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ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE INVESTIGATION

CASE NUMBER - IN09017
LOCATION - TEXAS
VEHICLE - 2008 VOLKSWAGEN RABBIT
CRASH DATE - April 2009

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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. <i>Abstract</i> This report covers an On-Site Certified Advanced 208-Compliant Vehicle Investigation that involved a 2008 Volkswagen Rabbit and a 1994 Ford Escort LX station wagon. This investigation focused on the frontal air bag system of the Volkswagen. The vehicle was certified by the manufacturer to be compliant to the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The Volkswagen was occupied by a restrained 25-year-old female driver and a 3-year-old male second row left passenger, who was restrained in an unknown make, model, and type of Child Safety Seat (CSS). The Volkswagen was traveling southwest on an urban interstate highway when it was impacted on the back plane by the front plane of the Ford (event 1). The impact caused the Volkswagen to rotated counterclockwise and its front plane impacted a concrete jersey barrier (event 2). The impact was sufficient to trigger a deployment of the driver's frontal air bag. The Volkswagen rode up the face of the barrier thereby inducing a right side leading rollover (event 3). The driver and second row left passenger sustained a police-reported C (possible) injury and a B (non-incapacitating) injury, respectively. The driver and passenger were transported by ambulance to a hospital. The hospital indicated on the police crash report had no record of treatment for either person.					
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CRASH DIAGRAM 10

This on-site investigation focused on the frontal air bag system of a 2008 Volkswagen Rabbit (**Figure 1**). The vehicle was certified by the manufacturer to be compliant to the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. This crash was initiated by the National Highway Traffic Safety Administration (NHTSA) on April 24, 2009 through the sampling activities of the National Automotive Sampling System–General Estimates System. This investigation was assigned on May 1, 2009. This crash involved the Volkswagen and a 1994 Ford Escort LX station wagon. The crash occurred in April, 2009 at 2355 hours, in Texas, and was investigated by the county sheriff's department. The Volkswagen and crash scene were inspected on May 5, 2009. The Ford was not inspected since it could not be located. The driver could not be located for an interview. This report is based on the police crash report, scene and vehicle inspections, exemplar vehicle inspection, occupant kinematic principles, and evaluation of the evidence.



Figure 1: The damaged 2008 Volkswagen Rabbit

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which both vehicles were traveling was a 10-lane, divided, interstate highway, traversing in a northeasterly and southwesterly direction. The trafficway was composed of a northern roadway, a southern roadway, and a center, time-dependent, High Occupancy Vehicle (HOV) roadway. The center roadway had 2 through lanes which could be used in either direction. Both the northern and southern roadways had 4 through lanes in this specific segment of the trafficway and were bordered on the inside by concrete Jersey barriers enclosing the HOV lanes and on the outside by concrete shoulders. The posted speed limit was 97 km/h (60 mph). At the time of the crash the light condition was dark with artificial lighting and the atmospheric condition was cloudy. The roadway pavement was dry concrete with an unknown positive grade, which was estimated to be greater than 2%. Due to high traffic volume on the urban interstate, it was not possible to conduct a crash scene inspection. The site of the crash was urban commercial and the traffic density at the time of the crash is not known. See the Crash Diagram on page 9 of this report.

Pre-Crash: The Volkswagen was occupied by a restrained 25-year-old female driver and a 3-year-old male second row left passenger, who was restrained in an unknown make, model, and type of Child Safety Seat (CSS). The Volkswagen was traveling southwest in the third lane from the right (**Figure 2**) and the driver intended to continue traveling southwest. The Ford's restrained 27-year-old female driver was traveling southwest in the second lane from the right approaching the Volkswagen. It is not known if the driver of the Volkswagen took any actions to avoid the crash. The police administered an alcohol breath test to the driver of the Ford following the crash and the test results were 0.18.

Crash: The Ford entered the Volkswagen's travel lane, and the front plane impacted the back plane of the Volkswagen (event 1). The inspection of the Volkswagen revealed no residual damage on the plastic back bumper fascia from this reported impact. However, the impact was sufficient to cause the Volkswagen to rotate counterclockwise an unknown number of degrees until the front plane (**Figure 3**) impacted a concrete Jersey barrier (event 2). The direction of force was within the 11 o'clock sector and the impact force was sufficient to trigger a deployment of the driver's frontal air bag. Due to the vertical displacement of the left portion of the front bumper, it is probable that the Volkswagen rode up the face of the barrier thereby inducing a right side leading rollover (event 3). The damage on the vehicle's top and right side planes (**Figures 3 and 4**) and the absence of damage on the left side plane indicated that it rolled over two quarter turns. The distance traveled during the rollover could not be determined. Any crash induced physical evidence relative to the barrier impact and the rollover could not be documented due to the lack of a full crash scene inspection. Based on the police crash schematic, the Volkswagen came to final rest on its top plane heading southeast and was partially blocking the second and third lanes from the right. The Ford came to final rest in the middle of the roadway heading northeast.

Post-Crash: The police were notified of the crash at 0004 hours and arrived on scene at 0010 hours. The driver of the Volkswagen and second row left passenger were transported by ambulance to a hospital. The Volkswagen was towed due to damage. The Ford was towed due to the impaired condition of the driver and impounded.



Figure 2: Approach of the Volkswagen and Ford to the police reported area of the crash



Figure 3: Damage to the front plane of the Volkswagen due to impact with the concrete Jersey barrier and on the roof due to the rollover



Figure 4: Arrows show damage to the right side plane due to the rollover.

The Volkswagen was not equipped with Electronic Stability Control (ESC) or a rollover inflatable side curtain air bag system. The NHTSA has given the vehicle a four star rollover rating on a five star scale and a Static Stability Factor of 1.36¹. A four star rating indicates that the vehicle has a 10%-20% chance of a rollover when involved in a single vehicle crash. This vehicle's specific chance of rollover was given as 12%. The Static Stability Factor (SSF) is a calculation based on the vehicle's track width and height of its center of gravity. The result of the calculation is a measure of a vehicle's resistance to rollover. A higher SSF indicates a more stable vehicle. The majority of passenger vehicles have an SSF of 1.30 to 1.50². An exemplar test vehicle did not tip during a dynamic steering maneuver test in which the test vehicle was put through a fish-hook shaped steering maneuver (i.e., hard left and hard right steer) at a speed of between 56 km/h-80 km/h (35-50 mph).

When the front plane of the Volkswagen impacted the concrete Jersey barrier, the vehicle rode up and deflected off the barrier in a clockwise rotation, which caused the vehicle to roll over over, right side leading. The damage on the vehicle indicated that it rolled over two quarter turns. The distance the vehicle traveled during the rollover could not be determined. The police crash scene schematic depicted no crash induced physical evidence nor accompanying measurements.

CASE VEHICLE

The 2008 Volkswagen Rabbit was a front wheel drive, 4-door hatchback (VIN: WVWDA71K78W-----) equipped with a 2.5-L, 5-cylinder engine, automatic transmission, 4-wheel, anti-lock brakes with electronic brake force distribution, traction control, and a tire pressure monitoring system. The front row was equipped with bucket seats, adjustable head restraints, lap-and-shoulder seat belts, dual stage driver and front right passenger frontal air bags, seat-mounted side impact air bags, and side impact inflatable curtain air bags protecting all outboard seating positions. The second row was equipped with a bench seat with folding backs, adjustable head restraints, lap-and-shoulder seat belts, and Lower Anchors and Tethers for Children (LATCH) in the outboard seating positions. The vehicle's specified wheelbase was 258 cm (101.6 in).

CASE VEHICLE DAMAGE

Exterior Damage: The back plane impact with the front plane of the Ford (event 1) involved only the plastic bumper fascia of the Volkswagen and there was no discernable damage on the bumper fascia (**Figure 5**) or the bumper bar. Due to the absence of any residual deformation, no crush measurements were taken on the back bumper.

The impact with the concrete Jersey barrier (event 2) involved the front plane of the Volkswagen. The direct damage began at the front left bumper corner and extended 58 cm (22.3

1 www.safercar.gov, 5/29/09

2 "Trends in the Static Stability Factor of Passenger Cars, Light Trucks and Vans", NHTSA Technical Report, DOT HS 809 868, June 2005

in) across the bumper. The bumper fascia was detached from the vehicle and the crush measurements were taken on the front bumper bar (**Figure 6**). The maximum residual crush was 20 cm (9.1 in) occurring at C₁. The vehicle’s left side wheelbase was reduced 10 cm (3.9 in) while the right side wheelbase was unchanged. The table below shows 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	2	58	20	110	20	13	7	4	4	8	-36	0
in		22.8	7.9	43.3	7.9	5.1	2.8	1.6	1.6	3.2	-14.2	0.0



Figure 5: Back plane of the Volkswagen

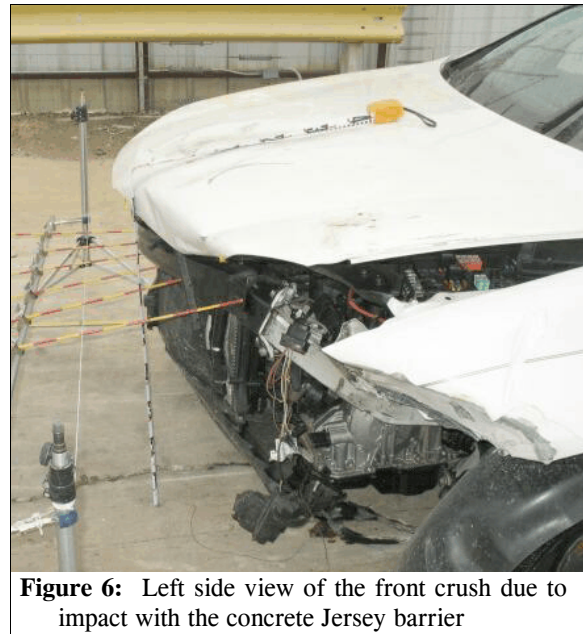


Figure 6: Left side view of the front crush due to impact with the concrete Jersey barrier

The damage from the rollover involved the top plane and the right side plane. The direct damage on the top plane began on the hood 70 cm (27.6 in) forward of the right front axle and extended 280 cm (110.2 in) rearward along the hood, right roof side rail, and the roof. The direct damage also involved the full width of the roof, 108 cm (42.5 in). The direct damage on the right side plane began at the front of the right fender and involved the fender, side of the right roof side rail, side view mirror, and the right front and right rear doors. The maximum vertical crush was 7 cm (2.8 in) and occurred on the windshield header 38 cm (15 in) left of the right A-pillar (**Figure 7**). The maximum lateral crush was 1 cm (0.4) and



Figure 7: The maximum vertical and lateral crush

involved the right A-pillar. The induced damage involved the hood, roof, windshield, and both fenders.

Damage Classification: The Collision Deformation Classifications (CDC) were **06-B99U-1** for the back plane impact by the front plane of the Ford (event 1) and **71-FYEW-1 (330 degrees)** for the impact with the concrete Jersey barrier (event 2). The 11 o'clock force direction for this impact was incremented by 60 due to the right shift of both front frame members, which exceeded the 10 cm (4 in) threshold on each frame member. The CDC for the rollover was **00-TYDO-2**. The Damage algorithm of the WinSMASH program calculated the Volkswagen's total Delta V as 17 km/h (10.6 mph) for the front impact with the barrier. The longitudinal and lateral velocity changes were -16 km/h (-9.9 mph) and 5.8 km/h (3.6 mph), respectively. Based on the extent of damage on the vehicle, the results appeared reasonable. Based on the roof crush, the severity of the rollover damage was minor.

The manufacturer's recommended tire size was P195/65R15. The Volkswagen 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	32 nd of an inch			
LF	Flat	Flat	234	34	3	4	Tire debeaded	Yes	Yes
LR	262	38	234	34	6	8	None	No	No
RR	255	37	234	34	4	5	None	No	No
RF	269	39	234	34	4	5	None	No	No

Vehicle Interior: The inspection of the Volkswagen's interior (**Figures 8 and 9**) revealed a blood transfer and several dark scuff marks on the roof above the front and second row. The vehicle came to final rest on its roof and these marks were probably related to the driver exiting the vehicle and/or assisting the second row left passenger following the crash. There was no deformation of the steering wheel or collapse of the energy absorbing steering column.

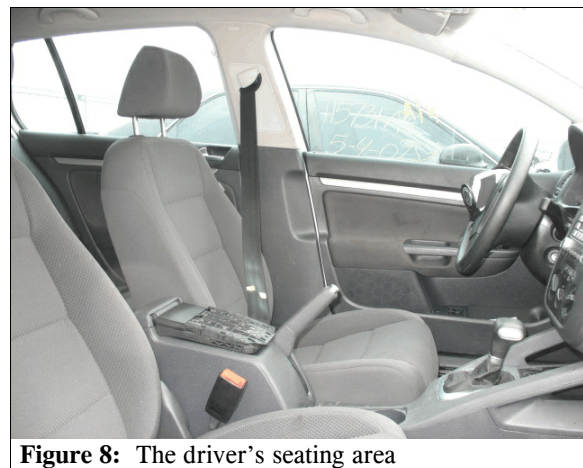


Figure 8: The driver's seating area

All the doors and the rear hatch remained closed and operational. The pre-crash status of all of the window glazing was either fixed or closed.

The right front window glazing was disintegrated from impact forces and the windshield was in place and cracked from impact forces.

The vehicle sustained three vertical intrusions into the driver's space involving the windshield header, roof, and the windshield. The most severe of these intrusions involved the windshield, which intruded 3 cm (1.2 in). The most severe passenger compartment intrusion occurred in the front row center and involved the windshield header and roof (**Figure 10**). Both of these components intruded vertically 7 cm (2.8 in). No intrusion occurred in the second row passenger's space.

AUTOMATIC RESTRAINT SYSTEM

The Volkswagen was equipped with a manufacturer Certified Advanced 208-Compliant (CAC) frontal air bag system that consisted of dual stage driver and front right passenger air bags, a driver seat position sensor, seat belt usage sensors, retractor-mounted pretensioners, and a front passenger weight sensor. The vehicle was also equipped with front seat-mounted side impact air bags and side impact inflatable curtain air bags. The driver's frontal air bag deployed in this crash. None of the other air bags deployed.

The driver's air bag was located within the steering wheel hub and the air bag module cover was a four-flap configuration constructed of pliable vinyl (**Figure 11**). The cover flap assembly was 13 cm (5.1 in) in width and 11 cm (4.3 in) in height. The cover flaps opened along the designated tear seams and were not damaged. The deployed driver's air bag (**Figure 12**) had a diameter of 62 cm (24.4 in). It was constructed with four tethers and had no external vent ports. There was no discernable evidence of occupant contact or damage to the air bag.



Figure 9: The second row



Figure 10: Intrusion of the windshield header and roof



Figure 11: The driver's frontal air bag cover flaps

The Volkswagen was equipped with lap-and-shoulder seat belts at all five seating positions. The driver’s seat 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-up position. The front right seat belt was equipped with a switchable ELR/Automatic Locking Retractor (ALR), a sliding latch plate, and an adjustable upper anchor that was located in the middle position. Both seat belts were equipped with retractor-mounted pretensioners. The second row seat belts were similar to the front right seat belt except they were equipped with fixed upper anchors.

The inspection of the driver’s seat belt assembly revealed a load mark on the belt webbing (**Figure 13**) located 24 cm (9.5 in) above the stop button. The retractor was also jammed indicating that the pretensioner actuated during the crash and that the driver was restrained at the time of the crash.

The inspection of the second row left seat belt assembly revealed that the belt webbing had been cut in two (**Figure 14**) and the sliding latch plate was missing. No load marks were observed on the remaining section of the seat belt webbing. The police report indicated that this occupant was restrained in a CSS. The evidence suggested that the seat belt was cut to remove the second row left passenger or the CSS from the vehicle. The remaining seating positions were unoccupied.

CHILD SAFETY SEAT

The CSS was not present with the vehicle at the time of the vehicle inspection and could not be located.



Figure 12: The driver’s deployed frontal air bag



Figure 13: Load mark on driver’s seat belt

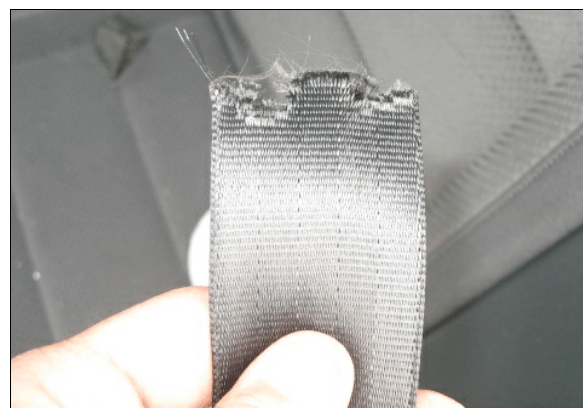


Figure 14: The second row left seat belt was cut in two

The driver of the Volkswagen (25-year-old, female; unknown height and weight) was seated in an unknown posture. At the time of the vehicle inspection, the seat track was located in the full-rear position and the seat back was slightly reclined. The seat track position at the time of the crash is not known. The head restraint was adjusted to the full-up position and the top of the head restraint was located 23 cm (9.1 in) above the top of the seat back. The tilt steering column was located in the center position and the telescoping adjustment was located between the middle and full-forward position.

After the impact with the Ford, the Volkswagen rotated in a counterclockwise direction as it approached the concrete Jersey barrier. Occupant kinematic principles suggest that the rotation probably displaced the driver to the right to some degree within her seat belt due to the deceleration as the vehicle rotated. The Volkswagen's frontal impact to the Jersey barrier displaced the driver forward and to the left opposite the 11 o'clock direction of force, and she loaded the seat belt. While there was no discernable occupant contact evidence on the driver's frontal air bag, it is probable that the driver's face and chest also loaded the deployed air bag. As the vehicle rode up the barrier and rolled over right side leading, the driver was probably redirected to the right and toward the roof within her seat belt.

CASE VEHICLE DRIVER INJURIES

The driver sustained a police reported C (possible) injury and was transported by ambulance to a hospital. The hospital had no record of treatment for the driver.

CASE VEHICLE SECOND ROW LEFT PASSENGER KINEMATICS

The second row left passenger (3-year-old, male; unknown height and weight) was seated in an unknown make, model, and type of CSS.

The Volkswagen's frontal impact with the concrete Jersey barrier displaced the second row left passenger forward and to the left within the CSS. There was no discernable evidence of occupant contact on the back of the driver's seat or in the second row.

CASE VEHICLE SECOND ROW LEFT PASSENGER INJURIES

The police crash report indicated that the passenger sustained a B (non-incapacitating) injury and was transported by ambulance to a hospital. The hospital had no record of treatment for the passenger.

OTHER VEHICLE

The 1994 Ford Escort LX was a front wheel drive, 4-door, station wagon (VIN: 3FARP15J8RR-----) equipped with a 4-cylinder, 1.9-liter engine.

Other Vehicle's Driver: The police crash report indicated that the Ford's driver (27-year-old, female) was restrained by the lap-and-shoulder seat belt and was not injured in the crash.

