Advanced Occupant Protection Investigation / Rollover
Dynamic Science, Inc. / Case Number: DS02014
2001 Volkswagen Jetta
Colorado
July, 2002

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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

1. Report No.	2. Government Accession No.	3. Recipient Catalog No.
DS02014		

4. Title and Subtitle	5. Report Date
Advanced Occupant Protection System Investigation	April 13, 2004
	6. Performing Organization Report No.

7. Author(s)	8. Performing Organization Report No.
Dynamic Science, Inc.	

9. Performing Organization name and Address	10. Work Unit No. (TRAIS)
Dynamic Science, Inc. 530 College Parkway, Ste. K Annapolis, MD 21401	11. Contract or Grant no. DTNH22-01-C-27002

12. Sponsoring Agency Name and Address	13. Type of report and period Covered [Report Month, Year]
U.S. Dept. of Transportation (NRD-32) National Highway Traffic Safety Administration 400 7th Street, SW Washington, DC 20590	14. Sponsoring Agency Code

15. Supplemental Notes

16. Abstract

This on-site investigation focused on the performance of the Advanced Occupant Protection System (AOPS) in a 2001 Volkswagen Jetta. The vehicle was equipped with eight air bags. A driver's steering wheel mounted air bag, a mid-mounted front right passenger's air bag, seat back mounted side air bags for the two front seats, and head impact air bags mounted above the side windows. The head air bags will expand to cover the side windows, door column and protect both front and rear outboard seat positions. This crash occurred in Colorado in July, 2002 at 0245 hours. The crash occurred on the northbound lanes of an interstate roadway. The roadway at this location is comprised of two straight asphalt paved travel lanes. The roadway has a slight downhill grade. There were no traffic controls present and the speed limit is 121 km/h (75 mph). It was dark at the time of the crash and no streetlights were present. It was raining hard at the time of the crash. The case vehicle was a 2001 Volkswagen Jetta driven by a restrained 21-year-old female. The front right seat was occupied by a restrained 24-year-old male. The driver of the Jetta lost control of the vehicle. The vehicle traveled off the left side of the roadway into the grass covered median and began a counterclockwise rotation. The vehicle struck the center median metal guardrail with its right side At impact, the front right passenger's side air bag and head impact air bag both deployed. The Jetta traveled backwards while engaged with the guardrail and then began a counterclockwise rotation away from the guardrail. The vehicle rotated until the right side of the vehicle began leading. The vehicle tripped at this point and began to roll along its longitudinal axis. The vehicle rolled six quarter turns. The top of the hood engaged the guardrail on the sixth turn. The vehicle continued to roll two additional quarter turns before coming to rest on its wheels with its front end partially on the guardrail facing southwest. Both occupants were transported, treated at a local medical facility and then released.

17. Key Words	18. Distribution Statement
Air bag, deployment, Advanced Occupant Protection, AOPS, side air bag, head air bag	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No of pages	22. Price

Form DOT F 1700.7 (8_72) Reproduction of this form and completed page is authorized

Dynamic Science, Inc.
Crash Investigation
Case Number: DS02014

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BACKGROUND:

Description: This on-site investigation focused on the performance of the Advanced Occupant Protection System (AOPS) in a 2001 Volkswagen Jetta. The vehicle was equipped with eight air bags. A driver's steering wheel mounted air bag, a mid-mounted front right passenger's air bag, seat back mounted side air bags for the two front seats, and head impact air bags mounted above the side windows. The head air bags will expand to cover the side windows, door column and protect both front and rear outboard seat positions. This AOPS case was reported to the NHTSA by the investigating police agency. DSI was assigned the case on July 9, 2002. An on-scene investigation was conducted. Present at the case vehicle's inspection was the investigating police officer. All scene field work was completed on July 12, 2002.

Investigation Type: Advanced Occupant Protection System (AOPS)
Crash Location: Colorado
Crash Date: July, 2002
Notification Date: July 9, 2002
Field Work Completed: July 12, 2002

SUMMARY

Crash Site

This crash occurred in Colorado in July, 2002 at 0245 hours. The crash occurred on the northbound lanes of an interstate roadway. The roadway at this location is comprised of two straight asphalt paved travel lanes. The roadway has a slight downhill grade. There is an asphalt paved shoulder on the east side of the roadway and a depressed grass median area on the west. Northbound traffic is separated from southbound traffic by a metal guardrail. There were no traffic controls present and the speed limit is 121 km/h (75 mph). It was dark at the time of the crash and no streetlights were present. It was raining hard at the time of the crash.

Figure 1. Overview of vehicle path (north)

Figure 2. Vehicle path into guardrail (first event)

Pre-Crash

The case vehicle was a 2001 Volkswagen Jetta driven by a restrained 21-year-old female. The front right seat was occupied by a restrained 24-year-old male. The Jetta was equipped with

eight[1] air bags: a driver's air bag, a front right passenger's air bag, seat back mounted side air bags for the two front seats, and left and right head impact air bags. The Jetta was traveling northbound at a police estimated speed of 129 km/h (80 mph).

Figure 3. Case vehicle at final rest on top of guardrail

Figure 4. Case vehicle at final rest on top of guardrail; right side of vehicle

Crash

The driver of the Jetta lost control of the vehicle. The vehicle traveled off the left side of the roadway into the grass covered median and began a counterclockwise rotation. The vehicle left 28.7 m (94 ft) of furrowing in the median prior to striking the center median metal guardrail with its right side (04RDAW3). Given the height of the guardrail contact to the Jetta, this vehicle would have had to have been partially rolled over prior to impact. At impact, the front right passenger's side air bag and head impact air bag both deployed. The Jetta traveled backwards while engaged with the guardrail for 21.3 m (70 ft). The vehicle then began a counterclockwise rotation away from the guardrail. The vehicle rotated until the right side of the vehicle began leading. The vehicle tripped at this point and began to roll along its longitudinal axis. The vehicle rolled six quarter turns (00TZDO3). The top of the hood engaged the guardrail on the sixth turn (00TFDW6). The vehicle continued to roll two additional quarter turns before coming to rest on its wheels with its front end partially on the guardrail facing southwest. The distance between the separation from the initial guardrail impact and final rest was 58.2 m (191 ft).

Post-Crash

The driver of the case vehicle sustained multiple contusions and abrasions, a left wrist sprain, a contusion to the left parietal occipital region, and a glass sliver in her right index finger. She was transported by ground ambulance to a local hospital. She arrived at 0350 hours. She was evaluated for a possible head injury but this was later ruled out. There was no loss of consciousness. She was treated and then released at 0650 hours.

The front right occupant of the case vehicle sustained a comminuted right clavicle (mid shaft) fracture, a left ankle sprain, and an unknown foreign body embedded in his right arm. He was transported by ground ambulance to a local hospital. He arrived at 0400 hours. He was treated and then released at 0710 hours. The foreign body was not removed. Doctors indicated that it

[1]The head impact air bags cover both the front and rear outboard seat positions and are, therefore, equivalent to four separate air bags.

would come out on its own. This occupant was arrested immediately after release on a warrant that was not related to this event.

The case vehicle was towed from the scene due to damage and had been placed on a police hold at the time of the vehicle inspection.

Figure 5. Front, Volkswagen Jetta

VEHICLE DATA - 2001 Volkswagen Jetta

The case vehicle is a 2001 Volkswagen Jetta GL four-door sedan. The vehicle was equipped with a 4-cylinder 1.8 L (109 CID) engine, 5-speed manual transmission, front wheel drive, hydraulic assist rack and pinion steering, and four-wheel anti-lock brakes.

VIN:	3VWSD69M11Mxxxxxx
Odometer:	25,552 km (15,877 miles)
Reported Defects:	None
Cargo:	Portable heater and clothes. Estimated at 18 kg (40 lbs).

The 2001 Volkswagen Jetta was equipped with Goodyear Eagle RS-A P205/55R16 tires at the left front, left rear, and right front locations. The right rear tire was missing at the time of inspection. The specific tire data is as follows:

Tire	Tread	Pressure	Manufacturer's Recommended Pressure
LF	5 mm (6/32 in)	200 kPa (29 psi)	200 kPa (29 psi)
LR	6 mm (7/32 in)	200 kPa (29 psi)	193 kPa (28 psi)
RF	6 mm (7/32 in)	Unknown	200 kPa (29 psi)
RR	Unknown	Unknown	193 kPa (28 psi)

The 2001 Volkswagen Jetta had a five passenger seating capacity. The front seating positions were configured with cloth covered bucket seats with adjustable head restraints. The rear seating positions were configured with a cloth covered bench seat with a 60/40 split folding back and adjustable head restraints for all three rear seat positions.

VEHICLE DAMAGE

Exterior Damage - 2001 Volkswagen Jetta

Damage Description:	The Jetta sustained major damage about the entire vehicle. Both of the rear doors were jammed shut.The windshield was cracked and holed and all the remaining glazing disintegrated.	
CDC:	Impact 1: 04RDAW3 (guardrail) Impact 2: 00TZDO3 (rollover) Impact 3: 00TFDW6 (guardrail during rollover)	
Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

Figure 6. Left side, Volkswagen Jetta

Figure 7. Right side, Volkswagen Jetta

Interior Damage - 2001 Volkswagen Jetta

Interior damage to the 2001 Volkswagen Jetta was significant and attributed to occupant contact and passenger compartment intrusion. The entire windshield was fractured from impact forces. The right side of the windshield was holed. The side glass for all four doors was disintegrated from impact forces, as was the backlight and the roof glass. Both rear doors were jammed shut. There was lateral intrusion into the driver's and front right passenger's compartment area through the A/B pillars and window frames.

Figure 8. Windshield integrity loss

MANUAL RESTRAINT SYSTEMS - 2001 Volkswagen Jetta

The Volkswagen Jetta was equipped with three-point safety belts at all five seating positions. The retractors for the front outboard safety belts were equipped with belt pretensioners. Sensors activate the belt pretensioners when deceleration is high enough. The belt pretensioners can only be actuated once and will not be actuated if the safety belt is not in use. All the seat locations were equipped with sliding belt latches. The driver's seat was equipped with an emergency locking retractor (ELR) while the remaining seats were equipped with switchable retractors.

There was no clear indication that the driver's seat belt pretensioner actuated. It appears that the belt was in use at the time of the crash. There was evidence of belt loading on the sliding belt latch and the webbing. The belt retracted in a normal fashion when pulled completely out. The shoulder belt upper anchorage was adjusted to the full up position.

The belt tensioner was clearly actuated for the front right seat position and the safety belt remained spooled out. The safety belt webbing had jammed from loading into the D ring. There was evidence of loading on the sliding belt latch. The shoulder belt upper anchorage was adjusted to the full up position.

AIR BAG SYSTEM - 2001 Volkswagen Jetta

The Volkswagen Jetta was equipped with eight air bags: a driver's air bag, a front right passenger's air bag, seat back mounted side air bags for the two front seats, and left and right head impact air bags that covered the front and rear outboard seat positions. The driver's air bag was housed in the steering wheel hub. The front right passenger's air bag was mounted in the middle of the instrument panel. The driver's and front right passenger's side air bags were mounted in their respective seat backs. The head air bags were located on the left and right sides above the doors and behind the headliner and behind the front door column trim (they extend from the A-pillars rearward to the C-pillars).

Figure 9. Displaced passenger's air bag module cover

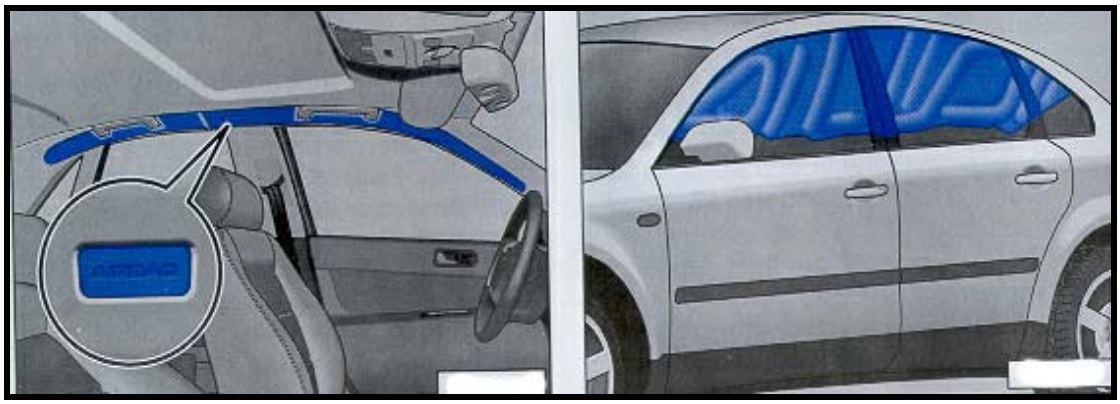

Figure 10. Overview of head impact air bag

The front air bags were of a dual-threshold design. The safety belts for the front seat positions have seat belt status sensors that indicate if the seat belts are latched or not. If they are latched, the front air bags will deploy at a slightly higher rate of deceleration than if the seat belt is not latched. The front air bags did not deploy. The air bag module cover on the front right passenger air bag was displaced during the crash.

Figure 11. Exterior view of head air bag

The front right passenger side air bag and the right side head air bag both deployed. The front right side air bag measured 19.0 cm (7.5 in) by 25.0 cm (9.8 in). It was housed within a plastic module. The side air bag was internally vented and was not tethered. There was red smears on the inner middle portion of the air bag that was possibly blood. The right side head air bag measured 38.0 cm (15.0 in) high by 174.0 cm (68.5 in) long. It was internally vented and was not tethered. There were no indications of occupant contact to the head air bag.

Figure 12. Right side head impact air bag deployed

Figure 13. Front right-side air bag and head impact air bag activated

Figure 14. Front right side air bag

OCCUPANT DEMOGRAPHICS - 2001 Volkswagen Jetta

	Occupant 1	Occupant 2
Age/Sex:	21/Female	24/Male
Seated Position:	Front left	Front right
Seat Type:	Fabric covered bucket seat. Seat adjusted to between middle and rear most track position. Seat back adjusted to 61 degrees from horizontal.	Fabric covered bucket seat. Seat adjusted to rear most track position. Seat back adjusted to 59 degrees from horizontal.
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Occupation:	Unknown	Unknown
Pre-existing Medical Condition:	None	None
Alcohol/Drug Involvement:	Breathalyzer results = 0.128	Drinking, no test given
Driving Experience:	Unknown	NA
Body Posture:	Presumed to be normal, upright	Presumed to be normal, upright
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt available, used.	Lap and shoulder belt available, used.
Air bag:	Steering wheel mounted front air bag, did not deploy. Seat back mounted side air bag, did not deploy. Roof rail mounted head air bag, did not deploy.	Mid instrument panel mounted front air bag, did not deploy. Seat back mounted side air bag, did deploy. Roof rail mounted head air bag, did deploy.

OCCUPANT INJURIES -2001 Volkswagen Jetta

Driver: Injuries obtained from emergency room records. Both hands were x-rayed to determine if any foreign bodies (glass) were present. Results were negative.

Injury	OIC Code	Injury Mechanism	Confidence Level
Contusion, left parietal region	190402.1,2	Window frame	Probable
Left wrist sprain	751420.1,2	Steering wheel rim	Possible
Glass fragment in right index finger[2]	790600.1,1	Glazing	Probable
Multiple contusions	990400.1,0	Unknown	NA
Multiple abrasions	990200.1,0	Unknown	NA

Front right occupant: Injuries obtained from emergency room records. Fracture verified by x-ray. Foreign body identified by x-ray.

Injury	OIC Code	Injury Mechanism	Confidence Level
Comminuted right clavicle (mid shaft) fracture	752200.2,1	Side door panel	Probable
Left ankle sprain	850206.1,2	Floor board	Possible
Foreign body in right arm[2]	790600.1,1	Unknown	NA

[2]Coded as laceration

OCCUPANT KINEMATICS - 2001 Volkswagen Jetta

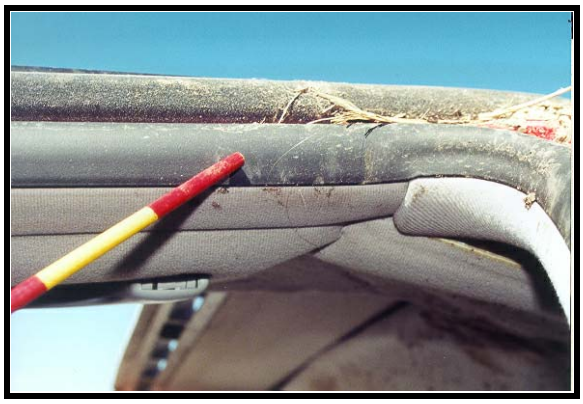

Figure 15. Hairs found on left upper window frame

The 21-year-old female driver of the Volkswagen Jetta was likely seated in a normal, upright position. She was wearing the available lap and shoulder belt. The shoulder belt upper anchorage was adjusted to the full up position. The fabric covered bucket seat was adjusted to between the middle and rear most track position. The seat back was adjusted to 61 degrees from horizontal. Prior to impact, the driver had lost control of the vehicle. It was in a counterclockwise rotation that had passed 90 degrees (front tires had crossed). Both hands were likely on the steering wheel as she tried to correct the vehicle's path of travel. This occupant was held in place by the seat belts but was experiencing loading to the right due to the spinning motion. At impact, she pitched sharply to the back right in response to the 4 o'clock direction of force. As the vehicle separated from the guardrail she would have experienced more lateral motion, first to the left where the left side of her head struck the window frame–causing a contusion, and then to right as the vehicle began to rollover. This occupant remained belted in place as the vehicle tripped and rolled eight quarter turns. She sustained multiple contusions and abrasions but the locations of the injuries are not known. She also sustained a wrist strain. This is likely connected to her efforts to hold onto steering wheel.

The 24-year-old male front occupant was positioned in the front right seat. He was wearing the available lap and shoulder belt. The shoulder belt upper anchorage was adjusted to the full up position. The fabric covered bucket seat was adjusted to the rear most track position. The seat back was adjusted to 59 degrees from horizontal. Prior to impact, the driver had lost control of the vehicle. It was in a counterclockwise rotation that had passed 90 degrees (front tires had crossed). This occupant was held in place by the seat belts but was experiencing loading to the right due to the spinning motion. At impact, he pitched sharply to the back right in response to the 4 o'clock direction of force and engaged the door panel with his right shoulder causing the clavicle fracture. As the vehicle separated from the guardrail he would have experienced more lateral motion, first to the left, and then to right as the vehicle began to rollover. This occupant remained belted in place as the vehicle tripped and rolled eight quarter turns. He also sustained an ankle sprain that was probably related to bracing against the floor board.

Attachment 1. Scene Diagram