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ON-SITE ADAPTIVE CONTROL-EQUIPPED VEHICLE INVESTIGATION

CASE NUMBER - IN-05-023
LOCATION - NEBRASKA
VEHICLE - 1994 FORD E350 R.V. CUTAWAY WITH BUS BODY
CRASH DATE - July 2005

Submitted:

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

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

Technical Report Documentation Page

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15. *Supplementary Notes*
On-site investigation involving a 1994 Ford E350 R.V. Cutaway with bus body equipped with a driver air bag, driver three-point safety belt; eight passenger seats, each with two-point lap belts and securement devices to accommodate four wheelchairs. Two wheelchairs were secured in the vehicle at the time of the crash.

16. *Abstract*
This report covers an on-site investigation of a 1994 E350 R.V. Cutaway with bus body which ran-off-road and rolled over. This crash is of special interest because the case vehicle was equipped with adaptive equipment, with two passengers in wheelchairs, and three of the case vehicle's occupants [54-, 86-, and a 75-year-old, White (non-Hispanic) males] sustained fatal injuries during the crash. In addition, the bus body sustained structural collapse and separation from the chassis during the crash and three of the occupants were ejected. The case vehicle was traveling northeast in the left lane of a four-lane Interstate highway negotiating a gentle right curve. For an unknown reason, the case vehicle departed the left side of the roadway and entered the median. The case vehicle's driver steered right and the case vehicle began to rotate clockwise and it reentered the roadway. The driver steered hard left, which put the case vehicle into a severe counterclockwise rotation and it rolled over passenger side leading. The case vehicle rolled over a total of one-and-one-half times (six quarter rolls) and came to rest off-road on its top facing northwest. The three ejected occupants came to rest near the right side of the case vehicle. The driver and remaining three passengers were entrapped in the vehicle. The fourth row right and left passengers were seated in wheelchairs. The wheelchairs were secured to floor-mounted securement anchorage plates by wheelchair securement straps. The left wheelchair passenger was restrained by a two-point lap belt attached to the securement anchorage plate. The right wheelchair passenger was not restrained. It is not known if a two-point lap belt was available for him. The wheelchairs were not equipped with lap belts. The right wheelchair passenger was ejected and sustained fatal injuries. The left wheelchair passenger remained restrained in her wheelchair and was entrapped under the vehicle. She was transported to a hospital and admitted. The second row right outboard passenger and third row left outboard passenger were not restrained by their available lap belts and were ejected. They were transported to a hospital and admitted. The driver and the two remaining passengers were restrained and entrapped. The driver was treated and released. The other two passengers sustained fatal injury.

17. *Key Words* Wheelchair Rollover	Motor Vehicle Traffic Crash Injury Severity	18. *Distribution Statement* General Public		
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This investigation was brought to NHTSA's attention on or before July 15, 2005 by the Office of Vehicle Safety Compliance in Washington, D.C. This crash involved a 1994 Ford E350 Recreational Vehicle Cutaway (case vehicle) with a THOR Industries, Eldorado National Company, Aerotech 22AR bus body. The case vehicle ran-off-road and rolled over. The crash occurred in July, 2005, at 11:22 a.m., in Nebraska and was investigated by the county sheriff's department. This crash is of special interest because the case vehicle was equipped with adaptive equipment with two passengers in wheelchairs and three of the case vehicle's occupants [54-, 86-, and a 75-year-old, White (non-Hispanic) males] sustained fatal injuries during the crash. In addition, the bus body sustained structural collapse and separation from the chassis during the crash and three of the occupants were ejected. This contractor inspected the case vehicle and scene on August 9 and 10, 2005. This contractor conducted a partial interview with the case vehicle's driver on October 18, 2006. This report is based on the police crash report, correspondence with police personnel, witness statements, scene and vehicle inspections, partial interview with case vehicle's driver, occupant medical records and autopsy reports, occupant kinematic principles and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling northeast in the left lane of a four-lane Interstate highway negotiating a gentle right curve. The case vehicle was occupied by the driver and six passengers. The driver stated he was traveling approximately 97 to 105 km.p.h. (60 to 65 m.p.h.). For an unknown reason, the case vehicle departed the left side of the roadway and entered the median. The case vehicle's driver steered right and the case vehicle began to rotate clockwise and it reentered the roadway. The driver steered hard left, which put the case vehicle into a severe counterclockwise rotation. As the case vehicle entered the outside shoulder, the counterclockwise rotation increased significantly and the case vehicle began to rollover passenger side leading. The case vehicle sustained a hard ground impact on the left roof side rail and left roof at the end of the second quarter roll. The bus body broke apart and it separated from the case vehicle's chassis near the end of the rollover. The second row right outboard passenger (43-year-old male), the third row left outboard passenger (25-year-old female) and the right wheelchair passenger (75-year-old male) were ejected from the case vehicle near the end of the rollover. The case vehicle rolled over a total of one-and-one-half times (six quarter rolls) across a distance of approximately 25 meters (82 feet) and came to rest on its top facing northwest. The driver was entrapped in the vehicle. The remaining wheelchair passenger and the other two passengers (see the seating diagram at the end of this report) were entrapped under the vehicle between the ground and their seats/wheelchair. The three ejected occupants came to rest near the right side of the case vehicle.

Based on the damage to the case vehicle, the rollover severity was determined to be severe. The speed range of the case vehicle at the initiation of the rollover was approximately 47 to 56 km.p.h. (29 to 35 m.p.h.).

The enclosed area right and left passengers were seated in wheelchairs. The wheelchairs were secured to floor-mounted securement anchorage plates by wheelchair securement straps. The left wheelchair passenger, who was a double leg amputee (above the knees) was restrained by a

removable two-point lap belt attached to the securement anchorage plate behind her wheelchair. Her thighs were also restrained by a strap located at the front of the wheelchair seat cushion. The right wheelchair passenger was not restrained. It is not known if a two-point lap belt was available for him. No shoulder belts were observed for either wheelchair passenger. The right wheelchair passenger was ejected and sustained fatal injuries. The left wheelchair passenger remained restrained in her wheelchair and was entrapped under the vehicle at final rest. She sustained police reported "A" (incapacitating) injuries and was transported to a hospital and admitted. The second row right outboard passenger and third row left outboard passenger were not restrained by their two-point lap belts and were ejected. They sustained police reported "A" (incapacitating) injuries and were transported to a hospital and admitted. The driver was restrained by his three-point lap-and-shoulder belt and was entrapped. He sustained police reported "A" (incapacitating) injuries and was transported to a hospital and treated and released. The ssecond row left outboard passenger and third row right outboard passenger were restrained by their two-point lap belts. They were entrapped under the vehicle at final rest and were fatally injured.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the case vehicle was traveling was a four-lane, divided Interstate highway, traversing in a northeasterly and southwesterly direction. The trafficway curved gently to the northeast. Each roadway had two bituminous travel lanes and bituminous shoulders. The roadways were divided by a grass median. The outside travel lanes were 3.8 meters (12.5 feet) in width while the inside travel lanes were 3.5 meters (11.5 feet) in width. The outside shoulders were 3.2 meters (10.5 feet) in width and the median shoulders were 1 meter (3.3 feet)in width. The case vehicle's approach to the crash location was uncontrolled and the posted speed limit was 121 km.p.h. (75 m.p.h). At the time of the crash, the light condition was daylight, the atmospheric condition was clear, and the roadway pavement was dry, level bituminous with an estimated coefficient of friction of 0.70. Traffic density was moderate and the site of the crash was rural. See the Crash Diagram at the end of this report.

Pre-Crash: The case vehicle was traveling northeast in the left lane (**Figure 1**) negotiating a gentle right curve. The driver was intending to continue northeastbound. The driver stated to police that he was traveling approximately 97 to 105 km.p.h. (60 to 65 m.p.h.). For an unknown reason, the case vehicle departed the left side of the roadway and entered the median (**Figure 2** below). The case vehicle traveled in the median (**Figure 3** below), the driver steered right and the case vehicle began to rotate clockwise and it reentered the roadway (**Figure 4** below). As the case vehicle crossed the roadway heading to the east side of the roadway, the driver steered hard left, which put the case vehicle into a severe counterclockwise rotation (**Figure 5** below). The crash occurred on the east side of the roadway.

Figure 1: Overview of approach of case vehicle northeastbound to area of left side roadway departure

Figure 2: Arrow shows location of case vehicle's roadway departure

Figure 3: Police on-scene photo showing travel path of case vehicle in median, arrows show left side tire marks in grass

Figure 4: Case vehicle's yaw marks as it reenters roadway in clockwise rotation

Figure 5: Police on-scene photo showing case vehicle's yaw marks leading to area of rollover initiation, case vehicle in counterclockwise rotation, arrows shows case vehicle at rest on its top in background

Crash: As the case vehicle entered the outside shoulder, the counterclockwise rotation increased significantly (**Figure 5**) and the case vehicle began to rollover, passenger side leading. The case vehicle sustained a hard ground impact on the left roof side rail and left roof (**Figure 6** below) at the end of the second quarter roll, and the bus body began to break apart and separate from the chassis. As the case vehicle continued to roll over, the bus body completely separated from the chassis (**Figures 7** and **8** below) near the end of the rollover (**Figure 9** below). The second row right outboard passenger (43-year-old male), the third row left outboard passenger (25-year-old female) and the enclosed area right wheelchair passenger (75-year-old male) were ejected from the case vehicle near the end of the rollover, most likely during the fifth or sixth quarter rolls. The case vehicle rolled over a total of one-and-one-half times (six quarter rolls) across a distance of approximately 25 meters (82 feet).

Figure 6: Damage to case vehicle's left roof and roof side rail from ground impact

Figure 7: Front right view of damage to case vehicle

Figure 8: Left side view of passenger area, bus body was screwed to metal frame (arrow)

Figure 9: Police on-scene photo showing rest position of case vehicle on its top, view is back toward roadway, front of vehicle is to right, bus body separated from chassis and laying on rear portion of vehicle

Post-Crash: The case vehicle came to rest on its top facing northwest (**Figure 9**). The driver was entrapped in the vehicle. The remaining wheelchair passenger and two other passengers were entrapped under the vehicle between the ground and their seats/wheelchair. The three ejected occupants came to rest near the right side of the case vehicle.

CASE VEHICLE

The 1994 Ford E350 R.V. Cutaway was a rear wheel drive, three door bus (VIN: 1FDKE30G1RH------) equipped with a Thor Industries, Eldorado National Company, Aerotech 22AR bus body; a 7.5L, V8 engine; four-speed automatic transmission and a wheelchair lift. The case vehicle was equipped with a driver's air bag and driver's manual, three-point, lap-and-shoulder safety belt system. The case vehicle was also equipped with two rows of passenger seats with four seats in each row. Each seat was equipped with a two-point lap belt system. The wheelchair lift was installed at the right rear of the case vehicle. The case vehicle was also configured with two wheelchair rows at the back of the vehicle that could accommodate four

wheelchairs. Each wheelchair row was equipped with two wheelchair securement anchorage plates attached to the floor. Each of the two wheelchairs was attached to the securement anchorage plates with four wheelchair securement straps (**Figures 10** and **11**), two in front and two in back of each wheelchair. A removable two-point lap belt was available for the left wheelchair. It was attached to the securement anchorage plate behind the left wheel chair. No lap belt was present for the right wheelchair at the time of the inspection. It is not known if one was available at the time of the crash. No available shoulder belts were observed for either wheelchair passenger. The wheelchairs themselves were not equipped with restraints. However, the left wheelchair was equipped with a thigh strap located at the front of the wheelchair seat cushion.

The case vehicle's wheelbase was 401 centimeters (158 inches). The case vehicle's odometer reading at the time of the inspection could not be determined because the vehicle was equipped with an electronic odometer. Lastly, anti-lock brakes were an option on the case vehicle, but it is not known if the vehicle was so equipped.

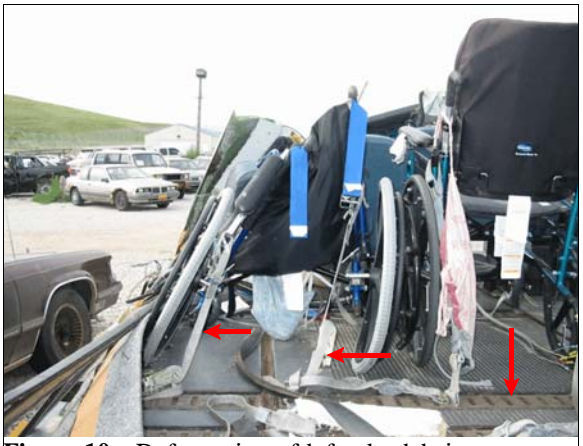

Figure 10: Deformation of left wheelchair, arrows show wheelchair securement straps secured to wheelchair and securement anchorage plate

Figure 11: Right wheel chair, arrows show wheelchair securement straps secured to wheelchair and securement anchorage plate

Figure 12: View of left front of bus body showing wooden frame and fiberglass construction

Figure 13: Arrow shows right side bus body screwed to metal frame that runs length of passenger compartment.

The bus body was constructed of a wooden frame with fiberglass panels approximately 5 mm (0.2 inch) thick glued to the wooden frame members (**Figure 12** above). The individual frame boards were 3.5 centimeters (1.4 inches) thick. The space between the inner and outer fiberglass side panels contained a cardboard honeycomb-type material (**Figure 12** above). The bus body was screwed to a metal frame that extended along each side of the vehicle chassis (**Figure 13** above and **Figure 8** above). The metal frame extended above the bus floor approximately 27 centimeters (10.6 inches).

The investigating sheriff's department had the case vehicle inspected by a local auto service establishment to determine the condition of the front end suspension, steering components and brakes. The vehicle inspection report concluded that the rear brakes were worn out, the right upper ball joint wear was over the maximum allowed movement specification and the steering toe-out adjustment was out of specification. The report indicated that the toe-out problem would cause the vehicle to "wander" over the road surface requiring constant corrective steering input by the driver. The report also concluded that nothing was found that would cause a "consistent pull" either way in the steering or make the vehicle uncontrollable.

CASE VEHICLE DAMAGE

Exterior Damage: The rollover directly damaged the top and both sides of the case vehicle. The left roof and left roof side rail sustained the hardest ground impact, which crushed the roof, left "A"-pillar and left roof side rail (**Figure 14**). The bus body fractured and separated from the vehicle chassis on the left side and separated from the bus body along the base of the windows on the right side (**Figures 7** and **8** above). The case vehicle's left side wheelbase was reduced approximately 6 centimeters (2.5 inches) while the right side wheelbase was extended approximately 8 centimeters (3.1 inches). Induced damage involved the hood, both fenders and the left and right front doors.

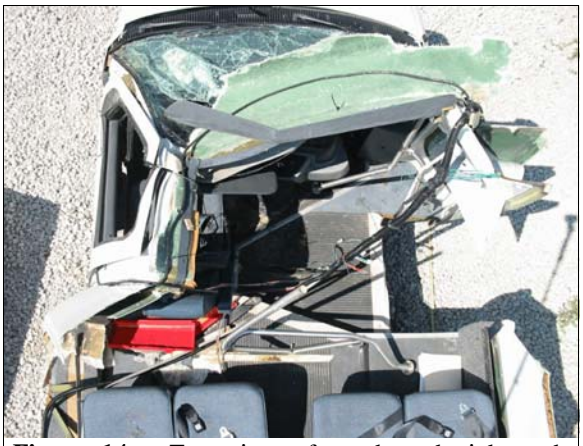

Figure 14: Top view of crush and rightward displacement of left roof side rail and "A"- pillar

The recommended tire size was: P235/75R16 and the vehicle was equipped with tires of this size. The case vehicle's tire data are shown in the table below. The pressure of the inflated tires is unknown because they exceeded the 60 psi limit of the tire pressure gauge.

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	Unk	Unk	414	60	11	14	Dirt and grass in bead	No	No

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
RF	Unk	Unk	414	60	14	18	None	No	No
LR Outside	Unk	Unk	414	60	8	10	None	No	No
LR Inside	Unk	Unk	414	60	9	11	None	No	No
RR Inside	Unk	Unk	414	60	12	15	None	No	No
RR Outside	Flat	Flat	414	60	16	20	None	No	Yes

Vehicle Interior: Inspection of the case vehicle's interior revealed blood on the nap of the roof above the driver's seat. No other evidence of occupant contact to any interior surfaces or components was observed. There were numerous intrusions into the passenger compartment. The most severe intrusions that could be documented involved 40 centimeters (15.7 inches) of vertical roof and windshield header intrusion into the driver' seating area and 31 centimeters (12.2 inches) of lateral "B"-pillar intrusion into the driver's seating area. There was no evidence of compression of the energy absorbing steering column and no deformation of the steering wheel rim was observed (**Figure 15**).

Figure 15: Left side view of steering column and steering wheel showing lack of deformation

Damage Classification: No CDC could be assigned to describe the damage to the case vehicle because buses are out of scope for CDC. In addition, the WinSMASH reconstruction program could not be used to reconstruct the case vehicle's Delta V because rollovers are out-of-scope for the WinSMASH program. However, based on the damage to the case vehicle, the rollover severity was determined to be severe. The case vehicle was towed due to damage.

ROLLOVER SPEED RECONSTRUCTION

Based on a rollover distance of 25 meters (82 feet), and using a rollover deceleration range from the reconstruction literature of -0.35g to -0.50g, the speed range of the case vehicle at the initiation of the rollover was approximately 47 to 56 km.p.h. (29 to 35 m.p.h.). The time duration of the rollover given the speed range was approximately 3.77 to 3.18 seconds, and the average rotational velocity of the vehicle during the rollover was approximately 143 to 170 degrees/second.

The case vehicle was equipped with a driver air bag, which was located in the steering wheel hub. The air bag could not be inspected because the entire air bag module was missing from the steering wheel and was not located at the vehicle inspection. The driver stated in the police crash report that his air bag deployed in the crash.

CASE VEHICLE FOURTH ROW RIGHT WHEELCHAIR PASSENGER KINEMATICS

Immediately prior to the crash, the case vehicle's fourth row right wheelchair passenger [75-year-old, White (non-Hispanic) male; 185 centimeters and 109 kilograms (73 inches, 240 pounds)] was seated in an upright position in his wheelchair. His wheelchair was secured to the wheelchair securement anchorage plates with four wheelchair securement straps. Two securement straps were attached to the front frame of the wheelchair and two were attached to the back frame of the wheelchair. At the time of the vehicle inspection, the securement straps were secured tightly and allowed the wheelchair to move only a small amount.

Based on the police crash report and correspondence with police personnel, this passenger was not restrained within his wheelchair and was ejected from the case vehicle during the rollover. The wheelchair was not equipped with a restraint system. No vehicle-mounted restraint system for this passenger was observed during the vehicle inspection. It is not known if a removable two-point lap belt, like the one used by the left wheelchair passenger, was available for him at the time of the crash.

The case vehicle driver's left steer maneuver just prior to the rollover caused the fourth row right wheelchair passenger to move to the right within his wheelchair. He most likely leaned significantly to the right as the case vehicle began to rotate counterclockwise. As the counterclockwise rotation increased and the vehicle began to rollover, passenger side leading, the right wheelchair passenger was ejected from his wheelchair. He most likely impacted the right side surface, possibly a window and the roof as the vehicle completed its first quarter roll. He was then most likely projected to the left toward the left roof area as the case vehicle's left roof and roof side rail sustained a hard ground impact at the end of the case vehicle's second quarter roll. He most likely impacted the left roof, roof side rail, left side surface and possibly a window. He most likely was ejected from the case vehicle as the bus body broke apart and separated from the case vehicle's chassis toward the end of the rollover. He was most likely contacted by the separated bus body causing multiple fractures of his ribs, a fractured sternum, fractured left femur and fractured right femoral neck. The right wheelchair passenger came to rest on the ground near the right side of the case vehicle.

CASE VEHICLE FOURTH ROW RIGHT WHEELCHAIR PASSENGER INJURIES

The police crash report indicated the fourth row right wheelchair passenger sustained fatal injuries as a result of the crash. He was transported from the scene by helicopter to a hospital. His medical records indicated he passed away during surgery. The passenger's injuries and injury mechanisms are shown in the table below.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Fracture ribs: right–1st through 9th laterally; left–1st through 7th in multiple places (i.e., anterolateral to posterior) with 100 cc of left hemothorax Complications include: enlarged heart, widen mediastinum, and multiple narrowed coronary arteries[1]	critical 450242.5,3	Exterior surface of motor vehicle: side surface	Probable	Autopsy
2	Fracture, transverse, complete, sternum at 3rd intercostal space	moderate 450804.2,4	Exterior surface of motor vehicle: side surface	Probable	Autopsy
3	Nonanatomic brain injury; awake and alert on initial observation but amnesic to events	moderate 160410.2,0	Unknown contact mechanism	Unknown	EMS treatment record
4	Fracture left femur, intertrochanteric, with left leg shorter than right and externally rotated	serious 851810.3,2	Exterior surface of motor vehicle: side surface	Probable	Emergency room records
5	Fracture right femoral neck, not further specified	serious 851812.3,1	Exterior surface of motor vehicle: side surface	Probable	Emergency room records
6	Contusion {hemorrhage}, 7.6 x 7.6 cm (3.0 x 3.0 in) subscalpular, confluent, right parietooccipital scalp	minor 190402.1,1	Unknown contact mechanism[2]	Unknown	Autopsy
7	Laceration, 1.6 cm (0.625 in) right superior parietal scalp	minor 190602.1,1	Unknown contact mechanism[2]	Unknown	Autopsy
8	Abrasion, up to 5.7 cm (2.25 in) right lateral cheek	minor 290202.1,1	Unknown contact mechanism[2]	Unknown	Autopsy
9	Contusion, up to 5.7 cm (2.25 in) right later cheek	minor 290402.1,1	Unknown contact mechanism[2]	Unknown	Autopsy
10	Abrasions upper mid back {posterior thorax}	minor 690202.1,7	Unknown contact mechanism[2]	Unknown	Autopsy
11	Abrasions posterior {extensor surface} left forearm; dorsum (back) hands, bilaterally; and volar (palm) aspect right wrist	minor 790202.1,3	Unknown contact mechanism[2]	Unknown	Autopsy

[1] Specifically cited, the left circumflex and left anterior descending arteries were 80-90% obstructed and the right coronary artery was 99% obstructed because of atherosclerosis. However, no acute myocardial infarct was found.

[2] There are numerous possibilities because this wheelchair-bound occupant was thrown around the vehicle during the rollover and ejected near the end of the roll before sustaining crushing-type injuries between the exterior surface of the vehicle and the ground.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
12	Contusions posterior {extensor surface} left forearm; dorsum (back) hands, bilaterally; and volar (palm) aspect right wrist	minor 790402.1,3	Unknown contact mechanism[2]	Unknown	Autopsy
13	Abrasions left upper posterolateral leg, left upper lateral leg, and left knee	minor 890202.1,2	Unknown contact mechanism[2]	Unknown	Autopsy

CASE VEHICLE FOURTH ROW LEFT WHEELCHAIR PASSENGER KINEMATICS

Immediately prior to the crash, the case vehicle's fourth row left wheelchair passenger [74-year-old, White (non-Hispanic) female; 165 centimeters and 95 kilograms (66 inches, 200 pounds)] was seated in an upright position in her wheelchair. This passenger was a double leg amputee above the knees. Her wheelchair was secured to the wheelchair securement anchorage plates with four wheelchair securement straps. Two securement straps were attached to the front frame of the wheelchair and two were attached to the back frame of the wheelchair. At the time of the vehicle inspection, the securement straps were secured tightly and the wheelchair would not move.

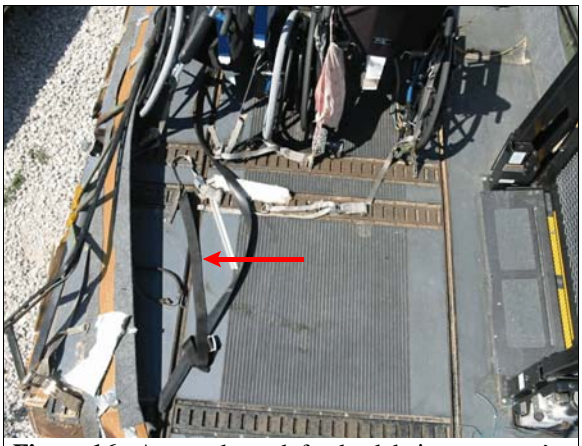

Figure 16: Arrow shows left wheelchair passenger's lap belt

Based on the vehicle inspection and correspondence with police personnel, this passenger was restrained by a removable two-point lap belt, which was attached to the securement anchorage plate behind the left wheelchair (**Figure 16**). In addition, the passenger was secured in the wheelchair by the thigh straps located at the front of the wheelchair cushion (**Figure 17**).

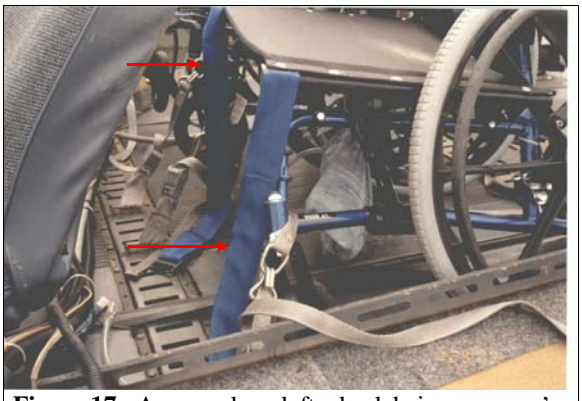

Figure 17: Arrows show left wheelchair passenger's leg straps

The case vehicle driver's left steer maneuver just prior to the rollover caused the left wheelchair passenger to move right within her wheelchair. As the case vehicle's counterclockwise rotation increased just prior to the rollover, the left wheelchair passenger was most likely leaned considerably to the right within her wheelchair. As the case vehicle began to rollover, passenger side leading, she remained restrained in her

wheelchair and most likely moved to the right, and then toward the roof within her wheelchair. As the vehicle's left roof side rail and roof sustained a hard ground impact during the case vehicle's second quarter roll, she most likely moved to the left and toward the roof within her wheelchair, and the left side of her body most likely contacted the left interior surface of the vehicle. As the case vehicle continued to rollover, the bus body broke apart and separated from the case vehicle's chassis toward the end of the rollover. The left wheelchair passenger remained restrained in her wheelchair as the case vehicle rolled onto its top to final rest. She impacted the ground since the bus body had separated from the case vehicle and was entrapped between the ground and her wheelchair. Her contact with the ground and resulting compression of her body due to her entrapment most likely caused her nonanatomic brain injury, thoracic cavity injury and the multiple fractures to her face, ribs, spine, shoulder and both femurs. The deformation to the wheelchair (**Figure 10** above) occurred during the last (sixth) quarter roll as the case vehicle rolled onto its top to final rest. The left wheelchair passenger was extricated from under the case vehicle by rescue personnel.

CASE VEHICLE FOURTH ROW LEFT WHEELCHAIR PASSENGER INJURIES

The police crash report indicated the left wheelchair passenger sustained an "A" (incapacitating) injury and was transported from the scene by helicopter to a hospital. The passenger's medical records indicated she was hospitalized for 29 days. The table below shows the passenger's injuries and injury mechanisms.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Nonanatomic brain injury, lethargic, unknown if loss of consciousness, GCS = 6; complications included generalized atrophy of brain parenchymal[3]	moderate 160602.2,0	Ground[4]	Probable	EMS treatment record
2	Contusion, cardiac–based on increased enzymes, with enlarged heart	minor 441004.1,4	Ground[4]	Probable	Hospitalization records
3	Contusion {hematoma} anterior mediastinal pleura with widened mediastinum	moderate 441804.2,4	Ground[4]	Probable	Hospitalization records

[3] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
parenchyma (pe-reng′ki-me): the essential elements of an organ; used in anatomical nomenclature as a general term to designate the functional elements of an organ; as distinguished from its framework, or stroma.
parenchymal (pe-reng′ki-mel): pertaining to or of the nature of parenchyma.

[4] This restrained wheelchair-bound occupant sustained crushing-type injuries when the shell of the bus broke apart and separated from the vehicle during the rollover, and she was crushed/trapped between her wheelchair seat and the ground.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
4	Injury thoracic cavity with left hemo and/or pneumothorax with complications of bilateral abnormalities[5] of pleural parenchymal[4] and ventilator dependence	serious 442202.3,2	Ground[4]	Probable	Hospitalization records
5	Fractures bilateral maxillary sinuses with multiple air fluid levels consistent with blood and debris in sinuses	moderate 250800.2,3	Ground[4]	Probable	Hospitalization records
6	Fracture anterior nasal spine[6], with multiple broken pieces of denture found in mouth and bilateral cheek emphysema	moderate 250800.2,8	Ground[4]	Probable	Hospitalization records
7	Fracture bilateral 3rd ribs, posteriorly, near vertebral body	moderate 450220.2,3	Ground[4]	Probable	Hospitalization records
8	Fracture spinous process C_7 with posterior displacement	moderate 650218.2,6	Ground[4]	Probable	Hospitalization records
9 10 11	Fracture spinous process T_1, T_2, and T_3 with posterior displacement	moderate 650418.2,7 650418.2,7 650418.2,7	Ground[4]	Probable	Hospitalization records
12 13	Fracture T_2 right transverse process and right and left transverse processes of T_3	moderate 650420.2,7 650420.2,7	Ground[4]	Probable	Hospitalization records
14	Fracture right lamina of T_3	serious 650424.3,7	Ground[4]	Probable	Hospitalization records
15	Fracture bilateral pedicles of T_3	serious 650426.3,7	Ground[4]	Probable	Hospitalization records

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[5] Possible ARDs, bilateral infiltrates, or edema; a persistent, patchy, diffuse, opacification was present in both lung fields through this occupant's hospital stay as well as bilateral lower lung atelectasis.
The term ARDs is defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
Acute respiratory distress syndrome: fulminant pulmonary interstitial and alveolar edema, which usually develops within a few days after the initiating trauma, thought to result from alveolar injury that has led to increased capillary permeability. Called also *adult respiratory distress s.* and *shock lung*.

[6] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
spine (spiin): 1. spina
***spina (spi′na)* [L.]**: 1. spine: general anatomical nomenclature for a thornlike process or projection.
s. nasa′lis ante′rior maxil′lae, anterior nasal spine of maxilla: the sharp anterosuperior projection at the anterior extremity of the nasal crest of the maxilla.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
16 17	Fracture, oblique, through T_3 and T_4 vertebral bodies, not further specified	moderate 650430.2,7 650430.2,7	Ground[4]	Probable	Hospitalization records
18 19	Fracture right and left clavicles, not further specified	moderate 752200.2,1 752200.2,2	Ground[4]	Probable	Hospitalization records
20	Fracture inferior aspect of right scapula, not further specified	moderate 753000.2,1	Ground[4]	Probable	Hospitalization records
21 22	Fracture, comminuted, bilateral distal femurs with osteopenia[7]	serious 851814.3,1 851814.3,2	Ground[4]	Probable	Emergency room records
23	Contusion {subgaleal hematoma} at vertex of scalp	minor 190402.1,9	Ground[4]	Probable	Hospitalization records
24	Contusion {subgaleal hematoma} occipital region of scalp	minor 190402.1,6	Ground[4]	Probable	Hospitalization records
25	Laceration at vertex of scalp, not further specified	minor 190600.1,9	Ground[4]	Probable	Hospitalization records
26	Contusion {ecchymosis} to bilateral lower arms and hands, not further specified	minor 790402.1,3	Ground[4]	Probable	EMS treatment record

CASE VEHICLE SECOND ROW LEFT OUTBOARD PASSENGER KINEMATICS

Immediately prior to the crash the case vehicle's second row left outboard passenger [86-year-old, White (non-Hispanic) male; 170 centimeters and 113 kilograms (67 inches, 250 pounds)] was likely seated in an upright position. His seat track and seat back were not adjustable.

Based on the case vehicle inspection and the police crash report, the second row left outboard passenger was restrained by his two-point lap belt. The lap belt had been cut by rescue personnel, indicating this passenger was restrained in this crash. Inspection of the lap belt assembly revealed no evidence of loading. However, numerous scratches were observed on the latch plate indicating historical usage of the lap belt.

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[7] This occupant had pre-existing bilateral above knee amputations. The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:

***lysin (li′sin)* [Gr. lyein to dissolve]**: 1. any substance that causes cytolysis (lysis of cells); those with specific action for a certain type of cell are named accordingly, as hemolysins, etc.

***lysis (li′sis)* [Gr. "dissolution; a loosing, setting free, releasing"]**: 1. destruction, as of cells by a specific *lysin*.

osteopenia (os"te-o-pe′ne-a): reduced bone mass due to a decrease in the rate of osteoid synthesis to a level insufficient to compensate normal bone lysis. The term is also used to refer to any decrease in bone mass below the normal.

The case vehicle driver's left steering maneuver just prior to the rollover caused the second row left outboard passenger to move to the right within his safety belt. As the case vehicle's counterclockwise rotation increased and the vehicle began to rollover, passenger side leading, he moved to the right and toward the roof and loaded his safety belt. As the case vehicle's left roof and roof side rail impacted the ground during the second quarter roll, he continued to load his safety belt and moved left and toward the roof. The left side of his body most likely contacted the left interior surface of the vehicle and possibly the window. As the case vehicle continued to rollover, the bus body broke apart and separated from the case vehicle's chassis toward the end of the rollover. This passenger's seat back was deformed rearward and to the right indicating he impacted the ground as the case vehicle came to rest on its top at the end of the sixth quarter roll. His contact with the ground and resulting compression of his body due to his entrapment under the vehicle most likely caused the transection of his spinal cord, multiple rib fractures and sternum fracture. He was extricated from underneath the vehicle by rescue personnel.

CASE VEHICLE SECOND ROW LEFT OUTBOARD PASSENGER INJURIES

The police crash report indicated that the second row left outboard passenger sustained fatal injuries as a result of the crash. He was pronounced dead at the scene and was transported to the county morgue. The table below shows the passenger's injuries and injury mechanisms.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Laceration {transection} spinal cord {vertebral column} at C_5-C_6	critical 640261.5,6[8]	Ground	Probable	Autopsy
2	Fracture ribs: right 1st through 7th anteriorly and right 1st through 6th posteriorly at costovertebral junction; left 1st through 9th posterolaterally; no hemothorax	severe 450240.4,3	Ground	Probable	Autopsy
3	Fracture, oblique, sternum at 2nd and 3rd intercostal spaces	moderate 450804.2,4	Ground	Probable	Autopsy
4	Dislocation {fracture} left acromioclavicular joint	moderate 750230.2,2	Ground	Probable	Autopsy
5	Contusion {hemorrhage}, subscalpular, bilateral frontal scalp	minor 190402.1,5	Ground	Probable	Autopsy
6	Contusion, 6.4 x 2.5 cm (2.5 x 1.0 in) mid-right, medial, parietal scalp	minor 190402.1,1	Ground	Probable	Autopsy

[8] The choice of injury code is difficult because the NASS CDS Injury Coding manual presumes that one knows whether the spinal lesion resulted in either a complete or an incomplete cord syndrome. Because the only available medical record is an autopsy, the syndrome issue is not discernable (i.e., you cannot determine the difference in a deceased person). In the absence of protocol, this contractor chooses to assume that the syndrome was complete.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
7	Contusions, diffuse, bilateral forehead, nose, and cheeks	minor 290402.1,0	Ground	Probable	Autopsy
8 9	Contusions {ecchymoses} bilateral upper and lower eyelids	minor 297402.1,1 297402.1,2	Ground	Probable	Autopsy
10 11	Abrasion **and** laceration, superficial, upper anterior nose	minor 290202.1,4 290602.1,4	Ground	Probable	Autopsy
12	Abrasions right lateral chest, not further specified	minor 490202.1,1	Ground	Probable	Autopsy
13	Abrasions, multiple, right abdomen, right lateral hip, left medial abdomen, left lateral abdomen–up to 8.9 cm (3.5 in)	minor 590202.1,0	Lap belt	Probable	Autopsy
14	Contusions right lower abdomen, supra-public area, and left lateral abdomen–up to 8.9 cm (3.5 in)	minor 590402.1,8	Lap belt	Probable	Autopsy
15	Abrasions, 17.8 x 7.6 cm (7.0 x 3.0 in), obliquely oriented right medial back {posterior chest}	minor 690202.1,1	Seat back, driver's	Probable	Autopsy
16	Contusion and ecchymosis bilateral posterior {extensor surface} forearms and dorsum (back) of hands	minor 790402.1,3	Seat back, driver's	Possible	Autopsy
17	Abrasions, up to 12.7 cm (5.0 in), scatter, bilateral thighs and right leg, not further specified	minor 890202.1,3	Ground	Possible	Autopsy
18	Laceration right mid-anteromedial leg, not further specified	minor 890600.1,1	Unknown contact mechanism	Unknown	Autopsy

CASE VEHICLE THIRD ROW RIGHT OUTBOARD PASSENGER KINEMATICS

Immediately prior to the crash, the case vehicle's third row right outboard passenger [54-year-old, White (non-Hispanic) male; 168 centimeters and 91 kilograms (66 inches, 200 pounds)] was likely seated in an upright position. His seat track and seat back were not adjustable.

Based on the police crash report, the third row right outboard passenger was restrained by his two-point lap belt. Inspection of the lap belt revealed no evidence of loading. Numerous scratches were observed on the latch plate indicating historical usage of the lap belt.

The case vehicle driver's left steer maneuver just prior to the rollover caused the third row right outboard passenger to move to the right within his safety belt, and the right side of his body most likely moved against the right interior surface of the vehicle. As the case vehicle's counterclockwise rotation increased and the vehicle rolled over, passenger side leading, he moved to the right and toward the roof, loaded his safety belt and the right side of his body most likely contacted the right interior surface and outboard of the vehicle. As the case vehicle's left roof and roof side rail impacted the ground during the second quarter roll, he moved to the left and toward the roof within his safety belt and continued to load the safety belt. As the case vehicle continued to rollover, the bus body broke apart and separated from the case vehicle's chassis toward the end of the rollover. He most likely impacted the ground as the case vehicle came to rest on its top during the sixth quarter roll. His contact with the ground and resulting compression of his body due to his entrapment under the vehicle most likely caused the transection of his vertebral column, subarachnoid hemorrhage, bilateral fractured ribs, and pericardium and myocardium lacerations. He was extricated from underneath the vehicle by rescue personnel.

CASE VEHICLE THIRD ROW RIGHT OUTBOARD PASSENGER INJURIES

The police crash report indicated that the third row right outboard passenger sustained fatal injuries as a result of the crash. He was pronounced dead at the scene and was transported to the county morgue. The table below shows the passenger's injuries and injury mechanisms.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Laceration {transection} of vertebral column at C_7-T_1, not further specified	critical 640261.5,6[9]	Ground[10]	Probable	Autopsy
2	Lacerations, multiple, myocardium with chamber perforation, including two transmural[11] lacerations, 5.0 and 4.0 cm (2.5, 1.6 in) to upper anterior right ventricle and an irregular	maximum 441016.6,4	Ground[10]	Probable	Autopsy

[9] Footnote #8 above also applies to this lesion.

[10] This restrained occupant sustained crushing-type injuries when the shell of the bus broke apart and separated from the vehicle during the rollover, and he was crushed/trapped between his seat and the ground.

[11] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
***atria (a/tre-a)* [L.]**: plural of *atrium*.
atrium (a/tre-m): a chamber; used in anatomical nomenclature to designate a chamber affording entrance to another structure or organ. Usually used alone to designate an atrium of the heart (a. cordis).
hamartoma (hamahr-to/m): a benign tumor-like nodule composed of an overgrowth of mature cells and tissues that normally occur in the affected part, but with disorganization and often with one element predominating.
transmural (trans-mu/ral): through the wall of an organ; extending through or affecting the entire thickness of the wall of an organ or cavity.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
2 (Cont'd.)	laceration, 3.0 cm (1.2 in) in width, to the bilateral posterior atria				
3	Laceration inter-atrial septum	critical 441300.5,4	Ground[10]	Probable	Autopsy
4	Lacerations x 2 upper lobe right lung–up to 2.0 cm (0.8 in), and one upper lobe left lung–1.0 cm (0.4 in), with hamartoma[11] right upper lobe lung and 100 cc hemothorax left pleural cavity	severe 441450.4,3	Ground[10]	Probable	Autopsy
5 6	Hemorrhage, subarachnoid, thin, over cerebral hemispheres, more extensive on right	serious 140684.3,1 140684.3,2	Ground[10]	Probable	Autopsy
7	Laceration and open pericardium, not further specified	moderate 441602.2,4	Ground[10]	Probable	Autopsy
8	Fractured ribs bilaterally, 1st through 12th, anterior to posterior with multiple fractured rib ends protruding into chest cavity and wide separation of 1st through 7th left costosternal joints	severe 450240.4,3	Ground[10]	Probable	Autopsy
9	Laceration {by ribs} of overlying parietal pleural membranes, bilaterally	moderate 441800.2,3	Ground[10]	Probable	Autopsy
10	Fracture, transverse, sternum at 2nd intercostal space	moderate 450804.2,4	Ground[10]	Probable	Autopsy
11	Dislocation {fracture} left acromioclavicular joint	moderate 750230.2,2	Ground[10]	Probable	Autopsy
12 13	Dislocation {fracture} bilateral sternoclavicular joints with wide separation of left joint	moderate 751230.2,1 751230.2,2	Ground[10]	Probable	Autopsy
14	Contusion, 12.7 x 6.4 cm (5.0 x 2.5 in) right forehead and right temple area	minor 290402.1,7	Ground[10]	Probable	Autopsy
15	Contusion {hemorrhage}, diffuse, subscapular over right scalp	190402.1,1	Ground[10]	Probable	Autopsy
16 17	Injury {hemorrhage} conjunctiva, lateral aspect of left and right eyes	minor 240416.1,1 240416.1,2	Ground[10]	Probable	Autopsy

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
18	Contusion {ecchymosis} medial right upper eyelid	minor 297402.1,1	Ground[10]	Probable	Autopsy
19	Abrasions chest: including right lateral chest–part of a 33.0 x 7.6 cm (13.0 x 3.0 in) area, and bilateral anterior inferior chest	minor 490202.1,0	Ground[10]	Probable	Autopsy
20	Contusions chest: including left upper chest and left medial shoulder–14.0 x 3.8 cm (5.5 x 1.5 in) area, and bilateral anterior inferior chest	minor 490402.1,0	Ground[10]	Probable	Autopsy
21	Abrasions abdomen: including right abdomen–part of a 33.0 x 7.6 cm (13.0 x 3.0 in) area, and left lower quadrant of abdomen–25.4 x 15.2 cm (10.0 x 6.0 in) area	minor 590202.1,0	Lap portion of safety belt system	Probable	Autopsy
22	Laceration, 3.8 cm (1.5 in) mid flexor surface left forearm	minor 790602.1,2	Unknown contact mechanism	Unknown	Autopsy
23	Abrasion, 40.6 x 1.3 cm (16.0 x 0.5 in), curvilinear, left back, left buttock, and left inferior-lateral buttock	minor 890202.1,2	Seat back support	Probable	Autopsy
24	Contusion, 27.9 x 12.7 cm (11.0 x 5.0 in) supra-pubic area and right anterior thigh	minor 890402.1,1	Unknown contact mechanism	Unknown	Autopsy
25	Contusions, 47.0 x 15.2 cm (18.5 x 6.0 in) left anterior thigh, knee, and upper anterior leg	minor 890402.1,2	Unknown contact mechanism	Unknown	Autopsy

CASE VEHICLE SECOND ROW RIGHT OUTBOARD PASSENGER KINEMATICS

Immediately prior to the crash the case vehicle's second row right outboard passenger [43-year-old, Black (non-Hispanic) male; 170 centimeters and 84 kilograms (67 inches, 185 pounds] was seated in an unknown position. He stated to police that he was asleep prior to the crash. His seat track and seat back were not adjustable.

This passenger was not restrained by his two-point lap belt. He was ejected during the crash.

The case vehicle driver's left steering maneuver just prior to the rollover caused the third row right outboard passenger to move to the right within his seat. He most likely moved against the right interior surface of the bus. As the case vehicle's counterclockwise rotation increased and the vehicle began to rollover, passenger side leading, he came out of his seat and most likely contacted the right interior surface and possibly the window and roof. He was then most likely projected to the left toward the left roof as the case vehicle's left roof and roof side rail sustained a hard ground impact at the end of the case vehicle's second quarter roll. He most likely impacted the left roof, left roof side rail, left side and possibly a window. He was most likely ejected from the case vehicle as the bus body broke apart and separated from the case vehicle's chassis toward the end of the rollover, most likely during the fifth or sixth quarter rolls. The second row right outboard passenger came to rest on the ground near the right side of the case vehicle.

CASE VEHICLE SECOND ROW RIGHT OUTBOARD PASSENGER INJURIES

The police crash report indicated that the second row right outboard passenger sustained an "A" (incapacitating) injury as a result of the crash. He was transported from the scene to a hospital and admitted for treatment of his injuries. The table below shows the passenger's injuries.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Nonanatomic brain injury; possible loss of consciousness; awake on initial observation, GCS=15, but amnesic to events	moderate 160410.2,0	Unknown contact mechanism[12]	Unknown	Emergency room records
2	Contusion left lung lower lobe and posterior upper lobe with small posterior hemothorax **and** small left anterior pneumothorax	serious 441406.3,2	Unknown contact mechanism[12]	Unknown	Emergency room records
3	Fracture ribs, all non-displaced: left posterior medial1st rib, left posterior 3rd, 4th, 5th, and 6th ribs; right posterior medial 1st rib, right lateral 7th and 8th ribs	severe 450240.4,3	Unknown contact mechanism[12]	Unknown	Emergency room records
4	Laceration, 6-7 cm (2.4-2.8 in), linear, posterior scalp	minor 190602.1,6	Unknown contact mechanism[12]	Unknown	Emergency room records
5	Abrasions to arms, not further specified	minor 790202.1,3	Unknown contact mechanism[12]	Unknown	Emergency room records

[12] There are numerous possibilities because this unrestrained occupant was thrown around the vehicle during the rollover and ejected at the end of the roll (i.e., came to rest near right side of vehicle).

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
6	Laceration left forearm, not further specified	minor 790600.1,2	Unknown contact mechanism[12]	Unknown	Emergency room records
7	Abrasions to legs, including left leg, not further specified	minor 890202.1,3	Unknown contact mechanism[12]	Unknown	Emergency room records

CASE VEHICLE THIRD ROW LEFT OUTBOARD PASSENGER KINEMATICS

Immediately prior to the crash the case vehicle's third row left outboard passenger [25-year-old, White (non-Hispanic) female; 173 centimeters and 54 kilograms (68 inches, 118 pounds)] was seated in an unknown position. She stated to police that she was asleep prior to the crash. Her seat track and seat back were not adjustable.

The passenger was not restrained by her two-point lap belt. She was ejected during the crash.

The case vehicle driver's left steer maneuver just prior to the rollover caused the third row left outboard passenger to move to the right within her seat row. As the case vehicle's counterclockwise rotation increased and the vehicle rolled over, passenger side leading, she moved to the right and was thrown out of her seat and may have contacted the passenger seated in the third row right outboard seat as well as the right interior side surface of the vehicle, and possibly the third row right side window and roof. She was then most likely projected toward the left roof as the case vehicle's left roof side rail and roof sustained a hard ground impact at the end of the case vehicle's second quarter roll. She most likely impacted the left roof, left roof side rail, left side and possibly a window. She most likely was ejected from the case vehicle as the bus body broke apart and separated from the case vehicle's chassis toward the end of the rollover, most likely during the fifth or sixth quarter rolls. The third row left outboard passenger came to rest on the ground near the right side of the case vehicle.

CASE VEHICLE THIRD ROW LEFT OUTBOARD PASSENGER INJURIES

The police crash report indicated that the third row left outboard passenger sustained an "A" (incapacitating) injury as a result of the crash. She was transported from the scene to a hospital and admitted for treatment of her injuries. The table below shows the passenger's injuries and injury mechanisms.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Fracture, compression, C7 vertebral body, not further specified, with fragment impingement on spinal canal	moderate 650230.2,6	Unknown contact mechanism[13]	Unknown	Emergency room records
2	Laceration, large, 15 cm (5.9 in), beginning at hairline of anterior scalp and is curvilinear toward vertex of left parietal scalp; no mention of subcutaneous involvement	minor 190602.1,5	Unknown contact mechanism[13]	Unknown	Emergency room records
3	Abrasions, multiple, with dirt over bilaterally forearms	minor 790202.1,3	Ground	Probable	Emergency room records
4	Contusions over arms (bilaterally), not further specified	minor 790402.1,3	Unknown contact mechanism[13]	Unknown	Emergency room records
5	Abrasions bilateral knees with underlying point tenderness	minor 890202.1,3	Unknown contact mechanism[13]	Unknown	Emergency room records
6	Contusions bilateral knees, not further specified	minor 890402.1,3	Unknown contact mechanism[13]	Unknown	Emergency room records

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash the case vehicle's driver [35-year-old, Black (non-Hispanic) male; 178 centimeters and 102 kilograms (70 inches, 265 pounds)] was seated in a nominal upright driving posture. He most likely had both hands on the steering wheel, his left foot on the floor and his right foot off the accelerator pedal. The driver's seat track was located in its approximate middle track position. His seat back was fixed in a slightly reclined position.

The driver was restrained by his manual, three-point, lap and shoulder safety belt system. The driver sustained belt pattern abrasions and contusions to his left shoulder during the crash. Inspection of the safety belt system revealed use scratches on the latch plate indicating prior usage; otherwise, the safety belt system was unremarkable.

The case vehicle driver's left steering maneuver just prior to the rollover caused the driver to move right within his safety belt and his safety belt retractor most likely locked. As the case vehicle's counterclockwise rotation increased and the vehicle rolled over, passenger side leading, he moved to the right and toward the roof and loaded his safety belt. As the case vehicle's left roof side rail and roof impacted the ground during the second quarter roll, he moved left and toward the roof and most likely impacted the left side of his body on his door and impacted the

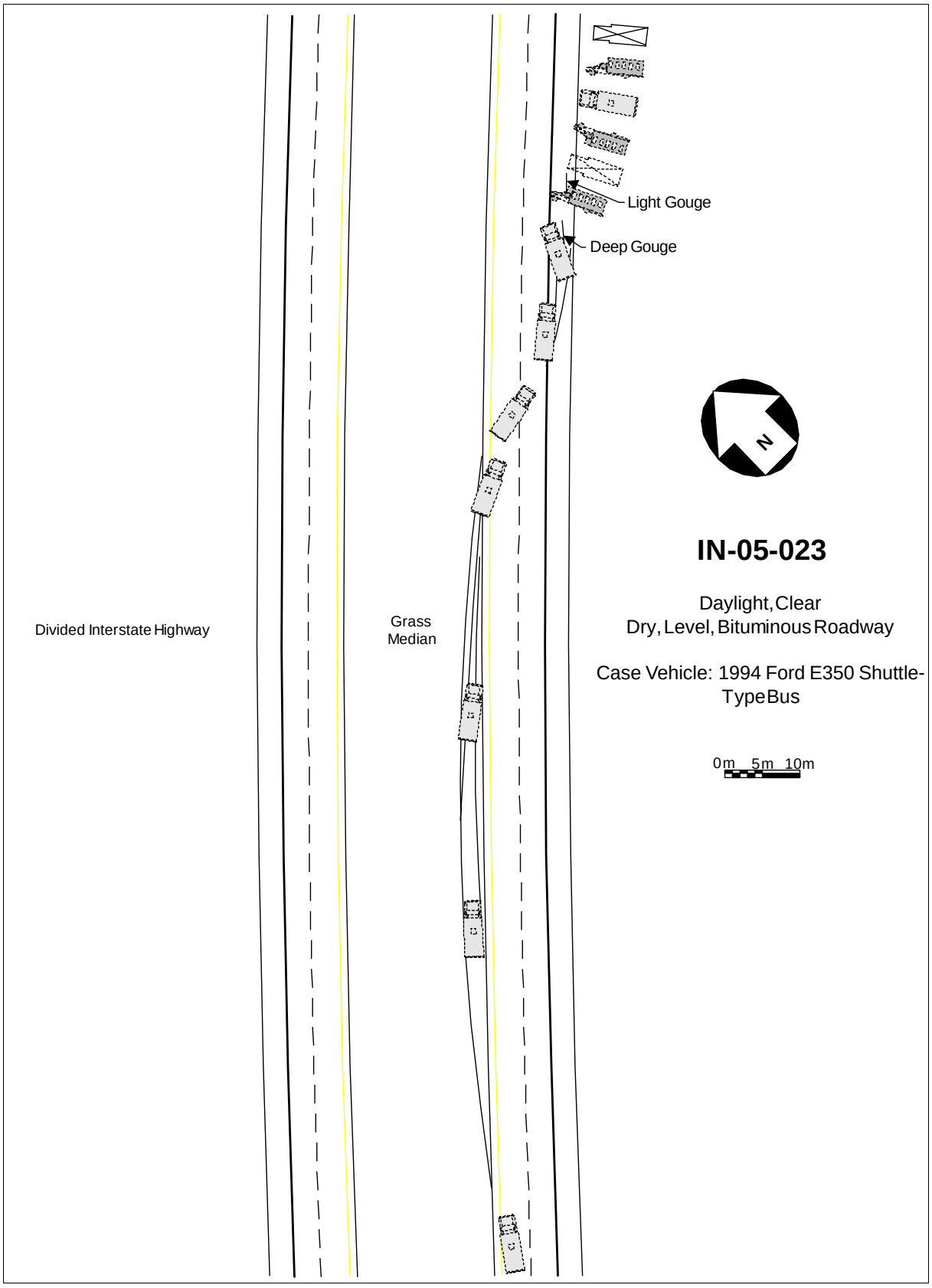
[13] There are likewise numerous possibilities because this unrestrained occupant was thrown around the vehicle during the rollover and ejected at the end of the roll.

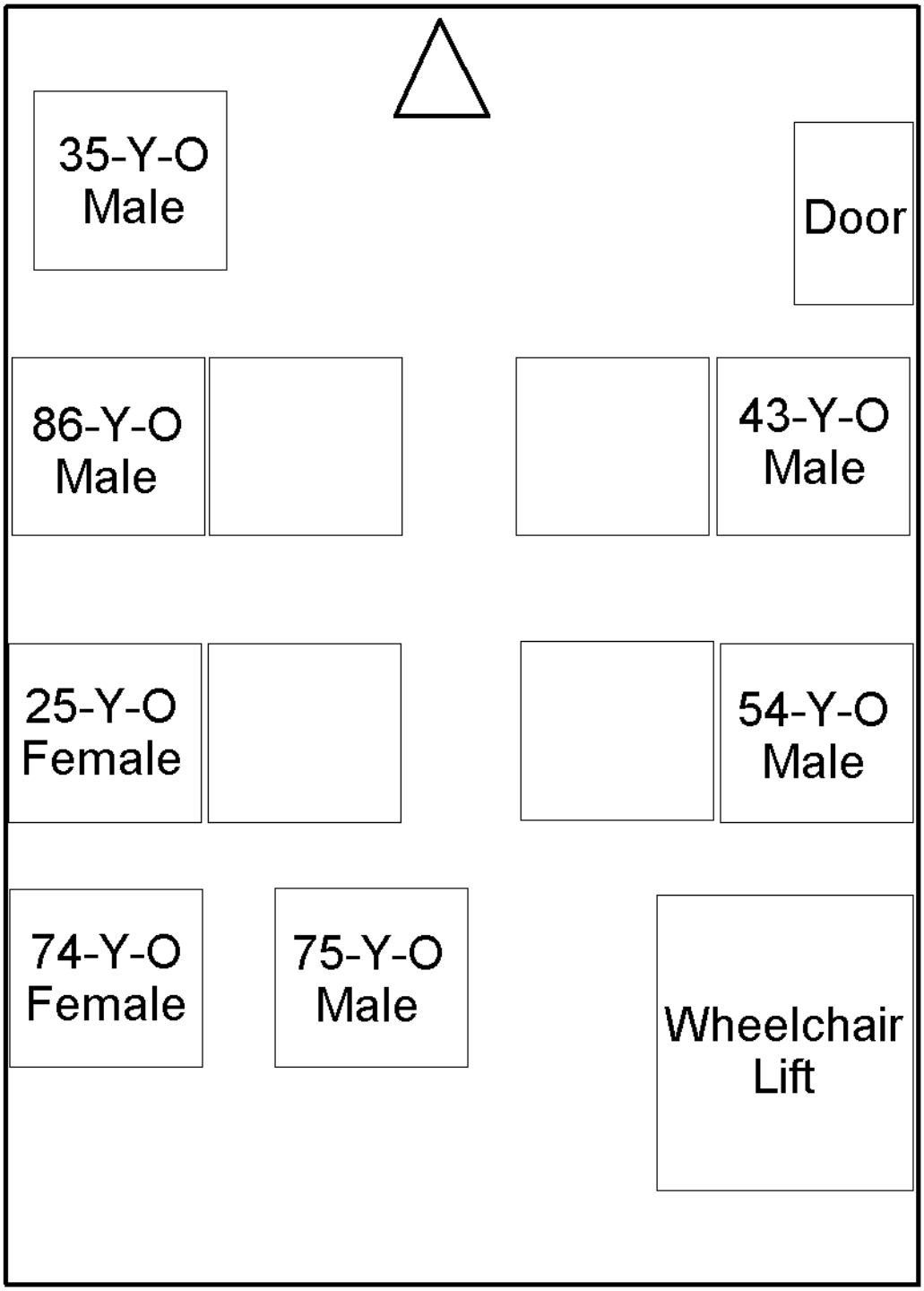
back of his head on the intruding left roof side rail lacerating his scalp. As the case vehicle continued to roll over, the driver remained restrained in his seat and was entrapped in the case vehicle as it rolled onto its top to final rest. The supplemental police incident report indicated that the driver's left arm was entrapped in the instrument panel. The driver's medical records indicated it took 40 to 45 minutes to extricate him from the vehicle.

CASE VEHICLE DRIVER INJURIES

The police crash report indicated that the case vehicle's driver sustained an "A" (incapacitating) injury as a result of the crash. He was transported from the scene by helicopter and treated and released. The table below shows the driver's injuries and injury mechanisms.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Laceration, 3-4 cm (1.2-1.6 in), involving subcutaneous tissue, left occipital scalp	minor 190602.1,6	Roof, left side rail	Probable	Emergency room records
2	Laceration, small, left forehead, above left eye	minor 290602.1,7	Noncontact injury: flying glass, unknown source	Probable	EMS treatment record
3	Abrasion left shoulder, not further specified	minor 790202.1,2	Torso portion of safety belt system	Probable	Emergency room records
4	Contusion left shoulder, not further specified	minor 790402.1,2	Torso portion of safety belt system	Probable	Emergency room records
5	Abrasion left forearm and hand, not further specified	minor 790202.1,2	Left instrument panel and below	Probable	Emergency room records
6	Contusion left arm, not further specified	minor 790402.1,2	Left instrument panel and below	Probable	Emergency room records
7	Contusion right arm–most likely right hand, not further specified	minor 790402.1,1	Roof	Possible	Emergency room records


Light Gouge
Deep Gouge
N
IN-05-023
Daylight, Clear
Dry, Level, Bituminous Roadway
Case Vehicle: 1994 Ford E350 Shuttle-Type Bus
0m 5m 10m
Divided Interstate Highway
Grass Median


35-Y-O Male
Door
86-Y-O Male
43-Y-O Male
25-Y-O Female
54-Y-O Male
74-Y-O Female
75-Y-O Male
Wheelchair Lift