver's seat-mounted side impact air bag. The Hyundai was occupied by a restrained 77-year-old male driver, a restrained 78-year-old female front right passenger and a restrained 51-year-old second row center passenger. The vehicle was traveling west on a divided state highway approaching the stop sign at the intersection with a second divided state highway. A 2002 Ford Windstar was traveling north and the driver intended to continue northbound through the intersection. The Hyundai entered the intersection and its left side plane was impacted by the front plane of the Ford (event 1). The direction of force on the Hyundai was within the 9 o'clock sector and the impact force triggered a deployment of the left side impact Inflatable Curtain (IC) air bag. The driver's seat-mounted side impact air bag did not deploy. The Hyundai rotated clockwise and the Ford rotated counterclockwise. The left quarter panel of the Hyundai sustained a minor secondary impact with the right quarter panel of the Ford (event 2). The Hyundai continued to rotate clockwise and came to final rest in the right turn lane channel on the northeast quadrant of the intersection heading northeast. The Ford rotated counterclockwise and came to final rest in the median heading southwest. The occupants of the Hyundai were transported by ground ambulance to a hospital. The driver was transferred via air ambulance to a trauma center where he was pronounced deceased 23 hours and 45 minutes following the crash. The front right passenger and second row passenger were treated and released. Both vehicles were towed from the crash scene.			
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This on-site investigation focused on a 2010 Hyundai Sonata GLS and the non-deployment of the driver's seat-mounted side impact air bag. This crash was brought to our attention on November 5, 2010 by the National Highway Traffic Safety Administration (NHTSA), Office of Defects Investigation (ODI). This investigation was assigned on November 5, 2010. The crash involved the Hyundai (**Figure 1**) and a 2002 Ford Windstar SE. The crash occurred in October, 2010, at 1053 hours in Mississippi and was investigated by the Mississippi Highway Patrol. The crash scene and both vehicles were inspected on November 10-11, 2010. An interview with the front right passenger was conducted on December 3, 2010. This report is based on the police crash report, crash scene inspection, vehicle inspections, exemplar vehicle inspections, occupant medical records, occupant kinematic principles, and evaluation of the evidence.

Figure 1: The damaged 2010 Hyundai Sonata LGS

CRASH CIRCUMSTANCES

Crash Environment: This crash occurred during daylight hours and clear weather conditions in the intersection of two 4-lane, divided, state highways. The trafficway that the Hyundai was traveling on traversed in an east-west direction. On the east leg of the intersection, the eastbound roadway had one through lane and a left turn lane. Each lane was 3.7 m (12.1 ft) in width. There was a bituminous shoulder 1.3 m (4.4 ft) in width adjacent to the turn lane and a 2.4 m (8 ft) wide grass shoulder adjacent to the through lane. There was also a channelized right turn lane prior to the intersection. The Hyundai's approach to intersection was controlled by a stop sign. The eastbound roadway was separated from the westbound roadway by a grass median 6.3 m (20.6 ft) in width. The trafficway that the Ford was traveling on traversed in a north-south direction. On the south leg of the intersection, the northbound roadway had two through lanes, a left turn lane, and a channelized right turn lane. Each lane was approximately 3.7 m (12.1 ft) in width. The northbound roadway was separated from the southbound roadway by a grass median 16.3 m (53 ft) in width. The Ford's approach to the intersection was uncontrolled. The speed limit for the Hyundai was 89 km/h (55 mph). The speed limit for the Ford was 97 km/h (65 mph). The Crash Diagram is on page 13 of this report.

Pre-Crash: The Hyundai was occupied by a restrained 77-year-old male driver, a restrained 78-year-old female front right passenger and a restrained 51-year-old second row center passenger. The vehicle was traveling west (**Figure 2**) in the through lane approaching the stop sign at the intersection. The front right passenger stated during the SCI interview that they were looking for an address. The Ford was traveling north in the first lane from the right (**Figure 3**) and the driver intended to continue northbound through the intersection. A skid mark from the Hyundai (which was partially obscured by an unrelated acceleration tire mark) extended approximately from the stop bar into the intersection approximately 3 m (9.8 ft). It indicated that the driver of the

Hyundai applied hard braking in an attempt to avoid the crash. The direct damage on the Ford resided only on the right portion of the front plane and overlapped the right fender, which indicated that the Ford's driver steered left in an attempt to avoid the crash.

Crash: The front plane of the Ford (**Figure 4**) impacted the left side plane of the Hyundai (**Figure 5**, event 1). The direction of force on the Hyundai was within the 9 o'clock sector and the impact force triggered a deployment of the left side impact Inflatable Curtain (IC) air bag. The driver's seat-mounted side impact air bag did not deploy. The Ford's frontal air bags also did not deploy. The Hyundai rotated clockwise and the Ford rotated counterclockwise. The left quarter panel of the Hyundai sustained a minor secondary impact with the right quarter panel of the Ford (event 2). The Hyundai rotated 140 degrees from its original westerly heading as it traveled 20 m (65.6 ft) to final rest in the right turn lane channel on the northeast quadrant of the intersection heading northeast. The Ford rotated counterclockwise 120 degrees as it traveled 18 m (59 ft) to final rest in the median heading southwest.

Post-Crash: The police were notified of the crash at 1053 hours and arrived on scene at 1055 hours. Emergency medical and rescue services also responded to the crash scene. Rescue personnel mechanically removed the left front door of the Hyundai and extricated the driver from the vehicle. The front right passenger and second row center passenger exited the vehicle through their respective doors. The occupants of the Hyundai were transported by ground ambulance to a hospital. The front right passenger and second row center passenger were treated in the emergency room and released. The driver was transferred the following day to a trauma center where he succumbed to his injuries approximately one day after the crash. The six occupants of the

Figure 2: Westbound approach of the Hyundai to the intersection

Figure 3: Northbound approach of the Ford to the intersection

Figure 4: The damage on the front plane of the Ford from the impact with the left side plane of the Hyundai

Ford were also transported by ambulance to a hospital. Both vehicles were towed from the scene due to damage.

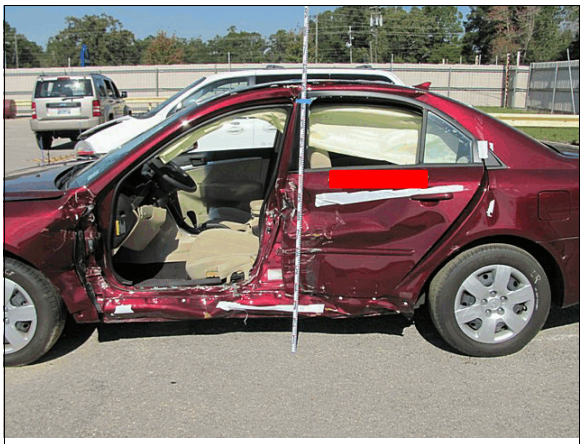


Figure 5: Damage on the left side plane of the Hyundai from the front plane impact by the Ford

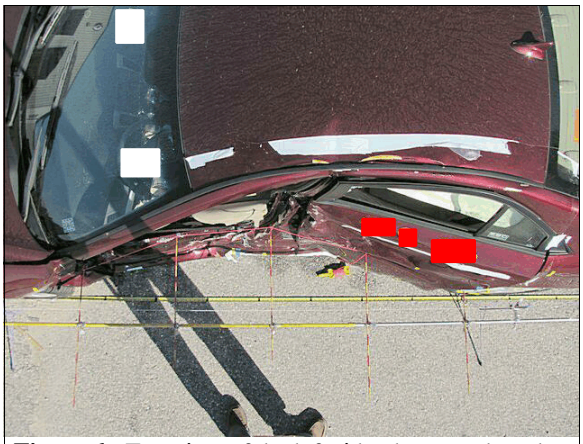


Figure 6: Top view of the left side plane crush to the Hyundai

CASE VEHICLE

The 2010 Hyundai Sonata GLS was a front wheel drive, 5-passenger, 4-door sedan (VIN: 5NPET4AC3AH------) that was manufactured on July 21, 2009. It was determined during the SCI interview with the front right passenger that the vehicle had been purchased new in October 2009 and never been involved in a previous crash nor ever had any service to air bag system. The vehicle was equipped with a 2.4-liter, I4 engine, 5-speed automated manual transmission, 4-wheel anti-lock brakes with electronic brake force distribution, traction control, and electronic stability control. The first row was equipped with bucket seats, adjustable active head restraints, manual lap-and-shoulder safety belts, driver and front right passenger frontal air bags, seat-mounted side impact air bags, and roof side rail-mounted side impact IC air bags that provided protection to the first and second row outboard seating positions. The second row was equipped with a bench seat with folding backs, manual lap-and-shoulder safety belts, adjustable head restraints, and Lower Anchors and Tethers for Children (LATCH) in the outboard seating positions. The vehicle's mileage at the time of the inspection was 12,141 kilometers (7,544 miles). The specified wheelbase was 273 cm (107.4 in).

CASE VEHICLE DAMAGE

Exterior Damage Event 1: The Hyundai sustained left side plane damage during the initial impact with the Ford. The left fender and both left side doors of the Hyundai sustained direct damage. The direct damage began 31 cm (12.2 in) rear of the left front axle and extended 186 cm (73.2 in) rearward on the left side. The crush measurements were taken at the mid-door level and the residual maximum crush was 35 cm (13.8 in) occurring at C_3 (**Figure 6**). The left front door had been removed from the vehicle and the crush measurements at C_3 and C_4 were estimated based on the crush to the A-pillar, B-pillar, and left rear door. The vehicle's sill height was 32 cm (12.6 in) and the height of the maximum crush was 60 cm (23.6 in). The door sill differential (DSD) was 9 cm (3.5 in). The vehicle's left side wheelbase was shortened 4 cm (1.6 in), while the right side wheelbase was unchanged. The induced damage involved the left fender, roof, and left quarter panel. The table below shows the left side crush profile.

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	186	35	236	0	21	35	30	13	0	17	14
in		73.2	13.8	92.9	0.0	8.3	13.8	11.8	5.1	0.0	6.7	5.5

Damage Classification Event 1: The Collision Deformation Classification (CDC) for the left side plane impact was 09LYEW3 (270 degrees). The Damage algorithm of the WinSMASH program calculated the Hyundai's total Delta V as 26 km/h (16.2 mph). The longitudinal and lateral velocity changes were 0.0 km/h and 26 km/h (16.2 mph), respectively. Based in the damage to both vehicles, the results appeared reasonable.

Exterior Damage Event 2: The Hyundai also sustained a minor secondary impact on the left quarter panel from the right quarter panel of the Ford. The quarter panel sustained only scuff marks from this impact. The direct damage began above the left rear axle and extended 28 cm (11 in) rearward on the quarter panel. There was no residual crush.

Deformation Classification Event 2: The CDC for the left quarter panel impact was 09LBMN1 (270 degrees). The WinSMASH program was not used on this impact since there was no residual crush on either vehicle. The severity of the damage was minor.

The manufacturer's recommended tire size was P215/60R16. The Hyundai was equipped with tires of the recommended size. The vehicle's tire data are shown in the table below.

Tire	*Measured Pressure*		*Vehicle Manufacturer's Recommended Cold Tire Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	165	24	221	32	7	9	None	No	No
LR	179	26	221	32	7	9	None	No	No
RR	179	26	221	32	7	9	None	No	No
RF	179	26	221	32	7	9	None	No	No

Vehicle Interior: The inspection of the interior of the Hyundai revealed that the steering wheel hub was scuffed from possible contact by the driver's right forearm. There was no deformation of the steering wheel or compression of the energy absorbing steering column. The right side of the center console near the instrument panel was scuffed and there was a light transfer of fabric from the front right passenger's left leg. In the second row left seating position, a single hair transfer was present on the left roof side rail from possible contact by the second row center

passenger's head. Scuff marks were present on the bottom of the driver's seat back and the back of the center console from contact by the second row center passenger's feet.

The left front door was jammed shut and had been removed from the vehicle. It was not present at the time of the SCI inspection. The left rear door was jammed shut. The right side doors were closed and operational. The left rear window was disintegrated from impact forces. The glazing in the left front window was also probably disintegrated by impact forces. The remaining glazing was undamaged.

The passenger compartment sustained 11 intrusions. The most severe intrusions in the driver's seating area involved the B-pillar (**Figure 7**), the driver's seat back, and the left roof side rail, which intruded laterally 28 cm (11 in), 19 cm (7.5 in), and 10 cm (3.9 in), respectively. The left front door also intruded into the driver's space but the extent of intrusion is unknown. In the second row, the forward upper quadrant of the left rear door and the left roof side rail intruded laterally 15 cm (5.9 in) and 4 cm (1.6 in), respectively.

Figure 7: Intrusion of the Hyundai's left B-pillar into the driver's seating position

Figure 8: Direct damage on the left B-pillar of the Hyundai

AUTOMATIC RESTRAINT SYSTEM

The Hyundai was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system that consisted of dual stage driver and front right passenger frontal air bags, driver seat position sensor, safety belt usage sensors, retractor-mounted pretensioners, and a front right passenger weight sensor. The manufacturer has certified that the vehicle is compliant to the Advanced Air Bag portion of the Federal Motor Vehicle Safety Standard (FMVSS) No. 208. Neither frontal air bag deployed in this crash.

Figure 9: Small portion of the driver's seat mounted side impact air bag was protruding out of the bottom of the seat back

The vehicle was also equipped with side impact IC air bags and seat-mounted side impact air bags. Based on the Holmatro Rescuer's Guide to Vehicle Safety Systems, the side impact sensors were located within the lower B-pillars.

The impact on the Hyundai involved direct contact to the left B-pillar (**Figure 8**) in the area where the sensor was located. The left IC air bag deployed in this crash, while the driver's seat-mounted side impact air bag did not deploy. The right IC air bag and front right passenger's seat-mounted side impact air bags did not deploy.

Figure 10: The partially unfolded condition of the driver's seat-mounted side impact air bag

The driver's seat-mounted side impact air bag was located in the outboard side of the seat back. The left B-pillar had intruded 28 cm (11 in) against the driver's seat back and displaced it to the right 19 cm (7.5 in). Inspection of the outboard side of the driver's seat back revealed that a small portion of the side impact air bag was protruding out of the bottom of the seat back below the tear seam (**Figure 9**), which suggested that the air bag may have partially deployed. Access to the air bag was restricted by the intruded B-pillar. The seat material was cut to expose as much of the air bag as possible for inspection. The air bag appeared to be in partially unfolded condition (**Figure 10**). The fabric panel that separated the air bag from the seat material was not torn. The product number on the air bag was 312313 630d.

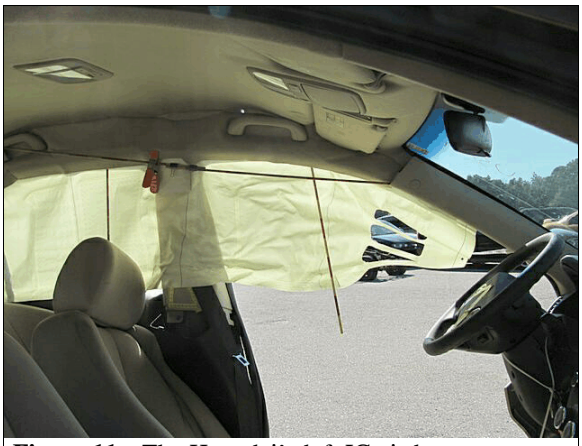


Figure 11: The Hyundai's left IC air bag

The left IC air bag (**Figure 11**) was located along the roof side rail inside the headliner and extended from the A-pillar to the C-pillar. The IC air bag was secured to the A-pillar by a nylon tether 15 cm (5.9 in) in length. There were no external vent ports. The deployed IC air bag was 167 centimeters (65.7 in) in length. Adjacent to the driver's seating position the IC air bag was 31 cm (12.1 in) in height. It was 35 cm (13.8 inches) in height adjacent to the second row left seating position. The gap between the IC air bag and the A-pillar at the bottom of the sail panel was 18 cm (7.1 in). The IC air bag did not extend below the beltline. Inspection of the deployed IC air bag revealed no discernable evidence of occupant contact and no damage.

MANUAL RESTRAINT SYSTEM

The Hyundai was equipped with lap-and-shoulder safety belts in all seating positions. The driver's safety belt consisted of continuous loop belt webbing, an Emergency Locking Retractor (ELR), a sliding latch plate, and an adjustable upper anchor that was in the full down position. The front right passenger safety belt was similar but was equipped with a switchable

ELR/Automatic Locking Retractor (ALR). Both safety belts were equipped with buckle-mounted pretensioners. The actuation of the driver's pretensioner could not be determined since the retractor was locked from the deformation of the B-pillar. The was no evidence to support actuation of the front right passenger's pretensioner.

Inspection of the driver's safety belt assembly revealed soiled marks on the outside surface of the belt webbing at the D-ring and 9 cm (2.5 in) below the D-ring. There were no load marks on the latch plate belt guide. The front right passenger stated during the SCI interview that the driver was restrained.

Inspection of the front right passenger's and the second row center passenger's safety belt assemblies revealed no evidence of loading. The front right passenger stated that she and the second row passenger were restrained.

CASE VEHICLE DRIVER KINEMATICS

The restrained driver of the Hyundai [77-year-old male, 185 cm (73 in) and 88 kg (195 lbs)] was seated in an upright posture with his back against the seat back. The seat track was located 16 cm (6.3 in) rear of the forward position, which corresponded to between the middle and rear positions. The seat back was located in the upright position. The tilt position of the steering column is not known. At the SCI inspection, it was displaced vertically beyond the full-up position.

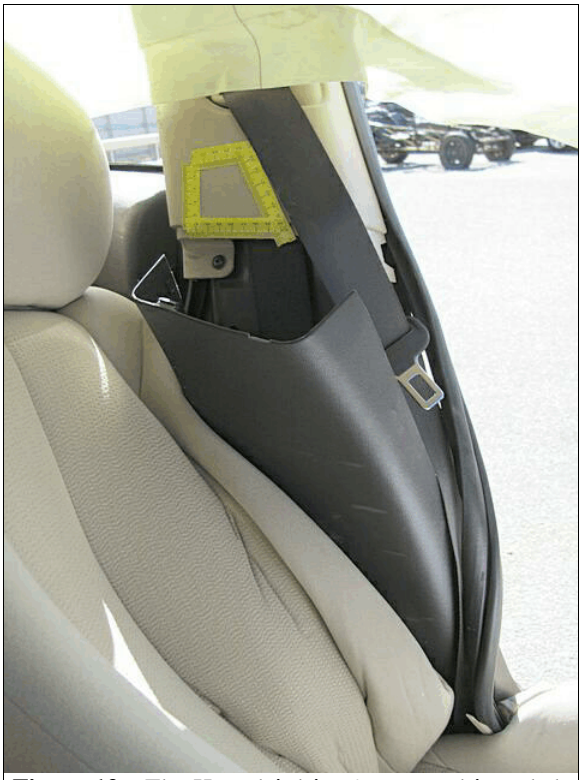


Figure 12: The Hyundai driver's seat and intruded left B-pillar

The impact on the left side plane of the Hyundai displaced the driver to the left. His head loaded through the left IC air bag and contacted the intruded left B-pillar (**Figure 12**), which caused subdural and subarachnoid hemorrhages of the brain. The left side of his upper torso also contacted the left B-pillar and he sustained fractures of left ribs 1-4 and 7-12 with bilateral hemothoraces. His left hip, contacted the intruded left front door, which fractured his left acetabulum and pubic ramus. He also sustained contusions, an abrasion, and a laceration from contacting the intruded left front door. Rescue personnel removed the left front door and extricated the driver from the vehicle.

The driver of the Hyundai was transported by ground ambulance to a hospital and subsequently transported by air the following day to a trauma center. He was pronounced deceased at the trauma center 23 hours and 45 minutes following the crash. The table below presents the driver's injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
1	Hemorrhage, subdural, along falx cerebri[1], tentorium, and	serious 140656.5,1	B-pillar, left	Certain	Hospitalization records
	right quadrigeminal cistern[2], 1.7 cm (0.7 in); no midline shift; loss of consciousness at scene				Emergency room records
2	Hemorrhage, subarachnoid, not further specified	moderate 140693.2,9	B-pillar, left	Certain	Hospitalization records
3	Fracture left ribs: 2nd, 7th, 8th, 10th, and 11th, not further specified	serious 450203.3,2	Left front door panel, rear upper quadrant	Certain	Hospitalization records
	Fractured, non-displaced, left ribs: 1st - 4th, 7th, 9th - 12th				Emergency room records
4	Hemothoraces, bilateral, left greater than right	serious 442200.3,3	Left front door panel, rear upper quadrant	Certain	Emergency room records

[1] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
falcial (fal′shal): pertaining to a falx.
falx (falks) pl. ***fal′ces***: a sickle-shaped organ or structure; used as a general term in anatomical nomenclature to designate such a structure.
f. ce′rebri, f. of cerebrum: the sickle-shaped fold of dura mater that extends downward in the longitudinal cerebral fissure and separates the two cerebral hemispheres.

[2] The quadrideminal cistern (also known as superior cistern or cistern of the great cerebral vein) is one of the subarachnoid cisterns. It is located between the splenium of the corpus callosum and the superior surface of the cerebellum and extends from the third ventricle to the great cerebral vein.
http://radiopaedia.org/articles/quadrigeminal-cistern alternatively,
Definition: an enlarged portion of the subarachnoid space located immediately superior to the tectum of the mesencephalon; may extend forward between the corpus callosum and thalamus as the cistern of the velum interpositum; contains caudal portions of the internal cerebral veins as they join to form the great cerebral vein (of Galen), distal parts of the quadrigeminal artery, the P4 segment of the posterior cerebral artery, and the exit of the trochlear nerve. Synonym(s): cisterna quadrigeminalis, cistern of great cerebral vein, cisterna venae magnae cerebri, Bichat canal, cisternal quadrigeminalis, superior cistern.
http://www.drugs.com/dict/quadrigeminal-cistern.html

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
5	Hematoma, massive, expanding, in left retroperitoneal space; unable to locate any specific bleeders in this region following exploratory laparotomy[3]–generally oozed venous blood; blood loss greater than 3 liters	moderate 543800.2,8	Left front hardware/armrest, rear lower quadrant	Certain	Hospitalization records
6 7	Fracture, non-displaced, left acetabulum and root of left pubic ramus; fracture, mildly comminuted, left superior pubic ramus	moderate 856151.2,4 856251.2,2	Left front hardware/armrest, rear lower quadrant	Certain	Hospitalization records
8	Contusion left elbow with swelling, not further specified	minor 710402.1,2	Left front door panel, rear upper quadrant	Certain	Emergency room records
9	Laceration left elbow, not further specified	minor 710600.1,2	Left front door panel, rear upper quadrant	Certain	Emergency room records
10	Abrasion right distal thigh, not further specified	minor 810202.1,1	Steering wheel rim	Probable	Emergency room records
11	Abrasion left proximal thigh, not further specified	minor 810202.1,2	Left front hardware/armrest, rear lower quadrant	Certain	Emergency room records
12	Contusion (hematoma) on anterior left shin, not further specified	minor 810402.1,2	Left front door panel, front lower quadrant	Probable	Emergency room records

CASE VEHICLE FRONT ROW RIGHT PASSENGER KINEMATICS

The restrained front right passenger of the Hyundai [78-year-old female, 168 cm (66 in) and 74 kg (164 lbs)] was seated in an upright posture with her back against the seat back. The seat track was located in the middle position and the seat back was slightly reclined.

The impact on the left side plane of the Hyundai displaced the front right passenger to the left. Her left leg contacted the forward portion of the center console and her left hip contacted the center console arm rest. She sustained no injuries from those contacts. Her left shoulder contacted the driver, which fractured her left clavicle. She exited the vehicle through the right front door.

[3] According to the discharge summary, they were unable to maintain transfusion requirements at rate to maintain blood pressure. The hospital decided to operate with very great risk, but the risk without surgery was certainly fatal.
Note: a 3.8 cm (1.5 in) infrarenal abdominal aortic aneurysm was present; there was no indication that this aneurysm ruptured.

The front row right passenger was transported by ground ambulance to a hospital where she was treated in the emergency room and released. The table below presents the passenger's injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
1	Fractured, mildly comminuted, left distal clavicle; non-angulated	moderate 750731.2,2	Interior object: other occupant–driver	Probable	Emergency room records
2	Contusion over left chest (rib area), not further specified	minor 410402.1,2	Torso portion of safety belt system	Probable	Emergency room records

CASE VEHICLE SECOND ROW CENTER PASSENGER KINEMATICS

The restrained second row center passenger of the Hyundai [51-year-old female, 160 cm (63 in) and 54 kg (120 lbs)] was seated in an upright posture.

The impact to Hyundai displaced the second row left passenger to the left. She contacted her head on the left roof side rail and her feet on the lower portion of the center console and driver's seat back. She sustained an abrasion and contusion on the forehead from the roof side rail contact. She exited the vehicle through the right rear door.

CASE VEHICLE SECOND ROW CENTER PASSENGER INJURIES

The second row center passenger was transported by ground ambulance to a hospital. She was examined in the emergency room released. The table below presents the passenger's injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
1	Contusion to forehead, not further specified	minor 210402.1,7	Roof left side rail, second row	Certain	Emergency room records
2	Contusion (probably forehead) secondary to crash, not further specified	minor 910400.1,9	Roof left side rail, second row	Certain	Emergency room records

OTHER VEHICLE

The 2002 Ford Windstar SE was a front wheel drive, 7-door minivan (VIN: 2FMZA52492B------) equipped with a 3.8-liter, V-6 engine, a 4-speed automatic transmission, and 4-wheel, anti-lock brakes with electronic brake force distribution. The front row was equipped

with bucket seats, lap-and-shoulder safety belts, and dual stage driver and front right passenger frontal air bags.

Exterior Damage Event 1: The Ford sustained front plane damage during the initial impact with the Hyundai. The front bumper, hood, right fender, and right headlamp/turn signal assembly were directly damaged. The direct damage began at the right front bumper corner and extended 92 cm (36.2 in) across the bumper. The crush measurements were taken at the bumper level and the maximum residual crush was 2 cm (0.8 in) occurring at C_6. The right side wheelbase was reduced 1 cm (0.4 in), while the left side wheelbase was unchanged. The table below presents the front crush profile.

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	92	2	129	0	1	1	1	1	2	27	0
in		36.2	0.8	50.8	0.0	0.4	0.4	0.4	0.4	0.8	10.6	0.0

Damage Classification Event 1: The CDC for the front plane impact was 12FZEW1 (10 degrees). The Damage algorithm of the WinSMASH program calculated the Ford's total Delta V as 22 km/h (13.7 mph). The longitudinal and lateral velocity changes were -22 km/h (-13.7 mph) and -4 km/h (-2.5 mph), respectively. Based in the damage to both vehicles, the results appeared reasonable. The Ford's Event Data Recorder (EDR) reported a maximum Delta V of -22.19 km/h (-13.79 mph).

Exterior Damage Event 2: The Ford also sustained a minor secondary impact on the right quarter panel from the left quarter panel of the Hyundai. The quarter panel sustained only scuff marks from this impact. There was no residual crush. The direct damage began 5 cm (2 in) rear of the right rear axle and extended 70 cm (27.6 in) rearward on the quarter panel.

Deformation Classification Event 2: The CDC for the right quarter panel impact was 03RBMW1 (90 degrees). The WinSMASH program was not used on this impact since there was no residual crush on either vehicle. The severity of the damage was minor.

The vehicle manufacturer's recommended tire size was P215/65R16. The Ford was equipped with the recommended size tires. The vehicle's tire data are shown in the table below.

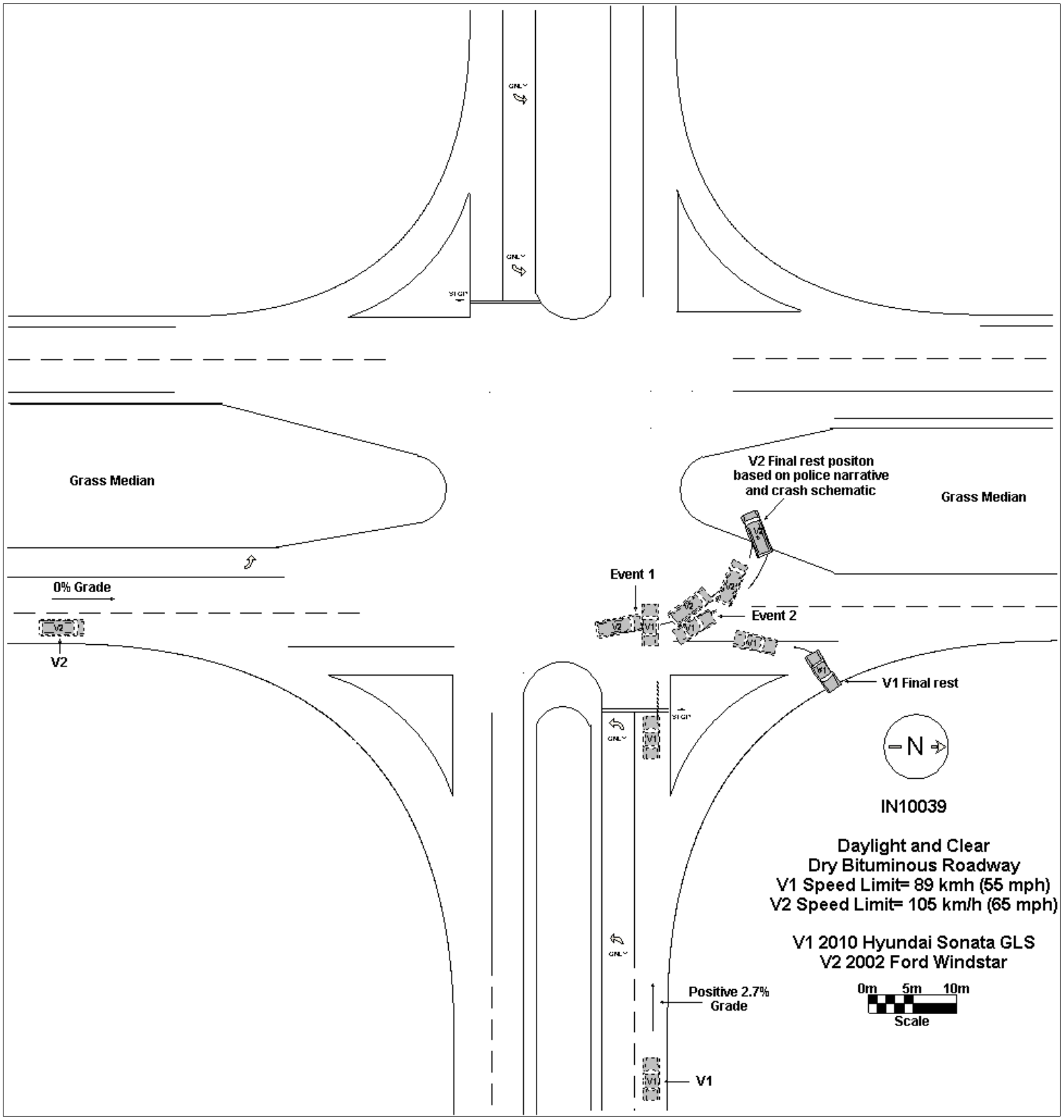
Tire	*Measured Pressure*		*Vehicle Manufacturer's Recommended Cold Tire Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	193	28	241	35	4	5	None	No	No

Tire	*Measured Pressure*		*Vehicle Manufacturer's Recommended Cold Tire Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LR	207	30	241	35	6	8	None	No	No
RR	186	27	241	35	6	7	None	No	No
RF	Flat	Flat	241	35	3	4	Debeaded	No	No

Event Data Recorder: The Ford's EDR was imaged using version 3.5.1 of the Bosch Crash Data Retrieval software and reported with version 3.8. The EDR recorded a non-deployment event. The imaged data indicated no active diagnostic codes were present when the event occurred. The driver's and front right passenger's safety belt circuits were reported as "Buckled." The occupant classification status for the front right passenger was reported as "Adult." The maximum reported Delta V was -22.19 km/h (-13.79 mph), which occurred at the end of the recording at the 97.6 ms point of recorded data. The Ford's EDR report is attached at the end of this report[4].

Other Vehicle's Occupants: The driver of the Ford (39-year-old, female) was restrained by her lap-and-shoulder safety belt system. The driver was transported by ground ambulance to the hospital, and she sustained a police-reported C (possible) injury. There were five additional occupants in the Ford, all of whom were restrained by their lap-and-shoulder safety belt systems. They are: front right passenger (10-year-old male), second row left passenger (24-year-old male), second row right passenger (23-year-old female), third row left passenger (10-year-old male), and third row right passenger (10-year-old male). All five of these occupants were transported by ground ambulance to the hospital. The second row passengers sustained police-reported C (possible) injuries while the front right passenger and the third row passengers sustained B (non-incapacitating-evident) injuries.

[4]. Page 8 of the EDR report has been deleted for confidentiality reasons.


Grass Median
V2 Final rest positon based on police narrative and crash schematic
Grass Median
0% Grade
Event 1
Event 2
V2
V1 Final rest
N
IN10039
Daylight and Clear
Dry Bituminous Roadway
V1 Speed Limit= 89 kmh (55 mph)
V2 Speed Limit= 105 km/h (65 mph)
V1 2010 Hyundai Sonata GLS
V2 2002 Ford Windstar
Positive 2.7% Grade
0m 5m 10m
Scale
V1

Event Data Recorder Report, 2002 Ford Windstar SE

IMPORTANT NOTICE: Robert Bosch LLC and the manufacturers whose vehicles are accessible using the CDR System urge end users to use the latest production release of the Crash Data Retrieval system software when viewing, printing or exporting any retrieved data from within the CDR program. Using the latest version of the CDR software is the best way to ensure that retrieved data has been translated using the most current information provided by the manufacturers of the vehicles supported by this product.

CDR File Information

User Entered VIN	2FMZA52492B******
User	
Case Number	
EDR Data Imaging Date	11/11/2010
Crash Date	
Filename	FORD WINDSTAR EDR.CDRX
Saved on	Thursday, November 11 2010 at 13:26:35
Collected with CDR version	Crash Data Retrieval Tool 3.5.1
Reported with CDR version	Crash Data Retrieval Tool 3.8
EDR Device Type	airbag control module
Event(s) recovered	Non Deployment

Comments

No comments entered.

Data Limitations

The retrieval of this data has been authorized by the vehicle's owner, or other legal authority such as a subpoena or search warrant, as indicated by the CDR tool user on Thursday, November 11 2010 at 13:26:35.

Important Limitations on Bosch Crash Data Retrieval (CDR) Tool Capabilities.

Disclaimer: This Restraint Control Module (RCM) records longitudinal deceleration data for the purpose of understanding the input data the Restraint Control Module used to determine whether or not to deploy restraint devices. This module does not record vehicle speed, throttle position, brake on-off, and other data, which may be recorded in some 1999 model year and later General Motors modules. The deceleration data recorded by Ford's module during a crash can subsequently be mathematically integrated into a longitudinal Delta-V. Delta-V is the change in velocity during the recording time and is NOT the speed the vehicle was traveling before the accident, and is also not the Barrier Equivalent Velocity. The Bosch CDR Tool will read and interpret both acceleration in G's and Delta-V in mph. RCM's in Ford vehicles that can be read by the Bosch CDR tool are listed in the Bosch Help Files.

Important

If there is any question that the restraint system did not perform as it was designed to perform, please read the system only through the diagnostic link connector. The Bosch CDR kit provides an RCM interface cable to plug directly into the restraint control module. The Bosch CDR RCM Interface Cable connects only power, ground, and memory read pins to the relevant vehicle restraint control module. The other RCM pins normally connect to inputs, such as sensors, and outputs, such as airbags, are not connected when you use the RCM Interface Cable to plug directly into the module. Since the vehicle restraint control module is constantly monitoring airbag system readiness, it will detect that the sensors and airbags are not connected. The restraint control module may record a new diagnostic trouble code into memory for each device that is not connected. These new diagnostic trouble codes may record over previously written diagnostic trouble codes present prior to the accident and spoil evidence necessary to determine if the restraint system performed in the accident as it was designed to perform. Not only could this prevent Ford from being able to determine if the system performed as it was designed to perform, but, regardless of innocent inadvertence, you could raise issues of evidence spoliation in any litigation that may arise out of the accident. If you cannot read the module via the diagnostic link connector, and if you suspect improper system performance, contact Ford Motor Company and request their assistance to read the module with a proper vehicle simulator attached. If you choose to read via the module connector, Ford recommends that you do so in the vehicle and that you leave the second large connector plugged into the vehicle wiring harness to minimize the number of new diagnostic trouble codes created.

While data stored in RCM's is accurate, accident reconstructionists must be aware of the limitations of the data recorded in Ford's control modules and should compare the recorded data with the physical evidence at the accident scene using professional accident reconstruction techniques (i.e. vehicle crush characteristics, skid marks, etc) before making any assumptions about the import and validity of the data recorded in the module with respect to the crash event being analyzed. The following describes specific limitations that must be considered when analyzing recorded data. Investigators should obtain permission of the vehicle owner prior to reading any data.

1. There may be no deceleration data recorded in the module.
Loss of power (cut wires, damaged battery, crushed fuse box) to the module during or immediately after the crash may prevent the crash data from being recorded. A backup power supply within the module has sufficient power to continue to analyze the deceleration data and deploy restraint devices if needed, but there is no backup power for recording.

If the deceleration input does not create a vehicle longitudinal Delta-V above 4 mph within 100 milliseconds, there may not be any data recorded.

2. In unusual circumstances, deceleration data stored in the module may be from a crash other than the one you are currently analyzing.
The module will record data from some non-deploy events. If, after the module has recorded data from a non-deploy event, and there is a subsequent event in which there is a loss of power and no new recording is made for that subsequent event, the deceleration data in the module's memory may be from the prior event. If the new, subsequent event is a deploy event and recording has occurred, the deployment times should be recorded. If there are no deployment times recorded, but airbags or other restraint devices are observed to have deployed, the recorded data that you read are most likely from a prior event.

Once an airbag or other restraint device has been commanded to deploy, the data recorded in connection with that deployment are "locked", and subsequent crashes cannot be recorded.

If a vehicle is being repaired, the RCM should be replaced after any crash in which restraint devices deploy. Early printed shop manuals refer to re-using modules by clearing the "crash data memory full" code, but this is no longer true and the latest on-line electronic shop manual directs that modules be replaced.

Crashes that involve multiple impacts will record only one of the impacts. If there is a deployment, the deployment event will be recorded and locked. If no restraint device is commanded to deploy, the recorded data are not "locked", and subsequent impacts may record over any previous recorded data. Further analysis will be required to determine which of the events was actually recorded.

3. The computed longitudinal Delta-V may understate the total Delta-V

Many real-world crashes can last longer than the memory has the capacity to record. Therefore, the actual Delta-V of the event may be higher than the Delta-V calculated and displayed by the Bosch CDR System output. Review the end of the longitudinal acceleration/deceleration pulse - if it has not settled to zero G's by the end of the recording, the vehicle longitudinal Delta-V is most likely understated. If there is a clear decaying trend line you may choose, at your own risk, to estimate the total Delta-V by extrapolating the decay trend to zero and to calculate the additional Delta-V not captured.

Under some circumstances where power is interrupted, during the recording of data, or the module re-sets during the recording of data, a partial recording may occur. This will be shown as "no data" in the data table and will not be plotted on the graph of acceleration. The "no data" sections may be at the beginning, in the middle, or at the end(s) - it will not be consistent from one occurrence to another. When some portion of the acceleration data is not recorded, the Delta-V during that time cannot be calculated. A Delta-V will be calculated for the points that are valid, but the user must be aware that the partial Delta-V calculated will further underestimate the actual event total Delta-V. Restraint device deployment times are recorded first in to memory, and the acceleration data is recorded last. Thus, even with partial acceleration traces, deployment times are valid.

4. This module records only longitudinal acceleration/deceleration of the vehicle. You must compute lateral or resultant total acceleration based on your estimated Principal Direction of Force (PDOF).

5. Vertical acceleration/decelerations are not recorded. Vehicle spin about a point not centered on the Restraints Control Module sensor may add or subtract from bulk vehicle motion.

6. This module is not intended to record acceleration/deceleration in a side-impact event. If the side impact generates a longitudinal deceleration component sufficient to wake up the frontal deployment algorithm, there may be a recording of longitudinal deceleration in a side impact event.

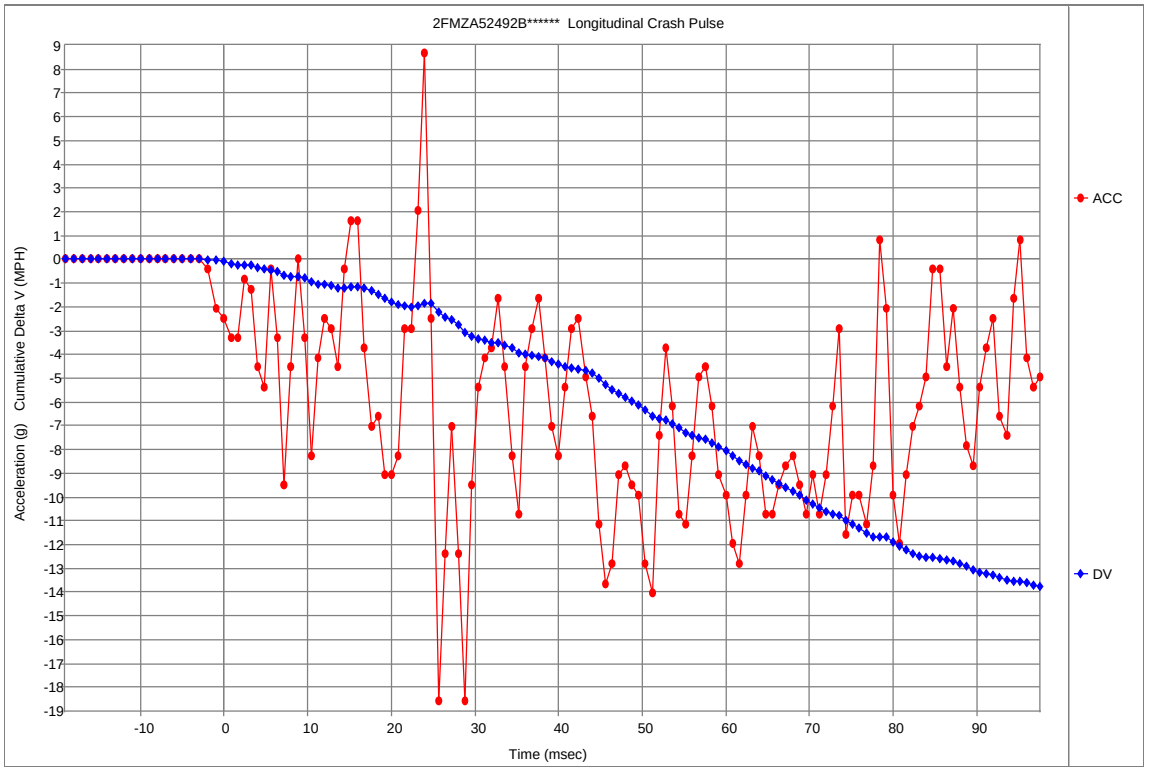
Any Longitudinal Delta-V determined by using data read from the air bag module should be verified with physical evidence from the crash (such as vehicle crush, skid marks) and assumed accident sequence. Multiple impacts, angular collisions, side impacts, vehicle spin, etc should be considered in addition to the data read from the air bag module.

02003_RCM-Takata_r002

System Status At Non-Deployment

Ford Part Number Prefix	1F2A
Diagnostic codes active when event occurred	0
Driver seat belt circuit status	Buckled
Driver seat forward of switch point	No
Right front passenger seat belt circuit status	Buckled
Passenger occupant classification status	Adult
Driver pretensioner	Not Enabled
Passenger Pretensioner	Not Enabled
Unbelted Stage 1	Not Enabled
Unbelted Stage 2	Not Enabled
Belted Stage 1	Not Enabled
Belted Stage 2	Not Enabled

Parameter	Driver	Passenger
Time between algorithm enable and seat belt pretensioner deployment (ms)	No deploy	No deploy
Time between algorithm enable and air bag first stage deployment (ms)	No deploy	No deploy
Time between algorithm enable and air bag second stage deployment (ms)	No deploy	No deploy


2FMZA52492B****** Longitudinal Crash Pulse
Acceleration (g) Cumulative Delta V (MPH)
Time (msec)
ACC
DV

Crash Pulse Data

Milliseconds	Long. Acceleration (Gs)	Long. Cumulative Delta V (MPH)
-19.0	0.00	0.00
-18.0	0.00	0.00
-17.0	0.00	0.00
-16.0	0.00	0.00
-15.0	0.00	0.00
-14.0	0.00	0.00
-13.0	0.00	0.00
-12.0	0.00	0.00
-11.0	0.00	0.00
-10.0	0.00	0.00
-9.0	0.00	0.00
-8.0	0.00	0.00
-7.0	0.00	0.00
-6.0	0.00	0.00
-5.0	0.00	0.00
-4.0	0.00	0.00
-3.0	0.00	0.00
-2.0	-0.41	-0.01
-1.0	-2.06	-0.05
0.0	-2.48	-0.11
0.8	-3.30	-0.17
1.6	-3.30	-0.22
2.4	-0.83	-0.24
3.2	-1.24	-0.26
4.0	-4.54	-0.34
4.8	-5.37	-0.43
5.6	-0.41	-0.44
6.4	-3.30	-0.50
7.2	-9.50	-0.67
8.0	-4.54	-0.75
8.8	0.00	-0.75
9.6	-3.30	-0.80
10.4	-8.26	-0.95
11.2	-4.13	-1.02
12.0	-2.48	-1.07
12.8	-2.89	-1.12
13.6	-4.54	-1.20
14.4	-0.41	-1.20
15.2	1.65	-1.17
16.0	1.65	-1.14
16.8	-3.72	-1.21
17.6	-7.02	-1.33
18.4	-6.61	-1.45
19.2	-9.08	-1.61
20.0	-9.08	-1.77
20.8	-8.26	-1.91
21.6	-2.89	-1.96
22.4	-2.89	-2.01
23.2	2.06	-1.98
24.0	8.67	-1.83

Milliseconds	Long. Acceleration (Gs)	Long. Cumulative Delta V (MPH)
24.8	-2.48	-1.87
25.6	-18.58	-2.20
26.4	-12.39	-2.41
27.2	-7.02	-2.54
28.0	-12.39	-2.75
28.8	-18.58	-3.08
29.6	-9.50	-3.25
30.4	-5.37	-3.34
31.2	-4.13	-3.41
32.0	-3.72	-3.48
32.8	-1.65	-3.51
33.6	-4.54	-3.59
34.4	-8.26	-3.73
35.2	-10.74	-3.92
36.0	-4.54	-4.00
36.8	-2.89	-4.05
37.6	-1.65	-4.08
38.4	-4.13	-4.15
39.2	-7.02	-4.28
40.0	-8.26	-4.42
40.8	-5.37	-4.51
41.6	-2.89	-4.57
42.4	-2.48	-4.61
43.2	-4.95	-4.70
44.0	-6.61	-4.81
44.8	-11.15	-5.01
45.6	-13.63	-5.25
46.4	-12.80	-5.47
47.2	-9.08	-5.63
48.0	-8.67	-5.78
48.8	-9.50	-5.95
49.6	-9.91	-6.12
50.4	-12.80	-6.35
51.2	-14.04	-6.59
52.0	-7.43	-6.72
52.8	-3.72	-6.79
53.6	-6.19	-6.90
54.4	-10.74	-7.09
55.2	-11.15	-7.28
56.0	-8.26	-7.43
56.8	-4.95	-7.51
57.6	-4.54	-7.59
58.4	-6.19	-7.70
59.2	-9.08	-7.86
60.0	-9.91	-8.04
60.8	-11.97	-8.25
61.6	-12.80	-8.47
62.4	-9.91	-8.64
63.2	-7.02	-8.77
64.0	-8.26	-8.91
64.8	-10.74	-9.10
65.6	-10.74	-9.29
66.4	-9.50	-9.46

Milliseconds	Long. Acceleration (Gs)	Long. Cumulative Delta V (MPH)
67.2	-8.67	-9.61
68.0	-8.26	-9.75
68.8	-9.50	-9.92
69.6	-10.74	-10.11
70.4	-9.08	-10.27
71.2	-10.74	-10.46
72.0	-9.08	-10.62
72.8	-6.19	-10.72
73.6	-2.89	-10.78
74.4	-11.56	-10.98
75.2	-9.91	-11.15
76.0	-9.91	-11.33
76.8	-11.15	-11.52
77.6	-8.67	-11.67
78.4	0.83	-11.66
79.2	-2.06	-11.70
80.0	-9.91	-11.87
80.8	-11.97	-12.08
81.6	-9.08	-12.24
82.4	-7.02	-12.36
83.2	-6.19	-12.47
84.0	-4.95	-12.56
84.8	-0.41	-12.56
85.6	-0.41	-12.57
86.4	-4.54	-12.65
87.2	-2.06	-12.69
88.0	-5.37	-12.78
88.8	-7.85	-12.92
89.6	-8.67	-13.07
90.4	-5.37	-13.17
91.2	-3.72	-13.23
92.0	-2.48	-13.28
92.8	-6.61	-13.39
93.6	-7.43	-13.52
94.4	-1.65	-13.55
95.2	0.83	-13.54
96.0	-4.13	-13.61
96.8	-5.37	-13.70
97.6	-4.95	-13.79