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CALSPAN ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION
SCI CASE NO: CA05-017

VEHICLE: 2002 FORD TAURUS
LOCATION: PENNSLYVANIA
CRASH DATE: MARCH, 2005

Contract No. DTNH22-01-C-17002

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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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<p>16. Abstract This investigation focused on the crash dynamics and injury sources that resulted in a double fatality in a 2002 Ford Taurus. The Ford was occupied by a 24 year old restrained male driver and a four month old male center rear occupant. The infant was restrained within an Evenflo PortAbout Rear-Facing Child Safety Seat (RFCSS). The Ford was involved in an opposite direction angular impact with a 1998 Dodge Grand Caravan. The Dodge was driven by a 41 year old male and was the vehicle's sole occupant. The front left aspect of the Dodge impacted the Ford at the left front corner and then continued to engage the left side of the Taurus to its C-pillar. The force of the angular impact resulted in severe intrusion into the Ford driver's occupant space. The driver was trapped within the vehicle and had to be extricated. The driver suffered a complete laceration of the thoracic aorta and multiple blunt traumatic injuries. He was pronounced deceased at the scene of the crash. The four month old infant remained secured in the RFCSS and was removed from the Ford within the RFCSS and carried to an ambulance that had arrived at the scene. The infant was transported via air ambulance to a regional trauma center in critical condition with an AIS 4 depressed occipito-parietal skull fracture, an AIS 5 subdural hemorrhage and associated injuries. The infant was removed from life-support two days post-crash after it was determined that his condition was unrecoverable.</p>			
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**CALSPAN ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION
SCI CASE NO: CA05-017**

**VEHICLE: 2002 FORD TAURUS
LOCATION: PENNSYLVANIA
CRASH DATE: FEBRUARY, 2005**

BACKGROUND

This investigation focused on the crash dynamics and injury sources that resulted in a double fatality in a 2002 Ford Taurus. The Ford was occupied by a 24 year old restrained male driver and a four month old male center rear occupant. The infant was restrained within an Evenflo PortAbout Rear-Facing Child Safety Seat (RFCSS). The Ford was involved in an opposite direction angular impact with a 1998 Dodge Grand Caravan. The Dodge was driven by a 41 year old male and was the vehicle's sole occupant. The front left aspect of the Dodge impacted the Ford at the left front corner and then continued to engage the left side of the Taurus to its C-pillar. The force of the angular impact resulted in severe intrusion into the Ford



Figure 1: Left side view of the Ford.

driver's occupant space. The driver was trapped within the vehicle and had to be extricated. The driver suffered a complete laceration of the thoracic aorta and multiple blunt traumatic injuries. He was pronounced deceased at the scene of the crash. The four month old infant remained secured in the RFCSS and was removed from the Ford within the RFCSS and carried to an ambulance that had arrived at the scene. The infant was transported via air ambulance to a regional trauma center in critical condition with an AIS 4 depressed occipito-parietal skull fracture, an AIS 5 subdural hemorrhage and associated injuries. The infant was removed from life-support two days post-crash after it was determined that his condition was unrecoverable.

This fatal crash was identified through an internet news article forwarded to the Crash Investigation Division of the National Highway Traffic Safety Administration on February 16, 2005. At the request of the agency, the Special Crash Investigations team at Calspan initiated follow-up investigation and established cooperation with the investigating police department. An on-site investigation was assigned by the NHTSA on February 17, 2005. The vehicles were being held in the police impound and the RFCSS was in the possession of the police pending the conclusion of the investigation. The on-site portion of the investigation took place February 21, 2005

VEHICLE DATA

2002 Ford Taurus

The 2002 Ford Taurus was identified by the Vehicle Identification Number (VIN): 1FAFP55282A (production sequence deleted). The four-door, five passenger sedan was equipped with the SES level trim package to include: six-way powered driver seat, split folding rear bench seat, cloth upholstery, air conditioning, power steering, power mirrors, power windows, power door locks, and remote key-less entry. The power train consisted of a 3.0 liter/V6 engine linked to a four-speed automatic transmission. The service brakes were a four-wheel disc system with ABS. The vehicle was manufactured in April 2002. The digital odometer could not be read due to crash related damage to the electrical system. 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 buckle pretensioners. The rear bench seat was equipped with Lower Anchors and Tethers for CHildren (LATCH) in the outboard positions. The frontal air bag system consisted of advanced dual-stage driver and front right passenger air bags. The vehicle was not equipped with an inflatable side impact protection system. The Ford was equipped with Continental Touring P215/60R16 tires on OEM alloy rims. The recommended tire pressure was 207 kPa (30 PSI) front and rear. The specific measured tire data was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	0 kPa	5 mm (6/32)	No	Rim fractured, Tire debanded
LR	179 kPa (26 PSI)	6 mm (8/32)	No	None
RF	179 kPa (26 PSI)	9 mm (11/32)	No	None
RR	179 kPa (26 PSI)	7 mm (9/32)	No	None

1998 Dodge Grand Caravan

The 1998 Dodge Grand Caravan was identified by the Vehicle Identification Number (VIN): 2B4GP44G6WR (production sequence deleted). The four-door, seven passenger minivan was configured on the 303 cm (119.3 in) wheelbase and was equipped with the SE level trim package. The power train consisted of a 3.3 liter/V6 engine linked to a four-speed automatic transmission. The service brakes were a front disc/rear drum system with ABS. The seating configuration consisted of two manual bucket seats in the front row, two captains chairs in the second row, and a third row three passenger bench seat. The manual restraint system consisted of three-point lap and shoulder belts in the six outboard positions and a third row center lap belt. The frontal air bag system consisted of redesigned driver and front right passenger air bags. The vehicle was manufactured in September 1997. The digital odometer could not be read due to crash related damage to the vehicle's electrical system. The Grand Caravan was equipped with Goodyear Integrity P215/70R15 tires in the left front and left rear positions. The right front tire was missing and could not be located. The right rear tire was a Michelin XW4 P215/70R15. The recommended tire pressure was 241 kPa (35 PSI). The specific measured tire data was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	0 kPa	5 mm (4/32)	No	Rim deformed by impact, Tire side wall cut
LR	152 kPa (22 PSI)	6 mm (4/32)	No	None
RF	N/A	N/A	N/A	Unknown
RR	193 kPa (28 PSI)	7 mm (9/32)	No	None

SUMMARY
CRASH SITE

This two-vehicle crash occurred during the afternoon hours of February, 2005. At the time of the crash, it was daylight and raining. The asphalt road surface was wet. The crash occurred on a two-lane predominately north/south road in a rural residential setting. At the scene, the respective travel lanes measured 3.1 m (10.3 ft) in width and were separated by a double yellow center line. The outboard edges of the travel lanes were bordered by white fog lines and 0.9 m (3 ft) wide asphalt shoulders. The point of impact was identified by two arc shaped gouge marks located in the middle of the southbound lane. There was an open fallow field on the west side of the road. The elevation of the field was approximately 1.2 m (4 ft) below the grade of the road. The embankment outboard of the west road shoulder had a negative grade with an averaged measured slope of 33 percent. The road profile was straight and level in the area of the impact. However, south of the point of impact there was a left curve for northbound traffic that contributed to the crash. The curve ended 23.7 m (78 ft) south of the point of impact. The radius of the curve measured 259 m (850 ft). South of the point of impact, through the apex of the curve, there was a 3.9 m (12.7 ft) wide parking lane located outboard of the northbound lane. Refer to **Figure 2**. This parking lane ended 50 m (164 ft) south of the impact. Tire marks attributed to the right tires of the Dodge were observed in the grass beginning at the termination of the parking lane. The tire marks measured 16.8 m (55 ft) in length and curved back into the northbound lane leaving side scuff marks. **Figure 3** is a look back view along the tire marks. **Figure 4** is



Figure 2: Northbound trajectory view at the crash site.

a northbound trajectory view of the Ford. The Ford came to rest on the open field on the right side of the figure. The speed limit in the area of the impact was 56 km/h (35 mph). A schematic of the crash is included at the end of this narrative report as **Figure 12**.



Figure 3: Southward look back view along the Dodge's trajectory.



Figure 4: Trajectory view of the Ford 60 m (200 ft) before impact.

CRASH SEQUENCE

Pre-Crash

The Ford Taurus was southbound driven by a 24 year old restrained male. A 4 month old male was restrained within an Evenflo Rear Facing Child Safety Seat (RFCSS) positioned in the center rear of the vehicle. The RFCSS was restrained within the Ford through the use of the vehicle's manual lap and shoulder restraint. The driver had picked the 4 month old up from daycare and was in the process of his evening commute to his home when the crash occurred. The 1998 Dodge Caravan was northbound driven by a 41 year old restrained male. This driver failed to properly negotiate the left curve located south of the impact and crossed into the parking lane located on the east side of the road. At the termination of the parking lane, the driver steered late to the left (counterclockwise) in an effort to regain the proper trajectory and lost directional control of the Dodge. The late steering maneuver was evidenced by the aforementioned tire marks documented during the SCI scene inspection. During this steering maneuver, the driver overcorrected and the Dodge crossed the center line directly into the path of the Ford.

Crash

The front left aspect of the Dodge struck the front left aspect of the Ford during the initial engagement. The initial impact to the Ford was located on the extreme left end of the front bumper reinforcement bar. As the crash developed, the Ford was deflected to its right evidenced by the gouge marks in the road and its trajectory after separation. The offset force of the impact caused the Dodge to counterclockwise rotation as it continued along its northward trajectory. As the vehicles reached maximum engagement, the front and center aspects of the Dodge were engaged with the left side of the Ford. The directions of force at maximum engagement were in the 12 o'clock and 10 o'clock sectors for the Dodge and Ford respectively. The engagement of the Dodge continued along the left side of the Ford to the Ford's left C-pillar area. The impact induced longitudinal deceleration of the impact caused the driver's seat belt buckle pretensioner in the Ford to fire. The Ford's driver air bag did not deploy in the 10 o'clock angular impact. The redesigned frontal air bags in the Dodge deployed as a result of the 12 o'clock impact force.

Upon separation, the Ford departed the right side of road, drove down the embankment and came to rest in the open field. A 7 m (24 ft) long left front tire mark in the soft soil defined this trajectory and the final rest location of the Ford. The final rest location of the Dodge was defined by a region of disintegrated glazing located on the west road shoulder 36 m (118 ft) north of the point of impact. The Dodge had rotated approximately 180 degrees CCW and came to rest facing southward.

The angular impact configuration and dynamics of the crash resulted in a non-central collision. The vehicles did not reach a common velocity at maximum engagement. The common velocity assumption was a basis premise of the WINSMASH model; therefore, this crash was beyond the scope of the model. It could not be used to analyze this crash.

Post-Crash

The police, fire, and ambulance personnel responded to the scene. The driver was trapped in the vehicle due to the intrusion and required extrication. The left doors, left B-pillar and roof were removed. The driver suffered fatal thoracic trauma as a result of the impact and was deceased at the scene. A passerby removed the four month old occupant from the Ford while he was still restrained within the RFCSS and carried him to an ambulance that had arrived on-scene. The child occupant was unresponsive at that time with an irregular heartbeat and respiration. The child was subsequently transported by air ambulance to a regional trauma center in critical condition. Medical diagnosis determined he had suffered a severe head injury to include multiple skull fractures, and subdural and subarachnoid brain hemorrhages. Medical intervention to improve his condition was unsuccessful and he was removed from life-support two days post-crash. The 41 year old male driver of the Dodge was treated and released from a local hospital with minor injuries. Both vehicles sustained disabling damage in the crash and were towed. The vehicles were subsequently impounded for the police investigation.

2002 FORD TAURUS

Exterior Damage

Figure 5 is a the front left oblique view of the Ford Taurus. The vehicle sustained an impact to the left front corner with sustained contact along its left side to the C-pillar. Initial inspection revealed the left aspect of the front bumper fascia had separated and the bumper reinforcement was exposed. Inspection of the bumper reinforcement bar determined that the impact occurred at the extreme left end of the reinforcement. The direct and induced frontal damage extended across the entire 150 cm (59 in) frontal end width of the Taurus. The direct contact damage began 56 cm (22 in) left of center and extended 18 cm (7 in) to the left corner. This impact was outboard of the uni-body structure of the Taurus. There was no deformation to the forward aspect of the uni-body fore structure that supported the bumper reinforcement. The deflection of the bumper



Figure 5: Left front view of the Ford.

fore structure that supported the bumper reinforcement. The deflection of the bumper

reinforcement was primarily induced damage caused by the left side deformation in the area of the left front suspension, cowl, and A-pillar. The residual deformation of the bumper reinforcement was as follows: C1 = 55 cm (21.8 in), C2 = 36 cm (14.2 in), C3 = 25 cm (10.0 in), C4 = 15 cm (5.9 in), C5 = 10 cm (4.1 in), C6 = 1 cm (0.5 in).

The front of the Dodge then engaged along the left side of the Taurus, **Figure 6**. The direct contact damage ended in the left C-pillar area 34 cm (13.5 in) forward of the left rear axle location. The left front wheel assembly was directly involved in the impact with the entire assembly separating at the lower control arm and transmission output shaft. The left front wheel was fractured and egg shaped. There was major intrusion of the left structures into the driver's compartment. The left lower sill buckled and was crushed inboard 28 cm (11 in) at the leading edge of the driver seat. The jammed left front door and roof were removed



Figure 6: Left side view of the Ford.

during the extrication of the driver. The left rear door buckled outward and reportedly separated from the vehicle during the impact. The upper and lower aspects of the left B-pillar were cut and the pillar was also removed from the vehicle. The lateral deformation of the roof measured 20 cm (8 in) at the upper B-pillar location. The right doors remained operational. There was no measurable change in the right wheelbase dimension. The Collision Deformation Classification (CDC) was 10-FLEE9. Analysis of this impact was beyond the scope of the WINSMAH model due to the two planes of direct contact damage and the violation of the common velocity assumption.

1998 DODGE GRAND CARAVAN

Exterior Damage

Figures 7 and 8 are the front and left lateral views of the Dodge Grand Caravan. The front plane of the Dodge sustained direct and induced damage that extended across the entire 157 cm (62 in) end width of the vehicle. The impact damage was biased to the left indicative of the offset nature of the crash configuration. The front fascia and bumper reinforcement bar separated from the vehicle during the impact. Inspection of these components revealed that initially the left aspect of the Dodge's front plane impacted the left corner of the Ford. The left aspect of the bumper fascia was fractured in multiple places with major fracture points located 25 cm (10 in) left and 50 cm (19.5 in) left of center respectively. The direct damage on the reinforcement bar began 15 cm (6 in) left of center and extended to its left end. As the Dodge began to rotate counterclockwise, the left and center aspects of the vehicle engaged the left side of the Ford. The direct contact at the hood elevation began 17 cm (6.5 in) right of center and extended to the left corner. The hood buckled rearward and folded at the designed points. The left front fender was crushed to the left A-pillar. The separation of the reinforcement bar necessitated crush measurement to the upper and lower radiator support. The residual crush profile along the upper radiator support was as follows: C1 = 46 cm (18.2 in), C2 = 34 cm (13.3

in), C3 = 25 cm (9.9 in), C4 = 17 cm (6.5 in), C5 = 6 cm (1.8 in), C6 = 5 cm (2.0 in). The crush of the lower radiator support was: C1 = 66 cm (25.8 in), C2 = 39 cm (15.3 in), C3 = 17 cm (6.5 in), C4 = 9 cm (3.5 in), C5 = 6 cm (2.5 in), C6 = 0. The left front wheel assembly was directly involved in the impact. The left front wheel rim was deformed and the outer sidewall of the tire was cut. The left wheelbase was reduced 34 cm (13.3 in). The right wheelbase was unchanged. The left front door was jammed shut by impact damage. It was removed along with the left B-pillar was cut during the extrication of the driver. All other doors remained closed during the crash and were operational post-crash. The interior surface of the windshield exhibited a 4 cm (1.5 in) bulging fracture from an interior loose object. The fracture was located 2.5 in left of center and 13 in below the header. A baseball was found on the floor between the front seats of the Dodge and was the probable source of the fracture. The estimated delta V of the Dodge based on SCI field experience was 24 km/h to 32 km/h (15 mph to 20 mph). The CDC of the impact was 12-FYEW4.



Figure 7: Front view of the Dodge.



Figure 8: Left side view.

2002 FORD TAURUS

Interior Damage

The interior damage to the Ford Taurus consisted of severe intrusion of the left side structures due to the 10 o'clock exterior force of the crash. There was a reduction in the volume of the driver's occupant space. The intrusion into the driver's position is summarized in the table below:

Component	<i>Row 1 Left Position</i>	
	Magnitude of intrusion	
	Longitudinal	Lateral
Left instrument panel	43 cm (17 in)	34 cm (13.5 in)
Sill forward driver seat	----	28 cm (11 in)
Left B-pillar (at sill)	15 cm (6 in)	19 cm (7.5 in)
Steering wheel	13 cm (5 in)	25 cm (10 in)

Figure 9 is a left side view of the occupant compartment. **Figure 10** is an overhead view.



Figure 9: Left interior view.



Figure 10: Overhead interior view.

The driver was in a full rear track position and could not be moved due to the floor pan deformation. This position was consistent with the driver's reported stature. The seat back was reclined 15 degrees. The horizontal distance from the seat back to the residual deformed location of the steering wheel hub/driver air bag module measured 66 cm (26 in). This horizontal distance was measured 48 cm (19 in) above the seat bight.

The four-spoke steering wheel rim was rotated approximately 30 degrees counterclockwise at the time of the SCI inspection. The position of the tilt steering column could not be determined due to the instrument panel deformation. There was no deformation of the steering wheel rim. The deformable coupling joint at the base of the steering column had separated.

The driver's lower extremities contacted the knee bolster **Figure 11**. The driver's left knee contacted the outboard aspect of the bolster evidenced by pocketed deformation to the panel. This contact resulted in a left femur fracture. The right lower extremity contacted the bolster evidenced by a 6 cm (2.5 in) scuff mark. The mark was located 17 cm (6.5 in) left of the steering column centerline. This contact did not result in an injury. The interior surface of the left front door panel was contacted by the left flank of the driver evidenced by a 8 cm (3 in) wide scuff mark to the central aspect of the arm rest that extended up to the belt line.



Figure 11: Knee bolster contacts.

The driver seat was displaced rearward and inboard as a result of the exterior crush and the deformation of the floor pan and intruded into the second row. The longitudinal and lateral intrusion of the driver seat measured 13 cm (5 in) and 19 cm (7.5 in), respectively. The intrusion of the seat coupled with the forward kinematic pattern of the RFCSS resulted in contact between

the seat back and the upper right aspect of the child seat shell. **Figure 12** is a view of the driver seat back and the contact evidence. A 3 cm (1 in) blue colored transfer was noted to the seat's fabric. The mark began on the centerline of the seat and extended to the right. It was located 6 cm (2.5 in) below the top of the seat. A 5 cm x 5 cm (2 in x 2 in) L shaped cut in the fabric was located 13 cm (5 in) left of the inboard aspect of the seat and 15 cm (6 in) below the top. A 5 cm (2 in) long fabric abrasion was located 19 cm (7.6 in) below the top and 18 cm (7 in) left of the inboard edge of the seat.



Manual Restraint Systems

The manual restraint systems in the Ford Taurus consisted of three-point lap and shoulder belts in all five seat positions. The restraints in the front row were equipped with buckle pretensioners. The driver's restraint consisted of

continuous loop webbing, a sliding latch plate, adjustable D-ring and an Emergency Locking Retractor (ELR) located in the base of the left B-pillar. The buckle was attached to the inboard aspect of the driver seat. Examination of the buckle stalk indicated that the pretensioner had fired. The stroke of the pretensioner (reduction in the buckle height) measured 78 mm (3.1 in). Initial observation of the webbing revealed that it had been cut in two places during the extrication of the driver. The webbing was cut over the central aspect of the driver's abdomen and immediately above the retractor. A 100 cm (39.5 in) webbing section was attached to the outboard floor anchor. A 114 cm (45 in) section of the webbing was found at the scene of the crash. The latch plate was missing from the vehicle and was not found.

Figure 12 is a view of the reconstructed driver's webbing. Examination of the webbing revealed a 20 cm (8 in) region of the lap belt that appeared waffled and stressed. The stressed webbing was a result of the driver's loading. A 2.5 in section of the belt was abraded in the area of the D-ring and appeared to have gathered in the D-ring during the inertial loading. The D-ring was adjusted to the full up position. A minor abrasion was noted on the friction surface. The entire webbing was soiled from its exposure at the scene.



Figure 13: View of the driver's seat belt.

The manual restraints in the three rear seat positions of the Taurus consisted of continuous loop webbing, a sliding latch plate and a switchable Automatic Locking/Emergency Locking

Retractor (ALR/ELR). Each seat position was equipped with a tether anchor. The outboard seat positions were equipped with lower anchors for the LATCH system.

The Rear Facing Child Safety Seat (RFCSS) base was restrained by the manual restraint in the center position, **Figure 13**. The belt was routed through the belt path designed into the RFCSS base and the latch plate was buckled. A locking clip was not used and the ALR was probably not set. At the time of the inspection, the base could be moved laterally approximately 7.1 cm (2.8 in) as a result of slack in the belt system. During the course of the inspection, this restraint was unbuckled and examined. There was no crash related evidence identified on the belt or the latch plate. Refer to the *Child Safety Seat Data* section of this report for further information regarding the RFCSS and its method of restraint.



Figure 14: View of the RFCSS base.

Frontal Air Bag System

The 2002 Ford Taurus was equipped with a frontal air system that was considered an Advanced Occupant Protection System (AOPS). The AOPS consisted of the combined use of 3-point lap and shoulder belts, front seat belt buckle pretensioners, front seat belt buckle switches, driver seat position sensing, and dual-stage frontal air bags. The driver and front right passenger air bags were designed to deploy at different thresholds based on crash severity, restraint use, and driver seat position. The AOPS system was monitored and controlled by a Restraint Control Module mounted on the vehicle's center line immediately to the right of the accelerator pedal. The RCM was not supported by the Vetronix Crash Data Retrieval System and could not be downloaded. In this crash, the frontal air bags were not commanded to deploy. The longitudinal deceleration of the impact was sufficient to cause the driver pretensioner to fire but was below the threshold to warrant frontal air bag deployment.

CHILD SAFETY SEAT DATA

Figure 15 is a front view of the Rear Facing Child Safety Seat (RFCSS) in use at the time of the crash. The RFCSS was an Evenflo Port About RFCSS Model No: 5581333N1, manufactured February 6, 2004. The base of the RFCSS was restrained in the center rear position of the Ford by the vehicle's 3-point lap and shoulder belt. The seat was labeled for use by infants 2.2 kg to 10 kg (5 lb to 22 lb) with a height of 66 cm (26 in) or less. The manufacture's labels were intact and legible. The instruction manual was not present. The locking clip was in place on the back aspect of the shell.



Figure 15: View of the RFCSS shell.

The RFCSS was configured with a 3-point harness system. The harness was routed through the top slots. Both harness straps were in good condition. They were not folded over, roped, or creased. The length of each strap measured 13 cm (5 in). The chest retainer clip was located 22 cm (8.5 in) below the top slot. There was no evidence of loading observed on the harness straps or retainer clip.

The shell was inspected for crash related physical evidence. The fabric covering was removed. The upper aspect of the shell exhibited stress marks that extended across the full width related to its contact with the driver seat back. Refer to **Figure 16**. The stress marks appeared heavier on the right indicative of the direct contact. Additional stress marks were observed on the right arm of the carrier handle. The presence of these marks indicated the carrier handle had been rotated to the proper position (for use in a vehicle) at the time of the crash.

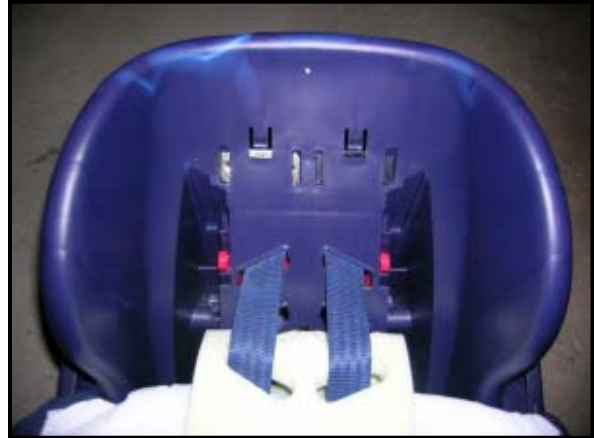


Figure 16: View of the stress marks to the RFCSS.

The RFCSS base was removed from the vehicle during the SCI inspection and examined. The adjustable foot was in the fully retracted position. No stress marks were observed along the belt path. Stress marks were noted along the sides of the base at the junction with the reinforced ribs. It could not be determined if these marks were crash related or related to a manufacturing process. The shell properly engaged the base and securely locked into position.

Figures 17 and 16 are views of the reconstructed position of the RFCSS. The RFCSS base fully engaged the depth of the seat cushion. The measured angle of the shell was 60 degrees and the manufacturer's inclinometer was in the "Green" zone. The upper right aspect of the seat was in-close proximity to the driver's seat back.



Figure 17: Overhead view of the RFCSS.



Figure 18: Left view of the RFCSS.

OCCUPANT DEMOGRAPHICS

	<i>Driver</i>	<i>Center Rear Child Passenger</i>
Age / Sex:	24 year old / Male	4 month old / Male
Height:	183 cm (72 in)	Not reported
Weight:	100 kg (220 lb)	5 kg (11 lb)
Seat Track Position:	Full ear track	Fixed bench
Manual Restraint Use:	3-pt. lap and shoulder	Restrained within a 3-pt. harness in a Rear Facing Child Safety Seat
Usage Source:	SCI inspection, PAR	SCI inspection, First responder, PAR
Medical Treatment:	None, fatally injured	Transported via air ambulance to a Level 1 Pediatric Trauma Center, hospitalized for two days and expired from his injuries

DRIVER INJURY

<i>Injury</i>	<i>Injury Severity (AIS 98 Update)</i>	<i>Injury Source</i>
Complete laceration of the transverse/oblique thoracic aorta, descending portion on or about the arch, Hemothorax	Critical (420210.5,4)	Intruding left door
Left ribs fractures (4,5,7,8) along the anterior axillary line	Severe (450232.4,2)	Intruding left front door (arm rest)
Bilateral lung contusions	Severe (441410.4,3)	Steering column
Complete cerebral hemorrhage, NFS	Severe (140629.4,9)	Front of the Dodge Grand Caravan (V2)
Subarachnoid hemorrhage to the right convexity	Serious (140684.3,1)	Front of the Dodge Grand Caravan (V2)
Edema in the cerebral convexities, NFS	Serious (140660.3,9)	Front of the Dodge Grand Caravan (V2)
Left femur fracture, NFS	Serious (851800.3,2)	Knee bolster
Fracture left humerus, NFS	Moderate (752600.2,2)	Intruding left front door
Multiple lacerations of the anterior aspects of the right and left lobes of the liver	Moderate (541820.2,1)	Seat belt
Multiple left lateral neck abrasions	Minor (390202.1,2)	Seat belt
Abrasions and contusion from the left upper chest to the abdomen	Minor (490402.1,0)	Seat belt
Band impression across the lower	Minor	Seat belt

abdomen	(590402.1,0)	
Multiple abrasions, minor lacerations and contusion to the left upper shoulder	Minor (790202.1,2) (790402.1,2) (790602.1,2)	Intruding left front door
Multiple abrasions, and contusions of the left arm	Minor (790202.1,2) (790402.1,2)	Intruding left front door
Multiple dicing abrasions to the left cheek and jaw	Minor (290202.1,2)	Left front window glazing
Triangular contusion to the left parietal region	Minor (190402.1,2)	Front of the Dodge Grand Caravan (V2)
Multiple abrasions with linear laceration to left posterior lateral parietal region	Minor (190202.1,2) (190600.1,2)	Front of the Dodge Grand Caravan (V2)
Multiple left facial abrasions	Minor (290202.1,2)	Front of the Dodge Grand Caravan (V2)
Contusion to the left lateral orbit	Minor (290402.1,2)	Front of the Dodge Grand Caravan (V2)
Contusion to the right posterior parietal region	Minor (190402.1,1)	Rebound contact to the head restraint
Multiple abrasions and contusions to the lower extremities, bilaterally	Minor (890202.1/2) (890402.1/2)	Knee bolster and foot controls

Note: the above injuries were identified in the driver's Postmortem Coroner's Report.

DRIVER KINEMATICS

The 24 year old restrained driver was seated in a full rear track position with a presumed upright posture. At impact the ELR retractor locked in response to the inertial deceleration of the impact and the buckle pretensioner was commanded to fire. The driver initiated a forward and left trajectory and loaded the locked belt system with his chest and pelvis. This loading was evidenced by the neck, chest, and abdominal abrasions. The driver's lower extremities were pre-positioned close the knee bolster and contacted the bolster during the early stages of the crash.

Coincident to this pattern the front and left side structures of the vehicle were intruding rearward and inboard. The driver's left knee pocketed in the intruding bolster and resulted in the left femur fracture. The intruding left door impacted the driver's left flank fracturing the left ribs along the axillary line. The left humerus fractured due to contact from the intruding door. The sudden deceleration of the driver's torso resulted in a complete laceration of the thoracic aorta as the driver's anatomy exceeded the limits of its internal structure. The driver's head extended through the (now) disintegrated front window glazing and contacted the front of the Dodge. This contact resulted in the identified soft tissue facial injuries and the brain injuries. During the ride down of the crash, the lap portion of seat belt rode up into the driver's abdomen and lacerated the right and left lobes of the liver. The driver's chest impacted the intruding steering wheel rim

resulting in the identified bilateral lung contusions. The driver then rebounded back into seat and came to rest.

CHILD OCCUPANT INJURY

<i>Injury</i>	<i>Injury Severity (AIS 98 Update)</i>	<i>Injury Source</i>
Large right cerebral subdural hemotoma	Critical (140656.5,1)	Rear Facing Child Safety Seat (RFCSS) Shell
Depressed right occipito-parietal skull fracture 2.2 cm in depth	Severe (150406.4,6)	RFCSS shell
Left cerebral subarachnoid hemorrhage in the high frontal region	Serious (140684.3,2)	RFCSS shell
Brain contusion, NFS	Serious (140602.3,1)	RFCSS shell
Hemotoma right occipital scalp	Minor (190402.1,1)	RFCSS shell
Right second rib fracture, NFS	Minor (450212.1,1)	RFCSS shell
Linear right frontal skull fracture	Moderate (150402.2,1)	Rebound into the rear bench seat back
Minor right frontal scalp abrasion	Minor (190202.1,1)	Rebound into the rear bench seat back
Child initially unresponsive with an irregular heart rate and respiration, in and out of consciousness, Glasgow Coma Score = 8 on arrival, Sluggish pupils		

Note: the above injuries were identified in the occupant’s Emergency Room, Radiology and Discharge Summary.

CHILD OCCUPANT KINEMATICS

Prior to the impact, the 4 month male was restrained by the 3-pt harness straps of the child safety seat in a rear facing mode. The RFCSS was restrained in the rear center of the Ford by the vehicle’s 3-pt lap and shoulder belt. A locking clip was not in use and the switchable retractor was not set.

At impact, the seat belt retractor locked in response to the inertial deceleration of the crash. The child and RFCSS initiated a forward and left trajectory in response to the 10 o’clock direction of the impact force. Initially the child and RFCSS moved together as a single unit. As the seat belt webbing became taut, the child safety seat loaded the locked belt system and began to ride down the force of the impact through the use of the vehicle’s restraint.

As the crash ensued, the child continued to load the back of the shell with his torso and then began to ramp up the shell. In this manner his head was positioned in the upper right aspect of the shell. Coincident to this kinematic pattern, the left structures and driver seat of the Taurus were intruding rearward and inboard (with respect to the vehicle). The back of the driver seat impacted the upper right aspect of the RFCSS evidenced by the identified contacts to the seat back and the stress marks to the RFCSS shell. This impact resulted in the child’s depressed

occipito-parietal skull fracture and multiple identified brain hemorrhages. The aspect of the rib fracture was not specified in the medical records. It was probable that the fracture was a posterior fracture and resulted from the impact between the RFCSS and driver's seat back.

The impact between the driver's seat back and RFCSS redirected the child seat into rebound. The RFCSS and child initiated a rearward trajectory (with respect to the vehicle). The RFCSS loaded the lower aspect of the rear seat back and the RFCSS rotated rearward about the seat bight and vehicle seat belt. The child loaded the 3-pt harness system with his shoulders and torso. His motion relative to the RFCSS shell exposed his head beyond the side aspects of the shell. The child's head impacted the vehicle's rear seat back evidenced by the frontal scalp abrasion and the linear frontal skull fracture. The RFCSS then rebound forward (w-r-t the vehicle) and came to rest.

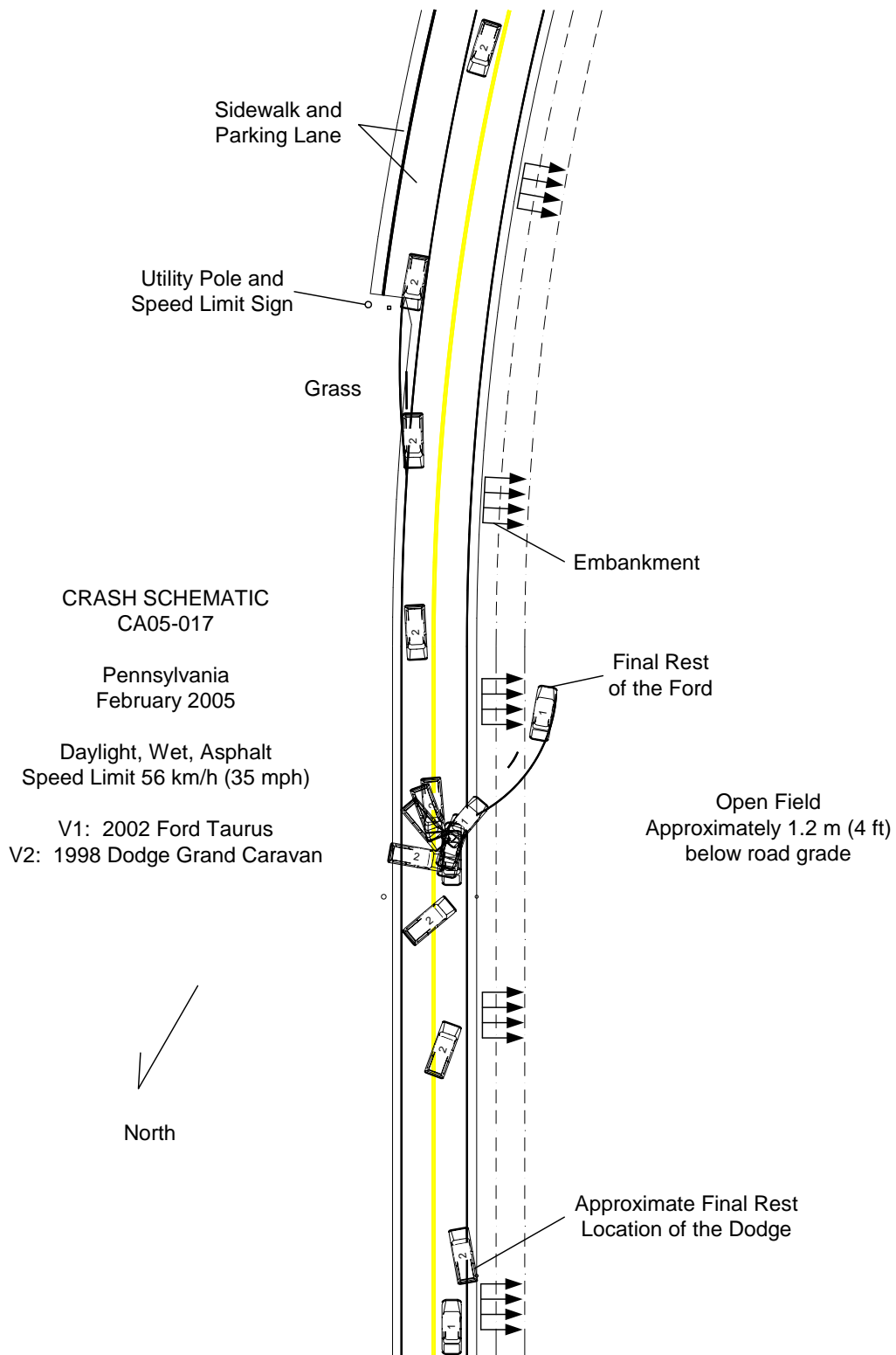


Figure 19: Crash Schematic.