CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE CHILD SAFETY SEAT INVESTIGATION

SCI CASE NO. – CA05-047

SUBJECT VEHICLE – 2003 FORD F-150 PICK-UP TRUCK

LOCATION – FLORIDA

CRASH DATE – JUNE 2005

Contract No. DTNH22-01-C-17002

Prepared for:

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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.

TECHNICAL REPORT STANDARD TITLE PAGE

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TABLE OF CONTENTS

CALSPAN ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION
SCI CASE NO: CA05-047
VEHICLE: 2003 FORD F-150 SUPERCREW PICK-UP TRUCK
LOCATION: FLORIDA
CRASH DATE: JUNE 2005

BACKGROUND

This on-site investigative effort focused on the performance of a Cosco Alpha Omega Convertible Child Safety Seat (CSS) and the resulting injury sources for its 2 year old female occupant. The CSS was installed in a forward facing mode in the center rear position of a 2003 Ford F150 Supercrew pick-up **(Figure 1)** that was involved in a run-off road/fixed object crash. The Ford was operated by a 28 year old restrained male driver and was occupied by a six-months-pregnant unrestrained 30 year old female front right passenger and the 2 year old child restrained by the 5-point harness of the CSS. The Ford was traveling southbound on a divided interstate roadway and departed the right side of the road for unknown reasons. During the vehicle's off-road travel, it impacted a delineator post and then struck a 30 degree embankment. The Ford then climbed the slope causing the vehicle to become airborne. The front header and roof area of the Ford then struck the sidewall of an overpass, located 2.4 m (8 ft) above the ground, arresting the southbound momentum of the vehicle. The Ford subsequently rolled onto its left side and came to rest against the overpass bridge pillar. The driver was pronounced deceased at the scene of the crash as a result of severe head injuries. The front right passenger was ejected from the vehicle and sustained multiple blunt force injuries. She was air lifted to a regional trauma center and expired approximately four hours post-crash. The 2 year old female remained restrained within the CSS and sustained minor severity injuries. She was transported by ground ambulance to a trauma center where she was treated and released.

Figure 1: Left front oblique view of the 2003 Ford F-150.

This crash was identified by the Crash Investigation Division (CID) of the National Highway Traffic Safety Administration (NHTSA) through an Internet news article. Due to the agency's interest in child passenger safety, the CID forwarded the article to the Calspan Special Crash Investigations (SCI) team for follow-up investigation. The Ford and the CSS were located at a local tow yard and were available for inspection. Cooperation was established with the attorney representing the family and permission was granted to inspect the Ford and CSS. The case was assigned to the Calspan SCI team on June 28, 2005. The on-site inspection of the vehicle, CSS, and the crash site took place during the week of August 8, 2005.

VEHICLE DATA

2003 Ford F-150 Supercrew

The 2003 Ford F-150 Supercrew pick-up truck, **Figure 2**, was identified by the Vehicle Identification Number (VIN): 1FTRW07673 (production sequence omitted). The rear-wheel drive, four-door pickup truck was equipped with the XLT trim package. The power train consisted of a 4.6 liter, V8 engine linked to a four-speed automatic transmission. The service brakes consisted of four-wheel disc brakes with anti-lock. The vehicle was manufactured in February 2003. The odometer reading was unknown at the time of the inspection due to lack of electrical power. The cloth-upholstered interior was configured with three-passenger bench seats in the front and second row. The manual restraint system consisted of three-point lap and shoulder belts in the four outboard positions. The front outboard restraints utilized retractor pretensioners. The center front and center rear positions were lap belt equipped. The rear seat was equipped with Lower Anchors and Tethers for CHildren (LATCH). The Ford was also equipped with redesigned air bags for the driver and front right passenger. The front tires on the vehicle were General Ameritrac P255/70R16. The rear tires were Goodyear Wrangler P255/70R16. All the tires were mounted on OEM alloy wheels. The specific tire data at the time of the SCI inspection was as follows:

Figure 2: Right front oblique view.

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	0 kPa	6 mm (8/32 in)	No	Rim fractured; tire debeaded
LR	83 kPa (12 PSI)	10 mm (13/32 in)	No	Axle fractured at wheel; outboard rim surface fractured; grass in bead
RF	262 kPa (38 PSI)	3 mm (4/32 in)	No	Tire cut – steel ply exposed; grass in bead
RR	214 kPa (31 PSI)	10 mm (12/32 in)	No	None

SUMMARY

Crash Site

This single-vehicle crash occurred during the daylight hours of June 2005. At the time of the crash, the weather was cloudy and the roadway was dry. The crash occurred on the southbound lanes of a north/south interstate highway. **Figure 3** is a southbound trajectory view at the crash site. The interstate was configured with two travel lanes in each direction, which were delineated by a broken white center line. The travel lanes were bordered by solid fog lines and asphalt shoulders. A W-beam guardrail and a depressed grass median separated the north/southbound lanes. The roadside in the area of the road departure consisted of grass, shrubbery, and an open drainage ditch. The open ditch was oriented perpendicular to the interstate and transitioned to a culvert pipe that passed under the roadway. The open ditch terminated at a concrete headwall located 9.1 m (30 ft) west of the road edge. Approximately

13.7 m (45 ft) south of the drainage ditch, the level roadside terrain transitioned to a 30 degree embankment that ascended 2.1 m (7 ft) along the Ford's trajectory. A 35 m (116 ft) wide concrete overpass was located 15 m (50 ft) south of the embankment. The east/west overpass crossed the interstate roadway at a 60 degree angle in relation to the roadway. The exposed sidewall of the overpass along the Ford's path of travel exhibited evidence of an impact. The overpass was supported by four 1 m (3 ft) diameter pillars spaced 9.1 m (30 ft) apart. The Ford came to rest on its left side against the north-most pillar. The posted speed limit for the interstate highway was 113 km/h (70 mph).

Figure 3: Southbound trajectory view at the crash site.

CRASH SEQUENCE

Pre-Crash

A schematic of the crash sequence is included at the end of this report, **Figure 13.** The restrained 28 year old male driver was operating the 2003 Ford F-150 southbound on the outboard (right) lane of the interstate at an estimated speed of 113 km/h (70 mph). For unknown reasons, the driver of the Ford relinquished directional control and allowed the vehicle to depart the right roadside. The police report indicated that the vehicle experienced an air out of the front left tire which caused the driver to lose control of the vehicle. However, a pre-crash left front tire failure was not supported by the physical evidence observed during the vehicle inspection. The damage to the left front wheel occurred as the Ford came to final rest and is discussed in further detail in the *Exterior Damage* section of this report.

The Ford departed the road at a shallow angle estimated at 10 degrees. The vehicle traveled 24.4 m (80 ft) along the roadside on a southwest trajectory and drove over the concrete head wall located at the end of the adjacent ditch.

Figure 4: Concrete headwall, delineator post and gouge.

Crash

The center right aspect of the Ford's front plane struck and overrode a delineator post located at the end of headwall. The Ford's front right tire drove off the concrete wall and dropped approximately 46 cm (18 in) due to the change in elevation for the ditch. The front right undercarriage contacted the ground evidenced by a 1.2 m x 1 m (3.8 ft x 3 ft) gouge that was located adjacent to the post. Refer to **Figure 4**.

The Ford then traveled approximately 7 meters (23 feet) and encountered the 30 degree embankment. **Figure 5** is a trajectory view of the embankment impact. The front undercarriage

impacted the embankment evidenced by a gouged area that measured 1.9 m x 4.7 m (6.2 ft x 15.3 ft). The force of this impact was sufficient to cause the driver's front seat belt pretensioner to fire and the vehicle's frontal air bags to deploy. Due to its speed, the Ford vaulted and became airborne as it ascended and crested the top of the embankment.

The Ford continued airborne approximately 9 meters (30 feet) and impacted the concrete sidewall of the overpass with the windshield header. **Figure 6** is a view of the overpass impact. Multiple abrasions, black transfer and dirt/debris displaced from the embankment evidenced the impact area. At impact, the Ford had rolled an estimated 20 to 30 degrees left about its longitudinal axis exposing the right aspect of the header. The impact separated the windshield and the front right header section deformed rearward to the B-pillar area. The roof was crushed down. The impact arrested the forward momentum of the vehicle and the unrestrained front right passenger was ejected through the windshield opening. The front right passenger came to rest under the overpass near the vehicle. The Ford continued to roll to the left and landed onto its left side coming to final rest against an overpass support pillar. The restrained driver and the restrained 2 year old female remained in the vehicle.

Figure 5: Southbound trajectory view at the embankment

Figure 6: Overpass impact and final rest.

Post-Crash

Police and EMS responded to the crash site. The 28 year old male driver sustained severe head injuries and was pronounced deceased at the crash site. The ejected front right passenger sustained multiple blunt traumatic injuries and was airlifted to a regional trauma center for treatment. However, she expired approximately four hours post admission. The 2-year old female was transported by ambulance to a local trauma center where she was treated for minor injuries. The 2 year old female was retained at the trauma center for observation and was released to her grandparent's one day post-crash.

2003 Ford F-150 SUPERCREW
Exterior Damage

Figure 7 is a front view of the Ford. The vehicle sustained minor frontal damage as a result of the impact with the delineator post. The damage from this impact consisted of a dent to the face of the hood which measured 1 cm (0.5”) in depth and was located 33 cm (13.0”) right of the centerline. Additionally, the center grille was fractured 25 cm (10.0”) right of the centerline. The Collision Deformation Classification (CDC) for this impact was 12-FREN-1.

Figure 7: Front view of the Ford.

The front bumper was displaced upward and the lower fascia was fractured due to the contact with the ground. Examination of the forward undercarriage revealed evidence of a widely distributed ground contact pattern. Grass, dirt and debris was adhered to multiple undercarriage components. The right front fender was displaced rearward and bowed out. This damage resulted from the embankment impact as well. The CDC of the embankment impact was 00-UFDW-1.

The Ford F-150 sustained severe damage to the front header and roof as a result of the impact with the overpass, **Figures 8 and 9**. The right and center aspects of the roof were crushed down to the level of the beltline. The direct contact damage to the windshield header began 8 cm (3 in) inboard of the left A-pillar and extended 122 cm (48 in) to the right A-pillar. The direct contact along the roof extended rearward to the right C-pillar and wrapped onto the right side doors due to the left roll attitude of the Ford during its engagement with the overpass. The direct contact on the right side doors extended 33 cm (13 in) below the beltline. Both right side doors were deformed rearward and were jammed shut. The CDC for the overpass impact was 12-FDGW8.

Figure 8: Right side view of the occupant compartment.

Figure 9: Front view of the header area.

The damage to the vehicle's left side consisted of longitudinal abrasions resultant to ground contact at final rest. The abrasions began 66 cm (26 in) forward of the left front axle and extended 513 cm (202 in) rearward. The front left door was jammed shut. The left rear door was operational. The CDC for this impact was 00-LDAO-2.

There was no change in either wheelbase dimension. Both left side tires were damaged as the vehicle fell and landed on left tires as it neared final rest. The left rear axle fractured at the wheel hub and the left rear wheel/tire separated. A 22 cm (8.7 in) section of the alloy rim fractured and was missing. The outboard surface of the rim was abraded by contact with the concrete slope at final rest. The left front tire had been removed from the vehicle prior to SCI involvement in this investigation. Examination revealed an impact related fracture of the left front wheel rim, **Figure 10**. The fracture occurred as the vehicle fell to final rest and was not a cause of the loss of control. The rim fracture measured 37 cm (14.7 in) and included one of the wheel spokes. Three additional spokes fractured at the outer circumference; however, they did not separate. There was no damage to the left front suspension components. The steering components, linkages, and pitman arm were intact as well.

Figure 10: Left front wheel/tire.

Interior Damage

The interior damage of the Ford consisted primarily of severe roof intrusion and the deployment of the frontal air bag system. The intruded roof and jammed doors prohibited access to the occupant compartment and hampered identification of potential occupant contact points. The occupant compartment intrusion is listed in the table below:

Position	Intruded Component	Magnitude	Direction
Row1 Left	A-pillar	10 cm (4 in)	Vertical
Row1 Left	A-pillar	13 cm (5 in)	Lateral
Row1 Left	Roof side rail	8 cm (3 in)	Vertical
Row 1 Left	Header at driver seat	25 cm (10 in)	Vertical
Row1 Left	B-pillar	8 cm (3 in)	Vertical
Row1 Left	B-pillar	10 cm (4 in)	Lateral
Row 2 Left	C-pillar	10 cm (4 in)	Vertical
Row 2 Left	Roof side rail	8 cm (3 in)	Vertical
Row 2 Left	Backlight header	13 cm (5 in)	Vertical
Row 1 Center	Header	34 cm (13.5)	Vertical

Position	Intruded Component	Magnitude	Direction
Row 2 Center	Backlight header	30 cm (12 in)	Vertical
Row 1 Right	A-pillar	43 cm (17 in)	Vertical
Row 1 Right	A-pillar	47 cm (18.7 in)	Longitudinal
Row 1 Right	Header	60 cm (23.5 in)	Vertical
Row 1 Right	Roof side rail	62 cm (24.5 in)	Vertical
Row 1 Right	B-pillar	51 cm (20 in)	Vertical
Row 1 Right	B-pillar	5 cm (2 in)	Lateral
Row 1 Right	B-pillar	38 cm (15 in)	Longitudinal
Row 2 Right	C-pillar	10 cm (4 in)	Vertical
Row 2 Right	Roof side rail	37 cm (14.5 in)	Vertical
Row 2 Right	Backlight header	18 cm (7 in)	Vertical

The right A- and B-pillars deformed rearward and were crushed down by the impact with the overpass. **Figure 11** is a front view of the roof deformation. The front right aspect of the roof impacted and compressed the front right seat back. The seat back was compressed an estimated 15 cm (6 in). The front right seat was in an estimated mid-track position. There were no identified contacts to the glove box door.

Figure 11: View of the deformed roof.

The driver seat was in a mid-to-rear track position. There was no steering wheel rim deformation or shear capsule displacement. There was no identified contact to the driver knee bolster. Trace blood evidence was identified on the driver seat and left B-pillar. Pooled blood evidence was located on the left front window glazing in the area of the driver's final rest.

Manual Restraint Systems

The driver's manual restraint consisted of a 3-point lap and shoulder belt with continuous loop webbing, a sliding latch plate adjustable D-ring and an Emergency Locking Retractor (ELR). The retractor was equipped with a pretensioner. Upon initial examination, the webbing was extended in the used position and the retractor was locked (presumably by the fired pretensioner). Blood evidence was present on shoulder portion of the webbing. The evidence observed at the time of the SCI inspection indicated the driver was restrained at the time of the crash.

The front right passenger restraint consisted of a 3-point lap and shoulder belt with continuous loop webbing, sliding latch plate, and an Automatic Locking/Emergency Locking Retractor. Inspection of the restraint revealed that the webbing was stowed in the retractor and restricted in that position by the deformation of the right B-pillar. The evidence observed at the time of the SCI inspection indicated the front right passenger was unrestrained at the time of the crash.

The manual restraint in the center rear position of the Ford consisted of a lap belt that spooled from an Automatic Locking Retractor (ALR). The latch plate was sewn on. The lap belt was used at the time of the crash to restrain the child safety seat. The webbing passed through the forward facing belt path and was latched in the buckle. The ALR was locked and the webbing was taut. Refer to the Child Safety Seat Data section of the report for further detail regarding the restraint of the child seat.

Frontal Air Bag System

The Ford was equipped with redesigned frontal air bags for the driver and front right passenger that deployed as a result of the impact to the embankment. The driver air bag deployed from an H-configuration module located within the center hub of the steering wheel. The width of the flaps measured 20 cm (7.8 in). The height of the upper and lower flaps measured 15 cm (6 in) and 7 cm (2.8 in), respectively. There was no occupant contact evidence to the cover flaps. The deployed driver air bag measured 61 cm (24 in) in diameter. It was tethered by two 13 cm (5 in) wide tethers and vented by two ports located in the 11 and 1 o'clock sectors on the back side of the bag. The face of the air bag was soiled from exposure to the elements. No evidence of occupant contact was identified.

The front right passenger air bag deployed from a mid-mount module located in the right aspect of the instrument panel. The rectangular cover flap was hinged on its top surface and measured 46 cm x 20 cm (18in x 8 in), width by height. The face of the air bag measured 56 cm x 61 cm (22 in x 24 in), width by height, in its deflated state. The rearward excursion of the bag measured 51 cm (20 in) from the vertical face of the instrument panel. The air bag was not vented or tethered. The face of the air bag was soiled from exposure and exhibited several small black transfer marks related to its deployment. There was no discernable contact evidence found on the air bag membrane during the SCI inspection.

Child Safety Seat

The Cosco Alpha Omega Convertible Child Safety Seat (CSS), **Figure 12**, was manufactured on June 3, 2004 and was identified by the Model and Serial Numbers: 22-155-HMR; AE2B022835. The CSS was to be used in either a rear-facing or forward facing mode dependant on the age and demographics of the child occupant. The seat was labeled for forward facing use by children over 1 year in age who weigh 9 kg to 18 kg (20 lb to 40 lb) with a height of 74 cm to 102 cm (29 in to 40 in). The seat was configured with an adjustable base and a 5-point harness. The CSS was designed for

Figure 12: Left interior view of the CSS.

use with Lower Anchors and Tethers for CHildren (LATCH) system.

At the time of the inspection, the CSS was restrained by both the vehicle's center rear lap belt and the LATCH belt. The rear seat cushion was compressed by the CSS and the lap belt and LATCH belt were tight. The side to side movement of the CSS was less than 3 cm (1 in). The top tether was not used. Due to pending civil litigation regarding this crash, the CSS was not removed from the vehicle for inspection. There was no apparent damage to the CSS shell or its components. The harness straps were adjusted to the top slots. The right strap was cut by the rescue personnel. The chest clip was in place and the buckle was operational.

Referring to Figure 12 above, the vertical distances depicted are measured to the deformed headliner. The deformed headliner was not backed up by the metal roof in this area. There was an air gap of approximately 23 cm (9 in) between the headliner and the deformed roof along the centerline of the vehicle (above the CSS).

OCCUPANT DEMOGRAPHICS

Driver

Age/Sex:	28-year-old/Male
Height:	170 cm (67")
Weight:	74 kgs (163 lbs)
Seat Track Position:	Mid-rear track estimated
Manual Restraint Use:	3-point manual lap and shoulder safety belt
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	No treatment, expired at crash site

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Large lacerations to the right front lobe and left parietal occipital lobe	Severe (140688.4,1 140688.4,2)	Windshield header/roof
Large contusions to the temporal lobes	Severe (140624.4,3)	Windshield header/roof
Moderate diffuse 75ml subdural hemorrhage	Severe (140650.4,9)	Windshield header/roof
Large diffuse subarachnoid hemorrhage	Serious (140684.3,9)	Windshield header/roof
Multiple skull fractures at the base anterior and middle cranial fossae	Serious (150200.3,8)	Windshield header/roof
Fracture of the right calvarium	Moderate (150400.2,1)	Windshield header/roof
Large forehead laceration exposing the underlying bones	Minor (290600.1,7)	Windshield header/roof

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Periorbital ecchymoses left and right eye	Minor (297402.1,1 297402.1,2)	Windshield header/roof
Multiple small 1 cm (0.3") facial abrasions	Minor (290202.1,0)	Windshield header/roof
Large subgaleal hemorrhage	Minor (190402.1,9)	Windshield header/roof
Small approximately 1 cm (0.3") contusions on left upper arm	Minor (790402.1,2)	Left door panel
Small contusions 1 cm (0.3") on both legs	Minor (890402.1,3)	Knee bolster
Right thigh contusion	Minor (890402.1,1)	Knee bolster

Injury Data Source = Medical examiner's report

Driver Kinematics

The 28 year old male driver was seated in a presumed upright driving posture and was restrained by the manual safety belt system. The initial impacts to the front plane and front right undercarriage from the delineator post and headwall drop-off were minor and probably did not displace the driver. The Ford then impacted the 30 degree embankment with the forward undercarriage. The force of this impact fired the driver's safety belt pretensioners and deployed the frontal air bag system. The driver responded to this non-horizontal force by initiating a forward and downward trajectory. The driver contacted and loaded the safety belt and deployed air bag with his torso and was displaced downward resulting in a loading of the seat cushion.

The Ford climbed the embankment, vaulted and became airborne upon reaching the top. During this interval, the seat cushion began to unload and the driver continued to ride down the embankment impact. The driver air bag had begun to deflate. The Ford then impacted the overpass with the windshield header.

The driver responded to the 12 o'clock direction of the impact force by a continued loading of the safety belt system and deflating air bag. The impact resulted in severe longitudinal intrusion of the windshield header and roof areas. The driver's head was impacted by the intruding windshield header and roof resulting in the large lacerations to the right front lobe and left parietal occipital lobe, large contusions to the temporal lobes, subdural hemorrhage, subarachnoid hemorrhage, multiple skull fractures at the base anterior and middle cranial fossae, fracture of the right calvarium, large forehead laceration exposing the underlying bones, periorbital ecchymoses left and right eye, multiple small approximately (1 cm (0.3") facial abrasions, and the large subgaleal hemorrhage. The driver's legs contacted the knee bolster which resulted in the small contusions to his lower extremities.

The Ford dropped onto the ground landing on its left side and came to rest near a support pillar for the overpass. During the travel to final rest the driver's left arm contacted the left door panel

which resulted in the small contusions to the left upper arm. The driver's head came to rest against the front left window evidenced by the pooled blood in the area of the left B-pillar. Due to his injuries the driver expired at the crash site.

Right Front Passenger

Age/Sex:	30-year-old/Female
Height:	160 cm (63")
Weight:	81 kg (179 lbs)
Seat Track Position:	Mid track estimated
Manual Restraint Use:	None Used
Usage Source:	Vehicle inspection
Eyewear:	Not currently available
Type of Medical Treatment:	Transported by helicopter to local trauma center where she expired approximately four hours post-crash

Right Front Passengers Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Fractured right side ribs 1-7 non-displaced and 8-11 displaced with right side hemothorax	Severe (450232.4,1)	Ground
Open book fracture of the symphysis pubis completely split with a comminuted fracture of the right cetabriliem, right side superior and inferior comminuted fractures of the right pubic rami, left inferior pubic ramus fracture, and a comminuted right sacral fracture	Severe (852606.4,0)	Ground
Abdominal aortic transection	Severe (520204.4,4)	Ground
Bilateral diffuse subarachnoid hemorrhage of the posterior half of the cerebrum	Serious (140684.3,1 140684.3,2)	Ground
Diffuse subarachnoid hemorrhage of the entire cerebellum	Serious (140466.3,6)	Ground
Large posterolateral right lung contusion	Serious (441406.3,1)	Ground
Comminuted fracture of the right humerus near the shoulder	Serious (752604.3,1)	Ground
Left distal humerus, oblique fractures with the second fracture through greater tuberosity	Serious (752604.3,2 752604.3,2)	Ground
Placenta abruption	Serious (543400.3,8)	Ground

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Traverse process fracture to the right side of T1	Moderate (650420.2,7)	Ground
Dislocation of the right shoulder	Moderate (751030.2,1)	Ground
Laceration of the urinary bladder	Moderate (540620.2,8)	Ground
Right kidney laceration at the hilum	Moderate (541620.2,1)	Ground
10 cm (4") abraded contusion of right liver lobe	Moderate (541810.2,1)	Ground
Large forehead hematoma and a large central forehead abrasion 5x5 cm (2x2")	Minor (290402.1,7 290202.2,7)	Front right air bag
Abrasions to the lips and chin	(290202.1,8)	Front right air bag
Large diffuse subgaleal hemorrhage of the right temporal area	Minor (190402.1,1)	Ground
Large area of punctate and small linear hemorrhages on entire abdomen	Minor (590402.1,0)	Ground
Laceration on the right flank	Minor (590600.1,1)	Ground
Upper left chest contusion 5x5 cm (2x2")	Minor (490402.1,2)	Ground
Large contusion to the right hip and thigh 36x18cm (14x7") and a large contusion on the lower lateral thigh and knee 13x13 cm (5x5")	Minor (890402.1,1)	Ground
Multiple punctate abrasions on the right foot and lower leg	Minor (890202.1,1)	Ground

Injury Data Source = Emergency room records and medical examiner's records

Right Front Passenger Kinematics

The 30 year old female front right passenger was seated in a presumed upright posture and was not restrained by the manual safety belt system. The initial impacts to the front plane and front right undercarriage from the delineator post and headwall drop-off were minor and probably did not displace the passenger to a large degree. The Ford then impacted the 30 degree embankment with the forward undercarriage. The embankment impact resulted in the deployment of the frontal air bag system. The passenger responded to this non-horizontal force by initiating a forward and downward trajectory loading the seat cushion. The passenger contacted the inflating front right passenger air bag with her face resulting in the abrasions to the lips and chin and the large forehead hematoma and a large central forehead abrasion.

The Ford climbed the embankment, vaulted and became airborne. During this interval, the seat cushion began to unload and the passenger continued to ride down the embankment impact by

loading the front right air bag. As a result of her loading, the front right air bag had begun to deflate. The Ford then impacted the overpass with the windshield header.

The impact deformed the header and the roof rearward and downward. Due to the crushing of the header and roof, the windshield separated and created an ejection portal. The front right passenger responded to the 12 o'clock direction of the crash forces by initiating a forward trajectory. The passenger loaded through the deflating air bag and separated windshield and was ejected through this medium. The front right passenger contacted the ground at an undocumented location near the vehicle.

The passenger sustained multiple blunt traumatic injuries as a result of this crash. The source of those injures was attributed to ground impact (as identified in the table above). The nature and severity of the injuries coupled with the lack of contact evidence to the center and right aspects of the instrument panel or to the front right passenger air bag ruled out interior components as a possible injury source.

The 30 year old female front right passenger was transported to a local trauma center where she underwent treatment of her injuries; however, she expired approximately four hours post-crash.

Rear Center Passenger

Age/Sex:	2-year-old/Female
Height:	Unknown
Weight:	Unknown
Seat Position:	Center position Row 2
Manual Restraint Use:	5-point harness system in a forward facing CSS
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Transported to a trauma center, hospitalized one day

Rear Center Passenger

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Abrasion to the left temple	Minor (190202.1,2)	Roof
Contusion of the left periorbital area	Minor (297402.1,2)	Roof
Abrasion to the left periorbital area	Minor (297202.1,2)	Roof
Small laceration to the distal tongue	Minor (243402.1,8)	Self-inflicted
Contusion to the left side of the face	Minor (290402.1,2)	Roof
Abrasion to the left side of the face	Minor (290202.1,2)	Roof
Abrasion to the left clavicle area	Minor (790202.1,2)	Left harness strap

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Abrasion to the right foot area	Minor (890202.1,1)	Front right seat back
Concussion	Minor (160402.1,0)	Roof

Injury data source = Emergency room records

Rear Center Passenger Kinematics

The 2 year old female rear center passenger was seated in the forward facing CSS and was restrained by the integrated harness system. The initial impacts to the front plane and front right undercarriage from the delineator post and headwall drop-off were minor and probably did not displace the passenger to a large degree. The Ford then impacted the 30 degree embankment with the forward undercarriage. The child responded to this non-horizontal force by initiating a forward and downward trajectory. The child contacted the harness straps of the CSS and loaded the shell of the seat.

The Ford climbed the embankment, vaulted and became airborne. The vehicle then impacted the overpass with the windshield header. The header and roof deformed rearward and downward. The 2 year old female initiated a forward trajectory in response to the 12 o'clock direction of the impact force and loaded the harness system causing the abrasion to the left clavicle area. Her right foot contacted the front right seatback which resulted in the abrasion to the right foot. The 2 year old passenger's head contacted the deformed headliner and roof resulting in the concussion, contusions and abrasions to the left temple, left periorbital area, and the left side of her face. The child came to rest within the confines of the CSS shell and was still restrained.

The 2 year old female was transported to a local trauma center where she was treated for her injuries. She remained at the trauma center for approximately 24 hours for observation and was then released.

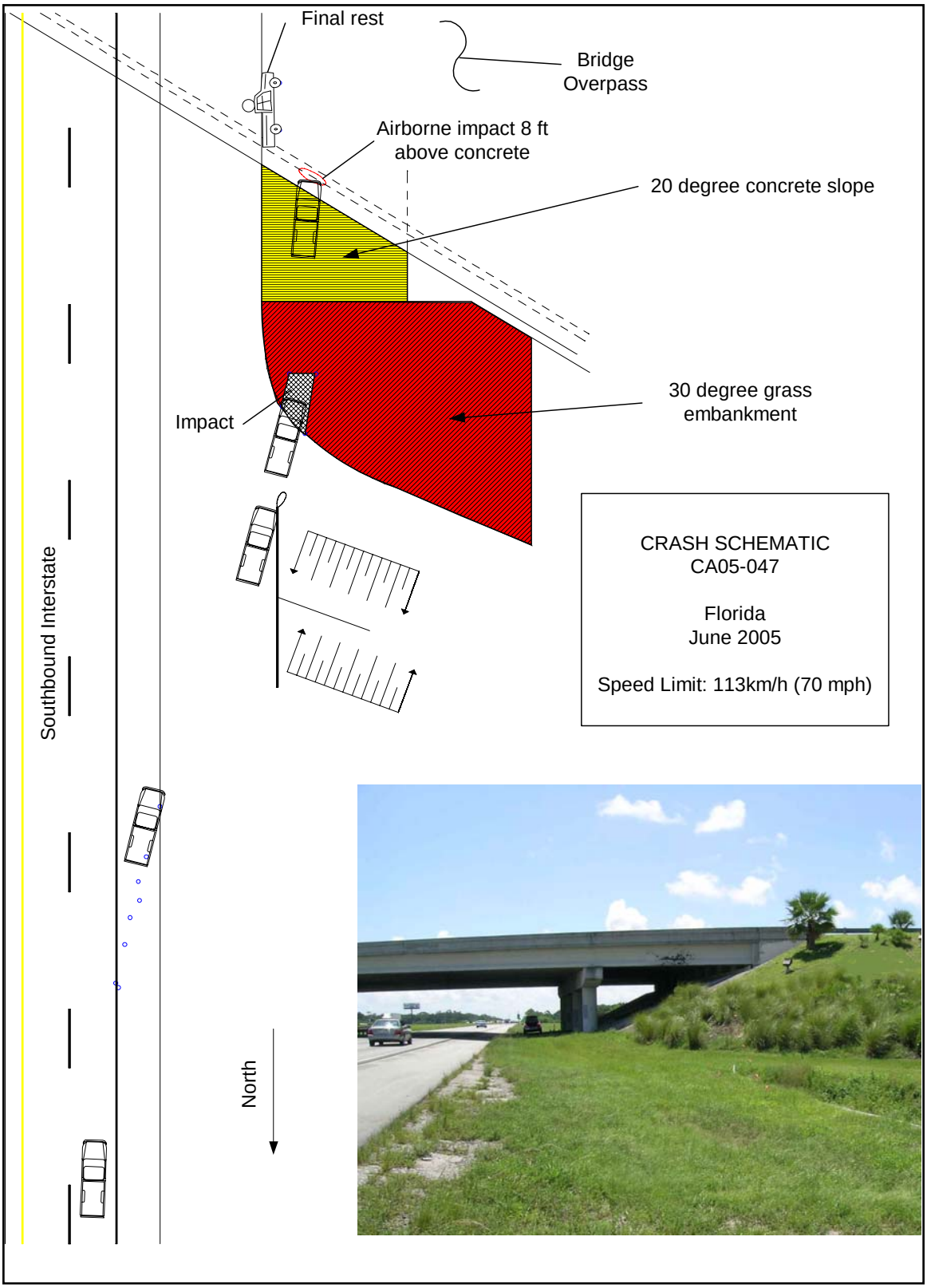

Figure 13: Crash Schematic