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ON-SITE REDESIGNED AIR BAG INVESTIGATION

CASE NUMBER - IN98-003
LOCATION - MISSOURI
VEHICLE - 1998 DODGE DURANGO SLT
CRASH DATE - December, 1997

Submitted:

May 24, 2001

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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 performance of the involved vehicle(s) or their safety systems.

Technical Report Documentation Page

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On-site air bag deployment investigation involving a 1998 Dodge Durango SLT, four-door sport utility, with manual safety belts and dual front redesigned air bags, and a 1985 Ford F700 pulling a trailer

16. *Abstract*

This report covers an on-site investigation of a redesigned air bag deployment crash that involved a 1998 Dodge Durango (case vehicle) and a 1985 Ford F-700 truck (other vehicle) towing a flatbed trailer containing a small construction vehicle. This crash is of special interest because the case vehicle was equipped with redesigned air bags and the case vehicle's driver (33-year-old male) reportedly sustained evident, but not disabling, injuries from his deploying driver air bag. The case vehicle was traveling southeastward in the second through lane (relative to the west roadside) of a five-lane southeastbound roadway, which was part of a divided, urban interstate trafficway (i.e., the southeast roadway had five through lanes but the number of through lanes for the northwestbound roadway is unknown). The Ford truck and its trailer were traveling southeastward in the same lane as the case vehicle. Based on the available information, prior to the crash the case vehicle's driver was locating, grabbing, and silencing his activated pager. The crash occurred in the second southeastbound lane of the southeast roadway. The front of the case vehicle impacted the rear of the flat bed trailer towed by the Ford, causing the case vehicle's driver and front right supplemental restraints (air bags) to deploy. The exact posture of the case vehicle's driver immediately prior to the crash is unknown. Presumably he was seated with his seat track located between its middle and rearmost positions, and the exact position of the tilt steering wheel is unknown. Based on the interior contact evidence, the case vehicle's driver was most likely not using his available, active, three-point, lap-and-shoulder, safety belt system, and he sustained, according to the Police Crash Report, evident, but not disabling, injuries and was treated and released. The specific injuries sustained by the case vehicle's driver are unknown. The second seated right passenger (4-year-old female) was seated in a fixed seat track position and was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. She also sustained, according to the Police Crash Report, evident, but not disabling, injuries and was treated and released. Her exact injuries are also unknown.

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BACKGROUND

IN98-003

This on-site investigation was brought to NHTSA's attention on January 2, 1998, by GES sampling activities. This crash involved a 1998 Dodge Durango SLT (case vehicle) and a 1985 Ford F-700 truck (other vehicle) towing a flatbed trailer containing a small construction vehicle. The crash occurred in December, 1997, at 12:20 p.m., in Missouri, and was investigated by the applicable state police department. This crash is of special interest because the case vehicle was equipped with redesigned air bags and the case vehicle's driver [33-year-old, (unknown race and or ethnic origin) male] reportedly sustained evident, but not disabling, injuries from his deploying driver air bag. This contractor inspected the scene and vehicles on 12-13 January, 1998. This contractor was never able to interview the driver of the case vehicle, despite numerous attempts throughout the winter of 1998. This summary is based on the Police Crash Report, scene and vehicle inspections, occupant kinematic principles, and this contractor's evaluation of the evidence.

CRASH CIRCUMSTANCES

Figure 1: Southeastward travel path viewed from center through lane of five-lane southeastbound roadway; Note: case vehicle and Ford F700 were both traveling southeastward in the adjacent right-hand lane (case photo #02)

The case vehicle was traveling southeastward in the second through lane (relative to the west roadside) of a five-lane southeastbound roadway (**Figure 1**), which was part of a divided, urban interstate trafficway. The case vehicle intended to continue in its southeasterly travel path (i.e., the southeast roadway had five through lanes but the number of through lanes for the northwestbound roadway is unknown; however, based on the available information, it is likely that there was an exit lane further to the southeast in the vicinity of the crash). The Ford truck and its trailer were traveling southeastward in the same lane as the case vehicle and intended to continue in a southerly travel path. Based on the available information, prior to the crash the case vehicle's driver was locating, grabbing, and silencing his activated pager. When the driver looked up, the truck and trailer were immediately before him. There was no indication on the Police Crash Report of any pre-crash avoidance maneuvers. The crash occurred in the second southeastbound lane of the southeast roadway. Available information does not indicate the case vehicle's pre-impact speed, but the Ford's driver estimated his speed at 56 km.p.h. (35 m.p.h.) as he was "getting ready to get off" the interstate trafficway. The posted speed limit for both vehicles was 97 km.p.h. (60 m.p.h.).

Figure 2: Case vehicle's frontal damage with contour gauge present and positioned to show above bumper crush (case photo #04)

The front (**Figure 2**) of the case vehicle impacted the rear of the flat bed trailer (**Figure 3** below) towed by the Ford, causing the case

vehicle's driver and front right supplemental restraints (air bags) to deploy. The post-crash trajectories of both vehicles are unknown, but they most likely came to rest in or near the second southeastbound through lane of the southeast roadway heading southeastward (i.e., both vehicles were towed due to damage).

Figure 3: Flatbed trailer towed by Ford showing damaged ramps and wooden floor planks to back of trailer (case photo #72)

CASE VEHICLE

The 1998 Dodge Durango SLT was a four wheel drive, six-passenger, four-door, sport utility vehicle (VIN: 1B4HS28YXWF------) equipped with a 5.2L, V-8 engine and a four-speed automatic transmission. The case vehicle was equipped with two-wheel, anti-lock brakes (i.e., four-wheel, anti-lock brakes were optional). The case vehicle's wheelbase was 294 centimeters (115.9 inches), and the odometer reading at inspection was 2,271 kilometers (1,411 miles).

Figure 4: Case vehicle's frontal damage with contour gauge present at bumper level viewed from left of front (case photo #08)

The case vehicle's contact with the Ford truck and trailer involved the entire front of the vehicle. Direct damage began at the left bumper corner and extended across the entire front bumper and hood (**Figure 4**). Maximum crush at the bumper was measured as 22 centimeters (8.7 inches) at C_6. Maximum crush above the bumper was measured as 29 centimeters (11.4 inches) at C_5 (**Figure 5**). The wheelbase on the case vehicle's left side was shortened 19 centimeters (7.5 inches) while the right side was extended 16 centimeters (6.3 inches). The case vehicle's front splash guard, front bumper, right and left headlamp and turn signal assemblies, grille, hood, and both fenders were directly damaged and crushed rearward. As a result of the crash, the case vehicle's left and right front tires were physically restricted and the left front tire was deflated (**Figures 6** and **7** below).

Figure 5: Case vehicle's frontal damage, viewed from right of front, with contour gauge showing bumper level crush (case photo #15)

Based on the vehicle inspection the CDC for the case vehicle was determined to be: **12-FDEW-2 (350)**. The WinSMASH reconstruction program, barrier algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 23.4 km.p.h. (14.5 m.p.h.), -23.0 km.p.h. (-14.3 m.p.h.), and +4.1 km.p.h. (+2.5

m.p.h.). The barrier equivalent speed was[1] 23.4 km.p.h. (14.5 m.p.h.). The case vehicle was towed due to disabling damage.

Figure 6: Close-up of case vehicle's restricted and deflated left front tire; Note: damage occurred as a result of frontal impact (case photo #12)

Figure 7: Close-up of case vehicle's restricted and damaged right front tire; Note: damage occurred as a result of frontal impact (case photo #16)

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 with overall dimensions of 15 centimeters (5.9 inches) at the horizontal seam and 11 centimeters (4.3 inches) vertically for the upper flap and 2 centimeters (0.8 inches) vertically for the lower flap. An inspection of the air bag module's cover flaps and air bag fabric revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with one tether, 6 centimeters (2.4 inches) wide. The driver's air bag had no vent ports. The deployed driver's air bag was elliptical with a height of approximately 52 centimeters (20.5 inches) and a width of approximately 63 centimeters (24.8 inches). An inspection of the driver's air bag revealed blood splotches and smears around the periphery of the bag's frontal surface, with other blood transfers to the top portion of the back surface (**Figure 8**).

Figure 8: Case vehicle's deployed driver air bag; Note: deployed front right air bag in background and steering wheel rotated nearly upside down (case photo #26)

The front right passenger's air bag was located in the middle of the instrument panel (**Figure 9** below). There was a single, essentially rectangular, modular cover flap. The cover flap was made of a thick vinyl over a thick cardboard type frame. The flap's dimensions were 33 centimeters (13.0 inches) at the lower horizontal seam and 23 centimeters (9.1 inches) along both vertical seams. The profile of the case vehicle's instrument panel resulted in a 4 centimeter (1.6

[1] Based on NASS CDS protocol, the actual Delta V values are not encoded in the EDCS and only the barrier equivalent speed is present.

inch) setback of the leading edge of the cover flap relative to the protruding right instrument panel. An inspection of the front right air bag module's cover flap and air bag fabric revealed that the cover flap opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flap. The front right passenger's air bag was designed without any tethers, it had no vent ports. The deployed front right air bag was rectangular with a height of approximately 60 centimeters (23.6 inches) and a width of approximately 52 centimeters (20.5 inches). There were scattered blood spots on the front surface and right and left side surfaces of the deployed front right air bag.

Figure 9: Case vehicle's front right seating area showing front right passenger air bag, which deployed from middle-mounted module, and module's undamaged cover flap (case photo #45)

Figure 10: Case vehicle's inverted steering wheel (rotated 180 degrees) showing blood and unidentified splatter evidence (orange dots) on steering wheel's rim and hub and blood evidence on lower front surface of driver's air bag (case photo #27)

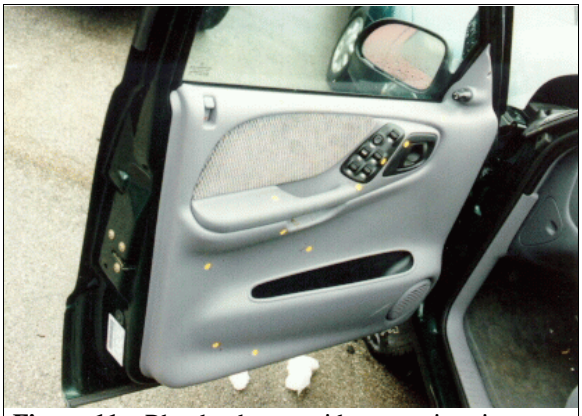

Figure 11: Blood splatter evidence on interior surface of case vehicle's driver door (case photo #19)

Figure 12: Unidentified splatter evidence on case vehicle's center console and blood evidence on front of driver's seat (case photo #53)

An inspection of the case vehicle's interior revealed blood spots around the steering wheel's rim (**Figure 10**), on the interior surface of the driver's door (**Figure 11**), and on the front portion of the driver's seat (**Figure 12**). There was contact evidence (i.e., scrape) on the driver's knee bolster, just to the right of the steering column (**Figure 13** below), and a scrape on the center instrument panel (**Figure 14** below). In addition, hair and skin transfers were detected on the case vehicle's windshield near the driver's side windshield header (**Figure 15** below) and on the header itself; this evidence is contraindicative of the use of the available, lap-and-shoulder, safety belts.

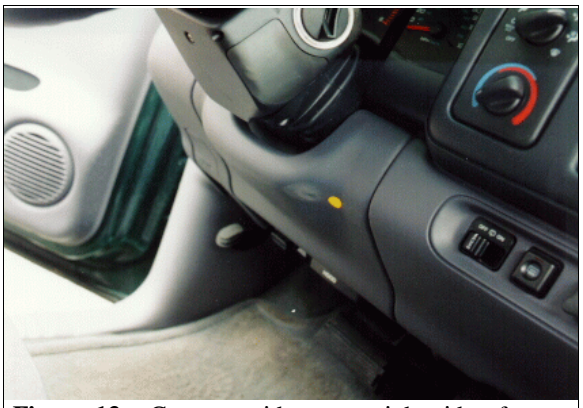

Figure 13: Contact evidence on right side of case vehicle's driver knee bolster (case photo #36)

Figure 14: Contact evidence on case vehicle's center instrument panel area (case photo #44)

Figure 15: Case vehicle's deployed driver air bag and smudge on windshield toward left "A"-pillar and broken rearview mirror (case photo #37)

Figure 16: Close-up of case vehicle's inverted (i.e., rotated 180 degrees) driver air bag module's top cover flap showing unidentified splatter evidence on cover flap and upper right rim area (case photo #33)

There were also unidentified splatter marks on the steering wheel's rim and spokes (**Figure 10** above) and to the driver air bag module's top cover flap (**Figure 16**). Furthermore, these unidentified splatter marks were noted on the center console (**Figure 12** above), the center and right instrument panel areas, and on the front right air bag module's cover flap. Finally, there was a scrape on the back surface of the front right seat back from contact by the second seated right passenger (**Figure 17**).

Figure 17: Contact evidence on back surface of case vehicle's front right seat back from contact by second seated right passenger (case photo #57)

Of interest is the fact that the case vehicle's back (third) seat was folded down prior to the crash. The seat being down enabled the vehicle's tire jack and the jack's crank handle to fly forward during the collision. The jack struck the case vehicle's second seat left's seat back with sufficient force that it bent the seat back forward while rotating it counterclockwise (**Figure 18** below). There was also a scrape on the back surface the

back seat's seat back (i.e., the seat back was down at the time of the crash–**Figure 19**). In this contractor's opinion, it is possible that the jack rotated off the second seat left's seat back and continued forward contacting the center instrument panel (**Figure 14** above) prior to rebounding backwards into the back seating area as the case vehicle continued to final rest.

Figure 18: Case vehicle's second seating area showing deformed seat back of second left seat and undeformed seating area where second seat right passenger was seated (case photo #55)

Figure 19: Case vehicle's folded down back seat and base of tire jack that deformed the second seat left's seat back and scraped the folded down area (highlighted) of the back seat (case photo #60)

CASE VEHICLE OCCUPANTS

The exact posture of the case vehicle's driver (of unknown height and weight) immediately prior to the crash is unknown. Presumably he was seated in an upright posture with his back slightly in front of the seat back, his left foot on the floor, his right foot most likely moving between the accelerator and brake pedals, his left hand on the steering wheel, and his right hand groping for his activated pager. His seat track was located between its middle and rearmost positions, the seat back was upright, and the exact position of the tilt steering wheel is unknown. During the vehicle inspection the steering wheel was found in its upmost position, but this contractor was not able to confirm this positioning from the case vehicle's driver, and this positioning is inconsistent with the driver's seat track position.

Based on the interior contact evidence, the case vehicle's driver was most likely not using his available, active, three-point, lap-and-shoulder, safety belt system. Although there were indications of frequent belt system use, inspection of the seat belt webbing, "D"-ring, and latch plate showed inconclusive evidence of loading (i.e., a lateral marking on the lap portion of the belt webbing near the midpoint of the driver's seat–**Figure 20**, and a slight "waffling" of the webbing near the left shoulder area of the shoulder portion of the three-point belt).

Figure 20: Case vehicle's driver safety belt showing loading evidence on webbing (case photo #39)

The case vehicle's driver made no known pre-crash avoidance maneuvers[2]. As a result and independent of the nonuse of his available safety belts, his pre-impact body position did not change just prior to impact. The case vehicle's impact with the Ford truck and trailer enabled the driver to continue forward and slightly upward and leftward toward the case vehicle's 350 degree Direction of Principal Force as the case vehicle decelerated. The case vehicle initially impacted the back of the towed trailer with its bumper but quickly overrode the back of the trailer and impacted the construction vehicle being hauled upon the trailer with its hood and bumper. The case vehicle's driver impacted the deploying driver's air bag and most likely continued forward and upward into the windshield's glazing and header areas (**Figure 15** above). It is entirely possible that the case vehicle's driver air bag may have deployed late during the duration of the impact because of the sequential involvement of the case vehicle's bumper, first with the back of the trailer, and second with the construction vehicle being hauled upon the trailer (**Figure 21**). Because of the lack of interview information, this contractor has no clear cut evidence that this occurred. As a result, the exact position of the driver, relative to the steering wheel, when the air bag deployed is unknown. Based on the available evidence that both vehicles continued straight ahead post-crash, the case vehicle's driver most likely rebounded backwards into his seat back where he remained as the case vehicle came to rest.

Figure 21: Small Toyota construction vehicle that was on trailer being towed by Ford; Note: vehicle's back was contacted by case vehicle's front (case photo #79)

The exact posture of the case vehicle's second seated right passenger [i.e., daughter; 4-year-old, (unknown race and/or ethnic origin), female; of unknown height and weight] is unknown. Presumably she was seated in an upright posture with her back against the seat back and her feet dangling over the front edge of the seat's cushion; however, the exact position of her hands is unknown. Her seat track and seat back were not adjustable.

The case vehicle's second seated right passenger was reportedly restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The inspection of the second seated right passenger's seat belt webbing, "D"-ring, and latch plate was inconclusive for evidence of loading. The vehicle inspection indicated that this safety belt had been used in the past, but this contractor was unable to determine from the inspection alone if it was used during this crash. Based on the interior inspection, this occupant's reported restraint usage is consistent with the contact evidence.

The case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the use of the second seated right passenger's available safety belts, her pre-impact body position did not change just prior to impact. The case vehicle's impact with the Ford truck

[2] No avoidance maneuvers were reported on the Police Crash Report and no interview with the driver was obtained; therefore, the EDCS was encoded as "unknown".

and trailer enabled the case vehicle's second seated right passenger to continue forward and slightly leftward toward the case vehicle's 350 degree Direction of Principal Force as the case vehicle decelerated. The case vehicle initially impacted the back of the towed trailer with its bumper but quickly overrode the back of the trailer and impacted the construction vehicle being hauled upon the trailer with its hood and bumper. The case vehicle's second seated right passenger loaded her safety belts limiting her forward movement. She also most likely contacted the back surface of the front right seat back, but because of the lack of cooperation, this contractor has no idea what was the nature or location of her alleged injuries. Based on the available evidence that both vehicles continued straight ahead post-crash, the case vehicle's second seated right passenger most likely rebounded backwards into her seat back where she remained as the case vehicle came to rest. It should be noted that this contractor suspects that the second seated right passenger had some sort of liquid in her hands at the time of the crash. This would explain the unidentified splatter that was found throughout the front seating area. However, this contractor has no solid evidence in this regard and the source of the splattering remains a matter of conjecture.

DRIVER INJURIES

The driver was transported by ambulance to the hospital. He sustained evident, but not disabling, injuries and was treated and released. The specific injuries sustained by the case vehicle's driver are unknown. It is most likely that the driver sustained some sort of neck, facial, and/or scalp injuries with active bleeding that enable a plentiful supply of blood to be splattered throughout the front passenger seating area. Because of the lack of medical and interviewee information, it cannot be determined what, if any, role the case vehicle's driver air bag played in the injuries sustained.

SECOND SEATED RIGHT PASSENGER INJURIES

The second seated right passenger was transported by ambulance to the hospital. She sustained evident, but not disabling, injuries and was treated and released. The specific injuries sustained by the case vehicle's second seated right passenger are unknown. However, the vehicle inspection indicates that this occupant most likely contacted the back of the front right seat back.

OTHER VEHICLE

The 1985 Ford F-700 was a rear wheel drive, two-door, incomplete chassis-cab vehicle fitted with a dump truck body (VIN: 1FDNF70H2FV------). The Ford truck was towing a 6 x 16 foot flatbed trailer upon which was a small construction vehicle (**Figure 21** above). The Ford's damage was limited to the hitch assembly and a steel backing plate (**Figure 22**). Its trailer damage included: a broken connecter, crumpled front connecter frames

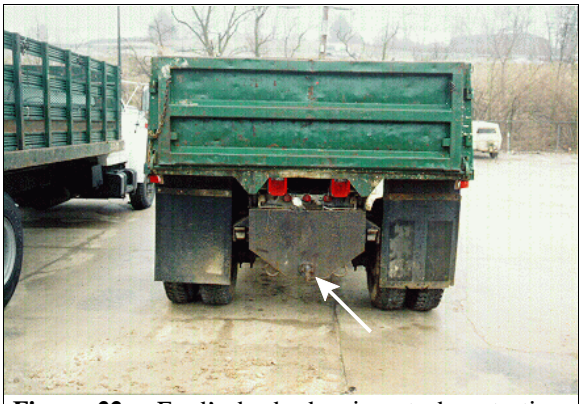

Figure 22: Ford's back showing steel protective plate and repaired hitch assembly (case photo #63)

(**Figure 23**), torqued rear ramps (i.e., both), bent rear frame member, and splintering to four of the eight wooden floor planks (**Figure 3** above). The Ford truck was towed due to disabling damage; specifically, the Police Crash Report indicates that the Ford's transmission was damaged. The Ford truck and its trailer were outside the scope of WinSMASH.

Figure 23: Deformed tongue of flat bed trailer towed by Ford; Note: trailer's tongue was bent upwards when trailer was jammed into back of Ford following trailer's impact by case vehicle's front (case photo #70)