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REMOTE CRASH INVESTIGATION OF AN ADAPTIVE CONTROL VEHICLE

VERIDIAN CASE NO. 1999-08-136F

VEHICLE - 1996 CHRYSLER TOWN AND COUNTRY/IMS CONVERSION

LOCATION - PENNSYLVANIA

CRASH DATE - AUGUST, 1999

Contract No. DTNH22-94-07058

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

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

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17. *Abstract*

This remote investigation focused on the crash of 1996 IMS alteration of a Chrysler Town & Country van and the injury mechanisms of the 44 year old male driver. The vehicle was equipped with a folding ramp, EZ-Lock wheelchair securement, steering wheel spinner knob, accelerator/brake hand control and associated adaptive controls to meet the needs of the disabled driver. The vehicle was also equipped with a Supplemental Restraint System (SRS) that consisted of driver and front right passenger air bags that did not deploy in the below threshold crash. The driver lost control of the van and the vehicle rolled from a private road into a 4-lane road. During the course of this event, the van struck a stopped 1990 Ford Ranger . The driver of the van sustained minor neck strain as a result of the impact. The driver of the Ford was not injured.

The crash was identified and selected for investigation by National Automotive Sampling System (NASS) and is identified by Case No:1999-08-136F. The Special Crash Investigations team at Veridian was assigned a remote investigation of this crash by the Crash Investigations Division of the National Highway Traffic Safety Administration (NHTSA) on September 2, 1999.

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BACKGROUND

This remote investigation focused on the crash of 1996 IMS alteration of a Chrysler Town & Country van and the injury mechanisms of the 44 year old male driver. The vehicle was equipped with a folding ramp, EZ-Lock wheelchair securement, steering wheel spinner knob, accelerator/brake hand control and associated adaptive controls to meet the needs of the disabled driver. The vehicle was also equipped with a Supplemental Restraint System (SRS) that consisted of driver and front right passenger air bags that did not deploy in the below threshold crash. The driver lost control of the van and the vehicle rolled from a private road into a 4-lane road. During the course of this event, the van struck a stopped 1990 Ford Ranger . The driver of the van sustained minor neck strain as a result of the impact. The driver of the Ford was not injured.

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SUMMARY

Crash Site

This two-vehicle crash occurred during the afternoon hours of August, 1999. At the time of the crash, it was daylight and the weather was not a factor. The road surfaces were dry. The crash occurred at the non-signalized junction of a 4-lane north/south road and 2-lane east/west private roadway. The private road served as the entrance/exit lanes of a shopping center. The shopping center was located on the east side of the primary roadway. The junction was controlled by a stop sign for traffic exiting the shopping center. The speed limit of the primary road was 64 km/h (40 mph). **Figure 1** is a southward view of the crash scene. The subject vehicle was entering the roadway from the left.

Figure 1: Southward view of the crash scene.

Pre-Crash

The 1990 Ford Ranger was stopped in the in-board (left) southbound lane of the road. The 53 year old male driver was the sole occupant of the vehicle. He was not restrained. The Ford's driver was waiting for northbound traffic to clear and it was his intention to turn left into the shopping center parking lot. The 1996 Chrysler Town and Country minivan was driven by a 44 year old disabled male. The Chrysler was westbound in the process of exiting the parking lot. It was the driver's intention to turn northbound (right).

Crash

The crash reportedly occurred when the driver of the Chrysler lost control of the vehicle and allowed the van to accelerate into the roadway. The driver's hand slipped off the adaptive control brake lever and the van crossed the northbound lanes. The driver attempted to avoid the impending crash by steering to the right. However, the late steering maneuver caused the vehicle to initiate a protracted right turn. The vehicle entered the inboard southbound lane and into contact with the Ford Ranger. The center front aspect of the van struck the left aspect of the Ford's front bumper in a 12/11 o'clock impact configuration. The force of the impact was below the deployment threshold of the van's Supplemental Restraint System bag system.

The Ford Ranger was driven rearward approximately 1 m (3 ft) and then rotated clockwise as a result of the offset frontal impact. A scuff mark attributed to the right rear tire of the Ford was identified by the researcher. This mark was directed to the northwest and located on center divider of the southbound lanes. As the van continued its protracted right turn, the forward aspect of its left side contracted the forward aspect of the Ford's left side in sideswiping contact.

Post-Crash

The vehicles came to rest adjacent to each other, blocking the center lanes of the roadway. Police and ambulance personnel responded to the scene. The ambulance personnel were immediately on-scene from the fire department located directly across the street from the crash site. The rescue personnel broke the front right glazing of the van in order to gain vehicle access. The driver, because of his excitement and conditions of his disability, was unable to unlock the doors. The disabled driver was removed and transported to the emergency room of a local hospital as a precaution for any unidentified injuries. The driver of the Ford Ranger was not injured in the crash and exited the vehicle under his own power. Both vehicles sustained disabling damage and had to be towed.

1990 FORD RANGER

Figure 4 is the left front view of the 1990 Ford Ranger. The vehicle was identified by a Vehicle Identification Number (VIN): 1FTCR10ALUB (production sequence deleted). The front bumper system sustained 60 cm (24 in) of direct contact damage that began 20 cm (8 in) left of center and extended to

the left corner. The maximum crush was located at C1 and measured 17 cm (7 in). The energy of the frontal impact was managed by the structures of the front bumper and its mounting. There was no damage to the left front suspension nor change in the wheelbase dimension. The CDC of the damage was 12-FDEW-01. The Barrier Equivalent delta V calculated by the WINSMASH model was 15 km/h (10 mph).

The left side damage consisted of 64 cm (25 in) of sideswiping direct contact. The direct damage began 58 cm (23 in) rearward of the left front axle and extended to approximately the midline of the door. The combined direct and induced damage measured 120 cm (47 in) and began 40 cm (16 in) rearward of the front axle. The maximum crush measured 5 cm (2 in) at the mid-door. The CDC was coded 11-LPEW-01. The Barrier Equivalent delta V was 8 km/h (5 mph).

Figure 2: Left front view of the Ford.

ADAPTIVE CONTROL VEHICLE

The 1996 IMS alteration was identified by the Vehicle Identification Number (VIN): 1C4GP64L0TB (production sequence deleted). The vehicle's date of manufactured was May 1996. The van was configured with an extended wheelbase and had a gross vehicle weight rating of 2722 kg (6000 lb). The power train consisted of a 3.8 liter/V6 engine linked to a 4 speed automatic transmission. The vehicle was equipped with a Supplemental Restraint System (SRS) that consisted of driver and front right passenger air bags. The air bags did not deploy in the below threshold crash. The odometer read approximately 17,541 km (10,900 miles) upon inspection.

Exterior Damage

Figures 3 and 4 are the front and left side views of the IMS, respectively. The vehicle's front plane sustained direct contact damage across the entire frontal width of the vehicle. The maximum crush of 8 cm (3 in) was measured at C6. Due to the relative bumper height mis-match the van sustained additional damage to the radiator and center grille area during the impact. Vehicular damage was confined to the structures forward of the radiator support plane indicative of the minor nature of this impact. The wheelbase dimensions were unchanged. The Collision Deformation Classification (CDC) of the impact was 12-FDEW-01. The Barrier Equivalent Delta V calculated by WINSMASH program was 12 km/h (7 mph).

The forward aspect of the vehicle's left side sustained 75 cm (30 in) of direct contact damage that began at the front bumper's left corner, **Figure 4**. The maximum crush of 9 cm (4 in) was measured at C6. The CDC of the impact was 12-FLEW-01. The delta V of this contact was determined to be 6 km/h (3 mph).

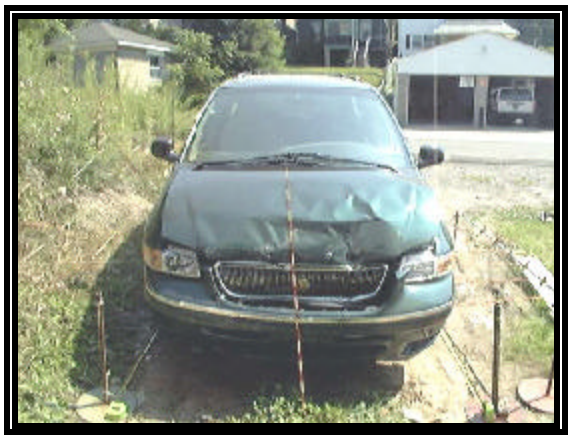

Figure 3: Front view of the Chrysler.

Figure 4: View of the left side damage.

ADAPTIVE CONTROL EQUIPMENT

The subject driver purchased the vehicle in August 1998 from a private individual. At that time, the vehicle had already been altered by IMS Inc.. IMS Inc. had installed the 25 cm (10 in) lowered floor and folding ramp lift to accommodate the transportation of a wheelchair user. The subject driver then had the vehicle further modified with the installation of the accelerator/brake hand control , a reduced effort steering package, steering wheel spinner knob, wheelchair lock and the associated electrical switches. The make and model of the adaptive equipment was not known. Ability Conversions Inc. handled the installation. The driver had just under 1 year of experience driving this vehicle prior to the subject crash. He indicated that he drove himself to and from work, 3 days per week, during that period.

Figures 5 is an interior view of the driver's position depicting the location of the adaptive controls installation. The steering wheel spinner knob was located in the 2 to 3 o'clock sector of the rim. The driver indicated that the reduced effort steering was very responsive and took some experience getting used to.

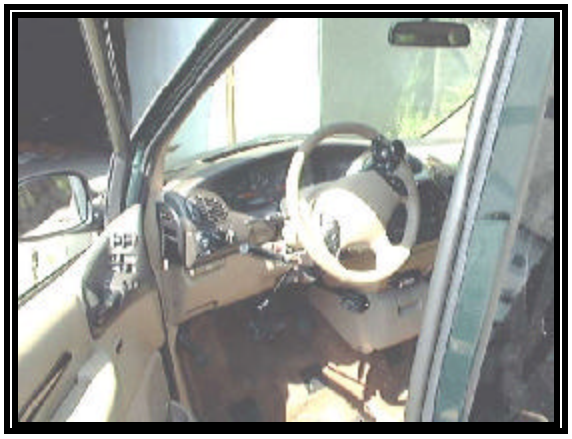

Figure 5: Interior view of the driver's position.

The accelerator/brake hand control electro-mechanically controlled the vehicle's operation. It was located on the left side of the steering column, directly below the turn signal stalk. A downward motion of the control electronically controlled the accelerator, increasing engine rpm. The brakes were actuated mechanically by a forward motion. Forward movement of the lever directly depressed the brake pedal, **Figure 6**. Both accelerator and brake could be foot operated, without the use of the adaptive control hand lever.

Figure 6: Close-up view of the mechanical brake actuation rod.

Figure 7: View of the driver's floor area.

The wheel chair was held stationary in the driver's position by an EZ Lock device, model unknown, **Figure 7.** The lock was electronically released via a remote switch mounted on the center console A manual/emergency release was located on the forward aspect of the lock. The lock was fastened to the floor by 4-3/8 in diameter grade 5 bolts. The lock latched about a ½ in diameter pin attached to the rear aspect of the wheelchair. The left front seating position was also equipped with floor anchors for the attachment of a OEM seat mounted on a special base. The anchors were arranged in a rectangular pattern that accommodated the dimensions of the base attachments.

The manual restraint system consisted of the OEM 3-point lap and shoulder belt with a modified inboard anchor. The buckle assembly was fixed to a webbing section attached to the floor of the van via a modified floor anchor, refer to Figure 7. The anchor consisted of a formed steel section that was spot-welded to the floor. The section extended across the width of the vehicle to allow for the adjustment of the inboard anchor.

DRIVER DEMOGRAPHICS

Age/Sex:	44 year old/ Male
Height:	180 cm (71 in)
Weight:	98 kg (215 lb)
Restraint Use:	3-point lap and shoulder, in addition to auxiliary lap and chest restraint on the wheelchair
Usage source:	Police Report/Interview
Treatment:	Examined and released from an Emergency Room of a local hospital

DRIVER INJURIES

Injury	Severity (AIS 90)	Injury Mechanism
Small anterior scalp abrasion	Minor (190202.1,5)	Sun visor (probable)
Right trapezius strain	Minor (640278.1,6)	Seat belt (Indirect/certain)

DRIVER KINEMATICS

Immediately prior to the crash, the driver of the van entered the vehicle after completing some shopping at a local store. He locked his wheelchair in the driver's position and started the vehicle. The driver reported he was restrained in an upright position by two restraints attached to the wheelchair in addition to the vehicle's 3-point lap and shoulder belt. The wheelchair restraints consisted of a lap belt and an upper body belt and assisted the driver in maintaining an upright posture. The lap belt was positioned over his pelvis and lower extremities and was anchored to the wheelchair's seat cushion. The upper body belt attached to the upper aspect of the wheelchair's seat back and was positioned horizontally across his chest. The driver buckled the OEM lap and shoulder restraint over the top of the wheelchair restraints. He encountered no problems using the vehicle's 3-point restraint system.

The driver accelerated the vehicle from its parking space toward the parking lot exit. As the driver was in the process of traversing the exit lane, he felt himself beginning to lose his balance and slouch/submarine in his seat. He tried to maintain his upright posture extending his left arm against the adaptive control lever. However, his hand slipped off the control releasing any brakes that may have been applied at that time.

The vehicle's forward momentum caused it to roll into the intersection. The driver steered the van clockwise (to the right) in an attempt to avoid the Ford Ranger. The driver responded to the 12 o'clock direction of the impact by initiating a forward trajectory. His scalp probably contacted the sun visor during his forward trajectory resulting in the identified abrasion. The driver's torso contacted and loaded the vehicle's 3-point restraint. As the driver's torso slowed (due to the 3-point restraint), the inertia of the head caused the head/neck complex to flex forward. The muscles of the upper back and shoulder resisted this motion resulting in the strain of the right trapezius. The driver then rebounded back into the wheel chair.