CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION SYSTEM INVESTIGATION

SCI CASE NO. – CA07-013

SUBJECT VEHICLE – 2005 FORD FREESTYLE

LOCATION – STATE OF FLORIDA

CRASH DATE – MARCH 2007

Contract No. DTNH22-07-C-00043

Prepared for:

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

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

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BACKGROUND

This on-site investigative effort focused on the side impact inflatable occupant protection system in a 2005 Ford Freestyle **(Figure 1)** and the injury sources that contributed to the death of the 9-year-old male third row right passenger. The Ford Freestyle was equipped with a side impact inflatable occupant protection system that included seatback mounted side impact air bags for the front seating positions and canopy air bags for the left and right outboard positions. The right front seatback mounted side impact air bag and the left and right canopy air bags deployed as a result of an intersection crash with a Freightliner dump-truck. In addition to the side impact system, the Ford was equipped with retractor mounted safety belt pretensioners and a Certified Advanced 208-Compliant frontal air bag system. Both safety belt pretensioners fired during the crash. The frontal air bag system did not deploy. The vehicle was designed for seven passenger occupancy (2/3/2); however, at the time of the crash, the Ford was occupied by eight passengers. In addition to the subject male, the occupants consisted of a 37-year-old female driver, a 57-year-old female front right passenger, a 37-year-old female second row left passenger, a 5-year-old female second row center passenger, a 27-year-old female second row right passenger, a 5-year-old male third row left passenger, and a 7-year-old male third center passenger.

Figure 1. Subject vehicle 2005 Ford Freestyle.

This crash was identified by the Calspan Special Crash Investigations (SCI) team through an Internet news search. The Calspan SCI team forwarded the news article to the Crash Investigation Division (CID) of the National Highway Traffic Safety Administration (NHTSA). Due to the agency's interest in side impact protection and the fatal injuries to the 9-year-old male, the CID assigned an on site investigation on March 22, 2007. The on-site portion of this investigation involved the inspection of the vehicles and the crash site during the week of April 18, 2007.

SUMMARY

Crash Site

This intersection crash occurred during the morning hours of March 2007. At the time of the crash, the weather was clear with no adverse conditions. The crash occurred at the intersection of a five-lane east/west roadway and an interstate on-ramp. The eastbound lanes measured 3.7 meters (12.1 feet) wide and were configured with two through traffic lanes and center left turn lane. The westbound direction consisted of two through traffic lanes that measured 3.5 meters (11.5 feet) in width. The east/westbound lanes were separated by a 7.9 meter (25.9 feet) wide grass median that was bordered by concrete curbs. The east/westbound lanes were bordered by white fog lines with asphalt shoulders that extended beyond the fog lines. Grass roadsides were located adjacent to the shoulders. The south roadside at the intersection contained numerous street signs and a utility pole. The interstate on-ramp was located at the southern aspect of the intersection. The off-ramp was located 22 meters (72 feet) east of the on-ramp. The posted speed limit for the east/west roadway was 89 km/h (55 mph). The Crash Schematic is included as **(Figure 17)** of this report.

Vehicle Data – 2005 Ford Freestyle

The 2005 Ford Freestyle was identified by the Vehicle Identification Number (VIN): 1FMDK02165G (production sequence omitted) and was manufactured in 02/05. The digital odometer reading at the time of the inspection was unknown due to the expended vehicle battery. The Ford was a four-door crossover vehicle that was equipped with a 3.0-liter, V6 engine, 4-speed automatic transmission, front-wheel drive, power-front and rear disc brakes with anti-lock, OEM five-spoke alloy wheels, and power-steering. The Ford was equipped with Continental ContiTouring Contact tires, size P215/65R17. The maximum pressure for these tires was 303 kpa (44 psi). The vehicle manufacturer recommended front and rear tire pressure was 221 kpa (32 PSI) and 234 kPa (34 PSI), respectively. The specific measured tire data at the time of the SCI inspection was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	186 kPa (27 PSI)	6 mm (7/32)	No	None
LR	Tire flat	5 mm (6/32)	No	De-beaded, rim abrasions
RF	193 kPa (28 PSI)	6 mm (7/32)	No	None
RR	Unknown	Unknown	Unknown	Separated at impact

The front seating positions in the Ford were configured with buckets seats. The second row consisted of a three-passenger split bench seat (60/40). Additionally, the Ford was equipped with a two-passenger third row split bench seat (50/50). All seven seating positions contained height adjustable head restraints that were adjusted to the full-down positions at the time of the SCI inspection.

1999 Freightliner Dump Truck

The 1999 Freightliner dump truck was identified by the VIN: 1FVXTWDB1XH (production sequence deleted). The chassis and cab were manufactured by Freightliner in 12-98 and the dump box was manufactured by Warren Incorporated and had a Model Number; FL651SE-16. The Freightliner was powered by a 12-liter, six-cylinder diesel engine, a manual transmission, and dual drive axles. The mileage of the Freightliner was 825,655 km (513,052 miles) at the time of the SCI inspection. The dump truck was a four axle vehicle which included a tag axle that can be pneumatically lowered by an air bag suspension to support additional weight when the truck is fully loaded. The tag axle was located forward of the drive axles. At the time of the crash, the tag axle was in the raised position. The vehicle was weighed post-crash by the trucking company and weighed 11,830 kgs (26,080 lbs).

Crash Sequence

Pre-Crash

A restrained 37-year-old female driver was operating the Ford westbound on the inboard through lane **(Figure 2)** approaching the intersection. As the vehicle approached the intersection, the driver initiated a left turn maneuver across the left turn lane. There were two non-contact vehicles stopped in the left turn lane waiting for traffic to clear. The drivers of the non-contact vehicles witnessed the pre-crash travel of the Ford and the impact. Reportedly, the driver of the Ford was visiting from another state and was unfamiliar with the roadway. A 35-year-old male was operating the Freightliner eastbound on the outboard lane approaching the intersection. As the Freightliner neared the intersection, the Ford traversed the inboard eastbound lane and entered the outboard lane. The driver of the Freightliner observed the Ford and applied the brakes in an attempt to avoid the crash. The brake application locked the Freightliner's rear tires and resulted in approximately 40 meters (130 feet) of skid marks leading to the intersection. The police on-scene images of the Freightliner's approach depict the skid marks (**Figure 3)**. Due to the heavy traffic pattern and the passage of time between the crash date and SCI investigation, the pre-impact skid marks from the Freightliner had eroded and were not present on the roadway at the time of the SCI inspection.

Figure 2. Ford's westbound approach to the intersection.

Figure 3. Freightliner's pre-impact skid marks.

Crash

The center and right aspects of the Freightliner's frontal plane impacted the center and aft aspects of the Ford's right side plane in the outboard eastbound lane. The resultant directions of force were within the 3 o'clock sector for the Ford and the 12 o'clock sector for the Freightliner. The force of the lateral impact caused the actuation of the front safety belt pretensioners, deployment of the right seatback mounted side impact air bag, and the deployment of the canopy air bags in the Ford. The Freightliner's impact with the Ford was above the Freestyle's center of gravity and caused the vehicle to momentarily roll to the left. The weight shift to the left rear tire (as a result of the induced roll) caused the left rear tire to de-bead and air out. The lateral impact rearward of the Ford's center of gravity induced a clockwise rotation as the vehicles crushed. The Freightliner's direct contact to the right rear wheel sheared the wheel from the suspension during the impact. As the Ford rotated, the right rear lower control arm contacted and gouged the road surface evidenced by a 1.2 meter (3.9 ft) gouge. The gouge extended in a southeast direction along the Ford's post-crash trajectory.

Figure 4. Overhead view of the vehicles at final rest.

The Ford departed the southwest corner of the on-ramp and came to final rest approximately 6 meters (20 feet) east of the area of impact facing northeast. The total rotation of the Ford was approximately 200 degrees. The Freightliner continued its forward trajectory and began a slight clockwise rotation. The Freightliner traveled approximately 15 meters (49 feet) east from the area of impact and departed the south roadside where it came to final rest. At rest, the Freightliner was facing a southeast direction 60 degrees from its original heading angle. **Figure 4** is an overhead view of the vehicles at final rest.

The barrier equivalent algorithm of the WINSMASH program was used to compute a delta-V for the Ford. The total calculated delta-V for the Ford was 28 km/h (17.4 mph). The longitudinal and lateral components for the Ford were -4.9 km/h (-3 mph) and -27.6 km/h (-17.1 mph), respectively. The Barrier Equivalent Speed (BES) was 28 km/h (17.4 mph).

Post-Crash

Police and Emergency Medical Service (EMS) personnel responded to the crash site. The 9-year-old male third row right passenger was removed by the EMS personnel from the vehicle and was placed on the ground near the vehicle. The EMS personnel evaluated his condition and determined that the injuries were fatal and he was pronounced deceased at the crash site. The 37-year-old female driver of the Ford and the 37-year-old female second row left passenger were reported as not injured. The 57-year-old female front

right passenger sustained police reported minor injuries and was not transported for treatment. The 5-year-old female second row center and the 27-year-old female second row right passengers reportedly sustained severe injuries and were transported by ground ambulance to a local hospital for treatment. The 5-year-old male third row left and the 7-year-old male third row center passengers sustained life threatening injuries and were transported by helicopter to a local hospital.

The Ford sustained severe damage and was towed from the crash site and was subsequently deemed a total loss by the insurance company. The Freestyle was located at an insurance salvage facility where it was inspected for this on-site investigation. The Freightliner was towed from the crash and was inspected at the trucking company.

Vehicle Damage

Exterior Damage – 2005 Ford Freestyle

The 2005 Ford Freestyle sustained severe right side damage as a result of the impact with the Freightliner **(Figures 5 and 6)**. The direct contact damage measured 185 cm (73") and began 201 cm (79") rear of the right front axle. The direct contact ended at the aft edge of the right quarter panel 386 cm (152") rearward of the front axle. The total height of the direct contact damage measured 135 cm (53") beginning 5 cm (2") above sill extending to the top of the roof side rail. Yellow paint transfers were noted on the roof side rail indicative of direct contact.

Figure 5. Resultant damage to the right side of the Ford.

Figure 6. Longitudinal view of the crush.

The damage consisted of lateral crush to the right center and rear aspects, separation of the right rear wheel, and deformation to the fuel filler neck. The crush was measured along the mid-door level using a combined direct and induced damage length of 211 cm (83") and was as follows: C1 = 23 cm (9"), C2 = 43 (16.75"), C3 = 51 cm (20"), C4 = 29 cm (11.5"), C5 = 12 cm (4.75"), C6 = 0 cm. The maximum crush located at C3 measured 51 cm (20"). It was located at the third row left seat position 66 cm (26") forward of the rear edge of the quarter-panel. The Collision Deformation Classification (CDC) for this impact was 03-RZAW-4.

The beltline at the third row location was located 117 cm (46") from the ground. The third row seat cushion at the area of impact was located 41 cm (16") below the beltline.

The front bumper of the Freightliner measured 20 cm (8”) in height and the bottom surface of the bumper was located 66 cm (26”) from the ground. At impact, the top aspect of the Freightliner’s bumper was 31 cm (12”) below the beltline which was the approximate area of the 9-year-old male’s lower torso.

In addition to the crush, the fuel filler neck which was located in the right quarter-panel was deformed. A 41 cm (16”) section of the sheet metal prior to and including the area of the filler neck was torn and peeled rearward. The steel filler neck loaded against top aspect of the frame rail resulting in slight bending of the neck. Although, the filler neck was deformed the integrity of the fuel system was not compromised.

The left side and right front doors remained closed during the crash and were operational post-crash. The right rear door was jammed in the closed position from the crush and could not be opened. The rear hatch was displaced laterally left 3 cm (1”) resulting in misalignment of the latch and striker. The hatch was opened post-crash and could not be closed due to the altered alignment.

The Ford’s glazing was comprised of an AS 1 laminated windshield, AS 2 tempered side door glazing, and AS 3 original deep tinted third row and hatch glazing. The windshield, left side, right front, and right rear door glazing were free of damage. The right rear door quarter window, third row, and the hatch glazing were disintegrated from the impact damage.

Exterior Damage – 1999 Freightliner

The 1999 Freightliner sustained moderate frontal damage from the impact sequence with the Freestyle **(Figure 7)**. The damage involved longitudinal crush to the front steel bumper, abrasions and paint transfers to the fiber glass hood, a fractured right headlamp, and fractures to the plastic grille. The direct contact damage measured 168 cm (68”) and began at the front right bumper corner terminating 46 cm (18”) inboard of the front left bumper corner. The height of the steel bumper measured was 20 cm (8”) and its lower aspect located 66 cm (26”) from the ground. A crush profile was documented at the bumper and was as follows: C1 = 0 cm, C2 = 0 cm, C3 = 1 cm (0.25”), C4 = 3 cm (1.25”), C5 = 3 cm (1”), C6 = 21 cm (8.25”). The Truck Deformation Classification (TDC) for this impact was 12-FZEW-1

Figure 7. Damaged 1999 Freightliner.

Interior Damage – 2005 Ford Freestyle

The interior damage to the Ford was severe and was attributed to intrusion of the passenger compartment **(Figure 8)** and occupant contact points. The front row of the Freestyle was free of occupant contact points from the driver and front right passenger.

The passenger compartment intrusions were as follows:

Seat Position	Intruded Component	Magnitude	Direction
Front Right	Roof side rail	3 cm (1.25”)	Lateral
Front Right	B-pillar	10 cm (4”)	Lateral
Second Row Right	Door panel	19 cm (7.5”)	Lateral
Second Row Right	Roof side rail	17 cm (6.5”)	Lateral
Second Row Right	Right seatback	11 cm (4.5”)	Lateral
Third Row Right	C-pillar	23 cm (9”)	Lateral
Third Row Right	Side panel	33 cm (13”)	Lateral
Third Row Right	Roof side rail	10 cm (3.75”)	Lateral
Third Row Right	D-pillar	25 cm (10”)	Lateral
Third Row Right	Right seatback	13 cm (5.25”)	Lateral
Third Row Right	Side panel in cargo area	22 cm (8.5”)	Lateral

Three orange colored transfers were noted on the second row right roof side rail area. These transfers were located from 31-38 cm (12-15”) aft of the B-pillar and from 3-8 cm (1-3”) above the bottom edge. Additionally, a black scuffmark was present on the roof side rail from 43-48 cm (17-19”) rear of the B-pillar and 8-9 cm (3-3.5”) above the lower aspect of the side rail. It was inconclusive if the transfer evidence were caused by occupant contact.

Figure 8. Rear to front view of the passenger compartment intrusion.

The second and third rows were equipped bench seats with forward folding seatbacks, 60/40 left side wide and 50/50, respectively. Post-crash the left sides of the both seatbacks had been moved and located folded forward at the time of the SCI inspection. Due to the intrusions sustained at the second and third rows, the right seatbacks were displaced laterally left prohibiting the left seatbacks from being placed in the upright position.

The right side of the third row exhibited possible evidence of occupant contact. These contact points consisted of a white stress mark on the plastic side panel from a combination of contact from the 9-year-old and the panel deforming around the child

passenger's hip area as the panel intruded. This stress mark was located from 36-58 cm (14-23") aft of the C-pillar. A black scuffmark was noted on the roof side rail over third row seat. This scuffmark was located 8-13-cm (3-5") rear of the C-pillar. Although not considered an occupant contact, spattered body fluid was present on the top surface of the side panel and safety canopy air bag membrane.

Figure 9. Deployed left canopy air bag.

Inflatable Side Impact Protection System

The 2005 Ford Freestyle was equipped with safety canopy air bags for the left and right outboard seating positions. The canopy air bags deployed from the roof side rails inboard of the pillars and side glazing. The canopy air bags extended from the A-pillar to the D-pillar. The canopy air bags were designed to deploy in the event of a side impact or rollover crash using the vehicle's respective side impact and rollover sensors. The canopy air bags were designed to remain inflated for a period of approximately six seconds following deployment.

In the subject crash, the right and left canopy air bags deployed. The canopy air bags deployed as a result of the right side impact and were commanded by the side impact sensor.

Figure 10. Deployed right canopy air bag.

The canopy air bags were rectangular in shape and measured 41 cm (16") vertically from the roof side rail and 239 cm (94") in length. The air bags were tethered by a sail-panel at the A-pillar and a rope-type tether at the C-pillar. The sail-panel at the A-pillar measured 32 cm (12.75") in height and 38 cm (15") in length. The tether at the C-pillar measured 18 cm (7") in length. No occupant contacts were noted to the left canopy air bag. **Figure 9** is an overall view of the deployed left canopy air bag.

The following nomenclature was located on the inboard center aspect of the left and right air bag membranes, respectively:

5241167C
SIPA6.6
5241167E
SIPA6/6

The right safety canopy air bag deployed from the right roof side rail **(Figure 10)**. The deployment of this air bag was partially impeded by the right C-pillar trim. At deployment, the C-pillar was beginning to intrude laterally left and top aspect of the trim separated from its closure against the headliner. As the canopy air bag expanded, the air bag membrane was captured between the C-pillar trim panel and the intruding C-pillar structure **(Figure 11)**. The trim panel remained attached to the C-pillar structure by its four mounting clips. The captured air bag resulted in the membrane extending in an inverted V-shaped pattern beginning 41 cm (16") forward of the C-pillar to 41 cm (16") rear of the C-pillar. The C-pillar trim panel was removed from its mounting points to conduct an inspection of the partially deployed membrane. Inspection of the membrane at this location revealed that it was still partially rolled similar to its un-deployed state **(Figure 12)**. Although that air bag was partially impeded, the air bag membrane expanded to its near full length and height offering a level of head protection to outboard passengers in all three rows. There were no visible occupant contact points or damage to the air bag membrane; however, spattered body fluid was present on the membrane at the area of the third row.

Figure 11. Canopy air bag membrane captured behind C-pillar trim panel.

Figure 12. Air bag membrane with removed C-pillar trim panel. Note membrane was partially rolled similar to its un-deployed state.

In a side impact crash test conducted by Karco on August 18, 2006 for NHTSA's SNCAP, Test number 5829, the left canopy air bag deployed in a similar pattern. The test video shows the impeded deployment of the canopy air bag. As the air bag reached its fully deployed status, the C-pillar trim panel was dislodged from its top mounting points and the membrane inflated behind the panel. **Figures 13 and 14** are images of the second row left side canopy air bag system pre- and post-test. In the post-test image the canopy air bag was captured behind the C-pillar trim panel.

Figure 13. Pre-test view of the left side.

Figure 14. Post-test view of the deployed canopy air bag.

The Ford was equipped with seatback mounted side impact air bags for the front seats. The right seatback mounted side impact air bag deployed as a result of the crash **(Figure 15)**. The air bag was concealed in the outboard aspect of the right front seatback. The air bag deployed through a 47 cm (18.5") vertical tear seam. The air bag membrane measured 23 cm (9") in height at the seatback and 37 cm (14.5") in width. There was no occupant contact or damage to the air bag.

Figure 15. Inboard aspect of the deployed side impact air bag.

Frontal Air Bag System

The 2005 Ford Freestyle was equipped with a Certified Advanced 208-Compliant frontal air bag system. The manufacturer certified that this vehicle met the advanced air bag requirements of the Federal Motor Vehicle Safety Standard (FMVSS) No. 208. In the subject crash, the frontal air bag system did not deploy.

Manual Restraints Systems

The Freestyle was equipped with manual 3-point lap and shoulder safety belts for the seven positions. Although this vehicle was designed as a seven-passenger vehicle, the Ford was occupied by eight passengers at the time of the crash.

The driver's safety belt was equipped with a sliding latch plate, Emergency Locking Retractor (ELR), height adjustable D-ring that was adjusted to the full-up position and a retractor mounted pretensioner that actuated during the crash. The driver was restrained at time of the crash which was supported by full width loading abrasions to the latch plate and D-ring. Additional evidence consisted of the safety belt found in the extended position due to the actuated pretensioner.

The front right safety belt system consisted of a sliding latch plate, a switchable ELR/Automatic Locking Retractor (ALR), an adjustable D-ring that was adjusted to the full-up position and a retractor mounted pretensioner that fired during the crash. Although the pretensioner fired, the mobility of the safety belt was not restricted. The 57-year-old female front right passenger used the safety belt during the crash which was supported by heavy full-width loading abrasions on the latch plate and D-ring. There was no loading evidence on the webbing.

The second row outboard safety belts were equipped with sliding latch plates and switchable ELR/Automatic Locking Retractors (ALR). The 37-year-old female occupied the second row left position and used the safety belt during crash. The crash related evidence consisted of minor loading abrasions to the latch plate. The integrated second row center safety belt was not used by the 5-year-old female that occupied this position. Due to the intrusion of the second row right seatback, the retractor for the center safety belt was locked restricting the webbing in the stowed position. Furthermore, there was no loading evidence to the webbing or hardware of the belt system. The third row right position was occupied by a 27-year-old female. The 27-year-old female used the safety belt during the crash which was supported by loading evidence to the latch plate and the restricted safety belt webbing in the used position. The safety belt was restricted due to the intrusion of the right C-pillar which jammed the retractor.

The third row of the Ford was designed as a two-passenger seat. At the time of the crash, this row was occupied by three passengers. The left seat was occupied by a 5-year-old male which used the safety belt during crash. Minor loading abrasions were evidenced on the latch plate. The center area of the third row was occupied by an unrestrained 7-year-old male. The center area of the third row was not a designated seating position; therefore, it was not equipped with a safety belt. The 9-year-old male passenger occupied the right seating position of the third row. At the time of the crash, this passenger was not restrained. His unrestrained status was supported by the D-pillar intrusion which restricted the safety belt in the stowed position and the lack of evidence on the belt system.

Occupant Demographics

Driver

Age/Sex:	37-year-old/Female
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Rear third track position
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Not injured

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Not injured	N/A	N/A

Source – Police reported

Driver Kinematics

The 37-year-old male driver of the 2005 Ford Freestyle was seated in a presumed upright posture with the seat track adjusted to a rear third track position. The driver of the Ford was restrained by the 3-point lap and shoulder belt system. Prior to the impact, the driver applied a rapid left steering input to complete a left turn maneuver. The steering input probably displaced the driver slightly to the right. At impact with the Freightliner, the front safety belt pretensioners actuated and the air bags deployed. The actuated pretensioner removed the slack in the belt system and tightened the webbing on the driver. The driver continued to the right in response to the 3 o'clock direction of the impact force and loaded the belt system. Her lateral motion was minimal due to the safety belt usage and fired pretensioner. The driver was not injured as a result of the crash.

Front Right Passenger

Age/Sex:	57-year-old/Female
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Rear third track position
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Unknown if treated at a medical facility

Front Right Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Minor injuries, NFS	Unknown	Unknown

Source – Police reported

Front Right Passenger Kinematics

The front right position of the Ford was occupied by a 57-year-old female seated in a presumed upright posture with the seat track was adjusted to a rear third track position. This passenger was restrained at the time of the crash by the lap and shoulder belt. The left turn maneuver prior to the impact resulted in a right movement by this passenger placing her within close proximity to the right door panel. At impact with the Freightliner, the safety belt pretensioner actuated, canopy air bag system, and right seatback mounted side impact air bag deployed. The actuated pretensioner tightened the

webbing by removing excess slack. She initiated a lateral right trajectory and her head loaded the deployed canopy air bag and her right flank loaded the side impact air bag. The belted status of this passenger and her interaction with the deployed air bag systems prevented significant movement, minimizing her injury potential. Although she sustained minor injuries, it was not known if she was transported to a hospital for treatment.

Second Row Left Passenger

Age/Sex:	37-year-old/Female
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Not adjustable
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	N/A Not injured

Second Row Left Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Not injured	N/A	N/A

Source – Police reported

Second Row Left Passenger Kinematics

The 37-year-old female passenger was seated in the second left position of the Freestyle. At the time of the crash, she was restrained by the lap and shoulder belt and was presumed to be seated in an upright posture. Immediately prior to the impact, the driver of the vehicle was negotiating an abrupt left turn. This turning maneuver resulted in lateral right movement of this passenger. During this movement she probably contacted the center seat passenger which arrested her lateral displacement. At impact, the seatbelt retractor locked and this passenger responded to the 3 o'clock direction of force. Her trajectory was minimal due to her loading of the locked safety belt. This passenger was not injured during the crash.

Second Row Center Passenger

Age/Sex:	5-year-old/Female
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Not adjustable
Manual Restraint Use:	None used
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Transported by ground ambulance to a hospital for treatment

Second Row Center Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Unknown severe injuries, NFS	Unknown	Unknown

Source – Police reported

Second Row Center Passenger Kinematics

The 5-year-old female passenger was seated in the second center position of the Freestyle and was unrestrained. During the pre-crash left turn trajectory, the 5-year-old female was displaced laterally right and probably contacted the second row right passenger which temporally arrested her movement. At impact, the canopy air bag system deployed and the right rear door began to intrude. The unrestrained 5-year-old female responded 3 o'clock impact force by continuing her lateral right trajectory. Her kinematic response placed her within close proximity of the intruding door panel. Although not supported by residual occupant contact evidence, she probably contacted the door panel which resulted in the reported severe injuries. The 5-year-old female was transported by ground ambulance to a local hospital where she treated for her injuries.

Second Row Right Passenger

Age/Sex:	27-year-old/Female
Height:	Unknown
Weight:	79 kgs (175 lbs)
Seat Track Position:	Not adjustable
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Transported by ground ambulance to a hospital where she was treated and released

Second Row Right Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Contusion to the left side of the face	Minor (290402.1,2)	Second row center passenger
Contusion to the left infraorbital region	Minor (297402.1,2)	Second row center passenger
Unspecified superficial head injury	Minor (115099.7,0)	Second row center passenger
Cervical strain	Minor (640278.1,6)	Impact forces

Source – Emergency room records

Second Row Right Passenger Kinematics

The second row right seating position was occupied by the 27-year-old female passenger. She was restrained by the lap and shoulder belt system and was seated in a presumed upright posture. Prior to the impact, the left turn maneuver displaced this passenger to the right against the right rear door. The left and center seat passengers were also displaced to the right and loaded this passenger. Her contact with center seat passenger resulted in the contusion to the left side of the face, left infraorbital, and the unspecified head injury. At impact, the canopy air bag system deployed and the passenger responded to the lateral impact forces by initiating a right trajecoty. Although the air bag membrane was impeded during the deployment and was partially captured behind the C-pillar trim panel, the downward deployment of the air bag provided approximately 25 cm (10") of vertical coverage at the area of the occupants head. The partially extended air bag membrane would have arrested the lateral movement of her head and provided some level of head protection. As the vehicles continued to engage, the right rear door panel intruded into this passenger's space. The 27-year-old female's hip and lower body loaded the intruding door panel and was displaced left by the door panel while her upper body continued a right trajectory. This movement resulted in the cervical strain. The 27-year-old female was transported by ground ambulance to a local hospital where she was treated and released.

Third Row Left Passenger

Age/Sex:	5-year-old/Male
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Not adjustable
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Transported by helicopter to a hospital where he was hospitalized for five days

Third Row Left Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Punctate hemorrhages of the frontal lobe	Severe (140629.4,9)	Left side panel
Contusion in the corpus callosum	Serious (140604.3,9)	Left side panel
1 x 1 cm (0.4 x 0.4") left forehead abrasions	Minor (290202.1,7)	Left side panel

Source – Emergency room records

Third Row Left Passenger Kinematics

The 5-year-old male passenger was seated in the third row left position of the Ford Freestyle and was restrained by lap and shoulder belt system. He was displaced laterally right during the pre-crash left turn maneuver initiated by the driver. This lateral

movement probably resulted in loading of the safety belt system and contact with the center seat passenger. At impact, he responded to the lateral impact forces by continuing load the belt system and center passenger. During the later stages of the vehicle's post0-impact travel he rebounded to the left. His head impacted the left side panel which resulted in the head injuries. As a result of the crash, this passenger was transported by helicopter to a local hospital where he was hospitalized for five days.

Third Row Center Passenger

Age/Sex:	7-year-old/Male
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Not adjustable
Manual Restraint Use:	None available
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Transported by helicopter, hospitalized for six days

Third Row Center Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Extensive right kidney laceration (right upper and mid pole) extends to the hilum with retroperitoneal hematoma	Severe (541626.4,1)	Third row right passenger
Right lung contusion of the lower lobe	Serious (441406.3,1)	Third row right passenger
Right rib fractures (at least 2) with small bilateral pneumthorax	Serious (450222.3,1)	Third row right passenger
Right shoulder contusion	Minor (790402.1,1)	Third row right passenger

Source – Emergency room records

Third Row Center Passenger Kinematics

The 7-year-old male passenger was seated in the third row center position of the Ford Freestyle which was not a designated seating position; therefore, it was not equipped with a safety belt system. Due to the pre-crash left turn trajectory, the 7-year-old male was displaced laterally right and contacted the third row right passenger which momentarily arrested his movement. At impact, the canopy air bag system deployed and the right rear side panel began to intrude. Due to the lateral crash forces, the unrestrained male continued his lateral right trajectory and loaded the third row right passenger. This loading resulting in the extensive right kidney laceration, right lower lobe lung contusion, right rib fractures with small bilateral pneumthorax, and a right shoulder contusion. The right aspect of all the passenger's injuries was consistent with his interaction with the left aspect of rear right passenger. The 7-year-old male was transported by helicopter to a local hospital where he hospitalized for six days.

Third Row Right Passenger

Age/Sex:	9-year-old/Male
Height:	137 cm (54”)
Weight:	45 kgs (99 lbs)
Seat Track Position:	Not adjustable
Manual Restraint Use:	None used
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Not treated, pronounced deceased at the crash site

Third Row Right Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Complete laceration of the proximal descending thoracic aorta involving 100% of the circumference	Critical (420210.5,4)	Right side panel
Laceration of the right lung with more than 20% percent blood loss (right cavity 380 ml and left cavity 620 ml)	Severe (441420.4,2)	Right side panel
Bilateral lung contusions 30% right and 20% left	Severe (441410.4,3)	Right side panel
Circumferential epidural hemorrhage of the cervical spinal canal	Serious (640202.3,6)	Right side panel
Pleural laceration associated with the rib fractures and lacerated on either side of aorta	Moderate (441800.2,3)	Right side panel
2 cm (0.8”) liver laceration at falciform ligament	Moderate (541822.2,1)	Right side panel
Anterior 1st and 2nd right rib fractures	Moderate (450220.2,1)	Right side panel
Right lateral clavicle complete and slightly displaced fracture	Moderate (752200.2,1)	Right side panel
Left lateral clavicle complete and slightly displaced fracture	Moderate (752200.2,2)	Third row center passenger
5 x 1.5 cm (2 x 0.6”) vertical abrasions that extended from the right forehead to the eyebrow	Minor (290202.1,7)	Right side panel
Small round linear abrasions to the nose	Minor (290202.1,4)	Right side panel
Small round linear abrasions from 0.3 cm to 3 cm (0.1 to 1.2”) to the right cheek	Minor (290202.1,1)	Right side panel

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Small round linear abrasions from 0.3 cm to 3 cm (0.1 to 1.2”) to the left cheek	Minor (290202.1,2)	Third row center passenger
Abrasions to the left and right eyelids	Minor (297202.1,1 297202.1,2)	Right side panel
Contusions to the left and right eyelids	Minor (297402.1,1 297402.1,2)	Right side panel
2 cm (0.8”) right subscapular occipital contusion	Minor (190402.1,1)	Right side panel
8 x 4 cm (3.1 x 1.6) left subscapular occipital contusion	Minor (190402.1,2)	Third row center passenger
Two horizontal parallel linear abrasions to the right side of the neck extending from sternoclavicular joint to lateral clavicle	Minor (390202.1,1)	Right side panel
4 x 1.5 cm (1.6 x 0.6”) oblique left neck abrasions extending earlobe to angle of jaw with an abrasion beneath	Minor (390202.1,2)	Third row center passenger
Scattered non-pattern linear abrasions with abraded contusions chest predominately below the areolas to inferior sternal borders	Minor (490202.1,0 490402.1,0)	Right side panel
Band like abrasions and contusion to the suprapubic area	Minor (590202.1,8 590402.1,8)	Right side panel
1.5 cm (0.6”) small oval contusion to the anterior left knee	Minor (890402.1,2)	Third row center passenger
Triangular contusion to the right calf and a scattered small and medium horizontal contusion of the right anterolateral to posterior upper thigh	Minor (890402.1,1)	Right side panel
Vertical linear abrasions to the right superior shoulder and scattered on right fingers	Minor (790202.1,1)	Right side panel
Right posterior shoulder and axillary line abrasions	Minor (690202.1,1)	Right side panel
Large irregular round horizontal right posteromedial upper arm contusion	Minor (790402.1,1)	Right side panel

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
10 cm x 3 cm (3.9 x 1.2”) oblique vertical irregular abrasions to the left anterior forearm with an adjacent three sided abrasion and abrasions to the left fingers and ulnar aspect of the wrist	Minor (790202.1,2)	Third row center passenger
Abrasion to the right buttocks	Minor (890202.1,1)	Right side panel

Source – Autopsy

Third Row Right Passenger Kinematics

The 9-year-old male passenger was seated in the third row right position of the Ford Freestyle and was not restrained. Prior to the impact, he became positioned against the side panel as result of the left turn maneuver and was loaded by the third row center passenger. At impact, the canopy air bag system deployed. The partially impeded air bag membrane extended vertically downward approximately 20 cm (8”) which was sufficient to cover the glazing area and offered a level of head protection to the passenger.

The passenger responded to the 3 o’clock impact force by initiating a rightward trajectory. As the vehicle crushed, the right side panel began to intrude into the right seating position. Due to the ride height of the Freightliner, the top aspect of the Freightliner’s front bumper was 66 cm (26”) above the ground. The third row seat cushion was located 76 cm (30”) above the ground which placed the bumper of the Freightliner and intruding side panel in the area of the 9-year-old male’s hip and torso. The 9-year-old male contacted and loaded the intruding side panel which was evidenced by a 23 x 14 cm (9 x 5.5”) area of stress (whitened plastic) to the side panel (**Figure 16**). The shape and location of the stressed area was consistent with the location of the passenger’s right flank and right lower extremity. The intruding side panel displaced his pelvic area to the left which allowed his upper body and head to flex laterally to the right. The side panel loading resulted in the fatal aortic laceration and the multiple thoracic and abdominal injuries identified during the autopsy (refer to the above table). The passenger’s fatal injuries were directly related to the location of the impact and the resulting intrusion. The right flexion movement was amplified by the loading from the unrestrained center passenger. This interaction was evidenced by the symmetrical injuries to the left and right aspects of the neck and the clavicles. Additional minor to moderate severity injuries were also

Figure 16: Right rear seat position.

identified by the autopsy to the left aspects of his head and torso. These injuries were consistent with, and could be directly linked to the contact and loading from the right aspect of the third row center passenger's torso.

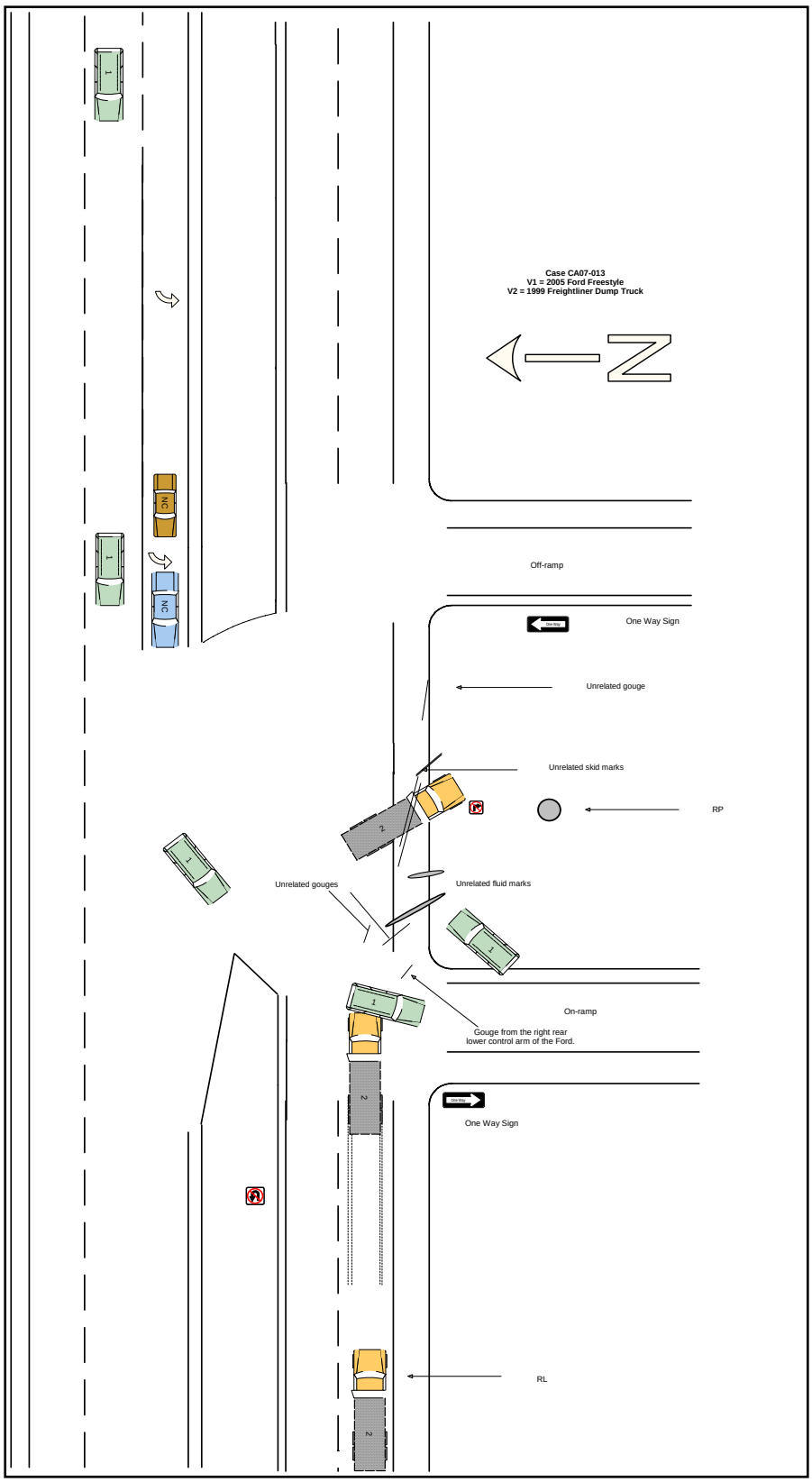

Figure 17: Crash Schematic