

**CRASH DATA RESEARCH CENTER**

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**CALSPAN REMOTE ROLLOVER INVESTIGATION**

**SCI CASE NO.: CA07-030**

**VEHICLE: 1994 DODGE B350 VAN**

**LOCATION: SOUTH CAROLINA**

**CRASH DATE: JULY 2007**

Contract No. DTNH22-07-C-00043

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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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**BACKGROUND**

This remote investigation focused on an alleged left rear tire tread separation and the loss of directional control that resulted in a tripped five-quarter turn rollover crash of a 1994 Dodge B350 van (**Figure 1**). The Dodge was equipped with mismatched tires at all four positions. The vehicle was occupied by the 50-year old male driver and four female passengers, all police reported as restrained by the available safety belt systems. A 10-year old female passenger seated in the second row, center position was restrained by a lap belt and ejected during the rollover event. She was transported by ambulance to a local hospital where she expired approximately two hours after the crash. The other occupants were restrained by 3-point lap and shoulder safety belts and remained in the vehicle and sustained police reported minor severity injuries.



**Figure 1. Final rest position of the Dodge B350 van.**

NHTSA was notified of the crash by the father of the deceased child passenger. The notification was forwarded to the Calspan Special Crash Investigations (SCI) team on September 25, 2007. The SCI team established cooperation with the investigating police agency and obtained the detailed Police Accident Report (PAR) and on-scene images of the vehicle and crash site. An interview was also conducted with a member of the Police Accident Reconstruction Team. Attempts to locate the Dodge B350 van from this July crash were unsuccessful as the vehicle was no longer available. This case was subsequently assigned for remote investigation on October 10<sup>th</sup>.

**SUMMARY**

***Crash Site***

The crash occurred on a four-lane divided interstate roadway during daylight hours. At the time of the crash, the conditions were clear and the environmental surfaces were dry. The interstate consisted of two lanes in both the east and westbound travel directions that were divided by a depressed grass median. The eastbound travel lanes were police documented at 3.7 m (12') in width. These lanes were bordered by a narrow inboard paved shoulder and a wide outboard shoulder. In the vicinity of the tread separation and loss of control, the eastbound lanes were straight with an estimated negative grade of 3-4 percent. All roadway surfaces were paved with asphalt and were in good condition based on the police images of the crash site. The posted speed limit was 113 km/h (70 mph).

Adjacent to the outboard shoulder of the eastbound lanes was a grass embankment with a downhill grade of approximately 25-30 percent. A welded wire fence supported by wooden posts was located at the base of the embankment. A drainage ditch extended beyond the fence line and transitioned to a shallow positive grade. Located beyond the ditch and grassy slope was a two lane road that paralleled the interstate roadway. This asphalt surface road consisted of two travel lanes delineated by double yellow centerlines. The police documented the width of the lanes as 3.3 m (10.9') and 3.4 m (11.25'). The south roadside of the two lane road consisted of a grassy area with a shallow drainage ditch located approximately 7.6 m (25') south of the road edge. **Figure 2** is an overall view of the crash scene. A non-scaled conceptual schematic of the crash site is attached as **Figure 16**.



**Figure 2. Overall view of the crash scene.**

### ***Vehicle Data***

The 1994 Dodge B350 series van was identified by Vehicle Identification Number (VIN) of 2B7KB3129RK (production number deleted). Based on the VIN, the Gross Vehicle Weight Rating for the Dodge van was between 3,630-4,980 kg (8,001-9,000 lb). The van was configured with the two front doors, a double center closing right side door, and two center-closing rear doors that provided access to the cargo area. The Dodge van was equipped with windows along both sides, inclusive of the right side and rear doors. All glass rearward of the B-pillars appeared to be gasket mounted. The police reported the vehicle's odometer reading as 121,391 km (75,429 miles). The service brakes for this vehicle were power assisted front disc/rear drum with rear anti-lock.

The interior of the van was configured as a passenger van with three known rows of seats and a cargo space behind the passenger seating. The front seats were high-back box mounted bucket seats with vinyl fabric. The second row seat appeared to be a three-passenger bench seat while the third row was presumed to be another three-passenger bench seat. The front and left outboard seating positions were equipped with lap and shoulder belt systems while the center and right seat positions of the second and third rows were equipped with adjustable lap belts. The investigating officer noted that all of the occupants were restrained by the available safety belt systems.



**Figure 3. rear seat area of an exemplar B350 van.**

***Tire Data***

The OEM tire size for this vehicle was 225/75-16 with a Load Range of D. The front tires on the Dodge van were police reported as an unknown model Firestone, size P235/70R16. The passenger style all-season tread was reported in good condition. The left front tire was deflated, but remained on the OEM-style steel wheel. The right front was inflated. The tire pressures and tread depths were not reported. A close examination of the tread patterns in the police provided images revealed two different tread patterns for the front tires. The arrows point to the subtle differences in the tread patterns in **Figures 4 and 5**.



**Figure 4. Right front tire tread.**



**Figure 5. Left front tire tread.**

The rear tires were reported by the police as Michelin light truck tires, size LT225/75R16. The images of the left rear tire indicated that this tire was a Michelin XCH4 with an all-season tread pattern. The tires were mounted on OEM-style steel wheels. Although the tread depths and pressures were not reported, the police did note during their safety inspection of the vehicle that the left rear tire was deflated and the right rear tire remained inflated. The police reported the rear tires as in new condition. A close inspection and comparison of the tire treads through the provided images (remaining tread on the left rear tire) revealed two different tread patterns on the rear axle. The difference in the outer lugs, groves, and sipes are highlighted by the yellow arrows in **Figures 6 and 7**. There was no further tire data reported by the police.



**Figure 6.** Edge of the remaining tread of the left rear tire.



**Figure 7.** Edge of the tread of the right rear tire.

### ***Left Rear Tire Tread Separation***

Based on the two available images of the left rear tire it appears that the entire inner and outer steel belt of the tread separated from the tire. The on-site police images detail the trajectory of the Dodge van with tire fragments (**Figure 8**) scattered along its travel path. Small fragments of the tread were observed at the crash scene. **Figures 9 and 10** show the tire malfunction.



**Figure 8.** Tire tread fragment highlighted in yellow circles.



**Figure 9.** Tire tread separated from the left rear tire.



**Figure 10.** Close-up view of the remaining tire carcass and inner steel belt.



## ***Crash Sequence***

### ***Pre-Crash***

The 1994 Dodge B350 van was occupied by the 50-year old male driver, a 44-year old female front right passenger, a 10-year old female in the second row left position, a 10-year old female in the second row center position, and a 14-year old female seated in the third row left position. They were en route to a sporting event and were traveling in an easterly direction on the interstate roadway in a posted 113 km/h (70 mph) speed zone. The police reported that the van departed the driver's residence earlier in the day and traveled approximately 193 km (120) miles on the interstate roadway. The National Weather Service recorded a temperature of 34 degrees C (93 degrees F) with winds out of the southwest at 14.8 km/h (9.2 mph).

En route to his destination, the driver was traveling in the inboard travel lane. He had crested a hill and was descending a grade of approximately five percent on a straight segment of road. The left rear tire tread separated and fragmented onto the travel lane. The driver apparently applied a rapid clockwise steering input that induced a CW yaw. The Dodge van crossed the broken white lane line and entered the outboard travel lane in a yaw. Yaw marks from the left front and left rear tires began near the centerline of the travel lanes (**Figure 11**).



**Figure 11. CW yaw marks on the travel lanes of the interstate.**



**Figure 12. Continued CW yaw down the grass embankment.**

The Dodge continued to rotate across the outboard travel lane and departed the south edge line onto the outboard shoulder. As the van exited the shoulder, it had rotated approximately 30 degrees CW as evidenced by a crossover of the right rear and left front tire marks. The Dodge entered the grassy slope and traversed the slope as it continued to rotate in a left side leading attitude (**Figure 12**).

### ***Crash***

The left side area of the van impacted and overrode the welded wire fence, fracturing three wood fence posts. The left side tires furrowed into the ground, which tripped the vehicle into a left side leading rollover event. The rollover was initiated on the grassy roadside adjacent to the two lane road that paralleled the interstate. The vehicle continued to roll across the two lane road. The right rear wheel gouged the asphalt road

surface and the tire scuffed the pavement in the center of the westbound lane. White paint transfers were present on the road surface from vehicle body contact. In the area of the tire/wheel gouge, a large fluid spill occurred from cargo that was displaced from the rear doors.

The Dodge continued to overturn across the road and onto the east roadside where it came to rest on its left side, facing in a westerly direction. The vehicle completed five-quarter turns from the initiation of rollover to final rest.

It is probable that the 10-year old second row center passenger slid out of the loosely adjusted manual lap belt and was ejected from the Dodge van. Her ejection portal was unknown. The other occupants remained in the vehicle and sustained minor severity injuries.

### ***Post-Crash***

Police, fire department, and several ambulances responded to the crash site. The remaining occupants of the Dodge van exited the vehicle unassisted. The first responders evaluated the status of the ejected 10-year old child passenger. She was intubated and placed on a backboard. The ambulance and emergency medical personnel that transported the 10-year old child passenger arrived on-scene approximately 46 minutes after the crash and prepared her for ground transport to a local hospital. Within three minutes of their arrival, the child's vital signs flat lined. The ambulance departed the scene within 11 minutes and arrived at the hospital in 15 minutes. The child was evaluated at the hospital and expired 33 minutes following her arrival from multiple trauma. Her death occurred approximately two hours after the crash. No autopsy was performed.

The remaining four occupants were transported by local ambulances to the local hospital where they were treated for police reported minor severity injuries and released.

### ***Vehicle Damage***

#### ***Exterior***

The B350 van sustained moderate severity damage as a result of the five-quarter turn rollover event (**Figure 13**). The maximum roof crush appeared to be located at the windshield header inboard of the right A-pillar. The crush was estimated at 15-20 cm (6-8"). There was ground contact damage distributed across the entire length of the roof at the roof side rail area. All tempered side glazing was shattered. The bonded laminated windshield was fractured and completely separated from the van. The right side doors appeared to have remained closed during the crash. The driver's door was not visible. The Collision Deformation Classification (CDC) for this event was estimated at 00-TDDO-3.



**Figure 13. Rollover damage to the Dodge B350 van.**

The left side area of the van impacted the welded wire fence and fractured the three fence posts. The van was lying on its left side in the available images; therefore the extent of this damage is unknown. The CDC for this event was estimated to be 10-LDEW-1.

### ***Manual Safety Belt Systems***

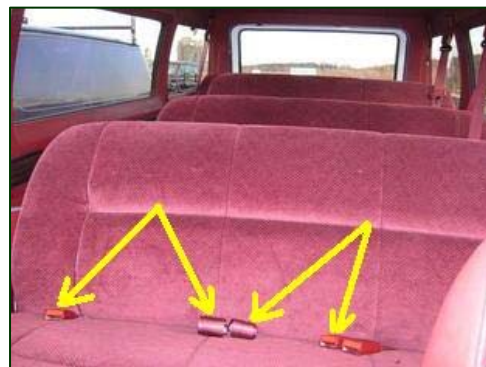
There were insufficient images of the interior to accurately identify the types and usage evidence of the safety belt systems. The police reported that all occupants were restrained.

Based on the review of images of exemplar vehicles, the 1994 Dodge B350 van was equipped with continuous loop lap and shoulder belt systems for the driver and front right passenger positions. The second and third row left seat positions of an exemplar vehicle were equipped with a continuous loop lap and shoulder belt system that detached from a roof side mounted buckle (**Figure 14**). The center and right positions of the second row were equipped with adjustable length lap belts. The center position buckled to the left side of the seat position and the right position buckled to the outboard aspect of the seat (**Figure 15**).

The police report did state that the 10-year old passenger seated in the second row center position and ejected from the van, was wearing the lap belt system. Post-crash, the police documented that the latch plate remained engaged in the buckle assembly. The investigating officer stated during the SCI interview that the length of webbing extending from the latch plate appeared to be excessive for the size of the child passenger. He therefore concluded that the child was wearing the lap belt loose around her pelvis. No images of the passenger seats and safety belt systems were available.



**Figure 14. Detachable left side shoulder belts of an exemplar vehicle.**



**Figure 15. Second row center and right lap belts of an exemplar vehicle.**

***Occupant Data/Demographics***

***Driver***

Age/Sex: 50-year old/Male  
Height: 180 cm (71")  
Weight: 69 kg (152 lb)  
Eyewear: Unknown  
Safety Belt Use: 3-point lap and shoulder belt  
Usage Source: Police Accident Report (PAR)  
Egress from Vehicle: Exited unassisted  
Mode of Transport  
From Scene: Ambulance  
Type of Medical  
Treatment: Transported to a local hospital with police reported minor injuries and released

There was insufficient data to detail the injuries and kinematics for the driver.

***Front Right Passenger***

Age/Sex: 44-year old/Female  
Height: Unknown  
Weight: Unknown  
Safety Belt Use: 3-point lap and shoulder belt  
Usage Source: Police Accident Report (PAR)  
Egress from Vehicle: Exited unassisted  
Mode of Transport  
From Scene: Ambulance  
Type of Medical  
Treatment: Transported to a local hospital with police reported minor injuries and released

There was insufficient data to detail the injuries and kinematics for the front right passenger

***Second Row Left Passenger***

Age/Sex: 10-year old/Female  
Height: Unknown  
Weight: Unknown  
Safety Belt Use: 3-point lap and shoulder belt  
Usage Source: Police Accident Report (PAR)  
Egress from Vehicle: Exited unassisted  
Mode of Transport  
From Scene: Ambulance  
Type of Medical  
Treatment: Transported to a local hospital with police reported minor injuries and released

There was insufficient data to detail the injuries and kinematics for the second row left passenger.

***Second Row Center Passenger***

Age/Sex: 10-year old/Female  
Height: Not reported  
Weight: Not reported  
Safety Belt Use: Lap belt  
Usage Source: Police Accident Report (PAR)  
Egress from Vehicle: Ejected during rollover event  
Mode of Transport  
From Scene: Ambulance  
Type of Medical  
Treatment: Transported to a local hospital where she expired approximately two hours following the crash

***Second Row Center Passenger Kinematics***

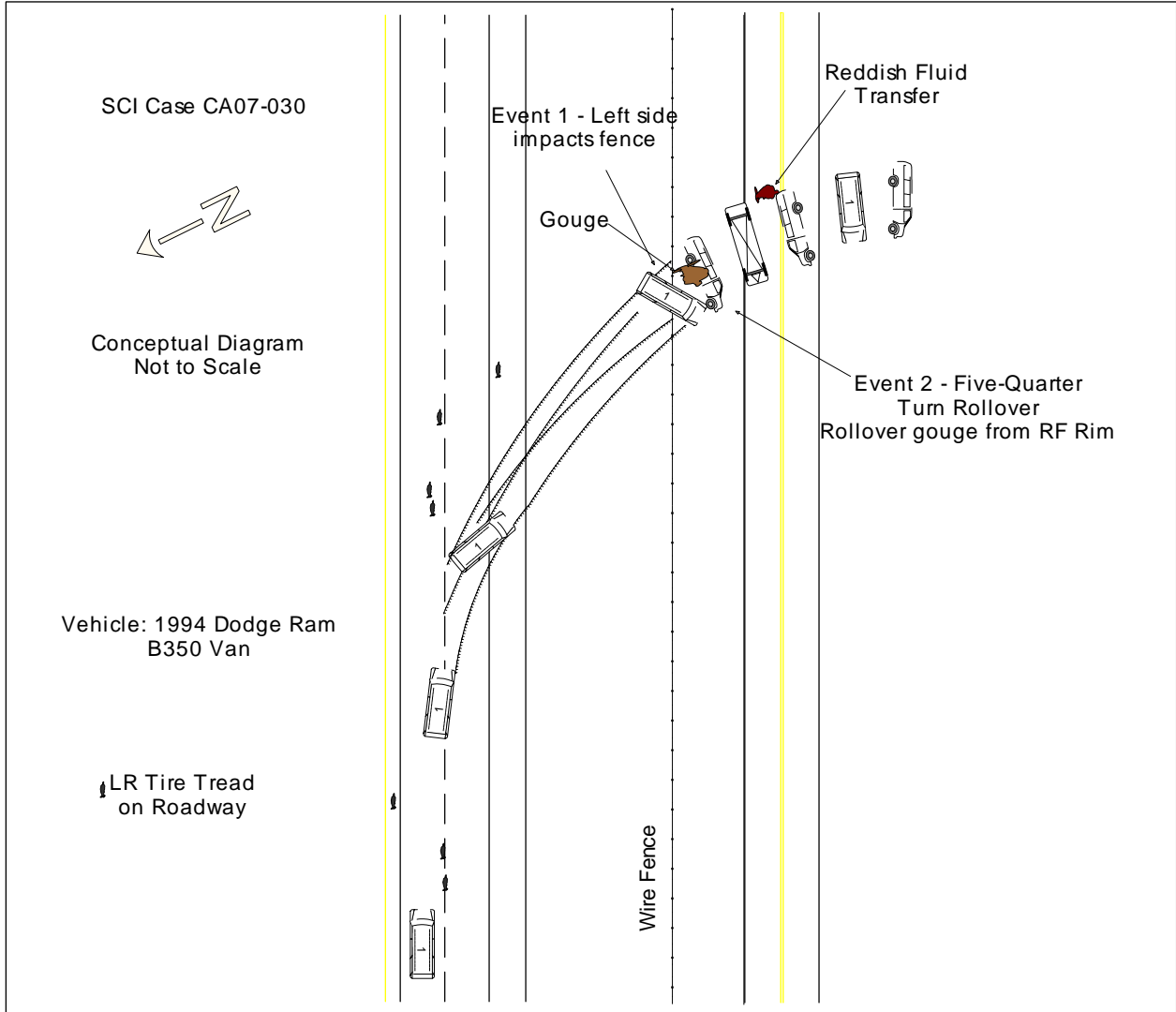
The 10-year old female second row center passenger was police reported as restrained by the manual safety belt system. The belt was positioned across her hips; however, it appears that it was not adjusted to fit snug. During the left side leading rollover event, the child passenger apparently slid out of the lap belt and was ejected from a side window of the vehicle.

The investigating officer stated that the latch plate remained buckled post-crash. He further stated that the adjusted belt length appeared to be too large for the child passenger. There was no report of loading evidence on the belt system or detailed evidence to support the portal of ejection.

***Third Row Left Passenger***

Age/Sex: 14-year old/Female  
Height: Unknown  
Weight: Unknown  
Eyewear: Unknown  
Safety Belt Use: 3-point lap and shoulder belt  
Usage Source: Police Accident Report (PAR)  
Egress from Vehicle: Exited unassisted  
Mode of Transport  
From Scene: Ambulance  
Type of Medical  
Treatment: Transported by ambulance to a local hospital with police reported minor injuries and released

There was insufficient data to detail the injuries and kinematics for the third row left passenger.



**Figure 16 - SCI Crash Schematic**