PB94-155678

Highway Accident Cases: Automatic Restraints
September 1990-May 1992

National Transportation Safety Board, Washington, DC

1994

U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
NTIS

BIBLIOGRAPHIC INFORMATION

PB94-155678

Report Nos: NTSB/HAB-94/01

Title: Highway Accident Cases: Automatic Restraints, September 1990-May 1992.

Date: 1994

Performing Organization: National Transportation Safety Board, Washington, DC.

NTIS Field/Group Codes: 85D (Transportation Safety), 85H (Road Transportation)

Price: PC A06/MF A02

Availability: Available from the National Technical Information Service, Springfield, VA. 22161

Number of Pages: 119p

Keywords: *Motor vehicle accidents, *Accident investigations, Highway transportation, Cars, Case studies, Accident reports, Wounds and injuries, Collision research, Restraint system usage.

Abstract: The publication summarizes 56 highway crash investigations conducted by the National Transportation Safety Board. All of these crashes, which occurred during the period September 1990 through May 1992, involved passenger cars equipped with automatic restraints. The investigations focused on the automatic restraints and the concurrent use or nonuse of the belt systems. Crash causes were not addressed. The investigations indicated that the restraint systems, when properly used, were effective in reducing head and upper torso injuries. No further conclusions could be drawn from the limited data. Because the Board's Most Wanted List of Safety Recommendations already includes mandatory seatbelt use laws, no recommendations were made as a result of these investigations.

ABSTRACT: Safety Board personnel from the regional offices investigated 56 crashes involving passenger cars equipped with automatic restraints: air bags and automatic belt systems. All crashes included in the study occurred during the period September 1990 through May 1992. Case selection was based on timely notification of the crash and on the availability of investigators and pertinent evidence. The study focuses on the automatic systems and on the concurrent use or nonuse of available belt systems. Crash causes are not addressed, and no safety recommendations are made.

The National Transportation Safety Board is an independent Federal agency dedicated to promoting aviation, railroad, highway, marine, pipeline, and hazardous materials safety. Established in 1967, the agency is mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable cause of accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The Safety Board makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

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PB94-155678

HIGHWAY ACCIDENT CASES

AUTOMATIC RESTRAINTS
SEPTEMBER 1990 — MAY 1992

NATIONAL
TRANSPORTATION
SAFETY BOARD

Washington, D.C. 20594

INTRODUCTION

This publication summarizes 56 highway crash investigations conducted by the National Transportation Safety Board. All of these crashes, which occurred during the period September 1990 through May 1992, involved passenger cars equipped with automatic restraints. The investigations focused on the automatic restraints and the concurrent use or nonuse of the belt systems. Crash causes were not addressed.

The investigations indicated that the restraint systems, when properly used, were effective in reducing head and upper torso injuries. No further conclusions could be drawn from the limited data. Because the Board's Most Wanted List of Safety Recommendations already includes mandatory seatbelt use laws, no recommendations were made as a result of these investigations.

Case selection was based on the timeliness of notification and on the availability of investigators and crash-related evidence from the vehicles. The study was conducted by Safety Board personnel from the Central Regional Office in Arlington, Texas; the Western Regional Office in Los Angeles, California; the Southeast Regional Office in Atlanta, Georgia; and the Northeast Regional Office in Parsippany, New Jersey. Both domestic and foreign cars were involved in the crashes. Automobile and air bag manufacturers and the National Highway Traffic Safety Administration assisted in some of the investigations and in the data research.

The Vehicles and Their Equipment

In 2 of the 56 crashes, both vehicles involved met the criterion for the study: passenger car equipped with automatic restraints. Thus, 58 passenger cars are included.

41 vehicles had air bags.

- 32 air bags deployed:
  Occupants were wearing manual lap/shoulder belts in 19 cases. (Table 1)
  Occupants were not wearing manual lap/shoulder belts in 13 cases. (Table 2)

- 9 air bags did not deploy:[1] Occupants in all 9 cases were wearing manual lap/shoulder belts. (Table 3)

17 vehicles had automatic belt systems. (Table 4)

- 3 had nonmotorized shoulder belts and knee bolsters.[2]

- 9 had motorized shoulder belts and manual lapbelts.

- 5 had door-mounted lap/shoulder belts.

[1]The nine air bags did not deploy for various reasons, mostly because the Delta V was too low.

[2]A knee bolster is a padded bar designed to cushion the knees and limit the forward movement of the lower body in a frontal crash. It was used by Volkswagen, in combination with the automatic shoulder belt, in the late 1970s and is now standard equipment in many new cars.

Measuring Crash Severity

The Delta V,[3] which most crash researchers consider the best single indicator of collision severity, is used in this study. The Delta V is the estimated instantaneous speed change that a vehicle undergoes during a collision. The estimate is based on structural deformation measurements and on vehicle crush coefficients used by the Calspan[4] Reconstruction of Accident Speeds on the Highway (CRASH 3) computer program. The CRASH 3 model analyzes such parameters as vehicle structural rigidity, force vectors with respect to vehicle center-of-mass, and vehicle weight.

The computer-generated Delta V is recognized as an estimate; however, it is a more accurate gauge of the forces affecting vehicle occupants than is vehicle damage alone. For example, the bodies of some vehicles crush at lower crash forces than others and therefore absorb these forces before they can be transmitted to the occupant.

Five of the 56 cases involved rollover; therefore, no Delta V calculations were performed. In three other cases, the Delta V was indeterminable. Table 1 shows the severity of the crashes in terms of computed Delta Vs. The severity scale used was established by the Safety Board during a previous study on lapbelts.

Crash Severity	Delta V Range (mph)	Number of Vehicles	Percentage
Low	0 - 10	5	9
Moderate	10.1 - 20	17	29
Moderately Severe	20.1 - 30	17	29
Severe	30.1 - 40	7	12
Very Severe	40.1 and higher	4	7
Unknown		8	14
Total		58	100

[3]Delta V estimates have longitudinal and lateral vector components that are combined for a total Delta V. Total Delta Vs are cited in this publication.

[4]Calspan Corporation developed the CRASH 3 program under contract with the National Highway Traffic Safety Administration, Department of Transportation.

Cases 3 and 42 involve computed Delta Vs exceeding 60 mph. A Delta V of this magnitude is usually considered nonsurvivable, and in these two cases, the occupants were in fact fatally injured. Nonetheless, occupants restrained with manual lap/shoulder belts and supplemental air bags have been known to survive such crashes.

Measuring Injury Severity

Each injury is described in medical terms and is also rated on the Abbreviated Injury Scale (AIS). The AIS is an anatomically based system that classifies injury severity on a 6-point scale, based on the threat to life. It was developed in 1990 by the Association for the Advancement of Automotive Medicine.

AIS	Severity code
1	Minor
2	Moderate
3	Serious
4	Severe
5	Critical
6	Nonsurvivable
9	Unknown

The AIS does not assess the combined effect of multiple injuries. However, to indicate a patient's overall condition in this study, Safety Board investigators have used the AIS number assigned to his or her most severe injury. They refer to this number as the maximum AIS (MAIS). For example, MAIS 4 means that the victim may have multiple injuries but the most severe injury is AIS 4.

Compiling the Data

The 56 cases fall into four broad categories based on the type/performance of the restraints involved. The information from each of these four catagories is charted on the following tables.

Table 1. Nineteen Vehicles: Air bag deployed; occupants wearing manual lap/shoulder belts

Case number	Vehicle	Principal direction of force (clock position)	Delta V (mph)	Occupant position	MAIS[a]	Sex	Age
1	1989 Lincoln Continental	12	28	Driver	1	M	47
				Right Front	1	M	78
2	1990 Ford Mustang	12	28	Driver	2	M	23
3	1989 Chrysler LeBaron	12	61	Driver	6[b]	M	19
4	1990 Ford Taurus	10	19	Driver	2	F	28
5	1990 Ford Taurus	9	29	Driver	1	M	50
6	1990 Lincoln Continental	1	35	Driver	1	M	35
9	1990 Ford LTD	12	17	Driver	1	M	25
10	1990 Ford LTD	1	24	Driver	1	M	62
13	1990 Ford Mustang	12	<5	Driver	1	M	33
17	1991 Plymouth Acclaim	12	13	Driver	0	M	70
25	1990 Ford Taurus	12	25	Driver	1	M	31
26	1991 Chevrolet Camaro	11	15	Driver	0	F	24
27	1990 Chrysler LeBaron	1	12	Driver	1	F	42
30	1991 Ford Taurus	12	12	Driver	0	F	35
33	1990 Ford Crown Victoria	12	26	Driver	2	M	25
39	1991 Ford Crown Victoria	1	18	Driver	1	M	31
40	1991 Ford Crown Victoria	12	7	Driver	1	M	31
42	1991 Plymouth Sundance	12	66	Driver	6[b]	F	21
49	1991 Ford Crown Victoria	11	18	Driver	1	M	26

[a] AIS = Abbreviated Injury Scale. MAIS = Maximum AIS, which is the AIS code assigned to a person's most severe injury (1 = minor; 2 = moderate; 3 = serious; 4 = severe; 5 = critical; 6 = nonsurvivable).

[b] The injuries were fatal. These two cases involved Delta Vs exceeding 60 mph and significant intrusion into occupant space.

Table 2. Nine Vehicles: Air bag deployed; occupants not wearing manual lap/shoulder belts

Case number	Vehicle	Principal direction of force (clock position)	Delta V (mph)	Occupant position	MAIS[a]	Sex	Age
8[b]	1991 Chevrolet Caprice	12	Unknown	Driver	0	M	70
9	1991 Ford LTD	4	17	Driver	1	M	25
23	1991 Dodge Spirit	12	21	Driver[c]	3	M	18
24	1990 Mazda Miata	12	12	Driver	1	M	28
31[b]	1991 Cadillac DeVille	12	11	Driver	2	F	55
36	1991 Chevrolet Corsica	12	15	Driver	1	F	32
37	1992 Chevrolet Beretta GT	11	Unknown	Driver	1	M	16
41[b]	1991 Chevrolet Camaro	12	<5	Driver	0	M	44
53	1990 Ford Taurus	12	41	Driver	1	M	26

[a] AIS = Abbreviated Injury Scale. MAIS = Maximum AIS, which is the AIS code assigned to a person's most severe injury (1 = minor; 2 = moderate; 3 = serious; 4 = severe; 5 = critical; 6 = nonsurvivable).

[b] The vehicle struck an animal.

[c] The shoulder strap was positioned behind the driver's shoulder.

Table 3. Thirteen Vehicles: Air bag did not deploy; occupants wearing manual lap/shoulder belts

Case number	Vehicle	Principal direction of force (clock position)	Delta V (mph)	Occupant position	MAIS[a]	Sex	Age
7	1990 Geo Storm	12	34	Driver	1	M	23
11	1989 Dodge Daytona	2	32	Driver	0	M	23
15	1992 Mercury Grand Marquis	12	13	Driver	3	F	73
19	1990 Ford Crown Victoria	12	7	Driver	0	M	21
21	1990 Lexus LS 400	2	24	Driver	1	M	40
22	1991 Ford LTD	11	21	Driver	3	M	31
28	1991 Dodge Dynasty	12	28	Driver	3	M	29
29	1991 Chevrolet Camaro	12	54	Driver	3	M	21
35	1991 Ford Mustang	12	10	Driver	2	M	31
38	1990 Dodge Shadow	12	39	Driver	3	M	21
46	1991 Lincoln Town Car	12	27	Driver	3	M	74
50	1990 Chrysler LeBaron	2	21	Driver	2	M	75
55	1991 Chrysler Fifth Avenue	1	25	Driver	4[b]	M	69

[a] AIS = Abbreviated Injury Scale. MAIS = Maximum AIS, which is the AIS code assigned to a person's most severe injury (1 = minor; 2 = moderate; 3 = serious; 4 = severe; 5 = critical; 6 = nonsurvivable).

[b] The injuries were fatal.

Table 4. Seventeen Vehicles: Equipped with automatic belt systems

Case number	Vehicle	Principal direction of force (clock position)	Delta V (mph)	Occupant position	MAIS[a]	Sex	Age
		Automatic shoulder belt with knee bolster					
34	1988 Hyundai Excel	12	31	Driver	2	M	32
				Right front	3[b]	F	32
48	1977 VW Rabbit	Rollover	Unknown	Driver	6[b]	M	18
				Right front	1	M	18
52	1979 VW Rabbit	Rollover	Unknown	Driver	6[b]	F	22
		Motorized shoulder belt with manual lapbelt[c]					
14	1990 Nissan Maxima	Rollover	Unknown	Driver	6[b]	M	18
				Right front	1	M	19
20	1988 Ford Escort	3	15	Driver	3	M	30
				Right front	6[b]	F	25
21	1991 Ford Escort	12	33	Driver	1	M	21
				Right front	5[b]	F	21
32	1991 Ford Thunderbird	4	12	Driver	4	F	73
43	1990 Ford Festiva	12	15	Driver	1	F	30
44	1990 Ford Thunderbird	3	Unknown	Driver	2	M	23
				Right front	6[b]	F	23
47	1991 VW Passat	1	24	Driver	1	M	19
				Right front	2	M	26
51	1991 Ford Festiva	Rollover	Unknown	Driver	6[b]	F	18
56	1992 Nissan Stanza	8	22	Driver	6[b]	F	16

Table 4. Seventeen Vehicles: Equipped with automatic belt systems

Case number	Vehicle	Principal direction of force (clock position)	Delta V (mph)	Occupant position	MAIS[a]	Sex	Age
		Door-mounted lap/shoulder belt combination					
12	1990 Chevrolet Caprice	10	22	Driver	4[b]	M	24
16	1990 Chevrolet Caprice	12	26	Driver	3	M	41
18	1990 Chevrolet Beretta	Rollover	Unknown	Driver	6[b]	M	21
				Right front	6[b]	M	30
45	1990 Chevrolet Lumina	12	35	Driver	4	F	27
54	1990 Chevrolet Caprice	10	20	Driver	1	M	27
				Right front	9[b]	M	31

[a] AIS – Abbreviated Injury Scale. MAIS – Maximum AIS, which is the AIS code assigned to a person's most severe injury (1 – minor; 2 – moderate; 3 – serious; 4 – severe; 5 – critical; 6 – nonsurvivable).

[b] The injuries were fatal.

[c] The lapbelt was not worn.

The 56 Case Summaries

Each summary has a diagram showing the case vehicle and its collision orientation. Each occupant's position is represented by a circle. Multiple lines across the circle indicate a deployed air bag; a single diagonal line indicates a shoulder belt; a single straight line, a lapbelt; and two lines (one diagonal and one straight), a lap/shoulder belt. Fatalities are noted. The occupant's age, sex, and MAIS are shown near the circle. For example, 24-M-4 indicates a 24-year-old male whose most severe injury was AIS level 4.

Each summary has an injuries list for occupants of the case vehicle; injuries sustained by occupants in any other vehicle are not included in this list. The designation "Vehicle 1" identifies the case vehicle.

The factual information collected during these investigations is maintained in public dockets at Safety Board headquarters in Washington, D.C. Interested parties may contact:

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Public Inquiries Section, RE-51
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Case	NTSB Number	Date	Location	Page
1	MKC90FH012	09/10/90	Nowata, OK	1
2	MKC90FH008	05/14/90	Marshalltown, IA	2
3	FTW90FH006	09/23/90	Crockett, TX	4
4	WRH91H0R09	03/27/91	Aurora, CA	6
5	CRH91H0R12	03/01/91	Seguin, TX	8
6	CRH91FH011	02/13/91	San Leanna, TX	10
7	NRH91F0R06	03/03/91	Olive, IL	12
8	CRH91H0R02	10/23/90	Hot Springs, AR	14
9	SRH91FH008	04/11/91	Smyrna, GA	15
10	SRH91FH019	06/06/91	Marietta, GA	17
11	SRH91FH006	03/30/91	Kansas City, MO	19
12	NYC91FH001	09/30/90	Brunswick, ME	20
13	CRH91H0R20	06/03/91	Kaufman, TX	22
14	CRH91H0R23	08/16/91	Como, TX	24
15	WRH91H0R16	09/09/91	Cortez, CO	26
16	NRH91H0R14	05/07/91	Tukwila, WA	28
17	NRH91F0R08	04/09/91	Elizabeth, PA	30
18	WRH91FH002	10/26/90	Watkins, CO	31
19	SRH91FH002	11/27/90	Atlanta, GA	33
20	SRH91FH016	06/01/91	Lilburn, GA	34
21	SRH91FH021	08/03/91	Stockbridge, GA	36
22	SRH91FH003	01/28/91	Atlanta, GA	38
23	CRH92H0R01	10/15/91	Lockesburg, AR	40
24	NRH91H0R16	05/17/91	Seattle, WA	42
25	CRH91FH007	01/11/91	West Siloam Springs, OK	44
26	CRH91H0R13	02/28/91	New Braunfels, TX	46
27	FTW90FH007	09/26/90	Grand Prairie, TX	47
28	CRH91H0R15	03/23/91	Wyandotte, OK	49
29	CRH91H0R18	05/21/91	Altus, OK	51
30	SRH91FH014	05/09/91	Smyrna, GA	53
31	CRH92H0R02	11/10/91	Centerville, TX	54
32	WRH91H0R17	09/16/91	Cortez, CO	56
33	SRH91FH018	06/21/91	Marietta, GA	58
34	SRH91FH017	06/04/91	Lawrenceville, GA	59
35	CRH91H0R19	05/23/91	Brookland, AR	61
36	CRH92H0R03	12/05/91	San Angelo, TX	63
37	CRH92H0R05	01/20/92	Lubbock, TX	65
38	NRH91F0R11	04/29/91	Taylor, PA	67
39	SRH91FH022	09/11/91	Marietta, GA	69
40	NRH91F0R13	05/12/91	Fermanagh, PA	71
41	WRH92H0R01	11/11/91	Cortez, CO	73
42	NRH91F0R17	07/12/91	Montgomery, PA	74

Case	NTSB Number	Date	Location	Page
43	CRH92H0R09	02/06/92	Renton, WA	76
44	NRH92F0R02	09/21/91	Chanceford, PA	78
45	CRH92H0R08	01/17/92	Kent, WA	80
46	NRH92F0R04	02/03/92	Huston, PA	82
47	CRH92H0R06	01/23/92	Fort Worth, TX	84
48	WRH91H0R18	09/25/91	Edmonds, WA	86
49	SRH92FH013	04/03/92	Atlanta, GA	88
50	SRH91FH005	04/02/91	Jackson, PA	90
51	WRH92H0R04	04/01/92	Brighton, CO	92
52	WRH91H0R14	05/19/91	Parker, AZ	94
53	NRH92H0R07	04/24/92	Clay, PA	96
54	NRH92H0R06	03/26/92	Queens, NY	97
55	CRH92H0R11	03/17/92	Skykomish, WA	99
56	WRH92H0R07	05/20/92	Los Angles, CA	101

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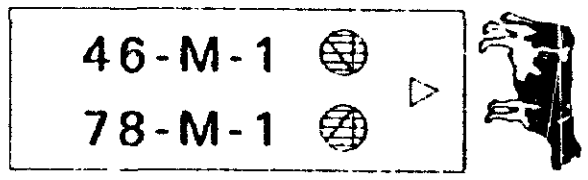
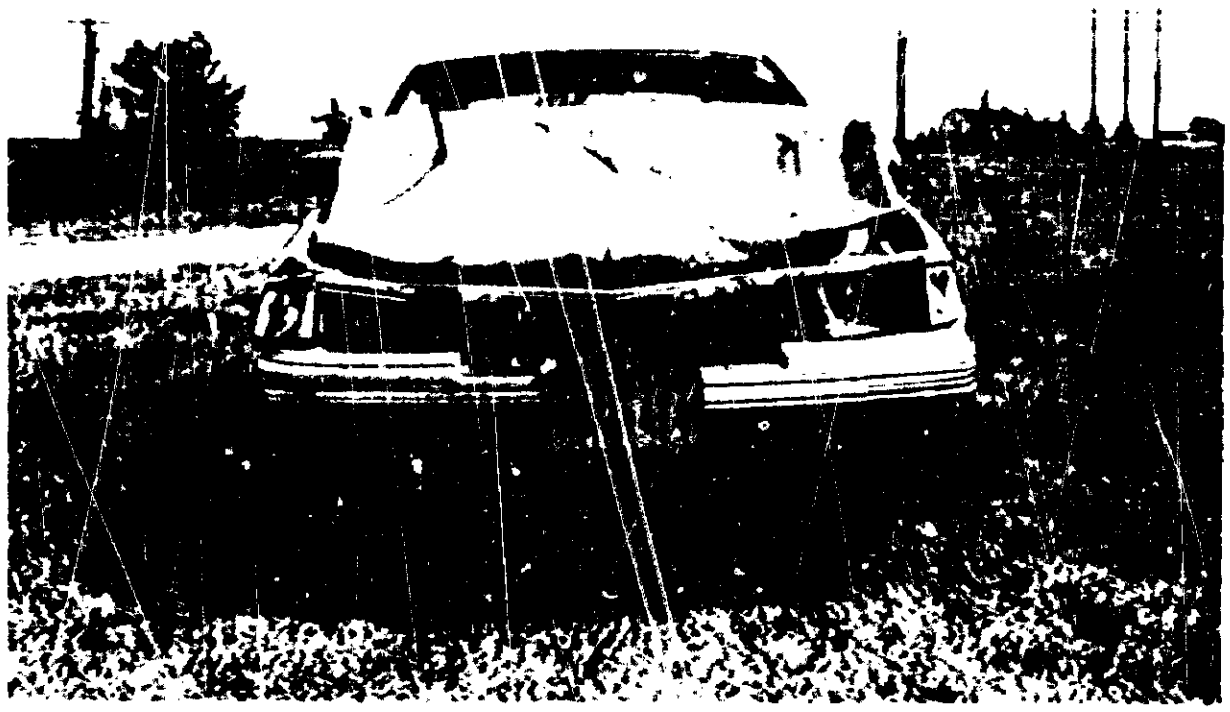
Case No. 1

Acc. No.:	MKC-90-F-H-012
Date:	September 10, 1990
Location:	Nowata, Oklahoma
Type:	Frontal
Vehicle:	1989 Lincoln Continental
Weight:	3,953 lbs
Delta V:	12 mph

Collision Diagram





A 1989 Lincoln Continental traveling at a driver-estimated speed of 55 mph hit a cow in the roadway. The Delta V for the Lincoln was 12 mph. The Lincoln was equipped with driver and passenger-side air bags, which deployed at impact. The driver was wearing the manual lap/shoulder belt and sustained abrasions on the back of his right hand and on the inside of his right elbow from the gear selector shift and steering wheel (AIS-1). The front passenger was restrained with the manual lap/shoulder belt and sustained an abrasion under his chin.

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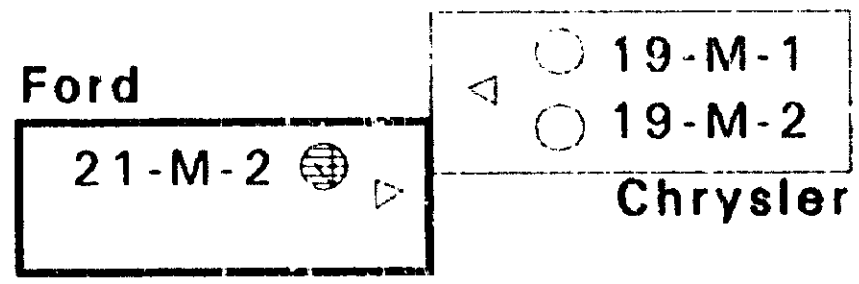
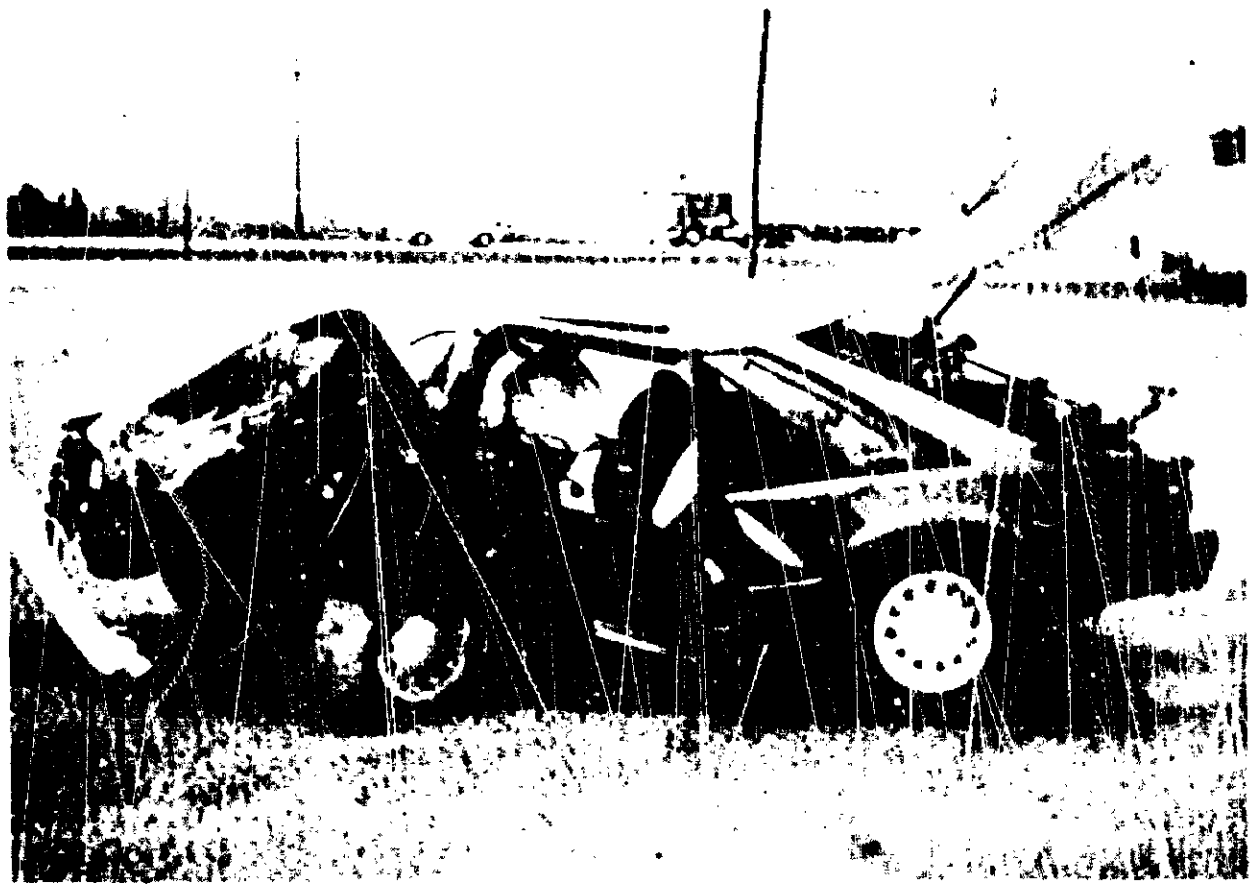
Case No. 2

Acc. No.:	MKC-90-FH-012
Date:	May 14, 1990
Location:	Marshalltown, Iowa
Type:	Frontal
Vehicle 1:	1990 Ford Mustang
Weight:	2,800 lbs
Delta V:	28 mph
Vehicle 2:	1981 Chrysler Cordoba
Weight:	3,396 lbs
Delta V:	23 mph

Collision Diagram





A 1990 Ford Mustang collided head-on (off-centered) with a 1981 Chrysler at a hillcrest on a nondelineated gravel road. The Ford's air bag deployed, and the driver, restrained with a manual lap/shoulder belt, received moderate injuries (AIS 2). The two Chrysler occupants were unrestrained and received moderate and minor injuries (AIS 2 and AIS 1).

Vehicle 1:

Occupant Location	Injuries	AIS	Probable Injury Source
Driver	Fractured left femur	2	Lower dashboard
	Fractured right ankle	1	Floor pan
	Laceration, left olecranon	1	Door
	Chest abrasion	1	Seat belt
	Ecchymosis, right knee	1	Lower dashboard
	Right coronal abrasion	1	Air bag
	Laceration of forehead	1	Air bag
	Nasal fracture	1	Air bag
	Lip lacerations	1	Air bag

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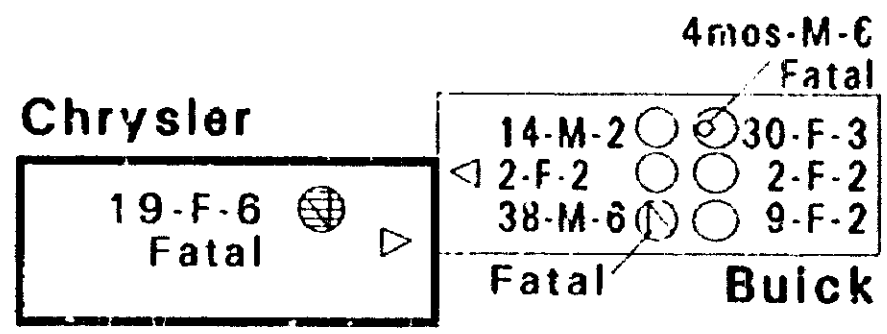
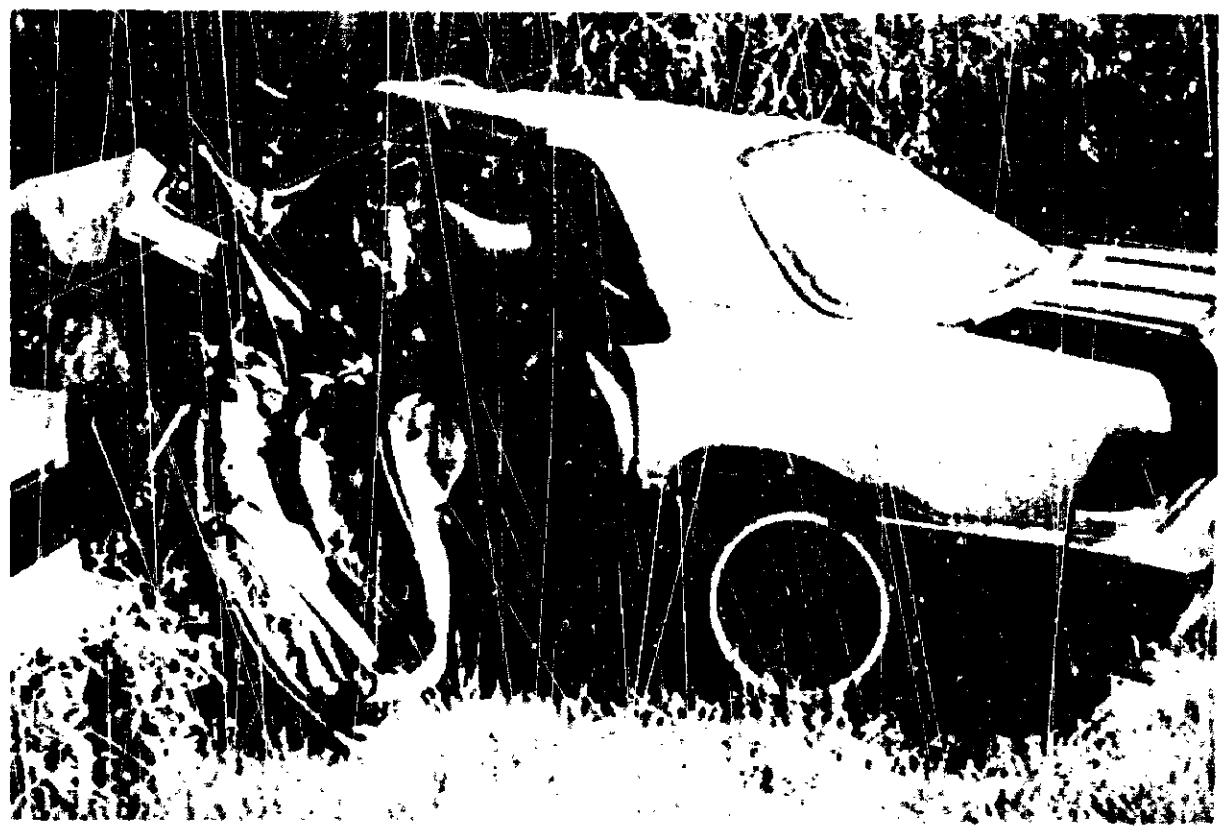
Case No. 3

Acc. No.:	FTW-90-FH-006
Date:	September 23, 1990
Location:	Crockett, Texas
Type:	Frontal
Vehicle 1:	1989 Chrysler LeBaron
Weight:	3,314 lbs
Delta V:	61 mph
Vehicle 2:	1984 Buick LeSabre
Weight:	4,400 lbs
Delta V:	46 mph

Collision Diagram





A 1989 Chrysler Lebaron GTS Turbo crossed the centerline and collided head-on with a 1984 Buick LeSabre. The Lebaron was equipped with a supplemental air bag, which deployed at impact. The Lebaron driver was restrained with the manual lap/shoulder belt and sustained fatal skull fractures (AIS-6).

The driver of the Buick was restrained with the manual lap/ shoulder belt and sustained fatal injuries. The six passengers were unrestrained. A 4-month-old infant sitting on his mother's lap in the right rear was ejected through the windshield on the driver's side into the engine compartment and sustained massive, fatal head injuries (AIS-6). The remaining passengers in the Buick received moderate to serious injuries (AIS 2 and AIS 3).

The Chrysler sustained extensive crush across the entire front, reaching a maximum of 77 inches. The crush on the Buick reached a maximum depth of 66 inches. There was survivable space for the passengers in the Buick; however, the extensive intrusion consumed the survival space of both drivers.

Vehicle 1:

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Massive skull fractures	6	Steering wheel/dashboard

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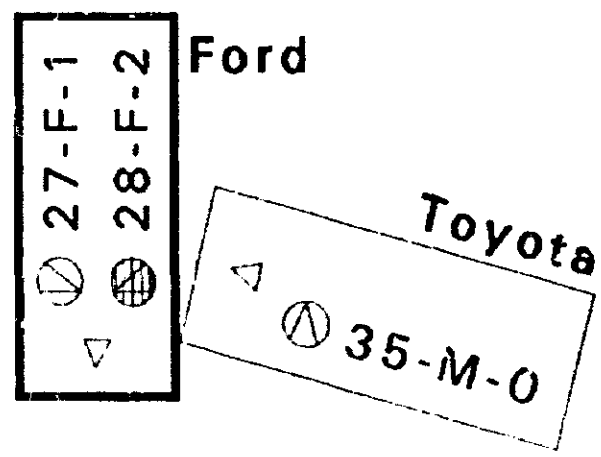
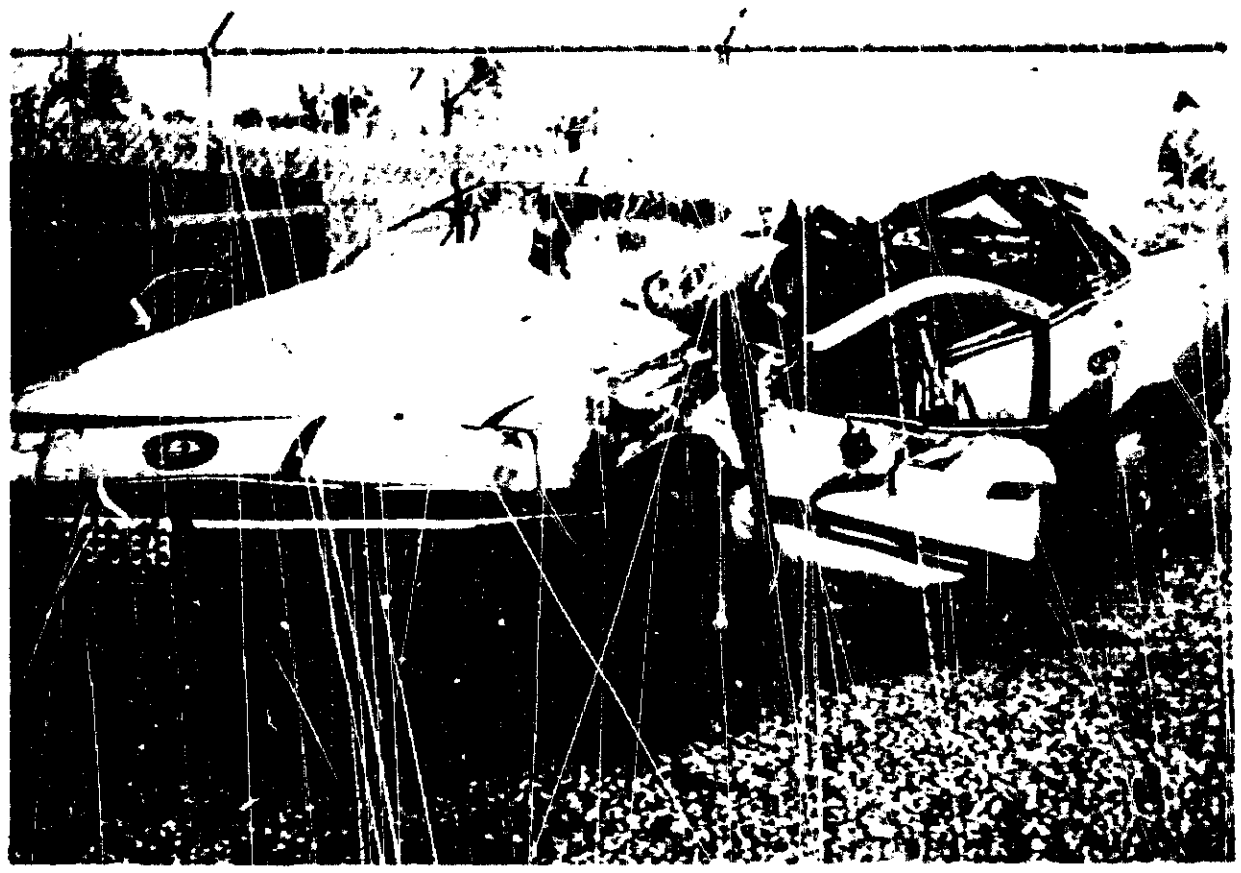
Case No. 4

Acc. No.:	WRH-91-HOR09
Date:	March 27, 1991
Location:	Aurora, California
Type:	Side
Vehicle 1:	1990 Ford Taurus
Weight:	3,675 lbs
Delta V:	19 mph
Vehicle 2:	1989 Toyota Pickup
Weight:	3,715 lbs
Delta V:	18 mph

Collision Diagram





A 1989 Toyota 4X4 crossed a median and struck the left front of a 1990 Ford Taurus. The Toyota driver was restrained with a manual lap/shoulder belt and was not injured. The Taurus was equipped with a driver-side supplemental air bag, which deployed at impact. The Taurus driver was restrained with the manual lap/ shoulder belt and sustained moderate injuries (AIS 2). The A-pillar and door frame were pushed into the driver's compartment. The right-front passenger was restrained with the manual lap/shoulder belt and sustained minor injuries (AIS 1).

Vehicle 1:

Occupant Location	Injuries	AIS	Probable Injury Source
Driver	Fractured humerus	2	A-pillar and door frame
	Fractured radius and ulna	2	A-pillar and door frame
	Three fractured ribs, lower left side	2	Unknown
Right front	Contusion, left hip	1	Seatbelt
	Separated clavicle	1	Unknown

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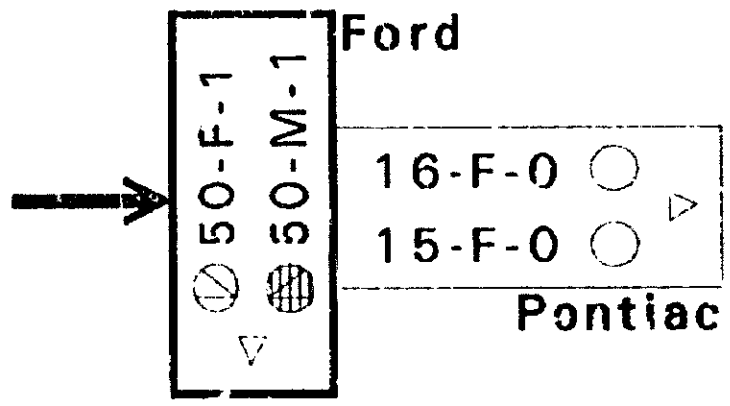
Case No. 5

Acc. No.:	CRH-91-HOR12
Date:	March 3, 1991
Location:	Seguin, Texas
Type:	Side
Vehicle 1:	1990 Ford Taurus
Weight:	3,406 lbs
Delta V:	29 mph
Vehicle 2:	1978 Pontiac LeMans
Weight:	3,380 lbs
Delta V:	29 mph

Collision Diagram



A 1990 Ford Taurus braked as it approached a slow-moving Pontiac LeMans that was riding on a flat tire. The Ford Taurus slid broadside and struck the rear of the Pontiac LeMans with its left side. The Taurus was equipped with a supplemental air bag, which deployed at impact. The driver was restrained with a manual lap/shoulder belt; however, he stated that he was wearing the shoulder strap under his arm when the accident occurred. The driver and passenger of the Ford received minor injuries (AIS 1).

The occupants of the Pontiac were not injured.

Vehicle 1:

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Two fractured fingers	1	Steering wheel/side window
	Contusion/abrasion, left cheek	1	Driver's door
Right front	Fractured right rib	1	Shoulder strap/door
	Laceration above right eye	1	Unknown

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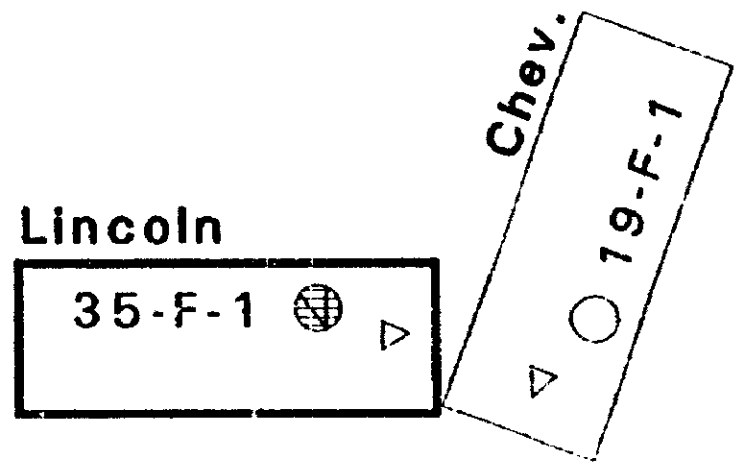
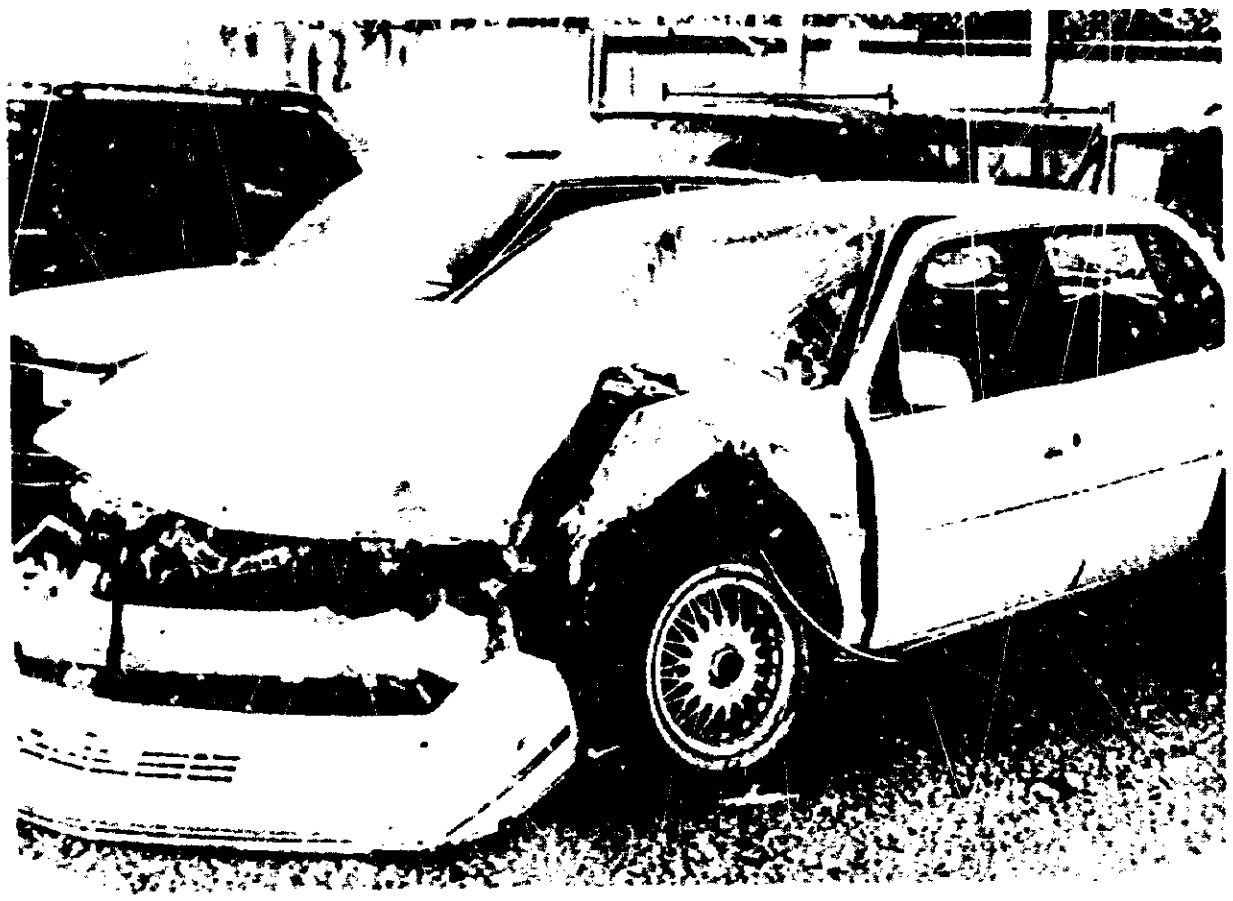
Case No. 6

Acc. No.: CRH-91-FH-011

Collision Diagram



Date:	February 13, 1991
Location:	San Leanna, Texas
Type:	Frontal
Vehicle 1:	1990 Lincoln Continental
Weight:	3,660 lbs
Delta V:	35 mph
Vehicle 2:	1978 Chevrolet Monte Carlo
Weight:	3,266 lbs
Delta V:	39 mph



A 1990 Lincoln Continental traveling at 40-45 mph collided with the right front of a 1978 Chevrolet Monte Carlo that was making a left turn. The Lincoln was equipped with driver and passenger air bags, which deployed at impact; the lap/shoulder-belted driver received minor injuries (AIS 1).

The unrestrained driver of the Chevrolet also received minor injuries (AIS 1).

Vehicle 1:

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Contusion/laceration, knee	1	Instrument panel
	Unspecified neck injury	9	Impact forces
	Rib soreness	9	Shoulder belt

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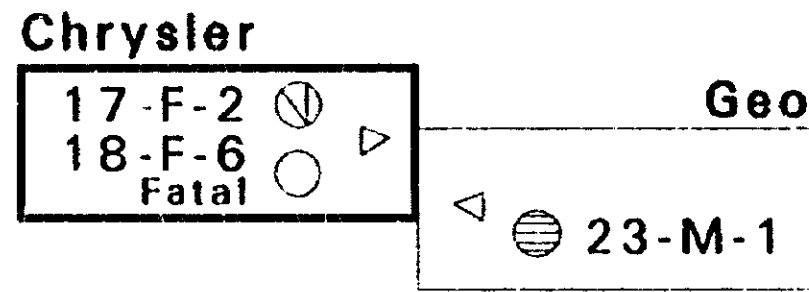
Case No. 7

Acc. No.:	NRH-91-FOR-06
Date:	March 3, 1991
Location:	Olive, Illinois
Type:	Frontal
Vehicle 1:	1990 Geo Storm
Weight:	2,552 lbs
Delta V:	34 mph
Vehicle 2:	1986 Chrysler New Yorker
Weight:	3,440 lbs
Delta V:	25 mph

Collision Diagram



A northbound 1986 Chrysler drove into the southbound lane and collided head-on with a 1990 Geo Storm. The Geo was equipped with a driver-side air bag, which deployed, and the unbelted driver sustained minor injuries (AIS 1).

The Chrysler, after colliding with the Geo, ran off the road and overturned. The unrestrained right-front passenger was ejected and killed, and the lap/shoulder-belted driver received moderate injuries (AIS 2).

Vehicle 1:

Occupant location	Injuries	AIS	Probable Injury Source
Driver	Back Strain	1	Unknown
	Abrasion on chin	1	Air bag
	Superficial cuts to both hands	1	Unknown
	Bruised knees	1	Knee bolsters
	Bruised right thigh	1	Gear shift

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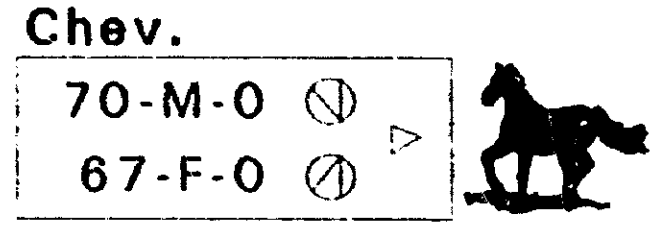
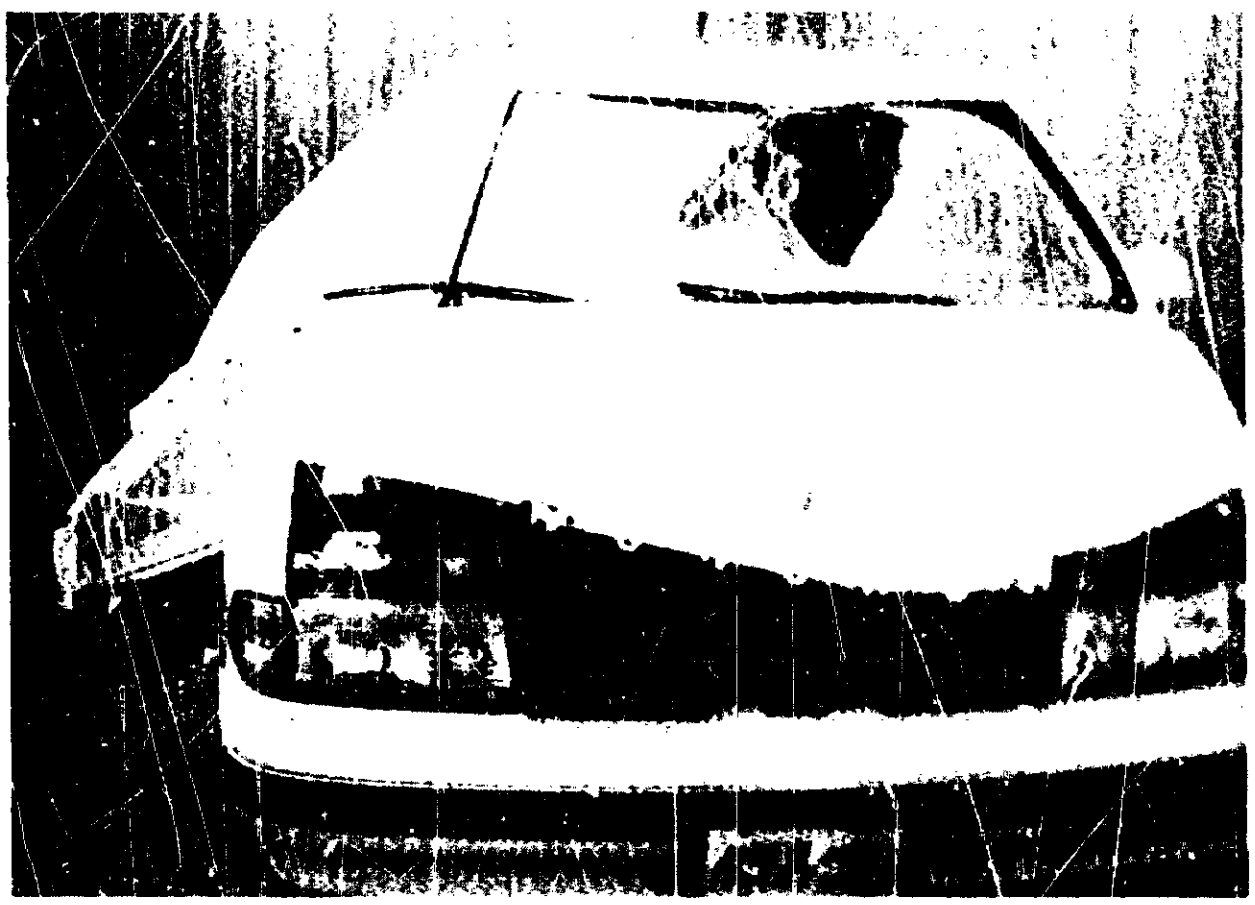
Case No. 8

Acc. No.:	CRH-91-HOR02
Date:	October 23, 1990
Location:	Hot Springs, Arkansas
Type:	Frontal
Vehicle:	1991 Chevrolet Caprice
Weight:	4,375 lbs
Delta V:	Undetermined

Collision Diagram





A 1991 Chevrolet traveling westbound at 45 to 50 mph struck a horse that was running eastbound in the roadway. The driver and right-front passenger were both restrained with the manual lap/shoulder belts; neither of them was injured. Although the vehicle was equipped with a driver-side air bag, it did not deploy.

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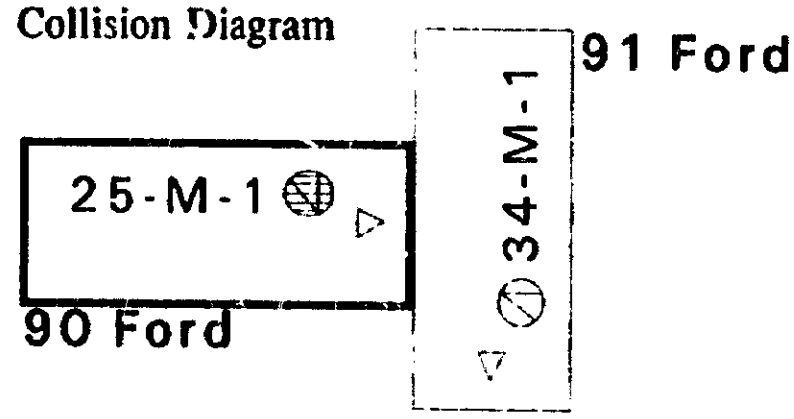
Case No. 9

Acc. No.:	SRH-91-FH-008
Date:	April 11, 1991
Location:	Smyrna, Georgia
Type:	Side
Vehicle 1:[5]	1990 Ford LTD
Weight:	4,181 lbs
Delta V:	17 mph
Vehicle 2:	1991 Ford LTD
Weight:	4,061 lbs
Delta V:	17 mph

Collision Diagram



Vehicle 1:
1990 Ford

The front of a 1990 Ford LTD county police unit struck the right side of a 1991 Ford LTD county sheriff's unit. Both vehicles were equipped with driver-side supplemental air bags. The air bag in the 1990 Ford deployed. The driver was restrained with the manual lap/shoulder belt and sustained abrasions on both forearms (AIS 1).

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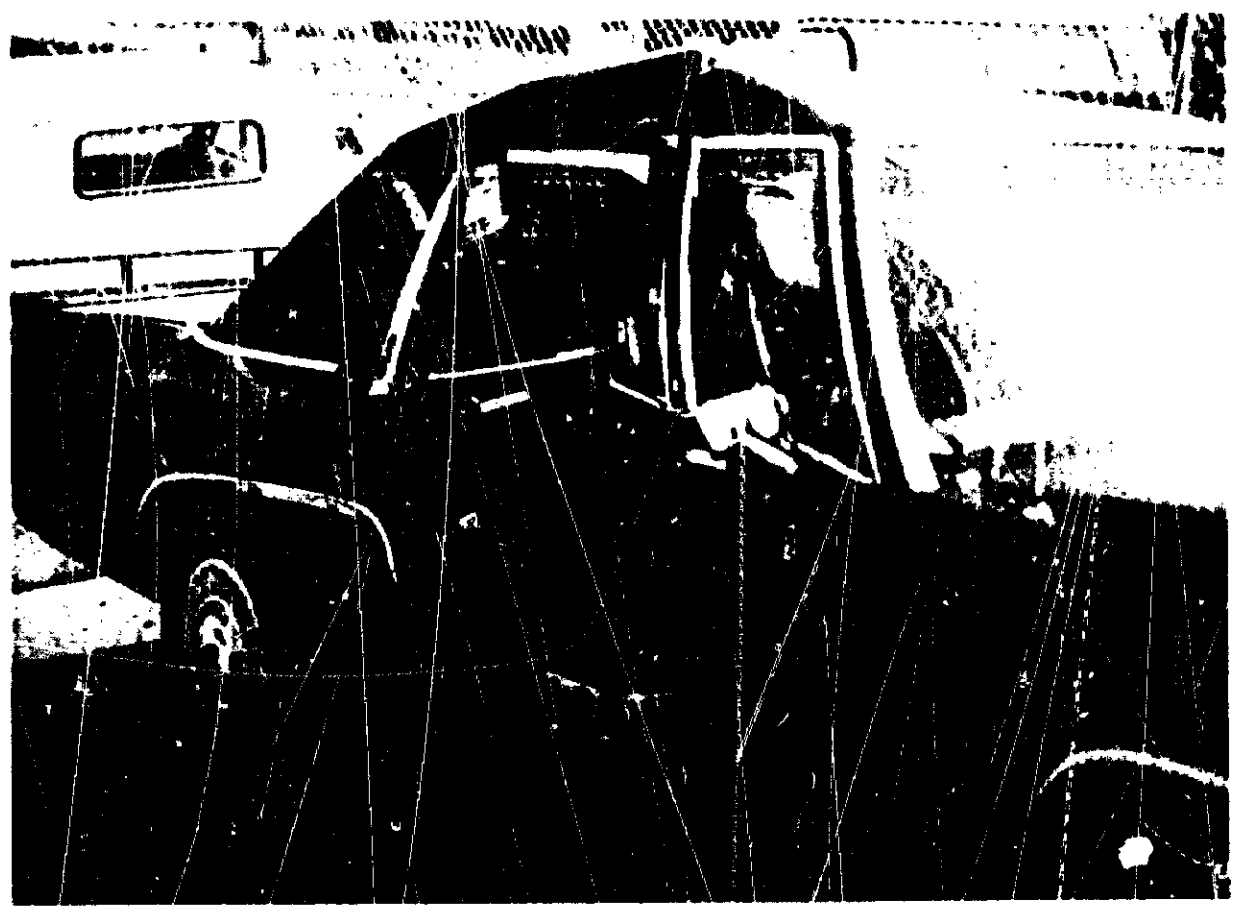
[5]Both vehicles in this accident were equipped with passive restraints, and both are therefore considered case vehicles.

Vehicle 2:
1991 Ford



The air bag in the 1991 Ford did not deploy, since the side impact to this vehicle did not produce a significant longitudinal deceleration. The driver was restrained with the manual lap/shoulder belt and sustained a bruised right shoulder (AIS 1).

Occupant Position	Injuries	AIS	Probable Injury Source
Vehicle 1: Driver	Abrasion, left/right forearms	1	Air bag
Vehicle 2: Driver	Bruised right shoulder	1	Storage box on front seat

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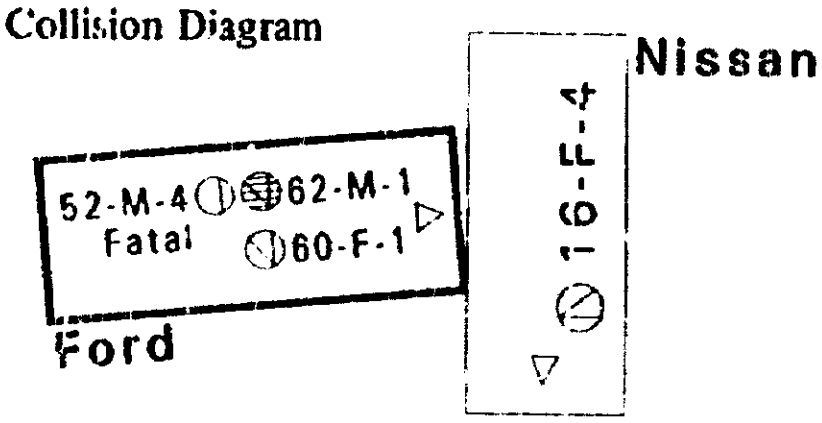
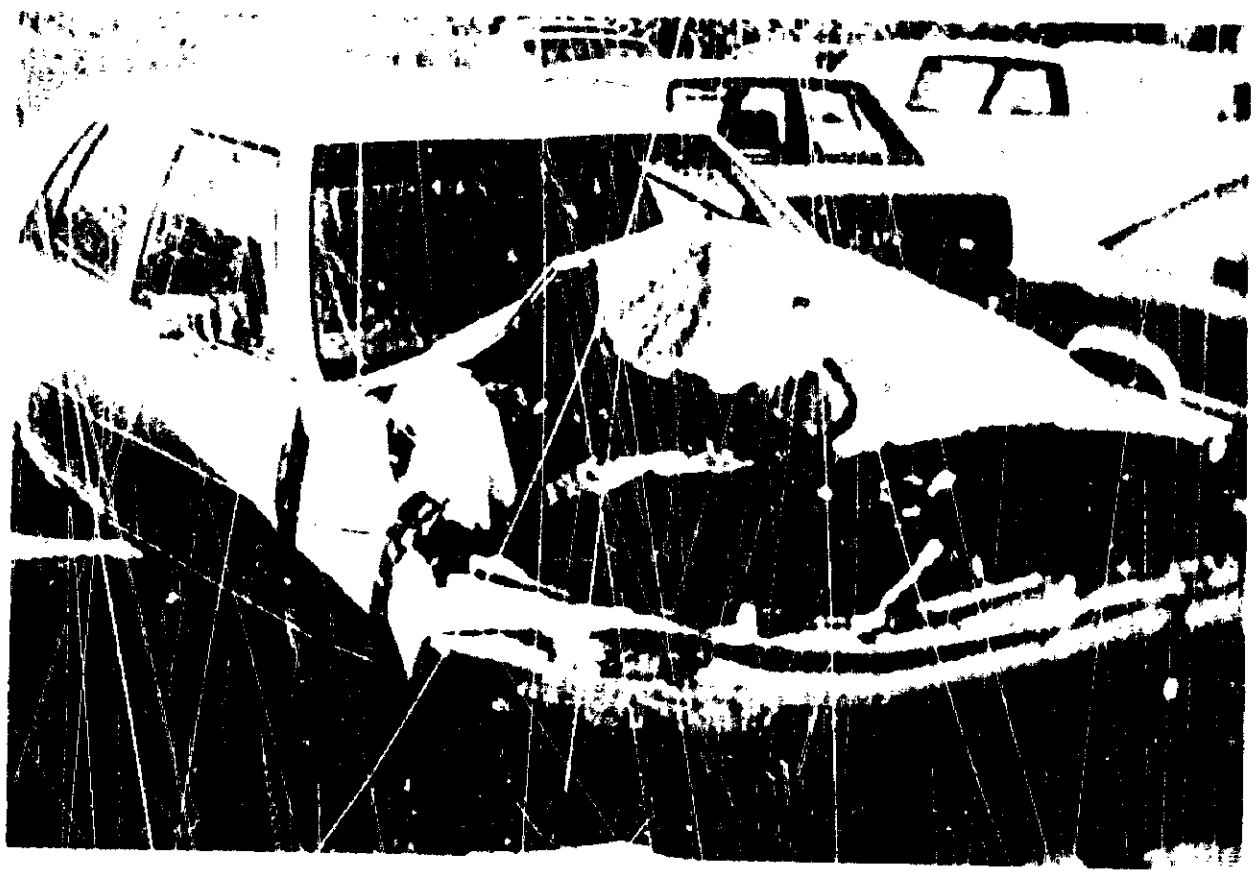
Case No. 10

Acc. No.:	SRH-91-FH-019
Date:	June 6, 1991
Location:	Marietta, Georgia
Type:	Frontal
Vehicle 1:	1990 Ford LTD
Weight:	4,251 lbs
Delta V:	24 mph
Vehicle 2:	1988 Nissan Sentra
Weight:	2,300 lbs
Delta V:	43 mph

Collision Diagram





A 1990 Ford LTD struck the right side of a 1988 Nissan Sentra that had veered into the opposing lane of traffic after being struck from the rear. The Ford was equipped with a driver-side air bag, which deployed. The Ford driver and right-front occupant were restrained with manual lap/shoulder belts and sustained minor injuries (AIS 1). The left-rear passenger, who was wearing the shoulder portion of a lap/shoulder belt behind his back, received fatal injuries.

The Nissan driver was restrained with a manual lap/shoulder belt and sustained severe injuries (AIS 4).

Vehicle 1:

Occupant Location	Injuries	AIS	Probable Injury Source
Driver	Bruised left knee	1	Unknown
Right front	Bruised right shin	1	Glove box
	Cut right elbow	1	Unknown
Left rear	Contusion, sternum	1	Unknown
	Right rib fracture	1	Unknown
	Contusions, lungs	4	Unknown
	Lacerations, liver	3	Lapbelt
	Hematomas, both kidneys	2	Unknown
	Laceration, mesenteric artery	3	Lapbelt
	Fractured nose	1	Front seat back

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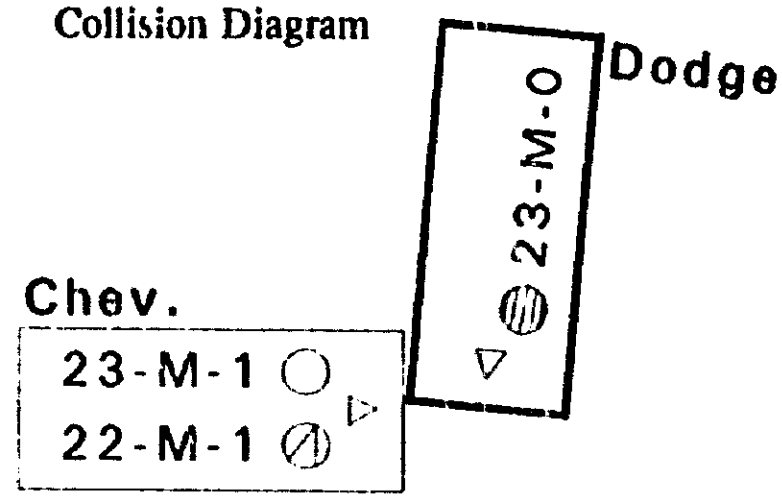
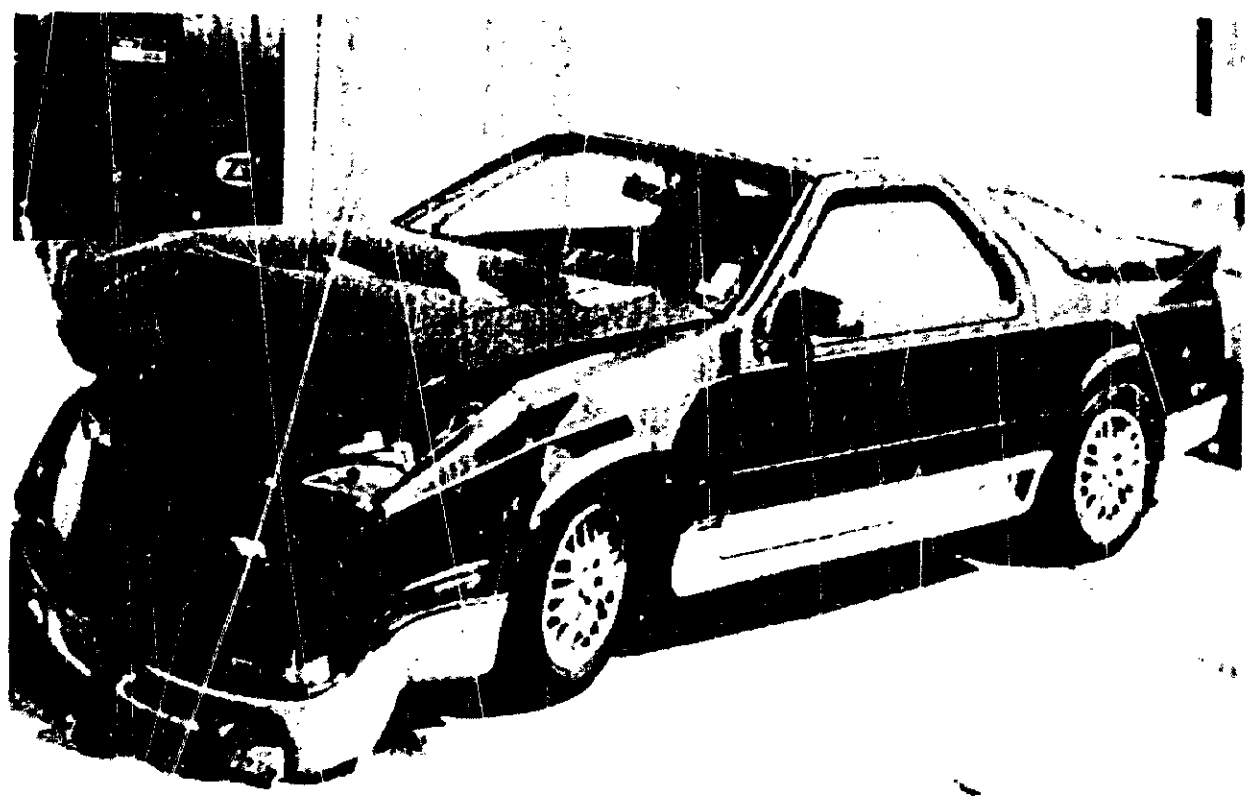
Case No. 11

Acc. No.:	SRH-91-FH-OO6
Date:	March 30, 1991
Location:	Kansas City, Missouri
Type:	Frontal
Vehicle 1:	1989 Dodge Daytona
Weight:	2,781 lbs
Delta V:	32 mph
Vehicle 2:	1988 Chevrolet Beretta
Weight:	2,908 lbs
Delta V:	31 mph

Collision Diagram





A 1989 Dodge Daytona making a left turn collided with the left front of a 1988 Chevrolet Beretta. The Dodge's driver-side air bag deployed, and the unbelted driver was not injured.

The unrestrained driver of the Chevrolet sustained minor injuries (AIS 1). The right-front passenger was restrained by a manual three-point lap/shoulder belt but was in a reclined position and received minor injuries (AIS 1).

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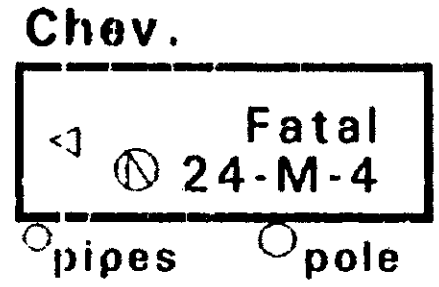
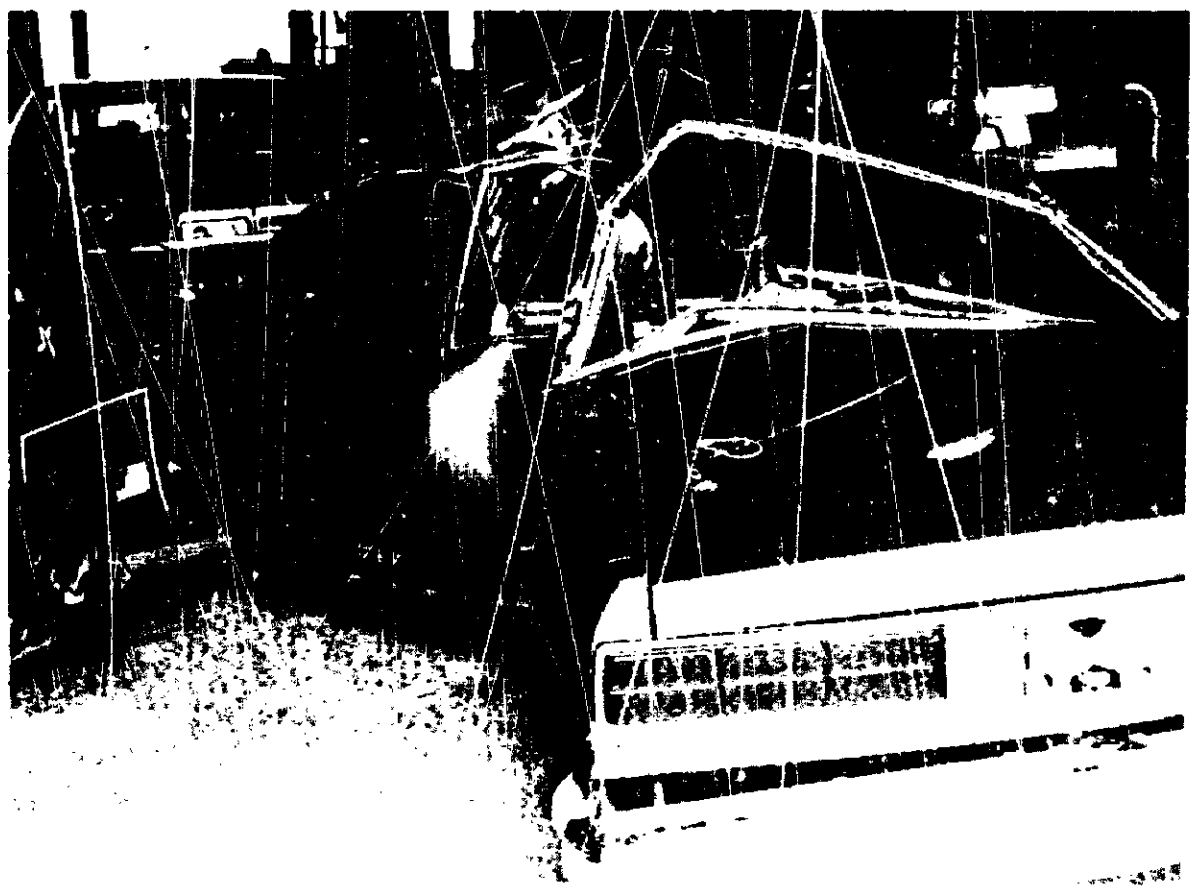
Case No. 12

Acc. No.:	NYC-91-FH-001
Date:	September 30, 1990
Location:	Brunswick, Maine
Type:	Side
Vehicle:	1990 Chevrolet Caprice
Weight:	3,950 lbs
Delta V:	22 mph

Collision Diagram





A 1990 Chevrolet Caprice police unit traveling 50-60 mph on an emergency call slid broadside off the right side of the roadway, mounted a curb, and struck a wooden utility pole at the left-rear passenger door. The left-front fender area then struck two concrete-filled steel pipes. The Delta V for the Caprice was 22 mph for the initial collision. The driver was wearing the automatic lap/shoulder belt combination attached to the door. At impact, the driver-door striker post pulled free from the B-pillar and the door opened sufficiently for the driver to fall out; he sustained fatal head injuries.

Occupant Location	Injuries	AIS	Probable Injury Source
Driver	Epidural hemorrhage	4	Pavement
	Subdural hemorrhage	4	Pavement
	Subarachnoid hemorrhage	3	Pavement
	Brain stem swelling	3	Pavement
	Separation/fracture, sagittal suture	2	Pavement
	Posterior parietal scalp abrasions	1	Pavement
	Contusions, forehead	1	Radar unit
	Abrasion/laceration, scalp	1	Pavement

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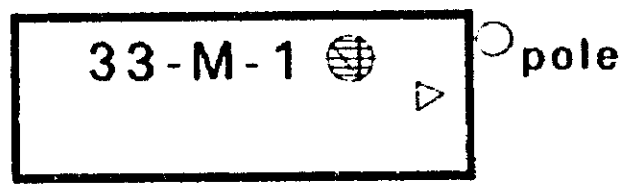
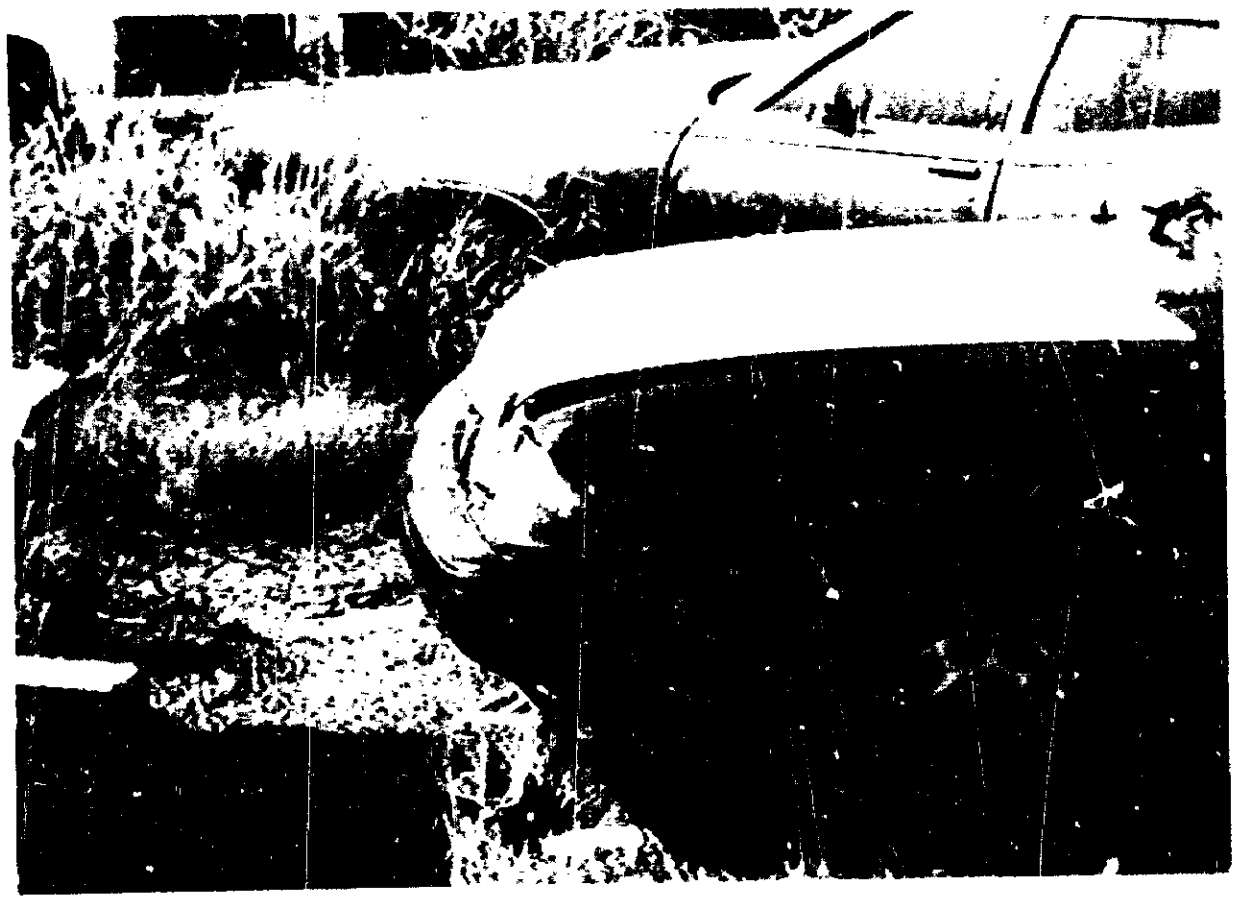
Case 13

Acc. No.:	CRH-91-HOR-20
Date:	June 3, 1991
Location:	Kaufman, Texas
Type:	Frontal
Vehicle:	1990 Ford Mustang
Weight:	3,159 lbs
Delta V:	<5 mph

Collision Diagram





A 1990 Ford Mustang police unit, in pursuit, skidded off the road, struck a 3.5-inch-diameter breakaway warning sign pole, traveled another 323 feet, and came to rest against a creek embankment. The Delta V for the Mustang was less than 5 mph for the pole impact. The driver's supplemental air bag deployed. The driver was restrained with the manual lap/shoulder belt and sustained a bruised chest wall.

The impact with the pole was near one of the air bag's sensors. Ford Motor Company engineers indicated that the air bag system had five sensors and that it would deploy if one main sensor and the safing sensor closed.

Occupant Location	Injuries	AIS	Probable Injury Source
Driver	Chest wall contusion	1	Shoulder belt

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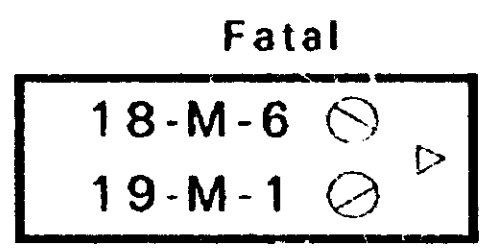
Case No. 14

Acc. No.:	CRH-91-HOR-23
Date:	August 16, 1991
Location:	Como, Texas
Type:	Rollover
Vehicle:	1990 Nissan Maxima
Weight:	3,388 lbs
Delta V:	Not Applicable

Collision Diagram



A 1990 Nissan Maxima was traveling at an estimated speed of 85 mph when the driver lost control. The vehicle left the road, vaulted 45 feet into a pasture, and landed on the right side and roof; it overturned again and landed in an upright position. The Maxima was equipped with motorized shoulder belts and manual lapbelts. The right-front passenger stated that neither he nor the driver was wearing the manual lapbelt but both were wearing the automatic shoulder belts.

During the accident sequence, the driver's door opened, the shoulder belt moved 21 inches in the track, and the driver was ejected, sustaining fatal injuries (AIS 6). The passenger door remained closed during the rollover, and the passenger remained in the vehicle, sustaining minor injuries (AIS 1). The door-frame track for the motorized shoulder belt provides 37 inches of available movement. The buckle in this accident was found 21 inches forward of the rear position (door-closed position). See arrows in picture below.

Occupant Location	Injuries	AIS	Probable Injury Source
Driver	Eviscerated intestines	6	Vehicle rolled over occupant
	Crushed chest	6	Vehicle rolled over driver
	Contusion, left side of neck	1	Shoulder belt
Right front	Contusion, head	1	Broken window glass
	Lacerations, hands	1	Broken window glass
	Hematoma, right shoulder	1	Interior side wall
	Possible closed head injury	9	Side window glass

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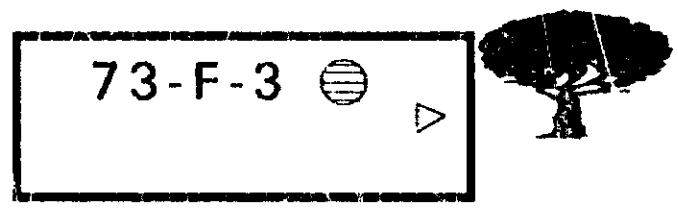
Case No. 15

Acc. No.:	WRH-91-HOR-16
Date:	September 9, 1991
Location:	Cortez, Colorado
Type:	Frontal
Vehicle:	1992 Mercury Grand Marquis
Weight:	4,028 lbs
Delta V:	13 mph

Collision Diagram



A 1992 Mercury Grand Marquis ran off the road, sideswiped a small tree with the right side, and struck a 5-foot-diameter tree head-on. The Mercury was equipped with a driver-side supplemental air bag, which deployed when the vehicle hit the large tree. The unbelted driver was thrown to the right; she struck the rearview mirror and windshield, sustaining serious injuries. The driver stated that it was her "right not to wear the available seatbelts."

Occupant Location	Injuries	AIS	Probable Injury Source
Driver	Fractured right ankle (crushed)	3	Unknown
	Fractured right hip	3	Unknown
	Contusion, forehead	1	Windshield
	Contusion, right shoulder	1	Dash

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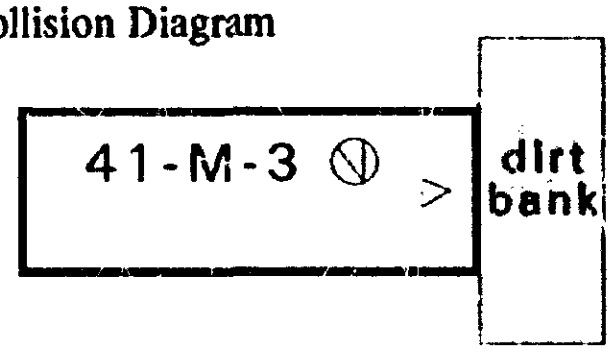
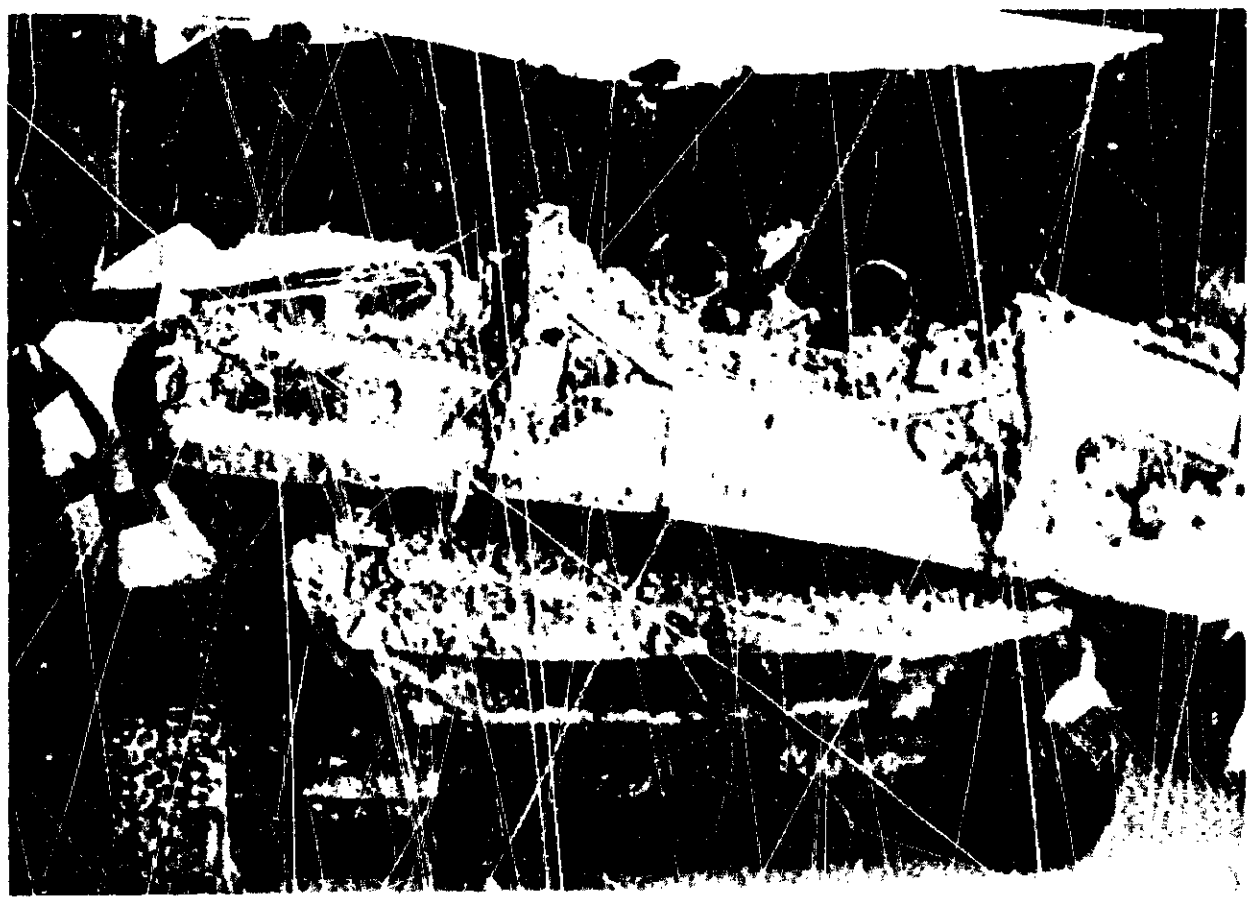
Case No. 16

Acc. No.:	NRH-91-HOR-14
Date:	May 7, 1991
Location:	Tukwila, Washington
Type:	Frontal
Vehicle:	1990 Chevrolet Caprice
Weight:	4,253 lbs
Delta V:	26 mph

Collision Diagram





A 1990 Chevrolet Caprice police unit in pursuit of a stolen car traveled off the right side of the road about 150 feet on the grass, went down a 30-foot embankment, crossed a creek, and hit a dirt embankment. The Delta V for the police unit was 26 mph. The driver was wearing the door-mounted lap/shoulder belt combination and sustained serious injuries. The steering wheel rim was bent forward about 6 inches.

Occupant Location	Injuries	AIS	Probable Injury Source
Driver	Skull fracture	3	Steering wheel
	Superior orbital rim fracture	2	Steering wheel
	Sinus fracture	1	Steering wheel
	Nasal fracture	1	Steering wheel
	Maxilla fracture	2	Steering wheel
	Nerve damage	9	Steering wheel
	Laceration, left eye	1	Unknown

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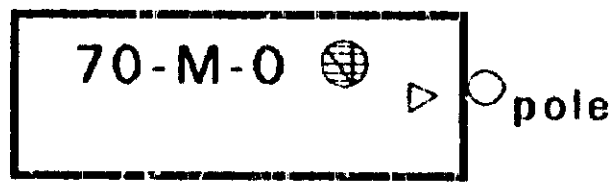
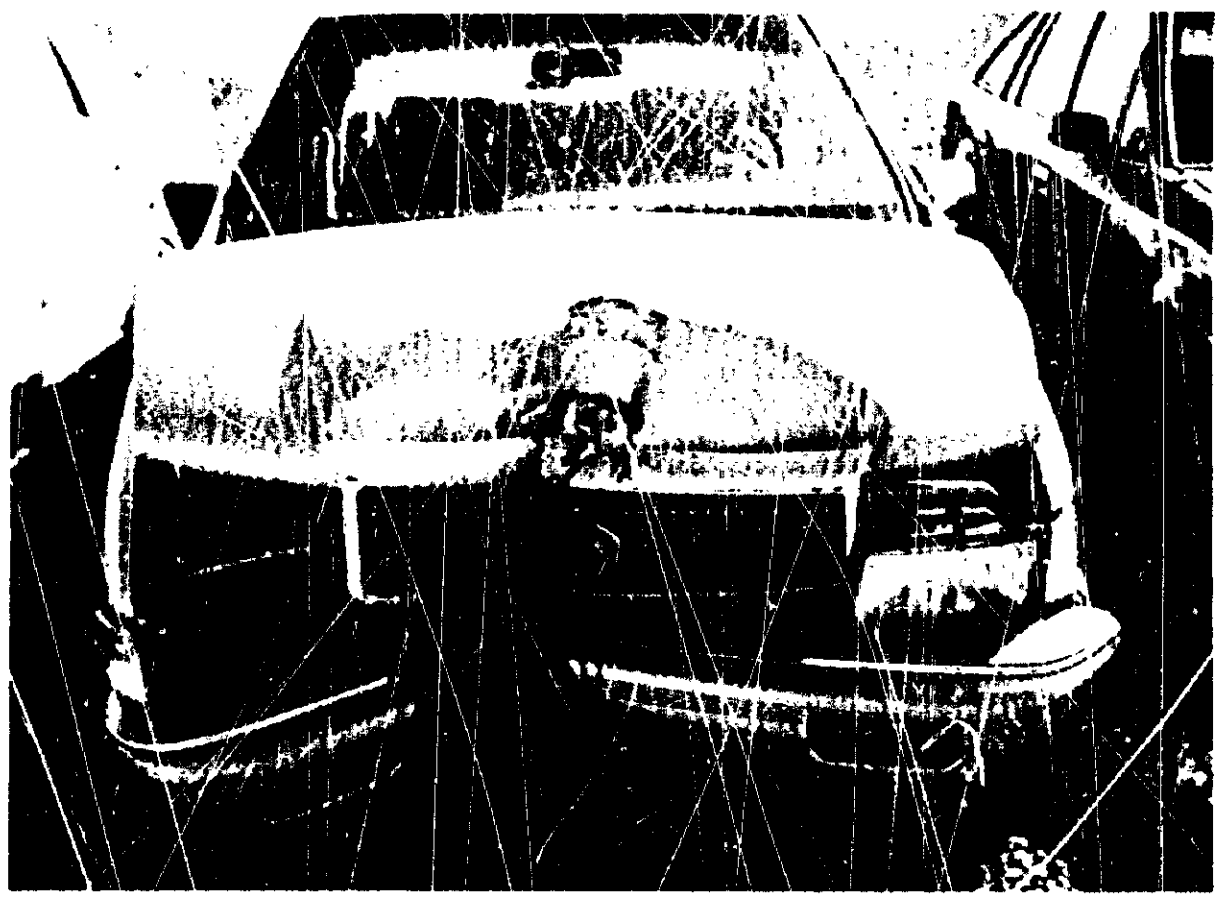
Case No. 17

Acc. No.:	NRH-91-FO-R08
Date:	April 9, 1991
Location:	Elizabeth, Pennsylvania
Type:	Frontal
Vehicle:	1991 Plymouth Acclaim
Weight:	3,098 lbs
Delta V:	13 mph

Collision Diagram





A 1991 Plymouth Acclaim was traveling at a witness-estimated speed of 40 mph when it left the road. It struck a wooden utility pole, which sheared at the base. It traveled another 18 feet and struck a stone wall with its right side before coming to rest on the grassy shoulder. The Delta V for the collision with the utility pole was 13 mph. The Acclaim was equipped with a driver-side supplemental air bag, which deployed during the accident sequence. The driver was restrained with the manual lap/shoulder belt and was not injured.

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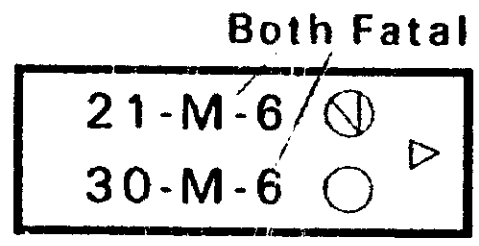
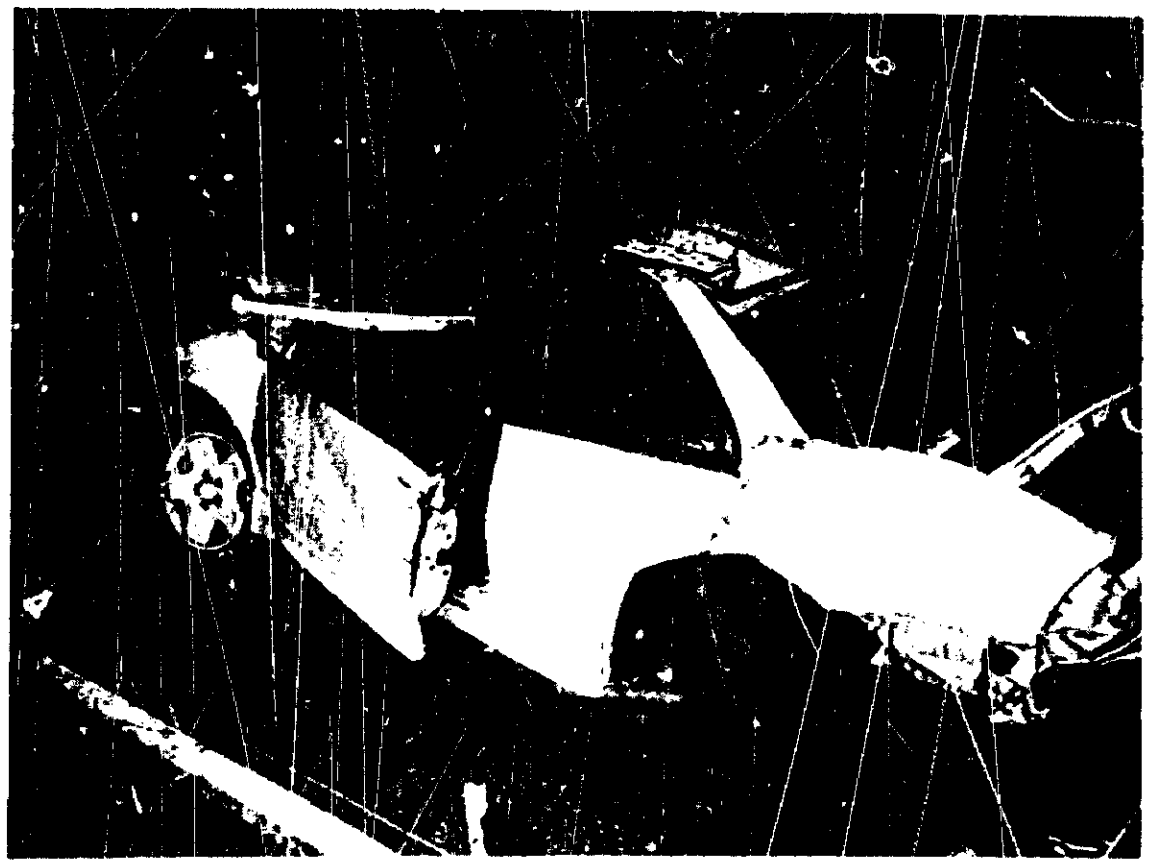
Case No. 18

Acc. No.:	WRH-91-FH-OO2
Date:	October 26, 1990
Location:	Watkins, Colorado
Type:	Rollover
Vehicle:	1990 Chevrolet Beretta
Weight:	2,850 lbs
Delta V:	Not Applicable

Collision Diagram





A 1990 Chevrolet Beretta traveling at a high rate of speed failed to negotiate a sweeping left curve. The Chevrolet slid broadside onto the median, rolled over, and came to rest on its wheels. The driver was wearing an automatic, door-mounted lap/shoulder belt combination. During the accident sequence, the driver's door opened and he was ejected and fatally injured. The unrestrained right-front passenger was ejected and fatally injured.

Occupant Location	Injuries	AIS	Probable Injury Source
Driver	Massive head injury	6	Unknown
Right Front	Massive head/chest injury	6	Unknown

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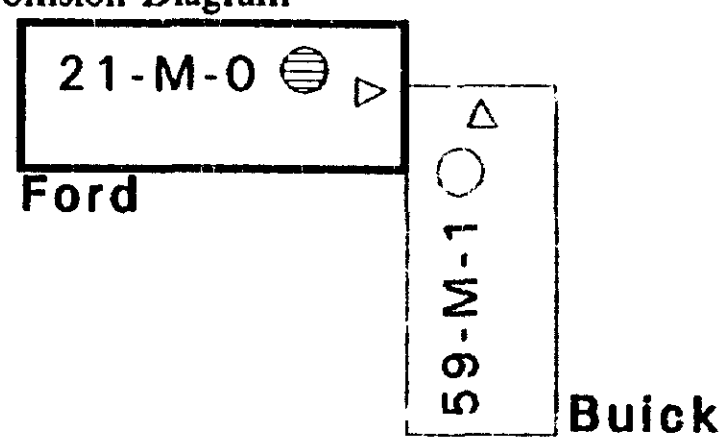
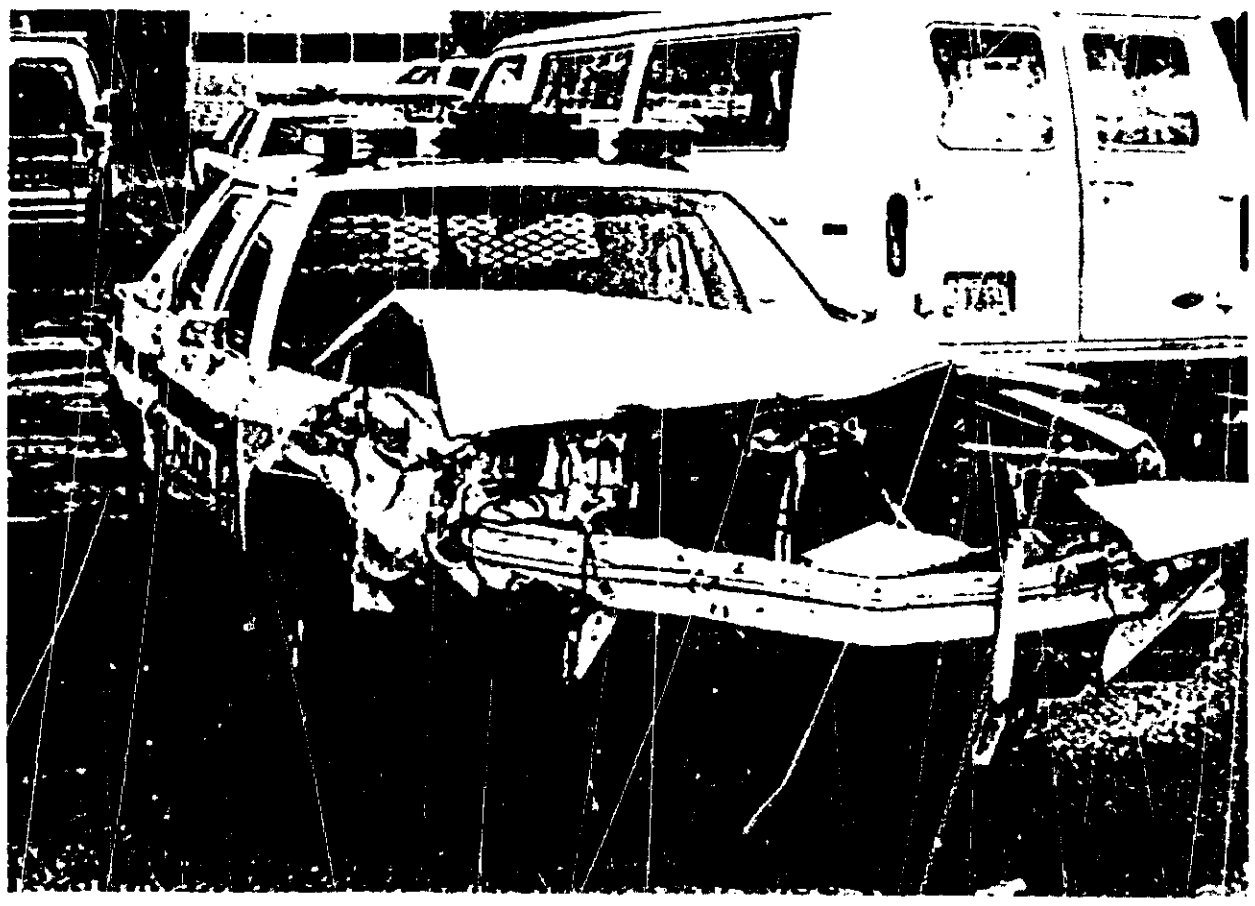
Washington, D.C. 20

Case No. 19

Acc. No.:	SRH-91-FH-OO2
Date:	November 27, 1990
Location:	Atlanta, Georgia
Type:	Frontal
Vehicle 1:	1990 Ford Crown Victoria
Weight:	4,121 lbs
Delta V:	7 mph
Vehicle 2:	1989 Buick Skylark
Weight:	2,800 lbs
Delta V:	14 mph

Collision Diagram





A 1991 Ford LTD Crown Victoria police unit struck the left-front side of a 1989 Buick Skylark. The Ford was equipped with a driver-side supplemental air bag, which deployed at impact. The unbelted Ford driver was not injured. The Ford driver reported that he felt a stinging sensation on the inside of his forearms. Red marks were in evidence on his arms the day after the accident.

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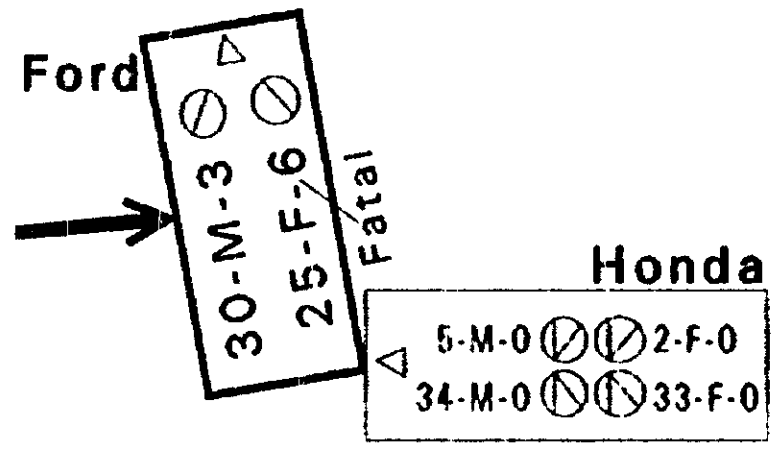
Case No. 20

Acc. No.:	SRH-91-FH-O16
Date:	June 1, 1991
Location:	Lilburn, Georgia
Type:	Side
Vehicle 1:	1988 Ford Escort
Weight:	2,522 lbs
Delta V:	15 mph
Vehicle 2:	1987 Honda Accord
Weight:	2,821 lbs
Delta V:	14 mph

Collision Diagram



The driver of a northbound 1988 Ford Escort lost control of his vehicle on a wet roadway and slid broadside into the southbound lanes, where the Escort's right side collided with the front of a southbound Honda. The Escort rotated clockwise after impact. The driver and passenger of the Ford were restrained by motorized, automatic shoulder belts but were not wearing the available manual lapbelts. The driver of the Ford was thrown to the right at impact, displacing the center console 5 inches with his lower torso, and sustained serious injuries (AIS 3).

During the collision, the right-front passenger was also thrown to the right, loading the shoulder belt with the right side of her neck. The door-latch mechanism deformed, allowing the door to open. She was ejected from the automobile and decapitated (AIS 6). The Medical Examiner's report stated:

> "Her injury patterns are almost classical for a decapitation from someone ejected, thrown up and through, or submarined under a sash belt [shoulder belt] when the victim is not wearing a lapbelt to restrain them in the seat.
>
> The initial contact with the belt appears to be across the right chest with the belt then riding up onto the base of the neck, 'cutting' into the neck, severing the neck, and the torso riding up through the belt leaving the diagonal contusion across the left anterior chest and then onto the left arm and forearm as the body was ejected through the sash and out of the vehicle."

Vehicle 1:

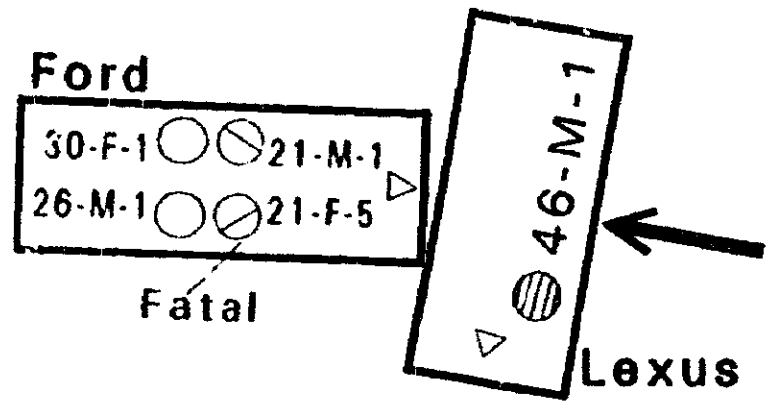
Occupant Location	Injuries	AIS	Probable Injury Source
Driver	Fractured right hip	3	Center console
	Laceration, rear of head	1	Unknown
	Abrasion, midchest	1	Shoulder belt
	Abrasion, right arm	1	Shoulder belt
	Abrasion, left arm	1	Shoulder belt
Right front	Decapitation	6	Shoulder belt
	Abrasion, chin/jaw	1	Unknown
	Contusion/abrasion, upper chest	1	Shoulder belt
	Contusion, left upper arm	1	Shoulder belt
	Contusion/abrasion, right/left hand	1	Shoulder belt
	Laceration, distal right upper arm	1	Unknown
	Laceration, right forearm	1	Unknown
	Abrasion to knees	1	Roadway surface
	Contusion, left lower leg	1	Unknown
	Abrasion to ankle/foot	1	Unknown

National Transportation Safety Board
Washington, D.C. 20594

Case No. 21

Acc. No.:	SRH-91-FH-021
Date:	August 3, 1991
Location:	Stockbridge, Georgia
Type:[6]	Frontal for Ford, side for Lexus
Vehicle 1:	1991 Ford Escort
Weight:	2,942 lbs
Delta V:	33 mph
Vehicle 2:	1990 Lexus LS 400
Weight:	3,939 lbs
Delta V:	24 mph

Collision Diagram



A 1991 Ford Escort LX two-door hatchback struck the right side of a 1990 Lexus. The Ford driver and right-front passenger were restrained by the motorized shoulder belts but not by the manual lapbelts. The two rear-seat passengers were not restrained and sustained minor injuries. The driver sustained an abrasion on his left chest. The right-front occupant was fatally injured. She was found with her pelvis and buttocks below the seat cushion and her shoulders held against the seatback by the shoulder belt.

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[6]Both vehicles in this accident were equipped with passive restraints, and both are considered case vehicles.

The Lexus was equipped with a driver-side supplemental air bag, which deployed. The unbelted Lexus driver was thrown to the right side of the vehicle, sustaining multiple lacerations and contusions about the face and head from A-pillar contact.

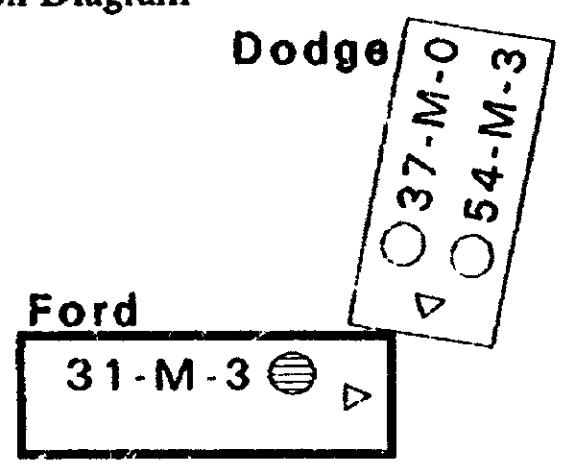
Occupant Location	Injuries	AIS	Probable Injury Source
Vehicle 1:			
Driver	Abrasion, chest	1	Shoulder belt
	Laceration, lower left leg	1	Unknown
	Laceration, back right hand	1	Probable glass cut
Right Front	Abrasion, chest	1	Shoulder belt
	Abrasion, neck	1	Shoulder belt
	Lacerations, lower legs	1	Underside dashboard
	Lacerated right ventricle	5	Shoulder belt
	Lacerated pericardial sac	5	Shoulder belt
	Contusions/lacerations, lungs	5	Shoulder belt
	Lacerated spleen	4	Shoulder belt
	Fractured ribs	2	Shoulder belt
Left Rear	Fractured rib	1	Unknown
	Sprained right hip	1	Back of driver's seat
	Sprained left hand	1	Back of driver's seat
	Contusion, left knee	1	Back of driver's seat
	Contusion, right foot	1	Underside driver's seat
	Contusion, lower leg	1	Back of driver's seat
Right Rear	Sprained knee	1	Back of front seat
Vehicle 2:			
Driver	Laceration, face/neck	1	Instrument panel at A-pillar
	Contusions, face/head	1	Instrument panel at A-pillar
	Neck strain	1	Instrument panel at A-pillar

National Transportation Safety Board
Washington, D.C. 20594

Case No. 22

Acc. No.:	SRH-91-FH-OO3
Date:	January 28, 1991
Location:	Atlanta, Georgia
Type:	Side
Vehicle 1:	1991 Ford LTD Crown Victoria
Weight:	4,200 lbs
Delta V:	21 mph
Vehicle 2:	1976 Dodge Van
Weight:	4,075 lbs
Delta V:	22 mph

Collision Diagram



A 1991 Ford Crown Victoria police unit was struck in the left front by a 1976 Dodge van. The Ford's driver-side supplemental air bag deployed. The officer was unbelted and sustained serious injuries.

Vehicle 1:

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Left arm fracture	2	Spotlight handle
	Pelvic fracture, left side	2	Unknown
	Right leg fracture	3	Unknown
	Laceration, parietal area	1	Unknown

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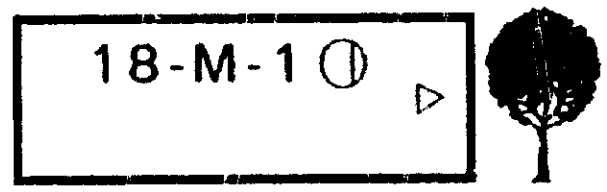
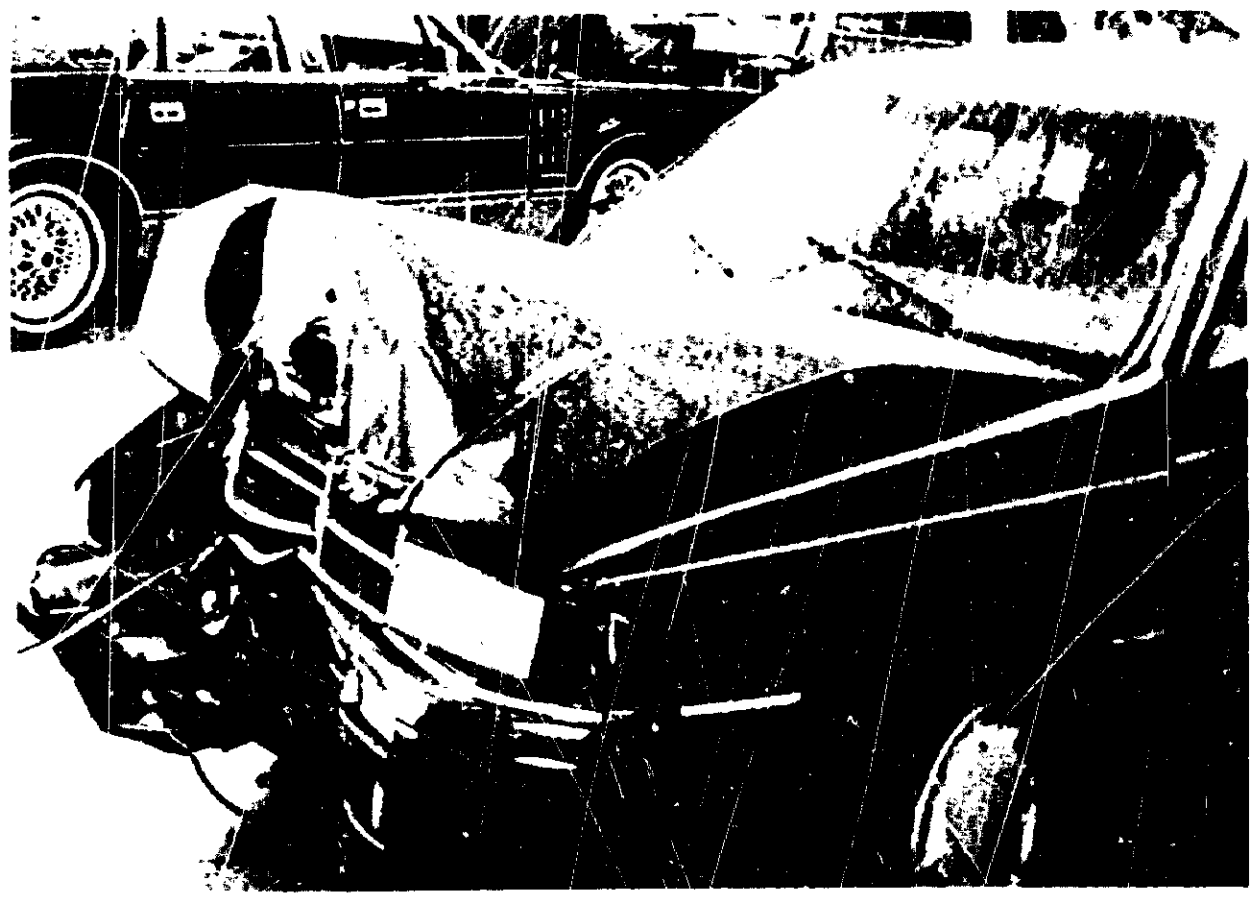
Washington, D.C. 20594

Case No. 23

Acc. No.:	CRH-92-H-OR01
Date:	October 15, 1991
Location:	Lockesburg, Arizonia
Type:	Frontal
Vehicle:	1990 Dodge Spirit
Weight:	2,928 lbs
Delta V:	21 mph

Collision Diagram





A 1990 Dodge Spirit, traveling at a driver-estimated speed of 55-60 mph, swerved to avoid a cow, skidded 181 feet through the grass, and its center front hit a 9-inch-diameter tree. The Dodge was equipped with a driver-side supplemental air bag, which did not deploy. The driver was wearing the manual lap/shoulder belt; however, the shoulder belt was placed behind his back, and he sustained minor injuries.

Chrysler engineers told the Safety Board that their sensors were set to deploy when a vehicle undergoes a longitudinal speed change of 8-14 mph. The Dodge driver stated that the air bag warning light was not illuminated on his instrument panel before the accident. However, the light was illuminated during the postcrash inspection, indicating a malfunction in the system. Diagnostic testing showed that the malfunction had existed for 8,144 fault minutes (approximately 4,000 miles).

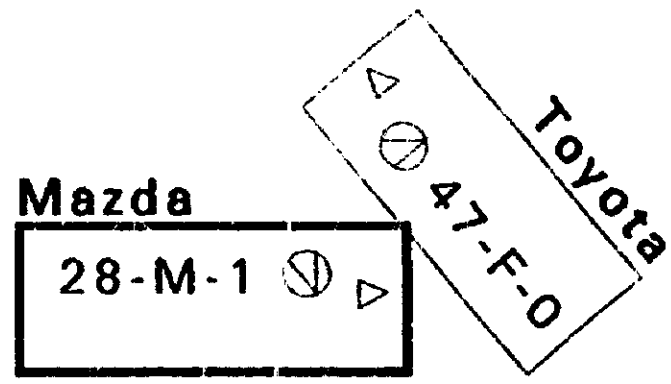
Occupant position	Injuries	AIS	Probable Injury Source
Driver	Contusion, left elbow	1	Steering wheel/instrument panel
	Contusion, right knee	1	Instrument panel
	Contusion, left cheek	1	Windshield
	Contusion, nose	1	Steering wheel
	Contusion, top of head	1	Windshield
	Abrasion, abdomen	1	Lapbelt

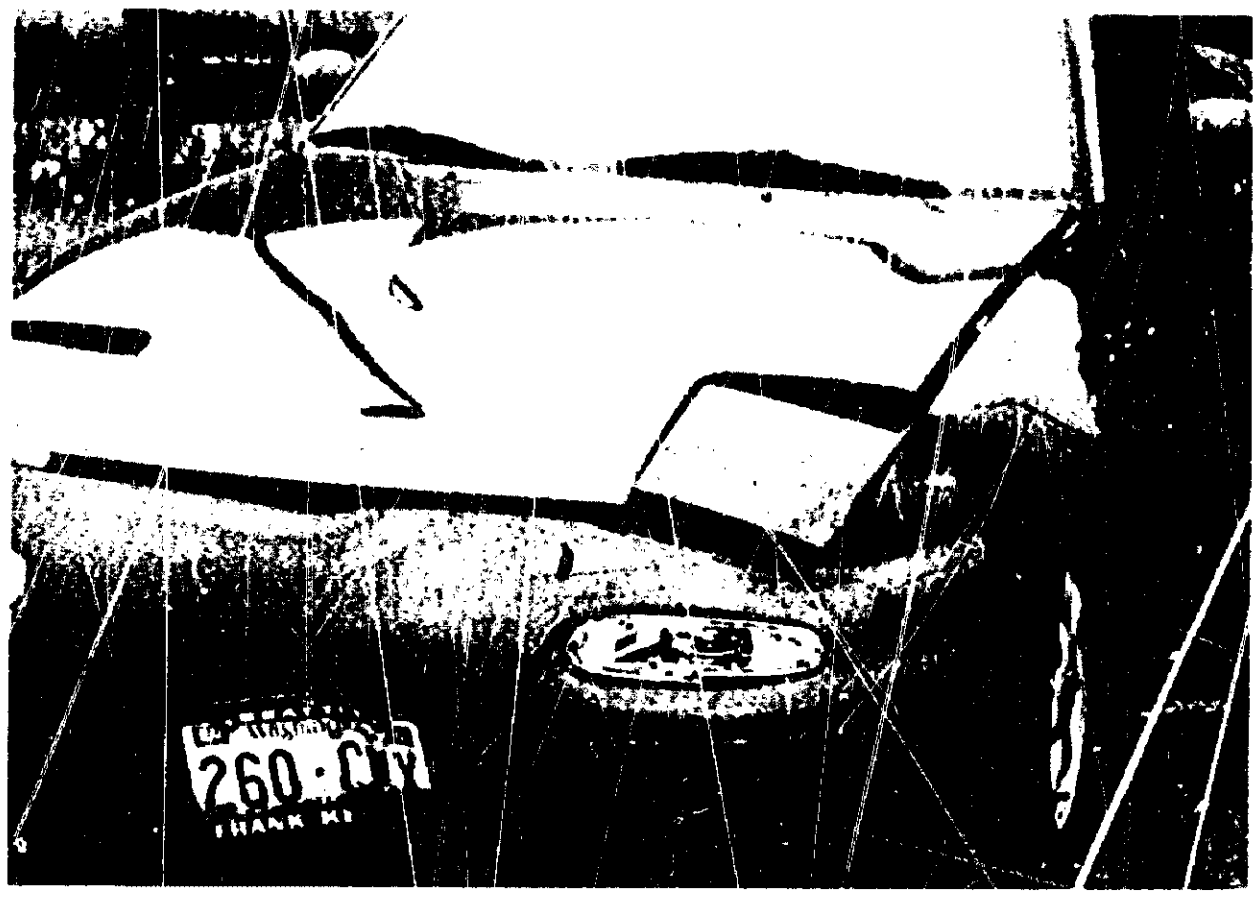
National Transportation Safety Board
Washington, D.C. 20594

Case No. 24

Acc. No.:	NRH-91-H-OR16
Date:	May 17, 1991
Location:	Seattle, Washington
Type:	Frontal
Vehicle 1:	1990 Mazda Miata
Weight:	2,432 lbs
Delta V:	12 mph
Vehicle 2:	1982 Toyota Supra
Weight:	3,157 lbs
Delta V:	9 mph

Collision Diagram





A 1990 Mazda Miata traveling at a driver-estimated speed of 25-30 mph collided with a 1982 Toyota Supra that was making a left turn at an intersection. The left front of the Mazda collided with the left side of the Toyota. The driver of the Mazda was restrained by a manual lap/shoulder belt and sustained minor injuries (AIS 1). The Mazda's driver-side supplemental air bag did not deploy.

The driver of the Toyota was restrained by the manual lap/shoulder belt and was not injured.

Vehicle 1:

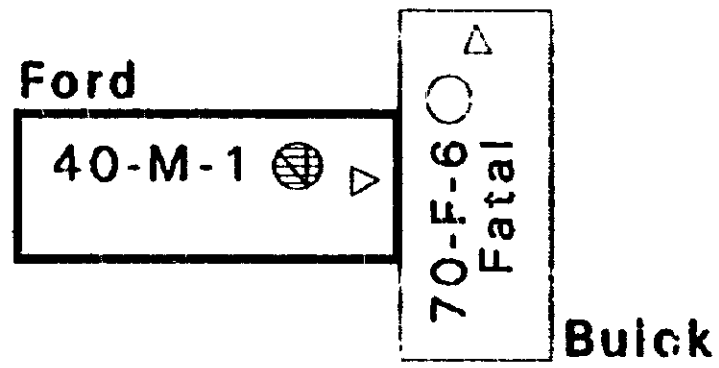
Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Lumbar muscle strain	1	Unknown
	Cervical muscle strain	1	Unknown
	Knee injury	1	Lower dash

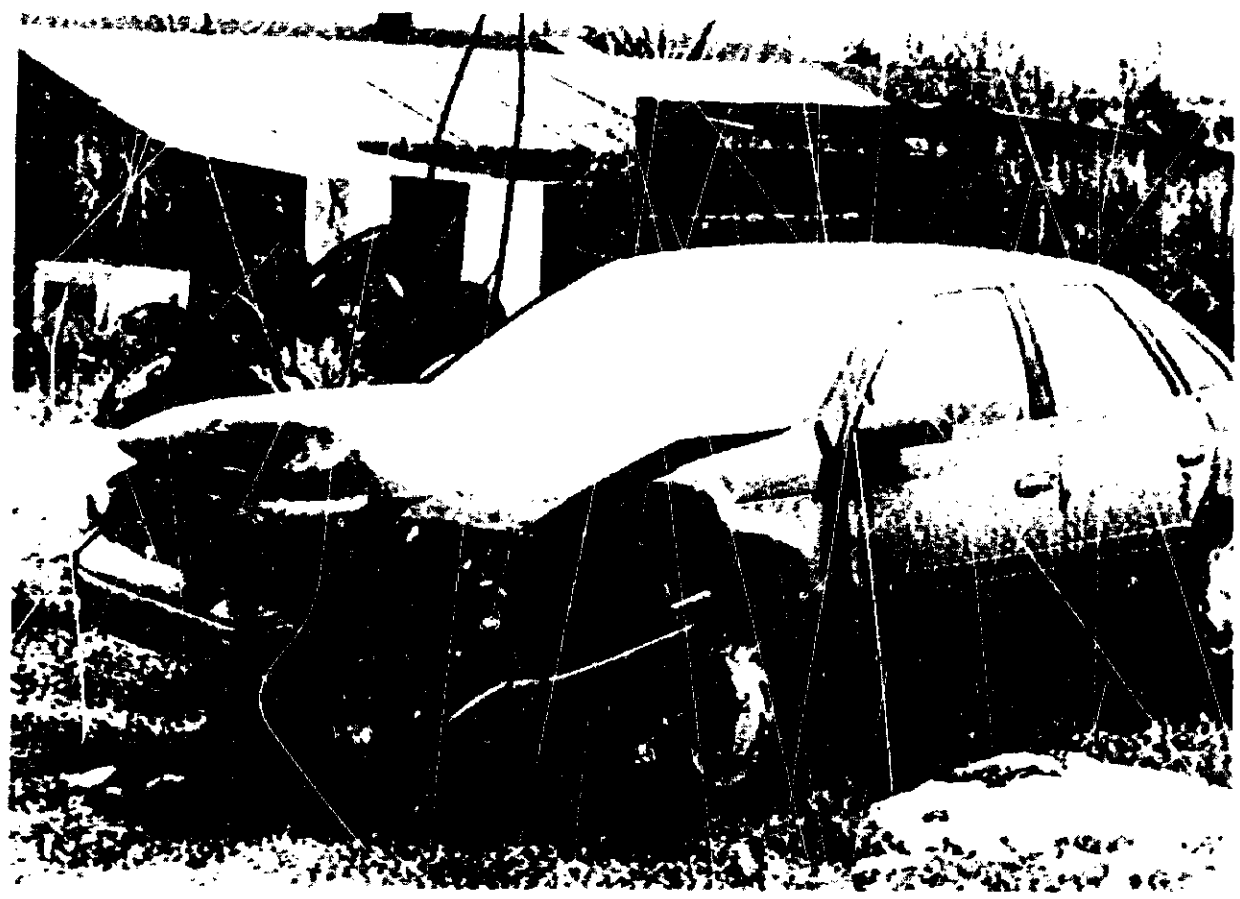
National Transportation Safety Board
Washington, D.C. 20594

Case No. 25

Acc. No.:	CRH-91-FH-007
Date:	January 11, 1991
Location:	West Siloam Springs, Oklahoma
Type:	Frontal
Vehicle 1:	1990 Ford Taurus
Weight:	3,176 lbs
Delta V:	25 mph
Vehicle 2:	1985 Buick Skylark
Weight:	2,730 lbs
Delta V:	29 mph

Collision Diagram





A 1990 Ford Taurus traveling at an estimated speed of 55 mph struck the left side of a 1985 Buick Skylark that had failed to yield the right-of-way. The driver-side supplemental air bag in the Ford deployed, and the driver, who was wearing the manual lap/shoulder belt, sustained minor injuries.

A black plastic paper binder clipped to the shoulder belt webbing approximately 1 inch from the "D" ring at the B-pillar[7] binder created excessive slack in the shoulder belt. The unrestrained driver of the Buick sustained a fatal head injury. The white shirt worn by the Ford driver had small pinhole-size burns along the left sleeve.

Vehicle 1:

Occupant Location	Injuries	AIS	Probable Injury Source
Driver	Chest contusion	1	Shoulder belt
	Left shoulder contusion	1	Shoulder belt
	Contusions, both lower arms	1	Steering wheel/air bag

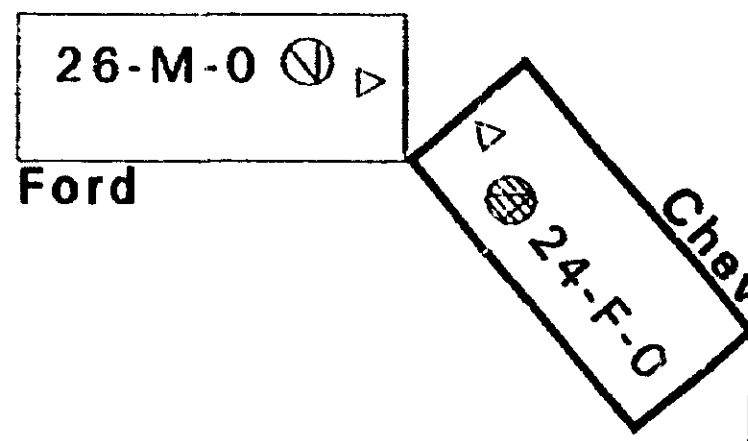
[7]A B-pillar is a vertical roof-support structure; it is located just rearward of the front door opening. An A-pillar is the forwardmost vertical roof-support structure; it is located at the windshield's outer edges.

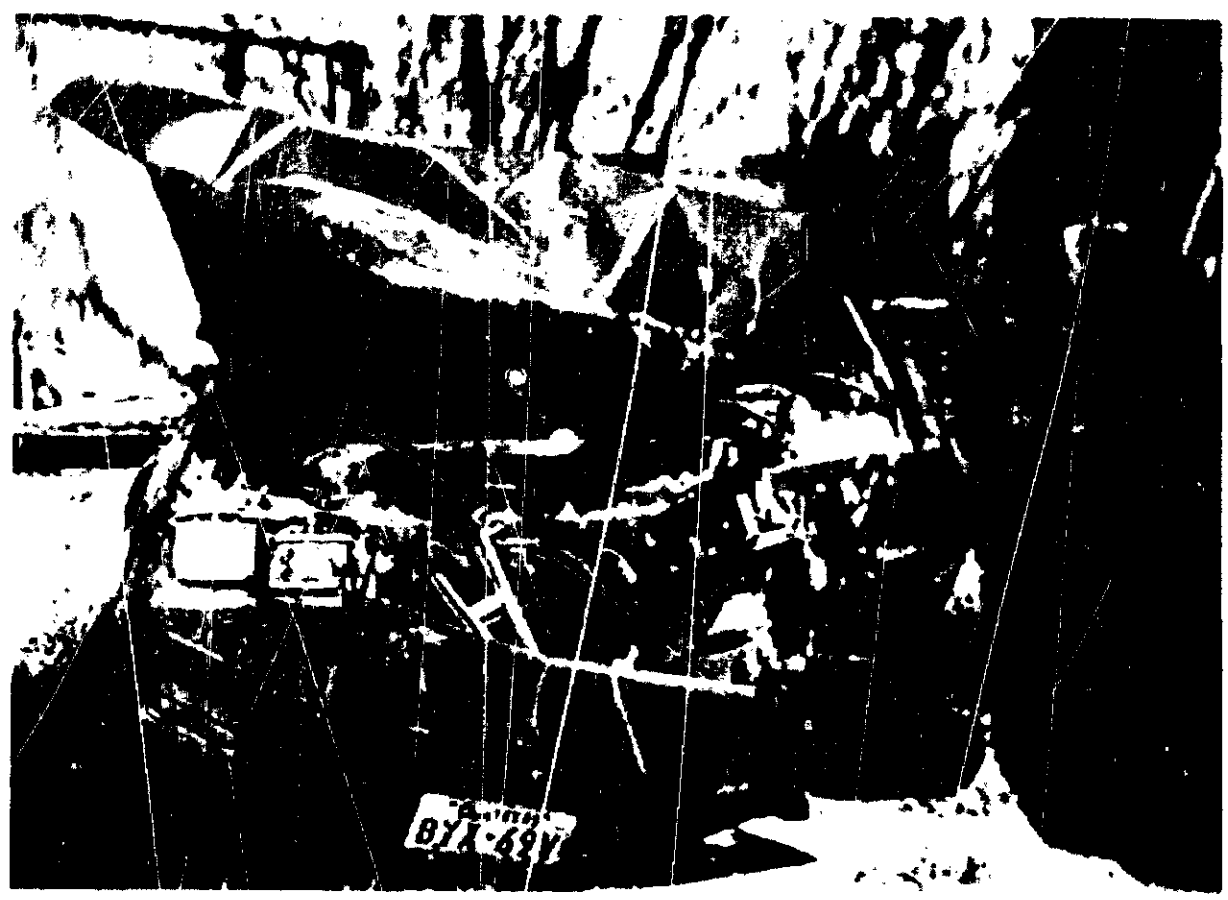
National Transportation Safety Board
Washington, D.C. 20594

Case No. 26

Acc. No.:	CRH-91-HO-R13
Date:	February 28, 1991
Location:	New Braunfels, Texas
Type:	Frontal
Vehicle 1:	1991 Chevrolet Camaro
Weight:	3,496 lbs
Delta V:	15 mph
Vehicle 2:	1987 Ford Pickup
Weight:	4,235 lbs
Delta V:	12 mph

Collision Diagram





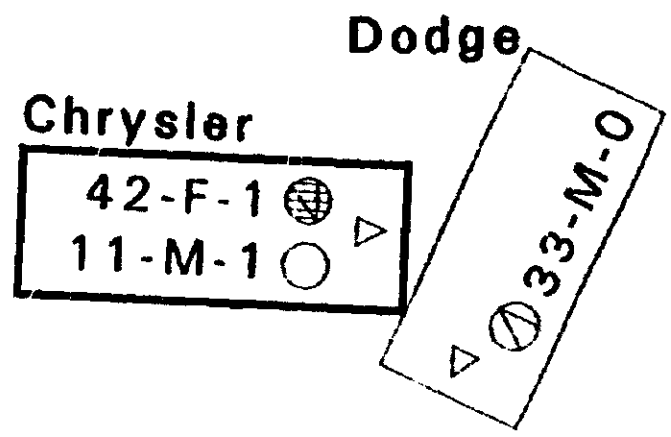
The right front of a 1987 Ford pickup struck the left front of a 1991 Chevrolet Camaro. The pickup driver was restrained with the available manual lap/shoulder belt and was not injured. The Camaro was equipped with a driver-side air bag, which deployed at impact. The Camaro driver was restrained by the manual lap/shoulder belt and was not injured.

National Transportation Safety Board
Washington, D.C. 20594

Case No. 27

Acc. No.:	FTW-90-FH-OO7
Date:	September 26, 1990
Location:	Grand Prairie, Texas
Type:	Frontal
Vehicle 1:	1990 Chrysler LeBaron
Weight:	3,236 lbs
Delta V:	12 mph
Vehicle 2:	1987 Dodge Omni
Weight:	2,385 lbs
Delta V:	17 mph

Collision Diagram



A 1990 Chrysler LeBaron collided with the right-front side of a 1987 Dodge Omni. The LeBaron was equipped with a driver-side supplemental air bag, which deployed at impact. The driver was restrained with the manual lap/shoulder belt and sustained minor injuries (AIS 1). The 11-year-old right-front passenger, who had just removed his lap/shoulder belt, struck the windshield, sustaining a contusion on the head. The Omni driver was restrained with a manual lap/shoulder belt and was not injured.

Vehicle 1:

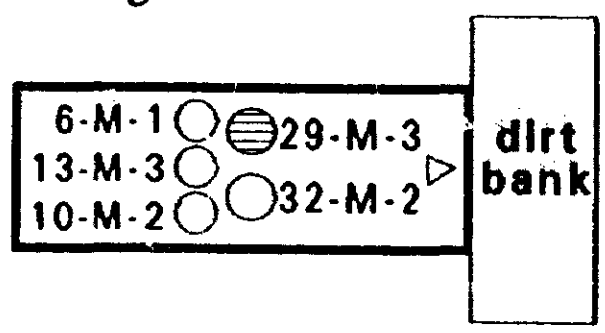
Occupant Location	Injuries	AIS	Probable Injury Source
Driver	Abrasion/Contusion, left arm	1	Air bag
Right front	Contusion on head	1	Windshield

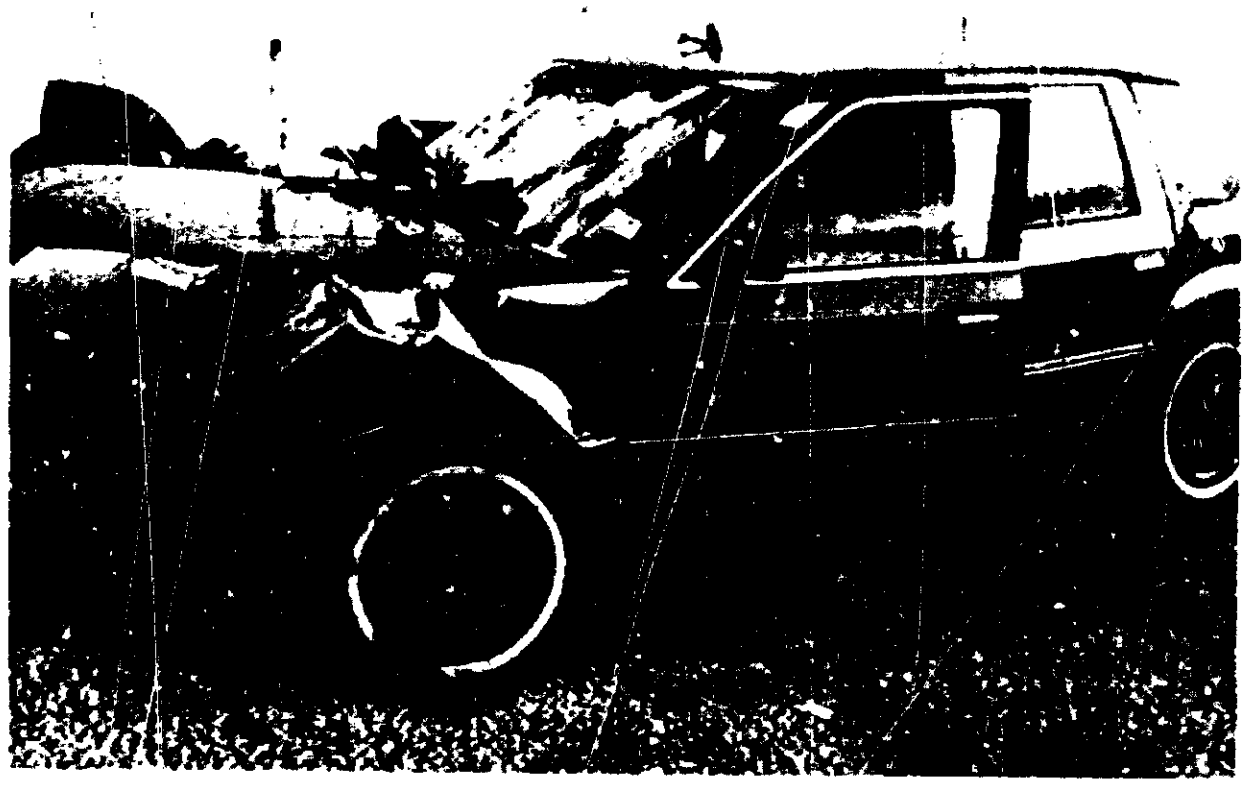
National Transportation Safety 'Board
Washington, D.C. 20594

Case No. 28

Acc. No.:	CRH-91-HO-R15
Date:	March 23, 1991
Location:	Wyandotte, Oklahoma
Type:	Frontal
Vehicle:	1991 Dodge Dynasty
Weight:	3,646 lbs
Delta V:	28 mph

Collision Diagram





A 1991 Dodge Dynasty traveling at an estimated speed of 45 mph approached a sharp right turn, skidded, left the roadway, and struck a dirt embankment. The Dodge was equipped with a driver-side air bag, which deployed at impact. The unbelted driver received serious injuries (AIS 3), and the unrestrained right-front passenger received moderate injuries (AIS 2). Three unrestrained passengers seated in the rear sustained minor (AIS 1) to serious (AIS 3) injuries.

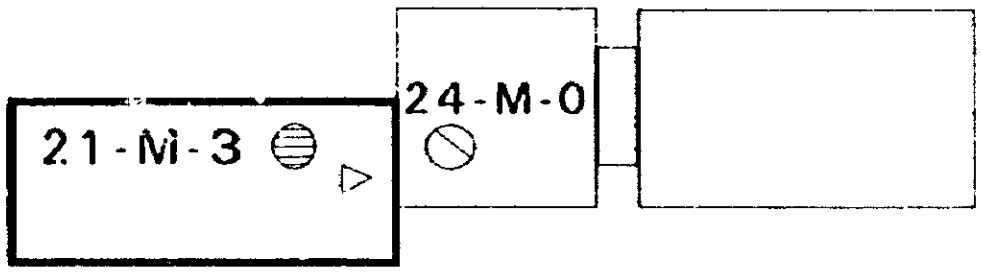
Occupant Location	Injuries	AIS	Probable Injury Source
Driver	Fractured ribs, left side	2	Door/steering wheel
	Hemothorax	3	Steering wheel
	Laceration, right eye	1	Windshield
	Laceration, left arm	1	Door sidewall
	Abrasions, both knees	1	Steering wheel
Right front	Closed head injury	2	Windshield
	Laceration, forehead	1	Rearview mirror/windshield
	Chest contusion	1	Instrument panel
	Fractured right toe	1	Floorboard
	Possible rib fractures	9	Instrument panel
Left rear	Back pain	9	Driver's seatback
Right rear	Fractures, mandible	2	Front headrest
	Closed head injury	2	Seatback
Center rear	Fractured right femur	3	Front instrument panel
	Unspecified head injury	2	Windshield/rearview mirror

National Transportation Safety Board
Washington, D.C. 20594

Case No. 29

Acc. No.:	CRH-91-HO-R18
Date:	May 21, 1991
Location:	Altus, Oklahoma
Type:	Frontal
Vehicle 1:	1991 Chevrolet Camaro
Weight:	3,238 lbs
Delta V:	54 mph
Vehicle 2:	1990 International Truck
Weight:	Unknown
Delta V:	Unknown

Collision Diagram



A 1991 Chevrolet Camaro veered across the center of the road and struck the left front of a 1990 International 8300 three-axle truck tractor. After initial impact, the Camaro continued down the side of the tractor and struck the outside forward-drive axle tire and wheel, causing it to rotate counterclockwise approximately 400 degrees. The Delta V for the Camaro was 54 mph. The driver-side supplemental air bag deployed during the collision. There was extensive intrusion into the occupant's compartment. The unbelted driver was found pinned in his seat, leaning to the left. He sustained serious injuries.

Vehicle 1:

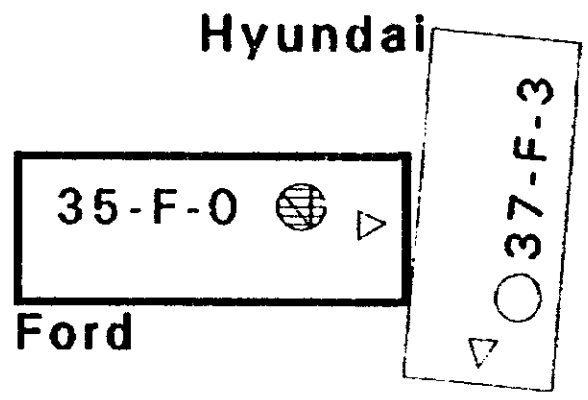
Occupant Location	Injuries	AIS	Probable Injury Source
Driver	Comminuted left femur fracture	3	Knee bolster/instrument panel
	Fractured right ankle	2	Floorboard
	Fractured left tibia	2	Knee bolster/instrument panel
	Abrasions/lacerations/contusions	1	Door/instrument panel
	Fractured left wrist	2	Upper dashboard

National Transportation Safety Board
Washington, D.C. 20594

Case No. 30

Acc. No.:	SRH-91-FH-O14
Date:	May 9, 1991
Location:	Smyrna, Georgia
Type:	Frontal
Vehicle 1:	1991 Ford Taurus
Weight:	3,091 lbs
Delta V:	12 mph
Vehicle 2:	1989 Hyundai Excel
Weight:	2,288 lbs
Delta V:	16 mph

Collision Diagram



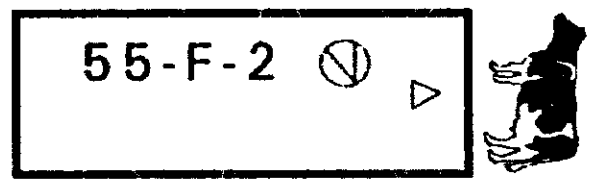
A 1991 Ford Taurus struck a 1989 Hyundai at the right B-pillar; a Ford wrecker struck both vehicles, and a BMW struck the Hyundai. The Taurus was equipped with a driver-side air bag, which deployed. The driver was restrained with the manual lap/shoulder belt and was not injured. The Hyundai driver was not wearing the available lap/shoulder belt and sustained serious injuries (AIS 3).

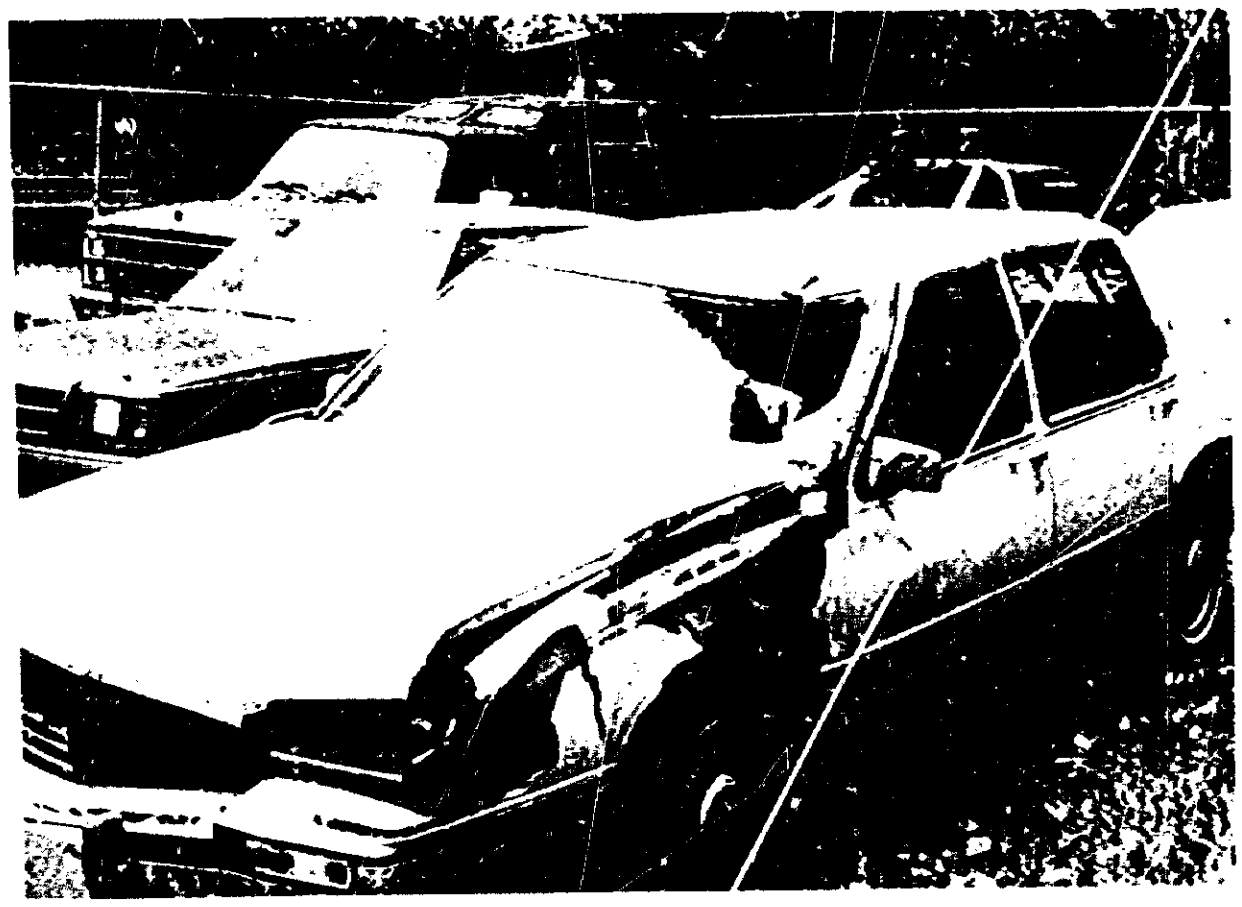
National Transportation Safety Board
Washington, D.C. 20594

Case No. 31

Acc. No.:	CRH-92-HO-RO2
Date:	November 10, 1991
Location:	Centerville, Texas
Type:	Frontal
Vehicle:	1991 Cadillac DeVille
Weight:	3,767 lbs
Delta V:	11 mph

Collision Diagram





A 1991 Cadillac Sedan Deville collided with an 800-pound cow. The supplemental driver-side air bag did not deploy. General Motors engineers told Safety Board investigators that impact sensors were set to signal the air bag to inflate when a 12-14 mph Delta V barrier equivalent speed change occurs.

The driver was restrained with the manual lap/shoulder belt and sustained a fractured vertebra. The windshield was displaced. The driver stated that "the cow came into the windshield and struck her in the face and head."

Occupant Location	Injuries	AIS	Probable Injury Source
Driver	C-2 vertebra fracture	2	Head struck by cow
	Odontoid fracture	1	Head struck by cow

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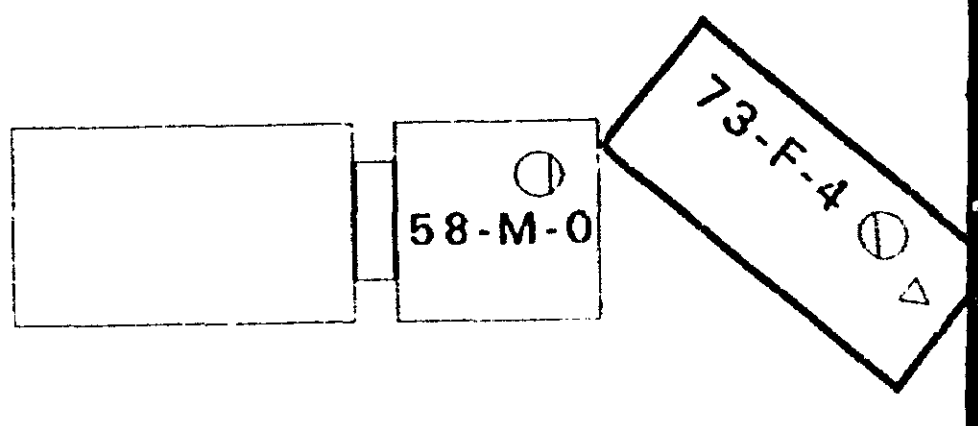
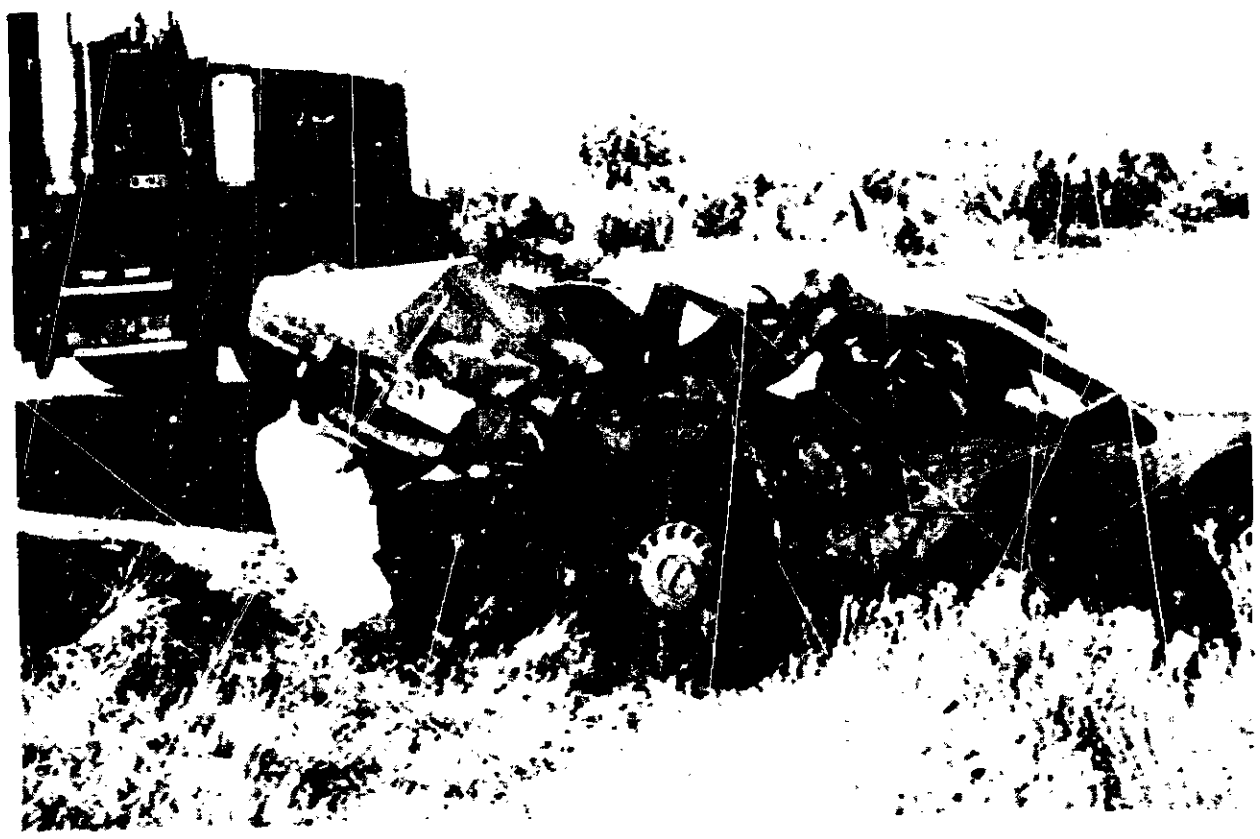
Washington, D.C. 20594

Case No. 32

Acc. No.	WRH-91-HO-R17
Date:	September 16, 1991
Location:	Cortez, Colorado
Type:	Frontal
Vehicle 1:	1991 Ford Thunderbird
Weight:	3,091 lbs
Delta V:	35 mph
Vehicle 2:	1989 Peterbuilt Truck
Weight:	80,000 lbs
Delta V:	Unknown

Collision Diagram





A 1991 Ford Thunderbird (rental car) was traveling 50-55 mph when the driver lost control. The Ford skidded, rotated in a counterclockwise direction, and was struck in the right rear by a 1989 Peterbilt tractor-trailer. The Delta V for the Thunderbird was 35 mph. The driver was wearing only the motorized shoulder belt and at impact was thrown backwards out of the seat into the right rear of the automobile. She was found by rescue personnel in a prone position on her back, lying across the seat backs with her head protruding out the right-rear broken window; the shoulder belt had torn from the motorized track and was lying across her legs. She sustained severe injuries.

She told the Safety Board investigator that she was wearing her seatbelt because it automatically locks a person in the seat whenever the ignition is turned on. When asked about using the lapbelt portion of the restraint, she replied: "What belt you talking about sonny?" She said no one, not even the Hertz people, had advised her that there is more to the restraint system than the shoulder belt that "locks you automatically." She had been renting Thunderbirds from rental car companies since 1987.

Vehicle 1:

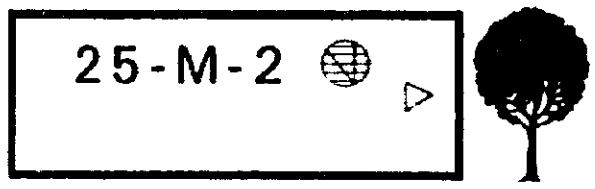
Occupant Location	Injuries	AIS	Probable Injury Source
Driver	Flail chest with pneumothorax	4	Unknown
	Contusions/abrasions, both breast	1	Shoulder belt
	Contusions above right eye	1	Unknown
	Laceration, top of head	1	Right-rear window

National Transportation Safety Board
Washington, D.C. 20594

Case No. 33

Acc. No.:	SRH-91-FH-O18
Date:	June 21, 1991
Location:	Marietta, Georgia
Type:	Frontal
Vehicle:	1990 Ford Crown Victoria
Weight:	4,106 lbs
Delta V:	26 mph

Collision Diagram



A 1990 Ford LTD Crown Victoria county police unit was traveling at an estimated speed of 75 mph when it skidded out of control; it ran off the road, across a street, through a vacant lot, down an embankment, and into a tree. The Crown Victoria was equipped with a driver-side air bag, which deployed at impact. The driver was restrained with the lap/shoulder belt and sustained moderate injuries (AIS 2).

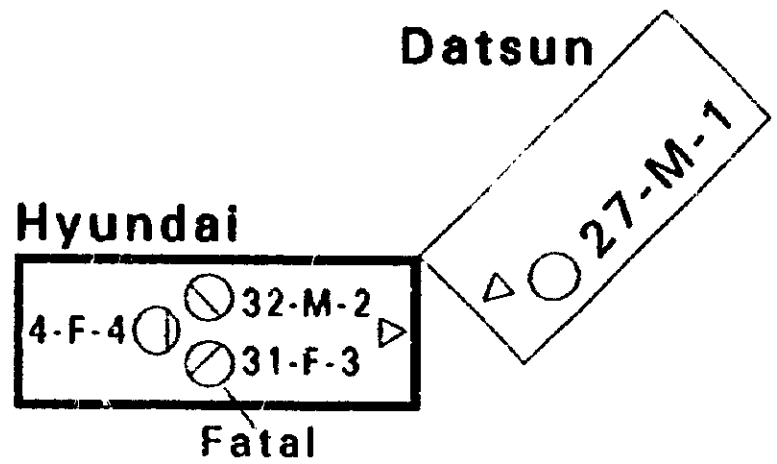
Occupant Location	Injuries	AIS	Probable Injury Source
Driver	Fractured left ankle	2	Floorboard/brake pedal

National Transportation Safety Board
Washington, D.C. 20594

Case No. 34

Acc. No.:	SRH-91-FH-017
Date:	June 4, 1991
Location:	Lawrenceville, Georgia
Type:	Frontal
Vehicle 1:	1988 Hyundai Excel
Weight:	2,530 lbs
Delta V:	31 mph
Vehicle 2:	1979 Datsun 280-ZX
Weight:	3,080 lbs
Delta V:	26 mph

Collision Diagram



A 1988 Hyundai Excel entered signalized intersection and collided head-on with an approaching 1979 Datsun 280-ZX that was making a left turn. The Hyundai rotated clockwise after impact. The Hyundai's driver and right-front passenger were wearing detachable automatic shoulder belts. The rear-seat passenger of the Hyundai was in the center position, restrained by

a manual two-point lapbelt, and received severe injuries (AIS 4). The right-front passenger was fatally injured (AIS 3). The Hyundai's front seats were not equipped with lapbelts.

Vehicle 1:

Occupant Location	Injuries	AIS	Probable Injury Source
Driver	Fractured left clavicle	2	Inside door panel
	Fractured right heel	2	Unknown
	Fractured sternum	2	Unknown
	Laceration, left forehead	1	Side-window glass
	Lacerations, both lower legs	1	Lower dashboard
Right front (Fatal)	Depressed skull fracture	3	Instrument panel
	Fractured right humerus	2	Unknown
	Fractured femur, right/left	3	Lower dashboard
	Bruises/abrasions, left side	1	Unknown
	Lacerated liver	3	Unknown
	Transected pancreas	3	Unknown
	Kidney destruction	3	Unknown
	Ruptured uterus	2	Unknown
Center rear	Mesentric laceration	4	Lapbelt
	Jejunal perforation	3	Lapbelt
	Fracture/dislocation, L-3 and L-4 vertebrae	3	Unknown
	Intra and retroperitoneal hematoma	2	Lapbelt

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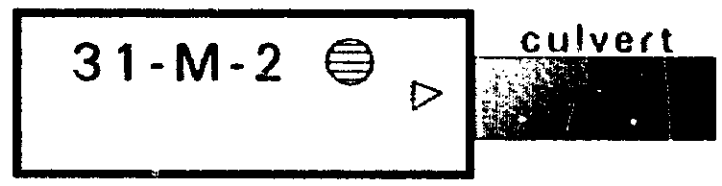
Case No. 35

Acc. No.:	CRH-91-HO-R19
Date:	May 23, 1991
Location:	Brookland, Arizona
Type:	Frontal
Vehicle:	1991 Ford Mustang GT
Weight:	2,989 lbs
Delta V:	10 mph

Collision Diagram



A 1991 Mustang GT left the pavement, traveled 208 feet in a drainage ditch, struck a driveway culvert, vaulted 38 feet, and rolled to a stop. The Mustang was equipped with a driver-side supplemental air bag, which deployed at impact. The driver was not wearing the manual lap/shoulder belt, and he sustained moderate injuries (AIS 2).

Occupant Location	Injuries	AIS	Probable Injury Source
Driver	Cerebral concussion	2	Vehicle roof
	Compression fracture, T-12 and L-1	2	Impact forces
	Abrasion, left knee	1	Lower instrument panel

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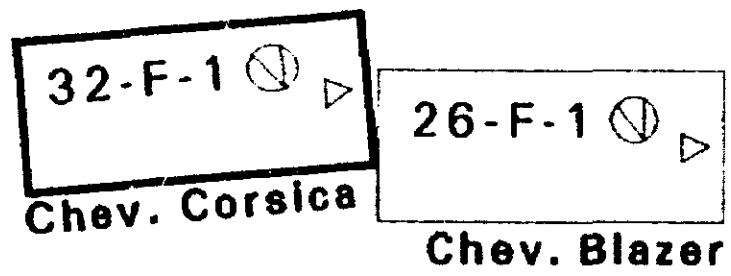
Case No. 36

Acc. No.:	CRH-92-HO-RO3
Date:	December 5, 1991
Location:	San Angelo, Texas
Type:	Frontal
Vehicle 1:	1991 Chevrolet Corsica
Weight:	2,785 lbs
Delta V:	15 mph
Vehicle 2:	1991 Chevrolet S-10 Blazer
Weight:	3,694 lbs
Delta V:	11 mph

Collision Diagram



A 1991 Chevrolet Corsica struck the rear of a 1991 Chevrolet S-10 Blazer. The Corsica's supplemental driver-side air bag did not deploy. The driver was wearing the manual lap/shoulder belt and sustained minor injuries (AIS 1). The Corsica had crush damage across the front grill area, but the vehicle contact was not frame to frame.

Vehicle 1:

Occupant Location	Injuries	AIS	Probable Injury Source
Driver	Contusion, forehead	1	Steering wheel

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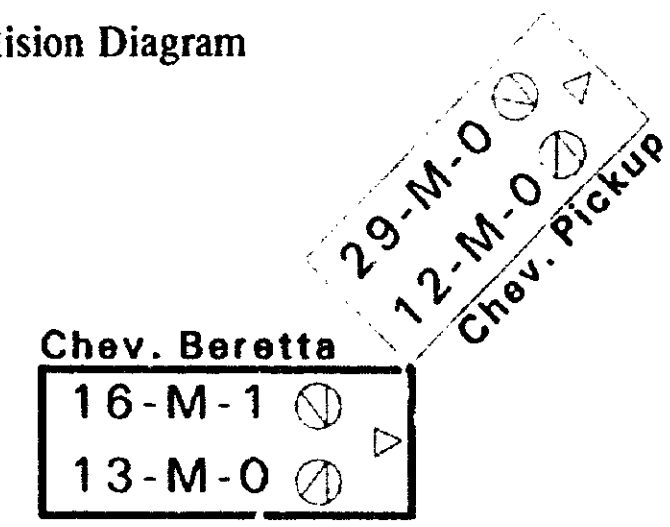
Case No. 37

Acc. No.:	CRH-92-HO-R05
Date:	January 20, 1992
Location:	Lubbock, Texas
Type:	Frontal for Vehicle 1
Vehicle 1:	1992 Chevrolet Beretta GT
Weight:	3,115 lbs
Delta V:	Unknown
Vehicle 2:	1992 Chevrolet Pickup
Weight:	4,934 lbs
Delta V:	Unknown

Collision Diagram



A 1992 Chevrolet Beretta traveling at an estimated speed of 62 mph collided into the right rear of a 1992 Chevrolet pickup that was turning left. The Beretta skidded off the right side of the roadway, vaulted about 20 feet, and came to rest in a field. The Beretta was equipped with a driver-side supplemental air bag, which did not deploy. The driver was wearing the manual lap/shoulder belt and sustained minor injuries. The right-front passenger was wearing the manual lap/shoulder belt and was not injured.

The Beretta bumper underrode the pickup bumper, displacing the Beretta's hood. The Beretta's left fender and door were displaced rearward, the A-pillar was compressed inward approximately 1 inch, the windshield was displaced into the driver's compartment, and the roof was buckled at the B-pillar. The vehicle frame was not damaged.

The driver and right-front passenger of the Chevrolet truck were restrained by manual three-point lap/shoulder belts and were not injured.

Vehicle 1:

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Eyelid laceration	1	Glass
	Contusion, top of head	1	Vehicle roof

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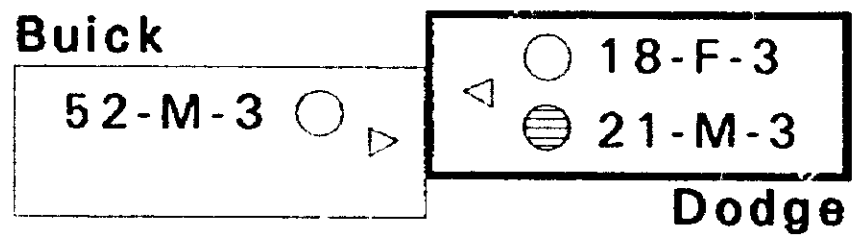
Case No. 38

Acc. No.:	NRH-91-FO-R11
Date:	April 29, 1991
Location:	Taylor Township, Pennsylvania
Type:	Frontal
Vehicle 1:	1990 Dodge Shadow
Weight:	2,935 lbs
Delta V:	39 mph
Vehicle 2:	1985 Buick Century Wagon
Weight:	3,259 lbs
Delta V:	35 mph

Collision Diagram



A 1990 Dodge Shadow crossed into the opposing lane of traffic and struck a 1985 Buick Century Station Wagon in the left front. The driver-side supplemental air bag in the Dodge deployed at impact. The collision compressed the left front of the Dodge 34 inches, pushing the steering wheel and column rearward and upward. The fire wall was pushed rearward to within 15 inches of the driver's seat. The impact jammed both doors closed and buckled the structure at the driver's door. The unbelted driver was thrown forward and sustained serious injuries (AIS 3).

The unrestrained right-front passenger was thrown into the windshield and pinned underneath the instrument panel, sustaining serious injuries (AIS 3).

Vehicle 1:

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Lacerated chin	1	Unknown
	Hyperextended neck	1	Air bag
	Comminuted femur fractures	3	Lower instrument panel
Right Front	Closed head injury	2	Windshield
	Facial lacerations/avulsions	3	Windshield
	Severe neck avulsion	1	Unknown
	Avulsions, right premaxilla	1	Windshield
	Fractured right radius	2	Unknown
	Fractured left hip	3	Unknown
	Fractured/dislocated left ankle	2	Fire wall

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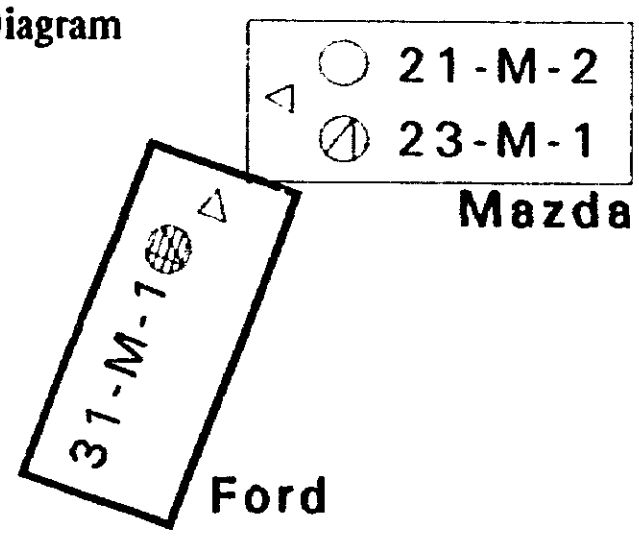
Case No. 39

Acc. No.:	SRH-91-FH-O22
Date:	September 11, 1991
Location:	Marietta, Georgia
Type:	Frontal
Vehicle 1:	1991 Ford Crown Victoria
Weight:	4,340 lbs
Delta V:	18 mph
Vehicle 2:	1990 Mazda RX-7
Weight:	2,900 lbs
Delta V:	27 mph

Collision Diagram



A 1991 Ford Crown Victoria police unit was making a U-turn to pursue speeding vehicles when it was struck in the front by a 1990 Mazda RX-7. The Ford was equipped with a driver-side air bag, which deployed. The driver was wearing the manual three-point lap/shoulder belt and sustained minor injuries (AIS 1), including multiple abrasions on his left forearm (reddish) and a burn on the upper left thigh.

Chemical laboratory testing of the police officer's 100-percent polyester trousers determined that the fabric would begin to scorch at 300 degrees F, begin to melt at 320 degrees F, and lose all physical properties at temperatures above 320 degrees F; in addition, the fibers tend to fuse and shrink away from heat.

The TRW air bag module involved in this accident was inspected by TRW, Ford, and the Safety Board. According to the Ford engineer, the "component and system function appeared normal in all respects."[8] Neither the Ford nor the TRW representatives could determine whether the burn to the officer's trousers was a friction or thermal burn. They stated they were not aware of any instance of clothing burns caused by an air bag, although they acknowledged there have been cases of an air bag allegedly causing abrasions or burns to a driver's forearms.

There was no intrusion into the interior of the vehicle. The two vent ports for the air bag module are located at the 10 and 2 o'clock positions on the steering wheel when the vehicle is being steered straight ahead. The driver was turning left at the time of impact, positioning the 10 o'clock vent port at the 6 o'clock position close to the driver's leg.

The lap/shoulder-belted Mazda driver received minor injuries (AIS 1), and the unrestrained right-front passenger received moderate injuries (AIS 2).

Vehicle 1:

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Contusion, back of head	1	Screen behind driver
	Abrasion, right chest	1	Shoulder belt
	Multiple abrasions, forearm	1	Air bag
	Burn, upper left thigh	1	Hot gas air bag
	Contusion, left hip	1	Arm rest

[8]January 8, 1992, letter to Jay Golden, Director NTSB Southeast Regional Highway Office, from Roger C. Wagner, P.E., Ford Motor Company, Dearborn, Michigan.

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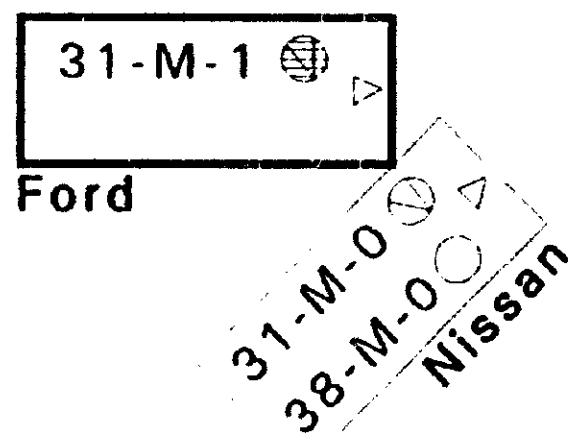
Case No. 40

Acc. No.:	NRH-91-FO-R13
Date:	May 12, 1990
Location:	Fermanagh, Pennsylvania
Type:	Frontal
Vehicle 1:	1991 Ford Crown Victoria
Weight:	4,091 lbs
Delta V:	7 mph
Vehicle 2:	1990 Nissan Sentra
Weight:	2,676 lbs
Delta V:	10 mph

Collision Diagram



A 1991 Ford Crown Victoria State Police unit struck the left-front side of a 1990 Nissan Sentra. The Ford was equipped with a driver-side air bag, which deployed at impact. The driver was restrained with the lap/shoulder belt and sustained minor injuries (AIS 1), including inner forearm abrasions. The Nissan driver was restrained with the motorized shoulder belt and the manual lapbelt but was bumped in the head by the unrestrained right-front passenger.

Vehicle 1:

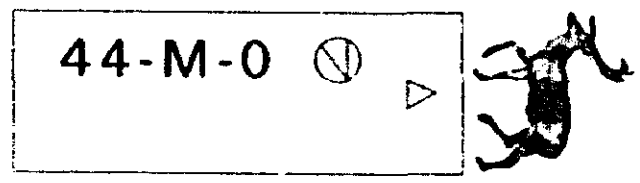
Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Inner forearm abrasions	1	Air bag

National Transportation Safety Board
Washington, D.C. 20594

Case No. 41

Acc. No.:	WRH-92-HO-RO1
Date:	November 11, 1991
Location:	Cortez, Colorado
Type:	Frontal
Vehicle:	1991 Chevrolet Camaro
Weight:	4,562 lbs
Delta V:	<5 mph

Collision Diagram



A 1991 Chevrolet Camaro highway patrol unit responding to an emergency struck a deer. The impact occurred at the center front of the Camaro and wrinkled the hood; there was no damage to the front bumper, grill, or windshield. After impact, the vehicle rotated clockwise 180 degrees. The driver-side supplemental air bag did not deploy. The officer was wearing the manual lap/shoulder belt and was not injured.

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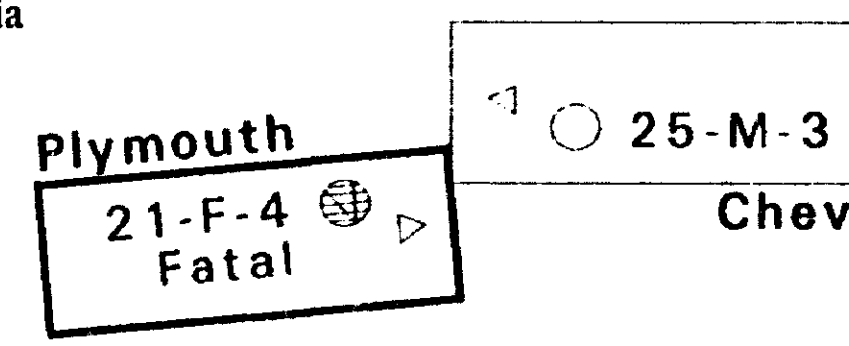
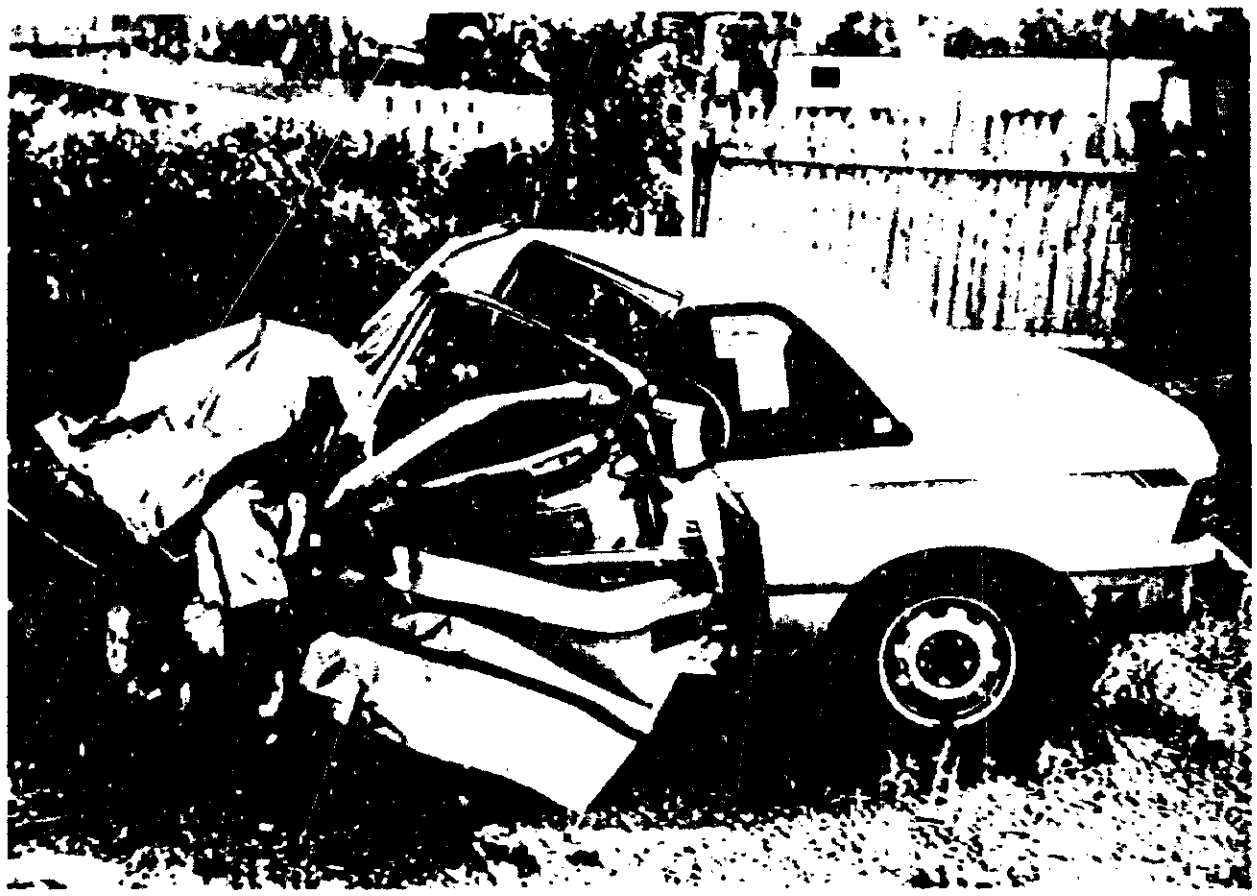
Case No. 42

Acc. No.:	NRH91FOR17	Collision Diagram
Date:	July 12, 1991	
Location:	Montgomery Township, Pennsylvania	
Type:	Frontal	
Vehicle 1:	1991 Plymouth Sundance	
Weight:	2,832 lbs	
Delta V:	66 mph	
Vehicle 2:	1990 Chevrolet Suburban	
Weight:	6,480 lbs	
Delta V:	29 mph	





A 1991 Plymouth Sundance crossed into the opposing lanes of traffic and collided head-on with a 1990 Chevrolet Suburban sport utility vehicle. The Plymouth's supplemental air bag deployed, and the driver was restrained by the manual lap/shoulder belt. However, the crash consumed the occupant's space, and she died as a result of several serious (AIS 3) or severe (AIS 4) head and abdominal injuries. The left front of the Sundance experienced 49 inches of crush and buckled the structure 6 inches at the driver's door; in addition, the instrument panel and the steering column were displaced 12 inches rearward.

Vehicle 1:

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Contusions/lacerations, head	1	Unknown
	Avulsion of teeth	1	Unknown
	Bilateral subarachnoid hemorrhage	3	Unknown
	Acute cerebral edema	3	Unknown
	Laceration, liver	4	Unknown
	Laceration, spleen	2	Unknown
	Hemoperitoneum	2	Unknown
	Hemothorax	3	Unknown
	Laceration, right lung	3	Unknown
	Contusion, bladder	2	Unknown
	Fractured femur	3	Unknown
	Abrasions/contusions/lacerations, trunk and extremities	1	Unknown

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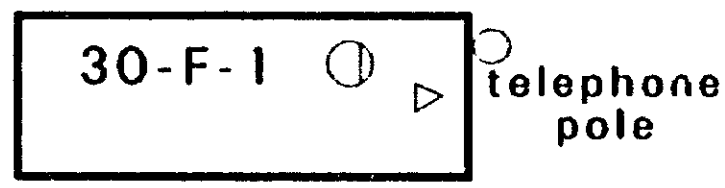
Case No. 43

Acc. No.:	CRH-92-HO-RO9
Date:	February 6, 1992
Location:	Renton, Washington
Type:	Frontal
Vehicle:	1990 Ford Festiva
Weight:	2,005 lbs
Delta V:	15 mph

Collision Diagram



A 1990 Ford Festiva two-door hatchback ran off the road, and the left front struck a telephone pole. The driver was wearing the available manual lapbelt but had disconnected the motorized shoulder belt because "it was uncomfortable across her neck." She sustained minor injuries (AIS 1). There was a "spider web crack" in the windshield directly in front of the driver's position, and the steering-wheel rim was bent forward.

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Laceration, bottom lip	1	Windshield
	Chipped tooth	1	Windshield
	Bruising on chest	1	Steering wheel
	Laceration, left knee	1	Lower instrument panel

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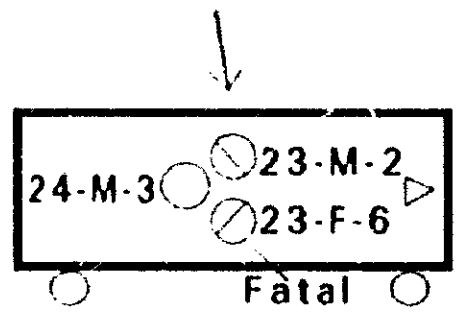
Washington, D.C. 20594

Case No. 44

Acc. No.:	NRH-92-FO-RO2
Date:	September 21, 1991
Location:	Chanceford, Pennsylvania
Type:	Side
Vehicle:	1990 Ford Thunderbird
Weight:	4,294 lbs
Delta V:	Unknown

Collision Diagram



A 1990 Ford Thunderbird Super Coupe traveling at 65-70 mph ran off the road into a wooded area. While rotating in a counterclockwise direction the Ford struck a large tree with the right-rear quarterpanel; then it rotated clockwise and struck several smaller trees before coming to rest. The driver and the right-front passenger were restrained by the motorized shoulder belts but not by the available manual lapbelts. The driver sustained moderate injuries (AIS 2). The right-front door opened and the passenger was ejected; she died of a cervical spine fracture (C1 and C2). Both front-seat shoulder belts were found in the fully engaged position with the tabs broken away from their tracks. The unrestrained rear-seat passenger sustained serious injuries (AIS 3).

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Fractured right ankle	2	Unknown
	Numerous abrasions	1	Unknown
Right front	Cervical spine fracture	6	Shoulder belt
Center rear	Subarachnoid hemorrhage	3	Roof
	Fractured right ribs	2	Unknown
	Right pneumothorax	3	Unknown
	Facial lacerations	1	Unknown
	Pulmonary contusion	3	Unknown

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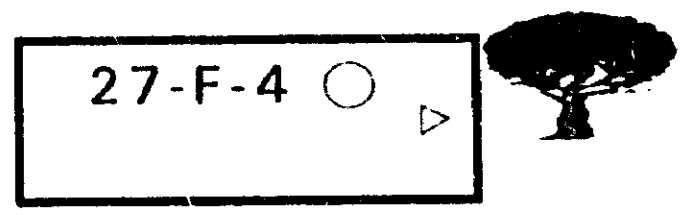
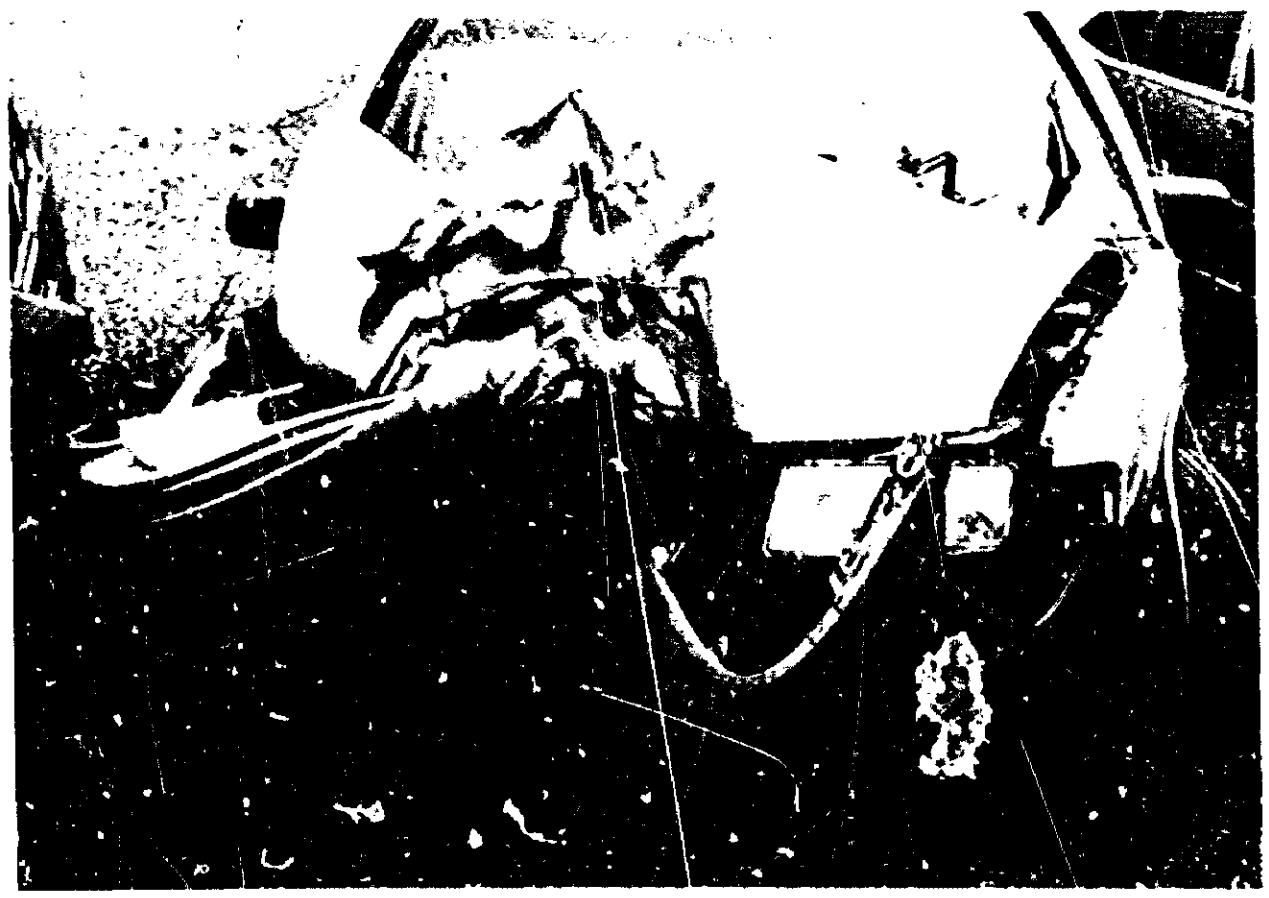
Case No. 45

Acc. No.:	CRH-92-HO-RO8
Date:	January 17, 1992
Location:	Kent, Washington
Type:	Frontal
Vehicle:	1990 Chevrolet Lumina
Weight:	3,419 lbs
Delta V:	35 mph

Collision Diagram





A 1990 Chevrolet Lumina traveling at an estimated speed of 50 mph braked suddenly, ran off the road into the brush, and struck a 21-inch-diameter tree with the front center of the vehicle. The Chevrolet was equipped with a detachable door-mounted lap/shoulder belt combination, which was detached at the time of the accident.

The unrestrained driver sustained severe injuries (AIS 4). She stated that she did wear the restraint most of the time but did not keep it attached when exiting the vehicle. She indicated that she was not wearing the restraint system this time because she was about 15 minutes behind schedule.

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Lacerations, liver	3	Steering wheel
	Massive lacerations, spleen	4	Steering wheel
	Bruised right kidney	2	Steering wheel
	Fractured/dislocated right ankle	3	Brake pedal/floor
	Laceration, right knee	1	Lower instrument panel
	Rib fractures with pneumothorax	2	Steering wheel
	Facial bruises	1	Windshield

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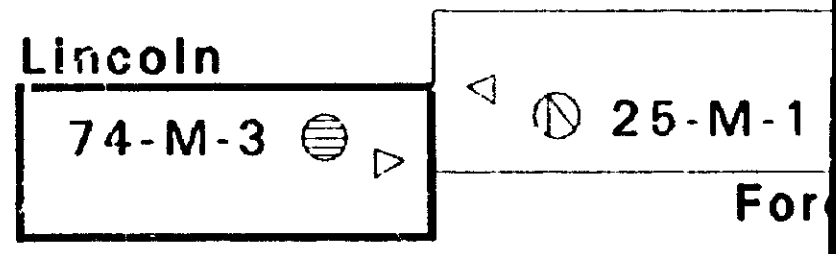
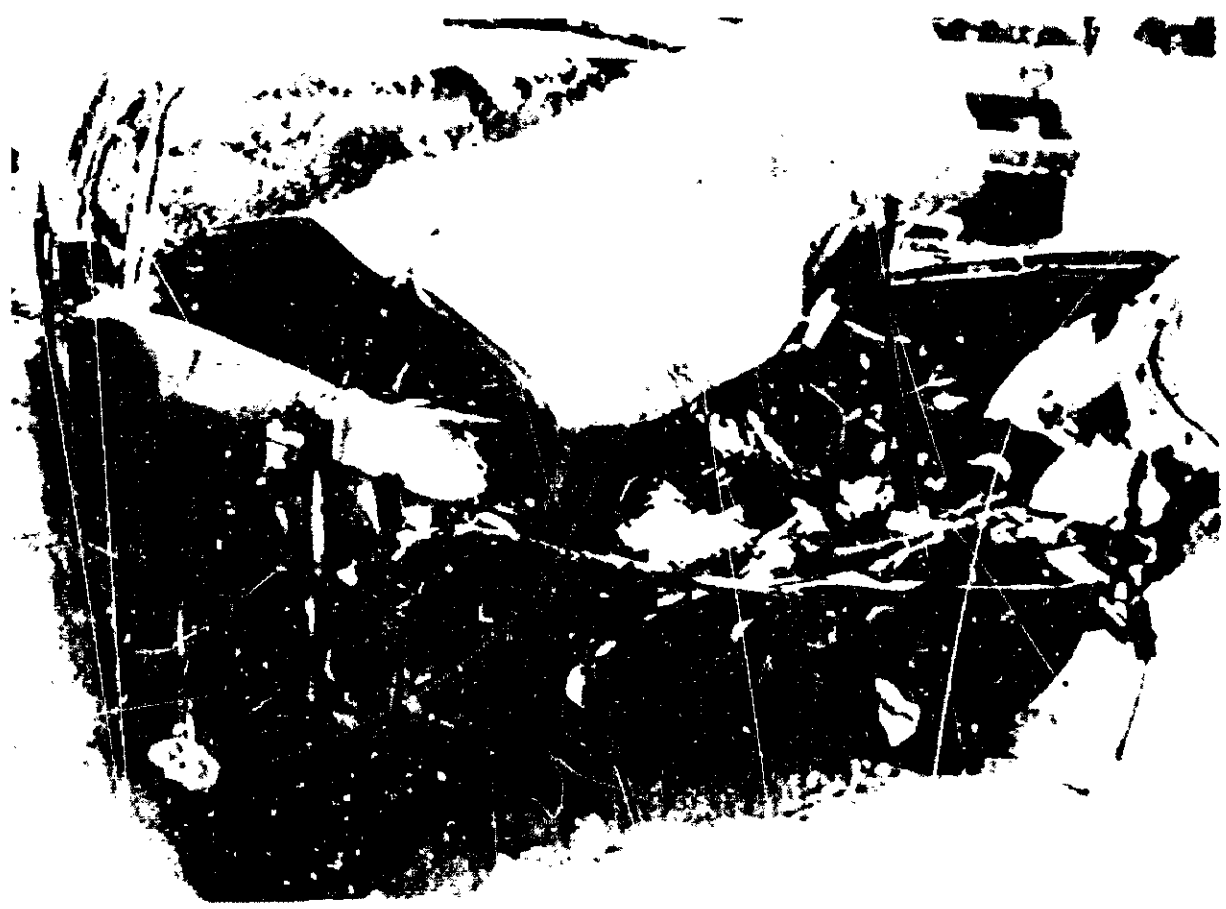
Washington, D.C. 20594

Case No. 46

Acc. No.:	NRH-92-FO-RO4
Date:	February 3, 1992
Location:	Huston, Pennsylvania
Type:	Frontal
Vehicle 1:	1991 Lincoln Town Car
Weight:	4,285 lbs
Delta V:	27 mph
Vehicle 2:	1986 Ford P-600 van
Weight:	Unknown
Delta V:	Unknown

Collision Diagram





A 1991 Lincoln Town Car crossed into the opposing lane of traffic while descending a grade and hit a 1986 Ford delivery van head-on. The Town Car was equipped with a driver-side supplemental air bag, which deployed. The driver was not wearing the available manual lap/shoulder belt and sustained serious injuries (AIS 3). The steering wheel was embedded into the instrument panel, and there were abrasions on the right side of the knee padding.

Vehicle 1:

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Left rib fractures with hemothorax	3	Steering wheel
	Pulmonary contusion/effusion	3	Steering wheel
	Chest trauma	9	Steering wheel
	Abdominal trauma	9	Unknown
	Acetabular fracture	2	Dashboard
	Left humerus fracture	2	Unknown
	Pelvic hematoma	9	Unknown
	Facial ecchymosis	1	Air bag

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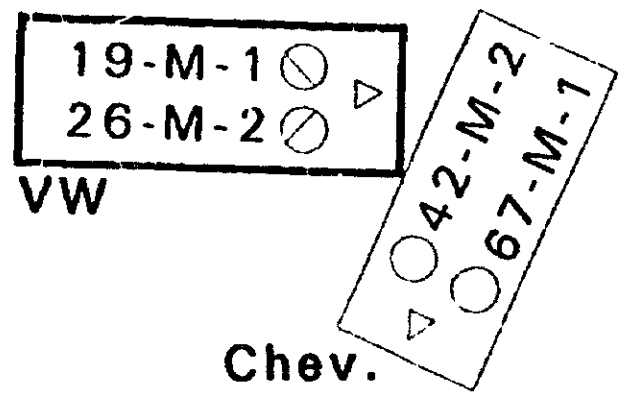
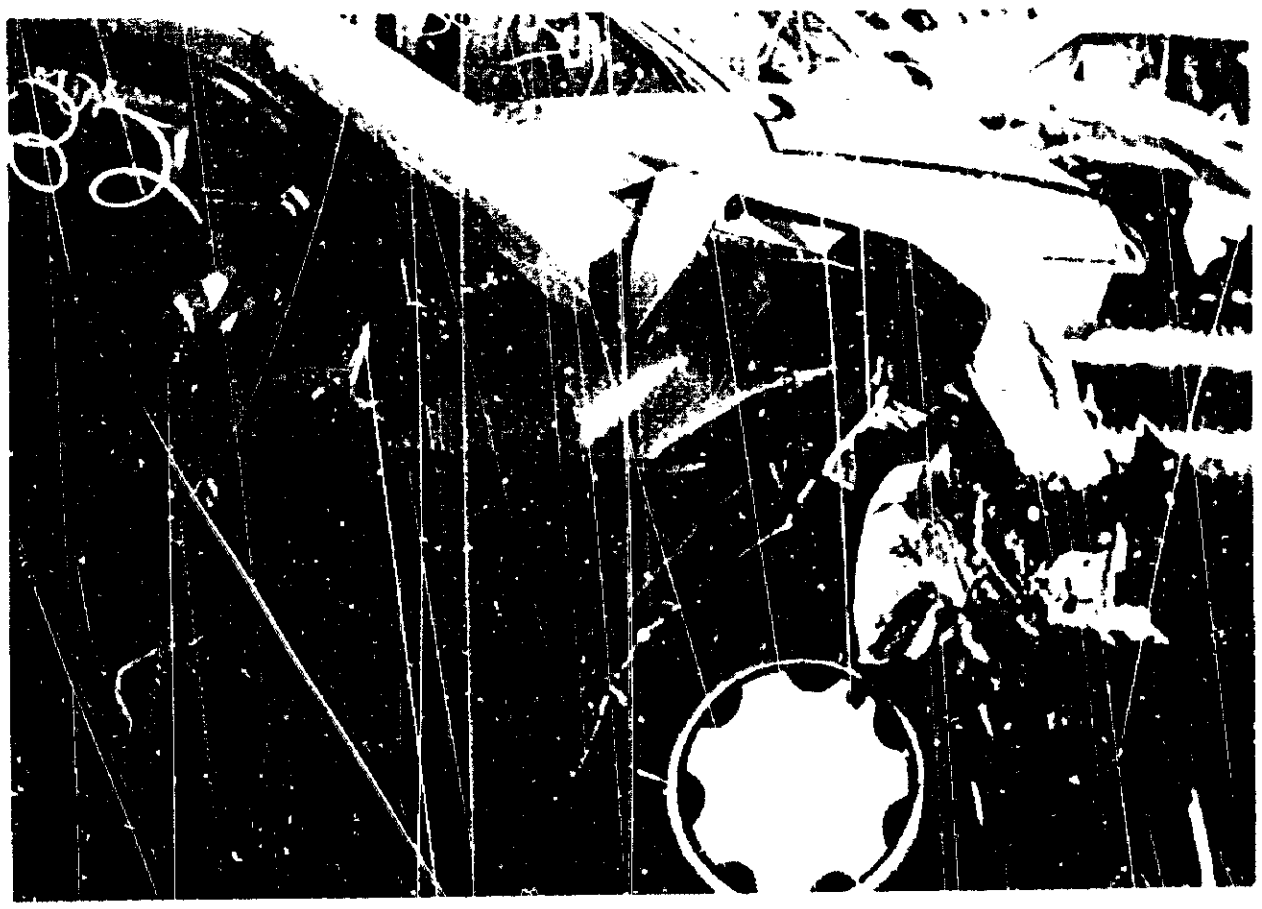
Washington, D.C. 20594

Case No. 47

Acc. No.:	CRH-92-HO-RO6
Date:	January 23, 1992
Location:	Fort Worth, Texas
Type:	Frontal
Vehicle 1:	1991 Volkswagen Passat
Weight:	3,310 lbs
Delta V:	24 mph
Vehicle 2:	1978 Chevrolet Caprice
Weight:	4,890 lbs
Delta V:	16 mph

Collision Diagram





A 1991 Volkswagen Passat traveling at an estimated speed of 47 mph struck the right side of a 1978 Chevrolet Caprice. After the collision, the vehicles rotated counterclockwise. The Passat was equipped with motorized shoulder belts, manual lapbelts, and padded knee bolsters for the front seat occupants. The driver sustained minor injuries (AIS 1), and the right-front passenger sustained moderate injuries (AIS 2).

There were occupant force loading marks on the webbing of both shoulder belts and extensive compression marks on the knee bolsters for both occupants. However, no force loading marks were observable on the lapbelts.

The unrestrained driver and right-front passenger of the Chevrolet sustained minor (AIS 1) and moderate (AIS 2) injuries, respectively.

Vehicle 1:

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Chest Contusion	1	Shoulder belt
	Contusions, both knees	1	Knee bolster
Right front	Contusion across chest	2	Shoulder belt
	Fractured left rib	1	Shoulder strap
	Contusions, both knees	1	Knee bolster

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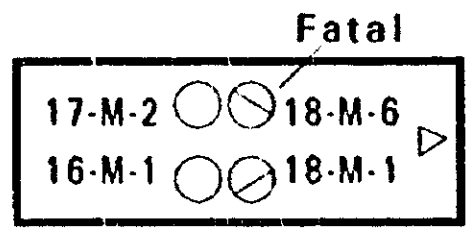
Case No. 48

Acc. No.:	WRH-91-HO-R18
Date:	September 25, 1991
Location:	Edmonds, Washington
Type:	Rollover
Vehicle:	1977 Volkswagen Rabbit
Weight:	2,875 lbs
Delta V:	Not Applicable

Collision Diagram



A 1977 Volkswagen Rabbit traveling at 68 mph was attempting to negotiate a right turn when the driver lost control and the Rabbit rolled over. The front seat occupants were restrained by automatic shoulder belts and knee bars; the vehicle had no manual lapbelts for the front seats. The two occupants in the rear were not wearing the lapbelts available in the back seats.

During the rollover sequence, the driver's door opened and the driver was ejected and fatally injured. The right-front door did not open; the shoulder belt-restrained passenger remained in the vehicle and sustained minor injuries (AIS 1).

The unrestrained left-rear passenger was ejected through the displaced left-rear passenger window and sustained moderate injuries (AIS 2). The unrestrained right-rear passenger remained in the vehicle and sustained minor injuries (AIS 1).

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Skull fracture	3	Impact outside vehicle
	Transection of aorta	6	Impact outside vehicle
	Severed spinal cord	5	Impact outside vehicle
	Fractures/abrasions/contusions/ lacerations, entire body	9	Unknown
Right front	Lacerated forehead	1	Unknown
	Abrasions, neck	1	Seatbelt
	Laceration, back of head	1	Unknown
	Abrasions, back of left hand	1	Unknown
Left rear	Laceration above left eye	2	Rear window frame
	Contusion/abrasion, back	1	Struck by car tire
	Cut on top of head	1	Unknown
Right rear	Laceration, back	1	Unknown

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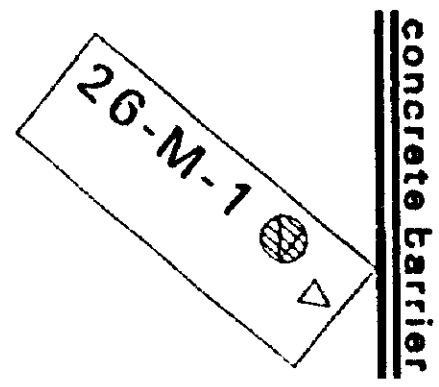
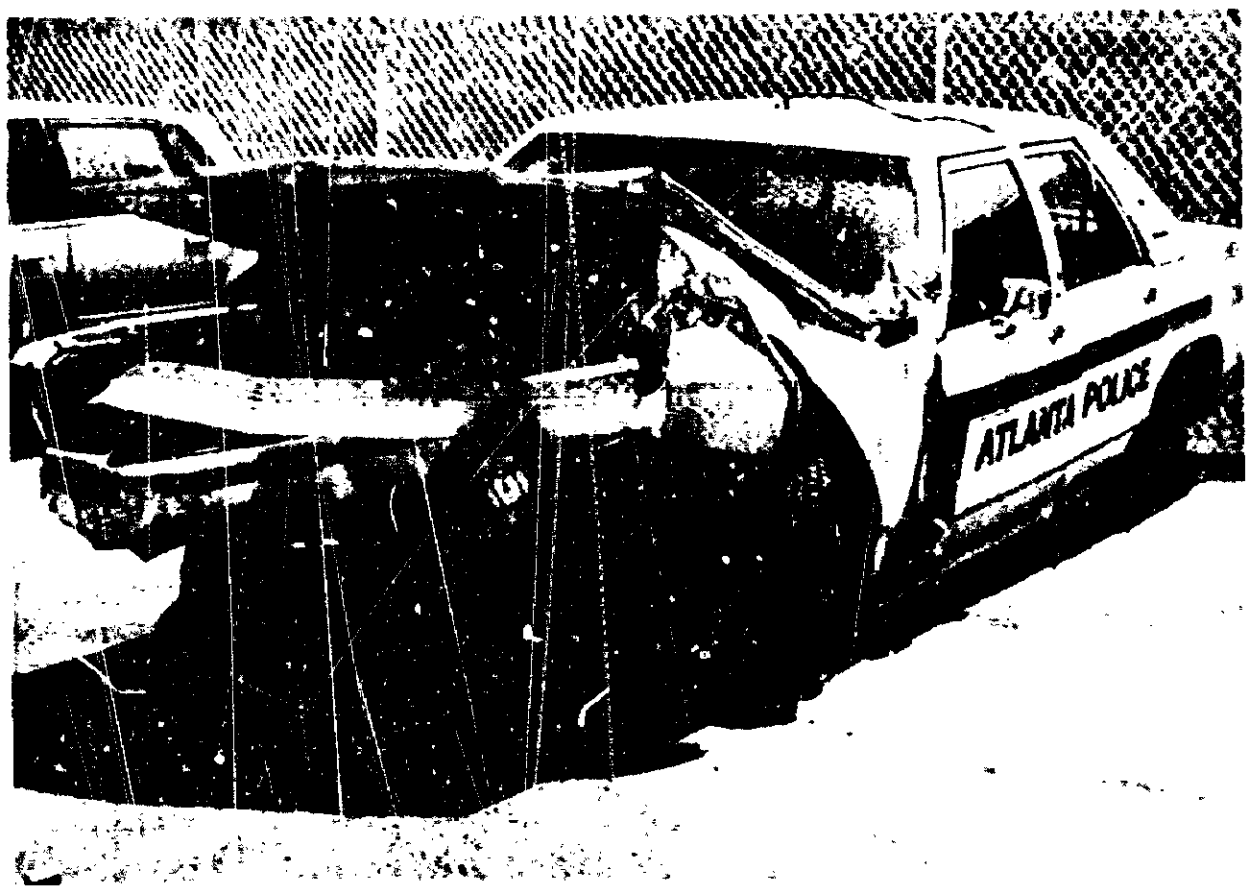
Case No. 49

Acc. No.:	SRH-92-FH-O13
Date:	April 3, 1992
Location:	Atlanta, Georgia
Type:	Frontal
Vehicle:	1991 Ford Crown Victoria
Weight:	4,150 lbs
Delta V:	18 mph

Collision Diagram





A 1991 Ford Crown Victoria municipal police unit on an emergency call swerved to avoid another vehicle and crashed into a concrete median barrier. The Ford was equipped with a driver-side supplemental air bag, which deployed at impact. The driver was restrained with the manual lap/shoulder belt and sustained minor injuries (AIS 1). The driver stated there was considerable slack in the belt because of police equipment.

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Contusion, left forearm	1	Left door
	Contusion, left hand	1	Left door
	Abrasion, right forearm	1	Air bag
	Lacerations, wrist/fingers	1	Windshield

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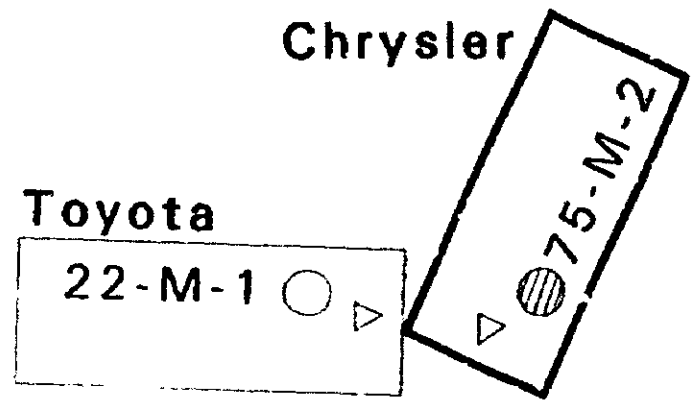
Case No. 50

Acc. No.:	SRH-91-FH-005
Date:	April 2, 1991
Location:	Jackson, Pennsylvania
Type:	Frontal
Vehicle 1:	1990 Chrysler LeBaron
Weight:	3,052 lbs
Delta V:	21 mph
Vehicle 2:	1991 Toyota SR-5 Pickup
Weight:	3,515 lbs
Delta V:	18 mph

Collision Diagram



A westbound 1990 Chrysler LeBaron attempting a left turn collided with an eastbound 1991 Toyota truck. The Chrysler was equipped with a supplemental air bag, which deployed, and the unbelted driver received moderate injuries (AIS 2). He was found lying across the front seat with his head on the right floor.

The unrestrained driver of the Toyota sustained minor injuries (AIS 1).

Vehicle 1:

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Fractured right tibia	2	Unknown
Vehicle	Laceration, top of head	1	Rearview mirror
	Concussion	2	Unknown

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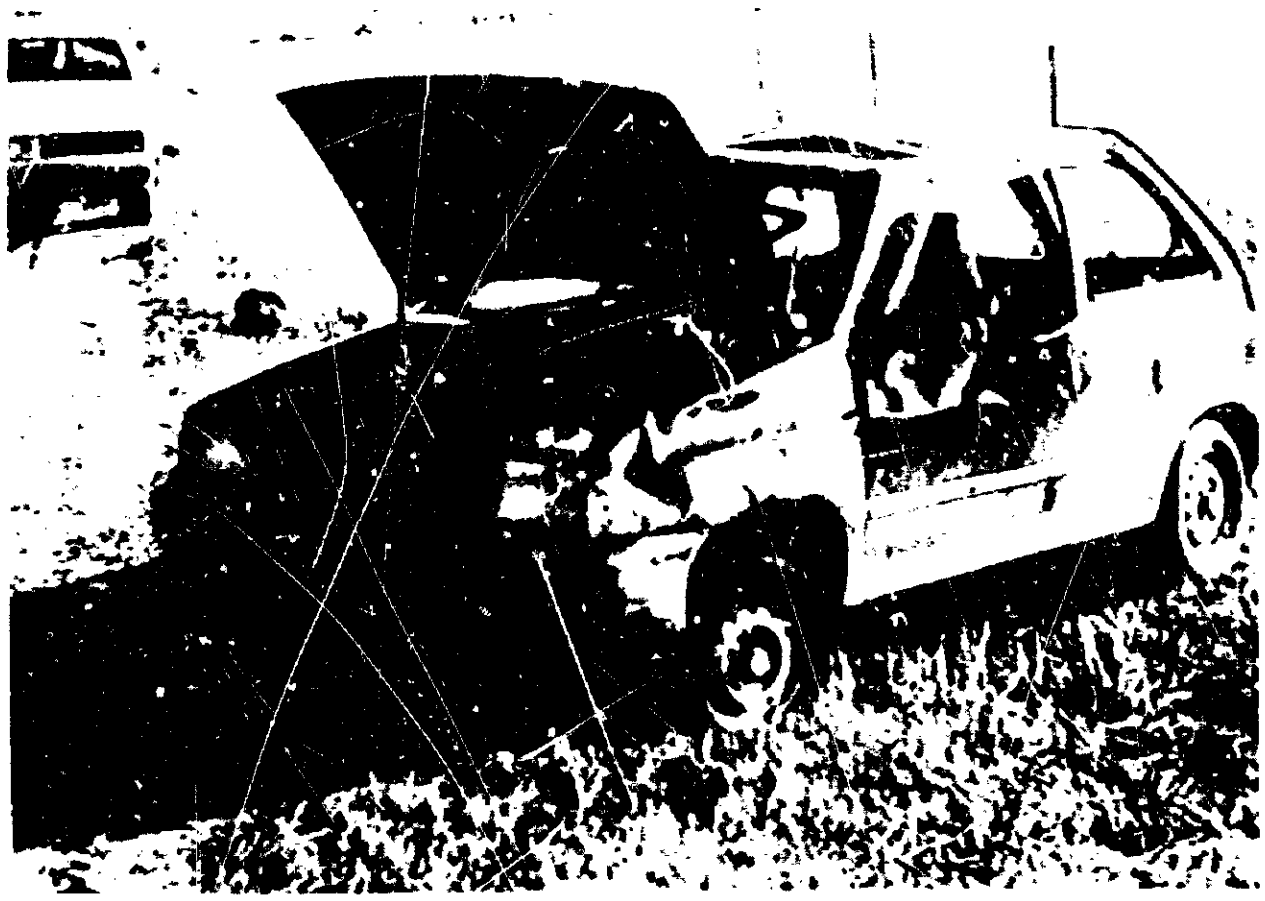
Washington, D.C. 20594

Case No. 51

Acc. No.:	WRH-92-HO-RO4
Date:	April 1, 1992
Location:	Brighton, Colorado
Type:	Rollover
Vehicle:	1991 Ford Festiva
Weight:	Unknown
Delta V:	Not Applicable

Collision Diagram



A 1991 Ford Festiva left the roadway and rolled over; the driver was ejected through the driver-side window and fatally injured. The Festiva was equipped with a motorized automatic shoulder belt and a manual lapbelt.

The driver's neck was broken at the cervical spine (vertebra C1) and displaced about 3 inches toward the right. She sustained ecchymosis (bruising) under the left ear around the neck, under the chin, across the right breast, and under the right armpit. Under her chin at the base of

her neck were two 6-inch-long narrow areas of extreme ecchymosis. The lower abdomen and hip area were devoid of any belt markings or bruising.

There was no intrusion into the occupant compartment even though the vehicle rolled three times. The driver's door, which remained secured during the rollover sequence, had a 9-inch outward bow at the window line. The metal tab between the shoulder-belt emergency-release buckle and the track was broken. Examination of the tab by the Safety Board metallurgy lab indicated that the failure was due to overstress; there was no evidence of a preexisting crack or other defect.

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Fractured cervical spine	6	Shoulder belt
	Ecchymosis under chin, right breast, and right armpit	2	Shoulder belt

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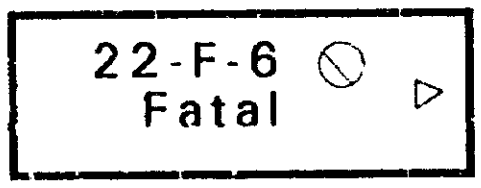
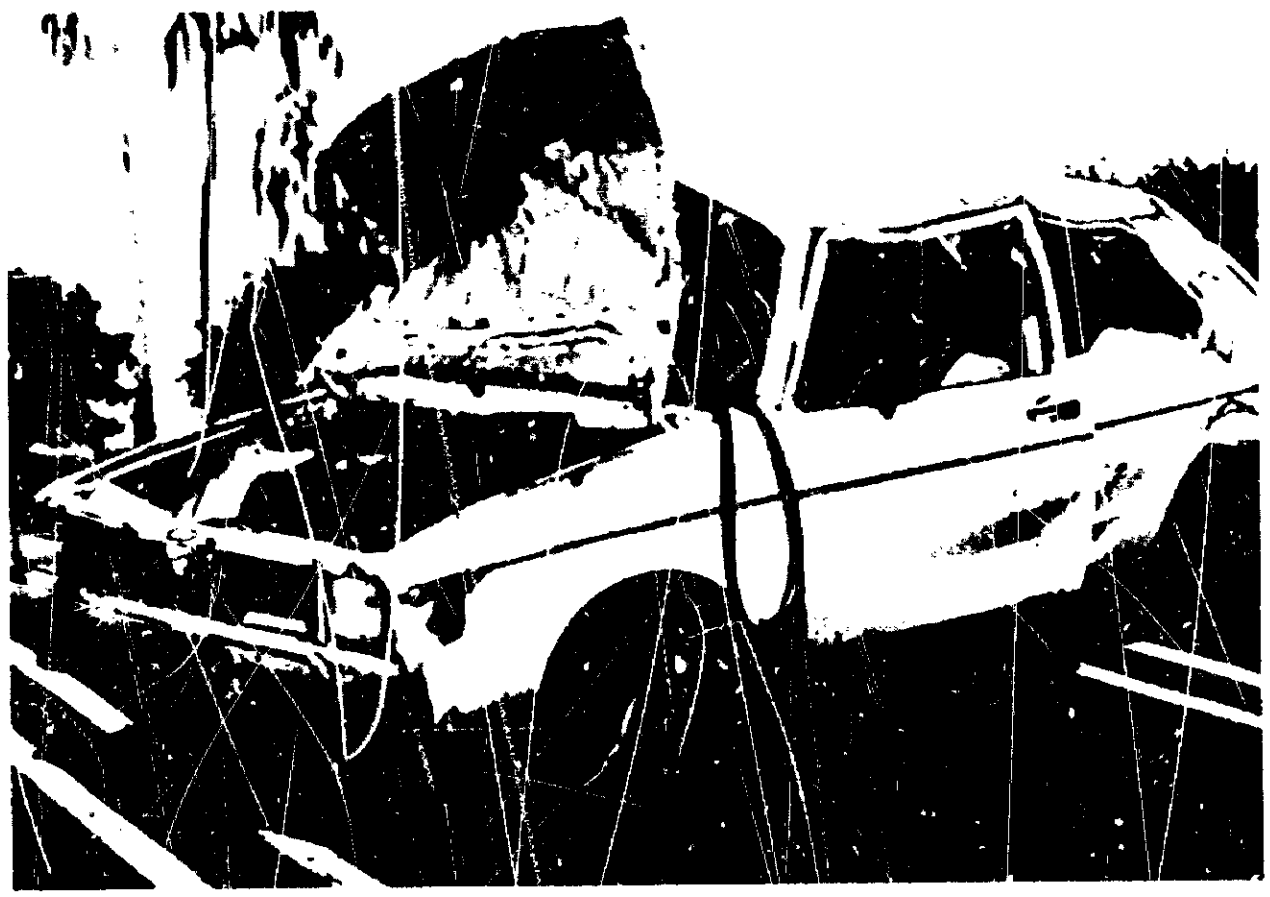
Washington, D.C. 20594

Case No. 52

Acc. No.:	WRH-91-H-OR14
Date:	May 19, 1991
Location:	Parker, Arizona
Type:	Rollover
Vehicle:	1979 Volkswagen Rabbit
Weight:	2,385 lbs
Delta V:	Not Applicable

Collision Diagram





A 1979 Volkswagen Rabbit was traveling at approximately 65 mph when the driver lost control. The Rabbit drifted to the right, swerved to the left, skidded, and rolled several times. The driver was restrained by an automatic shoulder belt attached to the door. A manual lapbelt was not available. During the rollover sequence, the driver was thrown through the driver-door window; she was found decapitated.

Human tissue deposits were found on both sides of the shoulder-belt webbing beginning several inches below the door-mounted latch plate and continuing for about 10 inches. The coroner indicated that the "angle of the shoulder harness from the attachment to the left side of the seat attachment coincides with the angle of severance of the . . . [neck] . . . starting at the left angle of the jaw."

Occupant Location	Injuries	AIS	Probable Injury Source
Driver	Decapitation	6	Shoulder-belt webbing

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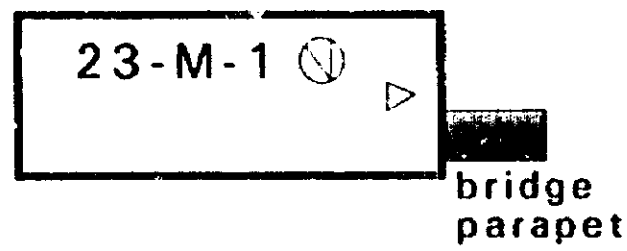
Case No. 53

Acc. No.:	NRH-92-F-ORO7
Date:	April 24, 1992
Location:	Clay Township, Pennsylvania
Type:	Frontal
Vehicle:	1990 Ford Taurus
Weight:	2,191 lbs
Delta V:	41 mph

Collision Diagram



A 1990 Ford Taurus crashed into a bridge parapet. The Delta V for the Taurus was 41 mph. The driver-side supplemental air bag did not deploy. The driver was restrained by the manual lap/shoulder belt and sustained minor injuries (AIS 1). Safety Board investigators and Ford Motor Company engineers examined the air bag system and found a wiring problem.

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Laceration, forehead	1	Steering wheel
	Abrasion, left shoulder/ clavicle	1	Shoulder belt

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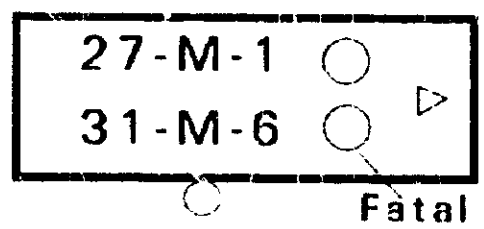
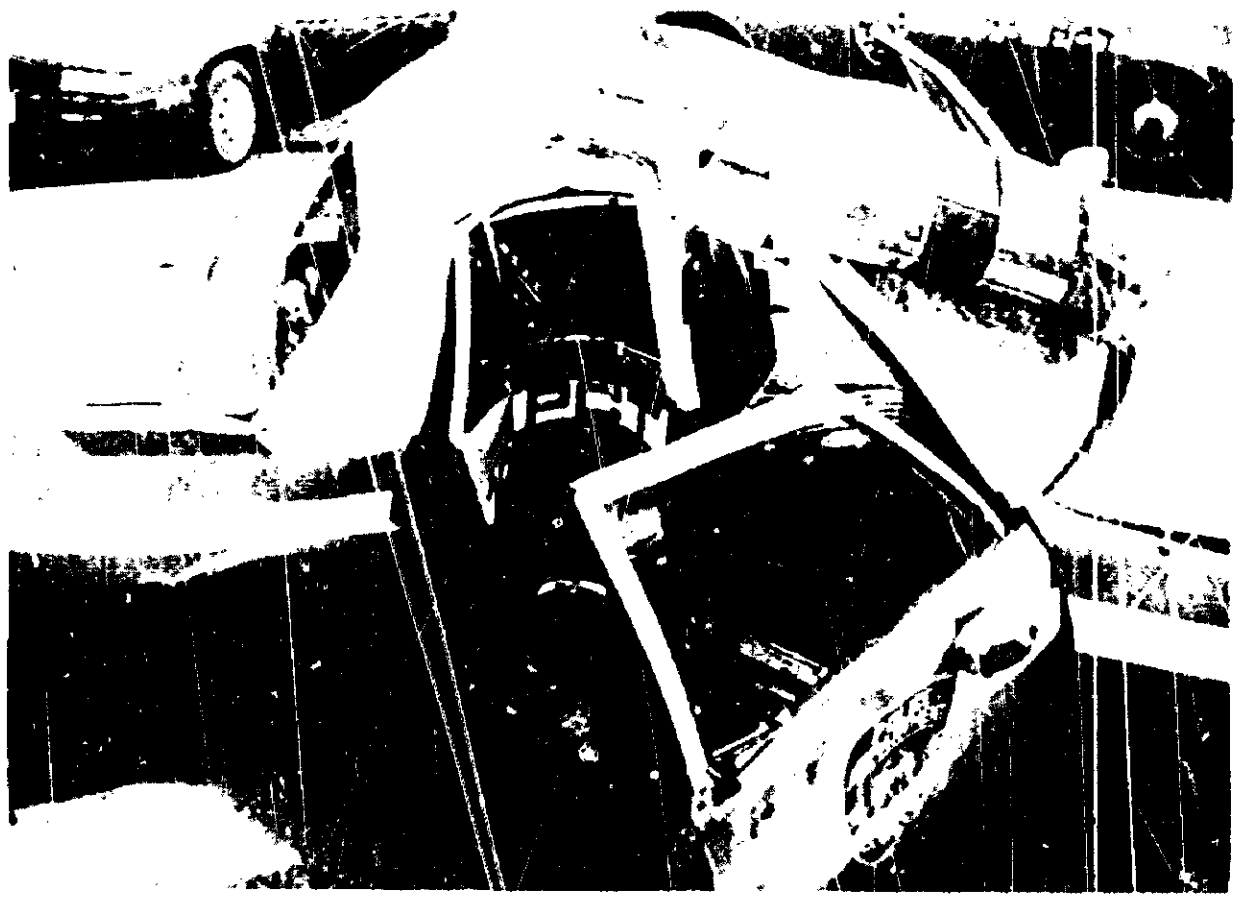
Washington, D.C. 20594

Case No. 54

Acc. No.:	NRH-92-FO-RO6
Date:	March 26, 1992
Location:	Queens, New York
Type:	Side
Vehicle:	1990 Chevrolet Caprice
Weight:	4,350 lbs
Delta V:	20 mph

Collision Diagram





A 1990 Chevrolet Caprice police unit responding to an emergency ran off the road and struck a utility pole at the right-rear door. The Caprice was equipped with door-mounted detachable automatic lap/shoulder belts, which had been detached. The unrestrained driver received minor injuries (AIS 1). The impact tore the right-front door-latch striker out of the B-pillar; the door opened, and the unrestrained right-front occupant was ejected. He died of head injuries.

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Abrasion/laceration, right leg	1	Radio
	Abrasion, right side, forehead	1	Unknown
Right front	Massive head injuries	9	Right-front B-pillar and instrument panel

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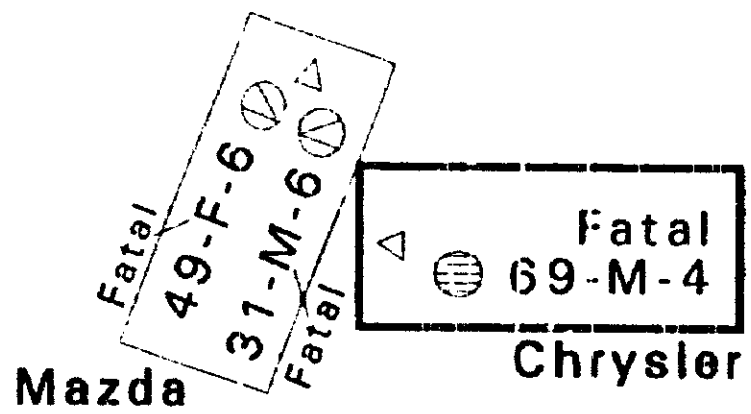
Washington, D.C. 20594

Case No. 55

Acc. No.:	CRH-92-HO-R11
Date:	March 17, 1992
Location:	Skykomish, Washington
Type:	Frontal
Vehicle 1:	1991 Chrysler Fifth Ave.
Weight:	3,723 lbs
Delta V:	25 mph
Vehicle 2:	1986 Mazda RX-7
Weight:	3,025 lbs
Delta V:	31 mph

Collision Diagram



A 1991 Chrysler collided with a 1986 Mazda. The Chrysler was equipped with a driver-side supplemental air bag, which deployed at impact. There was little intrusion into the occupant compartment. The unbelted driver sustained fatal injuries.

The Mazda driver and passenger, who were wearing lap/shoulder belts, also received fatal injuries.

Vehicle 1:

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Basilar skull fracture	3	Lower A-pillar
	Laceration w/ brain hemorrhage	4	Lower A-pillar
	Fractured/dislocated left tibia	3	Floor
	Bilateral clavicular fracture	2	Air bag or instr. panel
	Sternal fracture	2	Air bag or instr. panel
	Multiple rib fractures, Right 1-7 and Left 1-5	4	Air bag or instr. panel
	Multiple lacerations of liver	3	Unknown
	Multiple lacerations and bruises		Vehicle interior

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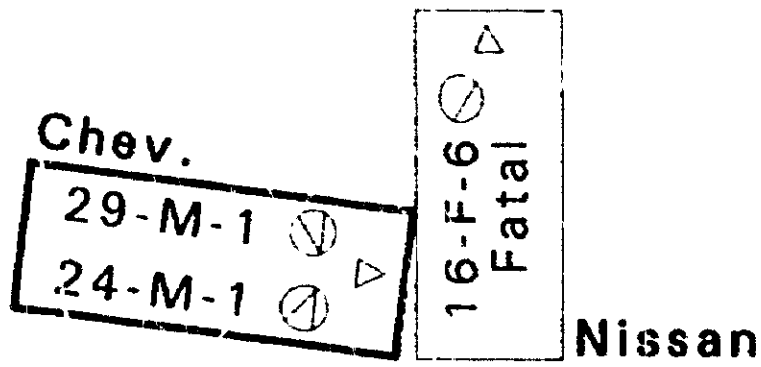
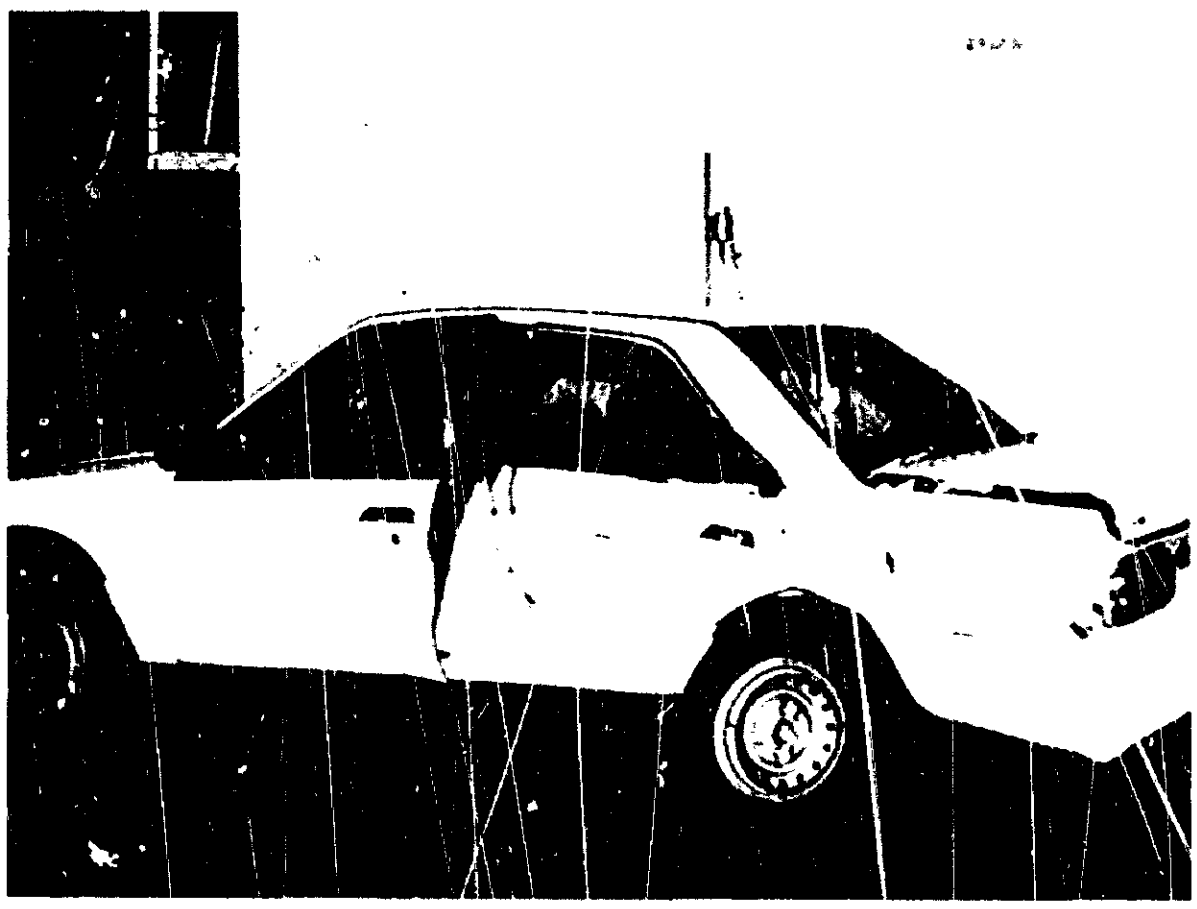
Case No. 56

Acc. No.:	WRH-92-HO-R07
Date:	May 20, 1992
Location:	Los Angeles, California
Type:	Side
Vehicle 1:	1992 Nissan Stanza XE
Weight:	3,020 lbs
Delta V:	22 mph
Vehicle 2:	1989 Chevrolet Caprice
Weight:	4,160 lbs
Delta V:	17 mph

Collision Diagram





A 1992 Nissan Stanza was struck in the left rear by a 1989 Chevrolet Caprice police unit. The Nissan rotated in a counterclockwise direction before coming to rest. The Nissan driver was wearing the motorized shoulder belt but not the available manual lapbelt.

During the accident sequence, the driver's door opened and the driver was ejected. She was found with the shoulder belt around the front part of her neck; the belt was supporting the weight of her body, which was outside the vehicle. She died at the scene because of a severed medulla oblongata (brain stem). The impact damage was behind the driver's door, and there was no occupant compartment intrusion.

Vehicle 1:

Occupant Position	Injuries	AIS	Probable Injury Source
Driver	Severed medulla at cervical junction	6	Shoulder belt
	Subdural hemorrhage, back of head	2	B-pillar
	Facial, oral, and buccal petechiae	9	Strangulation by shoulder belt
	Bruise/burn around front of neck	9	Shoulder belt
	Soft tissue trauma, neck	9	Shoulder belt

*U.S. G.P.O.:1994-300-644:80026