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CALSPAN ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION
SCI CASE NO: CA07-026

VEHICLE: 2006 FORD FOCUS
LOCATION: VIRGINIA
CRASH DATE: JULY, 2007

Contract No. DTNH22-07-C-00043

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

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

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16. Abstract

This investigation focused on two child safety seats used to restrain two male children (year ages 3 and 4) within the rear seat of a 2006 Ford Focus during a high-speed, three-quarter turn, tripped rollover crash. The vehicle was driven by a restrained 23 year old male and was occupied by a 3 year male restrained within a Century Smart Move forward facing child safety seat in the rear left position and by a 4 year old male restrained within an unknown make/model backless booster in the rear right position. The vehicle was traveling southbound in the right lane of a divided two-lane state route at a driver reported speed of 105 km/h (65 mph). The driver became distracted by the children and allowed the vehicle to drift off the outboard (right) shoulder on the road. The driver then steered counterclockwise (left) and overcorrected causing a loss of control. The Ford yawed counterclockwise across the southbound lanes and impacted the depressed center median. The vehicle exited the median, tripped, and rolled over. The Ford impacted the pavement with its hood and roof and came to rest on the inboard northbound lane. The three occupants of the Ford were transported to a local hospital with minor injuries, treated and released within two hours of the crash.

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BACKGROUND

This investigation focused on the installation and usage of two child safety seats used to restrain two male children (year ages 3 and 4) within the rear seat of a 2006 Ford Focus during a high-speed, three-quarter turn, tripped rollover crash. **Figure 1** is a left front oblique view of the Ford Focus. The vehicle was driven by a restrained 23 year old male and was occupied by a 3 year male restrained within a Century Smart Move forward facing child safety seat in the rear left position and by a 4 year old male restrained within an unknown make/model backless booster in the rear right position. The vehicle was traveling southbound in the right lane of a divided two-lane state route at a driver reported speed of 105 km/h (65 mph). The driver became distracted by the children and allowed the vehicle to drift off the outboard (right) shoulder of the road. The driver then steered counterclockwise (left) and overcorrected causing a loss of control. The Ford yawed counterclockwise across the southbound lanes and impacted the depressed center median. The vehicle exited the median, tripped, and rolled over. The Ford impacted the pavement with its hood and roof and came to rest on the inboard northbound lane. The three occupants of the Ford were transported to a local hospital with minor injuries, treated and released within two hours of the crash.

Figure 1: Front left oblique view of the Ford Focus.

This crash was identified by the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) on July 9, 2007 through an Internet news search and forwarded the notification to the Calspan Special Crash Investigations (SCI) team. Calspan SCI initiated follow-up investigation and established cooperation with the investigating police department and the vehicle's insurance carrier. The agency subsequently assigned an on-site investigation of the crash to the SCI team due its interest in the performance of child safety seats and child passenger safety. The vehicle and child safety seats were available for inspection at a local tow yard. The on-site portion of the investigation took place August 1 and 2, 2007.

SUMMARY

Vehicle Data: 2006 Ford Focus

The 2006 Ford Focus ZX4 was identified by the Vehicle Identification Number (VIN): 1FAFP34N36W (production sequence deleted). The four-door, five passenger sedan was equipped with the SE level trim package to include: cloth upholstered seats, air conditioning, power mirrors, power windows, power door locks, and remote key-less entry. The power train consisted of a 2.0 liter/I4 engine linked to a four-speed automatic transmission. The service brakes were a four-wheel disc system with ABS. The date of vehicle manufacture was April 2006. The digital odometer could not be read due to crash related damage to the electrical system. The interior seating consisted of front bucket seats and a second row three-passenger bench seat. The manual restraint systems consisted of three-point lap and shoulder belts in the five seat positions. The manual restraints in the front row were equipped with retractor pretensioners. The rear bench seat was equipped with Lower Anchors and Tethers for CHildren (LATCH) in the outboard positions. Three tether anchors were installed across the rear backlight shelf. The frontal air bag system consisted of advanced dual-stage driver and front right passenger air bags certified to the advanced FMVSS 208 occupant protection standard. The vehicle was not equipped with an inflatable side impact protection system. The Focus was equipped with Goodyear Eagle RSA P195/60R15 tires on OEM steel rims with plastic wheel covers. The vehicle's recommended tire pressure was 221 kPa (32 PSI) front and rear. The specific measured tire data was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	207 kPa (30 PSI)	6 mm (8/32)	No	None
LR	221 kPa (32 PSI)	5 mm (6/32)	No	None
RF	Tire Flat	5 mm (6/32)	No	Tire debeaded, wheel cover fractured
RR	Tire Flat	5 mm (6/32)	No	Tire debeaded, suspension damage

Crash Site

This single vehicle rollover crash occurred during the daylight hours of July 2007. At the time of the crash, the weather was clear and the asphalt road was dry. The crash occurred on a straight section of a north/south two-lane divided state highway in a rural setting. The posted speed limit was 97 km/h (60 mph). **Figure 2** is a south view depicting the roadway. The asphalt road surface was level. The southbound roadway consisted of two 3.7 m (12 ft) wide lanes separated by broken white center lines. The

Figure 2: Southward view of the crash site.

edges of the southbound traffic lanes were delineated by solid lane lines. The outboard lane line was white in color. The inboard lane line was yellow. Outboard of the southbound traffic lane, the west roadside consisted of a 1.0 m (3.3 ft) wide asphalt shoulder, a 2.1 m (7.0 ft) wide gravel shoulder and W-beam guardrail. The northbound and southbound traffic lanes were separated by a 10.0 m (32.7 ft) wide depressed grass median. The center of the median ditch was 1.3 m (4.4 ft) below road level. The front slope of the median ditch measured negative 36 percent, the back slope of the ditch measured positive 70 percent. The slopes of the median ditch altered the trajectory and crash dynamics of the Ford. The ditch transitioned into a culvert pipe that was buried under an 8.3 m (27.1 ft) wide gravel crossover located along the vehicle's trajectory. A guardrail that bordered the inboard northbound road shoulder was not contacted during the crash sequence. A schematic of the crash site is attached to the end of this narrative report as **Figure 18**.

Crash Sequence

Pre-Crash

The 23 year old male driver involved in the crash was the day care provider for the two children seated in the rear of the Ford. On the morning of the crash, the mother met the male driver to drop off the children. At that time, the involved child safety seats were moved from the mother's vehicle and were reinstalled in the Ford. Refer to the *Child Safety Seat* Section of this report for further details regarding the installation. Immediately prior to the crash, the 23 year old restrained male was operating the 2006 Ford Focus southbound in the outboard lane at a driver reported speed of 105 km/h (65 mph). The driver reported to the police that he became distracted by the two children fighting in the back seat and allowed the vehicle to drift off the right side of the road. The vehicle departed the asphalt surface at a shallow angle and the right side tires traveled onto gravel shoulder located immediately outboard of the pavement. Recognizing the vehicle's errant trajectory, the driver returned his attention forward and applied a hard counterclockwise (left) steer input. This maneuver caused the rear tires of the vehicle to break traction and the vehicle began a counterclockwise rotation. The Ford yawed 29.9 m (98 ft) across the southbound travel lanes and departed the inboard (east) side of the road. The yaw marks were attributed to the right side tires of the Focus and were documented by the police photograph, **Figure 3**. Due to the passage of time between the crash date and the on-site SCI inspection, the yaw marks within the traveled portion southbound lanes had deteriorated. The SCI inspection of the west gravel shoulder identified two 27.0 m (88.5 ft) long tire marks attributed to the Ford at the onset of the yaw. **Figure 4** is a northward lookback view of the right tire marks in the gravel. Additionally, four 2.7 m (9.0 ft) long tire marks were observed departing the inboard shoulder and related to the Ford's road departure during the fully developed yaw, **Figure 5**. The vehicle had rotated 70 degrees counterclockwise relative to its original southbound travel direction at the time of the inboard departure.

Figure 3: On-scene police photograph of the

Figure 4: Look back view of the right side tire marks in the gravel.

Figure 5: Yaw marks at the inboard roadside departure.

Crash

The Ford entered the center median with a right side leading attitude. The vehicle traveled down the front slope and the right end of the front bumper impacted the back slope of the ditch with a 3 o'clock direction of force. The forward structure of the uni-body deformed and the front bumper reinforcement bar shifted to the left. The vertical face of the front bumper fascia was heavily abraded by ground contact and separated. This impact force located forward of the vehicle's center of gravity increased the counterclockwise rotational component of the Ford.

The vehicle's continued rotation caused the right rear corner of the Focus to impact the backslope of the ditch approximately 6.7 m (22 ft) north of the end of the guardrail. This impact was evidenced by deformation of the Ford's right rear quarterpanel and a 5.4 m (18 ft) long gouging of the backslope. Refer to **Figure 5** above. This impact displaced gravel in a southeast direction along the vehicle's trajectory. A portion of the displaced gravel was captured by the back side of the guardrail and remained within the W-beam at the time of the SCI scene inspection. The Ford rotated rapidly counterclockwise along the backslope in a sustained contact across its back plane displacing the rear bumper fascia and deforming the left rear quarterpanel. As the vehicle traveled along its southeast trajectory, it climbed the embankment to the elevation of the gravel crossover.

The Ford exited the center median immediately south of the guardrail that bordered the inboard northbound lanes at the gravel crossover. Refer to **Figure 6**. The Focus had rotated approximately 325 degrees. A road sign located 2.6 m (8.5 ft) southwest of the end of the guardrail was struck by the vehicle's left side plane and deformed. The total rotation of the Focus reached approximately 425 degrees when the right side tires encountered the gravel crossover. The Focus tripped about the front right tire and rolled two-quarters impacting the ground with its roof. A series of gouge and

Figure 6: Lookback view at the vehicle's trip point.

scratch marks in the inboard northbound lane identified this impact (**Figure 7**). The gouges were located 18.5 m (60.8 ft) south of the guardrail end and extended laterally across the inboard northbound lane 2.7 m (8.8 ft) from the yellow lane line. The vehicle's battery was dislodged in this impact and slid diagonally across the road coming to rest in the outboard northbound lane. The Ford rolled onto its left side and slid to rest. As the Ford came to rest, it rolled back onto its roof facing north in the center of the inboard northbound lane 28 m (92 ft) from the end of the guardrail. The approximate distance from the vehicle's trip point to final rest was 25.9 m (85 ft). **Figure 8** is an on-scene police photograph depicting the final rest position of the vehicle.

Figure 7: View of the northbound lanes at the time of the SCI inspection. The final rest position of the vehicle is in the foreground.

Figure 8: On-scene police photograph of the final rest position of the Ford.

Post-Crash

The police, fire department and ambulance personnel responded to the crash site. The restrained occupants of the Ford came to rest within their respective seating positions and only sustained minor injuries. The driver exited the vehicle and crawled into the second row. He helped each child individually from the vehicle. They waited in the center median for the first responders. The occupants were transported via ground ambulance to a local hospital, examined, treated and released from the emergency room within two hours of the crash.

2006 Ford Focus

Exterior Damage

The Ford Focus sustained damage to both end planes, both side planes and the top plane as a result of the multiple impact rollover crash sequence. **Figure 9** is a front view of the Focus. The vertical face of the front bumper fascia was heavily abraded by ground contact and had separated. The front bumper reinforcement bar was shifted to the left due to the deformation of the forward uni-body frame structure. The shift of the left and right frame members measured 28 cm (11 in) and 20 cm (8 in), respectively. This

Figure 9: Front view of the Ford.

impact resulted in an induced outboard deflection of the front left fender structure. The Collision Deformation Classification (CDC) for this impact was 83-RFLE2. The left shift of the front structure was denoted by incrementing the 3 o'clock direction by 80. The driver's safety belt pretensioner was probably actuated by this impact.

The right rear quarterpanel and back plane sustained a damage pattern consistent with continuous contact to the backslope of the ditch embankment during the vehicle's rotation. The direct contact damage began on the right rear quarterpanel 20 cm (8 in) aft of the right rear axle and extended to the right rear corner. The quarterpanel was buckled and deformed inboard collapsing the right side of the trunk well. The impact force in the 5 o'clock sector displaced the right rear wheel assembly forward into the forward aspect of the wheelhouse. The upper shock absorber mount fractured and the right rear coil suspension spring was dislodged. The right wheelbase was shortened 9 cm (3.7 in). The rear bumper fascia separated during the impact sequence. Inspection of the displaced component revealed that the fascia was intact but fractured on both corners. The right rear bumper mount was crushed forward 5 cm (2 in). The trunk lid opened by deformation and would not close. The left rear quarterpanel buckled forward and collapsed over a 25 cm (10 in) length into the left aspect of the trunk well. **Figure 10** is the right rear oblique view of the Ford. The CDC of this impact was 05-RBEW-3.

Figure 10: Right rear oblique view.

The Focus climbed the embankment to the elevation of the gravel crossover with a left side leading attitude due to its counterclockwise rotation. The left door contacted and deformed the sign post located southwest of the guardrail end. This impact was evidenced by localized deformation at the left sill. A faint abrasion pattern extended vertically onto the mid-aspect of the door panel from contact with the post. The CDC of this event was 09-LPEN1.

The Ford rotated an additional 100 degrees past the sign post and tripped into a three-quarter turn right side leading rollover. The vehicle rolled two-quarter turns and landed on its hood and roof evidenced by the vertical deformation of the windshield header and left A-pillar area. The deployment of the frontal air bags probably occurred at this time. The roof was crushed down and to the right, buckling the right A-pillar area of the roof, **Figure 11**. The maximum lateral and vertical crush was located at the left A-pillar and measured 9 cm (3.5 in) and 20 cm (7.9 in), respectively. The Focus rolled an additional quarter turn and the left side plane

Figure 11: View of the maximum crush at the left A-pillar area.

contacted the pavement. The exposed edges of the left body panels sustained vertically oriented abrasions due to the pavement contact. The exterior handles of the left doors were abraded indicative of the direct contact as well. There was no lateral deformation (crush) of the left side panels due to this contact. As the Ford came to rest in the northbound lane, it then rolled back onto its roof. The CDC of the rollover event was 00-TDYO4.

The doors of the Focus remained closed during the crash sequence. The left front, left rear and right rear door were operational post-crash. The right front door was jammed shut by the deformation. The windshield fractured and the front window glazings and backlight disintegrated during the rollover. The rear window glazing remained intact. There were no occupant ejections.

Interior Damage

The interior damage of the Focus consisted primarily of the intrusion in the front row interior occupant space and the deployment of the frontal air bags. There were no identified occupant contacts. A post-crash blood smear was observed on the upper left C-pillar. The lack of interior occupant contact points was consistent with the minor injury status of the occupants post-crash and the use of the vehicle's safety belts and the child safety seats. The measured intrusions are noted in the following table:

Position	***Component***	***Intrusion***	***Direction***
Row 1 Left	Left roof rail	20 cm (8.0 in)	Vertical
Row 1 Left	Windshield header	13 cm (5.0 in)	Vertical
Row 1 Left	A-pillar	21 cm (8.1 in)	Vertical
Row 1 Left	A-pillar	9 cm (3.5 in)	Lateral
Row 1 Left	A-pillar	3 cm (1.5 in)	Longitudinal
Row 1 Left	B-pillar	9 cm (3.5 in)	Lateral

There was no intrusion into the vehicle's second row.

The driver seat was located in a rear track position that measured 7 cm (2.8 in) forward of full rear. The total seat track travel measured 24 cm (9.5 in). The seat back was reclined 25 degrees aft of vertical. The upper inboard aspect of the seat back was deformed rearward approximately 5 cm (2 in). The horizontal distance form the seat beak to the center of the steering wheel measured 67 cm (26.5 in). The head restraint was adjusted up 6 cm (2.5 in). The four spoke tilt steering wheel was adjusted to the center position. There was no deformation of the steering wheel rim; the steering wheel was rotated 100 degrees clockwise at the time of the SCI inspection. There was no displacement of the steering column's shear capsules. The front right seat was not occupied during the crash and was adjusted to a full forward track position at the time of the SCI inspection.

Manual Restraint Systems

The manual restraint systems in the Ford Focus consisted of three-point lap and shoulder belts in all five seat positions. The driver's restraint consisted of a continuous loop webbing, a sliding latch plate, an adjustable D-ring and a Emergency Locking Retractor (ELR) located in the base of the B-pillar. The retractor was equipped with a pretensioner that actuated as a result of the impact. The webbing was locked in the extended/worn position. The extended length of the webbing measured 196 cm (77.2 in). Examination of the webbing revealed it was creased and abraded in the area of the buckled latch plate. The creased webbing section measured 8 cm (3.0 in) in length and began 77 cm (30.5 in) above the outboard floor anchor. Examination of the latch plate revealed a corresponding abrasion to the friction surface of the hardware. The latch plate revealed evidence of historical use. The adjustable D-ring was in the full up position. The webbing was gathered and trapped in the D-ring's friction surface. The evidence observed during the SCI inspection indicated the driver was restrained at the time of the crash.

The right rear manual restraint consisted of continuous loop webbing, a sliding latch plate and a switchable Automatic Locking Retractor/ELR (ALR/ELR) attached to the right C-pillar. The webbing extended through a guide in the C-pillar trim. The webbing was stowed within the retractor upon initial inspection and the retractor was operational. Extension and examination of the webbing revealed a 6 cm (2.5 in) loading crease located 74 cm (29.0 in) from the anchor, **Figure 12**. Examination of the friction surface of the latch plate revealed a corresponding abrasion to the hardware. This safety belt was in use at the time of the crash to restrain the 4 year old male seated in the backless booster seat.

The left rear manual restraint consisted of continuous loop webbing, a sliding latch plate and a switchable ALR/ELR attached to the left C-pillar. The webbing was stowed within the retractor upon initial observation. Examination of the webbing revealed the belt was abraded in two areas that were attributed to the inboard and outboard edges of the child safety seat's forward facing belt path. The webbing abrasions were located 33 cm (13 in) and 71 cm (28 in) above the anchor respectively. Examination of the latch plate identified an abrasion on the friction surface of the hardware. The lower inboard aspect of the child seat base was abraded by contact from the latch plate. The evidence identified on this restraint was consistent with its use to restrain the forward-facing child safety seat. **Figure 13** is a view of the left rear safety belt and child safety seat. Refer to the *Child Safety Seat Section* of this report for further detail regarding the condition of the CSS.

Figure 12: Right rear safety belt.

Figure 13: Left rear seat belt and CSS.

A tether anchor for each rear seat position was located across the rear package shelf. Each anchor was equipped with a plastic trim cover. The trim cover was hinged on its rear aspect and concealed the anchor with a positive "snap" closure. It was observed during the SCI inspection that the cover for the left rear tether was open. Refer to **Figure 14**. Examination of this anchor revealed that the anchor was abraded (paint removed) from repeated contact with the CSS tether fastener. The tether of the CSS was in use at the time of the crash.

Figure 14: Rear tether locations.

Air Bag System

The Ford Focus was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system that consisted of advanced dual stage/dual threshold air bags for the driver and front right passenger, driver seat track position sensor, front safety belt buckle switches, front safety belt pretensioners and a front right occupant detection sensor. The frontal air bag system was certified by the manufacturer to have met the requirements of the advanced Federal Motor Vehicle Safety Standard 208. The CAC system was controlled and monitored by a Restraints Control Module (RCM) located under the center console immediately rearward of the transmission selector. Additionally, a front crash sensor located within the engine compartment was used to aid in crash detection and assess crash severity. The RCM commanded the deployment of the CAC system based on the severity of the crash and the inputs from the sensors. The unoccupied front right seat should have resulted in the suppression of the front right air bag deployment. However, it was observed that both the driver and front right passenger air bags had deployed. The deployment of the front right passenger air bag probably resulted due to a change in the status of the right front occupant presence sensor as a consequence of the rollover and the subsequent ground impact.

The driver air bag deployed from an H-configuration module that was located in the center hub of the steering wheel rim. The width of the asymmetrical upper and lower flaps measured 18 cm (7 in). The height of the upper and lower flaps measured 5 cm (2 in) and 8 cm (3.2 in), respectively. The flaps opened at the designed tear seams during the deployment sequence and were free from occupant contact. The deployed driver air bag measured 56 cm (22 in) in diameter. The bag was not internally tethered. A series of broken red stitching was observed across the face of the bag. This stitching was probably used to package the bag and also to control the path of the air bag during deployment sequence. The air bag was vented by semi-circular petal vents located in the 10 and 2 o'clock sectors. The diameter and height of each vent measured 3 cm (1 in) and 1 cm (0.5 in), respectively. There was no residual evidence of occupant contact to the face of the bag.

The front right passenger air bag was a top mount design located in the right aspect of the instrument panel. The module was a rectangular design. The cover flap measured 42 cm x 20 cm (16.5 in x 8 in), width by height. The flap was constructed of sheet vinyl and had a sheet

metal backer that deformed forming a hinge during the deployment sequence. The deflated passenger air bag was tethered and measured 43 cm x 57 cm (17 in x 22.5 in). The excursion of the face of the bag measured 43 cm (17 in) from the edge of the module. The air bag was vented by two 3 cm (1 in) diameter ports on the bag's side panels. There was no evidence of occupant contact to the air bag.

CHILD SAFETY SEAT DATA

Convertible Child Safety Seat

Figure 15 is a front view of the Century Smart Move SE Child Safety Seat (CSS) in use at the time of the crash. The CSS was restrained in the rear left position of the Ford by the vehicle's three-point lap and shoulder belt in a forward facing mode. The model number and serial number of the CSS were not present on the shell. The markings and seat design indicate the seat was manufactured approximately December 2001. The seat was labeled for rear facing use by infants weighing up to 14 kg (30 lb) and for forward facing use by toddlers 9 kg to 18 kg (20 to 40 lb). The labeled maximum height restriction was 102 cm (40 in). The instruction manual was not present and there was no locking clip. Many of the instructions labels affixed to the side of the CSS were missing from repeated washing.

Figure 15: Front view of the convertible CSS.

The CSS was configured with a five-point harness system and a top tether. The harness was routed through the top slots. Both harness straps were twisted over, roped, and creased. The chest retainer clip was located 27 cm (10.5 in) below the top slots. The harness buckle and chest retainer clip latched properly. Examination of the forward facing belt path revealed abrasions consistent with the evidence observed on the vehicle's safety belt. An abrasion to the inboard aspect of the base consistent with interaction with the latch plate was observed. Refer to **Figure 16**. The seat was designed with an adjustable base. The shell was adjusted to Forward Facing Position 4. There were no fractures of the plastic shell. A Styrofoam absorber located under the fabric covering was attached to the shell. It was observed the right upper aspect of the Styrofoam was fractured, **Figure 17**. It did not appear that the fracture was related to the crash. There was no other contact evidence related to the Styrofoam fracture.

During her interview, the mother of the children indicated that the driver (day care provider) obtained the CSS second hand from a relative. She reported that the CSS had no prior crash history. The mother indicated that she was very conscious of child seat safety and had attended three child seat safety check points over a 2 to 3 year time period. The last check point she attended was approximately 1-1/2 years prior to the crash. The mother was very informed regarding the installation process and stated she took as much time as necessary to properly install the seat to her satisfaction. She stated that "unless the entire car rocked when checking the installation", she would reinstall the seat." Her technique to install the forward facing convertible seat was to feed the seat belt through the belt path, kneel in the shell to compress the

seat cushion, set the switchable retractor to the locking mode and feed the safety belt back in. She did indicate that the switchable retractor was set the day of the crash and that the top tether was in use. The harness straps restraining the 3 year old had approximately one finger of slack and the chest retainer clip was adjusted to the level of the child's arm pits.

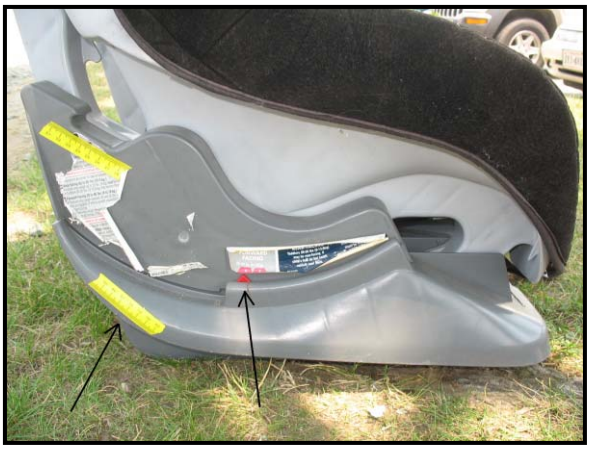

Figure 16: Inboard aspect of the CSS.

Figure 17: Fractured Styrofoam absorber.

Backless Booster Child Safety Seat

The mother indicated in her interview that the 4 year old child was seated in a backless booster CSS positioned in the rear right. She did not know the manufacturer or model of the seat. She further stated that the booster seat elevated the 4 year old sufficiently, such that, the vehicle's three-point safety belt provided a better fit. The shoulder portion of the belt came across the child's shoulder, not the neck. On the day of the crash, she indicated that she assisted getting the child buckled into the seat. She believed the safety belt was snug, but did not do anything out of the ordinary to buckle the safety belt. Reportedly the booster seat was left inside the vehicle post-crash; however, it was not present at the time of the SCI inspection. The location of the seat was unknown.

OCCUPANT DEMOGRAPHICS

	Driver	***Front Right Passenger***
Age/Sex:	23 year old / Male	Not Occupied
Height:	188 cm (74 in)	n/a
Weight:	104 kg (230 lb)	n/a
Seat Position:	Rear track	n/a
Manual Restraint Use:	Three-point lap and shoulder	n/a
Usage Source:	SCI inspection	n/a
Medical Treatment:	Transported to a local hospital, treated and released	n./a

	Rear Left Passenger	***Rear Right Passenger***
Age/Sex:	3 year old / Male	4 year old / Male
Height:	81 cm (32 in)	97 cm (38 in)
Weight:	16 kg (35 lb)	17 kg (38 lb)
Manual Restraint Use:	Restrained by a five-point harness within a convertible child safety seat in a forward facing mode	Restrained within an unknown back-less booster seat by the vehicle's three-point lap and shoulder belt
Usage Source:	SCI inspection	SCI inspection
Medical Treatment:	Transported to a local hospital, treated and released	Transported to a local hospital, treated and released

DRIVER INJURY

Injury	***Injury Severity (AIS 98 Update)***	***Injury Source***
Small lacerations to the top of the scalp, NFS	Minor (190602.1,5)	Roof
Left knee contusion	Minor (890402.1,2)	Knee bolster
Abdominal contusions, NFS	Minor (590402.1,4)	Safety belt
Multiple small lacerations to the lower extremities, NFS	Minor (890602.1,2)	Post-crash contact with disintegrated glazing

Note: the above injuries were identified during an interview with the mother of the rear seated children. The driver declined cooperation.

DRIVER KINEMATICS

The 23 year old driver was seated in a rear track position in a presumed upright posture. He was distracted by the children in the rear seat of the Ford and had turned around to his right. During his distraction, he relinquished of directional control and allowed the vehicle to drift right onto the outboard shoulder precipitating the crash. The driver overcorrected to the left, crossed the travel southbound lanes and departed the inboard shoulder.

Upon impact with the median ditch, the driver's safety belt retractor locked and pretensioner actuated. The actuated pretensioner removed potential slack in the belt system and tightened the restraint about the driver. The driver loaded the locked restraint system with his torso and pelvis and rode down the multiple impact sequence and rollover. During the crash sequence, the driver sustained a contusion to the left knee from knee bolster contact and a small laceration from roof contact. The use of the manual restraint maintained his position with the left front interior and helped mitigate significant injury.

REAR LEFT PASSENGER INJURY

Injury	***Injury Severity (AIS 98 Update)***	***Injury Source***
Abrasions and contusions to both shoulders, NFS	Minor (790202.1,3) (790402.1,3)	Harness straps

Note: the above injuries were identified during an interview with the mother of the rear seated children. The requested medical records were not available.

REAR LEFT PASSENGER KINEMATICS

The 3 year old was seated in a forward facing mode within a convertible child safety seat in the left rear position. He was restrained by a five-point harness system. The vehicle's seat belt retractor was switched to the locking mode during the installation of the CSS and the top tether of the CSS was in use. During the multiple impact sequence and rollover, the child loaded the harness straps with his shoulders and chest and rode down the force of the crash. The loading of the harness straps was evidenced by the abrasions and contusions sustained by the child. The installation and use of the child safety seat protected the child from interior contact and mitigated his injuries in this severe crash.

REAR RIGHT PASSENGER INJURY

Injury	***Injury Severity (AIS 98 Update)***	***Injury Source***
Small contusion to the right temple, NFS	Minor (190402.1,1))	Right rear window
Right shoulder abrasion, NFS	Minor (790202.1,1)	Safety belt
Bilateral contusions over both hips, NFS	Minor (890402.1,3)	Safety belt

Note: the above injuries were identified during an interview with the mother of the rear seated children. The requested medical records were not available.

REAR RIGHT PASSENGER KINEMATICS

The 4 year old was seated on a backless booster in the right rear position and was restrained by the vehicle's lap and shoulder belt. Upon impact, the safety belt retractor locked. The child

loaded the locked restraint and rode down the force of the multiple impact sequence and rollover. The loading of the restraint was evidenced by the right shoulder abrasion and the bilateral hip contusions. During the crash sequence, the child struck the right rear window glazing with his head resulting in the head contusion. The use of the manual restraint maintained the child's position within the right rear interior space and helped to mitigate his injuries.

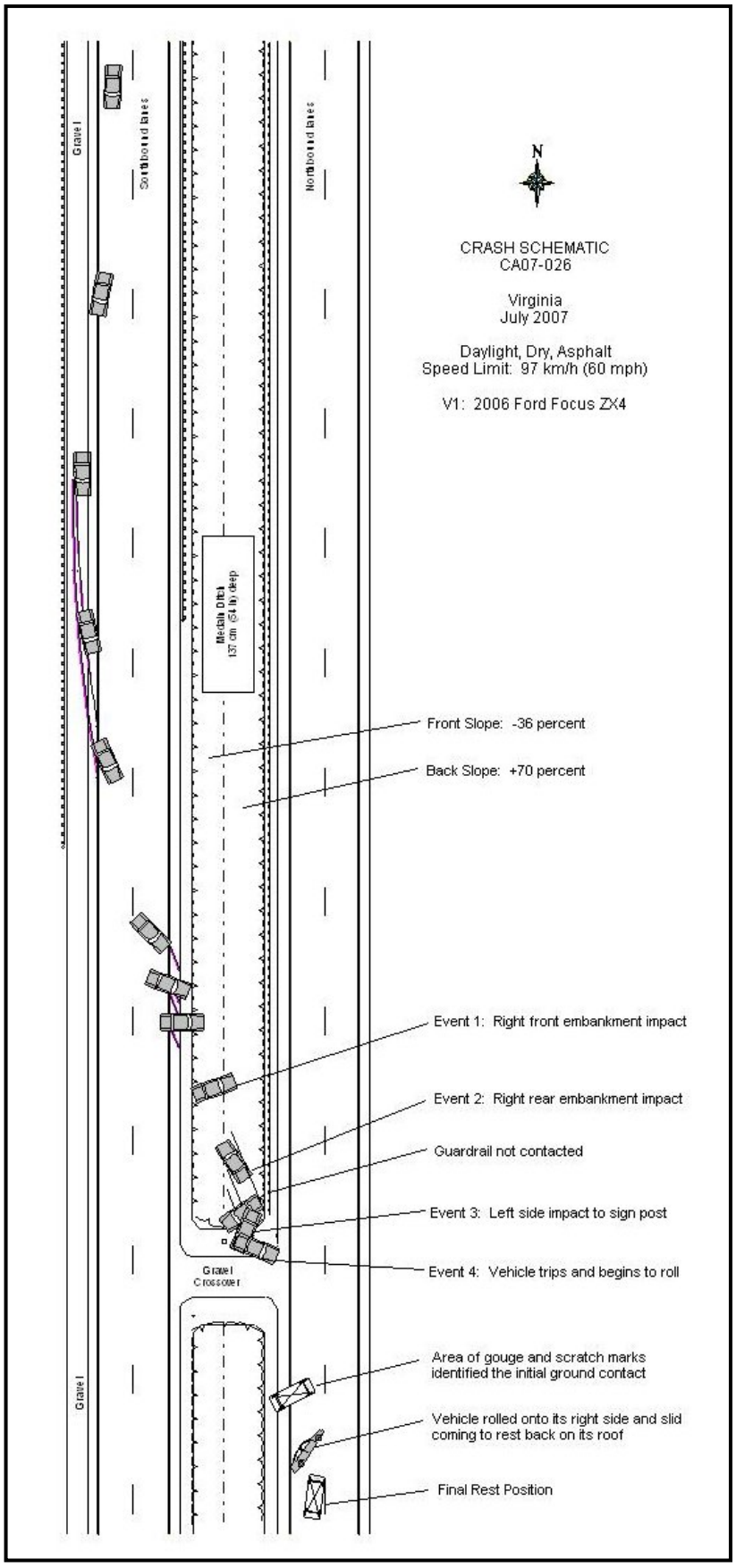

Figure 18: Crash Schematic.