



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

SCI/NASS COMBINATION SEAT BELT-RELATED SERIOUS INJURY INVESTIGATION

CASE NUMBER - 2006-48-006K
LOCATION - Alabama
VEHICLE - 1999 HONDA ACCORD
CRASH DATE - January 2006

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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16. Abstract This report covers a SCI/NASS combination investigation of a crash involving a 1999 Honda Accord EX coupe (case vehicle) and a 1999 GMC Yukon SUV (other vehicle). This crash is of special interest because the case vehicle's driver (51-year-old female) sustained multiple serious internal injuries as a result of loading her manual, three-point, lap-and-shoulder safety belt system. There was no other occupant in the case vehicle. The case vehicle had been traveling westward in the westbound left turn lane of a three-lane roadway that was part of a divided trafficway, approaching a left turn median cut, intending to turn left to travel southward. The other vehicle was traveling eastward in the inside eastbound lane of the two-lane roadway that was part of the same divided trafficway, approaching the same intersection, intending to pass through the intersection and continue eastward. It was daylight, the weather was clear and the asphalt road surface was dry and free of defects. The speed limit for both vehicles was 72 km.p.h. [45 m.p.h.]. The case vehicle's driver began the intended left turn across the other vehicle's path. The other vehicle's driver attempted to steer to the right but could not avoid the impact. The case vehicle's driver did not attempt any avoidance maneuver. The case vehicle's front right corner was impacted by the other vehicle's front, causing the case vehicle's frontal air bags to deploy and causing the driver's safety belt retractor to lock. The case vehicle driver moved forward and rightward in response to the impact force, loading against the safety belt webbing. The case vehicle rotated counterclockwise very rapidly causing the driver to move further to the right. The lap portion of the safety belt webbing compressed the driver's abdomen and she sustained lacerations of the ileum, mesentery and colon, and contusions across her abdomen. The case vehicle driver was hospitalized for 6 days. Both vehicles were towed due to disabling damage.			
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This SCI/NASS combination investigation was brought to the NHTSA's attention in mid-January 2006 by NASS-CDS sampling activities and was designated for SCI on August 16, 2006. This crash involved a 1999 Honda Accord EX coupe (case vehicle, NASS vehicle #1) and a 1999 GMC Yukon multi-purpose vehicle (other vehicle, NASS vehicle #2). The crash occurred in January 2006, at 7:50 a.m., in Alabama, and was investigated by the applicable municipal police. This crash is of special interest because the case vehicle's driver (51-year-old female, white, non-Hispanic) sustained multiple serious internal injuries as a result of loading her manual, three-point, lap-and-shoulder safety belt system. There was no other occupant in the case vehicle. In addition, the other vehicle was equipped with an EDR that was successfully downloaded. This report is based on the coded NASS case data, occupant kinematic principles and this contractor's evaluation of the available evidence.

CRASH CIRCUMSTANCES

The case vehicle had been traveling westward in the westbound left turn lane of a three-lane roadway that was part of a divided trafficway, approaching a left turn median cut with a “YIELD” sign for left turning vehicles and no other controls for east-west traffic, intending to turn left to travel southward on the intersecting roadway (**Figure 1**). The other vehicle was traveling eastward in the inside eastbound lane of the two-lane roadway that was part of the same divided trafficway, approaching the same intersection, intending to pass through the intersection and continue eastward (**Figure 2**). It was daylight, the weather was clear and the asphalt road surface was dry and free of defects. The speed limit for both vehicles was 72 km.p.h. [45 m.p.h.]. The case vehicle's driver began the intended left turn across the other vehicle's path. The other vehicle's driver attempted to steer to the right but could not avoid the impact. The case vehicle's driver did not attempt any avoidance maneuver.

The crash occurred within the intersection. The case vehicle's front right corner was impacted by the other vehicle's front, causing the case vehicle's driver and front right passenger air bags to deploy. The other vehicle's frontal air bags also deployed. The case vehicle rotated approximately



Figure 1: Case vehicle's eastbound approach toward intended left turn, with lookback view of the other vehicle's approach

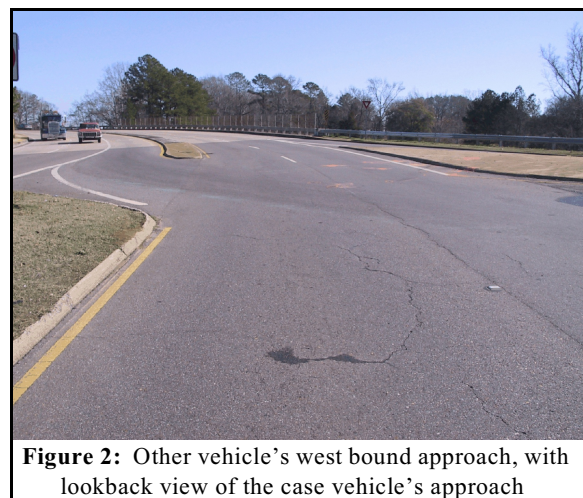


Figure 2: Other vehicle's west bound approach, with lookback view of the case vehicle's approach

90 degrees counterclockwise, ran off the south edge of the eastbound lanes a short distance eastward of the intersection and came to rest with its front wheels off the roadway, heading slightly south of due east. The other vehicle was deflected to the south, ran off the south edge of the eastbound lanes and came to rest on the roadside a short distance eastward of the intersection, heading due east.

CASE VEHICLE: 1999 HONDA ACCORD

The case vehicle was a 1999 Honda Accord EX front wheel drive, two-door, five-passenger coupe (VIN: 1HGCG3258XA-----), equipped with a 4-cylinder, 2.3 liter gasoline engine and an automatic transmission with a console-mounted selector lever. Four-wheel anti-lock brakes were an option for this model, but it is not known if the case vehicle was so equipped. The case vehicle was equipped with manual, three-point, lap-and-shoulder safety belts and redesigned frontal air bags that deployed for the two front bucket seats. Its odometer reading is not known due to the non-functional electronic instrument cluster, but the driver estimated 88,512 kilometers [55,000 miles]. Its specification wheelbase was 267 centimeters [105.1 inches]. The case vehicle was towed from the scene due to disabling damage.

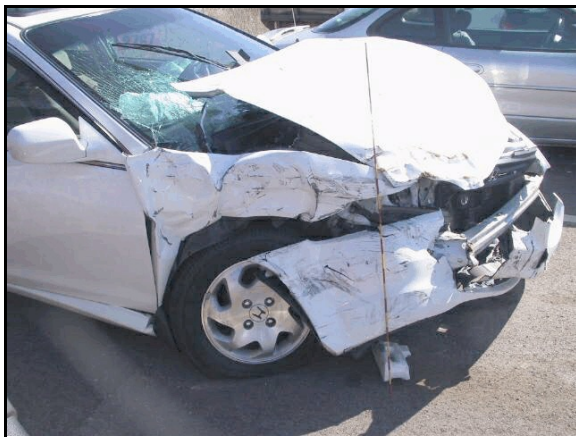


Figure 3: Case vehicle's front and right side



Figure 4: Case vehicle's front and left side

The case vehicle's single impact was at the front right corner, with direct contact damage extending across approximately the right half of the front plane, and on the right fender with direct contact rearward to the A-pillar. The other vehicle's front bumper overrode the case vehicle's bumper and the structures at the front right corner were crushed rearward and inward, with the right side of the radiator pressed against the engine block. The engine hood was buckled and displaced rearward, with its right rear corner impacting the windshield and causing extensive cracking across the entire width. There was no other glazing damage. The bumper cover was torn off and the steel bumper was crushed rearward on the right. The right door and rocker panel sustained induced damage but the door remained closed and operational. The right front wheel/tire assembly was displaced rearward and restricted due to being pressed against the right lower A-pillar with the tire deflated, and there was no other wheel/tire damage. The right wheelbase was shortened by 7 centimeters [2.8 inches]

and the left wheelbase shortened by 2 centimeters [0.8 inches]. The grille and the right headlamp/turn signal assembly were shattered and broken away, with the left headlamp/turn signal assembly intact but displaced due to damage to the adjacent components.¹

The CDC for the case vehicle's single impact was determined to be **01-FZEW-2 (40 degrees)**. The WinSMASH reconstruction program, CDC-only algorithm based on the case vehicle's CDC and the other vehicle's crush profile, was used. The total, longitudinal and lateral delta-Vs are, respectively: 36 km.p.h. [22.4 m.p.h.], -28 km.p.h. [-17.4 m.p.h.] and -23 km.p.h. [-14.3 m.p.h.]. This is a borderline reconstruction but the results seem reasonable and this was a crash of moderate severity (24-40 km.p.h. [15-25 m.p.h.]) for the case vehicle.

The manufacturer's recommended tire size is P195/65R15 and the case vehicle was fitted with four tires of this size. The findings of the tire inspection are presented in the following table.

Tire	Measured Pressure		Recommend Pressure		Tread Depth		Damage	Restricted	Deflated
	kpa	psi	kpa	psi	milli-meters	32 nd of an inch			
LF	241	35	200	29	7	9	None	No	No
RF	flat		200	29	6	8	None	Yes	Yes
LR	241	35	200	29	7	9	None	No	No
RR	200	29	200	29	7	9	None	No	No

Inspection of the case vehicle's interior revealed minor intrusion and several points of occupant contact. The toe pan in the front right footwell was measured as intruding 8 centimeters [3.1 inches] longitudinally. Evidence of occupant contact was noted on the front of the driver's air bag fabric (cosmetics transfer), on the knee bolster to the left of the steering column (scratches) and on the torso portion of the driver's safety belt webbing, which was stretched.

The driver's air bag was located in the steering wheel hub with the module cover flaps in the "H" configuration (**Figure 5**). The cover flaps opened at



Figure 5: Front of driver's air bag; the top of the air bag is at the lower right in this view

¹The frontal crush profile measurements are not known because the field researcher measured the right side.

the designated tear points and there was no evidence of damage to the cover flaps or the adjacent structures. The deployed driver's air bag was round. There was no evidence of damage to the air bag. There was an area of cosmetics transfer on the front of the air bag fabric near the center.

The front right passenger's air bag was located in the top of the instrument panel. The module was set into the instrument panel with a pre-stressed seam across the top of the module along the long dimension. The cover flaps opened at the designated locations and there was no evidence of damage to the cover flaps or the adjacent structures, except the front edge of the module (close to the windshield) was displaced upward. The deployed front right passenger's air bag was rectangular. There was no evidence of damage to the air bag, and no evidence of occupant contact.

CASE VEHICLE DRIVER'S KINEMATICS

The case vehicle's driver (51-year-old female, white, non-Hispanic, 152 centimeters, 64 kilograms [60 inches, 141 pounds]) was restrained by her available, manual, three-point, lap-and-shoulder safety belt system and the steering wheel air bag deployed. The driver was not able to describe the position of either the lap or the shoulder portions of the safety belt webbing. The seat track was found at the full rear position at the time of the inspection, but the driver stated that the seat track was adjusted full forward at the time of the crash. The adjustable head restraint was flush against the top of the seat and the seat back was slightly reclined. The driver stated that her back was against the seat back, with her right foot operating the foot controls, her left foot on the floor and both hands on the steering wheel (**Figure 6**).

The case vehicle driver was in the midst of executing a left turn and she was probably leaning slightly to the right in response to this maneuver. She did not attempt any avoidance actions and her posture did not change immediately prior to the impact. The case vehicle's front right corner was impacted by the front of the other vehicle, causing the case vehicle's driver and front right passenger frontal air bags to deploy, and causing the safety belt retractor to lock. The driver moved forward and slightly to the right in response to the 1:00 o'clock impact force and loaded the safety belt webbing. The impact caused the case vehicle to rotate counterclockwise and the WinSMASH reconstruction calculations indicated the change in angular velocity as -309 degrees per second (the minus sign indicates counterclockwise rotation). The rapid rotation caused the driver to move further to the right and to load heavily against the safety belt webbing. The lap portion of the safety belt webbing compressed her abdomen and she sustained lacerations of the ileum, mesentery and colon, with contusions across her abdomen. Her right foot impacted the floor/toe pan and she sustained a fracture of the phalanx in her right great toe. Her left foot also impacted the floor/toe pan and she sustained a comminuted fracture of the left calcaneus and contusions around her left ankle, heel and



Figure 6: Driver's seat area view from right

foot. The driver was amnesic to the crash events and her posture at final rest is not known. She was removed from the case vehicle by rescue personnel.

DRIVER'S INJURIES

The driver was transported by ground ambulance to a local trauma center, where she was admitted for six days, for treatment of her injuries.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1.	Ileum laceration (perforation)	serious 541424.3,8	Lap portion of safety belt	certain	Emergency Room
2.	Colon (cecum) laceration (perforation)	serious 540824.3,8	Lap portion of safety belt	certain	Emergency Room
3.	Mesentery laceration (minor)	moderate 542022.2,8	Lap portion of safety belt	certain	Emergency Room
4.	Fracture, proximal phalanx, right great toe	minor 853602.1,1	Floor/toe pan	certain	Emergency Room
5.	Comminuted fracture, left calcaneus	moderate 851400.2,2	Floor/toe pan	certain	Emergency Room
6.	Contusion, left ankle, heel and foot	minor 890402.1,2	Floor/toe pan	certain	Emergency Room
7.	Contusion, abdomen, aspect not known	minor 590402.1,9	Lap portion of safety belt	certain	Interview (same person)

OTHER VEHICLE: 1999 GMC YUKON

The other vehicle was a 1999 GMC Yukon rear wheel drive, four-door, five passenger, multipurpose vehicle (VIN: 1GKEC13R7XJ-----), equipped with a V8 5.7 liter gasoline engine and an automatic transmission with a column-mounted selector lever. Four-wheel anti-lock brakes were standard equipment on this model. The Yukon's odometer reading was recorded as 211,114 kilometers [131,184 miles] and its specification wheelbase was 297centimeters [117.5 inches]. The Yukon was towed due to disabling frontal damage.

The Yukon's damage was concentrated at the center of the front, with a relatively deep V-shaped indentation resulting from the Yukon's initial contact with the apex of the case vehicle's front right corner (**Figures 7 and 8**). Direct contact was measured as beginning at the front left corner and extending inward 108 centimeters [42.5 inches], reflecting the Yukon's contact with the case vehicle's front surface (to the right of the V) and right fender (to the left of the V). The bumper was crushed inward and slightly upward at the center, with the right end of the bumper flexed forward. The wheelbase was unchanged. The bottom edge of the radiator was crushed rearward but the top

edge and the support bracket were not damaged, reflecting the Yukon's override engagement with the case vehicle's front. The grille and the left headlamp assembly were shattered and broken away, and the two turn signal assemblies were separated from their mountings and dangling from their wires. The right headlamp was undamaged and there was no direct contact on the leading edge of the hood. Maximum crush was measured as 52 centimeters [20.5 inches], between C3 and C4. The right front tire was deflated, with no other wheel/tire damage. All of the Yukon's glazing was intact.



Figure 7: Other vehicle's front and right side



Figure 8: Other vehicle's front and left side

The CDC for the Yukon's single impact was determined to be **12-FYEW-2 (350 degrees)**. The WinSMASH reconstruction program, CDC-only algorithm based on the case vehicle's CDC and the Yukon's crush profile, was used. The total, longitudinal and lateral delta-Vs are, respectively: 21 km.p.h. [13.0 m.p.h.], -21 km.p.h. [-13.0 m.p.h.] and +4 km.p.h. [+2.5 m.p.h.]. This is a borderline reconstruction but these results seem reasonable and this was a crash of low severity (14-25 km.p.h. [9-14 m.p.h.]) for the Yukon.

The manufacturer's recommended tire size is P235/75R15 and the Yukon was fitted with four tires of this size. The findings of the tire inspection are presented in the following table.

Tire	Measured Pressure		Recommend Pressure		Tread Depth		Damage	Restricted	Deflated
	kpa	psi	kpa	psi	milli-meters	32 nd of an inch			
LF	172	25	221	32	5	6	scuff on wheel hub	No	No
RF	flat		221	32	3	4	None	No	Yes
LR	345	50	241	35	4	5	None	No	No
RR	207	30	241	35	4	5	None	No	No

The Yukon's Event Data Recorder was successfully downloaded in the field. The Sensing and

Diagnostic Module reports are presented as **Figures 9 and 10** at the end of this report. The report shows that the SIR warning lamp was off, indicating no faults in the air bag system, and the passenger's air bag was not suppressed. There is no pre-crash data in the report for this early (model year 1999) EDR. The command to deploy the air bags was issued 60 milliseconds (ms) after algorithm enable. The velocity change data show a moderately steep crash pulse, from -1.1 km.p.h. [-0.66 m.p.h.] at 10 ms to -20.1 km.p.h. [-12.51 m.p.h.] at 60 ms and -29.7 km.p.h. [-18.43 m.p.h.] at 120 ms. The velocity change oscillated between -29.9 km.p.h. [-18.43 m.p.h.] and -29.0 km.p.h. [-17.99 m.p.h.] for the duration of the recording, which ceased at 300 ms.

The other vehicle's driver (30-year-old female) and three passengers (front right 13-year-old female; back left 5-year-old male; back right 11-year-old female) all sustained minor or no injuries. The driver and the two back seat passengers were transported via ground ambulance to a local hospital, where all three were treated for their minor injuries and released. The front right passenger sought medical attention later and it was confirmed that she did not sustain any injuries.



CDR File Information

Vehicle Identification Number	1GKEC13R7X[REDACTED]
Investigator	
Case Number	
Investigation Date	[REDACTED] January [REDACTED] 2006
Crash Date	
Filename	N200648006K_V2.CDR
Saved on	[REDACTED], January [REDACTED] 2006 at 09:41:37 AM
Collected with CDR version	Crash Data Retrieval Tool 2.70
Collecting program verification number	[REDACTED]
Reported with CDR version	Crash Data Retrieval Tool 2.800
Reporting program verification number	[REDACTED]
Interface used to collected data	Block number: 00 Interface version: 41 Date: 11-04-04 Checksum: 9E00
Event(s) recovered	Deployment

SDM Data Limitations

SDM Recorded Crash Events:

There are two types of SDM recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event is an event severe enough to "wake up" the sensing algorithm but not severe enough to deploy the air bag(s). The SDM can store up to one Non-Deployment Event. This event can be overwritten by an event that has a greater SDM recorded forward velocity change. This event will be cleared by the SDM after the ignition has been cycled 250 times. The second type of SDM recorded crash event is the Deployment Event. The SDM can store up to two different Deployment Events, if they occur within five seconds of one another. Deployment Events cannot be overwritten or cleared from the SDM. Once the SDM has deployed the air bag, the SDM must be replaced. The data in the Non-Deployment Event file will be locked after a Deployment Event, if the Non-Deployment Event occurred within 5 seconds before the Deployment Event unless a Deployment Level Event occurs within 5 seconds after the Deployment Event, and then the Deployment Level Event will overwrite the Non-Deployment Event file.

SDM Data Limitations:

- SDM Recorded Vehicle Forward Velocity Change reflects the change in forward velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle Forward Velocity Change is the change in velocity during the recording time and is not the speed the vehicle was traveling before the event, and is also not the Barrier Equivalent Velocity. This data should be examined in conjunction with other available physical evidence from the vehicle and scene when assessing occupant or vehicle forward velocity change. The SDM records the first 300 milliseconds of Vehicle Forward Velocity Change after Algorithm Enable. The maximum value that can be recorded for Vehicle Forward Velocity Change is 56 MPH.
- Driver's Belt Switch Circuit Status indicates the status of the driver's seat belt switch circuit.
- The Time between Non-Deployment and Deployment Events is displayed in seconds. If the time between the two events is greater than five seconds, "N/A" is displayed in place of the time.
- If power to the SDM is lost during a crash event, all or part of the crash record may not be recorded. An indication of a loss of power would be if the ignition cycles at the event is recorded as zero. Data recorded after that may not be reliable, such as Time Between Non-Deployment and Deployment Events, Driver Belt Switch Circuit Status, and Passenger SIR Suppression Switch Circuit Status.

SDM Data Source:

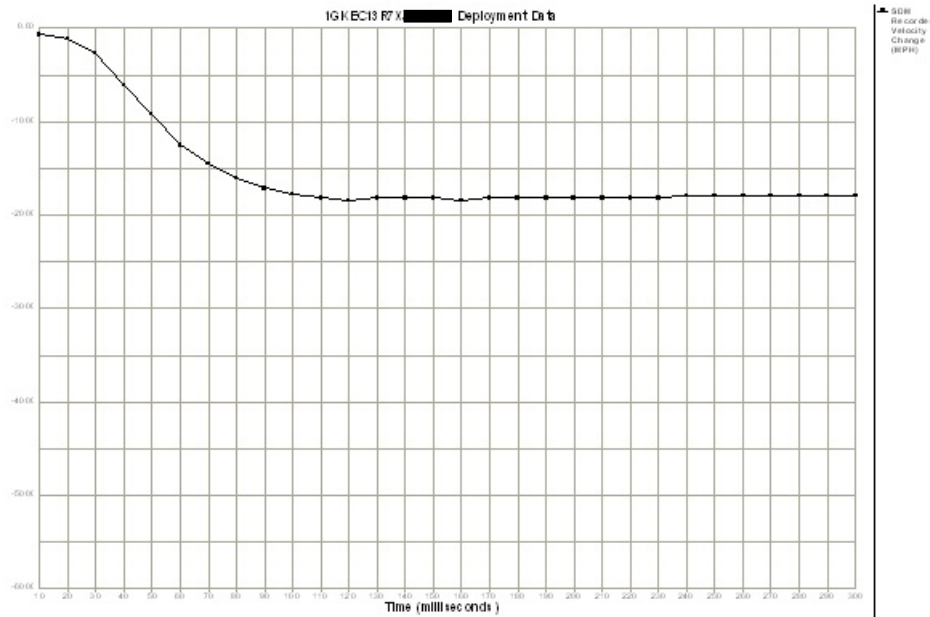
- All SDM recorded data is measured, calculated, and stored internally, except for the following:
- The Driver's Belt Switch Circuit is wired directly to the SDM.
- The Passenger Front Air Bag Suppression Switch Circuit is wired directly to the SDM.

Figure 9: Other Vehicle's SDM report, Data Limitations



System Status At Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Passenger Front Air Bag Suppression Switch Circuit Status	Air Bag Not Suppressed
Ignition Cycles At Deployment	17053
Ignition Cycles At Investigation	17056
Time From Algorithm Enable To Deployment Command (msec)	60
Time Between Non-Deployment And Deployment Events (sec)	N/A



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-0.66	-1.10	-2.63	-6.14	-9.21	-12.51	-14.48	-16.02	-17.11	-17.77	-18.21	-18.43	-18.21	-18.21	-18.21
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Recorded Velocity Change (MPH)	-18.43	-18.21	-18.21	-18.21	-18.21	-18.21	-18.21	-18.21	-17.99	-17.99	-17.99	-17.99	-17.99	-17.99	-17.99

Figure 10: Other Vehicle's SDM report, System Status at Deployment and Velocity Change graph and data

