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ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION INVESTIGATION

CASE NUMBER - IN08024

LOCATION - TEXAS

VEHICLE - 2008 FORD FOCUS SE

CRASH DATE - April 2008

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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. <i>Abstract</i> This report covers an on-site investigation that involved a 2008 Ford Focus SE, a 2003 Toyota Prius, and a 1989 Chevrolet C1500 Suburban, which were involved in an intersection collision. The focus of this on-site investigation was on the Ford's side impact air bag system. The Ford was traveling northwest and turned left at a four leg urban intersection and was struck in the right side by the Toyota. The Ford rotated clockwise and was redirected to the south. Its left side impacted the front of the Chevrolet, which was stopped heading northeast. The Ford's right and left side impact curtain air bags and front left seat back-mounted side impact air bag deployed in the crash. The Ford's restrained 36-year-old female driver sustained a C (possible) injury, but refused transport to a hospital. The driver's of the Toyota and Chevrolet were not injured. The Ford and Toyota were towed from the scene due to damage while the Chevrolet was driven from the crash scene.					
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CRASH DIAGRAM 9

This crash was brought to the National Highway Traffic Safety Administration's attention on June 4, 2008 by the sampling activities of the National Automotive Sampling System. This on-site investigation was assigned on June 18, 2008. The crash involved a 2008 Ford Focus SE, a 2003 Toyota Prius, and a 1989 Chevrolet C1500 Suburban. The crash occurred in April, 2008 at 0910 hours in Texas, and was investigated by the applicable city police department. The focus of this on-site investigation was on the Ford's side impact air bag system. This contractor inspected the scene and the Ford on June 24 and 25, 2008. No driver interview was conducted because the driver could not be located. The Toyota and Chevrolet were not inspected because the Toyota had been repaired and the Chevrolet could not be located. This report is based on the police crash report, scene and vehicle inspections, occupant kinematic principles, and this contractor's evaluation of the evidence.



Figure 1: The damaged 2008 Ford Focus SE

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the Ford was traveling was a seven-lane, divided, state highway, traversing in a northwest and southeast direction, and the Ford was traveling northwest approaching a four-leg intersection. The Ford's roadway had three through lanes, a left turn lane, and was separated from the southeast roadway by a raised, concrete median 1.2 m (3.9 ft) in width. The Toyota was traveling southeast on the same trafficway also approaching the intersection. Its roadway also had three through lanes, a left turn lane, and was separated from the north roadway by a raised, concrete median 1.1 m (3.6 ft) in width. The lanes for each vehicle's roadway were nominally 3.2 m (10.5 ft) in width, and the pavement markings consisted of a solid yellow median line, a solid white turn lane line and broken white through lane lines. The trafficway on which the Chevrolet was traveling was a 7-lane, divided, state highway, traversing in a southwest and northeast direction, and the Chevrolet was stopped at the intersection heading northeast. The Chevrolet's roadway had three through lanes, a left turn lane, and was separated from the southwest roadway by a raised, concrete median. Each lane was nominally 3.3 m (10.5 ft) in width and the median was 1.2 m (3.9 ft) in width. The intersection was controlled by multiple three-phase traffic signals and the speed limit for all the vehicles was 56 km/h (35 mph). At the time of the crash, the light condition was daylight, the atmospheric condition was cloudy, and the roadway pavement was dry bituminous. The traffic density at the time of the crash was unknown and the site of the crash was urban commercial. See the Crash Diagram on page 9 of this report.

Pre-Crash: The Ford was occupied by a restrained 36-year-old female driver. She was traveling northwest in the left turn approaching the intersection on a green light (**Figure 2**) and intended to turn left. The Toyota was occupied by a restrained 61-year-old female driver. She was traveling southeast in the outside through lane (**Figure 3**) and intended to continue straight through the intersection. The Chevrolet was stopped at the mouth of the intersection (**Figure 4**) heading

northeast waiting for the traffic signal to change. The initial impact occurred within the intersection as the Ford was turning left (**Figure 2**).



Figure 2: Approach of the Ford in the left turn lane; arrow on left shows area of initial impact; arrow on right shows approach of Ford turning left



Figure 3: Approach of Toyota traveling southeast in outside through lane; arrow shows approach of Ford as it turned left



Figure 4: Location of Chevrolet stopped heading northeast in the left turn lane



Figure 5: Damage to Ford's right side from impact with the Toyota

Crash: As the Ford's driver was turning left, the front of the Toyota impacted its right side plane (**Figure 5**, event 1). The Ford's direction of principal force was within the 1 o'clock sector and the impact force was sufficient to trigger a deployment of the vehicle's right side impact curtain air bag. The deployment of the Ford's front right seat back-mounted side impact air bag was suppressed because there was no passenger on the seat. The impact caused the Ford to rotate clockwise and redirected it south toward the Chevrolet. The left side plane of the Ford (**Figure 6**) impacted the front of the Chevrolet (event 2). The Ford's direction of principal force was within the 9 o'clock sector and the impact force was



Figure 6: Damage to the Ford's left side from impact with the Chevrolet

sufficient to trigger a deployment of the Ford’s left side impact curtain air bag and the driver’s seat back-mounted side impact air bag. The Ford came to final rest against the front of the Chevrolet heading northwest. The Toyota rotated clockwise and came to final rest within the intersection heading south.

Post-Crash: A passer-by notified authorities of the crash and police and emergency medical personnel responded to the scene. The Ford’s driver refused transport to a hospital and the drivers of the Toyota and the Chevrolet were not injured. The Ford and the Toyota were towed from the scene due to damage. The Chevrolet was driven from the scene by the driver.

CASE VEHICLE

The 2008 Ford Focus SE was a front wheel drive, 4-door sedan (VIN:1FAHP35N98W-----) that was manufactured in December, 2007. It was equipped with a 2.0L, 4-cylinder engine, automatic transmission, and 4-wheel anti-lock brakes. The front row was equipped with bucket seats with adjustable head restraints, lap-and-shoulder belts, dual stage driver and front right passenger frontal air bags, seat back-mounted side impact air bags, and side impact curtain air bags. The second row was equipped with a bench seat with folding backs, lap-and-shoulder belts, and Lower Anchors and Tethers for Children (LATCH) in the outboard seating positions.

CASE VEHICLE DAMAGE

Exterior Damage: The Ford’s impact with the Toyota involved the right side plane. Both of the right side doors, sill, and the lower B-pillar sustained direct damage. The direct damage began 56 cm (22.1 in) rear of the right front axle and extended 185 cm (72.3 in) rearward along the right side. The residual maximum crush was 24 cm (9.4 in) occurring 19 cm (7.5 cm) rear of C₅ (**Figure 7**), and the height of the maximum crush was 53 cm (20.9 in). The sill height was 36 cm (14.2 in) and the Door Sill Differential (DSD) was 18 cm (7.1 in). The table below shows the vehicle’s right 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	185	24	198	0	8	15	20	21	2	-17	-21
in		72.8	9.4	78.0	0.0	3.2	5.9	7.9	8.3	0.8	-6.7	-8.3

The Ford’s impact with the Chevrolet involved the left side plane. Both of the left side doors and the B-pillar sustained direct damage, which began 125 cm (49.2 in) rear of the left front axle and extended 70 cm (27.6 in) rearward along the left side. The residual maximum crush was 19 cm (7.4 in) occurring at both C₃ and C₄ (**Figure 8**), and the height of the maximum crush was 68 cm (26.8 in). The sill height was 36 cm (14.2 in) and the DSD was 10 cm (7.1 in). The table below shows the vehicle’s 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	2	70	19	210	0	11	19	19	8	1	-32	-25
in		27.6	7.5	82.7	0.0	4.3	7.5	7.5	3.2	0.4	-12.6	-9.8

The induced damage on the vehicle’s right side involved both doors and the sill. The induced damage on the left side involved both doors, the sill, and the quarter panel. The vehicle’s wheelbase retained its original specified value of 261 cm (102.8 in) on each side.



Figure 7: Top view of Ford’s right side crush from impact with the Toyota; each increment on rods is 5 cm (2in)



Figure 8: Top view of Ford’s left side crush from impact with the Chevrolet

Damage Classification: The Ford’s Collision Deformation Classifications (CDC) were **01-RPEW-2 (30 degrees)** for the impact with the Toyota and **09-LPEW-2 (270 degrees)** for the impact with the Chevrolet. The Missing Vehicle algorithm of the WinSMASH program calculated the Ford’s Total Delta V for the right side impact as 17.0 km/h (10.6 mph). The Longitudinal and Lateral velocity changes were -14.7 km/h (-9.1 mph) and -8.5 km/h (-5.3 mph), respectively. The Missing Vehicle algorithm calculated the Total Delta V for the left side impact as 21.0 km/h (13.0 mph). The Longitudinal and Lateral velocity changes were 0.0 km/h (0.0 mph) and 21.0 km/h (13.0 mph), respectively. The results are considered borderline because they are based only on the Ford’s crush profile.

The manufacturer’s recommended tire size was P195/60R15. The Ford was equipped with the recommended size tires. The Ford’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	131	19	221	32	7	9	None	No	No
LR	165	24	221	32	7	9	None	No	No
RR	207	30	221	32	7	9	None	No	No
RF	117	17	221	32	7	9	None	No	No

Vehicle Interior: There was no discernable evidence of occupant contact on any of the front row interior surfaces or components. The left front, right front, and right rear doors were jammed shut and the left rear door remained closed and operational. All of the window glazing was either closed or fixed and the left front and left rear window glazing was disintegrated from impact forces. The front and rear doors, and B-pillars on both sides of the vehicle intruded into the passenger compartment. The most severe intrusions into the driver's occupant space were the rear upper quadrant of the left front door, which intruded 12 cm (4.7 in), and the B-pillar, which intruded 16 cm (6.3 in). There was no deformation of the steering wheel or compression of the energy absorbing steering column.

AUTOMATIC RESTRAINT SYSTEM

The Ford was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system that consisted of dual stage driver and front right passenger air bags, driver seat position sensor, seat belt usage sensors, buckle-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.

The driver's frontal air bag was located in the steering wheel hub and the front right passenger air bag was located in the middle of the right instrument panel. Neither of these air bags deployed in this crash because the vehicle did not sustain a frontal impact.

The vehicle was also equipped with front seat back-mounted side impact air bags and side impact curtain air bags. The sensors for these air bags were located within the front doors and lower B-pillars. Based on the Holmatro Rescuer's Guide to Vehicle Safety Systems, the inflation cylinders were located within the C-pillars between the roof side rail and lower edge of the window glass.

The left side curtain air bag was located along the left roof side rail (**Figures 9 and Figure 10**), within the head liner and extended from the A-pillar to the C-pillar. The air bag was 150 cm (59.1 in) in width and 36 cm (14.2 in) in height and was anchored to the A-pillar by a nylon rope tether and a triangular section of fabric. The nylon rope was 12 cm (4.7 in) in length and the

fabric was 28 cm (11.0 in) in length. The distance between the air bag and the A-pillar was 40 cm (15.7 in) at the bottom of the tether. The air bag was anchored to the C-pillar by a nylon rope tether 5 cm (2 in) in length and was designed without any external vent ports. Inspection of the air bag revealed no evidence of occupant contact and there was no damage to the air bag.



Figure 9: Front portion of Ford's left side impact curtain air bag



Figure 10: Back portion of Ford's left side impact curtain air bag

The Ford's right side impact curtain air bag was the same design and dimensions. Inspection of the air bag revealed no evidence of damage.

The driver's seat back-mounted side impact air bag was located within the left side of the driver's seat back and deployed through a tear seam. The deployed air bag (**Figure 11**) was oval and measured 25 cm (9.8 in) in width and 19 cm (7.5 in) in height. It was designed without tethers or vent ports. Inspection of the air bag revealed no evidence of occupant contact and there was no damage to the air bag.



Figure 11: Driver's seat back-mounted side impact air bag

MANUAL RESTRAINT SYSTEM

The Ford was equipped with lap-and-shoulder belts in all five seating positions. The driver's seat belt consisted of continuous loop belt webbing, sliding latch plate, buckle-mounted pretensioner, an Emergency Locking Retractor (ELR) with an energy management feature, and an adjustable upper anchor that was in the full down position. The front right seat belt was similar but had a switchable ELR/Automatic Locking Retractor (ALR). The second row seat belts were equipped with continuous loop belt webbing, sliding latch plates, switchable ELR/ALR retractors, and fixed upper anchors.

The inspection of the driver's seat belt assembly revealed friction marks on the webbing (**Figure 12**) and the buckle-mounted pretensioner had actuated (**Figures 13**). The actuation of the pretensioner reduced the length of the buckle stalk by 6 cm (2.4 in). The evidence indicated that the driver was restrained in this crash.

CASE VEHICLE DRIVER KINEMATICS

The Ford's driver (36-year-old, female; unknown height and weight) was seated in an unknown posture. During the vehicle inspection, the seat track was found adjusted to the rear most track position and the seat back was partially reclined. The tilt steering column was located in the center position.

The Ford's right side impact with the Toyota displaced the driver forward and to the right opposite the 1 o'clock direction of force, and she loaded the seat belt. She remained restrained in the seat as the vehicle rotated clockwise, and she was displaced to the left opposite the 9 o'clock direction of principle force upon impact with the Chevrolet. While there was no discernable evidence of occupant contact on either left side impact air bag, the driver probably contacted both of the left side air bags.

CASE VEHICLE DRIVER INJURIES

The police crash report indicated that the driver sustained C (possible) injuries but refused transport to a medical facility.

1ST OTHER VEHLCE

The 2003 Toyota Prius was a front wheel drive, four-door sedan (VIN: JT2BK18UX30-----) equipped with a 1.5L, 4-cylinder gasoline/electric hybrid engine, automatic transmission and 4-wheel anti-lock brakes. The vehicle was also equipped with driver and front right passenger frontal air bags. The vehicle had been repaired and was not inspected.

Damage Classification: The Missing Vehicle algorithm of the WinSMASH program calculated the Toyota's Total Delta V as 16.0 km/h (9.9 mph). The Longitudinal and Lateral velocity



Figure 12: Abrasions on driver's seat belt



Figure 13: Driver's buckle-mounted pretensioner actuated

changes were -13.9 km/h (-8.6 mph) and 8.0 km/h (5.0 mph), respectively. The results are considered borderline because they are based only on the Ford's crush profile.

Toyota's Occupants: The Toyota's driver (61-year-old female) was restrained by the lap-and-shoulder belt and was not injured.

2ND OTHER VEHICLE

The 1989 Chevrolet Suburban was a rear wheel drive, four-door station wagon (VIN: 1GNER16K5KF-----) equipped with a 5.7L, V8 engine. The Chevrolet was not inspected because it could not be located.

Damage Classification: The Missing Vehicle algorithm of the WinSMASH program calculated the Chevrolet's Total Delta V as 13.0 km/h (8.1 mph). The Longitudinal and Lateral velocity changes were -10.0 km/h (-6.2 mph) and 8.4 km/h (5.2 mph), respectively. The results are considered borderline because they are based only on the Ford's crush profile.

Chevrolet's Occupants: The Chevrolet's driver (38-year-old male) was restrained by the lap-and-shoulder belt and was not injured.

