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ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE INVESTIGATION

CASE NUMBER - IN09006
LOCATION - MISSOURI
VEHICLE - 2008 FORD FOCUS SE
CRASH DATE - February 2009

Submitted:

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Contract Number: DTNH22-07-C-00044

Prepared for:

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National Highway Traffic Safety Administration
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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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On-site Certified Advanced 208-Compliant Vehicle investigation involving a 2008 Ford Focus SE and a 1999 Ford Crown Victoria LX.

16. *Abstract*

This report covers an on-site investigation of a crash that involved a 2008 Ford Focus SE and a 1999 Ford Crown Victoria LX, which were involved in an offset frontal crash on a 2-lane state highway. This investigation focused on the frontal air bag system of the Focus and the sources of the injuries sustained by the driver. The Focus was certified by the manufacturer to be compliant to the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The Focus was occupied by an unrestrained 40-year-old male driver. He was traveling north when his vehicle crossed into the southbound lane. The front of the Focus impacted the front of the Crown Victoria in a left offset configuration. The direction of force of the Focus was within the 12 o'clock sector and the impact force was sufficient to deploy the driver's frontal air bag. The driver's seat back-mounted side impact air bag and the side impact inflatable curtain air bags also deployed. The driver's knees contacted the lower left instrument panel and his face and chest loaded the frontal air bag. He loaded through the air bag and deformed the top half of the steering wheel rim 1 cm (0.4 in) and compressed the steering column 5 cm (2 in). The driver sustained severe injuries and was hospitalized for eight days.

17. *Key Words* Advanced Air Bag Air Bag Deployment Motor Vehicle Traffic Crash Serious Injury		18. *Distribution Statement* General Public	
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This on-site investigation focused on the frontal air bag system of a 2008 Ford Focus SE (**Figure 1**) and the sources of the injuries sustained by the driver. The Focus 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 brought to the National Highway Traffic Safety Administration's attention on February 20, 2009 by this contractor. This investigation was assigned on February 27, 2009. The crash involved the Focus and a 1999 Ford Crown Victoria LX. The crash occurred in February, 2009, at 0708 hours, in Missouri and was investigated by the Missouri State Highway Patrol. This contractor inspected the Focus, the Crown Victoria, and the crash scene on March 4, 2009. The driver of the Focus was interviewed on March 21, 2009. This report is based on the police crash report, inspections of the crash scene and vehicles, an exemplar Focus inspection, driver medical records, occupant kinematic principles, and this contractor's evaluation of the evidence.

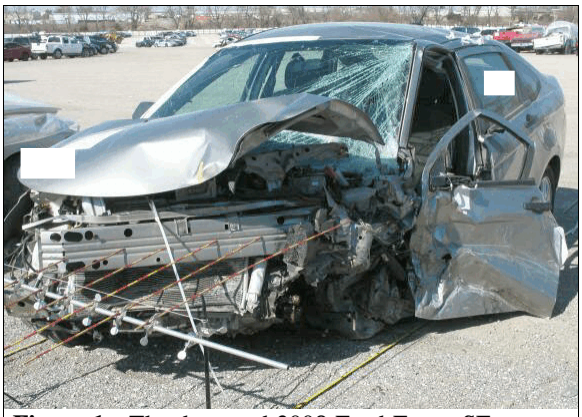


Figure 1: The damaged 2008 Ford Focus SE

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which both vehicle were traveling was a 2-lane, undivided, rural roadway, traversing in a nominal north-south direction. The roadway was straight and level and was bordered by gravel shoulders and steep embankments. Each travel lane was 3.5 m (11.5 ft) in width. The east shoulder was 3.9 m (12.8 ft) in width and the west shoulder was 3.4 m (11.2 ft) in width. The roadway pavement markings consisted of solid white edge lines and a broken white centerline. The speed limit was 89 km/h (55 mph). The grade of the west embankment perpendicular to the roadway was negative 37.5%. The grade of the east embankment was negative 35.4%. At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the roadway pavement was dry bituminous. Traffic density was moderate and the site of the crash was rural agricultural. See the Crash Diagram on page 12 of this report.

Pre-Crash: The Focus was occupied by an unrestrained 40-year-old male driver. He was traveling north (**Figure 2**) and intended to continue north. The Crown Victoria was occupied by a restrained 49-year-old female driver. She was traveling south and intended to continue south. The driver of a vehicle that was traveling south in front of the Crown Victoria told police that the Focus suddenly entered the southbound lane. The driver of the southbound vehicle

Figure 2: Approach of the Focus traveling north; arrow shows location of impact in the south lane

initiated a right steering maneuver onto the west shoulder to avoid the Focus. The driver of the Focus stated during the SCI interview that he took no actions to avoid the crash. The crash occurred within the southbound lane.

Crash: The front plane of the Focus (**Figure 3**) impacted the Crown Victoria's (**Figure 4**) front plane in a left offset configuration. The direction of force on the Focus was within the 12 o'clock sector and the impact force was sufficient to trigger a deployment of the driver's frontal air bag. The side impact inflatable curtain (IC) air bags and front left seat back-mounted side impact air bag also deployed. The two vehicles remained engaged and the damage extended down the left side of each vehicle (**Figures 5** and **6**), and the left front wheel of the Focus was broken off. The Focus separated from impact and rotated counterclockwise toward the east side of the roadway. The vehicle traversed 24.6 m (80.7 ft) across the road and down the east embankment while rotating counterclockwise approximately 430 degrees. It came to final rest at the bottom of the embankment heading northwest (**Figure 7**). The Crown Victoria traversed 23.2 m (76.1 ft) in a southwest direction across the road and down the west embankment while rotating counterclockwise 170 degrees. It came to final rest at the bottom of the embankment heading northeast (**Figure 8**).

Figure 3: Damage to the front of the Focus from impact with the Crown Victoria

Figure 4: Damage to the front of the Crown Victoria from impact with the Focus

Post-Crash: The police were notified of the crash at 0711 hours and arrived on scene at 0714 hours. Emergency rescue and medical services also responded to the scene. The left front door of the Focus was mechanically opened by rescue personnel to extricate the driver. He was transported by air ambulance to a hospital. The driver of the Crown Victoria sustained a fatal injury and was transported to a local funeral home. Both vehicles were towed from the crash scene due to damage.

Figure 5: The damage extended down the left side of the Focus breaking off the left front wheel and crushing the left front door

Figure 6: The damage extended down the left side of the Crown Victoria displacing the left front wheel rearward and crushing the left front door

Figure 7: View from east shoulder to the rest position of the Focus (arrow); photo taken along approximate path to the rest position

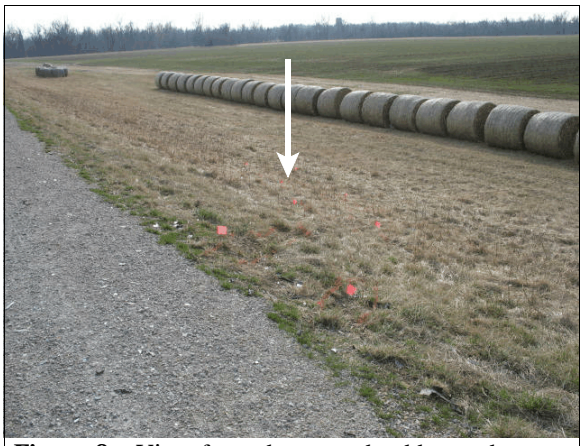


Figure 8: View from the west shoulder to the rest position of the Crown Victoria (arrow); orange paint and flags shows tire marks leading to the rest position

CASE VEHICLE

Case Vehicle: The 2008 Ford Focus SE was a front wheel drive, 4-door sedan (VIN: 1FAHP35N58W------) that was manufactured in April 2008. It was equipped with a 2.0L, I4 engine, 4-wheel anti-lock brakes, a 5-speed manual transmission, a tire pressure monitoring system, and an Event Data Recorder (EDR). The front row was equipped with bucket seats, adjustable head restraints, dual stage driver and front right passenger frontal air bags, seat back-mounted side impact air bags, IC air bags, and lap-and-shoulder belts. 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. The vehicle's mileage could not be determined at the inspection since the vehicle was equipped with an electronic odometer and the electronic circuitry was disrupted as a result of the crash. The driver estimated the vehicle's mileage as approximately 27,358 kilometers (17,000 miles). The vehicle's specified wheelbase was 261 cm (102.8 in).

Exterior Damage: The impact with the Crown Victoria involved the front plane of the Focus and occurred at the front left corner. The front bumper, hood, left fender, left front wheel and left front door were directly damaged. The direct damage began at the front left bumper corner and extended 40 cm (15.7 in) across the bumper. It also extended down the left side of the vehicle to the back of the left front door (**Figure 5**). The crush measurements were taken at the bumper bar, and the maximum residual crush was 88 cm (34.6 in) occurring at C_1 (**Figure 9**). The table below shows the vehicle's front crush profile.

Figure 9: Left side view of the Focus' front crush

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	40	88	57	88	64	53	38	21	0	-43	0
in		15.7	34.6	22.4	34.6	25.2	20.9	15.0	8.3	0.0	-16.9	0.0

The vehicle's left side wheelbase was reduced 16 cm (6.3 in) while the right side wheelbase was unchanged. The induced damage involved the hood, windshield, left A-pillar, roof, and left rear door.

Damage Classification: The Collision Deformation Classification (CDC) for the front impact was **12-FLEE-8** (**0** degrees). The Damage algorithm of the WinSMASH program calculated the total Delta V of the Focus as 57.0 km/h (35.4 mph). The longitudinal and lateral velocity changes were -57.0 km/h (-35.4 mph) and 0.0 km/h, respectively. Based on the damage sustained by both vehicles, the results of the WinSMASH program appeared reasonable.

The vehicle manufacturer's recommended tire size was P195/60R15. The Focus 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	32nd of an inch			
LF	Unk	Unk	221	32	Unk	Unk	Unknown, wheel broken off not present	No	Unk
LR	186	27	221	32	6	8	None	No	No

Tire	*Measured Pressure*		*Vehicle Manufacturer's Recommended Cold Tire Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
RR	186	27	221	32	6	7	None	No	No
RF	193	28	221	32	5	6	None	No	No

Vehicle Interior: Inspection of the Focus' interior revealed scuffs and deformation on the lower instrument panel left of the steering column due to contact by the driver's left knee (**Figure 10**). The instrument panel right of the steering column was also probably loaded by the driver's right knee; however, the panel was dislodged and was not present at the time of the inspection. The left A-pillar was abraded, probably due to contact by the driver's left hand. A scuff was located on the driver's frontal air bag, which was probably the result of the driver's face loading the air bag. The top half of the steering wheel rim was displaced forward 1 cm (0.4 in), which was the result of the unrestrained driver loading through the air bag and contacting the steering wheel. Based on measurements of the damaged steering column and from an exemplar vehicle, it was determined that the steering column was compressed 5 cm (2 in). Damage to the instrument panel and intrusion of the side panel forward of the A-pillar prevented inspection of the lower steering column.

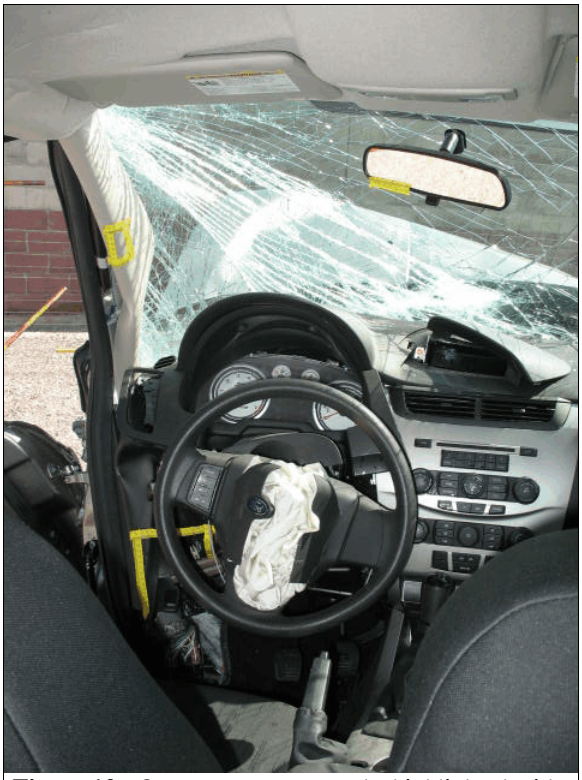


Figure 10: Occupant contact marks highlighted with yellow tape

The left front door was jammed closed and had been mechanically opened by rescue personnel. The remaining doors were closed and operational. The pre-crash status of all the window glazing was either closed or fixed. The left front window glazing was disintegrated from impact forces while the windshield was in place and cracked from impact forces.

The Focus sustained nine passenger compartment intrusions into the front row **Figures 11** and **12**). The most severe intrusions into the driver's space involved the side panel forward of the left A-pillar, the windshield, toe pan, left A-pillar, left instrument panel, and the steering assembly. The side panel intruded 25 cm (9.8 in) laterally while the windshield, toe pan, left A-pillar, instrument panel, and steering assembly intruded longitudinally 19 cm (7.5 in), 17 cm (6.7 in), 16 cm (6.3 in), 11 cm (4.3 in), and 5 cm (2 in), respectively.

The imaging of the vehicle's EDR was attempted through the diagnostic link connector by powering up the Restraint Control Module (RCM) through the air bag fuse. The attempt was unsuccessful since the vehicle's electrical system had been damaged during the crash, and the Crash Data Retrieval tool was unable to communicate with the RCM. It was not possible to image the EDR via direct connection to RCM since the required RCM adapter and cable was unavailable.

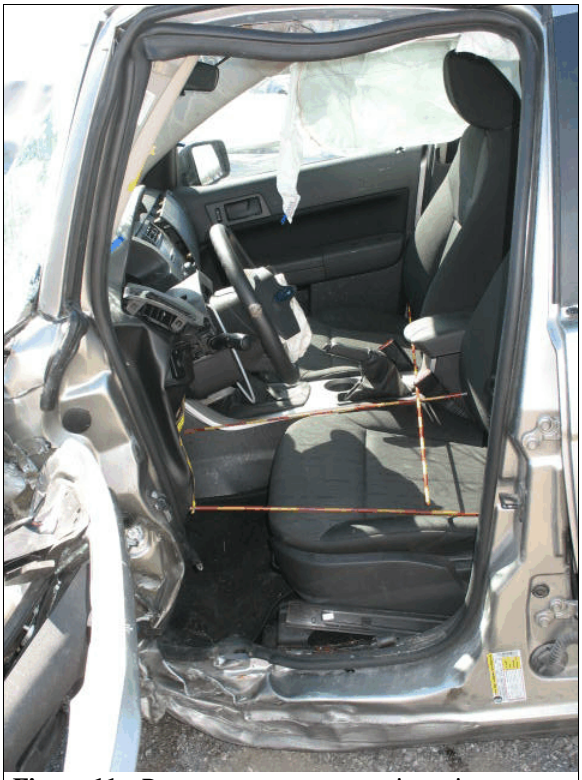


Figure 11: Passenger compartment intrusion

Figure 12: Intrusion of side panel forward of left A-pillar and toe pan

AUTOMATIC RESTRAINT SYSTEM

The Focus 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, seat belt 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 within the steering wheel hub and the module cover was a two flap configuration constructed of pliable vinyl. Each cover flap was 7 cm (2.3 in) in width and 15 cm (5.9 in) in height, and they opened at the designated tear points. The deployed air bag (**Figure 13**) was 48 cm (19 in) in diameter and was designed with two 3 cm (1.2 in) diameter vent ports and one tether, which was 12 cm (4.7 in) in width. The vent ports were located at the 11 and 1 o'clock positions. Inspection of the air bag revealed no damage and a probable occupant contact scuff located 17 cm (6.7 in) above and 3 cm (1.2 in) to the right of the center of the air bag. There were also several other scuffs on the air bag, which appeared to be related to the deployment or post-crash handling of the air bag.

The front right passenger frontal air bag was located within the top of the instrument panel. There was no front right passenger in the vehicle and the deployment of this air bag was suppressed.

The Ford was also equipped with front seat back-mounted side impact air bags and roof side rail-mounted IC air bags. Based on the Holmatro Rescuer's Guide to Vehicle Safety Systems, the side impact sensors were located on each side of the vehicle within the front doors and lower B-pillars. The inflators for the ICs were located within the C-pillars, between the roof side rail and the lower edge of the window glass. Both ICs and the front left seat back mounted side impact air bag deployed in this crash.

Figure 13: The driver's frontal air bag; yellow tape shows probably occupant contact scuff

The left IC was located along the left roof side rail (**Figure14**), within the head liner and extended from the A-pillar to the C-pillar. The IC was 150 cm (59.1 in) in width and 35 cm (13.8 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 8 cm (3.1 in) in length and the fabric was 32 cm (12.5 in) in length. The IC was anchored to the C-pillar by a nylon rope tether 5 cm (2 in) in length. A section of the IC 38 cm (15 in) in width and 32 cm (12.9 in) in height had been cut out of the front portion of the IC, probably by rescue personnel. The remainder of the IC was unremarkable. The right IC was of the same dimensions and was unremarkable except for a cut on the inside front portion, which did not appear to be crash related.

Figure 14: The left side impact curtain air (front portion cut away), seat back mounted side impact air bag and the frontal air bag

The front left seat back-mounted side impact air bag was located within the outboard side of the seat back and deployed through a tear seam. The deployed air bag (**Figure 15**) was oval and was 27 cm (10.6 in) in width and 22 cm (8.7 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 15: The deployed front left seat back-mounted side impact air bag

The Focus was equipped with lap-and-shoulder belts for the front and second row seating positions. The driver's seat belt consisted of continuous loop belt webbing, Emergency Locking Retractor (ELR), sliding latch plate, and adjustable upper anchor that was located in the middle position. The front right seat belt was equipped with switchable ELR/Automatic Locking Retractor (ALR), sliding latch plate, and adjustable upper anchor that was located in the full-down position. The front row seat belts were equipped with buckle-mounted pretensioners that did not deploy in this crash. The second row outboard seat belts consisted of continuous loop belt webbing, switchable ELR/ALRs, sliding latch plates and fixed upper anchors. The second row center seat belt was similar but had an ALR and a locking latch plate.

The inspection of the driver's seat belt assembly revealed no evidence of loading and little evidence of historical usage on the latch plate. The evidence indicated that the driver was not restrained in this crash. The driver also stated during the SCI interview that he was not using the seat belt at the time of the crash. The remaining seat positions were unoccupied.

CASE VEHICLE DRIVER KINEMATICS

Based on the SCI interview, the driver of the Focus [40-year-old, male; 183 cm and 93 kg (72 in, 205 lbs)] was seated in an upright posture with both hands on the steering wheel. The left hand was at the 11 o'clock position and the right hand at the 2 o'clock position. The right foot was on the accelerator and the left foot was on the toe pan. The seat track was located between the middle and rear track position, which was measured as 2 cm (0.8 in) forward of the full rear position, and the seat back was upright. The steering column was adjusted to the full-down position. The driver was not wearing glasses or contact lenses.

The front impact of the Focus with the Crown Victoria displaced the unrestrained driver forward opposite the 12 o'clock direction of force. The driver's left knee contacted the lower left instrument panel, which caused a dislocation of the left hip and displaced fracture of the left acetabulum. His face loaded the deployed frontal air bag, which caused facial abrasions and a nonanatomic brain injury. He loaded through the air bag and his chest contacted and deformed the upper half section of the steering wheel rim that compressed the steering column 5 cm (2 in). This contact resulted in bilateral pulmonary contusions. The driver's right arm contacted the center instrument panel, which caused a comminuted fracture of the right ulnar olecranon process. The driver also sustained multiple contusions and abrasions. He remained in his seat as the vehicle traveled to its final rest position. Emergency rescue personnel mechanically opened the left front door to extricate the driver.

CASE VEHICLE DRIVER INJURIES

The driver was transported from the crash scene by ambulance. He was hospitalized for eight days and received three follow-up visits to his doctor. The driver had not returned to work at the time of the SCI interview on March 21, 2009, and did know when he would be able to resume his work schedule. The table below shows the driver's injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
1	Nonanatomic brain injury, unknown if loss of consciousness, but amnestic to event	moderate 160410.2,0	Air bag, driver's	Probable	Hospitalization records
2	Contusions, bilateral, pulmonary, not further specified	severe 441410.4,3	Steering wheel hub and/or spokes and rim	Certain	Hospitalization records
3	Fracture, comminuted, with fragment displacement right ulnar olecranon process[1]	serious 753204.3,1	Center instrument panel	Probable	Hospitalization records
4	Dislocation, posteriorly, left hip (i.e., femoral head) with internal rotation left leg	moderate 850610.2,2	Left lower instrument panel, left of steering column (Indirect injury)	Certain	Hospitalization records
5	Fracture, comminuted, left acetabulum with displaced fracture fragments[1]	serious 852604.3,2	Left lower instrument panel, left of steering column (Indirect injury)	Certain	Hospitalization records
6	Abrasions face, not further specified	minor 290202.1,9	Air bag, driver's	Certain	Emergency room records
7	Hemorrhage with clotting from left nare (nose)	minor 251090.1,4	Air bag, driver's	Probable	Emergency room records
8	Abrasion dorsum left hand, not further specified	minor 790202.1,2	Left A-pillar	Probable	Emergency room records
9	Lacerations x 8 (cuts), small, left upper extremity, not further specified	minor 790602.1,2	Noncontact injury: flying glass, unknown source	Probable	Interviewee (same person)
10	Abrasions, multiple, around bilateral knees and right anterior shin	minor 890202.1,3	Left lower instrument panel	Certain	Emergency room records
11	Contusions bilateral lower extremities, not further specified	minor 890402.1,3	Left lower instrument panel	Probable	Emergency room records
12	Abrasion right ankle, not further specified	minor 890202.1,1	Floor, foot controls	Probable	Emergency room records

[1] Lesion required open reduction and internal fixation.

The 1999 Ford Crown Victoria LX was a rear wheel drive, 4-door sedan (VIN: 2FAFP74W6XX------) equipped with a 4.6L, V8 engine, an automatic transmission, and redesigned driver and front right passenger frontal air bags.

Exterior Damage: The impact with the Focus involved the Crown Victoria's front plane and occurred at the front left corner. The front bumper, hood, left fender, left front wheel, left front door and left rear door were directly damaged. The direct damage began at the front left bumper corner and extended 40 cm (15.7 in) across the bumper. The direct damage extended down the left side of the vehicle to the back of the left rear door. The crush measurements were taken at the bumper bar, and the maximum residual crush was 51 cm (20.1 in) occurring at C_1. The vehicle's left side wheelbase was reduced 45 cm (17.7 in) while the right side wheelbase was extended 2 cm (0.8 in). The induced damage involved the hood, windshield, left A-pillar, and roof. The vehicle's crush profile is shown in the table below.

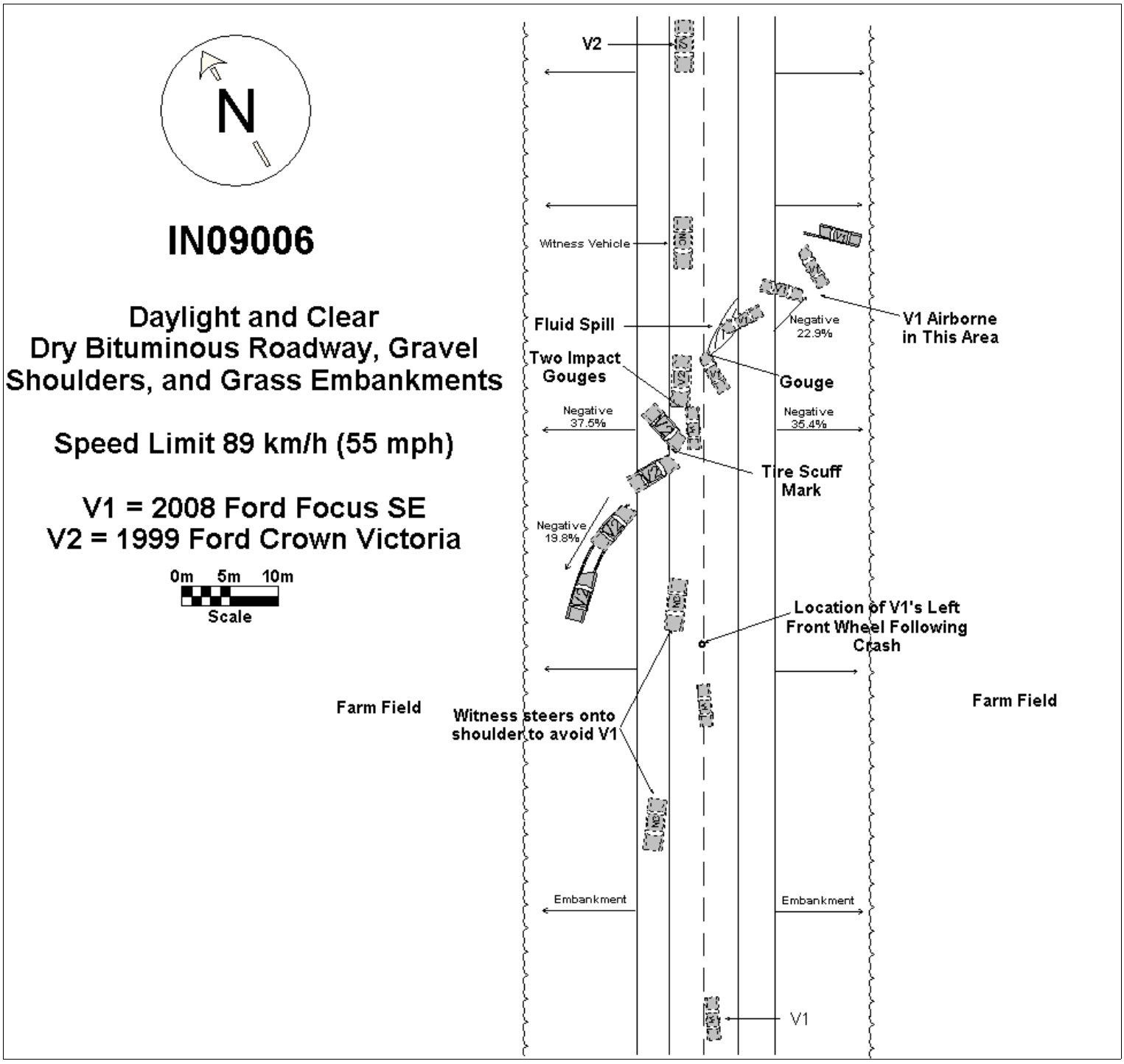
Units	Event	Direct Damage		Field L	C_1	C_2	C_3	C_4	C_5	C_6	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	40	51	117	51	40	32	22	10	0	-60	0
in		15.7	20.1	46.1	20.1	15.7	12.6	8.7	3.9	0.0	-23.6	0.0

Damage Classification: The CDC for the front impact was **12-FLEE-9** (**0** degrees). The Damage algorithm of the WinSMASH program calculated the total Delta V of the Crown Victoria as 39.0 km/h (24.2 mph). The longitudinal and lateral velocity changes were -39.0 km/h (-24.2 mph) and 0.0 km/h, respectively. Based on the damage to both vehicle, the WinSMASH results appeared reasonable.

The vehicle manufacturer's recommended tire size was P225/60R16. The Crown Victoria was equipped with the recommended size tires. The 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	32nd of an inch			
LF	Flat	Flat	221	32	6	8	Sidewall cut	Yes	Yes
LR	228	33	221	32	4	5	None	No	No
RR	221	32	221	32	2	2	None	No	No
RF	228	33	221	32	4	5	None	No	No

Other Vehicle's Driver: The police crash report indicated that the driver of the Crown Victoria (49-year-old, female) was restrained by the lap-and-shoulder belt. The driver's frontal air bag also deployed. The county coroner pronounced the driver deceased at the crash scene.


N
IN09006
Daylight and Clear
Dry Bituminous Roadway, Gravel Shoulders, and Grass Embankments
Speed Limit 89 km/h (55 mph)
V1 = 2008 Ford Focus SE
V2 = 1999 Ford Crown Victoria
0m 5m 10m
Scale
V2
Witness Vehicle
Fluid Spill
Two Impact Gouges
Negative 37.5%
Negative 19.8%
Negative 22.9%
Negative 35.4%
V1 Airborne in This Area
Gouge
Tire Scuff Mark
Location of V1's Left Front Wheel Following Crash
Farm Field
Farm Field
Witness steers onto shoulder to avoid V1
Embankment
Embankment
V1