

On-Site Child Restraint System Investigation  
Dynamic Science, Inc. (DSI), Case Number DS09027  
1998 Ford F-150  
California  
July 2009

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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16. Abstract <p>This child restraint system (CRS) investigation focused on the occupants and child restraints in a vehicle that was involved in a multiple-impact crash. The subject vehicle was a 1998 Ford F-150 extended cab pickup that was being driven by a 50-year-old female. The front row right seat was occupied by a 43-year-old male and the second row center seat was occupied by a 3-year-old female who was seated in a forward-facing CRS. The other vehicle was a 2005 Freightliner Columbia truck towing a covered trailer that was being driven by a 56-year-old male. The Ford entered a divided north/south interstate highway from an on-ramp and the Freightliner was traveling southbound in the second lane from the right. As the Ford entered the highway the driver lost control of the vehicle. The Ford departed the roadway on the right side, impacting a row of shrubbery and a metal utility pole. The vehicle then returned to the roadway and its left side impacted the right side of the Freightliner. The Ford continued traveling southbound, again departed the roadway on the right side, and then came to rest facing southwest at the gore point of an on-ramp. The Freightliner continued traveling southbound and was then brought to a controlled stop by the driver. During the crash the 3-year-old female seated in the CRS sustained serious injuries, was transported to a local hospital, and was pronounced deceased at 1012 hours. The cause of death was a basilar skull fracture due to multiple traumatic injuries. The police report indicated the CRS was used improperly. The driver of the Ford sustained minor injuries, the front row right occupant sustained serious injuries, and they were both transported. The subject vehicle was towed due to damage and was later declared a total loss by the insurance company. The driver of the Freightliner was not injured. The Freightliner sustained minor damage and was driven from the scene.</p>			
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## Background

This on-site child restraint system (CRS) investigation focused on the occupants and child restraints in a vehicle that was involved in a multiple-impact crash. The crash occurred in July 2009 in the state of California. The subject vehicle was a 1998 Ford F-150 extended cab pickup (**Figure 1**) that was being driven by a 50-year-old female. The front row right seat was occupied by a 43-year-old male. The second row center seat was occupied by a 3-year-old female who was seated in a forward-facing CRS.



**Figure 1.** Subject vehicle, 1998 Ford F-150

The other vehicle was a 2005 Freightliner Columbia truck towing a covered trailer that was being driven by a 56-year-old male. The crash site was the southbound lanes and adjacent west shoulder of a north/south interstate highway. The Ford entered the highway from an on-ramp and the Freightliner was traveling southbound in the second lane from the right. At the time of the incident the roadway was wet and conditions were daylight and cloudy.

As the Ford entered the highway from the on-ramp the driver lost control of the vehicle. The Ford initiated a counterclockwise rotation, departed the roadway on the right side, impacting a row of shrubbery and a metal utility pole. The vehicle then traveled back onto the roadway and its left side impacted the right side of the Freightliner. The Ford continued traveling southbound, again departed the roadway on the right side, and then came to rest facing southwest at the gore point of an on-ramp. The Freightliner continued traveling southbound and was then brought to a controlled stop by the driver.

During the crash, the 3-year-old female seated in the CRS sustained serious injuries, was transported to a local hospital, and then was pronounced deceased at 1012 hours. The cause of death was a basilar skull fracture due to multiple traumatic injuries. The police report indicated the CRS was used improperly. The Ford's frontal air bags deployed during the crash; the police removed the air bags and placed them into evidence.

The driver of the Ford sustained minor injuries, the front row right occupant sustained serious injuries, and both were transported. The subject vehicle was towed due to damage and was later declared a total loss by the insurance company. The driver of the Freightliner was not injured. The Freightliner sustained minor damage and was driven from the scene.

This investigation was initiated by the National Highway Traffic Safety Administration (NHTSA). On July 28, 2009, DSI was forwarded the police report and autopsy report for the deceased 3-year-old occupant of the subject vehicle. The subject vehicle was located at an auto auction lot and the CRS and frontal air bags were being held in evidence by the police. The case was assigned on August 25, 2009. Permission to remove the Ford's Event Data Recorder (EDR) was not obtained.

## Summary

### Crash Site

The crash site was a five-lane southbound interstate highway that was bordered on the left by a raised concrete divider and on the right by a paved shoulder. (Figure 2). Outboard of the paved shoulder were unpaved ground and shrubbery. The travel lanes each measured 3.7 m (12.0 ft) in width and were separated by dashed white stripes; the outboard lane was bordered on the right by a solid white fog line. The paved shoulder measured 4.3 m (14.0 ft) in width and the unpaved ground measured between 0 - 1.8 m (0 - 6.0 ft) in width from the shoulder to the shrubbery.



**Figure 2.** Southbound approach, subject vehicle

The roadway alignment was straight and the profile was level. The roadway composition was asphalt and it was wet at the time of the crash. Conditions were daylight with no street lights illuminated and the weather was cloudy. The posted speed limit was 105 km/h (65 mph) for two-axle vehicles and 89 km/h (55 mph) for all others.

### Pre-Crash

The Ford entered the roadway from an on-ramp and traveled southbound in the outboard lane. The police report stated that the Ford was traveling at a pre-crash speed of 72 km/h (45 mph); a family member who was interviewed stated the vehicle's approximate speed was 105 km/h (65 mph). The Freightliner was traveling southbound in the third lane from the right at a police-reported speed of 89 km/h (55 mph). The driver of the Ford lost control of the vehicle and it departed the roadway on the right side and crossed over the paved shoulder onto unpaved ground. During the roadway departure the subject vehicle initiated a counterclockwise rotation. The driver attempted to return to the roadway by steering left. It is not determined if she was actively braking.

### Crash

The right side of the Ford impacted the roadside shrubbery (Event 1). The damage to the shrubbery measured 9.3 m (30.5 ft) in length. The impact redirected the vehicle slightly left, the vehicle continued to rotate counterclockwise, and the right side of the Ford impacted first a metal streetlight pole (Event 2) and then a reflector marker on a metal post (Event 3) (Figure 3). The distance from the end of the shrubbery impact to the streetlight pole measured 4.0 m (13.1 ft) and the distance from the street light pole to the roadway marker measured 1.5 m (4.9 ft).

The pole was designed to breakaway and was mounted to a triangular slip base plate seated on a concrete base and connected by three bolts. The base plate measured 3.0 cm (1.2 in) in height. The base end of the pole measured 23.0 cm (9.0 in) in diameter and the top end measured 10.0 cm (4.0 in) in diameter. The pole measured 10.7 m (35.0 ft) in length and had a 5.5 m (18.0 ft) long

extension attached near the top that extended laterally and contained the light fixture. The extension was also metal and measured 10.0 cm (3.9 in) in diameter. The triangular slip plate measured 43.0 cm (17.0 in) at its median and was 10.0 cm (3.9 in) in height above the concrete base. The concrete base was 76.0 cm (30.0 in) in diameter and was 5.0 cm (2.0 in) above grade. The direct damage to the pole began at the base and extended upward 180.0 cm (70.9 in). The damage extended laterally to approximately one half of its circumference. The pole was deformed inward at 42.0 cm (16.5 in) from the base where it was contacted by the vehicle's right sill. During the crash, the pole was displaced into the roadway and was later moved onto the shoulder.



**Figure 3.** Point of impact with streetlight pole, base in foreground

The impacted roadside marker was a reflector mounted to a metal post. The post measured 130.0 cm (51.2 in) above grade and was 11.0 cm (4.3 in) wide at the base. The post bent where it entered the ground to an angle of 80 degrees.

After the impact with the pole, the vehicle was displaced forward and left and it initiated a clockwise rotation. The vehicle re-entered the roadway, crossed the first and second travel lanes, and entered the third lane. After rotating approximately 360 degrees from its pole-impact orientation, the left side of the Ford impacted the right side of the Freightliner (Event 4). The police estimated the point of impact for Event 4 to be 77.0 m (252.0 ft) south of the pole impact. The impact with the Freightliner displaced the Ford forward and right. It traveled in a southwest trajectory, again departed the roadway on the right, and came to final rest facing southwest in a median between the roadway and an on-ramp. The estimated distance traveled by the Ford from Event 4 to final rest was 169.0 m (554.0 ft). The linear distance between the pole impact and final rest as measured along the reference line was approximately 245.0 m (805.0 ft). The Freightliner remained in its original travel lane and the driver then brought the vehicle to a controlled stop on the paved shoulder.

A WinSMASH computation was generated for the event involving the subject vehicle and the streetlight pole (Event 2) for the purpose of calculating a Barrier Equivalent Speed (BES). Based on the Ford's crush profile, the BES for the Ford was 38.4 km/h (23.9 mph). Delta-V values could not be computed by WinSMASH because the yielding nature of the pole rendered the WinSMASH application invalid.

### Post-Crash

The Ford came to final rest off the right edge of the roadway and facing southwest. The front left door remained closed and operational and the second row right door was jammed shut. The vehicle was configured with only one door on the left side. The front row right door was removed during post-crash extrication activity. The windshield was cracked and in place, the left and center backlight was out of place and the right backlight was in place. The front and second row right side glass was disintegrated and the front and second row left side glass was intact.

The driver of the Ford sustained contusions to the face, chest, and abdomen; and abrasions to the face. She was presumably assisted from the vehicle based on post-crash extrication damage that included cutting the driver's safety belt webbing. The driver was transported to a local hospital where she arrived at the emergency department with at 1012 hours with a Glasgow Come Score (GCS) of 15. She was admitted for two days and then discharged.

The 43-year-old male front row right occupant sustained injuries including fractures of the right forearm and upper arm, and a closed head injury. He exited with assistance through the front row left door and was transported to a local hospital where he was admitted for two days and then discharged.

The 3-year-old female sustained serious injuries including a basilar skull fracture. On-scene witnesses reported to police that the driver picked up and held the child at some point after the crash. Blood deposits on the second row left side panel and B-pillar, as well as on-scene police photographs, suggested the child was removed through the front left door. She was transported to a local hospital and declared deceased in the emergency department 39 minutes post-crash.

The Ford was towed due to damage, inspected by the state police, then declared a total loss by the insurance company. The driver of the Freightliner was not injured and the vehicle was driven from the scene.

#### **Vehicle Data - 1998 Ford F-150**

The Ford F-150 was identified by Vehicle Identification Number (VIN): 1FTRX17L5WKxxxxxx. The vehicle's date of manufacture was November 1997 and the odometer reading was 204,307 km (126,954 mi). The vehicle was equipped with a 5.4-liter, 8-cylinder engine, automatic transmission, rear wheel drive, and tilt steering column functionality. Standard equipment included anti-lock brakes and power steering. The fuel system included a single metallic fuel tank.

The vehicle manufacturer's recommended tire size was P235/70R16; the recommended cold tire pressure was 221 kPa (32 psi) for the front and 241 kPa (35 psi) for the rear. The vehicle was equipped with BFGoodrich Radial Long Trail T/A P245/75R16 for the front, which had a tire manufacturer's recommended maximum tire pressure of 241 kPa (35 psi). The left rear tire was a Goodyear Wrangler RT/S P235/70R16 with a tire manufacturer's maximum pressure rating of 300 kPa (44 psi) and the right rear tire was a Goodyear Wrangler AP P225/75R16 with a tire manufacturer's maximum pressure rating of 340 kPa (50 psi). The specific tire information was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	Tire flat	7 mm (9/32 in)	No	None
LR	138 kPa (20 psi)	6 mm (8/32 in)	No	None
RR	172 kPa (25 psi)	6 mm (7/32 in)	No	None
RF	234 kPa (34 psi)	6 mm (8/32 in)	No	None



The Ford's interior was configured with seating for five occupants. The front row consisted of outboard bucket seats with adjustable head restraints. The second row consisted of a 60/40 split bench seat without head restraints.

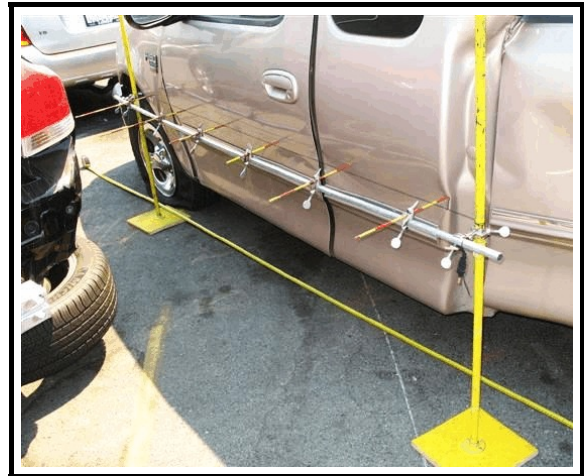
## Vehicle Damage - 1998 Ford F-150

### Exterior Damage

The Ford sustained direct and induced damage to the left and right sides, and top plane. The left front tire was flattened. The right front row door panel was displaced from the vehicle as a result of hinge damage. The right side wheelbase was shortened by 21.0 cm (8.3 in) as a result of lateral crush and vehicle bowing.

The direct damage from the shrubbery impact (Event 1) began at the right rear bumper corner and extended forward 206.0 cm (81.1 in) to the right C-pillar. Much of the direct damage was light surface scratches; the Field L began 67.0 cm (26.4 in) forward of the right rear axle and extended 16.0 cm forward. In accordance with National Automotive Sampling System (NASS) coding conventions, four crush measurements were taken due to the narrow impact at sill level as follows:  $C_1 = 0$  cm,  $C_2 = 2.0$  cm (0.8 in),  $C_3 = 2.0$  cm (0.8 in), and  $C_4 = 0$  cm. Maximum crush was located 71.0 cm (28.0 in) forward of the right rear axle at  $C_2$  and measured 2.0 cm (0.8 in). The Collision Deformation Classification (CDC) for Event 1 was 01RBLS1.

Following Event 1, the right side of the Ford impacted metal streetlight pole. The direct and induced damage from the pole impact was distributed from the right C-pillar to the A-pillar. The direct damage began 135.0 cm (75.6 in) forward of the right rear axle and extended 62.0 cm (24.4 in) forward. The Field L began 114.0 cm (44.9 in) forward of the rear axle and extended forward 148.0 cm (58.3 in) (**Figure 4**). The direct and induced damage extended vertically from the sill to the roof and measured 171.0 cm (67.3 in) in height. Due to the detached front row right door panel, a string line was used to obtain crush measurements for  $C_3 - C_5$ . Six crush measurements were taken at mid-door level as follows:  $C_1 = 9.0$  cm (3.5 in),  $C_2 = 65.0$  cm (25.6 in),  $C_3 = 49.0$  cm (19.3 in),  $C_4 = 37.0$  cm (14.6 in),  $C_5 = 24.0$  cm (9.5 in),  $C_6 = 9.0$  cm (3.5 in). Maximum crush at mid-door level was located 144.0 cm (56.5 in) forward of the rear axle at  $C_2$  and measured 65.0 cm (25.6 in). The CDC for Event 2 was 02RPAW5.



**Figure 5.** Left side crush profile, Event 4



**Figure 4.** Right side crush profile

After the pole impact the Ford impacted a metal roadway marker and reflector with its right front tire. The reflector yielded and there was no direct damage or residual crush to the vehicle. The CDC for Event 3 was 12FREU1.

The Ford was redirected to the left and it reentered the roadway traveling southeast. The vehicle crossed the paved median and first two travel lanes, entered the third lane and traveled into the path of the Freightliner. The left side of the Ford impacted the right side of the Freightliner. The direct damage to the Ford began 117 cm (46.1 in) forward of the left rear axle and extended forward 199.0 cm (78.3 in); the Field L included the same location (**Figure 5**). Six crush measurements were taken at mid-door as follows:  $C_1 = 2.0$  cm (0.8 in),  $C_2 = 0$  cm,  $C_3 = 0$  cm,  $C_4 = 0$  cm,  $C_5 = 0$  cm,  $C_6 = 2.0$  cm (0.8 in). Maximum vertical crush was located 117.0 cm (46.1 in) forward of the left rear axle and measured 2.0 cm (0.8 in). The CDC for Event 4 was 07LYES1.

The Ford sustained crush damage to the left front door due to vehicle-to-vehicle contact. The height of maximum door crush measured 66.0 cm (26.0 in), the sill height measured 37.0 cm (14.6 in), and the Door Sill Differential (DSD) measured 7.0 cm (2.8 in).

### **Interior Damage**

The Ford sustained moderate interior damage as a result of impact forces, intrusions, occupant loading and contacts. The front right door panel was displaced from the vehicle. The windshield was cracked and in place and the right front and right rear side glass was disintegrated. The right front and second row door panels sustained multiple fractures. The right B-pillar intruded laterally into the occupant compartment and deformed the front right seat cushion and back. The second row right door panel intruded laterally and deformed the second row right seat cushion. The second row width was reduced by 45.0 cm (17.7 in). Additional intrusion into the occupant compartment was attributed to the right roof, roof side rail, sill, A- and C-pillars, front row seat-back, center console, and second row armrest. All of the intrusions resulted from the pole impact to the right side of the vehicle.

Evidence of occupant loading or contact was documented on the following components: the driver's and front right occupant's safety belts, rear-view mirror, front row center console, front and second row right door panels, and right B-pillar.

### **Manual Restraints**

Front row seating was configured with 3-point manual lap and shoulder safety belts with sliding latch plates, and adjustable D-ring anchorage assemblies. Second row seating was equipped with outboard lap and shoulder safety belts and a center position lap belt.

The driver's safety belt was equipped with an Emergency Locking Retractor (ELR). The safety belt upper anchorage was set to middle position and the D-ring showed no evidence of occupant loading. The safety belt webbing was cut in two places as a result of extrication activities. Based on the overall length of the right position safety belt, approximately 54.0 cm (21.3 in) of webbing was cut away from the belt and was not located in the vehicle. The shoulder portion of webbing measured

170.0 cm (66.9 in) and the lap portion measured 30.0 cm (11.8 in); neither section of webbing showed evidence of loading but showed wear indicating historical usage.

The latch plate was found separated from the webbing and in the buckled position. The metal tang was scratched indicating historical usage. The plastic cover was scuffed and fractured as a result of occupant loading during the pole impact (**Figure 6**). The fracture measured less than 1 cm (0.4 in) in diameter and was located where the belt webbing was routed through the latch plate. The abrasions were located on both sides of the latch plate and were deposited by the safety belt webbing. Based on evidence of occupant loading, post-crash extrication activities, and occupant kinematics, it was determined the driver's safety belt was used during the crash.



**Figure 6.** Driver's safety belt latch plate showing scuffs and fracture

The front right passenger's safety belt webbing was torn, folded over itself and stuck in the D-ring in the used position. The tear was located along the edge of the webbing and measured 5 cm (2.0 in) in length. The damage to the safety belt was the combined result of occupant loading and intrusion damage caused by the right door panel. The retractor was nonfunctional as a result of contact damage from the right door panel; the retractor type was unknown. The safety belt upper anchorage was set between mid- and full-down.



**Figure 7.** Front right occupant's latch plate showing loading marks

The latch plate (**Figure 7**), safety belt webbing, and D-ring showed evidence of occupant loading. The latch plate was scratched indicating historical usage and was abraded where the webbing was routed through it. The D-ring was abraded where the webbing was routed through it. An area of scuff marks on the safety belt webbing began at the D-ring and extended 13.0 cm (5.1 in) toward the stop button. A second area of loading damage began 35.0 cm (13.8 in) from the D-ring and extended 6.0 cm (2.4 in) toward the stop button. This area of webbing contained scuff marks, frayed fibers and body fluid deposits from the occupant. Based on the post-impact position of the safety belt webbing, evidence of occupant loading, and occupant kinematics, it was determined that the safety belt was in use at the time of the crash.

The second row outboard safety belts were equipped with a non-adjustable D-ring anchorages and ELR/Automatic Locking Retractors (ALR). The safety belt latch plates were scratched indicating historical usage. The safety belts were otherwise unremarkable and not used during the crash.

The second row center position was equipped with a manual lap belt and locking latch plate. This

seat position was occupied by the 3-year-old female seated in a Cosco Ventura combination CRS (**Figure 8**). The safety belt latch plate was scratched indicating historical usage and the webbing showed wear marks. The latch plate was otherwise unremarkable. On-scene police photographs show the belt routed through the CRS and the latch plate fully engaged in the buckled position. The police report stated there was some slack in the belt that allowed the CRS to move away from the seat. During the vehicle inspection, the latch plate was inserted into the buckle and would not properly engage. The buckle was examined and although no deformation was observed, glass kernels or other debris in the buckle prevented the latch plate from properly engaging.



**Figure 8.** Second row center lap belt routed through CRS and buckled (Police photo)

The locking latch plate was adjusted on the webbing 52.0 cm (20.5 in) from the seat bight. The safety belt webbing exhibited two areas of occupant loading evidence. The first was a 3.0 cm (1.2 in) stretch mark that was located 52.0 cm (20.5 in) from the seat bight where the cinching latch plate had been positioned. The second was an area of abrasion 11.0 cm (4.3 in) from the seat bight where transfers from the CRS were deposited in the safety belt webbing. The deposits were on the side of the belt that, if properly installed, had been in contact with the CRS shell.

Based on evidence of occupant loading and on-scene photographs, the second row center position lap belt was determined to have been used during the crash in combination with the Cosco CRS.

### **Supplemental Restraint Systems**

The Ford's Supplemental Restraint System (SRS) included an air bag control module, and driver and passenger frontal air bags. The frontal air bags were second-generation, meaning they were engineered to deploy with less speed and force as compared with first-generation air bags. The vehicle was equipped with an ON/OFF switch for the right passenger air bag and the switch was in the "ON" position at the time of the crash.

The driver had purchased the vehicle two years prior to the crash and the interviewee could not provide information regarding previous crashes or service performed on the air bags. A vehicle history report was obtained for the Ford that reported one previous crash without air bag deployment, and no air bag recalls or service.<sup>1</sup> Based on the vehicle history report, it was determined the frontal air bags were original manufacturer installed equipment and not previously serviced. The deployed air bags were removed from the vehicle by investigating police officers and held in evidence. The front panels were cut from the modules and parts of the back panels remained attached to the vehicle.

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<sup>1</sup> [www.carfax.com](http://www.carfax.com)

The driver's air bag module was located in the steering wheel hub and the air bag deployed through two H-configured cover flaps that opened at the tear points and were not damaged. The air bag was circular in shape and measured 60.0 cm (23.6 in) in diameter in its deflated state (**Figure 9**). It had one internal tether that terminated at the center of the front panel; it had two vent ports measuring 3.0 cm (1.2 in) in diameter that were located at the 11 and 1 o'clock positions on the air bag's back panel.



**Figure 9.** Driver's frontal air bag

The air bag showed several blood deposits that were concentrated in the center and lower left quadrant of the front panel. The driver's medical records did not reveal blood loss related to her injuries, and the interviewee stated that the driver did not sustain blood loss as a result of her injuries. Based on the medical records and interview, the blood deposits were determined to be from sources other than the driver. The air bag did not show additional evidence of occupant loading was otherwise unremarkable.



**Figure 10.** Front right occupant's frontal air bag

The right passenger's frontal air bag deployed from the right middle instrument panel (**Figure 10**) through a single rectangular cover flap that opened at the tear points and was undamaged. The air bag was rectangular in shape and measured 55.0 cm (21.7 in) in height and 76.0 cm (29.9 in) in width in its deflated state. It was configured with two vent ports and a single internal tether.

The air bag showed several blood deposits that were concentrated in the upper right quadrant but also present in the upper and lower left quadrants of the front panel. The front right occupant sustained a right arm laceration resulting from a door panel contact. It is probable the blood deposits to the air bag resulted during post-crash occupant activity. The air bag revealed eight small holes that probably resulted from contact with flying glass. The holes were less than 1.0 cm (0.4 in) in diameter and were scattered within the upper right quadrant of the front panel. The air bag showed no additional evidence of occupant loading and was otherwise unremarkable.

## Child Restraint System

### Cosco Ventura

The second row center occupant was a 3-year-old female who was seated in a Cosco Ventura CRS (**Figure 11**). The CSS model number was 22-248-WAL and the date of manufacture was 6/29/2006. The Ventura was equipped with a 5-point harness system with a chest retainer clip and buckle, padded seat cushion, non-detachable base, locking clip, and LATCH hardware. The CRS was a

combination model that could be used either with the 5-point harness system or without the harness as a booster safety seat. At the time of the crash, the 5-point harness system was installed in the CRS.

The CRS was placed on the center seat cushion in a forward facing orientation. According to the driver's statement to police, the front right occupant had assisted the child into the CRS. The vehicle's lap belt was routed through the forward facing slots in the CRS shell, and the latch plate was inserted into the appropriate buckle on the right side of the seat. The vehicle's center seat cushion showed wear marks on the forward aspect indicating a CRS had been used historically in that position. The distance between the wear marks measured 25.0 cm (9.8 in) indicating the Cosco Ventura probably indented the seat cushion. The marks were 4.0 cm (1.6 in) and 6 cm (2.4 in) in width and suggested the CRS was not tightly secured, allowing it to move upon the cushion. The Ford was not equipped with Lower Anchors and Tethers for Children (LATCH) hardware. The CRS locking clip was not used as part of the installation.



**Figure 11.** Cosco Ventura CRS

The harness shoulder straps were routed through the top set of slots and the center buckle strap was routed through a slot in the CRS seat cushion. The shoulder harness straps were adjusted to their full length, possibly due to the child's size. The slot was slightly torn at each end resulting in a larger opening and allowing the center buckle to move closer to the child than designed. On-scene police photographs showed the retainer clip unbuckled and the left shoulder webbing twisted four turns.

The usage label on the CRS indicated that when using the 5-point harness system, the user should meet the following criteria:

- 86.0 - 109.0 cm (34.0 - 43.0 in) in height
- 10.1 - 18.1 kg (22.0 - 40.0 lb) in weight
- greater than one year in age

Additionally, the usage label warned against using the CRS if the mid-point of the child's head was above the top of the CRS's back.

According to the autopsy report, the 3-year-old occupant was 109.0 cm (43.0 in) in height and 25.0 kg (55.0 lb) in weight. Based on the child's weight it was determined that the child did not meet the usage requirements for the CRS when using the 5-point harness system. She exceeded the weight limit by 6.8 kg (15.0 lb).

The CRS was inspected for damage and evidence of occupant loading. The left harness strap was

twisted and the retainer clip was positioned low on the harness. The harness straps did not sustain any deformation due to loading and the retainer clip functioned properly. The occupant's safety belt webbing exhibited loading evidence, and there was evidence of loading to the CRS at the left slot where the safety belt webbing was routed through the shell. Scuffs were documented at the lower aspect of the slot that corresponded to scuffs on the vehicle's lap belt.

The CRS did not show any fractures, deformities or transfers that suggested contact with components in the vehicle such as the intruded right B-pillar, or door panel, or front right seat-back. It was therefore determined that while the police report stated there was lateral movement of the CRS due to slack in the lap belt, the CRS was not displaced from the center seat position during the crash. No further damage to the CRS was documented.

It is this investigator's opinion that due to the child's size, the shoulder harness straps were adjusted to full length and the retainer clip was positioned well below chest level. Abrasion injuries to the occupant's chest and left leg indicated the harness was used. At impact with the pole the occupant was displaced completely from the CRS, indicating the retainer clip was not used. Additionally, on-scene police photos show the retained clip was unbuckled. The occupant contacted the right B-pillar and door panel, then she was displaced to the left and came to rest on the second row left floor. Occupant kinematics, occupant contacts, occupant injuries, the CRS inspection, and blood deposits in the vehicle support this theory.

#### **Vehicle Data - 2005 Freightliner Columbia**

The 2005 Freightliner Columbia was identified by Vehicle Identification Number (VIN): 1FUJA6CK45Pxxxxxx. The vehicle's date of manufacture and its odometer reading was not known. It was equipped with a 14.1-liter, 6-cylinder diesel engine and three axles. The vehicle's Gross Vehicle Weight Rating (GVWR) was in excess of 14,969 kg (33, 000 lb).

#### **Exterior Damage - 2005 Freightliner Columbia**

The Freightliner's exterior damage data was determined based on police photographs only. The vehicle sustained minor damage to the right front fender during the vehicle to vehicle impact (Event 4). Lateral crush was not determined but the overall damage was minor. For Event 1, the estimated Truck Deformation Classification (TDC) for the Freightliner was 12RFWS1.

**Occupant Demographics - 1998 Ford F-150**

	Driver	Occupant 2
Age/Sex:	50 years/Female	43 years/Male
Height:	160 cm (63 in)	183 cm (72 in)
Weight:	100 kg (220 lb)	91 kg (200 lb)
Seat Type:	Bucket	Bucket
Seat Track Position:	Middle track	Middle track
Manual Restraint Usage:	Lap and shoulder belt	Lap and shoulder belt
Restraint Usage Source:	Vehicle inspection	Vehicle inspection
Air Bag:	Steering wheel mounted, deployed	Middle IP mounted, deployed
Eyewear:	None	Unknown
Alcohol/Drug Involvement:	None	N/A
Type of Medical Treatment	Transported, hospitalized for two days	Transported, hospitalized for two days
	Occupant 3	
Age/Sex:	3 years/Female	
Height:	109 cm (43 in)	
Weight:	25 kg (55 lb)	
Seat Type:	Bench	
Seat Track Position:	Non adjustable	
Manual Restraint Usage:	Lap belt with CRS	
Restraint Usage Source:	Vehicle inspection	
Air Bag:	None	
Eyewear:	None	
Alcohol/Drug Involvement:	N/A	
Type of Medical Treatment	Transported, declared deceased in ER	



## **Occupant Kinematics - 1998 Ford F-150**

### **Driver**

The 50-year-old female driver was seated in an unknown posture and restrained by the vehicle's lap and shoulder safety belt. The D-ring anchorage was adjusted to the mid-position and the seat track was set to mid-track. She was actively steering the vehicle; presumably, her right foot was on the accelerator. The vehicle had just entered the interstate highway from an on-ramp and was traveling in the outboard southbound lane at an estimated speed of 72 - 105 km/h (45 - 65 mph). The driver lost control of the vehicle, it initiated a slight counterclockwise rotation and departed the roadway on the right side.

The right side impacted with a row of shrubbery was a low Delta-V event and had minimal effect on the driver's kinematics. She remained in her seat and steered the vehicle to the left. Following the shrubbery impact, the right side of the vehicle impacted a metal street light pole that resulted in a high Delta-V event. The driver's frontal air bag deployed and the driver was displaced forward and right in response to the direction of force. She loaded the safety belt, resulting in contusions to her chest and right abdomen. The safety belt latch plate fractured during the impact but the driver remained secured in her seat. Her face probably contacted the deployed air bag, resulting in multiple facial contusions.

The driver's face was contacted by flying glass resulting in abrasions. Her right hip loaded the center console and armrest, deposited a 10.0 cm (3.9 in) scuff, and displaced the armrest to the right. Her right knee contacted the lower IP, depositing a 3.0 x 11.0 cm (1.2 x 4.3 in) scuff that began 6.0 cm (2.4 in) below the steering column and extended downward. In the emergency room she complained of pain to the left knee and thigh. The driver's right arm or hand contacted the rear view mirror, which then impacted and fractured the windshield and was displaced from its mounted position.

The vehicle initiated a post-impact clockwise rotation, was displaced forward and left, and returned to the roadway. The driver was displaced left in response to the rotational forces and trajectory of the vehicle. The left side of the Ford then impacted the right side of the Freightliner in a swiping, low Delta-V event, and the driver continued to be displaced left in response to the direction of force. The impact displaced the Ford back to the right, the vehicle traveled southbound, departed the roadway on the right side and came to final rest heading southwest and off the roadway on a paved median.

The driver was assisted from the vehicle by on-scene emergency responders who cut the safety belt webbing during extrication efforts. She was transported to a local hospital, admitted for two days, and then discharged.

### **Front Row Right Occupant**

The 43-year-old male occupant was positioned in the front row right in an unknown posture and restrained by the vehicle's lap and shoulder safety belt. The D-ring was set to the middle position. His seat cushion was set to mid-track and his seat back was slightly reclined.

The shrubbery impact had minimal effect on the occupant's kinematics. He was displaced slightly

forward and right and was held in place by the safety belt. At impact with the pole, he was displaced forward and right in response to the direction of force. He loaded his safety belt, the frontal air bag deployed, and the left side glazing disintegrated. It is probable that the occupant loaded the air bag but no specific evidence of air bag loading was revealed. He was contacted by flying glass resulting in multiple facial abrasions. The frontal air bag sustained several small punctures due to contact with flying glass.

The front right door panel, window frame, roof side rail, B-pillar and sill intruded laterally into the occupant compartment. The occupant's right arm contacted the door panel resulting in fractures to the shoulder, upper arm and forearm, dislocation of the elbow, and laceration of the forearm. Occupant contacts to the door were documented in the upper forward and rear quadrants. The control panel that housed the electric door lock and window switches was displaced from the armrest and the occupant probably contacted this component with his right forearm resulting in the forearm fracture. His upper arm contacted the upper rear quadrant at its upper aspect, resulting in a 2.0 cm (0.8 in) deep impression in the padded area just below the bottom of the side glass, resulting in a fracture to the upper arm.

The occupant's left abdomen contacted the upper rear quadrant resulting in abrasions and contusions. His right thigh contacted the lower forward quadrant of the door panel resulting in a 12.0 cm (4.7 in) fracture to the panel. The door panel was fractured and scuffed in all four quadrants due to a combination of impact forces and occupant contact.

Due to intrusion damage of the right B-pillar and sill, the occupant's seat rotated clockwise approximately 10 degrees, was displaced 12.0 cm (4.7 in) to the right and 11.0 cm (4.3 in) rearward. The seat's anchorages remained intact. The intruding door panel contacted the safety belt webbing, D-ring and retractor cover. The safety belt webbing sustained a tear at the D-ring, and the retractor was locked in place due to impact forces. The safety belt was locked in the used position.

After loading the door panel, the occupant was displaced to the left in response to intrusion forces. He loaded the center console with his left hip, displacing the component 5.0 cm (2.0 in) to the left. The occupant was displaced further left at impact with the Freightliner. He remained seated until the vehicle came to rest.

After the crash, the occupant was transported to a local hospital, admitted for two days, and then discharged.

### **Second Row Center Occupant**

The 3-year-old female occupant was seated in the second row center, in an unknown posture, in a Cosco Ventura Convertible CRS that was secured to the seat by the vehicle's manual lap safety belt. The child exceeded the recommended weight limit for use with the internal harness. The harness shoulder straps were adjusted to full length, and the retainer clip was not used. The vehicle's lap belt was routed through the CRS forward facing slots and buckled on the right side. The police report indicated that there was slack in the safety belt, resulting in approximately 3.0 cm (1.2 in) of lateral movement of the CRS on the seat cushion and back.

At impact with the shrubbery, she was displaced slightly forward and right, and the CRS shifted

slightly due to slack in the lap belt. At impact with the pole, the occupant was displaced forward and right in response to the direction of force. Impact forces to the right side of the vehicle resulted in intrusion of the right B-pillar, second row door panel, and the window frame. The center seat cushion was deformed longitudinally 6.0 cm (2.4 in). The occupant loaded the CRS harness shoulder webbing with her chest, resulting in an abrasion to her right chest and multiple abrasions to her left chest. She loaded the lower aspect of the harness with her left thigh, resulting in a contusion to her left thigh. The child was then fully displaced from the CRS, resulting in an abrasion to the right knee and multiple abrasions to the left lower leg.

The child's head contacted the forward aspect of the right window frame, resulting in a basilar skull fracture, subgaleal hemorrhage, and multiple facial abrasions and contusions. A Y-shaped fracture measuring 14.0 cm (5.5 in) in length was documented at the lower forward corner of the window frame and was determined to be the contact point for the occupant's basilar skull fracture. Body fluid was distributed radially from that point and hair deposits were concentrated in that area. Occupant contacts to the right B-pillar and upper forward quadrant of the right side door panel resulted in hair and body fluid deposits covering an area that began at the upper window frame, extended down 40.0 cm (15.8 in), and rearward above the armrest 30.0 cm (11.8 in). Additionally, the occupant was contacted by flying glass.

During the vehicle's post-impact clockwise rotation, the occupant was displaced to the left and she came to rest in the second row left floor. The floor area exhibited a large blood deposit. The child was transported to a local hospital and declared deceased 39 minutes post-crash.

### **Occupant Injuries - 1998 Ford F-150**

#### **Driver**

The injury data was obtained from the occupant's medical records, police report, and interview.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Multiple contusions, chest and right abdomen	490402.1, 9 590402.1, 1	Safety belt webbing	Certain
Multiple abrasions, face	290202.1,0	Flying glass	Certain
Multiple contusions, face	290402.1,0	Frontal air bag	Probable

#### **First Row Right Occupant**

The injury data was obtained from the occupant's medical records, police report, and interview.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Cerebral concussion	161000.2,1	Right window frame	Possible

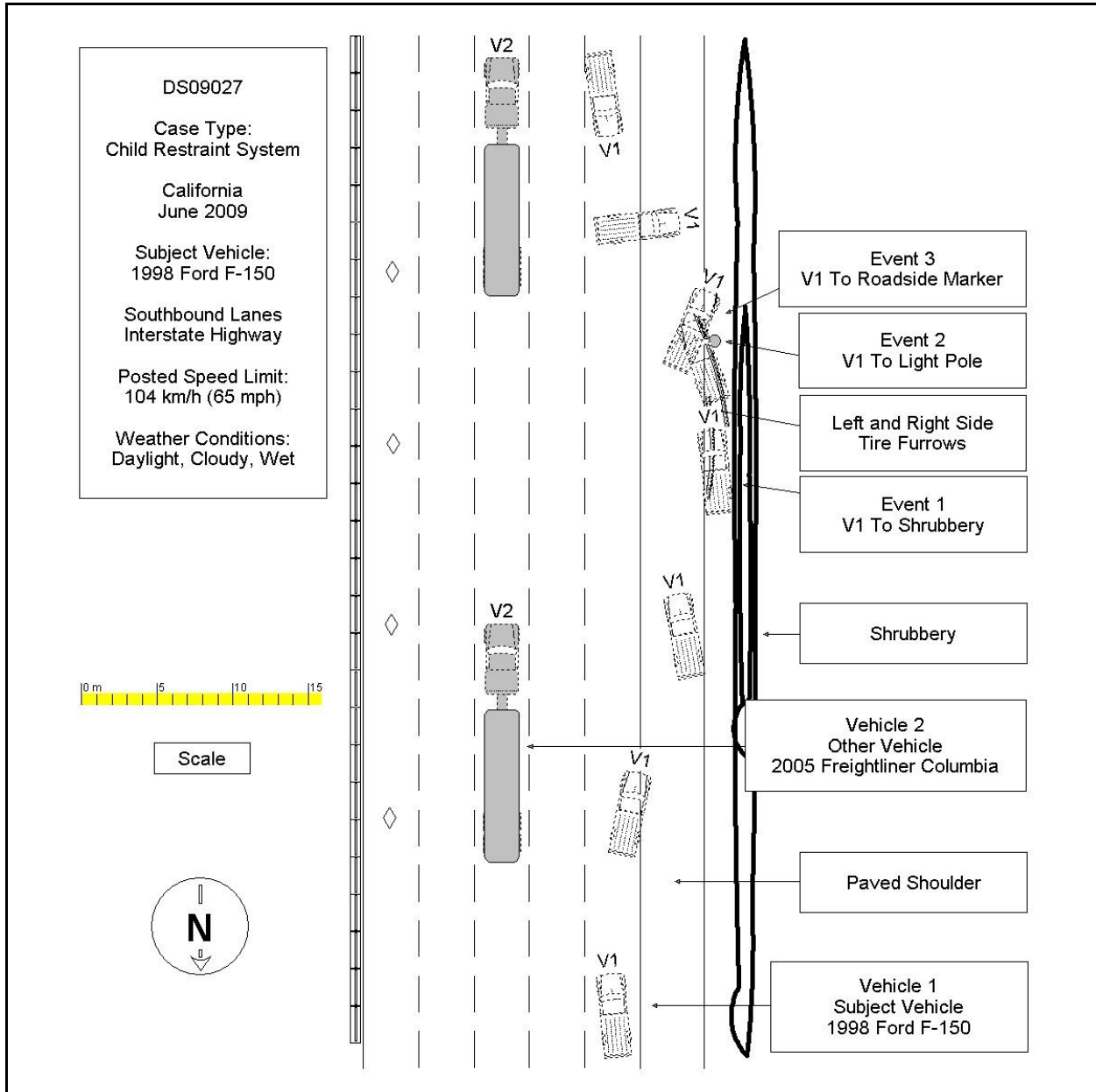
Abrasions, face	290202.1,0	Flying glass	Certain
Fracture, comminuted, right humerus	752604.3,1	Right door panel, rear upper quadrant	Probable
Fracture, displaced, right proximal ulna with elbow dislocation	753204.3,1	Right door panel, forward upper quadrant	Probable
Fracture, right distal ulna	750630.1,1 753202.2,1		
Fracture, right glenoid (scapula)	753000.2,1	Right door panel, rear upper quadrant	Probable
Laceration NFS, right forearm	790600.1,1	Right door panel, forward upper quadrant	Probable
Abrasions, left abdomen	590202.1,2	Safety belt webbing	Probable
Contusions, left abdomen	590402.1,2		

### Second Row Center Occupant

The injury data obtained from the Autopsy Report. The cause of death was a basilar skull fracture due to multiple traumatic injuries.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Multiple abrasions and contusions, right face	290202.1,1	Right window frame	Probable
Multiple abrasions, left face	290402.1,1 290202.1,2		
Abrasion, right chest	490202.1,1		
Multiple abrasions, left chest	490202.1,2	CRS harness system	Probable
Abrasion, right knee	890202.1,1	Unknown	Unknown
Multiple abrasions, left lower leg	890202.1,2	CRS harness system	Probable
Contusion, left thigh	890402.1,2	CRS harness system	Probable
Fracture NFS, basilar skull	150200.3,8	Right B-pillar	Probable
Subgaleal hemorrhage	Not codable	N/A	N/A

Attachment 1. Scene Diagram



Attachment 2. Scene Diagram

