

15 Passenger Van Rollover Investigation / Vehicle Rollover
Dynamic Science, Inc. / Case Number: DS06012
2004 Ford E350 Van
Utah
May 2006

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

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.

1. Report No. DS06012	2. Government Accession No.		3. Recipient Catalog No.	
4. Title and Subtitle 15 Passenger Van Rollover Investigation			5. Report Date August 25, 2006	
			6. Performing Organization Report No.	
7. Author(s) Dynamic Science, Inc.			8. Performing Organization Report No.	
9. Performing Organization name and Address Dynamic Science, Inc. 530 College Parkway, Ste. K Annapolis, MD 21401			10. Work Unit No. (TRAVIS)	
			11. Contract or Grant no. DTNH22-01-C-27002	
12. Sponsoring Agency Name and Address U.S. Dept. of Transportation (NRD-32) National Highway Traffic Safety Administration 400 7th Street, SW Washington, DC 20590			13. Type of report and period Covered [Report Month, Year]	
			14. Sponsoring Agency Code	
15. Supplemental Notes				
16. Abstract This on-site investigation focused on a 2004 Ford E50 van involved in a rollover. This is a single vehicle crash that occurred in May 2006 in a rural area of Utah. The crash occurred on a US highway. The case vehicle is a 2004 Ford 15-passenger van. At the time of the crash, the van was being driven by a 32-year-old American driver who was transporting 13 international passengers. The passengers ranged in age from 20 to 33. The van was traveling northbound. As the vehicle attempted to pass another vehicle, the driver lost control of the vehicle due to a reported tire malfunction. The driver swerved left, then right, then departed the roadway and rolled several times. Seven passengers were ejected from the vehicle. One occupant, a 21-year-old male, sustained head injuries and died in the crash. The injured were taken to three separate hospitals.				
17. Key Words 15 passenger van, rollover, ejection, fatality		18. Distribution Statement		
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No of pages	22. Price	

Dynamic Science, Inc.
Crash Investigation
Case Number: DS06012

TABLE OF CONTENTS

Background	1
Summary	1
Crash Site	1
Pre-crash	2
Crash	3
Post-crash	4
Vehicle Data -2004 Ford E350 Van	6
Vehicle Damage	8
Exterior Damage	8
Interior Damage	9
Manual Restraint Systems	11
Supplemental Restraint System	11
Occupant Demographics	12
Occupant Injuries	17
Occupant Kinematics	23
Scene Diagram	28

BACKGROUND

This on-site investigation focused on a 2004 Ford E350 van involved in a rollover. This is a single vehicle crash that occurred in May 2006 in a rural area of Utah. The crash occurred on a US highway. The case vehicle is a 2004 Ford 15-passenger van. At the time of the crash, the van was being driven by a 32-year-old American driver who was transporting 13 international passengers. The passengers ranged in age from 20 to 33. The van was traveling northbound. As the vehicle attempted to pass another vehicle, the driver lost control of the vehicle due to a reported tire malfunction. The driver swerved left, then right, then departed the roadway and rolled several times. Seven passengers were ejected from the vehicle. One occupant, a 21-year-old male, sustained head injuries and died in the crash. The injured were taken to three separate hospitals.



Figure 1. Left side, 2004 Ford E350

This 15-passenger Van Rollover Investigation was identified by NHTSA through an on-line news article. DSI was requested to locate the case vehicle and obtain permission to inspect the vehicle. Shortly after the crash, the vehicle was released to its owner. The owner was a tour company based out of California. DSI located the tour company and obtained permission to inspect the vehicle from their attorney and insurance company. The inspection took place on June 20, 2006. An attorney representing the tour company was present during the vehicle inspection. A representative from the Ford Motor Company arrived shortly before the vehicle inspection was completed to conduct a separate investigation.

SUMMARY

Crash Site

This single vehicle crash took place on an undivided state highway in May 2006 at 1759 hours. At the time of the crash, there were no adverse weather conditions and the asphalt roadway surface was dry. The north/south roadway was configured with one lane in each direction that were separated by a dashed yellow painted centerline. There are paved shoulders adjacent to the roadway that are delineated by solid painted white lines. Just beyond the shoulders, there is a grass covered embankment with a slight downward grade. The posted speed limit is 105 km/h (65 mph).



Figure 2. Overhead view of initial loss of control area and path to roadway departure

Crash

The driver lost control of the vehicle. The vehicle began a clockwise rotation, tripped and began a left side leading rollover. The vehicle rolled at least two times and came to rest on its wheels on the east roadside. Seven passengers were ejected from the vehicle. One occupant, a 21-year-old male, sustained head injuries and died in the crash. The injured were taken to three separate hospitals.



Figure 4. Overview of overturn and roadway departure area

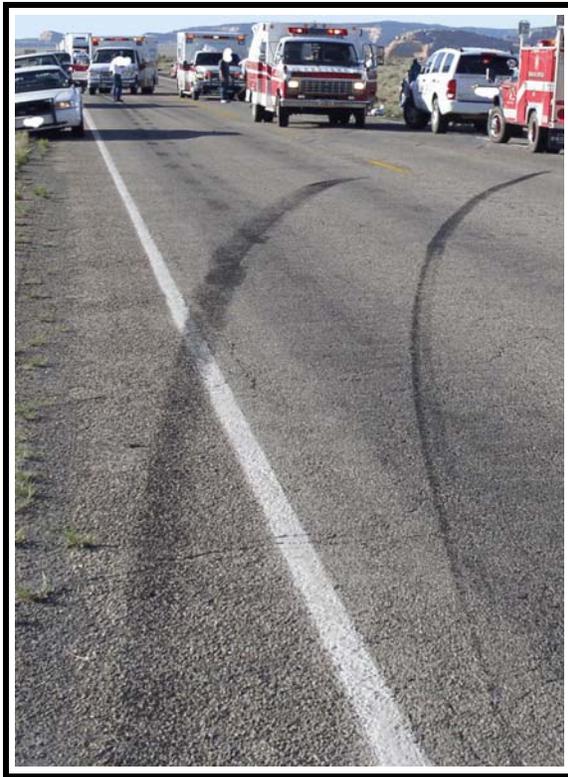


Figure 5. Left front and left rear tires approaching trip point



Figure 6. Left front and left rear tires at trip point—left rear gouging roadway

Post-Crash

The driver of the case vehicle sustained a contusion to the right arm. He was transported from the scene, treated and then released.

The first row right seat occupant (02) sustained a concussive head injury, a contusion to the right orbit area, a forehead abrasion, a left shoulder abrasion, and a laceration to the left elbow. She was transported to an area hospital where she was admitted and hospitalized for two days.

The second row left occupant (03) sustained a liver contusion and an abrasion to the left posterior ribs. He was transported to an area hospital. He was first seen at 1930 hours. He was treated and released. He returned the following morning for a follow up x-ray that proved to be negative.

The second row middle occupant (04) was ejected from the vehicle. She sustained multiple contusions, lacerations and abrasions to her right arm and left shoulder area. She was transported to an area hospital. She was admitted at 1909 hours and was hospitalized for two days.

The second row right occupant (05) was ejected from the vehicle. He sustained a concussive head injury and lacerations to the right elbow. It was reported that he lost consciousness for approximate five minutes after the crash. He was transported to an area hospital and treated. He arrived with a GCS score of 15. He was later transferred to a Level II trauma center.

The third row left occupant (06) was ejected from the vehicle. She sustained pelvic fractures, a left humerus fracture, a C2 spinal fracture, a laceration to the nerve root, and multiple contusions and lacerations. She was transported to an area hospital. She was admitted at 1902 hours with a Glasgow Coma Scale score of 15. She was transferred later that day to an area Level I trauma center where she was hospitalized for an unknown number of days.

The third row middle occupant (07) sustained a concussive head injury and multiple lacerations and contusions. She was transported to an area hospital. She was awake when examined. She was admitted 1900 hours and was hospitalized for two days.

The third row right occupant (08) was ejected. He was fatally injured. The time of death was indicated to have been immediate. There was no autopsy conducted. The Certificate of Death indicated that he had died due to a blunt head trauma.

The fourth row left occupant (09) sustained a left shoulder contusion. She was transported to an area hospital, treated and then released.

The fourth row middle occupant (10) was ejected from the vehicle. He sustained a concussive head injury, multiple comminuted left pubic ramus fractures, a left sacrum fracture, a left ilium fracture, and a contusion to the pelvic region. He had an apparent loss of consciousness and a 20 minute lapse of awareness. He was transported to an area hospital. He was admitted at 1857 hours. He was treated and then transferred to a Level III trauma center.

The fourth row right occupant (11) was ejected from the vehicle. She sustained a concussive

head injury, an L3 vertebral fracture, a T1 fracture, and multiple abrasions and contusions. She was transported to an area hospital. She was admitted at 1845 hours. She was treated and then transferred to a Level III trauma center.

The first fifth row occupant (12) was ejected from the vehicle. He sustained multiple facial fractures, teeth fractures, and multiple abrasions and contusions. He was transported to an area hospital. He arrived with a GCS score of 14. He was admitted at 1850 hours. He was hospitalized for three days before being transferred to an area trauma center.

The second fifth row occupant (13) sustained contusions her left hip, thigh and buttock. She was transported to an area hospital. She was admitted at 1850 hours. She was hospitalized for two days.

The third fifth row occupant (14) sustained minor injuries of an unknown nature.

The case vehicle was towed from the scene due to damage. It was first placed on a police hold and inspected by investigators. It was later released to the tour company and placed in secure storage by their legal representatives. The vehicle's rear tires were removed by police investigators and were initially being held as evidence.

VEHICLE DATA -2004 Ford E350 van

The 2004 Ford E350 Econoline E350 Super Duty 4 x2 van was identified by the Vehicle Identification Number (VIN): 1FBSS31S14HBxxxxxx. The Ford van was equipped with a 6.8 liter (415 CID) V10 engine, a 4-speed automatic transmission, rear wheel drive, power 4-wheel disc brakes with ABS, power steering and a tilt steering wheel. This vehicle model has a reported static stability factor (SSF) of 1.11. Measurements on a lightly loaded and fully loaded E350 showed SSF ranges from 1.07 to 0.95¹.

The 2004 Ford E350 van was equipped with Bridgestone LT245/75R16 V Steel tires on the front and Cooper Chaparral LT245/75R16 tires on the rear. The rear tires were manufactured for Del_Nat in Tennessee and the build date was the second week of February 2005. Both rear tires had been replaced prior to the vehicle inspection. The entire tread had come off the right rear tire. Approximately 91 cm (3 ft) of the tread was found under the right side fender well. The entire tread had come off the left rear tire. The tread had wrapped around the axle and wheel. The manufacturer's recommended cold tire pressure for the front and rear tires was 552 kPa (80 psi). The specific tire information is as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	207 kPa (30 psi)	10 mm (12/32 in)	No	None
LR	Unknown	5-8 mm (6-10/32 in), inside to out	NA	Tread separation
RR	Unknown	2-6 mm (3-8/32 in), inside to out	NA	Tread separation
RF	545 kPa (79 psi)	10 mm (13/32 in)	No	None

The front seating positions in the 2004 Ford Econoline E350 van included two front bucket seats followed by three rows of bench seats with seating for three passengers each, and a fifth row with seating for four passengers.



Figure 7. Left rear tire (police photo)

¹The Rollover Propensity of Fifteen-Passenger Van, NHTSA Research Note, April, 2001.



Figure 9. Roof attachment point



Figure 10. Roof attachment point



Figure 8. Roof rack side rail

VEHICLE DAMAGE

Exterior Damage - 2004 Ford E350 van

The 2004 Ford E350 van sustained moderate rollover damage to the roof and both sides of the vehicle. A Collision Deformation Classification (CDC) was assigned as 00TDDO3.

The crush was documented at each pillar as shown in the following table:

Pillar	Left	Right
A	12.0 cm (4.7 in) vertical	34.0 cm (13.3 in) vertical, 32.0 cm (12.6 in) lateral
B	6.0 cm (2.4 in) vertical	19.0 cm (7.5 in) vertical, 37.0 cm (14.6 in) lateral
C	3.0 cm (1.2 in) vertical	9.0 cm (3.5 in) vertical
D	2.0 cm (0.8 in) vertical	7.0 cm (2.8 in) vertical
E	None	2.0 cm (0.8 in) vertical



Figure 11. Right side, Ford E350

Interior Damage - 2004 Ford E350 van

The 2004 Ford E350 sustained moderate interior damage from intrusion, occupant contacts and the failure of one of the bench seats. The glazing was disintegrated at every side glass location. The windshield was fractured. There was A pillar, B pillar, windshield header, roof rail and side rail intrusion to both front seat locations. There was roof and side rail intrusion located for each outboard seat location.

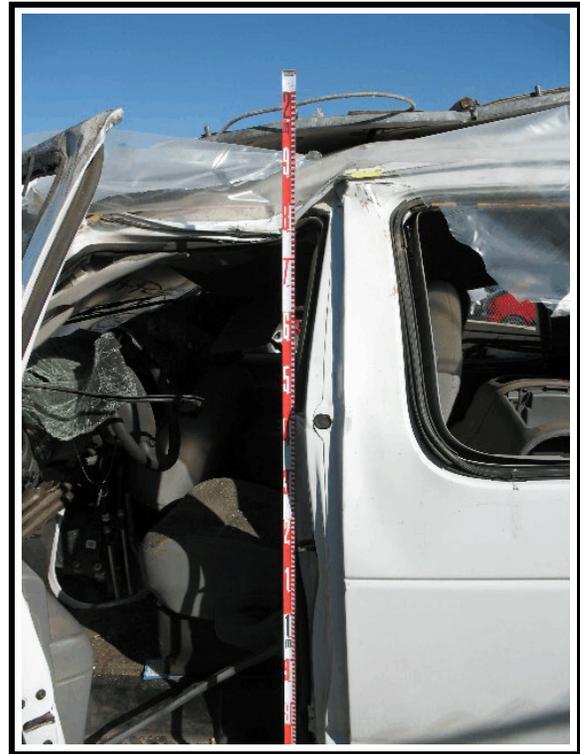


Figure 12. Left side roof rail intrusion

The specific passenger compartment intrusions were documented as follows:

Position	Intruded Component	Magnitude of Intrusion	Direction
LF	A pillar	12.0 cm (4.7 in)	Vertical
LF	B pillar	10.0 cm (3.9 in)	Vertical
LF	Windshield header	14.0 cm (5.5 in)	Vertical
LF	Roof	10.0 cm (3.9in)	Vertical
LF	Left side rail	30.0 cm (11.8 in)	Vertical
RF	A pillar	40.0 cm (15.7 in)	Vertical
RF	Side rail	38.0 cm (14.9 in)	Vertical
RF	Roof	46.0 cm (18.1 in)	Vertical
RF	B pillar	42.0 cm (16.5 in)	Vertical
2nd row right	Side rail	34.0 cm (13.4 in)	Vertical
2nd row right	Roof	34.0 cm (13.4 in)	Vertical

Position	Intruded Component	Magnitude of Intrusion	Direction
3rd row right	C pillar	13.0 cm (5.1 in)	Vertical
3rd row right	Roof	14.0 cm (5.5 in)	Vertical
3rd row right	C pillar	12.0 cm (4.7 in)	Lateral
4th/5th row right	Side rail	7.0 cm (2.8 in)	Vertical
4th/5th row right	Roof	9.0 cm (3.5 in)	Vertical
5 th row left	Fascia	38.0 cm (14.9 in)	Lateral
5 th row right	Fascia	32.0 cm (12.6 in)	Lateral



Figure 13. Overview of intrusion, left side



Figure 14. Overview of intrusion, right side

It appears that the double rear doors came open during the rollover. The right front door was jammed shut. There was blood found along the upper right side window frame adjacent to the third, fourth and fifth rows. The blood extended down the exterior right rear of the vehicle. The fifth row seat back was deformed. There was blood forward of the right D pillar. Brown scuff marks were located along the left interior roof, as well as above the third row seat. The third row seat was separated from its base. The seat is designed to be removable. A lever at the base is rotated rearward to unlock the seat from the floor attachment. At the time of the vehicle inspection, the seat was no longer locked in place and was rotated rearward at approximately a 45 degree angle.



Figure 15. Seat locking lever, third row right



Figure 16. Seat locking attachment, third row right

MANUAL RESTRAINT SYSTEMS - 2004 Ford E350 van

The 2004 Ford E350 van was configured with manual 3-point lap and shoulder belts for all outboard seat locations. Lap belts were located in the middle seat positions for second, third and fourth rows. A set of two lap belts were located in the middle seat position for the fifth row. There were indications of usage for the two front seat belts and for the fifth row right seat. The remaining seat belts do not appear to have been used.

Supplemental Restraint System - 2004 Ford E350 van

The 2004 Ford E350 van was equipped with depowered frontal air bags that did not deploy.

OCCUPANT DEMOGRAPHICS - 2004 Ford Econoline E350 van

	Driver	Occupant 2
Age/Sex:	32/Male	28/Female
Seated Position:	Front left	Front right
Seat Type:	Bucket	Bucket
Height:	173 cm (68 in)	Unknown
Weight:	82 kg (180 lbs)	59 kg (130 lbs)
Occupation:	Driver	Unknown
Pre-existing Medical Condition:	None	None noted
Alcohol/Drug Involvement:	None	NA
Driving Experience:	Unknown	NA
Body Posture:	Presumed upright	Presumed upright
Hand Position:	Hands on steering wheel, actively steering	Unknown
Foot Position:	Right foot presumed to be on brake	Unknown
Restraint Usage:	Lap and shoulder belt available, used	Lap and shoulder belt available, used



Figure 17. Driver/front right passenger seating area

	Occupant 3	Occupant 4	Occupant 5
Age/Sex:	24/Male	23/Female	20/Male
Seated Position:	Second row, left	Second row, middle	Second row, right
Seat Type:	Bench	Bench	Bench
Height:	Unknown	Unknown	Unknown
Weight:	Unknown	Unknown	Unknown
Occupation:	NA	NA	NA
Pre-existing Medical Condition:	Asthma	None noted	None noted
Alcohol/Drug Involvement:	NA	NA	NA
Driving Experience:	NA	NA	NA
Body Posture:	Presumed upright	Presumed upright	Presumed upright
Hand Position:	Unknown	Unknown	Unknown
Foot Position:	Unknown	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt available, used	Lap belt available, not used	Lap and shoulder belt available, not use



Figure 18. Second row

	Occupant 6	Occupant 7	Occupant 8
Age/Sex:	20/Female	21/Female	21/Male
Seated Position:	Third row, left	Third row, middle	Third row, right
Seat Type:	Bench	Bench	Bench
Height:	Unknown	Unknown	Unknown
Weight:	Unknown	54 kg (120 lbs)	Unknown
Occupation:	NA	NA	NA
Pre-existing Medical Condition:	None noted	None noted	None noted
Alcohol/Drug Involvement:	NA	NA	NA
Driving Experience:	NA	NA	NA
Body Posture:	Presumed upright	Presumed upright	Presumed upright
Hand Position:	Unknown	Unknown	Unknown
Foot Position:	Unknown	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt available, not used	Lap belt available, not used	Lap and shoulder belt available, not used



Figure 19. Third row

	Occupant 9	Occupant 10	Occupant 11
Age/Sex:	22/Female	33/Male	23/Female
Seated Position:	Fourth row, left	Fourth row, middle	Fourth row, right
Seat Type:	Bench	Bench	Bench
Height:	Unknown	Unknown	Unknown
Weight:	Unknown	90 kg (180 lbs)	145 lbs
Occupation:	NA	NA	NA
Pre-existing Medical Condition:	None noted	None noted	None noted
Alcohol/Drug Involvement:	NA	NA	NA
Driving Experience:	NA	NA	NA
Body Posture:	Presumed upright	Presumed upright	Presumed upright
Hand Position:	Unknown	Unknown	Unknown
Foot Position:	Unknown	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt available, not used	Lap belt available, not used	Lap and shoulder belt available, not used



Figure 20. Fourth row

	Occupant 12	Occupant 13	Occupant 14
Age/Sex:	21/Male	21/Female	22/Male
Seated Position:	Fifth row, unknown	Fifth row, unknown	Fifth row, unknown
Seat Type:	Bench	Bench	Bench
Height:	Unknown	Unknown	Unknown
Weight:	Unknown	Unknown	Unknown
Occupation:	NA	NA	NA
Pre-existing Medical Condition:	None noted	None noted	None noted
Alcohol/Drug Involvement:	NA	NA	NA
Driving Experience:	NA	NA	NA
Body Posture:	Presumed upright	Presumed upright	Presumed upright
Hand Position:	Unknown	Unknown	Unknown
Foot Position:	Unknown	Unknown	Unknown
Restraint Usage:	None, ejected	Unknown	Unknown



Figure 21. Fifth row

OCCUPANT INJURIES

Driver: Injuries obtained from ER Records, Radiology Reports and Discharge Instructions.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Contusion, right arm	790402.1,1	Center console	Probable

First row right occupant (02): Injuries obtained from ER Records, Radiology Reports and Discharge Instructions.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Contusion, right orbital area (eye)	297402.1,1	Roof rail	Probable
Abrasion, forehead	290202.1,7	Roof rail	Probable
Abrasion, left shoulder	790202.1,2	Center console	Possible
Awake on admission, had headache and nausea symptomatic of head injury	160402.1,0	Roof rail	Probable
Laceration, left elbow, minor (3.0 cm/1.2 in)	790602.1,2	Unknown	Unknown

Second row left occupant (03): Injuries obtained from ER Records, Radiology Reports and Discharge Instructions.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Abrasion, left posterior ribs	490202.1,2	Side interior surface	Possible
Contusion, liver NFS	541810.2,1	Seat belt webbing	Possible

Second row middle occupant (04): Injuries obtained from ER Records, Radiology Reports and Discharge Instructions.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Laceration, minor, right arm (biceps, 5.0 cm/1.9 in)	790602.1,1	Ground	Probable
Laceration, minor, right arm (biceps, 2.0 cm/0.8 in)	790602.1,1	Ground	Probable
Multiple abrasions, left posterior scapular region	790202.1,2	Ground	Probable
Contusion, left shoulder	790402.1,2	Ground	Probable
Multiple abrasions, left shoulder	790202.1,2	Ground	Probable

Second row right occupant (05): Injuries obtained from ER and Transfer records.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Awake on Admission, with amnesia	160410.2,0	Ground	Possible
Multiple lacerations (punctures), minor, right elbow	790602.1,1	Ground	Possible

Third row left occupant (06): Injuries obtained from ER, Radiology and Transfer records.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Contusions, upper eyelid, right	297402.1,1	Unknown	Unknown
Contusions, upper eyelid, left	297402.1,2	Unknown	Unknown
Laceration, left arm (Biceps)	790602.1,2	Unknown	Unknown
Fracture, Cervical spine, C2, with dislocation of C2 on C3	650216.2,6	Roof	Possible
Laceration NFS, nerve root (vertebral foramen)	630204.2,6	Unknown	Unknown
Fracture, displaced, left humerus (upper arm)	752604.3,2	Unknown	Unknown
Fractures, pelvis NFS, left superior and inferior pubic rami	852600.2,2	Side interior surface	Possible
Disc herniation NFS	650299.2,6	Roof	Possible

Third row middle occupant (07): Injuries obtained from ER, Radiology and Discharge records.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Awake on Admission, had headache and nausea symptomatic of head injury	160402.1,0	Unknown	Unknown
Multiple lacerations, minor, left arm (11 total, ranging in length 1.0-6.0 cm/0.4-2.4 in)	790602.1,2	Unknown	Unknown
Laceration, minor, left temple (0.5 cm/0.2 in)	190602.1,2	Unknown	Unknown
Contusion, right elbow	790602.1,1	Unknown	Unknown

Third row right occupant (08): Injuries obtained from Certificate of Death.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Closed head injury/blunt head trauma NFS	115099.7,0	Ground	Probable

Fourth row left occupant (09): Injuries obtained from ER, Radiology and Discharge records.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Contusion, left shoulder	790402.1,2	Left interior surface	Probable

Fourth row middle occupant (10): Injuries obtained from ER, Radiology and Transfer records.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Awake on Admission, with amnesia, loss of consciousness < 1 hour (20 minutes)	160414.2,0	Ground	Probable
Multiple fractures, comminuted, left superior and inferior pubic ramus	852604.3,2	Ground	Probable
Fracture, closed, left sacrum	852602.2,2	Ground	Probable
Fracture, closed, left ilium	852602.2,2	Ground	Probable
Contusion, posterior pelvic region	690402.1,6	Ground	Probable

Fourth row right occupant (11): Injuries obtained from ER, Radiology and Transfer records.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Awake on Admission, prior unconsciousness, length of time NFS	160406.2,0	Ground	Probable
Fracture, L3 vertebra	650616.2,8	Ground	Probable
Contusion, left thigh	890402.1,2	Ground	Probable
Contusion, left ankle	890402.1,2	Ground	Probable
Fracture, T1 vertebra, minor compression	650432.2,7	Ground	Probable
Multiple abrasions, left scapular region	790202.1,2	Ground	Probable
Multiple abrasions, left upper arm	790202.1,2	Ground	Probable

Fifth row, unknown position (12): Injuries obtained from ER, Radiology and Discharge records.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Fracture, closed, nose	251002.2,4	D pillar, right	Probable
Multiple blowout fractures, left orbit (medial orbital wall, ethmoid sinus and left orbital wall	251204.3,2	D pillar, right	Probable
Multiple abrasions, left lower leg	890202.1,2	Ground	Probable
Multiple abrasions, right and left hands	790202.1,3	Ground	Probable
Contusion, left orbit (soft tissue)	297402.1,2	D pillar, right	Probable
Laceration NFS, right upper lip	290600.1,8	Ground	Probable
Fractures, upper and lower incisors	251404.1,8	D pillar, right	Probable

Laceration NFS, left cheek	290600.1,2	D pillar, right	Probable
-------------------------------	------------	-----------------	----------

Fifth row, unknown position (13): Injuries obtained from ER, Radiology and Discharge records.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Contusion, left thigh	890402.1,2	Unknown	Unknown
Contusion, left hip	890402.1,2	Unknown	Unknown
Abrasions, left buttock	890202.1,2	Unknown	Unknown

Unknown (14): Minor injuries of an unknown nature.

Occupant Kinematics

Driver Kinematics

The 32-year-old male driver was seated in an upright posture and was restrained by the 3-point manual lap and shoulder belt. The driver had changed lanes to the left to pass a slower moving vehicle. As the vehicle began the passing maneuver, the right rear tire malfunctioned. The driver lost control of the vehicle. The vehicle began a clockwise rotation. The driver was actively steering to the right. He was likely leaning to the left in response to the rotational forces. As the vehicle's left side tires gouged the roadway, the vehicle tripped and began a left side leading rollover. The driver pitched sharply to the left. As the roll continued, the driver pitched back and forth. The driver sustained a minor contusion to his right arm that likely came as a result of contacting the center console. He was able to exit the vehicle under his own power.



Figure 22. Driver's seated position

Front Right Occupant Kinematics (02)

The 28-year-old female front right occupant was seated in an upright posture and was restrained by the 3-point manual lap and shoulder belt. The driver had changed lanes to the left to pass a slower moving vehicle. As the vehicle began the passing maneuver, the right rear tire malfunctioned. The driver lost control of the vehicle. The vehicle began a clockwise rotation. The driver was actively steering to the right. This occupant was likely leaning to the left, against the center console. As the vehicle's left side tires gouged the roadway, the vehicle tripped and began a left side leading rollover. This occupant pitched sharply to the left, possibly contacting the center console with her left shoulder. She remained restrained but during the rollover her head and face likely contacted the intruding roof rail. She sustained a concussion, a contusion to the right orbital area, and an abrasion to the forehead. The front right door was jammed shut, but it appears that she was able to exit the vehicle on her own. She was transported to an area hospital where she was admitted and hospitalized for two days.



Figure 23. Front row right occupant position

Second Row Left Occupant Kinematics (03)

The 24-year-old second row left occupant was seated in an upright posture on the bench seat. He was using the manual lap and shoulder belt. The driver lost control of the vehicle. The vehicle began a clockwise rotation. The driver was actively steering to the right. This occupant was likely leaning to the left, against the side of the vehicle. As the vehicle's left side tires gouged the roadway, the vehicle tripped and began a left side leading rollover. This occupant pitched sharply to the left, possibly contacting left side interior of the vehicle—causing an abrasion to the left posterior ribs. As the vehicle rolled, this occupant appears to have loaded the lap and shoulder belt—causing a liver laceration. He was transported to an area hospital where he was treated and released. He returned to the hospital the following morning for a follow up x-ray that proved to be negative.



Figure 24. Second row, left and middle seat positions

Second Row Middle Occupant Kinematics (04)

The 23-year-old female second row middle occupant was seated in an upright posture on the bench seat. She was not using the available safety belt. The driver had changed lanes to the left to pass a slower moving vehicle. As the vehicle began the passing maneuver, the right rear tire malfunctioned. The driver lost control of the vehicle. The vehicle began a clockwise rotation. The driver was actively steering to the right. This occupant was likely leaning to the left, against Occupant 03. As the vehicle's left side tires gouged the roadway, the vehicle tripped and began a left side leading rollover. This occupant pitched sharply to the left, possibly contacting Occupant 03 with her left shoulder. As the vehicle rolled, the dual right side doors failed and opened. This occupant was fully ejected from the vehicle. She sustained multiple contusions, lacerations and abrasions to her right arm and left shoulder area. She was transported to an area hospital. She was admitted at 1909 hours and was hospitalized for two days.

Second Row Right Occupant Kinematics (05)

The 20-year-old male second row right occupant was seated in an upright posture on the bench seat. He was not using the available safety belt. The driver had changed lanes to the left to pass a slower moving vehicle. As the vehicle began the passing maneuver, the right rear tire malfunctioned. The driver lost control of the vehicle. The vehicle began a clockwise rotation. The driver was actively steering to the right. This occupant was likely leaning to the left. As the vehicle rolled, the dual right side doors failed and opened. This occupant was fully ejected from the vehicle. He sustained a concussive head injury and lacerations to the right elbow. It was reported that he lost consciousness for approximately five minutes after the crash. He was transported to an area hospital and treated. He arrived with a GCS score of 15. He was later transferred to a Level II trauma center.

Third Row Left Occupant Kinematics (06)

The 20-year-old female third row left occupant was seated in an upright posture on the bench seat. She was not using the available safety belt. The driver had changed lanes to the left to pass a slower moving vehicle. As the vehicle began the passing maneuver, the right rear tire malfunctioned. The driver lost control of the vehicle. The vehicle began a clockwise rotation. The driver was actively steering to the right. This occupant was likely leaning to the left. As the vehicle rolled, this occupant pitched over to the right. The seat base separated from the vehicle. It appears that this occupant was fully ejected from the vehicle through the right side window. She sustained pelvic fractures, a left humerus fracture, a C2 spinal fracture, a laceration to the nerve root, and multiple contusions and lacerations. She was transported to an area hospital. She was transferred later that day to an area Level I trauma center where she was hospitalized for an unknown number of days.



Figure 25. Third row seating



Figure 26. Blood splatter contact at side glass frame

Third Row Middle Occupant Kinematics (07)

The 21-year-old female third row middle occupant was seated in an upright posture on the bench seat. She was not wearing available safety belt. As the vehicle began its clockwise rotation, she moved to the left. As the vehicle rolled, this occupant pitched to the right and possibly contacted the third row right occupant. She remained within the vehicle. It is not clear how she extricated herself from the vehicle. She sustained a concussive head injury and multiple lacerations and contusions. She was transported to an area hospital where she was hospitalized for two days.

Third Row Right Occupant Kinematics (08)

The 21-year-old male third row right occupant was seated in an upright posture on the bench seat. He was not wearing the available safety belt. As the vehicle began a passing maneuver, the right rear tire malfunctioned. The driver lost control of the vehicle. The vehicle began a clockwise rotation. The driver was actively steering to the right. This occupant was likely leaning to the left. As the vehicle rolled, this occupant pitched over to the



Figure 27. Final rest, Occupant 08

right. The seat base separated from the vehicle. It appears that this occupant was fully ejected from the vehicle through the right side window. This occupant was fatally injured. The time of death was indicated to have been immediate. The Certificate of Death indicated that he had died due to a blunt head trauma.

Fourth Row Left Occupant Kinematics (09)

The 22-year-old female fourth row left occupant was seated in an upright posture on the bench seat. She was not wearing available lap and shoulder safety belt. As the vehicle began a passing maneuver, the right rear tire malfunctioned. The driver lost control of the vehicle. The vehicle began a clockwise rotation. The driver was actively steering to the right. This occupant was likely leaning to the left. As the vehicle rolled, this occupant pitched over to the right. As the vehicle continued to roll, this occupant appears to have struck the side of the vehicle interior with her left shoulder, causing a minor contusion. She remained within the vehicle.



Figure 29. Close up of blood/hair at right rear window

Fourth Row Middle Occupant Kinematics (10)

The 33-year-old male fourth row middle occupant was seated in an upright posture on the bench seat. He was not wearing available safety belt. As the vehicle began a passing maneuver, the right rear tire malfunctioned. The driver lost control of the vehicle. The vehicle began a clockwise rotation. The driver was actively steering to the right. This occupant was likely leaning to the left. As the vehicle rolled, this occupant pitched over to the right. As the vehicle continued to roll, this occupant was fully ejected from the vehicle through the right side window. He sustained a concussive head injury, multiple comminuted left pubic ramus fractures, a left sacrum fracture, a left ilium fracture, and a contusion to the pelvic region. He was transported to an area hospital and later transferred to a trauma center.

Fourth Row Right Occupant Kinematics (11)

The 23-year-old female fourth row right occupant was seated in an upright posture on the bench seat. She was not wearing the available safety belt. As the vehicle began a passing maneuver, the right rear tire malfunctioned. The driver lost control of the vehicle. The vehicle began a clockwise rotation. The driver was actively steering to the right. This occupant was likely leaning to the left. As the vehicle rolled, this occupant pitched over to the right. As the vehicle continued to roll, this occupant was fully ejected from the vehicle through the right side window.

She sustained a concussive head injury, an L3 vertebral fracture, a T1 fracture, and multiple abrasions and contusions. She was transported to an area hospital, treated and then transferred to an area trauma center.

Fifth Row Unknown Position Occupant Kinematics (12)

The 20-year-old male in the fifth row was seated in an unknown position on the bench seat. He was not wearing the available safety belt. As the vehicle began a passing maneuver, the right rear tire malfunctioned. The driver lost control of the vehicle. The vehicle began a clockwise rotation. The driver was actively steering to the right. This occupant was likely leaning to the left. As the vehicle rolled, this occupant pitched over to the right and appears to have struck the right side D pillar with his face, causing the nasal fracture, orbit fractures, and incisor fractures. As the vehicle continued to roll, this occupant was fully ejected from the vehicle. The ejection path is not known. He was transported to an area hospital. He was hospitalized for three days before being transferred to an area trauma center.



Figure 30. Overview of fifth row

Fifth Row Unknown Position Occupant Kinematics (13)

The 20-year-old female in the fifth row was seated in an unknown position on the bench seat. She was not wearing the available safety belt. This occupant stayed in the vehicle throughout the rollover sequence. She sustained contusions her left hip, thigh and buttock. She was transported to an area hospital and was hospitalized for two days.



Figure 31. Contact to D pillar from Occupant 12.

Fifth Row Unknown Position Occupant Kinematics (14)

The 22-year-old male in the fifth row was seated in an unknown position on the bench seat. He was not wearing the available safety belt. This occupant stayed in the vehicle throughout the rollover sequence. He sustained minor injuries of an unknown nature.

Scene Diagram

