



# INDIANA UNIVERSITY

## TRANSPORTATION RESEARCH CENTER

School of Public and Environmental Affairs  
222 West Second Street  
Bloomington, Indiana 47403-1501  
(812) 855-3908 Fax: (812) 855-3537

## ON-SITE POTENTIAL SAFETY-RELATED DEFECT INVESTIGATION

CASE NUMBER - IN-04-018

LOCATION - MISSOURI

VEHICLE - 1998 FORD E350, SUPER EXTENDED CLUB WAGON XLT

CRASH DATE - June 2004

Submitted:

January 14, 2005

Revised: August 16, 2007



Contract Number: DTNH22-01-C-07002

Prepared for:

U.S. Department of Transportation  
National Highway Traffic Safety Administration  
National Center for Statistics and Analysis  
Washington, D.C. 20590-0003

## **DISCLAIMERS**

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.

**Technical Report Documentation Page**

1. <i>Report No.</i> IN-04-018		2. <i>Government Accession No.</i>		3. <i>Recipient's Catalog No.</i>	
4. <i>Title and Subtitle</i> On-Site Potential Safety-Related Defect Investigation Vehicle - 1998 Ford E350, Super Extended Club Cab XLT Location - Missouri			5. <i>Report Date:</i> January 14, 2005		
			6. <i>Performing Organization Code</i>		
7. <i>Author(s)</i> Special Crash Investigations Team #2			8. <i>Performing Organization Report No.</i>		
9. <i>Performing Organization Name and Address</i> Transportation Research Center Indiana University 222 West Second Street Bloomington, Indiana 47403-1501			10. <i>Work Unit No. (TRAIS)</i>		
			11. <i>Contract or Grant No.</i> DTNH22-01-C-07002		
12. <i>Sponsoring Agency Name and Address</i> U.S. Department of Transportation (NPO-122) National Highway Traffic Safety Administration National Center for Statistics and Analysis Washington, D.C. 20590-0003			13. <i>Type of Report and Period Covered</i> Technical Report Crash Date: June 2004		
			14. <i>Sponsoring Agency Code</i>		
15. <i>Supplementary Notes</i> On-site potential safety-related defect investigation involving a 1998 Ford E350, Super Extend Club Cab XLT 15-passenger van with dual front air bags which ran-off-road and rolled over					
16. <i>Abstract</i> This report covers an on-site investigation of a 15-passenger van that ran off the road and rolled over. The crash involved a 1998 Ford E350, Super Extended Club Wagon XLT. This crash is of special interest because the case vehicle was a 15-passenger van and sustained a tire failure and subsequent off-road rollover. The case vehicle was traveling northeast in the inside northeastbound lane of a four-lane divided interstate highway when the tread separated from the left rear tire. The case vehicle's driver lost control of the vehicle and it departed the east side of the roadway, impacted a ditch and rolled over, driver side leading, two and three quarter rolls. During the rollover the case vehicle's roof sustained a severe impact with a tree. Three of the four occupants seated in the second back seat row (i.e., a three-seat bench seat), two of which were occupying the middle seat position, were ejected from the case vehicle. The three ejected occupants were not restrained. All of the occupants of the case vehicle were injured and transported to a local hospital by ambulance for treatment. Three of the occupants sustained police reported "A" (incapacitating) injury, four sustained "B" (non-incapacitating-evident) injury and three sustained "C" (possible) injury.					
17. <i>Key Words</i> Tire failure, rollover, air bag deployment			Motor Vehicle Traffic Crash Injury Severity		18. <i>Distribution Statement</i> General Public
19. <i>Security Classif. (of this report)</i> Unclassified		20. <i>Security Classif. (of this page)</i> Unclassified		21. <i>No. of Pages</i> 17	22. <i>Price</i> \$10,600

**TABLE OF CONTENTS**

IN-04-018

Page No.

BACKGROUND . . . . . 1

SUMMARY . . . . . 1

Crash Circumstances . . . . . 5

CASE VEHICLE: 1998 FORD E350, SUPER EXTENDED CLUB CAB XLT . . . . . 7

    CASE VEHICLE DAMAGE . . . . . 8

    AUTOMATIC RESTRAINT SYSTEM . . . . . 10

    CASE VEHICLE DRIVER KINEMATICS . . . . . 12

    CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS . . . . . 13

    CASE VEHICLE BACK SEAT PASSENGERS’ KINEMATICS . . . . . 14

FIFTEEN-PASSENGER VAN SEAT POSITIONS . . . . . 15

CASE VEHICLE OCCUPANT INFORMATION . . . . . 16

CRASH DIAGRAM . . . . . 17

SELECTED PHOTOGRAPHS

    Figure 1: Overview of northeastbound travel lanes and area of roadway  
            departure . . . . . 5

    Figure 2: On-scene photo of case vehicle’s tire marks on shoulder . . . . . 5

    Figure 3: On-Scene photo of case vehicle’s tire marks on shoulder and ground  
            at road departure . . . . . 6

    Figure 4: Left side overview of front of case vehicle and vertical displacement  
            of front bumper . . . . . 6

    Figure 5: On-scene photo of case vehicle in area of final rest . . . . . 7

    Figure 6: Left side view of crush to case vehicle’s roof and left roof side rail . . . . . 7

    Figure 7: Front view of crush to case vehicle’s right A-pillar and roof . . . . . 8

    Figure 8: Case vehicle’s right front wheel . . . . . 8

    Figure 9: On-scene photo of case vehicle’s left rear tire . . . . . 8

    Figure 10: Close view of on-scene photo showing case vehicle’s left rear tire  
            with tread separated . . . . . 9

    Figure 11: Roof and side rail intrusion into case vehicle’s third back seat row . . . . . 10

SELECTED PHOTOGRAPHS (Continued)

Figure 12:	Right side overview of case vehicle's driver seat, steering wheel and steering column . . . . .	10
Figure 13:	Case vehicle's top driver air bag module cover flap . . . . .	10
Figure 14:	Case vehicle's driver air bag . . . . .	11
Figure 15:	Case vehicle's driver air bag vent ports . . . . .	11
Figure 16:	Case vehicle's front right passenger air bag . . . . .	12
Figure 17:	Overview of case vehicle's right front instrument panel and location of front right passenger's air bag . . . . .	12
Figure 18:	Case vehicle's front right passenger air bag module cover flap . . .	12
Figure 19:	Case vehicle's driver safety belt pretensioner . . . . .	12
Figure 20:	Case vehicle's front right passenger safety belt pretensioner . . . . .	13

This investigation was brought to NHTSA's attention on June 8, 2004 by an article from a newspaper clipping service. This crash involved a 1998 Ford E350, Super Extended Club Wagon XLT, 15-passenger van (case vehicle). The crash occurred in June, 2004, at 11:35 a.m., in Missouri and was investigated by the applicable state highway patrol troop. This crash is of special interest because the case vehicle was a 15-passenger van (however, it was configured for only 11 passengers) that experienced a potential tire failure with subsequent off-road rollover, multiple occupant ejections and numerous injuries to the 10 passengers in the van. This contractor inspected the case vehicle on June 16, 2004 and the crash scene on June 17, 2004. In addition, this contractor had several phone conversations with the attorney representing the owner of the case vehicle. The attorney allowed the inspection of the case vehicle but would not allow an inspection of the left rear tire, which reportedly failed and the tread separated from the tire carcass. The left rear tire carcass, tread and rim were in the possession of the attorney. This summary is based on the state highway patrol crash report, scene and vehicle inspections, on-scene photographs taken by the tow truck operator, interviews with the tow truck operator and a witness, occupant kinematic principles and this contractor's evaluation of the evidence.

## SUMMARY

***Crash Environment:*** The trafficway on which the case vehicle was traveling was a four-lane, divided, interstate highway traversing in a northeast and southwest direction. The trafficway was divided by a grass median and each travel direction contained two travel lanes with asphalt shoulders. The case vehicle's approach to the crash location was uncontrolled and the speed limit was 113 km.p.h. (70 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 asphalt with a negative 2% slope. 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 northeastbound inside lane and was overtaking the witness' vehicle, which was traveling in the outside lane. The witness stated his cruise control was set between 121 km.p.h. (75 m.p.h.) and 129 km.p.h. (80 m.p.h.) and the case vehicle passed him quickly. The witness stated that as the case vehicle advanced past him about five to 10 car lengths, he saw a heavy puff of smoke come out of the left side of the case vehicle. He stated the case vehicle immediately went left, then right and began rotating clockwise, departed the east side of the roadway and rolled over. He stated the case vehicle came to rest on its right side facing east.

The tire mark evidence depicted on the highway patrol crash scene diagram indicates that the case vehicle's left side wheels departed the inside, northeastbound lane and entered the inside shoulder. The case vehicle then began a clockwise yaw and traveled diagonally across both northeastbound travel lanes and the outside shoulder. The tire mark evidence on the outside shoulder indicates the case vehicle was yawed clockwise about 62 degrees when it departed the shoulder and entered a ditch. It is unknown what avoidance actions the driver took; however, it is likely he applied the brakes at some point prior to the rollover. The crash occurred on the east side of the roadway as the case vehicle departed the shoulder.

**Crash:** As the case vehicle departed the outside shoulder and entered a ditch, the left side wheels furrowed into the ground, the front undercarriage impacted the ditch and the case vehicle tripped and initiated a driver side leading rollover. It appears that as the case vehicle contacted the ditch, a sufficient longitudinal deceleration occurred to deploy the driver and front right passenger air bags. It appears likely the air bags deployed at this time because the subsequent rollover was side-to-side and no impacts occurred to the front of the case vehicle during the rollover. In addition, the left corner of the front bumper was shifted upward several centimeters and displaced rearward about five centimeters (two inches) indicating the bottom of the bumper and front undercarriage contacted the ground as the case vehicle's left front wheel furrowed into the back slope of the ditch. The case vehicle rolled over, driver side leading two and three quarter rolls (eleven quarter turns). The case vehicle impacted several pine trees near the end of the rollover and three of the ten occupants were ejected from the vehicle.

**Post-Crash:** The case vehicle came to rest on its right side facing southeast. The highway patrol crash scene diagram indicated that two of the three ejected occupants came to rest a short distance northeast of the case vehicle with the third at rest near the back of the case vehicle.

**Tire Failure Analysis:** The highway patrol crash report stated that the right front tire blew out and the driver lost control. This contractor's investigation found no evidence that any tires blew out prior to the case vehicle leaving the roadway. However, the evidence does indicate that the tire tread separated from the left rear tire carcass while the vehicle was on the roadway.

The right front and right rear tires did not blow out because the vehicle inspection showed the right front tire was restricted by damage and fully inflated, and the right rear tire was inflated and undamaged. The left front tire did not blow out because the on-scene photographs show a heavy tire mark on the outside shoulder from this tire (as well as the other three tires), and it does not exhibit characteristics of a flat tire mark. The left rear tire did not blow out because an on-scene photograph of the left rear wheel shows the tire was still inflated following the crash.

This contractor's analysis of the left rear tire tread separation is based on the on-scene photographs and the interviews with the witness and the tow truck operator. The attorney representing the owner of the case vehicle had possession of the left rear tire carcass, rim and tread, and would not allow this contractor to inspect them.

The evidence indicates that the tire tread separated from the left rear tire carcass while the case vehicle was in the inside travel lane as the case vehicle was beginning its clockwise yaw. The tow truck operator stated that he found the two pieces of the tread in the left lane near the inside shoulder. His description of the location along the roadway where the two tread pieces were found placed them near the beginning of the case vehicle's clockwise yaw. The witness' observations of smoke coming from the left side of the case vehicle prior to the control loss suggest the tire was overheating.

The case vehicle's recommended tire size was: LT245/75R16. The three tires that were present during this contractor's vehicle inspection were Continental Premium LT, M+S (mud and snow), size LT245/75R16. These tires all appeared to be in good condition. The tire data are

shown in the table below [Note: The pressure in the right front tire pegged the gauge when measured. The highest pressure the gauge was capable of measuring was 414 kpa (60 psi)].

Tire	Measured Pressure		Recommend Pressure		Tread Depth		Damage	Restricted	Deflated
	kpa	psi	kpa	psi	milli-meters	32 <sup>nd</sup> of an inch			
LF	0	0	379	55	6	8	Inner sidewall cuts	No	Yes
RF	414	60+	379	55	6	8	None	Yes	No
LR	?	?	552	80	?	?	Tread separation	No	No
RR	234	34	552	80	8	10	None	No	No

**Case Vehicle:** The 1998 Ford E-350 Super Extended Club Wagon XLT was a four-door, rear wheel drive, 15-passenger van (VIN: 1FBSS31L9WH-----) equipped with hydraulic front disc brakes and rear drum anti lock brakes, redesigned driver and front right passenger air bags, lap and shoulder safety belts in all outboard seating positions and driver and front right passenger, buckle-mounted safety belt pretensioners. The case vehicle was configured for 11 passengers. It was equipped with two bucket seats in front and three-passenger bench seats in back seat rows one, two and three. The row four bench seat was not installed, and it appeared this area was being used for cargo space.

**Vehicle Exterior:** Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **00-UFYW-2** for the front undercarriage impact to the back slope of the ditch, **00-TDDO-3** for the rollover and, **00-TZDN-4** and **00-TBRN-3** for the two tree impacts that occurred during the rollover. The WinSMASH reconstruction program could not be used to reconstruct the case vehicle's Delta-Vs because rollover and non-horizontal impacts are out of scope for the program. The case vehicle was towed due to damage.

**Exterior Damage:** The case vehicle's impact with the ground and two trees during the rollover produced direct and induced damage that involved the entirety of the vehicle. The area of most severe crush occurred to the roof due to a tree impact and to the right A-pillar, roof and windshield header due to impact with the ground. In addition, the glass was broken out of all the side windows and the backlight during the crash. There was no evidence that any of the doors came open during the crash.

**Vehicle Interior:** Inspection of the case vehicle's interior revealed numerous areas of occupant contacts to the roof and side surfaces of the case vehicle. In addition, there were multiple occupant compartment intrusions. The most severe intrusions involved the roof intruding vertically into the left and center seat positions of the third back seat row, the right A-pillar intruding laterally into the front right seat position and the roof intruding vertically into the driver seat position. Lastly, there was no evidence of compression of the energy absorbing steering column, and no deformation of the steering wheel rim was observed.

***Supplemental Restraints:*** The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module cover flaps and the air bag fabric revealed that the cover flaps opened at the designated tear points. There was no evidence of damage during the deployment to the air bag or the air bag module cover flaps. There were numerous dirty/greasy areas all over the air bag and a few blood stains on the lower right section of the air bag. However, no clear occupant contacts were found on the air bag. The deployed driver's air bag was round with a diameter of 62 centimeters (24 inches). The air bag was designed with two tethers, each 14 centimeters (5.5 inches) in width and had two vent ports. The vent ports were located near the 12:00 position and were 3.5 centimeters (1.4 inches) in diameter.

The front right passenger's air bag was located in the middle of the instrument panel. An inspection of the single air bag module cover flap and the air bag fabric revealed that the cover flap opened at the designated tear points. There was no evidence of damage during the deployment to the air bag; however, the air bag module cover flap was bent. The bend to the cover flap did not appear to be due to occupant contact. The deployed front right air bag was rectangular with a height of 75 centimeters (29.5 inches) and a width of 49 centimeters (19.3 inches) and was designed without any tethers. It had two vent ports located at the 9:00 and 3:00 o'clock positions. The vent ports were six centimeters (2.4 inches) in diameter. Although some occupant contact with the air bag was likely, an inspection of the air bag fabric revealed no evidence of occupant contact.

***Case Vehicle Occupants Kinematics:*** The case vehicle occupants moved forward and to the left in response to the deceleration force on the case vehicle as it yawed clockwise across the roadway. The occupants continued to move forward, but primarily to the left as the case entered the ditch, driver side leading, and impacted the back slope of the ditch. As the vehicle rolled over, driver side leading, the occupants moved toward the outside and roof of the vehicle. Occupant contact marks were found on the interior roof and side surfaces of the case vehicle. Two of the three ejected occupants were sharing the middle position of the second back seat row, and the third was seated in the right outboard position of the second back seat row. It is likely that their ejection portal was one or both of the left rear windows adjacent to their seat row.

The highway patrol crash report indicated that safety belt usage was unknown for the three ejected occupants seated in the second seat row. Inspection of their safety belt assemblies revealed no evidence of occupant loading. The evidence indicates that none of the three ejected occupants were restrained. As regards to their seating positions and the seating positions in the first seat row, the highway patrol crash report indicates that four occupants were seated in each of these two seat rows. However, the seats in these two rows were bench seats designed for only three occupants (i.e., the outboard positions were equipped with lap and shoulder belts and the center positions were equipped with one lap belt). This suggests that the third seat row may have been used to store cargo. In addition, the fourth row seat was not installed in the case vehicle suggesting this area was also used for cargo storage. Two diagrams depicting the case vehicle's seating positions and known occupant information are presented at the end of this report.

***Case Vehicle's Driver:*** The case vehicle's driver [24-year-old, (unknown race, ethnic origin, height and weight) male] was seated in unknown posture. The positions of his hands and feet are

also unknown. Upon inspection of the case vehicle, the driver's seat track was found to be located between its middle and rear-most positions. The seat back was found slightly reclined, and the tilt steering wheel was located between its center and full down position. The evidence indicates the driver was not using his available, active, three-point, lap-and-shoulder, safety belt system. The safety belt system was equipped with a belt pretensioner, which did not activate, and inspection of the safety belt assembly revealed no load markings on the safety belt webbing, latch plate or "D"-ring.

**Case Vehicle's Front Right Passenger:** The case vehicle's front right passenger [20-year-old, (unknown race, ethnic origin, height and weight) female] was seated in an unknown posture. The positions of her hands and feet are also unknown. Upon inspection of the case vehicle, the front right passenger's seat track was found to be located between its middle and rear-most positions and the seat back was reclined rearward of the midrange position. The evidence indicates that the front right passenger was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The safety belt system was equipped with a belt pretensioner. The safety belt buckle stalk was shortened and the stalk cover compressed indicating the pretensioner activated during the crash.

#### CRASH CIRCUMSTANCES

**Crash Environment:** The trafficway on which the case vehicle was traveling was a two-way, four-lane, divided, interstate highway traversing in a northeast and southwest direction. The trafficway was divided by a grass median and each travel direction contained two travel lanes with improved shoulders. The case vehicle's approach to the crash location (**Figure 1**) was uncontrolled and the speed limit was 113 km.p.h. (70 m.p.h.). There was no regulatory speed limit sign posted near the crash site. The interstate highway was straight and had a 2.0% negative grade in the case vehicle's northeastbound direction of travel. The pavement was traveled bituminous, and the widths of the outside and inside northeastbound travel lanes were 3.5 meters (11.5 feet) and 3.6 meters (11.8 feet) respectively. The shoulders were bituminous, and the width of the outside and inside shoulders were 3.2 meters (10.5 feet) and 1.8 meters (5.8 feet) respectively. Adjacent to the outside shoulder was a shallow ditch. The grade of the front slope of the ditch was 34% negative. The grade of the back slope of the ditch was 29% positive and formed an embankment that was



**Figure 1:** Overview of northeastbound lanes; arrow shows area of rollover; shoulders have been oiled since crash (case photo # 01)



**Figure 2:** On-scene photo showing four tire marks from the case vehicle on shoulder; tire marks are (from bottom to top): left rear, right rear, left front and right front (case photo #150)

considerably higher than the roadway. The grade of the embankment along the path of travel of the case vehicle was 7% positive. Pavement markings for the roadway consisted of a single broken white centerline, a white outside edge line and a yellow inside median line. There were no traffic controls on the case vehicle's approach to the crash location. The estimated coefficient of friction of the roadway surface was 0.70 when dry. At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the roadway pavement was dry. Traffic density was moderate and the site of the crash was rural undeveloped. See the Crash Diagram at the end of this report.

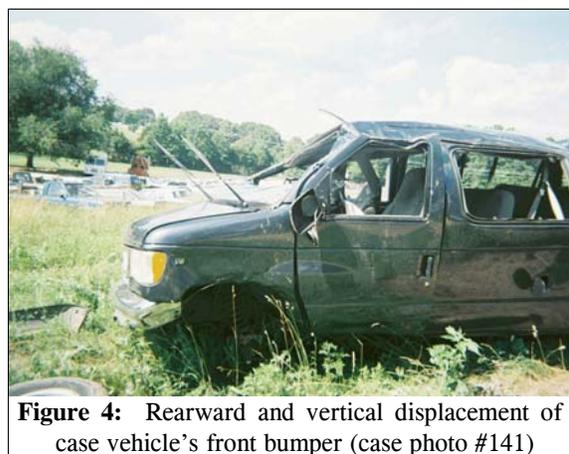
**Pre-Crash:** The case vehicle was traveling northeast in the inside lane and was overtaking the witness' vehicle, which was traveling in the outside lane. The witness stated his cruise control was set between 121 km.p.h. (75 m.p.h) and 129 km.p.h. (80 m.p.h.) and the case vehicle passed him quickly. The witness stated that as the case vehicle advanced past him about five to 10 car lengths, he saw a heavy puff of smoke come out of the left side of the case vehicle. He stated the case vehicle immediately went left, then right and began rotating clockwise, left the right side of the roadway and rolled over. He stated the case vehicle came to rest on its right side facing east.

The tire mark evidence depicted on the highway patrol crash scene diagram indicates that the case vehicle's left side wheels departed the inside, northeastbound lane and entered the inside shoulder. The case vehicle then began a clockwise yaw and traveled diagonally across both northeastbound travel lanes and the outside shoulder. The tire mark evidence on the outside shoulder (**Figure 2** above) indicates the case vehicle was yawed clockwise about 62 degrees when it departed the shoulder and entered a ditch. It is unknown what avoidance actions the driver took; however, it is likely he applied the brakes at some point prior to the rollover. The crash occurred on the east side of the roadway as the case vehicle departed the shoulder.

**Crash:** The case vehicle departed the outside shoulder and entered a ditch. The left side wheels furrowed into the ground, the front undercarriage impacted the ditch (**Figure 3**) and the case vehicle tripped and rolled over driver side leading. It appears that as the case vehicle contacted the ditch, a sufficient longitudinal deceleration occurred to deploy the driver and front right passenger air bags. It appears likely the air bags deployed at this time because the subsequent rollover was side-to-side and no impacts occurred



**Figure 3:** On-scene photo showing tire marks on shoulder and ground; marks are (from left to right): left rear, right rear, left rear ground divot, left front ground divot, right front ground divot (case photo #150)



**Figure 4:** Rearward and vertical displacement of case vehicle's front bumper (case photo #141)

to the front of the case vehicle during the rollover. In addition, the left corner of the front bumper (Figure 4 above) above was shifted upward several centimeters and displaced rearward about five centimeters (two inches) indicating the bottom of the bumper and front undercarriage contacted the ground as the case vehicle's left front wheel furrowed into the back slope of the ditch. The case vehicle rolled over two and three quarters rolls (eleven quarter turns). The case vehicle impacted several pine trees near the end of the rollover and three of the ten occupants were ejected from the vehicle. The most severe tree impact occurred to the top of the case vehicle during the ninth quarter roll.



Figure 5: On-scene photo of case vehicle at area of final rest, it is in process of being pulled to tow truck (case photo #156)

**Post-Crash:** The case vehicle came to rest on its right side facing southeast (Figure 5). The highway patrol crash scene diagram indicated that two of the three ejected occupants came to rest a short distance northeast of the case vehicle with the third at rest near the back of the case vehicle.

#### CASE VEHICLE

The 1998 Ford E-350 Super Extended Club Wagon XLT was a four-door, rear wheel drive, 15-passenger van (VIN: 1FBSS31L9WH-----) equipped with a 5.4 L, V8 engine, four-speed transmission with overdrive, hydraulic front disc brakes and rear drum anti lock brakes. The case vehicle's wheelbase was 351 centimeters (138 inches), and the odometer reading at inspection was 131,586 kilometers (81,766 miles).

Inspection of the vehicle's interior revealed adjustable front bucket seats with integral head restraints and non-adjustable three-passenger bench seats without head restraints in back seat rows one, two and three. The row four bench seat was not installed, and it appeared this area was being used for cargo space. The front seats and all outboard back seats were equipped with continuous loop, three-point, lap-and-shoulder, safety belt systems, and the back center seat positions were equipped with two-point, lap belt systems. The front safety belt systems were equipped with manually operated, upper anchorage adjusters for the "D"-rings and buckle-mounted pretensioners. The driver's upper anchorage adjuster was located in its down-most position, and the front right passenger's upper anchorage was located in its middle position. The vehicle was equipped with knee bolsters for both



Figure 6: Crush to the roof and left roof side rail over third seat row due to impact with tree during rollover (case photo #38)

the driver and front right passenger, neither of which showed evidence of occupant contact or deformation. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a redesigned frontal air bag for the driver and front right passenger seating positions. Both frontal air bags deployed as a result of the case vehicle's impact with the back slope of the ditch.

### CASE VEHICLE DAMAGE

**Exterior Damage:** The case vehicle's impact with the ground and two trees during the rollover produced direct and induced damage that involved the entirety of the vehicle. The area of most severe crush occurred to the roof and roof side rail over the third back seat row (Figure 6 above) due to a tree impact and to the right A-pillar, roof and windshield header (Figure 7) due to impact with the ground. The maximum roof crush was about 25 centimeters and occurred to the left roof side rail over the third back seat row. The case vehicle's left side wheelbase was reduced by eight centimeters (3.1 inches) and the right side wheelbase was unchanged. The glass was broken out of all the side windows and backlight during the crash. There was no evidence that any of the doors came open during the crash.

**Tire Failure Analysis:** The highway patrol crash report stated that the right front tire blew out and the driver lost control. This contractor's investigation found no evidence that any tires blew out prior to the case vehicle leaving the roadway. However, the evidence does indicate that the tire tread separated from the left rear tire carcass while the case vehicle was on the roadway.

The right front and right rear tires did not blow out because the vehicle inspection showed the right front tire (Figure 8) was restricted by damage and fully inflated and the right rear tire was inflated and undamaged. The left front tire did not blow out because the on-scene photographs show a heavy tire mark on the outside shoulder (Figure 2 above) from this tire (as well as the other three tires), and it does not exhibit characteristics of a flat tire mark. In addition,



Figure 7: Crush of right A-pillar and roof; each stripe on the rod is five centimeters (two inches), (case photo #34)



Figure 8: Right front wheel inflated and restricted by damage (case photo #50)

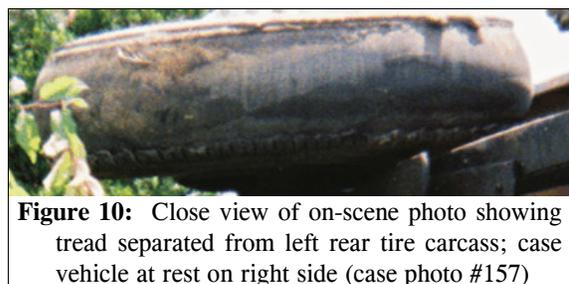


Figure 9: Case vehicle on tow truck at crash scene; left rear tire inflated, tread separated (case photo #148)

the case vehicle was in a severe driver side leading yaw, and a flat tire on the leading side would most likely peel off the rim and the rim would gouge the pavement. No rim gouges were found on the roadway or outside shoulder during this contractor’s scene inspection. The left rear tire did not blow out because an on-scene photograph of the left rear wheel (**Figure 9** above) shows the tire was still inflated.

This contractor’s analysis of the left rear tire tread separation is based on the on-scene photographs and the interviews with the witness and the tow truck operator. The attorney representing the owner of the case vehicle had possession of the left rear tire carcass, rim and tread, and would not allow this contractor to inspect them.

The evidence indicates that the tire tread separated from the left rear tire carcass while the case vehicle was in the inside travel lane as the vehicle was beginning its clockwise yaw. The tow truck operator stated that he found the two pieces of the tread in the left lane near the inside shoulder. His description of the location along the roadway where the two tread pieces were found placed them near the beginning of the case vehicle’s clockwise yaw. The witness’ observations of smoke coming from the left side of the case vehicle prior to the control loss suggest the tire was overheating. The condition of the left rear tire carcass following the crash is shown in **Figure 10**.



**Figure 10:** Close view of on-scene photo showing tread separated from left rear tire carcass; case vehicle at rest on right side (case photo #157)

The case vehicle’s recommended tire size was: LT245/75R16. The three tires that were present during this contractor’s vehicle inspection were Continental Premium LT, M+S (mud and snow), size LT245/75R16. These tires all appeared to be in good condition. The tire data are shown in the table below [Note: The pressure in the right front tire pegged the gauge when measured. The highest pressure the gauge was capable of measuring was 414 kpa (60 psi)].

Tire	Measured Pressure		Recommend Pressure		Tread Depth		Damage	Restricted	Deflated
	kpa	psi	kpa	psi	milli-meters	32 <sup>nd</sup> of an inch			
LF	0	0	379	55	6	8	Inner sidewall cuts	No	Yes
RF	414	60+	379	55	6	8	None	Yes	No
LR	?	?	552	80	?	?	Tread separation	No	No
RR	234	34	552	80	8	10	None	No	No

**Interior Damage:** Inspection of the case vehicle's interior revealed occupant contacts to the roof in the driver's seat position and front right seat position, as well as the left outboard and center seat positions in the first back seat row, and the roof in the left outboard third back seat row. There was also evidence of occupant contact to the left C-pillar. In addition, there were multiple occupant compartment intrusions. The most severe intrusion involved the roof and roof side rail intruding vertically about 28 centimeters (11 inches) into the left outboard seat position of the third back seat row (**Figure 11**). Other primary intrusions involved the right A-pillar intruding laterally into the front right seat position and the roof intruding vertically into the driver's seat position (**Figure 7** above). Lastly, there was no evidence of compression of the energy absorbing steering column, and no deformation of the steering wheel rim was observed (**Figure 12** below).

**Damage Classification:** Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **00-UFYW-2** for the front undercarriage impact to the back slope of the ditch, **00-TDDO-3** for the rollover and, **00-TZDN-4** and **00-TBRN-3** for the two tree impacts that occurred during the rollover. The WinSMASH reconstruction program could not be used to reconstruct the case vehicle's Delta-Vs because rollover and non-horizontal impacts are out of scope for the program. The case vehicle was towed due to damage.

#### AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained frontal air bags at the driver and front right passenger positions. Both frontal air bags deployed as a result of the frontal undercarriage impact with the embankment. The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of asymmetrical "H"-configuration cover flaps made of thick vinyl (**Figure 13**). The top flap was 19.5 centimeters (7.7 inches) in width and 16 centimeters (6.3 inches) in height. The bottom flap was 18



**Figure 11:** Roof and roof side rail intrusion into the third back seat row (case photo #129)



**Figure 12:** Overview of driver's seat, steering wheel and steering column (case photo #77)



**Figure 13:** Driver's top air bag module cover flap (case photo #75)

centimeters (7.1 inches) in width at the horizontal seam and 7 centimeters (2.8 inches) in height. The distance between the mid-center of the driver's seat back, as positioned at the time of the vehicle inspection, and the front surface of the air bag's fabric at full excursion was 27 centimeters (10.6 inches). An inspection of the air bag module cover flaps and the air bag fabric revealed that the cover flaps opened at the designated tear points. There was no evidence of damage during the deployment to the air bag or the air bag module cover flaps. There were numerous dirty/greasy areas all over the air bag and a few blood stains on the lower right section of the air bag. However, no clear occupant contacts were found on the air bag. The deployed driver's air bag (**Figure 14**) was round with a diameter of 62 centimeters (24 inches). The air bag was designed with two tethers, each 14 centimeters (5.5 inches) in width and had two vent ports (**Figure 15**) were located near the 12:00 position and were 3.5 centimeters (1.4 inches) in diameter.

The front right passenger's air bag (**Figure 16** below) was located in the middle of the instrument panel (**Figure 17** below). There was a single, essentially rectangular, air bag module cover flap (**Figure 18** below). The cover flap was made of thin vinyl over a sheet metal frame/liner which acted as the hinge point for the deploying flaps. The flap's dimensions were 37.5 centimeters (14.8 inches) in width at the lower horizontal seam and 28.5 centimeters (11.2 inches) in height along both vertical seams. The profile of the case vehicle's instrument panel was flush with the leading edge of the cover flap. An inspection of the single air bag module cover flap and the air bag fabric revealed that the cover flap opened at the designated tear points. There was no evidence of damage during the deployment to the air bag; however, the air bag module cover flap was bent. The bend to the cover flap did not appear to be due to occupant contact. The deployed front right air bag was rectangular with a height of 75 centimeters (29.5 inches) and a width of 49 centimeters (19.3 inches) and was designed without any tethers. It had two vent ports located at the 9:00 and 3:00 o'clock positions. The vent ports were six centimeters (2.4 inches) in diameter. Although some occupant contact with the air bag was likely, an inspection of the air bag fabric revealed no evidence of occupant contact.



**Figure 14:** Driver's air bag; each stripe on rod is five centimeters (two inches), (case photo #71)



**Figure 15:** Driver air bag, vent ports (case photo #73)



**Figure 16:** Overview of front right passenger's air bag; each stripe on the rod is five centimeters (two inches), (case photo #92)

### CASE VEHICLE DRIVER KINEMATICS

The case vehicle's driver [24-year-old, (unknown race, ethnic origin, height and weight) male] was seated in unknown posture. The positions of his hands and feet are also unknown. Upon

inspection of the case vehicle, the driver's seat track was found to be located between its middle and rear-most positions. The seat back was found slightly reclined, and the tilt steering wheel was located between its center and full down position.

The evidence indicates the driver was not using his available, active, three-point, lap-and-shoulder, safety belt system. The safety belt system was equipped with a belt pretensioner, which did not activate (**Figure 19**), and inspection of the safety belt assembly revealed no load markings on the safety belt webbing, latch plate or "D"-ring.



**Figure 17:** Overview of front right instrument panel and air bag location (case photo #81)



**Figure 18:** Front right passenger's air bag module cover (case photo #95)



**Figure 19:** Driver's safety belt pretensioner did not activate; the buckle stalk is not shortened and the stalk cover is not compressed (case photo #67)

During the pre-crash clockwise rotation of the case vehicle, the driver most likely moved forward and to the left in response to the deceleration force on the case vehicle as it yawed clockwise across the roadway. The driver continued to move forward, but primarily to the left as the case vehicle entered the ditch, driver side leading, and impacted the back slope of the ditch. As the vehicle rolled over, driver side leading, the driver moved toward the outside and roof of the vehicle.

The highway patrol crash report indicated that the driver sustained a “B” (non-incapacitating-evident) injury and was transported to a local hospital for treatment. It is not known if the driver was admitted to the hospital. The extent of the driver’s injuries is also not known.

### **CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS**

The case vehicle’s front right passenger [20-year-old, (unknown race, ethnic origin, height and weight) female] was seated in an unknown posture. The positions of her hands and feet are also unknown. Upon inspection of the case vehicle, the front right passenger’s seat track was found to be located between its middle and rear-most positions, and the seat back was reclined rearward of the midrange position.



**Figure 20:** Front right passenger’s safety belt pretensioner activated; the buckle stalk is shortened and the stalk cover compressed (case photo #90)

The evidence indicated that the front right passenger was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The safety belt system was equipped with a belt pretensioner. The safety belt buckle stalk was shortened and the stalk cover compressed indicating the pretensioner activated during the crash (**Figure 20**).

During the pre-crash clockwise rotation of the case vehicle, the front right passenger most likely moved forward and to the left in response to the deceleration force on the case vehicle as it yawed clockwise across the roadway, and she loaded her safety belt. The front right passenger continued to move forward, but primarily to the left as the case vehicle entered the ditch, driver side leading, and impacted the back slope of the ditch. As the vehicle rolled over, driver side leading, the passenger continued to load her safety belt as she moved toward the outside and roof of the vehicle.

The highway patrol crash report indicated that the front right passenger sustained a “B” (non-incapacitating-evident) injury and was transported to a local hospital for treatment. It is not known if the front right passenger was admitted to the hospital. The extent of the front right passenger’s injuries is also not known.

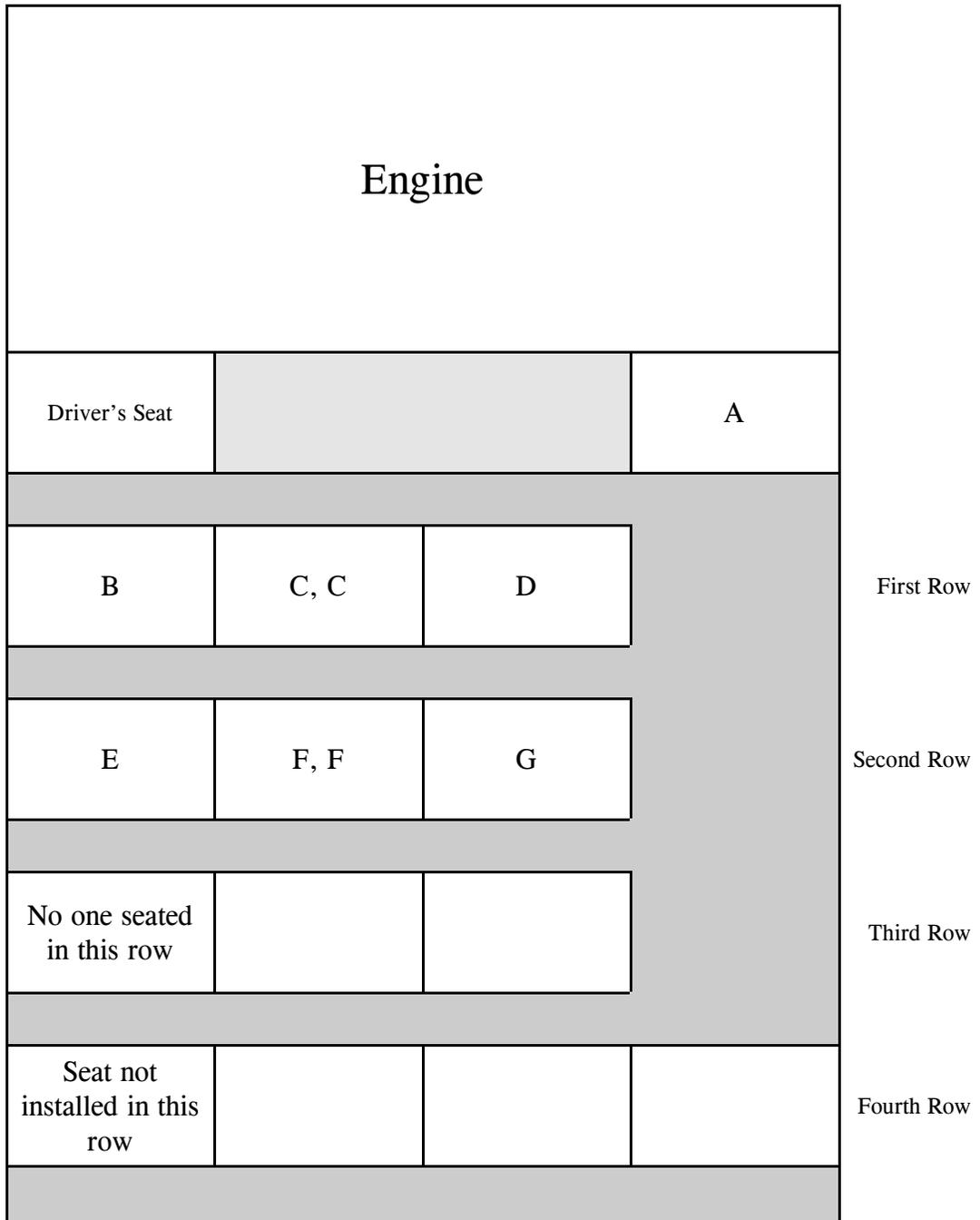
The case vehicle's back seat passengers moved forward and to the left in response to the deceleration force on the case vehicle as it yawed clockwise across the roadway. The occupants continued to move forward, but primarily to the left as the case vehicle entered the ditch, driver side leading, and impacted the back slope of the ditch. As the vehicle rolled over, driver side leading, the occupants moved toward the outside and roof of the vehicle. The majority of the occupant contact marks were found on the left interior roof and side surface. The three ejected occupants were seated in the second back seat row. Two of the ejected occupants were sharing the middle seat position, and the third was seated in the right outboard position. The evidence indicates that none of these occupants were restrained. It is likely that their ejection portal was one or both of the left rear windows adjacent to their seat row. Based on their final rest position indicated on the highway patrol crash diagram, it is likely they were ejected from the case vehicle during the seventh quarter turn.

The inspection of the safety belt assemblies in the first back seat row indicated that the outboard left and right occupants were restrained by their available, active, three-point, lap-and-shoulder safety belts, and the two occupants sharing the middle seat position were not restrained by the available lap belt. The highway patrol crash report indicated that safety belt usage was unknown for the two occupants seated in the center seat position of the second back seat row. Inspection of the safety belt assemblies in this row revealed that the outboard left and right occupants were not using their available, active, three-point, lap-and-shoulder safety belts, and the two occupants sharing the middle seat position were not restrained by the available lap belt. As regards the seating positions in the first and second back seat rows, the highway patrol crash report indicates that four occupants were seated in each of these two seat rows. However, the seats in these two rows were bench seats designed for only three occupants (i.e., the outboard positions were equipped with lap and shoulder belts and the center positions were equipped with one lap belt). This suggests that the third back seat row may have been used to store cargo. In addition, the fourth row back seat was not installed in the case vehicle suggesting this area was also used for cargo storage. Two diagrams depicting the case vehicle's back seat occupant seating positions and known occupant information are presented at the end of this report.

# FIFTEEN-PASSENGER VAN SEAT POSITIONS

IN-04-018

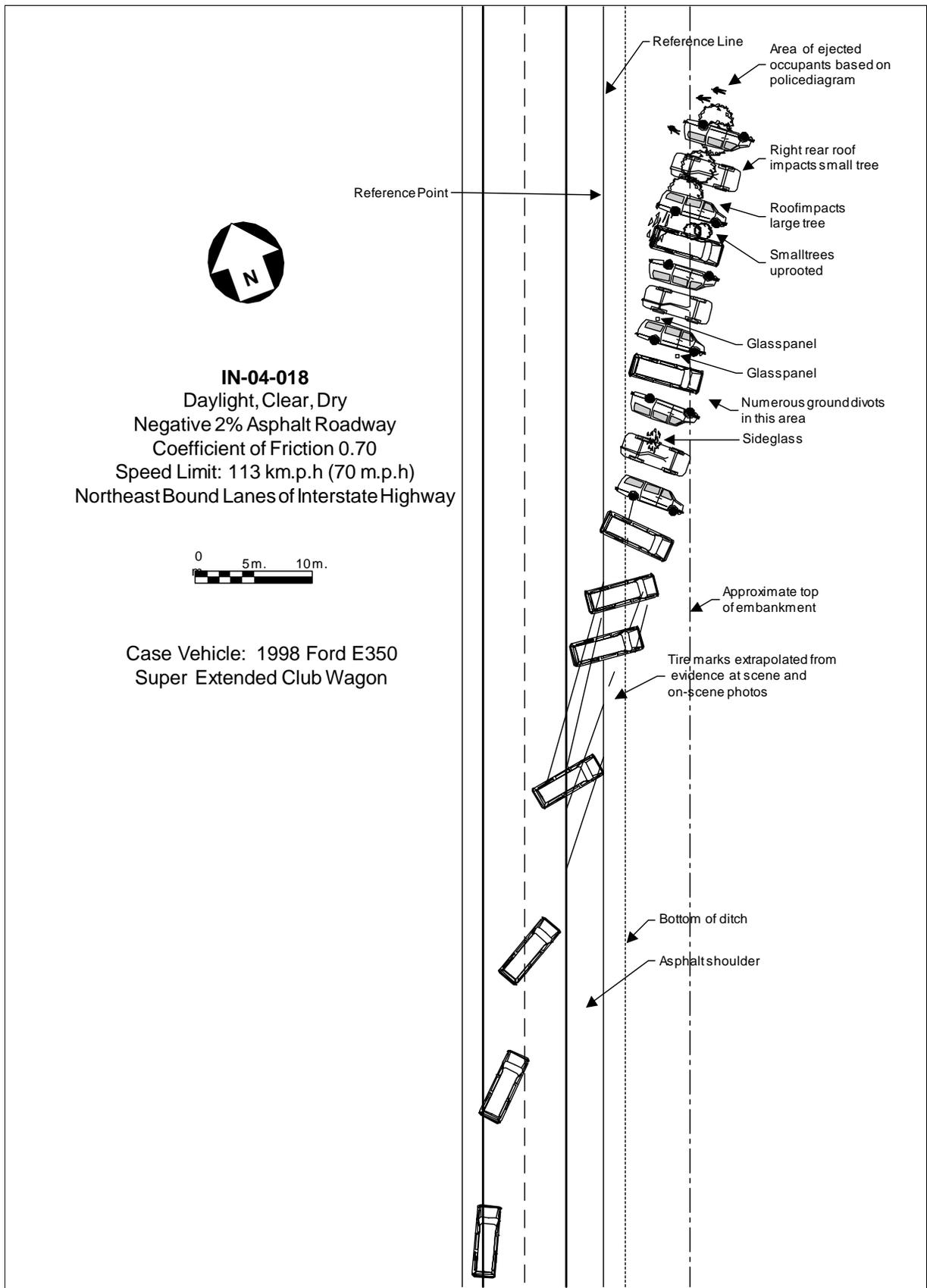
Shaded areas represent either an aisle or the area in front of a seat, refer to next page for occupant information



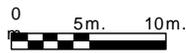
CASE VEHICLE OCCUPANT INFORMATION

IN-04-018

Occupant Identification	Age	Sex	Police-reported injury descriptor	Police-Reported Ejection	Police-Reported Restraint Use	EMS Transport Status
Driver	24	M	B	No	Lap and Shoulder	Ambulance, unknown if admitted
A	20	F	B	No	Lap and Shoulder	Ambulance, unknown if admitted
B	18	F	C	No	Lap and Shoulder	Ambulance, unknown if admitted
C	17	M	A	No	Lap not used	Ambulance, unknown if admitted
C	18	F	A	No	Lap not used	Ambulance, unknown if admitted
D	18	F	C	No	Lap and Shoulder	Ambulance, unknown if admitted
E	19	M	A	No	L&S not used	Ambulance, unknown if admitted
F	18	M	C	Total ejection	unknown	Ambulance, unknown if admitted
F	21	M	B	Total ejection	unknown	Ambulance, unknown if admitted
G	18	F	B	Total ejection	L&S not used	Ambulance, unknown if admitted



**IN-04-018**  
Daylight, Clear, Dry  
Negative 2% Asphalt Roadway  
Coefficient of Friction 0.70  
Speed Limit: 113 km.p.h (70 m.p.h)  
Northeast Bound Lanes of Interstate Highway



Case Vehicle: 1998 Ford E350  
Super Extended Club Wagon