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

ON-SITE ADVANCED OCCUPANT PROTECTION SYSTEM INVESTIGATION

CASE NUMBER - IN-05-010
LOCATION - TEXAS
VEHICLE - 2005 VOLKSWAGEN JETTA
CRASH DATE - January 2005

Submitted:

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

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

Technical Report Documentation Page

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15. *Supplementary Notes* On-site air bag investigation involving a 2005 Volkswagen Jetta with manual safety belts and dual front advanced air bag system.			
16. *Abstract* This report covers an on-site investigation of an air bag deployment crash that involved a 2005 Volkswagen Jetta (case vehicle) and a 2005 Chevrolet Malibu LS (other vehicle), which were involved in a rear end collision on an entrance ramp to an Interstate highway. This crash is of special interest because the case vehicle was equipped with an Advanced Occupant Protection System (AOPS), and the case vehicle's driver (31-year-old,) male) did not sustain any police reported injuries as a result of the crash. The case vehicle was traveling north in the entrance ramp to an Interstate highway in heavy traffic. The Chevrolet was just ahead of the case vehicle. The Chevrolet was behind a vehicle that braked suddenly for an accident that just occurred in front of it. The Chevrolet's driver braked to avoid a collision. The case vehicle's driver then braked to avoid a collision with the Chevrolet. The front of the case vehicle impacted and underrode the back of the Chevrolet. The impact caused the case vehicle's driver and front right air bags to deploy. The case vehicle came to final rest with its front end still in contact with the back of the Chevrolet. Both vehicles were in the entrance ramp facing north at final rest. Immediately prior to the crash, the case vehicle's driver was seated in an upright driving position and was restrained by his manual, three-point, lap-and-shoulder safety belt. His seat was adjusted to its full rear track position, the seat back was slightly reclined and the tilt steering column was adjusted to its full down position. As a result of the crash he loaded his safety belt and his face and chest contacted his deployed air bag. He was not injured in the crash.			
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This investigation was brought to NHTSA's attention on or about February 1, 2005 by the Nationwide Insurance Company. This crash involved a 2005 Volkswagen Jetta GL (case vehicle) and a 2005 Chevrolet Malibu LS (other vehicle). The crash occurred in January, 2005, at 6:50 a.m., in Texas and was investigated by the applicable city police department. This crash is of special interest because the case vehicle was equipped with an Advanced Occupant Protection System (AOPS), and the case vehicle's driver [31-year-old, White (Hispanic) male] did not sustain any police reported injury as a result of the crash. This contractor inspected the case vehicle on March 8, 2005, and inspected the crash scene on March 9, 2005. The case vehicle's driver was not interviewed. He could not be located. The Chevrolet had been repaired and was not inspected. This report is based on the police crash report, scene and vehicle inspections, occupant kinematic principles and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling north in the entrance ramp to an Interstate highway in heavy traffic. The Chevrolet was just ahead of the case vehicle. The Chevrolet was behind a vehicle that braked suddenly for an accident that just occurred in front of it. The Chevrolet's driver braked to avoid a collision. The case vehicle's driver then braked to avoid a collision with the Chevrolet. The front of the case vehicle impacted and underrode the back of the Chevrolet. The impact caused the case vehicle's driver and front right air bags to deploy. The case vehicle came to final rest with its front end still in contact with the back of the Chevrolet. Both vehicles were in the entrance ramp facing north at final rest.

The CDC for the case vehicle was determined to be: **12-FZEW-2** (**0**-degrees). The WinSMASH reconstruction program, missing vehicle algorithm calculated the case vehicle's Total, Longitudinal, and Lateral Delta Vs respectively as: 19.0 km.p.h (11.8 m.p.h.), -19.0 km.p.h. (11.8 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The case vehicle was towed due to damage.

Immediately prior to the crash the case vehicle's driver was seated in an upright driving position with both hands on the steering wheel and his right or left foot on the brake. The driver's seat track was located in its rear-most position, the seat back was slightly reclined, and the tilt steering column was in its full-down position. The driver was restrained by his manual, three-point, lap-and-shoulder safety belt system.

The driver's application of the brakes just prior to the impact most likely locked his safety belt retractor, and he most likely moved forward and loaded his safety belt. The case vehicle's impact with the back of the Chevrolet caused the driver to move forward along a path opposite the case vehicle's 0 degree direction of principal force as the case vehicle decelerated. The driver loaded his seat belt, and his face and chest most likely made contact with his deployed air bag. The driver most likely rebounded back into his seat following the impact. He remained in his seat as the vehicle came to final rest. The deployment of the driver's air bag, and the driver's use of his manual, three-point, lap-and-shoulder safety belt system mitigated his interaction with the case vehicle's frontal interior components and prevented him from being injured in the crash.

Crash Environment: The trafficway on which the case vehicle was traveling was a one-lane entrance ramp to an Interstate highway, traversing in a northerly direction (**Figure 1**). The entrance ramp was under construction and had been narrowed to 2.4 meters (7.9 feet) in width by orange traffic barrels and concrete jersey barriers placed on the right side of the lane. The case vehicle's approach to the crash location was uncontrolled and the police reported speed limit was 97 km.p.h. (60 m.p.h.). At the time of the crash the light condition was dawn, the atmospheric condition was clear, and the roadway pavement was dry, level bituminous. Traffic density was heavy and the site of the crash was urban. See the Crash Diagram at the end of this report.

Figure 1: Approach of case vehicle and the Chevrolet northbound in the entrance ramp to impact

Pre-Crash: The case vehicle was traveling north in the entrance ramp in heavy traffic. The case vehicle's driver was intending to merge onto the expressway. The Chevrolet was just ahead of the case vehicle. Its driver was also intending to merge onto the expressway. The Chevrolet was behind a vehicle that braked suddenly for an accident that just occurred in front of it. The Chevrolet braked to avoid a collision with the vehicle ahead of it. The underride damage to the front of the case vehicle indicates the case vehicle's driver braked to avoid a collision with the Chevrolet. The crash occurred in the entrance ramp (**Figure 2**) as the case vehicle was braking.

Figure 2: Overview of area of impact and final rest of case vehicle and Chevrolet in the entrance ramp

Crash: The front of the case vehicle (**Figure 3**) impacted and underrode the back of the Chevrolet. The damage to the case vehicle indicates that the impact was offset, with the front right two-thirds of the case vehicle making contact with the back left two-thirds of the Chevrolet. The impact caused the case vehicle's driver and front right air bags to deploy.

Figure 3: Overview of front damage to the case vehicle from underriding the back of the Chevrolet

Post-Crash: The case vehicle came to final rest with its front end still in contact with the back of the Chevrolet. Both vehicles were in the entrance ramp facing north at final rest.

CASE VEHICLE

The 2005 Volkswagen Jetta GL was a front wheel drive, four-door sedan (VIN: 3VWRK69M85M------) equipped with a 2.0L, I4 engine; four speed automatic transmission; four wheel, anti-lock brakes and traction control. The front seating row was equipped with bucket seats with adjustable head restraints, seat back-mounted side impact air bags, advanced driver and front right passenger air bags, side curtain air bags; manual, three-point, lap and shoulder safety belt systems with pretensioners and adjustable upper anchors, and a driver seat belt buckle sensor. The back seating row was equipped with side curtain air bags; manual, three-point, lap and shoulder safety belt systems in all three seat positions and a LATCH system for securing child safety seats. The driver's safety belt buckle sensor detects if the driver's safety belt is buckled. The advanced air bag system sets the driver's air bag deployment threshold appropriately based on the use or non-use of the driver's safety belt.

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle's impact with the back of the Chevrolet involved the front bumper, grille, hood , right fender and the right headlamp/turn signal assembly. The grille, hood and right fender were crushed rearward. Direct damage began at the right corner of the front bumper and extended 83 centimeters (32.7 inches) along the bumper. Crush measurements were taken at the bumper and above bumper levels. There was no crush at the bumper level. Crush above the bumper level was measured at the radiator frame. The maximum crush at this level was determined to be 24 centimeters (9.4 inches) occurring at C_5 (**Figure 4**). The table below shows the average of the bumper and above bumper crush.

Figure 4: Crush above the level of the case vehicle's bumper, each increment on rods is 5 cm (2 in)

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	83	24	139	0	0	0	7	12	0	30	0
in		32.7	9.4	54.7	0.0	0.0	0.0	2.6	4.7	0.0	11.8	0.0

Neither the right or left side wheelbase was reduced due to the impact. Induced damage also involved the front bumper, grille, hood and right fender. No other obvious induced damage or remote buckling was observed to the remainder of the case vehicle's exterior.

The recommended tire size was: P195/65R16 and the vehicle was equipped with tires of this size. The case vehicle's tire data are shown in the table below.

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kpa	psi	kpa	psi	milli-meters	32nd of an inch			
LF	241	35	207	30	6	8	None	No	No
RF	234	34	207	30	6	8	None	No	No
LR	241	35	283	41	7	9	None	No	No
RR	234	34	283	41	7	9	None	No	No

Vehicle Interior: Inspection of the case vehicle's interior (**Figure 5**) revealed a possible occupant contact to the center portion of the driver's air bag. No evidence of occupant contact was observed to any of the other interior surfaces or components. In addition, there was no evidence of compression of the energy absorbing steering column, and no deformation of the steering wheel rim was observed **(Figures 6).**

Figure 5: Overview of case vehicle's steering wheel and instrument panel

Figure 6: Left side view of case vehicle's steering assembly showing lack of deformation

Damage Classification: Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **12-FZEW-2** (**0**-degrees). The WinSMASH reconstruction program, missing vehicle algorithm was used to reconstruct the case vehicle's Delta Vs. The Total, Longitudinal, and Lateral Delta Vs are respectively: 19.0 km.p.h (11.8 m.p.h.), -19.0 km.p.h. (11.8 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The case vehicle was towed due to damage.

The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module cover flaps and the air bag fabric revealed that the cover flaps opened at the designated tear points. There was no evidence of damage during the deployment to the air bag module cover flaps or the air bag. The deployed driver's air bag (**Figure 7** below) was round with a diameter of approximately 68 centimeters (26.8 inches), and the air bag was designed with four tether straps. The size of the tether straps could not be determined because there was no access to them, since the air bag was designed without vent ports. There were two air bag module cover flaps (**Figure 8** below). Each flap was approximately rectangular in shape. The upper flap was 17 centimeters (6.7 inches) in width and 5.5 centimeters (2.2 inches) in height. It had a small semi-circular contour at the center bottom of the flap to accommodate the "VW" emblem. The lower flap was also 17 centimeters (6.7 inches) in length, and was 6 centimeters (2.4 inches) in height. It had a corresponding semi-circular cut-out that mated to the "VW" emblem on the upper flap. A few small scuffs and a spot, which appeared to be possible occupant contact, were observed on the center portion of the air bag (**Figure 9**). The distance between the mid-center of the driver's seat back, as positioned at the time of the vehicle inspection (i.e., slightly reclined, seat at rear most track position) and the front surface of the air bag's fabric at approximate full excursion was 39 centimeters (15.4 inches).

Figure 7: Case vehicle's driver air bag

Figure 8: Case vehicle's driver air bag module flaps

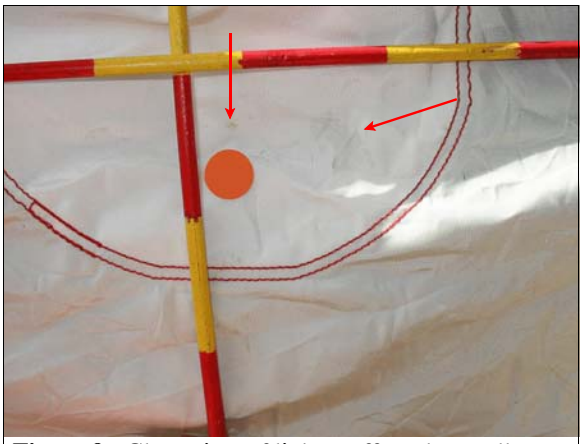


Figure 9: Close view of light scuffs and a small spot (arrows) on the driver's air bag indicating possible occupant contact

The front right passenger air bag was located in the middle of the instrument panel (**Figure 10** below). An inspection of the air bag module cover flap and air bag fabric revealed that the cover flap opened at the designated tear points. The deployed front right air bag (**Figure 11** below) was approximately oval in shape with a height of approximately 70 centimeters (27.6 inches) and a width of approximately 72 centimeters (28.3 inches). The front right passenger's air bag was designed with one tether that was 37 centimeters (14.6 inches) in width and had two

vent ports, each approximately 6 centimeters (2.4 inches) in diameter, located at the 3 and 9 o'clock positions. The single air bag module cover flap (**Figure 12**) was approximately rectangular in shape and was 31 centimeters (12.2 inches) in width at the top, 32 centimeters (12.4 inches) in width at the bottom and was 17 centimeters in height. The air bag was unremarkable. There was no occupant seated in the front right seat position at the time of the crash.

Figure 10: Overview of case vehicle's front right instrument panel and location of front right passenger air bag

Figure 11: Case vehicle's front right passenger air bag

Figure 12: Case vehicle's front right passenger air bag cover flap

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash the case vehicle's driver [31-year-old, White (Hispanic) male; unknown height and weight] was most likely seated in a nominal upright driving position with both hands on the steering wheel and his right or left foot on the brake. During the case vehicle inspection, the driver's seat track was located in its rear-most position, the seat back was slightly reclined, and the tilt steering column was in its full-down position. The seat and steering column were most likely adjusted to these positions at the time of the crash.

The police crash report indicated the case vehicle's driver was restrained by his manual, three-point, lap-and-shoulder safety belt system. Inspection of the safety belt system revealed no load marks on the safety belt webbing. The D-ring was made of chrome steel, so no load marks were present on the D-ring. The latch plate showed evidence of historical usage.

Just prior to the impact, the case vehicle driver was applying the brakes in an attempt to avoid the impact. The braking most likely locked the driver's safety belt retractor, and he most likely moved forward and loaded his safety belt. The case vehicle's impact with the back of the Chevrolet caused the driver to move forward along a path opposite the case vehicle's 0 degree direction of principal force as the case vehicle decelerated. The driver loaded his safety belt, and his face and chest most likely made contact with his deployed air bag. The driver most likely

rebounded back into his seat following the impact. He remained in his seat as the case vehicle came to final rest. The case vehicle's driver was most likely able to exit the case vehicle without assistance. The deployment of the driver's air bag, and the driver's use of his manual, three-point, lap-and-shoulder safety belt mitigated his interaction with the case vehicle's frontal interior components and prevented him from being injured in the crash.

CASE VEHICLE DRIVER INJURIES

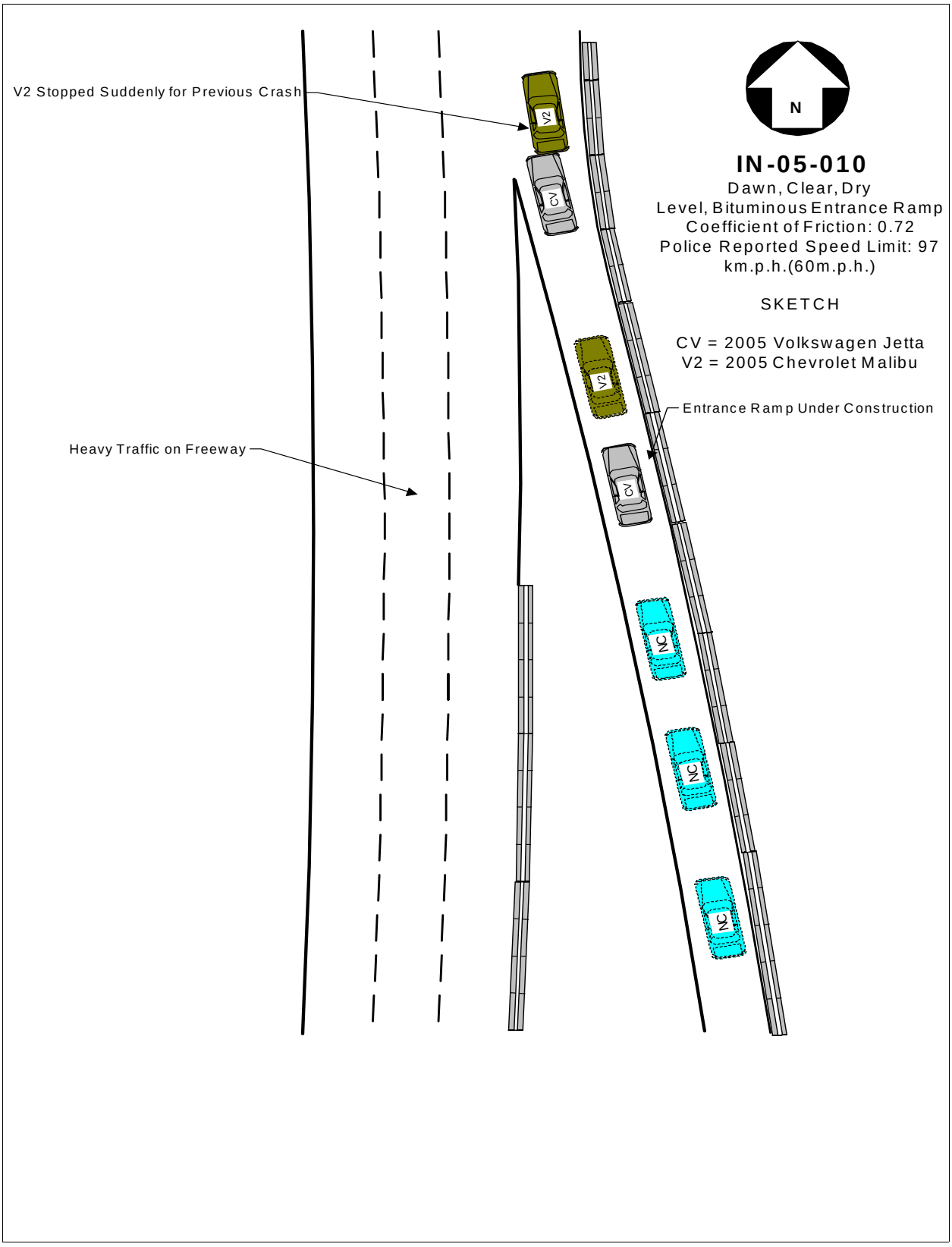
The police crash report indicated the driver sustained no injury as a result of the crash, and was not transported from the scene.

OTHER VEHICLE

The 2005 Chevrolet Malibu LS was a front wheel drive, four-door sedan (VIN: 1G1ZT62885F------) equipped with a 3.5L, V6 engine and driver and front right passenger air bag system.

Exterior Damage: The Chevrolet had been repaired and was not inspected. With no inspection and no available vehicle photographs, the CDC for the Chevrolet could not be estimated.

Chevrolet's Occupants: According to the police crash report, the Chevrolet's driver [37-year-old, White (unknown if Hispanic) male] was restrained by his manual, three-point, lap-and-shoulder safety belt system. The driver was not transported by ambulance to the hospital, and according to the police crash report, did not sustain any injuries as a result of this crash.


V2 Stopped Suddenly for Previous Crash
Heavy Traffic on Freeway
Entrance Ramp Under Construction
V2
CV
V2
CV
NC
NC
NC
N
IN-05-010
Dawn, Clear, Dry
Level, Bituminous Entrance Ramp
Coefficient of Friction: 0.72
Police Reported Speed Limit: 97 km.p.h.(60m.p.h.)
SKETCH
CV = 2005 Volkswagen Jetta
V2 = 2005 Chevrolet Malibu