

Child Safety Seat Investigation
Dynamic Science, Inc. (DSI), Case Number DS08016
2002 Ford Focus
Idaho
May 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.

1. Report No. DS08016	2. Government Accession No.		3. Recipient Catalog No.	
4. Title and Subtitle Child Safety Seat Investigation			5. Report Date May 15, 2009	
			6. Performing Organization Report No.	
7. Author(s) Dynamic Science, Inc.			8. Performing Organization Report No.	
9. Performing Organization name and Address Dynamic Science, Inc. 299 West Cerritos Avenue Anaheim, CA 92805			10. Work Unit No. (TRAIS)	
			11. Contract or Grant no. DTNH22-07-00045	
12. Sponsoring Agency Name and Address U.S. Dept. of Transportation (NVS-411) National Highway Traffic Safety Administration 1200 New Jersey Ave, SE Washington, DC 20590			13. Type of report and period Covered [Report Month, Year]	
			14. Sponsoring Agency Code	
15. Supplemental Notes				
16. Abstract <p>This on-site investigation focused on a belt positioning booster child seat that was placed in the left rear position of a 2002 Ford Focus. The Ford Focus was occupied by a restrained 39-year-old female driver, a restrained 38-year-old male, and a 3-year-old female, who was seated in the booster seat. The vehicle's manual 3-point lap and shoulder belt was being used by the 3-year-old child. The Ford was traveling east at an unknown speed. The other vehicle was a westbound 1993 Dodge Ram pickup that was being driven by an unrestrained 70-year-old female. For unknown reasons, the Dodge departed the roadway on the right side, struck a guardrail, traveled back onto the roadway, and crossed the centerline into the path of the eastbound Ford. The Dodge struck the front left of the Ford. The impact resulted in sufficient longitudinal deceleration of the Ford to command the deployment of the frontal air bag system. Upon impact, the driver of the Dodge was ejected. Both vehicles came to rest on the south side of the roadway with the Dodge facing north with its rear tires down an embankment and the Ford facing northeast completely on the embankment. The front seat occupants of the Ford were pronounced dead at the scene. The 3-year-old occupant was transported from the scene to a local hospital with abrasions to the upper left shoulder, the chest, and the abdomen.</p>				
17. Key Words Child safety seat, booster seat, fatality			18. Distribution Statement	
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No of pages	22. Price	

Dynamic Science, Inc.
Crash Investigation
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Background

This on-site investigation focused on a belt positioning booster child seat that was placed in the left rear position of a 2002 Ford Focus (**Figure 1**). The Ford was occupied by a restrained 39-year-old female driver, a restrained 38-year-old male, and a 3-year-old female, who was seated in the booster seat. The vehicle's manual 3-point lap and shoulder belt was being used by the 3-year-old child. The Ford was traveling east at an unknown speed. The other vehicle was a westbound 1993 Dodge Ram pickup that was being driven by an unrestrained 70-year-old female. For unknown reasons, the Dodge departed the roadway on the right side, struck a guardrail, traveled back onto the roadway, and crossed the centerline into the path of the eastbound Ford. The Dodge struck the front left of the Ford. The impact resulted in sufficient longitudinal deceleration of the Ford to command the deployment of the frontal air bag system. Upon impact, the driver of the Dodge was ejected. Both vehicles came to rest on the south side of the roadway with the Dodge facing north with its rear tires down an embankment and the Ford facing northeast completely on the embankment. The front seat occupants of the Ford were pronounced dead at the scene. The 3-year-old occupant was transported from the scene to a local hospital with abrasions to the upper left shoulder, the chest, and the abdomen.

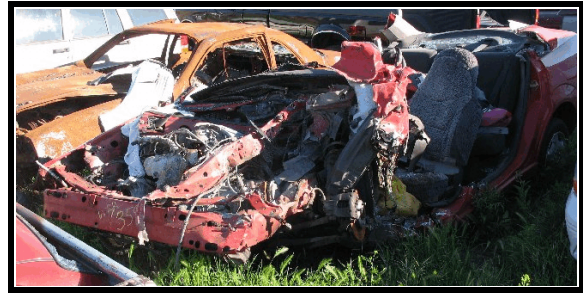


Figure 1. Subject vehicle, 2002 Ford Focus

This investigation was initiated by the National Highway Traffic Safety Administration (NHTSA) in response to an Internet news article describing a two-vehicle crash with multiple fatalities in which a 3-year-old child in a booster seat survived the crash. On May 27, 2008 DSI was instructed to locate the case vehicle and the booster seat. On June 9, 2008, DSI obtained cooperation from the investigating police agency. The vehicle and booster seat were located on June 9, 2008 and DSI was assigned the case on June 10, 2008. Field work was completed on June 16, 2008. The medical records for the front seat occupants of the Ford were received in May 2009.

Summary

Crash Site

This two-vehicle crash occurred in May 2008 at 1934 hours on an east/west, two-lane US highway. There was a light rain at the time of the crash and the roadway was wet. This section of roadway had a left-hand curve in the westbound direction. The asphalt roadway was separated by a dashed yellow centerline for westbound traffic and a solid yellow line for eastbound traffic. A guardrail was located on the edge of the north shoulder as was an ascending embankment on the south side of the roadway. The posted speed limit was 89 km/h (55 mph).

Pre Crash

The subject vehicle was a 2002 Ford Focus four-door sedan that was being driven by a restrained 38-year-old female. The front right seat was occupied by a restrained 39-year-old male. The second row left seat was occupied by a 3-year-old female seated in a Graco TurboBooster belt positioning booster seat. The Ford was traveling east at an unknown speed (**Figure 2**). The other vehicle was a 1993 Dodge 2500 series pickup that was being driven by an unrestrained 70-year-old female. The Dodge was traveling west (**Figure 3**).



Figure 2. Approach to area of impact with Dodge (east).

Crash

For unknown reasons, the Dodge departed the roadway on the right side, struck a guardrail, and then overcorrected into the path of the eastbound Ford. There were no marks left on the roadway prior to the Dodge striking the guardrail or prior to crossing in the path of the Ford. As the Dodge entered the eastbound travel lane it struck the left front of the Ford. The impact damage was severe and resulted in the deployment of the frontal air bag system in the Ford. The Missing Vehicle algorithm of the WinSmash program computed a total delta V of 34 km/h (21.1 mph), based on the Ford's frontal crush profile. The longitudinal and lateral components were -32 km/h (-19.8 mph) and 12 km/h (7.2 mph), respectively. Upon impact, the unrestrained driver of the Dodge was ejected. The Ford was forced rearward and to the south where it came to rest facing northeast in the embankment alongside the roadway. The Dodge rotated in a counterclockwise direction and came to rest on the south side of the roadway with its rear tires on an embankment.



Figure 3. Area of guardrail contact and approach to impact with Ford (west).

Post Crash

Both front seat occupants of the Ford were fatally injured and were pronounced dead at the scene. The cause of death of the driver was severe trauma to the neck. The cause of death to the front right passenger was severe trauma to the chest.

The 3-year-old child was removed from the vehicle/child seat by a passerby. She sustained abrasions to the upper left shoulder, the chest, and the abdomen. Shortly after the crash, she was walking around the scene. She was transported to a local hospital where she arrived with a Glasgow Coma Score (GCS) of 15 and was hospitalized for one day. X-rays to her neck and chest were negative.

The driver of the Dodge was located on the roadway between the two vehicles. She sustained fractures to the femur, right orbit, right maxillary sinus, left ulna, neck, skull, and spine. She was conscious at the time of the investigating agency's arrival and was transported from the scene to a local hospital. She arrived with a GCS of 15. She was transferred to a trauma center later that day.

The roof and all four doors of the Ford were removed during the extrication effort. Both vehicles were towed from the scene due to damage and the Ford was later declared a total loss by the insurance company. The Dodge could not be located and was not inspected.

Vehicle Data - 2002 Ford Focus

The 2002 Ford Focus four-door sedan was identified by the Vehicle Identification Number (VIN): 1FAFP33P32Wxxxxxx. The Ford Focus was equipped with a 2.0 liter, 4-cylinder engine, a manual transmission, and front wheel drive. The Ford was configured a Toyo Eclipse P185/65R14 tire for the left front, an unknown tire for the right front, and Nexen CP641 P185/65R14 tires for the rear. The tire manufacturer's maximum pressure was 303 kPa (44 psi). The vehicle manufacturer's recommended tire pressure was 221 kPa (32 psi). The left front tire was detached from the vehicle at the time of inspection. It was located with other detached vehicle components. The right front tire was displaced horizontally beneath the vehicle.

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	Tire flat	9 mm (11/32 in)	Yes	Side wall cut
LR	255 kPa (37 psi)	11 mm (14/32 in)	No	None
RR	Tire flat	12 mm (15/32 in)	Yes	Tire debanded
RF	Tire flat	10 mm (13/32 in)	Yes	Unknown

The seating in the Ford was configured with front bucket seats with adjustable head restraints and a rear bench seat. The front seats were located 42 cm (16.5 in) rear of the A-pillar in the mid-track position. The front right passenger seatback adjustment hardware had been damaged during the crash and would move freely forward and rearward.

Vehicle Data -1993 Dodge Ram

The 1993 Dodge Ram 2500 series pickup was identified by the Vehicle Identification Number (VIN): 1B7KE26C4PSxxxxxx. The Dodge was configured with a 5.9 liter, 6-cylinder diesel engine, automatic transmission, and rear wheel drive.

Vehicle Damage - 2002 Ford Focus

Exterior Damage

The Ford sustained moderate front end damage as a result of the impact with the Dodge pickup. The direct damage began at the left front bumper corner and extended 17 cm (6.7 in) laterally. The bumper fascia had been knocked off (**Figure 4**) and portions of the left side of the fascia were broken away. There was direct damage along the left side plane that extended to the driver's door (**Figure 5**). The damage included contact to the left A-pillar and possibly the windshield header (**Figure 6**). All the doors and the roof were removed by emergency personnel. Based on the extrication marks found on the left side of the vehicle, it was determined that the left side doors had been jammed shut. The left wheelbase was reduced by 41 cm (16.1 in). Six crush measurements were documented along the bumper backing bar as follows: C1 = 44 cm (17.3 in), C2 = 39 cm (15.3 in), C3 = 31 cm (12.2 in), C4 = 24 cm (9.4 in), C5 = 11 cm (4.3 in), C6 = 2 cm (0.8 in). The Collision Deformation Classification (CDC) for the impact with the Dodge pickup truck was 11FLAE6.

Interior Damage

The Ford sustained severe interior damage as a result of passenger compartment intrusion and occupant contacts. The left instrument panel, left toe pan, left A-pillar, left lower A-pillar, windshield header, center instrument panel, and right instrument panel sustained longitudinal intrusion. The left front door intruded laterally to the right. The glove compartment door was found in the open position and would not close. The brake and clutch pedals were deformed to the right. The driver's knee bolster exhibited skin transfers on the right side and was cracked on the left. The steering wheel rim sustained 3 cm (1.2 in) of longitudinal deformation and left spoke was fractured and separated from the hub. The steering column appeared to have collapsed, but the shear capsule status was unknown. The center console was fractured and deformed to the right. There were scuffs across the center console and several control knobs were missing. Scuffs were located along the right instrument panel. There was substantial damage from the extrication efforts throughout the vehicle.



Figure 4. Bumper fascia



Figure 5. Damage to driver's door



Figure 6. Windshield header/A-pillar damage

The specific passenger compartment intrusions were documented as follows:

Position	Intruded Compartment	Magnitude of Intrusion	Direction
Front row left	A-pillar	38 cm (14.9 in)	Longitudinal
Front row middle	Center Instrument panel	15 cm (5.9 in)	Longitudinal
Front row right	Glove box	15 cm (5.9 in)	Longitudinal
Front row middle	Center console	12 cm (4.7 in)	Lateral
Front row left	Windshield header	12 cm (4.7 in)	Longitudinal
Front row left	Left instrument panel	10 cm (3.9 in)	Longitudinal
Front row left	Toe pan	7 cm (2.8 in)	Longitudinal
Front row right	Right instrument panel	6 cm (2.4 in)	Longitudinal
Front row left	Left door, forward upper quadrant	Unknown	Lateral
Front row left	Side panel - forward of A-pillar	Unknown	Longitudinal

Manual Restraints

The Ford was configured with manual 3-point lap and shoulder belts for each seating position. According to the owner's manual, the front row safety belts were equipped with belt height adjustments. Their position was not known. The driver's safety belt was configured with a sliding latch plate and an Emergency Locking Retractor (ELR). Loading evidence was located on the webbing and rescue personnel had cut the webbing during extrication efforts (**Figure 7**).



Figure 7. Loading to driver's seat belt webbing.

The remaining safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractors (ALR).

The front right safety belt was being used by the front right passenger. Rescue personnel had cut the webbing and the latch plate was still inserted in the receiver.

The second row left safety belt was being used by the rear seat occupant. The belt was routed through the belt positioning guides of the booster seat. At the time of the vehicle inspection, the seat belt webbing was found in the upper positioning guide of the seat and the retractor was in the ELR mode. There were loading marks on the seat belt webbing that corresponded to the upper seat belt

guide (**Figure 8**). The loading was 33 cm (12.9 in) in length and began 93 cm (36.6 in) from the stop button.

Supplemental Restraint System

The Ford was equipped with dual-stage frontal air bags and safety belt retractor pretensioners for the driver and front right passenger positions. The system included safety belt usage sensors, a driver's seat position sensor, and a Restraints Control Module (RCM) with impact and safing sensors. The frontal air bags deployed as a result of the longitudinal deceleration of the Ford during the impact with the Dodge pickup.

The driver's air bag module had been removed from the vehicle by emergency personnel. It was located with other vehicle components that had also been removed from the vehicle. The driver's air bag deployed from the center of the steering wheel hub through asymmetrical H-configuration module cover flaps (**Figure 9**). The top flap measured 9 cm (3.5 in) in height and 18 cm (7.0 in) in width. The bottom flap measured 9.5 cm (3.7 in) in height and 18 cm (7.0 in) in width. The deployed air bag measured 40 cm (15.7 in) in diameter in its deflated state. The air bag was tethered by a single internal strap. There were four 2.5 cm (1.0 in) semi-circular vent ports located at the 12 o'clock position on the back of the air bag. The air bag was cut and torn at the 1 and 11 o'clock positions. The damage was probably due to extrication efforts. The air bag was water-stained and covered in mud, dirt, and grease. There was a possible make-up contact to the right upper quadrant and a blood deposit was located at the bottom center and bottom left of the air bag.

The front right passenger air bag deployed from a top mount module with a single rectangular cover flap that was hinged at the forward aspect (**Figure 10**). The module cover flap measured 44 cm (17.3 in) in width and 17 cm (6.7 in) in height. The deployed air bag measured 54 cm (21.2 in) in width seam to seam and 41 cm (16.1 in) in height. The air bag was tethered by a single internal strap. There was a single vent port located on the right side of the air bag in the 3 o'clock position.

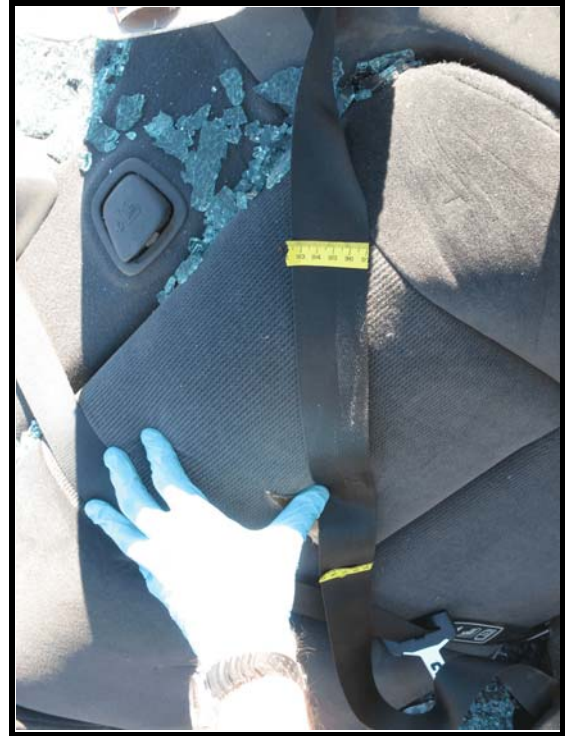


Figure 8. Loading to second row left seat belt webbing.



Figure 9. Driver's air bag.

Child Safety Seat

A Graco TurboBooster belt positioning booster seat was positioned in the second row left seat of the Ford Focus (**Figure 11**). The model number was 8E01CPK and the date of manufacture was June 13, 2007. The booster seat was designed to be used with or without the detachable seatback. The manufacturer recommends that the seatback be used for children 3-10 years old, whose height is between 96-145 cm (38-57 in), and whose weight is between 13-45 kg (30-100 lbs). When not using the seatback, the manufacturer recommends that the seat be used for children 4-10 years old, whose height is between 101-145 cm (45-57 in), and whose weight is between 18-45 kg (40-100 lbs). The seat was being used with the seatback in this crash. The child's height and weight are not known.

The seat was designed with adjustable armrests. The armrests had two available positions and were found in the upper position.

The 3-year-old child was seated in the booster seat and was restrained by the vehicle's lap and shoulder belt.

There were loading marks located at the left shoulder belt guide (**Figure 12**) and along the right lap guide (**Figure 13**). There were corresponding marks located on the vehicle seat belt webbing. There was some shifting of the plastic along the base on the right side from seat belt loading.



Figure 10. Front right passenger's air bag.



Figure 11. Graco TurboBooster belt positioning booster seat.



Figure 12. Loading marks to upper belt guide.



Figure 13. Loading marks to lower belt guide.

OCCUPANT DEMOGRAPHICS - 2002 Ford Focus

	Driver	Front Row Right Occupant
Age/Sex:	38/Female	39/Male
Seated Position:	Front left	Front right
Seat Type:	Bucket	Bucket
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Alcohol/Drug Involvement:	None	N/A
Body Posture:	Unknown	Unknown
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt used	Lap and shoulder belt used
Air bag:	Driver's air bag deployed	Front right passenger's air bag deployed

Second Row Left Occupant

Age/Sex:	3/Female
Seated Position:	Second row left
Seat Type:	Bench
Height:	Unknown
Weight:	Unknown
Alcohol/Drug Involvement:	N/A
Body Posture:	Seated in booster seat
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt used with belt positioning booster seat

OCCUPANT KINEMATICS

Driver Kinematics

The 38-year-old female driver was seated in an unknown posture in the bucket seat and was restrained by her lap and shoulder belt (**Figure 14**). The seat was adjusted to the mid-track position. It was not known if the driver was able to execute any evasive maneuvers. At impact with the Dodge, the driver's frontal air bag deployed as the driver was displaced forward and to the left in response to the 11 o'clock direction of force. The driver's face loaded the air bag and both knees loaded the lower instrument panel/knee bolster, causing the left femur fracture and the right knee fracture. Skin transfers were located on the knee bolster. The driver's right foot and ankle contacted the toe pan area and sustained open fractures. The driver's torso loaded and fractured the steering wheel. The driver was displaced to the right and engaged the center console with her right hip. She sustained C1 or C2 neck fractures as a result of the impact force and lacerations/abrasions to both arms from an unknown source. The driver was found in her vehicle without a pulse and was pronounced dead at the scene.



Figure 14. Driver's seated position.

Front Right Seat Passenger Kinematics

The 39-year-old male front right occupant was seated in the bucket seat in an unknown posture and was restrained by the manual lap and shoulder belt (**Figure 15**). The seat was adjusted to the mid-track position. At impact with the Dodge, the front right passenger's frontal air bag deployed as he was displaced forward and to the left in response to the 11 o'clock direction of force. He likely loaded the passenger air bag. He loaded the lap and shoulder belt, causing the flail chest, chest abrasions, and the abdominal abrasion. There were knee contacts to the center and right instrument panel. His left knee engaged the instrument panel causing an indirect left hip fracture. His right foot was on the floorboard and probably engaged the toe pan, causing the fracture. This passenger survived the crash for a short period of time. Volunteer first-responders were performing cardiopulmonary resuscitation (CPR) on this passenger when the police arrived. This effort was discontinued shortly after the arrival of the police and the front right passenger was pronounced dead at the scene.



Figure 15. Front right passenger's seated position.

Second Row Left Passenger Kinematics

The 3-year-old female child was seated in a belt positioning booster seat that had been placed in the second row left seat position (**Figure 17**). The child was restrained by the vehicle's lap and shoulder belt. The belt had been routed through the upper left belt guide and across the lower seat guides and the retractor was in the ELR mode. At impact with the Dodge, the second row left passenger was displaced forward and to the left in response to the 11 o'clock direction of force. There was evidence of loading to the seat belt webbing and the belt guides. This passenger sustained abrasions to her upper left shoulder, chest, and abdomen. She was transported from the scene by ambulance to a local hospital.



Figure 16. Second row left passenger's seat position.

OCCUPANT INJURIES

Driver: Injuries obtained from coroner's report.

<u>Injury</u>	<u>AIS Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Fracture C1 or C2	650216.2,6	Impact forces	Possible
Fracture, left femur, mid shaft	851814.3,2	Knee bolster	Certain
Right foot fracture, open	852000.2,1	Toe pan	Probable
Right ankle fracture, open	852002.2,1	Toe pan	Probable
Right knee fracture, open	852400.2,1	Knee bolster	Certain
Lacerations/abrasions, both arms	790600.1,3 790202.1,3	Unknown	Unknown

Front right occupant: Injuries obtained from coroner's report.

<u>Injury</u>	<u>AIS Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Left hip fracture, closed	852600.2,2	Knee bolster	Probable
Right ankle fracture, open	852002.2,1	Toe pan	Probable
Lacerations, abrasions to head	190600.1,9 190202.1,9	Unknown	Unknown
Flail chest, left	450260.4,2	Seat belt webbing	Probable
Seat belt marks across chest	490202.1,0	Seat belt webbing	Certain
Seat belt marks across waist	590202.1,4	Seat belt webbing	Certain

Second row left occupant: Injuries obtained from Medical Records (EMS, ER, Radiology).

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Abrasions, upper left shoulder, chest, abdomen	790202.1,2 490202.1,2 590202.1,0	Seat belt webbing	Certain

Attachment 1. Scene Diagram

