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REMOTE ADULT AIR BAG-RELATED SERIOUS INJURY REPORT

CASE NUMBER - IN98-026
LOCATION - MISSISSIPPI
VEHICLE - 1998 VOLVO S70
CRASH DATE - September, 1997

Submitted:

December 31, 2002

Contract Number: DTNH22-94-D-17058

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
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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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15. *Supplementary Notes*
Remote air bag deployment investigation involving a 1998 Volvo S70, four-door sedan, with manual safety belts and pretensioners, and dual front and side air bags, and a 1992 GMC Safari XT, minivan

16. *Abstract*

This report covers a remote investigation of an air bag deployment crash that involved a 1998 Volvo S70 (case vehicle) and a 1992 GMC Safari XT minivan (other vehicle). This crash is of special interest because the case vehicle's front right passenger (42-year-old male) sustained a critical spinal cord injury, with complete quadriplegia, from contacting his deploying front right air bag. The case vehicle was traveling south in the southbound lane of a two-lane, undivided, state roadway. GMC minivan was traveling north in the northbound lane of the same state roadway. The case vehicle had passed several other southbound vehicles, and upon returning to its original travel lane, ran off the right (west) pavement edge. The case vehicle's driver overcorrected, crossed the roadway, and traveled onto the east shoulder. The crash occurred off the east side of the roadway. The front of the case vehicle impacted the left side of GMC minivan, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The exact posture of all three of the case vehicle's occupants is unknown. Presumably, the front right passenger was seated, leaning a little to his left, with his seat track located forward of its middle position. It is unknown whether he was restrained by his available, active, three-point, lap-and-shoulder, safety belt system, and he sustained, according to the medical information provided by his attorney, critical injuries which included: an injured cervical spinal cord at the area of the 5TH cervical vertebra with quadriplegia and fracture at C_5-C_6, a dissection of the left carotid artery, and a dissection of the left vertebral artery. In addition, he is dependent on a ventilator/respirator, and he cannot communicate verbally but only by blinking his eyes in response to questions. Presumably, the driver (37-year-old male) was seated, but the exact location of his seat track and tilt steering wheel are unknown. Available physical evidence indicates that he was not restrained. His police-reported injuries were classified as "B" (moderate injury). Presumably, the back right passenger (28-year-old male) was seated, and his seat track was not adjustable. He was reportedly unrestrained. His police-reported injuries were also classified as "B" (moderate injury).

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TABLE OF CONTENTS

Page No.

This remote report was brought to NHTSA's attention on October 22, 1998, by a law firm representing the case vehicle's front right passenger. This crash involved a 1998 Volvo S70 (case vehicle) and a 1992 GMC Safari XT minivan (other vehicle). The crash occurred in September 1997, at 6:48 p.m., in Mississippi, and was investigated by the applicable state police department. This crash is of special interest because the case vehicle's front right passenger [42-year-old, Black (unknown if Hispanic) male] sustained a critical spinal cord injury, with complete quadriplegia, from contacting his deploying front right air bag. This contractor received photographs from the front right passenger's attorney in November, 1998. Numerous attempts to contact the involved drivers and another passenger in the case vehicle were unsuccessful. The case vehicle's quadriplegic, front right passenger cannot verbally respond and communicates only through eye blinks. This report is based on the Police Crash Report, attorney provided photographs, occupant kinematic principles, attorney provided medical information, and this contractor's evaluation of the evidence.

CRASH CIRCUMSTANCES

The case vehicle was traveling south in the southbound lane of a two-lane, undivided, state roadway and intended to continue its southerly travel path. GMC minivan was traveling north in the northbound lane of the same two-lane, undivided, state roadway and intended to continue its northerly travel path. At the completion of passing several other southbound vehicles, the case vehicle's driver apparently lost control as he returned to his original travel lane and ran off the right (west) pavement edge. He then overcorrected the case vehicle, crossed the centerline and the northbound lane, and traveled onto the east shoulder. In this contractor's opinion, the case vehicle's driver most likely initiated a right-hand steering input just prior to the case vehicle's left (east) roadway departure. The steering input resulted in the case vehicle's travel path changing from east-southeast to south-southeast. GMC minivan's driver saw the encroaching case vehicle and attempted to avoid the collision by steering to her right (east), off the roadway, just prior to the crash. The crash occurred off the east side of the roadway.

Figure 1: Case vehicle's damaged front; Note: damaged components have been removed and engine removed during salvage (case photo #01)

Figure 2: Case vehicle's damaged front viewed from right of front; Note: engine, wheels, etc. have been removed for salvage as well as missing crash damaged components (case photo #14)

The state highway was straight and level near the area of impact. The pavement was bituminous. Pavement markings and traffic

controls are unknown. Estimated travel speed for the case vehicle was 97 km.p.h. (60 m.p.h.) and 93 km.p.h. (58 m.p.h.) for GMC minivan; the posted speed limit was 89 km.p.h. (55 m.p.h.) for both vehicles. At the time of the crash the light condition was dusk, the atmospheric condition was clear, and the road pavement was dry. Traffic density and site characteristics (i.e., beyond rural) are also unknown. According to the Police Crash Report, the case vehicle's driver had been drinking, and his ability was impaired.

The front of the case vehicle (**Figures 1** and **2** above) impacted the left center and back of GMC minivan (**Figures 3** and **4**), causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. This contractor believes it is likely that the case vehicle rotated counterclockwise post-crash, but its degree of rotation and its final rest position are unknown.

Figure 3: GMC minivan's left side damage viewed from left of front (case photo #34)

Figure 4: GMC minivan's damaged left side viewed from left of back (case photo #35)

CASE VEHICLE

The 1998 Volvo S70 was a front wheel drive, five-passenger, four-door sedan (VIN: YV1L5542W1------) equipped with a 2.4L, DOHC, I-5 engine and either a five-speed manual (standard) or a four-speed automatic (optional) transmission. The case vehicle was equipped with four-wheel, anti-lock brakes; traction control was an option. The case vehicle's wheelbase was 266 centimeters (104.9 inches). Because there are no available vehicle photographs of post-crash damage before the case vehicle was stripped for parts, a CDC is not estimable. No reconstruction program was used on this crash because the NASS, CDS, WinSMASH protocol requires that actual vehicular crush measurements be obtained; however, from the attorney-provided photographs of the two involved vehicles, this contractor's visually estimated Delta V is, at least, between 14 km.p.h. (9 m.p.h.) and 23 km.p.h. (14 m.p.h.). The case vehicle was towed from the scene due to disabling damage.

The case vehicle's driver and front right passenger air bags deployed as a result of the impact with GMC minivan. The case vehicle was also equipped with driver and right front, seat-mounted, side air bags which did not deploy during the frontal impact. The front right passenger's air bag was located in the top of the dash/instrument panel (**Figure 5** below). From the available photographs, inspection of the front right 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. It is not known if the front right passenger's air bag was designed with any tethers; however, at least one vent port (right side) is visible in the photographs, but there is no estimate of its diameter while it is approximately at the 3 o'clock position. The deployed front right passenger air bag appears to be rectangular, but as well, no estimate can be provided for its dimensions (**Figures 6** and **7**). There are no photographs of the passenger air bag's front panel and, thus, no visible evidence of occupant contact was evident. However, there are several dark transfer marks on the passenger air bag fabric's right side panel (**Figure 8**). The marks do not appear to be blood stains and, due to the removal of interior vehicle components by auto parts yard personnel, may not be crash-related.

Figure 5: Case vehicle's front right air bag which deployed from the top of the right dash/instrument panel; Note: the right windshield was cracked by the air bag module's cover flap (case photo #21)

Figure 6: Case vehicle's deployed front right passenger air bag showing approximate size and shape of air bag's fabric (case photo #28)

Figure 7: Case vehicle's deployed front right air bag and greenhouse area; Note: cracked right windshield directly corresponds to module's cover flap and sun visor is down in this photo but was most likely up at time of crash (case photo #26)

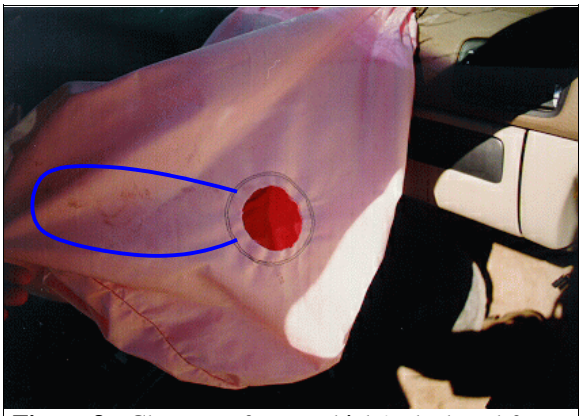

Figure 8: Close-up of case vehicle's deployed front right passenger air bag showing a vent hole and marks (highlighted) on underneath surface of air bag that are of unknown origin (case photo #29)

The case vehicle's driver air bag was located in the steering wheel hub. Because the driver's air bag fabric was shoved through the rim by someone post-crash, there are no photographs providing a view of the air bag module's cover flaps. Thus, it is not known if the cover flaps opened at their designated tear points. As well, no assessment of possible crash damage or occupant contact to the cover flaps can be made. There is no knowledge concerning whether or

not the driver's air bag was designed with tethers or was equipped with one or more vent ports; therefore, vent port (if existing) diameter and location are not known. The dimensions and shape of the deployed driver's air bag are also unknown. In addition, no occupant contact evidence was apparent in any photograph of the driver's air bag.

The only other evidence of possible occupant contacts on the interior surfaces included a classic spider web impact near the top of the windshield (**Figure 9**), a contact point near the base of the windshield on the driver's side (**Figure 10**), a crack to the rearview mirror, and some vertical marks on the interior surface of the right front window glazing (**Figure 11**).

Figure 9: Case vehicle's cracked windshield; Note: spider web on driver's side indicates that the driver contacted the windshield while the crack on the passenger's side is from the air bag module's cover flap (case photo #02)

Figure 10: Close-up of case vehicle's windshield damage showing front right air bag module's cover flap lining up with cracked windshield; Note: driver's side appears to have two contact points, one near the header from the driver and one near the base from an unidentified source (case photo #16)

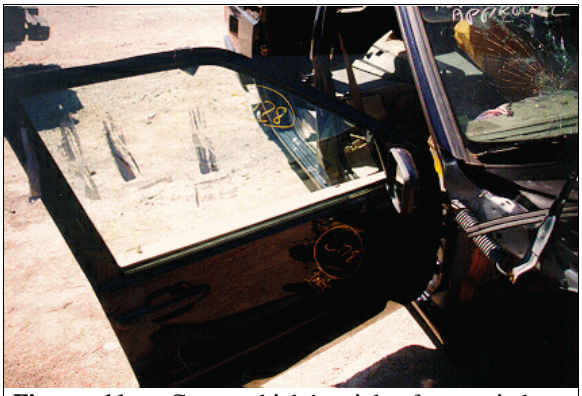

Figure 11: Case vehicle's right front window showing vertical marks on interior surface of glazing (case photo #15)

CASE VEHICLE FRONT RIGHT PASSENGER

Immediately prior to the crash, the exact posture of the case vehicle's front right passenger [42-year-old, Black (unknown if Hispanic) male] is unknown. Presumably, he was seated in an upright posture with his back near the seat back and both feet on the floor; however, the exact position of his hands are unknown. According to his attorney, the front right passenger was leaning a little to his left. Because the case vehicle's two front bucket seats had been removed and placed for sale in the auto parts store, the exact position of the front right seat track and seat back are unknown; however, according to his attorney, his seat track was forward of its middle position.

The safety belt restraint use for the case vehicle's front right passenger (height and weight not known) was not assessed by the investigating police officer; instead, the Police Crash Report indicated this passenger was protected by an air bag and no other restraint use was described or evaluated. Available medical information supplied by the attorney does not speak to evidence of belt pattern bruising and/or abrasions to the front right

passenger's body. Available vehicle photographs do not provide definitive proof of the safety belt system's use.

The case vehicle's driver steered leftward (i.e., overcorrected from his rightward steering maneuver) from the right (west) shoulder in order to reenter the roadway and then most likely steered rightward, just prior to the crash, attempting to keep from going off the roadway toward GMC minivan. Assuming that the case vehicle's front right passenger was facing forward with his back near the seat back and leaning slightly to his left just before the case vehicle's driver lost control (i.e., the rightward steering maneuver as the case vehicle was attempting to return to its travel lane after passing other vehicles), the front right passenger, as a result of these attempted avoidance maneuvers and independent of the front right passenger's restraint usage, most likely moved slightly forward and to his right during the leftward steer and then back to his left toward his original position in front of, or slightly left of, the front right air bag module just prior to impact. Because there is no knowledge of safety belt usage by the case vehicle's front right passenger, this occupant kinematic scenario can only estimate the ***tendency*** of his body to change positions and/or postures throughout this crash sequence. The case vehicle's impact with GMC minivan enabled the front right passenger to move forward, upward, and to the right, toward the estimated **30** degree Direction of Principal Force, as the case vehicle decelerated. The case vehicle's front right passenger impacted the deploying front right air bag. The available photographs suggest that the front right passenger's head was lifted upwards where it contacted the right sun visor (**Figure 12**). Given that the case vehicle most likely rotated counterclockwise post-impact, the front right passenger would have moved rightward toward the right front door, "A"-pillar, and/or roof rail. The front right passenger rebounded backwards into his seat after contacting the right side interior components. The front right passenger's final rest position is unknown.

Figure 12: Case vehicle's right sun visor showing possible occupant contact evidence (highlighted); Note: cracked rearview mirror (case photo #22)

FRONT RIGHT PASSENGER INJURIES

The case vehicle's front right passenger was transported by ambulance to a medical facility. He sustained critical injuries and was hospitalized an unknown length of time. The injuries sustained by the case vehicle's front right passenger included: an injured cervical spinal cord at the area of the 5TH cervical vertebra with quadriplegia and fracture at C_5-C_6, a dissection of the left carotid artery, and a dissection of the left vertebral artery. In addition, he was dependent on a ventilator/respirator, and he could not communicate verbally but only by blinking his eyes in response to questions.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Injury cervical spinal cord at the area of the 5th cervical vertebra with quadriplegia and fracture C_5-C_6	640224.5[1] critical	Air bag, front right passenger's	Probable	Hospitalization records
2	Dissection left carotid artery, not further specified	320499.2[2] moderate	Air bag, front right passenger's	Possible	Other: letter from attending trauma surgeon to attorney
3	Dissection left vertebral artery, not further specified	321099.2[3] moderate	Air bag, front right passenger's	Possible	Other: letter from attending trauma surgeon to attorney

CASE VEHICLE DRIVER

The exact posture of the case vehicle's driver [37-year-old, Black (unknown if Hispanic) male] just prior to the crash is unknown. Presumably, the case vehicle's driver was seated in an upright posture with his back against the seat back, his left foot on the floor, his right foot either on the accelerator or moving between the accelerator and the brake pedals, and both hands on the steering wheel. Because the case vehicle's front seats had been removed, the exact position of the driver's seat track and seat back are unknown. The case vehicle was equipped with a tilt steering wheel, but the exact location is unknown. The safety belt usage of the case vehicle's driver (unknown height and weight) was not assessed by the investigating police officer. The available physical evidence indicates that he was not restrained.

The case vehicle's driver steered leftward (i.e., overcorrected from his rightward steering maneuver) from the right (west) shoulder in order to reenter the roadway and then most likely steered rightward, just prior to the crash, attempting to keep from going off the roadway toward GMC minivan. Presuming that the case vehicle's driver was most likely facing forward with his back near the seat back just before he lost control (i.e., during the rightward steering maneuver as the case vehicle was attempting to return to its travel lane after passing other vehicles), the

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[1] The choice of injury code is difficult because the NASS CDS Injury Coding manual presumes that one knows whether the spinal lesion is either a contusion or a laceration (i.e., no option for "unknown" is provided). Because the only available medical records are inadequate and in the absence of protocol, this contractor chooses to assume the lesion was a contusion.

[2] The physician who wrote the letter chose to use the term "dissection". Even if the dissection was "blunt" (see Dorland's Illustrated Medical Dictionary), the definition is inadequate for this contractor to determine whether the lesion is an intimal tear or a laceration; therefore, the AIS code for the unknown line is used. In addition, since it is unknown whether the lesion involved the common/internal carotid artery or the external carotid artery, the AIS Uncertainty Rule is used.

[3] See the remarks in footnote two above pertaining to the term "dissection".

driver, as a result of these attempted avoidance maneuvers and independent of the driver's restraint usage, most likely moved slightly forward and to his right during the leftward steer and then back to his left toward the left front door just prior to impact. Because there is no knowledge of safety belt usage by the case vehicle's driver, even though the available pictorial evidence indicates that he was not restrained, this occupant kinematic scenario can only estimate the ***tendency*** of his body to change positions and/or postures throughout this crash sequence. The case vehicle's impact with GMC minivan enabled the driver to move forward, upward, and to the right, toward the estimated **30** degree Direction of Principal Force, as the case vehicle decelerated. The case vehicle's driver impacted his deploying air bag. The available photographs suggest that the driver's head was lifted upwards where it contacted the windshield just below the front left header. Therefore, the deploying air bag most likely loaded his chest and abdomen. Given that the case vehicle most likely rotated counterclockwise post-impact, the driver would have moved rightward toward the center instrument panel and rearview mirror. It is plausible that the right hand and/or wrist of the case vehicle's driver impacted the windshield, just to the right of the steering wheel (**Figures 9** and **10** above), either as a result of slipping off of the steering wheel or as the driver attempted to brace himself against his forward movement. In addition, the case vehicle's driver may have contacted the windshield-mounted rearview mirror (Figure **12** above). The driver most likely rebounded backwards into his seat as the case vehicle came to final rest. The driver's final rest position is unknown.

DRIVER INJURIES

He was transported by ambulance to a medical facility. His police-reported injuries were classified as "B" (moderate injury).

CASE VEHICLE BACK RIGHT PASSENGER

The exact posture of the case vehicle's back right passenger [28-year-old, Black (unknown if Hispanic) male] is unknown. Presumably, he was seated in an upright posture with his back against the seat back and both feet on the floor, but the exact position of his hands is unknown. His seat track and seat back were not adjustable. According to the Police Crash Report, the case vehicle's back right passenger (unknown height and weight) was unrestrained.

The case vehicle's driver steered leftward (i.e., overcorrected from his rightward steering maneuver) from the right (west) shoulder in order to reenter the roadway and then most likely steered rightward, just prior to the crash, attempting to keep from going off the roadway toward GMC minivan. Assuming that the case vehicle's back right passenger was facing forward with his back near the seat back just before the case vehicle's driver lost control (i.e., the rightward steering maneuver as the case vehicle was attempting to return to its travel lane after passing other vehicles), the back right passenger, as a result of these attempted avoidance maneuvers and independent of his restraint usage, most likely moved slightly forward and to his right during the leftward steer and then back to his left toward his original position in front of the backside of the front right seat back just prior to impact. The case vehicle's impact with GMC minivan enabled the back right passenger to move forward, upward, and to the right, toward the estimated **30** degree Direction of Principal Force, as the case vehicle decelerated. The case vehicle's back right

passenger most likely impacted the backside of the front right seat back. It is plausible that passenger may have contacted the roof with his head. Given that the case vehicle most likely rotated counterclockwise post-impact, the back right passenger would have moved rightward toward the right rear door, "B"-pillar, and/or roof rail. The back right passenger rebounded backwards into his seat after contacting these right side interior components. The back right passenger's final rest position is unknown.

BACK RIGHT PASSENGER'S INJURIES

He was transported by ambulance to a medical facility. His police-reported injuries were also classified as "B" (moderate injury).

OTHER VEHICLE

The 1992 GMC Safari XT was a rear wheel drive, 4x2, one-half-ton, five (standard)-, seven-, or eight-passenger, three-door, extended minivan (VIN: 1GDDM19Z4NB------) equipped with a 4.3L, EFI, V-6 engine and a four-speed automatic transmission. GMC minivan was equipped with hydraulically booster, four wheel, anti-lock brakes. GMC minivan's wheelbase was 282 centimeters (111.0 inches). Based on the available photographs, the CDC for GMC minivan is estimated as: **10-LZEW-3**. No reconstruction program was used on this crash because the NASS, CDS, WinSMASH protocol requires that actual vehicular crush measurements be obtained. GMC minivan was towed from the scene due to disabling damage.