

CRASH DATA RESEARCH CENTER

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**CALSPAN REMOTE FIFTEEN-PASSENGER VAN
ROLLOVER INVESTIGATION**

CASE NO: CA05-039

VEHICLE: 2002 FORD E-350 SUPER DUTY VAN

LOCATION: SOUTH CAROLINA

CRASH DATE: JUNE 2005

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

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

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<p>16. Abstract This remote investigation focused on the cause and severity of a rollover of a 2002 Ford E-350 Super Duty 15-passenger van. The Ford was utilized as a business transportation van and was en-route to Springfield, Virginia from Houston, Texas. The Ford was operated by a 32-year old male driver and occupied by another rotating driver seated in the front right position and 11 paid adult passengers seated in rows 2-5. The driver and front right passenger were police reported as belted while the remaining rear seated passengers were unrestrained. A 29-year old male passenger seated in the second row left position and a 30-year old male passenger seated in the second row center position were ejected from the vehicle through the second row left window opening and killed. The van was initially traveling northbound on an interstate highway as the left rear tire tread separated. The driver experienced a steering problem and exited onto an off-ramp. The vehicle subsequently departed the right side of the ramp. The driver applied a rapid left steering input in an attempt to regain the travel lane. The van yawed counterclockwise as evidenced by right side tire marks on the shoulder and travel lane. The right rear wheel gouged into the asphalt road surface which tripped the van into a right side leading nine-quarter turn rollover event. The Ford came to rest on its right side on the grassy north shoulder approximately 45 m (150') from the initial trip point. The impact resulted in moderate damage to the vehicle's roof and minor damage to its sides. The driver and the remaining ten passengers sustained minor injuries and were transported to local hospitals by ambulance.</p>			
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BACKGROUND

This remote investigation focused on the cause and severity of a rollover of a 2002 Ford E-350 Super Duty 15-passenger van (**Figure 1**). The Ford was utilized as a business transportation van and was en-route to Springfield, Virginia from Houston, Texas. The Ford was operated by a 32-year old male driver and occupied by another rotating driver seated in the front right position and 11 paid adult passengers seated in rows 2-5. The driver and front right passenger were police reported as belted while the remaining rear seated passengers were unrestrained.



Figure 1 - Damaged 2002 Ford E-350

A 29-year old male passenger seated in the second row left position and a 30-year old male passenger seated in the second row center position were ejected from the vehicle through the second row left window opening and killed. The van was initially traveling northbound on an interstate highway as the left rear tire tread separated. The driver experienced a steering problem and exited onto an off-ramp. The vehicle subsequently departed the right side of the ramp. The driver applied a rapid left steering input in an attempt to regain the travel lane. The van yawed counterclockwise as evidenced by right side tire marks on the shoulder and travel lane. The right rear wheel gouged into the asphalt road surface which tripped the van into a right side leading nine-quarter turn rollover event. The Ford came to rest on its right side on the grassy north shoulder approximately 45 m (150') from the initial trip point. The impact resulted in moderate damage to the vehicle's roof and minor damage to its sides. The driver and the remaining ten passengers sustained minor injuries and were transported to local hospitals by ambulance.

The crash was identified through an Internet news article by the Crash Investigations Division of the National Highway Traffic Safety Administration (NHTSA). The remote investigation was assigned to the Calspan Special Crash Investigations (SCI) team on June 13, 2005. The investigation involved a telephone follow-up with the investigatory police agency, the acquisition of a comprehensive Police Accident Report (PAR) prepared by the South Carolina Highway Patrol's Multi-disciplinary Accident Investigation Team (MAIT), and digital images of the crash scene and vehicle.

SUMMARY

Crash Site

This single vehicle crash occurred on a one-lane exit-ramp stemming from a divided interstate highway. At the time of the crash, the asphalt roadway was dry and there were no adverse weather conditions. The eastbound exit-ramp was curved to the right with no sight obstructions on a positive grade. A painted white fog line delineated the right edge of the roadway and a painted yellow line delineated the left edge. The roadside environment consisted of asphalt shoulders that were approximately 2 m (7') in width and grassy roadsides. A worn asphalt secondary shoulder was located outboard of the south (right) shoulder and began at the vehicle's point of departure. The police-reported speed limit was 97 km/h (60 mph). An SCI crash schematic based on the police sketch is included as **Figure 13** at the end of this narrative report.

Vehicle Data – 2002 Ford E-350 Super Duty Van

The 2002 Ford E-350 was identified by the Vehicle Identification Number (VIN): 1FBSS31L72H (production number omitted). The police reported odometer reading was 642,474 km (399,214 miles). The rear-wheel drive vehicle was equipped with a, 5.4-liter, V8 engine linked to a 4-speed automatic transmission. The service brakes consisted of four-wheel disc brakes with anti-lock (ABS). Suspension features included an independent front stabilizer bar with coil springs and a rigid rear suspension beam with leaf springs. The vehicle was configured with 41 cm (16") steel wheels and varied tires. The manufacturers recommended tire pressure was not reported. The tire information noted on the PAR was limited to the following:

Position	Tire Model/Nomenclature	Tire Pressure	Tread Depth	Damage
LF	All Position Radial DOT#: PJ11 HVKV 2602 Load Range E	Unknown	Unknown	None
RF	Telluride A/P CR 860 YKS DOT#: 7DT3FTS Load Range E 10 PR	Deflated	Unknown	Deflated with dirt and grass embedded into sidewall and debanded
LR	Telluride A/P CR 860 YKS DOT#: 7DT3FTS 2904 Load Range E 10 PR	Deflated	Unknown	Tread separation with multiple tears in sidewall and tread
RR	Firestone Steeltex Radial A/T 2 Ply Polyester DOT#: VN11BAB 4703	Deflated	Unknown	Deflated with dirt and grass embedded into sidewall and debanded

The 2002 Ford E-350 was configured with front bucket seats and four rows of bench seats. The second row bench seat was fixed and the remaining three rows were removable to accommodate cargo. The van was designed to accommodate up to 15-passengers. The front seats were equipped with integrated head restraints. Access to the rear seats was provided by right side and dual rear doors. The van was also equipped with power steering and windows, and cruise control.

Crash Sequence

Pre-Crash

The 32-year old male driver of the Ford E-350 was traveling in a northerly direction in the right lane of a three-lane interstate highway and was approaching an exit ramp stemming to the right. The left rear tire tread separated. Police images of the tire revealed a 360 degree circumferential separation of the tread. It was unknown if the tire aired out as a result of the tread separation. The driver stated to the investigating officer that he experienced a steering problem and exited the interstate onto the off-ramp. He estimated his travel speed at 97 km/h (60 mph). The driver traveled an estimated 105 m (350') onto the ramp which curved to the right with a positive grade (**Figure 2**). As the driver approached the apex of the curve, the van departed the travel lane onto the right shoulder. He probably braked which induced a slight clockwise yaw. The front tires began to mark on the asphalt shoulder. Based on the images and a scaled police crash schematic, the tire markings flowed in a gradual clockwise arch approximately 80 m (265') before rapidly deflecting into a counterclockwise (CCW) direction another 23 m (75'). The van departed the right edge of the shoulder with the right side tires overriding the worn asphalt secondary shoulder. The driver applied a rapid left steering maneuver in an attempt to regain the travel lane. The van began to yaw CCW as the right side tires remained on the worn asphalt secondary shoulder (**Figures 3 and 4**). As the van's right rear wheel transitioned from the secondary shoulder onto the asphalt shoulder, the right rear wheel gouged into the asphalt, which tripped the van into a lateral right side leading rollover.



Figure 2 - 2002 Ford departs right roadside.



Figure 3 - Vehicle reenters roadway while yawing CCW.



Figure 4 - Gouge on asphalt shoulder from right rear wheel.

It should be noted that this vehicle was traveling to Virginia from Texas and had already traveled a distance of 1,473 km (915 miles) to this point. The estimated time to travel this distance was approximately 14 hours according to the Internet service site *Mapquest*.

The transport van's business itinerary indicated that it departed Texas at 1750 hours the day prior to the crash or approximately 23 ½ hours earlier. The time gap is indicative of an overnight stay along the route, although nothing was noted in the PAR to support that indication. Therefore, any conclusions on driver fatigue could not be ascertained.

Crash

The van began to overturn right side leading at approximately the inboard edge of the right shoulder on the one-lane exit ramp. Gouges associated with the rollover were present in the travel lane (**Figure 5**). The vehicle continued to overturn on the roadway and as the vehicle entered its third quarter turn, the left rear wheel contacted the asphalt road surface (**Figure 6**). A significant circular gouge was present at this location and correlative damage was present on the left rear wheel rim (**Figure 7**). The vehicle continued overturning and departed the north roadside and came to final rest after a total of nine-quarter turns. The vehicle traveled approximately 45 m (150') during the rollover event before coming to rest on its right side approximately 8 m (25') outboard of the left (north) shoulder. During the course of the rollover, two occupants were ejected from the vehicle through the second row left window opening and killed. It was unknown where the ejected victims came to rest, although the police did indicate they were not trapped under the vehicle.



Figure 5 - Area of initial rollover.



Figure 6 - Gouge from left rear wheel rim.



Figure 7 - Correlative damage on wheel rim.

Post-Crash

It was not reported how the driver and the other non-ejected passengers exited the vehicle following the crash. Emergency personnel arrived on the scene and transported all 13 occupants to area hospitals. The 29-year old male passenger in the second row left position expired at the scene while the 30-year old male passenger seated in the second row center seat expired later that evening. The driver sustained moderate injuries and was airlifted to a regional trauma center. The remaining 10 occupants sustained minor injuries and were transported by ambulance to a local hospital where they were treated and released.

Vehicle Damage

Exterior Damage – 2002 Ford E-350 Super Duty Van

The 2002 Ford E-350 sustained moderate damage to its roof and minor damage to its left and right sides due to the rollover (**Figure 8**). Precise measurements were not available for this SCI remote investigation. Based on police provided images of the vehicle’s exterior, the maximum crush on the vehicle’s roof was located at the left A-pillar. The A-pillar was deformed rearward and downward and the roof crushed vertically approximately 13 cm (5”). The midline of the roof buckled resulting in a near complete separation of the windshield. The entire left roof side rail was slightly crushed downward. The Collision Deformation Classification (CDC) for this impact was 00-TDDO-3.



Figure 8 - Damaged 2002 Ford E-350 Van.

The left side plane of the Ford was also deformed from the rollover. Damage appears to encompass the entire left side but is most notable rear of the vehicle’s left B-pillar extending rearward to the D-pillar. All four left side windows were shattered and the front left door appears to be jammed closed.

The right side also sustained minor damage beginning near the forward aspect of the fender and extending rearward to the back aspect of the right rear door. The second and third right side windows were shattered during the crash. Both right side tires were deflated and grass and dirt was embedded into the wheel rims (**Figures 9 – 10**).



Figure 9 - Damaged RF wheel.



Figure 10 - Damaged RR wheel and right side of Ford E-350.

Tire Tread Separation – 2002 Ford E-350 Super Duty Van

The left rear tire experienced a 360 degree circumferential separation of the tread (**Figure 11**). The investigative officer noted that the tire displayed a bluish color indicating excessive heat buildup from rotation. Distinguishable tire marks were present on the outboard aspect of the left rear wheel opening of the van due to the tire tread slapping the quarter panel while still in a longitudinal direction (**Figure 12**). The rim was deformed and the tire sustained an abrasion when the wheel impacted the asphalt roadway during

the third quarter-turn of the rollover. The general condition of the left rear tread appeared to be satisfactory prior to the crash and the PAR noted its condition as good. Additional damage to the left tire included tears in the sidewall and multiple abrasions. Positioning the tire with the valve stem representing 12 o'clock, a tear was present in the sidewall at 3 o'clock and another at 10 o'clock. A large section of the tread separated; however, exact measurements could not be determined.



Figure 11 – Left rear tread separation.



Figure 12 - Left rear tire transfers onto wheel opening.

Interior Damage – 2002 Ford E-350 Super Duty Van

No interior images were provided by the investigating agency and the exterior images did not contain a clear view of the interior components. However, from the images the following estimates of passenger compartment intrusion by seating location were identified:

Position	Intruded Component	Estimated Magnitude	Direction
Front left	A-pillar	8 - 15 cm (3 – 6”)	Lateral
Front left	Roof	8 - 15 cm (3 – 6”)	Vertical
Front left	Roof side rail	8 - 15 cm (3 – 6”)	Vertical
Front left	Roof side rail	8 - 15 cm (3 – 6”)	Lateral
Front left	Windshield header	8 - 15 cm (3 – 6”)	Vertical
Front middle	Windshield header	8 - 15 cm (3 – 6”)	Vertical
Front middle	Roof	3 – 8 cm (1 – 3”)	Vertical
Second row left	B-pillar	8 - 15 cm (3 – 6”)	Lateral
Second row left	Roof side rail	3 – 8 cm (1 – 3”)	Lateral
Third row left	Roof side rail	3 – 8 cm (1 – 3”)	Vertical
Third row left	Roof	3 – 8 cm (1 – 3”)	Vertical
Third row left	C-pillar	3 – 8 cm (1 – 3”)	Lateral
Fourth row left	D-pillar	3 – 8 cm (1 – 3”)	Lateral
Fifth row left	E-pillar	3 – 8 cm (1 – 3”)	Lateral
Fifth row left	Backlight header	3 – 8 cm (1 – 3”)	Vertical

Manual Restraints - 2002 Ford E-350 Super Duty Van

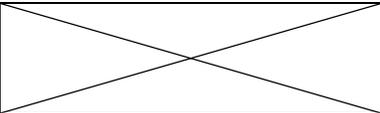
The 2002 Ford E-350 was equipped with 3-point manual lap and shoulder restraints for all ten outboard seating positions. The belt availability and status for the five center positions could not be determined. The police reported that the driver and front right passenger utilized their restraints, but all rear seated occupants were unrestrained.

Frontal Air Bag System - 2002 Ford E-350 Super Duty Van

The 2002 Ford E-350 was equipped with redesigned frontal air bags for the driver and front right position. The air bags did not deploy during the crash.

Occupant Demographic Table

The following table identifies the seating positions, age, gender, and injury level for the occupants of the Ford van:

Row 1	(Driver) 33-year old male Moderate injuries			31-year old male Minor injuries
Row 2	28-year old male Fatal injuries	30-year old male Fatal injuries		46-year old male Minor injuries
Row 3	33-year old male Minor injuries	21-year old male Minor injuries		34-year old male Minor injuries
Row 4		27-year old male Minor injuries		35-year old male Minor injuries
Row 5	33-year-old male Minor injuries	29-year old Male Minor injuries		22-year old male Minor injuries

No information could be discerned regarding occupant contact information or motion during the impact. None of the rear seated occupants were restrained. The second row left and center occupants were ejected from the vehicle through the second row left side window opening and killed. Emergency personnel arrived on the scene and transported all 13 occupants to area hospitals. The 29-year old male passenger in the second row left position expired at the scene while the 30-year old male passenger seated in the second row center seat expired later that evening. The driver sustained moderate injuries and was airlifted to a regional trauma center. The remaining 10 occupants sustained minor injuries and were transported by ambulance to a local hospital where they were treated and released.

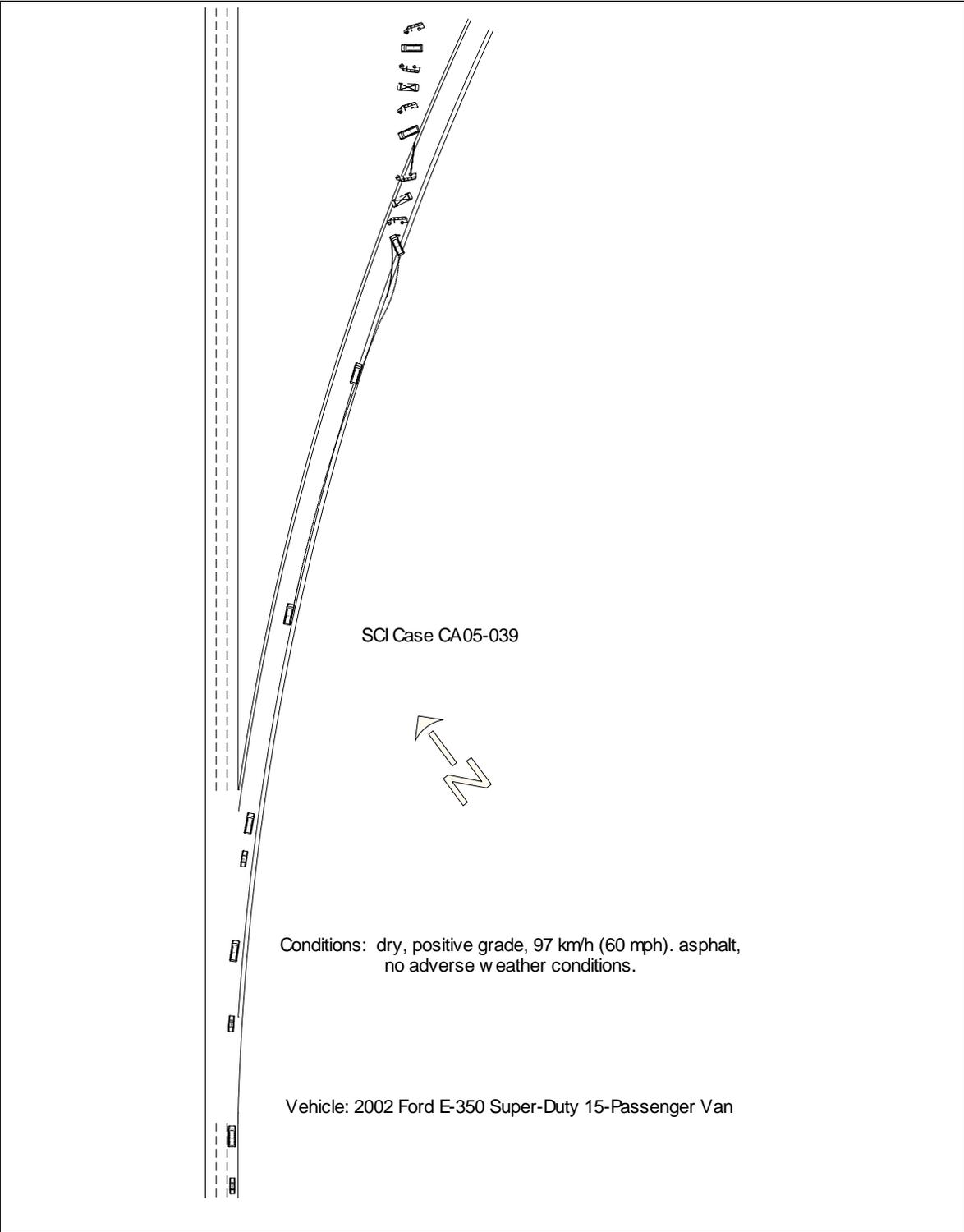


Figure 13 – SCI Crash Schematic