CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE POTENTIAL SAFETY-RELATED DEFECT INVESTIGATION

CASE NO: CA03-003

VEHICLE: 1993 ISUZU RODEO

LOCATION: FLORIDA

CRASH DATE: JANUARY 2003

Contract No. DTNH22-01-C-17002

Prepared for:

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

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

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16. Abstract This on-site crash investigation focused on a reported tire tread separation that resulted in a multiple rollover event, the ejection of four passengers and the death of three. The crash involved a 1993 Isuzu Rodeo sport utility vehicle (SUV). The Isuzu was occupied by a 33-year old male driver, a 40-year old adult male front right passenger, a 41-year old female second row left passenger, an 11-year old female second seat center passenger, a 20-year old female second row right passenger, and a 14-year old male who was seated in the rear cargo area of the vehicle. The driver, the front right passenger, and the second row center passengers were utilizing their safety belts at the time of the crash. The remaining three passengers were unrestrained. The vehicle sustained a loss of pressure of the right rear tire as the driver was traveling at a high-rate of speed on an interstate roadway. As the tire lost pressure, it continued to rotate. The wheel eventually cut the entire tread from the tire leaving the sidewalls as the only remaining tire components on the alloy wheels. The tire tread did not separate from the tire prior to the tire separation. Remnants of the tire became displaced from the right rear wheel and fractured the left rear glazing of a 2002 Chevrolet Astro Minivan traveling in the outside lane adjacent to the Isuzu. The driver of the Isuzu lost directional control of the vehicle which yawed in a counterclockwise direction into the depressed grass median. The vehicle tripped in a side-over-side rollover event across the median before coming to rest on the inboard lane of the opposing travel lanes. The three rear seated occupants and the child passenger positioned in the cargo area of the vehicle were fully ejected from the Isuzu. Three of the ejected passengers sustained fatal injuries and expired within two days of the crash. The fourth ejected passenger sustained incapacitating injuries and was hospitalized for an undetermined amount of time. The driver and front right passengers also sustained incapacitating injuries and were transported to a regional trauma center and admitted for their injuries. The Isuzu was towed from the scene due to severe damage.			
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BACKGROUND

This on-site crash investigation focused on a reported tire tread separation that resulted in a multiple rollover event, the ejection of four passengers and the death of three. The crash involved a 1993 Isuzu Rodeo **(Figure 1)** sport utility vehicle (SUV). The Isuzu was occupied by a 33-year old male driver, a 40-year old adult male front right passenger, a 41-year old female second row left passenger, an 11-year old female second seat center passenger, a 20-year old female second row right passenger, and a 14-year old male who was seated in the rear cargo area of the vehicle. The driver, the front right passenger, and the second row center passengers were utilizing their safety belts at the time of the crash. The remaining three passengers were unrestrained. The vehicle sustained a loss of pressure of the right rear tire as the driver was traveling at a high-rate of speed on an interstate roadway. As the tire lost pressure, it continued to rotate. The wheel eventually cut the entire tread from the tire leaving the sidewalls as the only remaining tire components on the alloy wheels. The tire tread did not separate from the tire prior to the tire separation. Remnants of the tire became displaced from the right rear wheel and fractured the left rear glazing of a 2002 Chevrolet Astro Minivan traveling in the outside lane adjacent to the Isuzu. The driver of the Isuzu lost directional control of the vehicle which yawed in a counterclockwise direction into the depressed grass median. The vehicle tripped in a side-over-side rollover event across the median before coming to rest on the inboard lane of the opposing travel lanes. The three rear seated occupants and the child passenger positioned in the cargo area of the vehicle were fully ejected from the Isuzu. Three of the ejected passengers sustained fatal injuries and expired within two days of the crash. The fourth ejected passenger sustained incapacitating injuries and was hospitalized for an undetermined amount of time. The driver and front right passengers also sustained incapacitating injuries and were transported to a regional trauma center and admitted for their injuries. The Isuzu was towed from the scene due to severe damage.

Figure 1 - View of 1993 Isuzu Rodeo.

The crash occurred in January 2003 during daylight hours. The crash was identified through media coverage and was assigned to the Calspan SCI team on January 6, 2003. Cooperation was established with the investigating officer of the Florida Highway Patrol and an on-site investigation was conducted on Wednesday, January 8, 2003.

SUMMARY

Crash Site

The crash occurred of a four-lane divided interstate roadway during daylight hours. At the time of the crash, the asphalt road surface was dry and the weather was clear. The travel lanes were 3.7 m (12') in width and bordered by a 3.2 m (10.5') outboard shoulder and a 1.3 m (4.3') wide paved inboard shoulder. Tactile rumble strips were cut into both shoulders and began 0.7 m (2.3') outboard of the edge lines. The travel lanes were delineated by a broken white lane line. The east/westbound travel lanes were divided by a 24 m (78') wide depressed grass median. The median sloped at a shallow grade to a depth of 1.5 m (5') at the centerline of the median. It should be noted that the median was composed of grass growing in a soft sandy soil. The interstate roadway was straight and level with a posted speed limit of 113 km/h (70 mph). The SCI scene schematic is included as **Figure 19** at the end of this narrative report.

Vehicle Data

The involved vehicle in this rollover crash was a 1993 Isuzu Rodeo, 4-door sport utility vehicle (SUV). The Isuzu was configured as a 4x2 platform with rear-wheel drive. The Rodeo was manufactured on January 1993 and identified by Vehicle Identification Number (VIN): 4S2CG58V5P4 (production number deleted). The Isuzu was powered by a 3.2 liter, 24-valve V-6 linked to a four-speed automatic overdrive transmission. The service brakes were power assisted four-wheel disc brakes without anti-lock. The vehicle's placarded Gross Vehicle Weight Rating (GVWR) was 2,109 kg (4,650 lb), split 953 kg (2,100 lb) front and 1,270 kg (2,800 lb) rear. The odometer reading at the time of the crash was 258,300 km (160,505 miles). The manufacturer recommended tire size was P225/75R15 on (15x6") wheels at a cold pressure of (26 PSI).

At the time of the crash, the Isuzu was equipped with three different tire models mounted on OEM alloy wheels. All four tires were sized at P235/75R15. The specific tires and conditions at the time of the SCI inspection are documented in the following table:

Position	Manufacturer/Model	Measured Pressure	Measured Tread Depth	Damage
Left Front	Dunlop AT Radial Rover	234 kPa (34 PSI)	5 mm (6/32")	None
Left Rear	Firestone Wilderness AT	Tire flat	Mid - 4 mm (5/32") Outer – 5 mm (6/32")	Debeaded, (3") of outer wheel bead fractured
Right Front	Goodyear Wrangler AT/S	365 kPa (53PSI)	5 mm (6/32")	None
Right Rear	Dunlop AT Radial Rover	Tire flat	Mid – 3 mm (4/32") Outer – 4 mm (5/32")	Tire tread cut from sidewalls

The front suspension of the Isuzu was configured with torsion bars and shock absorbers while the rear axle was suspended with leaf-springs and shock absorbers. All equipment appeared to be OEM original.

The interior of the Isuzu Rodeo was configured with five-passenger seating with front bucket seats with reclining seat backs and adjustable head restraints. Both front head restraints were adjusted 4 cm (1.5") above the top of the seat backs. The second row seat was a 60/40 split-bench, driver's side wide with forward folding seat cushions and back rests. The outboard rear positions were equipped with head restraints that were adjusted to the full-down positions.

Crash Sequence

Pre-Crash

The driver of the Isuzu Rodeo was traveling in an easterly direction on the inboard lane of the interstate roadway at a police reported 129 km/h (80 mph). The driver was passing a slower moving 2002 Chevrolet Astro van that was traveling on the outboard lane. While eastbound, the right rear tire experienced an air-out. As the vehicle continued eastbound, the aired-out right rear tire marked with a thin black transfer on the asphalt road surface for a SCI documented distance of 10.6 m (34.7'). The police reported that the separated tire tread struck the left side of the slower moving Chevrolet and deflected off the vehicle and came to rest in the median.

The Isuzu continued in an easterly direction **(Figure 2)** as the driver apparently initiated a counterclockwise steering maneuver in an attempt to maintain control of the vehicle. The Isuzu initiated a counterclockwise yaw as the remaining right rear tire sidewall and wheel began to mark in a dotted gouge pattern on the asphalt surface. The right rear yaw mark began 41.4 m (135.8') east of the previously noted tire mark that resulted from the air out. As the vehicle continued to yaw counterclockwise, the right front tire marked 18.2 m (59.7') east of the start point of the right rear yaw mark. At this point, the left front tire departed the inboard road edge and the vehicle had rotated approximately 35 degrees CCW. The left rear tire yaw mark began 9.7 m (31.8') east of the start point of the right front. As this tire began to mark, it had crossed the right front tire mark and exceeded the degrees of rotation that a driver can typically recover from by steering and accelerating into the direction of yaw. **Figure 3** is a view of the vehicle's point of roadway departure.

Figure 2 - Eastbound approach of the vehicle.

Figure 3 - CCW tire marks leading to road departure.

The Isuzu fully departed the inboard shoulder and entered the median in a broadside CCW yaw. The right side wheels gouged into the soft surface of the median which tripped the Rodeo into a lateral right side leading, side-over-side rollover event. The trip point was located 107 m (352') east of the point where the aired out right rear tire initially marked on the road surface. It should be noted that this scene documentation occurred eight days after the crash and that some of the subtle evidence may have been worn away by traffic on this high-speed roadway.

Crash

The Isuzu Rodeo rolled over onto the depressed grass median of the interstate roadway. At the on-set of the rollover, the Rodeo had rotated approximately 95 degrees CCW to its initial travel direction. The first series of gouges in the median began 13.6 m (44.6') east of the trip point. The gouges continued diagonally across the median supporting six-quarter turns. The Isuzu entered the westbound travel lane as it came to rest on it is right side. Based on the distance traveled, the location and spacing of the gouges, and the known final rest position of the vehicle, the Isuzu completed a seven-quarter turn rollover event. During the rollover, four of the vehicle's occupants were ejected from the vehicle on to the median and westbound travel lanes.

Post-Crash

Passing motorists stopped at the crash site to render aid to the injured occupants of the Isuzu. Police and emergency personnel responded to the scene and initiated traffic control and medical treatment. Five of the six passengers were transported to a local hospital where two were pronounced deceased within two days of the crash. A sixth passenger was pronounced deceased at the scene. The Isuzu was removed from the scene and towed to a local tow yard where it was held under a police impound order. The separated right rear tire tread was retrieved by the investigating officer. The tow yard operator removed the right rear wheel from the vehicle and the wheel and tire were secured by police as evidence. The wheel and tire tread were inspected at the police barracks following the vehicle inspection.

Vehicle Damage – 1993 Isuzu Rodeo

Exterior

Frontal Damage

The 1993 Isuzu Rodeo sustained severe damage as a result of the seven-quarter turn rollover **(Figure 4)**. The frontal plane exhibited minor damage across the front bumper with moderate displacement of the radiator support which was crushed rearward approximately 20 cm (8"). The hood latch released which allowed the hood to buckle rearward more than 90 degrees. The hood contacted the windshield during the rollover and associative glass from the windshield was embedded into the paint of the hood. The windshield laminate bond held;

Figure 4 - Frontal and left side planes of the vehicle.

however, approximately 90 percent of the laminate was torn from the vehicle during the crash. The left fender was deformed at its leading edge and multiple abrasions were present on the hood and left fender typical of a rollover event.

Left Side Damage

The left side of the vehicle sustained damage along its entire length and the side glazing at all four glazing locations was shattered **(Figure 5)**. The left rear door was torn from the side of the vehicle and the door's latch and striker became separated during the roll sequence. The door's latch released as the backing panel became deformed and the C-pillar mounted striker bar rotated approximately 45-degrees outward responding to the damage flow. The roof side rail was crushed 6 cm (2.5") below its original position at 3 cm (1") forward of the left B-pillar and grass was embedded in the left front window frame. The left C-pillar crushed downward 18 cm (7"). The leaf spring of the left rear wheel was fractured at the front hangar and the bottom shock mount was also fractured.

Figure 5 - Left and back planes of the vehicle.

Back Plane Damage

The maximum crush was to the backlight header in the vehicle's cargo area **(Figure 6)**. The vertical crush measured 18 cm and was located at the right side D-pillar. The backlight header at the left side D-pillar was also crushed downward 10 cm (4"). The rear tailgate was a two-piece unit equipped with a downward opening door with the backlight glazing that was hinged at the top aspect of the backlight header. The backlight was disengaged from the latch lever arms and completely shattered. The combination of the downward crush of the rear hatch and the window opening exposed approximately 70 percent of the rear cargo area as an ejection portal.

Figure 6 - Back plane of vehicle.

Right Side Damage

The right side of the vehicle sustained moderate damage as a result of the rollover **(Figure 7)**. The right quarter panel was crushed laterally approximately 15 cm (6") and the right D-pillar was displaced forward 23 cm (9"). The four right side window glazings were shattered. Both right side doors jammed closed during the impact sequence responding to the body distortion of the vehicle.

Figure 7 - Right side of the vehicle.

Right Rear Wheel and Tire Damage

The right rear tire tread separated from the sidewalls of the tire following an air-out of the tire. The damage was not consistent with the patterns typical of a tread separation event. The right rear wheel well was devoid of the characteristic transfer patterns normally associated with tread separation events. The alloy wheel was heavily abraded due to damage incurred during the rollover. The abrasions were circumferential and a 10 x 3 cm (4 x 1") area of the rim was missing. On the inner aspect of the rim, an 11 x 3 cm (4.25 x 1") dent was present that was 5 cm (2") in depth. The wheel and tire components were held by the investigating police agency for evidentiary purposes allowing only a minimal inspection. The investigating agency limited the time available for the inspection and it consisted of a brief examination and photographic images. **Figures 8 – 13** exhibit the damage to the right rear wheel of the vehicle.

Figure 8 - Outer aspect of right rear wheel.

Figure 9 - Inner aspect of right rear wheel.

Figure 10 - Vertical view of right rear wheel.

Figure 11 - Right rear wheel well and axle.

Figure 12 - View of right rear tread.

Figure 13 - View of post-crash right rear tread.

Top Plane Damage

The top plane of the vehicle sustained damage along the entire roof structure, with the greatest extent of the crush primarily to the back third of the plane **(Figure 14)**. The roof was significantly creased from the left C-pillar to the right B-pillar extending rearward. The glazing within the sunroof was completely disintegrated and the four rails comprising the roof rack were all fractured. The maximum crush to the roof was within the cargo area of the vehicle at the D-pillar point of the backlight header and measured 40 cm (16”). The Collision Deformation Classification (CDC) for the rollover event was 00-TDDO-5.

Figure 14 - View of roof and backlight header area.

Interior

The 1993 Isuzu Rodeo sustained severe interior damage as a result of passenger compartment intrusion and moderate damage resulting from occupant contact incurred during the rollover crash. The greatest levels of intrusion were to the roof and backlight header within the cargo area of the SUV. The apex of the intrusion was to the backlight header which encroached into the right side of the cargo area. The intrusion was vertical in orientation and measured 76 cm (30”). The remaining intrusions are detailed by their magnitude in the table below:

Position	**Intruded Component**	**Magnitude**	**Direction**
Rear cargo area right	Backlight header	76 cm (30”)	Vertical
Rear cargo area left	Roof	71 cm (28”)	Vertical
Rear cargo area middle	Roof	71 cm (28”)	Vertical
Rear cargo area right	Roof	71 cm (28”)	Vertical
Rear cargo area middle	Backlight header	70 cm (27.5”)	Vertical
Rear cargo area left	Backlight header	70 cm (27.5”)	Vertical
Second row right	Roof side rail	27 cm (10.6”)	Vertical
Second row left	Roof	21 cm (8.3”)	Vertical
Second row middle	Roof	20 cm (8”)	Vertical
Rear cargo area	D-pillar	15 – 30 cm (6 – 12”)	Vertical
Front row left	Windshield header	10 cm	Vertical
Rear cargo area right	D-pillar	8 – 15 cm (3 – 6”)	Vertical
Second row left	C-pillar	5 cm (2”)	Vertical
Second row left	C-pillar	3 cm (1.2”)	Lateral
Front row left	B-pillar	1 cm (0.5”)	Lateral

Five discernable areas of occupant contact were identified during the SCI investigation. The power window switch unit housed within left front armrest was fractured from its mounting plate and the door panel was slightly bowed **(Figure 15)**. The damage pattern

was not consistent with the damage flow of the exterior of the vehicle and was probably the result of the driver's left upper leg interacting with the component.

The right front door panel was bowed outward a distance of 18 cm (7.25") with associative fabric transfers embedded within the upper aspect of the panel. The fabric transfers were located 55 – 72 cm (21.75 – 28.5") rear of the leading edge of the door panel and 0 – 5 cm (0 – 2") below the beltline. The armrest contained associative abrasions 65 – 80 cm (25.5 – 31.5") aft of the door panel's leading edge and 23 – 28 cm (9 – 11") below the beltline. A separate scuff mark was identified at the top aspect of the door panel. The scuff was located 19 – 25 cm (7.5 – 9.8") aft of the door panel's leading edge and 1 – 3 cm (0.5 – 1.25") below the beltline. A "blackish" transfer was identified at the forward aspect of the front right door panel's window switch. The transfer was located 20 – 28 cm (8 – 11") aft of the leading edge of the door panel and 14 – 20 cm (5.5 - 8") below the beltline. The power window switch was dislodged from its housing. **Figure 16** is an overall view of the loading patterns on the front right door panel.

Figure 15 - Contact evidence on front left door panel.

Figure 16 - Contact evidence on front right door panel.

A lone contact point was identified within the second row and cargo area of the Isuzu. The right front seatback exhibited loading marks consistent with occupant contact. The loading marks were of lateral orientation and were confined to the right aspect of the seatback.

Manual Safety Belt Systems

The 1993 Isuzu Rodeo was configured as a five-passenger vehicle with 3-point continuous loop lap and shoulder belt systems for the four outboard positions and a center rear lap belt. The driver's safety belt system utilized an Emergency Locking Retractor (ELR) with a sliding latch plate. The retractor was incorporated into the lower B-pillar. The upper D-ring was fixed on the B-pillar. The driver was belted at the time of the crash. Belt loading evidence consisted of partially torn energy management loop that was concealed on a vinyl sleeve. The total length of the torn stitching was 4 cm (1.5"). A subtle abrasion was noted to the polymer coating of the D-ring with no matching abrasion/transfer visible on the webbing. Another subtle abrasion was noted to the latch plate.

The front right safety belt system utilized a switchable retractor with ELR and Automatic Locking Retractor (ALR) modes. The D-ring was fixed and the latch plate was sliding. The front right passenger was belted at the time of the crash. Belt loading evidence consisted of a partially separated energy management loop that was concealed in the vinyl sleeve. Approximately 7 cm (2.9”) of the loop tore and the webbing was cupped in the vinyl sleeve. Longitudinally oriented stretching/stress marks of the shoulder belt webbing was located in the area of the D-ring covering an area of 27 cm (10.5”) in length. The inside surface of the latch plate was abraded from belt interaction with corresponding abrasions of the webbing located 109 – 117 cm (43-46”) above the floor anchor.

The rear outboard belt systems utilized ELR/ALR retractors and sliding latch plates and fixed D-rings to the C-pillars. These belt systems were not used during the crash and exhibited historical wear indicators only; no crash related loading evidence was present.

The center rear lap belt was adjustable with a locking latch plate. The buckle was mounted on the left side of this seat position and was marked with CENTER. The lap belt webbing was found at the time of the SCI inspection nearly fully extended with 17 cm (6.5”) of webbing protruding from the latch plate and 93 cm (36.5”) of webbing looping around the cinch bar to the anchor point. The buckle assembly was torn from the tethered webbing at the buckle loop by occupant loading of the lap belt. The latch plate was found engaged in the buckle which was separated from the plastic housing. The release mechanism was operational. There was no distinct loading evidence on the lap belt webbing. As a consequence of the torn webbing, the child passenger was fully ejected from the vehicle. **Figures 17** and **18** are views of the damaged second row center lap belt.

Figure 17 - Post-crash condition of center lap belt.

Figure 18 - Another view of center lap belt.

Occupant Data/Demographics – 1993 Isuzu Rodeo

Driver

Age/Sex:	33-year old/Male
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Full rear
Manual Safety Belt Usage:	3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Ejection Status:	Not ejected
Mode of Transport from Scene:	Ambulance
Type of Medical Treatment:	Admitted for observation and treatment of his injuries to a regional trauma center
GCS on Arrival:	15
Length of Hospitalization:	Two days

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Abrasions to right arm, NFS	Minor (790202.1,1)	Unknown
Abrasions to left arm, NFS	Minor (790202.1,1)	Ground contact
Bilateral eyelid contusions	Minor (297402.1,1) (297402.1,2)	Steering wheel (possible)
Small right forearm laceration	Minor (790602.1,1)	Unknown

Source: Medical records

Driver Kinematics

The 33-year old male driver was seated in an unknown posture and was restrained by the 3-point manual lap and shoulder belt. As the vehicle tripped and began to overturn right-side-leading, the driver responded by initiating with a trajectory towards the left side of the vehicle as it rotated. The driver loaded the belt system as evidenced by the deployed energy management loop and the stretched belt webbing. During the rollover sequence the driver sustained abrasions to both of his arms, a laceration to his right arm, and bilateral eyelid contusions. It is possible that the driver contacted the steering column to cause the eyelid contusions and the left arm abrasions were probably the result of ground contact during the rollover. The cause of the driver's injuries to his right arm could not be determined. The driver was removed from the vehicle by rescue personnel and transported by ambulance to a regional trauma center. He was treated for his injuries and released after two days of hospitalization.

Front Right Passenger

Age/Sex:	40-year old/Male
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Full rear
Manual Safety Belt Usage:	3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Ejection Status:	Not ejected
Mode of Transport from Scene:	Ambulance
Type of Medical Treatment:	Admitted for treatment of his injuries to a regional trauma center
GCS on Arrival:	15
Length of Hospitalization:	Nine days

Front Right Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Right hip dislocation with internal rotation	Moderate (850610.2,1)	Door panel
Oblique fracture of the proximal fibula shaft	Moderate (851606.2,1)	Door panel
Fracture of the right clavicle at mid-shaft	Moderate (752200.2,1)	Shoulder belt
Right periorbital contusion	Minor (297402.1,1)	Ground contact (possible)
Trauma to right side of face, NFS	Unknown (215099.7,0)	Ground contact (possible)

Source: Medical records.

Front Right Passenger Kinematics

The 40-year old male front right passenger was seated in an unknown posture and was restrained by the 3-point manual lap and shoulder belt. The front right passenger responded to the rollover event by initiating a trajectory toward the midpoint of the vehicle during the early sequence of the rollover. The front right passenger loaded the lap and shoulder belt and sustained a mid-shaft fracture of his right clavicle. The loading of the belt is supported by evidence on the belt webbing as well as the deployed status of the belt's energy management loop. As the right side of the vehicle impacted the median of the roadway, the front right passenger was redirected toward the right side of the vehicle. The front right passenger loaded the door panel as evidenced by the discernable contact patterns identified during the SCI inspection. From this loading, he sustained a dislocation of his right hip and an oblique fracture of his proximal fibula shaft. The front right passenger also sustained unspecified injuries to the right side of his face and a right periorbital contusion. It is possible that these injuries were the result of ground contact at some point during the rollover sequence. The front right passenger was removed from the vehicle by emergency personnel and transported by ambulance to a regional trauma center. He was treated for his injuries and hospitalized for nine days.

Second Row, Left Passenger

Age/Sex:	41-year old/Female
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Not adjustable
Manual Safety Belt Usage:	None
Usage Source:	Vehicle inspection
Ejection Status:	Fully ejected
Mode of Transport from Scene:	Ambulance
Type of Medical Treatment:	Admitted for treatment of her injuries to a regional trauma center
GCS on Arrival:	3
Length of Hospitalization:	Not reported

Second Row, Left Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Bilateral lung contusions with 5% pnuemothorax of right lung	Severe (441410.4,3)	Ground contact
Comminuted fracture of left radius	Serious (752804.3,2)	Ground contact
Comminuted fracture of left ulna	Serious (753204.3,2)	Ground contact
Pedicle fracture of C3	Serious (650226.3,6)	Ground contact
Bilateral laminar fractures of C5, C6, and C7	Serious (650224.3,6) (650224.3,6) (650224.3,6)	Ground contact
Subarachnoid hemorrhage	Serious (140466.3,6)	Ground contact
Small tears around vena cava	Serious (421804.3,4)	Ground contact
Multiple fractures of the superior pubic ramus of the ischiopubic junction	Moderate (852600.2,5)	Ground contact
Sacral fracture	Moderate (852600,2,6)	Ground contact
Liver laceration	Moderate (541820.2,1)	Ground contact
Serosal tear of ascending colon, NFS	Moderate (540820.2,8)	Ground contact
Transverse process fracture of C2	Moderate (650220.2,6)	Ground contact

Comminuted mandibular fracture – right ramus and left body	Moderate (250612.2,3)	Ground contact
Vertebral body fracture of C4	Moderate (650230.2,6)	Ground contact
Right lumbar spine transverse process fracture, NFS	Moderate (650620.2,8)	Ground contact
Large tear of proximal ilium to the diaphragm, NFS	Moderate (541420.2,8)	Ground contact
Complex laceration of left hand	Minor (790602.1,2)	Ground contact
Bilateral contusions to both eyes	Minor (297402.1,1) (297402.1,2)	Ground contact
Laceration to right forehead	Minor (290602.1,7)	Ground contact
Left lateral upper eyelid lacerations	Minor (297602.1,2)	Ground contact
Small tears around left adrenal gland	Minor (540299.1,2)	Ground contact
Posterior upper right rib fracture, NFS	Minor (450212.1,1)	Ground contact
Scalp contusion, NFS	Minor (190402.1,9)	Ground contact

Source: Medical records.

Second Row, Left Passenger Injuries

The 41-year old female seated in the second row left position was in an unknown posture and was unrestrained. As the vehicle began to overturn, she responded by initiating a trajectory toward the left side of the vehicle. The left rear door was torn from the side of the vehicle and the door's latch and striker became separated during the roll sequence. The door's latch released as the backing panel became deformed and the C-pillar mounted striker bar rotated approximately 45-degrees outward responding to the damage flow. As the left side of the vehicle lost its integrity, this passenger was fully ejected. After being ejected, the female passenger sustained bilateral lung contusions, fractures of the left radius, left ulna, C-spine (C2 – C7), pubic ramus, sacrum, mandible, and unspecified fractures to her lumbar spine and ribcage. She also sustained a subarachnoid hemorrhage, liver laceration, and tears to her colon, ilium, adrenal gland, and around her vena cava. These injuries were attributed to the ground; however, a combination of the ground and the vehicle striking the ejected passenger is possible. She was transported to regional trauma center by ambulance and was admitted in critical condition. During the initial stages of treatment, the hospital reported that her chance of survival was grave; however, she survived and was hospitalized for an undetermined amount of time.

Second Row, Center Passenger

Age/Sex:	11-year old/Female
Height:	155 cm (61”)
Weight:	58 kg (127 lb)
Seat Track Position:	Not adjustable
Manual Safety Belt Usage:	Lap belt
Usage Source:	Vehicle inspection
Ejection Status:	Fully ejected
Mode of Transport from Scene:	Medical Examiner
Type of Medical Treatment:	None, pronounced deceased at scene

Second Row, Center Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Laceration of pontomedullary junction	Maximum (140212.6,8)	Ground contact
1 cm (0.5”) endocardial laceration in the right atrium	Critical (441012.5,4)	Ground contact
Descending thoracic aorta laceration	Severe (420206.4,4)	Ground contact
Bilateral lung contusions	Severe (441410.4,3)	Ground contact
Subarachnoid hemorrhage, NFS	Serious (140684.3,9)	Ground contact
Laceration of right diaphragm	Serious (440604.3,8)	Ground contact
Linear fracture of occipital skull	Moderate (150400.2,6)	Ground contact
Linear fracture of right temporal skull	Moderate (150400.2,1)	Ground contact
Multiple capsular lacerations to liver	Moderate (541820.2,1)	Lap belt
Left cheek linear abrasion – 5 cm (2”)	Minor (290202.1,2)	Ground contact
Vertical abrasion to center chest – 1 cm (0.5”)	Minor (490202.1,4)	Ground contact
Abrasions and lacerations to left lower posterior arm – 30 x 15 cm (12 x 6”) in area	Minor (790202.1,2) (790602.1,2)	Ground contact
Left wrist contusion – 1 cm (0.5”)	Minor (790402.1,2)	Ground contact
Linear abrasion to left lower back – 5 x 1 cm (2 x 0.25”)	Minor (690202.1,8)	Ground contact
Multiple lacerations to left leg – upper leg abraded laceration 14 cm (5.5”) and	Minor (890602.1,2)	Ground contact

lower leg horizontal laceration – 8 cm (3")		
Bilateral leg abrasions – lateral left leg – 23 x 1 cm (9 x 0.5") – small abrasion to anterior right leg	Minor (890202.1,3)	Ground contact
Fracture of 1st rib on left side of cage	Minor (450212.1,2)	Ground contact
Nasal bridge abrasion and contusion – 1 cm (0.5")	Minor (290202.1,4) (290402.1,4)	Ground contact
Left occipital scalp contusion	Minor (190402.1,6)	Ground contact

Source: Autopsy

Second Row, Center Passenger Kinematics

The 11-year old female seated in the second row middle position was in an unknown posture and was restrained by the manual fixed length lap belt. As the vehicle began to overturn, she responded by initiating a trajectory toward to the left side of the vehicle. She loaded the lap belt causing multiple capsular liver lacerations. Due to crash dynamics and the loading force of the passenger, the lap belt webbing failed during the crash. The buckle assembly was torn from the tethered webbing at the buckle loop due to occupant loading. The latch plate was found engaged in the buckle which was separated from the plastic housing. The release mechanism was operational. There was no distinct loading evidence on the lap belt webbing. As a consequence of the torn webbing, the child passenger was fully ejected from the vehicle.

After being ejected through the left rear door opening, the child passenger sustained a laceration of her pontomedullary junction, an endocardial laceration in the right atrium, a thoracic aorta laceration, bilateral lung contusions, a subarachnoid hemorrhage, a laceration of the right diaphragm, linear fractures to the occipital and temporal skull, a fractured rib (left side – rib 1), and multiple soft tissue injuries. The injuries resulted from striking the ground either by itself or in combination with the overturning vehicle compressing her before becoming clear of the vehicle. Emergency personnel pronounced the child deceased at the scene.

Second Row, Right Passenger

Age/Sex:	20-year old/Female
Height:	173 cm (68")
Weight:	87 kg (192 lb)
Seat Track Position:	Not adjustable
Manual Safety Belt Usage:	None
Usage Source:	Vehicle inspection
Ejection Status:	Fully ejected
Mode of Transport from Scene:	Ambulance
Type of Medical Treatment:	Admitted for treatment of her injuries to a regional trauma center

GCS on Arrival: 3
Length of Hospitalization: Expired on day two of hospitalization

Second Row, Right Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Right lateral intraventricular hemorrhage	Severe (140678.4,1)	Ground contact
Cerebral edema – basilar cisterns are diffusely effaced and cerebral ventricles are somewhat compressed but midline	Severe (140664,4.9)	Ground contact
Interhemispheric fissure cistern hemorrhage	Severe (140640.4,9)	Ground contact
Bilateral lung contusions with left pnuemothorax	Severe (441410.4,3)	Ground contact
Right subarachnoid hemorrhage	Serious (140684.3,1)	Ground contact
Bilateral rib fractures with pnuemothrorax – right ribs 1 and 2 posteriorly and rib 2 laterally – left rib 1 posteriorly	Serious (450222.3,3)	Ground contact
Degloving avulsion to right upper arm skin and muscle – area of 13 cm (5”)	Moderate (794002.2,1)	Ground contact
Multiple liver lacerations – 8 cm (3”) inferior and lateral left lobe – 3.5 cm (1.5”) and 6 cm (2.4”) on right lobe involving the capsule and superficial parenchyma	Moderate (541822.2,1)	Ground contact
Colon contusion right of serosa	Moderate (540810.2,8)	Ground contact
Comminuted right distal clavicle	Moderate (752200.2,1)	Ground contact
Chest contusion, NFS	Minor (490402.1,9)	Ground contact
Laceration of anterior left knee – 11 cm (4.5”)	Minor (890602.1,2)	Ground contact
Abrasion to right lower face and right chin – both 4 cm (1.5”)	Minor (290202.1,1) (290202.1,8)	Ground contact

Abrasions to posterior right shoulder and upper arm – area of 15 x 10 cm (6 x 4")	Minor (790202.1,1)	Ground contact
Scalp laceration and contusion, NFS	Minor (190602.1,9) (190402.1,9)	Ground contact
Lacerations and abrasions to anterior right lower arm – area of 30 x 10 cm (10 x 4")	Minor (790202.1,1)	Ground contact
Small abrasions to lateral right abdomen	Minor (590202.1,1)	Ground contact
Abrasions to lower right leg, right shin, and right upper leg	Minor (890202.1,1)	Ground contact
Lacerations to right upper leg and medial right knee – leg 25 x 20 cm (10 x 8") knee 3 cm (1")	Minor (890602.1,1)	Ground contact

Source: Autopsy, medical records.

Second Row, Right Passenger Kinematics

The 20-year old female passenger seated in the second row right position was in an unknown posture and was unrestrained. As the vehicle began to overturn, this passenger was displaced to the left of the vehicle and followed the trajectory of the other two second row passengers. She was ejected from the vehicle through the rear left door. As a result of being ejected, the female passenger sustained a right intraventricular hemorrhage, a cerebral edema, an interhemispheric fissure cistern hemorrhage, bilateral lung contusions, a subarachnoid hemorrhage, bilateral rib fractures, an avulsion to the right arm and hand, multiple liver lacerations, a colon contusion, a fracture to her right distal clavicle, and multiple soft-tissue injuries. She was transported by ambulance to a regional trauma center where she expired two days following the crash.

Additional Passenger, Cargo Area

Age/Sex:	14-year old/Male
Height:	165 cm (65")
Weight:	59 kg (130 lb)
Seat Track Position:	Not applicable – seated in cargo area
Manual Safety Belt Usage:	None available
Usage Source:	Vehicle inspection
Ejection Status:	Fully ejected
Mode of Transport from Scene:	Ambulance
Type of Medical Treatment:	Admitted for treatment of his injuries to a regional trauma center
GCS on Arrival:	3
Length of Hospitalization:	Expired after one day of hospitalization

Additional Passenger Injuries, Cargo Area

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Uncal and tonsillar herniation	Critical (140202.5,8)	Ground contact
Hemorrhage to left basal ganglia periventricular cerebrum	Severe (140629.4,2)	Ground contact
Cerebral contusion (frontal, parietal, temporal lobes, NFS)	Serious (140602.3,9)	Ground contact
Subarachnoid hemorrhage, NFS	Serious (140684.3,9)	Ground contact
C-spine facet fracture (C6)	Serious (650222.3,6)	Ground contact
C-spine pedicle fracture (C6)	Serious (650226.3,6)	Ground contact
Degloving laceration to popliteal region behind right knee with muscle present – 15 x 10 cm (6 x 4”)	Serious (894006.3,1) (853422.3,1)	Ground contact
Open comminuted ankle fracture of right fibula and tibia	Serious (851614.3,1)	Ground contact
Multiple left side rib fractures	Moderate (450210.2,2)	Ground contact
Fracture of right calcaneus	Moderate (851400.2,1)	Ground contact
Avulsion fracture of left medial malleous with ligament laceration	Moderate (840402.2,2)	Ground contact
Oblique pelvic fracture to iliac (5 mm wide)	Moderate (852602.2,1)	Ground contact
Multiple fractures of pubic ramus – superior and right inferior	Moderate (852602.2,5)	Ground contact
Abrasion to anterior neck - 3 x 3.5 cm (1.2 x 1.4”)	Minor (390202.1,5)	Ground contact
Abrasions to mid and right forehead	Minor (290202.1,7)	Ground contact
Contusion to right forehead 2.5 cm (1”)	Minor (290402.1,7)	Ground contact
Abrasion and contusion to lateral aspect of right eyebrow – 2 cm (.8”)	Minor (290202.1,1) (290402.1,1)	Ground contact
Diffuse coronal and frontal scalp hematoma	Minor (190402.1,5)	Ground contact

Contusion and laceration of right upper eyelid	Minor (297402.1,1) (297602.1,1)	Ground contact
Brush abrasions of mid and lateral right chin – 3 x 3.5 cm (1.2 x 1.4")	Minor (290202.1,8)	Ground contact
Bilateral brush abrasions to chest – 3 x 8 cm (1.2 – 3.2") to upper chest and lower right and left chest	Minor (490202.1,3)	Ground contact
Brush abrasions to right upper abdomen	Minor (590202.1,1)	Ground contact
Brush abrasions to mid, left upper, and mid lower back – mid 24 x 6 cm (9.4 x 2.4"); left upper small linear, and lower mid 7 x 7 cm (2.75 x 2.75")	Minor (690202.1,0)	Ground contact
Abrasion to right upper arm – 5 x 2 cm (2 x 0.8")	Minor (790202.1,1)	Ground contact
Abrasions to both knees and left shin	Minor (890202.1,3)	Ground contact

Source: Autopsy and medical records.

Additional Passenger Kinematics, Cargo Area

The 14-year old male passenger was seated improperly within the cargo area of the vehicle. His posture within this area of the vehicle could not be determined. The cargo area contained no seats or restraint systems. As the vehicle overturned, the cargo area was crushed and the backlight was disengaged from the latch lever arms and the glazing was completely disintegrated. The combination of the downward crush of the rear hatch and the window opening exposed approximately 70 percent of the rear cargo area as an ejection portal. The male passenger was ejected through this opening and onto the ground as the vehicle overturned. He sustained and uncal and tonsillar herniation, a cerebral hemorrhage, multiple cerebral contusions, a subarachnoid hemorrhage, fractures to the right fibula, C-spine, left side ribcage, right calcaneus, pelvis and pubic ramus. He also sustained an avulsion of the posterior aspect of his right knee and multiple soft-tissue injuries. The child's injuries were attributed to the ground, but it is probable that he was compressed between the ground and the overturning vehicle at some point during the rollover sequence. He was transported to a regional trauma center by ambulance where he expired one day later.

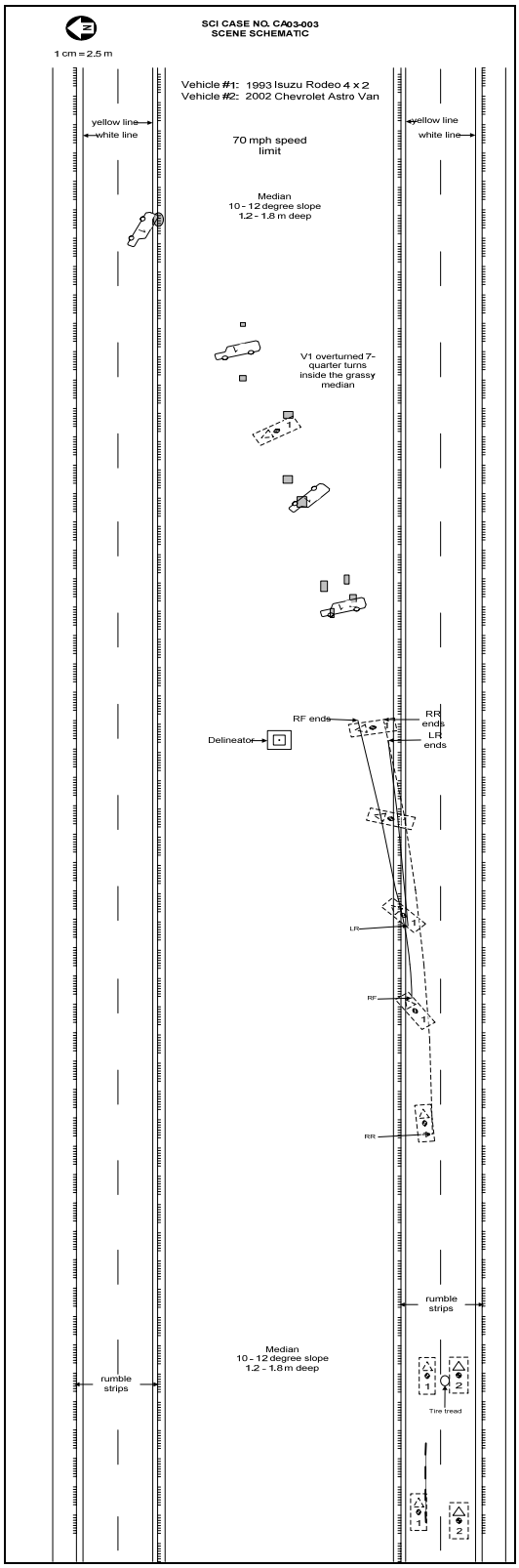

Figure 19 – SCI Scene Schematic