

**CRASH DATA RESEARCH CENTER**

Veridian  
Engineering Division  
Buffalo, New York 14225

**VERIDIAN ON-SITE ALLEGED INADVERTENT AIR BAG  
DEPLOYMENT INVESTIGATION**

**VERIDIAN CASE NO. CA00-057**

**VEHICLE - 2001 FORD FOCUS LX**

**LOCATION - STATE OF VIRGINIA**

**CRASH DATE - OCTOBER, 2000**

Contract No. DTNH22-94-D-07058

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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 are 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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***BACKGROUND***

This on-site investigation focused on the deployment of the redesigned frontal air bag system of a 2001 Ford Focus LX 4-door sedan. The Ford was equipped with redesigned frontal air bags for the driver and front right passenger positions which the driver reported deployed inadvertently without incident. The driver of the Ford was operating the vehicle eastbound when she approached a sewer grate in an attempt to exit a parking lot. As the vehicle straddled the sewer grate, the front suspension pivot supports impacted the sewer grate which resulted in minor undercarriage damage. The restrained 49 year old female driver sustained a mild subconjunctiva hemorrhage of the right eye and multiple soft tissue injuries to the face as a result of interaction with the deployed redesigned driver air bag. Indirect air bag contact “fling” type injuries consisted of a contusion to the posterior aspect of the right hand and an avulsion fracture of the right fifth finger. She was subsequently transported by private vehicle to a local hospital for treatment and released. The restrained 26 year old male front right passenger was uninjured in the collision.

The crash notification was provided to NHTSA on Wednesday, November 1, 2000 and immediately assigned to the Veridian SCI team as an on-site investigative effort. Despite cooperative delays and inclement weather conditions, the on-site investigator departed on December 5 and completed field activities Wednesday, December 6, 2000.

***SUMMARY***

**Crash Site**

This single vehicle crash occurred during the afternoon hours of October, 2000. At the time of the crash, it was daylight with no adverse conditions as the parking lot and nearby road were dry. The crash occurred in close proximity to the east entrance of a large parking lot with sewer grates located along the centerline of the ingress/egress lane. Although the dirt/gravel surface was level, traffic and past weather conditions had eroded the soil from the edges of the sewer grate. This erosion produced a 3.8 cm (1.5 in) protrusion of the grate above the surface of the parking lot. During the SCI scene inspection, large furrows were also noted in the surface which produced “humps” to the outboard parking spaces, however, they were later discounted as a source of pre-crash movement of the vehicle’s front suspension system upon receipt of on-scene photographs from the driver. Environmental features also included trees and landscaped railroad ties that surrounded the parking area (see **Figure 16 - page 8**). No traffic control or posted speed limit was present at the scene.

**Pre-Crash**

The 49 year old female driver of the 2001 Ford Focus had concluded afternoon activities at an adjacent recreational area and was exiting the parking lot in an easterly direction (**Figure 1**) when she reportedly straddled the sewer grate at a (driver reported) speed of 8 km/h (5 mph).



**Figure 1. East view of parking lot.**

## Crash

As the Ford straddled the sewer grate, the front undercarriage impacted the sewer grate (**Figure 2**) resulting in minor damage to the vehicle. The undercarriage impact produced a longitudinal pulse to the vehicle that deployed the frontal air bag system. This impact was classified as out-of-scope for the WinSMASH reconstruction program. Although the vehicle's electronic data recorder could not (*by design*) record a total Delta-V for this event, the algorithm "wake-up" was 5 milliseconds prior to deployment with a 24.5G spike (*see Figures 14 & 15*). This translated to a 2.4 km/h (1.5 mph) velocity change during only 5 milliseconds up to the time of deployment. The vehicle was driven to rest approximately 5.2 meters (17.1 feet) east of the point of impact facing east (**Figures 3 & 4**).



**Figure 2. North view of struck sewer grate and associated height measurement.**



**Figure 3. North view of vehicle final rest position.**



**Figure 4. Multiple views of vehicle final rest position east of struck sewer grate.**

## Post-Crash

The occupants of the Ford Focus exited the vehicle through their respective doors under their own power. The driver was subsequently transported by private vehicle to a local hospital for treatment and released. The front right passenger was not injured in the collision. The vehicle was towed from the scene with non-disabling damage.

## **VEHICLE DATA**

The 2001 Ford Focus LX (**Figure 5**) was manufactured on 8/00 and identified by the vehicle identification number (VIN): 1FAFP33P41W (production number deleted). The rental vehicle was a 4-door sedan equipped with front-wheel drive and a 2.0 liter, 4-cylinder engine. At the time of the crash, the odometer had recorded 3,833 km (2,382 miles). The seating was configured with front bucket and rear bench seats (with folding backs). The rental company reported no previous crashes or maintenance on the Ford's frontal air bag system. A cellular phone was present (and on) but not in use at the time of the collision.

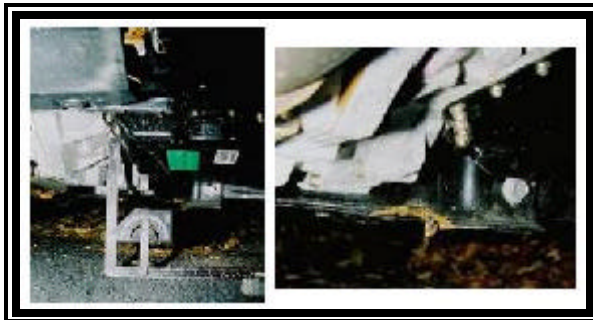


**Figure 5. Oblique view of the 2001 Ford Focus LX.**

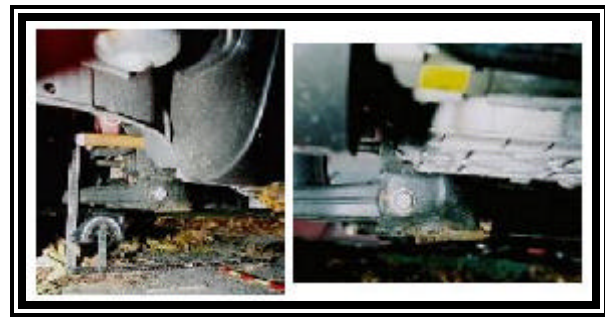
## **VEHICLE DAMAGE**

### **Exterior**

The 2001 Ford Focus LX sustained minor undercarriage damage as a result of the impact with the sewer grate. The direct contact damage was centered along the catalytic converter and extended 44.4 cm (17.5 in) laterally outward to the (front) lower suspension pivot supports (**Figures 6 & 7**). No contact damage was identified to the front air dam. Although the event could be considered a *low frontal* impact with a principal direction of force within the horizontal plane, this impact resulted in snagging of undercarriage components which tends to produce significant vertical as well as longitudinal components of force. Therefore, a Collision Deformation Classification (CDC) of 00-UFDW-1 was assigned to the Ford. The vehicle's ground clearance measured 15.2 cm (6.0 in) at the catalytic converter, 12.1 cm (4.8 in) at the leading edge of the exhaust pipe and 11.4 cm (4.5 in) at the pivot supports. Reduction in the right side wheelbase measured 2.0 cm (0.8 in).



**Figure 6. Contact damage to the left front lower suspension pivot support.**



**Figure 7. Contact damage to the right front lower suspension pivot support.**

### **Interior**

There was no damage to the interior surfaces of the Ford Focus from intrusions or occupant contact.

## **MANUAL RESTRAINT SYSTEMS**

The interior of the Ford Focus consisted of a five passenger seating configuration with front bucket and rear bench seats (with folding backs). The driver 3-point manual lap and shoulder belt system consisted

of a continuous loop belt webbing with a sliding latchplate and dual mode retractors (inertial lock/belt sensitive). No loading evidence was identified on the restraint webbing or D-ring. The driver restraint system also included a retractor pretensioner (deployment status unknown). The front right 3-point manual lap and shoulder belt system consisted of a continuous loop belt webbing with a sliding latchplate and a retractor equipped with an inertial and switchable lock mechanism. No loading evidence was identified on the restraint webbing or D-ring. The front right passenger restraint system also included a buckle pretensioner mounted longitudinally alongside the seat cushion. The deployment of this pretensioner resulted in 7.0 cm (2.8 in) of piston movement. The piston pulls a cable which lowers the height of the buckle assembly (**Figure 8**), reducing the slack in both the lap and shoulder belt webbing. The rear seated positions were equipped with 3-point manual lap and shoulder belt systems which consisted of continuous loop belt webbings with sliding latchplates that retracted into inertial sensitive and switchable locking retractors.



**Figure 8. Pretensioner deployment in the front right restraint buckle.**

### ***SUPPLEMENTAL RESTRAINT SYSTEMS***

The 2001 Ford Focus LX was equipped with redesigned frontal air bags for the driver and front right passenger positions. The air bags had deployed as a result of the impact with the sewer grate (**Figure 9**). The driver air bag was housed in the center of the steering wheel with a horizontally oriented flap tear seam (H-configuration). No contact evidence was identified on the exterior surface of the module cover flaps. The flaps were trapezoidal in shape as the upper flap measured 17.7 cm (7.0 in) in width along the flap tear seam, 11.4 cm (4.5 in) in width along the upper portion and 5.3 cm (2.1 in) in height. The lower flap measured 17.7 cm (7.0 in) in width along the flap tear seam, 6.3 cm (2.5 in) in width along the lower portion and 7.6 cm (3.0 in) in height. The diameter of the driver air bag measured 59.4 cm (23.4 in) in its deflated state (**Figure 10**). Makeup transfers were documented to the upper left and lower right quadrants of the air bag face. The bag was vented by perforations in the rear (upper) centered portion of the air bag membrane (**Figure 11**) which consisted of two rows of semi-circular ports which (grouped) measured 14.0 cm (5.5 in) in width and 3.7 cm (1.5 in) in height. No conventional internal tether straps were present. Rearward air bag excursion measured 51.0 cm (20.1 in) from the center of the steering wheel hub.



**Figure 9. 2001 Ford Focus deployed redesigned frontal air bags.**

The front right passenger air bag deployed from the right top instrument panel area with a single cover flap design hinged at the forward aspect. The cover flap was rectangular in shape and measured 47.0 cm (18.5 in) in width along the top portion, 43.0 cm (16.9 in) in width along the lower portion and 12.0 cm (4.7 in) in height. Glass fragments were noted along the aft edge of the flap from contact to the (fractured) right mid-windshield area. Although no contact evidence was identified on the passenger air bag or exterior surface of the module cover flap, multiple black vinyl transfers were noted along the upper portion of the air bag from expansion within the module. The passenger air bag measured 43.5 cm (17.1 in) in width and 63.2 cm (24.9 in) in height in its deflated state (**Figure 12**). The bag was vented by two ports located at the 10 o'clock and 2 o'clock sectors on the side aspect of the bag. No



internal tether straps were present. Rearward air bag excursion measured 32.0 cm (12.6 in) from the aft portion of the right instrument panel.



**Figure 10. 2001 Ford Focus deployed redesigned driver air bag.**



**Figure 11. Driver air bag vent ports.**



**Figure 12. 2001 Ford Focus deployed redesigned passenger air bag.**

### ***DRIVER DEMOGRAPHICS***

Age/Sex: 49 year old female  
 Height: 163 cm (64 in)  
 Weight: 64 kg (140 lb)  
 Seat Track Position: Mid-to-forward position [16.5 cm (6.5 in) forward of the full rearward position or 7.5 cm (3.0 in) aft of the full forward position]  
 Manual Restraint Use: 3-point lap and shoulder belt system  
 Usage Source: Vehicle inspection, driver interview  
 Eyeware: None  
 Type of Medical Treatment: Transported by private vehicle to a local hospital and released

### **Driver Injuries**

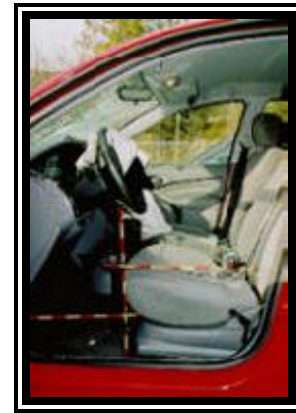
<b><i>Injury</i></b>	<b><i>Severity (AIS 90)</i></b>	<b><i>Injury Mechanism</i></b>
#Mild subconjunctiva hemorrhage right eye	Minor (240416.1,1)	Driver air bag
#Small abrasion and rupture (nosebleed) of buccal mucosa	Minor (251090.1,4)	Driver air bag
#Contusion right face	Minor (290402.1,1)	Driver air bag
*Laceration right upper lip	Minor (290602.1,8)	Driver air bag
^Avulsion fracture right fifth finger (middle phalanx)	Minor (752404.1,1)	Transmission lever (indirect air bag contact "fling" injury)
#Contusion posterior right hand (3 <sup>rd</sup> - 5 <sup>th</sup> digits)	Minor (790402.1,1)	Transmission lever (indirect air bag contact "fling" injury)

*Sources: \*-driver, #-emergency room report, ^-radiology report*

### **Driver Kinematics**

The 49 year old female driver of the 2001 Ford Focus LX was presumed to be seated in an upright

posture with the seat track adjusted to the mid-to-forward position (**Figure 13**). She stated her hands were placed at the 8 o'clock and 4 o'clock positions on the steering wheel rim. The driver further stated she was wearing the 3-point manual lap and shoulder belt system, however, there was no loading evidence to support belt use in this low Delta-V crash.



**Figure 13. Interior view of the driver space.**

Interaction with the deployed redesigned driver air bag resulted in a mild subconjunctiva hemorrhage of the right eye (*a result of bag compression against the eye*), a small laceration of the right upper lip, a contusion to the right face and an abrasion/rupture of the buccal mucosa (nose).

Trauma to the right hand included a posterior contusion and an avulsion fracture of the fifth finger. Two possible mechanisms existed as a source of the injuries sustained by the driver. Initially, this injury pattern was consistent with a hand to face “fling” type injury sustained during bag expansion. At deployment, her right hand may have been positioned in front of the air bag. The air bag contacted the anterior aspect of the right hand and propelled it into the face resulting in the above mentioned facial injuries. The driver stated during the SCI interview that she *may* have maneuvered her right hand in front of her face “*to protect herself*”. This maneuver is a typical reaction to an impending crash, and seems unrealistic given no anticipation of impact.

Although the injury pattern was consistent with an air bag “fling” type deflection, it was not consistent with the driver’s (known) stated pre-crash hand placement on the steering wheel rim. At that position, the right hand would be outside the deployment path of the air bag, and thus, discounted as the source of the facial injuries. If the right hand was at the 4 o'clock position, the shape of the lower module cover flap would have produced a laceration in addition to the fracture of the fifth finger. However, bag expansion against the *forearm* would have most likely deflected the hand into another adjacent component, such as the gearshift. This probable mechanism is further evidenced by the contusions to the posterior aspect of the right hand and lack of soft tissue injury to the anterior aspect. A possibility also exists that the driver was engaged in some unknown pre-impact activity and seated slightly forward out-of-position. This posture would have placed the head and upper body into the path of the expanding air bag (*driver stated: “it felt like I was punched in the face by the air bag”*), evidenced by the makeup transfers documented across the face of the air bag. She was transported by private vehicle to a local hospital for treatment and released.

### ***FRONT RIGHT PASSENGER DEMOGRAPHICS***

Age/Sex:	26 year old male
Height:	165 cm (65 in)
Weight:	82 kg (180 lb)
Seat Track Position:	Mid-to-rear position [5.5 cm (2.2 in) forward of the full rearward position or 18.5 cm (7.3 in) aft of the full forward position]
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	Vehicle inspection, driver interview
Eyewear:	None

Type of Medical

Treatment: None

### Front Right Passenger Injuries

*Injury*

None

*Severity (AIS 90)*

N/A

*Injury Mechanism*

N/A

### Front Right Passenger Kinematics

The 26 year old male front right passenger of the 2001 Ford Focus LX was restrained by the available 3-point manual lap and shoulder belt system, seated in an upright posture with the seat track adjusted to the mid-to-rear position. Restraint usage was confirmed by the deployment of the buckle pretensioner.

At impact, the passenger probably remained in his pre-impact posture as this minor event produced no resulting kinematic response from the occupant. He was uninjured in the collision.

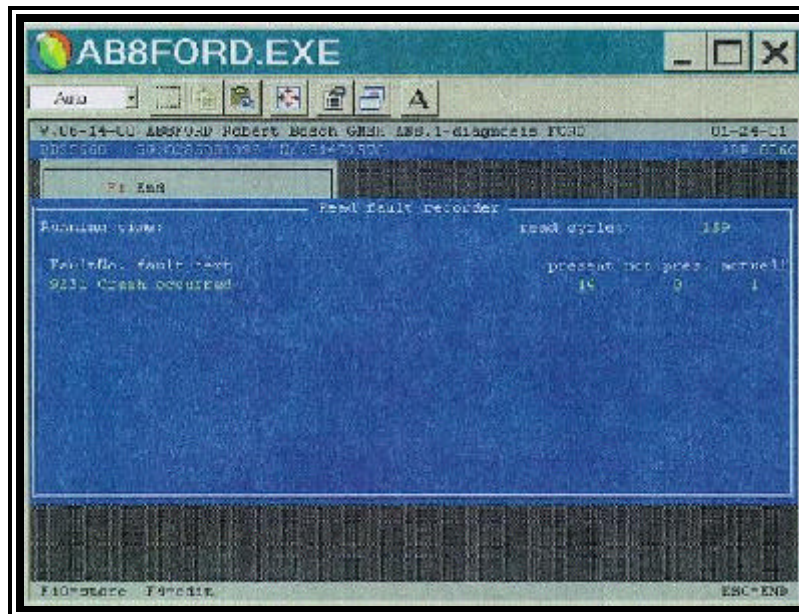


Figure 14. 2001 Ford Focus LX EDR report.

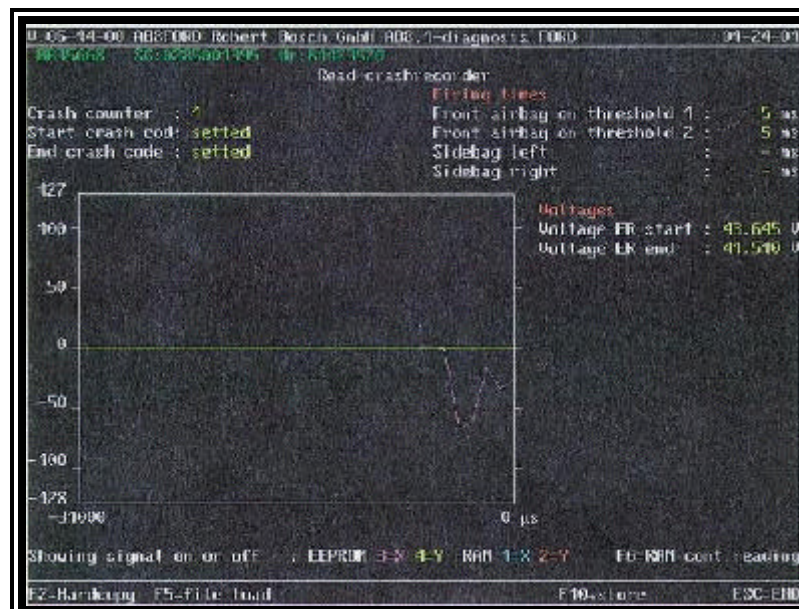


Figure 15. 2001 Ford Focus LX EDR report.

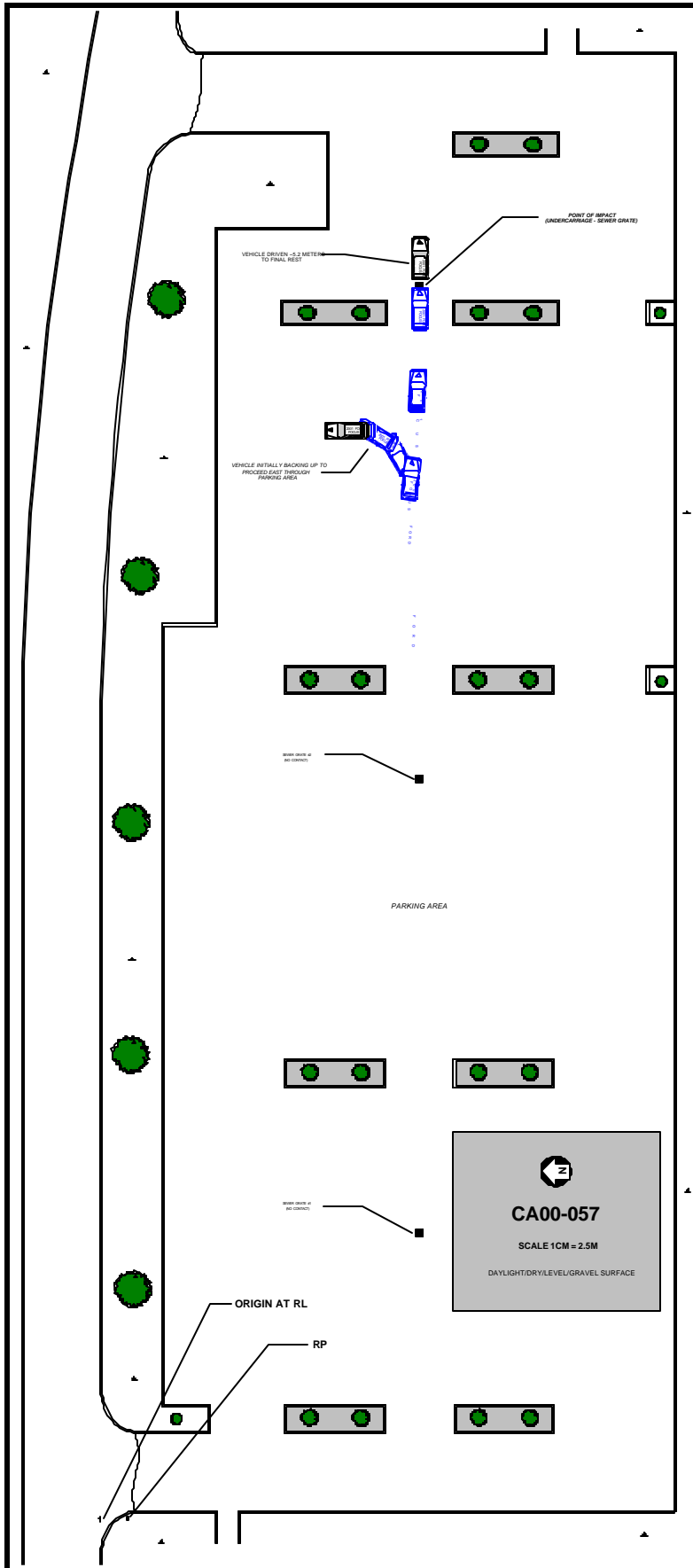


Figure 16. Scene Diagram.