

On-scene Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS02003
Wheeled Coach Moduvan ambulance on a 1997 Ford E350 series chassis
Washington
February, 2002

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

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

1. Report No. DS02003		2. Government Accession No.		3. Recipient Catalog No.	
4. Title and Subtitle In-Depth Accident Investigation				5. Report Date	
				6. Performing Organization Report No.	
7. Author(s) Dynamic Science, Inc.				8. Performing Organization Report No.	
9. Performing Organization name and Address Dynamic Science, Inc. 530 College Parkway, Ste. K Annapolis, MD 21401				10. Work Unit No. (TRAIS)	
				11. Contract or Grant no. DTNH22-94-D-27058	
12. Sponsoring Agency Name and Address U.S. Dept. of Transportation (NRD-32) National Highway Traffic Safety Administration 400 7th Street, SW Washington, DC 20590				13. Type of report and period Covered [Report Month, Year]	
				14. Sponsoring Agency Code	
15. Supplemental Notes					
16. Abstract This two-vehicle crash occurred on a four-lane interstate highway in the state of Washington in February, 2002 at 1219 hours. The weather was clear and dry. The speed limit is 97 km/h (60 mph). The case vehicle, a Wheeled Coach Moduvan ambulance on a 1997 Ford E350 series chassis driven by a 29-year-old male, was traveling southbound on the interstate roadway with emergency lights and sirens activated. The rear of the ambulance was occupied by an unrestrained 28-year-old male Patient Care Provider (PCP) and a 73-year-old female patient. The PCP was seated on the right side of the vehicle facing the patient. The patient was strapped to an ambulance cot in the center of the vehicle with her head toward the front of the vehicle. The other vehicle was a 1999 Chevrolet Silverado K2500 series 4x4 pickup driven by a 44-year-old male. This vehicle was in the same lane as and in front of the case vehicle. The driver of the other vehicle slowed and the case vehicle could not stop in time and the front of the case vehicle (12FZEW1) struck the rear of the other vehicle. The case vehicle sustained a longitudinal delta v of -20.7 km/h (-12.9 mph) as calculated using the barrier option of the WinSmash program. At impact, both the driver's air bag and the front right passenger's air bag deployed. The driver of the case vehicle did not report any injuries; nor did the rear compartment patient occupant. At impact, the PCP in rear compartment pitched towards the front of the vehicle—possibly engaging a cabinet to his right side—and then fell onto the floor. He complained of neck and back pain. He was transported to a local hospital for treatment and was released shortly after arrival. He did not sustain any codeable injuries. Both vehicles were towed from the scene.					
17. Key Words Air bag, deployment, injury, ambulance, medical response, passenger.			18. Distribution Statement		
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No of pages	22. Price		

Dynamic Science, Inc.
Accident Investigation
Case Number: DS02003

TABLE OF CONTENTS

Background	1
Description	1
Investigation Type	1
Crash Location	1
Crash Date	1
Notification Date	1
Field Work Completed:	1
 Summary	 1
 Scene Diagram	 4
 Detailed Information	 5
Vehicles	5
Moduvan Discussion	6
Manual Restraint Systems	7
Safety Equipment Discussion	9
Occupants	12
Injuries and Injury Mechanisms	14
Occupant Kinematics	15

BACKGROUND:

Description: This emergency vehicle case was generated in response to a notification from the National Institute for Occupant Safety and Health (NIOSH) on February 20, 2002. DSI was assigned the case on February 21, 2002.

Investigation Type: On-scene
 Crash Location: Washington
 Crash Date: February, 2002
 Notification Date: February 21, 2002
 Field Work Completed: March 7, 2002

SUMMARY:

This two-vehicle crash occurred on a four-lane interstate highway in the state of Washington in February, 2002 at 1219 hours. The weather was clear and dry. The speed limit is 97 km/h (60 mph).

The case vehicle was a Wheeled Coach Moduvan ambulance on a 1997 Ford E350 series chassis. The vehicle was driven by a 29-year-old male and was traveling southbound on the interstate roadway with emergency lights and sirens activated.

The rear of the ambulance was occupied by an unrestrained 28-year-old male (188 cm/74 in, 82 kg/180 lbs) Patient Care Provider (PCP) and a 73-year-old female patient. The PCP was seated on the right side squad bench facing the patient. A lap belt was available, but was not being used at the time of the crash. The patient was strapped to the Rugged brand ambulance cot in the center of the vehicle with her head toward the front of the vehicle.

The other vehicle was a 1999 Chevrolet Silverado K2500 series 4x4 pickup driven by a 44-year-old male. This vehicle was in the same lane as and in front of the case vehicle.

The driver of the other vehicle slowed and the case vehicle could not stop in time and the front of the case vehicle (12FZEW1) struck the rear of the other vehicle.

The case vehicle sustained a longitudinal delta v of -20.7 km/h (-12.9 mph) as calculated using the barrier option of the WinSmash program. The results appear high. At impact, both the driver's air bag and the front right passenger's air bag deployed.



Figure 1. Area of POI, traveling south

The driver of the case vehicle did not report any injuries; nor did the rear compartment patient occupant. At impact, the PCP in rear compartment pitched towards the front of the vehicle—possibly engaging a cabinet to his right side—and then fell onto the floor. He complained of neck and back pain. He was transported to a local hospital for treatment and was released shortly after arrival. He did not sustain any codeable injuries.

Both vehicles were towed from the scene.



Figure 2. Front, case vehicle



Figure 3. Driver's seated position



Figure 4. Overview of patient compartment



Figure 5. Rugged brand ambulance cot

Scene Diagram

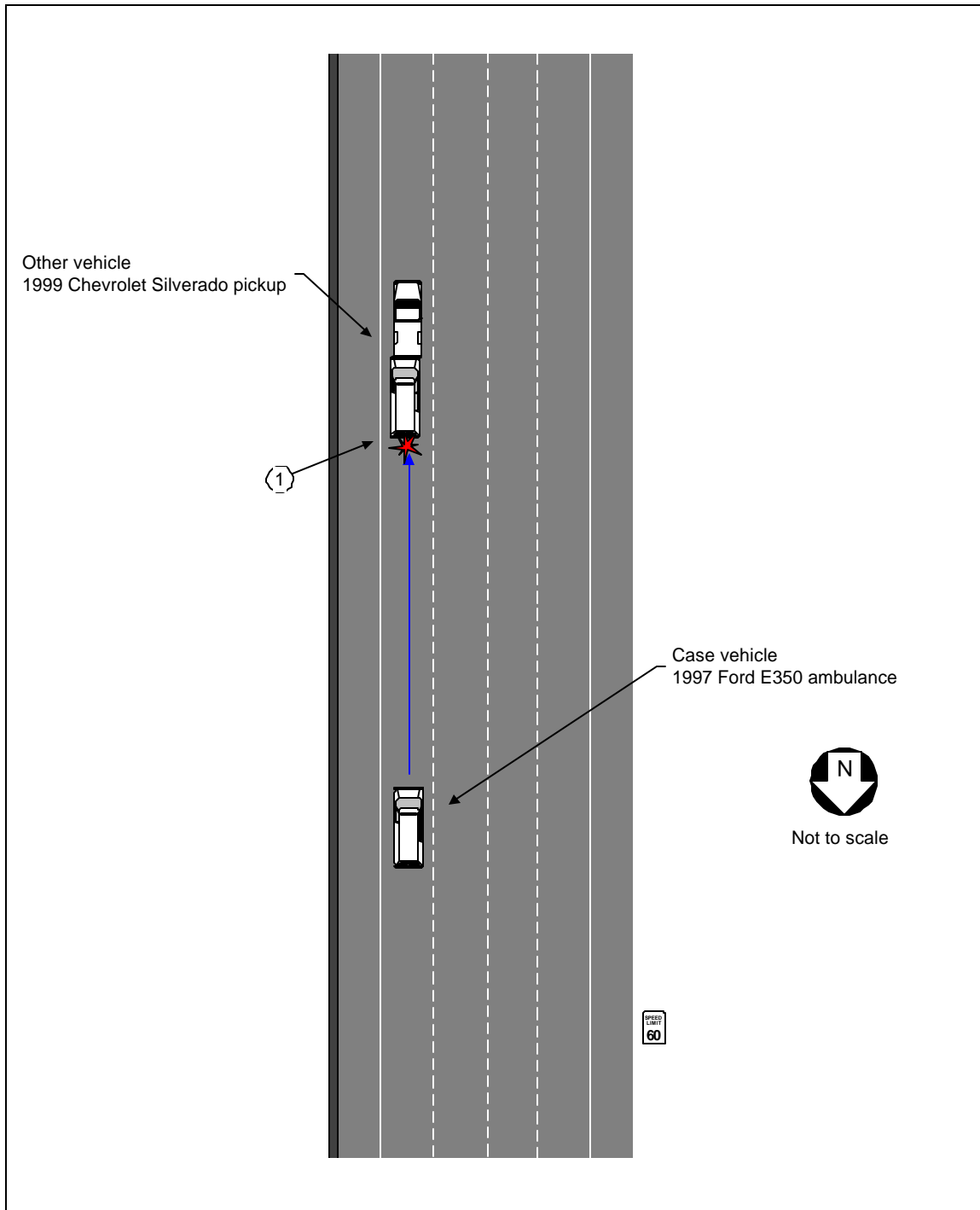


Figure 6. Scene diagram

DETAILED INFORMATION

Vehicles

Case vehicle

Description:	Wheeled Coach Moduvan ambulance on a 1997 Ford E-350 single rear wheel cutaway chassis	
VIN:	1FDJE30F0VHAxxxxxxx	
Odometer:	308,578 km (191,747 miles)	
Engine:	7.3 L, V8 diesel	
Reported Defects:	None	
Cargo:	Assorted medical equipment and supplies. Unknown weight.	
Damage Description:	Minor frontal damage to bumper and grille.	
CDC:	12FZEW1 (photos only)	
Delta V ¹ :	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

The Wheeled Coach Moduvan was installed on a Ford E-350 single rear wheel cutaway chassis. The vehicle has a curb weight of 3,548 kg (7,822 lbs) and a GVW of 4,378 kg (9,600 lbs) giving it a maximum payload of 811 kg (1,778 lbs).



Figure 7. Front right, case vehicle

¹No crush profile available, unable to run WinSmash with missing vehicle algorithm

Moduvan Discussion

The Moduvan measures 366 cm (144 in) by 211 cm (83 in). It has 163 cm (64 in) of headroom.

Exterior: The right rear compartment contains the spare tire; the front left compartment contains oxygen storage. There are dual rear entry doors and a single right side entry door.

Interior: The left interior side has cabinets from floor to ceiling and a single patient care seat facing to the right. The right interior side is equipped with a 183 cm (72 in) squad bench with three individual backrests. The front of the module contains a single patient care seat facing to the rear and a set of cabinets. The interior cabinetry features what Wheeled Coach calls “Radius Corner Cabinetry” that is designed to prevent blunt trauma injuries.



Figure 8. Overview of Wheeled Coach Moduvan patient compartment



Figure 9. Left side, ambulance compartment

Manual Restraint Systems

There were two forward facing OEM bucket seats in the cab of the ambulance. The driver's seat belt was a 3-point continuous loop belt with a sliding latch plate and an Emergency Locking Retractor (ELR). There was no indication of crash related loading on the D-ring or on the belt itself. The front right passenger belt was a 3-point continuous loop belt with a sliding latch plate and a switchable retractor. The belt was in the ELR mode.

The left side patient care seat was equipped with a manual lap belt. The seat back was padded and covered with a vinyl material. It was attached to the side of the compartment using Velcro straps. The left, right, and top of the seating area was constructed with vinyl covered padding.

The front, rear-facing patient care seat was equipped with a manual belt. The seat back was padded and covered with a vinyl material. It was attached to the side of the compartment using Velcro straps. At the time of the inspection, the seat back was found on the floor on the right side of the compartment.

The right side squad bench was equipped with three safety belts—one each at the base of the three backrests. The safety belts can be secured to buckles on the right hand wall and used as lap belts for seated occupants. The safety belts can also be secured to buckles just below the squad bench seat cushion and used to restrain a patient in a horizontal position. The three seat backs were padded and covered with a vinyl material. They were attached to the side of the compartment using Velcro straps.



Figure 10. Left side patient care seat



Figure 11. Front, rear-facing patient care seat



Figure 12. Right side, ambulance compartment—showing squad bench



Figure 13. Lap belt and buckle at PCP seated position

Safety Equipment Discussion

This vehicle was equipped with a driver's air bag and a front right passenger air bag. The air bags had deployed as a result of the frontal crash. The driver air bag was housed in the center of the steering wheel with a horizontally oriented flap tear seam (H-configuration). No contact evidence was identified on the exterior surface of the module cover flaps. The upper flap measured 19.0 cm (7.5 in) along the flap tear seam, and 14 cm (5.5 in) in height. The lower flap measured 19.0 cm (7.5 in) along the flap tear seam and 3.0 cm (1.2 in) in height. The diameter of the driver air bag measured 54.0 cm (21.3 in) in its deflated state. The bag was vented by two ports located at the 11 and 1 o'clock sectors on the back of the bag. No contact evidence was found on the air bag.

The front right passenger air bag deployed from the right top instrument panel area with a single cover flap design hinged at the forward aspect. The cover flap was rectangular in shape and measured 37.0 cm (14.6 in) along the horizontal tear seam and 27.0 cm (10.6 in) in height. The flap detaches during deployment and is secured by two tethers that are 12.0 cm (4.7 in) long and 5.0 cm (1.9 in) wide. There were contact marks to the module cover from its contact with the windshield during deployment. The passenger air bag measured 42.0 cm (16.5 in) wide and 70.0 cm (27.6 in) in height in its deflated state. The bag was vented by two parts located at the 3 and 9 o'clock sectors on the sides of the bag. There were two internal tethers present.

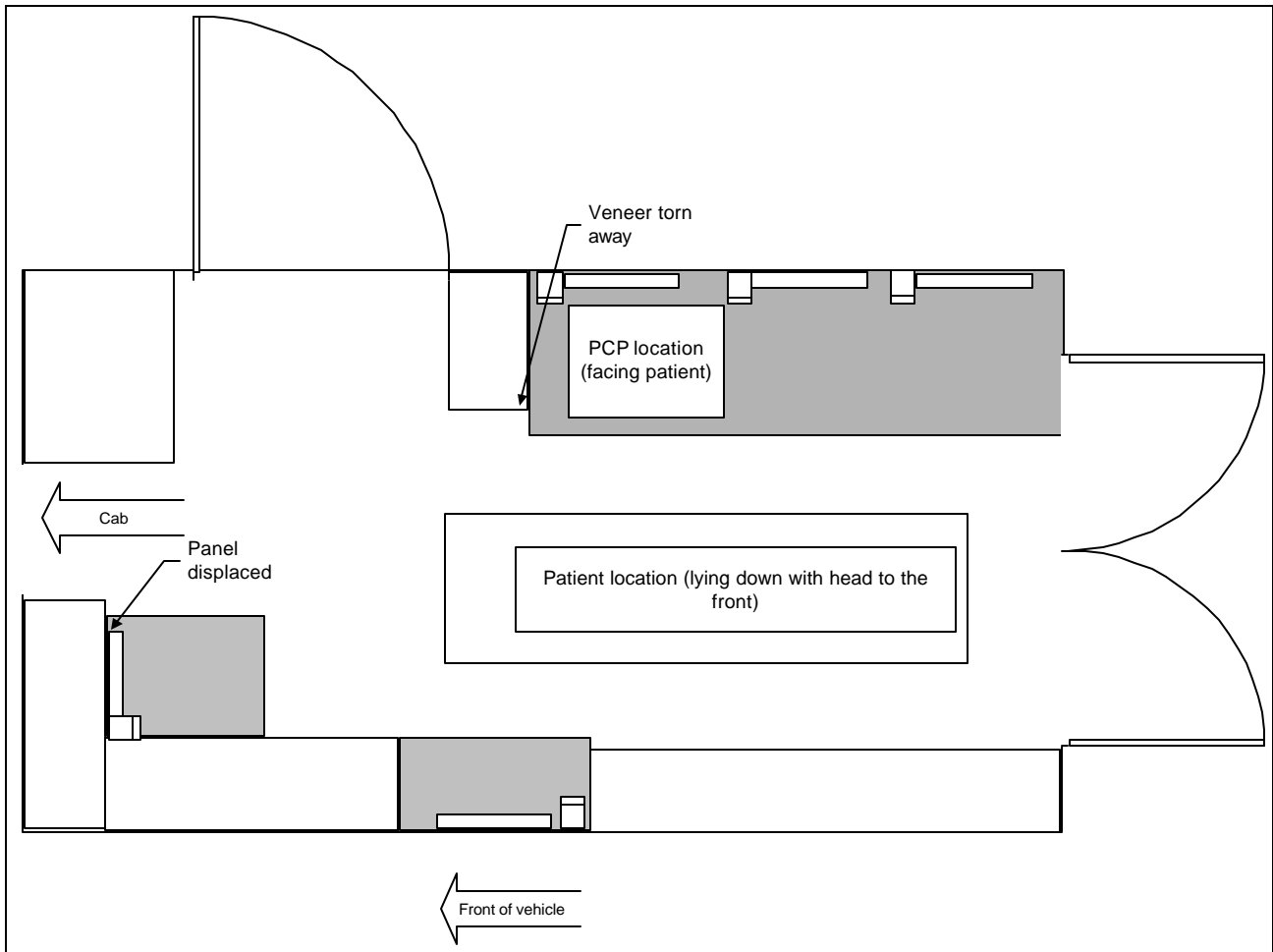


Figure 14. Patient compartment schematic

Other vehicle

Description:	1999 Chevrolet K2500 4x4 extended cab pickup	
VIN:	1GCGK29U4XExxxxxx	
Odometer:	Unknown	
Engine:	6.0 L, 8 cylinder	
Reported Defects:	None noted	
Cargo:	Unknown	
Damage Description:	Minor rear end damage shown on police report. Towed from the scene.	
CDC:	Unknown	
Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

Occupants

<u>Case vehicle</u>	Occupant 1	Occupant 2	Occupant 3
Age/Sex:	29/Male	28/Male	73/female
Seated Position:	Front left	Rear of ambulance body, right side, seated facing middle of vehicle	Rear of ambulance body, middle, lying prone, head toward front of the vehicle
Seat Type:	Bucket seat, seat adjusted to rear most track position	Vinyl covered bench seat.	Rugged brand ambulance cot
Height:	Unknown	188 cm (74 in)	Unknown
Weight:	Unknown	82 kg (180 lbs)	Unknown
Occupation:	Emergency medical technician	Emergency medical technician	Unknown
Pre-existing Medical Condition:	None noted	None noted	Unknown
Alcohol/Drug Involvement:	None	NA	NA
Driving Experience:	Presumed to be greater than 10 years	NA	NA
Body Posture:	Normal, upright	Normal, upright. Facing center of vehicle	Lying prone, face up, head towards front of vehicle
Hand Position:	Unknown	Unknown	Unknown
Foot Position:	Right on brake, left on floor board	Both feet on floor	Unknown
Restraint Usage:	3-point continuous loop seat belt used	Lap belt available, not used	Strapped to cot, cot anchored to vehicle side
Air bag:	Driver's air bag available, deployed	None	None

Other vehicle

Age/Sex:	44/Male
Seated Position:	Front left
Seat Type:	Unknown
Height:	Unknown
Weight:	Unknown
Occupation:	Unknown
Pre-existing Medical Condition:	Unknown
Alcohol/Drug Involvement:	None
Driving Experience:	Presumed to be greater than 10 years
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt used, per police report

Injuries and Injury Mechanisms

Case vehicle

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Not injured			
Occupant 2:	Complained of neck and back pain. No codeable injuries.			
Occupant 3:	Not injured			

Other vehicle

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Possible injury, per police report			

Occupant Kinematics

The 29-year-old male driver of the case vehicle was seated in a normal, upright fashion. He was wearing the available lap and shoulder belt. The cloth-covered bucket seat was adjusted to the rear most track position. The ambulance was traveling to the hospital with a patient on board. The emergency lights and sirens had been activated. Just prior to the crash, the driver began braking. At impact, the driver's frontal air bag deployed. The driver responded to the 12 o'clock direction of force by exhibiting a forward trajectory and loading the manual lap and shoulder belt. The driver was held in place by the restraint system and did not sustain any injuries.

The 28-year-old right rear occupant (188 cm/74 in, 82 kg/180 lbs) was seated in a normal, upright fashion facing the center of the vehicle on the vinyl covered squad bench seat. He was not using the available lap belt. He was attending the 78-year-old female patient. This occupant reacted to the initial braking by pitching somewhat to his right. At impact, he pitched out of his seat to the right—possibly catching the cabinet corner with his right hip. He was projected forward and onto the floor—sliding forward into the left side of the door panel—causing it to shift and displacing the Velcro-attached seat back. It is believed that he came to rest near the passage between the ambulance body and the ambulance cab. He complained of pain to his neck and back, but was otherwise unhurt.



Figure 15. Fresh area of peeled away laminate



Figure 16. Close up to possibly right hip contact



Figure 17. Possible contact to door portal—panel shifted



Figure 18. Close up of shifted panel

The 78-year-old female middle rear occupant was lying face up on a Rugged brand ambulance cot. The cot was attached to the wall of the ambulance using a Stryker 6371 cot fastener system. This occupant was lying down with her head towards the front of the vehicle. She was strapped to the cot. The cot was equipped with a four-point shoulder harness and two manual lap belts. It is not known how many of the restraints were in use. At impact, this occupant would have traveled forward to some degree but the restraints and her supine position would have limited her movement. She did not sustain any injuries.



Figure 19. Cot fastener



Figure 20. Cot fastener system