PB88-917003

Safety Study - Performance of Lap-Shoulder Belts in 167 Motor Vehicle Crashes. Volume 2

(U.S.) National Transportation Safety Board
Washington, DC

1 Mar 88

U.S. Department of Commerce
National Technical Information Service

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB/SS-88/03	2. GovernmentAccession No. PB88-917003	3. Recipient's Catalog No.
4. Title and Subtitle Safety Study-- Performance of Lap/Shoulder Belts in 167 Motor Vehicle Crashes (Volume 2)		5. Report Date March 1, 1988
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Safety Programs Washington D.C. 20594		10. Work Unit No., 4378D
		11. Contract or Grant No.,
		13. Type of Report and Period Covered Safety Study
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D.C. 20594		14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report is a case study presenting data from in-depth investigations of 167 motor vehicle crashes involving lap/shoulder-belted occupants. The accidents and the crashes had to meet specific criteria, and represent a wide range of accident configuration and severity. Volume 1 (NTSB/SS-88/02) of the study describes the good crash protection provided by lap/shoulder belts, residual injuries sustained, degraded protection provided by any misused lap/shoulder belts (i.e., misrouted, excess slack, reclining seat), and use of the three-point belt by children and pregnant women. Volume 2 (NTSB/SS-88/03) contains the 167 case summaries that provided the data discussed in Volume 1.

17. Key Words lap/shoulder belt; lap belt; misuse; slack; windowshade; misrouting; reclining seatback; belt-induced injuries; children; pregnant women		18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161	
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21 No. of Pages 485	22 Price

NTSB Form 1765.2 (Rev. 3/88)

INTRODUCTION

That lap/shoulder belts are valuable in reducing death and injury is undisputed; however, debate has always existed over their actual level of effectiveness. Manual seatbelt systems in motor vehicles (unlike passive restraints) have never been required to be tested for crash protection performance; complete and accurate data on their performance in real-world crashes have been extremely limited; basic changes in vehicle design have taken place over the years that could affect belt performance. In addition, seatbelt performance is a timely topic since States are enacting mandatory seatbelt use laws requiring front seat occupants (and rear seat occupants, in some cases) to wear their seatbelts.

With many of these factors in mind, the Safety Board conducted a study on the performance of seatbelts in real-world crashes during 1984-86. The study was a case study, emphasizing the collection of accurate, complete data on a number of specific points relevant to the question of belt performance. 1/ Specifically, the Board wished to explore how well the belts protected occupants from injury and what injuries resulted despite (or because of) the belt.

The summaries for each of the 167 cases involving lap/shoulder belt use are presented here in Volume 2 of the study. The case summaries provided data on the crash performance of 180 case vehicles and crash outcome for 341 case vehicle occupants. Photographs of the case vehicles and a crash diagram are presented in each summary.

The reader is referred to Volume 1 (NTSB/SS-88/02) for a discussion of the overall lap/shoulder belt performance in the cases investigated for the study. In summary, the Safety Board found that, in the range of crashes for which they were designed to be effective, properly used lap/shoulder belts can reduce the level of serious injuries or chance of death. The good crash performance of this belt system in a variety of crash configurations is documented in the case summaries appearing in this volume.

In many instances, lap/shoulder-belted occupants fared dramatically better, in terms of crash outcome, than unrestrained occupants or occupants wearing lapbelts only. Furthermore, in the cases investigated, the Safety Board saw no evidence that a properly used lap/shoulder belt results in the type of serious or fatal belt-induced injuries often associated with lap-only belt use and described in the Board's lapbelt report 2/--that is, injuries induced by the restraint itself that are more serious than the injuries likely if the occupant had been unrestrained at the time of the crash. As long as the belt was not misused, Safety Board investigators judged that the injuries induced by the lap/shoulder belt itself probably were less severe than the injuries the occupant would have sustained if restrained. This was not true of many lapbelted occupants in the study.

1/ Due to the inherent limitations of the Safety Board's resources and the time required to conduct an in-depth study of the crashes investigated, only a relatively small number of cases were investigated, and these had to meet specific selection criteria. Hence, the Board's study cannot be used to derive seatbelt effectiveness statistics. A case study, however, can supply accurate and complete data on crash events and severity, vehicle deformation, and severity level and cause of occupant injuries--data not available in police-report generated accident data files.
2/ Safety Study--"Performance of Lap Belts in 26 Frontal Crashes" (NTSB/SS-86/03), July 28, 1986, is available through the National Technical Information Service, Springfield, Virginia 22161.

Accident investigations for this study began in the fall of 1984. The criteria for inclusion of an accident were:

- Case vehicle must be a post-1974 model car, light truck, or van.
- At least one occupant in the case vehicle must have used a seatbelt. 3/ (This criterion resulted in atypically high proportions of restrained occupants. Very few case occupants were unrestrained.)
- The crash must have been of sufficient severity to require that the case vehicle be towed from the scene. 4/
- The crash must not have been so severe for the case vehicles as to be deemed unsurvivable for its belted occupant(s). 5/

The investigations were conducted by Safety Board headquarters staff and field staff located in eight field offices. At the beginning of the program, each Safety Board field office set up an accident notification scheme, involving a network of law enforcement and medical authorities in the multi-State region surrounding the field office. These local and State authorities agreed to notify the Safety Board of any crash meeting the Board's criteria as soon as they became aware of it. Upon notification, Board investigators were to go to the accident location, determine if the crash met the selection criteria, and if so, begin a detailed investigation.

A careful examination of the case vehicle was carried out in each crash investigation, documenting its "vital statistics" and information about the restraint system available to each occupant. The age, weight, height, and seating location of each occupant was determined. For each occupant, the investigator determined whether the available seatbelt was used, whether it was used correctly, the probable cause of each injury, and the severity of each injury sustained, expressed in terms of the Abbreviated Injury Scale (AIS). Throughout this volume, occupants are frequently described in terms of his or her maximum AIS level injury. The AIS codes used in this study are:

AIS	Severity Code
1	Minor
2	Moderate
3	Serious
4	Severe
5	Critical
6	Maximum injury, virtually unsurvivable
7	Injured, unknown severity
9	Unknown if injured

3/ Before the program was completed, it was decided to document a few vehicles in which no occupants were restrained, for comparison purposes.
4/ As the program progressed, it was found that, for a variety of reasons, vehicles may be towed even though they are essentially undamaged. Since in these cases the "crash" was extremely minor and seatbelts could not be expected to affect the outcome, these particular tow-away cases were not followed up.
5/ That is, there must have been sufficient space after the crash at the seating locations of the belted occupants to permit survival.

The events of the accidents were carefully reconstructed, and necessary measurements were taken to estimate collision severity in terms of the velocity change ("Delta V") experienced by the case vehicle. Based on these data, Safety Board investigators could judge the performance of the belt system in use during the crash, and draw some overall conclusions about the role of belt restraint systems in the crashes studied.

Delta V is considered by most crash researchers as the best single measure of collision severity. Delta V as used in these investigations is the instantaneous change in speed of a vehicle at impact. Vehicle weight and closing speed are reflected in Delta V. The amount of vehicle deformation may not reflect the severity of crash forces; the bodies of some vehicles "give" at lower crash forces than others, and therefore absorb crash forces before they are transmitted to the vehicle occupant. Hence, the reader is cautioned not to judge crash severity by vehicle damage. The Delta V computed is a far more sensitive and accurate gauge of crash severity experienced by the case vehicle occupants.

SUMMARIES
OF SAFETY BOARD
CRASH INVESTIGATIONS

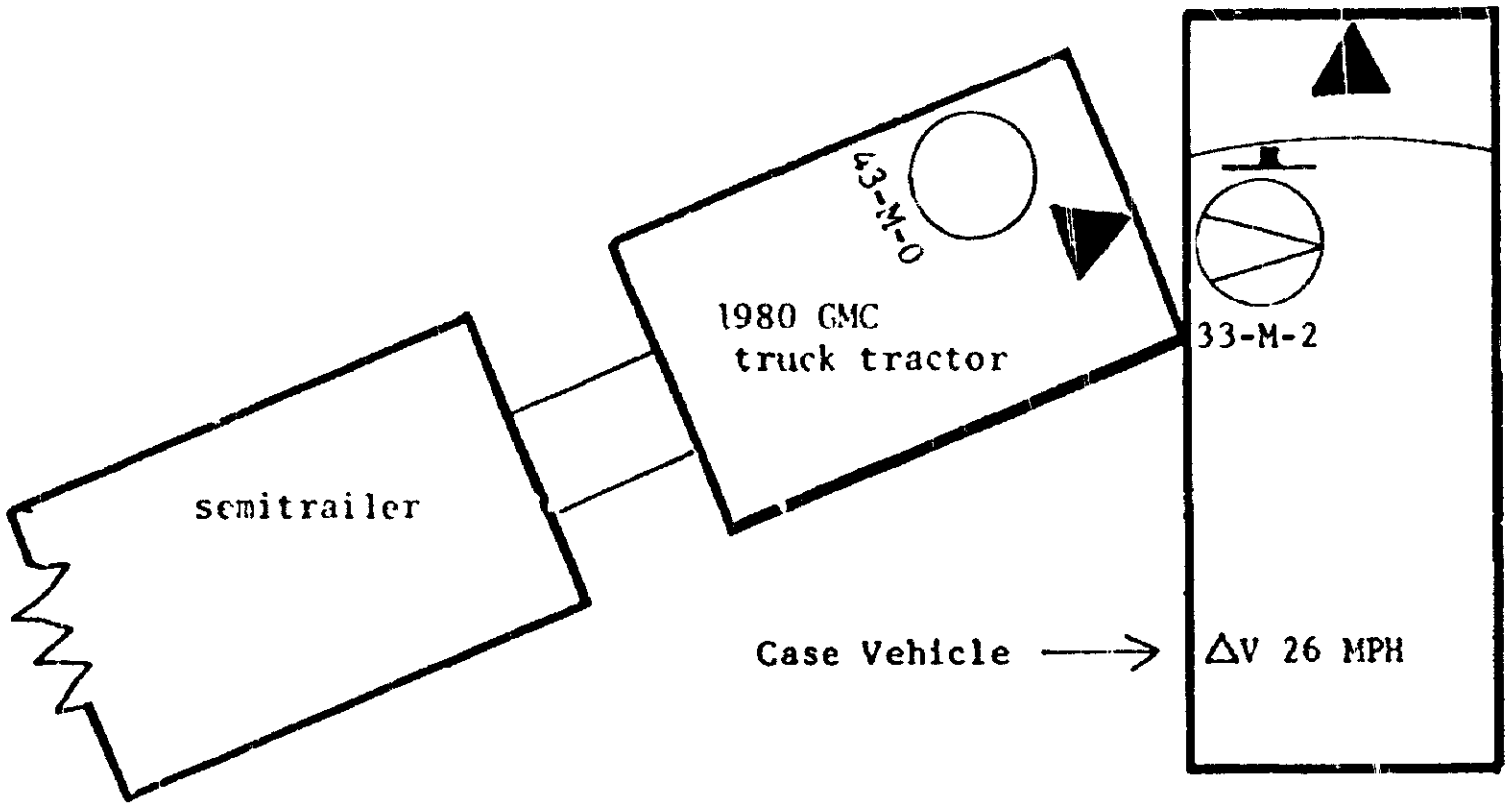
The following case summaries present factual information on each case. Where appropriate, an explanation of certain facts is included to asist the reader in understanding the performance of the restraint system used, or to suggest an alternate outcome under a different set of circumstance. The limited analysis included in these case summaries was developed from an examination of each vehicle, each occupant, and each accident circumstance. This information should prove valuable to the reader who might not be familiar with the results of occupant space intrusion, the effects of various impact force directions, or the vehicle dynamics and occupant kinematics of a rollover; for example, an unrestrained occupant might be ejected from a vehicle with its T-tops removed, or an unrestrained occupant might contact various components of the vehicle interior. The case files from which these summaries are derived are part of a public docket maintained at the Safety Board's Office of Public Inquiries in Washington, D.C. Additional factual information, along with extensive photographic documentation, is available in these files.

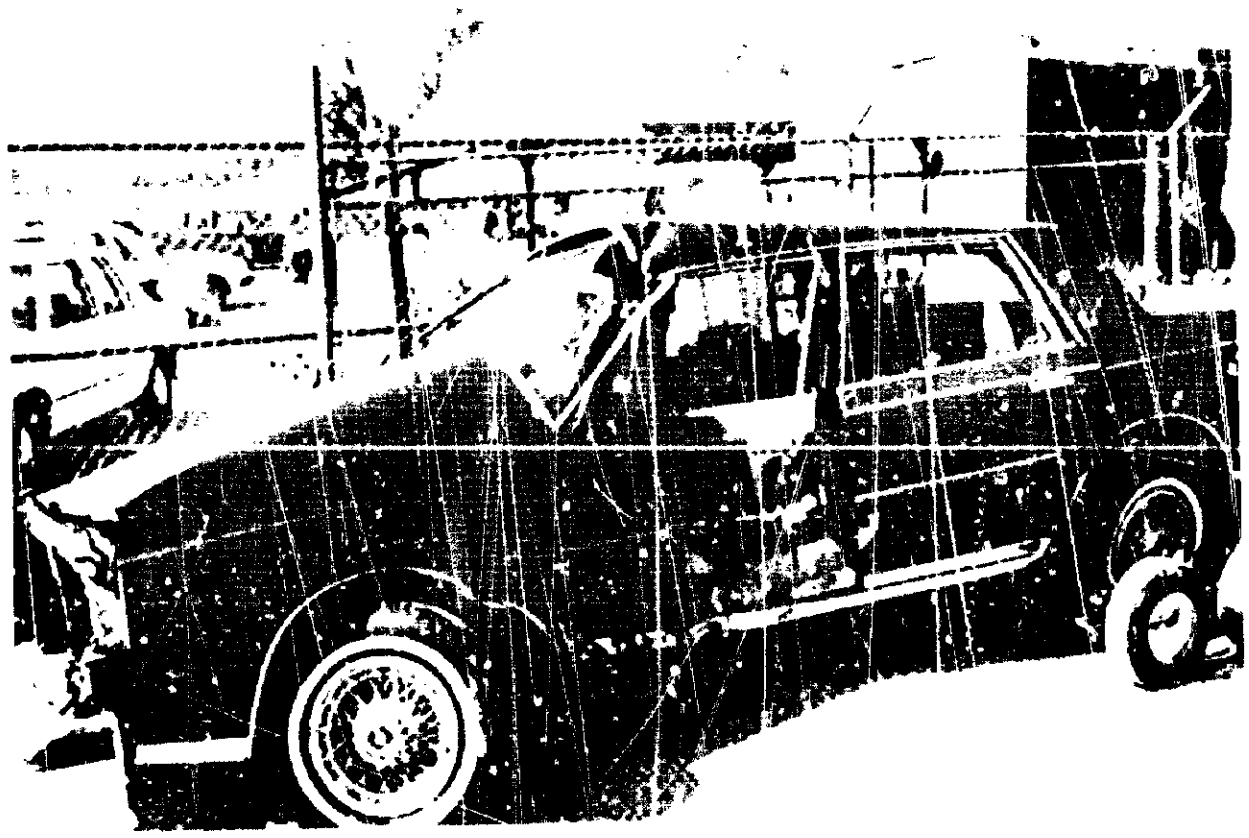
On the first page of each case summary is a sketch of the crash configuration, showing the case vehicle and its position (at initial impact event) relative to whatever object it struck or was struck by. Obviously, some crashes were more complex than others, with multiple impacts, secondary impacts, or rotational dynamics. The reader should refer to the case circumstances statement for additional information. Each occupant is represented by a circle at the occupant's seating position. The type of restraint used by that occupant is indicated also; two lines across the circle indicate a 3-point lap/shoulder belt, a single diagonal line across the circle indicates a 2-point diagonal shoulder belt, and one straight line across the circle indicates a 2-point lapbelt. If the occupant was killed, the word "fatal" is across, or near, the circle. Each occupant's age, sex, and highest AIS injury level is indicated on or near each circle. For example, 3-M-5 indicates a 3-year-old male who received an AIS 5 level injury as his most severe injury; 37-F-1 indicates a 37-year-old female whose most severe injury was AIS 1.

A photograph of the case vehicle is also provided. It should be noted that a substantial amount of crush in the front area of a passenger car does not necessarily denote severe crash forces. There is a considerable difference in the "stiffness" of various motor vehicle designs; if a "stiff" vehicle sustains substantial deformation, that would suggest greater crash forces than would the same deformation depth in a less "stiff" vehicle. The width and area of deformation also greatly influence the resultant crash forces. It is important for the reader to focus attention on the passenger compartment shown in the photograph, and also to read the circumstances statement, for evidence of intrusion. All crash-involved factors must be considered together for a complete understanding of the crash results. The Delta V for the occupant's vehicle is discussed, in most cases, in a section that describes performance of the restraint system.

CASE 1 (FTW-84-H-OR14)

Case Vehicle: 1983 Buick Regal, 4-door
Case Vehicle Weight: 3,260 pounds
Case Vehicle Delta V: > 26 mph





Circumstances

A 1983 Buick Regal was attempting to change from the right to the left lane, when it was struck in the driver's door by a fully loaded tractor/semi-trailer. The Buick received substantial structural damage to the left side, with inward deformation of up to 25 1/2 inches.

The Buick driver, restrained by a lap/shoulder belt, sustained moderate injuries.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: M
Age: 33
Height: 75 inches
Weight: 175 pounds
Restraint used: Lap/shoulder belt (ELR)

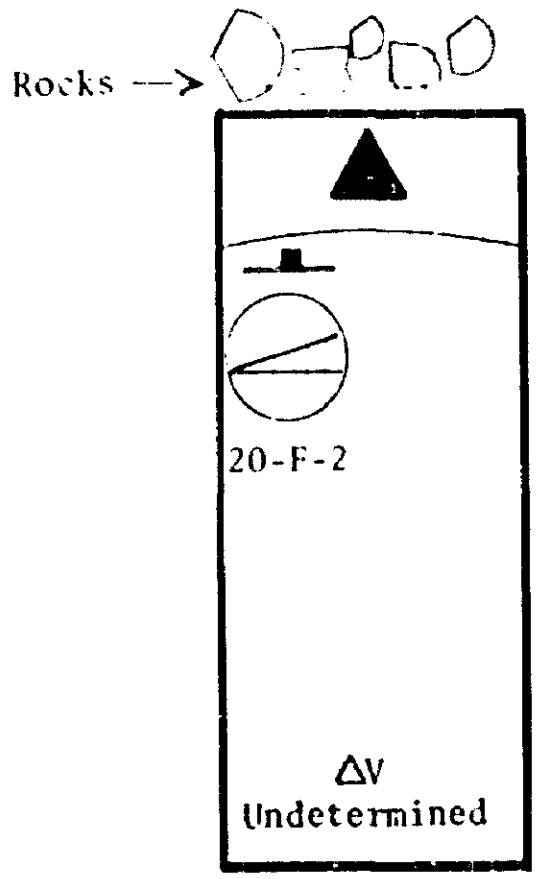
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver described the precrash lap portion of the belt adjustment as being positioned low across his hips with approximately 1 inch of slack. The shoulder portion of the belt was reportedly adjusted with about 2 inches of slack between the shoulder portion of the belt and the driver's chest. Force loading marks were found upon the system webbing in the area of the B-pillar mounted D-ring.

Injuries	AIS	Probable Source
Undefined closed head injury	2	B-pillar
Major contusions, lower left leg	2	Interior sidewall
Contusion, left shoulder	1	B-pillar
Laceration, left forearm	1	Broken side window glass
Laceration, left hand	1	Broken side window glass
Laceration, lower left leg	1	Interior sidewall

The driver was admitted to an area hospital for approximately 1 1/2 days; he reported loss of work for 7 days. His use of the available lap/shoulder belt prevented uncontrolled movement into the area of major collapse. Considering the dynamics of this collision, the rearward collapse of the driver's seatback, and the displacement of the left side rear window glass, it is likely that use of the lap/shoulder belt prevented ejection of the driver.

CASE 4 (DEN-84-H-OR35)

Case Vehicle: 1979 Ford LTD
Case Vehicle Weight: 4,123 pounds
Case Vehicle Delta V: Undetermined (not compatible with Crash-III)



Circumstances

A 1979 Ford LTD ran off of the roadway and traveled 16 feet vertically and 39 feet horizontally before colliding with a group of large boulders. The front of the vehicle sustained substantial rearward and upward structural deformation.

The driver of the Ford, restrained by a lap/shoulder belt, sustained moderate injuries.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: F
Age: 20
Height: 5 feet 9 inches
Weight: 132 pounds
Restraint used: Lap/shoulder belt (ELR)

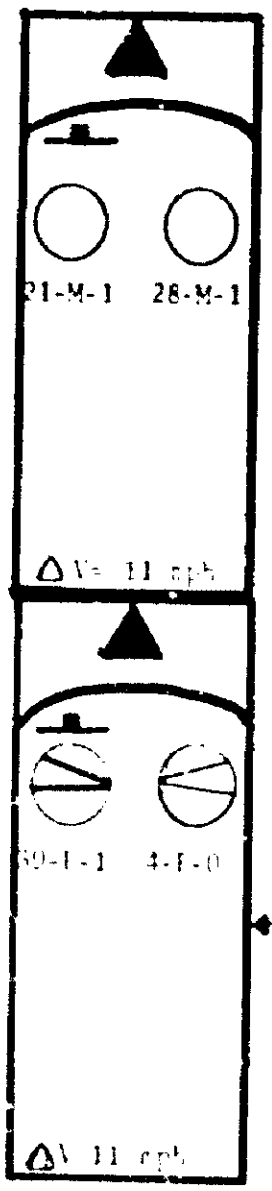
The driver was restrained with a lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver told NTSB investigators that she always adjusted her belt for a proper and tight fit.

Injuries	AIS	Probable Source
Deep 4-inch laceration, right forehead	2	Top steering wheel rim
Contusions on scalp	1	Top steering wheel rim
Contusion, left and right iliac crest	1	Lap portion of belt
Contusions, both knees	1	Struck lower dash
Laceration, right knee cap	1	Struck lower dash
Fractured right knee cap	2	Struck lower dash

The driver was taken by ambulance to a local hospital. She was hospitalized for 2 days and reported a loss of 10 days work. Although no Delta V could be estimated for this collision, it is apparent that substantial crash forces were present. An unrestrained occupant would have been free to contact the interior surfaces much more violently. It is probable that this driver might have sustained a higher level of injury had she not been wearing the lap/shoulder belt.

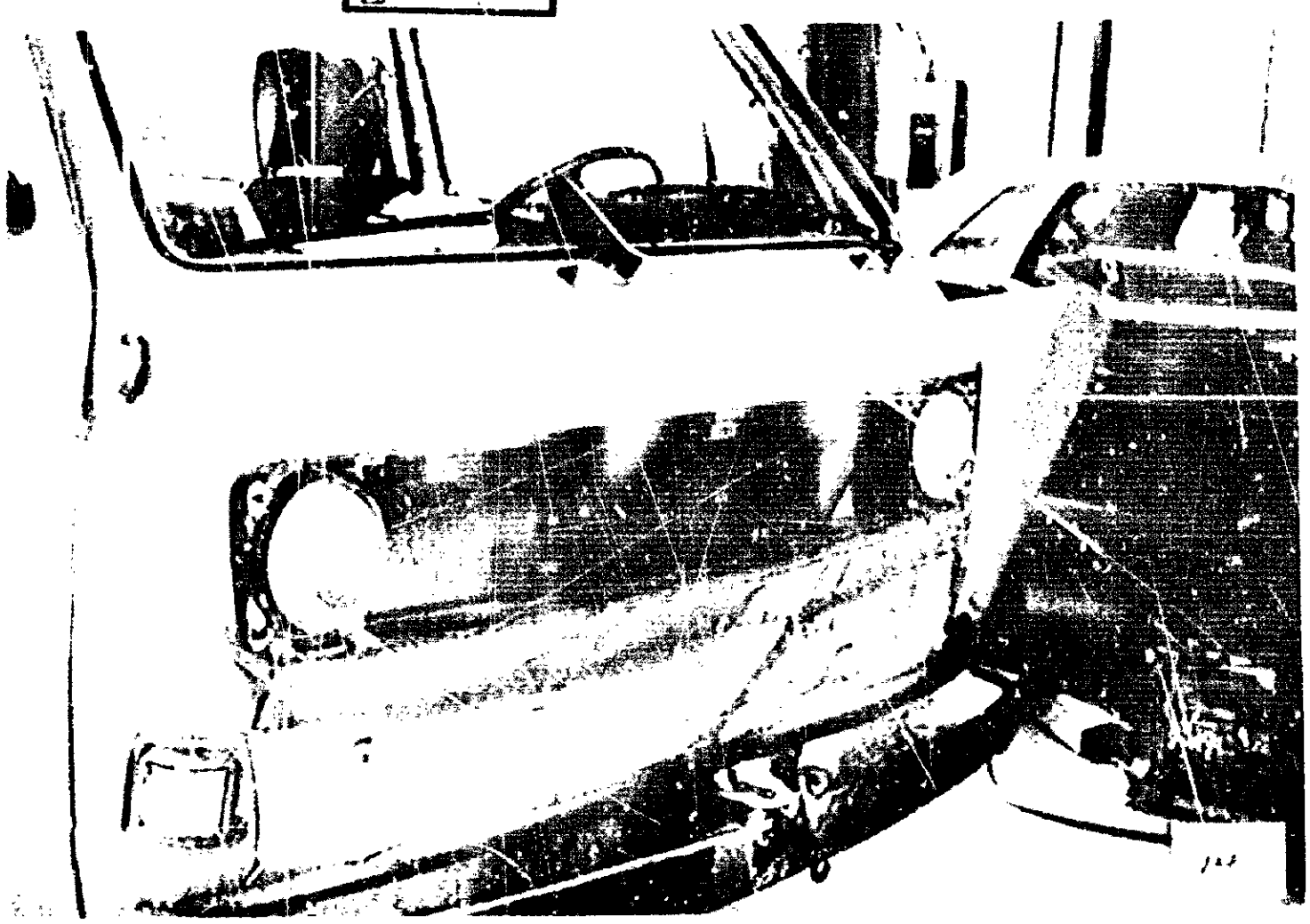
CASE 5 (SEA-84-II-OR01)

Case Vehicle: 1980 Volkswagen Vanagon
Case Vehicle Weight: 3,265 pounds
Case Vehicle Delta V: 10.8 mph



1983 Ford Ranger Pick-up Truck
Weight 3,189

CASE VEHICLE



Circumstances

A 1980 Volkswagen Vanagon collided with the rear of a 1983 Ford Ranger pick-up truck. The VW sustained moderate front end damage. The damage was concentrated above the bumper structure and deformation reached a maximum depth of 7 inches. Only 2 1/2 inches of structural collapse was noted at the rear of the Ford.

The driver of the VW was restrained by a lap/shoulder belt. A 5-year-old child was seated in a child booster seat at the right front seating position; the seat and child were restrained by a lap/shoulder belt. The driver sustained a minor cervical strain and the right front passenger was not injured. Both unrestrained occupants of the Ford pickup received minor injuries.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: F
Age: 39
Height: 5 feet 3 inches
Weight: 115 pounds
Restraint used: Lap/shoulder belt (ELR)

The driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a free-sliding latchplate, and a push-button release buckle attached to rigid metal stalk which was bolted to the seat frame below the base of the seat cushion. The driver described the precrash lap portion of the belt adjustment as snug, and positioned low on her hips. Marks on the system webbing were attributed to webbing load at the D-ring.

Injuries	AIS	Probable Source
Cervical strain	1	Impact forces

Although she sought no medical attention, the driver stated she suffered pain from her injury for 3 days. The lap/shoulder belt performed well in restraining the occupant from contact with the steering wheel and other interior surfaces in this 11 mph Delta V collision.

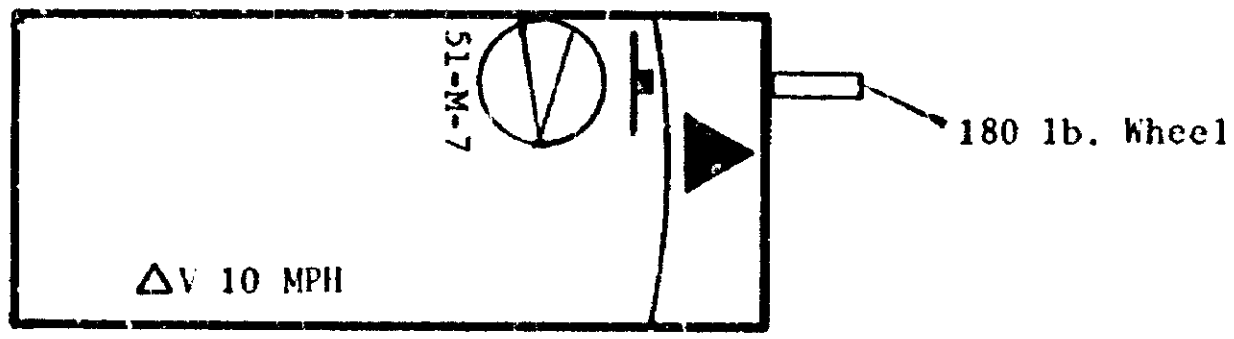
Case Vehicle
Seating location: Right Front
Sex: F
Age: 5
Height: 3 feet 6-1/2 inches
Weight: 45 pounds
Seated height: 23 inches (including 3 inches for child booster seat)
Restraint used: Lap/shoulder belt (ELR) and booster seat

This passenger was seated in a child booster seat secured by a continuous loop lap/shoulder belt equipped with the same features described for the driver's position. The driver described the precrash adjustment of her daughter's lap portion of the three-point belt as snug and positioned low on the hips.

The child was not injured. The combination of the child booster seat and the lap/shoulder belt restrained her from contacting the interior surfaces of the vehicle. Considering the 11 mph Delta V, the child might have sustained minor or greater injuries if she had not been properly restrained.

CASE 6 (CHI-84-H-0R17)

Case Vehicle: 1982 Cadillac Eldorado
Case Vehicle Weight: 3,734 pounds
Case Vehicle Delta V: 10 mph



Circumstances

A 1982 Cadillac Eldorado was traveling on a 4-lane divided roadway when a large truck tire (weighing 180 pounds) disengaged from a truck traveling in the opposite direction. The tire rolled across the median, and struck the left front of the Cadillac. The Cadillac sustained approximately 15 inches of rearward deformation in the left front.

The Cadillac driver, restrained by a lap/shoulder belt, complained of minor pain.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: M
Age: 51
Height: 6 feet 2 inches
Weight: 195 pounds
Restraint used: Lap/shoulder belt with dual retractors (ELR/ELR)

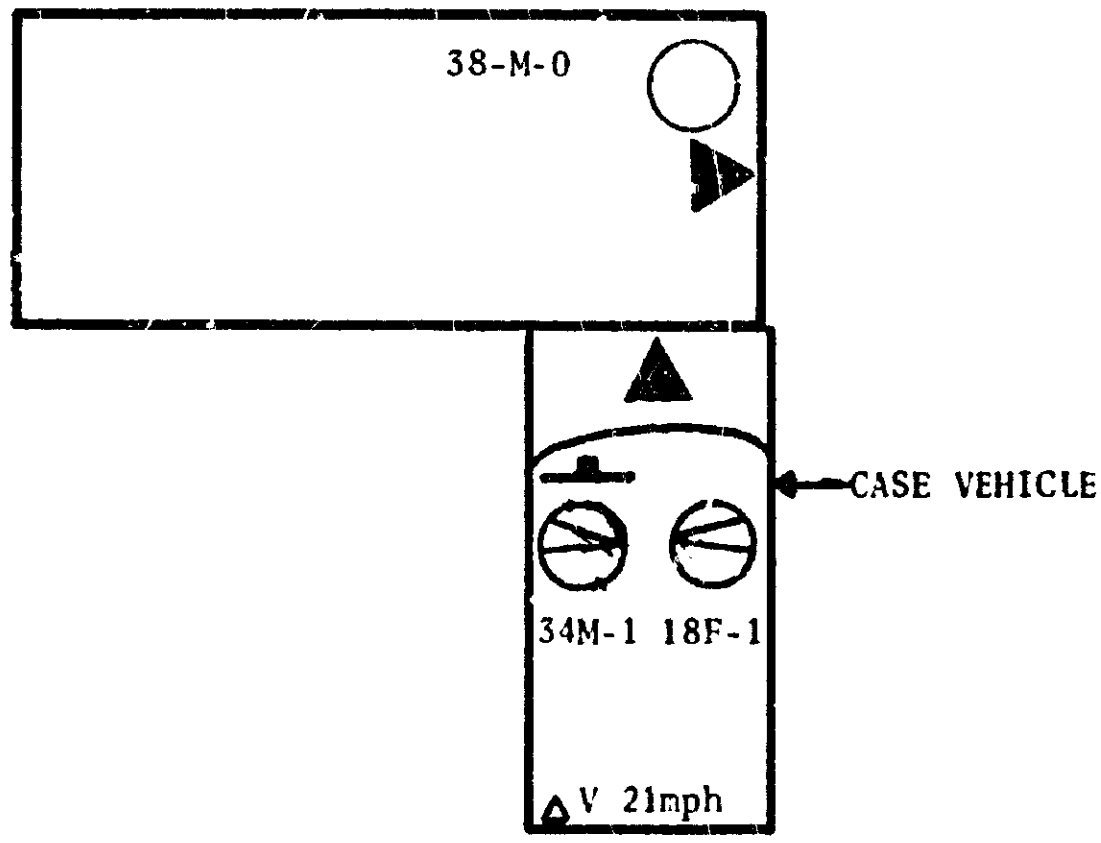
The driver was wearing a lap/shoulder belt with dual emergency locking retractors. There was no windowshade tension-relief mechanism. The driver stated that he wore the belt loose and, in this instance, believed that there were approximately 2 inches of slack in both the lap and shoulder portions of the belt. Due to the fact that the system is designed to be self-tensioning, his statement is questionable.

Injuries	AIS	Probable Source
Sore ribs	1	Sudden change in motion
Neck & back pain	1	Sudden change in motion

The driver did not seek immediate medical attention, but did go to a physician 2 weeks later because of neck pain. Because of the relatively low Delta V (10 mph), an unrestrained driver would probable have sustained similar minor injuries. Use of restraints in this crash probably did not change the outcome appreciably.

CASE 8 (DEN-84-H-OR33)

Case Vehicle: 1984 Chevrolet Citation, 4-door sedan
Case Vehicle Weight: 2,875 pounds
Case Vehicle Delta V: 21 mph



Circumstances

A 1984 Chevrolet Citation 4-door sedan struck the right front of a 1977 AMG city transit bus. The Citation sustained substantial front structural damage with rearward deformation up to 18 inches at the left front.

Both the driver and right front passenger of the Chevrolet were restrained by lap/shoulder belts; each sustained minor injuries. The unrestrained driver of the transit bus was not injured.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: M
Age: 34
Height: 6 feet
Weight: 200 pounds
Restraint used: Lap/shoulder belt (ELR)

The driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a windowshade tension-relief feature, a cinching latchplate, and a push-button release buckle attached to a flexible stalk. The driver described the precrash adjustment of the lap portion of the belt as being positioned across his abdomen. The shoulder portion was probably slack. He told NTSB investigators that he had leaned forward in his seat moments before the collision while looking for a street sign. This action probably allowed the windowshade tension-relief feature to introduce excessive slack in the shoulder portion. There were marks on the webbing, attributed to loading at the D-ring. The steering wheel rim was displaced forward 2 inches and the emergency brake release handle was bent.

Injuries	AIS	Probable Source
Multiple contusions on chest	1	Steering wheel/shoulder portion of belt
Contusion, area of left eye	1	Steering wheel
Contusion, left arm	1	Interior sidewall
Contusion, left hip	1	Armrest
Contusion, right knee	1	Dashboard
Contusion/laceration, left knee	1	Emergency brake handle
Cervical strain	1	Impact forces

The driver was admitted to a local hospital for 2 1/2 hours and then released. Considering the 21 mph Delta V, this driver would probably have sustained a higher level of injury if he had not been restrained by the available lap/shoulder belt.

Case Vehicle
Seating location: Right Front
Sex: F
Age: 18
Height: 5 feet 1 inch
Weight: 105 pounds
Restraint used: Lap/shoulder belt (ELR)

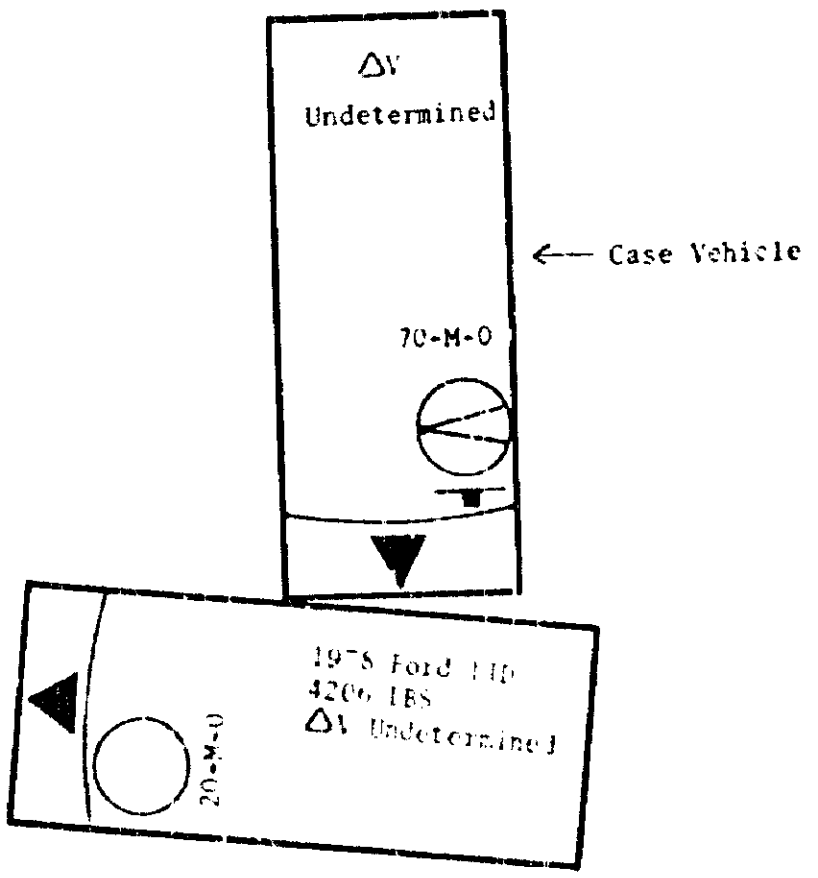
This passenger was wearing a lap/shoulder belt identical to the belt system available to the driver. She described the precrash adjustment of the lap belt as snug and positioned across her abdomen; the shoulder portion of the belt was not snug against her chest. There were force loading marks on the webbing attributed to loading at the D-ring. There were no contact points noted in front of this occupant's seating position.

Injuries	AIS	Probable Source
Abrasion, right shoulder	1	Shoulder portion of belt
Contusion on chest	1	Shoulder portion of belt
Abdominal c· ısions	1	Lap portion of belt
Muscle strain, left foot	1	Contact with floorboard

This woman was admitted to a local hospital for 6 hours and released. If she had not been restrained in tnis 21 mph Delta V collision, this occupant would have probably made contact with the windshield and instrument panel, thereby increasing her chances of a more serious injury level.

CASE 9 (DEN-84-H-OR37)

Case Vehicle: 1983 Honda Accord
Case Vehicle Weight: 2,342 pounds
Case Vehicle Delta V: Undetermined (not compatible with Crash-III)



Circumstances

A 1983 Honda Accord was traveling through an intersection when a 1978 Ford made a left turn across its path. The front of the Honda struck the left side of the Ford. It is uncertain how much crush the Honda received; the car had been partially dismantled before being made available to the Safety Board investigator. The Ford received moderate damage to the right side door and right rear quarter panel.

The Honda driver, restrained by a lap/shoulder belt, was uninjured. The police reported that the unrestrained driver of the Ford was uninjured.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: M
Age: 70
Height: 5 feet 6 inches
Weight: 140 pounds
Restraint used: Lap/shoulder belt (ELR)

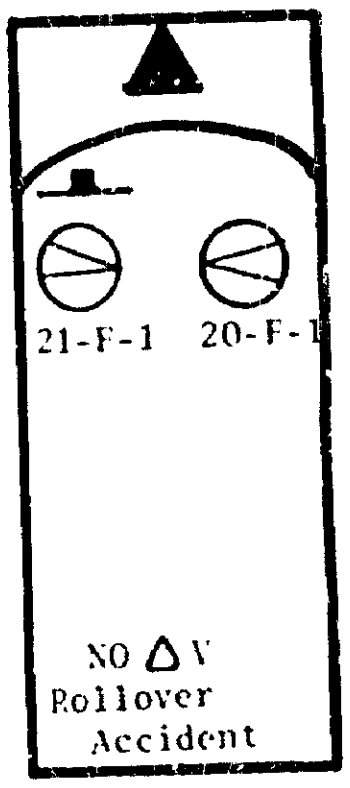
The driver was wearing a continuous loop lap/shoulder belt with a free-sliding latchplate and an emergency locking retractor sensitive to vehicle motion. The driver related that the lap portion of the belt was tight, positioned low on the hips, and that the shoulder strap was snug across his midchest.

Injuries: none.

The driver stated that he was not injured and sought no medical treatment. He also stated that he did not recall striking any interior part of the vehicle.

CASE 10 (DEN-84-H-OR36)

Case Vehicle: 1975 Mercury Bobcat, 3-door hatchback
Case Vehicle Weight: 2,996 pounds
Case Vehicle Delta V: 450-degree rollover (No Delta V)



10

Circumstances

A 1975 Mercury Bobcat 3-door hatchback, traveling at a driver-estimated speed of 50 mph, left the roadway of an interstate exit ramp and overturned. The vehicle rolled approximately 450 degrees and came to rest on its right side. The rollover resulted in substantial damage to the Mercury with roof deformation on the driver's side of approximately 5 inches.

The Mercury driver and right front passenger, both restrained by lap/shoulder belts, sustained minor injuries.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: F
Age: 21
Height: 5 feet 2 inches
Weight: 105 pounds
Restraint used: Lap/shoulder belt with dual retractors (ALR/ELR)

The driver was wearing a continuous loop lap/shoulder belt equipped with an automatic locking retractor for the lap portion, an emergency locking retractor for the shoulder portion, a windowshade tension-relief feature, a sewn-in latchplate, and a push-button release buckle attached to a flexible stalk. The driver stated that the precrash adjustment of the lap portion of the belt was snug and positioned low on her hips. She also indicated that the shoulder portion was adjusted snug against her chest. Although the webbing was frayed from frequent use, there were no force loading marks found on the webbing.

Injuries	AIS	Probable Source
Laceration, top of head	1	Roof
Contusion, right thigh	1	Steering wheel
Laceration, left hand	1	Windshield glass
Contusion, left thigh	1	Steering wheel
Contusion, left knee/lower leg	1	Under dashboard components
Contusion, top of left foot	1	Foot controls

The driver was treated and released at a local hospital. Considering the 450 degree rollover of this accident, she may have been ejected had she not been restrained.

Case Vehicle
Seating location: Right Front
Sex: F
Age: 20
Height: 5 feet 5 inches
Weight: 150 pounds
Restraint used: Lap/shoulder belt with dual retractors (ALR/ELR)

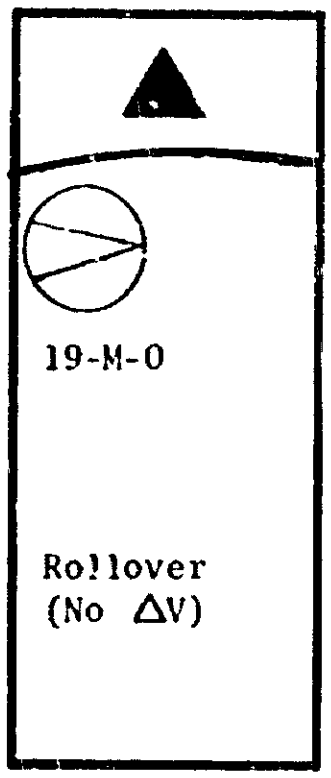
This passenger was wearing a lap/shoulder belt identical to that worn by the driver. She described the precrash adjustment of the lap portion of the belt as snug, positioned low on her hips; the shoulder portion of the belt was adjusted snug against her chest. She stated that she was sitting sideways facing the driver prior to impact. Moderate outward deformation was noted to the right front door.

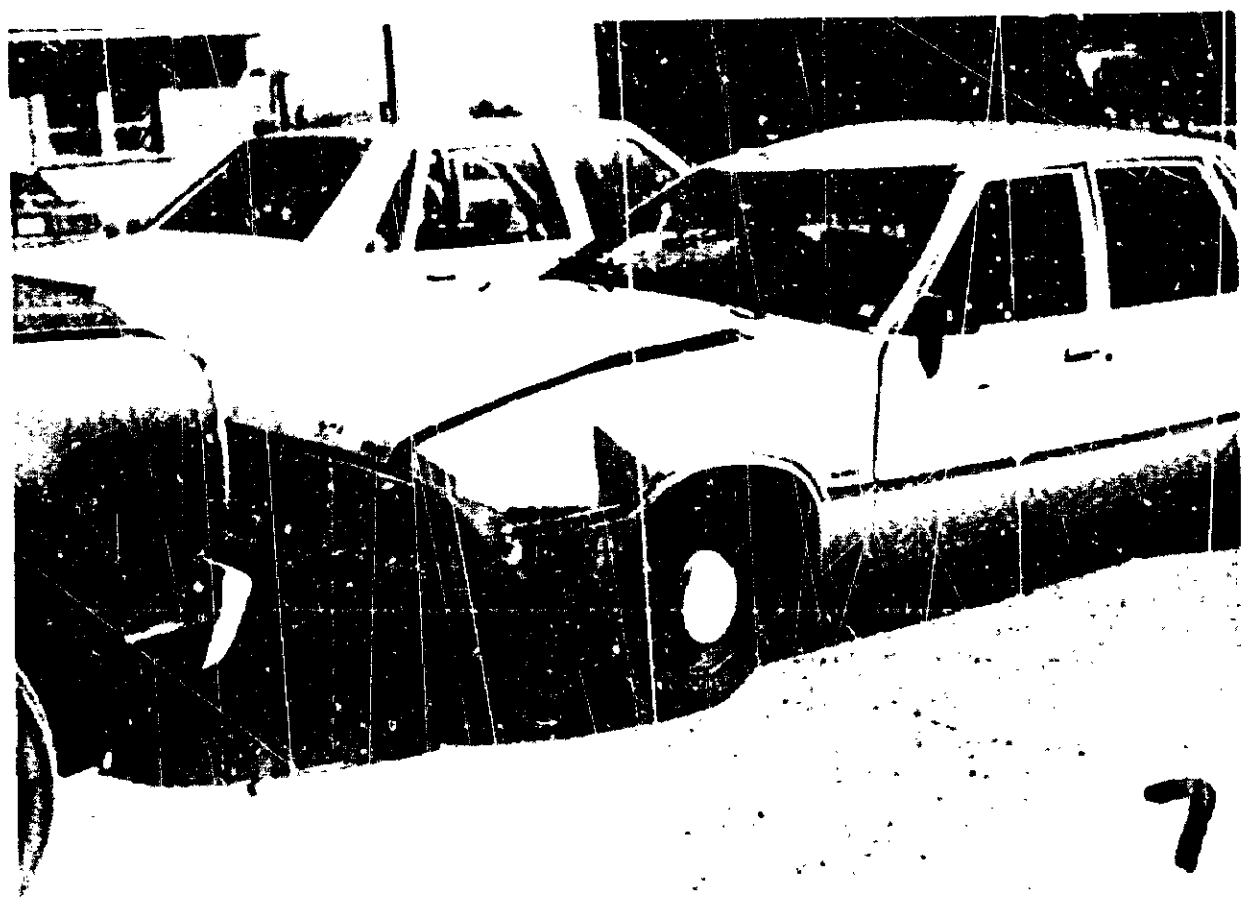
Injuries	AIS	Probable Source
Contusion, right deltoid	1	Interior sidewall
Contusion, left breast/chest	1	Loose object in vehicle
Contusion, right thigh	1	Lap portion of the belt

This occupant struck the interior sidewall of the right door with force. Had this occupant not been restrained in this 450 degree rollover accident, it is possible that she could have been ejected.

CASE 12 - (DEN-84-H-OR32)

Case Vehicle: 1982 Fairmont
Case Vehicle Weight: 2,994 pounds
Case Vehicle Delta V: 180-degree rollover (no Delta V)





Circumstances

A 1982 Ford was traveling on an interstate highway when the driver swerved to miss another car. The vehicle struck a guard rail and rolled 180° cnto its roof. The rollover resulted in moderate damage to the Ford's roof and windshield.

The driver, wearing a lap/shoulder belt, sustained minor injuries.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: M
Age: 19
Height: 5 feet 9 inches
Weight: 126 pourds
Restraint used: Lap/shoulder belt (ELR)

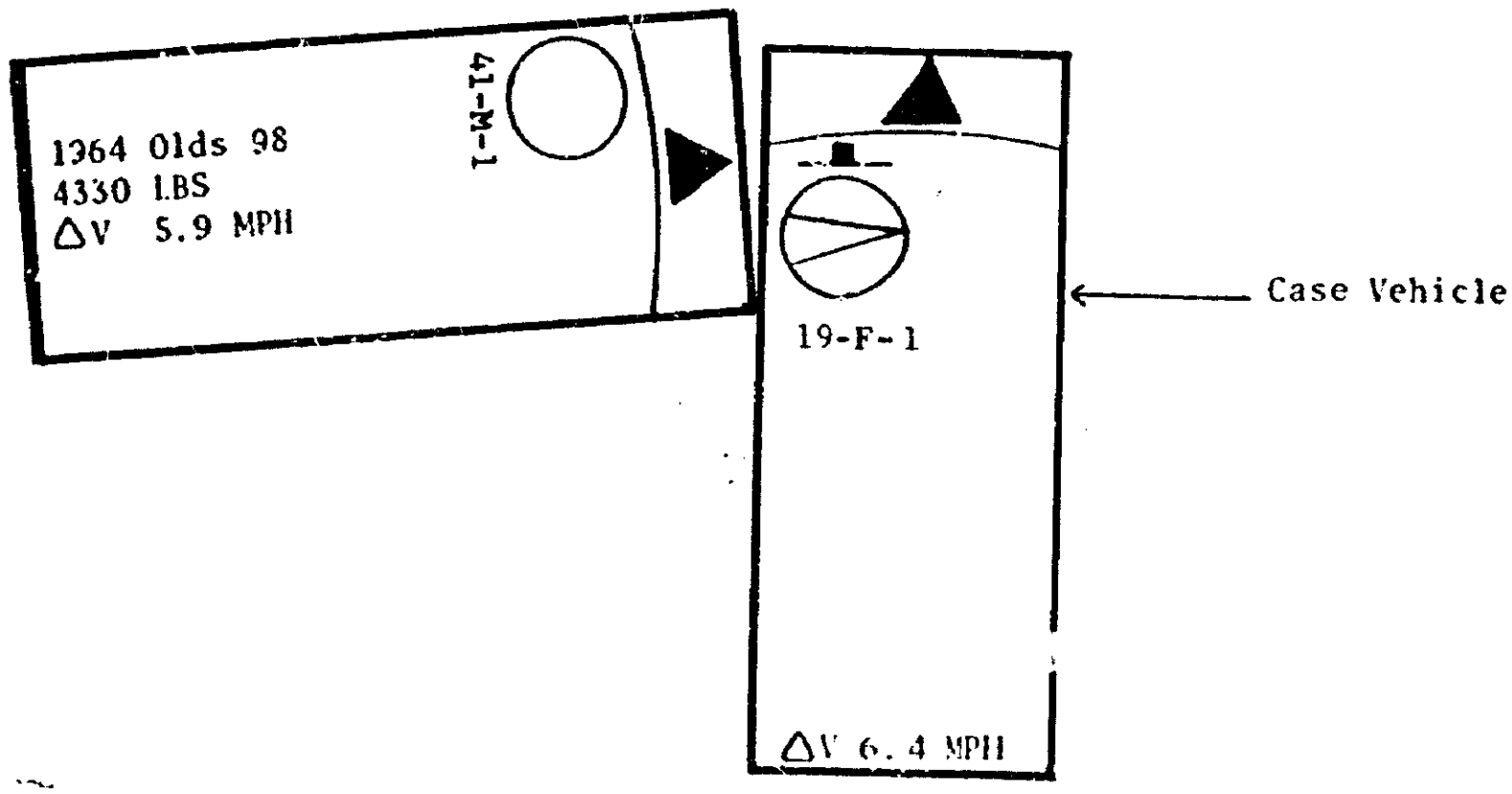
The driver was wearing a lap/shoulder belt with a cinching latchplate, an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, and a stalk-mounted buckle assembly. The driver stated that the lap portion of the belt was worn "across his abdomen" with the shoulder portion adjusted so that he could get the palm of his hand between his chest and the belt.

Injuries	AIS	Probable Source
Laceration, right elbow	1	Windshield glass
Puncture wound, right thigh	1	keys in ignition
Laceration, left side of nose	1	Broken windshield glass
Lower back strain	1	Body twist during rollover
Contusion, right knee	1	Lower dashboard

The driver refused treatment at the scene, later he was taken to a hospital where he was treated and released. The driver missed 7 days of work due to his injuries. Considering the crash forces involved in this 180 degree rollover accident, the lap/shoulder belt clearly prevented more serious injuries.

CASE 14 (SEA-84-H-OR02)

Case Vehicle: 1977 Pontiac LeMans, 4-door sedan
Case Vehicle Weight: 4,000 pounds
Case Vehicle Delta V: 6.4 mph



Circumstances

A 1977 Pontiac LeMans 4-door sedan was struck on its left front side by a 1964 Oldsmobile 98 4-door sedan. The Pontiac rotated clockwise after the initial impact and its left rear side impacted the right rear of the Oldsmobile. The accident resulted in approximately 8 inches of deformation at the left front wheel of the Pontiac. The front bumper of the Oldsmobile was deformed inward 5 inches.

The lap/shoulder belted Pontiac driver and unrestrained driver of the Oldsmobile sustained minor injuries.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: F
Age: 19
Height: 5 feet 6 inches
Weight: 120 pounds
Restraint used: Lap/shoulder belt with dual retractors (ELR/ELR)

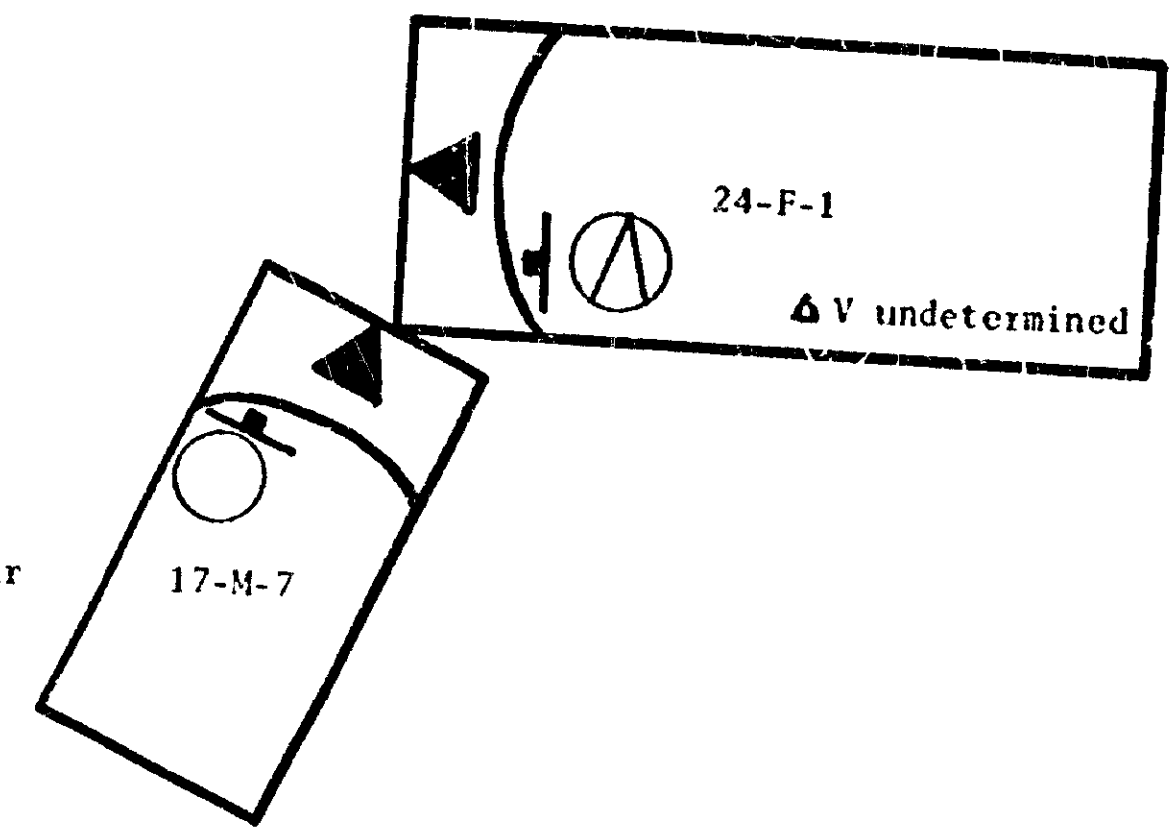
This driver was wearing a continuous loop lap/shoulder belt equipped with dual emergency locking retractors, a sewn-in latchplate, a comfort clip, and a push-button release buckle attached to a flexible stalk. The driver stated that precrash adjustment of the lap portion of the belt was snug and positioned low on the hips. She was not sure how tightly the shoulder portion of the belt was adjusted, however, the self-tensioning feature should have ensured a snug fit if not altered by the comfort-clip. The precrash location of the comfort-clip could not be determined.

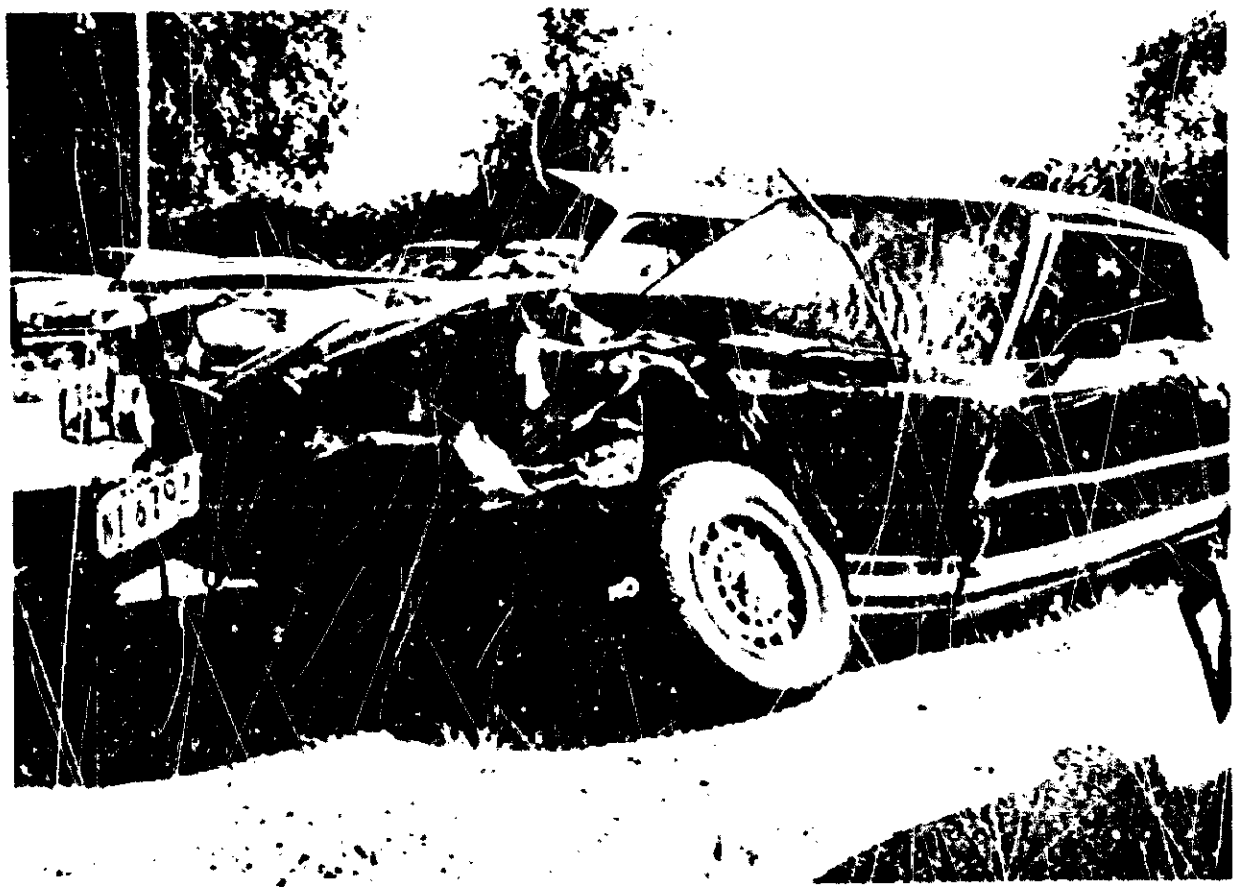
Injuries	AIS	Probable Source
Contusion, left side of head	1	Driver's door
Cervical strain	1	Impact forces
Contusion, upper left leg	1	Window handle, left door
Contusion, left ankle	1	Interior sidewall

The Pontiac driver did not seek medical attention for her injuries sustained when she struck the door at the time of impact. Given the low Delta V of 6.4 mph, it is likely that the restraint system had little influence on the injury outcome. The lap/shoulder belt could not prevent her movement into the injury producing contacts with the side interior components.

CASE 18 (CHI-84-H-OR20)

Case Vehicle: 1980 Mazda RX-7, 2-door coupe
Case Vehicle Weight: 2,555 pounds
Case Vehicle Delta V: Undetermined





Circumstances

A 1980 Mazda, traveling at a driver estimated speed of 45 mph, was struck in the left front by the right front of a 1984 Mercury Cougar which was turning left at an intersection. The Mazda then crossed a raised concrete median divider and struck the left front of a stopped 1983 Ford Van. The Mazda received substantial damage on its left front, with collapse of over 15 inches. Damage to the Mercury was extensive.

The lap/shoulder belted Mazda driver sustained minor injuries. The injury outcome and restraint status for the Mercury driver was not determined.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: F
Age: 24
Height: 5 feet 11 inches
Weight: 160 pounds
Restraint used: Lap/shoulder belt (ELR)

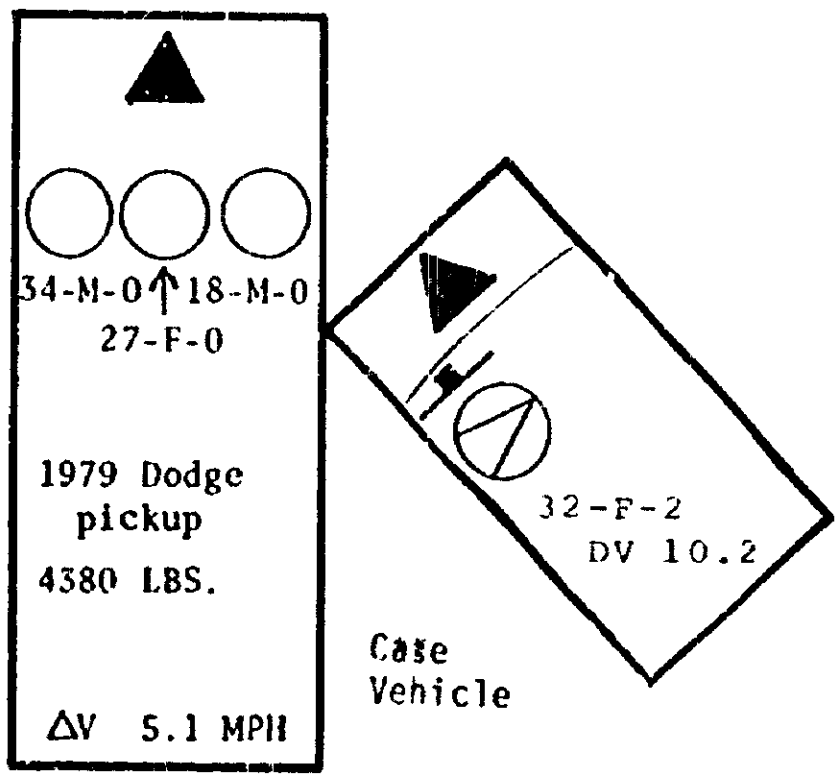
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a free-sliding latchplate, and a push-button release buckle attached to a flexible stalk. The driver described the precrash lap portion of the belt adjustment as snug, positioned low on the hips and described the shoulder portion as snug against her chest. Restraint use was verified by marks on the webbing, attributed to loading by the latchplate during the crash.

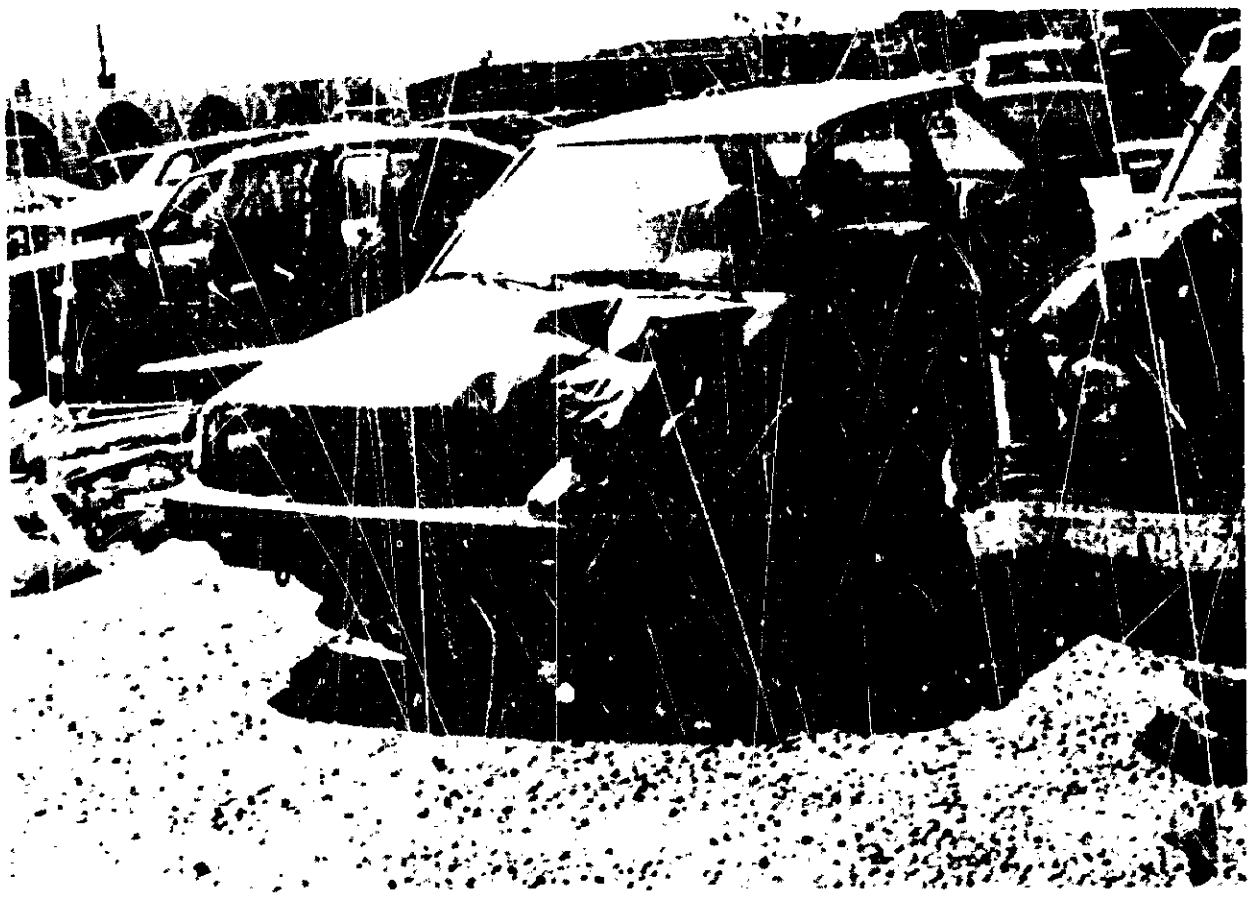
Injuries	AIS	Probable Source
Cervical strain	1	Impact forces
Contusion, left shoulder	1	Shoulder portion of belt
Contusion, top of right foot	1	Foot pedals
Contusion, right hip	1	Lap portion of the belt
Contusion, left hip	1	Lap portion of the belt
Contusion, lower abdomen	1	Lap portion of the belt

This driver was treated and released at an outpatient medical facility. Although Delta V could not be estimated in this colllision, it is apparent from drivers' stated speeds and vehicle structural damage that substantial crash forces were present. If unrestrained, the Mazda driver probably would have sustained more serious injuries.

CASE 19 (DEN-84-H-OR42)

Case Vehicle: 1984 Toyota Tercel
Case Vehicle Weight: 2,210 pounds
Case Vehicle Delta V: 10.2 mph





Circumstances

A 1984 Toyota Tercel was entering an intersection when it struck the right side of a Dodge pick-up backing up on the roadway. The Toyota received moderate damage to the left front with a maximum crush of 10 inches.

The driver of the Toyota was restrained by a lap/shoulder belt but she had the shoulder portion of the belt improperly routed under her left arm. She sustained moderate injuries in the crash.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: F
Age: 32
Height: 5 feet 6 inches
Weight: 175 pounds
Restraint used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver stated that she wore the shoulder portion of the belt under her left armpit, because, when properly placed, "it rubs the left side of my neck." The lap portion of the belt reportedly was adjusted snug across her abdomen.

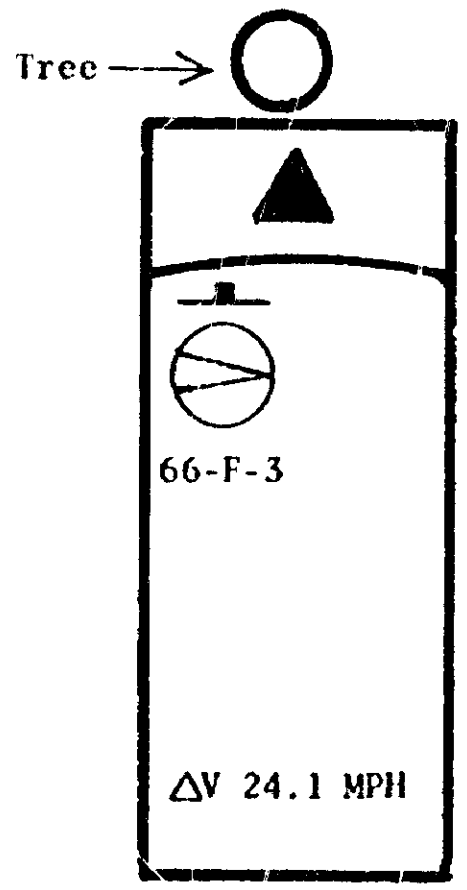
Injuries	AIS	Probable Source
Undefined concussion	2	Windshield contact
Chest contusions	1	Steering wheel
Abdominal bruises	1	Lap portion of belt
Lumbar strain	1	Impact force/lap portion of belt
Cervical strain (whiplash)	1	Windshield contact/impact force
Unspecified ankle injury	7	Floor/foot controls
Contusions of thigh	1	Steering wheel

The driver was transported via ambulance to a local hospital where she was treated and released. After returning home, she experienced fainting spells and again sought medical attention. A concussion was diagnosed at the second visit.

When the driver placed the shoulder portion of the lap/shoulder belt system under her arm, she effectively eliminated upper torso restraint. In the frontal impact, she jackknifed forward over the lap belt portion of the system and struck the windshield and steering wheel. A properly worn belt would have restrained her upper torso and prevented her from striking the windshield, the probable source of her concussion.

CASE 20 (DEN-85-H-OR02)

Case Vehicle: 1978 Subaru, 4-door station wagon
Case Vehicle Weight: 2,348 pounds
Case Vehicle Del'a V: 24.1 mph



Circumstances

A 1978 Subaru station wagon collided head-on into a large tree. This collision resulted in extensive damage to the front of the Subaru with structural deformation up to 20 inches.

The Subaru driver, restrained by a lap/shoulder belt with homemade "comfort clip" (safety pin), sustained serious injuries.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: F
Age: 66
Height: 5 feet 4-1/2 inches
Weight: 123 pounds
Restraint used: Lap/shoulder belt (ELR) - (modified with safety pin)

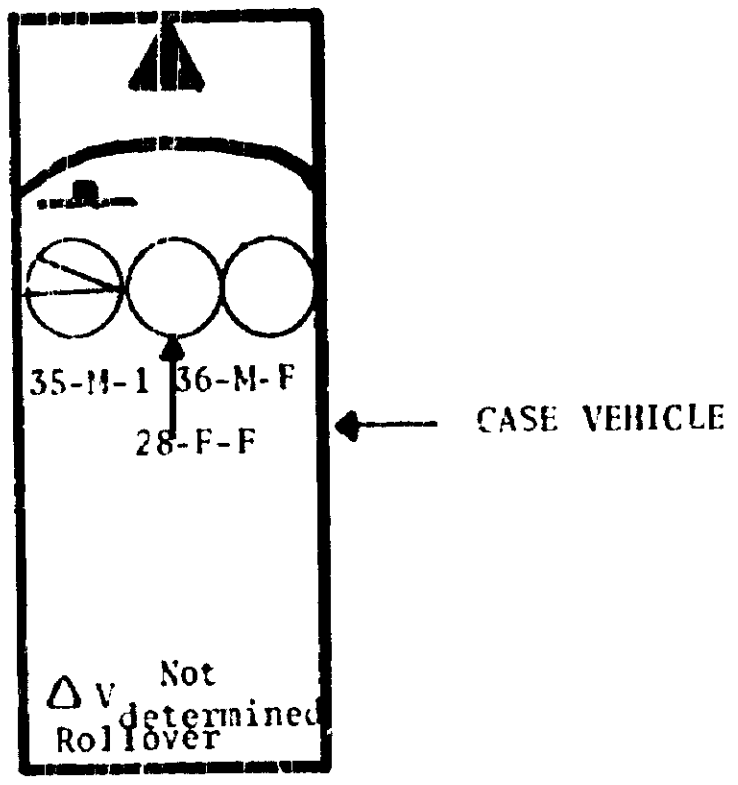
The driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a free-sliding latchplate, and a push-button release buckle attached to a flexible stalk. The driver stated that the precrash adjustment of the lap portion of the belt was snug, and positioned "across her abdomen." The shoulder strap was loose. The driver's statement about the lap portion is questionable because the system could not maintain tension of the lap belt portion independent of the shoulder portion. The driver had inserted a large safety pin through the belt webbing below the D-ring, introducing an excessive amount of slack between her chest and the shoulder strap. She told NTSB investigators she had modified the belt system by means of this homemade "comfort clip" in order to prevent the belt webbing from rubbing on her left shoulder which was inflamed with tendonitis. A postcrash examination of the vehicle revealed that the steering assembly was displaced forward and the instrument panel was moderately deformed.

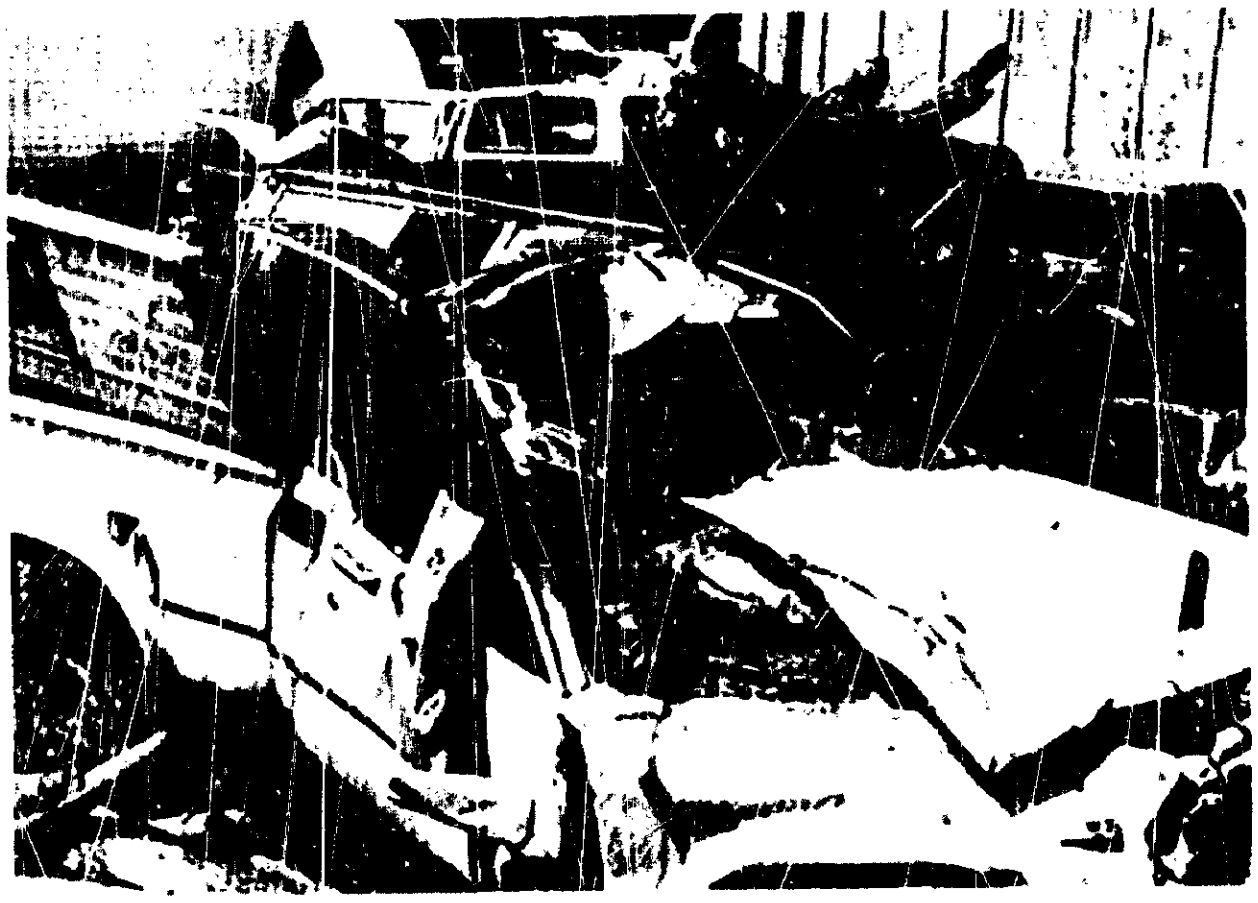
Injuries	AIS	Probable Source
Basilar skull fracture	3	Steering wheel
Facial laceration	1	Steering wheel
Cervical fracture at C2	2	Steering wheel/impact force
Fractured clavicle	2	Steering wheel/shoulder portion of belt
Fractured ribs (3), lower right	2	Shoulder portion of belt/steering wheel
Fracture, left patella	2	Instrument panel
Fracture, right radius	2	Steering wheel
Sprain, right ankle	1	Floor

The driver was admitted to a local hospital where she remained for 1 month for treatment of her injuries. It is likely that the safety pin modification to the shoulder portion of the belt webbing degraded the performance of the restraint system. However, considering this was a moderate-speed collision (Delta V of 21.4 mph) and the driver's seat was adjusted far forward, it is likely that the driver would have contacted the steering wheel even if she had worn the lap/shoulder belt properly. The driver did not sustain any abdominal bruising that would be expected in a collision of this force. She was wearing heavy, padded clothing.

CASE 21 (DEN-84-H-OR40)

Case Vehicle: 1981 Toyota four-wheel drive pick-up truck
Case Vehicle Weight: 3,800 pounds
Case Vehicle Delta V: 630-degree rollover (no Delta V)





Circumstances

A 1981 Toyota pick-up truck, traveling at a witness-estimated speed of 55 mph, struck a truck tire and rim in the roadway, went out of control and overturned. The 630 degree rollover resulted in extensive damage to the cab structure, partially tearing the roof from its attachment points.

The lap/shoulder belted-driver of the Toyota received minor injuries while two unrestrained passengers were ejected and fatally injured.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: M
Age: 35
Height: 5 feet 10 inches
Weight: 145 pounds
Restraint used: Lap/shoulder belt (ELR)

The driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a free-sliding latchplate, and a push-button release buckle attached to a flexible stalk. The driver refused to provide a statement of lap/shoulder belt adjustment. Marks were found on the belt webbing that were attributed to webbing load at the D-ring. No occupant contact marks were found on the instrument panel or the steering assembly.

Injuries	AIS	Probable Source
Contusion, left shoulder	1	Shoulder portion of belt
Contusion, right thigh	1	Lap portion of belt

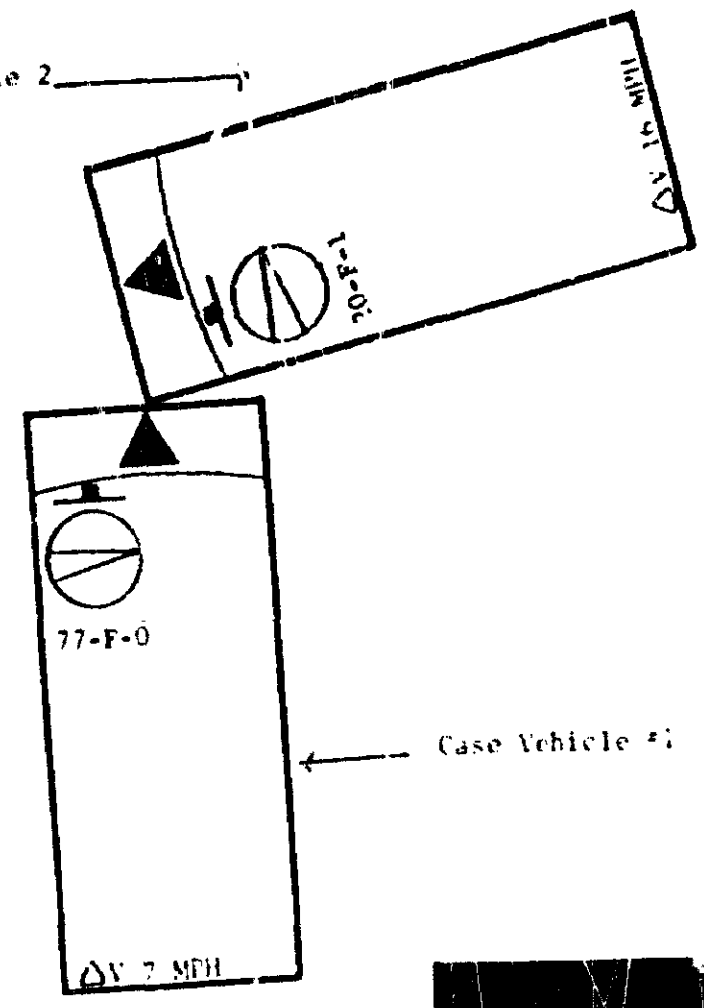
The driver did not require medical treatment. The forces in this 630 degree rollover displaced the roof structure of the Toyota, creating a large open area through which the two unrestrained passengers were ejected. Had the driver been unrestrained, he, too, probably would have been ejected and fatally injured.

One of the ejected passengers had been seated on the console of the Toyota, a non-designated seating position not equipped with any kind of restraint system. The other ejected passenger was in the right front seat, a position provided with a lap/shoulder belt which was not used. Had these two passengers been restrained, they would not have been ejected and would have probably survived.

CASE 22 (CHI-84-H-OR22)

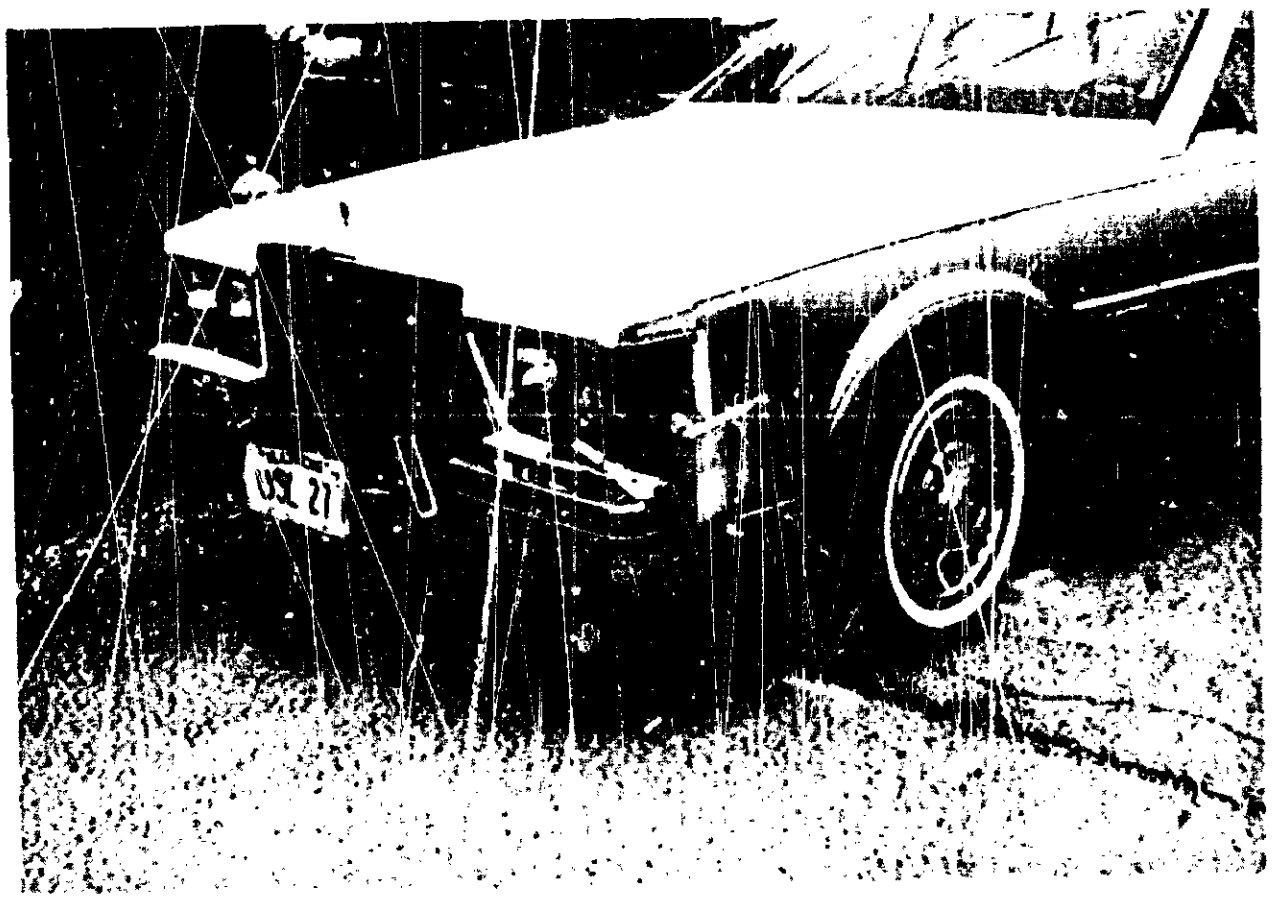
Case Vehicle #1: 1981 Cadillac Seville
Case Vehicle Weight: 4,283 pounds
Case Vehicle Delta V: 7 mph

Case Vehicle #2: 1981 Honda Civic
Case Vehicle Weight: 1,931 pounds
Case Vehicle Delta V: 16 mph



CASE VEHICLE #2

CASE VEHICLE #1



Circumstances

A 1981 Cadillac executed a left turn and collided left front to left front with a 1981 Honda Civic moving through the intersection. The Cadillac sustained a maximum deformation of 5.7 inches and the Honda 7.45 inches.

Both drivers were wearing lap/shoulder belts. The driver of the Cadillac was uninjured, while the Honda driver sustained minor injuries.

Restraint and Injury

Case Vehicle #1 - Cadillac
Seating location: Driver
Sex: F
Age: 77
Height: 5 feet 2 inches
Weight: 120 pounds
Restraint used: Lap/shoulder belt with dual retractors (ALR/ELR)

The driver of the Cadillac was wearing a continuous loop lap/shoulder belt equipped with dual retractors and a cinching latchplate. The retractor for the shoulder portion was equipped with an emergency locking retractor sensitive to vehicle motion equipped with a windowshade tension-relief mechanism. The retractor for the lap portion was an automatic locking retractor (ALR). The driver stated that the lap belt was snug, and positioned low across her hips. The shoulder portion of the belt was also snug. It was positioned across the midchest area.

The driver of the Cadillac was not injured. Not only was it a low-speed collision (Delta V of 7 mph), but the Cadillac weighed more than twice that of the Honda as well. It is likely that the restraint system had little effect on the injury outcome.

Case Vehicle #2 - Honda
Seating location: Driver
Sex: F
Age: 20
Height: 5 feet 4 inches
Weight: 118 pounds
Restraint used: Lap/shoulder belt (ELR)

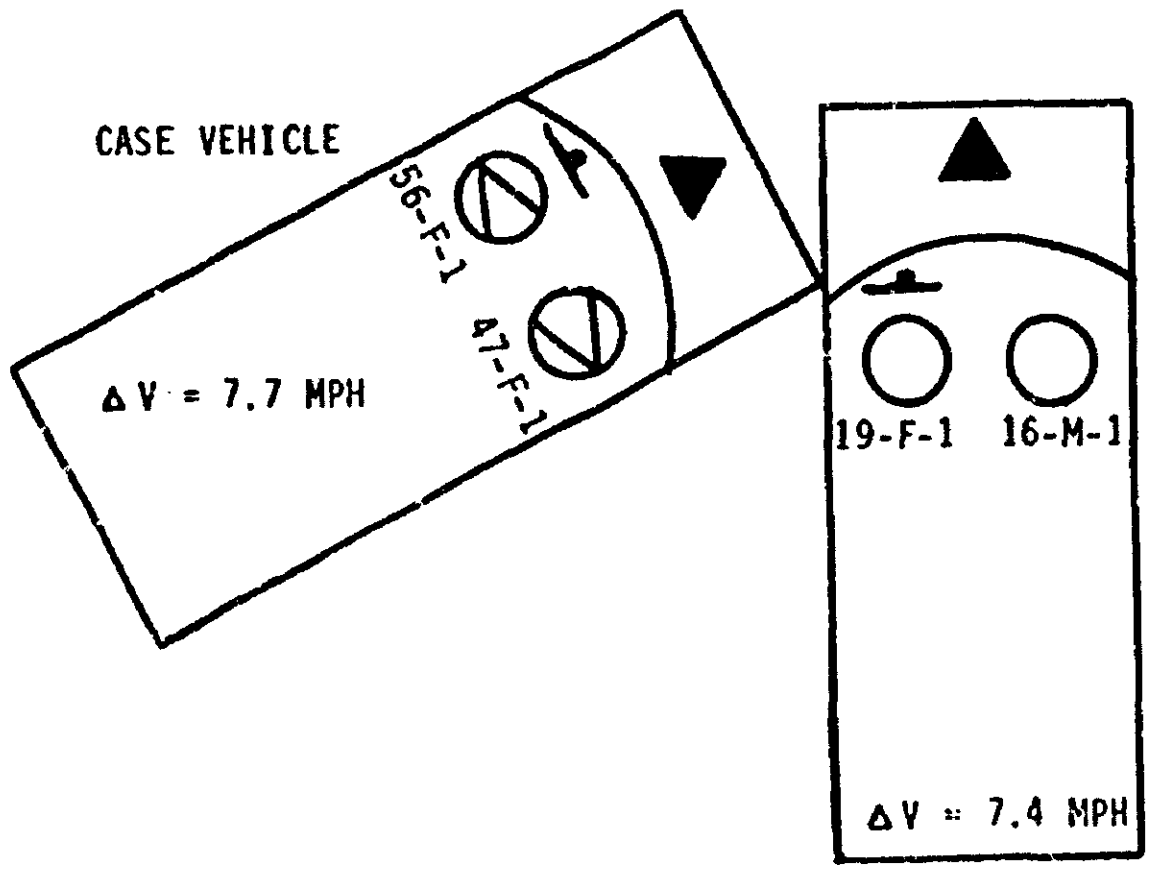
The Honda driver was wearing a continuous loop lap/shoulder belt with a free-sliding latchplate and an emergency locking retractor sensitive to vehicle motion. The driver related that the lap belt fit was snug, positioned low on his hips, and that the shoulder strap was snug and positioned across the midchest area.

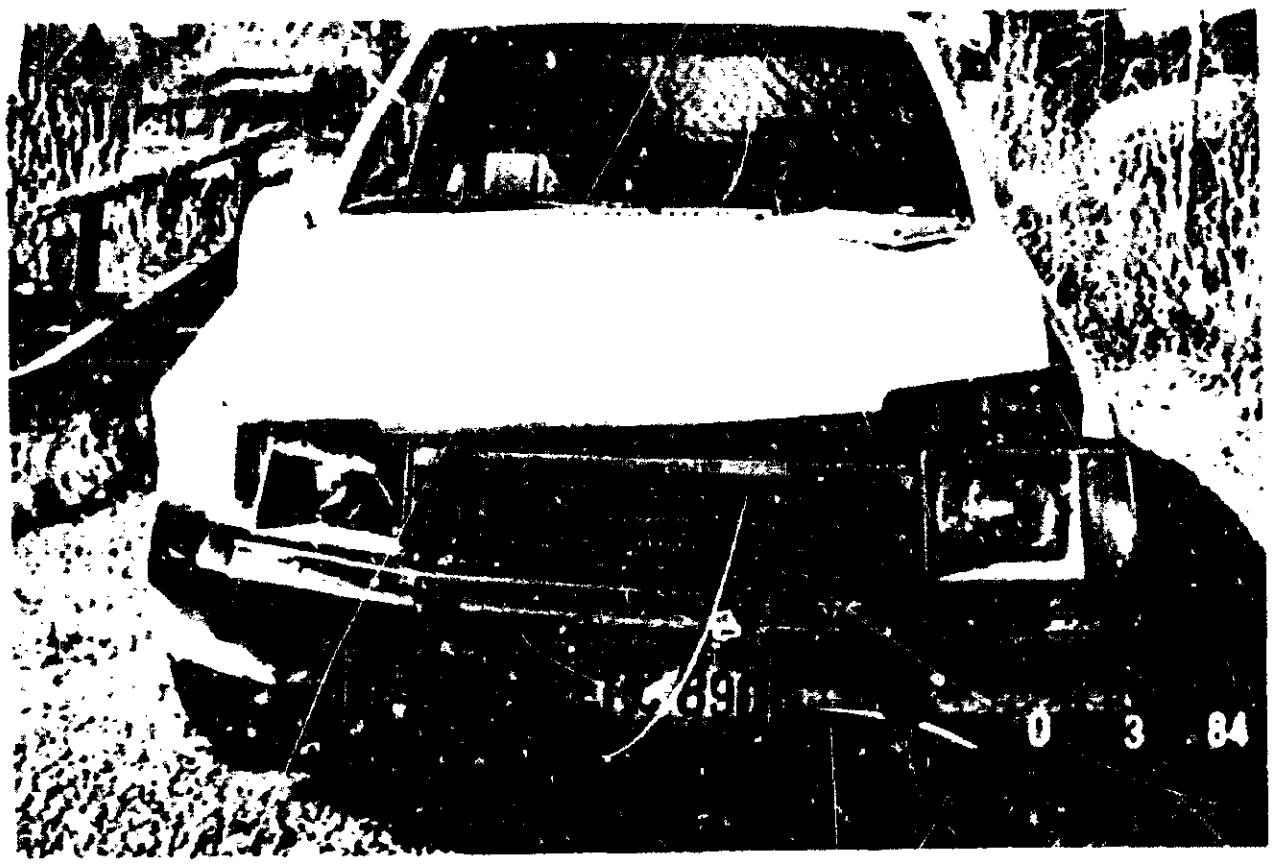
Injuries	AIS	Probable Source
Contusion with hematoma near left ear	1	Driver's door window
Cervical strain	1	Side motion of head during crash

The driver of the Honda was admitted briefly to a hospital, but released the same day. Later he received follow-up treatment. The driver's minor injuries occurred as a result of moving to the left during the collision. Considering the 16 mph Delta V of this collision, it is probable that the restraint system prevented uncontrolled movement within the vehicle and, therefor, helped reduce the driver's injury level.

CASE 23 (SEA-84-H-0R03)

Case Vehicle: 1981 Ford Escort, 2-door coupe
Case Vehicle Weight: 2,480 pounds
Case Vehicle Delta V: 7.7 mph





Circumstances

A 1981 Ford Escort struck the front left side of a 1976 Triumph TR-7 with its right front. After the initial impact, the Ford rotated counterclockwise and the Triumph clockwise. A second impact occurred with the right rear of the Ford contacting the left rear of the Triumph. The Ford sustained damage across a 60-inch wide area of its front with a maximum deformation of 14 inches. Minor damage was noted at the left side of the Triumph.

Both the driver and right front passenger of the Ford were restrained by lap/shoulder belts; both sustained minor injuries. The unrestrained occupants of the Triumph sustained minor injuries.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: F
Age: 56
Height: 5 feet 4 inches
Weight: 123 pounds
Restraint used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a windowshade tension-relief feature, a cinching latchplate, and a push-button release buckle attached to a flexible stalk. The driver described the precrash adjustment of the lap belt as snug, positioned low on the hips. The shoulder portion of the belt was adjusted for a snug fit. The driver's seat was adjusted close to the front of the track. No loading scars were present on the belt webbing postcrash, but the latchplate had scratches attributed to frequent use. Contact marks on the windshield were attributed to the driver's head striking the rearview mirror.

Injuries	AIS	Probable Source
Contusion, left side of head	1	Rearview mirror
Cervical strain	1	Impact forces
Contusion, inner thigh	1	Unknown
Contusion, both knees	1	Lower dash/instrument panel

This driver was treated at a local outpatient medical facility and released. Considering the initial impact angle, rotation, and the secondary impact, it is probable that this driver was displaced from behind the shoulder belt. That displacement allowed her head to strike the rearview mirror.

Case Vehicle
Seating location: Right front
Sex: F
Age: 47
Height: 5 feet 3 inches
Weight: 145 pounds
Restraint used: Lap/shoulder belt (ELR)

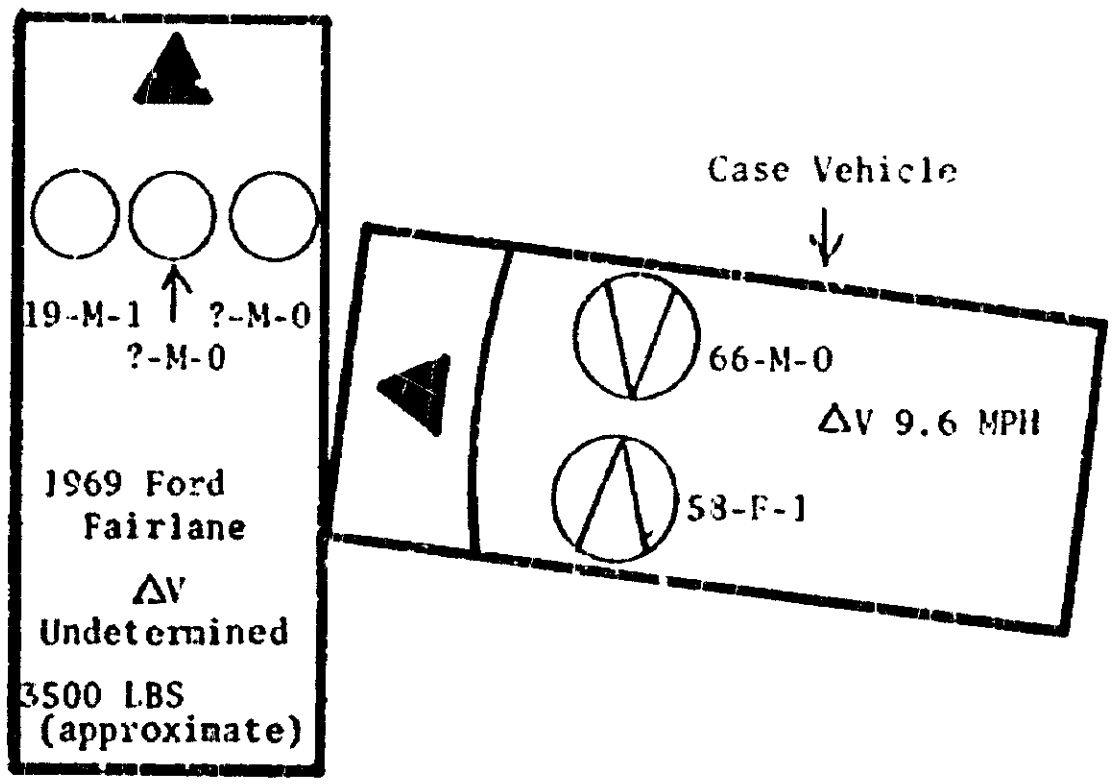
This passenger was wearing a lap/shoulder belt identical to that worn by the driver. She described the precrash position of the lap belt as being positioned low on her hips. She was unsure about how snug it was adjusted. There were no force loading scars on the webbing, nor were there contact points found on the frontal interior of this occupant area.

Injuries	AIS	Probable Source
Cervical strain	1	Impact forces
Contusion, right forearm	1	Contact with armrest
Contusion, left knee	1	Lower dash/instrument panel

This passenger was treated at a local outpatient hospital and released.

CASE 24 (FTW-84-H-OR13)

Case Vehicle: 1984 Oldsmobile Cutlass station wagon
Case Vehicle Weight: 3,385 pounds
Case Vehicle Delta V: 9.6 mph



Circumstances

A 1984 Oldsmobile Cutlass station wagon was proceeding through an intersection when a 1969 Ford Fairlane entered from the left and was struck in the right rear by the Oldsmobile. The Oldsmobile sustained moderate damage to the left front with a maximum deformation of 9 inches.

The Oldsmobile driver, restrained by a lap/shoulder belt, sustained minor injuries. The right front passenger, also restrained by a lap/shoulder belt, was uninjured.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: F
Age: 58
Height: 5 feet 7 inches
Weight: 156 pounds
Restraint used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver stated that the precrash adjustment was low on the hips with an adjustment "between snug and loose." The shoulder portion of the belt was reportedly "loosely" adjusted.

Injuries	AIS	Probable Source
Contusion, left parietal	1	Door window
Contusion, left arm	1	Steering wheel
Contusion, right lower leg	1	Lower instrument panel
Contusion, left hip	1	Lap portion of belt/door
Abrasion, left elbow	1	Door

The driver was admitted to an area hospital for 1 day and reported 1 day's loss of work. Her use of the available lap/shoulder belt prevented uncontrolled movement during the crash dynamics. Considering the low velocity change (Delta V of 9.6 mph), the slack in the lap/shoulder belt probably made little difference in injury severity.

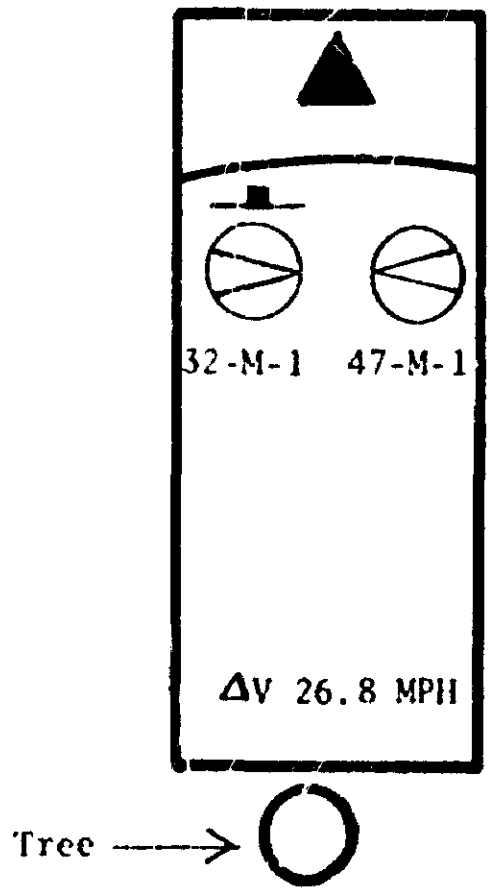
Case Vehicle
Seating location: Right front
Sex: M
Age: 66
Height: 6 feet
Weight: 165 pounds
Restraint used: Lap/shoulder belt (ELR)

The right front passenger was wearing a restraint identical to that worn by the driver. He stated that the system adjustment was snug, with the lap portion positioned low on his hips.

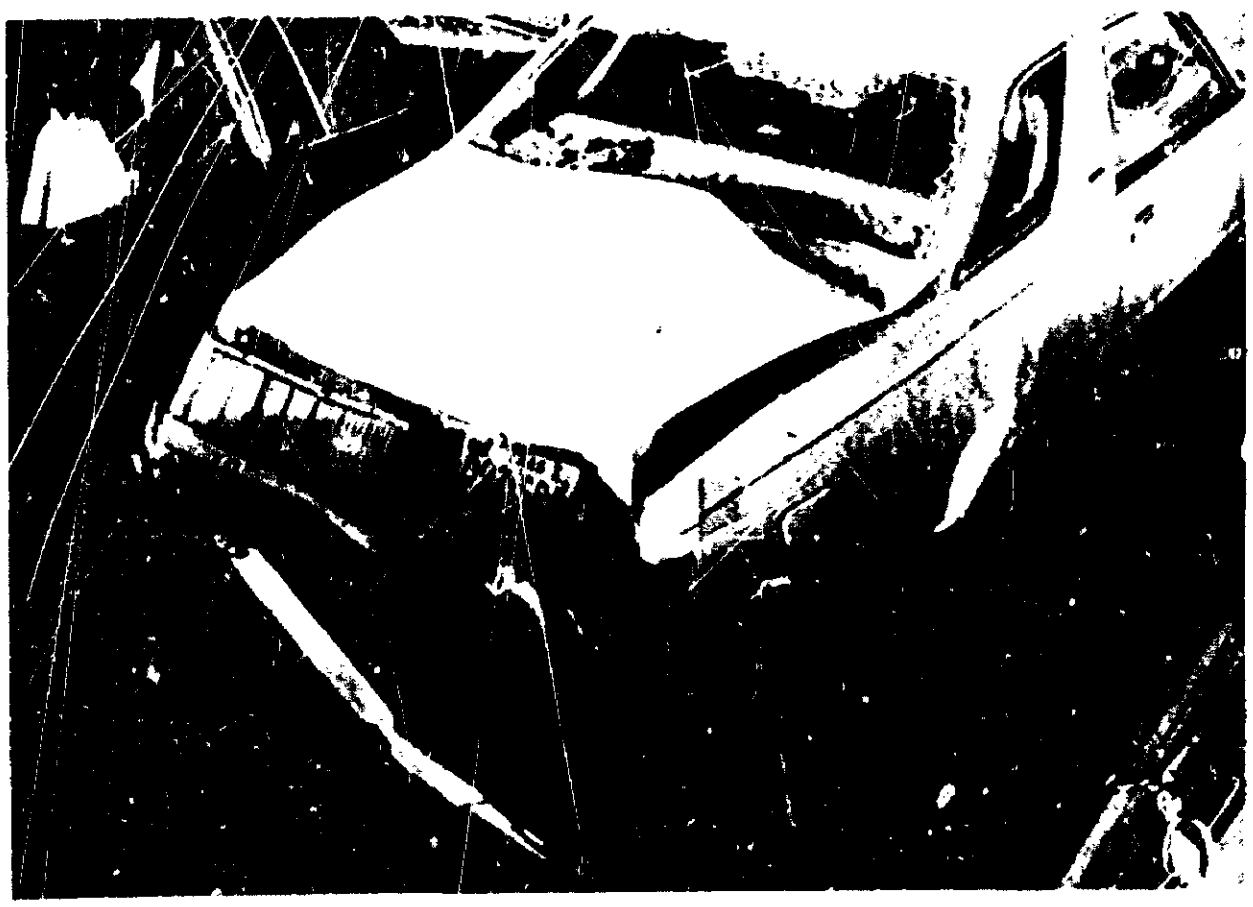
The passenger was not injured.

CASE 25 (FTW-85-H-0R01)

Case Vehicle: 1980 Ford Fairmont, 2-door
Case Vehicle Weight: 3,070 pounds
Case Vehicle Delta V: 26.8 mph



(Note: Vehicle backing)



Circumstances

A 1980 Ford was being used for a driver's examination. As the driver was attempting to demonstrate proper backing, the vehicle suddenly accelerated rearward and struck a tree. The rear of the vehicle received substantial damage with a maximum deformation of 29 inches.

Both the driver and the test examiner who was the right front passenger were restrained by lap/shoulder belts. Both occupants received minor neck injuries.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: M
Age: 32
Height: 6 feet 1 inch
Weight: 136 pounds
Restraint used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver, of foreign descent with limited knowledge of English, could not offer any information as to the webbing adjustment other than it "looked tight." The test examiner confirmed that the driver was wearing the lap/shoulder belt, a requirement for all driving tests. Force loading marks were found on the belt webbing in the area of the latchplate.

Injuries	AIS	Probable Source
Cervical strain	1	Impact force

The driver did not seek medical treatment for his injury, however, he reportedly required 4 days of rest recuperating at home. At impact, the front seat backs collapsed rearward, down to the level of the lower rear seat cushion. Considering the 26.8 mph Delta V in combination with the collapsed seat backs, it is possible that the driver would have been ejected through the rear window had he not been wearing a lap/shoulder belt.

Case Vehicle
Seating location: Right front
Sex: M
Age: 47
Height: 6 feet 2 inches
Weight: 204 pounds
Restraint used: Lap/shoulder belt (ELR)

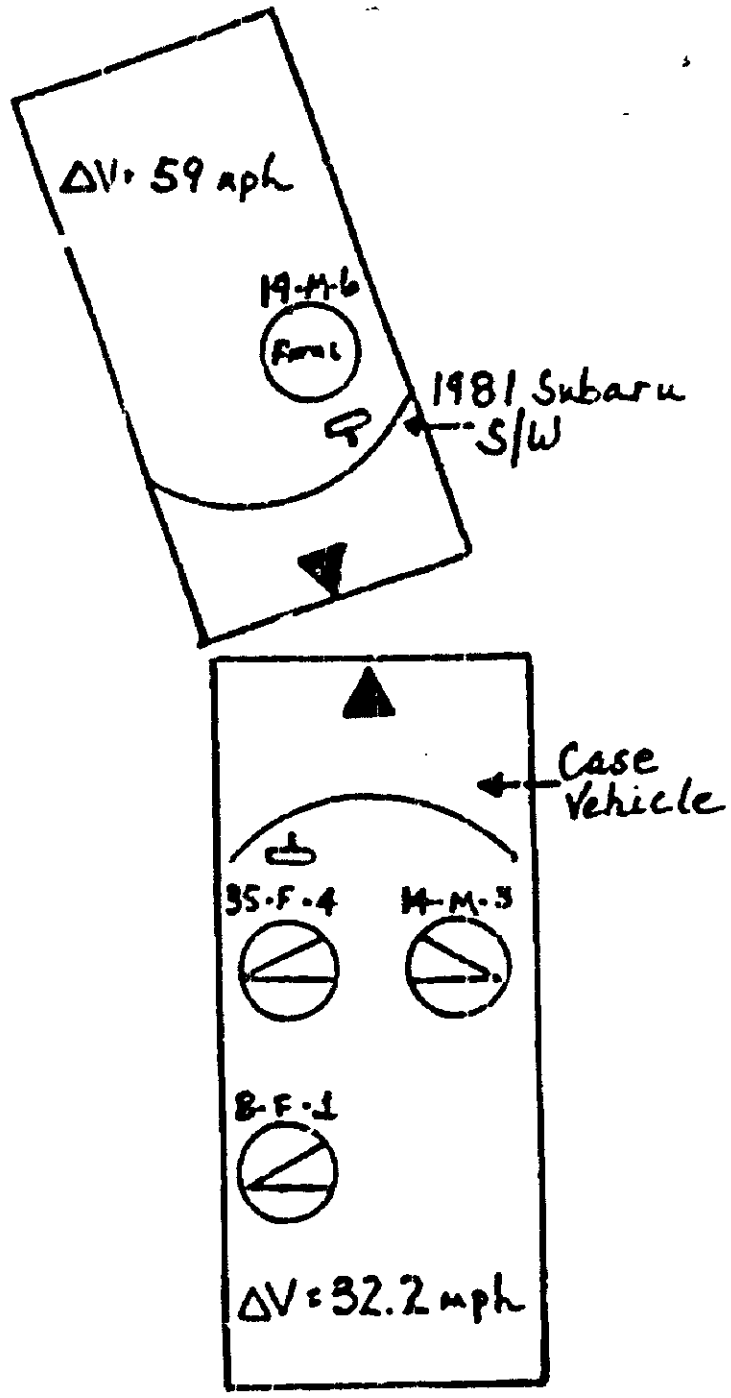
This passenger was wearing a continuous loop lap/shoulder belt identical in design to that worn by the driver. The passenger, a Texas Department of Public Safety Drivers License Test Examiner, had no memory of any precrash adjustment of the lap portion. He described the adjustment to the shoulder portion of the belt as having considerable slack between the strap and his chest. Although his Department requires the use of available lap/shoulder belts during testing, he deliverately introduces slack in the shoulder belt to allow himself freedom to turn his body sideways and view the driver being tested. The passenger also complained that a tight belt interfers with his police gunbelt. Force loading marks were found upon the belt webbing 31 inches above the lower anchor. Abrasion marks from the officer's gun belt and service revolver handles were found extending from the lower portion of the seat back to just below the topmost portion of the seat.

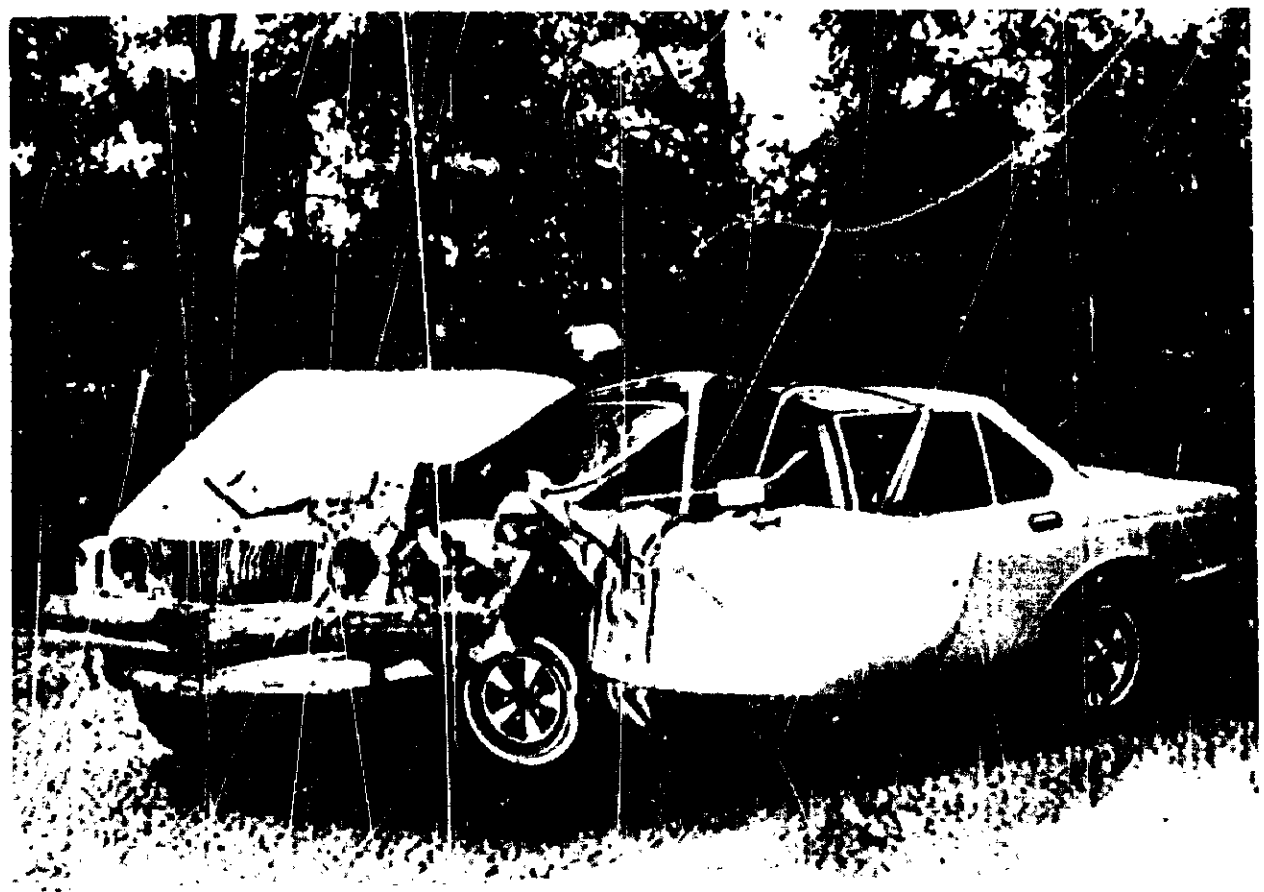
Injuries	AIS	Probable Source
Cervical strain	1	Impact forces

The passenger did not seek medical treatment for his injury or miss any time from work. The use of the available lap/shoulder belt, although improperly adjusted, did retard violent rearward movement in this 26.8 mph Delta V collision. Given the rearward forces indicated by the occupants travel over the deformed seatback, it is reasonable to assume that the belt system might have prevented him from being ejected through the rear window.

CASE 26 - (FTW 84-H-OR16)

Case Vehicle: 1982 Jaguar XJ-6, 4-door
Case Vehicle Weight: 4,350 pounds
Case Vehicle Delta V: 32.2 mph





Circumstances

A 1982 Jaguar was struck on the left front by a 1981 Subaru station wagon. The Jaguar sustained substantial damage to the front and left front with rearward deformation of up to 67 inches at the left front. The Subaru sustained deformation of up to 45 inches at its left front.

The Jaguar driver, restrained by a lap/shoulder belt, received severe injuries. The lap/shoulder restrained right front passenger sustained serious injuries, and the lap/shoulder restrained left rear passenger sustained minor injuries. The unrestrained Subaru driver sustained fatal injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 35
Height: 5 feet 2 inches
Weight: 100 pounds
Restraint Used: Lap/Shoulder belt (ELR)

This driver was wearing a continuous loop, lap/shoulder belt with an emergency locking retractor (ELR), a free-sliding latchplate, and a stalk-mounted buckle assembly. There was no evidence found of improper use or failure of the restraint system.

Force loading marks were on the belt belt webbing at the area where it passed through the D-ring. The plastic buckle housing shattered, however, the latchplate remained secured within the buckle.

Injuries	AIS	Probable Source
Laceration, inside lower lip	1	Steering wheel rim
Contusion, lower front face	2	Steering wheel rim
Contusion, lower right neck	2	Steering wheel
Concussion	4	Impact forces
Fractured right femur	3	Lower instrument panel
Laceration into right knee joint	2	Lower instrument panel
Contusion, left knee	1	Lower instrument panel
Fractured right ankle	2	Floorpan & foot controls
Fractured toes, left foot	2	Floorpan & foot controls
Contusions, lower abdomen area	2	Lap portion of belt
Multiple contusions, upper torso	2	Shoulder portion of belt and steering assembly

The driver was admitted to a local hospital for 19 days and reported a 6-month loss of work. Lap/shoulder belt use could not prevent her injuries which were due to inward collapse of the frontal interior of the vehicle. The interior collapsed rearward into the driver, allowing no space for safe ride-down. The space between the seatback cushion and steering assembly was reduced from 21 inches to 13 inches. The underdash components and foot controls were pushed rearward and inboard producing severe injuries.

Seating Location:	Right front passenger
Sex:	M
Age:	14
Height:	5 feet 4 inches
Weight:	125 pounds
Restraint Used:	Lap/shoulder belt (ELR)

This passenger was wearing a continuous loop, lap/shoulder belt with an emergency locking retractor, a free-sliding latchplate, and a stalk-mounted buckle assembly. No evidence was found of system misuse or failure. Force loading scars were found on the belt webbing.

Injuries	AIS	Probable Source
Major contusion, nose and left face	2	Instrument panel
Nose fracture	1	Instrument panel
Fractured cheekbone	2	Instrument panel
Major contusion, lower abdomen	2	Lap belt
Contusion, bladder	3	Lap portion of belt
Contusion, lower right neck	1	Shoulder portion of belt
Contusion, shoulder	1	Shoulder portion of belt

This occupant was admitted to a local hospital for 4 days, and reportedly missed an additional 4 days of school. The front passenger, absorbing an angular line of force, was propelled forward into head contact with the dashboard. Use of the available lap/shoulder belt probably prevented windshield contact, and resultant severe head injuries, in this 32.2 mph Delta V collision.

Seating Location:	Left Rear
Sex:	F
Age:	8 years
Height:	4 feet 2 inches
Weight:	45 pounds
Restraint Used:	Lap/shoulder belt (ELR)

This passenger was restrained by a continuous loop, lap/shoulder belt with an ELR mounted on the rear parcel deck, a free-sliding latchplate, and a webbing mounted buckle assembly.

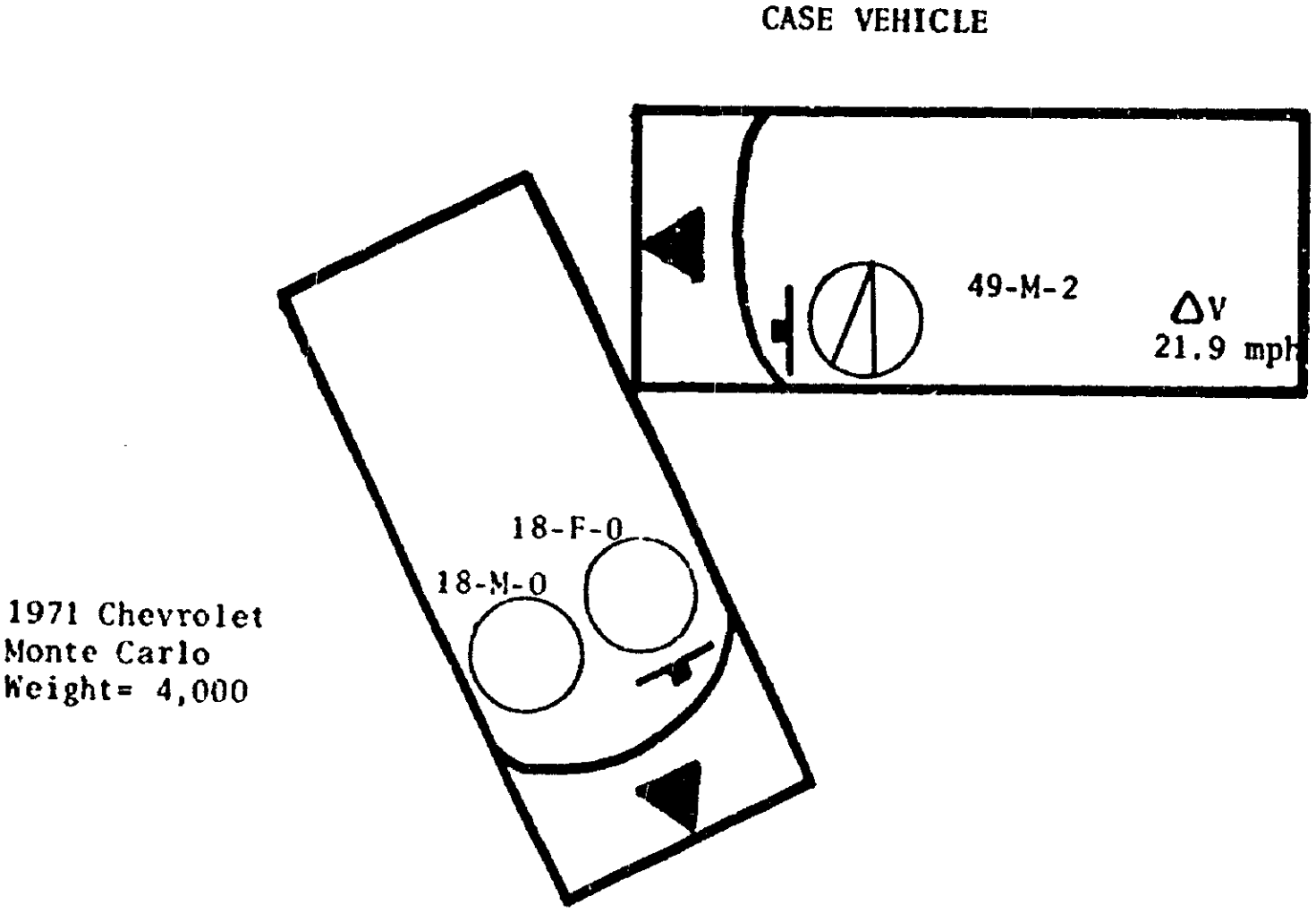
Injuries	AIS	Probable Source
Contusion, left side of neck	1	Shoulder portion of belt
Lower abdominal contusions	1	Lap portion of belt

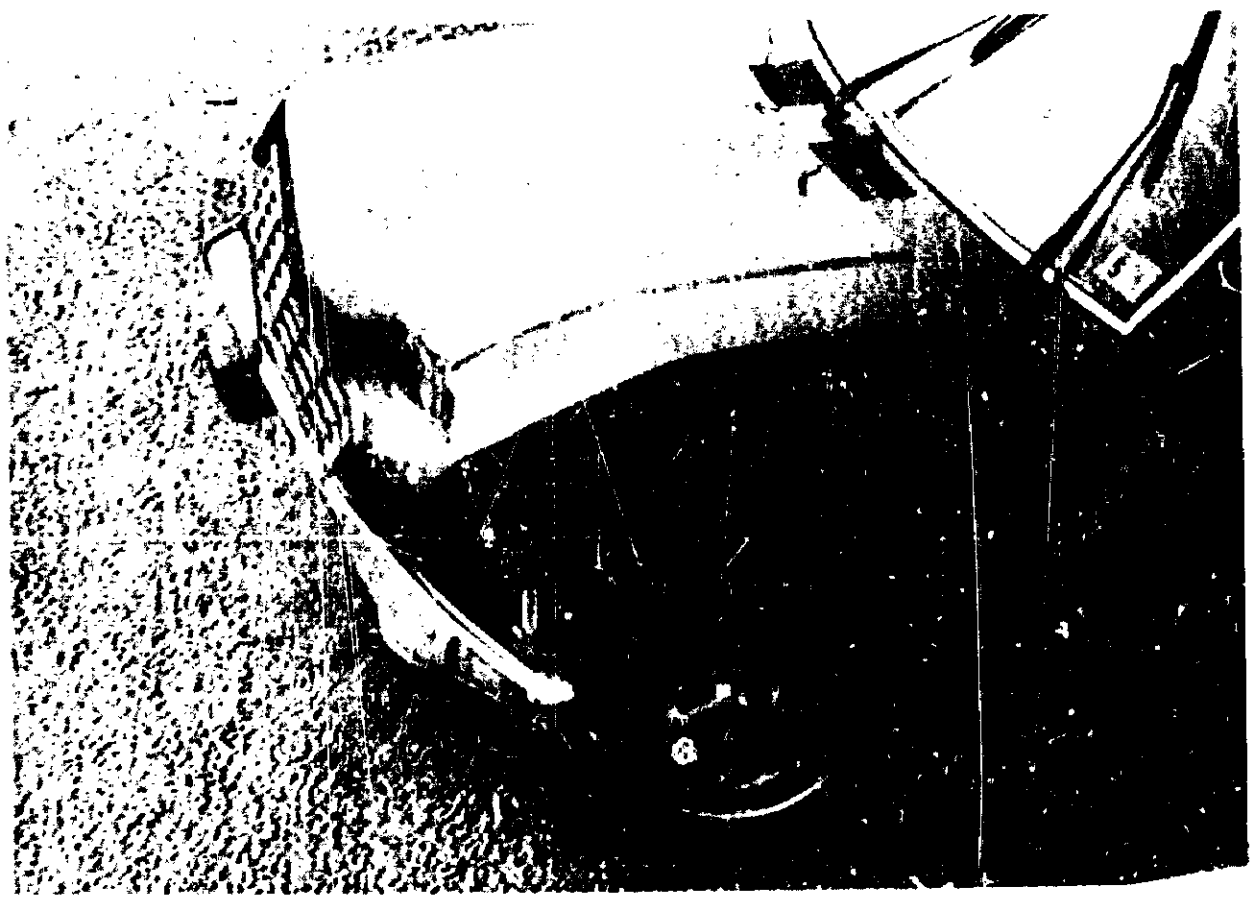
The occupant was treated at a local emergency hospital and released. There was no significant deformation at this occupant's seating position.

There was no evidence found to indicate misuse or failure of the restraint system. Injury patterns were consistent with proper belt placement. Considering the crash forces involved in this 32.2 mph Delta V collision, it is probable that use of the lap/shoulder belt prevented a more serious injury level for this occupant.

CASE 27 (FTW-85-H-OR04)

Case Vehicle: 1980 Dodge Colt
Case Vehicle Weight: 2,000 pounds
Case Vehicle Delta V: 21.9 mph





Circumstances

A 1971 Chevrolet Monte Carlo was attempting a left turn from a driveway, across traffic, when it was struck in the left rear quarter panel by a 1980 Dodge Colt. The Dodge received substantial damage, with deformation of up to 27 inches at the left front. The Chevrolet was unavailable for examination.

The driver of the Dodge, restrained by a lap/shoulder belt, sustained moderate injuries while the unrestrained occupants of the heavier Chevrolet were reportedly uninjured.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: M
Age: 50
Height: 5 feet 9 inches
Weight: 200 pounds
Restraint used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver described precrash lap belt adjustment as being positioned across his abdomen. The shoulder portion of the belt was reportedly adjusted so that more than a clenched fist could be placed between the occupant's chest and the shoulder portion. Force loading marks were found on the webbing in the area of the free-sliding latchplate.

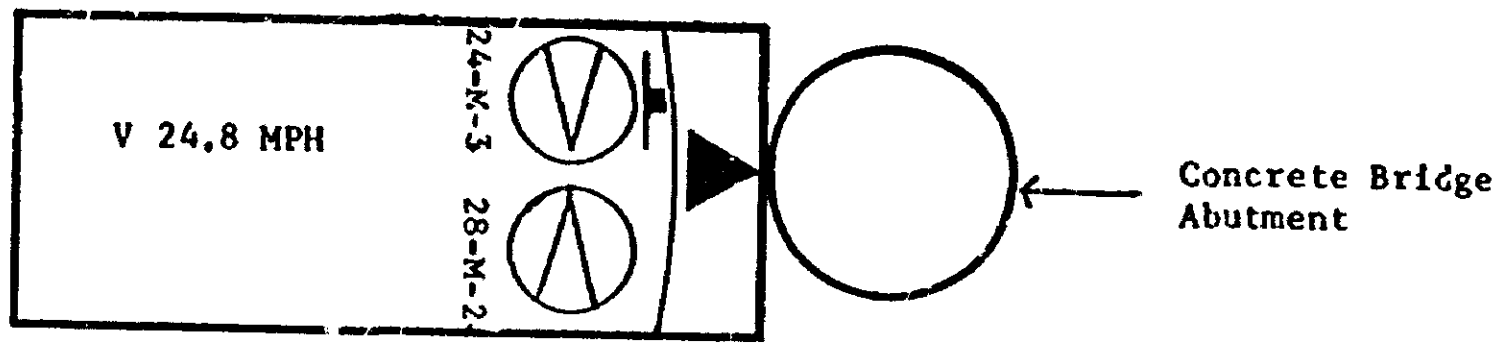
Injuries	AIS	Probable Source
Major contusion, forehead	2	Headliner/sunvisor
Closed head injury (unconsciousness)	2	Headliner/sunvisor
Fracture of sternum	2	Steering wheel

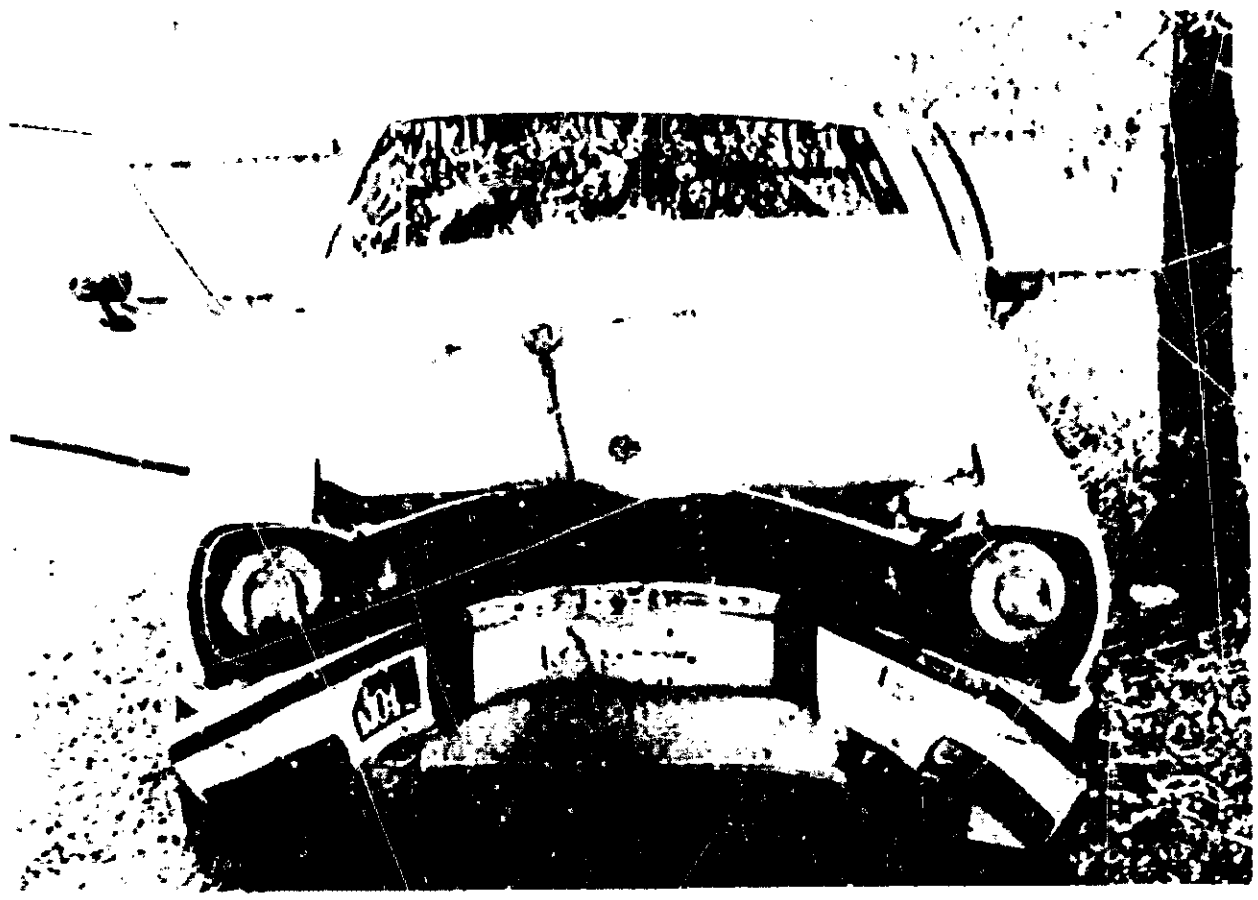
The lap portion of the restraint was positioned across the abdomen, rather than low on the hips, probably due to the buckle location well above and forward of the seat junction. This, together with the free-sliding latchplate, would introduce slack into the lap portion of the three-point belt and allow the driver to move forward. Considering the driver's injuries, the points of contact and the location of the loading marks on the seat belt webbing, it appears that either excessive slack was present or that the retractor did not immediately lock upon impact.

Because of a pre-existing medical condition involving the driver's sternum, he probably was more susceptible than others to a sternum fracture.

CASE 28 (FTW-85-H-ORC3)

Case Vehicle: 1975 AMC Hornet, 2-door
Case Vehicle Weight: 3,371 pounds
Case Vehicle Delta V: 24.8 mph





Circumstances

A 1975 AMC Hornet struck head-on into a 29-inch diameter concrete bridge pillar. The Hornet received substantial damage with inward collapse of up to 20 inches at its approximate center front.

Both the driver and the right front passenger were restrained by lap/shoulder belts. The driver sustained serious injuries while his passenger received moderate injuries and a neck injury of unknown severity which caused temporary partial paralysis.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: M
Age: 24
Height: 5 feet 10 inches
Weight: 155 pounds
Restraint used: Lap/shoulder belt with dual retractors (ALR/ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an automatic locking retractor on the lap belt, an emergency locking retractor on the shoulder portion, a sewn-in latchplate, and a push-button release buckle attached to a flexible stalk. The driver was unable to describe the precrash adjustment of the belt. However, the location of scarring found on the belt webbing, attributed to loading at the D-ring, indicates that the belt was probably adjusted in a snug manner. The rim of the steering wheel was displaced forward 3 inches and the instrument panel was moderately deformed.

Injuries	AIS	Probable Source
Concussion	3	Windshield
Major contusion, nose/lips/chin	2	Steering wheel
Cervical strain	1	Steering wheel
Laceration, right hand	1	Unknown
Contusion, chest	1	Shoulder strap
Contusion, upper abdomen	1	Lap portion of belt
Sprained jaw	1	Steering wheel

This driver was admitted to a local hospital in serious condition. Considering the crash forces of this 24.8 mph Delta V collision, he might have sustained severe or fatal injuries if he had been unrestrained, making more violent contact with the steering assembly, instrument panel, and windshield.

Case Vehicle
Seating location: Right front
Sex: M
Age: 28
Height: 5 feet 5 inches
Weight: 150 pounds
Restraint used: Lap/shoulder belt with dual retractors (ALR/ELR)

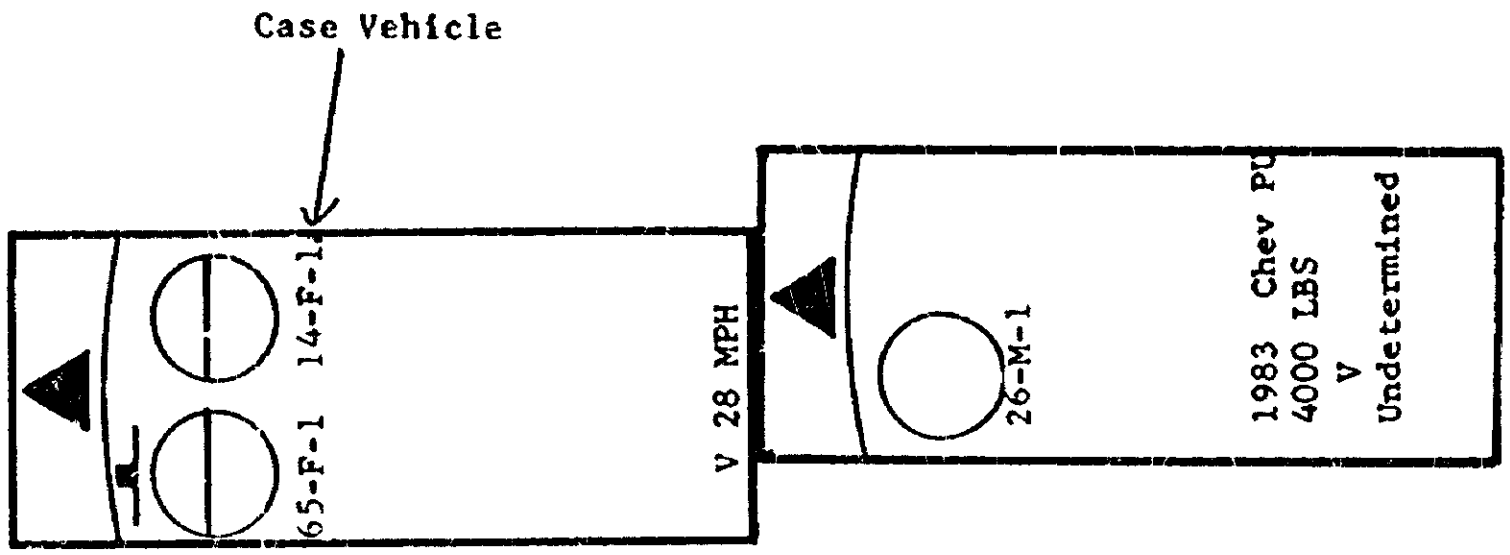
This passenger was wearing a lap/shoulder belt identical to that worn by the driver. He described the precrash adjustment of the lap belt as loose, positioned low over the hips. He indicated that he could get a clenched fist between his chest and the shoulder portion. Force loading marks were found on the belt webbing, attributed to webbing load at the D-ring. Contact marks were found on the lower instrument panel, attributed to impact by the passenger's lower extremities. The windshield was cracked forward of the passenger's seating position.

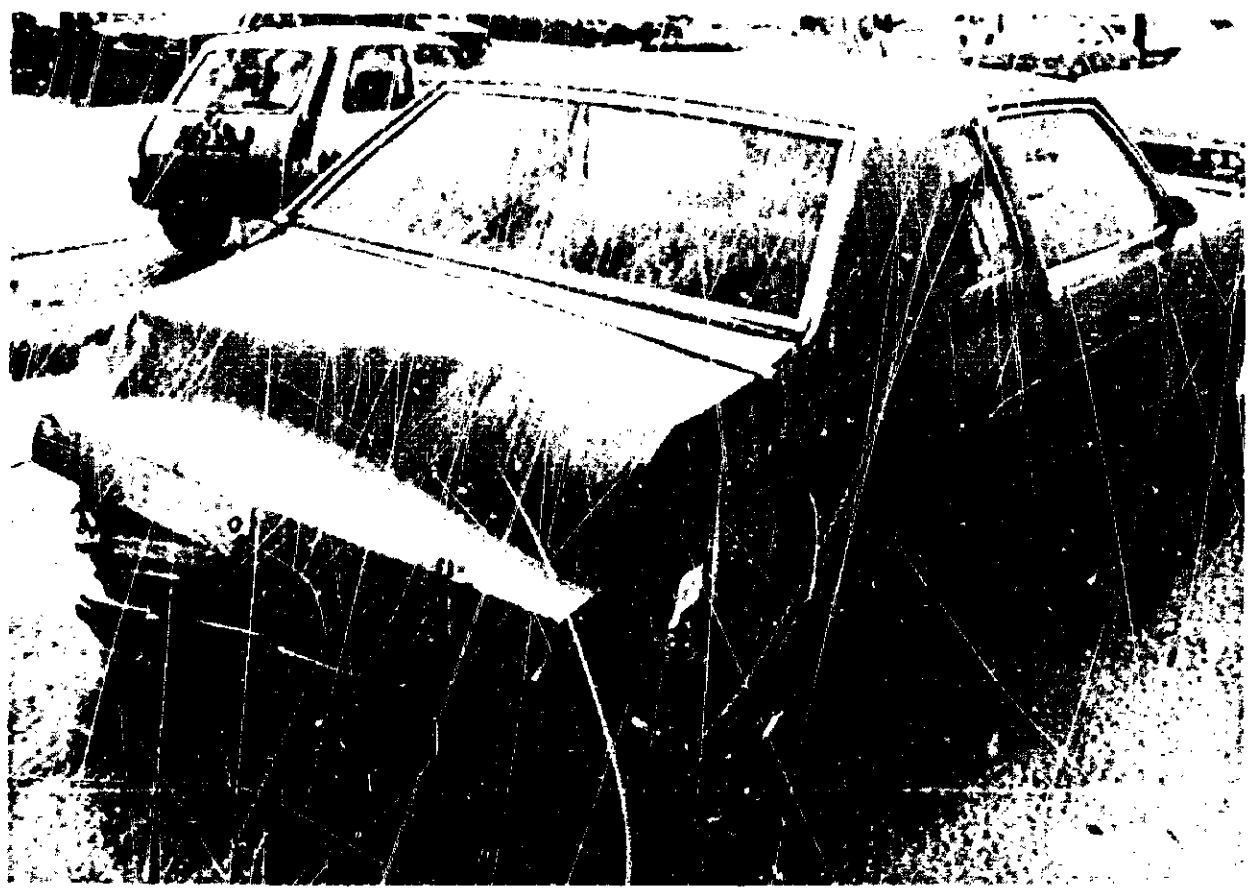
Injuries	AIS	Probable Source
Carotid artery contusion	7	Shoulder portion of belt
Contusion, right side of head	1	Windshield/rearview mirror
Major contusion, left chest	2	Shoulder portion of belt

This man was admitted to a local hospital and missed a week of work due to a temporary partial paralysis resulting from the bruising of his carotid artery. He might have sustained a higher level of injury had he not been restrained in this 24.8 mph collision.

CASE 29 (FTW-85-H-0R06)

Case Vehicle: 1979 Pontiac Bonneville
Case Vehicle Weight: 4,000 pounds
Case Vehicle Delta V: 28 mph





Circumstances

A 1979 Pontiac was stopped on the roadway, waiting to make a left turn, when it was struck on the rear by a 1983 Chevrolet pick-up truck. The collision resulted in extensive damage at the rear of the passenger car, with structural deformation of up to 31 inches. Moderate damage was noted at the front of the Chevrolet.

Both occupants of the Pontiac, the driver and right front passenger, were restrained by misrouted lap/shoulder belts: the shoulder portion of the belt was routed behind the back. Minor injuries were reported by both occupants. The unrestrained driver of the Chevrolet received minor injuries.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: F
Age: 65
Height: 5 feet 2 inches
Weight: 175 pounds
Restraint used: Lap/shoulder belt (ELR)

The driver was wearing a lap/shoulder belt with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver stated that the adjustment of the lap portion of the three-point belt was snug and positioned low across the hips, but the shoulder portion was improperly worn: the shoulder portion was routed behind the driver's back, reportedly for comfort reasons. The belt was frayed in the area of the latchplate, indicating frequent use. The stalk-mounted buckle assembly was anchored 4 inches forward of the seat cushion junction.

Both sides of the split bench front seat collapsed 41-43 degrees rearward at impact. Both seats were equipped with nonadjustable headrests which extended only 2 1/2 inches above the seat back cushion.

Injuries	AIS	Probable Source
Cervical strain	1	Impact forces
Contusion, lower right leg	1	Lower rim of steering wheel
Contusion, left hand	1	Unknown

Case Vehicle
Seating location: Right front
Sex: F
Age: 14
Height: 5 feet 4 inches
Weight: 125 pounds
Restraint used: Lap/shoulder belt (ELR)

The right front passenger was wearing a misrouted lap/shoulder belt of the same design as the driver. The lap portion of the belt was described as being "comfortable," positioned low across her hips, but, this passenger also had improperly routed the shoulder portion behind her back. No reason for the misuse was given.

Injuries	AIS	Probable Source
Cervical strain	1	Impact forces
Abdominal contusions	1	Lap portion of the belt

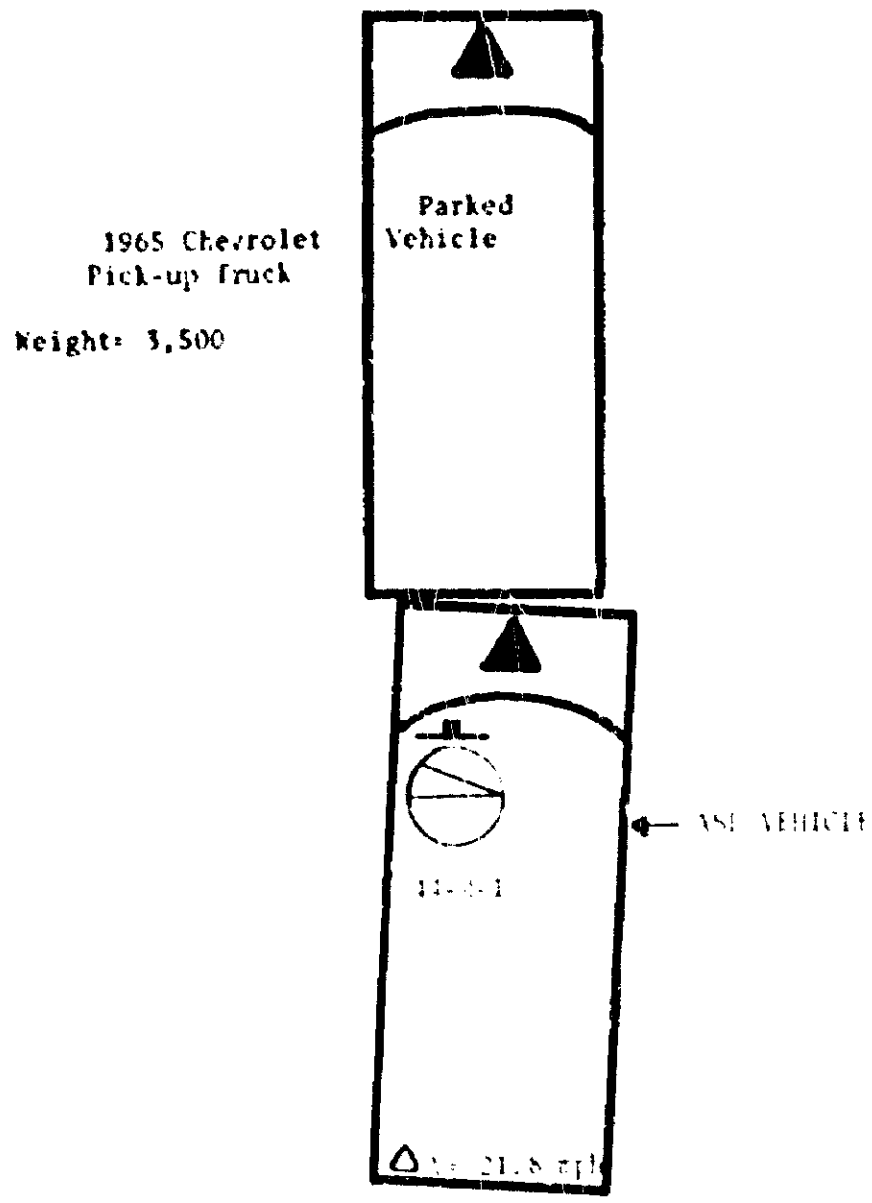
Both occupants of the Pontiac misused their lap/shoulder belts by placing the shoulder portion behind their back. Because they were involved in a rear end collision, the misuse of the belt was not as detrimental as it could have been, as for example in a frontal collision. The rearward collapse of the seat backs absorbed some of the crash forces which otherwise would have been absorbed by the occupants.

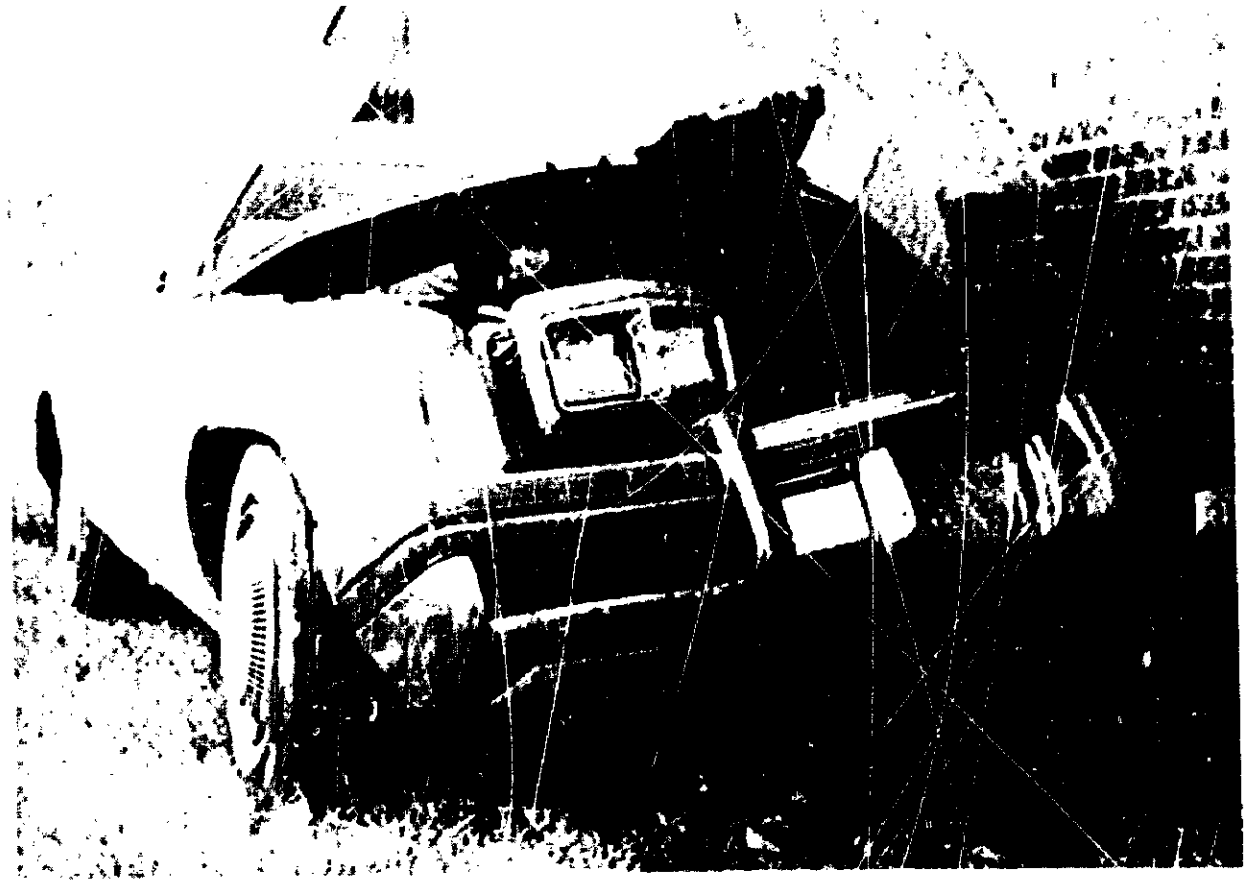
The stalk-mounted buckle anchors were four inches forward of the seat back junction, allowing additional slack into the system. Again, because this was a rear end collision, there is no evidence to indicate it adversely affected the occupants.

Due to downward deformation of the rear of the Pontiac, coupled with the rearward deformation of the seat backs, it is possible that the occupants might have been thrown into the back seat or possibly ejected through the rear window if they had been unrestrained in this 28 mph Delta V collision.

CASE 32 (FTW-85-H-OR10)

Case Vehicle: 1976 Oldsmobile Toronado, 2-door
Case Vehicle Weight: 5,031 pounds
Case Vehicle Delta V: 21.8 mph





Circumstances

A 1976 Oldsmobile Toronado veered off the travel lane and struck the rear of a parked 1965 Chevrolet pick-up truck. The left front of the Oldsmobile received substantial damage with rearward deformation of up to 28 inches. The rear of the Chevrolet pickup was reportedly extensively damaged.

The Oldsmobile driver, restrained by a lap/shoulder belt, sustained a minor injury.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: M
Age: 44
Height: 5 feet 10 inches
Weight: 170 pounds
Restraint used: Lap/shoulder belt with dual retractors (ELR/ALR)

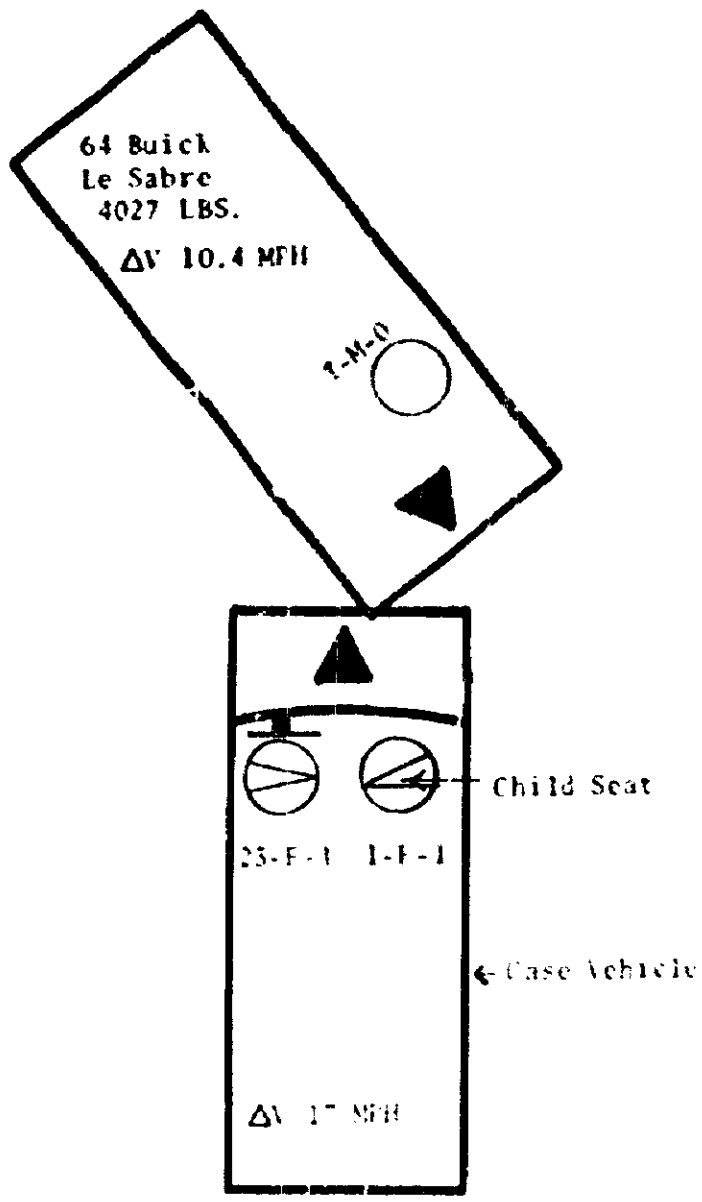
The driver was wearing a lap/shoulder belt equipped with an automatic locking retractor on the lap portion and an emergency locking retractor on the shoulder portion of the belt. The belt is equipped with a comfort clip and a stalk-mounted buckle assembly. The driver could not recall how the lap portion was adjusted; however, he related that the shoulder portion of the belt was snug across his midchest. Evidence indicated that precrash lap portion adjustment was proper, with slight slack in the shoulder portion. Extra slack in the shoulder portion was created by the webbing guide on the left side of the seat back. The precrash position of the comfort cllip is not known.

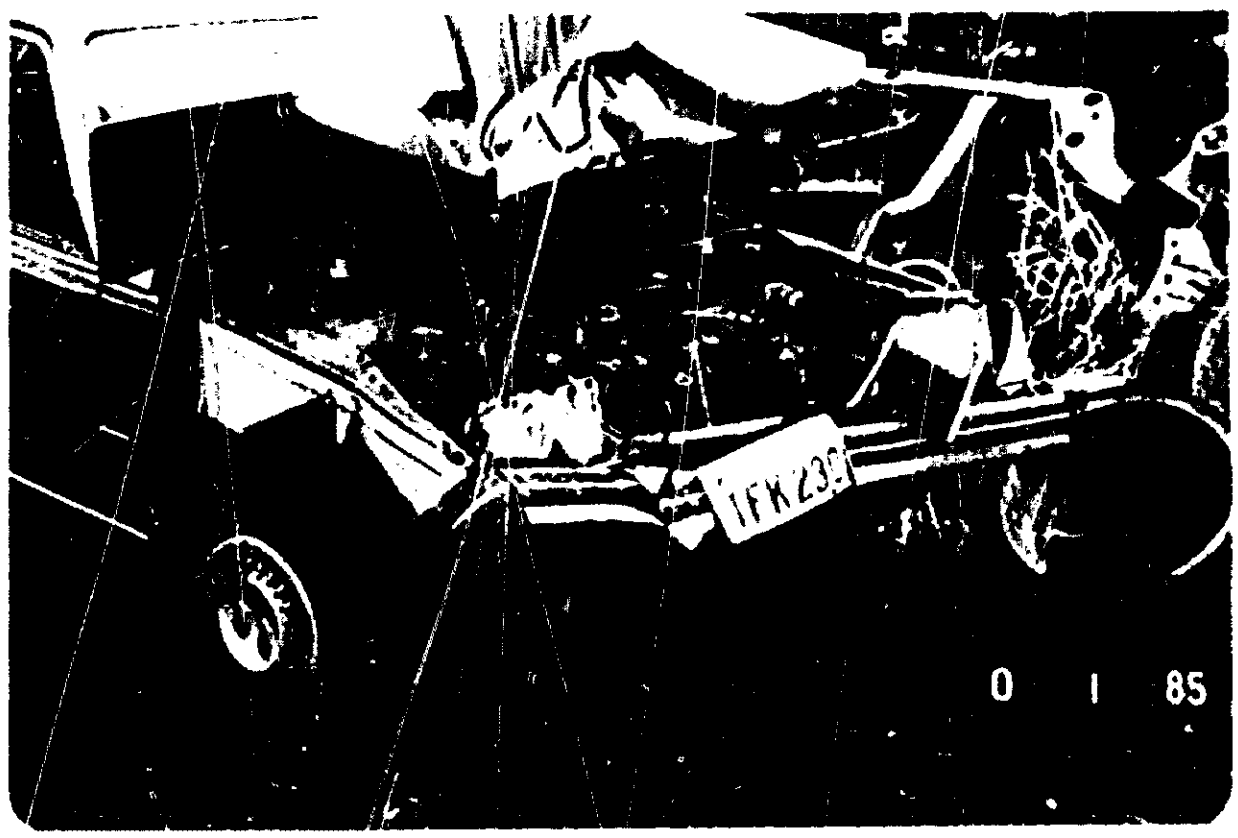
Injuries	AIS	Probable Source
Laceration, left forehead	1	Steering wheel

The driver received on-scene medical treatment from EMS personnel. Use of the lap/shoulder belt prevented uncontrolled movement within the vehicle. The driver's seat was adjusted as far back as possible on the seating track, and this, combined with use of the three-point belt, probably prevented more serious injuries in this 21.8 mph Delta V collision.

CASE 33 (SEA-85-H-OR01)

Case Vehicle: 1981 Renault 18i
Case Vehicle Weight: 2,471 pounds
Case Vehicle Delta V: 17.0 mph





Circumstances

A 1981 Renault 18i was crossing a signal-controlled intersection, attempting a left turn, when it was struck in the front by a 1967 Buick LeSabre. The Renault received substantial structural damage over a 68-inch wide area of the front with maximum deformation of 11.5 inches.

The 7-month pregnant driver of the Renault, restrained by a lap/shoulder belt, sustained only minor injuries. A child in the Renault was restrained at the right front position in a child safety seat and suffered an abrasion on the lower forehead. No injury information was available for the unrestrained driver of the Buick.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: F
Age: 23
Height: 5 feet 2 inches
Weight: 130 pounds
Restraint used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver stated that the lap belt portion was positioned low on her hips and snug. The shoulder portion of the restraint was reportedly adjusted so that it crossed the sternum.

Injuries	AIS	Probable Source
Abrasion, left side of neck	1	Shoulder portion of belt
Contusion, right knee	1	Lower instrument panel

Considering the crash forces present in this 17 mph Delta V collision, the driver's use of the available lap/shoulder most likely prevented more serious injuries No injury to the fetus was reported, and the driver subsequently carried the child full term and delivered a healthy infant. If she had been unrestrained, her uncontrolled movement into the steering wheel and column might have resulted in serious or fatal injuries to the fetus.

Case Vehicle
Seating location: Right front, child safety seat
Sex: F
Age: 1
Height: 2 feet 6 inches
Weight: 30 pounds
Restraint used: Child safety seat secured with lap/shoulder belt (ELR)

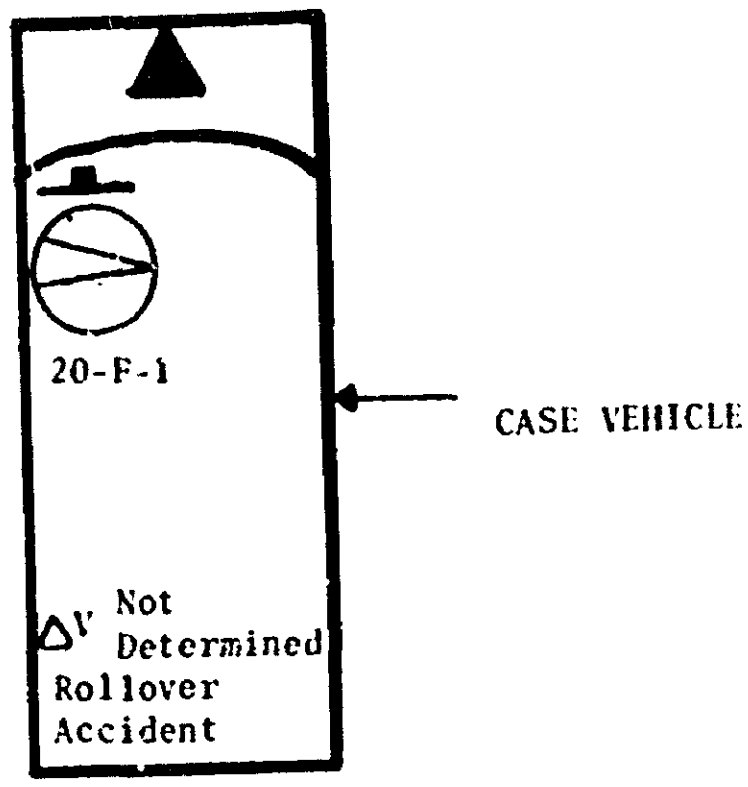
The child was sitting in a Century 200 child safety seat which was secured with a lap/shoulder belt identical to that worn by the driver.

Injuries	AIS	Probable Source
Abrasion, lower forehead	1	Top of safety seat shield

The restraint provided by the by the child safety seat prevented uncontrolled movement into the frontal interior. Given the 17 mph Delta V, this child would probably have sustained more serious injuries if unrestrained.

CASE 36 (DEN-85-H-OR01)

Case Vehicle: 1982 Renault LeCar, 4-door
Case Vehicle Weight: 1,985 Pounds
Case Vehicle Delta V: 360-degree rollover (no Delta V)



Circumstances

A 1982 Renault LeCar 4-door, traveling at a witness-estimated speed of 70 mph, struck a concrete barrier on its right side, overturned 360 degrees, and came to rest on its wheels. The collision and subsequent rollover resulted in substantial damage to the small vehicle.

The Renault driver, restrained by a lap/shoulder belt, sustained minor injuries.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: F
Age: 20
Height: 5 feet 5 inches
Weight: 140 pounds
Restraint used: Lap/shoulder belt (ELR)

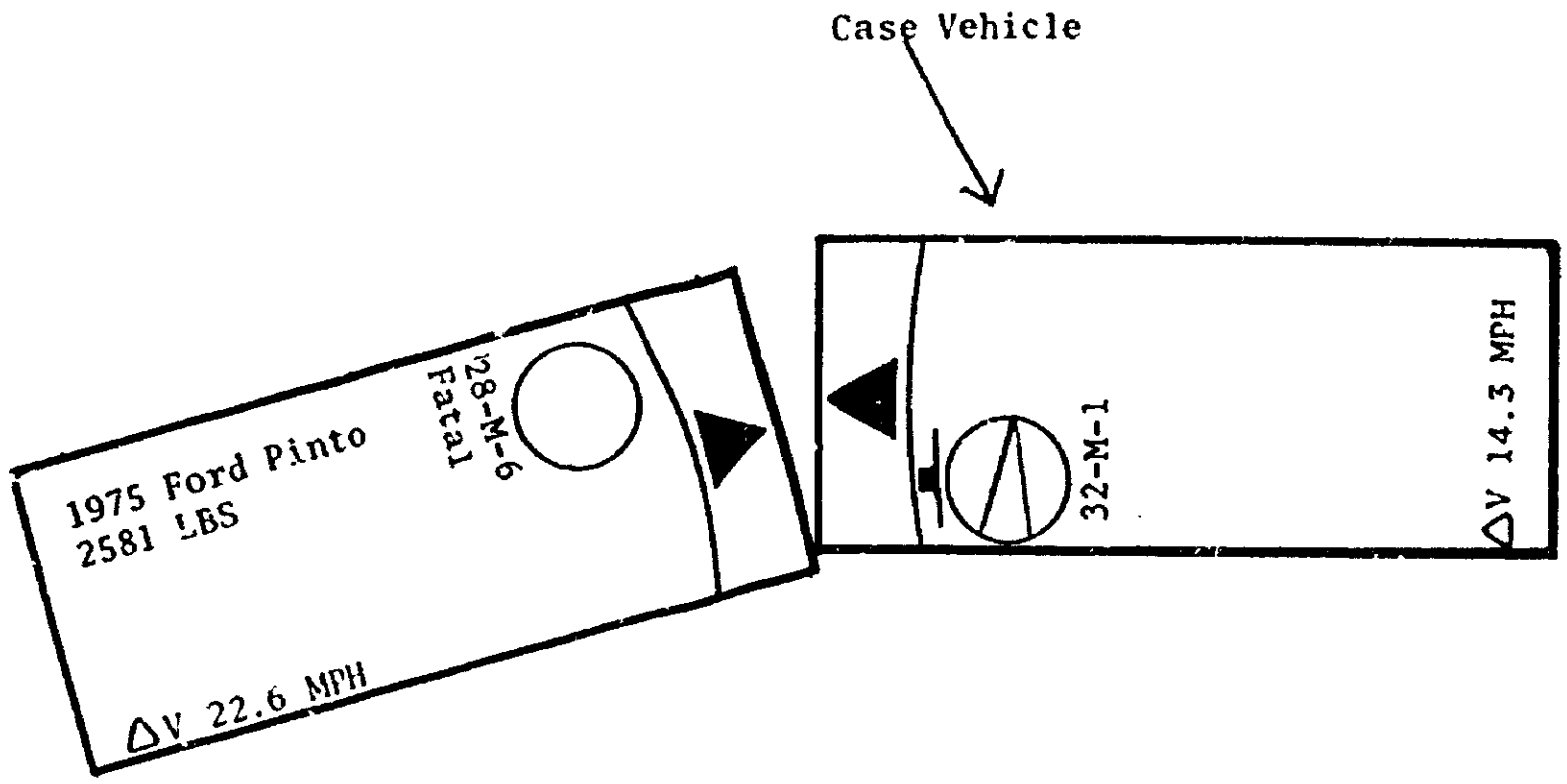
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a free-sliding latchplate, and a push-button release buckle attached to a flexible stalk. The driver was unable to relate the precrash positioning and adjustment of the lap portion but she indicated she was able to get a clenched fist between her chest and the shoulder strap. She also told investigators that she was wearing a heavy winter coat at the time of the crash. The roof structure of the Renault was extensively crushed.

Injuries	AIS	Probable Source
Laceration, left scalp	1	Door/roof/steering wheel
Contusion, left eye	1	Door/roof/steering wheel
Contusion, upper left shoulder	1	Shoulder strap
Contusion, upper left arm	1	Interior sidewall
Contusion, left thigh	1	Lap belt
Laceration, left knee	1	Lower dashboard
Contusion, lower left leg	1	Lower dashboard
Contusion, lower right leg	1	Lower dashboardd
Contusion, right thigh	1	Lap belt
Laceration, lower right arm	1	Windshield
Contusion, lower abdomen	1	Lap portion of belt
Contusion, back of neck	1	Unknown
Contusion, lower left arm	1	Door/steering wheel

This driver was treated at a local outpatient medical facility and missed 1 week of work as a result of her injuries. She might have been ejected and sustained serious to fatal injuries if she had been unrestrained in this high-speed, 360 degree rollover collision.

CASE 37 - (DEN 85-H-0R08)

Case Vehicle #1: 1984 Chevrolet, C-10, 1/2 ton pick-up
Case Vehicle Weight: 4,420 pounds
Case Vehicle #1 Delta V: 14.3 mph



Circumstances

A 1984 Chevrolet pick-up, southbound on a 2-lane road, had a frontal collision with a 1975 Ford Pinto that pulled into the southbound lane to pass some slow moving vehicles. The initial impact caused the pick-up to leave the road and strike a utility pole. The pick-up received substantial structural damage with deformation of up to 18 inches at the left front.

The pick-up driver, restrained by a lap/shoulder belt, sustained minor injuries. The unrestrained Pinto driver was ejected from his vehicle and sustained fatal head injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 32
Height: 6 feet
Weight: 170 pounds
Restraint Used: Lap/shoulder belt with dual retractors (ELR/ALR)

The driver was wearing a lap/shoulder belt with dual retractors, a sewn-in latchplate, and a stalk-mounted buckle assembly. The shoulder portion of the belt was equipped with an emergency locking retractor sensitive to vehicle motion and a windowshade tension-relief device. The lap portion of the belt had an automatic locking retractor. The driver stated that the lap portion was snug, positioned low across his hips, and that the shoulder portion was snug across his midchest. Force loading marks were found on the webbing of the shoulder portion of the belt.

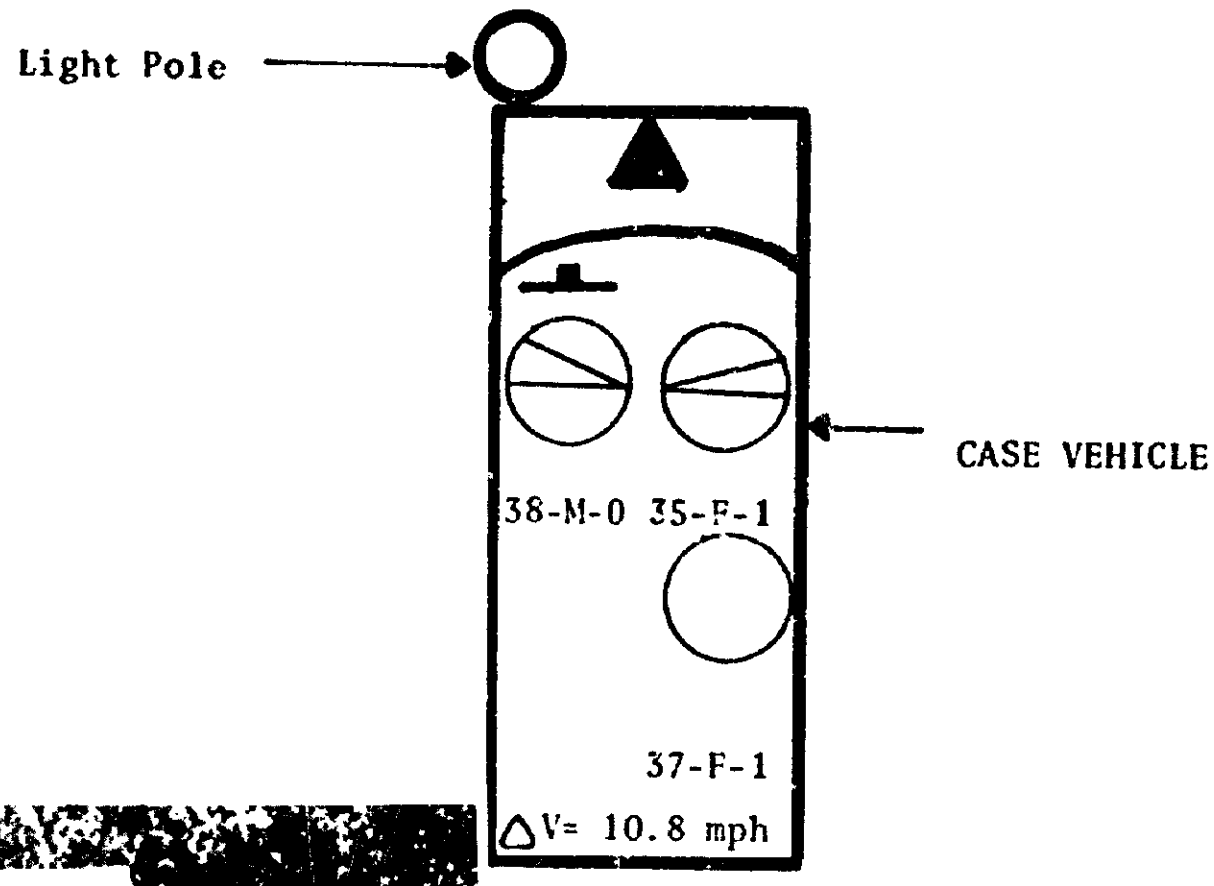
Injuries	AIS	Probable Source
Abrasion, center forehead	1	Steering wheel rim
Contusion, right bicep	1	Steering wheel rim
Contusion, right knee	1	Lower dash
Contusion, center chest	1	Shoulder portion of belt

The driver was treated at a local hospital and released, and he reported a 3-day loss of work. Had this driver been unrestrained in this 14.3 mph Delta V collision, it is likely that a higher level of injuries would have resulted.

If the driver of the Ford Pinto had been restrained by a lap/shoulder belt, he would not have been ejected and probably would have survived the accident.

CASE 39 (FTW-85-H-0R05)

Case Vehicle: 1979 GMC Suburban
Case Vehicle Weight: 5,500 pounds
Case Vehicle Delta V: 10.3 mph (impact with light pole)



Circumstances

A 1979 GMC Suburban was making a left turn when it was side-swiped on the left side by a Toyota. After the initial impact, the Suburban veered into a 10-inch diameter light pole. The GMC received minor damage across the left front with a maximum depth of 9 inches.

The GMC driver, restrained by a lap/shoulder belt, was uninjured. The right front passenger, similarly restrained, was seated sideways at the time of the crash and sustained minor injuries. The unrestrained right rear passenger was reported by police to have received "visible" injuries; no further injury information was available.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: M
Age: 38
Height: Unavailable
Weight: Unavailable
Restraint used: Lap/shoulder belt with dual retractors (ELR/ALR)

This driver was wearing a lap/shoulder belt with an automatic locking retractor on the lap portion of the belt and an emergency locking retractor on the shoulder portion. A comfort clip was available for tension relief on the shoulder portion. The driver did not furnish a description of system adjustment; however, a passenger reported that the driver wore the lap portion of the belt snug and that the shoulder portion was tight across the driver's chest.

Injuries: none.

Crash forces were minor (Delta V of 10.3 mph), but the snug lap/shoulder belt may have helped the driver avoid minor injuries.

Seating location: Right front passenger
Sex: F
Age: 35
Height: Unavailable
Weight: Unavailable
Restraint used: Lap/shoulder belt with dual retractors (ELR/ALR)

This occupant was wearing a lap/shoulder belt identical in design to the driver's belt. She described the adjustment of the lap portion of her belt as "extended" and "improperly positioned due to the fact that she was turned sideways." Before the first impact, the passenger was turned in the seat talking to the right rear passenger. She subsequently leaned forward to see the striking vehicle. At the time of impact with the pole, she probably had created excessive slack within the restraint system.

Injuries	AIS	Probable Source
Contusion, right side of head	1	Windshield
Contusion, right knee	1	Glove box

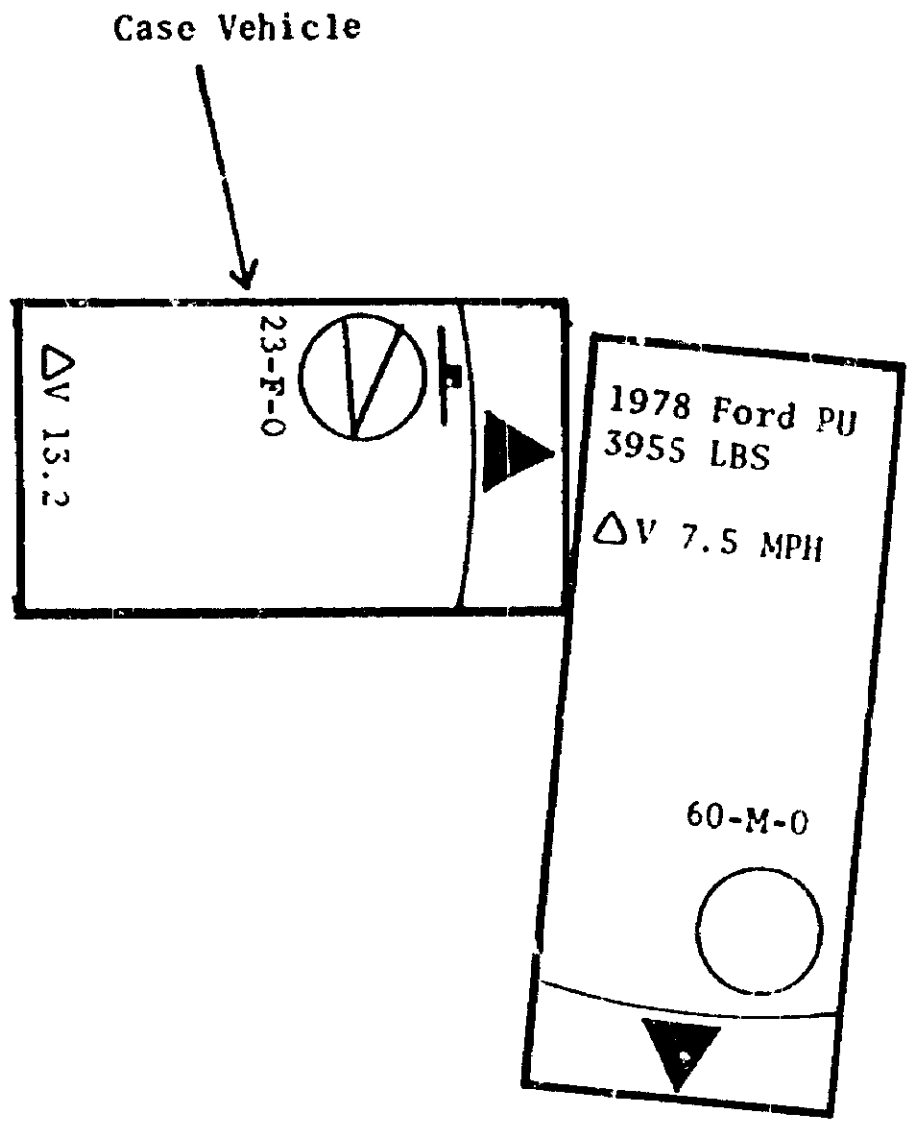
Because the occupant had introduced slack into the lap/shoulder belt system and was out-of-position at the time ofthe crash, she was able to contact the windshield, an interior component normally out of reach for a properly belted occupant. The low crash forces (Delta V of 10.3 mph), however, made the misuse not particularly detrimental; minor injuries resulted only.

Seating location: Right rear passenger
Sex: F
Age: 37
Height: Unavailable
Weight: Unavailable
Restraint used: None

Injuries: "Visible" injuries were reported in the police accident report. Further information was not available.

CASE 40 (FTW-85-H-0R09)

Case Vehicle: 1980 Honda Prelude
Case Vehicle Weight: 2,345 pounds
Case Vehicle Delta V: 13.0 mph



Circumstances

A 1980 Honda Prelude proceeding through a green light struck a 1978 Ford F-250 on the right side. The Ford had pulled from a driveway into the path of the Honda. The Honda sustained substantial damage with deformation of up to 13.4 inches at its front.

The restrained Honda driver sustained no injury.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: F
Age: 23
Height: Unknown
Weight: Unknown
Restraint used: Lap/shoulder belt (ELR)

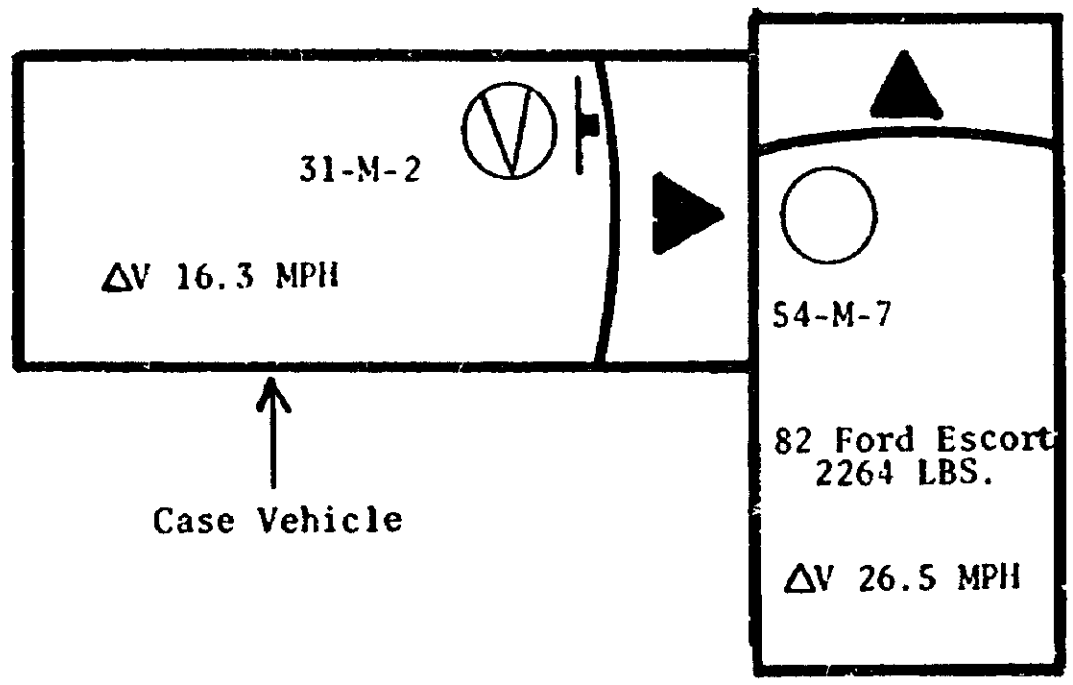
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver described the precrash lap portion of the belt adjustment as being positioned across her lap and snug. The shoulder portion was reportedly adjusted so the driver could slide her palm between the shoulder belt and her chest. Force loading marks were found on the webbing in the area of the B-pillar mounted D-ring.

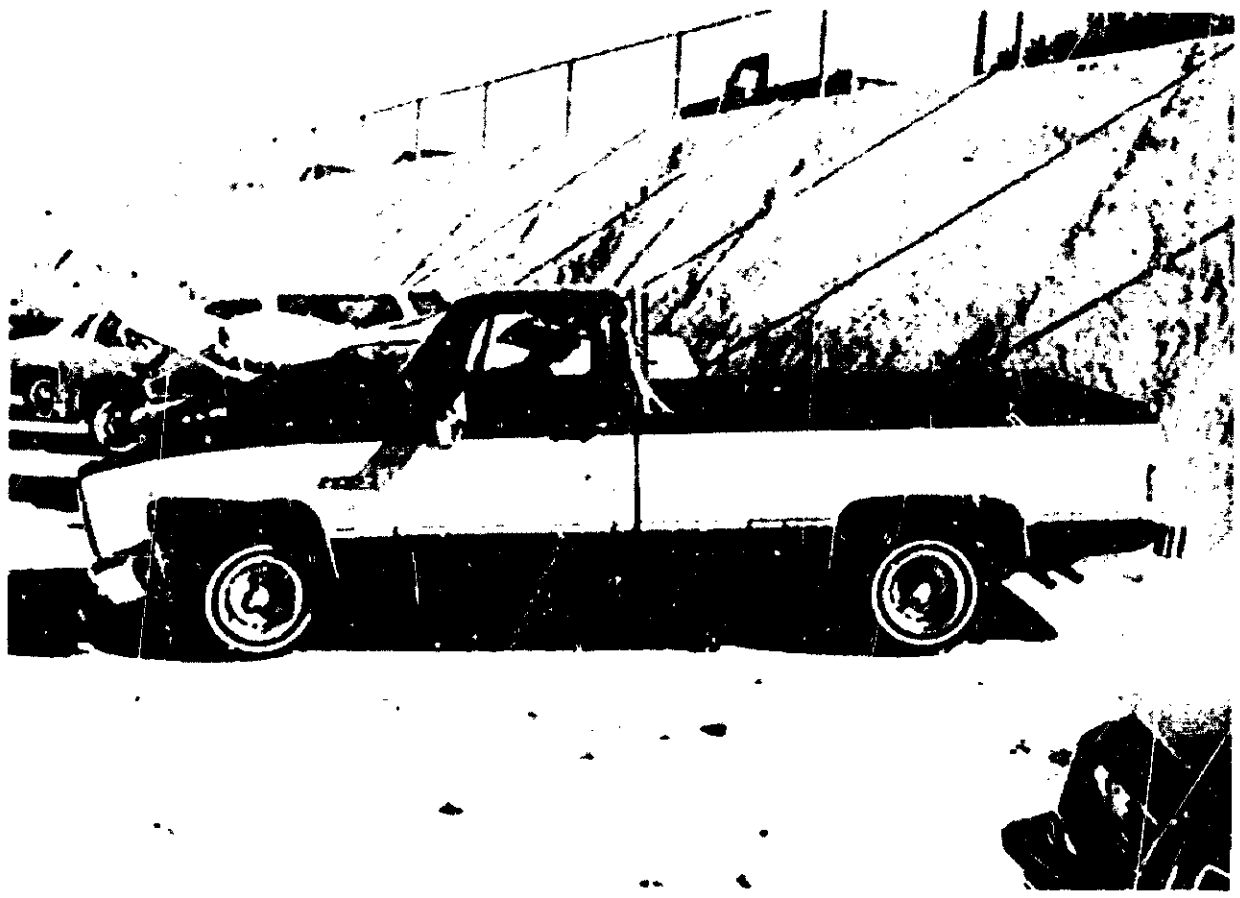
Injuries: none.

This collision was of minor to moderate severity (Delta V of 13 mph). It is probable that the restraint system prevented the driver from sustaining some degree of injury.

CASE 41 (FTW-85-H-OR12)

Case Vehicle: 1984 GMC Pick-up Truck
Case Vehicle Weight: 3,680 pounds
Case Vehicle Delta V: 16.3 mph





Circumstances

The front of a 1984 GMC pick-up truck struck the left front side of a 1982 Ford Escort. The collision resulted in substantial damage to both vehicles, with the GMC receiving a maximum frontal crush depth of 22 inches. The driver's side door of the Ford was deformed inward by several inches. The crush contributed to the injury severity of the driver.

The GMC driver, restrained by a lap/shoulder belt, sustained a moderate injury. The unrestrained driver of the Ford reportedly sustained serious injuries.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: M
Age: 31
Height: 6 feet 2 inches
Weight: 265 pounds
Restraint used: Lap/shoulder belt with dual retractors (ELR/ELR)

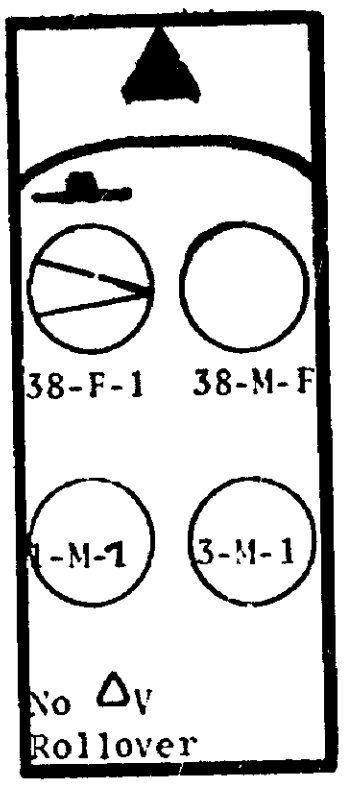
The driver was wearing a continuous loop lap/shoulder belt equipped with dual self-tensioning emergency locking retractors, a sewn-in latchplate, and a push-button release buckle attached to a flexible stalk. The driver stated that the precrash adjustment of the lap portion of the belt was snug and positioned low on his hips. In describing the shoulder portion adjustment, he indicated that he could get more than a clenched fist between his chest and the strap. The driver's description of slack in the shoulder strap is questionable because of the self-tensioning retractors. Marks were found on the belt webbing, attributed to webbing load at the D-ring. The steering wheel assembly was found bent forward slightly, reportedly the result of bracing by the driver.

Injuries	AIS	Probable Source
Chipped bone, left hand	2	Steering wheel

This man was treated at a local outpatient medical facility. However, he reportedly missed 3 weeks of work as a result of his injury. The dual ELR restraint system performed well in preventing the driver from contacting the front interior of the vehicle in this moderate speed collision (Delta V of 16.3 mph). He probably would have received additional injuries if unrestrained.

CASE 44 (DEN-84-H-OR43)

Case Vehicle: 1983 Subaru Four Wheel Drive Wagon
Case Vehicle Weight: 2,739 pounds
Case Vehicle Delta V: 720-degree rollover (no Delta V)



Both rear seat occupants restrained in child safety seats.

Circumstances

A 1983 Subaru station wagon veered off the roadway and rolled over twice, ejecting the unrestrained right front occupant. The vehicle sustained moderate exterior damage with moderate roof crush.

The Subaru driver, restrained by a lap/shoulder belt, sustained a minor injury. The right front passenger, who had unfastened his lap/shoulder belt minutes before the accident, was ejected and sustained fatal injuries. Two small children, seated in the rear and restrained in child safety seats, sustained minor injuries.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: F
Age: 38
Height: 5 feet 9 inches
Weight: 120 pounds
Restraint used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to webbing movement, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver described precrash system adjustment as being very tight with the shoulder portion positioned across her chest. No description of the position of the lap belt portion was given. Force loading marks were found on the webbing from the seat belt guide.

Injuries	AIS	Probable Source
Contusion, left eye	1	Steering wheel

The driver declined medical treatment for her minor injury. Considering the dynamics of this 720 rollover accident, the restraint system prevented uncontrolled movement and possible ejection, thereby substantially reducing the severity of injuries.

Seating location: Right front passenger
Sex: M
Age: 37
Height: Unavailable
Weight: Unavailable
Restraint used: None

This passenger had been wearing the available lap/shoulder belt, but unfastened it immediately before the collision to tend to the children in the rear seat.

Injuries: Unspecified head injuries which proved fatal (AIS-7).

The passenger was ejected at some point within the 720 degree rollover sequence and sustained fatal head injuries. Lap/shoulder belt use would have prevented ejection and reduced injury severity significantly.

Seating location: Left rear passenger
Sex: M
Age: 10 months
Height: Unavailable
Weight: Unavailable
Restraint used: Child restraint device secured by a lap belt (ALR)

This passenger was restrained in a Cosco/Peterson infant/toddler child safety seat which was secured in place by a lap belt.

Injuries	AIS	Probable Source
Unspecified "minor" injury	7	Unknown

The properly used child safety seat precluded both ejection and movement about the interior of the vehicle, thus protecting the occupant from serious injury.

Seating location: Right rear passenger
Sex: M
Age: 3
Height: Unavailable
Weight: Unavailable
Restraint used: Child restraint device secured by a lap belt (ALR)

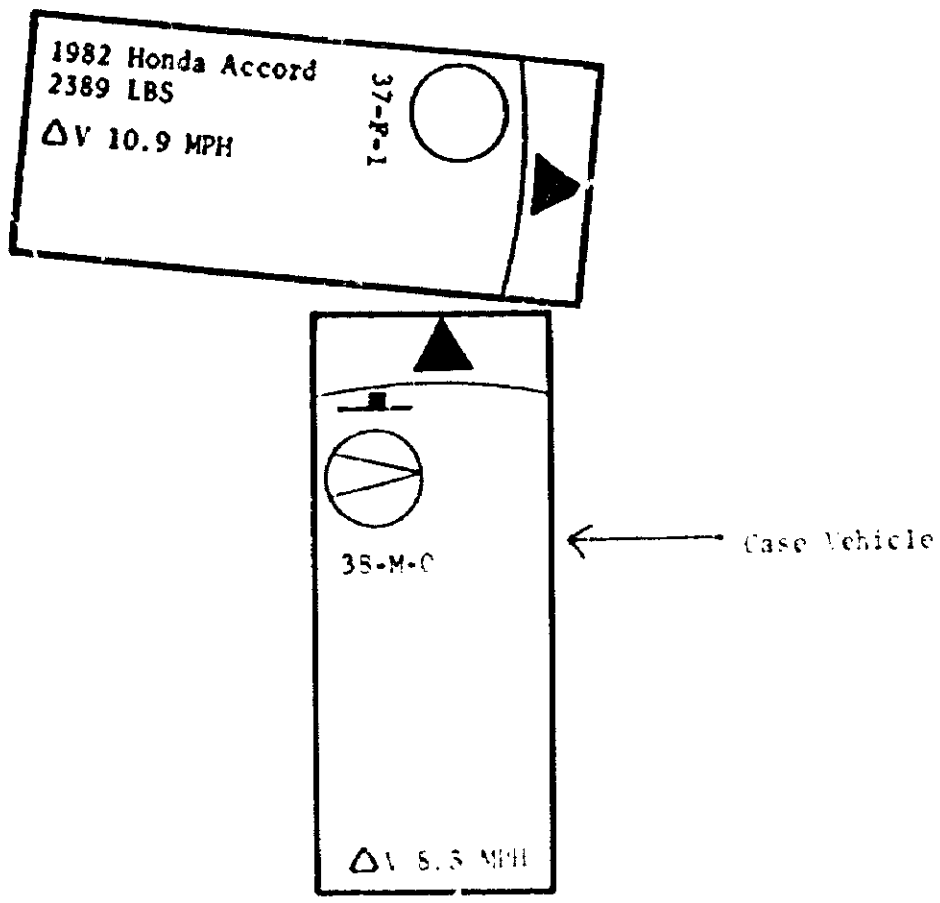
This passenger was restrained in a Strollee infant/toddler child safety seat which was secured by a lap belt.

Injuries	AIS	Probable Source
Contusion, right thigh	1	Child safety seat

The properly used child safety seat significantly reduced the severity of injuries. Had either of these rear seated children been unrestrained in this 720 degree rollover accident, it is likely that they could have been ejected from the vehicle, thereby increasing chances for more serious injury. Even if they had not suffered ejection, the violent interior contacts within the vehicle could easily have resulted in serious injury to an unrestrained child occupant.

CASE 45 - (CHI 85-H-OR04)

Case Vehicle 1984 Toyota Celica
Case Vehicle Weight: 3,150 pounds
Case Vehicle Delta V: 8.3 mph



Circumstances

A 1984 Toyota Celica was westbound when an eastbound 1981 Honda Accord made a left turn across its path. The front of the Toyota struck the right front of the Honda. The entire front of the Toyota had moderate damage with inward crush of up to 5.6 inches. The Honda also received moderate damage to the right front fender, door, and wheel assembly with a maximum crush of 6 inches.

The driver of the Toyota, wearing a lap/shoulder belt, was uninjured. The unrestrained driver of the Honda was transported to a local hospital where she was treated for minor injuries.

Restraint and injury

Case Vehicle

Seating Location:	Driver
Sex:	M
Age:	33
Height:	6 feet
Weight:	180 pounds
Restraint Used:	Lap/shoulder belt (ELR)

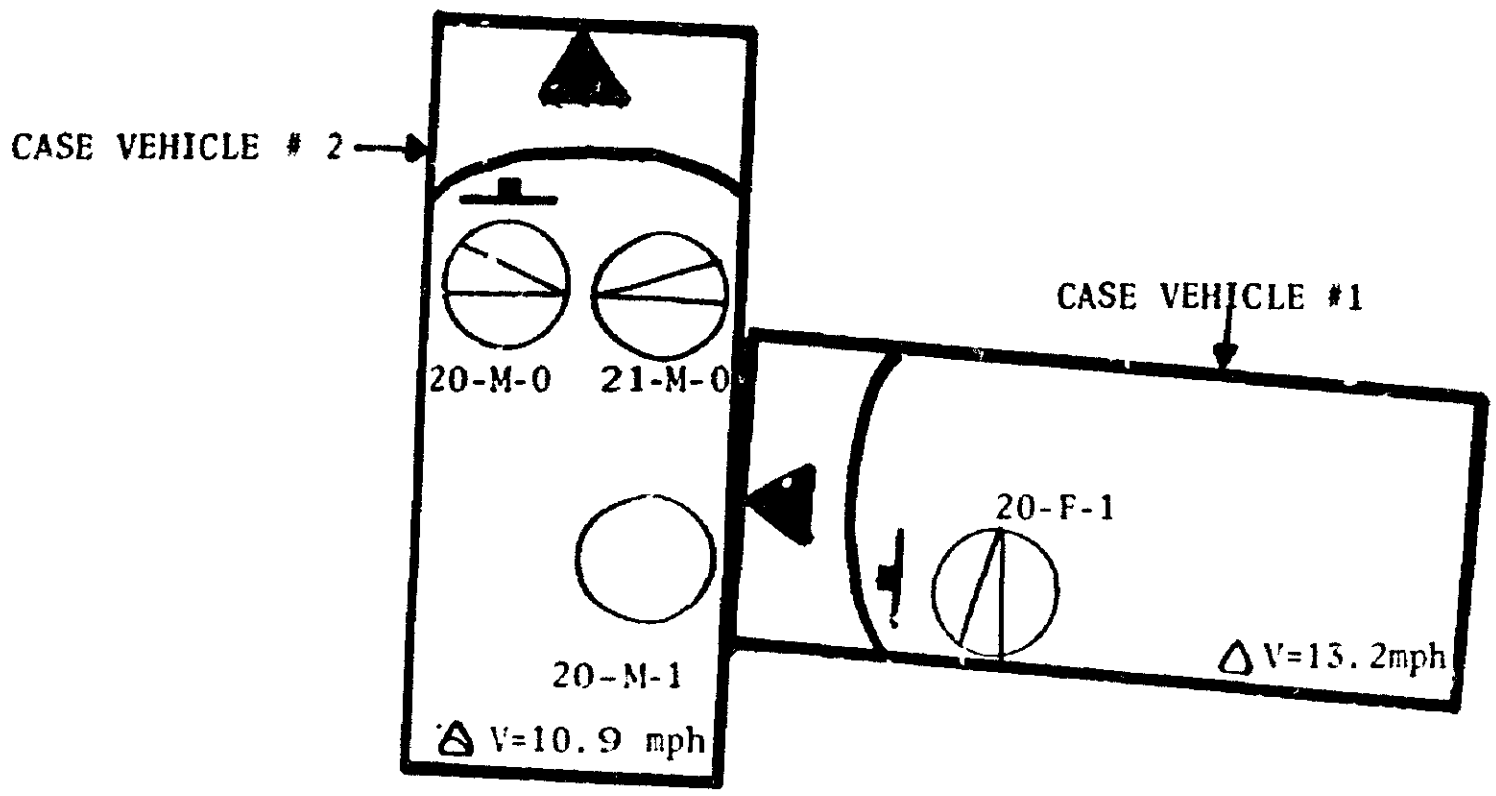
This driver was wearing a continuous loop lap/shoulder belt with a free-sliding latchplate and stalk-mounted buckle. The driver reported that the lap portion of the belt was snug, positioned low on her hips, and that the shoulder portion was tight across the midchest area.

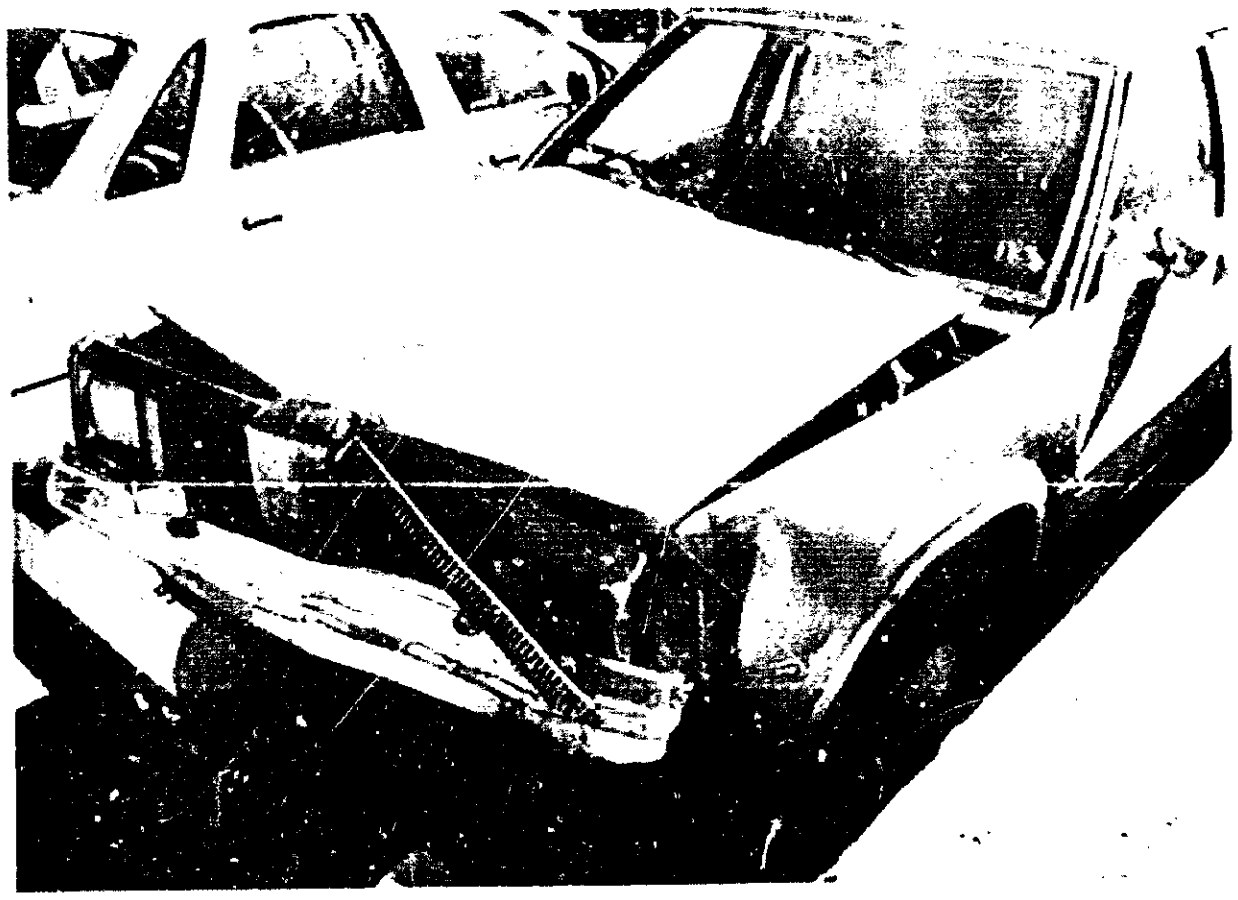
The restrained driver was not injured. The Delta V in this crash, however, was so low (8.3 mph) that the belt was probably not a factor in preventing injury.

CASE 47 (FTW-85-H-OR14)

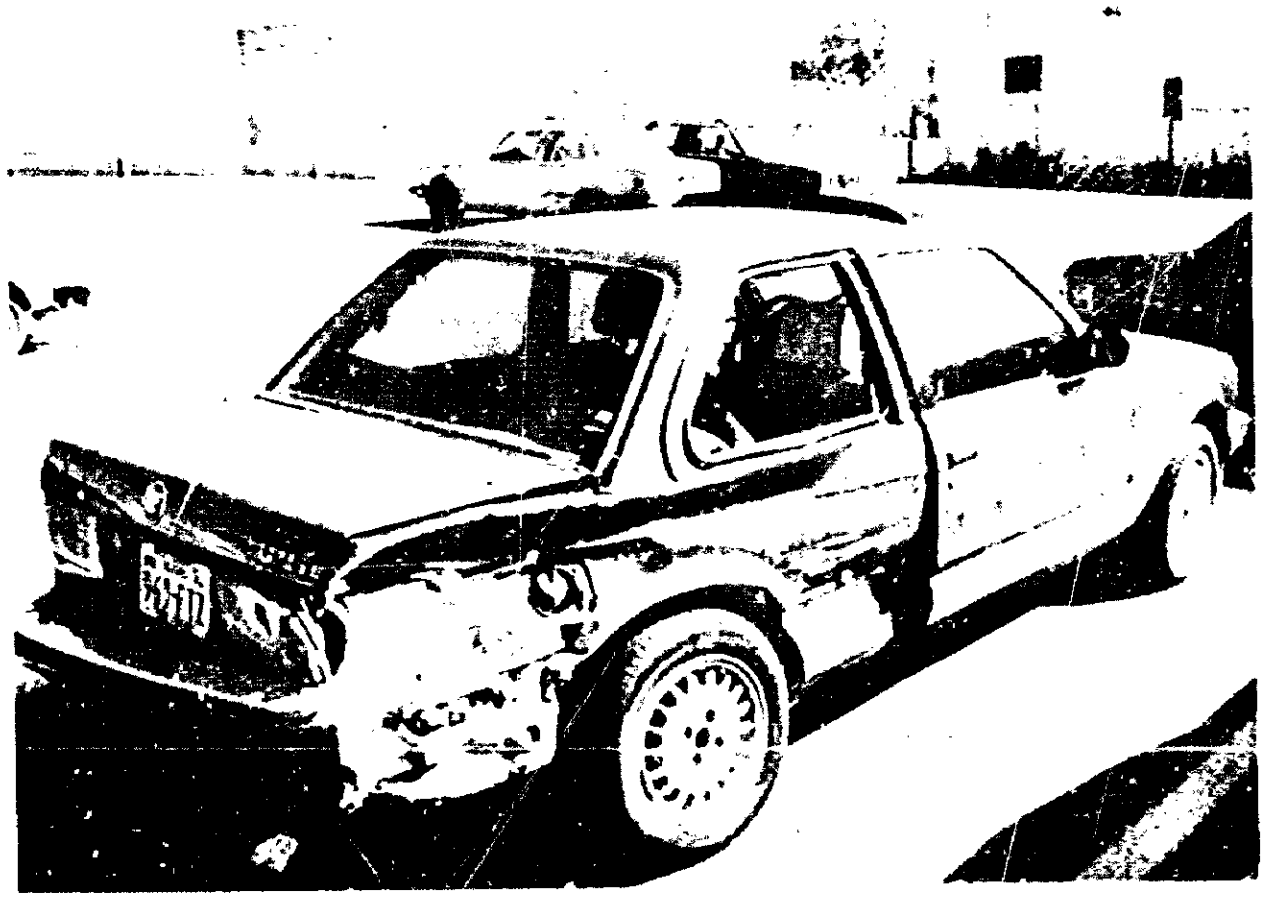
Case Vehicle #1: 1980 Oldsmobile Omega, 4-door
Case Vehicle Weight: 2,660 pounds
Case Vehicle Delta V: 13.2 mph

Case Vehicle #2: 1984 BMW 325e, 2-door
Case Vehicle Weight: 3,220 pounds
Case Vehicle Delta V: 10.9 mph





CASE VEHICLE #1



CASE VEHICLE #2

Circumstances

A 1984 BMW was crossing a T-intersection when it was struck in the right side by a 1980 Oldsmobile. The BMW received substantial damage with collapse of up to 14 inches to the right rear. The 1930 Oldsmobile had deformation of the front varying from 15 inches at the left front to 6 inches at the right front. Following the initial collision, the BMW rotated over 360 degrees as it travelled toward final rest.

The Oldsmobile driver, restrained by a lap/shoulder belt, sustained minor injuries. The BMW driver and right front passenger, restrained by lap/shoulder belts, were not injured. The unrestrained right rear passenger of the BMW received numerous minor contusions and lacerations.

Restraint and Injury

Case Vehicle #1 - 1980 Oldsmobile
Seating location: Driver
Sex: F
Age: 20
Height: 5 feet 9-1/2 inches
Weight: 115 pounds
Restraint used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver described precrash lap portion of the belt adjustment as being positioned low across her hips and snug. The shoulder portion of the belt was reportedly adjusted with about 2 inches of slack between the strap and the driver's chest. Force loading marks were found upon the webbing in the areas of both the latchplate and D-ring.

Injuries	AIS	Probable Source
Cervical strain	1	Impact forces
Contusion, right knee	1	Steering column

The driver of vehicle #1 was treated at an area hospital for approximately 3 hours and reported loss of work for 2 days. Use of the available restraint system probably prevented her from receiving more serious injuries in this 13.2 mph Delta V collision.

Case Vehicle #2 - 1984 BMW
Seating location: Driver
Sex: M
Age: 20
Height: Unknown
Weight: Unknown
Restraint used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to webbing and vehicle motion, a free-sliding latchplate, and stalk-mounted buckle assembly. The driver refused to cooperate with investigators; no information is available as to the precrash positioning of the belt. The belt was self-tensioning, so fit probably was snug. A loading scar on the belt webbing near the D-ring, provided evidence that the belt was being worn at the time of the crash.

Injuries: none.

The restraint used by the driver of the BMW apparently worked well in this collision. Considering the side impact forces (Delta V of 10.9 mph) and the resultant rotations of the vehicle as it travelled to final rest, an unrestrained driver might have been injured.

Case Vehicle #2 - 1984 BMW
Seating location: Right front
Sex: M
Age: 21
Height: Unknown
Weight: Unknown
Restraint used: Lap/shoulder belt (ELR)

This passenger, based on the driver's statement, was wearing a lap/shoulder belt identical to the driver's. No information concerning precrash system adjustment was furnished by this occupant. The restraint was self-tensioning. No loading marks could be detected on this occupant's belt.

Injuries: none.

Case Vehicle #2 - 1984 BMW
Seating location: Right rear
Sex: M
Age: 20
Height: Unknown
Weight: Unknown
Restraint used: No

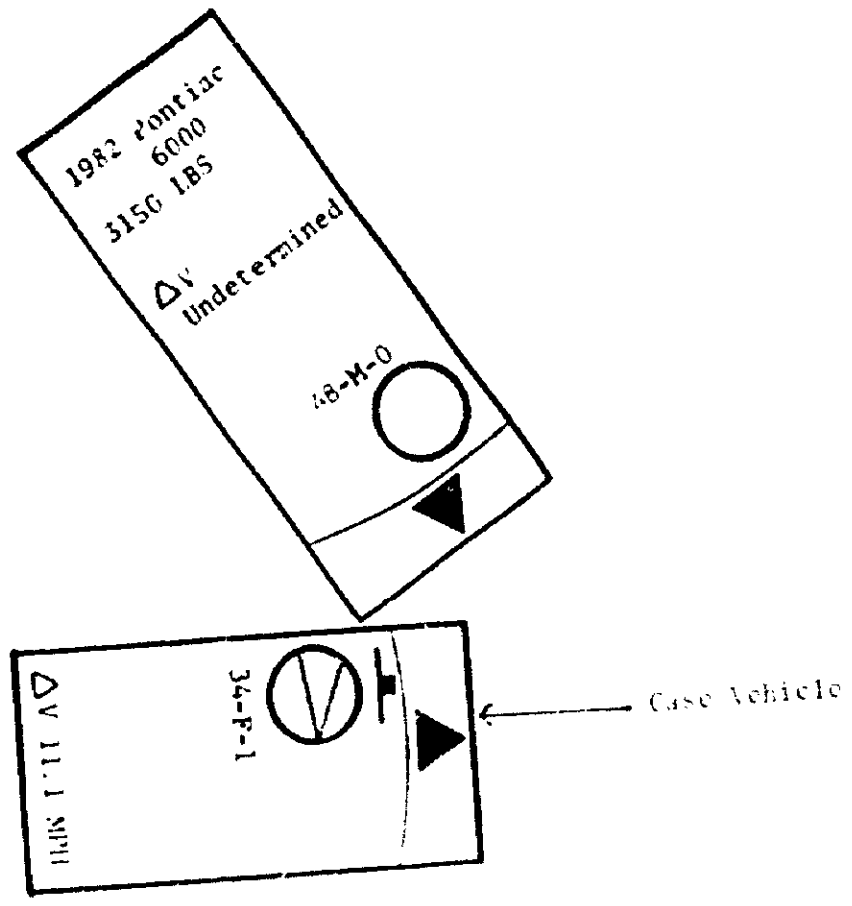
This passenger was not wearing the available lap/shoulder belt. The unrestrained occupant was thrown forward, hitting the side door and seatback in front of him, and sideways, in opposition to the impact force. He struck the seat with enough force to break and permanently deform the right front seatback. This occupant was in direct line with the impact from the striking Oldsmobile.

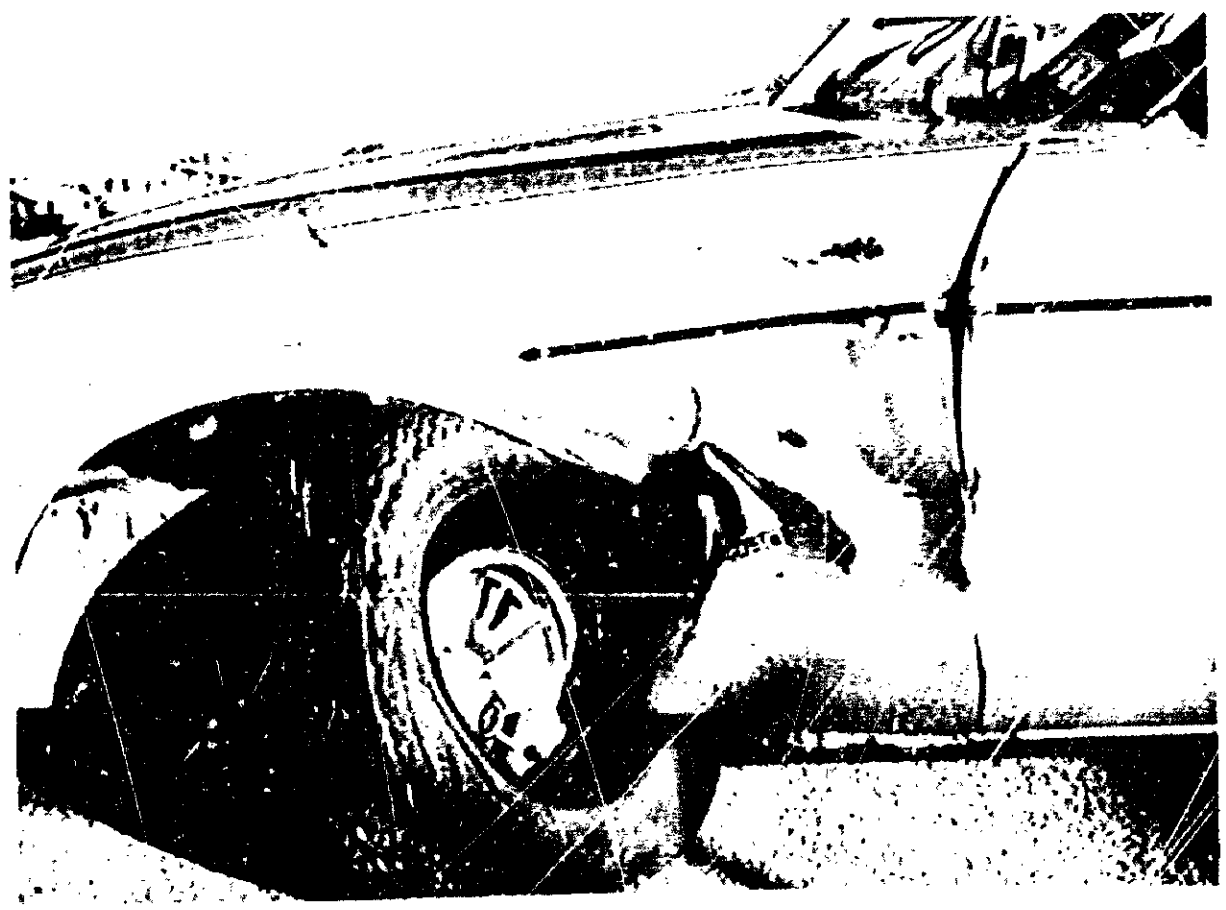
Injuries	AIS	Probable Source
Contusion, right side of head	1	Right rear door glass/panel
Laceration right side of face	1	Right rear door glass
Contusion, left knee	1	Rear of front seatback
Contusion, right knee	1	Rear of front seatback
Contusion, upper right arm	1	Right rear interior door panel
Contusion, right thigh (outside)	1	Right rear interior door panel

No information concerning treatment of injuries was furnished by this occupant. Although lap/shoulder belt use probably would have prevented the minor knee injuries sustained when the occupant was thrown forward into the seatback, restraint use would not have been able to prevent or reduce the minor injuries resulting from impact with the interior door panel.

CASE 48 (FTW-86-H-OR16)

Case Vehicle: 1979 Datsun 280ZX, 2-door
Case Vehicle Weight: 2,921 pounds
Case Vehicle Delta V: 11.1 mph





Circumstances

A 1979 Datsun 280ZX 2-door was struck in the left front side by the right front of a 1982 Pontiac 6000 4-door sedan. The collision resulted in a maximum deformation of up to 8.5 inches over a 30-inch area of the left front side of the Datsun. The Pontiac sustained only minor damage and was driven from the accident scene.

The Datsun driver, wearing a lap/shoulder belt, received minor injuries. The unrestrained driver of the Pontiac was not injured.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: F
Age: 34
Height: 5 feet 6 inches
Weight: 125 pounds
Restraint used: Lap/shoulder belt (ELR)

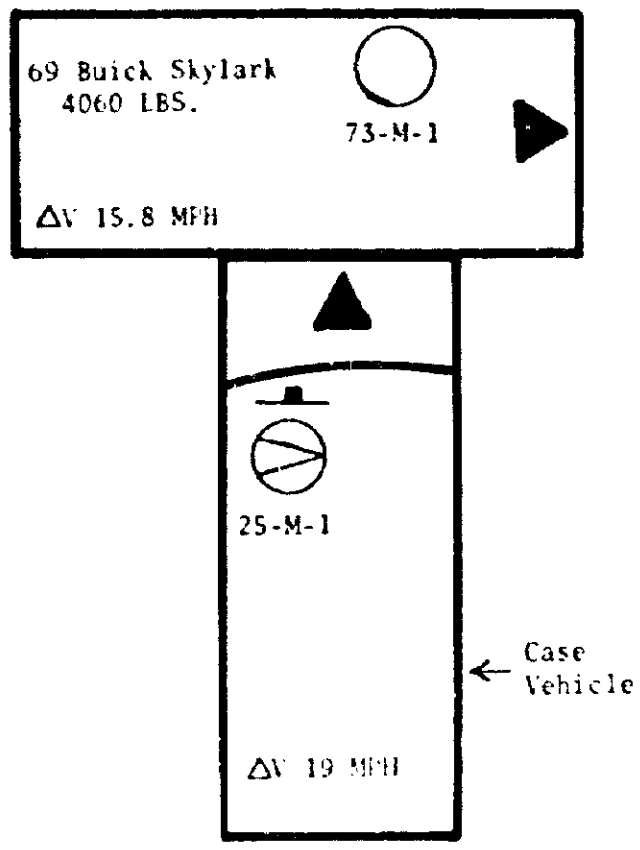
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a free sliding latchplate, and a push bar release buckle attached to a rigid stalk which was secured to the seat frame. The driver stated that the precrash adjustment of the lap portion of the belt was snug and positioned "across her abdomen." She related that the shoulder portion was snug across her chest. Marks were found on the belt webbing, attributed to webbing load at the latchplate. No occupant contact points were discernable on the interior sidewall. However, the driver stated that she struck her left hand on the left side window.

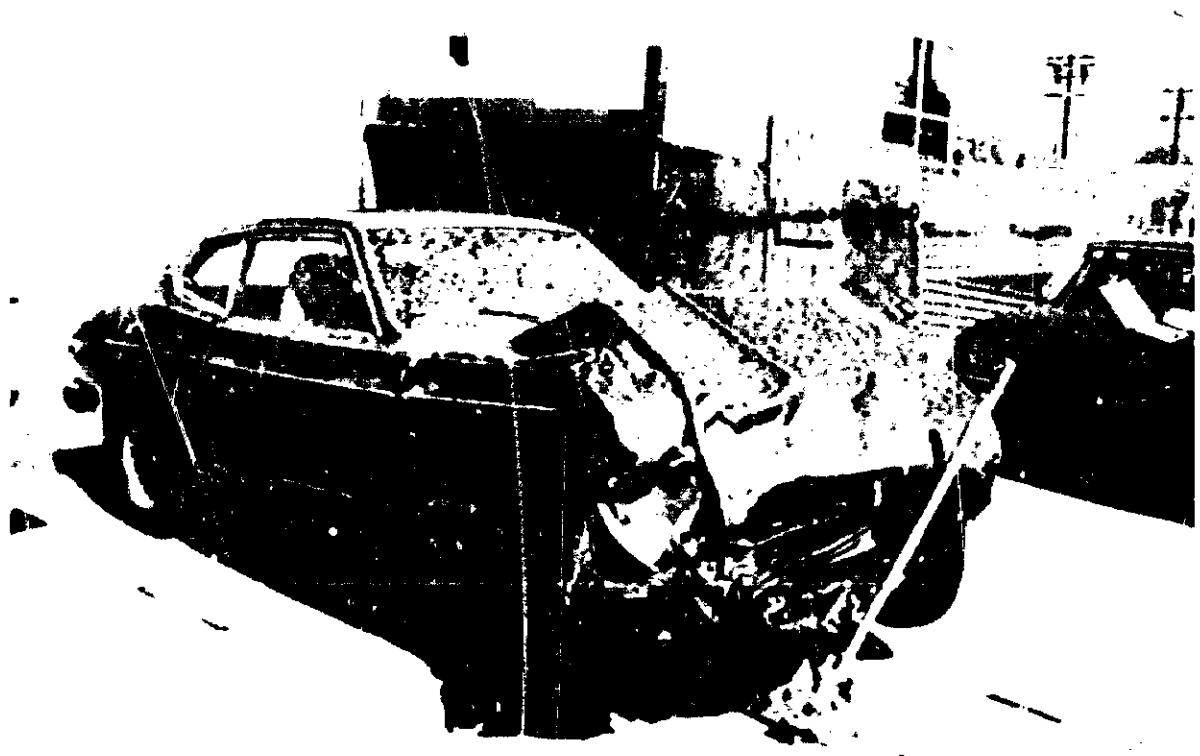
Injuries	AIS	Probable Source
Sprain, left index finger	1	Door glass

This driver did not seek medical attention but reported 1 day of lost work as a result of her injury. The benefit of restraint use in this low-speed collision was minimal. Considering the dynamics and expected kinematics of the 11.1 mph Delta V collision, the driver probably would have received no more than minor injuries if she had not been restrained. A lap/shoulder belt can not prevent occupant contact with the adjacent side interior.

CASE 49 (LAX-84-H-OR24)

Case Vehicle: 1976 Datsun 280Z
Case Vehicle Weight: 3,112 pounds
Case Vehicle Delta V: 19.8 mph





Circumstances

A 1976 Datsun 280Z was approaching an intersection when a 1969 Buick Skylark, entering the intersection from the opposite direction, turned left in front of the Datsun. The Datsun struck the middle right side on the Buick. Damage to the Datsun was substantial with deformation of up to 16.5 inches over a 56-inch wide area on the front end.

The Datsun driver, restrained by a lap/shoulder belt, sustained minor injuries, as did the unrestrained driver of the Buick.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: M
Age: 25
Height: 5 feet 9 inches
Weight: 158 pounds
Restraint used: Lap/shoulder belt with dual retractors (ELR/ALR)

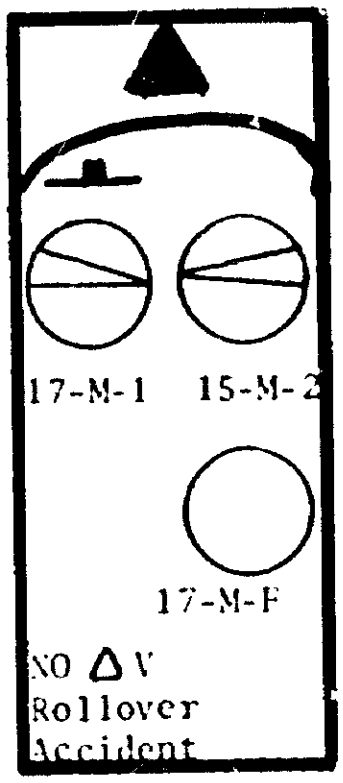
This driver was wearing a continuous loop lap/shoulder belt equipped with an automatic locking retractor on the lap portion, an emergency locking retractor sensitive to webbing motion for the shoulder portion, a comfort clip on the shoulder portion, a sewn-in latchplate, and a stalk-mounted buckle assembly. The driver could provide no description of the lap portion of the belt adjustment, however, the automatic locking retractor on the lap portion should have provided a snug fit. The shoulder portion adjustment was also unknown.

Injuries	AIS	Probable Source
Strained wrist	1	Bracing on steering wheel
Laceration, left knee	1	Lower instrument panel

This driver also complained of chest pain, which probably resulted from the shoulder strap. Considering the impact forces involved in this 19.8 mph Delta V collision, it is apparent that the lap/shoulder belt prevented interior contacts which might have resulted in additional injuries. An unrestrained driver would have been free to make violent contact with the frontal interior, thus increasing the chances of additional and more serious injuries.

CASE 50 (LAX-84-H-OR26)

Case Vehicle: 1979 Audi 5000
Case Vehicle Weight: 3251 pounds
Case Vehicle Delta V: >360 Rollover



Circumstances

A 1979 Audi 5000 failed to negotiate a curve at a high speed, went off the roadway, and rolled over. The windshield was broken, the sun roof displaced, and there was substantial deformation to the right side of the roof.

The driver and right front passenger were wearing lap/shoulder belts. The driver sustained minor injuries. The right front passenger received moderate injuries. The unrestrained right rear passenger was ejected and killed.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: M
Age: 17
Height: 6 feet
Weight: 158 pounds
Restraint used: Lap/shoulder belt (ELR)

The driver was wearing a lap/shoulder belt with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver stated that the lap portion of the belt was snug, positioned "across her abdomen," and that the shoulder portion was positioned comfortably across the midchest area.

Injuries	AIS	Probable Source
Abrasions, left side of face	1	Window glass or frame
Contusions, left side of face	1	B-pillar or door frame

The driver was treated and released at a local hospital. Considering the dynamics of this high-speed, 360 degree rollover, it is likely that lap/shoulder belt use prevented ejection and serious injury or death.

Seating location: Right front
Sex: M
Age: 15
Height: 6 feet 2 inches
Weight: 155
Restraint used: Lap/shoulder belt (ELR)

The right front passenger wore a lap/shoulder belt identical in design to that of the driver. No system adjustment information was available.

Injuries	AIS	Probable Source
Cervical strain	1	Roof intrusion
Small lacerations, back of head	1	Flying glass particles
Avulsion behind right ear	2	Sun roof frame
Tempero/parietal skull fracture	2	Roof
Lacerations, both hands	1	Window glass
Lacerations, right knee	1	Under dash
Multiple lacerations to back	1	Window glass
Lacerations, right upper arm	1	Window glass

The right front passenger was admitted to a hospital for 5 days. The reason for the severity in this passenger's injuries, as compared to the driver's minor contusions and abrasions, is the intrusion of the roof. It is likely that the use of the lap/shoulder belt use prevented ejection, and the possibility of serious injury or death, in this 360 degree rollover. Even without ejection, an unrestrained occupant would have been free to make violent contacts with the vehicle interior, thus increasing the chances of more severe injuries.

Seating location: Right rear
Sex: M
Age: 16
Height: 5 feet 9 inches
Weight: 170 pounds
Restraint used: None

Although a lap belt restraint was available at this passenger's seating position, it was not in use at the time of the accident.

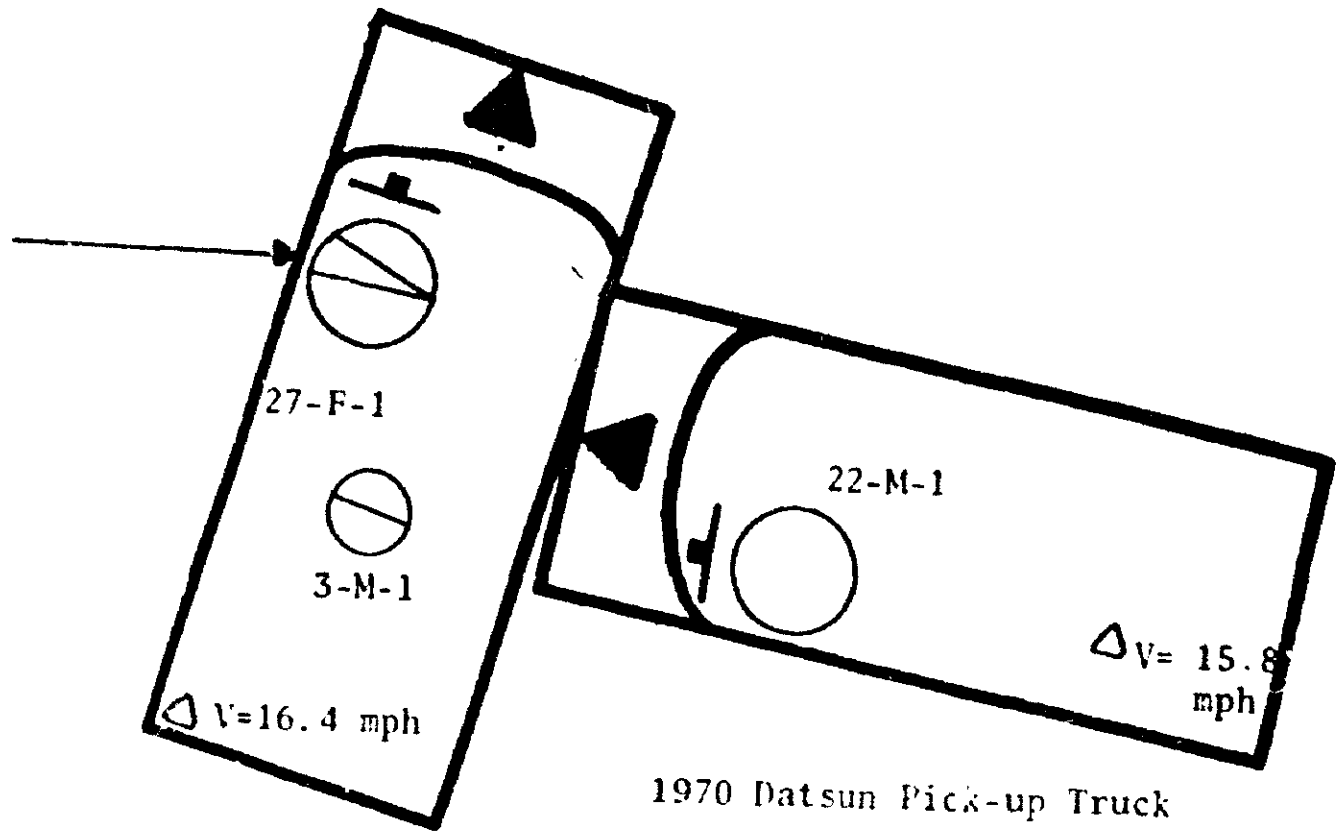
Injuries	AIS	Probable Source
Abrasions, nose and face	1	Ground
Abrasions, left forearm & wrist	1	Sun roof
Fracture, left ribs (5,6,7, & 8)	2	Ejected/crushed by vehicle
Fracture, left clavicle	2	Ejected/crushed by vehicle
Fracture, left 10th costovertebral angles	2	Ejected/crushed by vehicle
Fracture, 12th rib	1	Ejected/crushed by vehicle
Fracture, right wrist	2	Ejected/crushed by vehicle
Fracture, right femur	3	Ejected/crushed by vehicle
Fracture, symphysis pubis	3	Ejected/crushed by vehicle
Ruptured spleen	4	Ejected/crushed by vehicle

This passenger was ejected through the sun roof and then crushed by the rolling vehicle. He was taken to a local hospital where he died 5 hours later.

The roof crush did not affect the interior compartment area of the right rear passenger. It is likely that the passenger would not have been ejected and, thus, would not have received fatal injuries had he been restrained in this high speed, 360 degree rollover.

CASE 51 (LAX-85-H-0R03)

Case Vehicle: 1982 Subaru, 4-door station wagon
Case Vehicle Weight: 2,560 pounds
Case Vehicle Delta V: 16 mph (Followed by 90 degree rollover)



1970 Datsun Pick-up Truck
Weight= 2,465

Circumstances

. 1982 Subaru station wagon was struck on the right side by a 1970 Datsun pick-up truck. After initial impact, the Subaru overturned and came to rest on its roof. The crash and subsequent rollover resulted in substantial damage to the Subaru. The Datsun pickup was also reported to have sustained substantial damage.

The Subaru was occupied by a lap/shoulder-belted driver and a lap-belted 3-year-old child who was the center rear passenger; both sustained minor injuries. The unrestrained driver of the Datsun also sustained minor injuries.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: F
Age: 27
Height: 5 feet 3 inches
Weight: 106 pounds
Restraint used: Lap/shoulder belt (ELR)

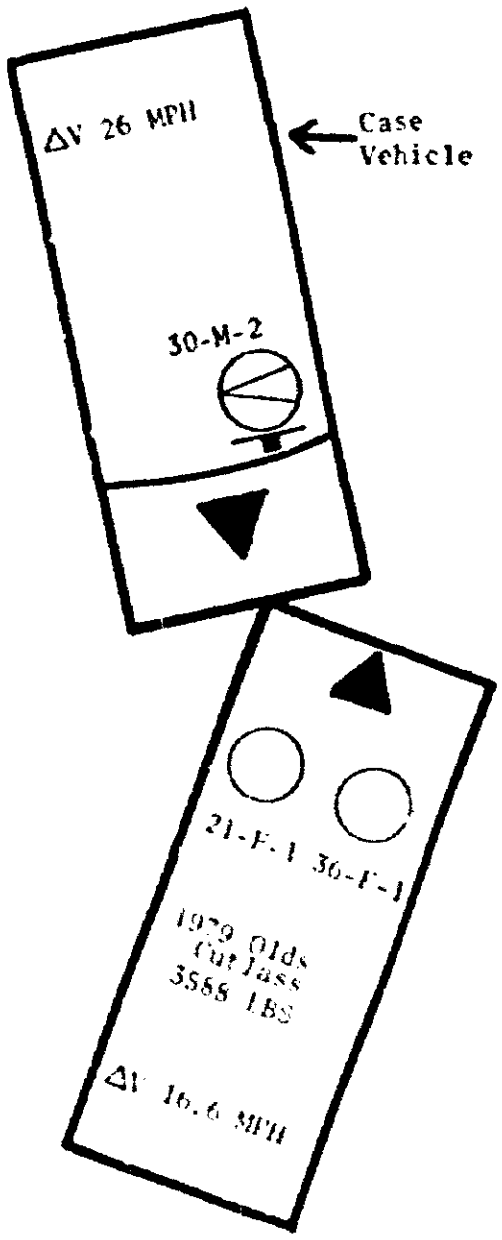
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a free-sliding latchplate, and a push-button release buckle attached to a flexible stalk. The driver stated that the precrash adjustment of the lap portion of the belt was snug and positioned "across her abdomen." In describing the shoulder portion adjustment, she related that she could get more than a closed fist between her chest and the strap. There were scars on the latchplate tongue attributed to force loading at the buckle. The passenger side and roof of this vehicle had substantial deformation.

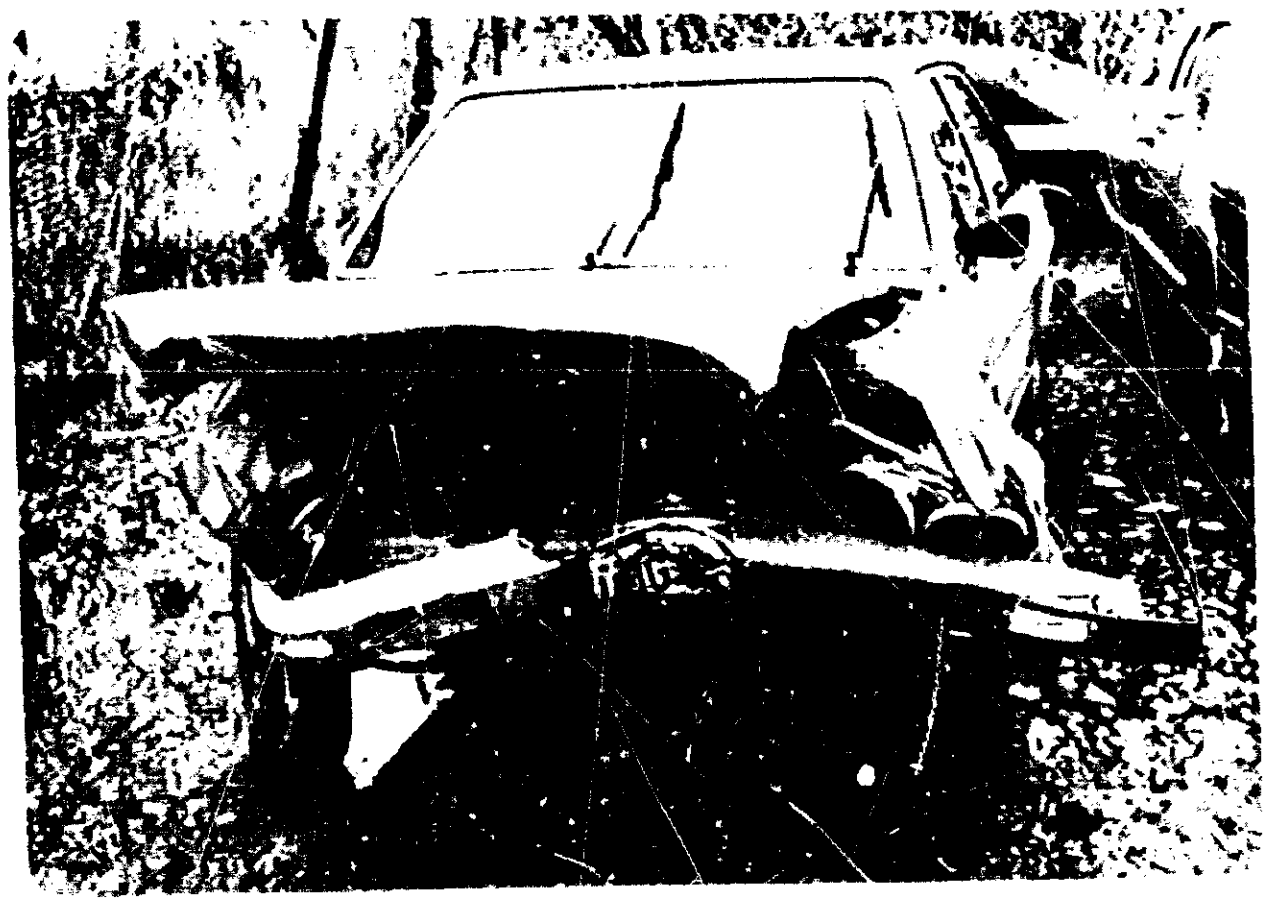
Injuries	AIS	Probable Source
Contusion, top of head	1	Interior roof
Laceration, rear of head	1	Broken glass
Laceration, left arm	1	Window glass
Contusion, abdomen/right side	1	Lap portion of belt
Lacerations, right hand	1	Window glass
Contusion, right thigh	1	Center instrument panel
Contusion, left knee	1	Steering wheel column
Contusion, lower left leg	1	Steering wheel column

This driver was treated at a local outpatient medical facility and lost 13 days of work as a result of her injuries. Considering the 16 mph Delta V of the initial impact, and the 180 degree rollover which followed, she could have sustained more serious injuries if she had been unrestrained, especially if she had come in contact with the deformed roof. Restraint use also precluded any chance of total ejection during the 180-degree rollover.

CASE 52 (SEA-85-H-0R02)

Case Vehicle: 1978 Audi Fox, 2-door
Case Vehicle Weight: 2,290 pounds
Case Vehicle Delta V: 26 mph





Circumstances

The 1978 Audi Fox was attempting a left turn when it was struck by an oncoming Oldsmobile Cutlass. The Audi sustained substantial damage which extended 65 inches across the front of the vehicle with structural deformation of up to 16.5 inches. The Oldsmobile Cutlass sustained substantial damage with crush reaching a depth of 21 inches at its left front.

The Audi driver, restrained by a lap/shoulder belt, sustained moderate injuries. Both unrestrained occupants in the Cutlass sustained minor injuries.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: M
Age: 30
Height: 6 feet 3 inches
Weight: 195 pounds
Restraint used: Lap/shoulder belt (ELR)

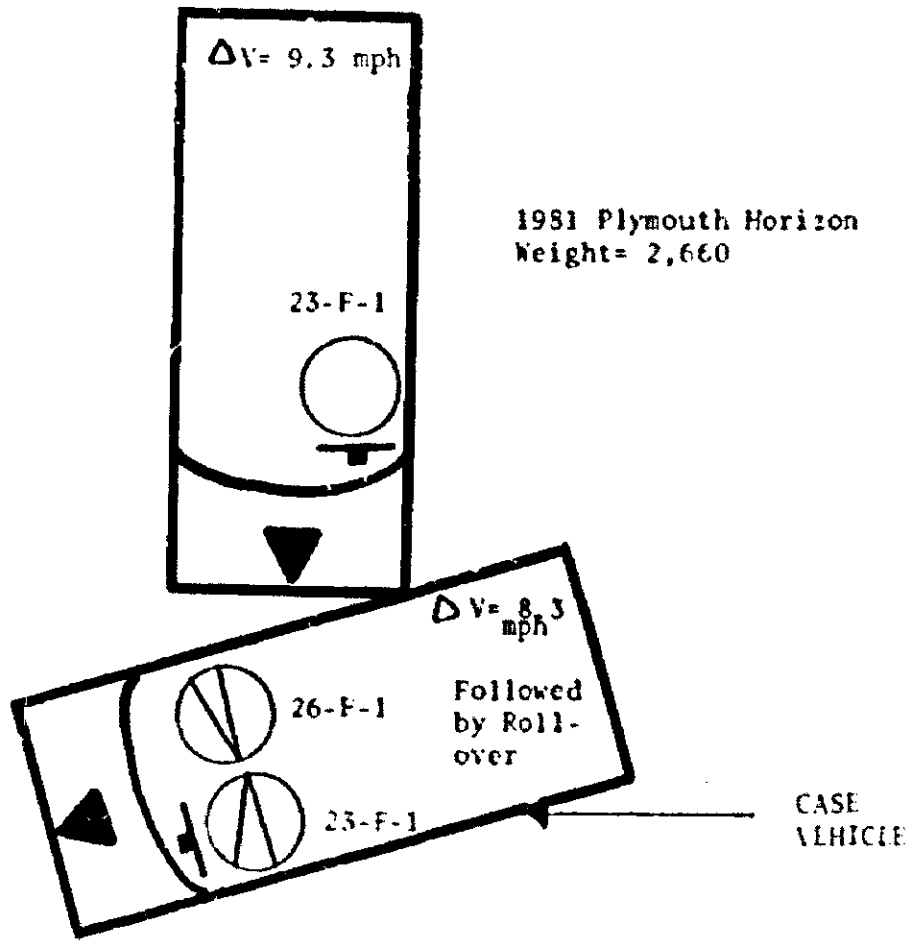
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a seat-mounted buckle assembly. The driver stated that the precrash lap portion adjustment was low on the hips and without slack. The driver stated he was "crouching forward" immediately before the collision, thus creating extra slack in the shoulder portion of the belt.

Injuries	AIS	Probable Source
Contusion, forehead	1	Steering wheel
Contusion, chin	1	Steering wheel
Abrasion, right shoulder	1	Shoulder belt
Sprain, left wrist	1	Steering wheel
Contusion, right hip	1	Lap portion of belt
Contusion, left hip	1	Lap portion of belt
Fracture, 9th and 10th ribs	2	Steering wheel

The driver was transported to an area hospital, treated, released, and reported a loss of work for 2 days. Use of the available lap/shoulder belt precluded extensive excursion about the vehicle and reduced the chances of more serious injuries in this 26 mph Delta V collision. The fact that he extended the webbing by crouching before the collision allowed him to strike the steering column with greater force and sustain moderate chest injuries.

CASE 53 (SEA-84-II-OR04)

Case Vehicle: 1981 Subaru GL station wagon
Case Vehicle Weight: 2,310 pounds
Case Vehicle Delta V: Undetermined (not compatible with Crash-III)
Followed by 180-degree rollover



Circumstances

A 1981 Subaru GL station wagon was traveling on a divided freeway when a 1981 Plymouth Horizon attempted to enter the freeway from an on-ramp, lost control, and struck the Subaru on the right side. After impact, the Subaru rotated, rolled onto its top, and slid to rest. The Subaru sustained moderate damage to the right side with deformation of up to 5 inches over a 74-inch area. The damage to the top of the Subaru was substantial with deformation being concentrated from the firewall back to the B-pillar.

The Subaru driver, restrained by a lap/shoulder belt, received minor injuries. A lap/shoulder belt was also worn by a right front passenger in the Subaru who sustained minor injuries.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: F
Age: 26
Height: 5 feet 11 inches
Weight: 160 pounds
Restraint used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver stated that the precrash lap portion adjustment was positioned low across her hips and snug. No information was available on shoulder adjustment but since the restraint system had no tension relieving device, the shoulder portion of the belt should have been snug against her chest

Injuries	AIS	Probable Source
Strain, cervical spine	1	Rollover forces
Strained ligaments, thoracic spine	1	Rollover forces
Contusion, left hip	1	Lap portion of belt
Contusion, left knee	1	Lower instrument panel
Abrasion, left shin	1	Lower instrument panel

The driver was treated for her injuries as an outpatient and reported 7 days loss of work. The impact forces from the collision with the Plymouth were minor compared to the 180 degree rollover, as far as injury-causing potential. The available restraint system prevented uncontrolled movement about the interior of the vehicle and, thus, probably prevented more serious injuries to the driver during the rollover.

Seating location: Right front
Sex: F
Age: 35
Height: 5 feet 2 inches
Weight: 140 pounds
Restraint used: Lap/shoulder belt (ELR)

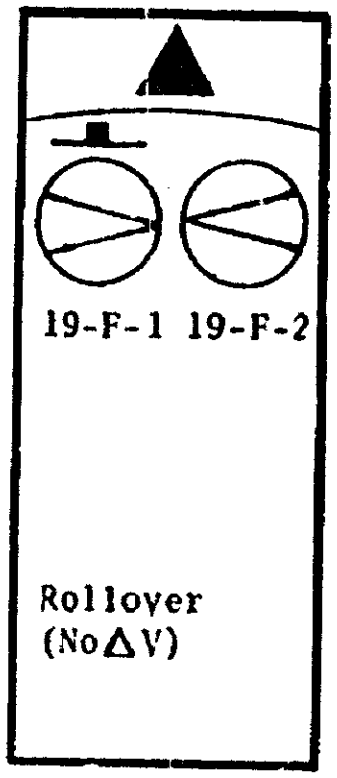
The passenger was wearing a continuous loop lap/shoulder belt identical to the one worn by the driver. The belt adjustment was reportedly snug, with the lap portion positioned low on the hips and the shoulder portion worn across the midchest area.

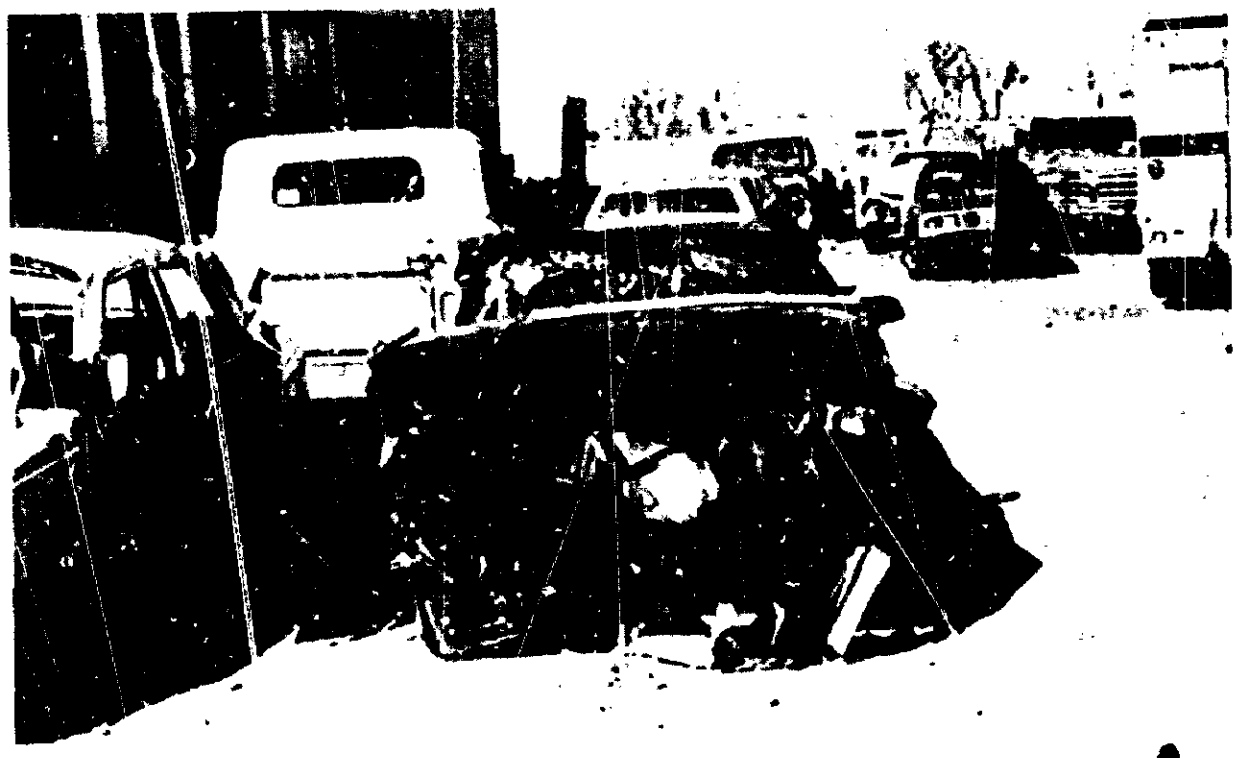
Injuries	AIS	Probable Source
Contusion, left side of head	1	Roof crush
Abrasion, right shoulder	1	Shoulder portion of belt
Strain, cervical spine	1	Rollover
Contusion, right hip	1	Door armrest

The passenger was treated for her injuries as an outpatient and reported missing 1 week of work. Although the restraint system could not prevent the minor injuries received during the initial side impact, it is probable that the lap/shoulder belt kept her from receiving more serious injuries during the 360 degree rollover. Had she been unrestrained, it is possible that the rollover forces might have resulted in ejection, thus increasing the chance for additional and more serious injuries.

CASE 54 (DEN-85-H-OR03)

Case Vehicle: 1984 Chevrolet Camaro Z-28, 2-door
Case Vehicle Weight: 3,223 pounds
Case Vehicle Delta V: 32 mph





Circumstances

A 1984 Chevrolet Camaro veered off the right road edge and struck a concrete culvert wall. Following collision with the wall, the vehicle vaulted several feet before landing on its wheels. The vehicle sustained substantial damage to the front with deformation of up to 24 inches. The vehicle was equiped with a T-top; both side inserts were removed.

The Chevrolet driver, restrained by a lap/shoulder belt system, sustained minor injuries. The right front passenger, also wearing a lap/shoulder belt, sustained a moderate injury.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: F
Age: 19
Height: 5 feet, 6 inches
Weight: 140 pounds
Restraint used: Lap/shoulder belt with dual retractors (ELR/ELR)

The lap/shoulder belt was equipped with dual emergency locking retractors, a sewn-in latchplate, a comfort-clip on the shoulder portion, and a stalk-mounted buckle assembly. The driver stated that the lap portion fit as low on the hip and the shoulder portion as "snug" across the chest. This driver was wearing thick clothing under his lap/shoulder belt.

Injuries	AIS	Probable Source
Laceration, right scalp	1	Steering wheel
Contusion, right thigh	1	Seat belt buckle
Contusion, left foot	1	Brake pedal
Contusion, left lower leg	1	Lower instrument panel
Contusion, left thigh	1	Lap portion of belt
Contusion, center chest	1	Shoulder portion of belt
Laceration, right hand	1	Windshield

The driver was treated at a local hospital emergency room and released, and reportedly lost 10 days work. Considering the impact forces (Delta V of 32 mph) and the vault dynamics, the lap/shoulder belt probably prevented her ejection and more serious injury. With the T-top inserts removed, an unrestrained driver might have been ejected at some point in this accident.

Seating location: Right front
Sex: F
Age: 19
Height: 5 feet 2 inches
Weight: 125 pounds
Restraint used: Lap/shoulder belt with dual retractors (ELR/ELR)

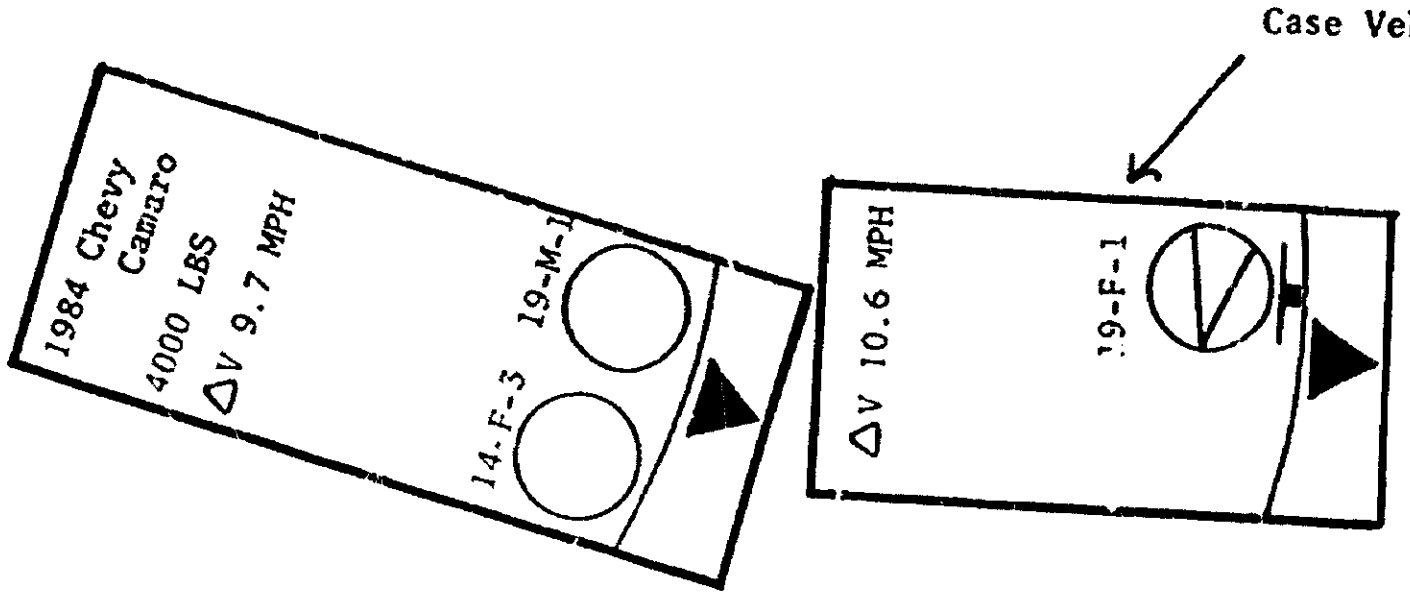
This occupant was wearing a lap/shoulder belt identical to that used by the driver. The passenger was also wearing thick clothing under the belt but described the fit as tight across the chest and low on the hips. Contusions sustained across the lower abdomen support proper use.

Injuries	AIS	Probable Source
Fracture, right humerus	2	Right door rest
Abrasion, right shoulder	1	Shoulder belt
Contusion, chest	1	Shoulder belt
Abrasion, right lower leg	1	Lower instrument panel
Contusion, right hip	1	Lap portion of belt

The passenger was treated and released from a local hospital and was absent from school for an unspecified time. The restraint system worked well in reducing the injury level for this occupant. Evidence indicated substantial restraint system loading which probably prevented ejection, through the open T-top, from the vehicle, and more serious or greater injury, during the vault which followed the initial 32 mph Delta V collision.

CASE 55 (DEN-85-H-OR07)

Case Vehicle: 1983 Mazda pick-up truck
Case Vehicle Weight: 2,645 pounds
Case Vehicle Delta V: 10 mph (followed by 720-degree rollover)



Circumstances

A 1971 Chevrolet Camaro, traveling at a driver-estimated speed of 60 mph, struck the rear of a 1983 Mazda pick-up truck which was traveling at a driver-estimated speed of 30 mph. After the initial impact, the Mazda departed the paved surface and overturned 720 degrees before coming to rest on its wheels. This collision resulted in substantial damage to the Mazda and the Chevrolet.

The Mazda driver, wearing a lap/shoulder belt, received minor injuries. The Chevrolet was occupied by a driver and right front passenger, both unrestrained. The Chevrolet driver reportedly received minor injuries. The right front Chevrolet passenger reportedly sustained a moderate head injury.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 19
Height: 5 feet 1 inch
Weight: 130 pounds
Restraint used: Lap/shoulder belt (ELR)

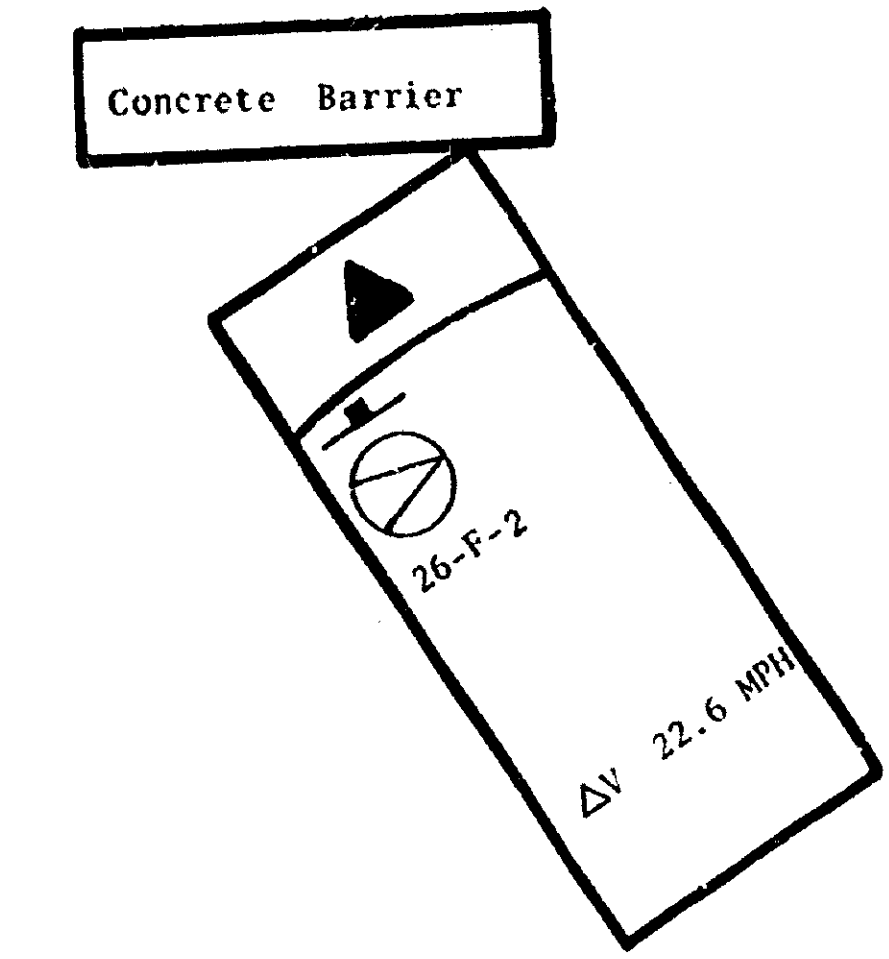
The driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a free-sliding latchplate, and a push-button release buckle attached to a flexible stalk. The driver stated that the adjustment of the shoulder strap was snug, but she was unable to relate the positioning or adjustment of the lap portion of the belt. Paint transfers were found on the system webbing attributed to webbing load at the D-ring. There were no occupant contact marks on the frontal interior, steering assembly, or windshield.

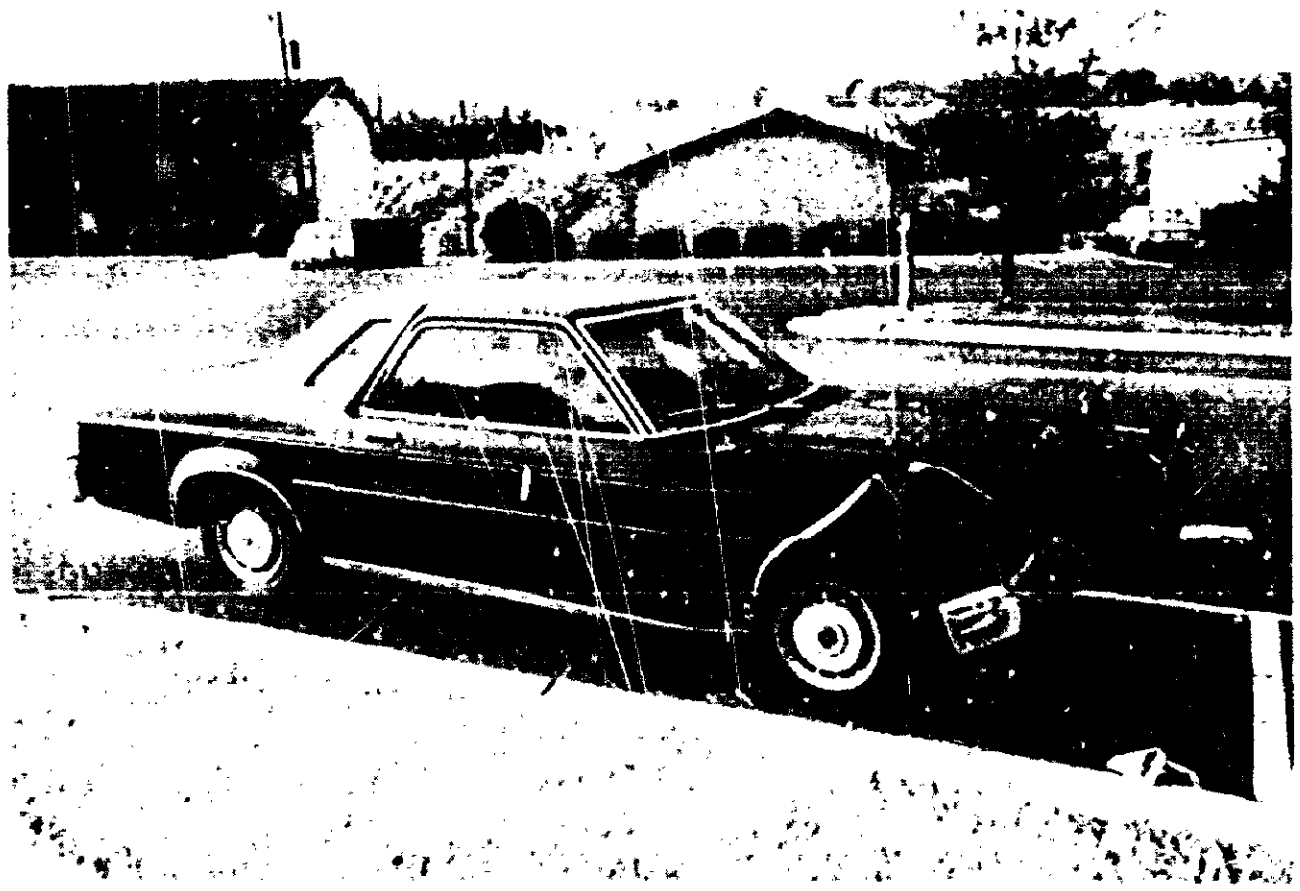
Injuries	AIS	Probable Source
Contusion, right lower leg	1	Lower dash
Abrasions, top of fingers right hand	1	Rear window glass

The driver was examined at an outpatient medical facility and released. Restraint use was probably of little benefit during the initial impact: when the vehicle was struck in the rear (a Delta V of 10 mph), the driver was accelerated into her seatback. Restraint use, however, was of substantial benefit during the 720° rollover, preventing the occupant from making violent contact with the vehicle interior and sustaining more serious injuries or ejection.

CASE 56 (ATL-85-H-OR04)

Case Vehicle: 1977 Mercury Monarch
Case Vehicle Weight: 3,606 pounds
Case Vehicle Delta V: 22 mph





Circumstances

A 1977 Mercury Monarch traveled off the right shoulder and struck the end of a concrete barrier. The Mercury received substantial structural damage over the front with deformation of up to 25 inches.

The Mercury driver, restrained by a lap/shoulder belt, sustained moderate injuries.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: F
Age: 26
Height: 5 feet 6 inch
Weight: 145 pounds
Restraint used: Lap/shoulder belt (ELR)

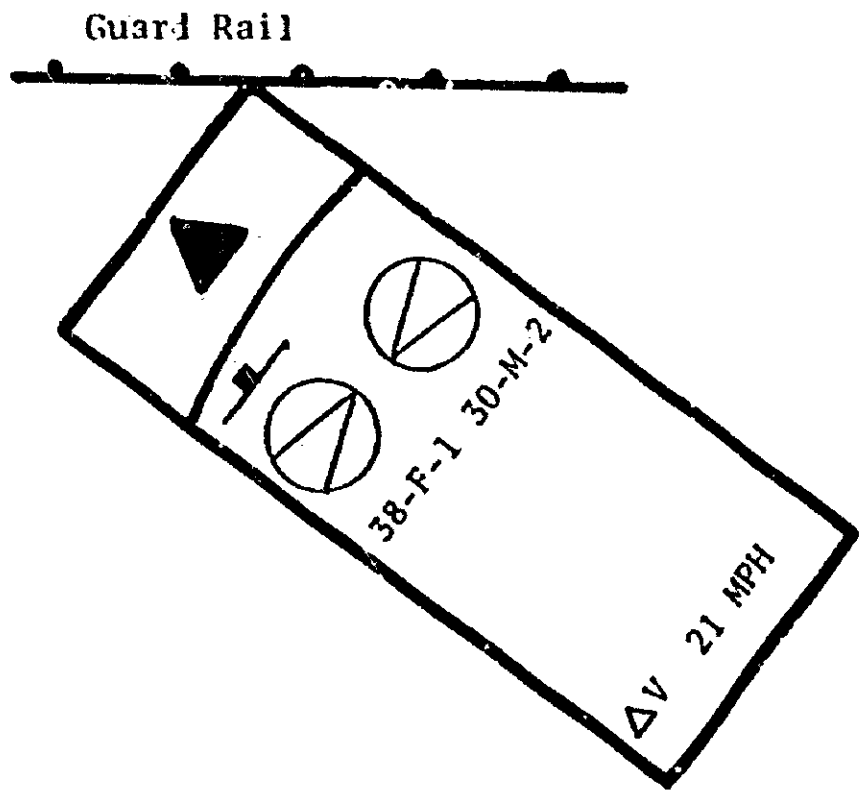
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The lap portion of the belt was reportedly tight and positioned low on the hips; the shoulder portion was routed across the midchest area. Although the driver reported that the shoulder portion was loose enough to get a clenched fist between the belt and her chest, the belt should have been relatively snug due to its self-tensioning feature. In addition, the free-sliding latchplate would apportion any slack in the system equally between both portions of the belt. If the lap portion was snug, so should have been the shoulder portion. A force loading mark was found on the webbing in the area of the free-sliding latchplate.

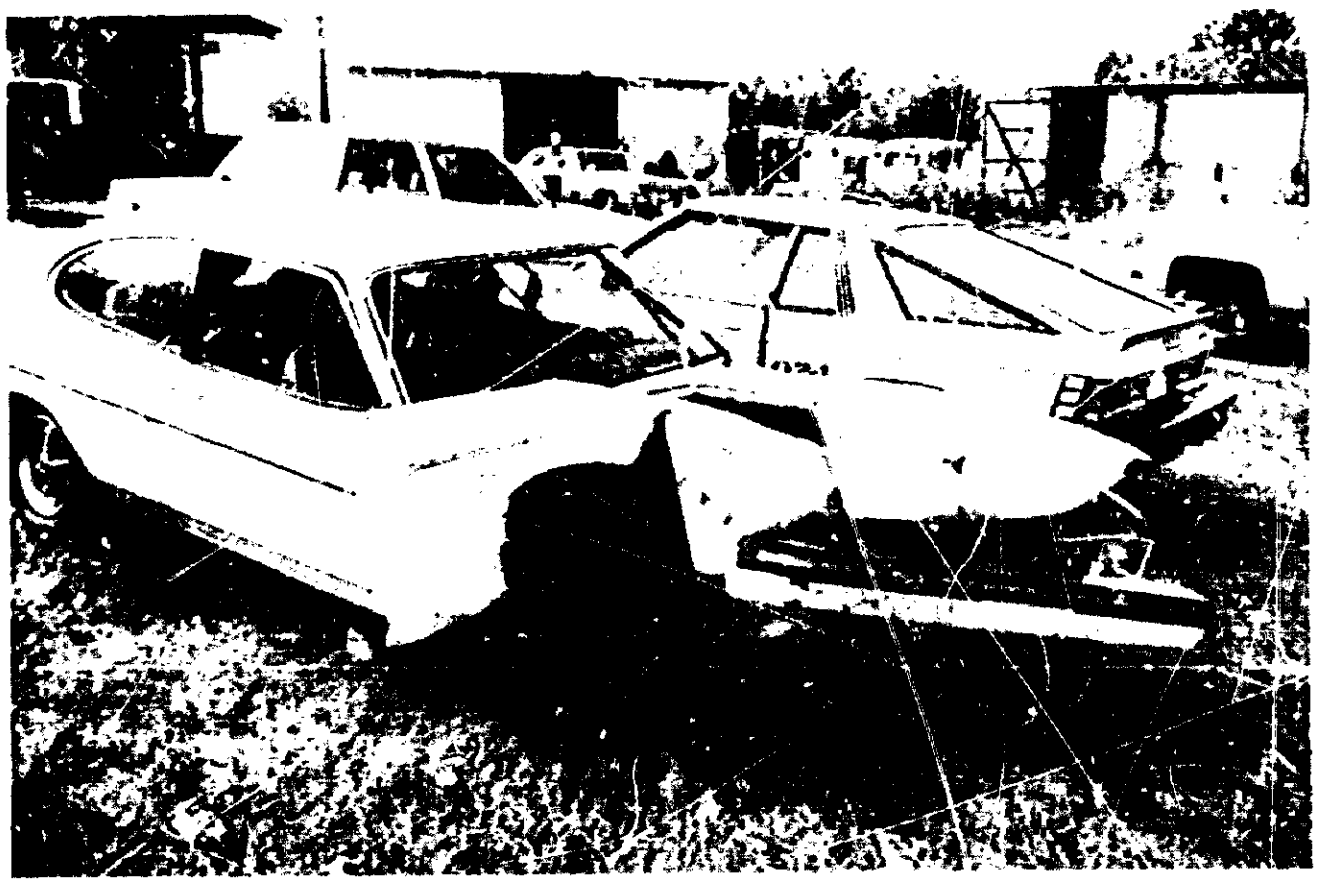
Injuries	AIS	Probable Source
Major contusion, forehead	2	Steering wheel
Contusion, upper nose & around eyes	1	Steering wheel
Major contusion, back of head	2	Headrest
Undefined closed head injury	2	Steering wheel
Contusion, upper abdomen	1	Shoulder belt
Contusion, lower abdomen	1	Lap belt
Contusion, left knee	1	Lower instrument panel
Contusion, right knee	1	Lower instrument panel
Laceration, lower left leg	1	Parking brake pedal
Contusion, lower left leg	1	Lower instrument panel
Contusion, left upper arm	1	Door panel
Contusion, left forearm	1	Armrest
Contusion, left hand	1	Mirror control knob
Abrasion, right elbow	1	Steering wheel

The driver was treated in an emergency room, released, and reported a loss of 2 weeks of work. Use of the available lap/shoulder belt prevented the driver from being more seriously injured in this 22 mph Delta V collision. An unrestrained driver would have been free to make violent contacts with the frontal interior, the steering wheel and column, and possibly the windshield.

CASE 57 (ATL-85-H-0R01)

Case Vehicle : 1976 Mercury Capri 2800, 2-door
Case Vehicle Weight: 3,055 pounds
Case Vehicle Delta V: 21 mph (followed by 90-degree rollover)





Circumstances

A 1976 Mercury Capri veered to the left onto a grass median, crossed two highway lanes, impacted a W-beam guardrail, vaulted, impacted the ground, and rolled onto its top. The vehicle sustained substantial damage across the front, with deformation of up to 22 inches. There was slight downward deformation of the roof.

The Mercury driver, restrained by a lap/shoulder belt, sustained minor injuries. The right front passenger, also restrained by a lap/shoulder belt but in a reclined seat, sustained moderate injury.

Restraint and Injury

Case Vehicle
Seating location: Driver
Sex: F
Age: 38
Height: 5 feet 8 inch
Weight: 130 pounds
Restraint used: Lap/shoulder belt (ELR)

The driver was wearing a continuous loop lap/shoulder belt with an emergency locking retractor sensitive to both vehicle and webbing motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver stated that the lap portion was snug and positioned low on the hips. She related that the shoulder portion was positioned across the midchest area but was unable to describe the tension. Restraint-induced abrasions verify the location of the shoulder portion.

Injuries	AIS	Probable Source
Abrasion, left shoulder/neck	1	Shoulder portion of belt
Abrasion, lower right abdomen	1	Belt buckle
Contusions, right thigh	1	Steering wheel
Contusions, left thigh	1	Steering wheel
Abrasion, left knee	1	Steering column

The driver was treated first in a local emergency room and then transported to another emergency room for additional treatment, and released. The belt system restrained the driver in place and precluded serious injury, even during the 180 degree rollover sequence. An unrestrained driver would possibly have received serious or greater injuries at some point within the complex dynamics of this 21 mph Delta V collision and subsequent vault, ground impact, and 180 degree rollover. Considering the expected occupant kinematics of an accident of this type, it is also possible that the driver might have suffered ejection had she not been restrained.

Seating location: Right front
Sex: M
Age: 30
Height: 6 feet 4 inch
Weight: 205 pounds
Restraint used: Lap/shoulder belt (ELR)

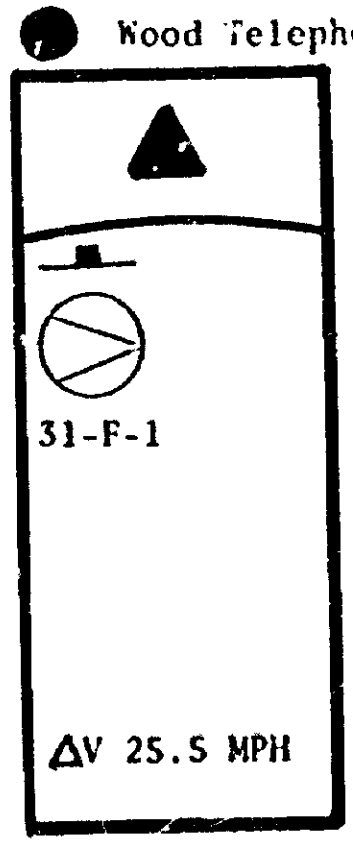
The right front passenger was wearing a lap/shoulder belt identical to that worn by the driver. He had been reclining in the seat before the onset of the collision, however, he sat up as he felt the collision events begin. The seat back remained reclined.

Injuries	AIS	Probable Source
Fracture, 8th and 9th ribs	2	Shoulder portion of belt
Abrasion, left knee	1	Lower instrument panel
Abrasion, right forearm	1	Right door window handle

The passenger was transported first to a local hospital, then transferred to another hospital for further care. He was admitted and hospitalized for 1 week, primarily to stabilize a preexisting medical condition, and lost an additional week of work. Although the seatback was reclined, the restraint system confined the passenger to the seat area and precluded contact with injury producing interior components. The fractures of the left ribs were probably due to the increased loading of the belt due to his improper position: he was farther back in the seat, further removed from the belt, than he would have been if the seatback was in its proper position. Considering the crash forces involved at the initial 21 mph Delta V collision with the guardrail, the vault, the ground impact, and the 180 degree rollover, it is likely that an unrestrained occupant would have received a more serious level of injuries.

CASE 58 - (ATL 85-H-OR03)

Case Vehicle: 1982 Buick Regal
Case Vehicle Weight: 3,400 pounds
Case Vehicle Delta V: 25 mph



Circumstances

A 1982 Buick Regal was rounding a right curve when it crossed into the opposite lane of travel, went off the roadway, and struck a wood telephone pole. The left front of the Buick was deformed rearward a maximum of 36 inches.

The driver, wearing a lap/shoulder belt was out-of-position at the time of the crash, and sustained minor injuries and an closed head injury of undefined severity. She was 5 months pregnant, but the fetus was reportedly uninjured. The driver subsequently carried the child full term and delivered a healthy infant.

Restraint and Injury

Case Vehicle
Seating Location: Driver

Sex: F
Age: 31
Height: 5 feet 8 inches
Weight: 155 pounds
Restraint used: Lap/shoulder belt (ELR)

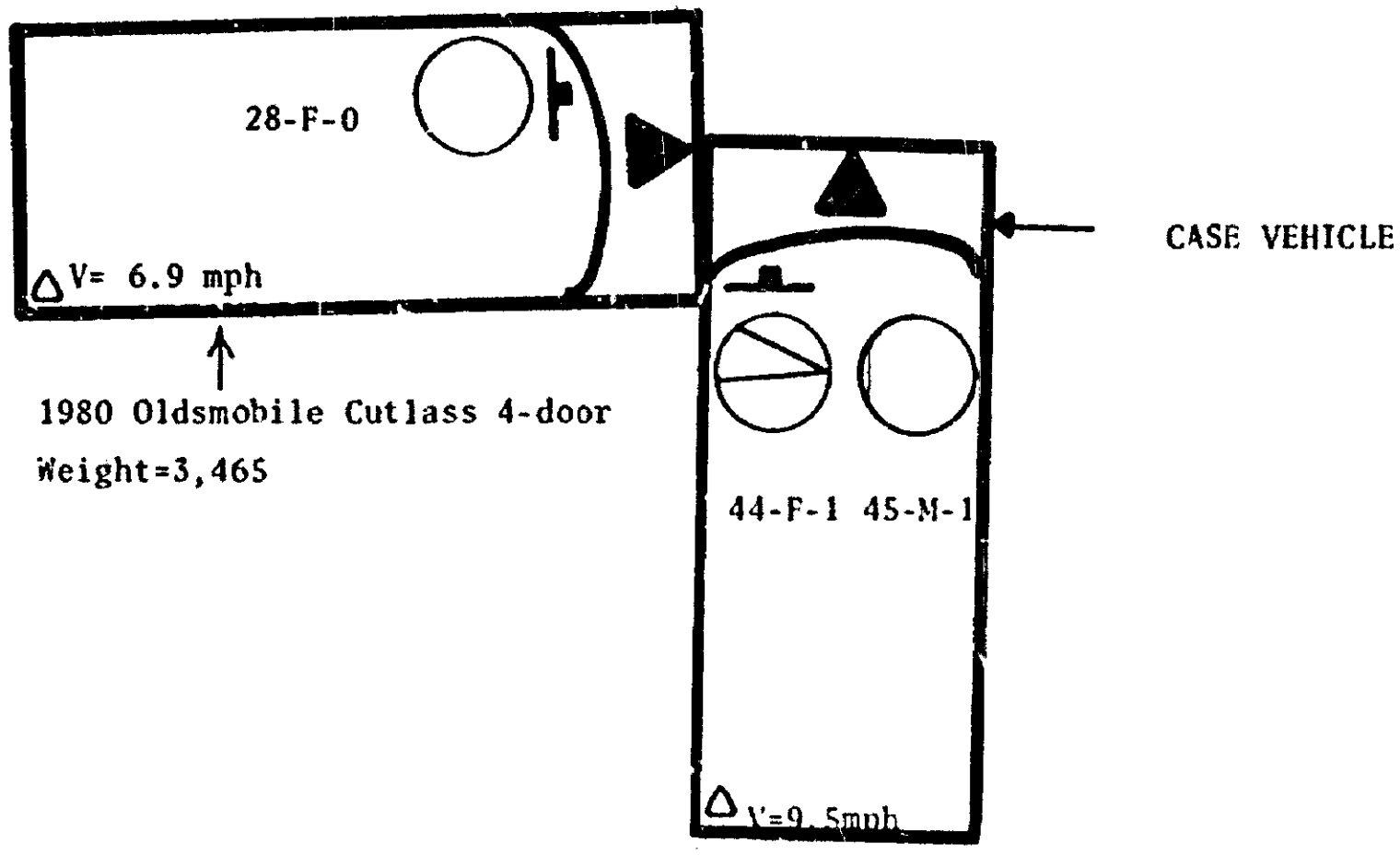
The driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a cinching latchplate, a windowshade tension-relief device, and a stalk-mounted buckle assembly. Force loading marks were found on the webbing in the vicinity of the latchplate. The driver stated that the shoulder portion of the belt was worn loosely, but that the lap portion was adjusted snugly, below her belly. While the loading mark from the latchplate verified the lap/shoulder belt was used, there is some question as to how much slack was introduced into the shoulder portion before impact. The driver stated that she had been leaning to the right to pickup something off the floor moments before the crash. The pregnant woman was wearing the belt on the advice of her doctor.

Injuries	AIS	Probable Source
Fractured ring finger, right hand	1	Unknown
Undefined closed head injury	7	Struck head on steering wheel
Laceration on lip	1	Struck steering wheel
Laceration on chin	1	Struck steering wheel
Laceration over left eye	1	Struck steering wheel

The driver was transported to a local hospital where she was treated and released. She complained of abdominal pain, but subsequently carried the fetus full term and delivered a healthy infant. Even though the driver was out of proper position behind the shoulder belt, it seems likely that the restraint system, as a whole, was of benefit in this 25 mph Delta V collision. An unrestrained driver would have been free to make violent, uncontrolled contacts with the frontal interior, thus increasing the chances of additional and more serious injuries. It is also possible that an impact with the steering assembly might have had serious consequences for the fetus.

CASE 59 - (DEN 85-H-OR10)

Case Vehicle: 1985 Toyota Corolla 4-door
Case Vehicle Weight: 2,526 Pounds
Case Vehicle Delta V: 9.5 mph



Circumstances

A 1985 Toyota Corolla was entering an intersection when it was struck in the left front by a 1980 Oldsmobile Cutlass. The initial collision caused both vehicles to rotate into a secondary impact. The Toyota received substantial damage with deformation of up to 18 inches. Substantial damage was also sustained to the left rear side during the secondary impact. The Cutlass sustained minor damage to the right front and right rear.

The Toyota driver, restrained by a lap/shoulder belt, sustained minor injuries. The unrestrained right front passenger of the Toyota sustained a minor injury. The unrestrained driver of the Oldsmobile was not injured.

Restraint and injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 44
Height: 5 feet 3 inches
Weight: 130 pounds
Restraint Used: Lap/Shoulder Belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver stated that the lap portion of the belt was fitted snugly "across her abdomen." The shoulder portion was reportedly adjusted with about 2 inches of slack between the shoulder portion of the belt and the driver's chest.

There was interior deformation of the driver's bucket seat: it was tilted leftward toward the driver's door during the initial and secondary impacts. During these impacts, the driver was thrown into the left side door striking her head, which pushed her glasses into the left side of her face and nose.

Injuries	AIS	Probable Source
Laceration on left eye lid	1	Rim of eye glasses
Laceration on nose	1	Rim of eye glasses
Fractured nose	1	Rim of eye glasses against driver's door window glass

The driver received emergency out-patient treatment at a local hospital and was released. She did not lose any time from work. Her use of the available lap/shoulder belt prevented forward movement in this 9.5 mph Delta V collision; however, the restraint was of little benefit in controlling the lateral movement of the driver's upper torso which resulted from the crash force direction and allowed her to come in contact with the driver's door window glass. An unrestrained driver would probably have received similar injuries from the adjacent interior side contact.

Seating Location: Right Front
Sex: M
Age: 45
Height: Unknown
Weight: Unknown
Restraint Used: None

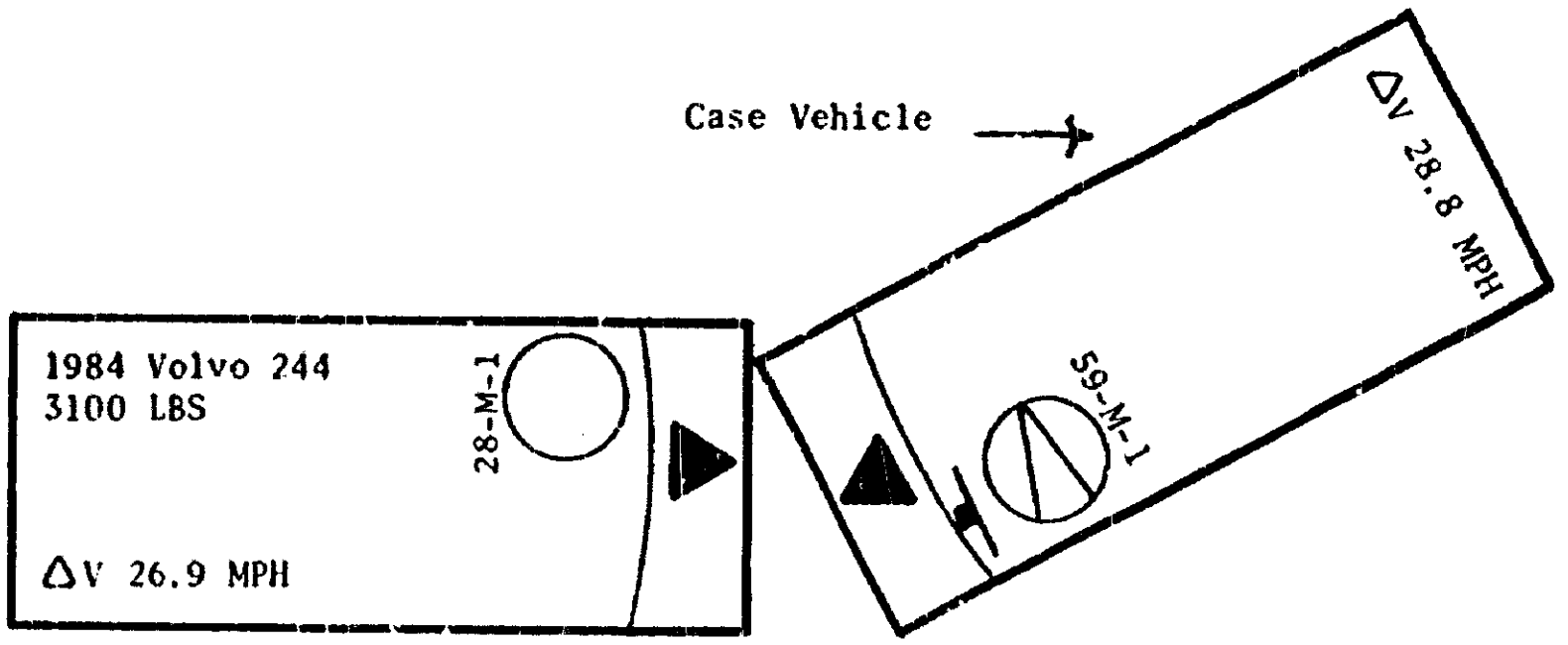
The occupant was not wearing the lap/shoulder belt that was available at his seating position. During the crash, he was thrown leftward and slightly forward causing his right knee to contact and the radio cassette player.

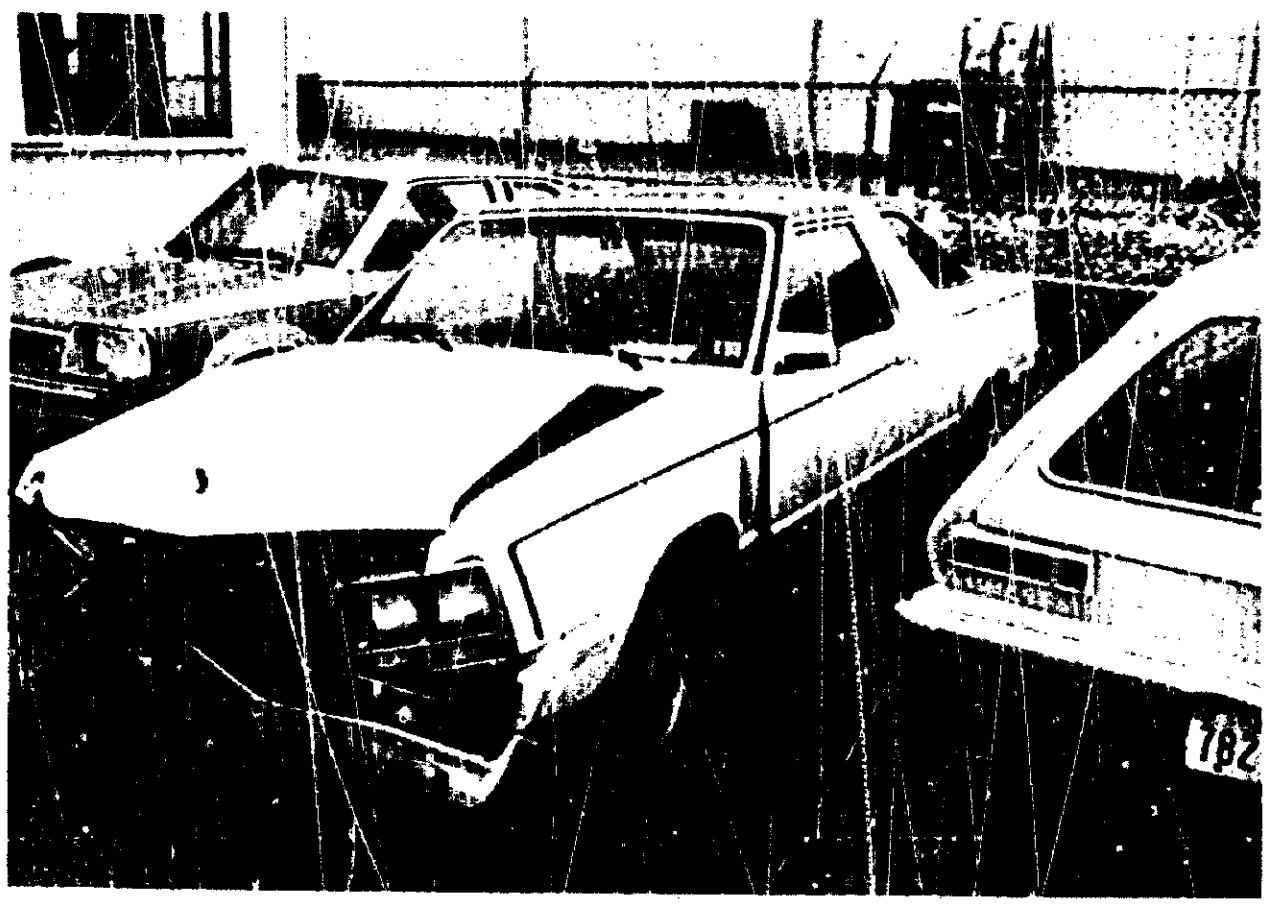
Injuries	AIS	Probable Source
Contusion, right knee (inside)	1	Radio cassette player

This passenger did not receive immediate medical treatment, but went to the hospital the day after the accident because of pain and swelling in his right knee. Given the contact point which produced this occupant's injury, it is likely that his use of the restraint might have prevented the knee injury in this 9.5 mph Delta V collision.

CASE 60 - (FTW 85-H-0R23)

Case Vehicle: 1980 Mercury Zephyr, 2 door
Case Vehicle Weight: 2,900 pounds
Case Vehicle Delta V: 28.8 mph





Circumstances

A 1980 Mercury, attempting a left turn, collided head-on with an on-coming 1984 Volvo. Both vehicles received substantial structural damage. The Mercury had deformation reaching depths of up to 25 inches in the front.

The Mercury driver, restrained by a lap/shoulder belt, sustained moderate injuries. The unrestrained driver of the Volvo complained of upper torso and neck pain but did not seek immediate medical attention.

Restraint and Injury

Case Vehicle
Seat Location: Driver
Sex: F
Age: 59
Height: 5 feet 8 inches
Weight: 167 pounds
Restraint Used: Lap/shoulder belt (ELR)

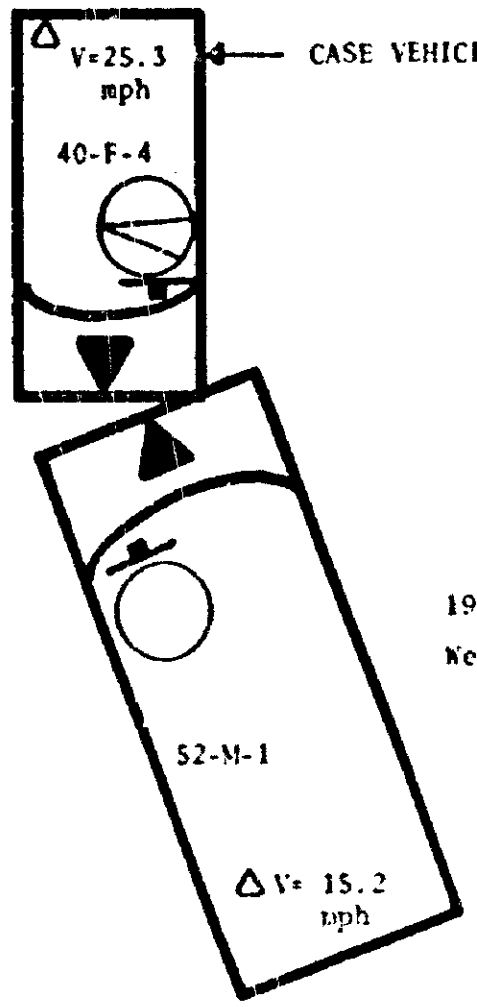
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The precrash adjustment of the lap portion was described by the driver as being snug "across her abdomen." The driver could not recall the amount of slack between her chest and the shoulder portion. Force loading marks were found upon the system webbing in the areas of the latchplate and D-ring.

Injuries	AIS	Probable Source
Fractured sternum	2	Shoulder portion of belt
Fractured metatarsal	2	Foot controls
Right elbow	1	Steering wheel spoke
Major contusions to central chest area	2	Shoulder portion of belt
Abdominal contusions	1	Lap portion of belt

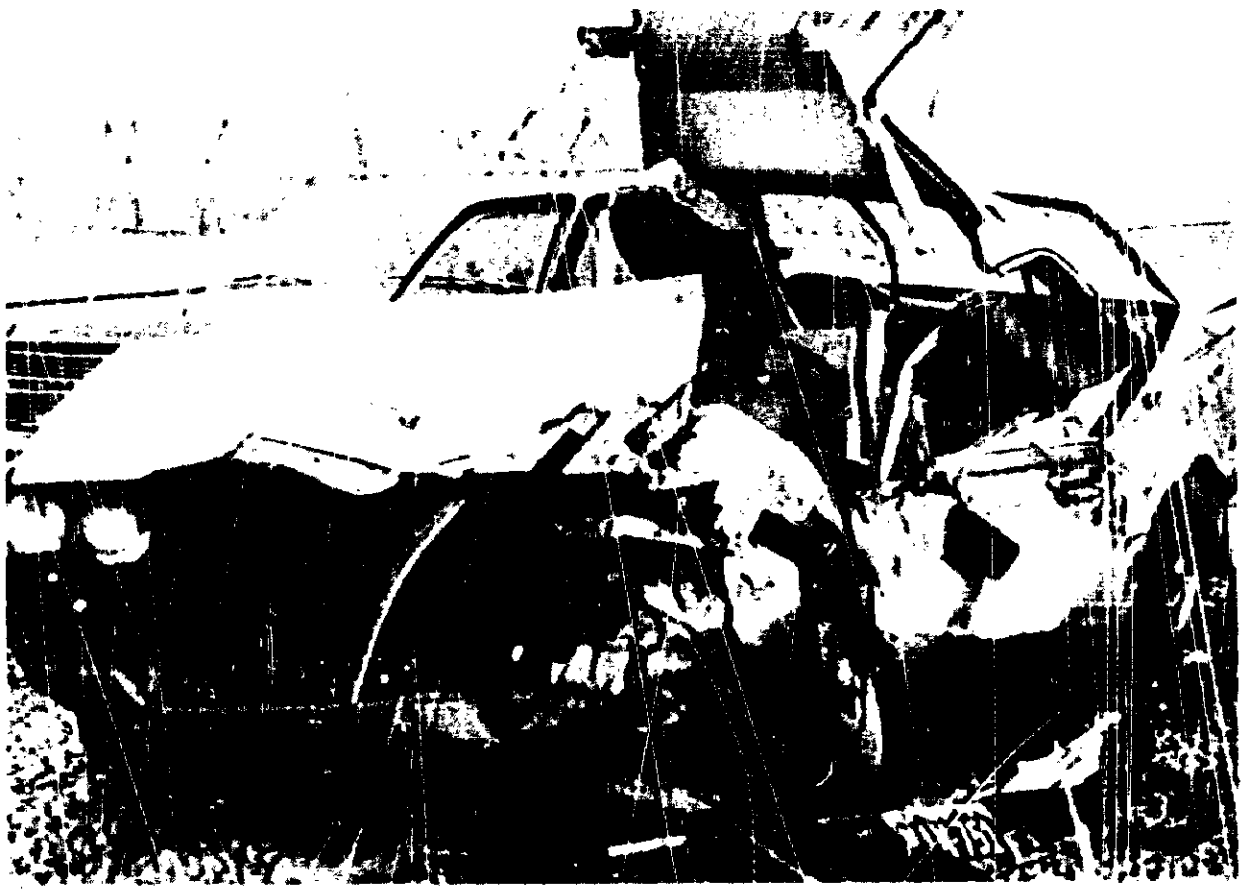
Injuries to the driver required her to be hospitalized for 4 days and prevented her from resuming her normal daily activities for about 2 weeks. The restraint system did, however, prevent violent contacts with the steering assembly for the driver. If she had been unrestrained in this 28.8 mph Delta V collision, it is likely that her injury level would have increased.

CASE 61 - (DEN-85-H-OR06)

Case Vehicle: 1981 Honda Accord, 4-door
Case Vehicle Weight: 2,404 pounds
Case Vehicle Delta V: 25.3 mph



1983 IHC Truck Tractor
Weight= 11,21[illegible]



Circumstances

A 1981 Honda was struck in the left front and left side by an International truck tractor which had braked for slowing traffic, skidded, and partially crossed the center line. Damage to the Honda was extensive, with severe inward deformation from the left front extending to the left C-pillar area. Maximum crush reached a depth of 33 inches at the front.

The Honda driver, restrained by a lap/shoulder belt, sustained severe injuries. The unrestrained truck driver reportedly sustained minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 40
Height: 5 feet 6 inches
Weight: 108 pounds
Restraint Used: Lap/shoulder belt (ELR)

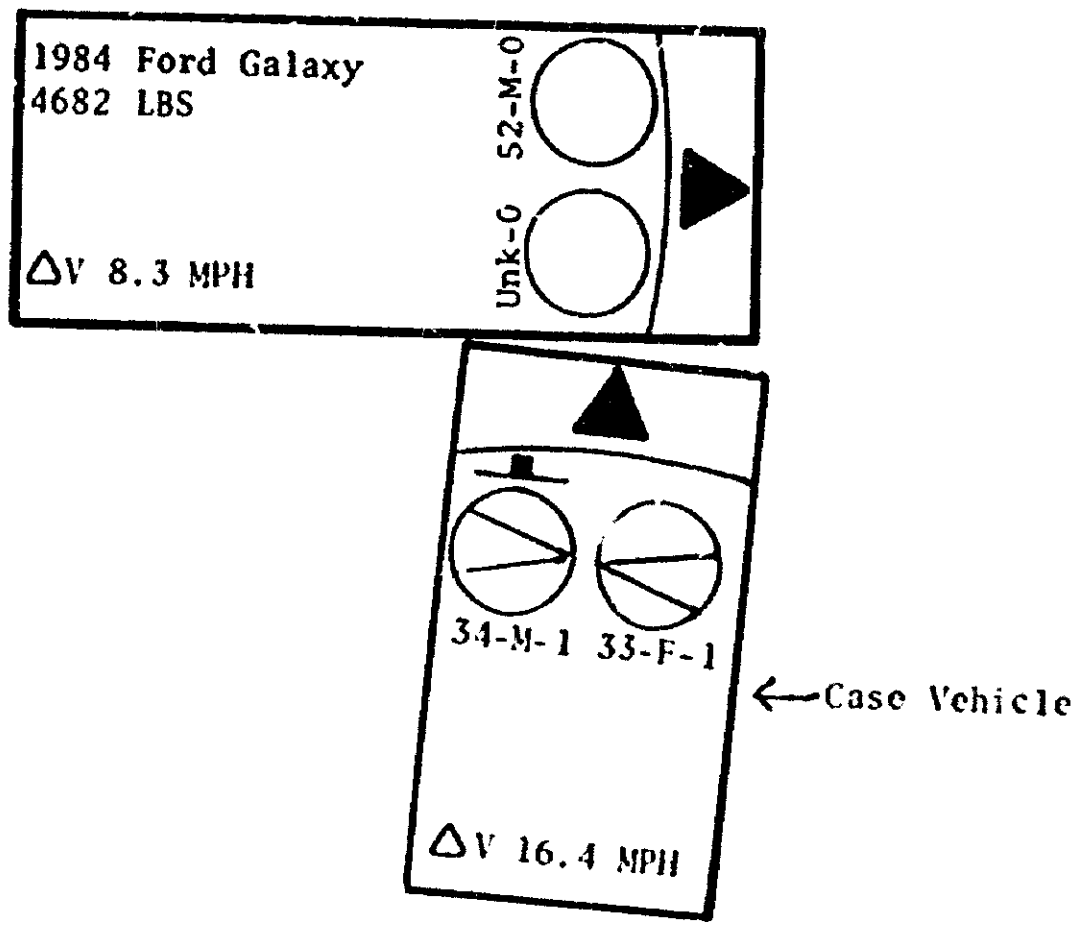
This driver was restrained by a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a free-sliding latchplate, and a stalk-mounted buckle assembly. The adjustment of the belt is unknown due to the driver's refusal to cooperate with the investigators. However, no evidence to indicate improper use was observed on the belt system.

Injuries	AIS	Probable Source
Unspecified head trauma	7	Steering wheel assembly
Fracture, nose	1	Steering wheel assembly
Fracture, Le Forte III	4	Steering wheel assembly
Fracture, right ankle	2	Floor intrusion/crush
Fracture, left tibia	2	Floor intrusion/crush
Fracture, left fibula	2	Floor intrusion/crush
Contusion, left kidney	3	Interior structure intrusion
Fractures, 9th, 10th, 11th left ribs	2	Interior structure intrusion
Fracture, right clavicle	2	Steering wheel
Facial lacerations	1	Unspecified as to extent or location

The driver was extricated from the vehicle and admitted to a local hospital where she remained for a minimum of 3 weeks. Lap/shoulder belt use was probably of little benefit to the driver due to the extensive deformation of the passenger compartment. The frontal interior of the driver's compartment was actually pushed rearward and inboard, violating the occupant's space and negating the benefits of restraint use which might have been expected in this 25.3 mph Delta V collision.

CASE 62 - (DEN 85-H-OR09)

Case Vehicle: 1983 Ford Escort, 4-door
Case Vehicle Weight: 2,378 pounds
Case Vehicle Delta V: 16 mph



Circumstances

A 1983 Ford Escort entered an intersection and struck a 1971 Ford Galaxie on the right side. The collision caused the vehicles to rotate into a secondary impact. The Escort received substantial structural damage across the front, with inward crush up to 24 inches. Damage to the Ford Galaxie was reported as moderate, concentrated in the right side door.

Both occupants of the Escort, driver and right front passenger, were restrained by lap/shoulder belts. Both received minor injuries that required emergency room treatment before being released. The unrestrained occupants of the Galaxie were uninjured.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 34
Height: 6 feet 2 inches
Weight: 185 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver was wearing a bulky cross-country ski coat over a sport coat; the lap/shoulder belt was worn over the coats. The driver described the precrash adjustment of the lap portion as being positioned snugly across his waist about 1 inch below his navel. The shoulder portion of the belt was reportedly adjusted quite loosely, as the driver believed the restraint system was designed to be worn loose and would tighten on impact.

Injuries	AIS	Probable Source
Interior chest contusion	1	Shoulder portion of belt
Contusion, left shoulder	1	Shoulder portion of belt
Contusion, left forearm	1	Door mirror adjustment control
Contusion, left hip	1	Lap portion of belt
Contusion, right hip	1	Lap portion of belt

The driver received medical treatment at a local hospital emergency room and was released. His injuries caused him to miss 1 day of work. The restraint system worked as designed in this 16 mph Delta V collision. The driver was fortunate that crash forces were not more severe; slack would have been more detrimental, allowing the driver to make contacts with the steering assembly and left front interior surfaces. Had he been unrestrained, the expected interior contacts would probably have resulted in a more serious injury level.

Case Vehicle
Seating Location: Right Front
Sex: F
Age: 33
Height: 5 feet 6 inches
Weight: 245 pounds
Restraint Used: Lap/shoulder belt (ELR)

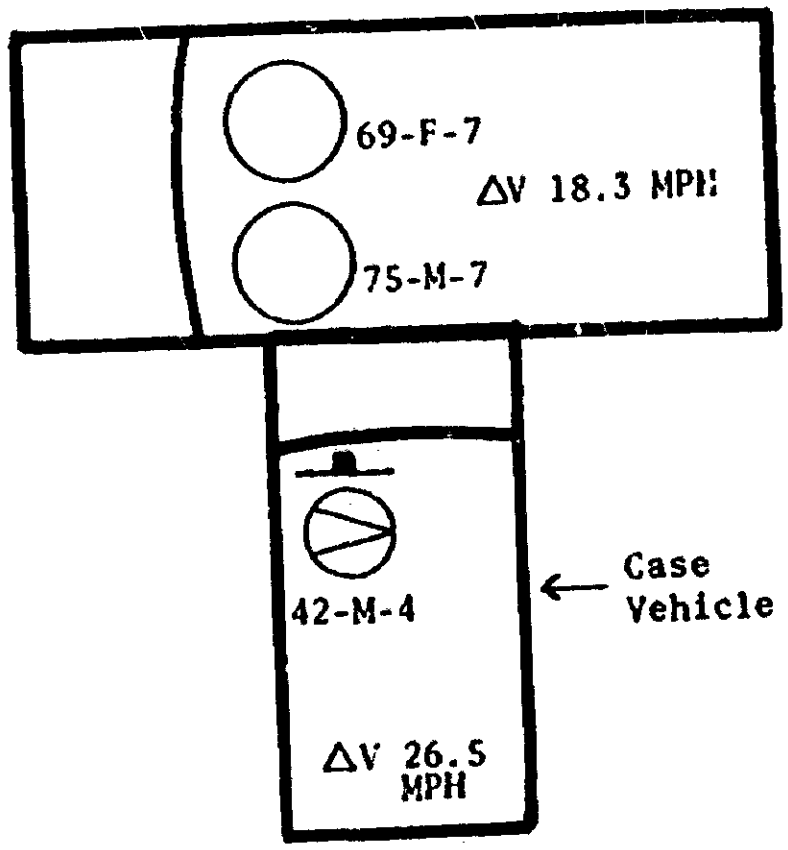
This occupant was wearing a lap/shoulder belt identical in design to that worn by the driver. She described the precrash adjustment of lap portion of the belt as being positioned loosely across her waist about 1 inch below her navel. The shoulder portion was reportedly adjusted quite loose, with even more slack than her husband's (driver) shoulder portion. The shoulder portion of the seat belt was purposely worn loose to prevent it from rubbing on the occupant's neck. Also, it was the occupant's belief that the lap/shoulder belt was designed to be worn loose and that it would tighten on impact. A stretch mark was found on the webbing in the area of the latchplate.

Injuries	AIS	Probable Source
Abrasions, left knee	1	Lower dash, right side
Lacerations, left knee	1	Lower dash, right side
Abrasions, right knee	1	Lower dash, right side
Lacerations, right knee	1	Lower dash, right side
Abrasions, right lower leg	1	Lower dash, right side
Lacerations, right lower leg	1	Lower dash, right side
Abrasions, left lower leg	1	Lower dash, right side
Lacerations, left lower leg	1	Lower dash right side

This occupant received medical treatment at a local hospital emergency room and was released. She missed 3 weeks of work because of the injuries. Even with the reported slack in the belt system, the lap/shoulder belt worked as designed in this 16 mph Delta V collision, preventing the occupant from making more violent contacts with the frontal components. It is possible, however, that a properly adjusted system would have reduced the number of injuries.

CASE 63 - (FTW 85-H-OR13)

Case Vehicle: 1982 Datsun 280ZX
Case Vehicle Weight: 2,940 pounds
Case Vehicle Delta V: 26.5 mph



Circumstances

A 1982 Datsun struck the left side of a 1982 Buick Park Avenue in a collision at an intersection. The Datsun received substantial crush on the front with a maximum depth of 22 inches. The Buick received substantial crush on the left side with a maximum inward crush of 20 inches.

The driver of the Datsun, wearing a lap/shoulder belt, sustained severe injuries. The unrestrained occupants of the Buick reportedly received minor to moderate injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 42
Height: 5 feet 7 inches
Weight: 180 pounds
Restraint Used: Lap/shoulder belt (ELR)

The driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. He described the precrash shoulder portion adjustment as being loose enough to get more than a clenched fist between the shoulder portion and his chest. The lap portion of the belt was reportedly positioned low on his hips but its tightness was unknown. An 8-inch loading mark was present on the belt where the belt webbing passed through the D-ring under loading.

Injuries	AIS	Probable Source
Laceration, right forehead	1	Windshield
Abrasions, right forehead	1	Windshield
Unspecified loss of consciousness	2	Head hit windshield while chest hit steering wheel
Contusion, left knee	2	Instrument panel
Contusion, right knee	1	Instrument panel
Major contusion, chest	2	Steering wheel
Myocardium contusion	4	Restraint webbing and steering assembly
Major contusions, upper back	2	Unknown
Major contusions, lower back	2	Unknown
Bruises on left shoulder	1	Shoulder portion of belt

The driver was taken to a nearby hospital where he was admitted and stayed 2 days. The injuries sustained in this case appear extraordinary severe for a fully restrained occupant in a Delta V 27 mph collision. The 8 inch loading mark on the webbing where it passed through the D-ring is conclusive evidence that the lap/shoulder belt was worn and the retractor functioned during the collision.

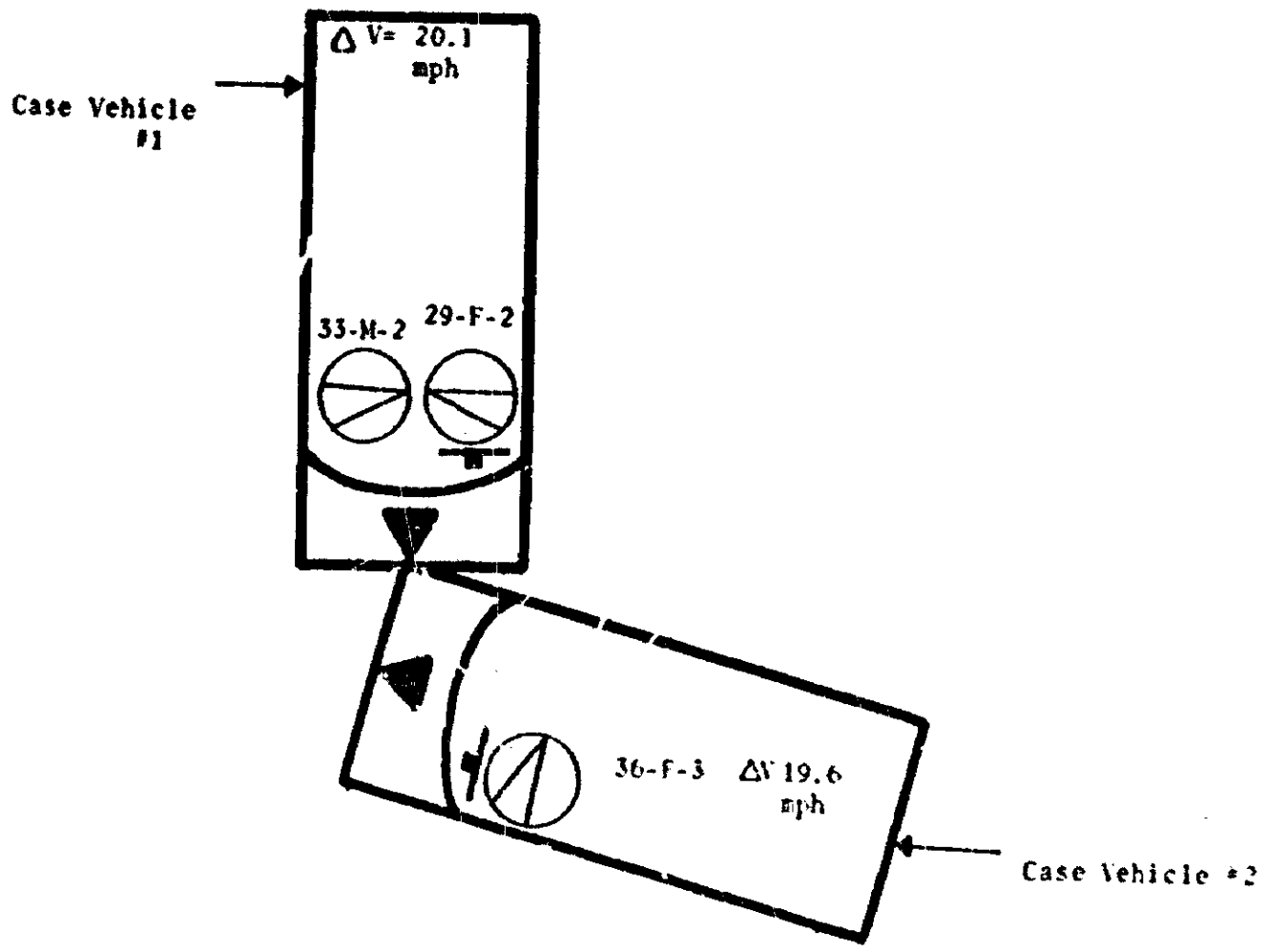
The driver's head went forward far enough to contact the sun visor and break the windshield, and his chest contacted and deformed the steering wheel. This suggests the possibility of excessive webbing slack in the system before the force loading of the webbing where it passed over the D-ring.

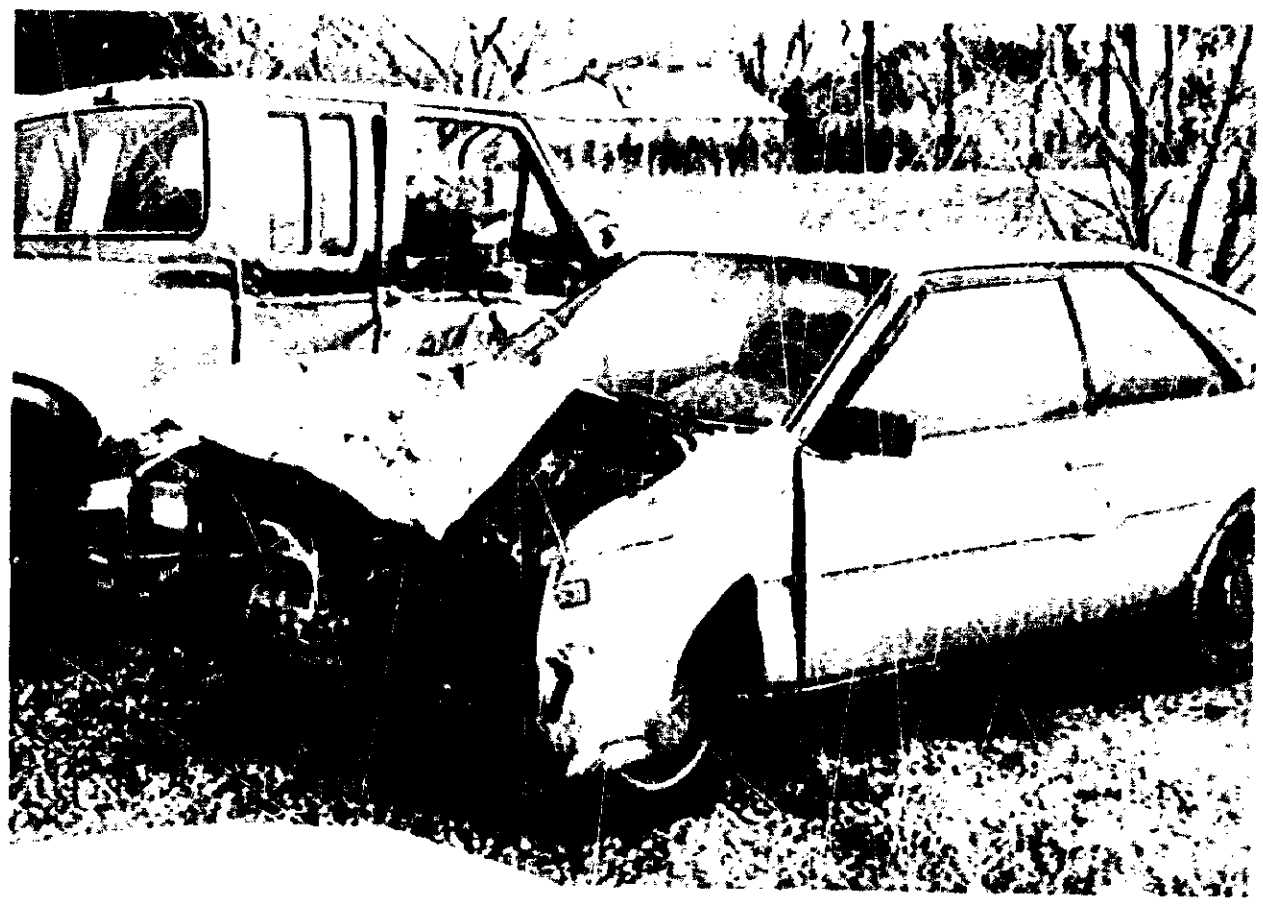
There are numerous explanations as to why this may have occurred, i.e., a weak spring in the retractor, improper routing of the webbing around the belt guide, excessive webbing in the lap portion causing snagging in the latchplate, bulky clothes (the occupant was wearing a heavy sweater), or a combination of these factors. There is insufficient evidence to suggest that any of these factors by itself was responsible for introducing excessive slack into the system. While it is apparent that excessive slack was in the lap/shoulder belt, it is uncertain as to how it occurred.

CASE 65 - (FTW 85-H-0R18)

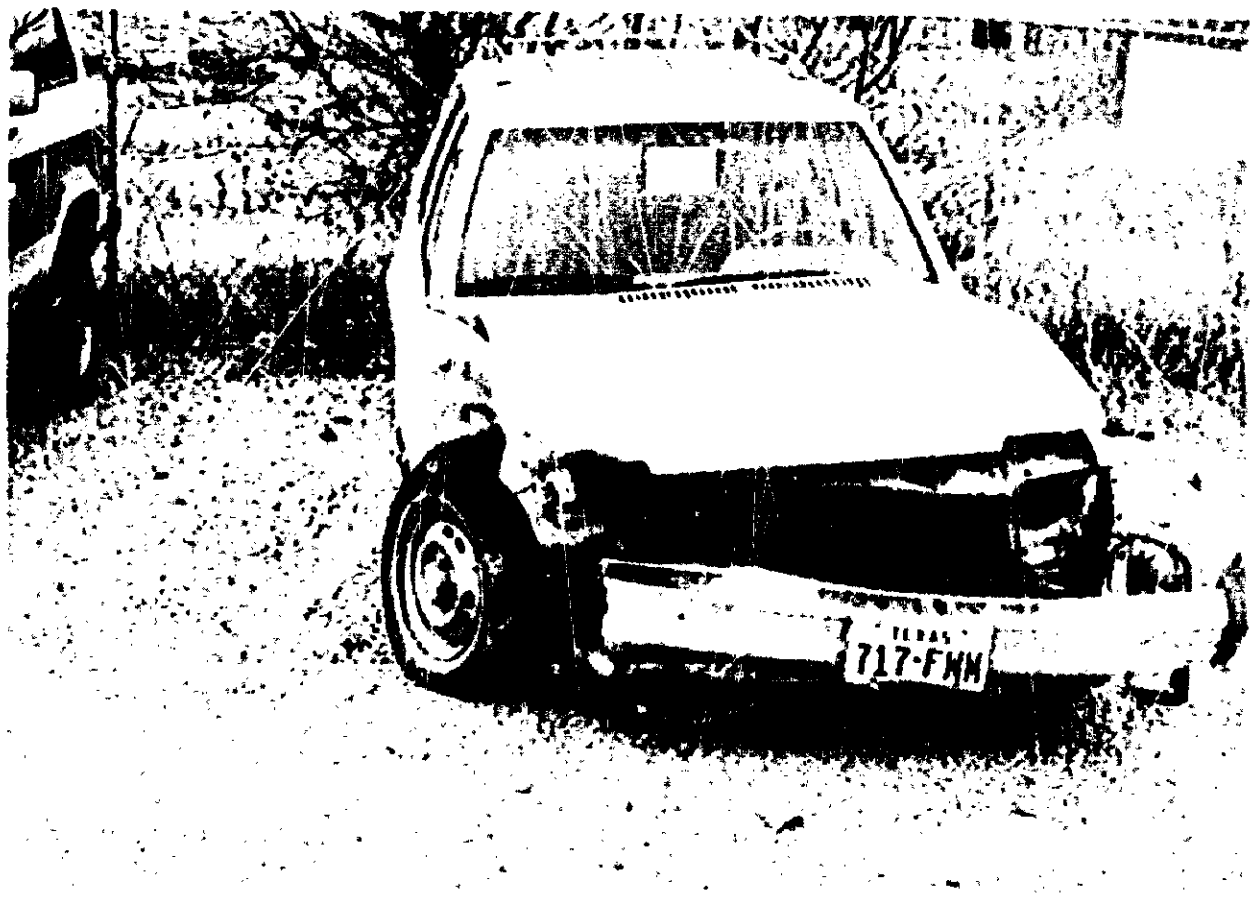
Case Vehicle #1: 1982 Nissan Sentra
Case Vehicle Weight: 2,355 pounds
Case Vehicle Delta V: 19.6 mph

Case Vehicle #2: 1984 Ford Escort Stationwagon
Case Vehicle Weight: 2,300 pounds
Case Vehicle Delta V: 20.1 mph





CASE VEHICLE #1



CASE VEHICLE #2

Circumstances

A 1984 Ford Escort Stationwagon and a 1982 Nissan Sentra were approaching each other from opposite directions when the Ford crossed the center line in a counterclockwise rotation and struck the Nissan directly in the front end. The Ford then rotated counterclockwise again, and impacted the rear of the Nissan in a minor secondary collision. The Nissan received major structural damage across the entire front, with inward collapse reaching depths of up to 23 inches. The damage to the Ford was to the right front side, resulting in a maximum crush depth of 21 inches over the area from the front right corner back toward the A-pillar.

The driver of the Nissan, restrained by a lap/shoulder belt, sustained moderate injuries. The passenger in the Nissan, also restrained by a lap/shoulder belt, but with the seatback reclined to a 45-degree angle, received moderate injuries. The lap/shoulder belted-driver of the Ford sustained serious injuries.

Restraint and Injury

Case Vehicle #1 - 1982 Nissan
Seating Location: Driver
Sex: F
Age: 29
Height: 5 feet 4 inches
Weight: 205 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver stated that the lap portion of the belt was positioned across her abdomen and was snug. She also stated she believed the shoulder portion would tighten upon impact, even though the shoulder portion should have been snug against her chest because of the lack of a tension-relieving device on he belt system. Force loading marks were found on the system webbing in the area of the B-pillar mounted D-ring and the free-sliding latchplate.

Injuries	AIS	Probable Source
Abrasion, neck	1	Necklace/shoulder portion of the belt
Major contusion, right chest	2	Steering wheel
Major contusion, abdomen	2	Lap portion of belt
Contusions, right knee	1	Lower instrument panel
Chipped teeth	1	Impact force

The driver was treated for her injuries as an out-patient and reported 4 days of lost work. Use of the available lap/shoulder belt probably prevented additional and more serious injuries in this 19.6 mph Delta V collision, as she most likely would have been thrown into the windshield and instrument panel without the belt.

Case Vehicle #1 - Nissan
Seating Location: Right Front
Sex: M
Age: 33
Height: 5 feet 10 1/2 inches
Weight: 230 pounds
Restraint Used: Lap/shoulder belt (ELR)

This passenger was wearing a continuous loop lap/shoulder belt equipped like the driver's except there was no latchplate locator on the webbing. The passenger described his seat back as being reclined 45 degrees and the of lap portion of the belt as being positioned "across his abdomen" with a snug fit. The shoulder portion would have been above his chest, due to reclined angle of the seat back. Force loading marks were found on the webbing in the areas of the free-sliding latchplate and the B-pillar mounted D-ring.

Injuries	AIS	Probable Source
Major contusions across chest	2	Shoulder portion of belt
Major contusion, abdomen	2	Lap portion of belt
Laceration, left lower chest	1	Pocket item, shoulder portion of belt
Contusion, left knee	1	Lower instrument panel

The passenger visited a hospital as an out-patient and reported 1 day loss of work. Considering the reclined angle of the seat back, this lap/shoulder belt performed remarkably well in this 19.6 mph Delta V collision. Had he not been using his lap/shoulder belt, he most likely would have received additional and more serious injuries. It's possible that the reclined seat contributed to his moderate contusions since the fit of the three-point belt used in conjunction with a reclined seat was far from ideal.

Case Vehicle #2 - 1984 Ford
Seat Location: Driver
Sex: F
Age: 36
Height: 5 feet 2 inches
Weight: 110 pounds
Restraint Used: Lap/shoulder belt (ELR)

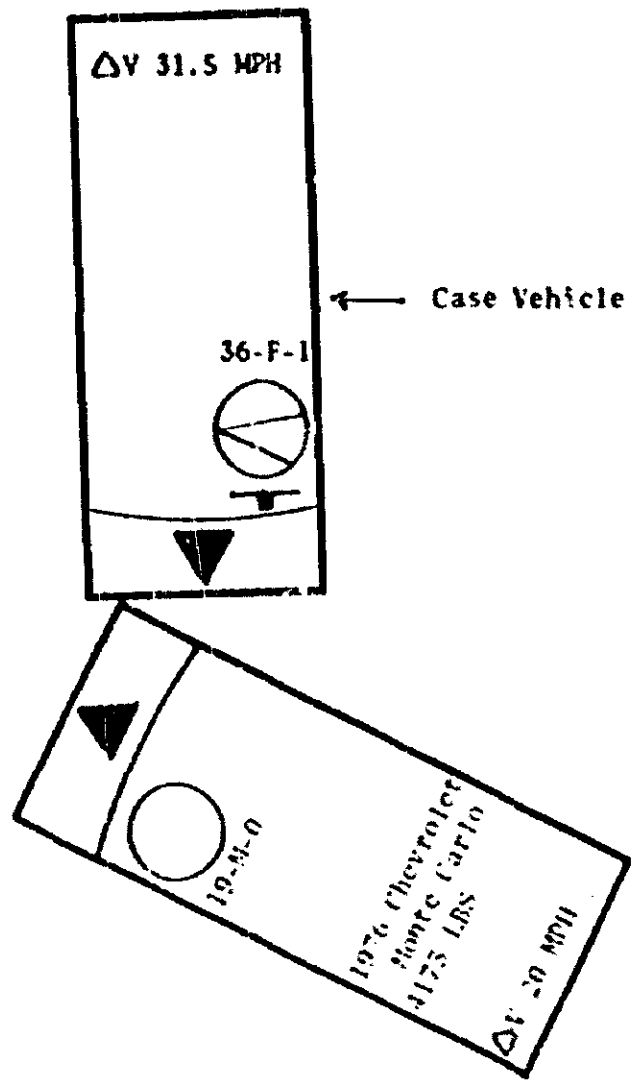
The driver of the Ford was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a locking latchplate, and a stalk-mounted buckle assembly. The driver stated that the lap portion of the belt was positioned across her abdomen and snug. The driver stated she crouched in a ball, leaning to the left before impact, thus introducing slack in the shoulder portion of the belt. Force loading marks were found upon the webbing in the area of the latchplate.

Injuries	AIS	Probable Source
Contusion, right kidney	3	Transmission selector lever
Contusion, abdomen	1	Lap portion of belt
Contusion, right knee	1	Lower instrument panel

The driver was admitted to an area hospital for 6 days and reported a work loss of about 1 month. She stated she did not understand the working of the windowshade device. Due to the direction of impact and subsequent rotation, the driver, who was crouched in a ball to the left, was thrown to the right, back first into the transmission selector lever which probably caused her kidney injury. Considering those dynamics, and resultant kinematics, it is probable that the restraint provided was benefical in this 20.1 mph Delta V collision even though the driver was out of proper position. An unrestrained driver would likely have been thrown forcefully into the right frontal interior, thus increasing the chances for additional serious injuires.

CASE 66 - (FTW 85-H-0R08)

Case Vehicle: 1980 Oldsmobile Omega 4-door
Case Vehicle Weight: 2,652 pounds
Case Vehicle Delta V: 31 mph



Circumstances

A 1980 Oldsmobile collided with a Chevrolet Monte Carlo which had turned left across its path. The Oldsmobile sustained substantial damage across a 60-inch wide area of the front with crush up to 26 inches. The Chevrolet sustained extensive damage to the left front.

The Oldsmobile driver, restrained by a lap/shoulder belt, sustained minor injuries. The unrestrained Chevrolet driver also sustained minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 36
Height: 5 feet 5 inches
Weight: 115 pounds
Restraint Used: Lap/shoulder belt (ELR)

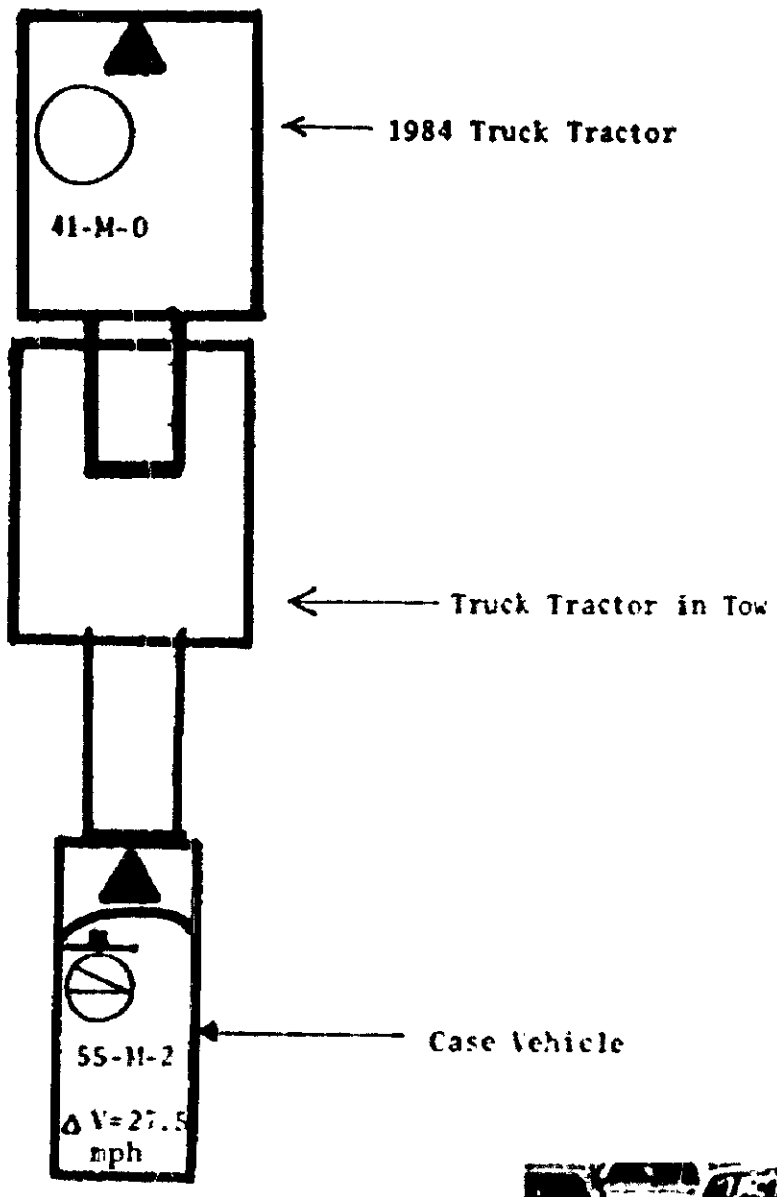
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver described the fit of the lap portion of the belt as snug, but did not remember the fit or the positioning of the shoulder portion. She did recall that the shoulder portion was worn over a sweater and ski jacket. An excessive amount of forward movement by the driver, coupled with evidence of webbing lockup (latchplate load marks on webbing and coupling marks on the tongue), indicated that extra slack had been introduced into the belt before the collision. The driver was unaware of the windowshade function.

Injuries	AIS	Probable Source
Contusion, right eye	1	Steering wheel
Laceration, bridge of nose	1	Steering wheel
Contusion, nose	1	Steering wheel
Contusion, right shoulder	1	Steering wheel
Strain, chest muscles	1	Impact forces
Contusion, right hip	1	Lap/shoulder belt
Lacerations, right wrist	1	Unknown
Contusion, right 5th finger	1	Unknown
Laceration, right thumb	1	Unknown

The driver was transported to a local hospital where she was treated and released. She was debilitated for approximately 5 days. The three-point system, although adjusted with some amount of slack in the shoulder portion, performed very well in this 32 mph Delta V collision. An unrestrained driver would certainly have made more violent contacts with the frontal interior components, thus increasing the chances for more serious injuries.

CASE 67 - (FTW 85-H-OR27)

Case Vehicle: 1984 Ford Tempo
Case Vehicle Weight: 2,630 pounds
Case Vehicle Delta V: 27.5 mph



Circumstances

When the driver of a 1984 Ford Tempo was distracted by roadway debris, the car rear-ended the back of a truck tractor being towed at low speed by another truck tractor. The front of the Ford received extensive damage, with crush up to 29 inches.

The Ford driver, restrained by a lap/shoulder belt, sustained a moderate injury.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 55
Height: 5 feet 8 inches
Weight: 170 pounds
Restraint Used: Lap/shoulder belt (ELR)

The driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, a stalk-mounted buckle assembly, a stalk-mounted D-ring that swivels, and a belt guide clip mounted on the B-pillar.

On the advice of an article read in a consumer magazine concerning the restraint system in the 1984 Tempo, the driver had removed the restraint webbing from the B-pillar mounted guide clip. The Safety Board investigator had the driver demonstrate how he wore the belt, and approximately 2 inches of slack was present in the lap portion. This determination was possible because the latchplate loading mark showed the original position of the cinching latchplate. The driver also illustrated how he had introduced several inches of extra slack into the shoulder belt by using the windowshade mechanism.

Injuries	AIS	Probable Source
Large contusion on forehead	2	Steering wheel rim
Abrasion on right forehead	1	Steering wheel rim
Contusions on left hip	1	Lap portion of belt webbing
Minor contusion to right knee	1	lower instrument panel

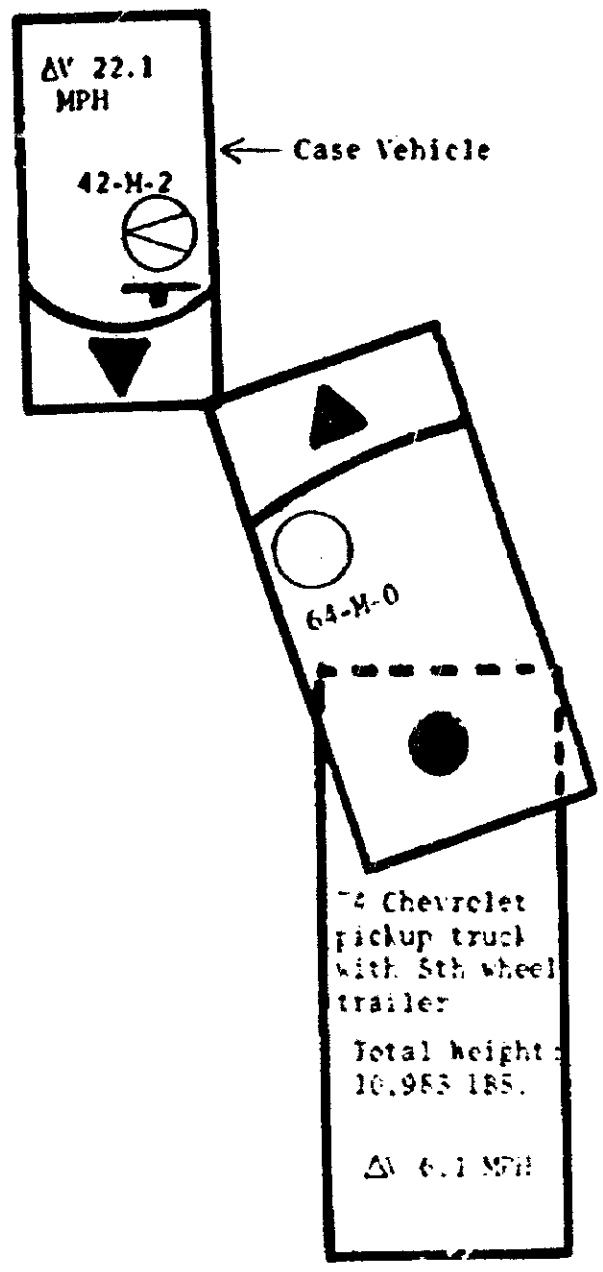
The driver, who reported loss of 1 day of work, was treated and released at a nearby hospital. Since there is no evidence to suggest retractor skipping or spoolout, it is apparent that excessive slack was present in the belt/system, especially since during the crash the driver went forward 15 to 17 inches and struck the steering wheel rim with sufficient force to bend it 2 inches. The

amount of slack present in the three-point system can be partially attributed to the slack deliberately introduced by the driver in both the lap and shoulder portions of the belt; however, the swiveling stalk on which the D-ring is mounted was also capable of introducing a lesser amount of slack. It should be noted that Ford eliminated the stalk-mounted D-ring in the 1985 models, mounting it instead on the b pillar.

Although there was excessive slack in the webbing system, with a 27.5 mph Delta V, it is probable that the driver would have sustained much more serious injuries had he been unrestrained.

CASE 68 - (SEA 85-H-OR04)

Case Vehicle: 1983 Ford Ranger Pick-up
Case Vehicle Weight: 3,035 pounds
Case Vehicle Delta V: 22 mph



Circumstances

A 1983 Ford Ranger pick-up collided left front to left front with a 1974 Chevrolet pick-up which was towing a fifth wheel stock trailer. Damage to the Ford was substantial with inward collapse up to 17.75 inches at the left front. The much heavier Chevrolet received moderate crush at the left front.

The Ford driver, restrained by a lap/shoulder belt, sustained minor injuries and a concussion of unknown severity.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 42
Height: 5 feet 11 inches
Weight: 185 pounds
Restraint Used: Lap/shoulder belt (ELR)

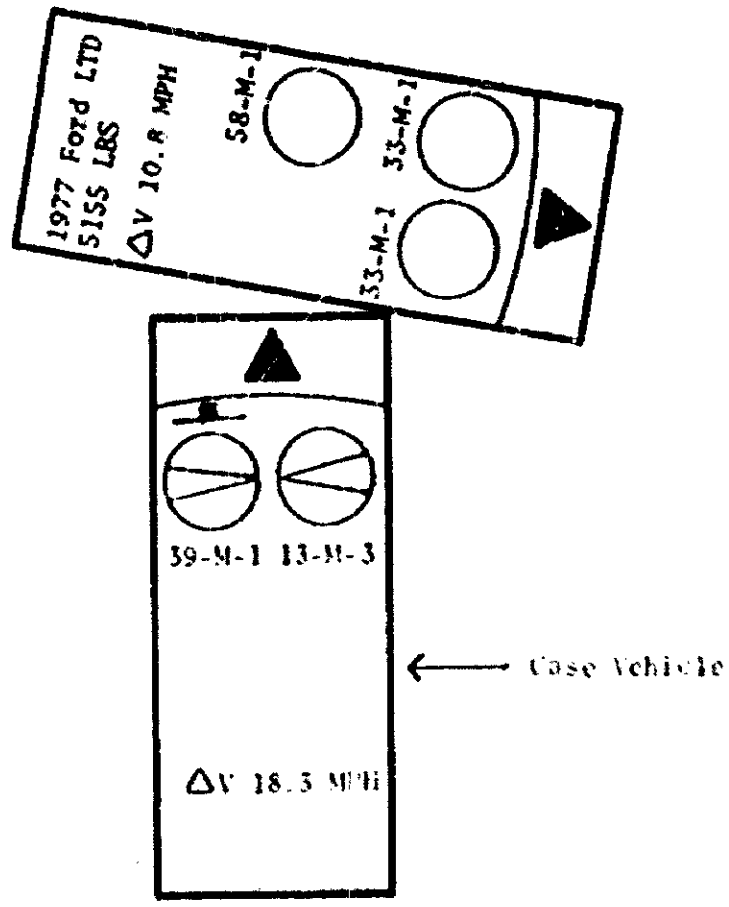
This driver was wearing a continuous loop, lap/shoulder belt equipped with a vehicle-sensitive emergency locking retractor, a free-sliding latchplate, and a stalk-mounted buckle assembly. The shoulder portion was reportedly positioned properly across the midchest and the lap belt was across the driver's abdomen. He reported that the system maintained tension.

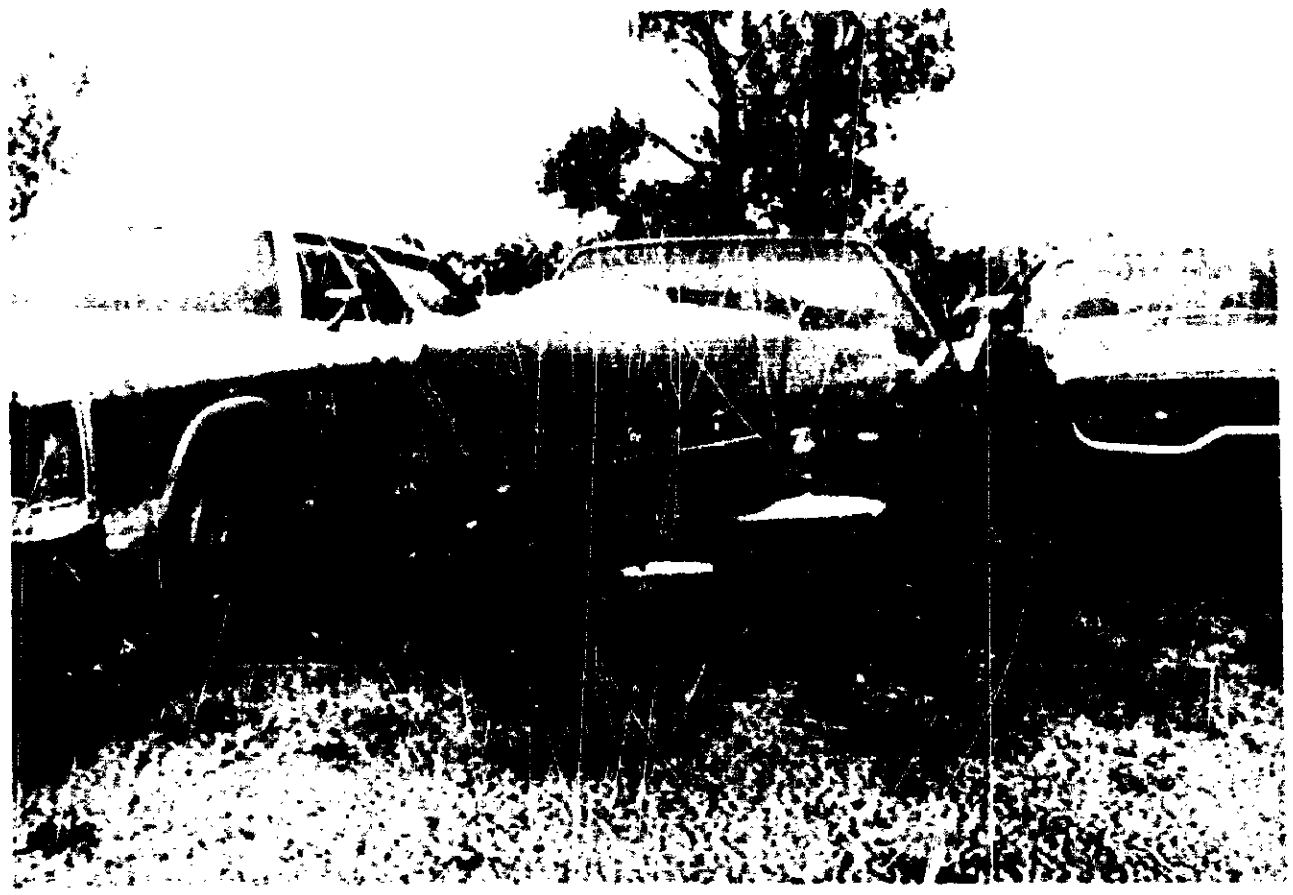
Injuries	AIS	Probable Source
Contusion, left cheek	1	Windshield and left A-pillar
Concussion, unknown severity	7	Windshield and left A-pillar
Contusion, right upper arm	1	Steering wheel rim
Contusion, left knee	1	Lower instrument panel and door
Contusion, left shoulder	1	Shoulder portion of belt
Contusion, left elbow	1	Left door
Abrasion, left lower leg	1	Surface of left interior of vehicle

The driver was transported to a local hospital where he was treated and released. He lost 1 day of work. The driver felt he had received inadequate crash protection from the shoulder portion. He also reported that he looked back, over his right shoulder immediately before the collision. This maneuver may have introduced slack into the system which would have explained his comment that "belts do not stop you quick enough." There was no evidence of system failure. If the driver had not been wearing his lap/shoulder belt, he probably would have received a more serious level of injuries in this 22 mph Delta V collision.

CASE 69 - (CHI 85-H-0R05)

Case Vehicle: 1984 Chevrolet Celebrity
Case Vehicle Weight: 3,045 pounds
Case Vehicle Delta V: 18.3 mph





Circumstances

A 1984 Chevrolet Celebrity and a 1977 Ford LTD were approaching an intersection from opposite directions when the Ford turned left in front of the Chevrolet and was struck on the right side. The Chevrolet received substantial structural damage with deformation up to 16.5 inches over the 59.5-inch area of the front. Both doors on the right side of the Ford were deformed inward, up to 9.5 inches.

The Chevrolet driver, restrained by a lap/shoulder belt, received minor injuries. The right front passenger in the Chevrolet, also restrained by a lap/shoulder belt, sustained a minor injury. All three unrestrained occupants of the Ford received minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 39
Height: 6 feet 4 inches
Weight: 200 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a locking latchplate, and a stalk-mounted buckle assembly. The driver stated that the lap portion of the belt was positioned low across his hips and snug. The shoulder portion of the belt was reportedly adjusted so that the palm of a hand could be placed between the webbing and his chest. Force loading marks were found on the belt webbing in the areas of the latchplate and the B-pillar mounted D-ring.

Injuries	AIS	Probable Source
Abrasion, lower right leg	1	Brake pedal
Cervical spine strain	1	Impact force

The driver visited a hospital as an out-patient, and reported no loss of work. Use of the lap/shoulder belt most likely prevented additional and more serious injuries in this 18.3 mph Delta V collision. An unrestrained driver would have been free to make forceful contacts with the instrument panel, steering assembly, and possibly the windshield.

Seating Location: Right Front
Sex: M
Age: 13
Height: 5 feet 6 inches
Weight: 70 pounds
Restraint Used: Lap/shoulder belt (ELR)

This passenger was wearing a continuous loop lap/shoulder belt identical in design to that worn by the driver. The passenger described the lap portion adjustment as being positioned low across his hips and snug. The shoulder portion of the restraint was reportedly adjusted so that the palm of a hand could be placed between the webbing and the passenger's chest. Force loading marks were discovered on the belt webbing in the areas of the latchplate and the B-pillar mounted D-ring.

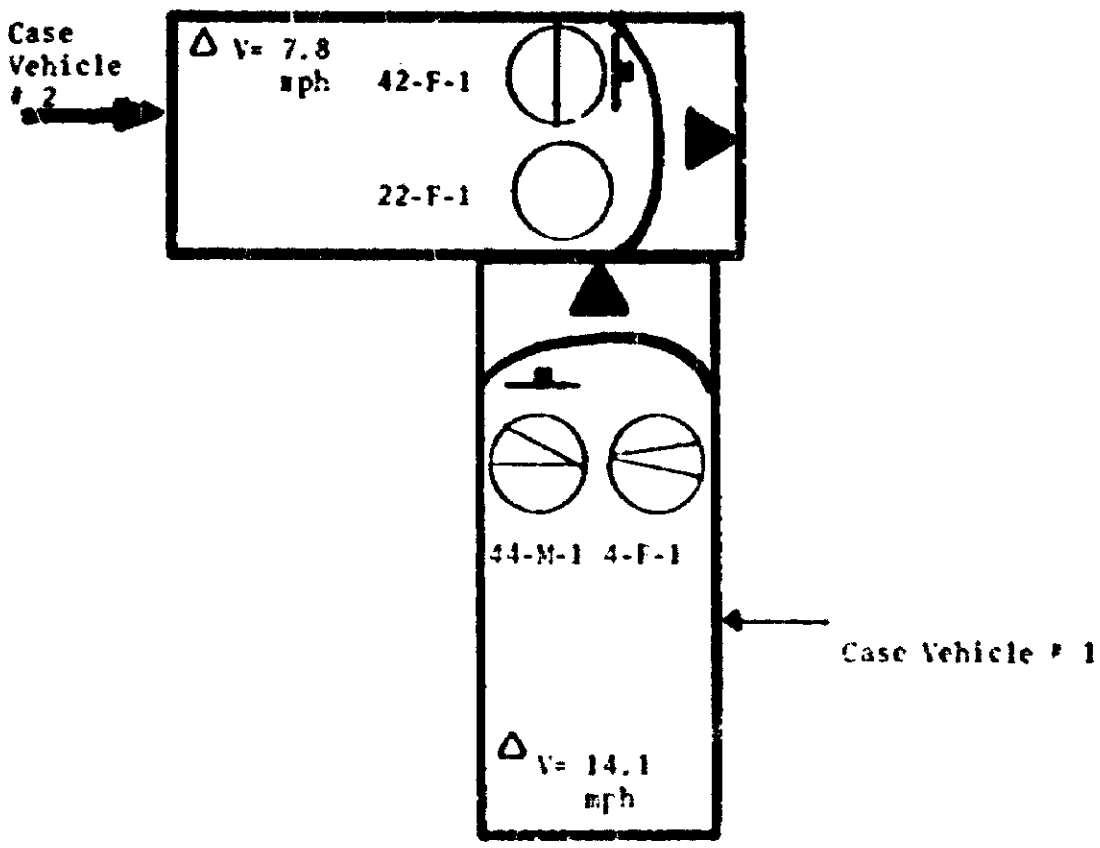
Injuries	AIS	Probable Source
Abrasion, right chest	1	Shoulder portion of belt

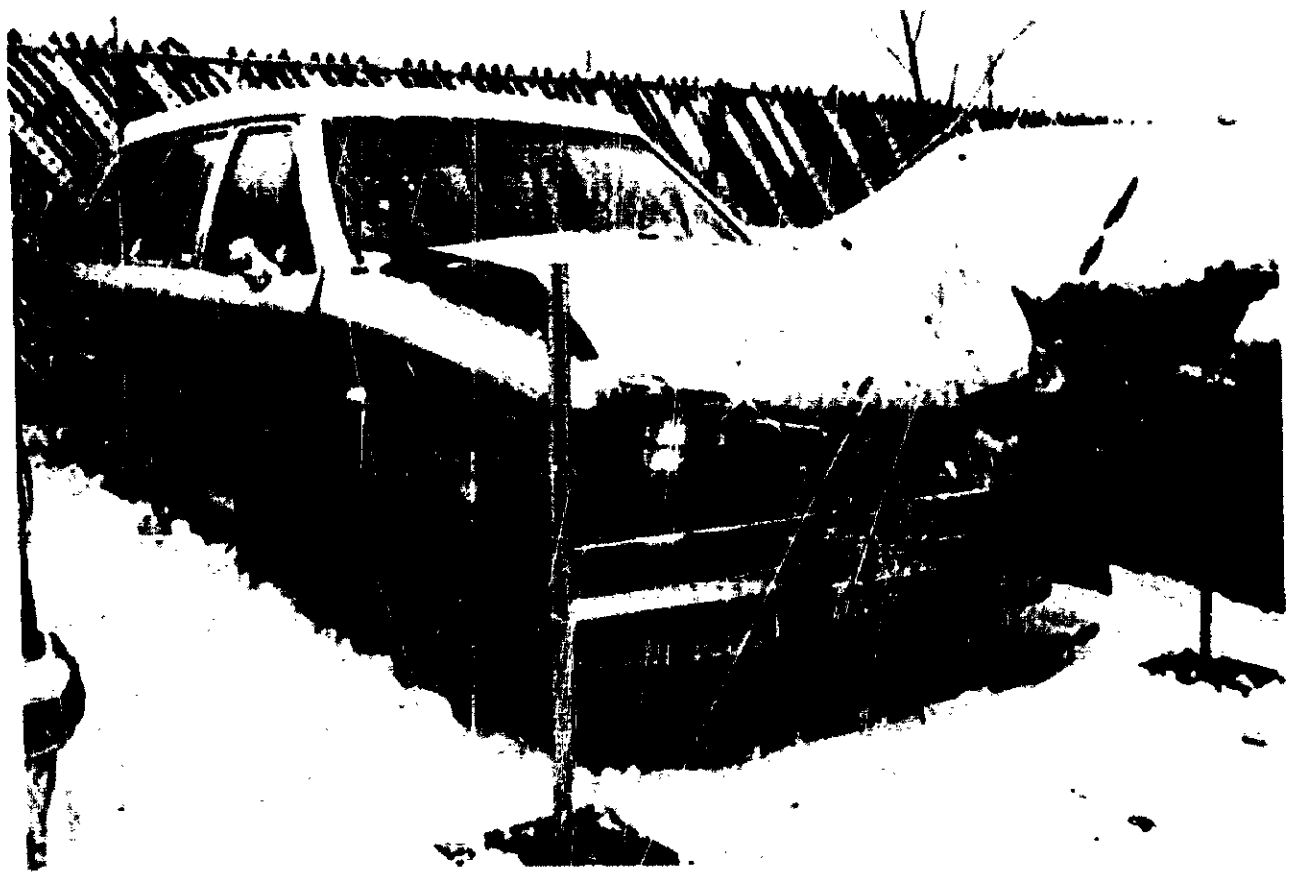
The passenger was examined at an area hospital as an out-patient, and reported that he stayed home from school for 1 day. Considering the crash forces present in this 18.3 mph Delta V collision, it is likely that this occupant's use of the available lap/shoulder belt prevented additional and more serious injuries.

CASE 71 - (CHI 85-H-OR08)

Case Vehicle #1: 1983 Ford Escort station wagon
Case Vehicle Weight: 2,397 pounds
Case Vehicle, Delta V: 14.1 mph

Case Vehicle #2: 1975 Chevrolet Chevelle, 4-door
Case Vehicle Weight: 4,298 pounds
Case Vehicle, Delta V: 7.8 mph





Circumstances

A 1983 Ford Escort station wagon struck the right front side of a 1975 Chevrolet which was crossing the roadway. The Escort's maximum crush across the front measured 7-1/2 inches. The maximum deformation on the Chevrolet was 6-1/4 inches.

The lap/shoulder belt restrained Escort driver and the right front passenger, a child restrained by a booster seat secured by a lap/shoulder belt, received minor injuries. The lap belted-Chevrolet driver received minor injuries, while the unrestrained passenger in the right front seat received moderate injuries.

Restraint and Injury

Case Vehicle #1 - 1983 Ford
Seating Location: Driver
Sex: M
Age: 44
Height: 5 foot 10 inches
Weight: 200 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The lap/shoulder belt was worn over a heavy down parka coat. The driver reported that lap portion of the belt was positioned low on his hips and snug, and that the shoulder portion had enough slack to allow a clenched fist to fit between his chest and the belt. Force loading marks were found on the belt webbing of the driver's belt.

Injuries	AIS	Probable Source
Acute cervical neck strain	1	Impact force

This driver was examined at a local hospital and released. There was no loss from work. Lap/shoulder belt use probably prevented additional injuries as an unrestrained driver would have been free to make contacts with the frontal interior in this 14.1 mph Delta V collision.

Case Vehicle #1 - 1983 Ford
Seating Location: Right Front
Sex: F
Age: 4
Height: 3 foot 9 inches
Weight: 45 pounds
Restraint Used: Booster seat with Lap/shoulder belt (ELR)

This child was in a booster seat restrained by a lap/shoulder belt identical in design to the driver's. The driver (father) stated that he placed the lap portion under the arms of the booster seat, snug across his daughter's waist. The shoulder portion was worn across her chest. Force loading marks were found on the belt webbing of the lap/shoulder belt.

Injuries	AIS	Probable Source
Laceration/abrasion	1	Shoulder portion of belt

The child was examined at a local hospital and released. The combination of the booster seat and lap/shoulder belt system prevented this occupant from uncontrolled movement within the interior and probably prevented additional and more serious injuries. An unrestrained child would have been thrown forward into the frontal interior in this 14.1 mph Delta V collision.

Case Vehicle #2 - 1975 Chevrolet
Seating Location: Driver
Sex: F
Age: 42
Height: 5 foot 3 inches
Weight: 200 pounds
Restraint Used: Lap belt (ALR) (originally a lap/shoulder belt but modified by owner)

This driver was wearing a modified lap belt with an automatic locking retractor, and a stalk-mounted buckle assembly. Originally, this belt had been a lap/shoulder belt with dual retractors but the belt had been modified by removing (cutting) the shoulder portion. The driver reported the lap belt was positioned low on her hips and snug across her thighs over a heavily quilted winter coat. No loading marks were found on the lap belt webbing. Steering wheel contact was not a factor in this accident due to the 90^{0} impact into the right side of the vehicle.

Injuries	AIS	Probable Source
Laceration to back of head	1	Headrest or B pillar
Acute cervical strain	1	Impact forces

This driver was examined at a local hospital and released. She reported loss of work for 2 days. The impact force caused lateral movement to the right, and a later rebound which resulted in the driver's head contacting the B-pillar or side door. Given the relatively low Delta V of 7.8 mph, it is probable that an unrestrained occupant would have received a similar injury severity level, and that restraint use was of minimal benefit for this driver.

Case Vehicle #2 - 1975 Chevrolet
Seating Location: Right front
Sex: F
Age: 22
Height: 5 foot 6 inches
Weight: 129
Lap/shoulder belt Used: None

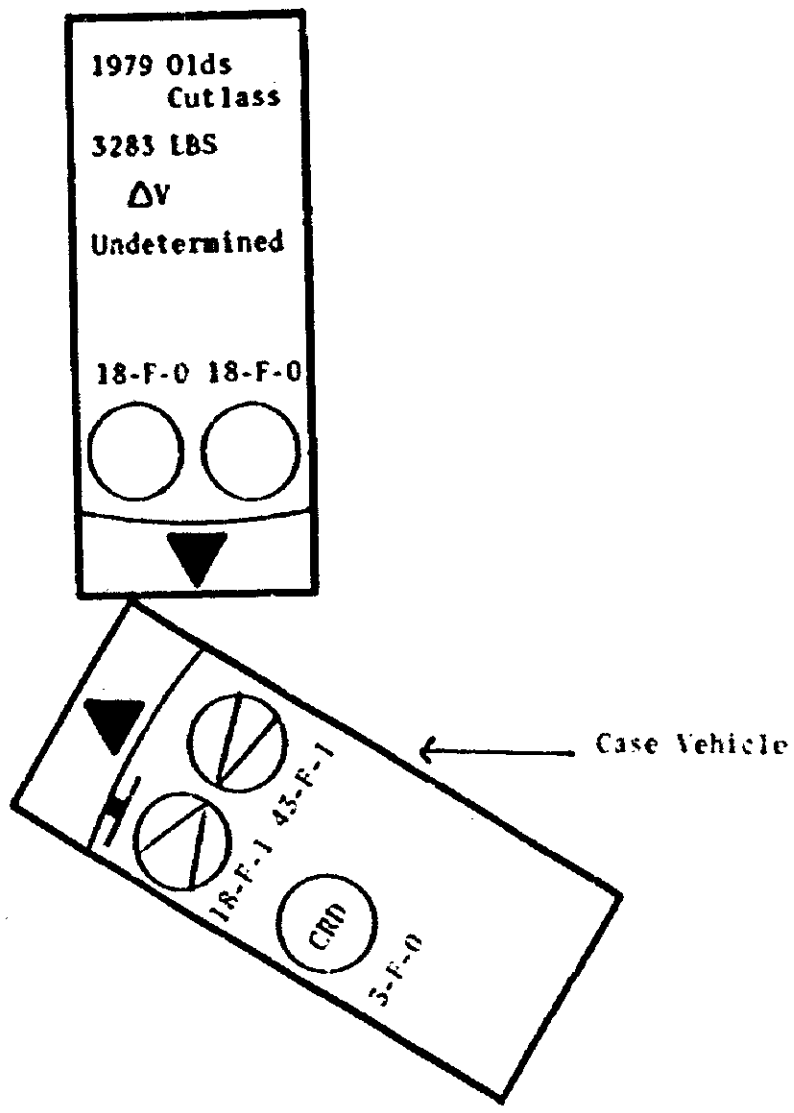
This occupant was not wearing the lap belt available at her position. She reported that she turned toward the oncoming Ford and watched the collision take place.

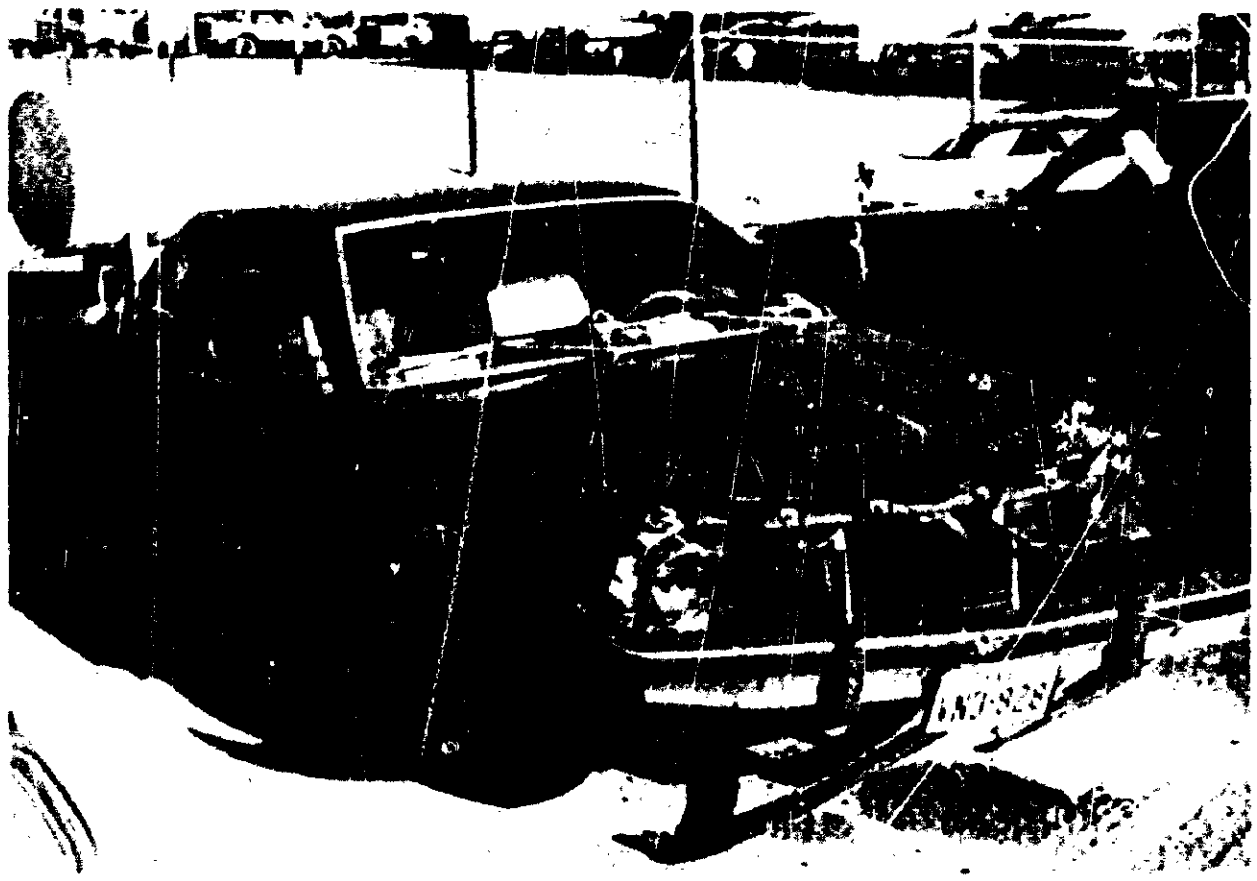
Injuries	AIS	Probable Source
Contusion back of head	1	Unknown
Contusion on forehead	1	Right door window glass
Undefined head injury	2	Interior side wall

This occupant did not receive medical attention until 2 days after the accident and then learned that she had sustained a mild concussion. Due to the direction and location of the impact, it is doubtful that use of a three-point or two-point restraint would have lessened this passenger's injuries. Restraints can not prevent contact with an adjacent interior sidewall.

CASE 72 - (FTW 85-H-0R26)

Case Vehicle: 1980 Chevrolet Monza
Case Vehicle Weight: 3,209 pounds
Case Vehicle Delta V: Undetermined (not compatible with Crash-III)





Circumstances

A 1980 Chevrolet Monza made a left turn across the path of a 1979 Oldsmobile Cutlass and was struck in the right front by the Oldsmobile. The Chevrolet received moderate front/right front damage with a deformation of up to 12 inches. Damage information on the Oldsmobile was not available and the investigation did not determine Delta V.

The Chevrolet driver and right front passenger, both restrained by lap/shoulder belts, sustained minor injuries. The left rear occupant, seated in a child safety seat ssecured by a lap/shoulder belt, was uninjured.

Case Vehicle
Seating Location: Driver
Sex: F
Age: 18
Height: 5 feet 2 inches
Weight: 118 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver stated that adjustment of the lap portion of the belt was snug and low on the hips, and that the shoulder portion fit "loosely" across her chest. Force load marks were identified from the latchplate.

Injuries	AIS	Probable Source
Contusion, right inner knee	1	Steering column
Contusion, right knee	1	Lower instrument panel

The driver declined medical treatment.

Seating Location: Right front
Sex: F
Age: 43
Height: 5 feet 4 inches
Weight: 125 pounds
Restraint Used: Lap/shoulder belt (ELR)

This passenger was wearing a lap/shoulder belt identical in design to the one used by the driver. The driver reported that the shoulder portion of this passenger's belt was snug but could not recall the lap portion adjustment. Latchplate load marks were present on the webbing.

Injuries	AIS	Probable Source
Contusion, right hip	1	Arm rest

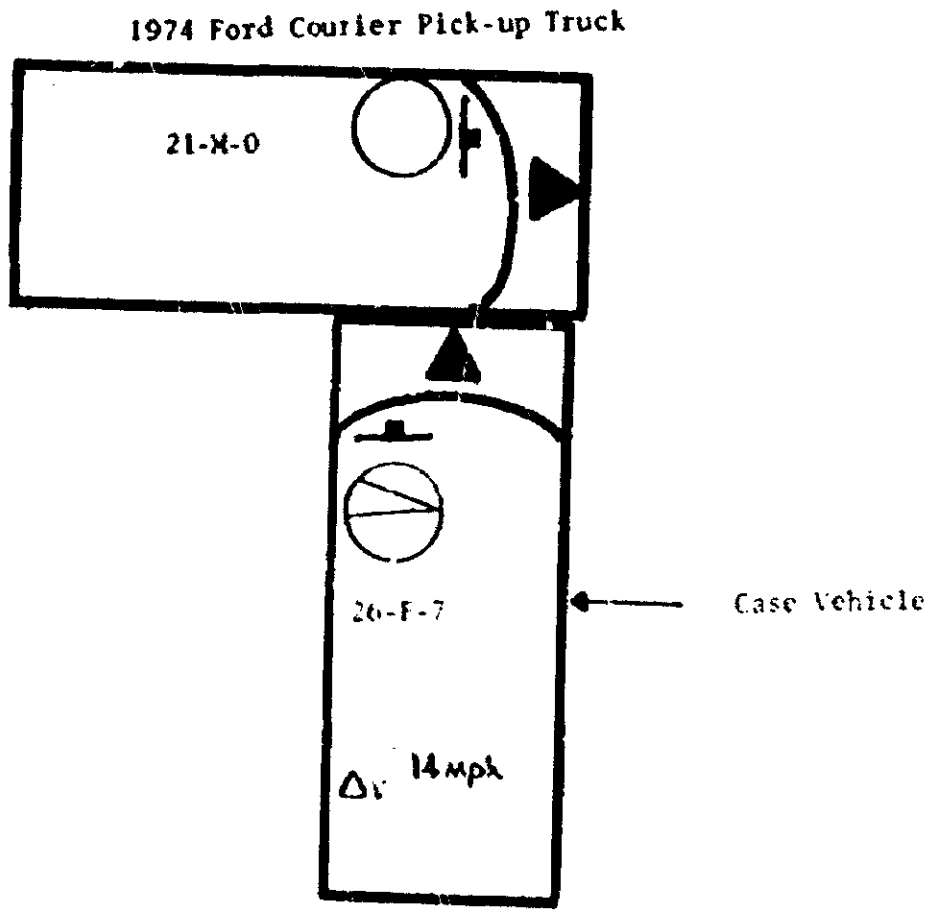
The passenger declined medical treatment initially, but later sought medical assistance for aggravation of a pre-existing condition to the right hip.

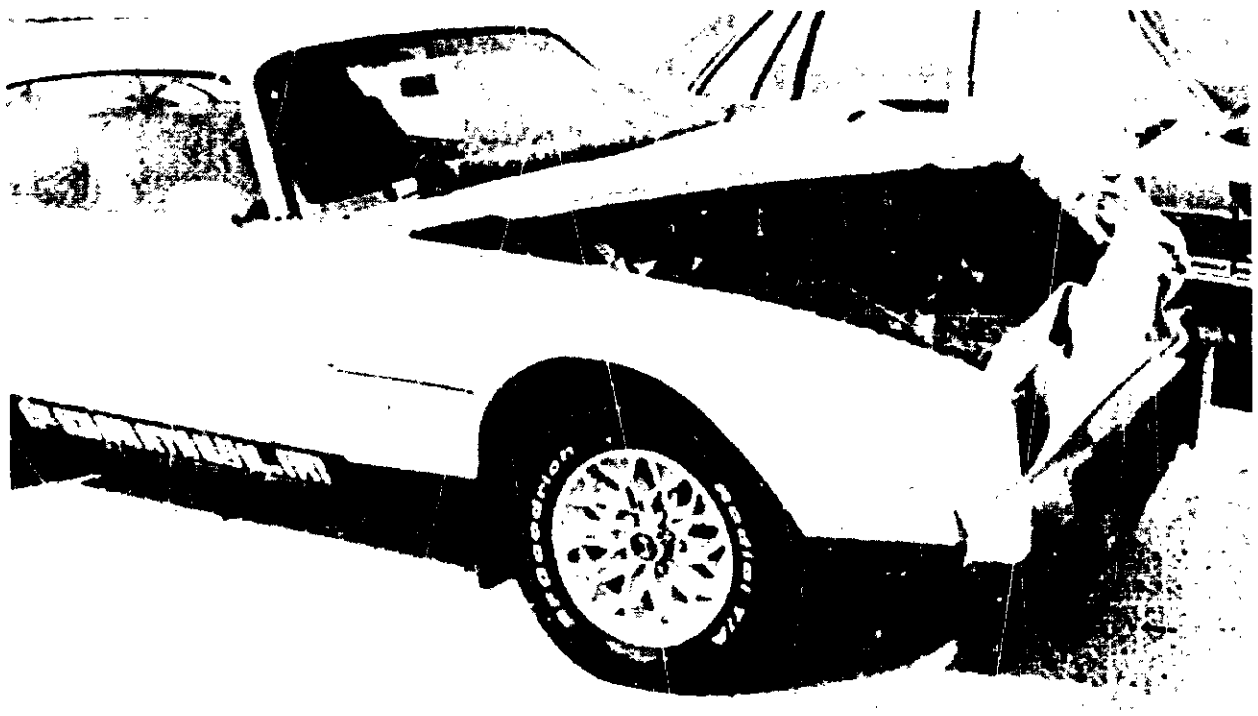
Case Vehicle
Seating Location: Left rear
Sex: F
Age: 3
Height: Unknown
Weight: Unknown
Restraint Used: Child safety seat secured by lap/shoulder belt (ELR)

This child, reportedly restrained in a child safety seat, was not injured.

CASE 73 - (FTW 85-H-OR25)

Case Vehicle: 1979 Pontiac Firebird
Case Vehicle Weight: 3,600 pounds
Case Vehicle Delta V: 14 mph





Circumstances

A 1974 Ford Pickup Courier was attempting a left turn when it was struck in the right front by a 1979 Pontiac Firebird. The front of the Pontiac received substantial damage, with a rearward collapse of up to 18 inches.

The driver of the Pontiac, wearing a lap/shoulder belt, sustained injuries including a possible fractured sternum. Injury outcome for the driver of the Ford pick-up was unknown as he refused to cooperate with the investigation.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 26
Height: 5 feet 4 inches
Weight: 115 pounds
Restraint Used: Lap/shoulder belt (ELR)

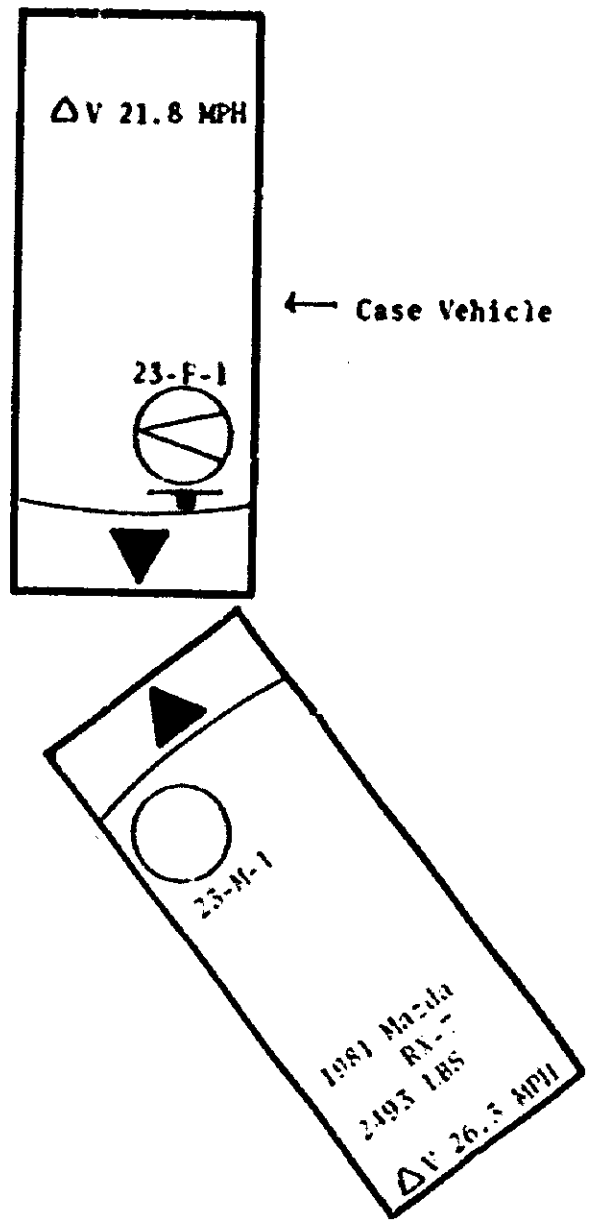
This driver was wearing a continuous loop lap/shoulder belt equipped with a ceiling mounted emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief mechanism, a cinching latchplate, and a stalk-mounted buckle assembly. The driver described the precrash adjustment of the shoulder strap as being in the "tightest possible position." The lap portion of the belt was reportedly snug, positioned low across her hips. The top of the steering wheel was bent forward 1/2 inch.

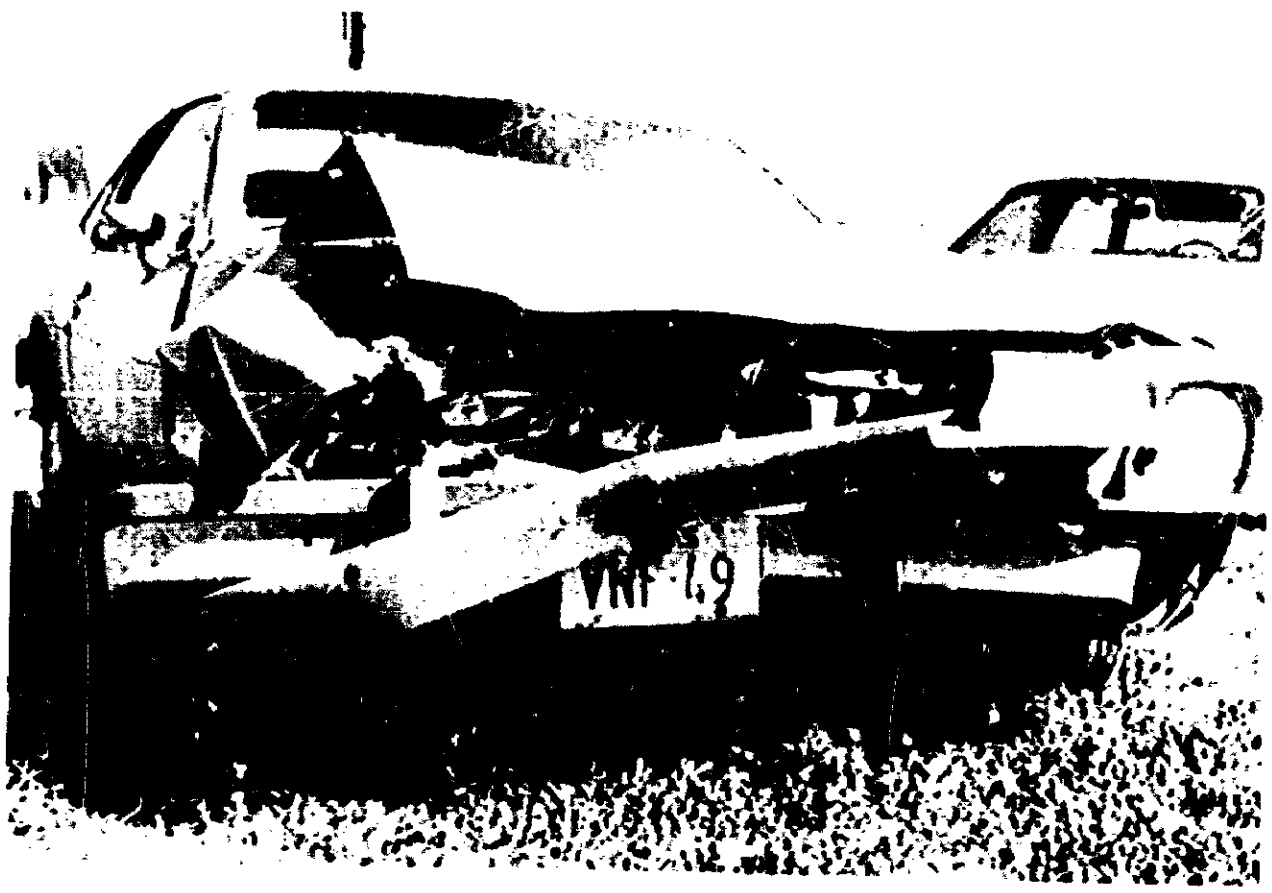
Injuries	AIS	Probable Source
Fractured sternum (possible, x-rays indeterminate)	7	Shoulder portion of belt and/or steering wheel assembly
Possible neck injury	9	Impact forces
Possible back injury	9	Impact forces

The driver was treated and released at a local hospital. (Note: the radiologist suspected a fractured sternum after viewing the x-rays, but was not certain). Because of a pre-existing medical condition, the driver may have been more susceptible than usual to a bone injury. Considering the estimated 14 mph Delta V for the Pontiac, it is probable that the driver's use of the restraint prevented additional injuries from contact with the frontal interior.

CASE 74 - (FTW 85-11-OR21)

Case Vehicle: 1980 Chevrolet Monza 2-door
Case Vehicle Weight: 3,017 pounds
Case Vehicle Delta V: 21 mph





Circumstances

A 1980 Chevrolet Monza and a 1981 Mazda RX-7 were approaching each other from opposite directions when the Mazda turned left and was struck in the right front corner by the front of the Chevrolet. The Chevrolet received substantial structural damage with crush up to 20 inches over the 62-inch wide front end. The Mazda sustained deformation of over 20 inches at its right front, with damage extending across the entire frontal structure.

The 5-1/2 month pregnant Chevrolet driver, restrained by a lap/shoulder belt, received minor injuries; no injuries to the fetus were reported. The unrestrained Mazda driver also sustained minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 23
Height: 5 feet 8 inches
Weight: 215 pounds
Restraint Used: Lap/shoulder belt (ELR)

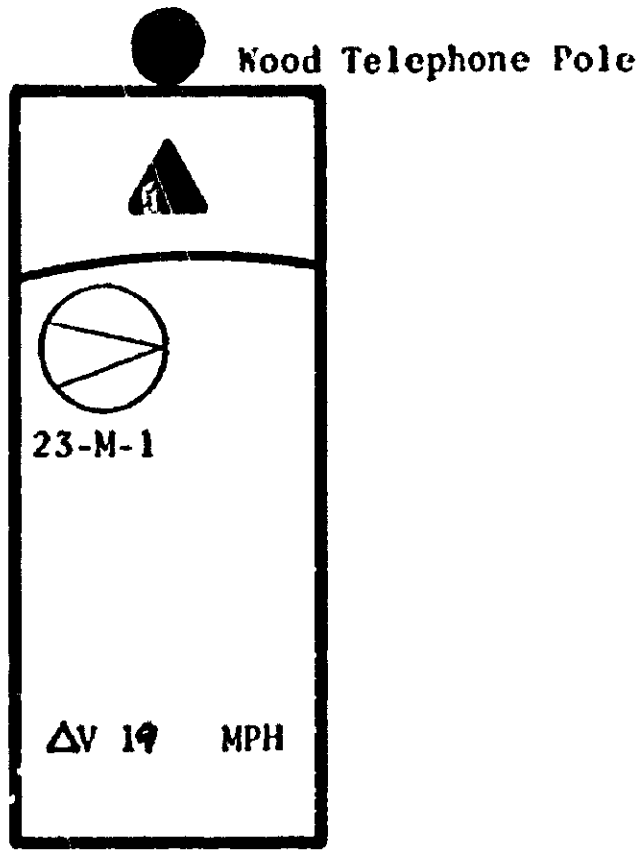
This driver was wearing a continuous loop lap/shoulder belt equipped with a roof-mounted emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a locking latchplate, and a stalk-mounted buckle assembly. The driver described the precrash adjustment of the lap portion of the belt being low on her hips and snug. The shoulder portion was reportedly adjusted so that the palm of a hand could be placed between the webbing and the driver's chest. Force loading marks were found on the webbing in the area of the latchplate.

Injuries	AIS	Probable Source
Contusion, lower left arm	1	Steering wheel
Strained abdominal muscles	1	Unknown

The driver was treated for her injuries as an out-patient and reported no loss of time from work. Due to the proper positioning of the lap/shoulder belt, there appeared to be no injuries to the 5-1/2 month old fetus. This lap/shoulder belt position and the fairly tight shoulder restraint performed as designed and most likely prevented more serious injuries in this 21.8 mph Delta V collision. The driver subsequently carrier the child full term and delivered a healthy infant. Had the driver not been restrained, it is likely that serious consequences would have resulted from violent contact with the steering assembly, both for the driver and the fetus; the fetal injuries could very well have proved fatal.

CASE 75 - (ATL 85-H-OR08)

Case Vehicle: 1981 Toyota Starlet 2-door
Case Vehicle Weight: 1,949 pounds
Case Vehicle Delta V: 19 mph



Circumstances

A 1981 Toyota Starlet failed to follow a curve in the roadway, veered off the right road edge, and impacted a wooden utility pole. The Toyota received structural damage across 33 inches of the front to a maximum depth of 16 inches.

The Toyota driver, restrained by a lap/shoulder belt, sustained moderate injury.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 23
Height: 6 feet 3 inches
Weight: 225 pounds
Restraint used: Lap/shoulder belt (ELR)

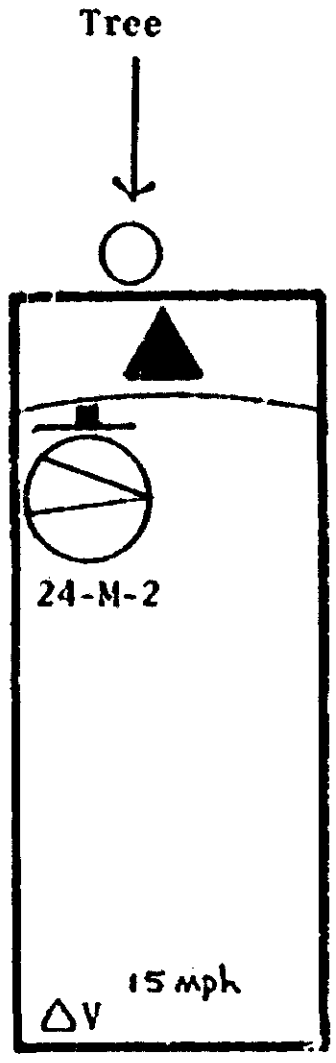
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to webbing acceleration, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver described precrash lap portion of the belt position as being low on his hips. Both the lap and shoulder portions were reportedly "snug." Force loading marks were found on the system webbing from both the D-ring and the free-sliding latchplate.

Injuries	AIS	Probable Source
Contusion, left forehead	1	Window frame
2-inch laceration, left eyebrow	2	Windshield frame
Contusion, left nose	1	A-Pillar
Contusion, upper arm	1	A-Pillar
Contusion, left shoulder	1	Shoulder portion of belt
Contusion, lower chest	1	Shoulder portion of belt
Contusion, lower abdomen	1	Lap portion of belt
Small avulsion, left knee	1	Lower dash
Contusion, left knee cap	1	Lower dash
Contusion, right knee	1	Lower dash
Laceration, left palm	1	Unknown
Laceration, right palm	1	Unknown

The driver was transported to a local hospital where he was treated and released. He reported missing 3 days of school. Even though the driver wore the lap/shoulder belt "snug," his size (6ft. 3 inches, 225 pounds) combined with the small interior of the subcompact, meant he was able to contact the windshield frame. Use of the lap/shoulder belt, however, may have reduced some forward movement in the 19 mph Delta V frontal collision, and thus eliminated some injuries. The force marks found on the webbing indicated significant loading of the belt webbing during the occupant dynamics.

CASE 76 - (ATL 85-H-OR09)

Case Vehicle: 1974 Ford Pinto station wagon
Case Vehicle Weight: 2,847 pounds
Case Vehicle Delta V: 15 mph



Circumstances

A 1974 Ford Pinto station wagon was negotiating a left curve when the driver lost control on ice, went down an embankment, and hit a tree. The Ford received substantial structural damage to the front of the vehicle with a maximum crush of 14.5 inches.

The driver of the Ford, restrained by a misrouted lap/shoulder belt (shoulder portion under his left arm) received minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 24
Height: 5 foot 8 inch
Weight: 200 pounds
Restraint used: Lap/shoulder belt with dual retractors (ELR/ALR)

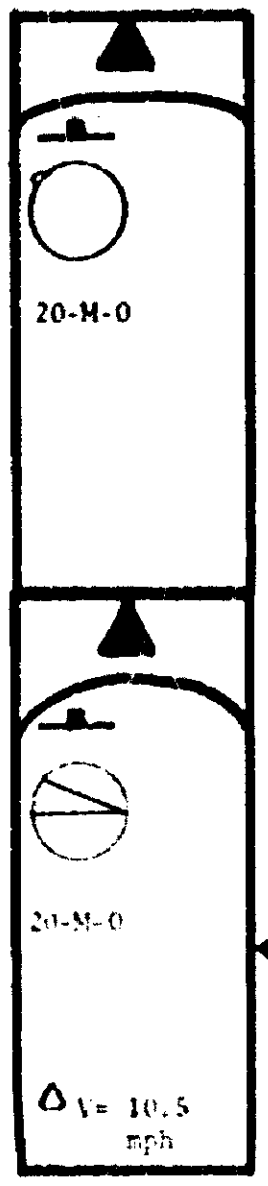
The driver was wearing a lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion on the shoulder portion, an automatic locking retractor on the lap portion, a windowshade tension-relief device on the shoulder portion retractor, a sewn-in latchplate, and a stalk-mounted buckle assembly. The shoulder portion was routed under the left arm, because the webbing "cut into the driver's neck" when routed properly. The driver described the lap portion adjustment as being positioned low on his hips and snug.

Injuries	AIS	Probable Source
Skin avulsion, right nostril	1	Steering wheel
Fracture, nose	1	Steering wheel
Contusion, right lower leg	1	Lower instrument panel
Contusion, left knee	1	Steering wheel column

The driver was treated in a hospital emergency room, released, and reported no loss of time from work. While it is likely that use of the restraint system reduced the number of injuries in this 15 mph Delta V collision, improper use of the shoulder strap allowed the driver to be thrown forward into contact with the steering wheel rim. A properly worn shoulder strap might have prevented some of the facial injuries.

CASE 77 - (MKC 85-H-OR03)

Case Vehicle: 1975 Mercedes Benz 280CE
Case Vehicle Weight: 3,690 pounds
Case Vehicle Delta: 10.5 mph



Circumstances

A 1975 Mercedes Benz struck the rear end of 1973 Plymouth Scamp that had the rear end jacked up. The front of the Mercedes, above bumper level, underrode the Plymouth Scamp bumper, resulting in moderate damage to the Mercedes that reached a depth of 8 inches. The Plymouth was reportedly undamaged.

The driver of the Mercedes, wearing a lap/shoulder belt, was uninjured. The unrestrained driver of the Plymouth was also uninjured.

Restraint and Injury

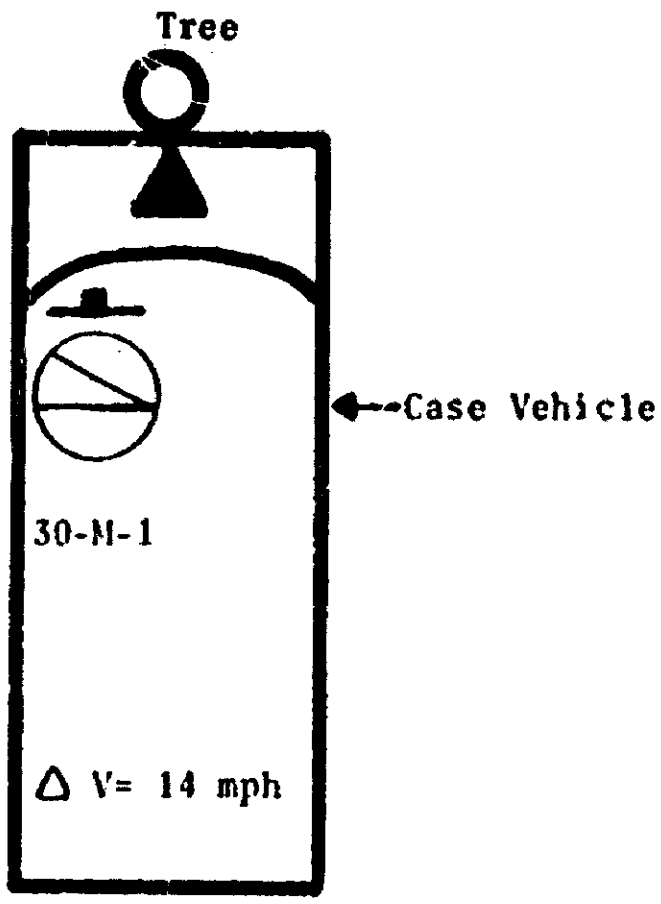
Case Vehicle
Seating Location: Driver
Sex: M
Age: 20
Height: 5 feet 9 inches
Weight: 120 pounds
Restraint Used: Lap/shoulder belt (ELR)

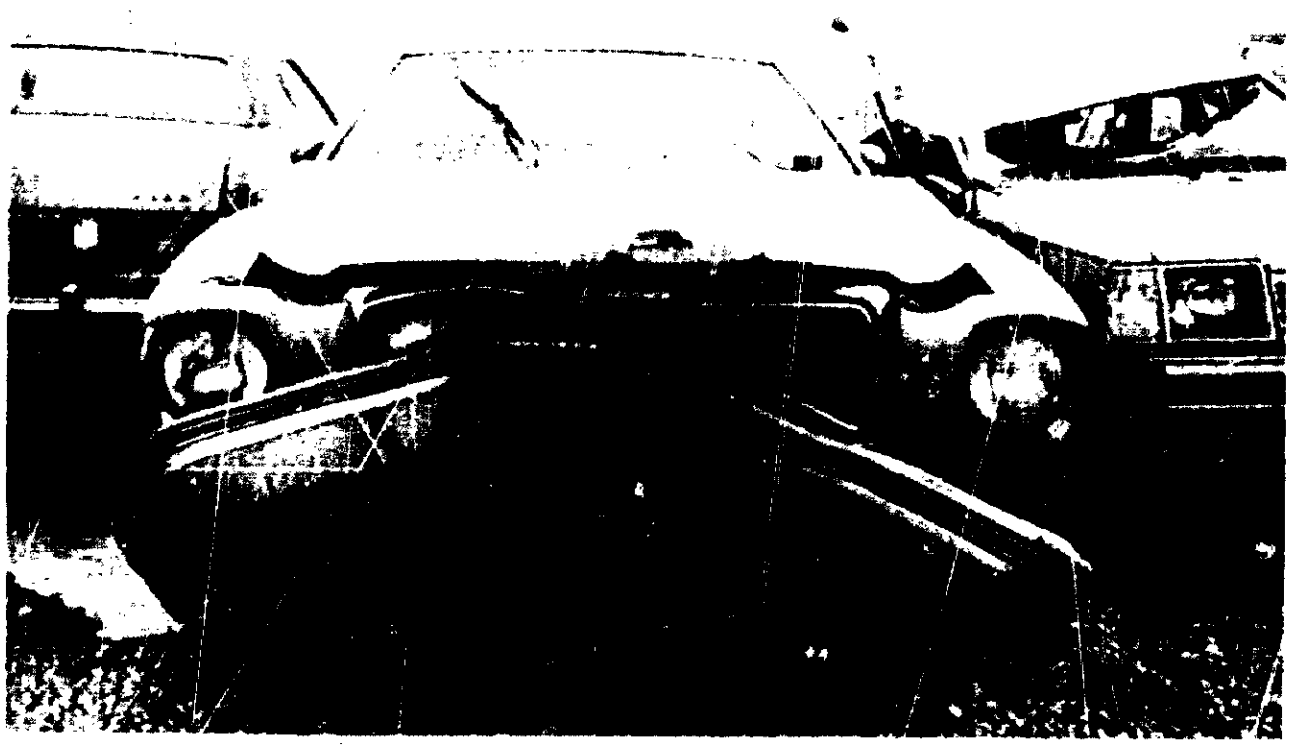
The driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver had no specific recollection of how the shoulder portion of the belt fit, but reported that he wore the lap portion snug "across his waist."

The driver was uninjured in this low-speed collision. Due to the low Delta V (10.5 mph), the apparent improper positioning of the lap portion was not a factor. The restraint system performed as designed in preventing the driver from contacting components of the frontal interior.

CASE 79 - (CHI 85-H-OR15)

Case Vehicle: 1978 Ford Mustang 2-door
Case Vehicle Weight: 2,858 pounds
Case Vehicle Delta V: 14.0 mph





Circumstances

A 1978 Ford Mustang approaching a left curve ran off the right side of the roadway, went through a snowbank, and struck a tree. The Mustang received substantial damage, with deformation up to 13.4 inches at center front.

The driver, restrained by a lap/shoulder belt, sustained minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 30
Height: 5 feet 11 inches
Weight: 160 pounds
Restraint used: Lap/shoulder belt (ELR)

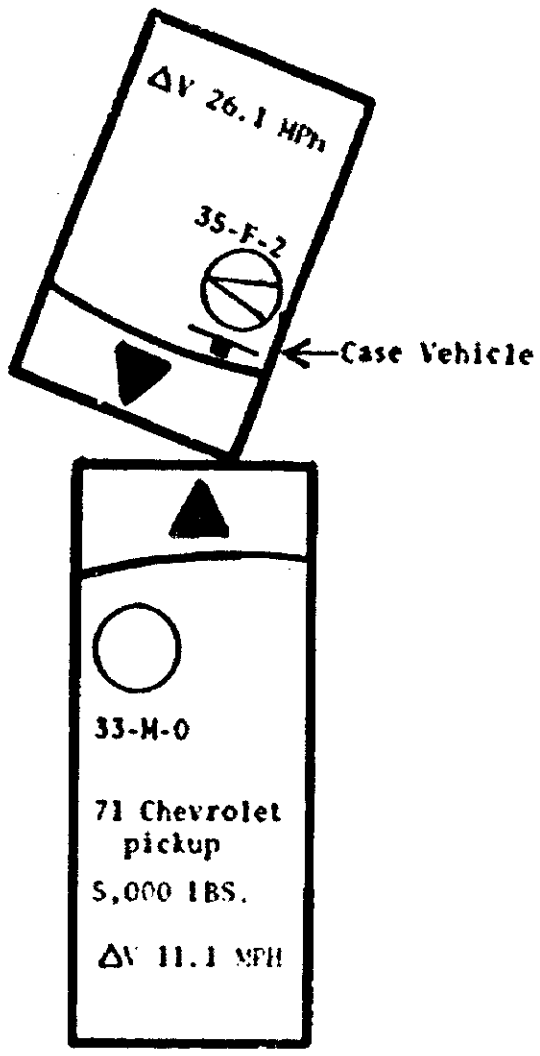
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver described the lap portion of the belt adjustment as "not very snug," resting on top of his thighs. The shoulder portion was reportedly worn loose over a heavy winter jacket with the webbing resting on the outer part of his shoulder. Force loading marks were found on the webbing of the driver's restraint.

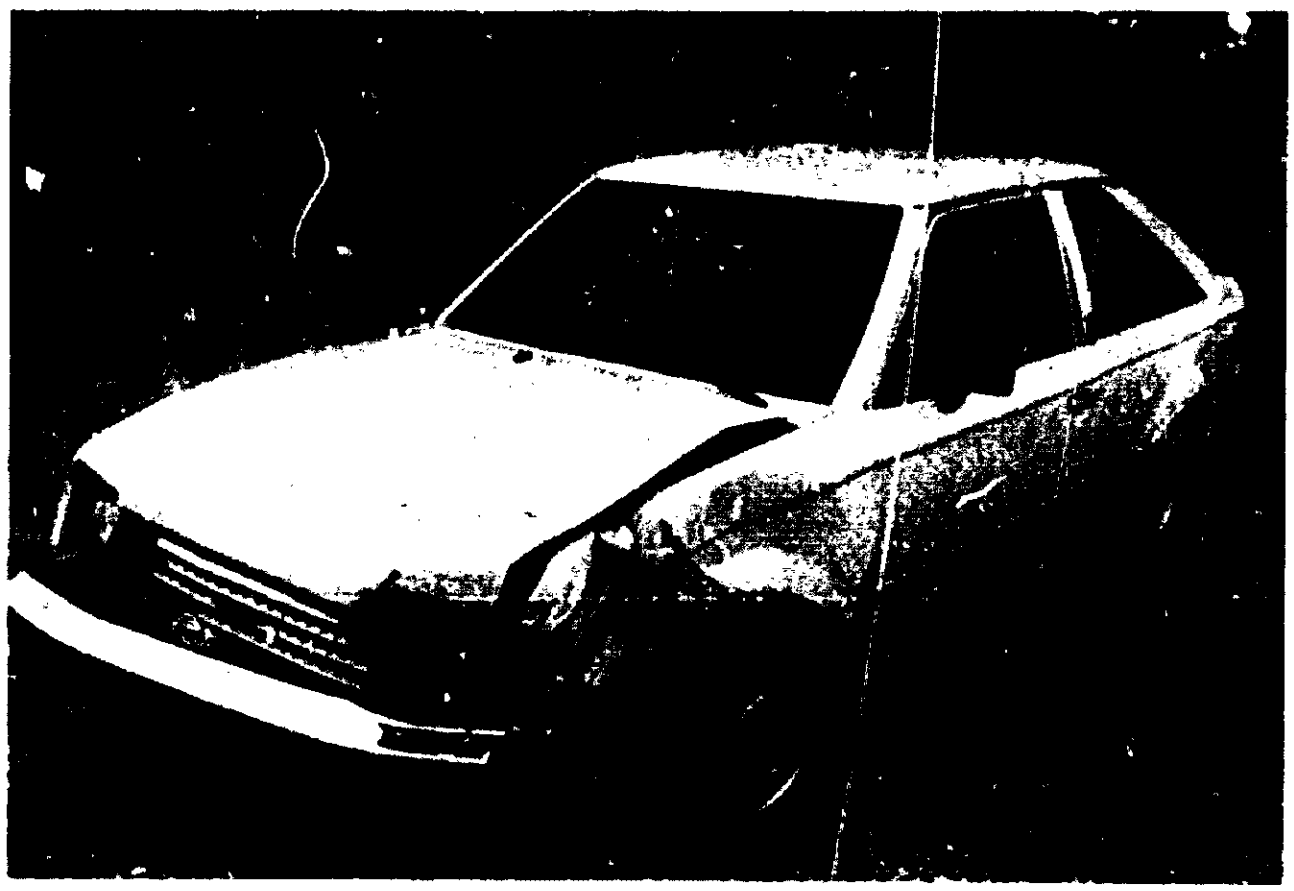
Injuries	AIS	Probable Source
Sprain, left wrist	1	Steering wheel

The driver received out-patient treatment at a local hospital the day after the accident. No work loss was reported. Although the seatbelt may have been worn loosely, it nevertheless performed well in preventing the driver from contacting the steering assembly, the instrument panel, and other component of the interior. An unrestrained driver might have received additional minor or greater injuries in this 14 mph Delta V collision.

CASE 80 - (ATL 85-H-0R07)

Case Vehicle: 1983 Ford Escort 2-door
Case Vehicle Weight: 2,131 pounds
Case Vehicle Delta V: 26.1 mph





Circumstances

A 1983 Ford Escort was attempting to negotiate a left curve on the roadway when a 1971 Chevrolet pickup truck initiated a left turn across the Ford's path. They impacted right front to front. The Ford sustained moderate damage with a maximum deformation of 12 inches at the left front. The much heavier Chevrolet pickup received moderate front structural damage.

The driver of the Ford, restrained by a lap/shoulder belt received a moderate injury while the unrestrained driver of the pickup was not injured.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 35
Height: 5 feet 3 inches
Weight: 115 pounds
Restraint used: Lap/shoulder belt (ELR)

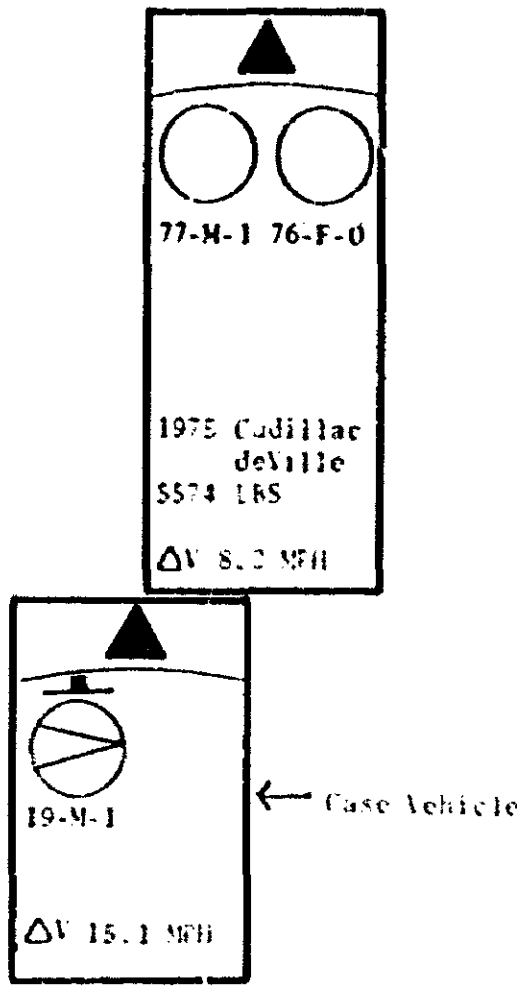
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latch plate, and a stalk-mounted buckle assembly. The driver described the lap portion of the belt as being across the abdomen and fitting snug. The shoulder portion was reportedly snug across the chest. The long buckle stalk caused the shoulder portion to align under the right rib cage rather than over the rib cage. Injury patterns confirm the reported alignment. There were force marks on the webbing from D-ring loading.

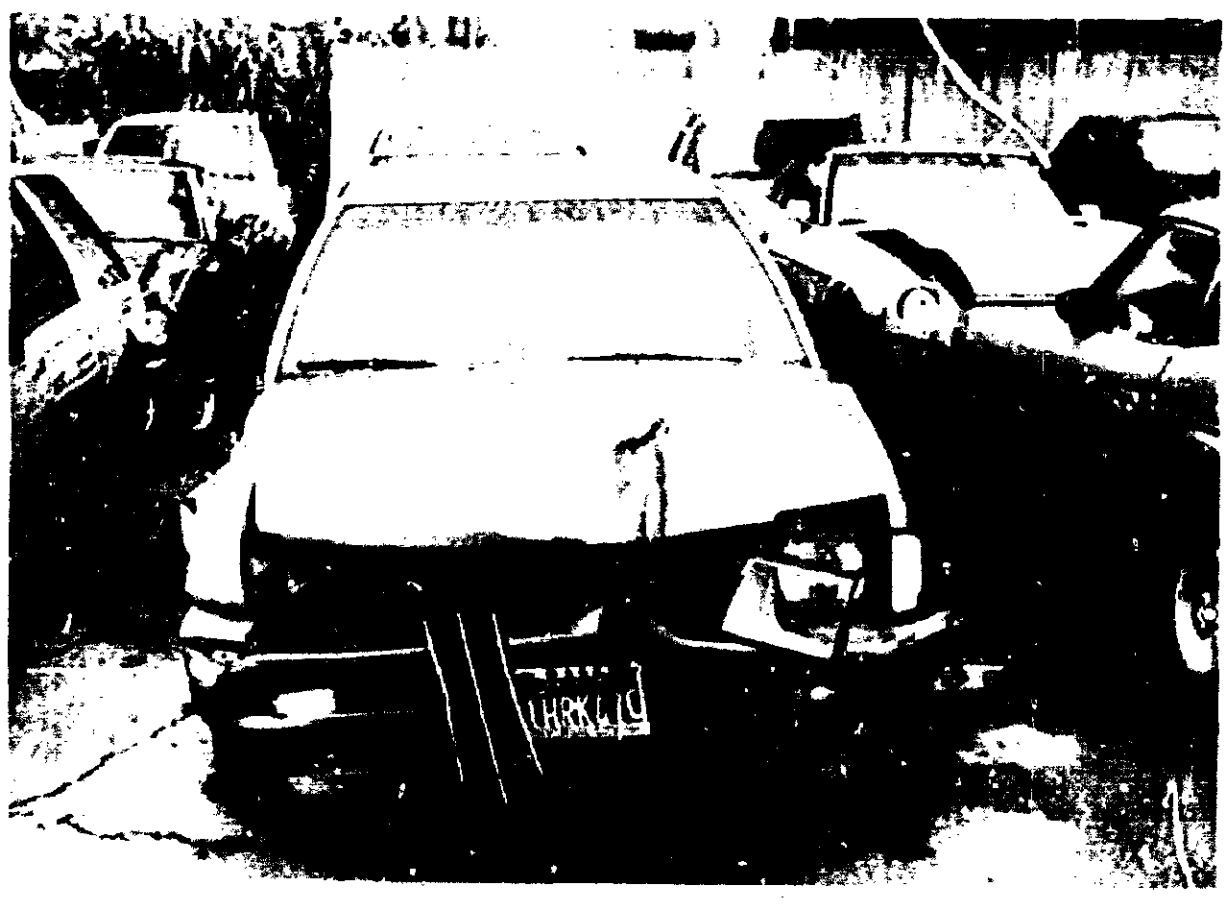
Injuries	AIS	Probable Source
Abrasion, left shoulder	1	Shoulder portion of the belt webbing
Contusion, upper abdomen region below right ribs	1	Shoulder portion of the belt webbing
Sprain, right ankle	1	Impact forces of foot on brake pedal
Sprain, cervical area	1	Impact forces
Fracture, left radius	2	Steering wheel

The driver was transported to a local hospital where she was treated and released. Two weeks of work were reportedly lost. Her use of the available lap/shoulder belt precluded additional forward movement within the car, preventing more serious impacts with the frontal components. The small stature of this driver, coupled with the design characteristics of the lap/shoulder belt, possibly induced a misalignment of the shoulder portion of the belt even though the belt was properly used. Considering the 26.1 mph Delta V of this collision, it is probable that an unrestrained driver would have received additional and more serious injuries due to contact with the forward interior.

CASE 81 - (LAX-85-H-0R10)

Case Vehicle: 1983 Nissan Stanza, 4-door
Case Vehicle Weight: 3,024 pounds
Case Vehicle Delta V: 15.1 mph





Circumstances

A 1983 Nissan Stanza was approaching the rear of a line of traffic waiting at a red signal when it struck the rear of a 1975 Cadillac DeVille. The Datsun received substantial damage with deformation of the frontal structure of up to 18 inches. The Cadillac sustained minor rear end damage with deformation of up to 2 inches.

The Nissan driver, restrained by a lap/shoulder belt, sustained only minor injuries. The unrestrained Cadillac driver sustained minor injuries, and the unrestrained right front passenger of the Cadillac was not injured.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 19
Height: 5 feet 9 inches
Weight: 144 pounds
Restraint Used: Lap/shoulder belt (ELR)

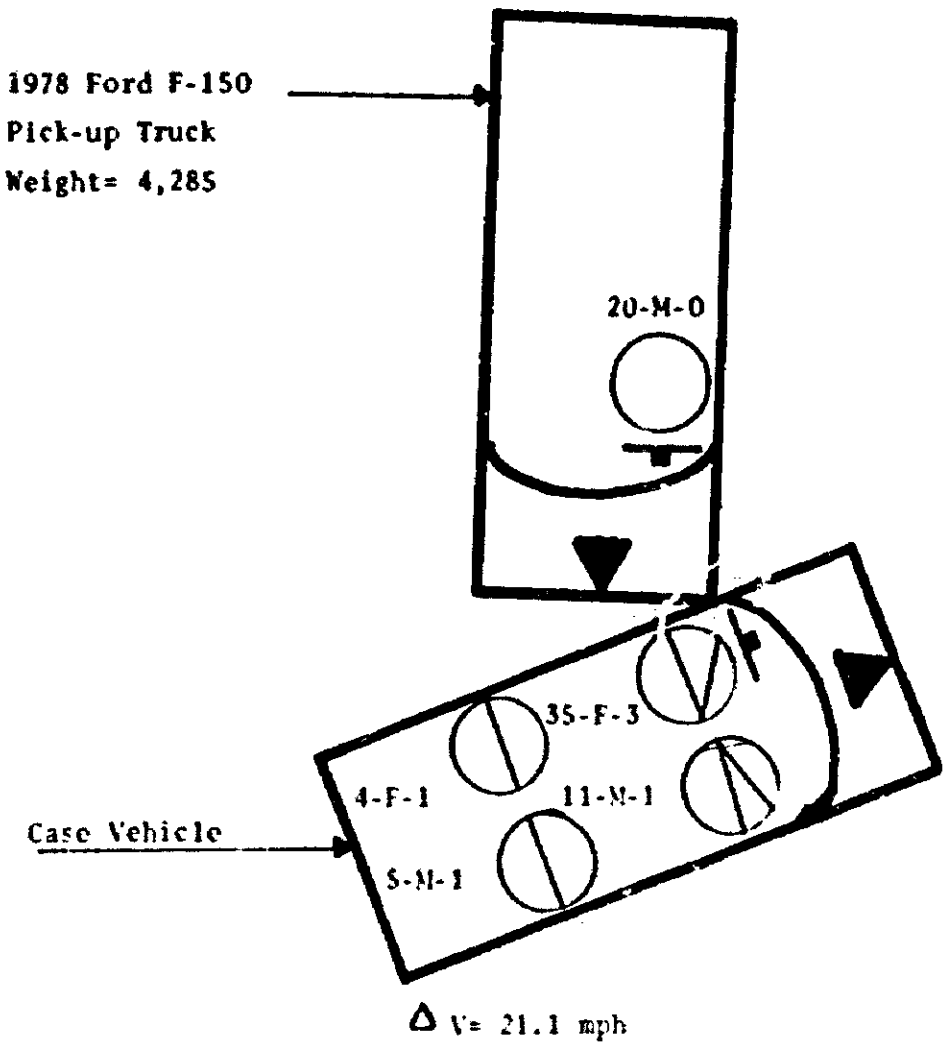
This driver was wearing a continuous loop lap shoulder belt equipped with an emergency locking retractor sensitive to webbing movement, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver stated that the lap portion of the belt adjustment was positioned low on his hips and snug. The shoulder portion was reportedly adjusted so that the palm of a hand could be placed between the webbing and the driver's chest.

Injuries	AIS	Probable Source
Contusions, left forehead	1	Sun visor
Contusions, chest	1	Shoulder portion of belt
Contusions, right wrist	1	Steering wheel
Contusions, left knee	1	Lower instrument panel
Contusions, right knee	1	Lower instrument panel

The driver was treated and released at an area hospital. There was no reported loss of time from work. Use of the available lap/shoulder belt likely prevented more serious injuries in this 15.1 mph Delta V collision. An unrestrained driver would have been free to contact the frontal interior components with greater force.

CASE 82 - (SEA 85-H-OR05)

Case Vehicle: 1983 Ford Escort
Case Vehicle Weight: 2,381 pounds
Case Vehicle Delta V: 21.1 mph



Circumstances

A 1983 Ford Escort was turning left when it was struck in the driver's door by a 1978 Ford pick-up truck. The Ford Escort sustained substantial damage on the left side with 12 inches of crush in the vicinity of the driver's door. The Ford pick-up truck sustained 11.5 inches of deformation in an 18-inch wide area of its left front corner.

The Ford Escort driver, restrained by a lap/shoulder belt, sustained serious injuries and the right front passenger, also restrained by a lap/shoulder belt sustained a minor injury. Two children, seated in the rear of the Escort, were restrained by booster seats secured by lap belts. One received moderate injuries; the other, minor injuries. The unrestrained driver of the Ford pick-up was not injured.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 35
Height: 5 feet 8 inches
Weight: 144 Pounds
Restraint Used: Lap/shoulder belt (ELR)

The driver was wearing a lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, a stalk-mounted D-ring suspended from the roof, and a stalk-mounted buckle assembly. The driver stated that the lap portion of the belt fit snug over her lower hips and that there was no "excessive" slack in the shoulder portion. There were metal deformations at the ratchet mechanism of the retractor where the locking bar caught during impact.

Injuries	AIS	Probable Source
Large laceration, forehead	2	A pillar and/or left door frame
Fractured left ribs (#2nd, 3rd, 4th, and 5th)	2	Impact with driver's door
Fractured right pelvis	2	Impact with driver's door and/or compression against lap portion of the belt
Lateral break on left hand	2	Impact on A-pillar
Contusions on inside of thighs	1	Steering wheel
Contusion on upper left calf	1	Unknown
Punctured lung	3	Impact with left door
Renal contusion (bruised kidney)	3	Compression against lap/ shoulder belt buckle

The driver was admitted to a nearby hospital where she spent 6 days. She reported a 1-week loss of work.

There was an intrusion of 12 inches in the vicinity of the driver's door. It is difficult to speculate on whether the driver's injuries, especially the fractured pelvis and bruised kidney, were the result of being compressed within the lap/shoulder belt or the result of the impact and intrusion of the driver's door. With the intrusion into the driver's space, it is doubtful that restraint use was of much benefit to the driver. An unrestrained driver would have had much the same contacts with the adjacent interior side wall and, considering the 21.1 mph Delta V, would probably have sustained injuries of similar severity.

Seating Location: Right Front
Sex: M
Age: 11
Height: 4 feet 11 inches
Weight: 85 pounds
Restraint Used: Lap/shoulder belt (ELR)

The right front passenger was restrained with a lap/shoulder belt of the same design as the driver. The 11-year-old-boy said that the belt fit him "tightly."

Injuries	AIS	Probable Source
Contusion, nose	1	Struck dash or driver

The 11-year-old boy was taken to a nearby hospital where he was treated and released. Considering the 21.1 mph Delta V in combination with the direction of impact forces, it is likely that use of the restraint system prevented additional and more serious injuries. An unrestrained right front occupant would have been thrown forcefully toward the left front interior, increasing the possibility of injuries to themself, and also the driver.

Seating Location: Left Rear
Sex: F
Age: 4
Height: 3 feet 6 inches
Weight: 36 pounds
Restraint Used: Booster seat secured by lap belt (ALR)

This child was sitting in a booster seat. The lap belt, equipped with an automatic locking retractor, held the booster seat in place while simultaneously restraining the passenger. The case vehicle driver (mother of the passengers), stated that she believed that the lap belt was snug, positioned low on her daughter's hips.

Injuries	AIS	Probable Source
Laceration, left side of head	1	Left door frame and/or window glass
Large contusion, left forehead	2	Left rear door frame
Dizziness, possible loss of consciousness	7	Left rear door frame

The 4-year-old girl was treated at a nearby hospital and released. The passenger forcefully hit her head against the left rear door frame or B-pillar. The emergency room physician diagnosed her as probably having had a loss of consciousness. The intrusion in the vicinity of the occupant appears to be no more than 6 inches, and is it unlikely that any of her injuries can be related to this intrusion. The booster seat was unable to protect the child from head injury in this 21.1 mph Delta V side impact; she was in direct line with the crash forces and her head was able to contact the side interior of the vehicle.

Case Vehicle
Seating Location: Right Rear
Sex: M
Age: 5
Height: 3 feet 6 inches
Weight: 38 pounds
Restraint Used: Booster seat secured by lap belt (ALR)

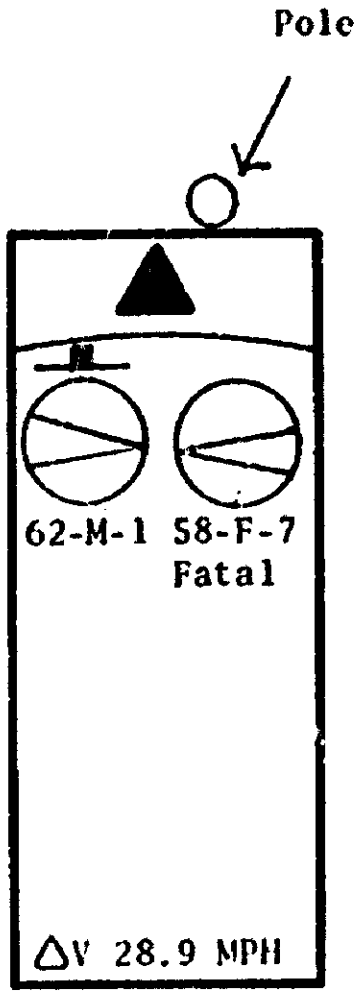
The right rear passenger's booster seat was restrained with an identical lap belt and in the same manner as the left rear passenger.

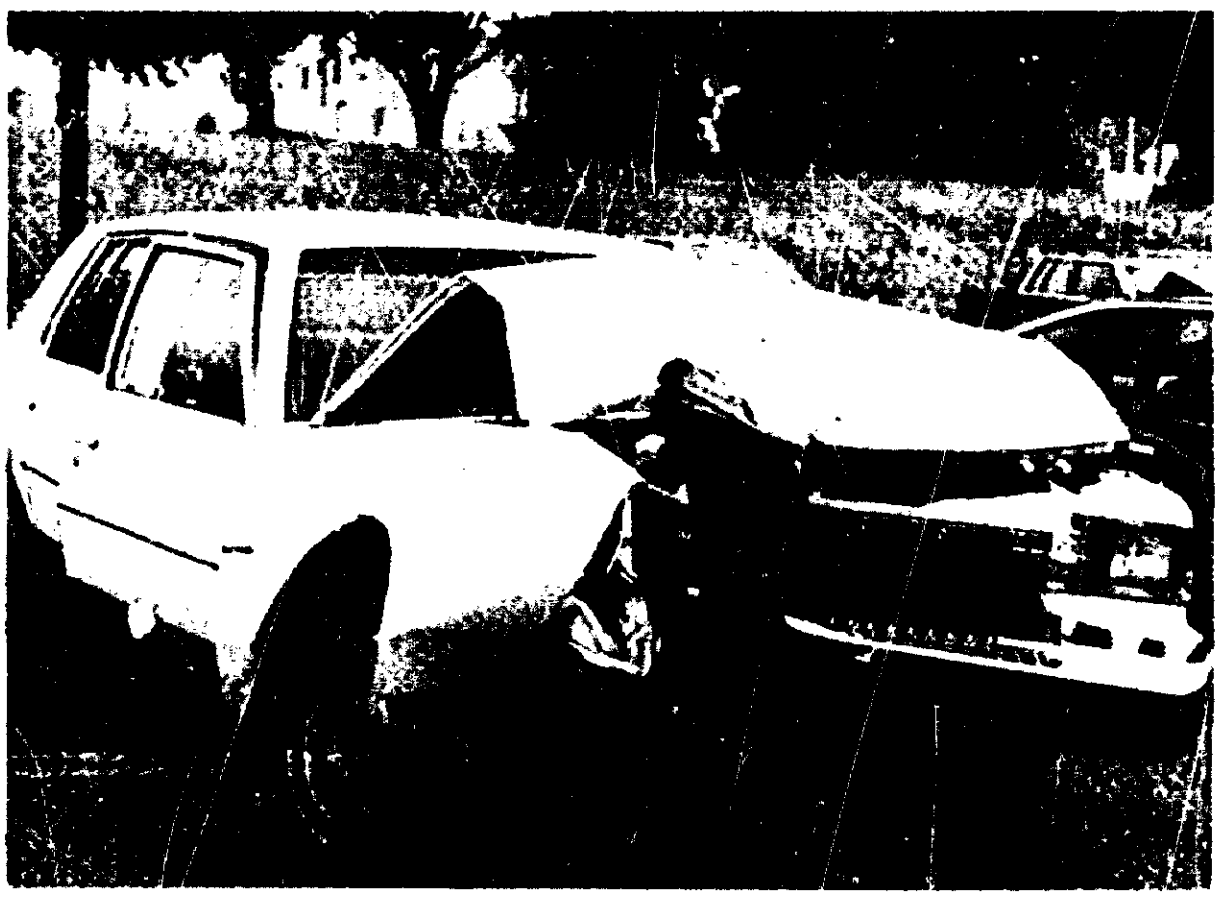
Injuries	AIS	Probable Source
Contusion, right forehead	1	Back of front seat or right door on rebound

This 5-year-old boy was also taken to a nearby hospital where he was treated and released. Restraint use was able to provide considerable protection to the far side passenger in this 21.1 mph Delta V collision. With the impact occurring at the opposite side from this passenger, the intrusion was not a factor. If he had been unretrained, however, he would likely have been thrown violently toward the left, increasing the chances of more serious injury.

CASE 84 - (NYC 85-H-0R06)

Case Vehicle: 1983 Buick Regal 4-door
Case Vehicle Weight: 3,615 pounds
Case Vehicle Delta V: 28.9 mph





Circumstances

A 1983 Buick Regal veered off the right side of the roadway and struck a utility pole head-on. The Buick received substantial front structural damage with deformation of up to 38 inches.

Both occupants, the driver and right front passenger, were wearing the lap/shoulder belts available at their positions. The accident resulted in minor injuries to the driver, who had introduced a substantial amount of slack into the belt. The right front passenger sustained massive chest trauma injuries which proved fatal.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 62
Height: 5 feet 10 inches
Weight: 165 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver, who was wearing a three-piece suit and a raincoat with a wool liner, stated that the lap portion of the belt was low across his hips with a little slack. The shoulder portion of the restraint was worn over his raincoat with a small amount of slack. Force loading marks were found on the webbing in the area of the cinching latchplate and D-ring.

Injuries	AIS	Probable Source
Laceration, bridge of nose	1	Steering wheel
Contusion under left eye	1	Steering wheel
Contusion under right eye	1	Steering wheel
Laceration, right wrist	1	Dashboard
Contusion, left wrist	1	Dashboard
Contusion, right side abdominal	1	Shoulder portion of the belt

The driver was treated at a local hospital and released. Given the 28.9 mph Delta V of this collision, his use of the available lap/shoulder belt likely prevented more serious injuries. An unrestrained driver would have been free to make contact with the frontal interior much more forcefully.

Seating Location: Right Front
Sex: F
Age: 58
Height: 5 feet 7 inches
Weight: 140 Pounds
Restraint Used: Lap/shoulder belt (ELR)

This passenger was wearing a lap/shoulder belt similar in design to the driver's. Rescue personnel who removed this occupant from her restraint and the car occupant's described the occupant's postcrash position as being leaned forward in the seat (fetal position) with her buttocks resting on the front edge of the bench seat. Her knees and lower legs were against the lower part of the dashboard. The shoulder strap was over the right shoulder and the lap portion was slightly above the navel. Force loading marks were found in the area of the latchplate and D-ring. Also, there were two scars found on the belt webbing which indicated the belt was being worn at the time of impact. Physical evidence and injuries indicated the lap/shoulder belt was being worn too loose to be totally effective as designed. One possible reason for the loose restraint was that the occupant was wearing an ibocystoplasty (waste bag) on her right side. The ibocystoplasty was not damaged during the accident.

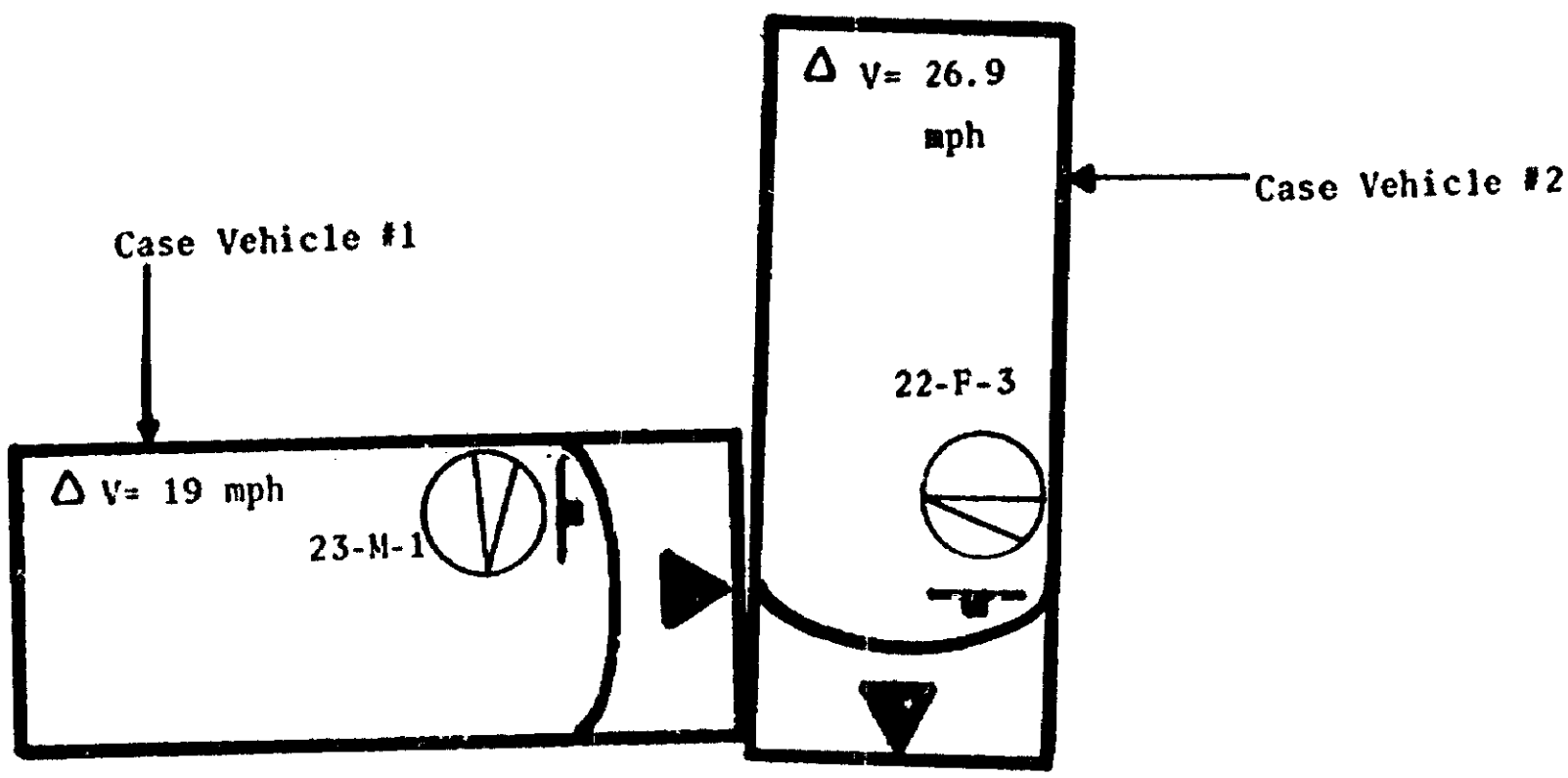
Injuries	AIS	Probable Source
Sternum fractured	2	Shoulder belt restraint
Ribs (all) left side fractured	2	Shoulder belt restraint
Exsanguination, internal hemorrhage, left chest cavity area*	7	Impact forces

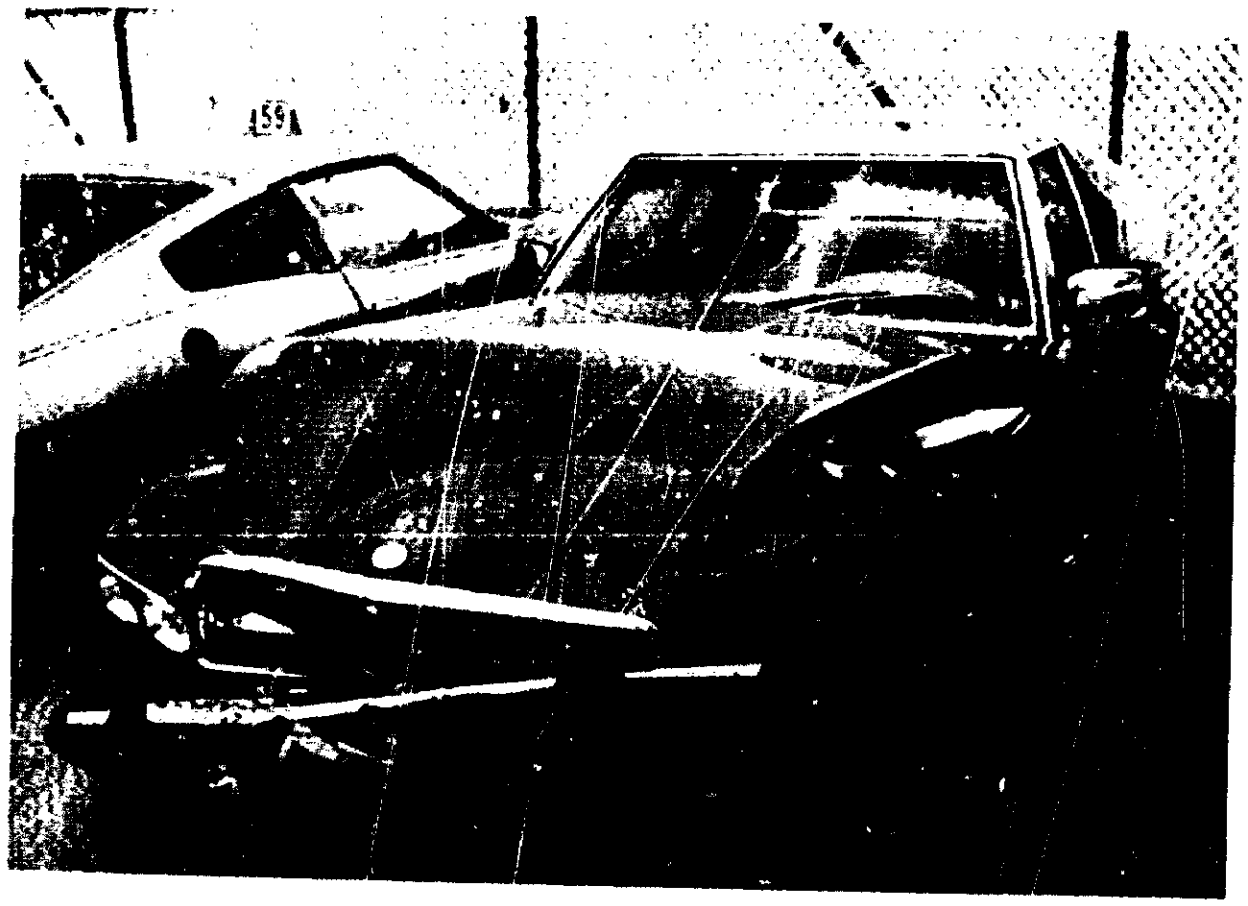
*Subject bled to death from possible rupture of aorta and/or heart.

This passenger died in the emergency room 49 minutes after the accident. Apparently, this occupant's death was not caused by restraint failure, but rather one of misuse. The misuse appears to be attributed to her wearing the lap/shoulder belt too loose. That allowed her body to move forward and down submarining under the belt. As a result, it is likely that the lap portion of the belt rose and severely compressed this passenger's chest. Given the crash forces of this 28.9 mph Delta V collision, a properly restrained occupant would still have been susceptable to serious injuries, however, she would probably would have survived.

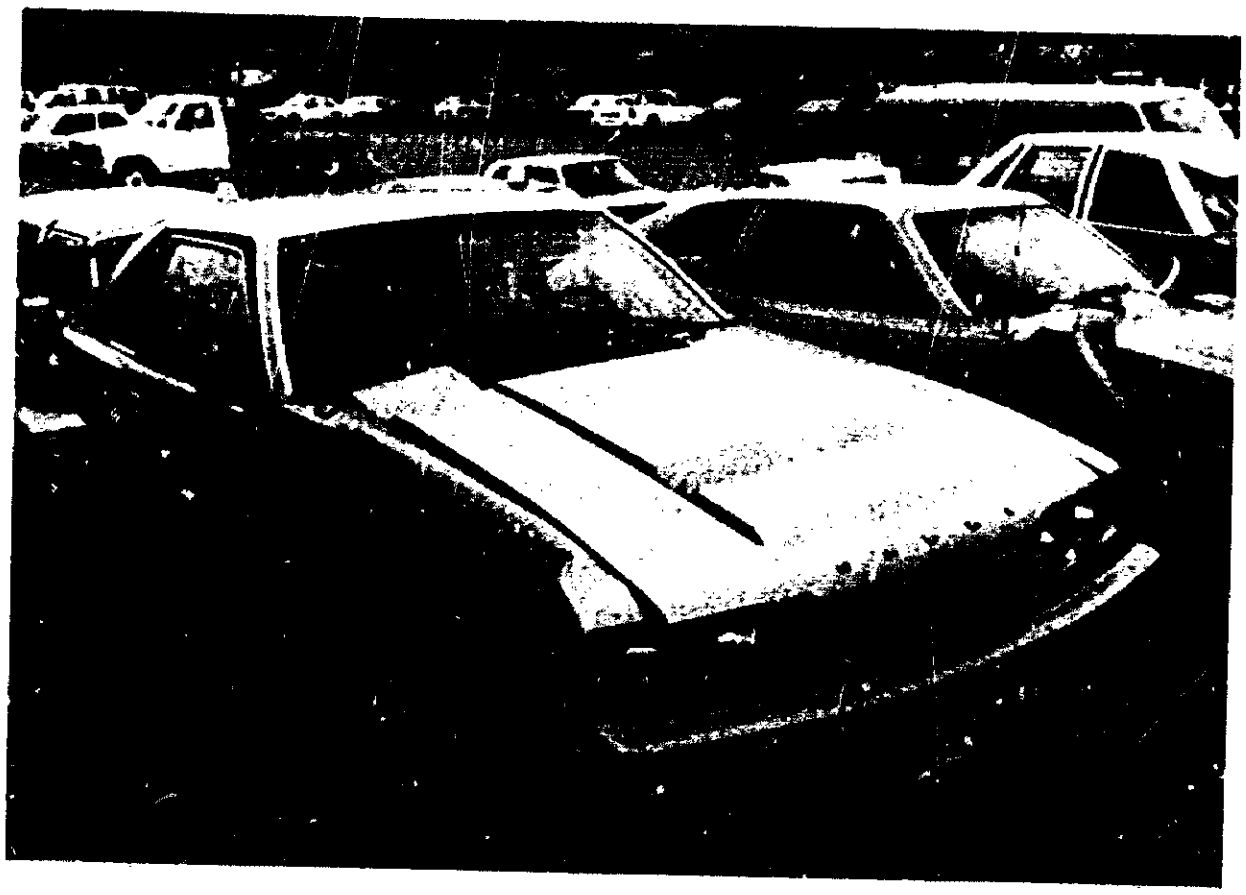
CASE 86 - (FTW 85-H-0R28)

Case Vehicle #1:	1977 Mercedes 450 SL
Case Vehicle Weight:	4,000 pounds
Case Vehicle Delta V:	19 mph
Case Vehicle #2:	1981 Mercury Capri
Case Vehicle Weight:	2,760 pounds
Case Vehicle Delta V:	26.9 mph





CASE VEHICLE #1



CASE VEHICLE #2

Circumstances

A 1977 Mercedes 450 SL and a 1981 Mercury Capri were approaching each other from opposite directions when the Mercury turned left and was struck on the right side by the front of the Mercedes; the vehicles then rotated into a secondary collision. The Mercedes sustained substantial deformation of up to 16 inches across the entire 70.5-inch front end. Maximum inward deformation on the Mercury was measured at 9 inches with a 62-inch area damage on the right side.

The Mercedes driver, restrained by a lap/shoulder belt, received a mild concussion. The operator of the Mercury, also wearing a lap/shoulder belt, sustained serious injuries.

Restraint and Injury

Case Vehicle #1 - 1977 Mercedes
Seating Location: Driver
Sex: M
Age: 23
Weight: 175 pounds
Height: 5 feet 10 inches
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to both webbing travel and vehicle motion, a free-sliding latchplate, and a seat-mounted anchor and buckle. The lap portion of the belt was described by the driver as being positioned across his lower abdomen and snug. The shoulder portion of the restraint should have been fairly tight on the driver's chest, since the system was self-tensioning. Force loading marks were found on the webbing in the areas of the latchplate and the D-ring. A plastic guide on the latchplate was broken off during the impact.

Injuries	AIS	Probable Source
Mild concussion	7	Side window glass

The driver visited an area hospital as an out-patient, but reported no loss of time from work as a result of his injuries. The lap/shoulder belt fit extremely well due to the seat-mounted anchor and buckle and the self-tensioning retractor. The driver's concussion resulted from the secondary impact as the vehicles rotated. Use of the lap/shoulder belt most likely prevented injuries in the 19 mph Delta V frontal collision. An unrestrained driver would certainly have made contact with the frontal interior components, thereby increasing the chances of additional and more serious injuries.

FTW-85-H-0R28

Case Vehicle #2 - 1981 Mercury
Seating location: Driver
Sex: F
Age: 22
Height: 5 feet 4 inches
Weight: 117 pounds
Restraint Used: Lap/shoulder belt (ELR)

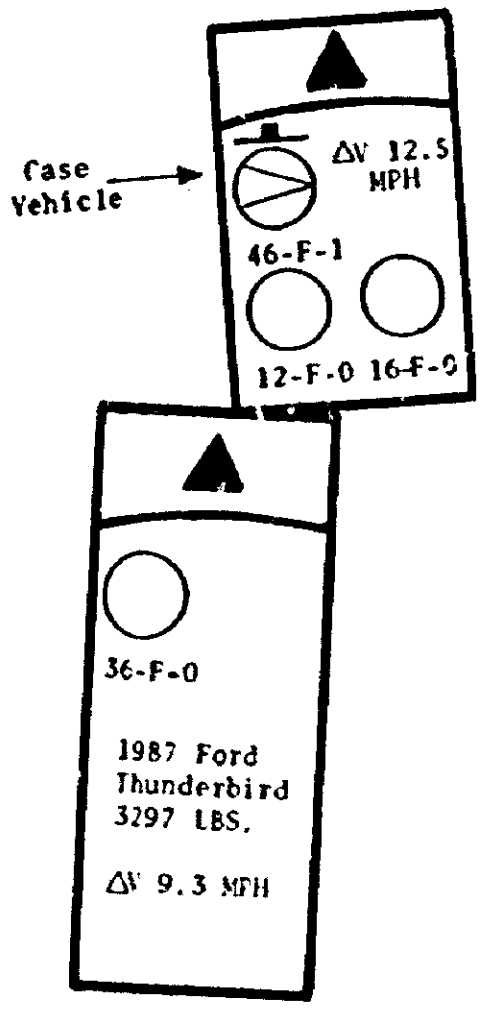
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a cinching latchplate, a windowshade tension relief device, and a stalk-mounted buckle assembly. The driver described the lap portion adjustment as being positioned low on her hips and snug. The shoulder portion was reportedly adjusted so that a clenched fist could be fit between the webbing and the driver's chest. Force loading marks were found in the areas of the latchplate and B-pillar mounted D-ring.

Injuries	AIS	Probable Source
Laceration, lower right leg	1	Center console
Contusion, bladder	3	Restraint latchplate and buckle
Major contusion, abdomen	2	Restraint system
Contusion, lower abdomen	1	Restraint system

This driver was treated at an emergency room and reported 2 days loss of time from work. Considering the high position of the stalk mounted buckle and the right side impact, this driver was most likely thrown forward and to the right. She possibly came out or under the shoulder portion of the belt which allowed the fastened latchplate and buckle to be forced against her abdominal area, causing bladder contusions. Regardless, the use of the lap/shoulder belt probably prevented her sustaining additional serious injuries in the 26.9 mph Delta V side impact. An unrestrained driver would have been thrown violently toward the right front interior.

CASE 87 - (SEA 85-H-0R07)

Case Vehicle: 1987 Ford Escort
Case Vehicle Weight: 2,458 pounds
Case Vehicle Delta V: 12.5 mph



Circumstances

A 1982 Ford Escort was stopped on the roadway to make a left turn when it was struck in the rear by a 1981 Ford Thunderbird. The Escort received moderate damage across the rear of the car with a maximum deformation of 7.5 inches. Damage to the Thunderbird was minor with 2.5 inches of deformation over a 28-inch area across on the right front.

The Ford driver, restrained by a lap/shoulder belt, sustained only minor injury. The two unrestrained rear seat occupants of the Escort were uninjured, as was the unrestrained driver of the Ford Thunderbird.

Restraint and Injury

Case Vehicle

Seating Location:	Driver
Sex:	F
Age:	46
Height:	5 feet 7 inches
Weight:	140 pounds
Restraint Used:	Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, a stalk-mounted D-ring, and a stalk-mounted buckle assembly. The driver stated that the position of the lap portion of the belt was low on her hips and "between snug and loose." The shoulder portion was across her mid-chest, with a "snug" tension maintained.

Injuries	AIS	Probable Source
Acute lower back strain	1	Impact forces

The driver was treated and released at a local clinic and reported a 1-week loss of work. The driver's upper body moved rearward at impact and her head struck the integral head rest. In this low Delta V (12.5 mph) rearend collision, restraint use was largely immaterial during initial impact. The forces acting on the driver were from the rear and, thus, the driver was contained by the seat back rather than the restraint system. The lap/shoulder belt may have provided some restraint during rebound.

Seating Location:	Left Rear
Sex:	F
Age:	12
Height:	5 feet 5 inches
Weight:	110 pounds
Restraint Used:	None

The vehicle was equipped with a lap belt with automatic locking retractor at this position but it was not in use.

The left rear passenger was uninjured and was not taken for a medical checkup.

Seating Location:	Right Rear
Sex:	F
Age:	16
Height:	5 feet 7 inches
Weight:	130 pounds
Restraint Used:	None

This seating position was also equipped with a lap belt with automatic locking retractor, but the belt was not used. This passenger was also uninjured and untreated.

These rear seated occupants were acted upon by the same type forces as the driver. The 12.5 mph Delta V, in this case a forward acceleration of the car as it was struck in the rear, would have acted between the occupants and the seat back. Due to the low velocity change, restraint use would have been immaterial.

CASE 88 - (SEA 85-H-0R08)

Case Vehicle: 1985 Ford Mustang 2-door
Case Vehicle Weight: 3,050 pounds
Case Vehicle Delta V: 180 degree rollover (No Delta V)

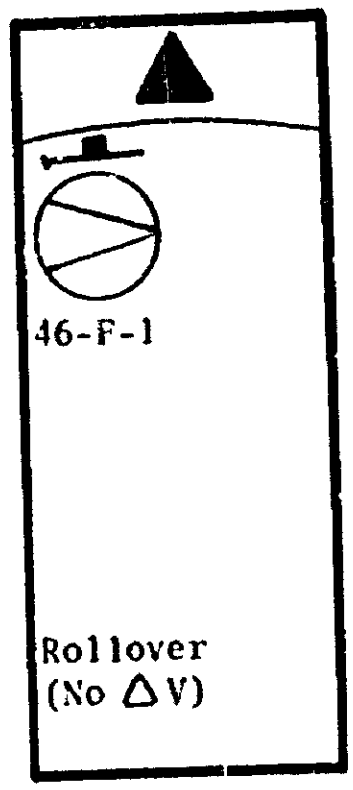
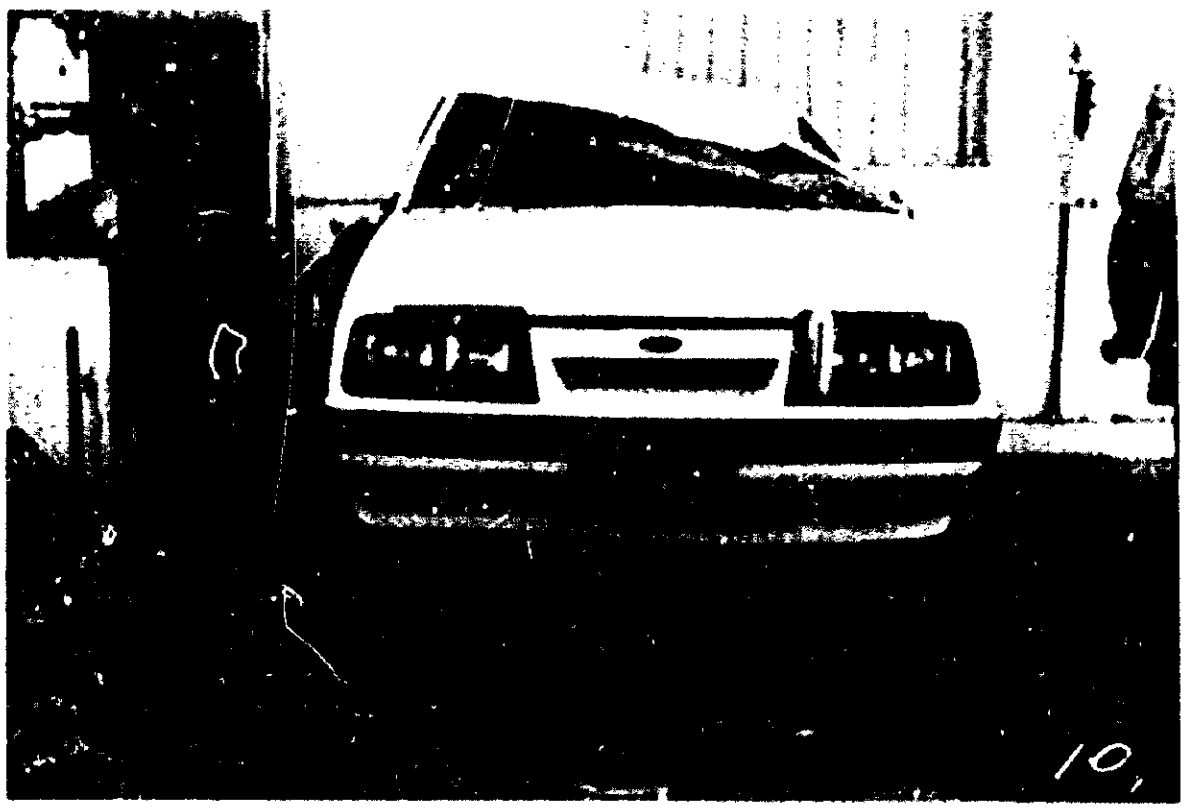


Photo # 10



Circumstances

A 1985 Ford Mustang was negotiating a curve to the left when it went out of control. The vehicle struck an embankment, rolled over, and came to rest on its top. The Ford received substantial structural damage with a maximum roof deformation of up to 11.5 inches. The deformation was located above the driver's position.

The lap/shoulder belted-driver sustained minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 46
Height: 5 feet 3.5 inches
Weight: 150 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver stated that the lap portion of the belt adjustment was positioned low on her hips and snug. The shoulder portion was reportedly adjusted so that the palm of a hard could be placed between the webbing and her chest. No force loading marks were found on the webbing.

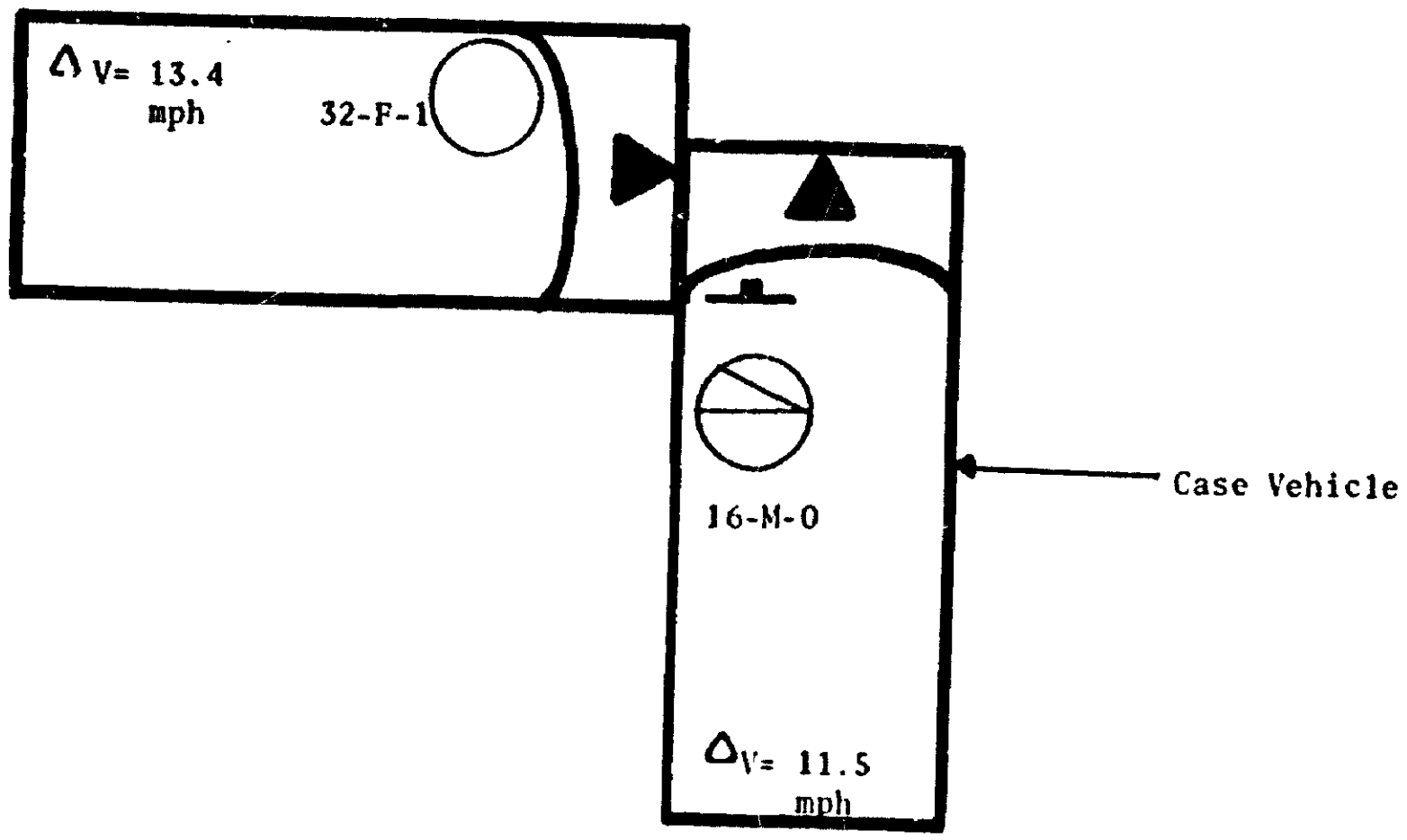
Injuries	AIS	Probable Source
Contusion, area of left eye	1	Unknown
Cervical spine strain	1	Roof interior/rollover dynamics

The driver was treated as an out-patient at an area hospital emergency room and reported a 2-week loss of time from work.

Considering the dynamics of this 180 degree rollover, the expected occupant kinematics, the side deformation on the roof, and the resultant open area above the driver's position, it is likely the driver would have been ejected and sustained more serious or even fatal injuries, had she not been wearing the lap/shoulder belt.

CASE 89 - (CHI 85-H-OR07)

Case Vehicle: 1978 Ford Fairmont, 2 door
Case Vehicle Weight: 2,953 pounds
Case Vehicle Delta V: 11.5 mph



Circumstances

A 1978 Ford Fairmont turning left out of a driveway was struck on the left front wheel by a 1983 Renault Alliance. The Ford received moderate structural damage with a maximum crush on the left side of 12 inches over a 55-inch area. The Renault was substantially damaged with an inward crush depth reaching a maximum of 15 inches over a 58-inch area across the front of the vehicle.

The Ford driver, restrained by a lap/shoulder belt, received no injuries. The unrestrained operator of the Renault sustained only a minor injury.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 16
Height: 5 feet 11 inches
Weight: 165 pounds
Restraint Used: Lap/shoulder belt (ELR)

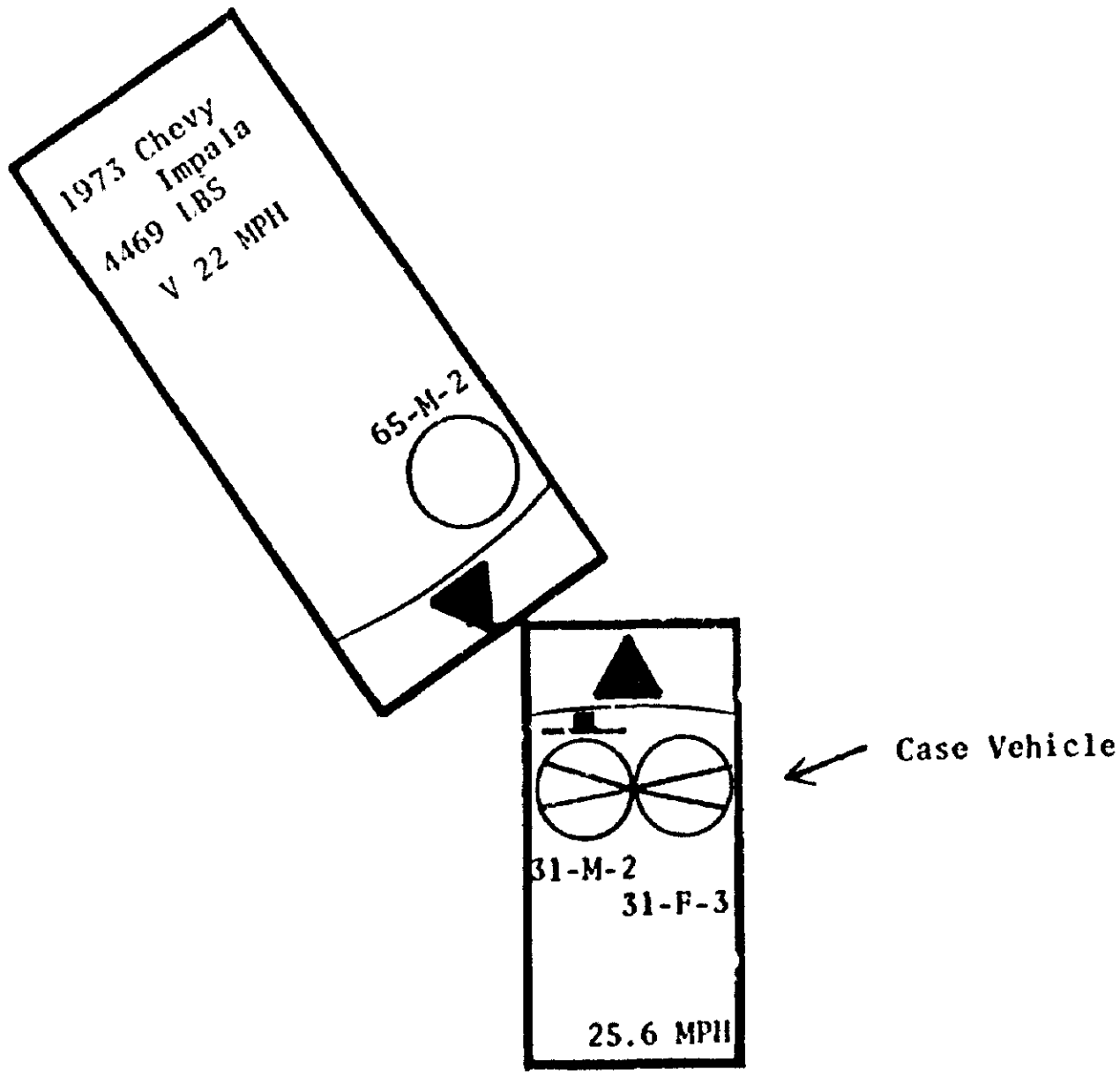
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver described the precrash lapbelt adjustment as being positioned low across his hips and snug. The shoulder portion of the restraint was reportedly adjusted so that the palm of a hand could be placed between the webbing and the driver's chest. The driver stated that the entire restraint always fits tightly because the seat adjustment spring was broken and a snug fitting restraint kept the seat from moving from its rearmost position.

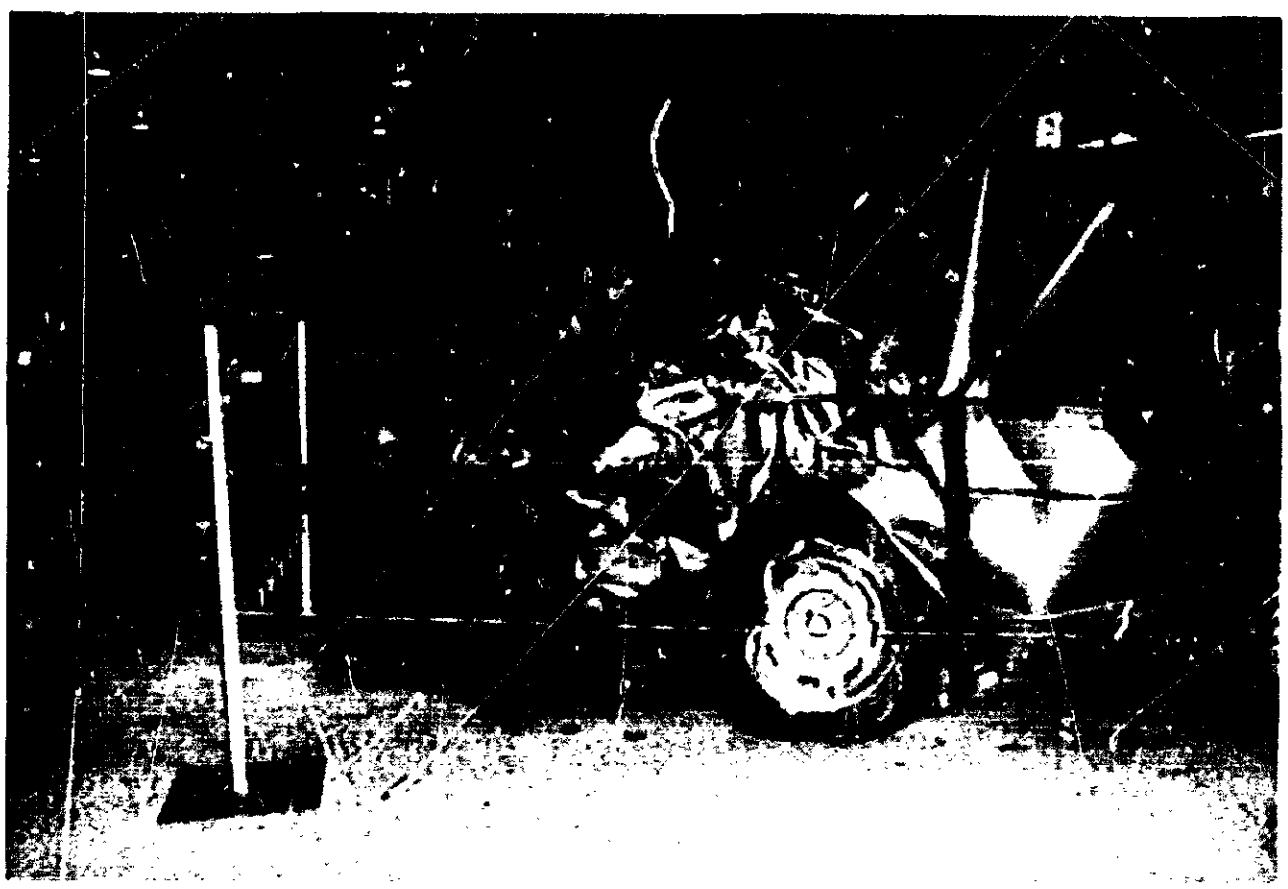
Injuries	AIS	Probable Source
None		

The driver of the Ford was not treated for injuries and lost no time from work. Considering the direction of the impact force and the low velocity change (Delta V of 11.5 mph) of the collision, the driver's use of the lap/shoulder belt probably had little to do with his being uninjured. A restraint system cannot prevent an occupant from striking an adjacent sidewall in this type collision.

CASE 90 - (CHI 85-H-OR09)

Case Vehicle: 1983 Volkswagen Rabbit, 4 door
Case Vehicle Weight: 3,480 pounds
Case Vehicle Delta V: 25.6 mph





Circumstances

A 1983 Volkswagen Rabbit and a 1973 Chevrolet Impala collided head-on when the Chevrolet crossed the centerline and struck the front of the Volkswagen. The Volkswagen received major structural damage over a 66-inch wide area of the front end with a maximum deformation of 32.4 inches. The Chevrolet sustained extensive damage over a 69-inch wide area of the right front with a maximum inward deformation of 29.5 inches.

The driver of the Volkswagen, restrained by a lap/shoulder belt, received moderate injuries. The right front passenger, also wearing a lap/shoulder belt, sustained multiple serious injuries. The unrestrained driver of the much larger and heavier Chevrolet received moderate injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 31
Height: 6 feet
Weight: 185 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to webbing acceleration, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver stated that the precrash lapbelt adjustment was positioned low across his hips and snug. The shoulder portion of the restraint was reportedly adjusted snugly, fitting against his down-filled coat. Force loading marks were found on the system webbing in the area of the latchplate.

Injuries	AIS	Probable Source
Fracture, left clavicle	2	Shoulder portion of belt
Fracture, right wrist	2	Windshield
Abrasion, left hip	1	Lap portion of belt
Abrasion, right hip	1	Lap portion of belt
Abrasion, left shoulder	1	Shoulder portion of belt
Abrasion, left knee	1	Instrument panel
Abrasion, right knee	1	Instrument panel

The driver was treated at an area hospital emergency room and released. He reported a 6-week loss of time from work. Considering the severity of this 25.6 mph Delta V collision, it appears that the driver's use of the lap/shoulder belt mitigated the severity of injury. Most of the minor injuries sustained were the result of the restraint provided by the belt system, an indication of the crash forces acting upon the driver. Had he been unrestrained, those forces would have acted between the driver and the left frontal interior and the probability of more serious injuries would have been much greater.

Case Vehicle
Seating Location: Right front
Sex: F
Age: 30
Height: 5 feet 9 inches
Weight: 135 pounds
Restraint Used: Lap/shoulder belt (ELR)

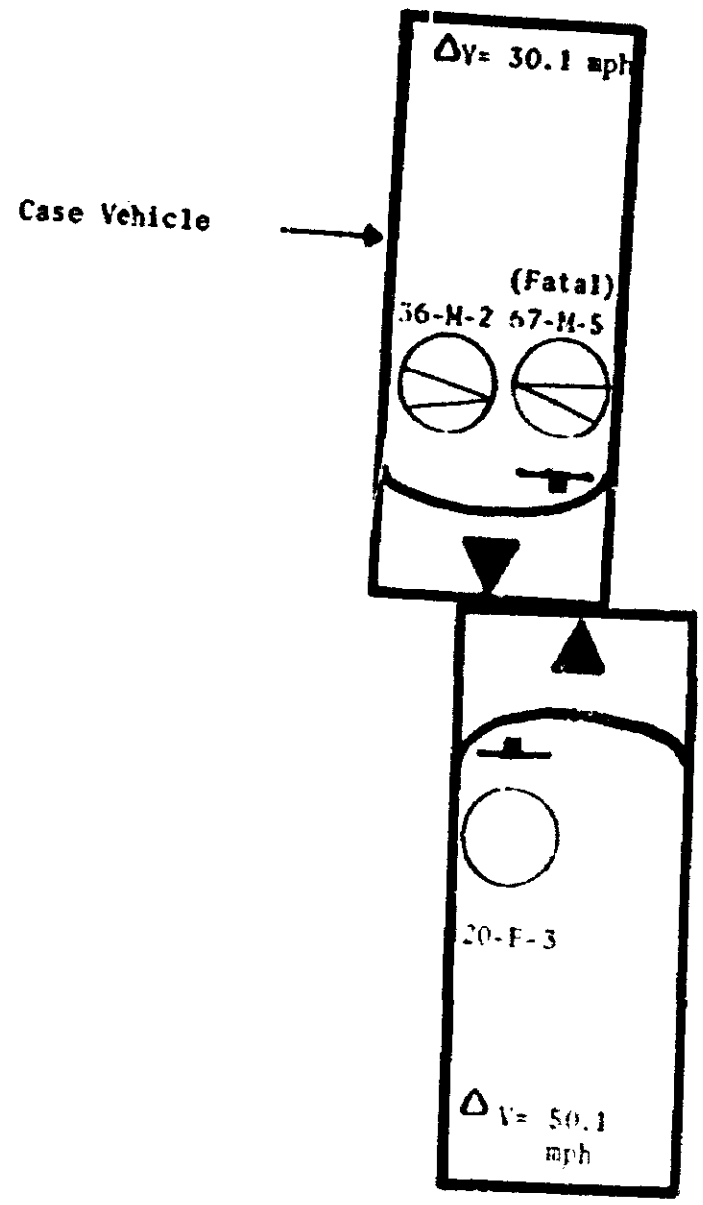
This occupant was wearing a continuous loop lap/shoulder belt equipped just like the driver's. The passenger described the precrash lap portion of the belt adjustment as being positioned low across her hips and snug. The shoulder portion was reportedly adjusted so that the palm of a hand could be placed between the webbing and the passenger's chest. Force loading marks were found on the webbing in the area of the latchplate.

Injuries	AIS	Probable Source
Abrasion, left temple	1	Unknown
Rupture of diaphragm	3	Shoulder portion of belt
Fracture, left femur	3	Instrument panel
Fracture, left wrist	2	Instrument panel
Fracture, right humerus	2	Unknown
Abrasion, left hip	1	Lap portion of belt
Abrasion, right hip	1	Lap portion of belt
Abrasion, chest	1	Shoulder portion of belt

The passenger was admitted to an area hospital for about a week. This occupant's fractured left femur seems to indicate a fair amount of forward movement of her lower body. However, if this passenger had not been wearing the available lap/shoulder belt in this 25.6 mph Delta V collision, she might have received additional and more serious injuries. The belt induced injuries are an indication of the restraining forces present for this occupant. Had she been unrestrained, those forces would have acted between the passenger and the frontal interior.

CASE 91 - (CHI 85-H-OR12)

Case Vehicle: 1980 Ford F-250 Pick-up
Case Vehicle Weight: 7,235 pounds
Case Vehicle Delta V: > 30 mph



Circumstances

A 1980 Ford pickup truck was traveling on a two-lane, snow-covered road when a Chevy 20 van, traveling in the opposite direction, slid out of control and struck the Ford nearly head-on. Both vehicles were damaged extensively across the front. The Ford pickup had a maximum crush of 52.5 inches on the left front side, and the Chevy van had a maximum crush of 44.5 inches on the left front side. The crush for both vehicles may have been greater than recorded because both vehicles were stretched by two tow trucks during the extrication process.

The driver and right front passenger in the Ford pickup were wearing lap/shoulder belts. The driver sustained critical injuries which proved fatal and the right front passenger was moderately injured. The unrestrained driver of the Chevy van received multiple serious injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 67
Height: 5 feet 8 inches
Weight: 180 pounds
Restraint Used: Lap/shoulder belt (ELR)

The driver was restrained with a lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The State Highway Patrol verified lap/shoulder belt use as a highway patrolman cut the belt.

Injuries	AIS	Probable Source
Right eye avulsed	3	Unknown sharp object
Periorbital lacerations	1	Unknown sharp object
Ruptured right ventricle	5	Steering assembly
Right front femur fracture at hip	3	Possible contact with dash
Multiple left anterior rib fractures	2	Driver door and/or steering assembly
Nondisplaced fracture of right ulna	2	Steering assembly
Left ankle fracture	2	Floorboard contact

Although the estimated Delta V (30.1 mph) may have been low due to the Ford pickup being stretched by two tow trucks, the displacement of the steering assembly and the dash into the driver's compartment probably would have made the accident unsurvivable even if the Delta V were no greater than 30 mph. According to the coroner, death was immediate: the result of a rupture of the right ventricle of the heart and intrathoracic hemorrage. Restraint use was immaterial in this accident for this driver.

Case Vehicle
Seating Location: Right Front
Sex: M
Age: 36
Height: 5 feet 10 inches
Weight: 150 pounds
Restraint Used: Lap/shoulder belt (ELR)

The right front passenger was wearing the same model and type of lap/shoulder belt as that of the driver. The passenger related that the lap portion of the belt fit snug and was low on his hips. The shoulder portion was reportedly adjusted snug across his midchest area. A latchplate loading mark was found 37 inches from the floor anchor.

Injuries	AIS	Probable Source
Laceration above left eye	1	Unknown
Abrasion to bridge of nose	1	Unknown
Compression fracture of lumbar vertebrae	2	Impact forces

The passenger was hospitalized for 4 days. He expected to be off work for at least 2 months.

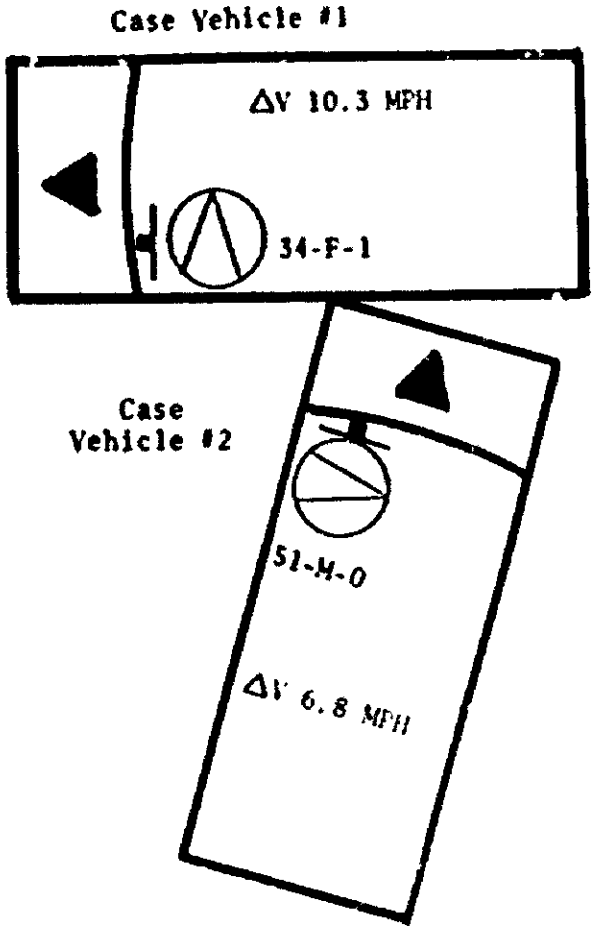
The difference in the moderate injuries sustained by the passenger, compared to the fatal injuries of the driver, apparently resulted from the much greater intrusion in the driver's area. While the left front of the pickup truck was crushed 52.5 inches, the right front was crushed only 6.5 inches. Wearing the lap/shoulder belt was an asset to the right front passenger and was responsible for preventing additional and more serious injuries.

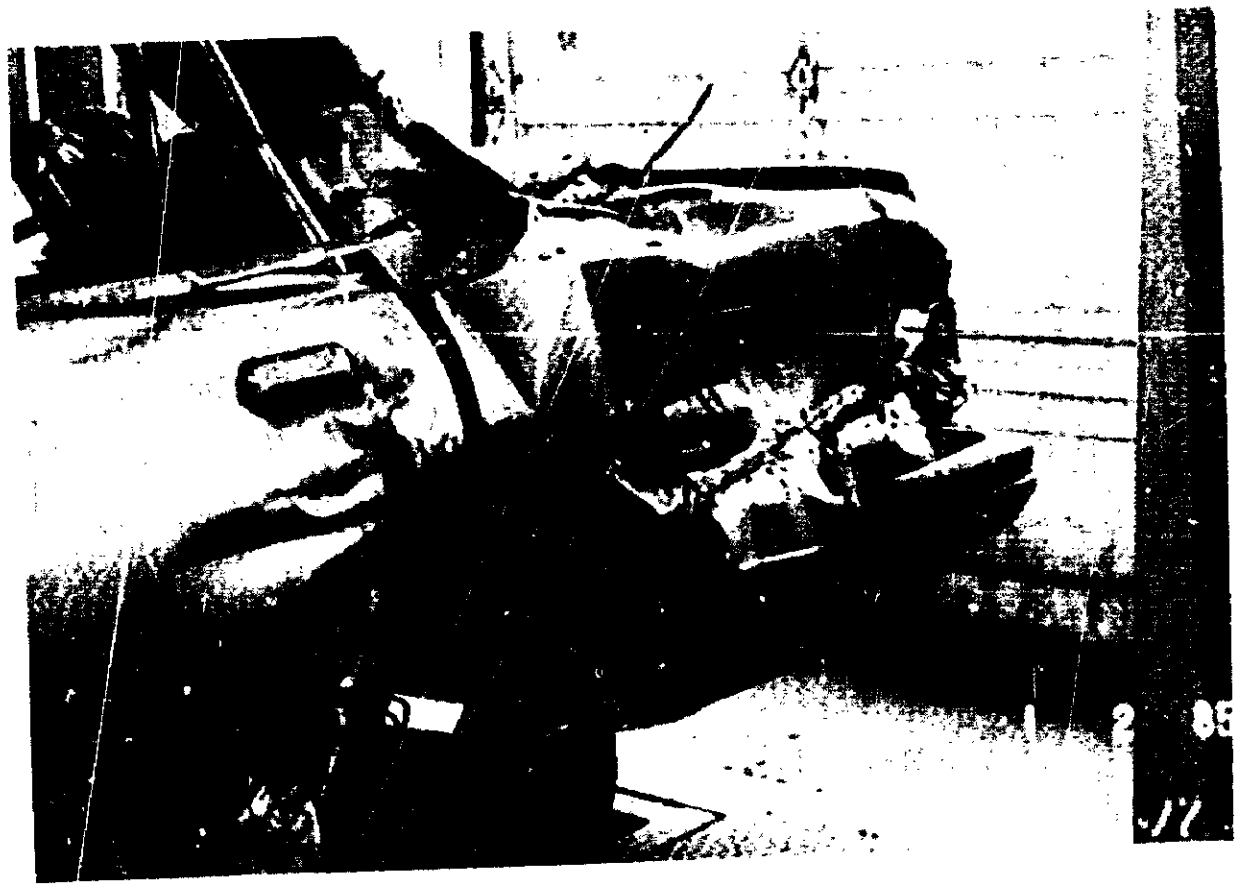
The survival of the unrestrained van driver who was subjected to a crash force Delta V estimated at over 50 miles per hour was unusual. There was no structure depth forward of his seating position to assist, by collapsing, in the force dissipation. The structure that was present deformed rearward, completely enclosing the driver within the crushed metal, requiring substantial extrication efforts on the part of rescue personnel.

CASE 92 - (SEA 85-H-OR06)

Case Vehicle #1: 1982 Mazda, 4 door
Case Vehicle Weight: 2,770 pounds
Case Vehicle Delta V: 10.3 mph

Case Vehicle #2: 1980 Jeep Cherokee, 4 door station wagon
Case Vehicle Weight: 4,190 pounds
Case Vehicle Delta V: 6.8 mph





CASE VEHICLE #1

CASE VEHICLE #2

Circumstances

A 1982 Mazda went out of control on a snow-packed road, slid broadside, and struck an on-coming 1980 Jeep. The Mazda had maximum crush of 7.5 inches to the left rear side of the car. A maximum crush of 17.5 inches was sustained to the left front of the Jeep.

The Mazda driver, restrained by a lap/shoulder belt, sustained minor injuries. The Jeep driver, restrained by a lap/shoulder belt but with the shoulder portion of the belt routed under his left arm, was not injured.

Restraint and Injury

Case Vehicle #1 - 1982 Mazda
Seating Location: Driver
Sex: F
Age: 34
Height: 5 feet 2 inches
Weight: 135 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion and webbing travel, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver described precrash lap portion of the belt as being snug with the shoulder portion being worn over her heavy winter coat. The restraint's D-ring had a webbing imprint on it.

Injuries	AIS	Probable Source
Abrasion, left side of neck	1	Shoulder belt
Contusion, left side of abdomen	1	Arm rest on driver's door

The driver received medical treatment at a local hospital and was released. She did not miss any work time as a result of the injuries. Considering the Delta V of 10.3 mph and the impact into the driver's side of the vehicle it is likely that the restraint was not of benefit in reducing or preventing injuries. Restraint use can not prevent an occupant from contacting the adjacent interior sidewall.

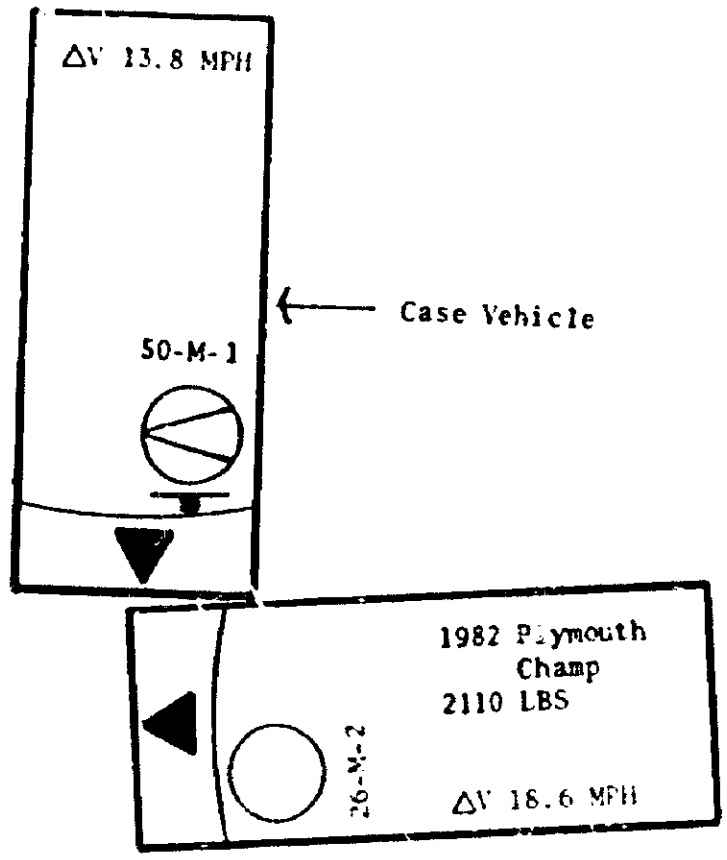
Case Vehicle #2 - 1980 Jeep
Seating Location: Driver
Sex: M
Age: 51
Height: 5 feet 8 inches
Weight: 185 pounds
Restraint Used: Lap/shoulder belt (ELR)

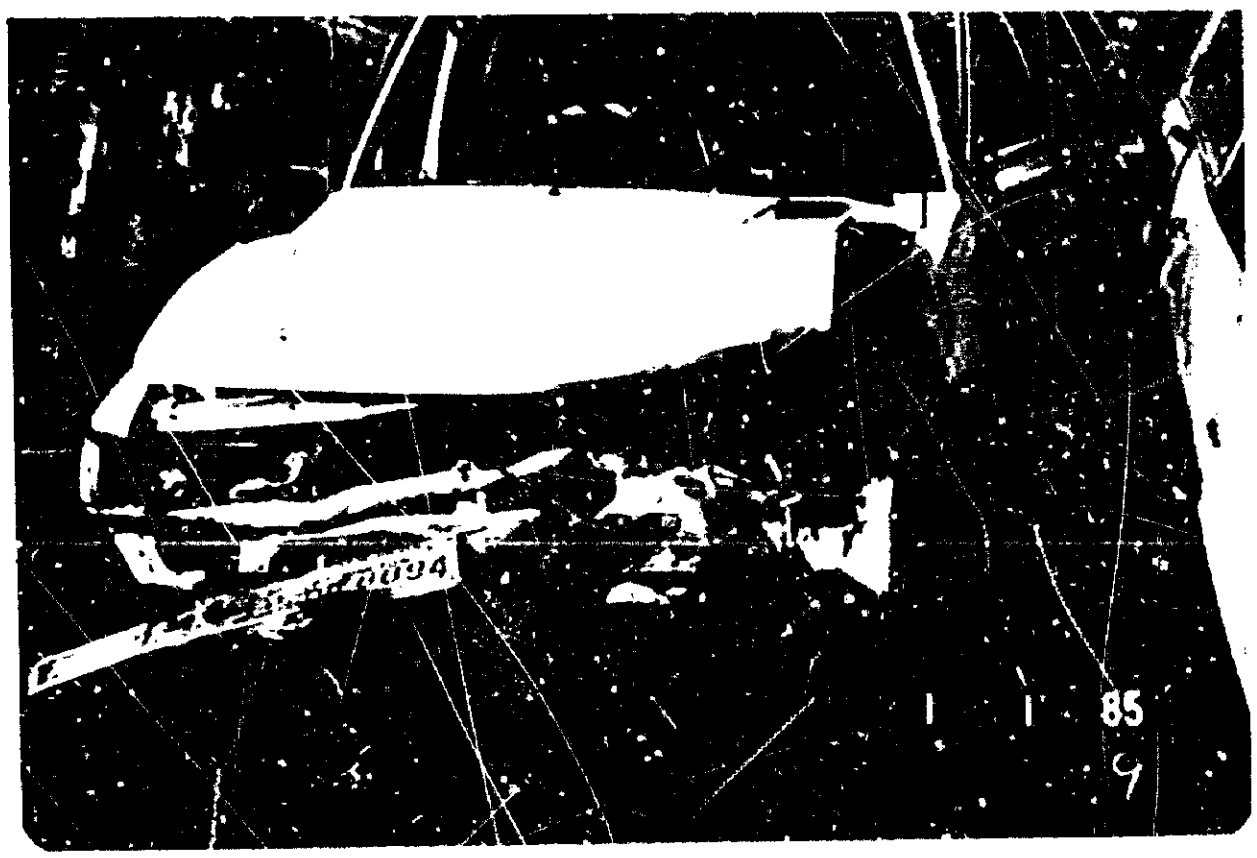
The driver was wearing a continuous loop lap/shoulder belt equipped with a self-tensioning emergency locking retractor sensitive to vehicle motion, a cinching latchplate, and a stalk-mounted buckle assembly. The precrash restraint usage was described as follows: the lap portion of the belt was loose across the hips, resting on top of driver's thighs; the shoulder portion was being worn under the left arm. The driver related that he tucked the shoulder portion under his arm because he feels constrained otherwise. No loading marks were found on the webbing.

This driver did not receive any injuries. It is likely that this driver would not have been injured in this 6.8 mph Delta V collision even if he had not been restrained. He was fortunate that crash severity was so low that the misrouting did not prove injurious.

CASE 93 - (SEA 85-H-OR11)

Case Vehicle: 1982 Datsun pick-up
Case Vehicle Weight: 2,860 pounds
Case Vehicle Delta V: 13.8 mph





Circumstances

A 1982 Datsun pick-up traveled through an intersection and struck a 1981 Plymouth Champ in the right front. The impact caused a second collision between the vehicles. The Datsun received substantial structural damage with maximum deformation to the left front of 13 inches. The Plymouth sustained substantial damage over a 60-inch wide area of the right front with deformation of up to 10 inches.

The Datsun driver, restrained by a lap/shoulder belt, sustained minor injuries. The unrestrained driver of the Plymouth sustained moderate injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 50
Height: 5 feet 8 inches
Weight: 175 pounds
Restraint Used: Lap/shoulder belt (ELR)

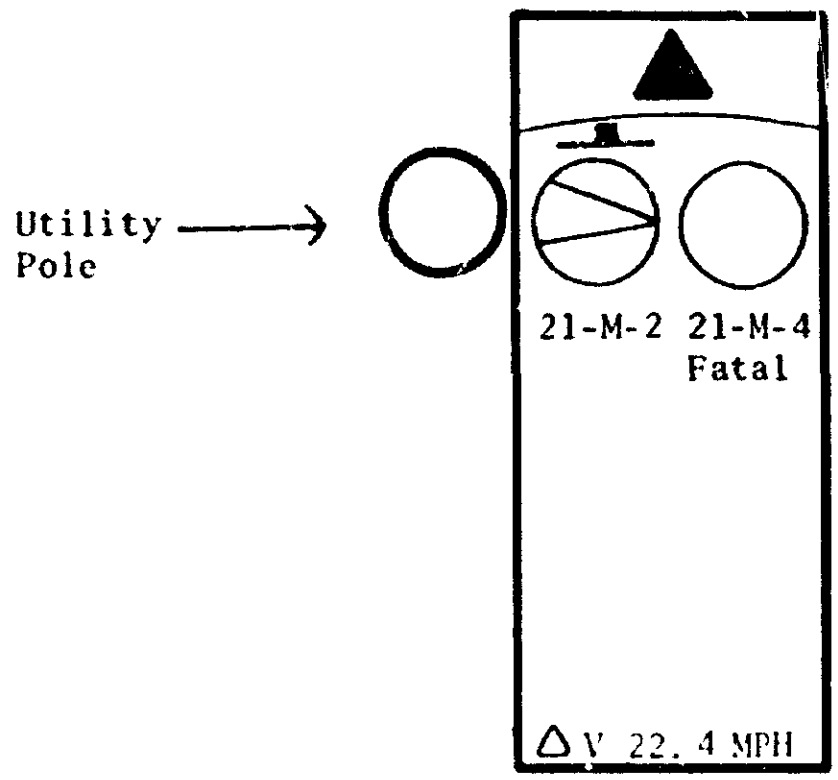
The driver was wearing a continuous loop lap/shoulder belt equipped with a self-tensioning emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver stated that the shoulder portion was very "loose," allowing more than a clenched fist between the chest and the belt. Postcrash testing confirmed the driver's statement. The self-tensioning retractor spring provided little resistance and allowed the webbing to be limp or slack.

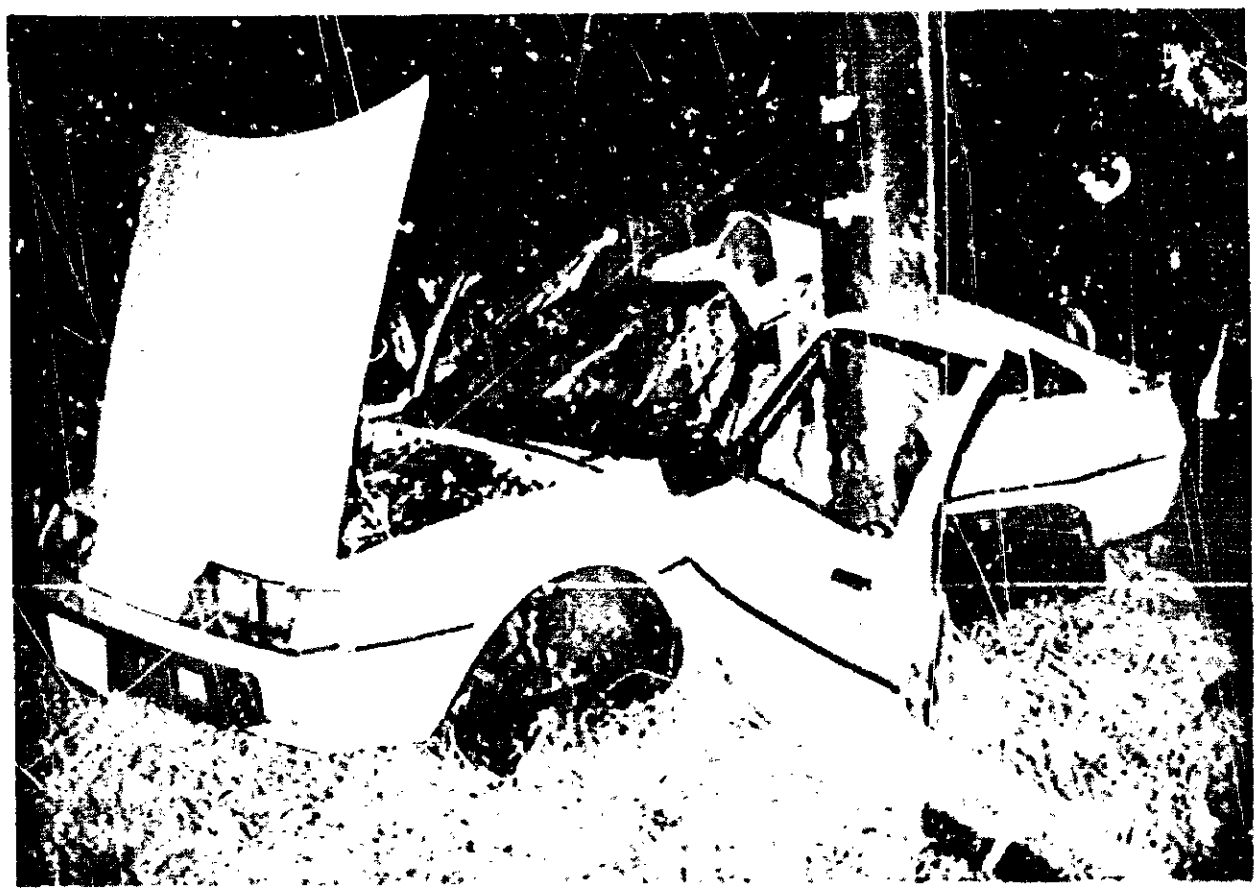
Injuries	AIS	Probable Source
Laceration, left forehead	1	Driver's door or window frame
Contusion, lower left ribs	1	Driver's door and arm rest

This driver received medical treatment at a local hospital and was released. He reported the loss of 1 workday as a result of the accident. Although adjusted loosely, according to the driver, the restraint system prevented the driver from contacting the frontal interior during the initial, 13.8 mph Delta V collision, but could not prevent his contact with the interior sidewall as the secondary collision occurred. An unrestrained driver might have received additional injuries from the steering assembly.

CASE 94 - (NYC 85-H-OR11)

Case Vehicle: 1984 Mitsubishi Cordia L, 2-door
Case Vehicle Weight: 2,628 pounds
Case Vehicle Delta V: 22.4 mph





Circumstances

The driver of a 1984 Mitsubishi Cordia L lost control of the vehicle on an icy road. The vehicle rotated clockwise as it slid to the right and then struck a 15-inch diameter metal light pole with its left side. The vehicle struck the pole at the left B-pillar, crushing the left side of the car inward behind the driver's position. The car then rotated about 180 degrees clockwise around the pole and came to rest several feet from the pole. The Mitsubishi received major structural damage with deformation of up to 28 inches over a 89.5-inch area of the left side. The primary damage was to the driver's door and left B-pillar. This area was torn open. The right front door also came open during the crash.

The driver of the Mitsubishi, restrained by a lap/shoulder belt, received moderate injuries. The unrestrained passenger in the Mitsubishi received severe injuries which proved fatal. The driver of the Mitsubishi, was found lying outside the car with his back against the door sill, still wearing his lap/shoulder belt. The right front passenger, who had been unrestrained, was found lying outside the car with his feet still inside the vehicle.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 21
Height: 6 feet
Weight: 210 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk mounted buckle assembly. The driver stated that the precrash lap portion of the belt adjustment was positioned "across his waist," near his navel, and snug. The shoulder portion was reportedly adjusted so that the palm of a hand could be placed between the webbing and the driver's chest. Force loading marks were found on the webbing as well as a black cloth transfer on the D-ring. A police officer witnessed the accident, immediately went over to the vehicle and observed the driver crouched outside of the driver's door, partially suspended by the restraint system, and leaning against the door sill. Rescuers had to cut both the lap and shoulder portion of his belt to free him and administer first aid. Restraint use was further confirmed by loading marks on the belt. The severe impact damage to the B-pillar, where the belt retractor is located, most likely damaged the retractor and allowed excess webbing to be played out. The left B-pillar made direct contact with the 15-inch diameter steel utility pole, causing the driver's door to pop open. Approximately 28 inches of crush resulted.

Injuries	AIS	Probable Source
Lacerations, right scalp	1	Passenger
Closed head injury	2	B-pillar
Contusion, lower abdomen	1	Lap portion of belt

The driver was admitted to an area hospital for 3 1/2 days but reported no loss of time from his college classes. Although the retractor was not removed due to inaccessability, the direct contact and severe damage to the B-pillar, where the retractor is located, most likely caused a malfunction to the retractor, introduced slack into the system, and allowed the driver to be ejected. Considering the side impact, the lap/shoulder belt use probably had little positive effect, but use may have benefited the driver during rotation prior to impact.

Case Vehicle

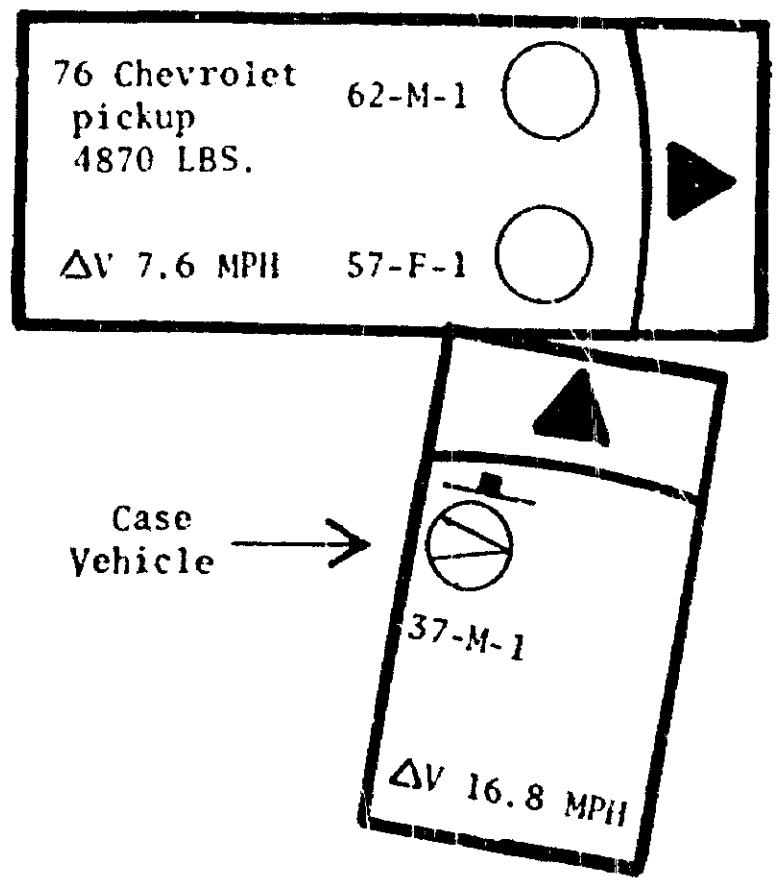
Seating Location:	Right Front
Sex:	M
Age:	21
Height:	5 feet 11 inches
Weight:	185 pounds
Restraint Used:	None

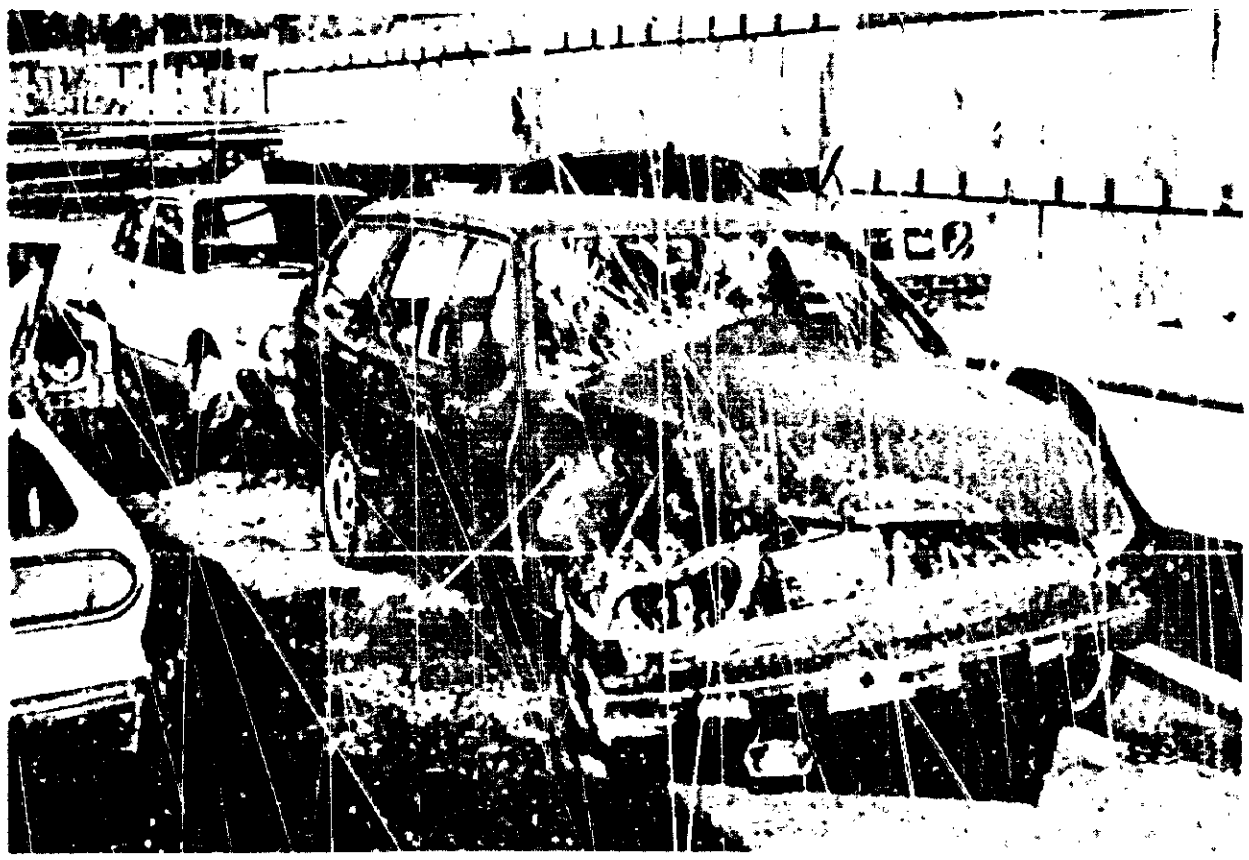
Injuries	AIS	Probable Source
Fracture, left cranium, exposed brain tissue	4	Bolt on D-ring
Abrasions, left cheek	1	Driver/rearview mirror
Abrasions, left side of neck	1	Steering wheel/ instrument panel
Abrasions, left leg	1	Instrument panel
Fractures, 5th, 6th and 7th ribs	2	Driver/steering wheel
Laceration, spleen	3	Ribs

The majority of this occupant's injuries likely resulted as he was thrown into the driver and the left B-pillar. The rotation of the vehicle then caused the ejection of the passenger out of the open right front door. Considering at therewas survivable space left at this occupant's position, it is likely that he would have survived this 22.4 mph Detla V collision if he had worn the lap/shoulder belt available to him.

CASE 95 - (SEA 85-H-OR09)

Case Vehicle: 1975 Volkswagen Dasher, 4-door station wagon
Case Vehicle Weight: 2,198 pounds
Case Vehicle Delta v: 16.8 mph





Circumstances

A 1982 Chevrolet Camaro was traveling westbound on a divided highway when the driver lost control. The vehicle went off the roadway, struck a utility pole, and rolled onto its roof. This caused deformation along the entire front of the vehicle with a maximum deformation of 27.5 inches in the area of impact, along with moderate deformation of the roof structure. Note: This vehicle had a T-top type roof with the glass inserts removed.

The driver, restrained by a lap/shoulder belt, received only minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 17
Height: 5 feet 9 inches
Weight: 130 pounds
Restraint Used: Lap/shoulder belt (ELR)

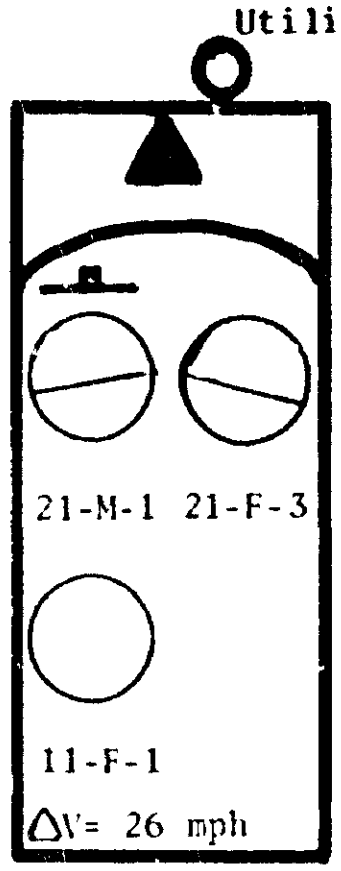
The driver was wearing a lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver described the lap portion of the belt as "snug," with no excessive slack in the shoulder portion. Force loading marks were found on the webbing at the latchplate's location.

Injuries	AIS	Probable Source
Multiple small scalp lacerations	1	Left A-pillar and shattered windshield.

The driver was treated and released at a nearby hospital. His use of the lap/shoulder belt undoubtedly prevented him from going forward when striking the pole and then held him in his seat during the rollover. Considering the 23 mph Delta V of the frontal hit, it is very likely that wearing the belt prevented serious injury. An additional consideration, had the driver been unrestrained, would have been a possibility of ejection through the open T-top at some point during the rollover.

CASE 96 - (ATL 85-H-OR12)

Case Vehicle 1979 Volkswagen Rabbit 2 Door
Case Vehicle Weight: 2,137 pounds
Case Vehicle Delta V: 26 mph



2 point
passive restraint

Circumstances

A Volkswagen sedan negotiating a left curve left the roadway to the right, struck a utility pole head-on, and then rotated clockwise before coming to rest on the roadway. The right front of the Volkswagen was deformed rearward a maximum of 26 inches.

The driver, restrained by a 2-point automatic shoulder belt (passive restraint), received minor injuries. The right front seat passenger, who was also restrained by an automatic shoulder belt, suffered serious injuries, and the unrestrained left rear seat passenger received minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 21
Height: 5 feet 11 inches
Weight: 180 pounds
Restraint Used: 2-point automatic shoulder belt (passive restraint)

The driver was wearing a 2-point automatic shoulder belt equipped with an emergency locking retractor. The driver said that he was able to get more than a clenched fist between his chest and the belt.

Injuries	AIS	Probable Source
Contusion of left arm	1	Steering wheel
Abrasion of right arm	1	Unknown

The driver was not hospitalized and reported no loss of work. Considering the 26 mph change in velocity at impact, it is apparent that the 2-point belt prevented the driver from being more seriously injured. An unrestrained driver would have been free to make more violent contacts with the frontal interior.

Case Vehicle
Seating Location: Right Front
Sex: F
Age: 21
Height: 5 feet 3 inches
Weight: 130 pounds
Restraint Used: 2-point automatic shoulder belt (passive restraint)

The right front seat passenger was restrained by a 2-point automatic shoulder belt that was equipped with an emergency locking retractor. She described the belt fit as being able to get more than a clenched fist between her chest and the belt. She related that, just before the crash, she had turned to the left to retrieve her pet that had jumped onto the driver's lap.

Injuries	AIS	Probable Source
Abrasion over right eye	1	A-pillar or windshield
Cerebral concussion	2	A-pillar or windshield
Comminuted fracture of right femur	3	Impact loading at lower dash
Contusion of right patella	2	Lower dash padding
Abrasion, right side of abdomen	1	Right front door window crank

After the crash, this passenger was reportedly found resting on the floor, with her back against the right front door panel and her legs extended forward on the driver's side.

This passenger was hospitalized for 1 week and expected to be absent from work for 3 months. She received substantially less benefit from the restraint than did the driver. This was probably due to her being out of position and introducing slack into the belt system when she reached for the dog. The dog, a miniature dachshund, was killed in the accident. Slack in the belt system apparently permitted her to submarine at impact and probably added to impact loading of the right femur.

Case Vehicle
Seating Location: Left Rear
Sex: F
Age: 11
Height: 5 feet 2 inches
Weight: 90 pounds
Restraint Used? No

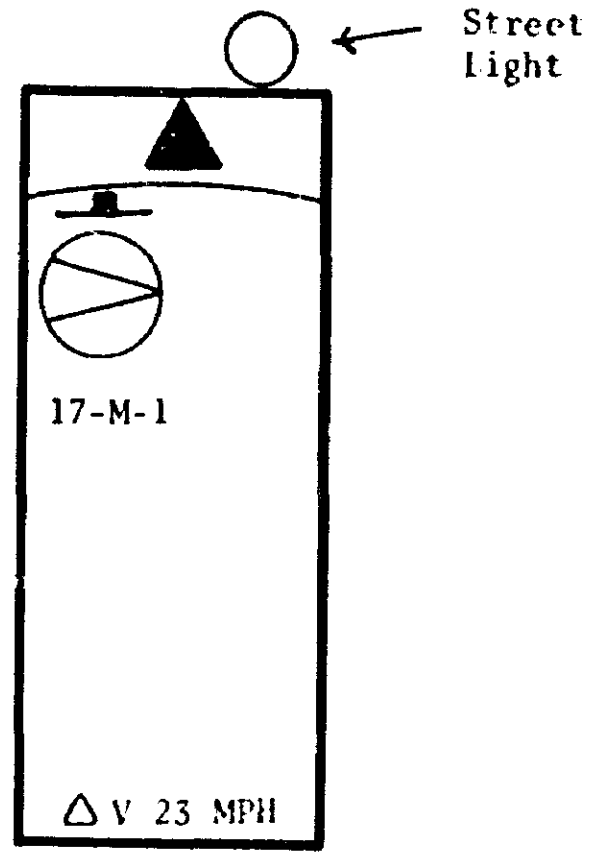
Although the rear seat was equipped with lap belts, this passenger was unrestrained. She said that she does not like to wear seat belts.

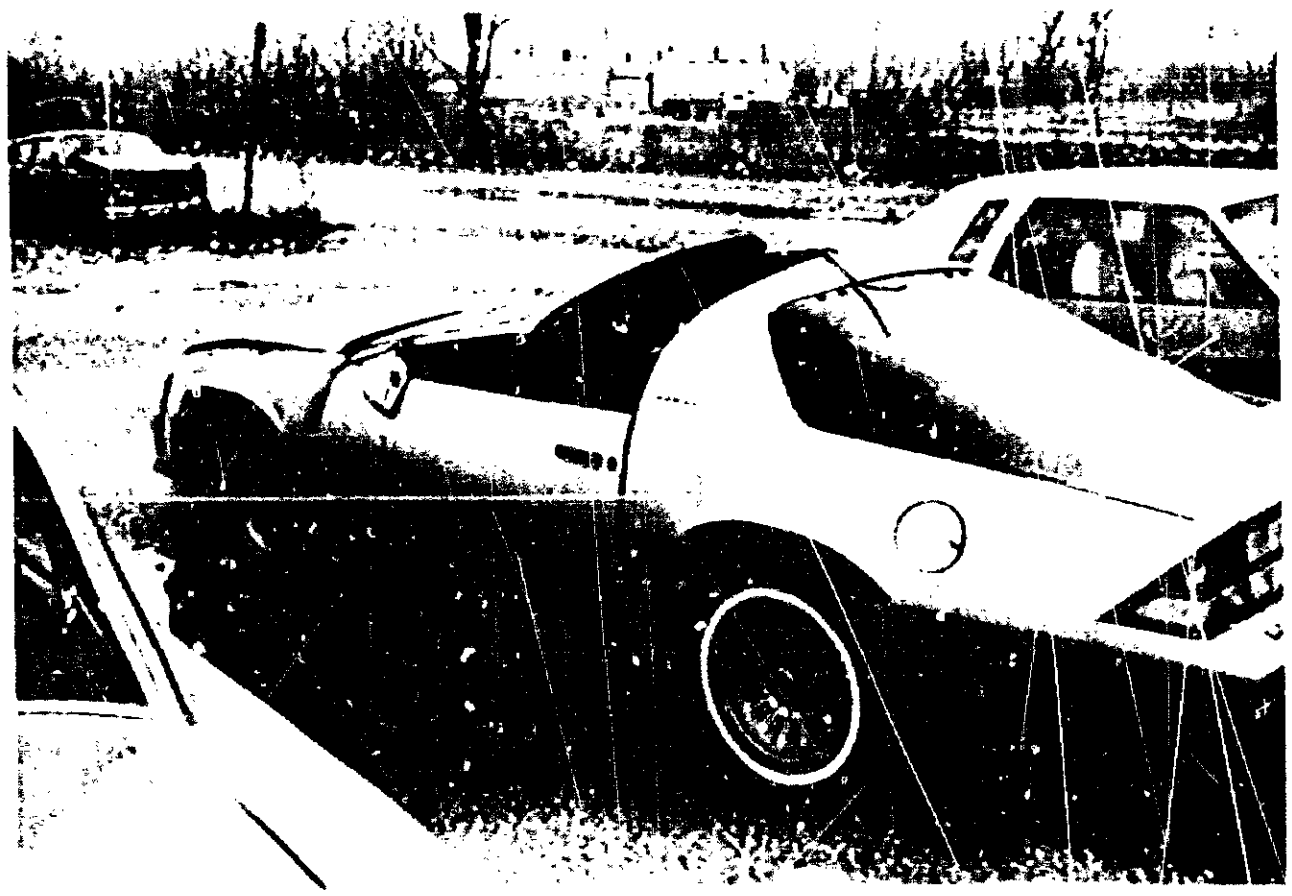
Injuries	AIS	Probable Source
Contusion to right shoulder	1	Rear of front seat
Abrasion on right thigh	1	Rear of front seat
Sprained ankle	1	Bottom of driver's seat

This passenger was treated at a hospital emergency room and was released. She was absent from school for 5 days. It is believed that this passenger would not have benefited from use of the rear seat lapbelt in this 26 mph Delta V frontal collision. Had she been wearing the lap belt, the entire decelerative force would have been concentrated at the 2 inch wide belt rather than the rear portion of the front seat.

CASE 97 - (MKC 85-H-OR11)

Case Vehicle: 1982 Chevrolet Camaro
Case Vehicle Weight: 3,130 pounds
Case Vehicle Delta V: 23 mph (followed by 90-degree rollover)





Circumstances

A 1982 Chevrolet Camaro was traveling westbound on a divided highway when the driver lost control. The vehicle went off the roadway, struck a utility pole, and rolled onto its roof. This caused deformation along the entire front of the vehicle with a maximum deformation of 27.5 inches in the area of impact, along with moderate deformation of the roof structure. Note: This vehicle had a T-top type roof with the glass inserts removed.

The driver, restrained by a lap/shoulder belt, received only minor injuries.

Restraint and Injury

Case Vehicle

Seating Location:	Driver
Sex:	M
Age:	17
Height:	5 feet 9 inches
Weight:	130 pounds
Restraint Used:	Lap/shoulder belt (ELR)

The driver was wearing a lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver described the lap portion of the belt as "snug," with no excessive slack in the shoulder portion. Force loading marks were found on the webbing at the latchplate's location.

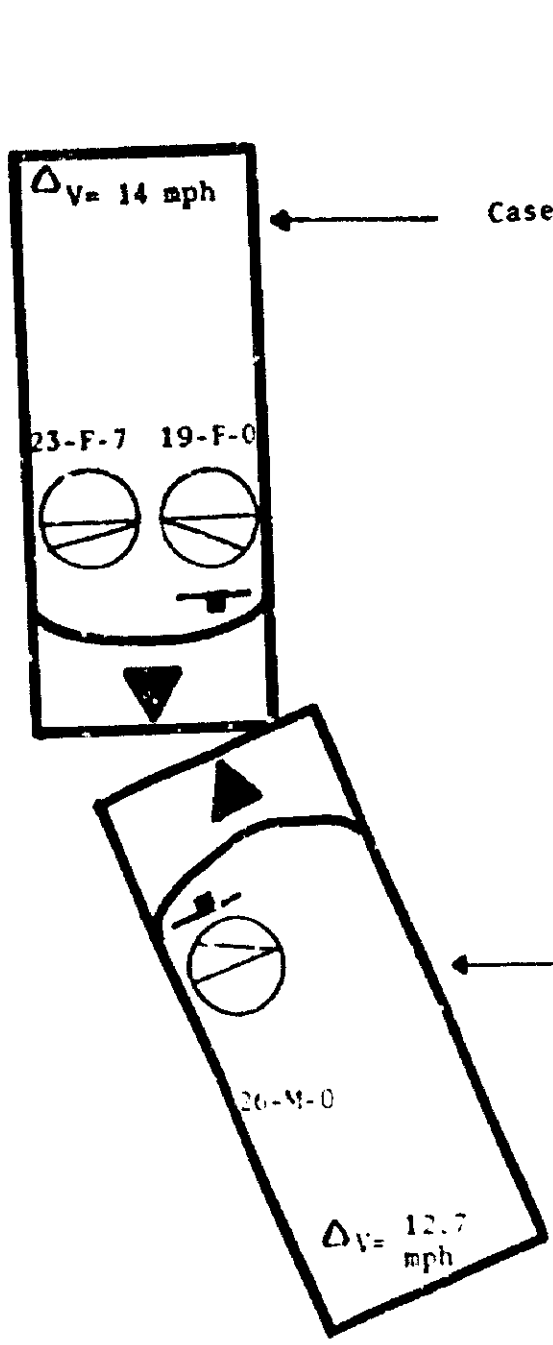
Injuries	AIS	Probable Source
Multiple small scalp lacerations	1	Left A-pillar and shattered windshield.

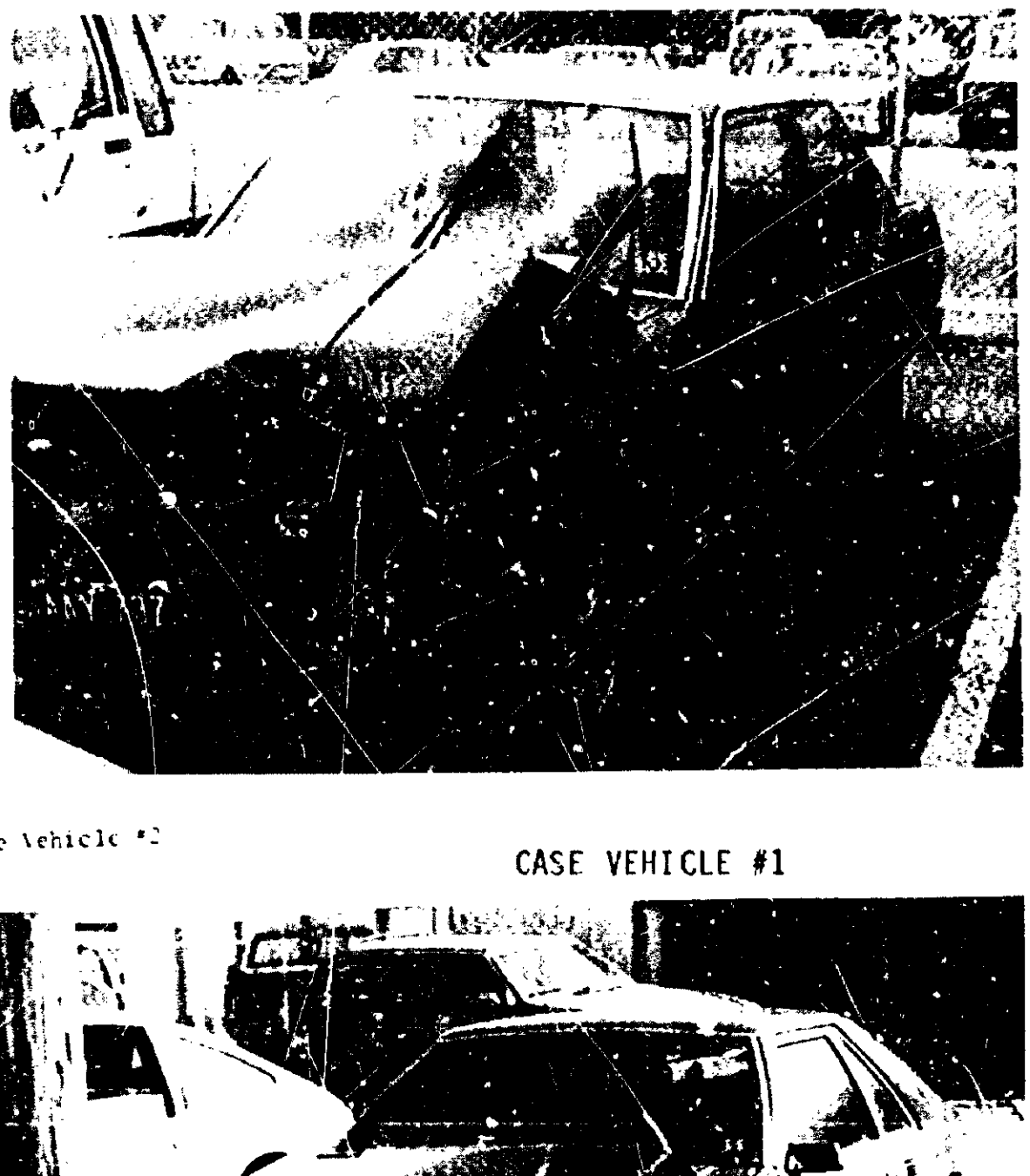
The driver was treated and released at a nearby hospital. His use of the lap/shoulder belt undoubtedly prevented him from going forward when striking the pole and then held him in his seat during the rollover. Considering the 23 mph Delta V of the frontal hit, it is very likely that wearing the belt prevented serious injury. An additional consideration, had the driver been unrestrained, would have been a possibility of ejection through the open T-top at some point during the rollover.

CASE 99 - (DEN 84-H-OR39)

Case Vehicle #1: 1982 Toyota Corolla 2 door
Case Vehicle Weight: 2,530 pounds
Case Vehicle Delta V: 14 mph

Case Vehicle #2: 1980 Ford Mustang 2 door
Case Vehicle Weight: 2,775 pounds
Case Vehicle Delta V: 12.7 mph





CASE VEHICLE #1

CASE VEHICLE #2

Circumstances

A 1982 Toyota Corolla and a 1980 Ford Mustang were approaching an intersection from opposite directions when the Ford attempted a left turn in the intersection and struck the Toyota on the left front corner. The Toyota sustained substantial damage to the left front and front. The Ford sustained substantial front damage.

The Toyota driver and passenger refused to cooperate fully with the Safety Board investigation, but the police report indicated that the driver was uninjured and the right front passenger received minor injuries. Both were restrained with lap/shoulder belts. The Ford driver, restrained by a lap/shoulder belt, reported no injuries.

Restraint and Injury

Case Vehicle #1 - 1982 Toyota
Seating Location: Driver
Sex: F
Age: 19
Height: Unknown
Weight: Unknown
Restraint Used: Lap/shoulder belt (ELR)

The driver of the Toyota was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to webbing acceleration, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver stated that the precrash lap portion of the belt was positioned snug across the hip area. The shoulder portion of the restraint was reportedly positioned across the shoulder with no statement given about the snugness.

Injuries: None.

No statement was given by the driver concerning any loss of time from work. Considering the 14 mph Delta V in this collision, this driver's use of the available lap/shoulder belt most likely prevented contact with the steering wheel, instrument panel, and possibly the windshield.

Case Vehicle #1 - 1982 Toyota
Seating Location: Right Front
Sex: F
Age: 23
Height: Unknown
Weight: Unknown
Restraint Used: Lap/shoulder belt (ELR)

The passenger in the Toyota was wearing a continuous loop lap/shoulder belt equipped just like the driver's. Due to this passenger's refusal to cooperate with the Safety Board investigation, nothing is known concerning the fit of the lap/shoulder belt. The only evidence even supporting this occupant's use of the belt is the statement of the driver.

Injuries: Unspecified minor injuries.

No information was available relating to this occupant's medical treatment or loss of time from work. Since the nature of her injuries are unknown it is difficult to speculate on what would have happened had she not been restrained.

Case Vehicle #2 - 1980 Ford Mustang

Seating Location:	Driver
Sex:	M
Age:	26
Height:	5 feet 10 1/2 inches
Weight:	175 pounds
Restraint Used:	Lap/shoulder belt (ELR)

The driver of the Ford was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver stated that the lap portion of the belt was positioned snug across his abdomen. The shoulder portion was reportedly adjusted so that the palm of a hand could be placed between the webbing and the driver's chest. Force loading marks were found on the webbing in the area of the B-pillar mounted D-ring.

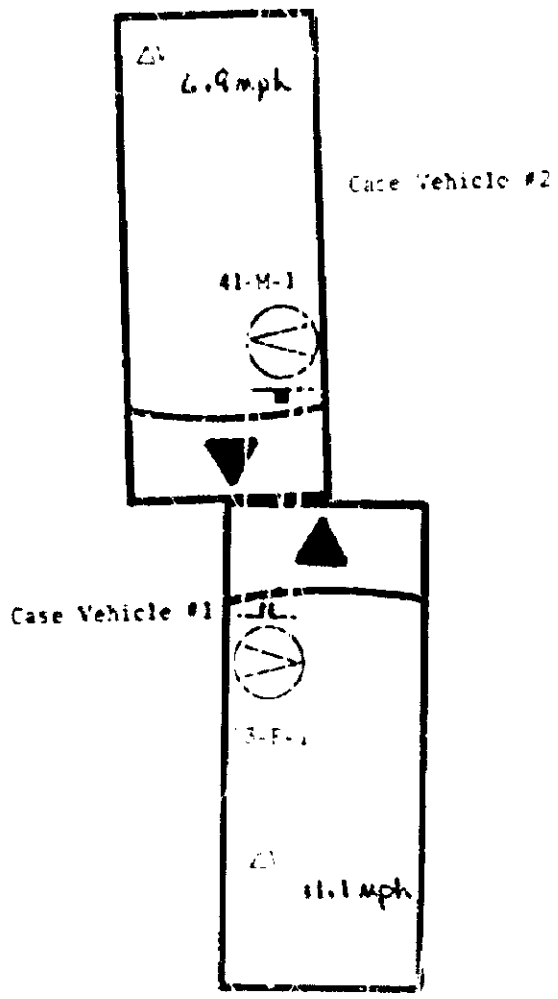
Injuries: None.

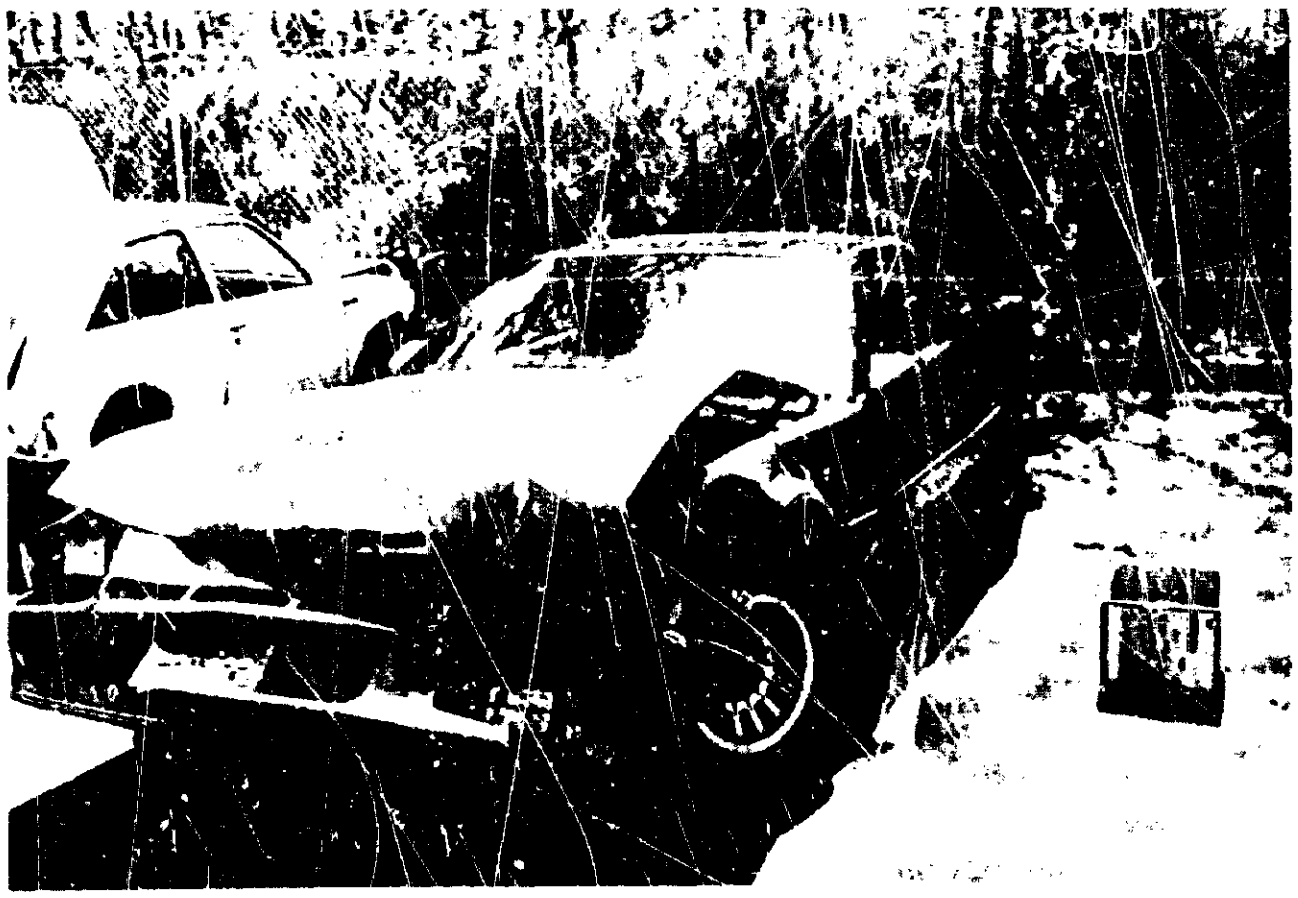
The driver reportedly visited no hospital and missed no time from work. Had this driver not been wearing the available restraint system, he would have been thrown forward and to the right, possibly contacting the instrument panel. He may have received a few minor injuries in this 12.7 mph Delta V collision.

CASE 100 - (ATL 85-H-OR11)

Case Vehicle #1: 1982 Chevrolet Camaro, 2 door
Case Vehicle Weight: 3,125 pounds
Case Vehicle Delta V: 11.1 mph

Case Vehicle #2: 1977 Lincoln Mark V, 2 door
Case Vehicle Weight: 5,051 pounds
Case Vehicle Delta V: 6.9 mph





Circumstances

A 1982 Chevrolet Camaro slid out of control on a wet road, crossed over the center line, and struck a 1977 Lincoln head on. The Camaro received moderate structural damage to the left front with deformation of up to 16 inches. The much heavier Lincoln received minor structural damage to the left front, with deformation of up to 8 inches.

Both drivers were wearing their available lap/shoulder belts and received only minor neck injuries. The driver of the Lincoln also suffered sore back muscles. The driver of the Chevrolet was wearing the shoulder portion of his belt improperly routed under his left arm.

Restraint and Injury

Case Vehicle #1 - 1982 Chevrolet
Seating Location: Driver
Sex: F
Age: 33
Height: 5 feet 6 inches
Weight: 125 pounds
Restraint Used: Misrouted lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver described the lap portion of the belt as being snug fitting across the lower part of her hips. The shoulder portion was misrouted; worn under her left arm for comfort purposes. There were no force marks found on the restraint webbing.

Injuries	AIS	Probable Source
Cervical strain	1	Impact forces

This driver did not receive medical treatment for her injury but claimed she experienced headaches for several days afterwards. The restraint system was probably beneficial in this 12 mph Delta V collision, however, the driver was fortunate that the crash forces were not greater. Had a more severe collision occurred, the misrouted belt would likely have resulted in additional injuries.

Case Vehicle #2 - 1977 Lincoln
Seating Location: Driver
Sex: M
Age: 41
Height: 5 feet 11 inches
Weight: 180 pounds
Restraint Used: Lap/shoulder belt with dual retractors (ALR/ELR)

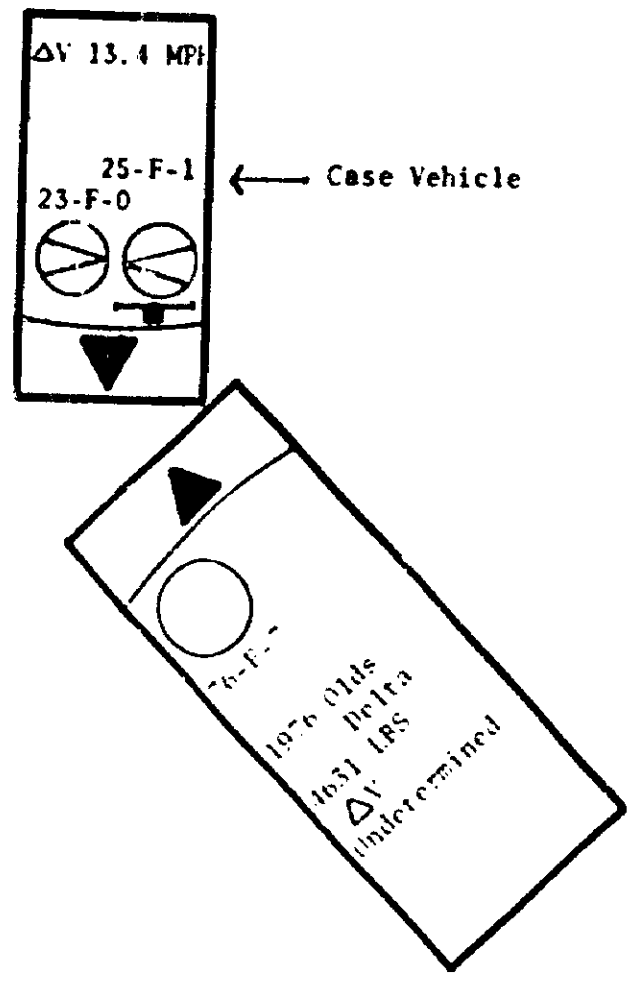
This driver was wearing a lap/shoulder restraint with dual retractors, and sewn-in latchplate. The lap portion was equipped with an automatic locking retractor. The shoulder portion was equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension relief device, and a stalk-mounted buckle assembly. The driver described precrash restraint adjustment as being snug fitting for both portions of the belt. The driver reported that the shoulder retractor failed to spool-in excess webbing when buckled; however, reeling the belt out inches further and then releasing it overcame the problem. This statement may reflect a weak retractor spring or, more probably, the driver's ignorance about how the windowshade device functioned.

Injuries	AIS	Probable Source
Acute cervical strain	1	Impact forces
Back muscle sprain	1	Impact forces

This driver did not receive medical treatment for his injury. Given the low Delta V of 6.9 mph for the Lincoln, is is likely that the restraint was not a real factor in prevention of injuries. An unrestrained driver would have been susceptable to the same minor level of injuries.

CASE 101 - (FTW 85-H-0R29)

Case Vehicle: 1985 Mazda RX-7 2 door
Case Vehicle Weight: 2,660 pounds
Case Vehicle Delta V: 13.4 mph



Circumstances

The left front of a 1985 Mazda RX-7 struck the right front of a 1976 Oldsmobile 88 2-door coupe. This accident resulted in substantial damage to the Mazda, with deformation up to 30 inches at the left front. The much heavier Oldsmobile sustained minor damage.

Both the driver and right front passenger of the Mazda were lap/shoulder belt restrained. The driver received minor injuries while her passenger reportedly was not injured. The unrestrained Oldsmobile driver reportedly received minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 25
Height: 5 feet 9 inches
Weight: 138 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an ELR, a free-sliding latchplate, and a push-button release buckle attached to a flexible stalk. The driver described the precrash adjustment of the lap portion of the belt as snug, positioned "low on her hips." The shoulder portion was self-tensioning so the shoulder portion was snug against her upper torso. However, the buckle stalk extended 7 inches above and 7 inches forward of the seat cushion. This meant the buckle/latchplate location caused the shoulder portion of the belt to be positioned far forward of the abdomen and lower chest area. There were force loading marks on the webbing attributed to webbing load at the D-ring and latchplate.

Injuries	AIS	Probable Source
Contusion, right forehead	1	Rearview mirror

This woman was examined at an outpatient medical facility and released. She might have received additional injuries if she had been unrestrained in this 13.4 mph Delta V collision, making uncontrolled contact with the windshield and frontal interior. The performance of the lap/shoulder belt could probably be upgraded if the buckle/latchplate attachment did not extend so far forward of the seat cushion.

Case Vehicle
Seating Location: Right Front
Sex: F
Age: 23
Height: 5 feet 10 inches
Weight: 140 pounds
Restraint Used: Lap/shoulder belt (ELR)

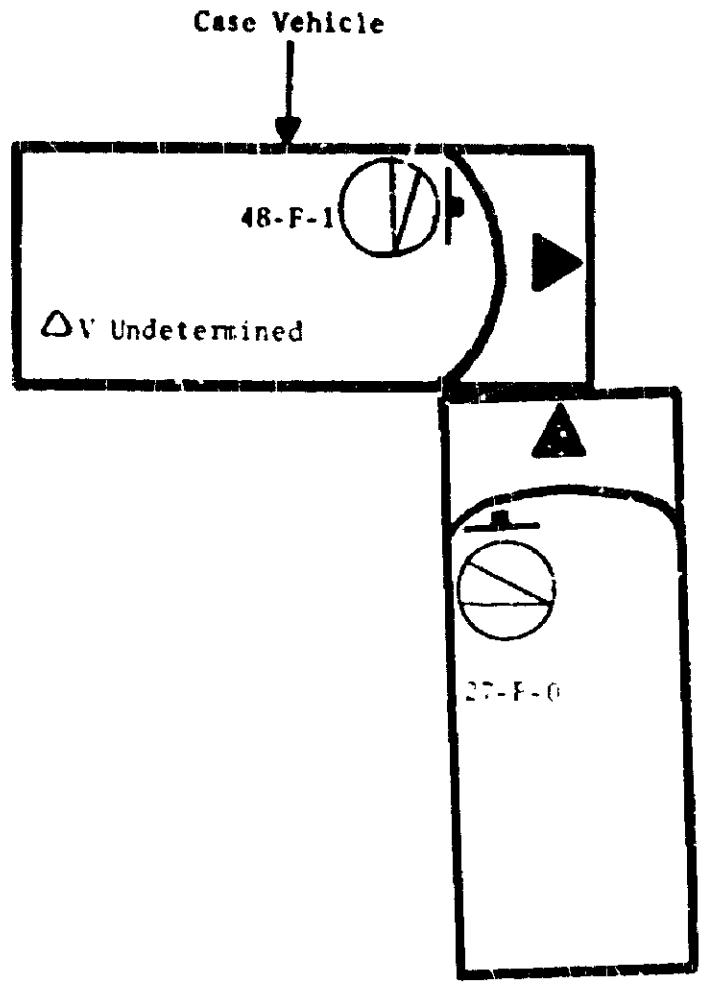
This occupant used a lap/shoulder belt identical to the driver's. No information concerning the precrash adjustment of the belt was furnished by this occupant. However, the absence of any contact points on the frontal interior and the loading marks on the webbing indicate that the belt was probably worn properly.

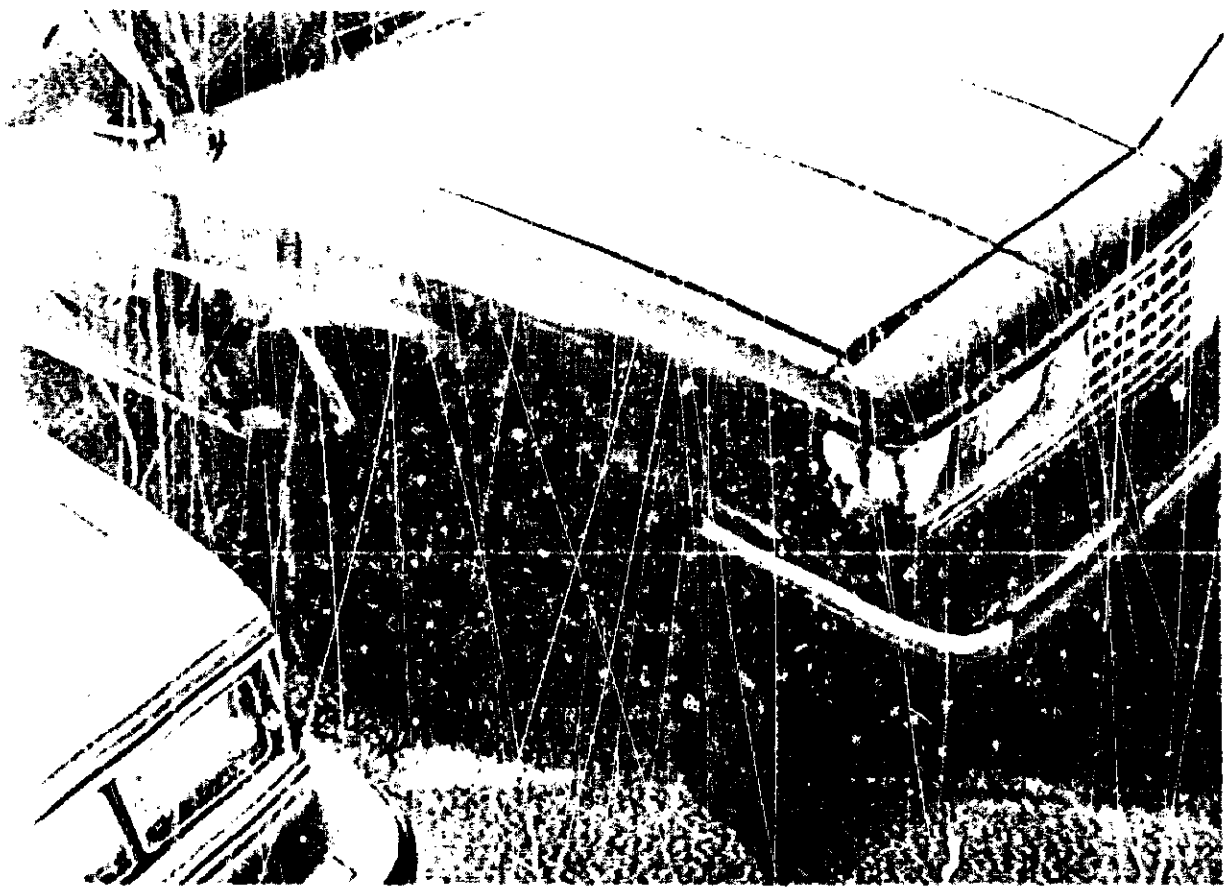
Injuries: none.

This passenger complained of soreness but she did not seek medical attention. Use of the available restraint prevented her from uncontrolled contact with the interior surfaces of the vehicle in this 13.4 mph Delta V collision. She might have received injuries had she not been restrained.

CASE 102 - (FTW 85-H-OR24)

Case Vehicle: 1983 Oldsmobile Ciera
Case Vehicle Weight: 2,970 pounds
Case Vehicle Delta V: Undetermined





Circumstances

The 1983 Oldsmobile was traveling northbound when it struck the left front of a 1976 Chevrolet Malibu attempting to cross the northbound lanes of traffic. Damage to the Oldsmobile extended from the right front corner rearward to just behind the A-pillar. While there was only 6 inches of inward deformation, the impact was severe enough to break the wheel assembly away from its suspension components. The police reported minor damage to the left front of the Malibu. However, the Malibu was not available for Safety Board inspection.

The driver of the Oldsmobile, restrained by a lap/shoulder belt, sustained minor lacerations. According to police, the driver of the Chevrolet Malibu, also restrained by a lap/shoulder belt, was uninjured; the driver could not be contacted by the Safety Board.

Restraint and Injury

Case Vehicle

Seating Location:	Driver
Sex:	F
Age:	48
Height:	5 feet 4 inches
Weight:	171
Restraint Used:	Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The stalk-mounted buckle extended 9 inches from the seat cushion junction. The driver related that the belt was worn "across her waist" and that neither the lap or shoulder portions were snug. There was a force load mark from the cinching latchplate located on the webbing.

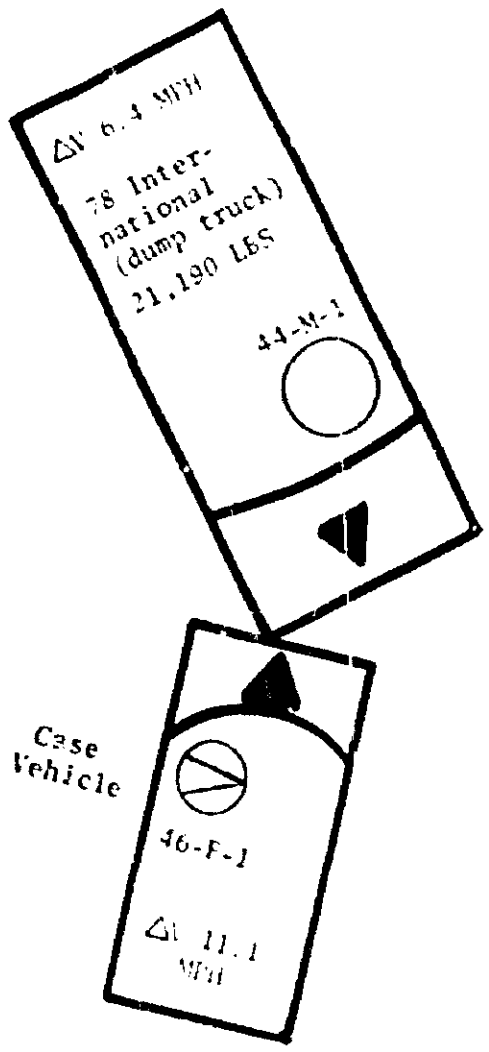
Injuries	AIS	Probable Source
Multiple minor facial lacerations	1	Rear view mirror
Multiple minor facial contusions	1	Rear view mirror
Large contusion, upper right leg	1	Steering wheel

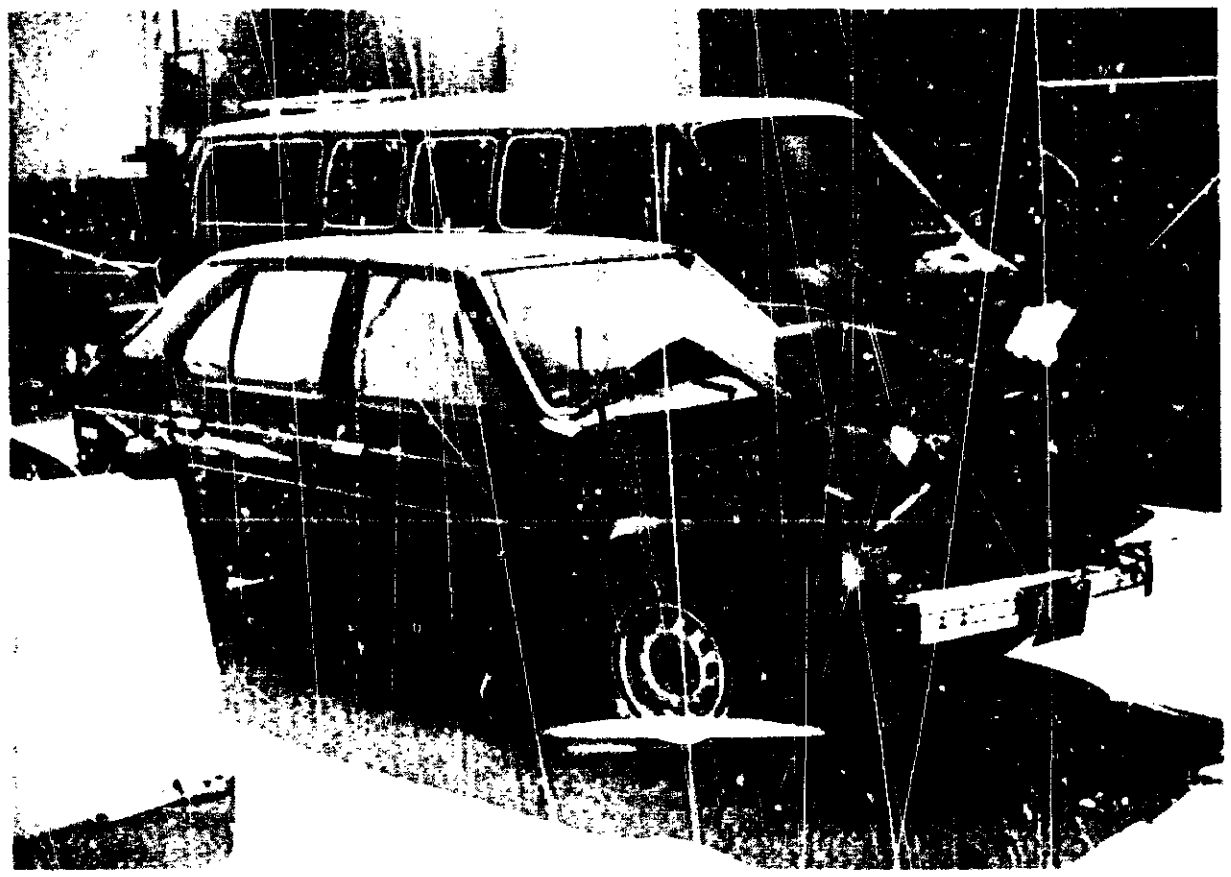
A Delta V could not be computed for the crash because the other vehicle involved was not available for damage measurements. The driver of the Oldsmobile was treated and released at a nearby hospital. She reported only a 1/2 day loss of work.

For the 5 feet 4 inch driver to have struck the mirror, excessive webbing slack would have to be present in the system. In this case, there may have been three contributing factors. The driver related that neither the lap nor shoulder portions of the belt were snug. The lap portion slack is probably due to the fact that she didn't tighten the belt after attaching it to the buckle. The shoulder portion was probably loose (she stated that she could get a clenched fist under the belt) because of slack introduced from the windowshade. A third factor to consider is that the stalk-mounted buckle extended 9 inches beyond the seat cushion junction. The buckle, protruding so far beyond the seat cushion junctions, would have a tendency to push the belt away from the body. All of these factors, cumulatively, were probably responsible for allowing the driver's upper body to go forward far enough for her head to hit the mirror.

CASE 103 - (LAX 85-H-0R04)

Case Vehicle: 1981 Plymouth Horizon 4 door
Case Vehicle Weight: 2,290 pounds
Case Vehicle Delta V: 11.1 mph





Circumstances

A 1981 Plymouth Horizon and a 1979 International dump truck were approaching an intersection from opposite directions. As the International dump truck attempted a left turn, it was struck on the right front corner by the Plymouth. The Plymouth received moderate structural damage with maximum deformation of nine inches over a 60-inch wide area on the front.

The Plymouth driver, wearing a lap/shoulder belt, complained only of neck pain following the accident.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 46
Height: 5 feet
Weight: 110 pounds
Restraint Used: Lap/shoulder belt (ELR)

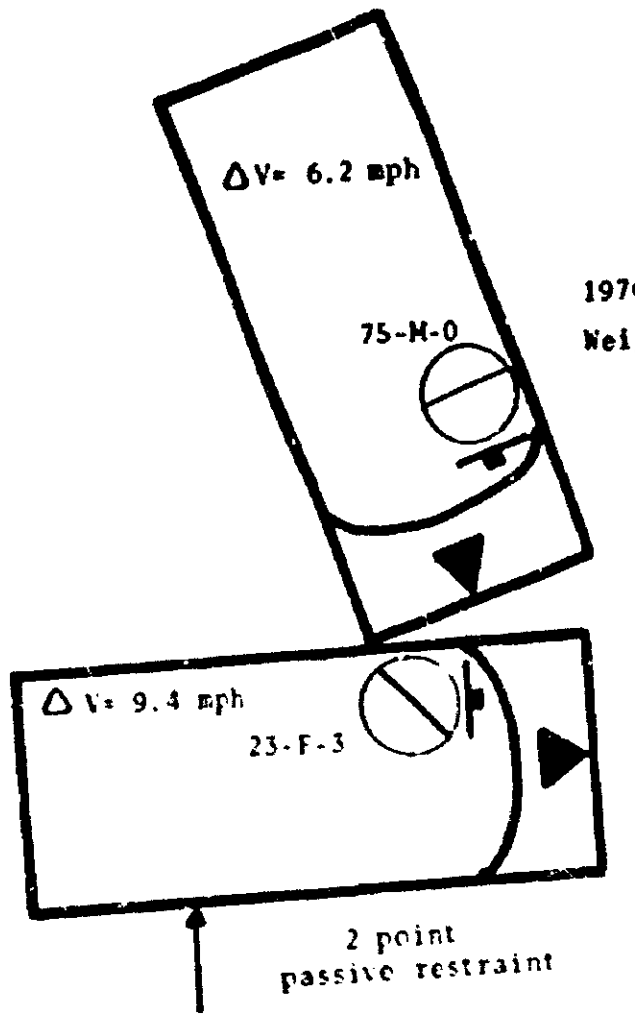
The driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver provided no information on the fit of the lap portion of the belt yet it should have been fairly tight since the belt is self-tensioning, has no windowshade, and has a free-sliding latchplate. The shoulder portion was reportedly adjusted so that the palm of a hand could be placed between the webbing and the driver's chest.

Injuries	AIS	Probable Source
Complained of neck pain	9	Impact force

The driver was treated at an area hospital emergency room and reported no loss of time from work. The restraint system performed as designed in this 11.1 mph Delta V collision, and most likely prevented additional injuries.

CASE 104 - (LAX 85-H-0R02)

Case Vehicle: 1980 Volkswagen Rabbit, 2-door
Case Vehicle Weight: 2,359 pounds
Case Vehicle Delta V: 9.4 mph



Circumstances

The front of a 1970 Chevrolet Malibu 2-door struck the left side of a 1980 Volkswagen Rabbit 2-door. The Volkswagen sustained extensive damage to the driver's door with deformation of 8 inches. The Chevrolet sustained minor damage.

The Volkswagen driver, restrained by a 2-point automatic shoulder strap, received serious injuries. The lap belt restrained driver of the Chevrolet was not injured.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 23
Height: 5 feet 7 inches
Weight: 145
Restraint Used: 2 point automatic shoulder strap

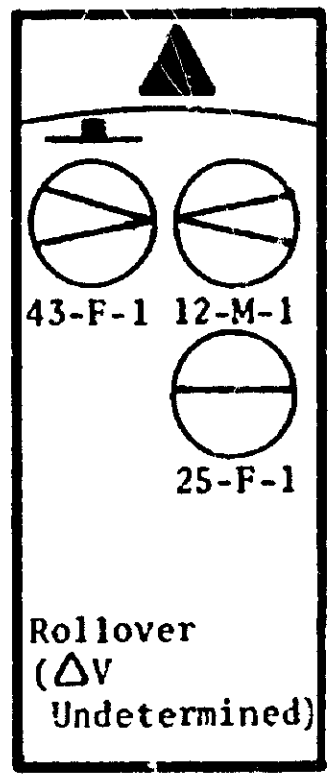
This driver was wearing a 2-point automatic shoulder strap (passive restraint). The driver described the adjustment of the restraint as "snug," positioned across her chest.

Injuries	AIS	Probable Source
Fracture, 4th rib on left side	1	Arm rest
Hematoma, large bowel	3	Arm rest and door
Collapsed lung	3	Arm rest and door

The driver was admitted to the hospital for 10 days and lost an additional 10 days of work due to her injuries. The automatic shoulder strap could not be expected to protect the driver in this side angle, 9.4 mph Delta V collision. The driver's door was deformed inward 8 inches, and the left side of the driver's body impacted the interior door and arm rest. An unrestrained driver would probably have received similar injuries.

CASE 105 - (DEN 84-H-OR38)

Case Vehicle: 1981 Subaru Station Wagon
Case Vehicle Weight: Unknown
Case Vehicle Delta V: 900-degree rollover (no Delta V)



Circumstances

A 1981 Subaru station wagon was in a curve to the left when the operator lost control. The vehicle rolled over two and one-half times and went down an embankment and into a creek. The Subaru was damaged on all exterior areas and was considered to be a total loss.

Both front seat occupants were restrained by a lap/shoulder belts while the passenger in the right rear was restrained by a lap belt only. The driver complained of a "bumped" head and the right rear seat passenger received minor injuries. The extent of injury to the right front seat passenger was unknown; injuries appeared to be minor.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 43
Height: 5 feet 7 inches
Weight: 133 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to both webbing acceleration and vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver described the lap portion adjustment as being positioned "across her abdomen." The shoulder portion was reportedly adjusted so that a clenched fist could be placed between the webbing and the driver's chest.

Injuries	AIS	Probable Source
Complained of bump on back of head	9	B-Pillar

The driver was treated as an out-patient at an area hospital and reported no loss of time from work. The buckle was positioned well above and several inches forward of the seat cushion junction, thus allowing the lap portion of the belt to be situated higher on the abdomen than desirable. In spite of this, the lap/shoulder belt performed well and kept the driver in the vehicle and most likely prevented additional and more serious injuries. Considering that the vehicle rolled two and one-half times and that the side windows were broken, this occupant would probably have been ejected had she not been wearing the available lap/shoulder belt.

Seating Location: Right Front
Sex: M
Age: 12
Height: 5 feet 5 inches
Weight: 125 pounds
Restraint Used: Lap/shoulder belt (ELR)

This occupant was wearing a continuous loop lap/shoulder belt of identical design to the driver's. The right front passenger described the lap portion adjustment as being positioned "across his abdomen." The shoulder portion was reportedly adjusted so that the palm of a hand could be placed between the webbing and the passenger's chest.

Injuries	AIS	Probable Source
Abrasion, left upper arm	1	Unknown
Abrasion, right hand	1	Broken window glass
Contusion, lower right leg	1	Instrument panel

The right front passenger was treated as an out-patient in an area hospital emergency room. The lap portion of the belt on this occupant also was worn higher than desirable due to the buckle being too high and too far forward of the seat junction. In any event, the lap/shoulder belt most likely kept him from being ejected during the 900-degree rollover. Had he been ejected, his injuries would have been more severe.

Case Vehicle
Seating Location: Right Rear
Sex: F
Age: 25
Height: 5 feet 5 inches
Weight: 125 pounds
Restraint Used: Lap belt (ALR)

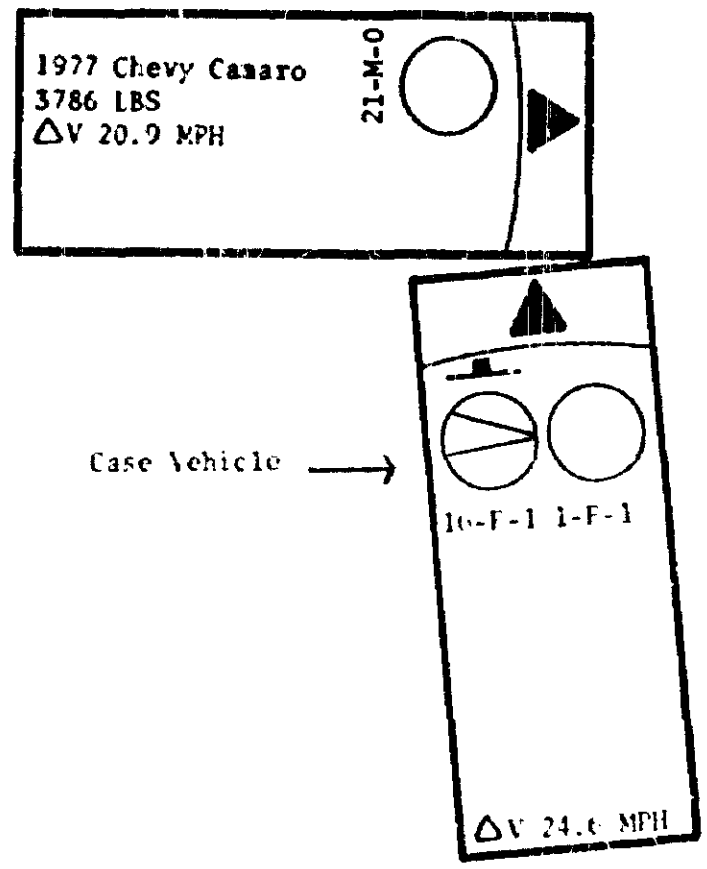
The right rear passenger was wearing a 2-point lap belt equipped with an automatic locking retractor fastened to the latchplate webbing and a webbing-mounted buckle assembly routed between the seat cushions. No information was available concerning the system fit or adjustment.

Injuries: minor (details unknown).

No specifics concerning the right rear occupant's injuries nor loss of time from work were reported. Considering that the vehicle rolled two and one-half times and that the rear and side window glass was broken, it is very likely that this passenger's use of the available belt kept her from being ejected and receiving additional and more serious injuries.

CASE 106 - (DEN 85-H-OR12)

Case Vehicle: 1984 Mercury Cougar, 2 door
Case Vehicle Weight: 3,210 pounds
Case Vehicle Delta V: 24.6 mph



Circumstances

A 1977 Chevrolet Camaro was attempting to make a left turn when it was struck in the right front fender by an on-coming 1984 Mercury Cougar. The Cougar received extensive structural damage with deformation of 26 inches at the front of the vehicle. The Camaro sustained substantial damage to the right front.

The Cougar driver, restrained by a lap/shoulder belt, sustained minor injuries to the lower extremities. Her 8-month-old daughter, restrained in the right front passenger seat by a rearward-facing child safety seat secured by a lap/shoulder belt, was not injured. The unrestrained driver of the Chevrolet was not injured.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 16
Height: 5 feet 2 inches
Weight: 120 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver said that her seat was in the "almost fully forward" position. She was wearing a continuous loop lap/shoulder belt restraint system that was equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver stated that the precrash position of the restraint fitted snugly across her hips and chest areas. Several force loading marks on the belt webbing substantiated the use of the lap/shoulder belt during the collision.

Injuries	AIS	Probable Source
Left knee abrasion	1	Lower dash
Lower right leg abrasion	1	Lower dash

The only medical treatment the driver received was from paramedics at the scene of the accident. She did not lose any time from work. The driver was protected from more serious injuries by being properly restrained in this 24.6 mph Delta V frontal collision.

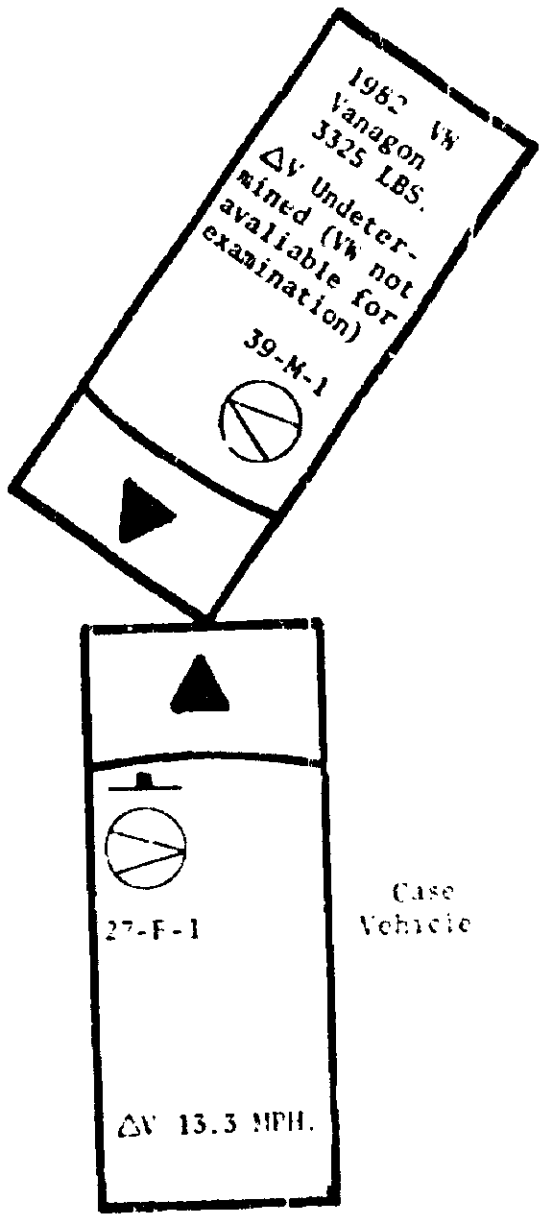
Case Vehicle
Seating Location: Right Front
Sex: F
Age: 8 months
Height: Unknown
Weight: Unknown
Restraint Used: Rearward-facing child restraint device secured by lap/shoulder belt (ELR)

This occupant was riding in a rearward-facing child safety seat positioned in the right front passenger seat. The child seat, brand unknown, had been purchased at a local hospital. It was secured by the available lap/shoulder belt in accordance with directions on the device. The child was not injured in the accident.

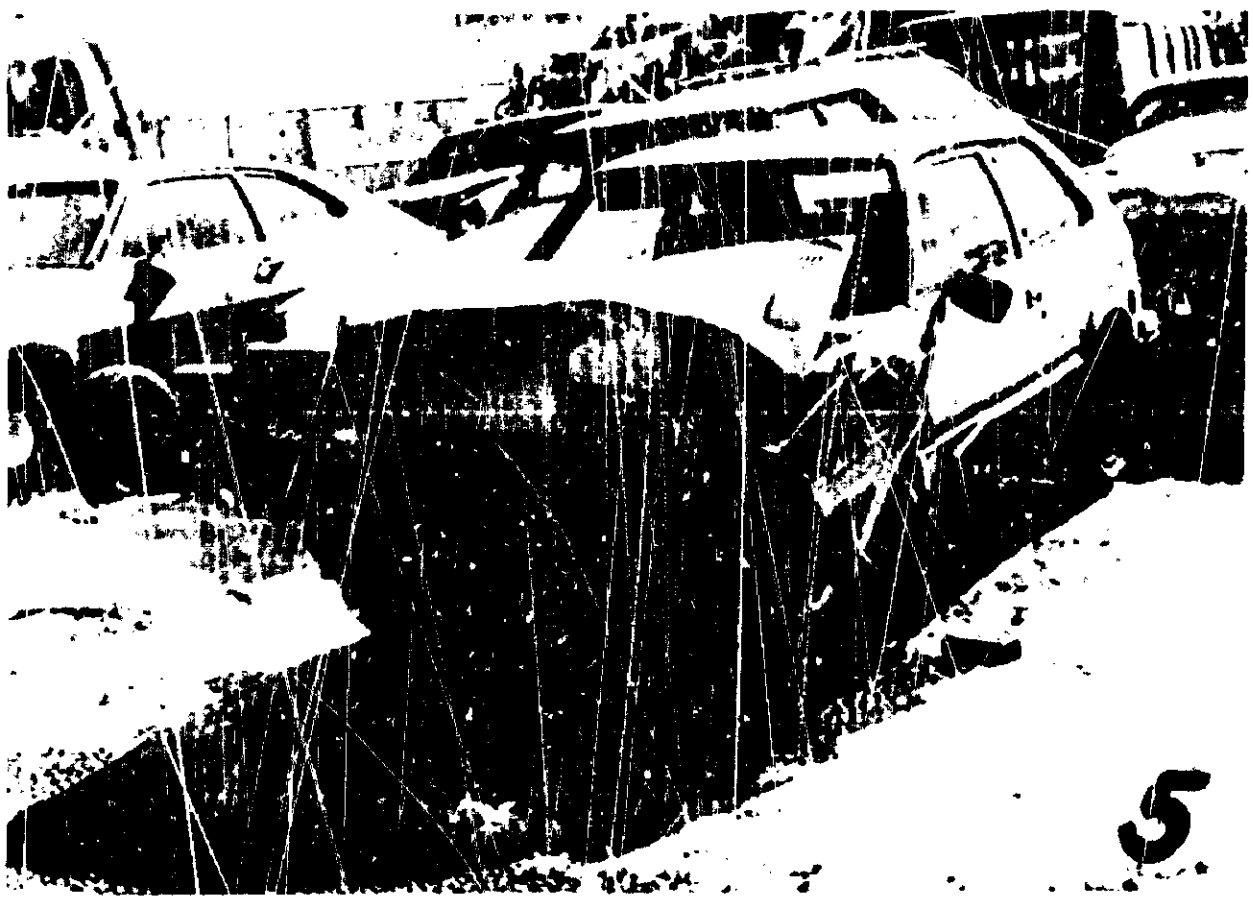
The child safety seat performed very well in protecting the child from serious injuries in this 24.6 mph Delta V collision. The rear-facing saety seat provided excellent crash protection for the 8-month-old infant in this 24.6 mph frontal collision. Such a small child belongs only in a child restraint, not in an adult seat belt, or in a parent's arms, while the vehicle is in motion. The restraint provided by the safety seat prevented the child from sustaining life-threatening injuries.

CASE 107 - (DEN 85-H-0R13)

Case Vehicle: 1981 Honda Civic, 2 door
Case Vehicle Weight: 1,908 pounds
Case Vehicle Delta V: 13.3 mph



Case Vehicle



Circumstances

The front of a 1981 Honda Civic 2-door struck the left front side of a 1982 Volkswagen Vanagon. The collision resulted in maximum frontal deformation of 11 inches over a 20-inch area to the Honda. The Volkswagen reportedly sustained substantial damage; however, access to the vehicle was refused.

The driver of the Honda, restrained by a lap/shoulder belt, received minor injuries. The lap/shoulder belt-restrained Volkswagen driver reportedly also received minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 27
Height: 5 feet 5.5 inches
Weight: 133 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a free-sliding latchplate, and a push-button release buckle attached to a flexible stalk. The driver stated that the adjustment of the lap portion of the belt was snug and positioned low on her hips. The shoulder portion was positioned across her midchest area with sufficient slack to allow placement of a clenched fist under the webbing. There were marks found on the webbing attributed to webbing load at the D-ring. An area of the lower instrument panel was deformed from contact with the driver's knees.

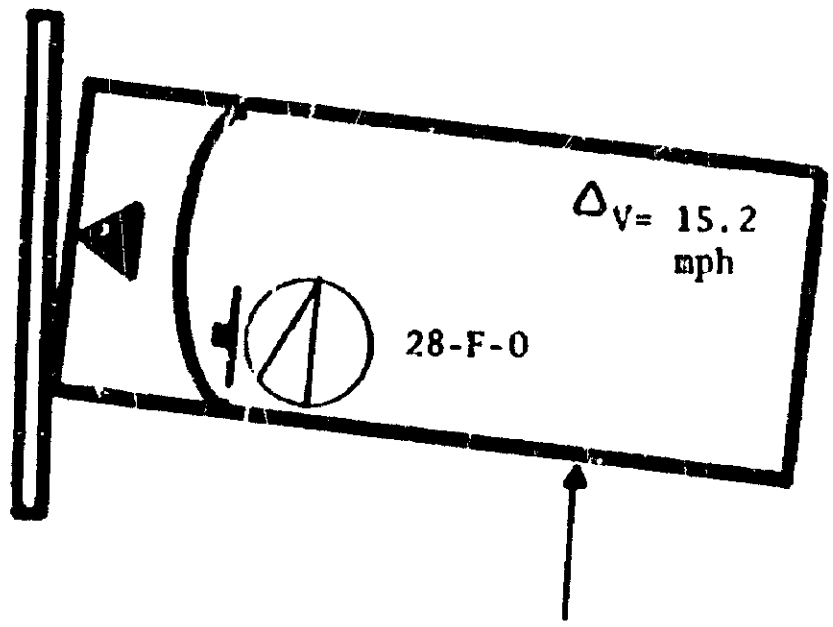
Injuries	AIS	Probable Source
Abrasion, left forehead	1	Steering wheel rim
Cervical strain	1	Impact forces
Contusion, left shoulder	1	Shoulder portion of the belt
Contusion, chest area over sternum	1	Necklace and shoulder portion of the belt
Contusion, left and right hips	1	Lap portion of the belt
Laceration, left and right knees	1	Lower dashboard

This driver was treated and released from a local hospital. She lost 3 days of work as a result of her injuries. The lap/shoulder belt performed well in this 13.3 mph Delta V accident. She might have received more serious injuries, due to more forceful interior contacts, had she not been restrained.

CASE 108 - (MKC 85-H-OR07)

Case Vehicle: 1985 Chevrolet Blazer
Case Vehicle Weight: 3,051 pounds
Case Vehicle Delta V: 15.2 mph

Concrete Barrier



Case Vehicle

Circumstances

A 1985 Chevrolet Blazer was traveling on a divided highway when the traffic ahead stopped. The driver of the Blazer applied the brakes and the vehicle slid out of control on the wet roadway. The left front of the Blazer struck a concrete median barrier. The entire front of the Blazer sustained substantial damage, with maximum deformation of 15.3 inches on the left front.

The lap/shoulder belted driver was not injured.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 23
Height: 5 feet 7 inches
Weight: 160 pounds
Restraint Used: Lap/shoulder belt (ELR)

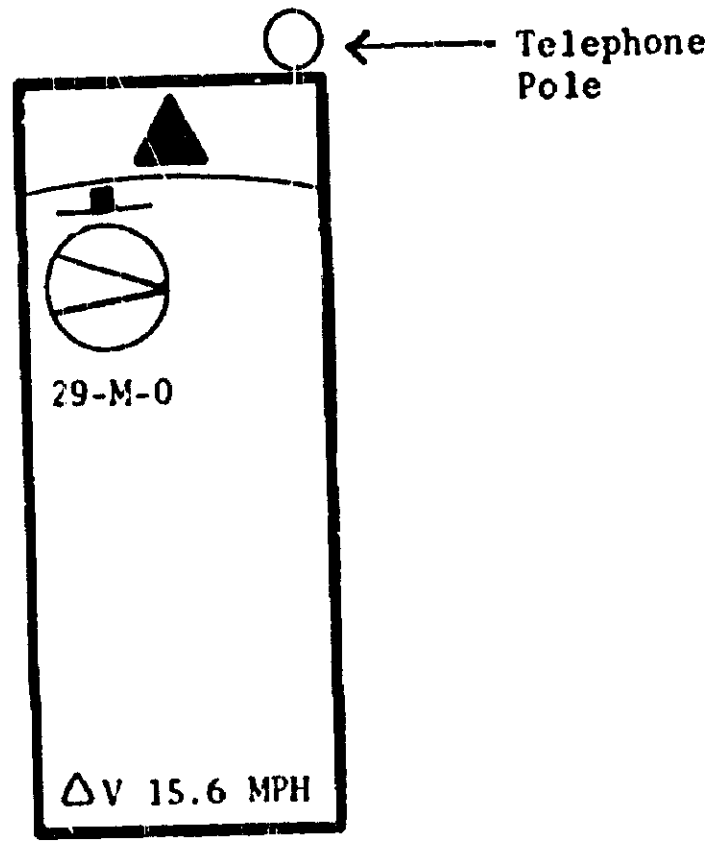
This driver was wearing a lap/shoulder belt equipped with dual emergency locking retractors and a sewn-in latchplate. The driver related that the lap portion of the belt fit snug across her abdomen, but that she could get more than a clenched fist between her chest and belt. This is highly unlikely as it is a self-tensioning system that should maintain constant tension. There were vinyl transfer marks on the webbing from the side of the seat and the retractor housing, thus substantiating use.

Injuries: None

The lap/shoulder belt was beneficial in this 15.2 mph Delta V collision, and probably prevented injuries from contact with the steering wheel, dash, and windshield.

CASE 109 - (MKC 85-H-OR17)

Case Vehicle: 1977 Oldsmobile Cutlass, 2 Door
Case Vehicle Weight: 3,846 pounds
Case Vehicle Delta V: 15 mph



No Photo Available

Circumstances

A 1977 Oldsmobile Cutlass was traveling on a city street when the driver lost control and the vehicle struck a wooden power pole. The vehicle sustained substantial damage with a maximum deformation of 29 inches to the right front.

The Oldsmobile driver, restrained by a lap/shoulder belt, was uninjured.

Restraint and Injury

Case Vehicle

Seating Location:	Driver
Sex:	M
Age:	29
Height	5 feet 11 inches
Weight:	178 pounds
Restraint Used:	Lap/shoulder belt with dual retractors (ALR/ELR)

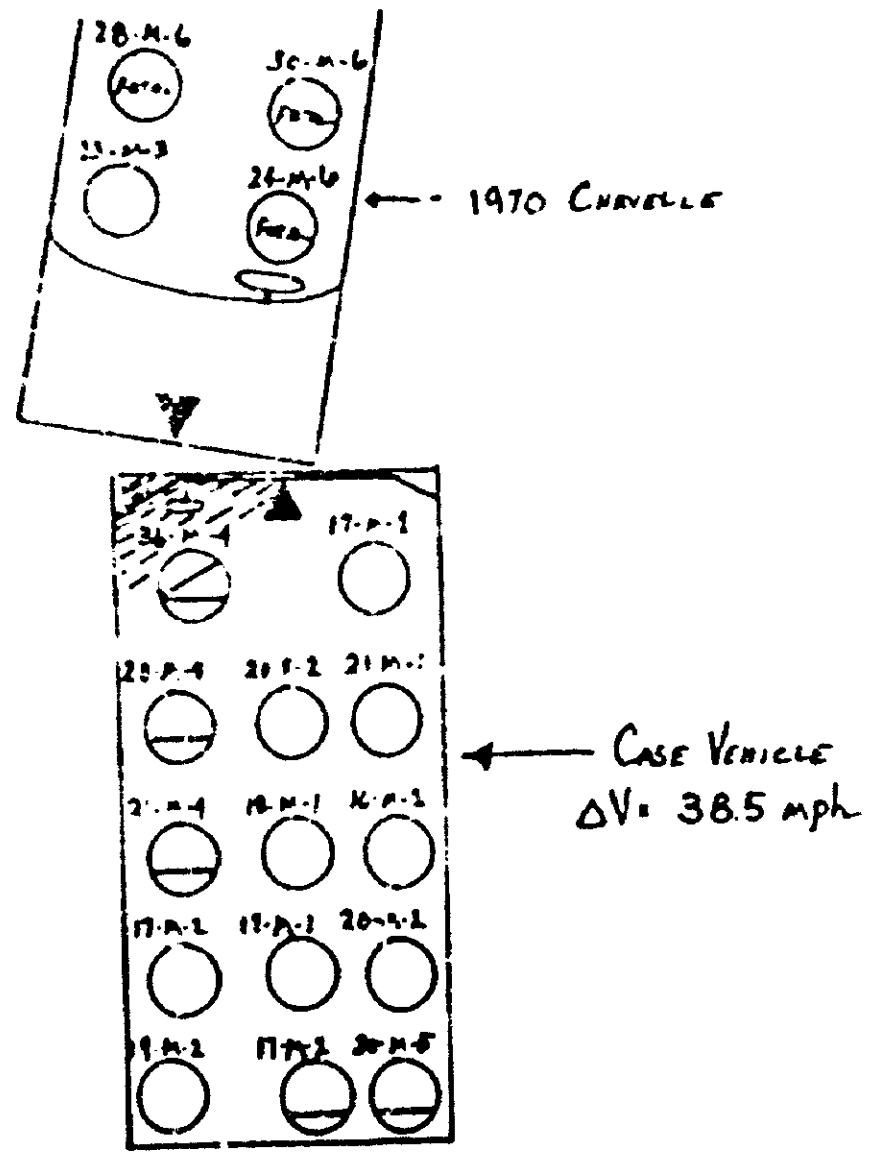
This driver was wearing a lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion on the shoulder portion, an automatic locking retractor on the lap portion of the belt, a comfort clip tension-relief device on the shoulder portion, a sewn-in latchplate, and a stalk-mounted buckle assembly. The driver stated that the lap portion of the belt was positioned low across his hips with no slack. The shoulder portion was reportedly adjusted so that the palm of a hand could be placed between the webbing and the driver's chest, thus discounting comfort clip position as a factor.

Injuries: none.

In this 15 mph Delta V collision the properly adjusted lap/shoulder belt served to prevent injuries. An unrestrained driver would have been free to make uncontrolled contact with the frontal interior.

CASE 110 - (SEA-84-H-0R06)

Case Vehicle: 1983 Dodge Maxi-Wagon (15-passenger van)
Case Vehicle Weight: 7,410 pounds
Case Vehicle Delta V: 38.5 mph



Circumstances

This accident occurred as the 1983 Dodge Maxi-Wagon was struck nearly head-on by a 1970 Chevrolet Chevelle. Both vehicles received severe frontal damage, with the Dodge having a maximum deformation of 56 inches and the Chevrolet a maximum deformation of 93 inches.

The driver of the Dodge Maxi-Wagon, wearing a lap/shoulder belt, sustained severe injuries. The unrestrained right front passenger sustained minor injuries. Four of the remaining 12 van passengers were restrained by lap belts. The collision caused severe to critical injuries to 3 of the 4 lap belted occupants; the fourth lap belted occupant received moderate injuries including an unspecified urinary tract injury. The nine unrestrained occupants sustained only minor to moderate injuries.

All of the occupants in the Chevrolet Chevelle were unrestrained. The driver and two rear-seated passengers were killed. The right front passenger sustained serious to critical injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver

Sex:	M
Age:	36 years
Height:	5 feet 10 1/2 inches
Weight:	160 pounds
Restraint Used:	Lap/shoulder belt (ELR)

The driver was restrained by a continuous loop lap/shoulder belt with an emergency locking retractor (ELR) sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and an immovable stalk-mounted buckle assembly mounted to the base of the driver's seat. The driver stated that the position of the lap portion was low on his hips and "snug," but was not certain how tight the shoulder portion was adjusted. He said the shoulder portion crossed over his mid-sternum. The belt webbing was cut by rescue workers. No documentation of loading scars on the belt webbing was made due to compartmental damage and the inaccessibility of the system components. For the same reasons, no determination of seat track adjustment could be made.

Injuries	AIS	Probable Source
Fracture, anterior cranial fossa floor	4	Steering assembly
Fracture, frontal maxillary	2	Steering assembly
Complex fracture, right zygomatic	2	Steering assembly
Fracture, intraorbital rim	2	Steering assembly
Fracture, 2nd left molar	1	Steering assembly
Scalp laceration, 3 inches	2	Steering assembly
Comminuted fracture, right patella	3	Lower instrument panel and below
Comminuted fracture, left tibia	3	Lower instrument panel and below
Comminuted fracture, left fibula	3	Lower instrument panel
Dislocation and fracture, right foot metatarsals	2	Lower instrument panel and below
Open lacerations, right leg tibia	2	Lower instrument panel and below
Abrasion, right side, top of iliac crest	1	Lap portion of belt
Contusion, upper left chest	1	Shoulder portion of belt and/or steering rim

This occupant spent a total of 13 days in two different hospitals, had an extended period of outpatient treatment, and was off work for at least 7 months. Due to the fact the left front of van sustained the deep intrusion (24-56 inches of exterior deformation, compared to 4-10 inches for the right side), it is extremely unlikely that the driver would have survived without wearing the lap/shoulder belt.

The collapsing front structure of the van resulted in this occupant being trapped in his seating area for hours. The steering assembly showed severe rearward and upward displacement; some of the upward displacement was due to extrication efforts. An unrestrained occupant seated behind this collapsing structure would be decelerated by a combination of jagged metal, broken plastic, and windshield. In adition, the steering wheel rim was pushed back so far it had reached the level of the restrained driver's face. An unrestrained driver would have contacted the steering rim violently in this 38.5 mph Delta V collision, arresting his head travel while his torso continued moving forward several inches. This probably would have resulted in fatal cervical injuries at a minimum.

Seating Location: Right Front
Sex: M
Age: 17 years
Height: 5 feet 10 inches
Weight: 135 pounds
Restraint Used: None

This passenger was not wearing the lap/shoulder belt available at his seating position. There was moderate rearward distortion of the lower inboard frontal compartment at this position. The occupant and other witnesses said he was partially ejected through the windshield, which had been displaced, probably from he impact forces.

Injuries	AIS	Probable Source
Laceration, right side of face	1	Front exterior
Laceration, right elbow	1	B-pillar area
Laceration, lower right arm	1	B-pillar area
Lacerations, lower right leg	1	Below instrument panel
Lacerations, lower left leg	1	Below instrument panel
Contusion, lower right hip and upper thigh	1	Instrument panel and sidewall
Contusion, right knee	1	Instrument panel and below

This passenger was treated and released at a hospital, and was off work for approximately 1 month. Considering the minor nature of the injuries this unrestrained passenger sustained in this severe collision, it is highly unlikely that lap/shoulder belt use could have reduced his injury severity, given the circumstances of the accident. The unrestrained occupant was fortunate that the windshield had been displaced (his head would have struck the glass otherwise) and that the missing windshield allowed him to decelerate into a padded, rounded dashboard. Without the displaced window and "friendly" nature of the dash, an unrestrained passenger would have been at great risk of more severe injuries.

Seating location, Bench 1, extreme left

Sex:	M
Age:	20 years
Height:	6 feet 2 inches
Weight:	155 pounds
Restraint Used:	Lap belt (static)

This passenger was wearing a seat-anchored, 2-point static (manually adjusted) lap belt that incorporated a cinching type of latchplate. He described the belt position as being low on his hips and snug and was wearing a heavy coat under the belt.

Injuries	AIS	Probable Source
Basilar skull fracture	3	Driver's seat back
Ruptured right tympanic membrane	2	Driver's seat back
Fractured right mandible-unspecified	1	Driver's seat back
Dislocation, teeth	1	Driver's seat back
Transverse process fracture, L2	2	Lap belt
Transverse body fracture, L4	3	Lap belt
Comminuted fracture, iliac crest	3	Lap belt
Two lacerations, small bowel	4	Lap belt
Torn mesentery and omentum	4	Lap belt
Abrasion, right iliac crest	1	Lap belt
Abrasion, left iliac crest	1	Lap belt
Fractured left foot	2	Base of frame, driver's seat

This occupant spent a total of 37 days in two hospitals, plus an extended period of outpatient care. The fact that the right iliac crest was fractured is evidence of the belt being worn low on his hips, which is considered proper. This occupant's head and facial injuries were probably the result of the upper body jackknifing forward and striking the driver's seat. The abdominal and back injuries can be attributed to the lap belt itself. If this occupant had not been wearing the lap belt, most of his body would have impacted the back of the driver's seat, thus dissipating the forces over a larger area. This passenger, undoubtedly, would have fared better unrestrained, rather than wearing the lap belt. The additional force against the driver's seat could have contributed to more severe injuries to the driver, however.

Seating Location: Bench 1, center
Sex: F
Age: 20 years
Height: 5 feet 6 inches
Weight: 240 pounds
Restraint used: None

This passenger was not wearing the avaliable static lap belt. Forward of her seating position was the engine cover, which had been displaced during the crash, thus exposing the engine itself.

Injuries	AIS	Probable Source
Fractured left fibula	2	Engine and engine cover
Fractured left tibia	2	Engine and engine cover
Deep laceration below left knee	2	Engine and engine cover
2nd degree burns, lower left leg	1	Engine
Laceration, right knee	1	Engine cover
Hairline fracture, unspecified hip	2	Engine cover

This passenger spent 5 days in a local hospital and then required several followup visits for treatment. If this occupant had been wearing a lap belt, it could be reasonably expected that she would have experienced abdominal injuries similar to those of the other lap belted passengers. While her injuries were multiple and moderate, it still appears that this unrestrained occupant sustained lesser injuries than three of the four lap-belted passengers.

Seating Location: Bench 1, extreme right
Sex: M
Age: 21 years
Height 6 feet
Weight 205 pounds
Restraint Used: None

This occupant was not wearing the available static lap belt. The right front bucket seat back cushion directly forward of him was displaced.

Injuries	AIS	Probable Source
Abrasion, forehead	1	Right front seat back
Abrasion, upper left leg	1	Engine cover
Superficial laceration, left elbow	1	Engine cover
Abrasion, right flank	1	Right front seat back
Contusion, right knee	1	Right front seat back

This occupant was treated and released at a local hospital and was off work for 1 week. The occupant's forward travel was mostly contained by the seat back cushion. Following the major deceleration provided by the seat back, he probably twisted inboard into the area between the front seats. Based upon the outcome of the other lap belted passengers, this occupant obviously fared better being unrestrained, as opposed to wearing the available lap belt.

Seating Location: Bench 2, extreme left
Sex: M
Age: 21 years
Height 5 feet 1 inch
Weight 130 pounds
Restraint used: Lap belt (static)

This occupant was wearing a 2-point, seat anchored, static lap belt with a cinching type latchplate. Due to injuries causing amnesia, he was unable to say if he had the belt on or how it was worn. However, three other occupants said they saw him with it on and that he was a regular seatbelt user. There is no evidence to suggest the lap belt was improperly worn.

Injuries	AIS	Probable Source
Unspecified laceration, forehead	1	Bench 1 back cushion
Contusion, area of both eyes	1	Bench 1 back cushion
Depressed frontal skull fracture	3	Bench 1 back cushion
LeFort III Maxillary fracture	4	Bench 1 back cushion
Closed head injury	2	Bench 1 back cushion
Unspecified laceration, right foot	1	Bench 1 seat frame

This occupant spent 4 months in a regular hospital before being transferred to an extended care facility. Seven months after the accident, the man still had not returned to work. His supervisor subsequently reported that he would require extended care for life.

The lap belt used by this occupant provided sufficient restraint of the lower body for pivoting action about the lap belt to occur. The pivoting action resulted in the occupant's face striking down into the uppermost tubular steel framework of the first seat bench. Had this occupant not been wearing the lap belt, his deceleration probably would have been with a major portion of his upper body into the seat back, thus dissipating the forces over a larger portion of his body rather than confining them to the head and face. Considering the permanent head injury sustained by this occupant, compared to the minor and moderate injuries received by the unrestrained passengers experiencing the same forces, one can reasonably conclude that this occupant would have been far better off unrestrained than wearing a lap belt. A lap/shoulder belt also would have prevented the dangerous pivoting action and its resulting head injuries.

Seating Location: Bench 2, center

Sex:	M
Age:	18 years
Height:	5 feet 8 1/2 inches
Weight:	150 pounds
Restraint used:	None

This occupant was not wearing the available static lap belt. In front of him was severe distortion to the first bench seat back and lower framework. The tubular steel seat top frame was bowed forward and down approximately 4 1/2 inches.

Injuries	AIS	Probable Source
Left leg sprain	1	Bench 1 seat back
Left elbow sprain	1	Bench 1 seat back
Laceration, just below left knee	1	Bench 1 lower frame
Lacerations, lower right leg	1	Bench 1 lower frame
Lacerations, lower left leg	1	Bench 1 lower frame
Pain in left shoulder	0	Bench 1 seat back

This occupant was treated and released at a local hospital. He related that he was off work for 10 days due to his injuries. This occupant's forward travel was contained by the seat back of the first bench. Because he was not wearing the lap belt, he was allowed to decelerate with the forces dissipating over a major portion of his body. This occupant was undoubtedly better off unrestrained in this collision.

Seating Location: Bench 2, extreme right

Sex:	M
Age :	16 years
Height:	6 feet
Weight:	125 pounds
Restraint used:	None

This occupant was not wearing the static lap belt available at his seat position. The upper framework of the first bench seat back was displaced forward in front of this occupant an undetermined distance. This occupant related his postcrash position to be on the floor between the first and second bench.

Injuries	AIS	Probable Source
Laceration to forehead with caudal avulsion (wearing sunglasses)	2	Bench 1 seat back
Abrasion, upper left ankle	1	Bench 1 lower framework
Abrasion, right knee	1	Bench 1 seat back
Abrasion, left knee	1	Bench 1 seat back
Contusion, right elbow	1	Cargo floor area
Contusion, left elbow	1	Cargo floor area
Minor lacerations, right shoulder	1	Exiting side window
Minor lacerations, right hand	1	Exiting side window
Minor lacerations, left hand	1	Exiting side window

This occupant was treated and released at a local hopital, and then missed 7 days work. Clearly, containment also worked in this position. This occupant also fared better than the lap belt restrained passengers.

Seating Location: Bench 3, extreme left

Sex:	M
Age:	17 years
Height:	5 feet 7 inches
Weight:	180 pounds
Restraint used:	None

This occupant was not wearing the available static lap belt. The uppermost framework of this bench was displaced forward several inches.

Injuries	AIS	Probable Source
Fracture, left distal radius	2	Bench 2 seat back
Mild Concussion	2	Bench 2 seat back
Abrasion, lower right leg	1	Bench 2 lower frame
Abrasion, lower right leg	1	Bench 2 lower frame

This occupant was treated and released at local hospital and was then off work for 1 month following the accident. Containment again worked in this position, as the forces acting upon this person dissipated over a large portion of his body, rather than being concentrated at the head or abdominal area.

Seating Location, Bench 3, center

Sex:	M
Age:	17 years
Height:	6 feet
Weight:	143 pounds
Restraint used:	None

This occupant was not wearing the available static lap belt. The top of the second bench was displaced several inches forward in front of this passenger. He stated that he was leaning over the seat back of the bench in front of him following the crash.

Injuries	AIS	Probable Source
Contusion, nose	1	Bench 2, center occupant
Abrasion, right lower leg	1	Bench 2, lower frame
Unspecified right hip injury	7	Bench 2 seat back
Abrasion, right knee	1	Bench 2 seat back
Unspecified injury, medial lower left thigh	7	Bench 2 seat back
Unspecified injury, medial lower right thigh	7	Bench 2 seat back

This occupant was treated and released at a local hospital and was able to return to work immediately. Containment also worked for this occupant, who also fared far better than the lap belt restrained passengers.

Seating Location: Bench 3, extreme right
Sex: M
Age: 20 years
Height: 5 feet 10 inches
Weight: 175 pounds
Restraint used: None

This occupant also was not wearing the available static lap belt. The top portion of the seat back on bench 2, in front of this occupant, was bent forward several inches. The occupant recalled being thrown into the floor area to the right of the bench seats.

Injuries	AIS	Probable Source
Contusion, right shoulder	2	Vehicle interior right side
Contusion, right thigh	1	Vehicle interior right side
Laceration, right shoulder	1	Vehicle interior right side
Abrasions, back of neck	1	Exit through broken side glass

This occupant was treated and released at a local hospital and did not lose any work as the result of this accident. Although this occupant was displaced from his seating position, the major impact forces were probably dissipated through upper body contacts with the seat back of the second bench seat, which prevented serious injuries. Compared with the lap-belted occupants, this unrestrained passenger also fared much better.

Seating Location: Bench 4, extreme left
Sex: M
Age: 17 years
Height: 5 feet 5 inches
Weight: 150 pounds
Restraint Used: None

This occupant was not wearing the static lap belt avaliable at his seating position. The top framework of the third bench seat, directly in front of this occupant, was displaced forward several inches.

Injuries	AIS	Probable Source
Closed head injury	2	Bench 3 seat back
Fracture, right scapula	2	Bench 3 seat back
Laceraton, right lower leg	1	Bench 3 lower frame
Contusion, lower left leg	1	Bench 3 lower frame
Contusion, right ankle	1	Bench 3 lower frame
Contusion, central chest	1	Bench 3 seat back
Contusion, right eye	1	Bench 3 seat back

This occupant was also treated and released at a local hospital and reported losing 1 week of work. This unrestrained occupant's forward movement was contained by the seat back of the third bench. The containment allowed him to ride down the severe Delta V with the dissipation of forces over a large body area. This unrestrained passenger also fared better than any of the lap-belted passengers.

Seating Location: Bench 4, right center
Sex: M
Age: 17 years
Height: 5 feet 10 inches
Weight: 135 pounds
Restraint used: Lap belt (static)

This occupant was wearing the available 2-point, floor anchored, static lap belt, equipped with a cinching type latchplate. The seat back of the third bench, directly forward of this positon, was deformed forward several inches at its uppermost edge. Further examination of this position found the spare tire of the vehicle unattached, laying directly below this seating position, on the cargo floor.

Injuries	AIS	Probable Source
Fractured left radius	2	Bench 3 seat back
Fractured left fibula	2	Bench 3 lower frame
Fractured left tibia	2	Bench 3 lower frame and unsecured tire
Lacerations to arms	1	Postcrash vehicle exit
Abrasions to arms	1	Postcrash vehicle
Numerious abrasions to face	1	Bench 3 seat back, postcrash exit
Numerous lacerations to face	1	Bench 3 seat back, postcrash exit
Unspecified urinary tract injury	0	lap belt

This man said that following the crash, a friend helped him get out of the vehicle through a broken window. He then rolled and tumbled down a 45 degree embankment.

This occupant was hospitalized for one week, followed by an extended period of outpatient treatment. He was then unable to return to work for 4 months.

The facial injuries sustained by this lap-belted occupant were less severe than those lap-belted occupants on the first and second benches. This could be due to a less rigid contact surface furnished by the center area of the third bench upper seat back, as it did bend forward, or the fact that he attemmpted to brace himself. His left lower leg fractures were the result of the unanchored spare tire sliding forward at impact and forcing his left leg against the base of the third seat.

This occupant fared better than the other lap-belted occupants, all of whom had at least AIS 4 injuries. It appears that the less rigid upper center seat back and the possibility of him bracing before impact, as he did break his left wrist, were responsible for his lesser injuries. It seems likely that he would have fared much better had he been unrestrained and able to benefit from the containment by the seat in front of him.

Seating Location: Bench 4, extreme right

Sex:	M
Age:	20 years
Height:	5 feet 6 inches
Weight	128 pounds
Restraint used:	Lap belt (static)

This occupant was wearing a floor-anchored 2-point static lap belt with a cinching type latchplate. He related that his lap belt tension was snug, but could not state the position about his body.

Injuries	AIS	Probable Source
Torn sigmoid colon	5	Lap belt
Torn mesentery	4	Lap belt
Torn serosa of jejunum	4	Lap belt
Fracture, 5th lumbar vertebra	3	Lap belt
Cauda equina injury	3	Lap belt
Contusions, right ankle	1	Tire well
Fracture, 1st left rib	1	Right side, bench 3 seat back

This occupant spent 2 months in a hospital. Following discharge, he required outpatient care about once a month. Seven months after the accident, he had still not returned to work. Only major injuries were noted in detail on his hospital records, with few details concerning contusions and abrasions.

The open space directly in front of this occupant accounted for his lack of any facial or head injuries. When his body pivoted forward, the left side of his chest struck the right side of the third bench. From this point, the lap belt over the abdominal area absorbed the remaining deceleration forces. The nature of his abdominal injuries and the fracture at the L5 vetebra indicate abdominal penetration by the restraint webbbing. The lap belt probably was above the top of the long iliac crests prior to the deceleration forces.

Had this occupant not been wearing his lap belt, he probably would not have fared as well as the other unrestrained passengers, as there was not a full seat back in front of him for containment. If this man had been restrained in a lap/shoulder belt, he probably would have sustained only minor to moderate injuries.

One can reasonably conclude that all of the lap-belted passengers would have fared better with a lap/shoulder belt. It is not reasonable, however, to conclude that all of the unrestrained passengers would have fared better with a lap/shoulder belt, especially given the minor nature of some of the passengers' injuries. Containment by the seat in front provided good protection for seven of the eight unrestrained bench passengers. Only the unrestrained passenger in the center of the first bench did not have a seat back for containment. She fared worse than any of the bench seated unrestrained passengers.

The lap/shoulder belt is undoubtedly a contributing factor in saving the driver's life. Again, it appears most extraordinary that the unrestrained right front passenger, who had a lap/shoulder belt available, sustained only minor injuries in this severe collision. The minor nature of his injuries is probably related to the displacement of the windshield, the rounded, smooth, padded dash, and lack of significant intrusion (as compared with the driver's side which had substantial intrusion).

CASE 111 - (FTW 85-H-0R31)

Case Vehicle: 1976 Volkswagen Van
Case Vehicle Weight: 4,000 pounds
Case Vehicle Delta V: 9.8 mph

Circumstances

A 1979 VW van impacted the left front of a 1985 Honda Accord. Both vehicles sustained damage.

The VW driver, restrained by a lap/shoulder belt, with the shoulder portion improperly routed under his arm, sustained moderate injuries. The lap/shoulder restrained right front occupant sustained minor injuries. The lapbelt restrained center rear passenger sustained minor injuries, and three other unrestrained rear occupants were uninjured. The unrestrained Honda driver sustained moderate injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 17 years
Height: 6 feet 2 inches
Weight: 175 pounds
Restraint Used: Lap/shoulder belt
Proper Use: No

This occupant was wearing a lap/shoulder belt with two separate lengths of webbing joined by a cinching adjustment device that formed an adjustable length system. It was equipped with a free-sliding latchplate and a stalk-mounted buckle assembly. At the time of the collision, the shoulder portion was improperly routed under his left arm.

Injuries	AIS	Probable Source
Fractured metacarpal	2	Steering wheel rim
Soreness in upper right shoulder without contusion	0	Impact forces

The driver was treated at a local facility and released. His use of the available restraint system combined with low Delta V probably protected him from more serious impact with the steering wheel assembly.

Seating Location: Right Front
Sex: M
Age: 13 years
Height: 5 feet 8 inches
Weight: 135 pounds
Restraint Used: Lap/shoulder belt
Proper Use: Yes

This occupant was wearing a lap/shoulder restraint made up of two lengths of webbing joined by a cinching type of adjustment device that formed an adjustable length, with free-sliding latchplate. The latchplate was coupled with a stalk mounted buckle.

Injuries	AIS	Probable Source
Contusion, upper right shoulder and chest	1	Shoulder portion of belt
Contusion, lower right leg just above the ankle	1	Collapsed frontal interior

This occupant did not seek medical attention. His use of the lap/shoulder belt probably precluded more serious injury and possible ejection through the displaced windshield.

Seating Location: Rear Center
Sex: M
Age: 14 years
Height: 5 feet 11 inches
Weight: 170 pounds
Restraint Used: Lap belt (Static)
Proper Use: No

This occupant was wearing a 2-point manually adjustable lap belt. He described the precrash adjustement of the system as loose and positioned low on his hips. Occupant kinematics indicate that the buckle assembly apparently failed or was not properly connected before the collision.

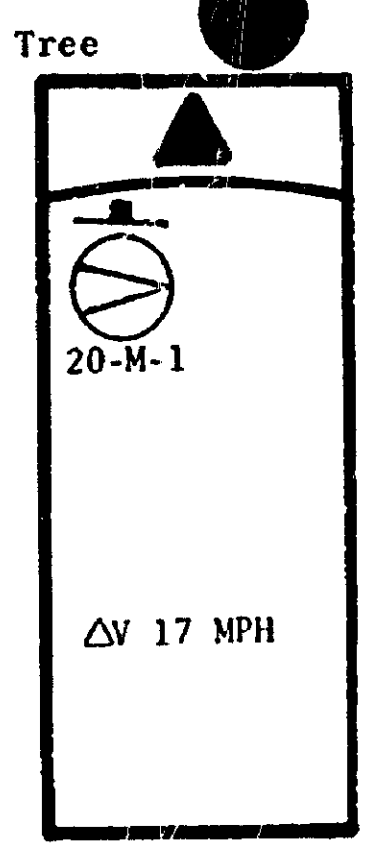
Injuries	AIS	Probable Source
Small laceration, right eyebrow line	1	Interior loose cargo
Abrasion to right knee	1	Cargo floor area

This occupant was treated at a local emergency clinic and released. Due to the apparent system release or failure, the amount of protection provided by the occupant restraint system is indeterminable.

Three other unrestrained occupants seated in the rear of the van were not injured.

CASE 112 - (FTW 85-H-OR15)

Case Vehicle: 1977 Ford LTD Stationwagon
Case Vehicle Weight: 5,030 pounds
Case Vehicle Delta V: 16.1 mph



Circumstances

The operator of a 1977 Ford LTD was negotiating a curve to the left when he lost control. The vehicle went off the right side of the roadway and struck a tree. The Ford received substantial structural damage with deformation of up to 25 inches over a 54-inch wide area on the front.

The Ford driver, restrained by a lap/shoulder belt, received a minor injury.

Restraint and Injury

Case Vehicle

Seating Location:	Driver
Sex:	M
Age:	20
Height:	6 feet 5 inch
Weight:	300 pounds
Restraint Used:	Lap/shoulder belt with dual retractors (ALR/ELR)

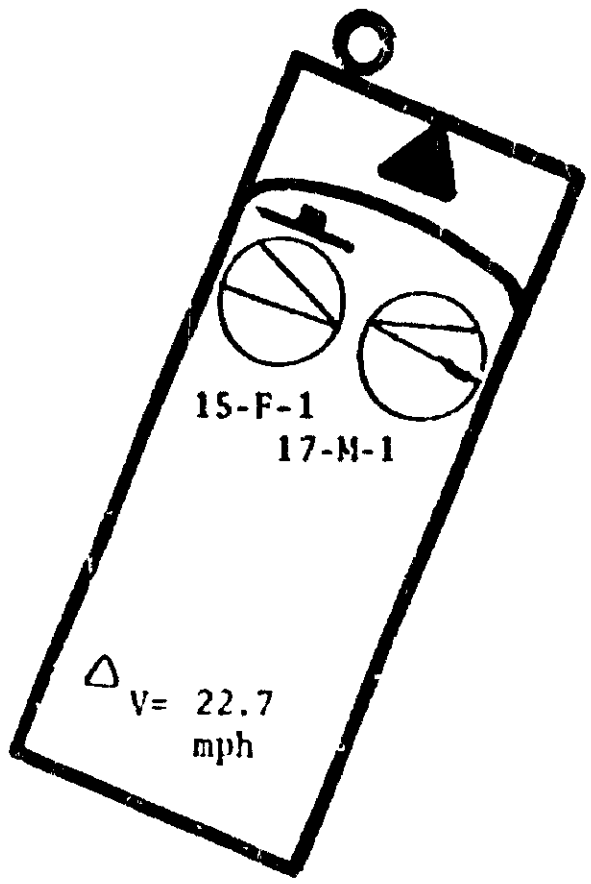
This driver was wearing a lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion on the shoulder portion, an automatic locking retractor on the lap portion, a sewn-in latchplate, a comfort clip, and a stalk-mounted buckle assembly. The comfort clip was placed low on the shoulder portion. The driver stated that the lap portion of the belt was positioned across his abdomen and very snug. The shoulder portion was reportedly adjusted so that a clenched fist could be placed between the webbing and the driver's chest. Force loading marks were found on the shoulder webbing in the area of the B-pillar mounted D-ring. There was also a load mark on the lap portion webbing in the area of the lower seat cushion.

Injuries	AIS	Probable Source
Contusion, left lower leg	1	Lower instrument panel

The driver did not require treatment for his injury and reported no loss of work. Even though the driver reported that there was some slack in his shoulder portion, it should have been fairly tight since the retractor is self tensioning and the comfort clip was not in a position to introduce any slack. This lap/shoulder belt performed well in this 16.1 mph Delta V collision. Had he been unrestrained, he likely would have received additional and more serious injuries from the steering assembly, instrument panel, and possibly the windshield.

CASE 114 - (SEA 85-H-CR14)

Case Vehicle: 1976 Datsun 610, 2-Door
Case Vehicle Weight: 2,758 pounds
Case Vehicle Delta V: 22.7 mph



Circumstances

A 1976 Datsun attempted a left turn, lost control, left the roadway, and struck a utility pole. The vehicle sustained substantial structural damage with deformation of up to 25 inches at the right front.

The driver and right front passenger, both restrained by lap/shoulder belts, sustained minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 15
Height: 5 feet 4 inches
Weight: 130 pounds
Restraint Used: Lap/shoulder belt with dual retractors (ALR/ELR)

This driver was wearing a lap/shoulder belt with dual retractors, a cinching latchplate, and a stalk-mounted buckle assembly. The lap portion of the belt was equipped with an automatic locking retractor and a self-tensioning device. The shoulder portion was equipped with a vehicle sensitive emergency locking retractor and a comfort clip. The comfort clip was not in a position that allowed slack to the shoulder portion. The driver stated that the lap/shoulder belt was snug, fitting across her hip and chest area. Force loading marks were not found on the belt webbing, however, minor injuries to the driver's left shoulder and chest area were consistent with restraint use.

Injuries	AIS	Probable Source
Contusion to forehead	1	Steering wheel
Abrasion, left shoulder	1	Shoulder portion of the belt
Contusion, front chest	1	Shoulder portion of the belt
Abrasion, left hip	1	Lap portion of the belt
Abrasion, right hip	1	Lap portion of the belt
Contusion, left knee	1	Instrument panel
Contusion, left forearm	1	Steering wheel

The driver did not seek medical treatment for her minor injuries and did not lose any time from school or work. Considering the 22.7 mph Delta V of this collision, use of the lap/shoulder belt probably reduced the severity of her injuries. Had she been unrestrained, contacts with the steering assembly and instrument panel would have been more violent.

Case Vehicle
Seating Location: Right Front
Sex: M
Age: 17
Height: 5 feet 10 inches
Weight 155 ounds
Restraint Used: Lap/shoulder belt with dual retractors (ALR/ELR)

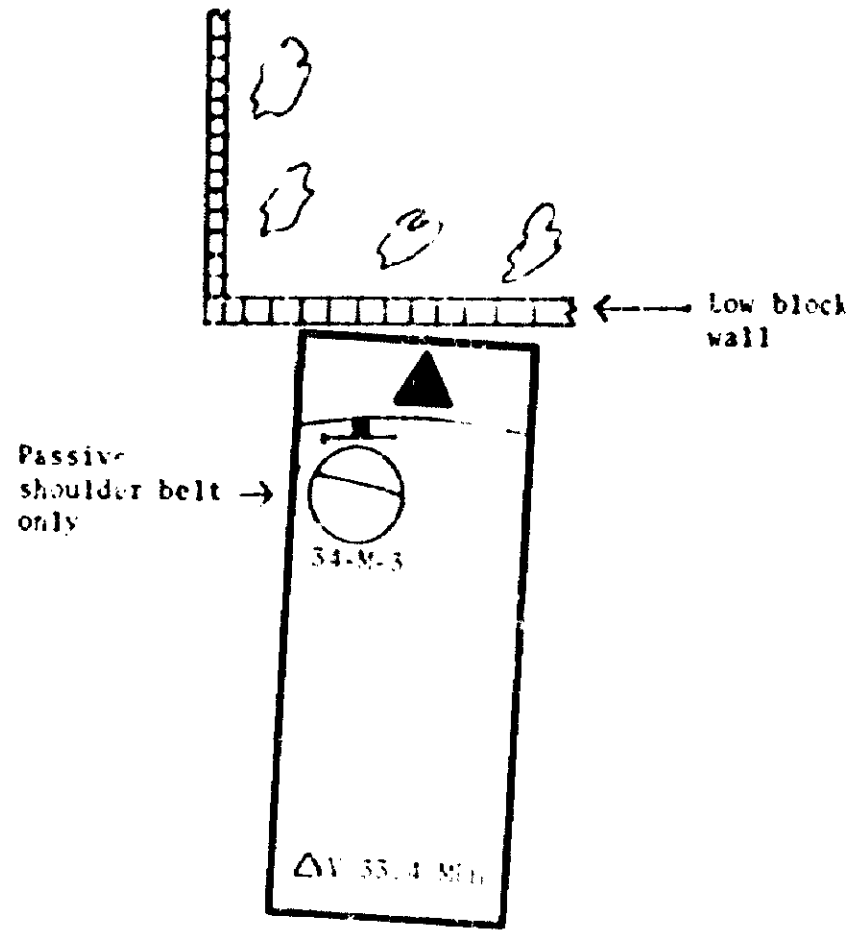
This occupant was wearing a lap/shoulder belt identical in design to the driver's. The comfort clip was not positioned to relieve tension on the shoulder portion. The occupant described the belt snug fitting across his hip and chest area. A force loading mark was found on the webbing in the area of the D-ring.

Injuries	AIS	Probable Source
Contusion, center chest	1	Shoulder portion of the belt
Abrasion, left hip	1	Lap portion of the belt
Sprained thumb	1	Instrument panel

The occupant did not seek medical treatment for his minor injuries and did not lose time from work or school. Use of the lap/shoulder belt prevented more serious injury. With the 22.7 mph Delta V, an unrestrained occupant would have been much more susceptable to serious injuries due to more violent contacts with the vehicle interior.

CASE 115 - (LAX 85-H-OR13)

Case Vehicle: 1982 Toyota Cressida Station Wagon
Case Vehicle Weight: 3,113 pounds
Case Vehicle Delta V: 33.4 mph



Circumstances

A 1982 Toyota Cressida Station Wagon accelerated through an intersection, went off the roadway to the right, and struck a brick wall. The Toyota received substantial structural damage with inward collapse reaching depths of up to 24 inches over the 66.5-inch wide front end.

The Toyota driver, restrained by a 2-point passive shoulder belt but not using the available manual lap belt, received serious injuries.

Restraint and Injury

Case Vehicle

Seating Location:	Driver
Sex:	M
Age:	35
Height:	5 feet 10 inches
Weight:	158 pounds
Restraint Used:	2-point automatic shoulder belt (ELR); available manual lap belt probably not used

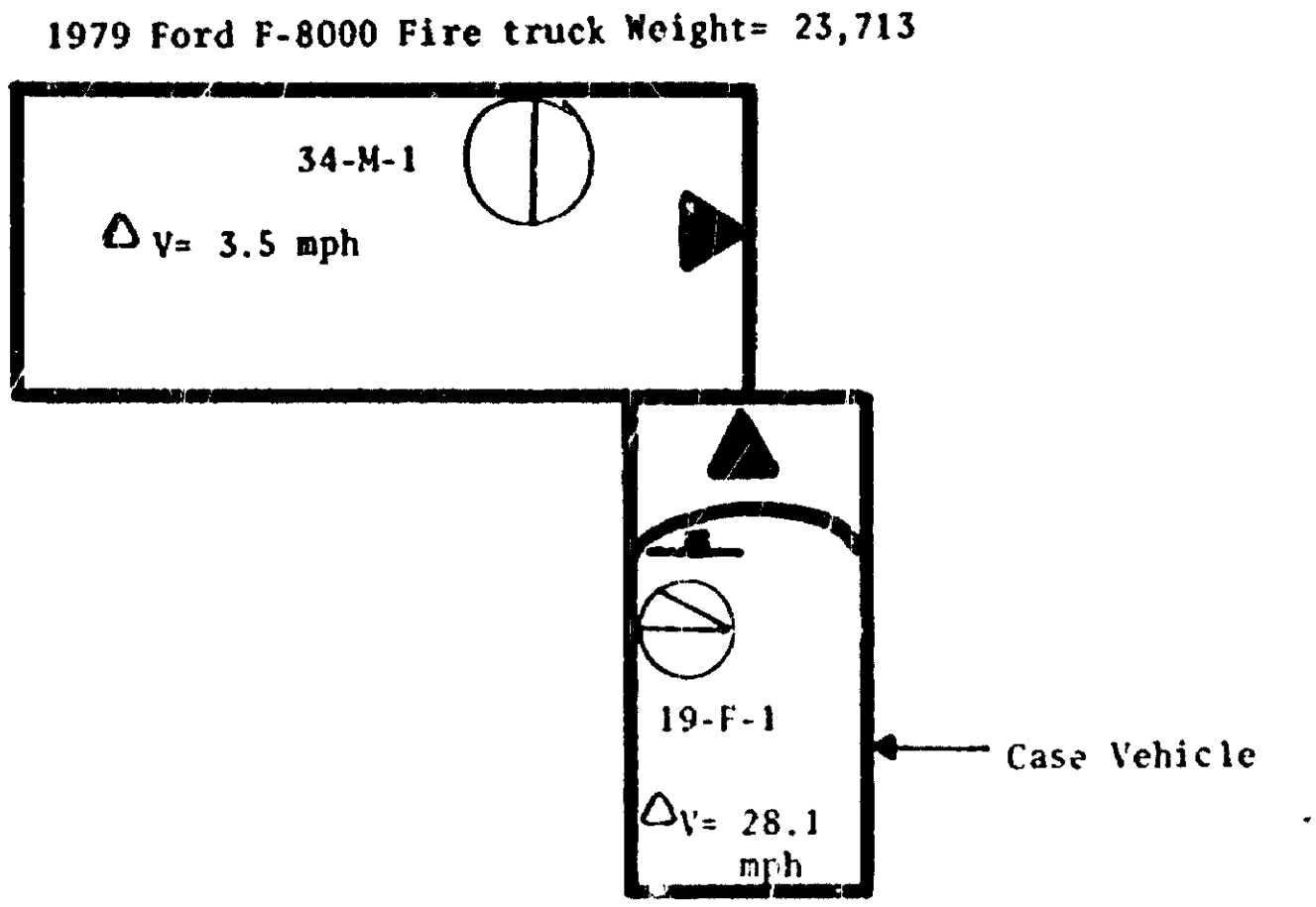
The driver was wearing a 2-point passive shoulder belt with an emergency locking retractor sensitive to vehicle motion. (The manual lap belt also available at this seating position had a sewn-on latchplate and a stalk-mounted buckle assembly.) The driver described the precrash shoulder portion adjustment as being positioned so that the palm of a hand could be placed between the webbing and the driver's chest. Although the driver indicated that the manual lap belt was also probably in use, the Safety Board investigator determined that it was, in fact, not used.

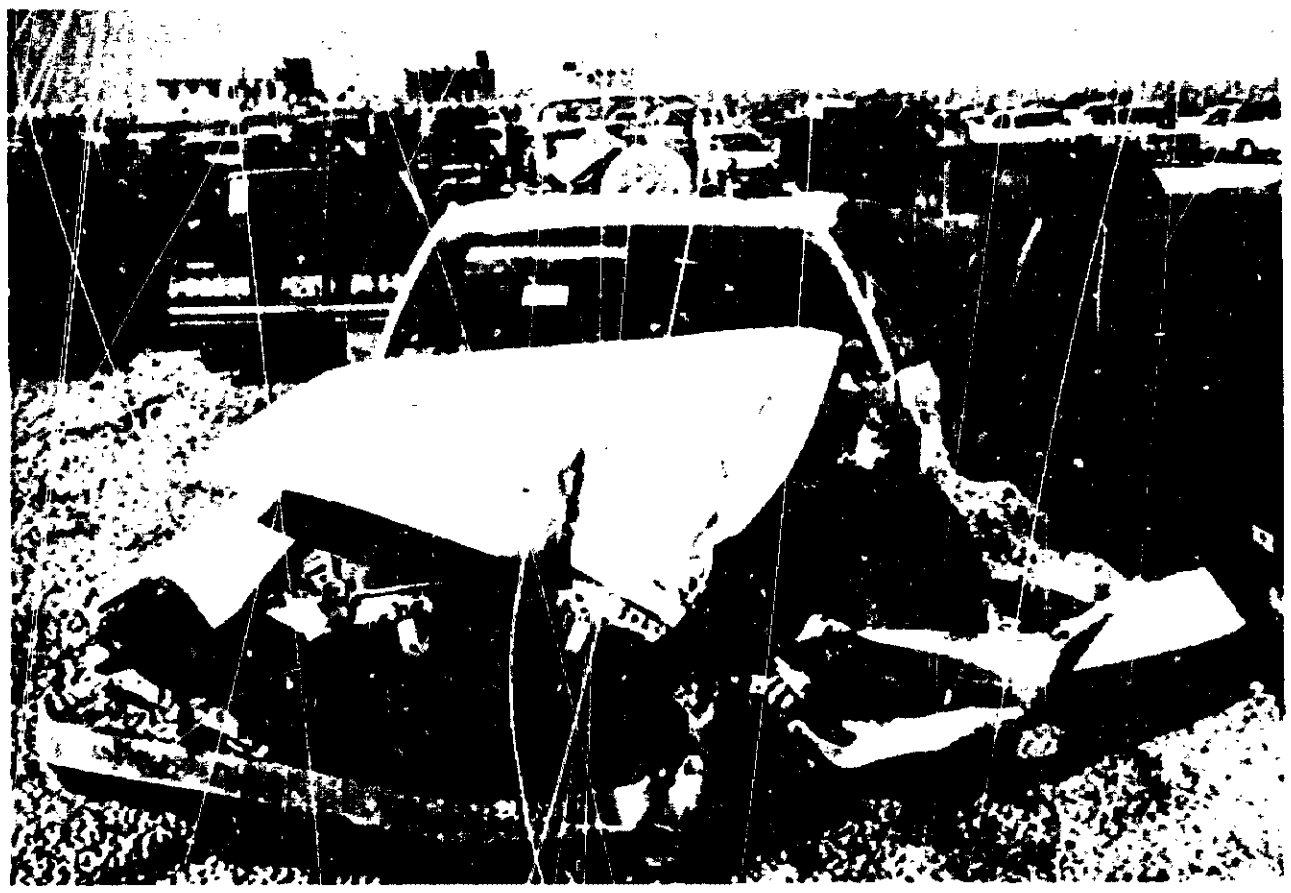
Injuries	AIS	Probable Source
2-inch laceration, forehead	2	Rearview mirror
Laceration, nose	1	Rearview mirror
Fracture, nose	1	Rearview mirror
Contusion, left shoulder	1	Shoulder portion of the belt
Comminuted fracture, L-2 vertebra	2	Impact force
Comminuted fracture, left tibia	3	Instrument panel
Fracture, right navicula	2	Floor and pedals
Fracture and dislocation, right talus	2	Floor and pedals
Fracture, right ankle	2	Floor and pedals

The driver was admitted to an area hospital for 60 days and he estimated a loss of time from work of 9 months. Considering the points of contact in the vehicle and the seriousness of the injuries, it appears that the automatic shoulder portion of this 2-point shoulder belt failed to prevent excessive forward movement of the driver. Had he also been wearing manual the lap belt, it is most likely that his injuries would have been reduced in number and severity. If this driver had not been wearing any portion of the 2-point shoulder belt in this 33.4 mph Delta V collision, he probably would have received even more serious injuries which could have been fatal.

CASE 116 - (MKC 85-H-OR04)

Case Vehicle: 1983 Ford Futura, 2 Door
Case Vehicle Weight: 2,974 pounds
Case Vehicle Delta V: 28.1 mph





Circumstances

A 1983 Ford Futura entered an intersection and struck the right front of a 1979 Ford fire truck that was responding to a fire call. The Futura rotated to the right, and again impacted the truck with the left side of the vehicle. The Futura sustained substantial front structural damage with deformation of up to 32 inches. Only minor damage was received by the heavier and structurally rigid fire truck.

The Futura driver, restrained by a lap/shoulder belt, sustained minor injuries while the lap belted-driver of the fire truck was not injured.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 19
Height: 5 feet 2 inches
Weight: 117 pounds
Restraint Used: Lap/shoulder belt (ELR)

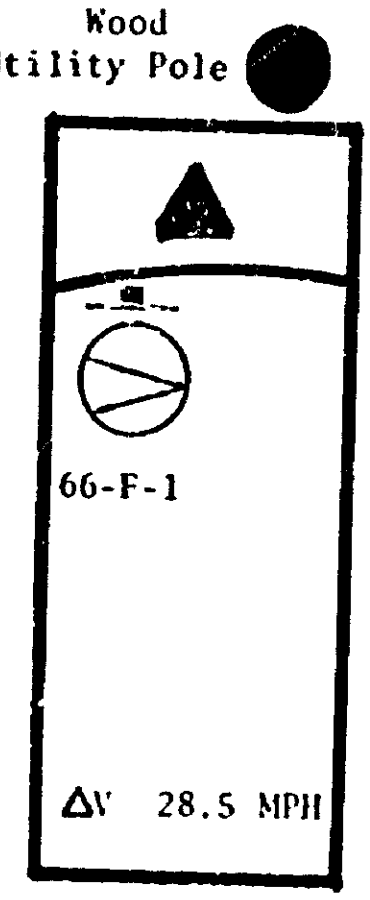
This driver was wearing a continuous lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver stated that the lap portion of the belt was fitted snug "across her abdomen" with the shoulder portion worn properly over her shoulder. Force loading marks near the latchplate indicated the lap/shoulder belt was being worn at the time of impact.

Injuries	AIS	Probable Source
Contusion, right side head	1	Unknown
Contusion, left side head	1	Driver's door glass
Contusion, left thigh	1	Driver's door panel
Laceration, right knee	1	Steering wheel column
Contusion, right forearm	1	Unknown

The driver was treated at a local hospital and released. The driver did not lose any time from work. Given the 28.1 mph Delta V of this collision, it is apparent that the restraint system served to reduce the injury level of this driver. The proper use of the lap/shoulder belt prevented uncontrolled forward movement during the principal impact; however, it was probably of little benefit in preventing or lessening the injuries received during sideways movement because of lateral and secondary impact forces.

CASE 117 - (MKC 85-H-0R05)

Case Vehicle: 1979 Ford LTD II 4 Door
Case Vehicle Weight: 4,123 pounds
Case Vehicle Delta V: 28.5 mph



Circumstances

A 1979 Ford LTD II veered off the right side of the roadway and struck a utility pole. The Ford sustained substantial structural damage with deformation of up to 42 inches at the right front.

The Ford driver, restrained by a misrouted lap/shoulder belt (shoulder portion worn under left arm), sustained minor injuries including facial injuries of unknown severity.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 66
Height: 5 feet 5 inches
Weight: 150 pounds
Restraint Used: Lap/shoulder belt with dual retractors (ELR/ALR)

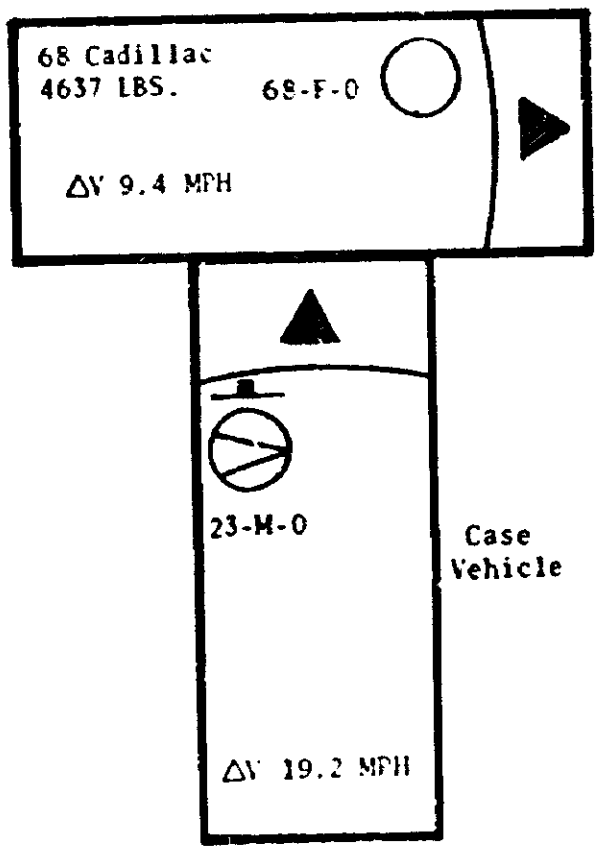
This driver was wearing a lap/shoulder belt with dual retractors. The lap portion had an automatic locking retractor and the self-tensioning shoulder portion had an emergency locking retractor sensitive to vehicle motion. The lap/shoulder belt was equipped with a sewn-in latchplate and a push botton buckle assembly. The driver stated that the lap/shoulder belt fit was snug "across her abdomen" and loose around her chest area, with the shoulder portion worn under the left arm and beneath the left breast. She explained that she routed the shoulder portion under her left arm because the webbing rubbed on her neck when properly routed. Force loading marks were found on the system webbing in the area of the latchplate and B-pillar mounted D-ring.

Injuries	AIS	Probable Source
Laceration of lip	1	Steering wheel
Swelling, right side of face	7	Steering wheel
Laceration, left cheek	1	Steering wheel
Swelling around left eye	7	Steering wheel
Multiple contusions of face	1	Steering wheel
Contusion of right shoulder	1	Steering wheel
Contusion of right chest	1	Steering wheel
Contusion of left chest	1	Steering wheel
Contusion of left knee	1	Instrument panel
Contusion of right knee	1	Instrument panel
Contusion of left chest beneath breast	1	Shoulder portion of the belt

The driver was admitted to an area hospital for 2 days and lost several work days as a result of the accident. Her use of the available lap/shoulder belt, although worn improperly, was of benefit in preventing uncontrolled forward movement in this 28.5 mph Delta V collision. If the shoulder portion had been worn properly over the left shoulder it would have prevented violent forward movement of the upper body torso and steering wheel contact, possibly reducing the number of injuries. The steering wheel, since she contacted it, did prevent some loading of the misrouted belt, thus possibly relieving her ribs from pressure from the improperly placed shoulder portion of the belt. A right front passenger, restrained by such a misrouted belt, in a crash of similar severity, would not have the steering wheel to remove some of the restraint load. This may explain the difference in outcome between the driver in this case and the right front passenger in case 215; both had misrouted their belts in the same fashion.

CASE 118 - (MKC 85-H-0R06)

Case Vehicle: 1980 Honda Accord
Case Vehicle Weight: 2,274 pounds
Case Vehicle Delta V: 19 mph



Circumstances

A 1980 Honda Accord struck a 1977 Cadillac DeVille was struck broadside at an intersection. The Honda sustained substantial structural damage with a maximum deformation of 20.7 inches on the left front. The Cadillac was struck on the right front door/right front fender and had a maximum deformation of 7 inches.

The driver of the Honda was restrained by a lap/shoulder belt; the Cadillac driver was unrestrained. Both drivers received minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 23
Height: 5 feet 8 inches
Weight: 148 pounds
Restraint Used: Lap/shoulder belt (ELR)

The driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to webbing acceleration, a free-sliding latchplate, and a stalk-mounted buckle. The driver stated that the self-tensioning belt fit "snug" and that the lap portion of the belt was positioned low on the hips.

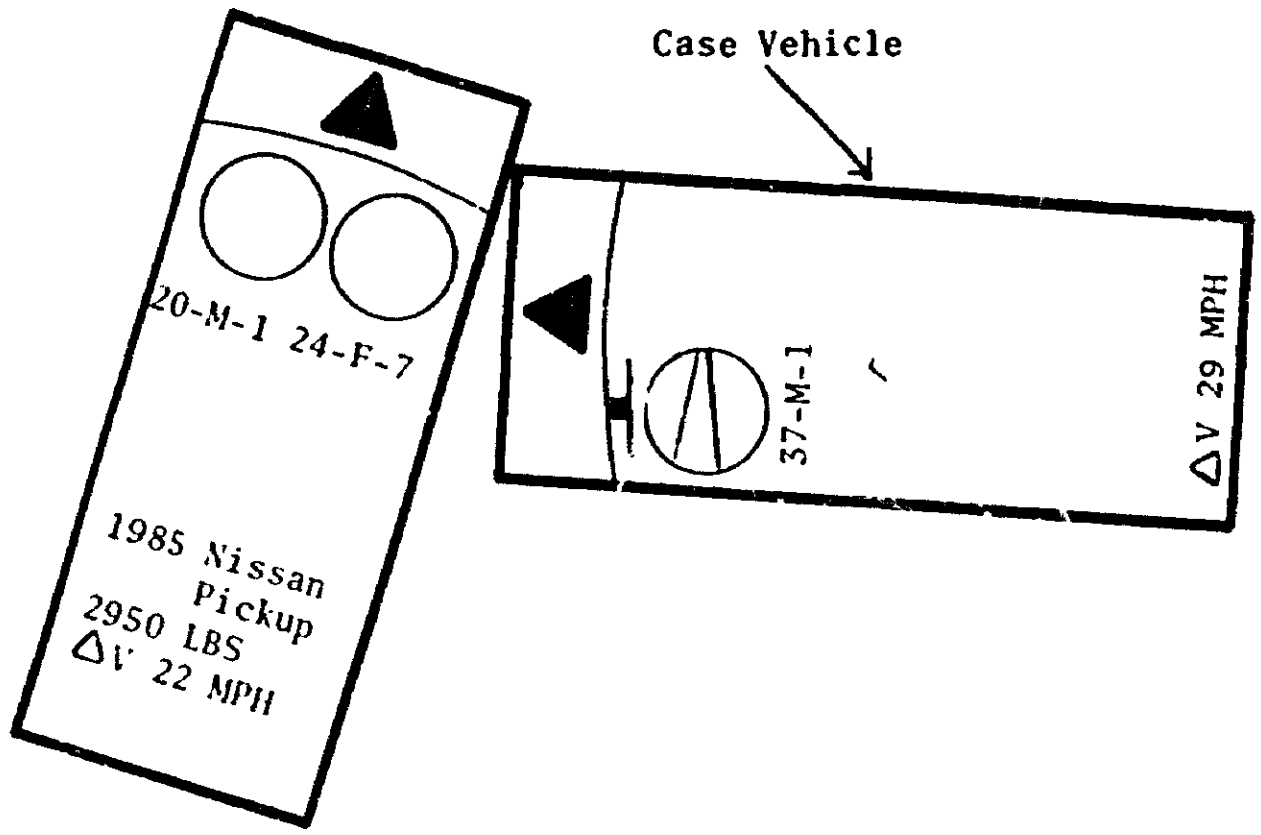
Injuries	AIS	Probable Source
Tenderness on left temple (unspecified)	9	Left side window
Chest contusion	1	Shoulder portion of the belt/steering wheel
Contusion on right knee	1	Steering column

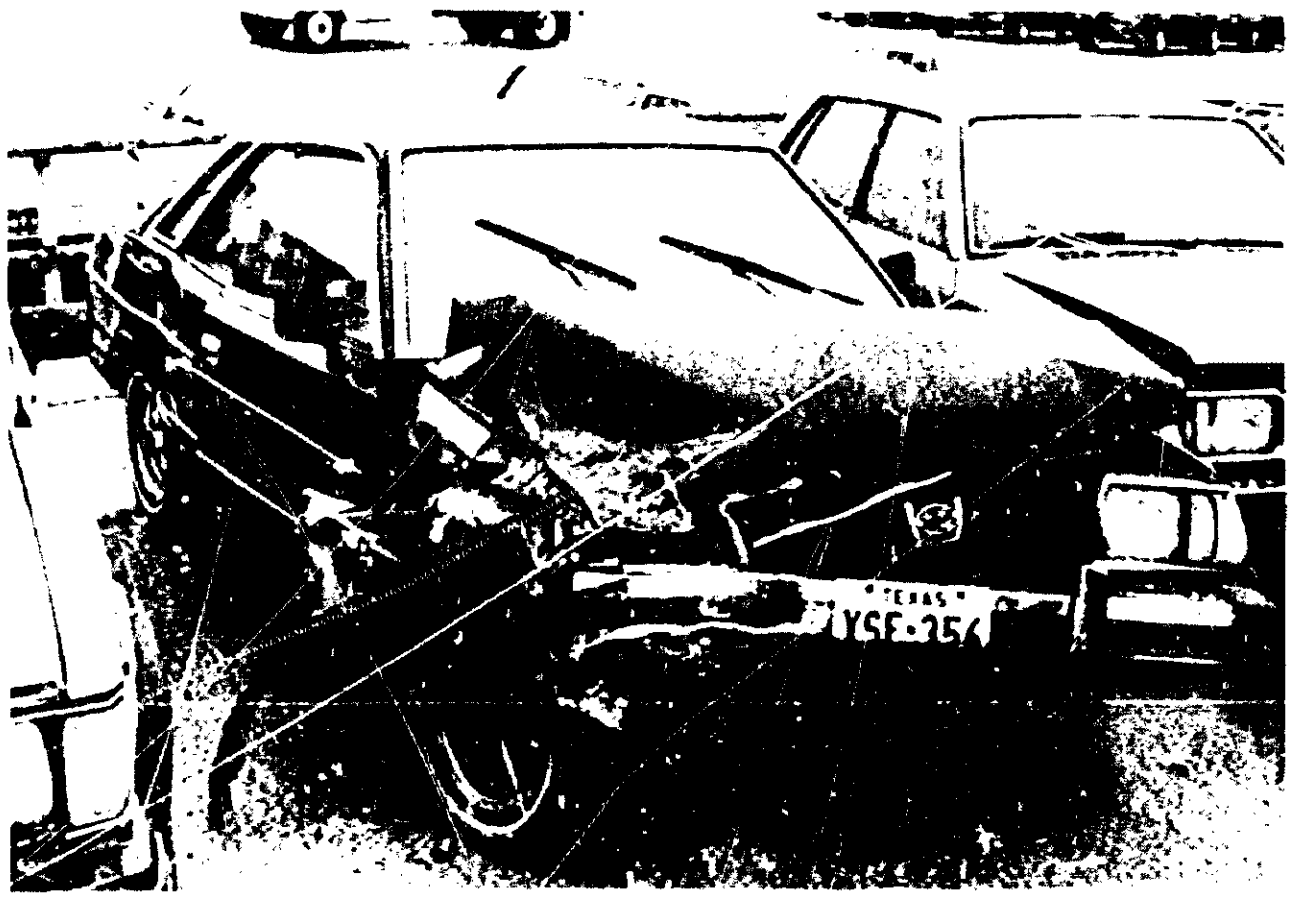
The driver of the Honda was not treated for his minor injuries. His use of the available lap/shoulder belt prevented more serious injury due to contact with the frontal interior components, in the initial 19.2 mph Delta V collision. However, since the driver was thrown forward and to the left, the belt could not have prevented the driver's head from striking the window.

While the unrestrained driver of the Cadillac also received only minor injuries, it should be noted that the Cadillac was twice the weight (4,472 pounds) of the Honda and underwent a crash only half as severe (9.4 mph Delta V).

CASE 119 - (MKC 85-H-0R08)

Case Vehicle: 1981 Subaru GLE, 2-Door
Case Vehicle Weight: 2,320 pounds
Case Vehicle Delta V: 29.3 mph





Circumstances

A 1981 Subaru GLF was crossing an intersection when it struck the right side of a left-turning 1985 Nissan pick-up. The Subaru received substantial structural damage with collapse of up to 22 inches across the 63.6-inch wide front end.

The Subaru driver, restrained by a lap/shoulder belt, received minor injuries. The two unrestrained occupants in the Nissan also received minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 37
Height: 6 feet 1 inch
Weight: 220 pounds
Restraint Used: Lap/shoulder belt (ELR)

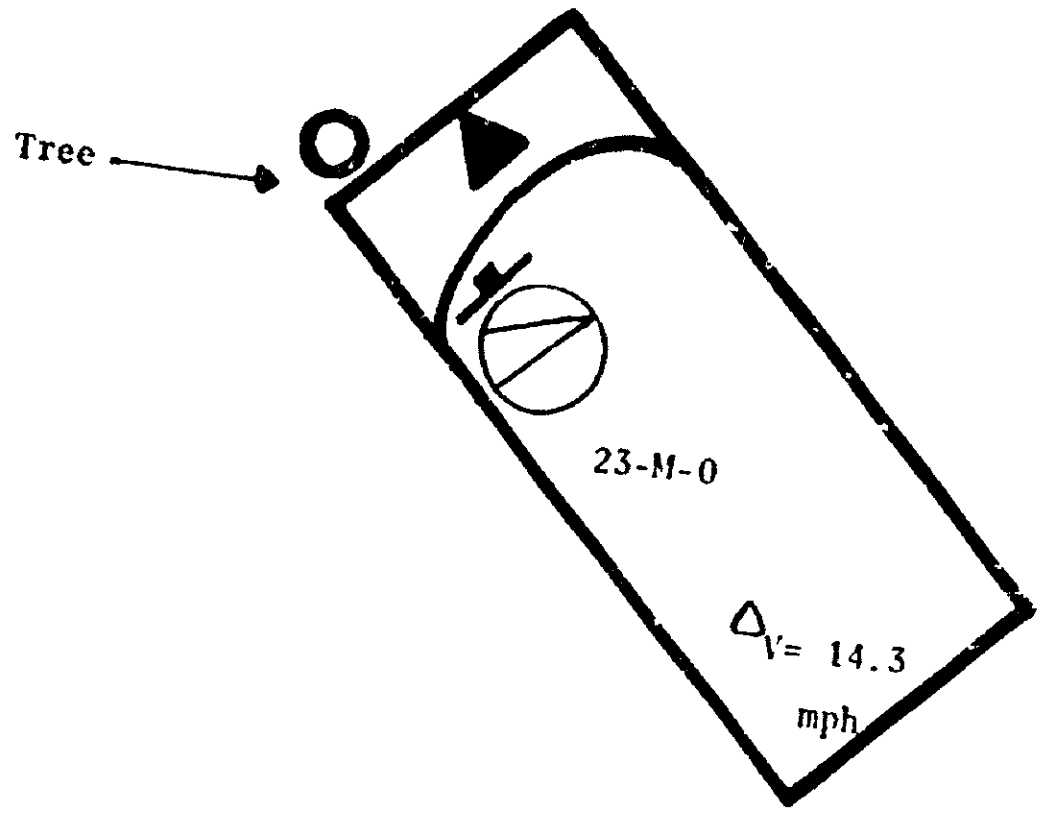
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to both vehicle motion and webbing acceleration, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver described the lap portion adjustment as being positioned low on his hips and "snug." The shoulder portion was reportedly adjusted so that the palm of a hand could be placed between the webbing and the driver's chest. Force loading marks were found in the areas of the lower seat cushion, the latchplate, and the B-pillar mounted D-ring.

Injuries	AIS	Probable Source
Contusion, right forearm	1	Console mounted shifter
Contusion, right hand	1	Console

The driver visited an area hospital as an out-patient but reported no loss of time from work. Considering the substantial impact forces (Delta V of 29 mph), the lap/shoulder belt performed extremely well and most likely prevented the driver from receiving additional and more serious injuries. An unrestrained driver would have been free to move forward into contact with the steering assembly, the instrument panel, and possibly the windshield.

CASE 120 - (MKC 85-H-0R09)

Case Vehicle: 1983 Dodge 400
Case Vehicle Weight: 2,667 pounds
Case Vehicle Delta V: 14.3 mph



Circumstances

A 1983 Dodge 400 was traveling on a 2-lane roadway when the driver lost control of the vehicle and it went off the roadway and struck a tree. The vehicle received substantial frontal damage with a maximum crush of 17.5 inches at the left front.

The driver, wearing a lap/shoulder belt, was uninjured.

Restraint and Injury

Case Vehicle

Seating Location:	Driver
Sex:	M
Age:	23
Height:	6 feet
Weight:	178 pounds
Restraint Used:	Lap/shoulder belt (ELR)

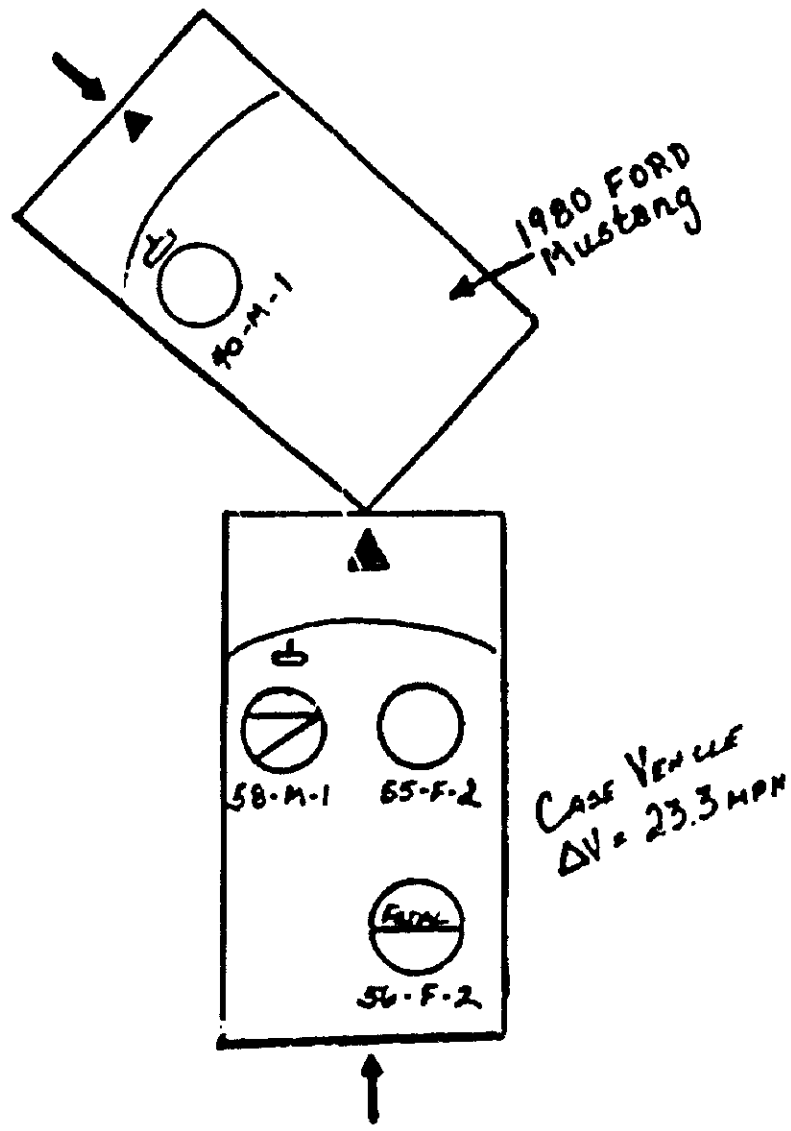
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. He described the adjustment of the lap portion as snug "across the lower waist." The shoulder portion was reportedly positioned across the mid-chest area. Force loading marks were found on the webbing in the area where it passed through the latchplate.

Injuries: None.

Although a 14 mph Delta V is not a severe crash, the belt still prevented the driver from going forward into the steering wheel and possibly the dash and/or windshield.

CASE 121 - (NYC 84-H-OR05)

Case Vehicle: 1983 Chevrolet Malibu, 4-door
Case Vehicle Weight: 3,690 pounds
Case Vehicle Delta V: 23.3 mph



Circumstances

A 1983 Chevrolet Malibu was struck in the center front by the left rear corner of an out-of-control 1980 Ford Mustang. The Chevrolet sustained moderate frontal damage with deformation of up to 16 inches. The Ford sustained up to 40 inches of deformation at its left rear.

The Chevrolet driver, restrained by a lap/shoulder belt, sustained minor injuries. The unrestrained right front passenger sustained moderate injuries. The lap belted right rear passenger sustained internal injuries which proved fatal. The unrestrained Mustang driver sustained minor injuries.

Restraint and Injury

Seating Location: Driver
Sex: M
Age: 58 years
Height: 6 feet
Weight: 207 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. Injury patterns indicate that the restraint system was properly used.

Injuries	AIS	Probable Source
Chest pain along shoulder line	0	Shoulder portion of belt
Neck strain	1	Impact forces
Contusion, anterior lower left leg	1	Under dashboard hardware
Contusion, anterior lower right leg	1	Under dashboard hardware

This driver was examined at a nearby hospital and released. Use of the available lap/shoulder belt probably prevented more serious impacts with the steering assembly and/or A-pillar area. Considering the 23.3 mph Delta V, the driver could have been seriously injured if unrestrained.

Seating Location: Right front
Sex: F
Age: 55
Height: 5 feet 6 inches
Weight: 160 pounds
Restraint Used: None

This occupant was not wearing the available lap/shoulder belt

Injuries	AIS	Probable Source
Laceration, left temple	2	Rear view mirror
Neck strain	1	Impact forces
Contusions, forehead, both eyes, cheekbones	1	Windshield moulding/ visor
Soreness above left breast	0	Unknown
Multiple abrasions, contusions, left arm	1	Steering wheel, gear shift, instrument panel
Multiple abrasions/contusions, both legs	1	Dashboard, glove compartment
Sprained ankle	1	Floorboard

This passenger was transported to a local hospital, treated, and released. Had she used the available lap/shoulder belt in this 23.3 mph Delta V collision, she probably would have reduced the severity and number of her injuries. Contact with the rear view mirror probably would have been avoided.

Seating Location: Right Rear
Sex: F
Age: 56 years
Height: 5 feet 8 inches
Weight: 155 pounds
Restraint Used: Lap belt (ALR)

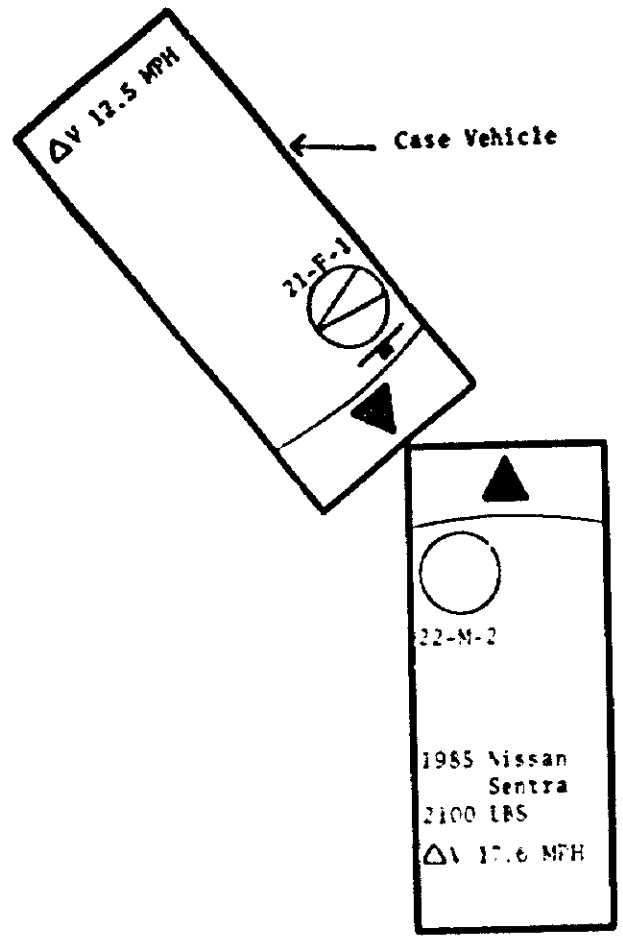
This occupant was wearing a lap belt with an automatic locking retractor. Injury patterns indicate proper placement low across the hips.

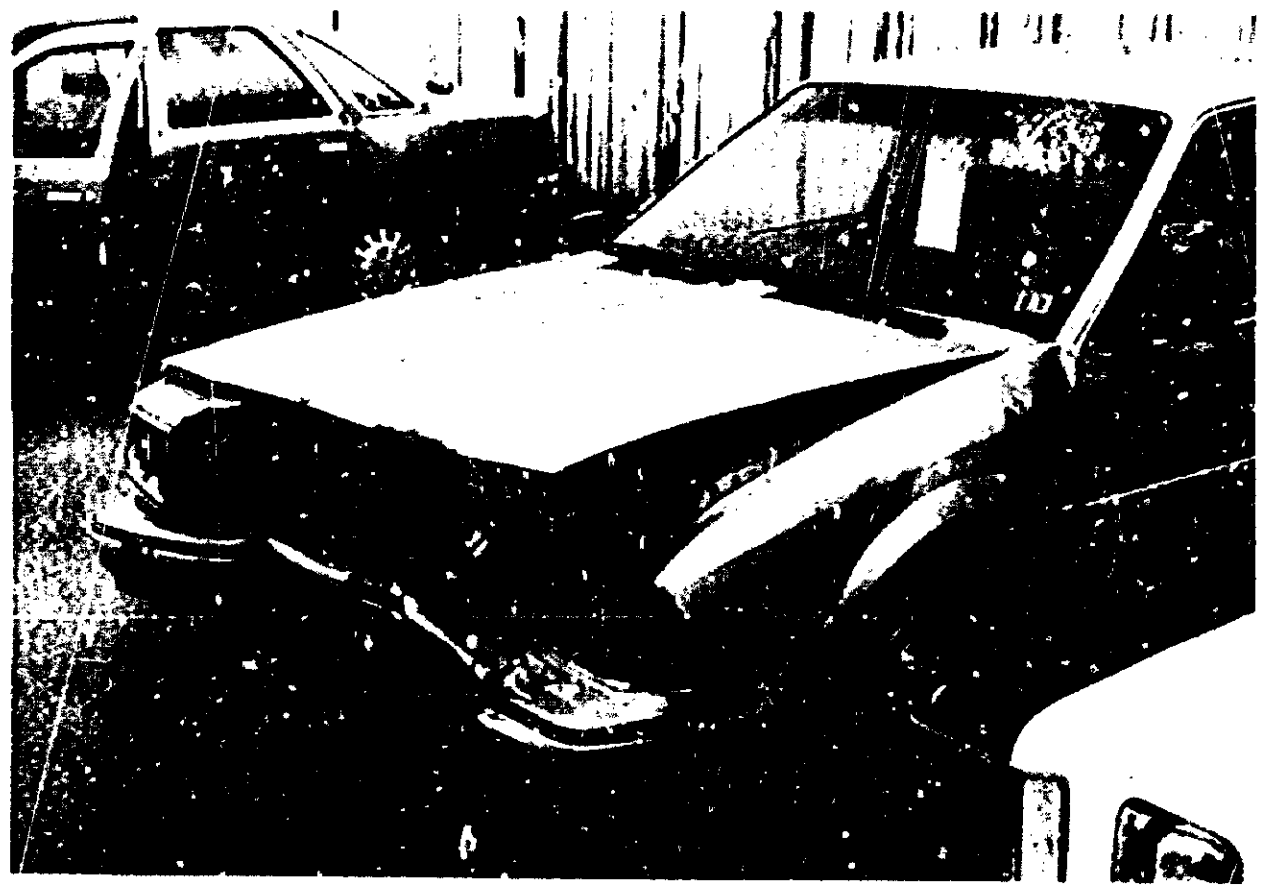
Injuries	AIS	Probable Source
Fracture (probable), nose	1	Front seat back
Contusion, left eye	1	Front seat back
Pelvis/rib pain	7	Unknown
Distended abdomen with 3-inch bruise along lap belt line about 2 inches below umbilicus, extending from iliac crests.		

This passenger was transported to a local hospital where she succumbed to her injuries. Although no autopsy was performed, emergency personnel statements, and described physical injuries, indicate severe intra-abdominal injuries with resultant hemorrhage. Given the level of injuries sustained, it is reasonable to believe that this woman would have fared much better if a lap/shoulder belt had been available and used. A lap/shoulder belt would diffuse restraint forces over a larger portion of the body, not concentrate them on the abdomen.

CASE 123 - (FTW 85-H-0R34)

Case Vehicle: 1983 Buick Century, 4-door
Case Vehicle Weight: 2,950 pounds
Case Vehicle Delta V: 10.5 mph





Circumstances

A 1983 Buick Century swerved across the centerline in order to avoid another vehicle entering traffic and then struck the left front corner of a 1985 Nissan Sentra. The Buick received moderate structural damage with up to 9 inches over a 64-inch wide area of the front end.

The Buick driver, restrained by a lap/shoulder belt, received minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 21
Height: 5 feet 3 inches
Weight: 130 pounds
Restraint Used: Lap/shoulder belt (ELR)

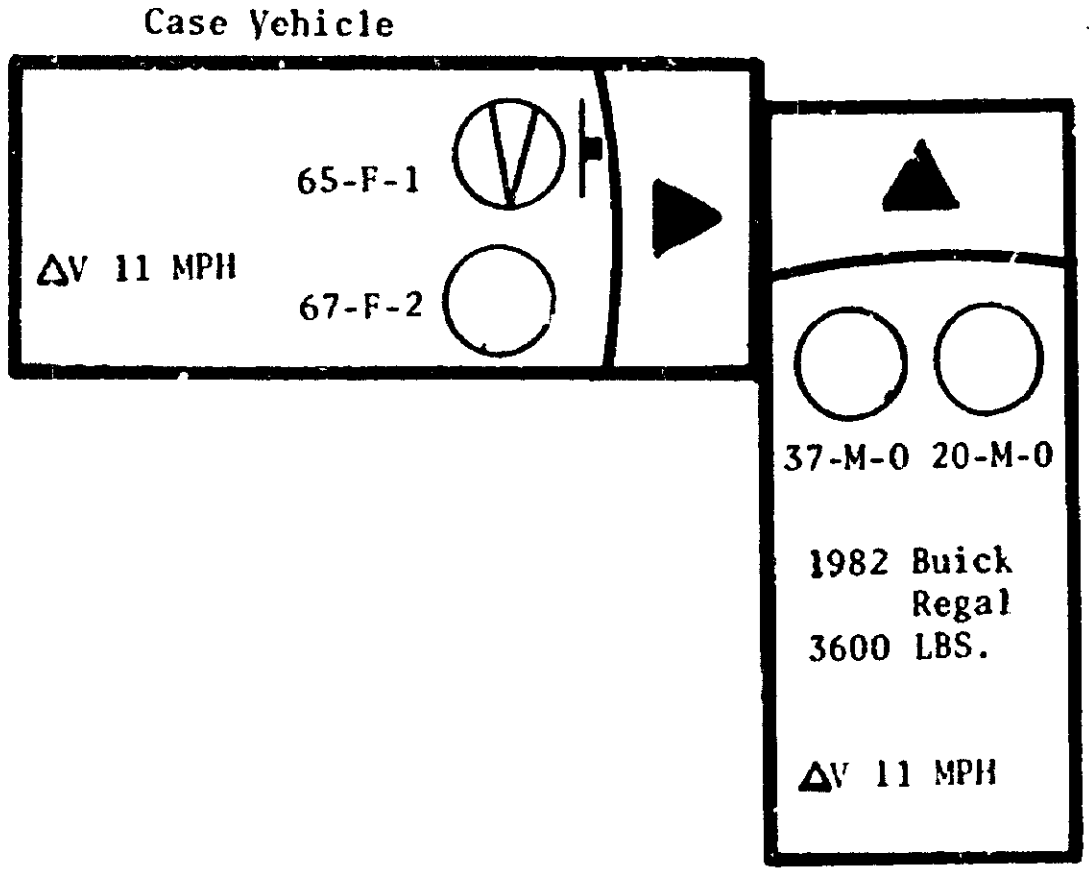
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, cinching latchplate, and a stalk-mounted buckle assembly. The driver described the lap portion of the belt as being "loose" and she was unsure of its routing location. The shoulder portion was reportedly adjusted so the fit was "very tight." Force loading marks were found on the webbing in the areas of the latchplate and the B-pillar mounted D-ring.

Injuries	AIS	Probable Source
Abrasion, left side of neck	1	Shoulder portion of the belt
Contusion, chest	1	Shoulder portion of the belt
Laceration, left elbow	1	Unknown
Contusion, left knee	1	Lower instrument panel
Contusion, right foot	1	Foot controls

The driver did not seek medical treatment and reported no loss of time from work. The loose fit of the lap portion of the belt most likely resulted from design of the belt: the stalk-mounted buckle was 5 inches above and 9 inches forward of the junction of the lower and back seat cushion. With this loose fit, even in spite of the moderate collision forces (Delta V of 12.5 mph), the driver was able to move forward and contact the lower instrument panel with her knee.

CASE 124 - FTW 85-H-OR35

Case Vehicle: 1983 Chevrolet Malibu, 4-door
Case Vehicle Weight: 3,600 pounds
Case Vehicle Delta V: 11 mph



Circumstances

A 1982 Buick Regal pulled into an intersection and was struck on the left front by a 1983 Chevrolet Malibu. The Chevrolet received moderate structural damage with inward collapse reaching depths of up to 9 inches.

The Chevrolet driver, restrained by a lap/shoulder belt, received minor injuries. The unrestrained right front Chevrolet passenger sustained moderate injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 65
Height: 5 feet 1[illegible] inches
Weight: 160 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver described the lap portion of the belt as being low on her hips and "in-between loose and snug." The shoulder portion was reportedly adjusted so that more than a clenched fist could be placed between the webbing and the driver's chest. Force loading marks were found in the areas of the latchplate and B-pillar mounted D-ring.

Injuries	AIS	Probable Source
Contusion, forehead	1	Steering wheel
Contusion, chest	1	Shoulder portion of belt
Contusion, right knee	1	Lower instrument panel
Contusion, left knee	1	Lower instrument panel

No medical treatment was required for the driver's injuries and she reported no loss of time from work. The loose fitting lap/shoulder belt can most likely be attributed to a lack of user knowledge concerning the use of the windowshade tension-relief device and the position of the stalk-mounted buckle. The buckle was 5 inches above and 7 inches forward of the junction of the lower and back seat cushions. This position makes it extremely difficult to keep the lap portion of the belt positioned low on the abdomen and snug.

Case Vehicle
Seating Location: Right Front
Sex: F
Age: 67
Height: 5 feet 3.5 inches
Weight: 113 pounds
Restraint Used: None

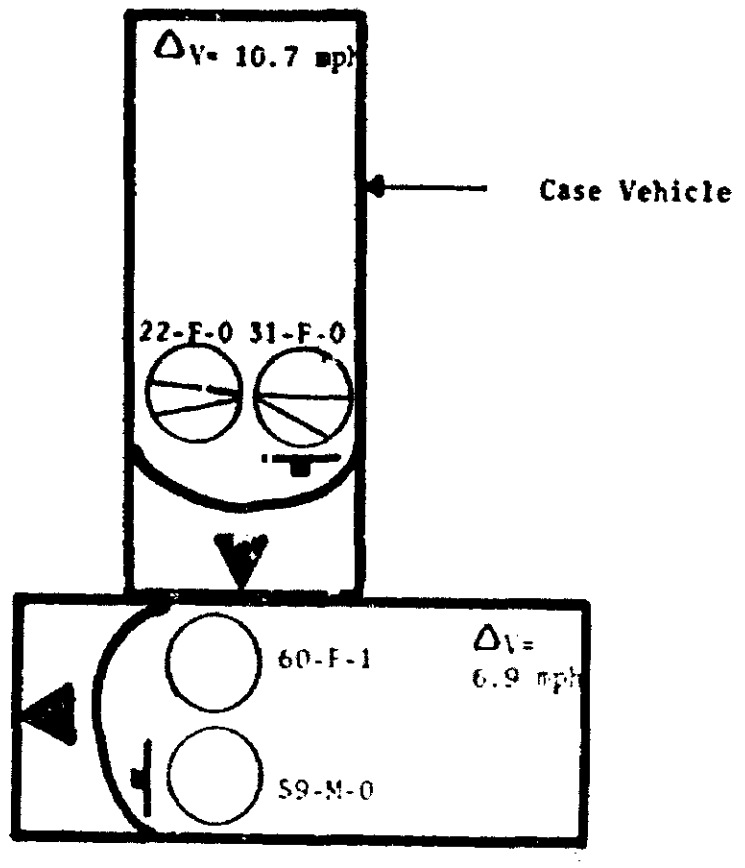
This passenger was not wearing the lap/shoulder restraint system available at this position.

Injuries	AIS	Probable Source
Large contusion, forehead	2	Windshield/A-pillar
Laceration, forehead	1	Windshield/A-pillar
Contusion, left hand	1	Interior contact
Laceration, right thigh	1	Unknown
Laceration, right knee	1	Unknown
Contusion, right foot	1	Below instrument panel

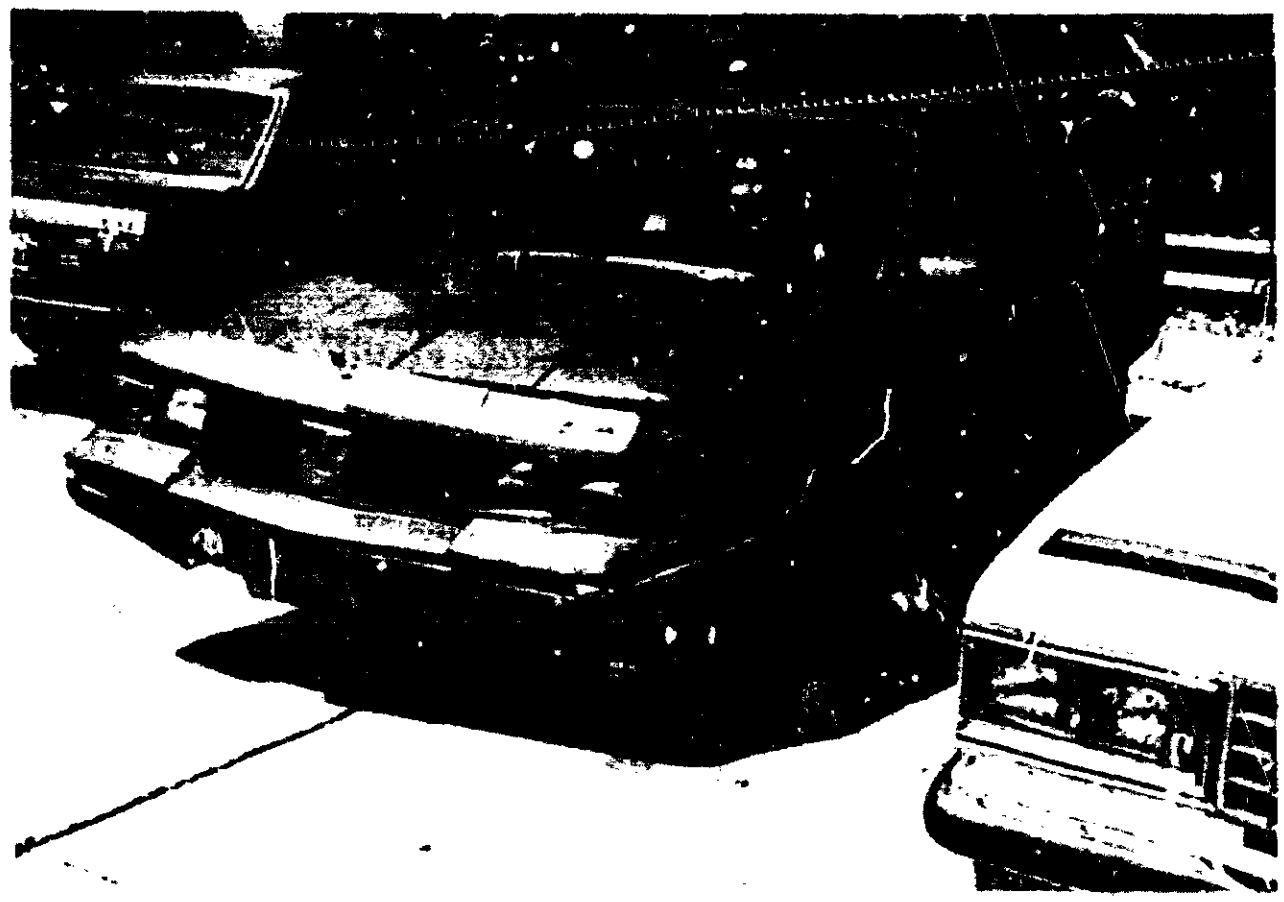
The right front passenger was treated as an out-patient at an Army medical center. Since the occupant was not wearing the available lap/shoulder belt, there was nothing to prevent her from being thrown forward into the windshield and instrument panel during the 11 mph Delta V collision. Had she been restrained properly, she probably would have sustained lesser injuries.

CASE 125 - (MKC 85-H-OR25)

Case Vehicle: 1984 Oldsmobile Ciera
Case Vehicle Weight: 2,850 pounds
Case Vehicle Delta V: 10.7 mph



1981 Oldsmobile 98 4-door
Weight= 4,431



Circumstances

A 1984 Oldsmobile Ciera was passing through an intersection when it struck the right side of a 1981 Oldsmobile 98. The Oldsmobile Ciera sustained moderate damage along the front with deformation of up to 12 inches. The 1981 Oldsmobile 98 received damage in the area of both right doors and had deformation of up to 4.5 inches.

The driver and right front passenger of the Ciera, both restrained by lap/shoulder belts, were uninjured. The unrestrained driver of the Olds 98 was not injured; however, the right front passenger, also unrestrained, sustained minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 31
Height: 5 feet 8 inches
Weight: 150 pounds
Restraint Used: Lap/shoulder (ELR)

The driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver stated that the lap portion of the belt was worn "snug across the abdomen" and the shoulder portion as being able to get a clenched fist between her chest and the belt. The driver was uninjured.

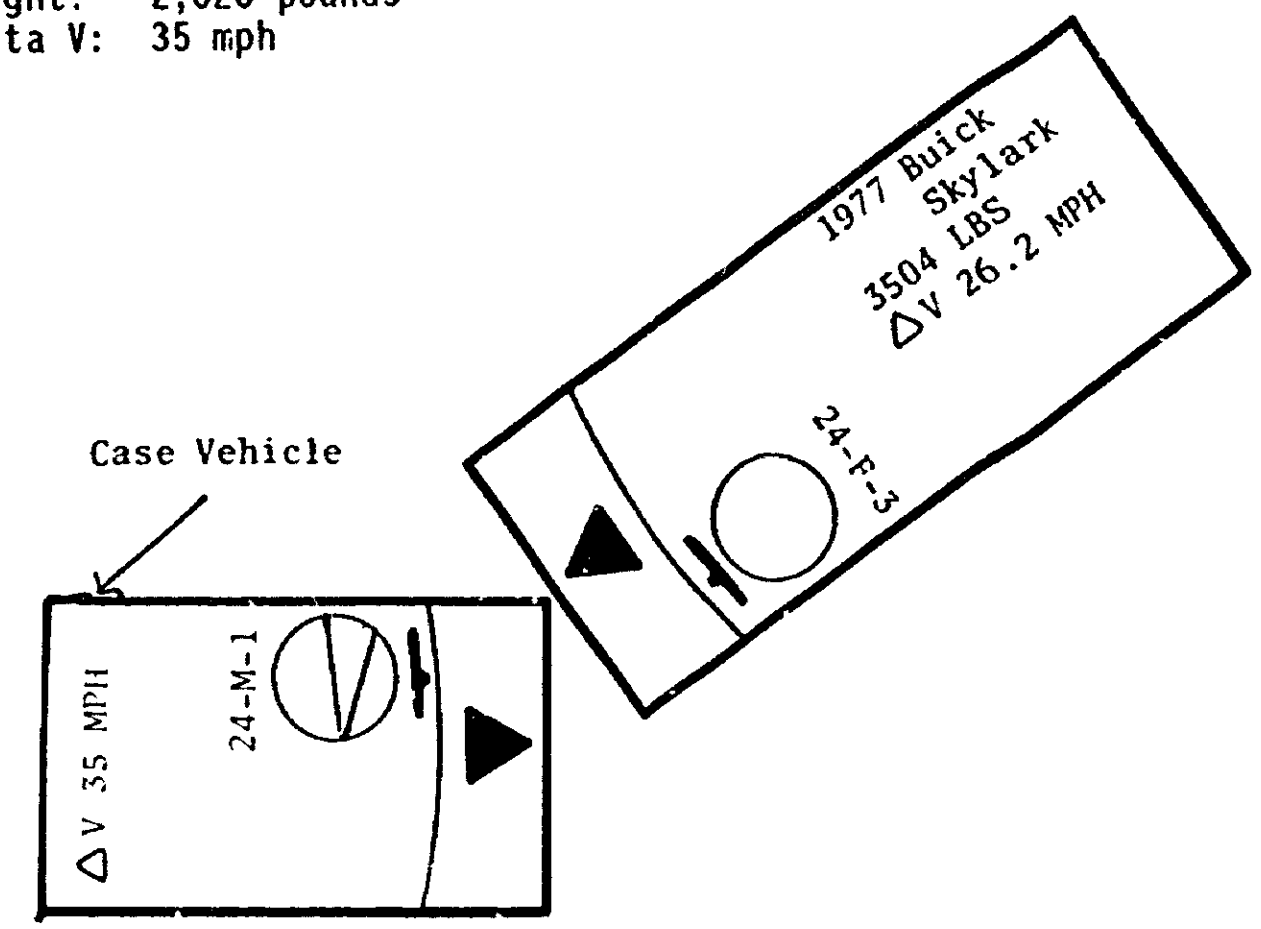
Case Vehicle
Seating Location: Right Front
Sex: F
Age: 22
Height: 5 feet 4 inches
Weight: 115 pounds
Restraint Used: Lap/shoulder belt (ELR)

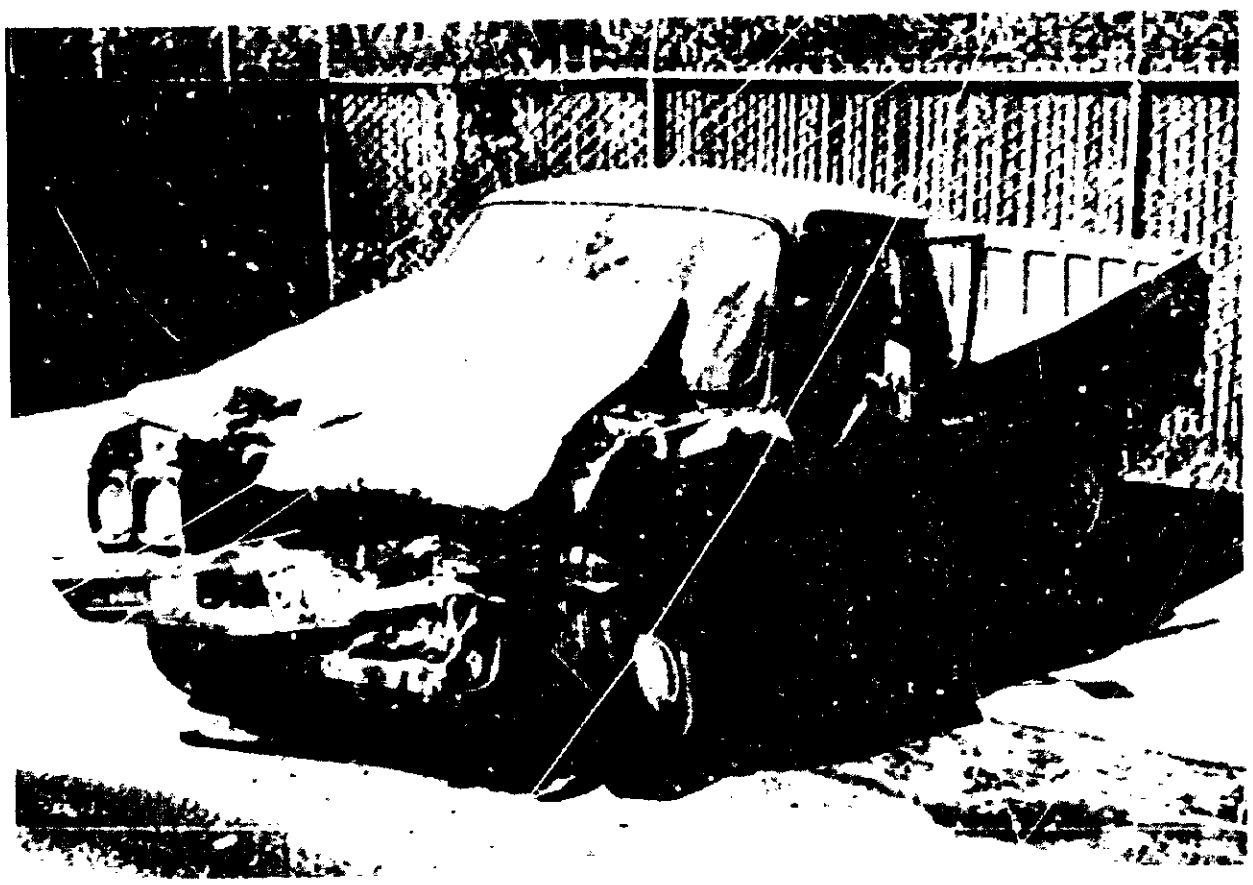
The right front passenger was wearing the same type of lap/shoulder belt as the driver. She related that the lap portion was worn "snug across the waist" and that she could get no more than the palm her hand between her chest and the belt webbing. This passenger was not injured.

If the belt was worn in the manner described, "snug across her waist," it was improperly positioned. The passenger was fortunate that crash forces were so low (Delta V of 10 mph).

CASE 126 - (SEA 85-H-OR15)

Case Vehicle: 1976 Chevrolet LUV Pick-up Truck
Case Vehicle Weight: 2,620 pounds
Case Vehicle Delta V: 35 mph





Circumstances

A 1977 Buick Skylark collided head-on into the left front corner of a 1976 Chevrolet pick-up truck. The Chevrolet sustained a maximum crush of 24 inches at the left front and the Buick sustained a maximum collapse of 36 inches at its left front.

The collision resulted in minor injuries to the lap/shoulder belted-Chevrolet pick-up driver, while the unrestrained Buick driver received serious injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 24
Height: 5 feet 10 inches
Weight: 160 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a free-sliding latchplate, and a push-button release buckle attached to a floor-mounted flexible stalk. The driver described the precrash adjustment as snug, with the lap portion of the belt positioned "across his waist near the navel" and the shoulder portion routed across his midchest. The presence of contusions at the left and right hip from the lap portion of the belt suggest that perhaps the belt was being worn lower than the driver indicated. There were marks on the webbing attributed to webbing load at the D-ring. The steering wheel rim was displaced inward 1 1/2 inches and the instrument panel was cracked near the base of the steering column.

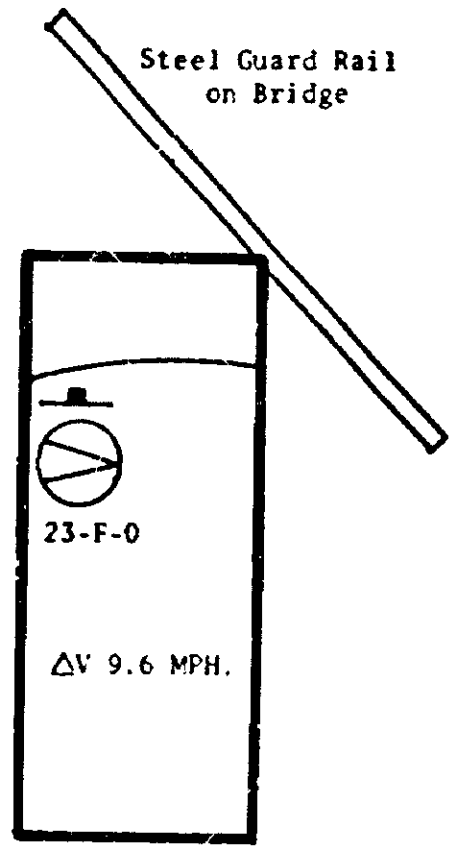
Injuries	AIS	Probable Source
Laceration, forehead	1	Steering wheel rim
Laceration, nose	1	Steering wheel rim
Contusion, under left and right eye	1	Steering wheel rim
Contusion, left shoulder	1	Shoulder portion of the belt
Strain, upper back	1	Impact forces
Laceration, right arm	1	Steering wheel spoke
Contusion, upper and lower right arm	1	Steering wheel spoke
Contusion, left and right hip	1	Lap portion of the belt
Laceration, right knee	1	Lower instrument panel
Contusion, right knee	1	Lower instrument panel

This man was examined at an out-patient medical facility and released. He reportedly lost 1 week of work due to his injuries. Considering the forces involved (Delta V of 35 mph for the small pickup), the lap/shoulder belt performed well in this frontal collision. The other vehicle in this collision underwent a 26.2 mph Delta V, much less than the case vehicle, and its unrestrained driver received serious injuries.

If the Chevrolet driver had been unrestrained, he probably would have been more seriously injured.

CASE 127 - (CHI 85-H-OR14)

Case Vehicle: 1981 Plymouth Reliant, 4-door Sedan
Case Vehicle Weight: 3,255 pounds
Case Vehicle Delta V: 9.6 mph



NO PHOTOGRAPH AVAILABLE

Circumstances

A 1981 Plymouth Reliant 4-door Sedan, traveling at a driver-estimated speed of 40-45 mph, spun out of control on an icy road and struck a bridge rail with its right front corner. The collision resulted in minor damage.

The Plymouth driver, who was 8 months pregnant, was restrained by a lap/shoulder belt and was not injured.

Restraint and Injury

Case Vehicle

Seating Location:	Driver
Sex:	F
Age:	23
Height:	5 feet 3 inches
Weight:	155 pounds
Restraint Used:	Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a cinching latchplate, a windowshade tension-relief feature, and a push-button release buckle attached to a flexible stalk. The driver stated that the precrash adjustment of the lap portion of the belt was snug and positioned low on her hips. She reported that the shoulder portion was snug and that she was wearing a heavy winter coat. Scratches on the latchplate indicated frequent usage. No loading marks were found on the system belt webbing.

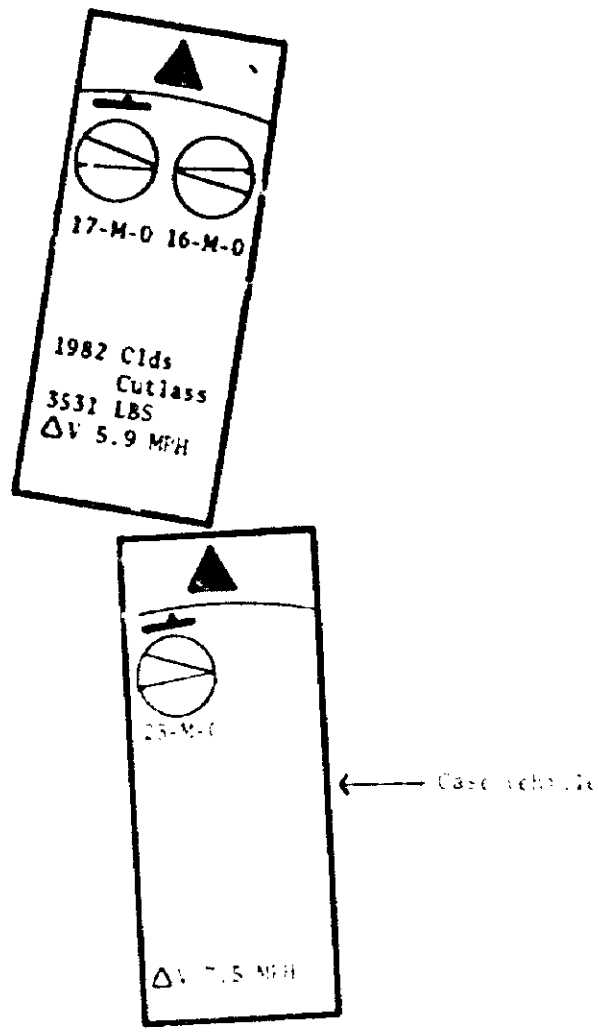
Injuries: none.

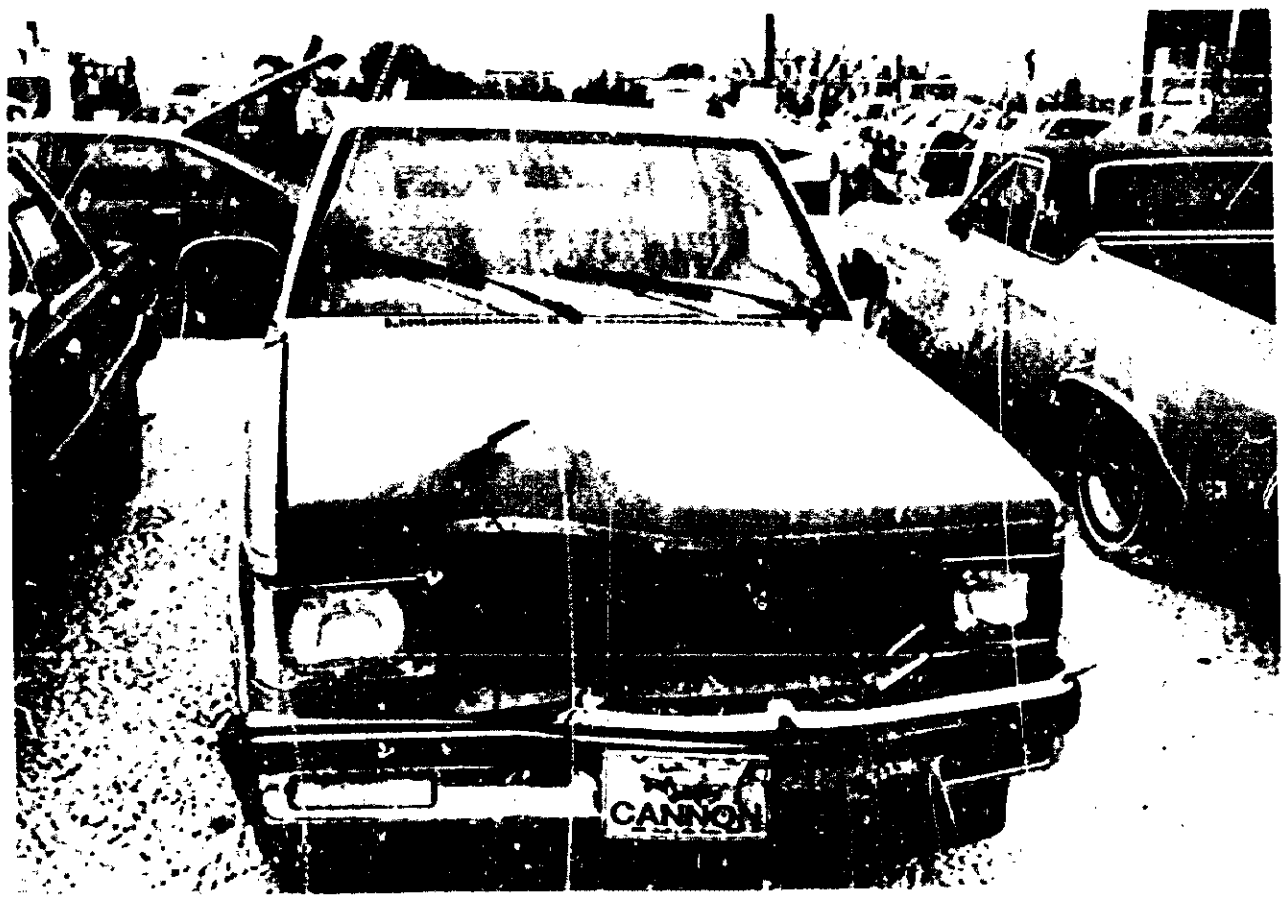
This woman, 8 months pregnant at the time of the collision, reported no injuries but she sought a medical examination because of her pregnancy. The fetus was not injured and no complications of the pregnancy occurred. This woman stayed home from work for 2 days at the request of her doctor. The child was carried full term and delivered as a healthy infant.

It is likely that the restraint system prevented injury in this 9.6 mph Delta V collision, primarily to the unborn child. Had the driver not been restrained, she likely would have made contact with the steering assembly thus increasing the chance of fetal injury.

CASE 128 - (MKC 85-H-OR15)

Case Vehicle: 1984 Chevrolet S-10 Pick-up Truck
Case Vehicle Weight: 2,774 pounds
Case Vehicle Delta V: 7.5 mph





Circumstances

A 1984 Chevrolet S-10 pick-up truck struck the right rear of a 1982 Oldsmobile Cutlass 2-door coupe. The accident resulted in moderate damage to the Chevrolet and minor damage to the Oldsmobile.

The Chevrolet was occupied by a lap/shoulder belted-driver. Both the driver and the right front passenger of the Oldsmobile were restrained by lap/shoulder belts. There were no reported injuries to the occupants of either vehicle. Safety Board investigators were unable to obtain restraint data from the Oldsmobile occupants; police investigators reported that they were restrained.

Restraint and Injury

Case Vehicle

Seating Location:	Driver
Sex:	M
Age:	23
Height:	5 feet 10 inches
Weight:	200 pounds
Restraint Used:	Lap/shoulder belt with dual retractors (ELR/ELR)

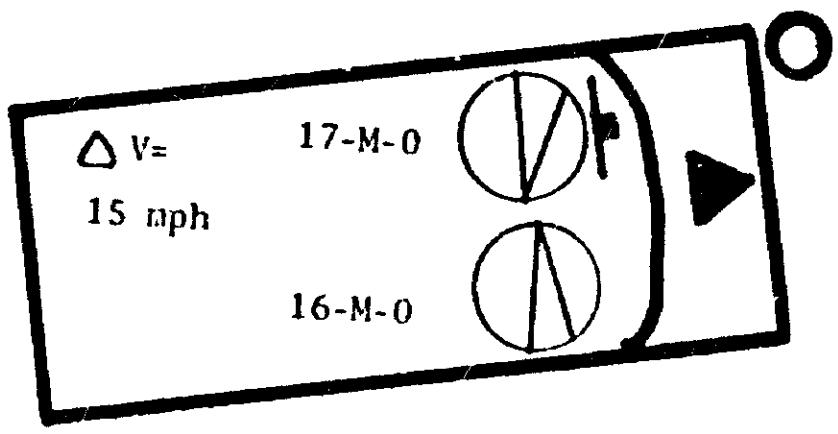
This driver was wearing a continuous loop lap/shoulder belt equipped with dual emergency locking retractors, a sewn-in latchplate, and a push-button release buckle attached to a flexible stalk. The driver described the adjustment of the lap portion of the belt as "snug" but was unable to describe the webbing routing. There were scratch marks on the latchplate attributed to frequent usage but there were no loading marks on the system. There were no contact points located on the frontal interior of the vehicle.

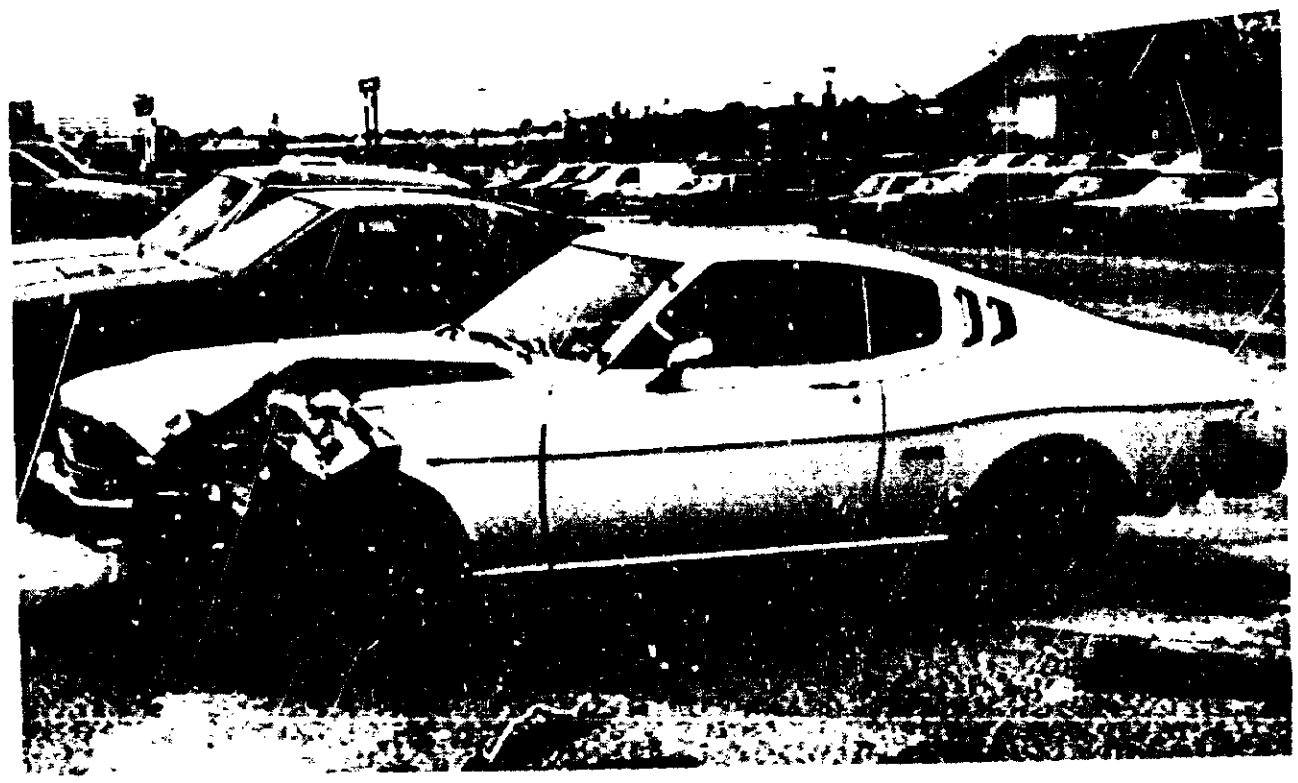
Injuries: none.

This man reported that he was not injured. It is possible that he might have contacted the steering assembly if the restraint had not been in use, but given the low-speed (Delta V of 7.5 mph) of the collision, it's not known if injuries would have resulted. Therefore, lap/shoulder belt use probably was of limited benefit in this minor collision.

CASE 129 - (MKC 85-H-0R14)

Case Vehicle: 1977 Toyota Celica, 2-door Coupe
Case Vehicle Weight: 2,900 pounds
Case Vehicle Delta V: 15 mph





Circumstances

A 1977 Toyota Celica ran off the road and struck a wooden utility pole with the left front. The Toyota sustained substantial impact damage to the left front and along the left side.

The Toyota driver and right front passenger, both restrained by lap/shoulder belts, were uninjured.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 17 years
Height: 5 feet 11 inches
Weight: 190 pounds
Restraint Used: Lap/shoulder belt with dual retractors (ELR/ALR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an automatic locking retractor on the lap portion of the belt, an emergency locking retractor for the shoulder portion (sensitive to vehicle motion), a sewn-in latchplate, and a push-button release buckle attached to a flexible seat-mounted stalk. The driver described the precrash adjustment of the lap portion of the belt as snug, positioned low on his hips, but he was unable to recall the adjustment of his shoulder portion. However, the shoulder portion on this system has a self-tensioning feature so it is presumed that its adjustment was snug. Marks were found on the webbing attributed to loading at the D-ring. This occupant did not contact the frontal interior of the vehicle.

Injuries: None.

This driver was not injured. The restraint performed well in this 15 mph Delta V collision. Had this driver been unrestrained, he would have contacted the frontal interior of the vehicle and probably received minor to moderate injuries.

Case Vehicle
Seating Location: Right front
Sex: M
Age: 16 years
Height: 5 feet 11 inches
Weight: 180 pounds
Restraint Used: Lap/shoulder belt with dual retractors (ALR/ELR)

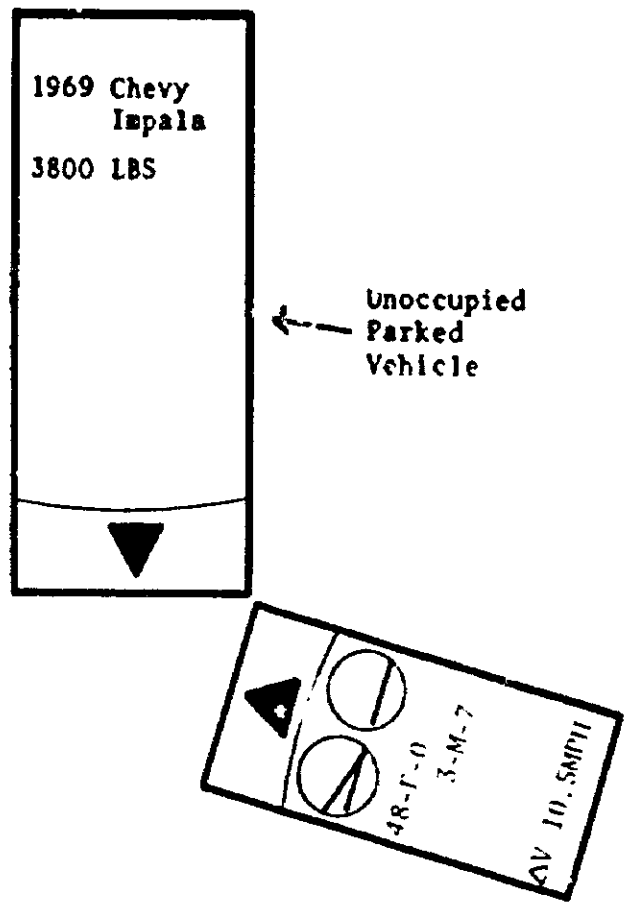
This passenger was wearing a lap/shoulder belt identical to that worn by the driver. He reported that his lap portion of the belt was adjusted snug on his hips but was unsure as to how the shoulder portion was adjusted. There were marks on the webbing from loading at the D-ring. This passenger did not contact the frontal interior of the vehicle.

Injuries: None

The restraint system performed well in preventing this passenger from contacting the interior in this moderate speed (Delta V of 15 mph) collision. Had he not been restrained, he might have received minor to moderate injuries from contacting the windshield and instrument panel.

CASE 130 - (MKC 85-H-OR16)

Case Vehicle: 1982 Honda Civic 4-door station wagon
Case Vehicle Weight: 2,265 pounds
Case Vehicle Delta V: 10.5 mph



Circumstances

A 19.. Honda 4-door station wagon ran off the roadway and collided right front into the left front side of a parked and unoccupied 1969 Chevrolet Impala 2-door. The accident resulted in moderate damage to the right front of the Honda with crush up to 32 inches over a 13-inch wide area. The Chevrolet sustained damage to the left side which was crushed up to 7 inches.

The Honda driver was restrained by a lap/shoulder belt and the child in the right front seat was restrained by a misrouted lap/shoulder belt; the shoulder portion of the belt was routed behind the child's back. The driver was not injured and the right front seat passenger reportedly suffered a nose bleed.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 48
Height: 5 feet 4 inches
Weight: 223 pounds
Restraint Used: Lap/shoulder belt (ELR)

The driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a free-sliding latchplate, and a push-button release buckle attached to a flexible stalk. The driver described the adjustment of the lap portion of the belt as snug, positioned "across her abdomen," and her shoulder portion as being snug across her mid-chest area. There were marks on the webbing attributed to webbing load at the D-ring. There was no compartment deformation noted forward of this seating position.

Injuries: None.

The restraint system performed well in preventing this occupant from contacting the frontal interior of the vehicle in this 10.5 mph Delta V collision. She would have made uncontrolled movement into the steering wheel assembly and might have received some level of injury had she not been restrained.

Case Vehicle
Seating Location: Right Front
Sex: M
Age: 3 years
Height: 2 feet 6 inches
Weight: 40 pounds
Restraint Used: Misrouted lap/shoulder belt: shoulder portion behind back

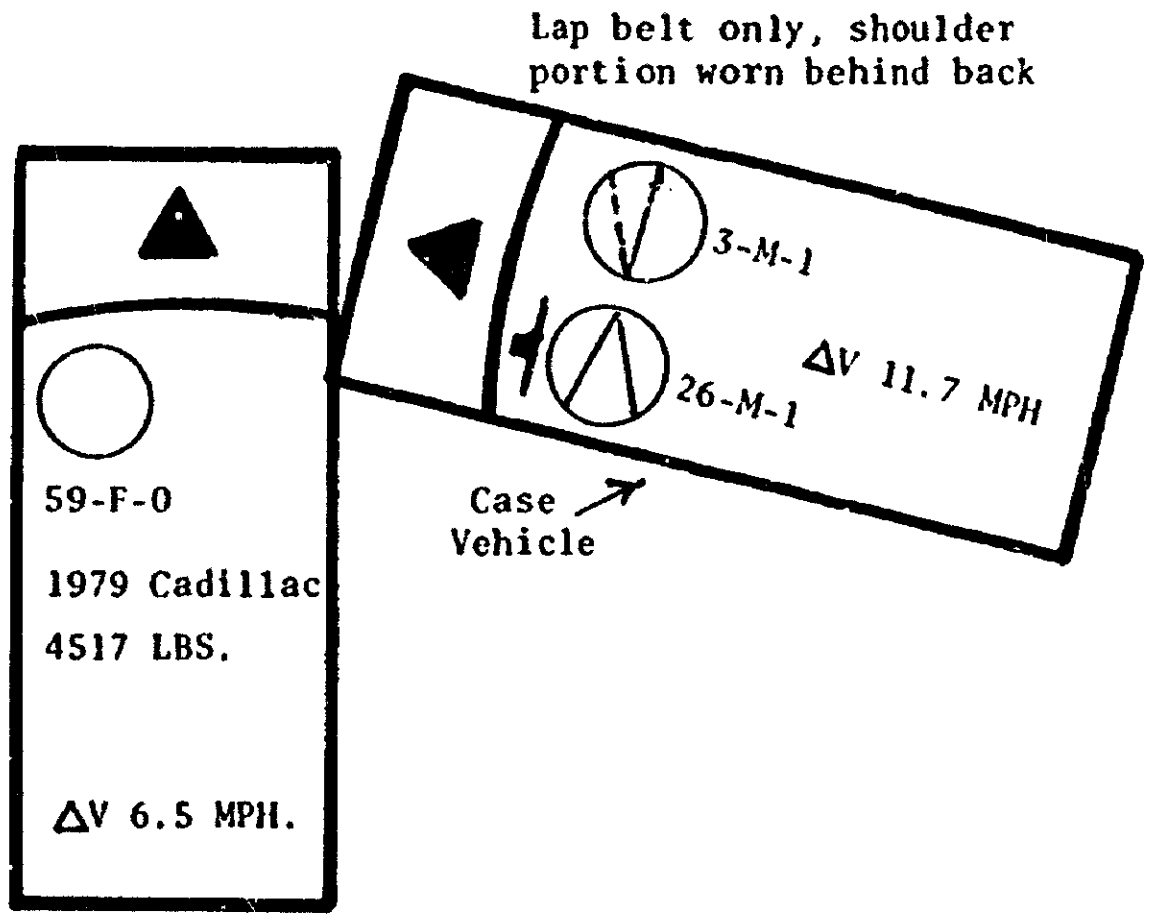
This passenger had a lap/shoulder belt identical to the driver's available for his use. However, the driver placed the shoulder portion behind this boy and placed the lap portion of the belt snug "around his waist." (The police report indicated the shoulder portion was used but the driver admitted that she had placed the strap behind her son.) There were no force loading marks on the webbing and there was no compartment deformation noted forward of this seating position. The Delta V of this crash was too low to make the improper positioning of the lap belt portion of the 3-point belt harmful.

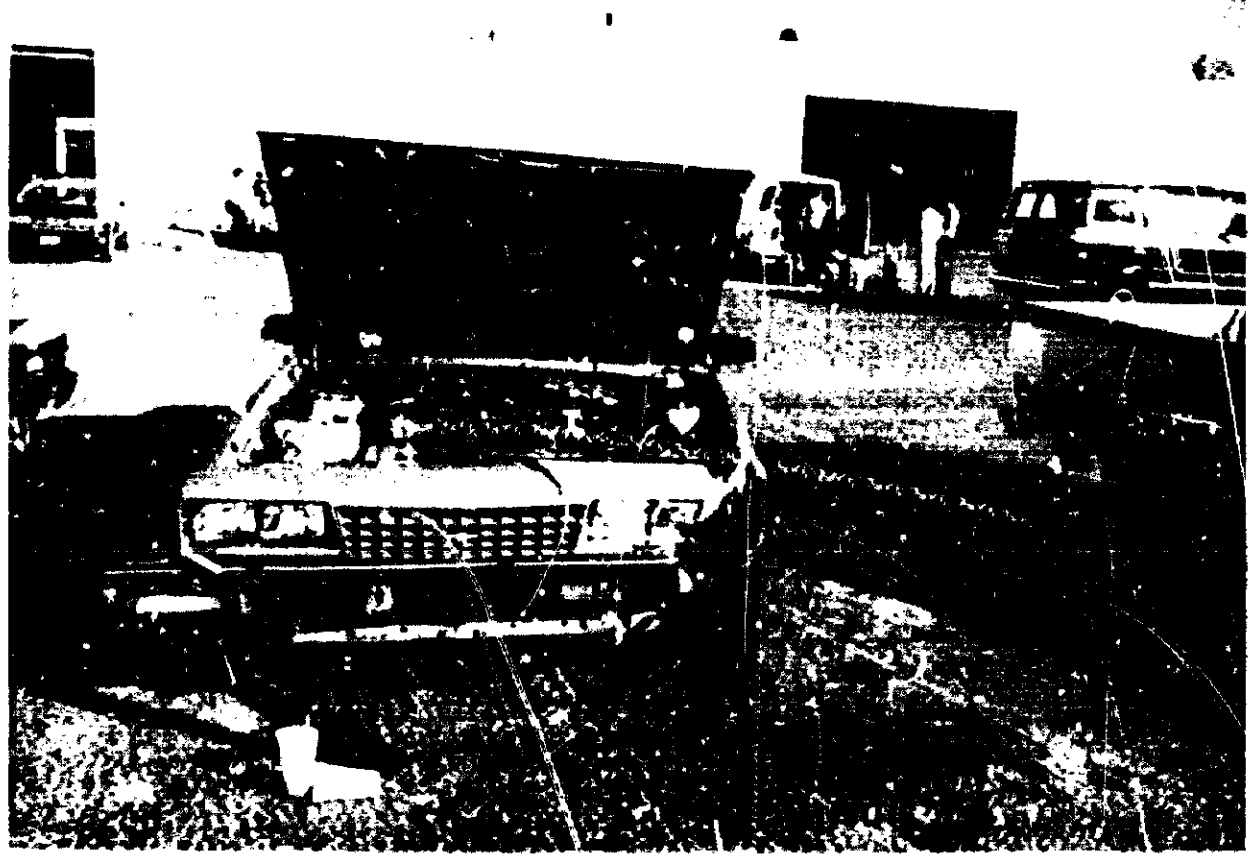
Injuries: Unknown.

The driver stated to the Safety Board investigator that her son was thrown forward and down at impact, striking his face on his legs. This resulted in what the mother termed as a minor nose bleed, but she did not take him to a doctor, so the exact injury and severity is unknown. The mother gave no reason, when questioned, as to why she did not restrain her son with the shoulder portion of the belt.

CASE 131 - (LAX 85-H-0R01)

Case Vehicle: Chevrolet Cavalier, 4-door
Case Weight: 2,774 pounds
Case Vehicle Delta V: 11.7 mph





Circumstances

A 1984 Chevrolet Cavalier, traveling at a driver-estimated speed of 20-25 mph, struck the right front side of a 1979 Cadillac 2-door with its left front. The Chevrolet sustained substantial damage with deformation of up to 14 inches over a 59-inch area.

The Chevrolet was occupied by a lap/shoulder belt-restrained driver and a child, restrained by a misrouted lap/shoulder belt (shoulder portion behind back), seated in the right front. The Cadillac was occupied only by an unrestrained driver. Both drivers were uninjured. The right front passenger of the Chevrolet sustained a minor head injury.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 26
Height: 6 feet 1 inch
Weight: 185 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a cinching latchplate, a windowshade tension-relief feature, and a push-button release buckle attached to a flexible stalk. The driver was unable to relate the precrash adjustment of the restraint system. Force loading marks were not found on the system webbing.

Injuries: None.

This driver was examined at an outpatient facility because of a back spasm complaint but he was released after the exam revealed no apparent injuries. The lap/shoulder belt prevented the driver from contacting interior components of the vehicle in this 11.7 mph Delta V collision.

Case Vehicle
Seating Location: Right front

Sex: M
Age: 3
Height: 3 feet
Weight: 37 pounds
Restrained: Misrouted lap/shoulder belt (ELR): shoulder portion behind back

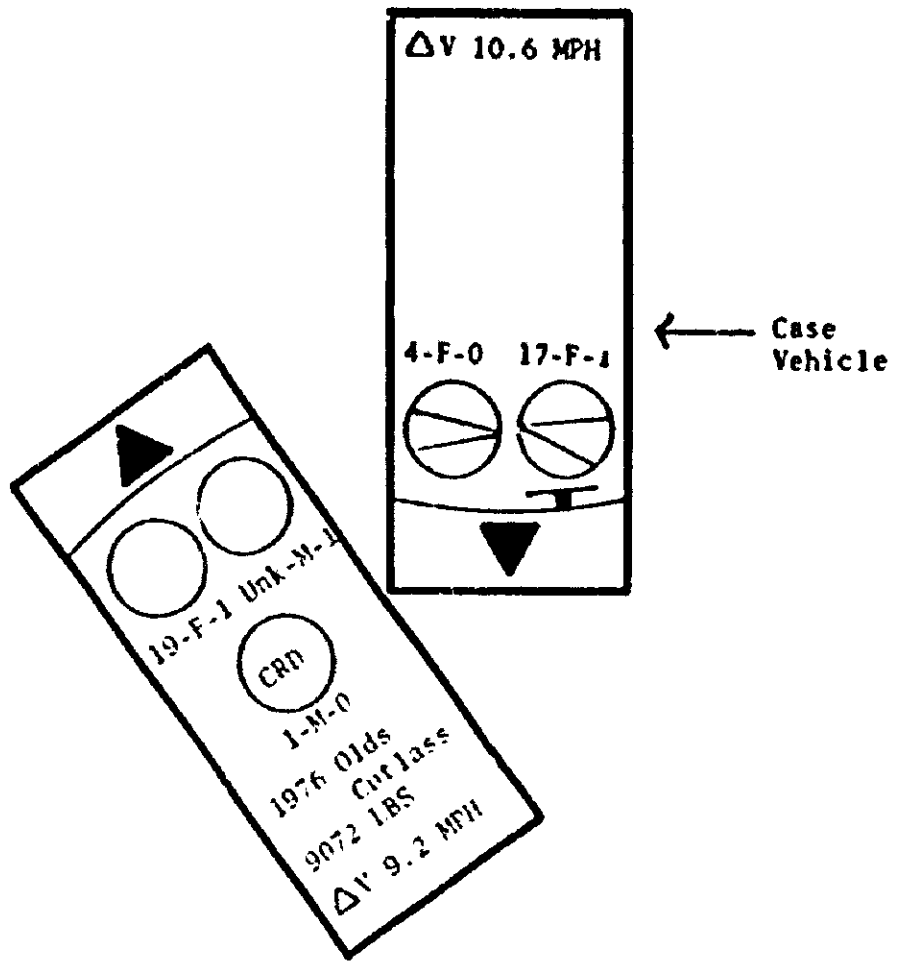
This passenger's position was equipped with a lap/shoulder belt identical to the driver's. However, the father had placed the shoulder portion of the 3-point belt behind the child because it "did not fit across the small child's chest." Consequently, the child was only restrained by the lap portion of the belt. The father was unable to relate the precrash positioning or adjustment of the lap portion of the belt on the child.

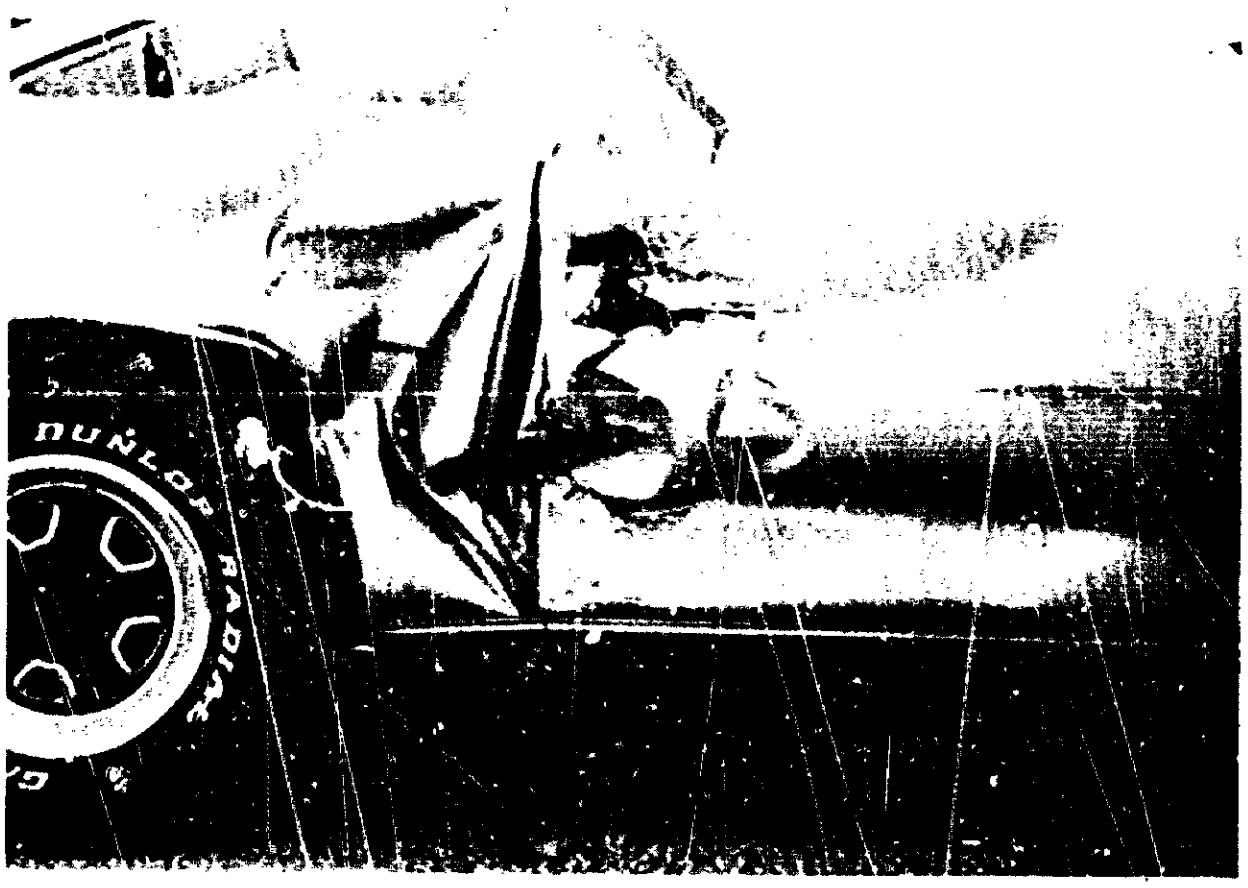
Injuries	AIS	Probable Source
Contusion, right forehead	1	Right front door frame

This child sustained a minor contusion which did not require medical treatment. With the relatively low Delta V of 11.7 mph, the restraint gave adequate protection to the occupant. However, the misrouting would probably have become a factor if the collision forces had been severe.

CASE 132 - (SEA 85-H-OR12)

Case Vehicle: 1976 Ford Grenada, 2-door
Case Vehicle Weight: 3,533 pounds
case Vehicle Delta V: 10.6 mph





Circumstances

A 1976 Ford struck the right side of a 1976 Oldsmobile 2-door with its left front. The collision resulted in substantial damage to the Ford with frontal collapse of up to 15 inches over a 50-inch wide area. The Oldsmobile sustained substantial damage on its right side.

Both the driver and the right front passenger of the Ford were restained by lap/shoulder belts. The Ford driver sustained a minor injury and the right front passenger was uninjured. The Oldsmobile was occupied by two unrestrained occupants, and a 2-week-old infant restrained in an infant seat. Both front seat occupants of the Oldsmobile received minor injuries. The baby in the infant seat in the rear seat of the Oldsmobile was uninjured.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 17
Height: 5 feet 3 inches
Weight: 115 pounds
Restraint used: Lap/shoulder belt with dual retractors (ELR/ALR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an automatic locking retractor for the lapbelt and an emergency locking retractor for the shoulder portion. The system also had a sewn-in latchplate, a comfort clip tension relief device, and a push-button release buckle attached to a flexible stalk. The comfort clip was found to be adjusted in a manner that would have put excessive slack on the shoulder portion. The driver described the adjustment of the lap portion as snug, positioned low on the hips, but she was unsure of the shoulder portion adjustment. No force loading marks were found on the webbing.

Injuries	AIS	Probable Source
Contusion, forehead above right eye	1	Steering wheel rim

This driver received a bump on her forehead but did not seek medical treatment. The restraint system performed as designed in this 10.6 mph Delta V collision. However, if the comfort clip had not been adjusted to add slack to the shoulder portion, she might not have contacted the steering wheel with her head. That extra slack might have substantially degraded the restraint's performance if the collision forces had been severe.

Case Vehicle
Seating Location: Right Front
Sex: F
Age: 4
Height: 2 feet 11 inches (seated height: 19 inches)
Weight: 25 pounds
Restraint Used: Lap/shoulder belt

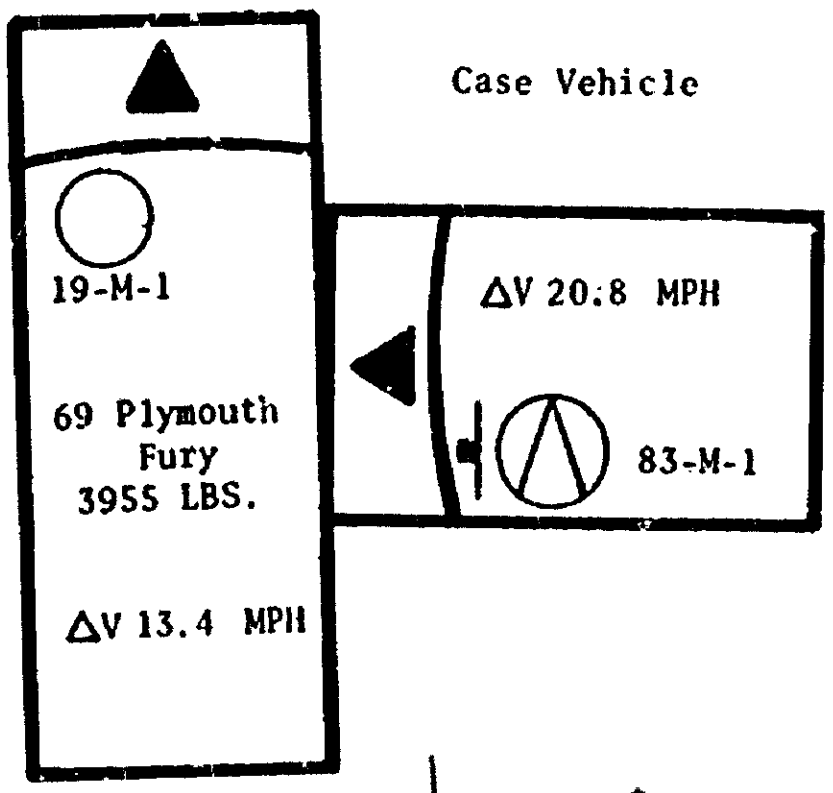
This passenger was wearing a lap/shoulder belt identical to that worn by the driver. However, the comfort clip was positioned so low on the belt it couldnot introduce slack. The driver stated that the adjustment of the child's lap portion was snug, positioned low on her hips. There were no force loading marks found on the webbing. There was no compartment deformation noted forward of this seating position.

Injuries: None.

The restraint performed well for this small child in that she did not contact the frontal interior surfaces of the vehicle. With the 10.6 mph Delta V, the child might have been injured without the lap/shoulder belt.

CASE 133 - (MKC 85-H-OR21)

Case Vehicle: 1984 Chevrolet Cavalier, 4-door
Case Vehicle Weight: 2,554 pounds
Case Vehicle Delta V: 20.8 mph



Circumstances

A 1969 Plymouth Fury 2-door went out of control on wet pavement and skidded broadside into the front of a 1984 Chevrolet Cavalier 4-door. The accident resulted in subtantial damage to both vehicles with deformation on the Chevrolet of up to 13 inches over a 66-inch wide area. The Plymouth sustained damage to the right side with deformation of up to 17 inches across 128 inches.

The Chevrolet was occupied by a lap/shoulder belt-restrained driver and the Plymouth was occupied by an unrestrained driver. Both drivers sustained minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 83 years
Height: 5 ft - 9 inches
Weight: 165 pounds
Restraint Used: Lap/shoulder belt (ELR)

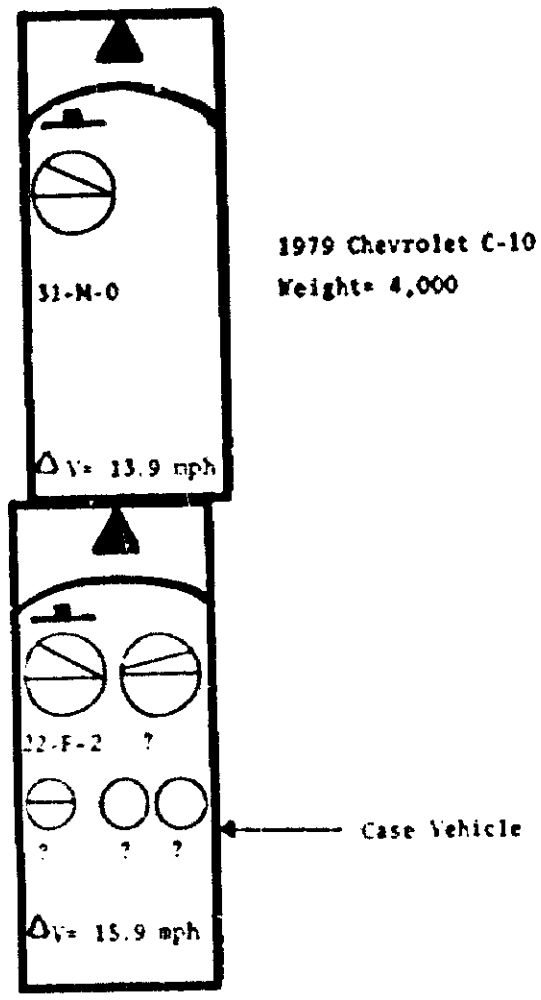
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a cinching latchplate, a windowshade tension-relief feature, and a push-button release buckle attached to a flexible stalk. The driver stated that the lap portion of the belt was loose and positioned "over his abdomen." He also stated that the shoulder portion was loose across his chest. He indicated that he adjusted the lap/shoulder belt to be loose because he was having some stomach discomfort. The steering wheel rim was displaced forward 3 inches and the windshield was cracked forward of this seating position.

Injuries	AIS	Probable Source
Laceration, forehead	1	Windshield
Contusion, left shoulder	1	Steering assembly
Contusion, right knee	1	Lower dash

The restraint system performed well in this 20.8 mph Delta V collision. Had the driver not been restrained, he would have contacted the frontal interior with much greater severity, thus increasing the chances of additional and more serious injuries. However, if he had adjusted the lap/shoulder belt properly, he probably would not have contacted the windshield.

CASE 134 - (FTW 85-H-OR30)

Case Vehicle: 1984 Chevrolet Celebrity
Case Vehicle Weight: 3,500 pounds
Case Vehicle Delta V: 15.9 mph



Circumstances

A 1984 Chevrolet Celebrity struck the rear of a stopped 1979 Chevrolet pick-up. The Chevrolet was, in turn, pushed forward into a 1970 Ford Galaxy. The Chevrolet Celebrity was damaged across the front (above bumper level) and had a maximum deformation of up to 18 inches. The Chevrolet pick-up and Ford Galaxy reportedly sustained minor damage.

The Chevrolet Celebrity driver, restrained by a lap/shoulder belt, sustained moderate chest contusions. In the Chevrolet were two additional restrained passengers, seated right front and left rear, and two unrestrained passengers, center and right rear; no passenger sought medical attention. The four were military personnel and could not be reached for further information. The driver of the pick-up, restrained by a lap/shoulder belt, was not injured. The driver and right front passenger of the Ford, both restrained by lap belts, sustained minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 23 years
Height: 5 feet 7 inches
Weight: 190 pounds
Restraint Used: Lap/shoulder belt (ELR)

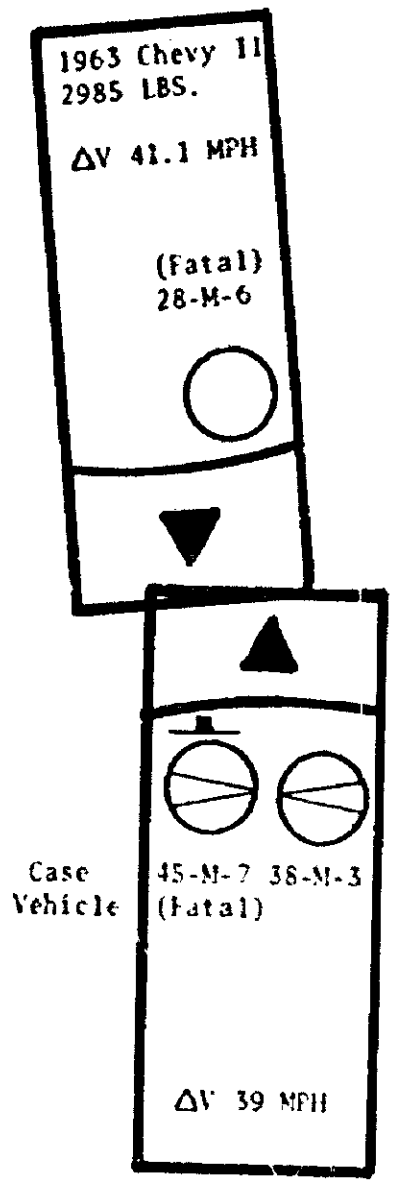
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver stated that the lap portion of the belt was "across the waist near the navel" and the shoulder belt adjusted so that she could get a clenched fist between her chest and the belt. There were force loading marks found on the belt webbing from both the latchplate and the D-ring. The steering wheel rim was deformed forward approximately 1/2 inch.

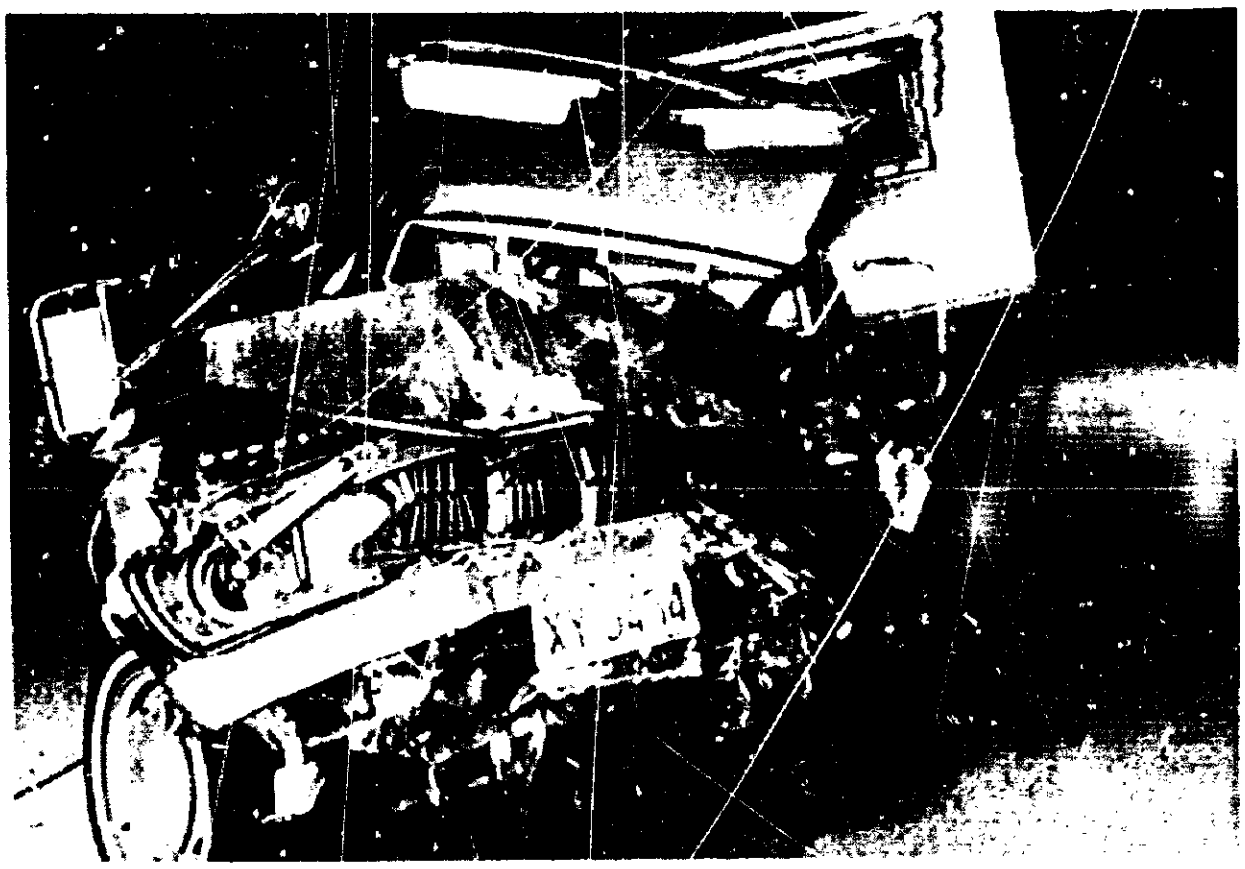
Injuries	AIS	Probable Source
Contusions, chest	2	Steering wheel rim/shoulder portion

The driver did not seek medical attention, nor did she report a loss of work. The restraint system provided adequate protection in this 15.9 mph Delta V collision, preventing contacts with the instrument panel and windshield. However, considering that the driver struck the steering wheel with sufficient force to deform it, excessive slack probably was in the shoulder portion of the belt. That slack would have degraded the performance of the system.

CASE 135 - (SEA 85-H-0R17)

Case Vehicle: 1978 Datsun pick-up
Case Vehicle Weight: 3,145 pounds
Case Vehicle Delta V: 39 mph





Circumstances

A 1978 Datsun pick-up was struck head-on by a 1963 Chevrolet II. The pick-up received extensive structural damage with deformation of up to 39.5 inches at the left front. Major interior damage was also noted. The steering wheel was driven back against the seat and moved into the center of the passenger compartment. The Chevrolet also received substantial damage, with deformation of up to 46 inches.

Both the driver and passenger in the Datsun pick-up were restrained by lap/shoulder belts. The driver was fatally injured while the passenger sustained serious injuries. The unrestrained Chevrolet driver died at the scene from internal chest injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 45 years
Height: 5 ft - 9 inches
Weight: 145 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and stalk-mounted buckle assembly. Force loading marks were found on the belt webbing in the area of the latchplate and B-pillar mounted D-ring. No information was available regarding the system adjustment.

Injuries	AIS	Probable Source
Fractured mandible	1	Steering wheel rim
Broken neck (fatal injury)	7	Steering wheel hub/rim
Fractured left forearm	2	Unknown
Fractured left ankle	2	Intrusion of floor
Fractured left femur	3	Instrument panel or intrusion of left side
Fractured Sternum	2	Steering wheel hub
Laceration, left thigh	1	Unknown

The driver was pinned in the vehicle wreckage by the steering assembly which was driven backward into his seating position. Due to the high impact forces (Delta V of 39 mph) and extensive damage to the vehicle's front side, the restraint system was of no benefit in reducing or preventing injury to the driver. This was not a survivable accident at his seating position.

Case Vehicle
Seating Location: Right Front
Sex: M
Age: 38 years
Height: 6 feet
Weight: 215 pounds
Restraint Used: Lap/shoulder belt (ELR)

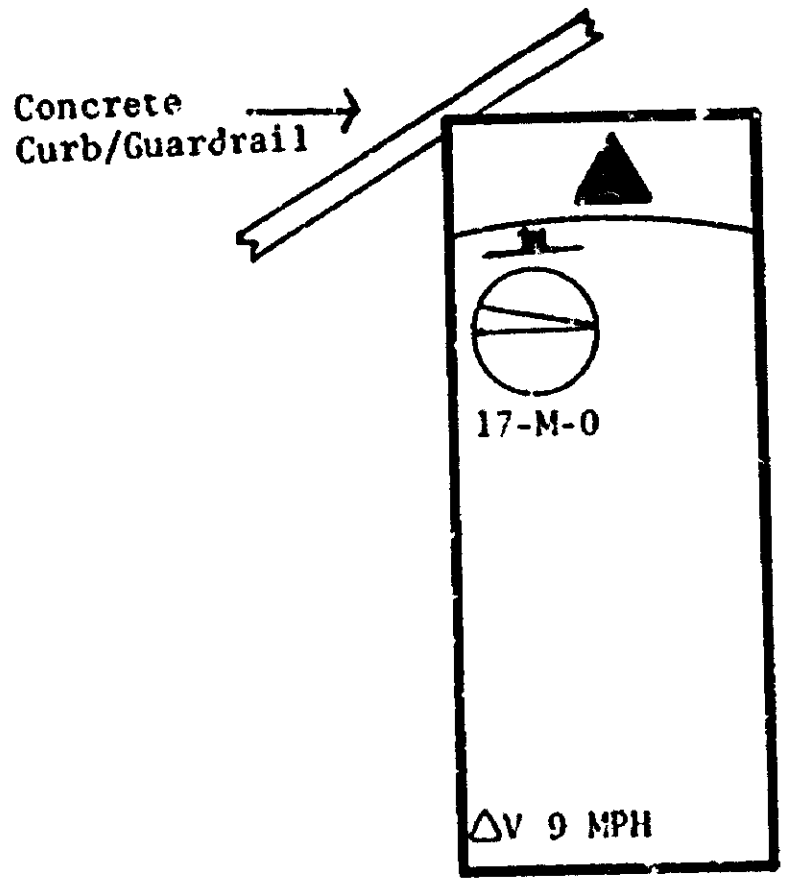
This passenger was wearing a lap/shoulder belt identical to the driver's. The passenger described the adjustment of the lap portion as being positioned low and snug across his hips. The shoulder portion was reportedly worn tight across his chest and over his shoulder. Force loading marks were found on the belt webbing in the area of the latchplate and the D-ring.

Injuries	AIS	Probable Source
Laceration, left forehead	1	Broken glass front windowshield
Abdomen contusion	1	Lap belt
Laceration left knee	1	Instrument panel shelf
Contusion, left iliac crest area	1	Lap and/or shoulder portion of the belt
Contusion, left upper back	1	Unknown
Fractured L-1 vertebrae	2	Impact forces
Fractured T-10 and T-11 vertebrae	3	Impact forces
Fractured L-5 vertebrae	2	Impact forces

The passenger was admitted to an area hospital for approximately 2 weeks and reported loss of work for 3 months. Use of the available lap/shoulder belt prevented movement into the collapsed frontal interior. Considering the violent impact of this 39 mph Delta V collision, and the intrusion into the interior, it is likely that the lap/shoulder belt prevented this passenger from more serious or fatal injuries.

CASE 136 - (SEA 85-H-0R10)

Case Vehicle: 1979 Audi Fox, 4-door
Case Vehicle Weight: 2,320 pounds
Case Vehicle Delta V: 9 mph



Circumstances

A 1979 Audi spun out of control while attempting to change lanes and struck a concrete bridge rail with its left front then left rear. The vehicle sustained moderate damage to the left front and left rear bumper, with crush up to 7.5 inches. There was substantial damage to the undercarriage at the left front.

The Audi driver, restrained by a lap/shoulder belt, was uninjured.

Restraint and Injury

Case Vehicle

Seating Location:	Driver
Sex:	M
Age:	17 years
Height:	5 feet 11 inches
Weight:	145 pounds
Restraint Used:	Lap/shoulder belt (ELR)

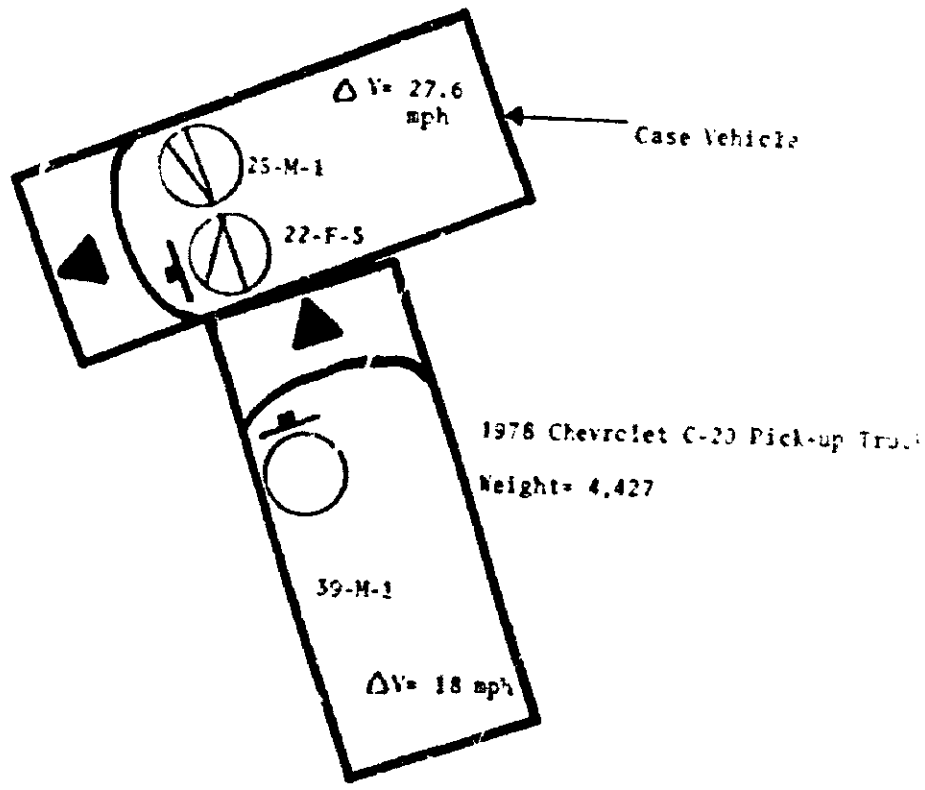
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to both vehicle and webbing motion, a free-sliding latchplate, and a seat-mounted buckle assembly. The driver described the lap portion of the belt as being positioned low across the hips and described the shoulder portion as fitting snug across the chest over a denim jacket.

Injuries: None.

Although the impact into the bridge rail was minor (Delta V of 9 mph), lap/shoulder belt use may have helped prevent some injuries during the rotational sequence.

CASE 137 - (SEA 85-H-OR18)

Case Vehicle: 1976 Toyota Celica, 2-door
Case Vehicle Weight: 2,899 pounds
Case Vehicle Delta V: 27.6 mph



Circumstances

A 1976 Toyota Celica was attempting to enter a T-type intersection and make a left turn when it was struck in the driver's door by a 1978 Chevrolet C20 pick-up truck. The Toyota sustained substantial damage with deformation of up to 24 inches across the left door area. The Chevrolet pickup sustained 22 inches of deformation across its front.

The 8-month pregnant driver of the Toyota was restrained by a lap/shoulder belt and sustained critical injuries; the fetus was fatally injured. The right front passenger of the Toyota, restrained by a lap/shoulder belt, sustained moderate injuries. Minor injuries were reported for the unrestrained driver of the pickup truck.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 22 years
Height: 5 feet 2 inches
Weight: 104 pounds
Restraint Used: Lap/shoulder belt with dual retractors (ELR/ELR)

This driver was wearing a lap/shoulder belt equipped with dual retractors sensitive to vehicle and webbing motion, a comfort clip, a seat-mounted buckle assembly, and a sewn-in latchplate. The driver, who was 8 months pregnant, described the adjustment of the lap portion of the belt as low on the hips and the shoulder portion as being snug across the chest.

Injuries	AIS	Probable Source
Fracture, left pelvis	2	Side intrusion components
Rupture, uterus	5	Side intrusion components
Laceration, spleen	3	Side intrusion components
Laceration, liver	4	Side intrusion components
Tear, vaginal wall	1	Side intrusion components
Laceration, left temporal area	1	Left side door
Unspecified closed head injury	2	Left side door

NOTE: The fetus received a fractured skull which resulted in its death.

The driver was admitted to a local hospital where she remained for 36 days. Convalescence was expected to be extended. Use of the available lap/shoulder belt retained her within the area of deformation. However, considering the impact location, impact severity (Delta V of 27.6 mph), and interior intrusion, this driver probably would have sustained injuries of similar severity if unrestrained. Restraint use can not prevent this type of contact with the adjacent interior sidewall.

Case Vehicle
Seating Location: Right Front Passenger
Sex: M
Age: 25 years
Height: 6 feet 3 inches
Weight: 190 pounds
Restraint Used: Lap/shoulder belt with dual retractors (ELR/FLR)

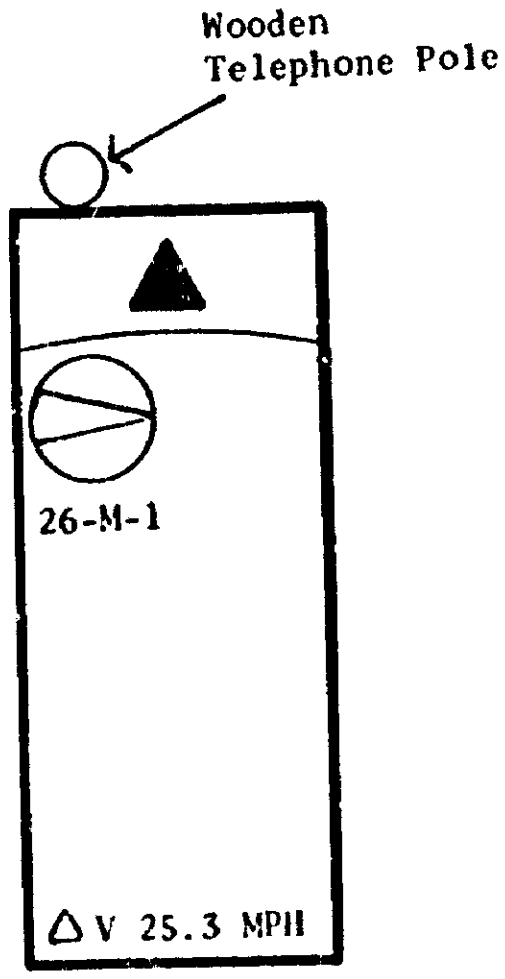
This passenger was wearing a lap/shoulder belt with dual emergency locking retractors sensitive to vehicle and webbing motion, a comfort clip, a seat-mounted buckle assembly, and a sewn-in latchplate. The passenger described the lap portion of the belt as fitting low on his hips and the shoulder portion as having been snug across the chest.

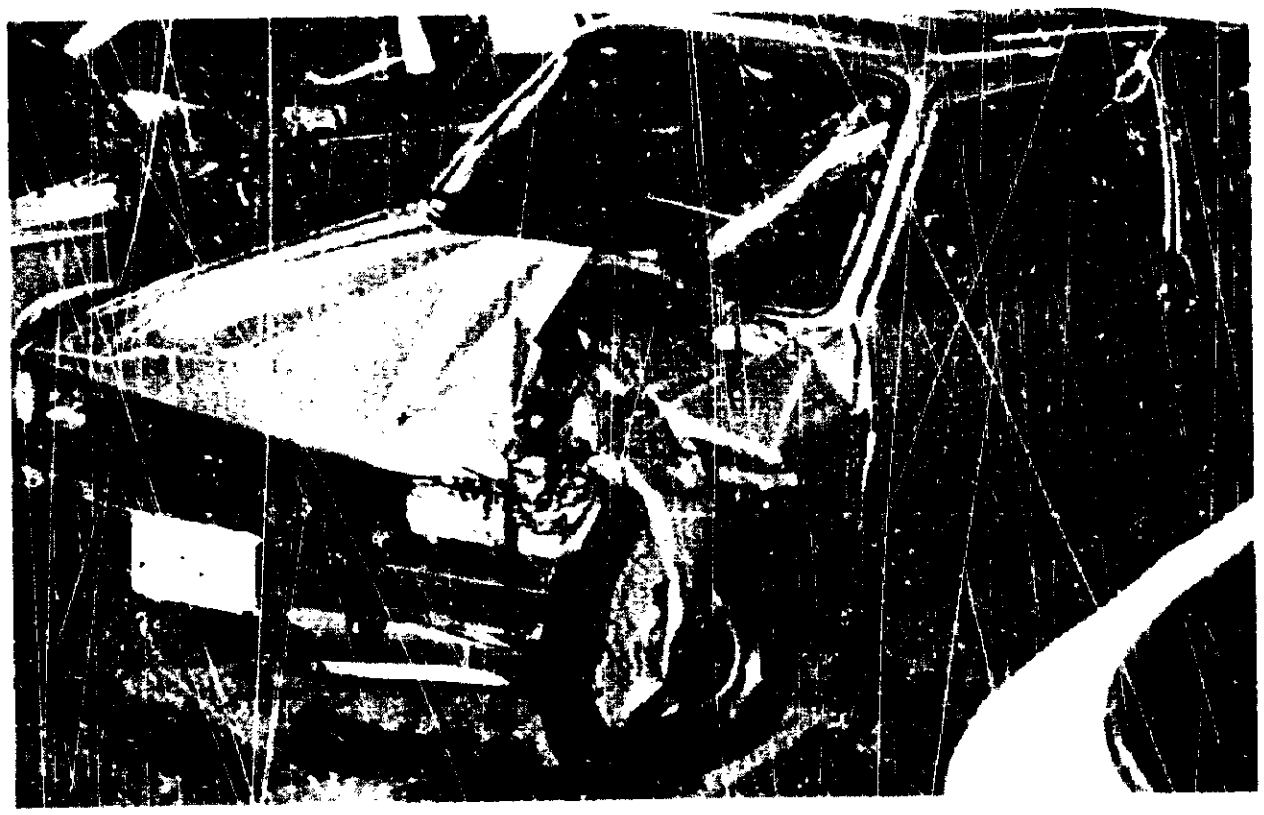
Injuries	AIS	Probable Sources
Fracture, thoracic spine	2	Impact force
Strain, cervical muscle	1	Impact force
Contusion, left forearm	1	Steering wheel rim

The restraint provided protection as designed in this 27.6 mph Delta V side impact. This passenger was treated at a local emergency room and released. His use of the available lap/shoulder belt prevented contact with the driver and the area of impact.

CASE 138 - (SEA 85-H-OR19)

Case Vehicle: 1982 Volkswagen Rabbit, 2-Door
Case Vehicle Weight: 2,095 pounds
Case Vehicle Delta V: 25.3 mph





Circumstances

A 1982 Volkswagen Rabbit 2-door ran off the road and struck an 18-inch wooden telephone pole with its left front. The accident resulted in substantial damage to the case vehicle, with deformation of up to 24.5 inches at the left front.

The driver of the vehicle was restrained by a misrouted 2-point automatic belt. Although the driver wore the system improperly with the shoulder strap routed under his arm, he sustained only minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 26 years
Height: 5 feet 10 inches
Weight: 175 pounds
Restraint Used: Misrouted 2-point automatic belt (ELR): under arm

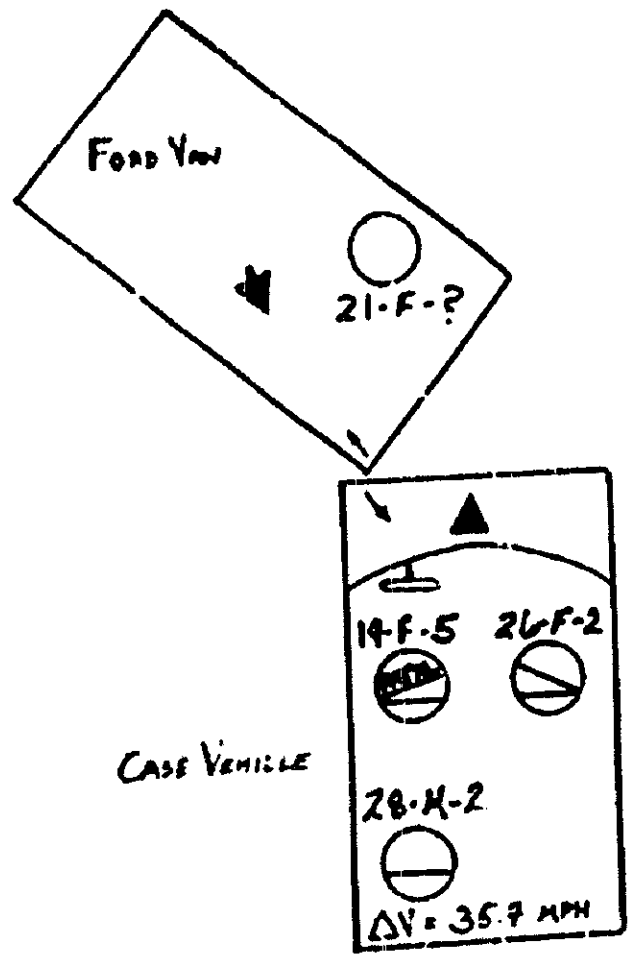
This driver was wearing a 2-point automatic shoulder strap equipped with an emergency locking retractor. In response to questions about how the system was worn, the driver stated that he placed the shoulder portion under his arm instead of across his shoulder and chest. He added that he was unaware that this was an incorrect way to wear the restraint. There were abrasions on the webbing and the windshield was broken forward of the driver's seating position.

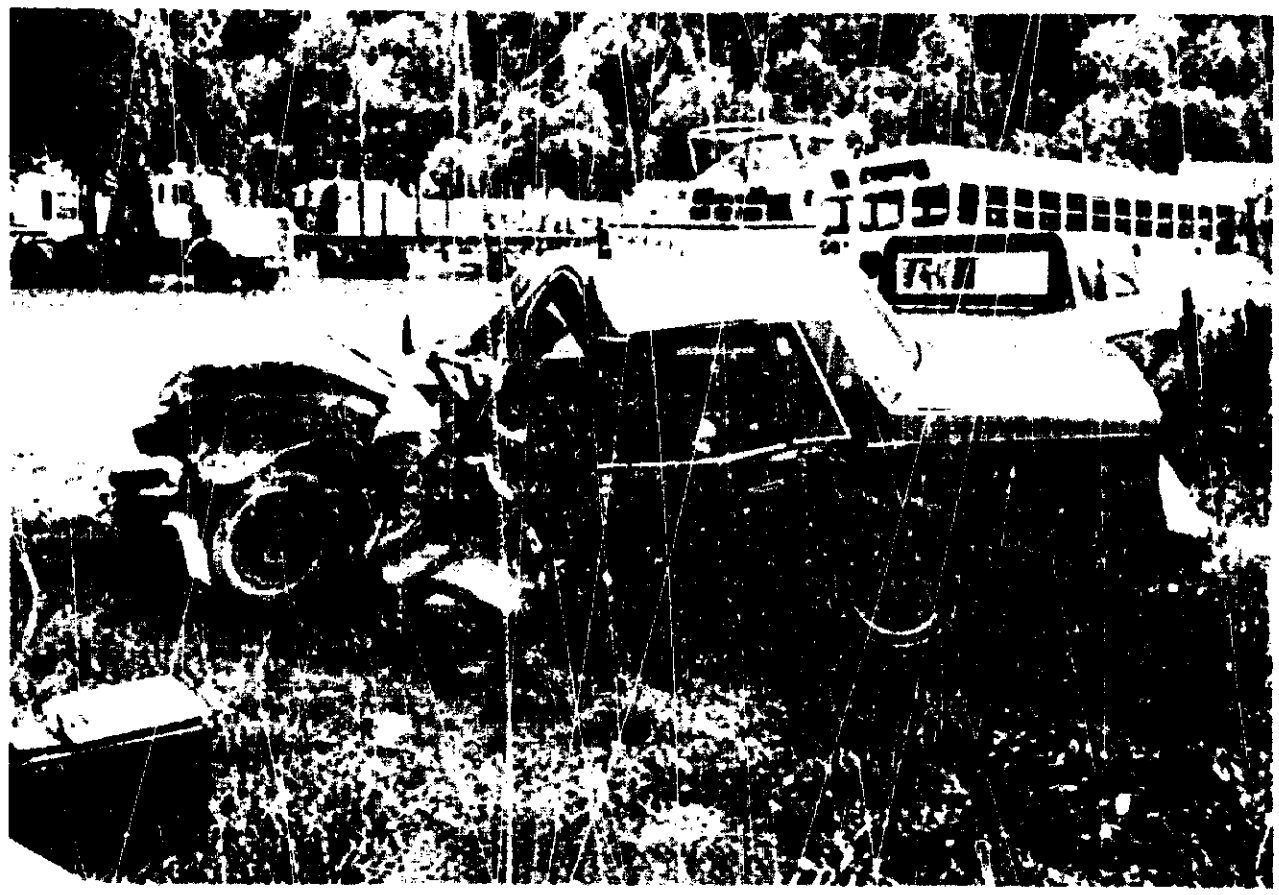
Injuries	AIS	Probable Source
Abrasions, forehead	1	Windshield
Fracture, nose	1	Windshield
Laceration, inside of lips	1	Windshield
Contusion, abdominal wall	1	Steering wheel/ shoulder strap

The misrouted automatic belt offered degraded protection for this driver. If he had worn the shoulder strap properly, he might not have contacted the windshield. However, considering the 25.3 mph Delta V with the relatively low number and level of injuries, it is apparent that use of the restraint was beneficial. A totally unrestrained driver would have been free to make more violent contact with the frontal interior.

CASE 139 - (CHI 85-H-0R02)

Case Vehicle: 1984 Chevrolet Celebrity, 4-door
Case Vehicle Weight: 3,172 pounds
Case Vehicle Delta V: 35.7 mph





Circumstances

A 1984 Chevrolet Celebrity was struck on the left front corner by the right front corner of a 1984 Ford van. The Chevrolet sustained extensive left front and front damage with deformation reaching up to 33 inches. There was extensive structural intrusion into the driver's seating position.

The Chevrolet driver, restrained by a lap/shoulder belt, sustained critical head injuries, as a result of intrusion, which proved fatal. The lap/shoulder belted right front occupant sustained moderate injuries. The lap belted left rear occupant also sustained moderate injuries. The unrestrained driver of the van was seriously injured.

Restraint and Injury

Seating Location: Driver
Sex: F
Age: 19 years
Height: 5 feet 5 inches
Weight: 122 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The right front passenger reported that the driver was wearing the lap belt portion "low and snug," but could give no information on the shoulder strap adjustment.

The A-pillar, instrument panel, and steering assembly were collapsed rearward several inches forward of this seating position; in fact, extrication tools were required to remove this occupant from the crushed interior.

Injuries	AIS	Probable Source
Loss of consciousness (1-24 hours) with neurologic defect	5	Transmitted force, head contact with A pillar
Laceration, left parietal scalp	2	A-pillar
Laceration, left supraorbital	1	A-pillar
Depressed skull fracture, left frontal area	3	A-pillar
Traumatic subarachnoid hemorrhage	3	Transmitted forces
Cerebral contusion	3	Transmitted forces
Depressed maxillary fracture	2	A pillar
Abrasions, multiple, left eyelid	1	A pillar
Fracture,. right sternum at junction with ribs	2	Steering assembly
Abrasions, left pectoral chest	1	Door side-glass
Contusion, right lower abdomen	1	Steering wheel and/or lap belt

Contusion, junction of abdomen and right thigh	1	Steering wheel and/or lap belt
Closed fracture, right femur	3	Transmitted force from instrument panel
Closed fracture, left femur	3	Transmitted force from instrument panel
Contusion, right thigh	2	Steering assembly
Contusion, posterior surface, left knee	1	Instrument panel and below, collapsed lower A pillar, interior sidewall
Abrasion, left mid-tibial region	1	Instrument panel and below, collapsed lower A pillar, interior sidewall
Contusion, left mid-tibial region	1	Instrument panel and below, collapsed lower A pillar, interior sidewall

This driver reportedly did not regain consciousness following the accident. She was transported to two different hospitals before being pronounced dead approximately 2 1/2 hours later. The official cause of death was multiple injuries with diagnosis of acute craniocerebral injury. This 35.7 mph Delta V collision was probably not survivable for the Celebrity driver, due to compression of her seating area.

Seating Location: Right front
Sex: F
Age: 28 year
Height: 5 feet 5 inches
Weight: 130 pounds
Restraint used: Lap/shoulder belt (ELR)

This occupant was using a lap/shoulder identical in design to that worn by the driver. She told NTSB investigators that the lap belt was positioned "low" and adjusted to a snug fit. The shoulder portion was properly adjusted across the mid-sternum area.

Injuries	AIS	Probable Source
Laceration, left eyelid	1	Instrument panel or steering wheel
Fractured nose	1	Instrument panel or steering wheel
Contusion, right shoulder to left abdomen	2	Shoulder portion of belt webbing
Contusions, hips and abdomen	1	Lap portion of belt webbing

Abrasion, left hip	1	Buckle and stalk
Fractured pelvis	2	Lap portion of belt
Laceration (4 inch) with avulsed tissue, left lateral thigh	2	Instrument panel parts
Contusion, left lateral ankle	1	Collapsed underpanel
Contusion, right shin	1	Collapsed underpanel
Laceration, left heel	1	Collapsed underpanel
Scratches, right hand	1	Windshield

This passenger was in a hospital for 6 1/2 days and was off work for 1 month. Considering the Delta V of over 35 mph, it is reasonable to believe that her use of the lap/shoulder restraint prevented additional and more serious injuries. Although the instrument panel was pushed rearward at this location, the amount of compartment compression was not nearly as great as that which occurred forward of the driver. Due to the angular force line, she came from out behind the shoulder strap and struck either the steering assembly or instrument panel with her head.

Seating Location: Left rear
Sex: M
Age: 28 years
Height 5 feet 7 inches
Weight: 145 pounds
Seated height: 30 inches
Restraint used: Lap belt (ALR)

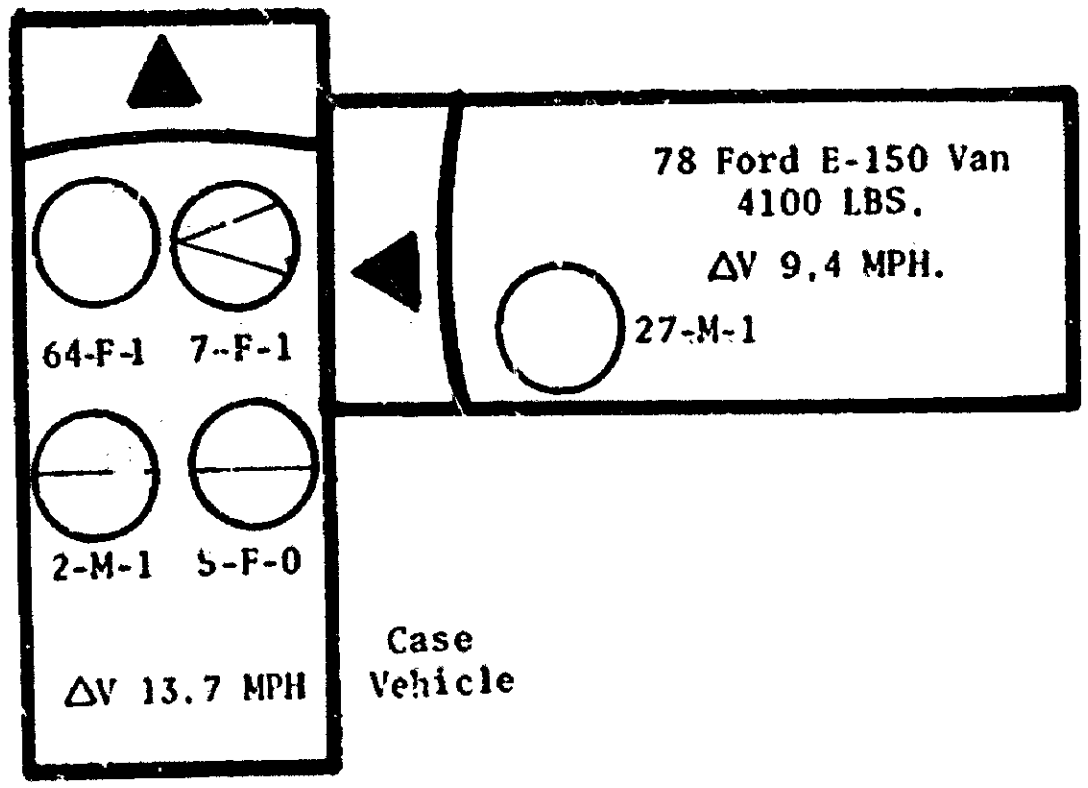
This man was restrained by a lap belt with an automatic locking retractor, a sewn-in latchplate attached to the retractor webbing, and a sewn-in push-button release type buckle attached to a short length of webbing. There was a slight compartmental compression at this seating position due to the rearward displacement of the left side B-pillar.

Injuries	AIS	Probable Source
Laceration, above left eye	2	B-pillar, side-glass
Lacerations, below left eye	2	B-pillar, side-glass
Lacerations, above right eye	1	B-pillar, side-glass
Contusion, large, left side face	2	B-pillar, side-glass
Fracture, left mandible	2	B-pillar, side-glass
Fracture, left zygoma	2	B-pillar, side-glass
Contusion, left parietal scalp	1	B-pillar, side-glass
Laceration, left parietal scalp	1	B-pillar, side-glass
Abrasions, left shoulder	1	B-pillar, side-glass
Lacerations (superficial), left shoulder	1	Side-glass
Contusion, abdominal	2	Lap belt
Laceration, small, left finger	1	Side-glass

This occupant was in a hospital for 8 1/2 days. He was off work for 2 months. The lateral forces of this 35.7 mph Delta V collision allowed his deceleration to be somewhat contained by the left interior sidewall and B-pillar instead of entirely into the lap belt webbing. (Had the force line been at 12 o'clock and not at an angle, the lap belt would have been his major deceleration point.) Given the forces in this accident, it is difficult to speculate lesser injuries for the occupant had he been unrestrained -- his travel path to the most serious injuries would have been similar. It is possible that if a lap/shoulder belt had been available and used, his head injuries might have been reduced.

CASE 140 - (SEA 85-H-OR21)

Case Vehicle: 1985 Cadillac Cimarron
Case Vehicle Weight: 2,806 pounds
Case Vehicle Delta V: 13.7 mph



Circumstances

A 1985 Cadillac Cimarron was entering an intersection when it was struck broadside from the right by a 1978 Ford Econoline van. The right front door of the Cadillac sustained substantial damage and had deformation of up to 13 inches. The entire front of the Ford van received damage and had deformation of up to 5.5 inches.

The driver of the Cadillac was unrestrained and sustained multiple minor injuries. The right front passenger, restrained by a lap/shoulder belt, sustained minor injuries. Both rear seated occupants were wearing lap belts. The left rear passenger sustained minor injury while the right rear passenger was reportedly uninjured.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 64 years
Height: 5 feet 2 inches
Weight: 105 pounds
Restraint Used: None

This driver was not wearing the available lap/shoulder belt.

Injuries	AIS	Probable Source
Laceration over right eyebrow	1	Window glass from right side
Laceration on right elbow	1	Unknown
Contusion on left wrist	1	Right front passenger
Contusion on right knee	1	Unknown
Contusion on left knee	1	Unknown
Contusion on right cheek	1	Right front passenger

This driver was treated and released at a nearby hospital. If she had been belted, it is possible that some of the minor injuries may have been prevented.

Case Vehicle
Seating Location: Right Front
Sex: F
Age: 7 years
Height: 3 feet 10 inches
Weight: 50 pounds
Restraint Used: Lap/shoulder belt (ELR)

The right front passenger was wearing a continuous loop shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a cinching latchplate, and a windowshade tension-relief device. This passenger reported that her lap portion of the belt was loose, positioned low on her hips, and that the shoulder portion was snug across the midchest. No loading marks were found; blood, however, was noted on the extended webbing.

Injuries	AIS	Probable Source
Laceration above nose	1	Side window glass
Contusion on back of right calf	1	Unknown

The passenger was treated and released at a local hospital. This occupant was in direct line with the 13.7 mph Delta V crash forces; belt use could not prevent her from contacting the door during the right side impact.

Case Vehicle
Seating Location: Left Rear
Sex: M
Age: 2 years
Height: 2 feet 9 inches
Weight: 29 pounds
Restraint Used: Lap belt (ALR)

The left rear passenger was wearing a 2-point lap belt with an automatic locking retractor. The Ford van driver related that he saw this passenger with the lap belt on.

Injuries	AIS	Probable Source
Bruise on left side of abdomen	1	Lap belt

This child was treated and released at a nearby hospital. The abdominal bruise was most likely caused by the lap belt as the child rebounded rebound from the side impact. Restraint use may have prevented additional injuries.

Case Vehicle
Seating Location: Right Rear
Sex: F
Age: 5 years
Height: 3 feet 4 1/2 inches
Weight: 39 pounds
Restraint Used: Lap belt (ALR)

The right rear passenger was wearing a lap belt with an automatic locking retractor. This passenger was also observed by the Ford van driver with the belt on.

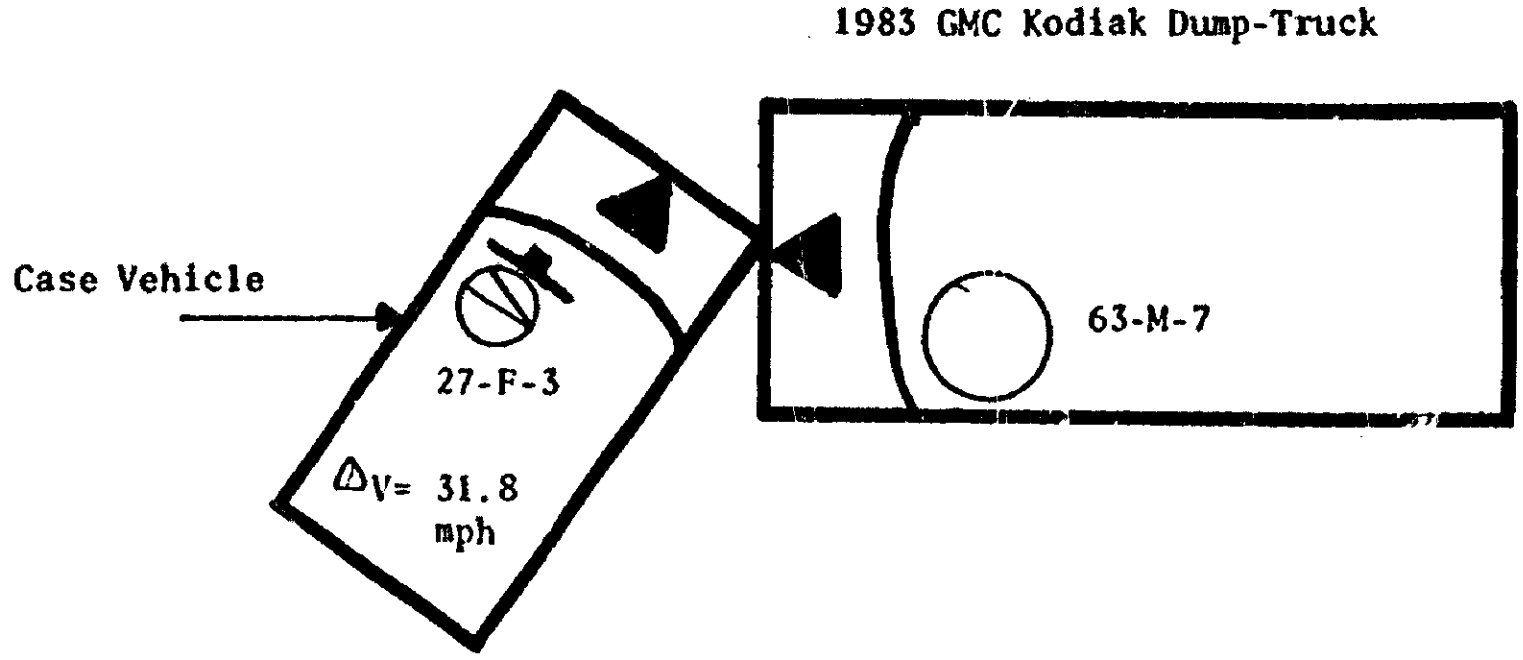
Injuries: None.

This passenger was examined at a nearby hospital and no injuries were noted. It is unlikely that the belt was a factor in preventing injury to this passenger as she was sitting against the door and the belt could not have lessened the forces to which the occupant was subjected.

While restraint systems, by their very design, have a limited value in side impacts, the use of the lap/shoulder belt for an occupant on the side opposite of direct impact should be of benefit. In this case, the driver would have benefited had she been restrained. (The right front passenger also would not have been struck by the driver.) The benefit of restraint, to passengers seated on the side impacted in a broadside collision, would be minimal to none, as the 3-point belt could not prevent the body from impacting the side of the vehicle's interior.

CASE 143 - (CHI-85-H-OR20)

Case Vehicle: 1984 Mazda B2000 pick-up
Case Vehicle Weight: 2,675 pounds
Case Vehicle Delta V: 31.8 mph



Circumstances

A 1984 Mazda B2000 pick-up was struck on the right front fender by a loaded 1983 GMC dump truck. The Mazda received extensive structural damage with deformation of up to 24.5 inches on the right side. The right door was deformed inward up to the middle of the right passenger seating position.

The Mazda driver, restrained by a lap/shoulder belt, sustained serious injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 27 years
Height: 5 feet 6 inches
Weight: 115 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver stated that the adjustment of the lap portion of the belt was low across the hips and snug. The shoulder portion of the restraint was reportedly adjusted so that the palm of a hand could be placed between the webbing and the chest. Force loading marks were found on the webbing in the area of the B-pillar mounted D-ring, and also on the plastic D-ring. The plastic buckle housing separated but still held the latchplate.

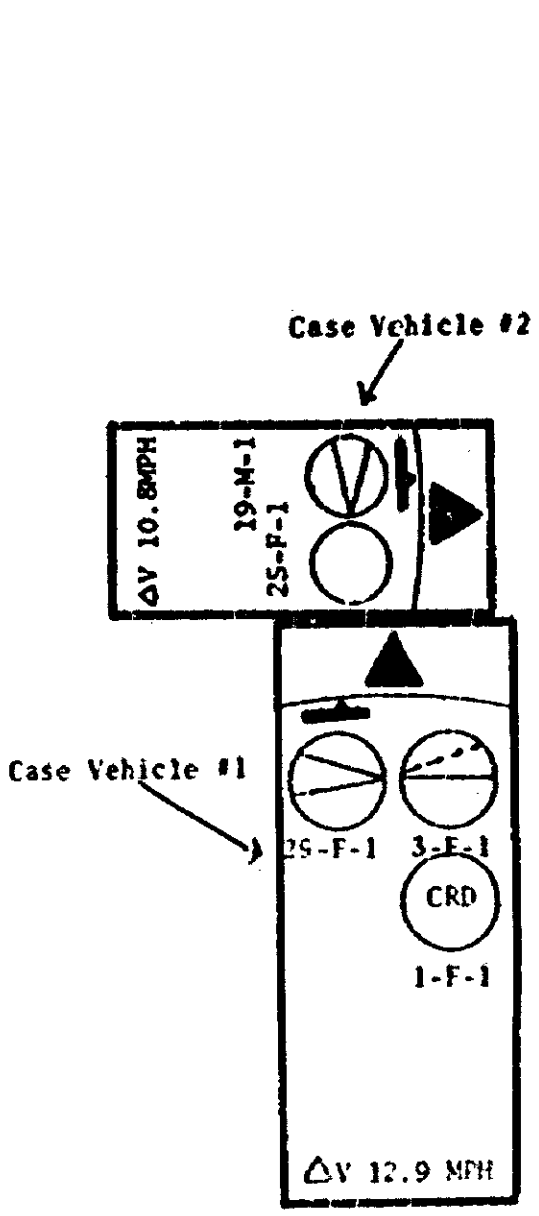
Injuries	AIS	Probable Source
Laceration, lip	1	Right side interior
Laceration, right forehead	2	B-pillar/right door glass
Undefined closed head injury	2	Right B-pillar
Contusion, right ear	1	Right B-pillar
Contusion, right side of neck	1	Right B-pillar
Contusion, right lung	3	Right side interior
Fracture, left scapula	2	Interior side surface
Fracture, right scapula	2	Interior side surface
Contusion, right hip	1	Restraint system
Contusion, left knee	1	Instrument panel
Contusion, right knee	1	Instrument panel
Abrasion, left lower leg	1	Lower instrument panel
Laceration, right lower leg	1	Lower instrument panel
Abrasion, right lower leg	1	Lower instrument panel
Lacerations, right arm	1	Window glass
Laceration, right upper arm	1	Window glass
Contusion, back	2	Seat back
Puncture wound, right elbow	1	Right side interior

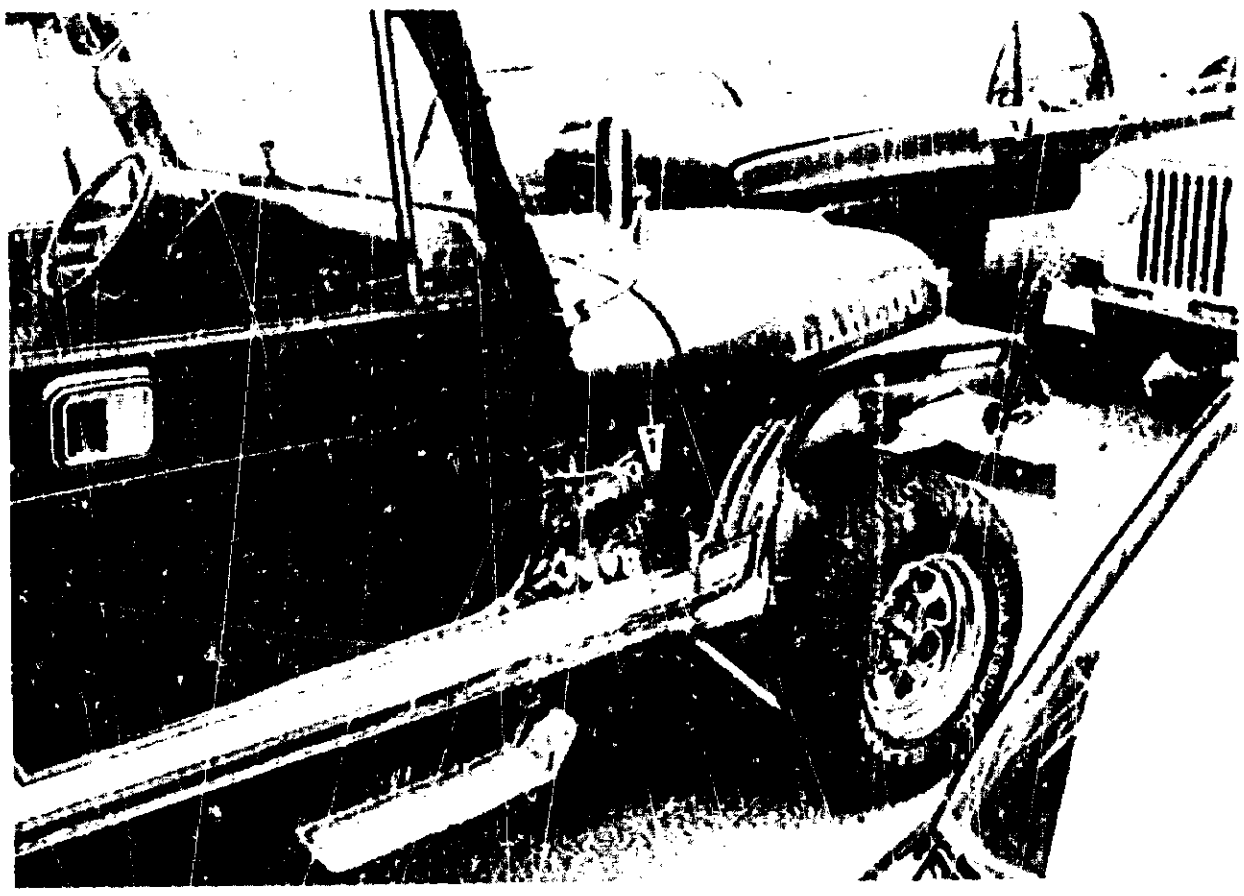
The driver was admitted to a hospital for 8 days and anticipated about a 7 week absence from work. The lap/shoulder belt did not restrain her upper torso as the direction of the 31.8 mph Delta V impact force was from the right front. She slid out of the shoulder portion and the vehicle was deformed inward at the right side, thus allowing her to contact the right B-pillar. However, the lap portion of the belt did restrain her and likely prevented more serious injuries.

CASE 144 - (FTW 85-H-OR22)

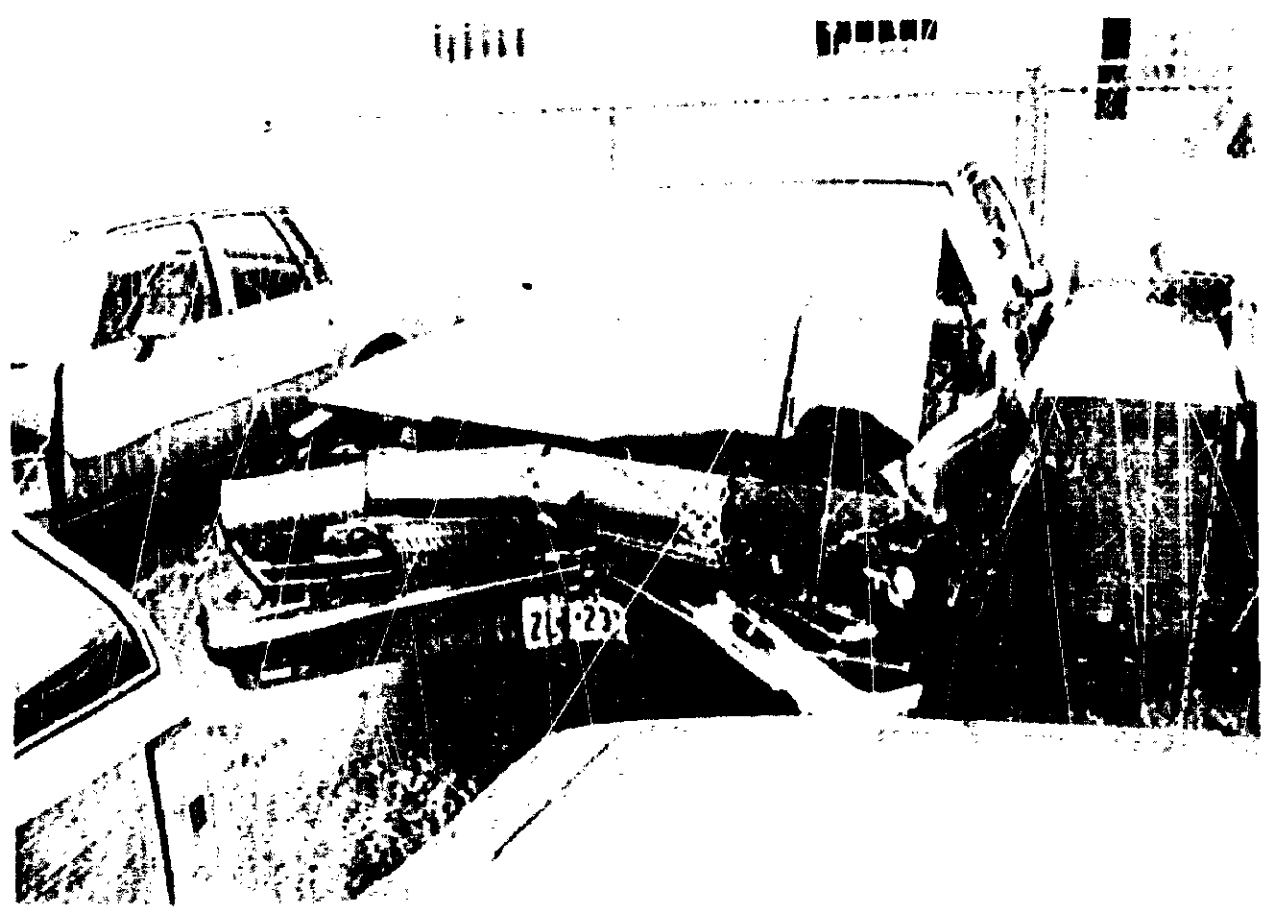
Case Vehicle #1: 1978 Oldsmobile 88, 2-door
Case Vehicle Weight: 3,950 pounds
Case Vehicle Delta V: 10.8 mph

Case Vehicle #2: 1985 AMC Jeep CJ-7
Case Vehicle Weight: 3,300 pounds
Case Vehicle Delta V: 12.9 mph





CASE VEHICLE #2



CASE VEHICLE #1

Circumstances

A 1978 Oldsmobile 88 2-door collided with the right front side of a 1985 Jeep CJ-7. From the initial collision, the Jeep CJ-7 traveled off the roadway where it struck and sheared off a 9-inch-diameter utility pole. The initial collision resulted in substantial damage to the front of the Oldsmobile with deformation of up to 14 inches. The Jeep received approximately 6 inches of deformation from the A-pillar forward on the right side from initial contact with the Oldsmobile. The pole impact also resulted in moderate damage to the Jeep's left front.

The Oldsmobile was occupied by a lap/shoulder belt-restrained driver, a child restrained by a misrouted lap/shoulder belt (shoulder portion behind back) in the right front, and a 1-year-old child seated right rear in a child safety seat. The Jeep was occupied by a lap/shoulder belt-restrained driver and an unrestrained passenger seated in the right front. All occupants of both vehicles received minor injuries.

Restraint and Injury

Case Vehicle #1: Oldsmobile
Seating Location: Driver
Sex: F
Age: 29 years
Height: 5 feet 2 inches
Weight: 120 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a cinching latchplate, a windowshade tension relief feature, and a push-button release buckle attached to a flexible stalk. The driver described the adjustment of the lap portion of the belt as snug, positioned "across her waist near the navel." She indicated that the shoulder portion was snug across her midchest area. Marks were found on the webbing attributed to force loading at the latchplate and D-ring. There was no compartment deformation forward of this seating position.

Injuries	AIS	Probable Source
Contusion, left side of head	1	Unknown
Cervical strain	1	Impact forces
Contusion, middle lower back	1	Impact forces
Contusion, left thigh	1	Steering wheel and rim

The lap/shoulder belt performed well in preventing the driver from making uncontrolled movement into the frontal interior of the vehicle. Considering the 12.9 mph Delta V, it is likely that an unrestrained driver might have received similar injury levels.

Case Vehicle #1
Seating Location: Right Front
Sex: F
Age: 3 years
Height: 3 feet
Weight: 30 pounds
Restraint Used: Misrouted lap/shoulder belt: shoulder portion behind back

This passenger was seated at a position equipped with a lap/shoulder belt identical to the driver's. The mother placed the child in the lap portion of the belt because the child's height was only 3 feet. The mother indicated that the lap portion of the belt was snug on her daughter's lower hips and the shoulder strap was routed behind the back. There were force loading marks on the webbing strap was routed behind the back. There were no contact points on the frontal interior of the vehicle.

Injuries	AIS	Probable Source
Contusion, lower abdomen	1	Lap portion of the belt

This passenger received a minor contusion which did not require medical treatment. She was fortunate that severe collision forces were not present, as the misrouting of the shoulder belt would probably have degraded the restraint performance.

Case Vehicle #1
Seating Location: Right Rear
Sex: F
Age: 9 months
Height: 2 feet 2 1/2 inches
Weight: 17 pounds
Restraint Used: Child safety seat

This child was restrained in a forward-facing child safety seat which was secured in the right rear seat with the lap belt. The seat was not available for inspection. The mother indicated that she thought her child sustained her bruised leg from striking the child seat arm rest.

Injuries	AIS	Probable Source
Contusion, upper left thigh	1	Unknown

This child did not require medical treatment. If she had not been restrained, she might have sustained some level of injury from contacting the seat back at impact.

Case Vehicle #2: Jeep CJ-7
Seating Location: Driver
Sex: M
Age: 19 years
Height: 5 feet 9 inches
Weight: 175 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retarctor, a cinching latchplate, and a push button-release buckle attached to a flexible stalk. The driver stated that the precrash adjustment of the lap portion of the belt as snug, positioned low on his hips. He also stated that the shoulder portion was adjusted tightly. There were marks found on the webbing attributed to force loading at the latchplate and the D-ring. There was no compartment deformation forward of this seating position.

Injuries	AIS	Probable Source
Contusion, right side of head	1	Occupants stated they hit their heads together

The lap/shoulder belt performed well in preventing the driver from striking the steering assembly and instrument panel. Considering the 10.8 mph Delta V side impact, he would have made uncontrolled movement into the frontal and side interior surfaces of the vehicle and might have sustained additional injuries.

Case Vehicle #2
Seating Location: Right Front
Sex: F
Age: 23
Height: 5 feet 5 inches
Weight: 130 pounds
Restraint Used: None

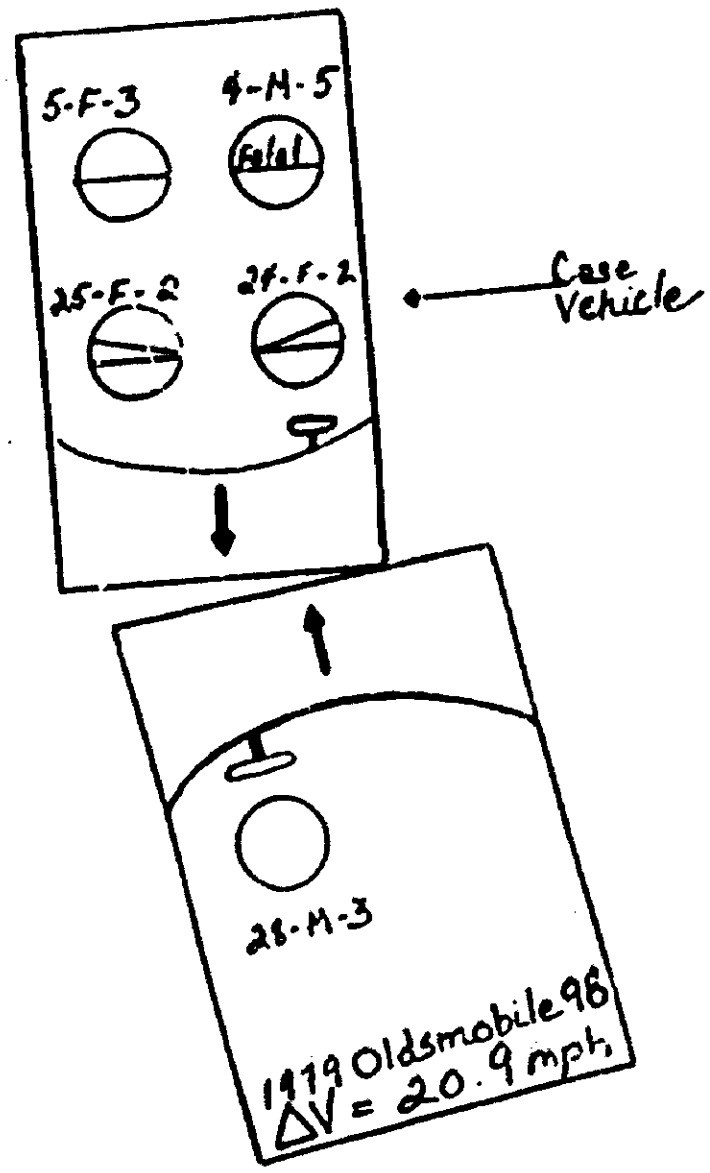
This passenger was seated in the right front which was equipped with a lap/shoulder belt identical to the driver's. She stated they had just pulled out of a parking lot and she was reaching to buckle up her seat belt when the accident occurred.

Injuries	AIS	Probable Source
Contusion, left side of head	1	Occupants hit their heads together
Contusion, right side of head	1	Right side door glass

Restraint use by this passenger may not have reduced the severity of her injuries since the only injuries she sustained was as a result of contact with another occupant.

CASE 147 - (NYC 85-H-0R09)

Case Vehicle: 1982 Subaru station wagon
Case Vehicle Weight: 2,715 pounds
Case Vehicle Delta V: 32.3 mph



Circumstances

A 1982 Subaru station wagon was struck head-on by a 1979 Oldsmobile 98. The Subaru sustained substantial damage at its front and left front with rearward deformation of up to 30 inches. The left front of the Oldsmobile was deformed rearward approximately 31 inches.

The Subaru driver and right front passenger were restrained by lap/shoulder belts, and both received moderate injuries. The lap belted left rear passenger sustained critical injuries which proved fatal. The lap belted right rear passenger sustained serious injuries. The unrestrained driver of the Oldsmobile received serious injuries.

Restraint and Injury

Seating Location:	Driver
Sex:	F
Age:	24 years
Height:	5 feet 6 inches
Weight:	135 pounds
Restraint used:	Lap/shoulder belt (ALR)

This woman was wearing a continuous loop lap/shoulder belt that had a free-sliding latchplate and a vehicle-sensitive automatic locking retractor. She described the system as being properly adjusted.

Injuries	AIS	Probable Source
Lacerated lip	1	Steering wheel
Lacerated right knee	2	Instrument panel
Fractured, right tibial plateau	2	Instrument panel
Fracture and dislocation of right foot	2	Foot control
Laceration, left elbow	1	Driver's door
Abrasion of lower abdomen	1	Steering wheel and/or lap portion of belt

This woman was 12 to 13 weeks pregnant, but she was unaware of it. Her condition was discovered during the postcrash hospital examination. No sign of life was found in the fetus. It was later determined that the fetus probably was dead before the accident. The women was diagnosed as having had a "missed abortion." She was released from the hospital 9 days after the accident. Given the severe collision forces (Delta V of 32.3 mph), it is apparent that the restraint system prevented more serious injuries to this driver. Some of her injuries resulted from the rearward collapse of the structure forward of her position. Due to that collapse, it is possible that an unrestrained driver would have been severely or fatally injured.

Seating Location: Right Front
Sex: F
Age: 25 years
Height: 5 feet 7 inches
Weight: 130 pounds
Restraint Used: Lap/shoulder belt

This woman was wearing a lap/shoulder belt identical to the driver's. No evidence of system misuse or improper adjustment was found.

Injuries	AIS	Probable Source
Laceration of left eyelid	1	Unknown
Contusion lower abdomen	1	Lap portion of belt
Fracture, left tibia	2	Dash panel
Contusion, right leg	1	Unknown
Contusion, left leg	1	Unknown
Contusion, left hip	1	Lap portion of belt

This woman also spent 9 days in the hospital. With the 32.3 mph Delta V of this collision, she would have been more seriously injured if she had not been restrained by the lap/shoulder belt. An unrestrained passenger at this seating position would have been thrown violently into the frontal interior surface.

Seating Location: Right Rear
Sex: F
Age: 5 years
Height: 40 inches
Weight: 35 pounds
Restraint Used: Lap belt (ALR)

This child sustained serious injuries, all induced by the lap belt.

Injuries	AIS	Probable Source
Abrasion, lower abdomen	1	Lap belt
Hematoma, small bowel	3	Lap belt
Retroperitoneal hematoma of lower left abdominal area	3	Lap belt
Mesenteric tear, sigmoid colon	3	Lap belt
Hematoma, sigmoid colon	3	Lap belt
Bilateral fracture of L4	2	Lap belt
Hematoma of the conus medularis (cone-shaped lower end of spinal cord)	7	Lap belt

Her severe abdominal and lumbar spinc injuries occurred despite the fact that she seems to have been wearing the lap belt in the proper location. A laparotomy was performed on this girl 2 days after the crash. She was transferred to two other hospitals before being released about 4 months later. She now wears leg braces and must use a "walker" for mobility.

Seating Location:	Left Rear
Sex:	M
Age:	4 years
Height:	40 Inches
Weight:	38 Pounds
Restraint Used:	Lap belt (ALR)

This child was wearing a 2-point lap belt with an automatic locking retractor. Injury patterns indicate that the belt was properly adjusted.

Injuries	AIS	Probable Source
Abrasion, right side of forehead	1	Unknown
Severe contusion of cervical spinal cord	3	Unknown
Subluxation of cervical spine (C2-C3)	3	Unknown
Fracture, thoracic spine (T-2)	2	Unknown
Abrasion of thorax at sternum cleft	1	Unknown
Abrasion, right shoulder	1	Unknown
Abrasion, left shoulder	1	Unknown
Brain edema	3	Unknown
Hematoma on back at T-2	1	Unknown
Abrasion, left iliac crest	1	Lap belt
Abrasion, right iliac crest	1	Lap belt
Unconscious more than 24 hours	5	Unknown

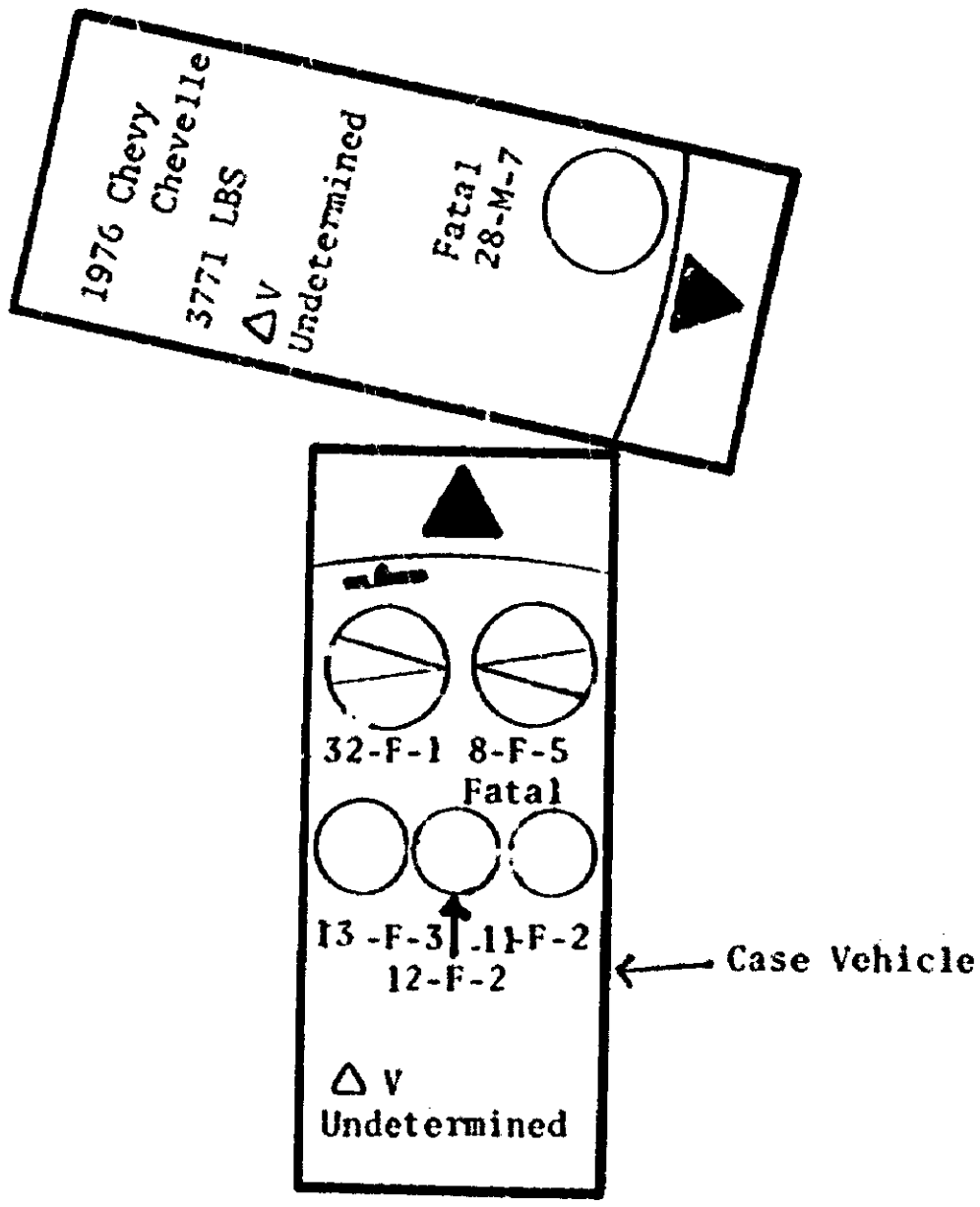
This child was found unconscious after the crash, and remained unconscious until he was pronounced dead 2 days later. The cause of death was listed as cerebral edema with anoxic changes (changes from lack of oxygen in the brain) and severe contusion of the spinal cord from subluxation of the cervical spine.

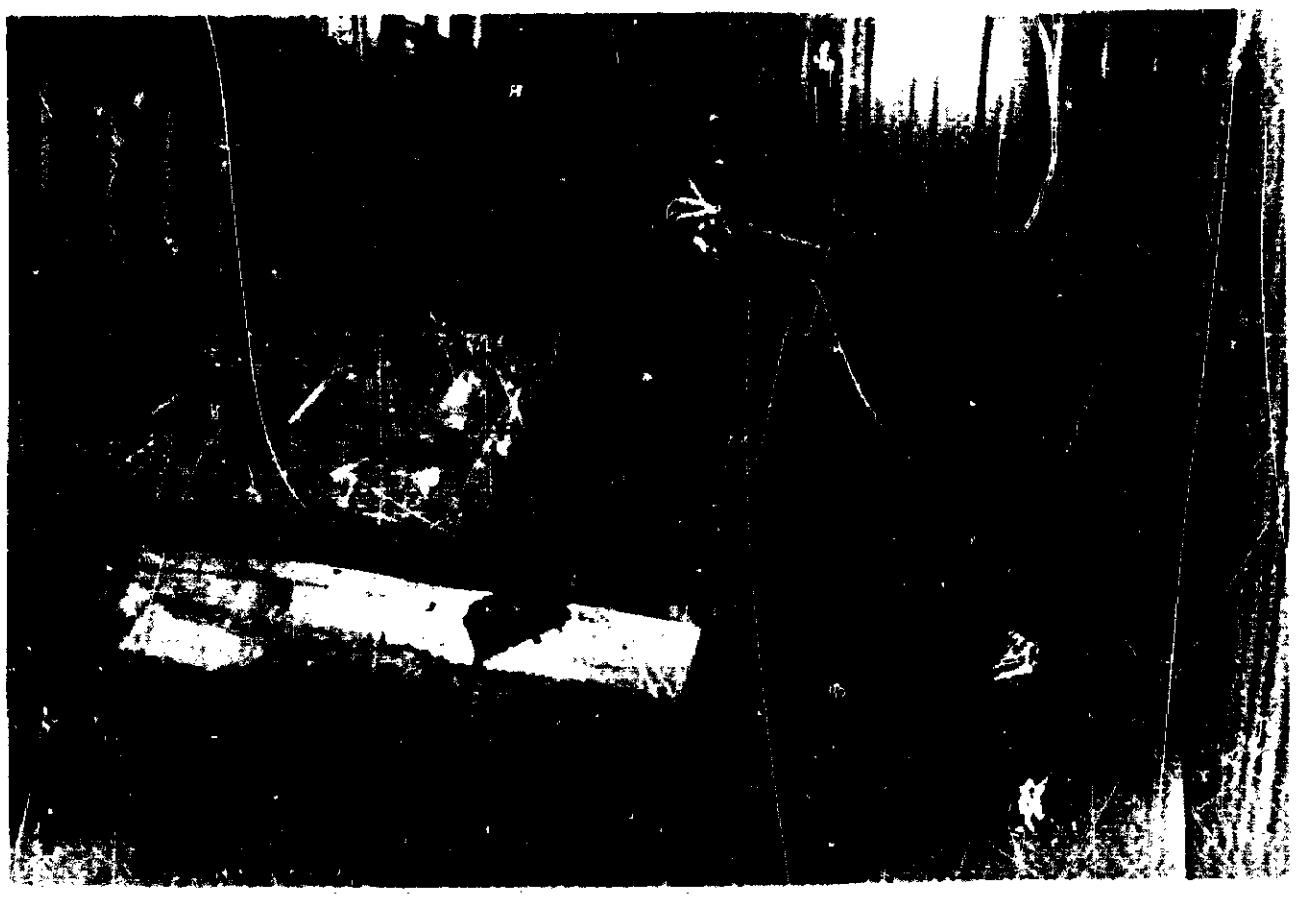
The use of the lap belt failed to protect this occupant from the effects of "jackknifing" forward over the lap belt, allowing severe flexation of the upper torso to occur. Based on his injuries, the Safety Board surmises that when the boy's upper body jackknifed over the belt, his shoulders struck his legs and his head went down between his knees, causing the spinal cord, spine and shoulder injuries.

The Safety Board concluded that both of these rear seated children would have sustained substantially less severe injuries had their upper bodies been restrained along with their pelvises, by the proper use of rear seat lap/shoulder belts.

CASE 148 - (CHI 85-H-OR11)

Case Vehicle: 1980 AMC Concord 2-door
Case Vehicle Weight: 3,252 pounds
Case Vehicle Delta V: Undetermined (not compatible with Crash III)





Circumstances

A 1980 AMC Concord was traveling straight ahead when an oncoming Chevrolet lost control, rotated counterclockwise, and entered the AMC's lane of travel. The front of the AMC struck the right front of the Chevrolet, resulting in substantial damage to both vehicles. Deformation of up to 31 inches was noted on the front of the AMC. The Chevrolet was destroyed.

The AMC driver, restrained by a lap/shoulder belt, sustained serious injuries. The lap/shoulder-restrained right front passenger of the AMC sustained severe injuries which proved fatal. Two passengers were seated in the rear, both unrestrained; one sustained serious injuries, the other moderate. The unrestrained driver of the Chevrolet was reportedly ejected and sustained fatal injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 32 years
Height: 5 feet 4 inches
Weight: 135 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a cinching latchplate, and a stalk-mounted buckle assembly. The driver stated that the lap portion of the belt was low across the hips, and fit "snug" across the chest. Force loading marks were found from the D-ring. Tears in the webbing occurred at the latchplate location and melting occurred on the D-ring.

Injuries	AIS	Probable Source
Laceration, left temporal region	1	Instrument panel
Laceration, left side of nose	1	Instrument panel
Laceration, inside mouth, left side	1	Instrument panel
Fracture, clavicle	2	Shoulder portion of belt
Contusion, chest	1	Steering wheel
Fracture, left radius	2	Instrument panel
Fracture, left patella	2	Lower dash
Contusion, right ankle	1	Foot pedals
Contusion, left ankle	1	Foot pedal
Laceration, right hand	1	Windshield
Laceration, left hand	1	Windshield

Contusion, upper pelvis	1	Lap portion of belt
Lacerations, right knee area	1	Lower dash
Severe laceration, left knee	2	Lower dash
Contusion, inner right arm	1	Steering wheel
Contusion, left arm	1	Steering wheel
Contusion and collapse, left lung	3	Steering wheel
Contusion, upper left thorax	1	Shoulder portion of belt
Fracture, left ulna	2	Steering wheel, dash

The driver was admitted to a local hospital for an unspecified time before being released to out-patient care. She reported 4 months loss of work. The driver's seat came off its track due to the crash forces and the loading from behind by two unrestrained rear seat passengers. The driver's lap/shoulder belt remained attached to the floor, however. The seat was deformed forward, bent around the steering column. The lap/shoulder belt was able to provide some protection to the driver by preventing his uncontrolled movement into the frontal interior of the car deformed by the crash.

Case Vehicle
Seating Location: Right Front
Sex: F
Age: 8 years
Height: 4 feet 2 inches
Weight: 65 pounds
Restraint Used: Lap/shoulder belt (ELR)

This occupant was wearing a continuous loop lap/shoulder restraint equipped with an emergency locking retractor sensitive to vehicle motion, a cinching latchplate, and a stalk-mounted buckle assembly. According to the driver, the passenger's lap portion of the belt was low "across the abdomen" with the shoulder portion adjusted "snug" across the chest. Load marks were found on the webbing from the melting of the D-ring material and on the D-ring from the webbing material. The buckle assembly shattered and the webbing was severed by the cinching latchplate.

Injuries	AIS	Probable Source
Severe laceration, forehead	2	Instrument panel
Severe laceration, right eye	2	Instrument panel
Severe laceration, left eye	2	Instrument panel
Laceration, left temporal region	1	Instrument panel
Laceration, left eye lid	1	Instrument panel
Abrasion, right jaw	1	Instrument panel
Contusion across chest	1	Shoulder portion of belt
Laceration, right iliac crest	1	Lap portion of the belt
Laceration, right iliac crest	1	Lap portion of the belt
Contusion, right outer arm	1	Door interior
Laceration, right thumb	1	Window glass

Injuries	AIS	Probable Source
Laceration, left hand	1	Broken glass
Lacerations, left hand	1	Broken glass
Lacerations, lower right leg	1	Lower instrument panel
Lacerations, lower left leg	1	Lower instrument panel
Lacerations, right shin	1	Lower instrument panel
Lacerations, pancreas	4	Impact forces
Lacerations, liver	4	Impact forces
Unspecified basilar fracture	3	Impact forces
Fracture, middle fossa	3	Impact forces
Fracture, posterior fossa	3	Impact forces
Fracture, right femur	3	Lower floor panel
Fracture, 6th left rib	1	Shoulder portion of belt
Contusion, heart	3	Shoulder portion of belt

This passenger sustained severe trauma to the chest which caused her to intake gastric contents into her lungs. She reportedly became asphyxiated and died at the scene. The passenger's seat came totally off its track during the crash due to the crash force and loading from behind by an unrestrained rear seat passenger. The lap/shoulder belt also was severed during the crash. Hence the severe nature of the crash, seat detachment, and belt webbing separation, meant lap/shoulder belt use was of little benefit to this occupant. If totally unrestrained, however, this passenger would have sustained equally or more severe injuries from instrument panel and windshield contact.

Case Vehicle
Seating Location: Left rear
Sex: F
Age: 13 years
Height: 5 feet 1 inch
Weight: 86 pounds
Restraint Used: No

This occupant was unrestrained even though a lap belt was available.

Injuries	AIS	Probable Source
Contusion, forehead	1	Side interior/seat back
Laceration, face	1	Side interior/seat back
Fracture, nose	1	Seat back
Fracture, left radius	2	Seat back
Fracture, left ulna	2	Seat back
Abrasions, right leg	1	Lower seat back
Fracture, left femur	3	Seat back

This occupant was admitted to a local hospital and was absent from school for an unknown time. With the severity of this collision, it is doubtful whether the available lap restraints would have reduced the injuries. It is, however, probable that the availability and use of a lap/shoulder belt would have significantly reduced the severity of this occupant's injuries. For example, the fractured leg and arm, caused when the passenger's full body contacted the seatback, loading his radius and ulna with the full weight of his body, would not have occurred. Also, had this person been restrained, the driver's injuries may have been reduced since the driver's seat would then not have been loaded from behind.

Case Vehicle

Seating Location:	Center Rear
Sex:	F
Age:	12
Height:	4 feet 11 inches
Weight:	85 pounds
Restraint Used:	None available

There was no restraint available for this seating location. This occupant sustained serious injuries.

Injuries	AIS	Probable Source
Severe laceration, upper forehead	2	Adjacent occupant and/or seat back
Severe laceration, chin	2	Adjacent occupant and/or seat back
Laceration, anterior neck	1	Adjacent occupant and/or seat back
Dislocation, hip	3	Adjacent occupant and/or seat back
Fracture, left femur	3	Adjacent occupant and/or seat back
Fracture, thoracic vertebra	3	Impact forces
Contusion, right buttocks	1	Adjacent occupant
Lacerations, left hand	1	Glass
Lacerations, right hand	1	Glass
Fracture, skull (unspecified)	3	Adjacent occupant

This occupant was transported to a local hospital and admitted. She was absent from school for an unspecified time. Had there been a lap/shoulder belt available and used at this position, it is likely that the injury severity would have been reduced; i.e., the dislocated hip and fractured femur probably would not have occurrred.

Case Vehicle
Seating Location: Right rear
Sex: F
Age: 11 years
Height: 4 feet 10 inches
Weight: 100 pounds
Restraint Used: None

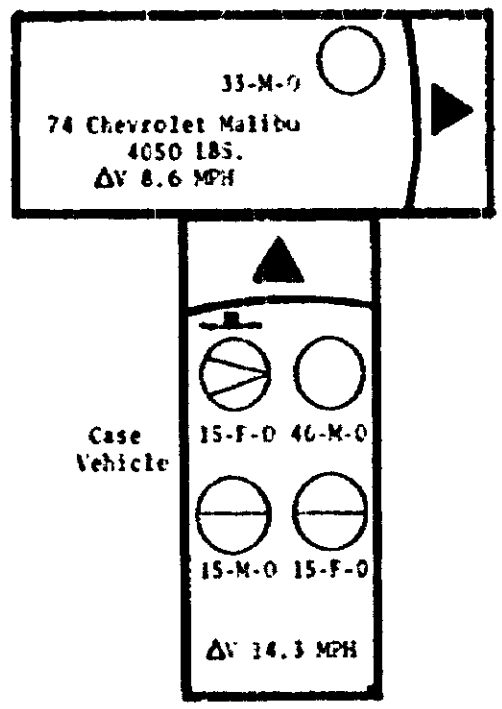
Although a lap belt was available, it was not used.

Injuries	AIS	Probable Source
Severe laceration, face	2	Seat back
Fracture, jaw (unspecified)	1	Seat back
Fracture, right radius	2	Seat back
Fracture, right ulna	2	Seat back
Contusions/abrasions, right lower leg	1	Lower seat back
Contusions/abrasions, left lower leg	1	Lower seat back

This occupant was admitted to a local hospital and remained hospitalized for an unknown period. Had a lap/shoulder belt been available and used at this position, it is likely that most of the moderate fractures could have been prevented. These fractures occurred when the unrestrained passenger contacted the front seat back with her entire body, loading her arm and leg bones beyond their tolerance. Restraint would also have prevented this occupant from loading the right front seat back, thereby lessening the forces which acted upon the right front passenger; the front seat passenger's seat came off the track during the crash.

CASE 149 - (ATL 85-H-OR02)

Case Vehicle: 1985 Plymouth Reliant, 2-door
Case Vehicle Weight: 2,920 pounds
Case Vehicle Delta V: 14.3 mph



Circumstances

A 1985 Plymouth Reliant entered an intersection and struck the right side of a 1974 Chevrolet Malibu. The Plymouth sustained moderate damage with deformation of up to 5.2 inches at the front end. The Chevrolet received moderate right side damage.

The Plymouth was occupied by a lap/shoulder belted-driver, an unrestrained right front passenger, and two lap-belted rear seat passengers. There were no reported injuries. The unrestrained driver of the Chevrolet was not injured.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 15
Height: 5 feet 7 inches
Weight: 155 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver stated that the precrash adjustment of the lap portion of the belt as being positioned low across her hips and snug. The shoulder portion was reportedly adjusted so that the palm of a hand could be placed between the webbing and the chest. No force loading marks were found.

Injuries: None.

If the driver had not been wearing the available restraint in this 14.3 mph Delta V collision, she might possibly have sustained injuries from contact with the steering assembly and instrument panel.

Case Vehicle
Seating Location: Right Front
Sex: M
Age: 46 years
Height: 6 feet
Weight: 200 pounds
Restraint Used: None

This seating position was equipped with a lap/shoulder belt identical in design to that worn by the driver.

Injuries: None.

Since this occupant was not injured, restraint use could not have improved the outcome.

Case Vehicle
Seating Location: Left Rear
Sex: M
Age: 15 years
Height: 4 feet 10 inches
Weight: 123 pounds
Restraint Used: Lap belt (ALR)

This passenger was wearing a lap belt equipped with an automatic locking retractor. The precrash lap belt adjustment was described as being positioned low across the hips and snug.

Injuries: None.

If this occupant had not been wearing the available lapbelt he would have been thrown forward into contact with the back of the front seat and the left side interior. It would be difficult to speculate on the change in injury outcome.

Case Vehicle
Seating Location: Right Rear
Sex: F
Age: 15 years
Height: 5 feet 3 inches
Weight: 105 pounds
Restraint Used: Lap belt (ALR)

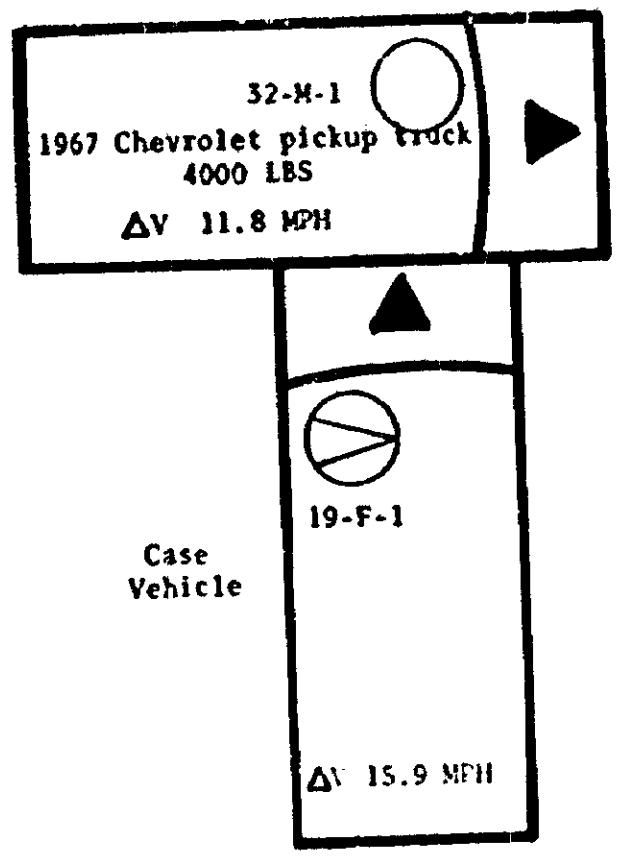
This passenger was also wearing a lap belt equipped with an automatic locking retractor. The precrash lap belt adjustment was described as being positioned low across the hips and snug.

Injuries: None.

If this occupant had been unrestrained, she would have been thrown forward into the back of the front seat. Again, it would be difficult to speculate on the change in injury outcome considering the 14 mph Delta V.

CASE 150 - (FTW 85-H-OR37)

Case Vehicle: 1985 Audi 5000S, 4-door
Case Vehicle Weight: 2,970 pounds
Case Vehicle Delta V: 15.9 mph



Circumstances

A 1985 Audi entered an intersection and struck a 1967 Chevrolet pick-up in the right front side. The Audi received substantial structural damage with deformation of up to 14 inches to the front. Damage to the Chevrolet was moderate.

The Audi driver, restrained by a lap/shoulder belt, sustained minor injuries. The unrestrained driver of the much heavier pickup truck received minor injuries.

Restraint and Injury

Case Vehicle

Seating Location:	Driver
Sex:	F
Age:	19 years
Height:	5 feet 5 inches
Weight:	125 pounds
Restraint Used:	Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a rigid stalk-mounted buckle assembly attached to the seat track. The driver stated that the lap/shoulder belt fit snug "across the waist" and chest areas. Force loading marks were found on the webbing in the areas of the latchplate and the B-pillar mounted D-ring.

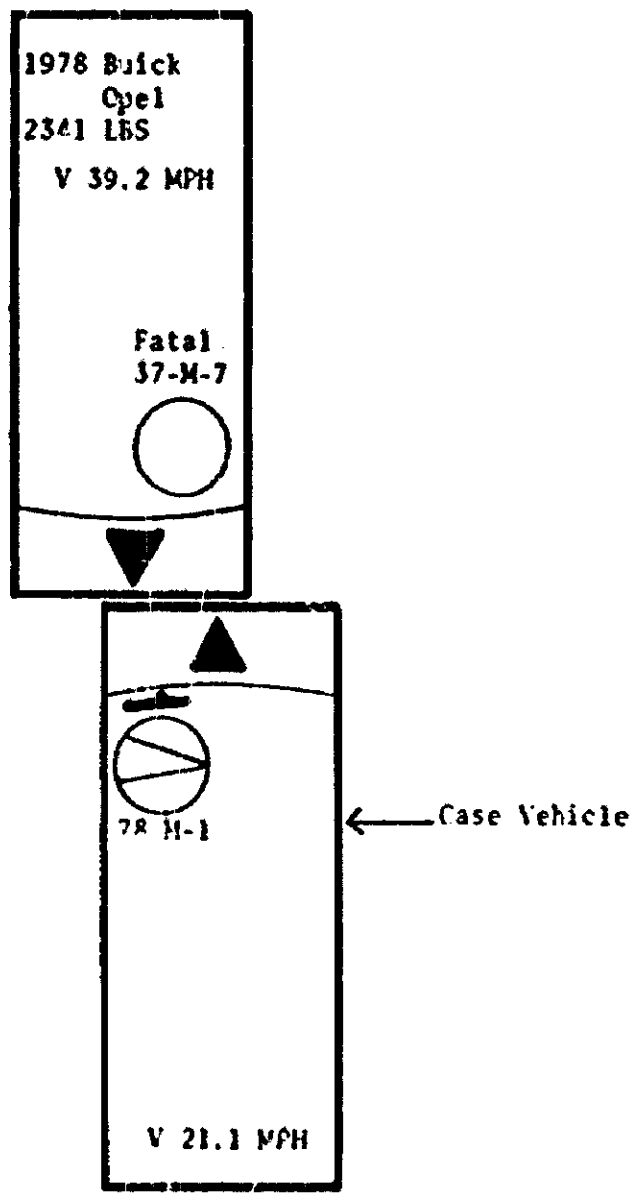
Injuries	AIS	Probable Source
Small contusion right leg	1	Instrument panel shelf

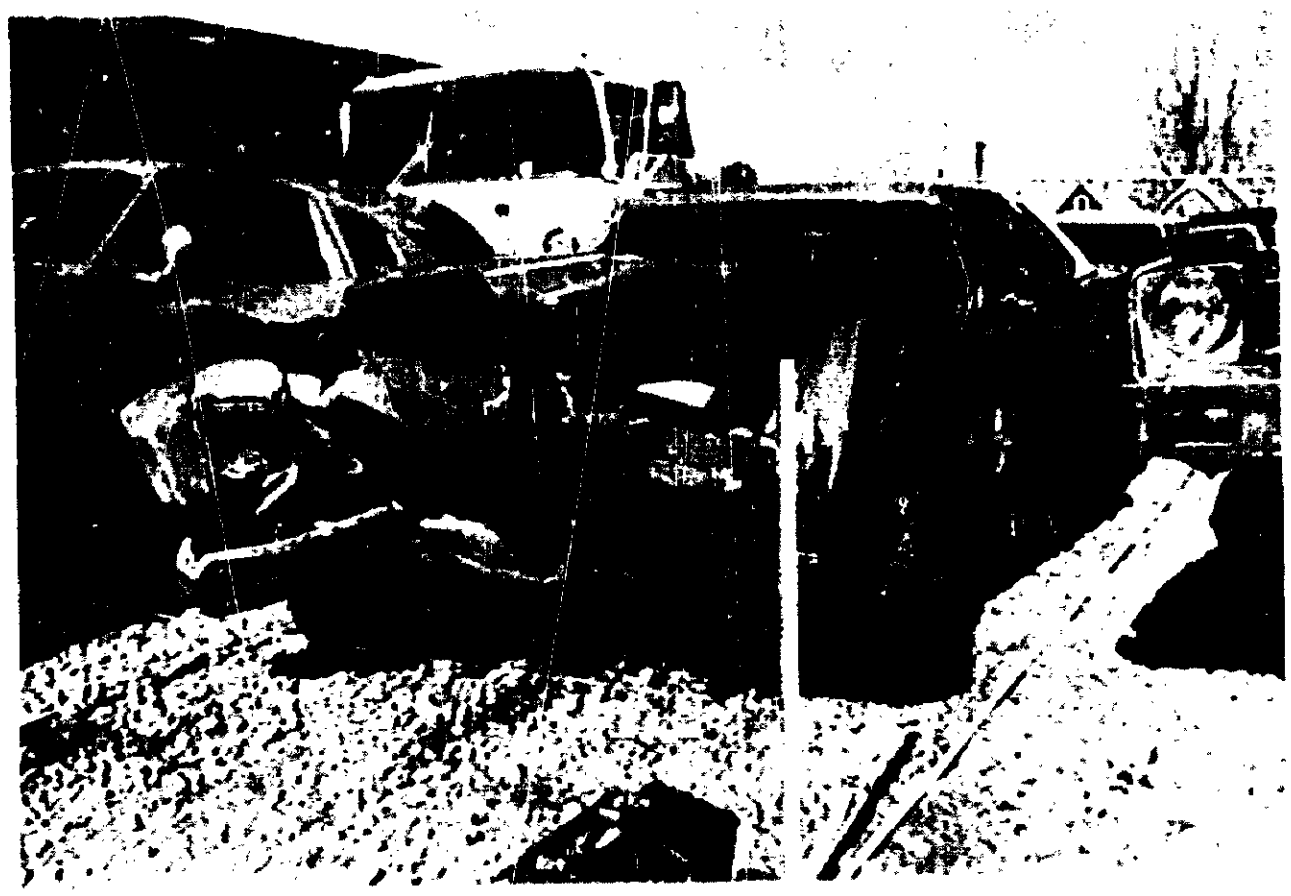
The Audi driver did not seek medical treatment for her minor injury. The lap/shoulder belt used by the driver performed well in this moderate speed collision (Delta V of 15.9 mph). The occupant's only contact point was her lower leg striking the instrument panel shelf. If this driver had not been properly restrained, more severe injuries could have been expected due to multiple contacts with the frontal interior of the vehicle.

All anchor points of the Audi's lap/shoulder belt are located well behind an occupant's body mass for all positions of seat track adjustment. The lower outboard anchor is well below a driver's lower body mass and the seat mounted buckle stalk ensures an excellent resultant buckle location, well below and behind the lower body mass of an occupant.

CASE 151 - (CHI 85-H-0R16)

Case Vehicle: 1975 Pontiac Gran Prix, 2-door
Case Vehicle Weight: 4,347 pounds
Case Vehicle Delta V: 21.1 mph





Circumstances

A 1975 Pontiac, traveling on a two-lane road, struck a 1978 Buick Opel head-on. The Pontiac received substantial structural damage, with deformation of the front structure up to 30 inches. The entire front structure of the lighter weight Opal was destroyed.

The Pontiac driver, restrained by a lap/shoulder belt, sustained minor injuries, while the unrestrained driver of the Opal was fatally injured.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 77 years
Height: 5 feet 8 inches
Weight: 180 pounds
Restraint Used: Lap/shoulder belt with dual retractors (ALR/ELR)

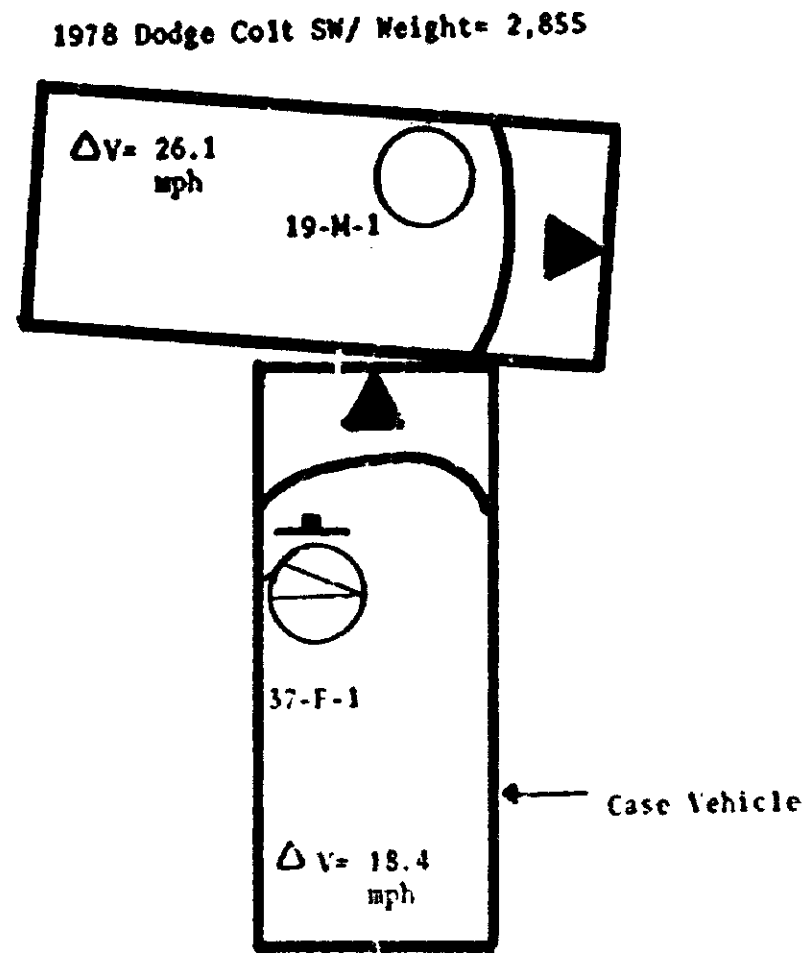
This driver was wearing a lap/shoulder belt with dual retractors. The lap portion of the belt was equipped with an automatic locking retractor. The shoulder portion was equipped with a comfort clip and an emergency locking retractor sensitive to vehicle motion. Both belts were attached to a sewn-in latchplate which inserted into a stalk-mounted buckle assembly. The driver stated that the position of the lap portion was low on his hips and snug, and that the shoulder portion was tight enough to allow only the palm of his hand to be inserted between the webbing and his chest. However, paramedics who unbuckled the lap/shoulder belt from the driver, after the collision, stated that the shoulder portion of the restraint was very loose when they removed it. Injuries were consistent with those caused by movement of the upper torso into the frontal interior components as a result of a loose shoulder portion. The top of the steering wheel rim was bent forward and down when struck by the driver's upper torso. Also, the windshield was cracked by contact with the driver's head.

Injuries	AIS	Probable Source
Abrasion to nose	1	Instrument panel
Lip laceration	1	Steering wheel
Fractured teeth (2)	1	Steering wheel
Laceration to top of head	1	Windshield
Abrasion to left knee	1	Lower instrument panel

The driver was admitted to an area hospital for approximately 2 weeks, principally due to a pre-existing heart condition. His use of the available lap/shoulder belt, although possibly worn too loose, probably prevented more serious injuries in this 21 mph Delta V collision. An unrestrained driver would have been free to make more violent contacts with the frontal interior components.

CASE 152 - (MKC 85-H-OR24)

Case Vehicle: 1979 Cadillac Eldorado, 2-door
Case Vehicle Weight: 4,037 pounds
Case Vehicle Delta V: 18.2 mph



Circumstances

A 1979 Cadillac Eldorado and a 1978 Dodge Colt station wagon were entering an intersection from opposite directions when the Dodge turned left in front of the Cadillac. The front of the Cadillac struck the middle of the right side of the Dodge. The Dodge then rolled over onto its roof. The Cadillac received moderate structural damage to its front deformation of up to 19 inches

The Cadillac driver, restrained by a lap/shoulder belt, sustained a minor laceration. The unrestrained driver of the Dodge sustained unspecified internal injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 37 years
Height: 5 feet 4 inch
Weight: 130 pounds
Restraint Used: Lap/shoulder belt with dual retractors (ALR/ELR)

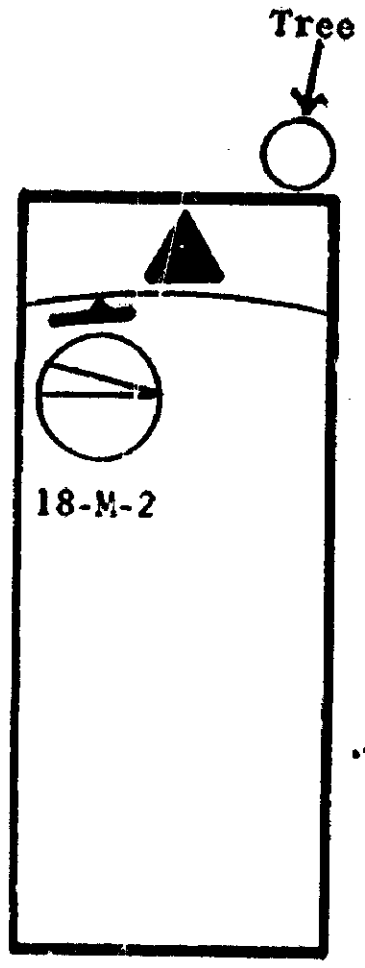
This driver was wearing a lap/shoulder belt equipped with an automatic locking retractor on the lap portion of the belt, an emergency locking retractor sensitive to vehicle motion on the shoulder portion, a sewn-in latchplate, a stalk-mounted buckle assembly, and a plastic guide ring mounted on the headrest. The driver stated that the lap portion was positioned "across her abdomen" and was snug. This driver also stated that she was not sure how tight the shoulder portion was. However, the self-tensioning feature of the shoulder portion retractor should have ensured a snug fit.

Injuries	AIS	Probable Source
Laceration, middle finger right hand	1	Steering wheel

The driver refused medical treatment and reported no loss of time from work. Considering the 18.4 mph Delta V of this collision, use of the available lap/shoulder very likely prevented her from receiving additional and more serious injuries.

CASE 153 - (ATL 85-H-OR15)

Case Vehicle: 1984 Honda Civic 2-door
Case Vehicle Weight: 2,052 pounds
Case Vehicle Delta V: Undetermined (not compatible with Crash III)



Circumstances

A 1984 Honda Civic 2-door, traveling at a driver-estimated speed of 35 mph, hit a puddle of water, went out of control, departed the roadway, and collided with a tree. The accident resulted in substantial damage to the front of the Honda with deformation of up to 20 inches at the right front.

The Honda was occupied by a driver wearing a misrouted lap/shoulder belt (shoulder portion under arm). The driver sustained moderate injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 18 years
Height: 6 feet 1 inch
Weight: 145 pounds
Restraint Used: Misrouted lap/shoulder belt (ELR): shoulder portion under arm

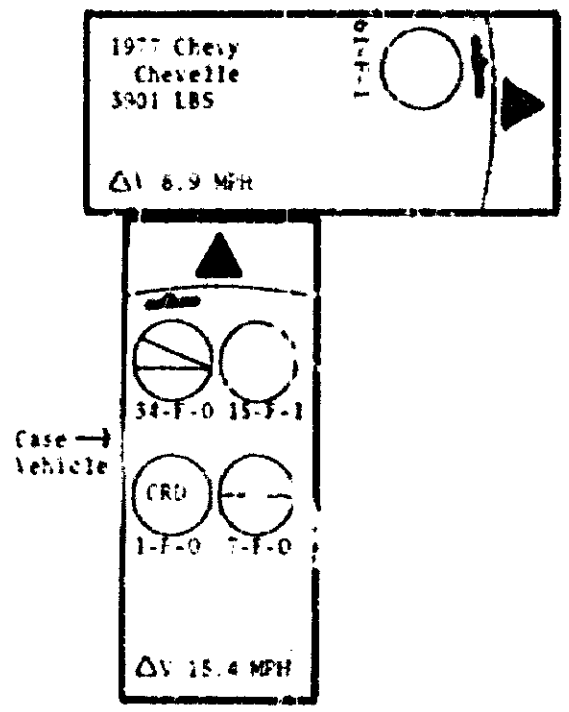
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a free-sliding latchplate, and a push-button release buckle attached to a flexible stalk. The driver stated that the adjustment of the lap portion of the belt was snug, positioned low on his hips, but revealed that the shoulder strap was positioned under his left arm. He stated that he placed the shoulder portion under his arm because, when positioned over his shoulder, the webbing cut into his neck. Marks were found on the system webbing attributed to force loading at the latchplate. The instrument panel forward and to the right of this seating position was slightly deformed.

Injuries	AIS	Probable Source
Laceration, right nostril	1	Steering wheel, rim
Fractured nasal bridge bone	1	Steering wheel rim
Contusion, lower abdomen	1	Lap portion of belt
Fracture, carpal bone, right wrist	2	Center instrument panel
Contusion, right forearm	2	Center instrument panel

This driver was treated at an outpatient medical facility and released. He reportedly lost 5 days of work due to his injuries. If the driver had properly positioned the shoulder portion across his chest, his forward movement would have been more controlled and his injuries may have been reduced in severity.

CASE 154 - (MKC 85-H-OR29)

Case Vehicle: Volkswagen Rabbit, 4-door
Case Vehicle Weight: 2,199 pounds
Case Vehicle Delta V: 15.4 mph



Circumstances

A 1981 Volkswagen Rabbit 4-door struck the right rear side of a 1977 Chevrolet Malibu 4-door with its front. The collision resulted in substantial damage to the Volkswagen with frontal deformation of up to 10 inches over a 63-inch wide area. The Chevrolet sustained minor damage on the right rear side.

The Volkswagen was occupied by a lap/shoulder-belt restrained driver, an unrestrained passenger seated in the right front, a lap belt-restrained passenger seated in the right rear, and an infant restrained in a child safety seat at the left rear seating position. The Chevrolet was occupied by an unrestrained driver. The unrestrained right front seat passenger of the Volkswagen and the unrestrained driver of the Chevrolet received minor injuries. Neither the Volkswagen driver nor the infant in the child restraint were injured.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 34 years
Height: 5 feet 6 inches
Weight: 130 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a free-sliding latchplate, and a push-button release buckle rigidly attached to the seat frame below the level of the seat cushion. The driver stated that the adjustment of her lap portion of the belt was snug, positioned low on her hips, and that the shoulder portion was snug across her midchest area. There were marks found on the webbing attributed to force loading at the latchplate. There were no contact marks on the frontal interior surfaces of the vehicle forward of this seating position.

Injuries: None.

The lap/shoulder belt performed well in keeping the driver from contact with the steering assembly and instrument panel. If she had not been restrained in this 15.4 mph Delta V collision, she would have impacted the steering wheel and frontal interior surfaces of the vehicle and might have sustained injuries.

Case Vehicle
Seating Location: Right Front
Sex: F
Age: 15 years
Height: 5 feet 4 inches
Weight: 120 pounds
Restraint Used: None

This passenger was not wearing the available lap/shoulder belt furnished at her seating position. There were no contact marks on the frontal interior surfaces forward of this seating position. However, this occupant stated that she hit her knees on the dash board.

Injuries	AIS	Probable Source
Contusion, left knee	1	Dash board
Contusion, right knee	1	Dash board

If this occupant had used the available lap/shoulder belt, she still could have sustained minor leg injuries.

Case Vehicle
Seating Location: Left Rear
Sex: F
Age: 1 year
Height: 2 feet 6 inches
Weight: 24 pounds
Restraint Used: Child safety seat secured by lap belt (ALR)

The child was restrained in an unspecified type of child safety seat. She was not injured.

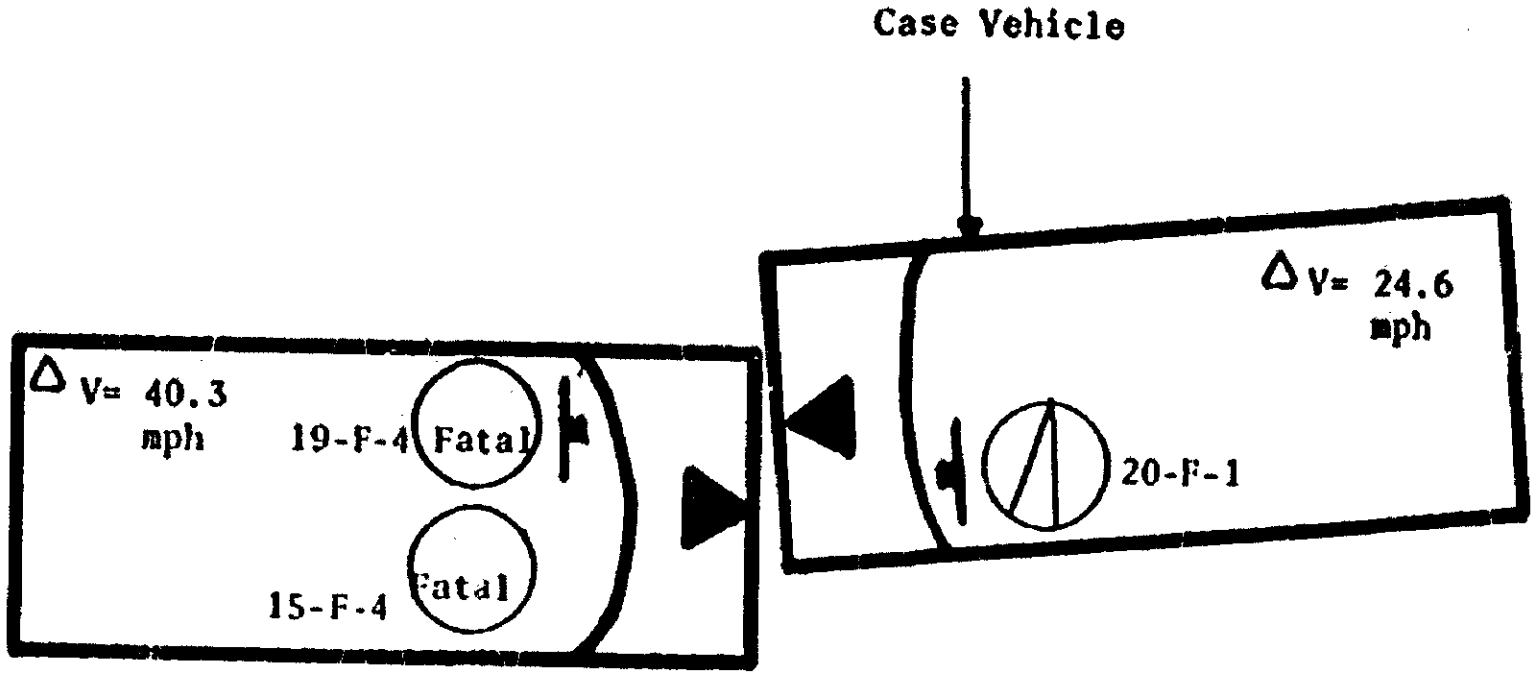
Seating Location: Right Rear
Sex: F
Age: 7 years
Height: 4 feet 1 inch
Weight: 60 pounds
Restraint Used: Lap belt (ALR)

This passenger was wearing a 2-point lap belt equipped with an automatic locking retractor, a sewn-on latchplate, and a push-button release buckle attached to the webbing. This occupant described the adjustment of the lap belt as snug, positioned low on her hips. There were no contact marks on the seat back or interior side wall near this seating position.

This passenger was reportedly uninjured. If she had not been restrained, she might have contacted the seat back forward of her seating position. At most, she might have sustained minor injuries.

CASE 155 - (MKC 85-H-OR12)

Case Vehicle: 1978 Chrysler Cordoba
Case Vehicle Weight: 4,278 pounds
Case Vehicle Delta V: 24.6 mph



1978 Toyota Celica
Weight= 2,605

Circumstances

The driver of a 1978 Chrysler Cordoba crossed into the opposite lane of traffic and struck a 1978 Toyota Celica nearly head-on. Both vehicles were destroyed. Each had substantial damage across their entire front structures. The Chrysler had deformation of up to 36 inches. The Toyota had deformation of up to 37 inches.

The Chrysler driver, restrained by a lap/shoulder belt, sustained only minor injuries. The driver and right front passenger of the Toyota, both unrestrained, sustained head injuries which proved fatal.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 20 years
Height: 5 feet 1 inch
Weight: 125 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver described the belt adjustment as being snug and low on the hips with very little slack in the shoulder portion. A force loading mark was found on the webbing in the vicinity of the latchplate.

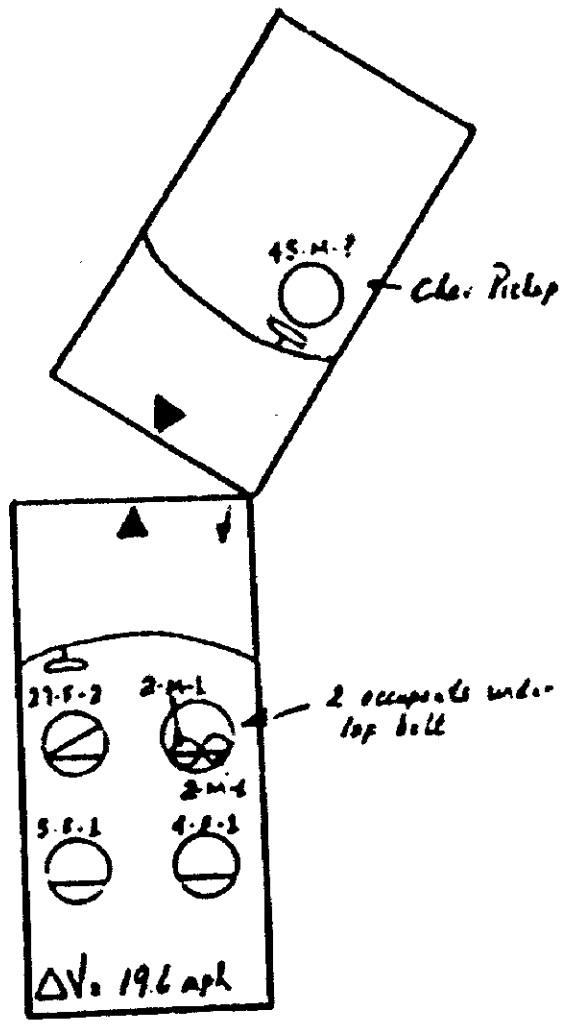
Injuries	AIS	Probable Source
Contusion, forehead	1	Steering wheel
Contusion, left side of chest	1	Shoulder portion of belt
Contusion, right side of abdomen	1	Lap portion of belt

This driver did not seek medical treatment, but she reported a loss of 2 days work. This was a good performance by the lap/shoulder belt, holding the driver in place, and preventing serious injury.

While the Chrysler driver fared well in this collision, it cannot be suggested that she would have been killed, as were the passengers in the Toyota, had she not been restrained. The difference lies mainly in the weight of the Chrysler (4,278 pounds) versus the weight of the Toyota (2,605 pounds), a difference of 1,673 pounds. The Delta V of the Toyota was 40.3 mph, 15.7 mph more than the Delta V of 24.6 mph for the Chrysler.

CASE 157 - (ATL 85-H-OR14)

Case Vehicle: 1977 Plymouth Arrow, 2-door
Case Vehicle weight: 2,395 pounds
Case Vehicle Delta V: 19.6 mph



Circumstances

A 1977 Plymouth Arrow struck a 1985 Chevrolet S-10 pick-up, right front to left front. The Plymouth sustained substantial frontal damage with deformation of up to 22.5 inches. The Chevrolet was not available for inspection.

The Plymouth driver, restrained by a lap/shoulder belt, sustained moderate injuries. Two small children seated in the right front seat, sharing a misrouted lap/shoulder belt (shoulder portion behind their backs), received minor injuries.

Restraint and Injury

Seating Location: Driver
Sex: F
Age: 27 years
Height: 5 feet 11 inches
Weight: 110 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop, lap/shoulder belt with an emergency locking retractor sensitive to webbing motion, a free sliding latchplate and a stalk-mounted buckle assembly. The driver described the adjustment as snug "across the abdomen" and snug across the midchest. Load marks were found on the webbing.

Injuries	AIS	Probable Source
Major contusion, lower abdomen	2	Lap portion of belt
Cervical strain	1	Impact forces
Contusion, left clavicle	1	Shoulder portion of belt
Contusion, left knee	1	Steering column
Contusion, right knee	1	Steering column
Abrasion, right lower arm	1	Steering wheel rim
Abrasion, medial left ankle	1	Foot pedal controls

The driver was transported to a local emergency facility, treated, and released. She reported losing 2 weeks of work. Use of the restraint system probably prevented more serious injuries in this 19.6 mph Delta V collision. If the lap portion was actually positioned across her abdomen, the restraint system's performance was probably degraded. However, an unrestrained driver would have contacted the frontal interior components much more forcefully.

Seating Location: Right Front (inboard) -- shared seat
Sex: M
Age: 2 years
Height: 36.5 inches
Weight: 35 pounds
Restraint Used: Sharing a misrouted lap/shoulder belt (shoulder portion behind back) with another child

This child was seated in the inboard portion of the right front bucket seat, sharing the seat and 3-point belt with another 2-year-old. The shoulder strap was improperly routed behind their backs. The driver related that the lap portion of the belt was positioned low across the children's hips and was tightly adjusted. The shoulder portion was improperly routed behind both of their backs.

Injuries	AIS	Probable Source
Laceration, right forehead	1	Instrument panel
Abrasion, right forehead	1	Instrument panel
Abrasion, right eyelid	1	Instrument panel
Contusion, lower right abdomen	1	Lap portion of belt
Contusion, lower left abdomen	1	lap portion of belt

He was treated and released from a local emergency facility.

The improper use of the available lap/shoulder belt, as well as the side-by-side restraint of the children, probably contributed to the abdominal loading on the inboard passenger. On the police accident forms, both children were reported as being restrained by lap/shoulder belts. No mention of belt-sharing was made, or of the misrouting.

Seating Location: Right Front (Outboard) -- shared seat
Sex: M
Age: 2 years
Height: 37.5 inches
Weight: 25 pounds
Restraint Used: Shared misrouted lap/shoulder belt (shoulder portion behind back)

This child was riding on the outboard side of the right front bucket seat co-restrained with the right front inboard passenger (refer right front inboard occupant for description). Two children were essentially restrained by an improperly used lapbelt. Seat belts should never be shared. In addition, these children belong in child restraints.

Injuries	AIS	Probable Source
Laceration, right parietal scalp	1	Instrument panel
Abrasion, right temporal to right zygomatic	1	Instrument panel

Lack of upper torso restraint allowed the children to strike the dashboard.

Seating Location: Left Rear
Sex: F
Age: 5 years
Height: 44 inches
Weight 40 pounds
Restraint Used: Lap belt (ELR)

This occupant was restrained by a lap belt with an emergency locking retractor and a latchplate integrated into the retractor. The lap belt was positioned low on the hips and tightened by the retractor.

Injuries	AIS	Probable Source
Contusion, mid to lower left abdomen	1	Lap belt and retractor
Contusion, upper left thigh	1	Lap belt and retractor
Contusion, lower right abdomen	1	Lap belt
Extended period of soreness in abdomen	0	Lap belt

The use of the available lap restraint probably contributed to the abdominal injuries, due to the jacknifing effect around the lap belt.

Seating Location: Right Rear
Sex: F
Age: 4 years
Height: 45 inches
Weight: 35 pounds
Restraint used: Lap belt (ELR)

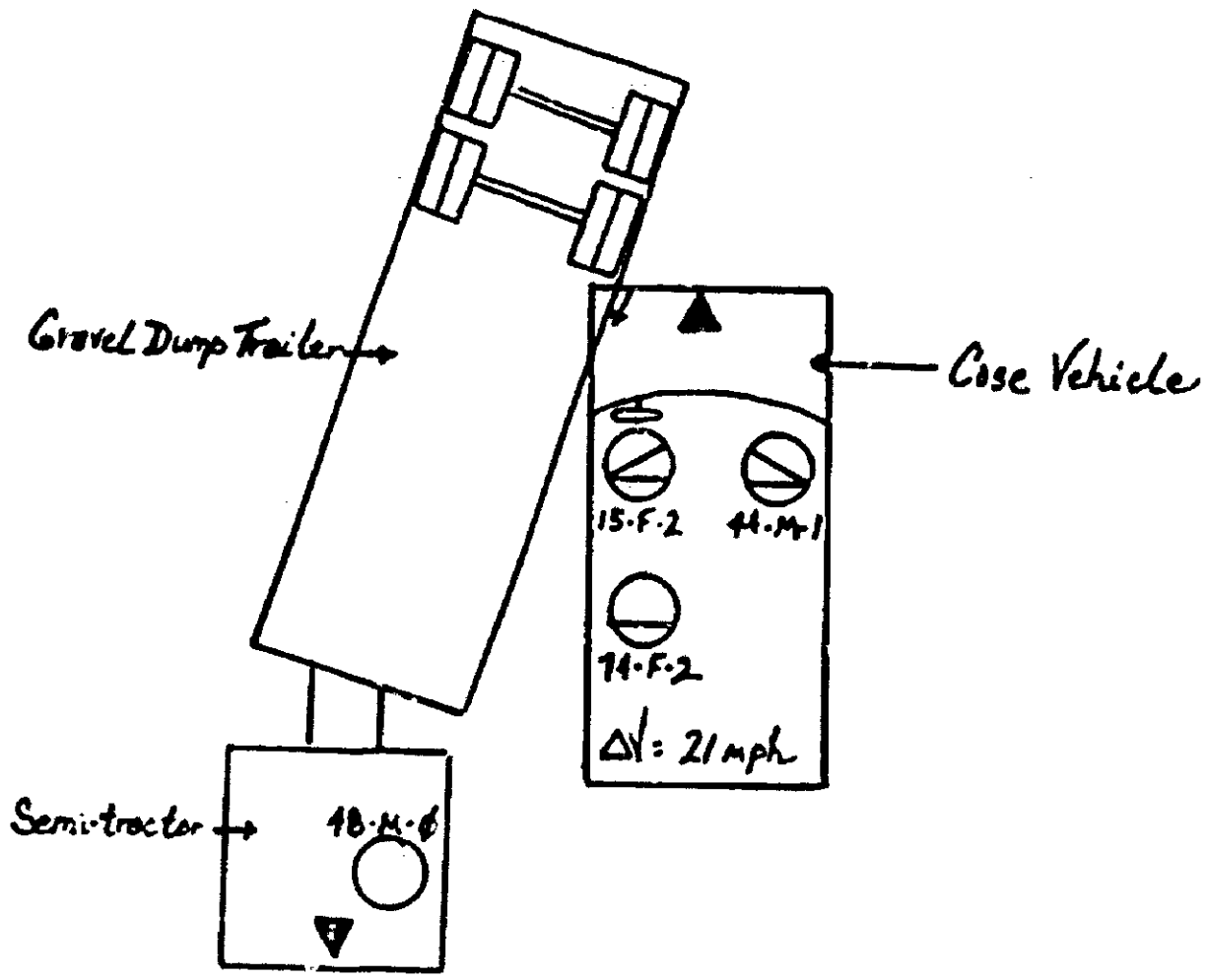
This occupant was restrained by a system similar to that used by the left rear occupant, properly adjusted across the lower hips.

Injuries	AIS	Probable Source
Large contusion, left side, mid-abdomen area	1	Lap belt
Contusion, right front hip	1	Lap belt and retractor
Contusion, upper front thigh	1	Lap belt and retractor
Extended period of soreness in abdomen	1	Lap belt

As with the left rear occupant, abdominal injuries were induced as a result of the "jackknifing" effect about the lap belt. The lap belt was loaded as the upper body rotated forward and to the left, thus allowing the belt to rise over the left iliac crest into an area of less resistence.

CASE 160 - (FTW 85-H-OR17)

Case Vehicle: 1984 Chevrolet Cavalier, 2-door
Case Vehicle Weight: 2,920 pounds
Case Vehicle Delta V: 21 mph



Circumstances

A 1984 Chevrolet Cavalier struck the left leading dual tires of a 42-foot dump trailer being pulled by a 1979 Ford semi-truck. The Chevrolet sustained extensive damage to the left front with a rearward deformation of up to 20 inches.

The Chevrolet driver, restrained by a lap/shoulder belt, sustained moderate injuries. The right front passenger, also restrained lap/shoulder belt, sustained minor injuries. The lap-belt restrained left rear passenger sustained moderate injuries.

Restraint and Injury

Seating Location:	Driver
Sex:	F
Age:	15 years
Height:	5 feet 1 inch
Weight:	125 pounds
Restraint Used:	Lap/shoulder belt

The driver was wearing the available continuous loop, lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a cinching latchplate, a windowshade tension-relief device and a stalk-mounted buckle assembly. The driver stated that the lap portion of the belt was positioned "across her abdomen", and was adjusted somewhere "between loose and snug", and that the shoulder portion was "loose" across her chest. Load marks were found on the webbing, seat cushion, and seat back. The upper portion of the steering wheel rim was deformed forward from 2 to 2 /1 inches.

Injuries	AIS	Probable Source
Deep abrasion with two areas of avulsions, left knee	2	Lower instrument panel
Right ankle sprain	1	Foot controls
Right ankle contusion	1	Foot controls
Contusion, abdominal muscle wall, lower left quadrant	1	Lap portion of belt
Contusion, lower sternum	1	Steering assembly/shoulder restraint
Contusion, below left clavicle	1	Shoulder portion of belt
Dislocated front teeth	1	Steering assembly
Abrasion, right knee	1	Lower instrument panel
Contusion, posterior upper left arm	1	Seatback cushion
Contusion, posterior upper right arm	1	Seatback cushion

The driver was treated and released at a hospital but required the use of crutches for 10 days.

While the restraint system probably worked to reduce injury severity in this 21 mph Delta V collision, the apparent introduction of excessive slack into the shoulder portion adjustment allowed significant forward travel of this occupant. This occupant should not have made the severe rim deformation impact with the steering assembly with a properly adjusted 3-point belt.

Seating Location:	Right Front
Sex:	M
Age:	44 years
Height:	6 feet 2 inches
Weight:	225 pounds
Restraint used:	Lap/shoulder belt

This passenger was wearing a lap/shoulder belt identical in design to the driver's. The passenger stated that the lap portion was positioned "across his abdomen," but did not relate the adjustment. Load marks were found on the webbing from the latchplate and D-ring.

Injuries	AIS	Probable Source
Contusions, chest wall	1	Shoulder portion of belt
Contusion, left knee	1	Instrument panel
Abrasion, left wrist	1	Instrument panel
Contusion, right knee	1	Instrument panel
Contusion, lower right abdomen	1	Lap portion of belt
Cervical strain	1	Transmitted forces

The passenger refused emergency treatment and sought his own medical aid. Given his size, the impact severity (Delta V of 21 mph), and the interior compartment dimensions, it appears that the restraint functioned well, and prevented more forceful interior impacts that could have increased the severity of his injuries.

Seating location:	Left rear
Sex:	F
Age:	74 years
Height:	5 feet 6 inches
Weight:	184
Restraint Used:	Lap belt (ALR)

This woman was wearing a lap belt with an automatic locking retractor, sewn-in latchplate, and a pushbutton release type of buckle. Although the occupant described her lap belt as being position "across her abdomen," photographs of the belt-induced contusion show that the belt was positioned below the iliac crest. Belt tension, as stated by the occupant, was somewhere between loose and snug.

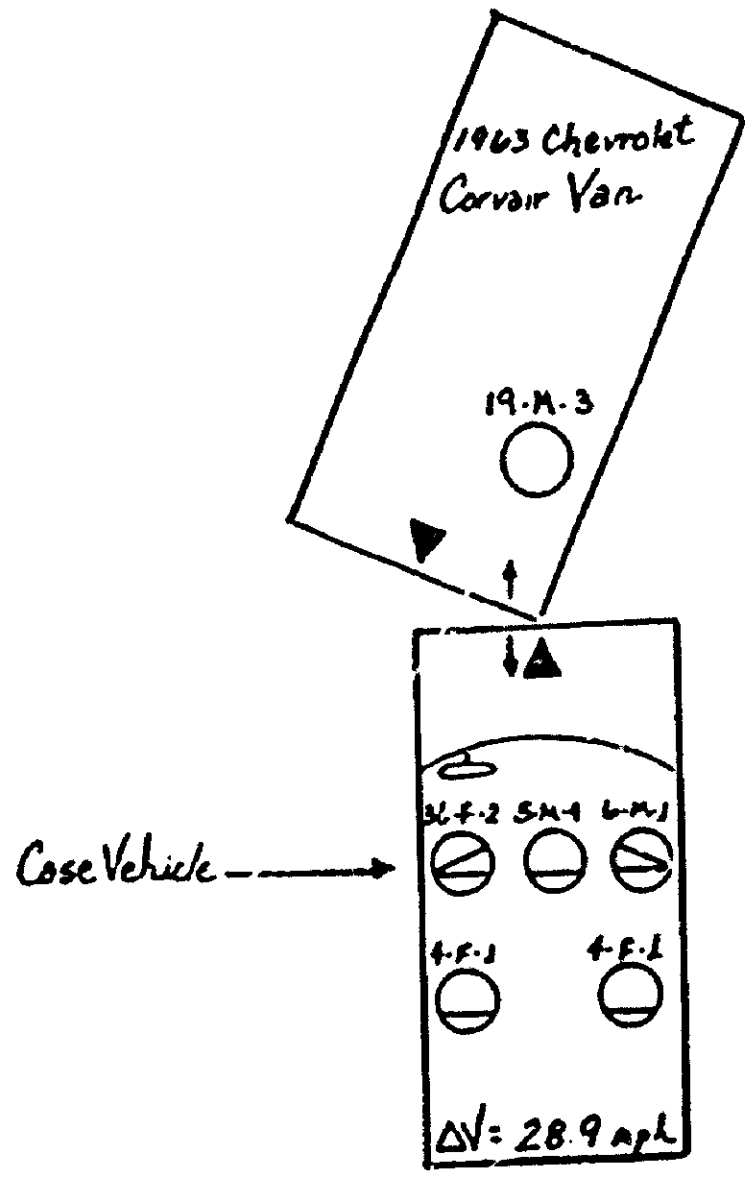
Injuries	AIS	Probable Source
Closed head injury, concussion	2	Transmitted forces
Deep laceration, right forehead	2	Contact with lower extremities
Major contusion/abrasion, left hip	2	Left interior sidewall
Major contusion, right side of face	2	Contact with lower extremities
Laceration, left forearm	1	Surface of driver seatback
Laceration, right forearm	1	Surface of driver seatback
Contusion, right lower chest	1	Contact with lower extremities
Foot laceration	1	Unknown
Lower left abdominal contusion	1	Lap belt
Contusion, right medial knee and below	1	Head contact
Contusion, right mid-abdomen	1	Lap belt

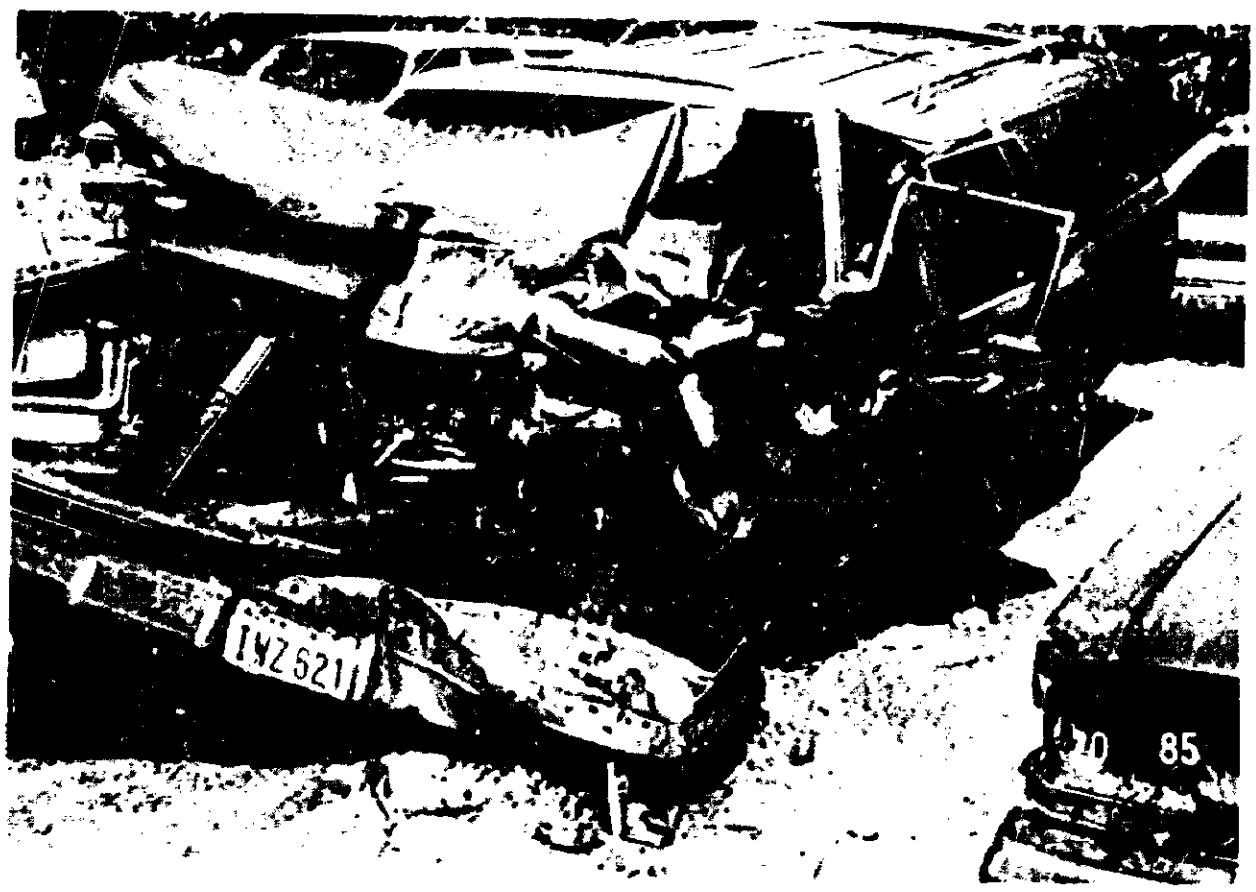
This passenger was hospitalized for 1 day. A lap/shoulder belt would probably have prevented the "jackknife"-type head injuries sustained in this 21 mph Delta V collision.

In riding down the impact forces, this occupant jackknifed violently. Her head injury was probably brought about by violent contact with her own right leg. She continued to travel into the semi-rigid rear surface of the driver's seat. The uppermost surface of the driver's seatback, directly in front of the woman was permanently deformed forward several inches and lower surface of seat back pushed inward.

CASE 161 - (SEA 85-H-0R20)

Case Vehicle: 1978 Buick Estate station wagon
Case Vehicle Weight: 4,570 pounds
Case Vehicle Delta V: 28.8 mph





Circumstances

A 1978 Buick Estate station wagon was struck in the center front by the left front of a 1963 Chevrolet van. The Buick sustained extensive left front damage with deformation of up to 40 inches. The entire front structure of the was destroyed.

The Buick driver, restrained by a lap/shoulder belt, sustained moderate injuries. The lap belted center front passenger sustained serious injuries. The lap/shoulder belted right front passenger sustained minor injuries, as did the lap belted left and right rear occupants. The unrestrained occupant of the van sustained serious injuries.

Restraint and Injury

Seating Location:	Driver
Sex:	F
Age:	36 years
Height:	5 feet 2 inches
Weight:	155
Restraint used:	Lap/shoulder belt (ELR)
Proper Use:	Not known

The driver was wearing a continuous loop, lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a cinching latchplate, a windowshade tension-relief device, and a stalk-mounted buckle assembly. The driver related that the belt was low across her hips and that the fit was "snug." She could not give information about the shoulder strap adjustment. When the distance of head travel into the A-pillar is considered, it appears there was excessive slack in the shoulder portion. Loading marks were not visible on the webbing.

Injuries	AIS	Probable Source
Closed head injury with unspecified loss of consciousness	2	A-pillar
Major contusions, right and left eyes	2	Steering rim and A-pillar
Lacerations with embedded glass, scalp	1	Windshield
Laceration, forehead	1	Steering rim or A-pillar
Contusion (10-cm diameter), chest	2	Steering assembly
Contusion, right forearm	1	Steering assembly
Contusion, left shoulder	1	Interior sidewall
Laceration, lower right leg	1	Below instrument panel

This woman was treated at a local hospital and released after several hours of observation required for the head injury. She required follow-up care by her personal doctor, but fully recovered from all injuries.

The driver's lap/shoulder belt did not prevent upper body contact with the vehicle's interior, due to the rearward displacement of the interior forward of the driver. The A-pillar, instrument panel, and steering assemby were displaced several inches upward. The steering column was broken, and the hub and wheel were displaced several inches outboard. Use of the 3-point belt did, however, reduce the overall severity of injuries sustained in this 28.8 mph Delta V collision.

Seating Location: Center front
Sex: M
Age: 5 1/2 years
Height: 40 inches
Weight: 52 pounds
Restraint used: Lap belt (static)

This child was wearing a static lap belt at the time of the collision. It had a push-button release type of buckle mounted to a 6 1/2-inch-length of webbing which entered the seat area through the lower seat cushion, and a cinching type of latchplate adjustable on a 43-inch length of webbing. Information regarding the lap belt adjustment and positioning was not available. However, there was no evidence of misuse found.

Injuries	AIS	Probable Source
Le Fort III maxilla fracture	4	Instrument panel
Le Fort II fracture	3	Instrument panel
Fractured nose	1	Instrument panel
Basilar skull fracture with cerebrospinal fluid leak	4	Instrument panel
Laceration to forehead	1	Instrument panel
Major contusion, face	2	Instrument panel

This child spent 9 days in the hospital.

The evidence presented by this child's injuries and the vehicle interior damage in his vicinity suggests that the major deceleration took place as his head hit the instrument panel, with little deceleration occurring at the lap belt level. If he had not been wearing the lap belt, he would have sustained at least moderate injuries, since his body would have been thrown into the instrument panel. The severe head and face injuries that he in fact sustained, however, were due to the jackknifing action, induced by the lap belt, that accelerated his face into instrument panel and concentrated much of the forces on this small part of his body. If the child had been restrained by a lap/shoulder belt (not available at this position), he probably would have sustained only minor abrasions or contusions considering the outcome of the lap/shoulder belted child seated next to him in the right front seating position.

Seating Location: Right front
Sex: M
Age: 6 years
Height: 44 inches
Weight: 40 pounds
Restraint used: Lap/shoulder belt

This child was wearing a lap/shoulder belt identical to the driver's. There was no evidence of force loading scars recovered during the Safety Board's investigation and no interior compartment distortion was noted. The seat was found adjusted to 3 inches from extreme forward on a 7-inch track. No information about system adjustment was given. However, no evidence of misuse was found.

Injuries	AIS	Probable Source
Minor lacerations at hairline	1	Broken glass
Abrasion, right shoulder	1	Shoulder portion of belt
Abrasion, across abdomen	1	Lap portion of belt
Small bump on head	1	Interior sidewall

This passenger was treated and released at a local clinic with a note at dismissal to contact the doctor if any abdominal complications developed. No complications were found during a followup interview 3 months after the crash. The restraint system performed well for this passenger. Considering the 28.8 mph Delta V of this collision, it is likely that he would have received additional and more serious injuries if he had been unrestrained.

Seating Location: Left rear
Sex: F
Age: 4 years
Height: 41 inches
Weight: 40 pounds
Restraint used: Lap belt (ALR)

This girl was restrained by a lap belt with an automatic locking retractor, a latchplate sewn in to the end of a 35-inch length of retractable webbing, and a push-button release type of buckle attached to an 8-inch length of webbing. Both the latchplate webbing and the buckle webbing entered the seating area through the junction of the upper and lower seat cushions. There was no evidence of restraint use noted from the webbing system or hardware.

The seatback cushion was displaced forward approximately 6 inches by cargo within the rear area of the station wagon. No other compartment deformation was noted. No estimate of seat belt adjustment was available.

Injuries	AIS	Probable Source
Lower abdominal contusion	1	Lap belt
Lower back strain	1	Lap belt
Small laceration, left cheek	1	Broken glass

The child was treated and released at an area children's hospital. No complications developed.

This child and the little girl on the right of the rear seat probably benefited tremendously from the extra wide and firm lower seat cushion installed in the full size station wagon. Although they probably jackknifed severely about the lap belt, the firm seat would not allow the submarining likely with an unsupported lower seat cushion. Also, the wide surface of the cushion allowed the downward acceleration around the lap belt to be dissipated into the cushion rather than hurling the girls' heads and necks downward between their knees into the area in front of their seat. The system anchor points being well below and behind the seat cushion junction kept the belt low on the girls' hips; the automatic locking retractor maintained "snug" tension.

Seating Location:	Right rear
Sex:	F
Age:	4 years
Height:	40 inches
Weight:	60 pounds
Restraint used:	Lap belt (ALR)

This child was restrained by a lap belt identical to the one at the left rear. No evidence of restraint was recovered from the belt system. The girl was reportedly wearing a lap belt low across her hips. No interior compartment deformation was noted at this position.

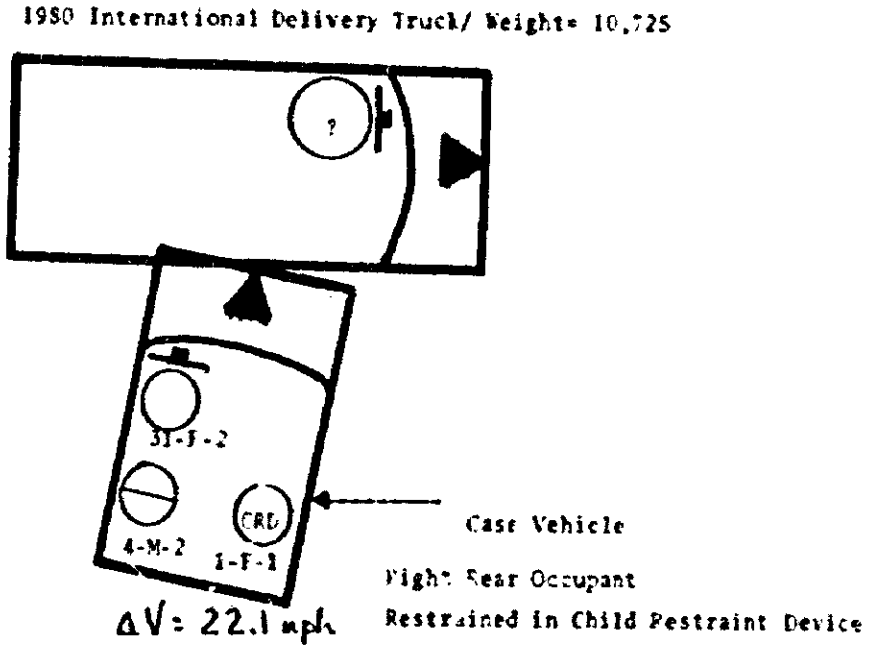
Injuries	AIS	Probable Source
Abdominal abrasions	1	Lap belt

This child was treated and released at a local clinic. The doctor specifically noted that there was no evidence of abdominal injury but cautioned to watch for later evidence of internal injury. A followup interview 3 months after the accident revealed no complications from the injury.

(See comments on the left rear position)

CASE 163 - (MKC 85-H-0R30)

Case Vehicle: 1985 Oldsmobile Cutlass, 4-door
Case Vehicle Weight: 2,953 pounds
Case Vehicle Delta V: 22.1 mph



Circumstances

A 1985 Oldsmobile Cutlass 4-door collided with the right side of a 10,725-pound 1980 International S-1800 truck as the truck executed a left turn. The Oldsmobile sustained substantial front end damage with deformation of up to 15 inches. The much heavier International truck was not damaged and the truck driver was not reported to be injured.

The Oldsmobile was occupied by an unrestrained driver, a child restrained by a lap belt in the left rear, and a small child in a child safety seat secured by a lap belt in the right rear. The unrestrained driver and the lap belt-restrained child sustained moderate injuries. The child in the safety seat sustained minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 31
Height: 5 feet 6 inches
Weight: 198 pounds
Restraint Used: None

This driver was not wearing the lap/shoulder belt available at her seating position. The steering column was broken, the windshield was broken, and the instrument panel was moderately deformed forward of this seating position.

Injuries	AIS	Probable Source
Multiple lacerations, face/forehead	2	Windshield
Ribs fractured, right side	2	Steering assembly
Contusion, left shoulder	1	A-pillar and side glass
Contusion, left upper chest	1	Steering assembly
Abrasion, left knee	1	Instrument panel
Comminuted fracture, first toe left foot	2	Foot controls
Abrasion, left elbow	1	Instrument panel
Abrasion, right elbow	1	Instrument panel
Abrasion, right lower leg	1	Lower instrument panel
Contusions, mid-abdominal area	1	Steering assembly
Contusion, right hand	1	Instrument panel
Contusion, lower left leg	1	Foot controls

If this driver had used the available lap/shoulder belt in this 22.1 mph Delta V collision, both the number of and severity of her injuries would probably have been reduced.

Case Vehicle
Seating Location: Left rear
Sex: M
Age: 4
Height: 3 feet 6 inches
Weight: 36 pounds
Restraint Used: Lap belt (ALR)

This passenger was wearing a lap belt equipped with an automatic locking retractor, a sewn-on latch plate, and a push-button release buckle. The adjustment of this child's lap belt was reportedly snug, positioned "over the abdomen." There were no documented loading marks on the webbing, but the bruising over the midabdominal area of this child confirmed use of the lap belt. The lap belt may have been positioned too high on this passenger.

Injuries	AIS	Probable Source
Major lacerations, left forehead	2	Interior side wall
Contusion, left forehead	1	Interior side wall
Large contusion, left cheek/face	2	Interior side wall
Contusion, left hip	1	Interior side wall
Contusion, right hip	1	Lap belt hardware
Contusion, mid-abdominal area	1	Lap belt

This passenger was treated and released at a local hospital. His head and facial injuries would have been less severe if a lap/shoulder belt had been available and used properly.

Case Vehicle
Seating Location: Right rear
Sex: F
Age: 1
Height: 2 feet 6 inches
Weight: 28 pounds
Restraint Used: Bobby Mac Champion child safety seat secured by lap belt (ALR)

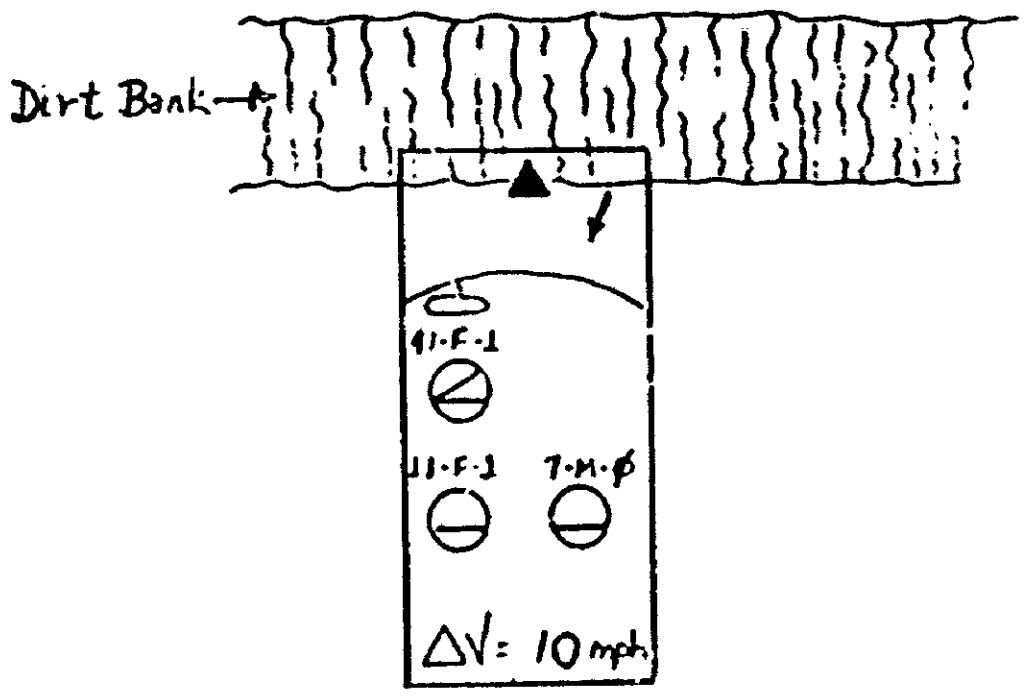
This child was reportedly restrained in a Bobby Mac Champion child seat which was secured with the lap belt at the right rear seating position. No information was available concerning the safety seat installation and use.

Injuries	AIS	Probable Source
Chest contusion	1	Child seat harness
Contusion, left shoulder	1	Child seat structure
Contusion, left elbow	1	Child seat structure

This child was treated at a local hospital and released. There was no compartment deformation forward of this seating position. The child restraint protected the infant from all but minor injureies.

CASE 164 - (ATL 84-H-OR28)

Case Vehicle: 1980 Ford Fairmont station wagon
Case Vehicle Weight: 3,338 pounds
Case Vehicle Delta V: 10 mph



Circumstances

A 1980 Ford Fairmont station wagon struck a dirt embankment sustaining substantial damage on the front and front undercarriage of the vehicle.

The lap/shoulder belted driver sustained minor injuries. The left rear occupant, wearing a lap belt, sustained minor injuries. The left rear passenger, also wearing a lap belt, was uninjured.

Restraint and Injury

Seating Location: Driver
Sex: F
Age: 41
Height: 5 feet 4 inches
Weight: 125 pounds
Restraint used: Lap/shoulder belt (ELR)

The driver was restrained by a continuous loop, lap/shoulder belt with an emergency locking device sensitive to vehicle motion, a cinching latchplate, a windowshade tension-relief device, and a stalk-mounted buckle assembly. The driver described the lap portion of the belt adjustment as low on her hips and "snug," with the shoulder portion across the midchest. The driver also described the shoulder portion as "snug."

Injuries	AIS	Probable Source
Small laceration, right forehead	1	Rear view mirror
Abrasion, right forehead	1	Rear view mirror
Contusion, mid-sternum	1	Steering wheel rim
Contusion, lower right leg	1	Lower instrument panel

The driver was transported to a local hospital, treated, and released. The injury patterns and lack of component loading evidence indicate that either she was wearing her restraint with excessive slack in the system, possibly due to improper windowshade adjustment, or that the retractor did not lock. Considering the impact angle of this 10 mph Delta V collision, It would be unlikely that a "snugged up" shoulder strap would allow her to strike the rear view mirror."

Seating Location: Left rear
Sex: F
Age: 22 years
Height: 4 feet 8 inches
Weight: 85 pounds
Restraint used: Lap belt (ALR)

This child was restrained by a lap belt with an automatic locking retractor, a latchplate sewn into the 33-inch-long retractable webbing, and a push-button release type buckle mounted to a short length of webbing. Both the latchplate and buckle webbing entered the seating area from between the junction of the upper and lower seat cushions. There was no interior compartment deformation at this seating position. The child's mother described system adjustment as proper.

Injuries	AIS	Probable Source
Contusion, center forehead	1	Lower extremity
Contusion, lower right thigh	1	Right elbow

This child was treated and released at a local hospital. Her mother said that no school time was lost as a result of the accident.

(See discussion at end of this case summary.)

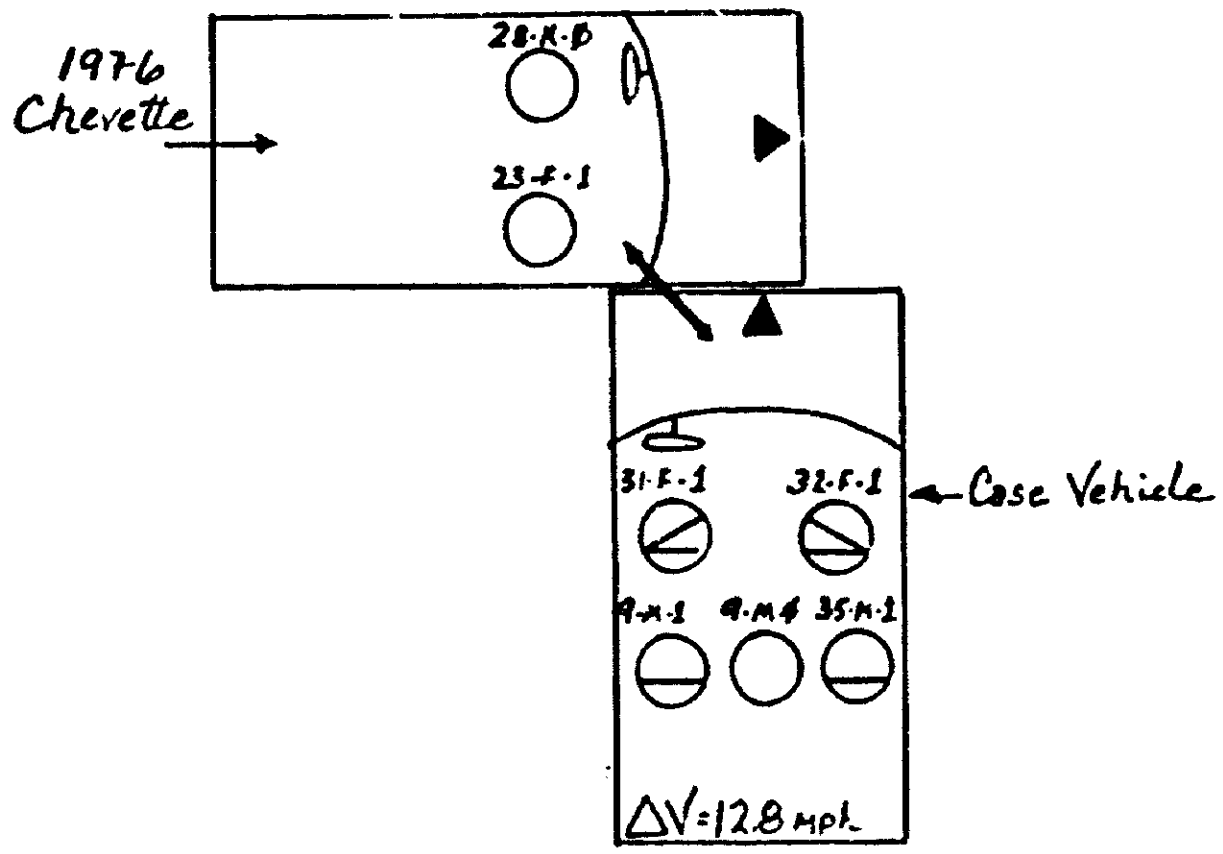
Seating Location: Right rear
Sex: M
Age: 7 years
Height: 3 feet 4 inches
Weight: 40 pounds
Restraint used: Lap belt (ALR)

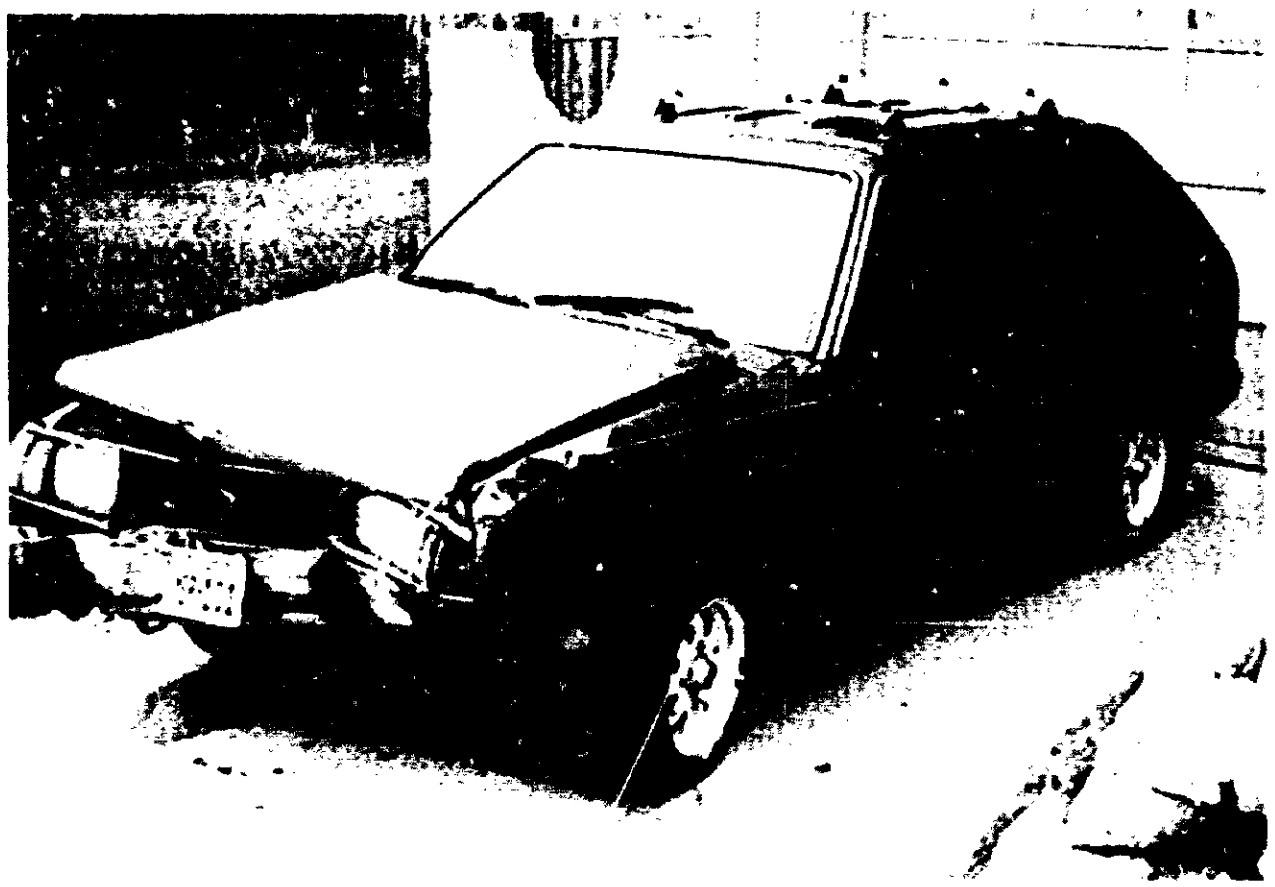
This child was wearing a lap belt identical to his sister's. The child's mother described the position of the lap belt as low and the adjustment as snug. There was no compartment deformation at this seating position. He was checked at a local hospital and released with no reported injuries.

Considering the relatively low Delta V of only 10 mph, the use of the lap belts by these children probably had little effect on injury. Had the children not been restrained, they would have been decelerated by the rear surface of the front bench seatbacks, a "containment" surface found to be an "occupant friendly" contact point in several cases with similar and higher crash forces.

CASE 165 - (MKC 85-H-OR26)

Case Vehicle: 1980 Subaru GL station wagon
Case Vehicle Weight: 3,111 pounds
Case Vehicle Delta V: 12.8 mph





CIRCUMSTANCES

A 1980 Subaru station wagon struck a 1976 Chevrolet in the right front side. Both vehicles sustained moderate damage, with rearward deformation of up to 13 inches at the front of the Subaru.

The Subaru driver, restrained by a lap/shoulder belt, sustained minor injuries. The right front passenger, also lap/shoulder restrained, sustained minor injuries. The left and right rear lap belted passengers sustained minor injuries, while the unbelted center rear passenger was uninjured. The unrestrained driver of the Chevrolet received minor injuries while the right front passenger, also unrestrained, was not injured.

Restraint and Injury

Seating Location: Driver
Sex: F
Age: 31
Height: 5 feet 7 inches
Weight: 130 pounds
Restraint used: Lap/shoulder belt (ELR)

This driver was restrained by a 3-point, continuous loop, lap/shoulder belt with an ELR sensitive to webbing acceleration, a free-sliding latchplate, and a pushbutton release type of buckle mounted to a flexible stalk. A "comfort clip" was attached to the webbing as a tension relief device. Her statement of system adjustment indicated that the restraint was used properly. There was no indication of force loading scars on the belt webbing.

Injuries	AIS	Probable Source
Small laceration, right hand	1	Broken sideglass from vehicle 2
Contusion, inside left knee	1	Steering column

This woman reportedly refused medical treatment for the minor injuries sustained in the collision. The restraint system apparently worked well in this 12.8 mph Delta V collision.

Seating Location: Right front
Sex: F
Age: 32
Height: 5 feet 6 inches
Weight: 200
Restraint used: Lap/shoulder belt (ELR)

This woman was restrained by a lap/shoulder belt identical to the driver's. She described the adjustment of the lap belt portion as snug, positioned low on the hips, but could not recall the adjustment of the shoulder strap. The self-tensioning retractor should not have allowed slack. There was no evidence of force loading.

Injuries	AIS	Probable Source
Contusion, right hip	1	Lap belt

This woman reportedly refused medical treatment of her minor injury. It is apparent that the lap/shoulder belt performed well in preventing contact with the forward interior.

Seating Location: Left rear
Sex: M
Age: 9
Height: 4 feet 6 inches
Weight: 73 pounds
Restraint used: Lap belt (ELR)

This boy was restrained by a lap belt with an ELR sensitive to webbing acceleration a latchplate sewn in to the retractor webbing, and a pushbutton release type of buckle attached to a short length of webbing. There was no evidence of force loading. There was no evidence of misuse found.

Injuries	AIS	Probable Source
Small laceration, right rear of head	1	Wrist watch worn by right rear passenger

This boy reported refused medical treatment.

Seating Location: Center rear
Sex: M
Age: 9
Height: 4 feet 7 inches
Weight: 68 pounds
Restraint used: None

This boy was riding unrestrained at center rear. The owner and driver of the Subaru was reportedly unaware that a static lap belt was installed at the position but tucked under the lower seat cushion.

There were no injuries reported by this occupant.

Seating Location: Right rear
Sex: M
Age: 35
Height: 5 feet 6 inches
Weight: 185 pounds
Restraint used: Lap belt (ELR)

This man was wearing a lap belt identical to the one on the left. There was no evidence of mis-use found. There was no evidence of force loading marks on the system webbing. This occupant was reportedly riding with his left arm extended and lying on the uppermost surface of the rear seatback. The wristwatch worn on his left arm was the source of the minor laceration to the left rear passenger's head.

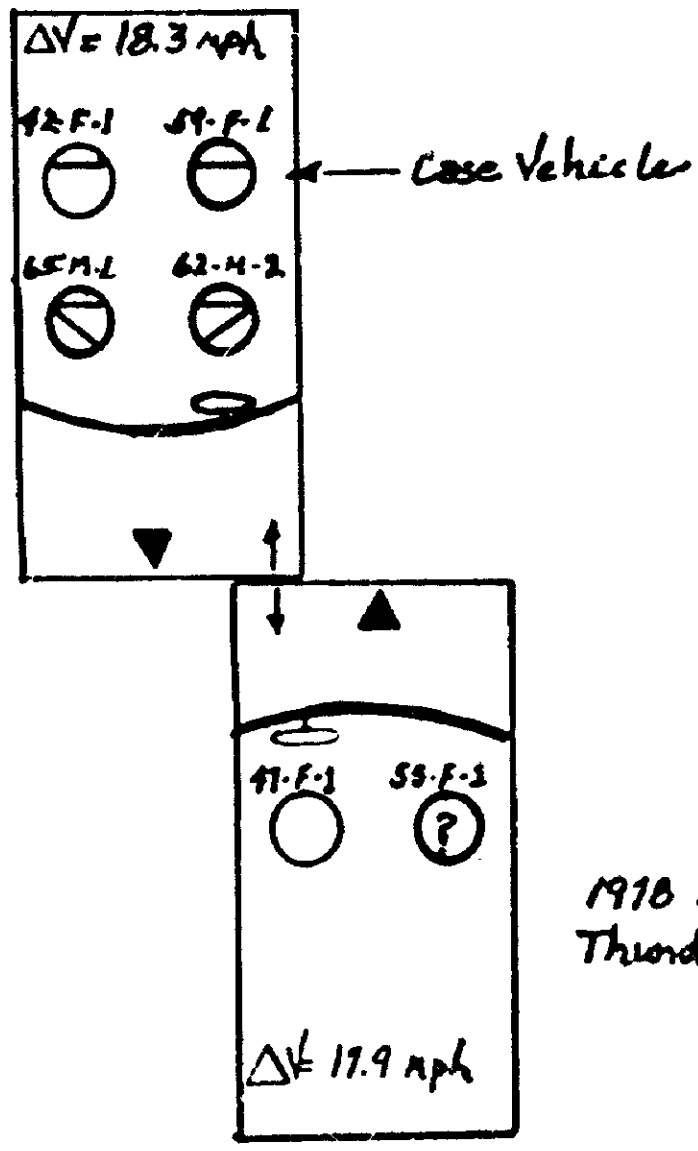
Injuries	AIS	Probable Source
Sprained left thumb	1	Rear of front seat

This man reportedly refused treatment for his minor injury.

The use or non-use of restraints by the rear seated occupants of this vehicle probably was not a major influence on injury outcome for them. The rear seat offers a much friendlier environment than does the front seating area. In a 12.8 mph Delta V frontal collision such as this, the rear occupants could be expected to decelerate into the rear of the front seatbacks without high injury levels.

CASE 171 - (SEA 85-H-OR26)

Case Vehicle: 1983 Chevrolet Malibu station wagon
Case Vehicle Weight: 4,258 pounds
Case Vehicle Delta V: 18.3 mph



Circumstances

A 1983 Chevrolet Malibu station wagon was impacted head on, left front to left front, by a 1978 Ford Thunderbird. The Chevrolet Malibu sustained substantial damage at the left front with a maximum rearward deformation of 26 inches. The Ford's front structure was deformed rearward approximately 32 inches.

The case vehicle driver, restrained by a lap/shoulder belt, sustained moderate injuries. The lap/shoulder belt-restrained right front passenger also sustained minor injuries. The lap belt-restrained left and rear occupants received minor injuries.

Restraint and Injury

Seating Location: Driver
Sex: M
Age: 62 years
Height: 5 feet 7 inches
Weight: 160 pounds
Restraint used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop, lap/shoulder belt with emergency locking retractor, a windowshade tension-relief feature, a cinching type of latchplate, and a stalk-mounted buckle assembly. The occupant described the precrash adjustment of the lap portion as snug and positioned low on his hips, but he was unable to relate the shoulder portion adjustment. There were force loading marks on the system webbing, attributed to webbing load at the D-ring.

Injuries	AIS	Probable Source
Abrasion, left forehead	1	Steering wheel rim
Sprain, right shoulder	1	Impact forces
Contusion, left elbow	1	Interior sidewall
Major contusion, right thigh	2	Steering wheel rim
Abrasion, left forearm	1	Interior sidewall
Small laceration, left hand	1	Broken glass

This man was treated and released at a local hospital. Considering the Delta V of 18.3 mph in this collision and the intrusion at the left side door area, it appears that the restraint system probably reduced the overall severity of his injuries. He might have sustained more serious injuries if he had been unrestrained, making violent contact with the steering assembly, A-pillar, and lower instrument panel.

Seating Location: Right front
Sex: M
Age: 65 years
Height: 5 feet 11 inches
Weight: 195 pounds
Restraint used: Lap/shoulder belt (ELR)

This passenger was wearing a lap/shoulder belt identical to the driver's. No information concerning precrash system adjustment was furnished by this occupant. There was a force loading scar attributed to the D-ring on the system webbing.

Injuries	AIS	Probable Source
Transverse fracture, 10th and 11th left ribs	1	Shoulder strap
Abrasion, left elbow	1	Right side steering wheel rim
Abrasion, left forearm	1	Right side steering wheel rim
Contusion, diagonally across chest	1	Shoulder strap
Abrasion, diagonally across chest	1	Shoulder strap
Contusion, over left iliac crest	1	Lap belt
Small laceration, lower right leg	1	Lower instrument panel

This man was treated and released at an area hospital.

The restraint system probably reduced the severity level of some of this passenger's injuries. Given this man's height, he probably would have received some level of facial injuries (from contacting the windshield), along with a higher level of injuries to his lower extremities, due to contacts with the lower instrument panel and below, if he had been unrestrained.

Seating Location: Left rear
Sex: F
Age: 59 years
Height: 5 feet 6 inches
Weight: 155 pounds
Restraint used: Lap belt (ALR)

This passenger was wearing a lap belt with an automatic locking retractor, a sewn-in latchplate attached to the retractable webbing, and a push-button release type buckle. The buckle was attached to an 11-inch portion of webbing which entered the seating area at the junction of the upper and lower seat cushions. This woman said that the precrash lap belt adjustment was "snug," with the webbing positioned low on her hips. There was no compartment deformation at this seating position.

Injuries	AIS	Probable Source
Laceration (1 cm), over left eye	1	Eyeglasses
Abrasion, lower abdomen	1	Lap belt
Contusion, lower abdomen	1	Lap belt
Contusion, around left eye	1	Front seatback

This passenger was treated and released at an area hospital. A Safety Board-followup interview revealed that she was still experiencing abdominal tenderness 1 month after the accident.

It is highly probable that this woman's principal deceleration in this moderate (18 mph Delta V) crash took place into the rear surface of the front seat. Given the rear compartment dimensions, she moved forward into the lap belt only a small amount before contacting the seat back. Thus, the penetration of the lap belt into her abdominal area was not forceful enough to cause serious internal injury.

Seating Location:	Right rear
Sex:	F
Age:	42 years
Height:	5 feet 2 inches
Weight:	170 pounds
Restraint used:	Lap belt (ALR)

This passenger was wearing a lap belt identical to her seatmate's. The precrash adjustment of this woman's lap belt was described as "snug," but with the webbing positioned above the navel. Despite the incorrect placement of this lap belt, and the overweight condition of the passenger, the Delta V was sufficiently low in this case (combined with her principal deceleration into the right front seatback) to prevent serious internal injury.

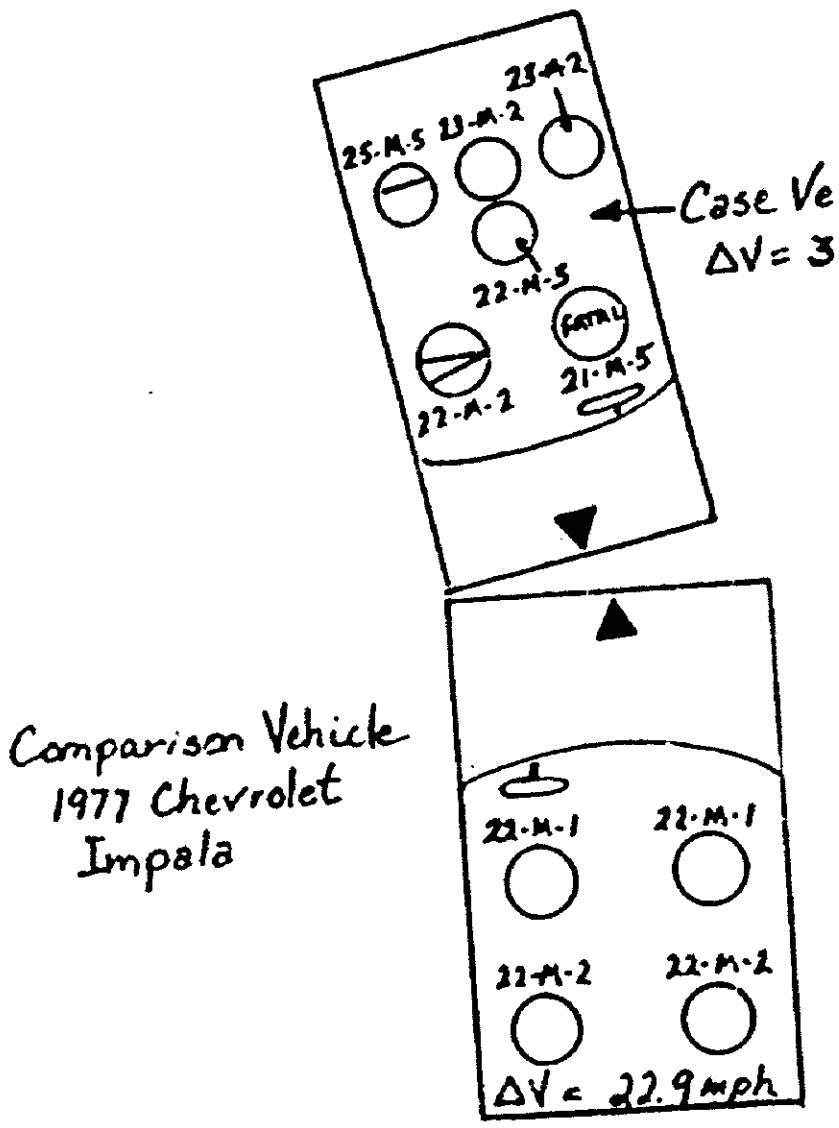
Injuries	AIS	Probable Source
Abrasion, left forehead	1	Rear surface of front seat
Contusion, mid-abdominal area	1	Lap belt
Contusion, left knee	1	Rear surface of front seat
Contusion, right knee	1	Rear surface of front seat

This passenger was treated and released at an area hospital. A Safety Board-followup interview one month after the accident revealed that she was experiencing abdominal soreness and bruising was still evident.

The most serious injury sustained in this crash was the contused thigh of the Malibu driver. All other occupants, restrained and unrestrained, suffered only minor injuries. If the rear seat passengers had been wearing lap/shoulder belts, they probably would not have sustained minor facial injuries.

CASE 175 - (ATL 85-H-OR21)

Case Vehicle: 1979 Volkswagen Rabbit, 4-door
Case Vehicle Weight: 2,900 pounds
Case Vehicle Delta V: 35.5 mph



Circumstances

A 1979 VW Rabbit collided head-on with a 1977 Chevrolet Impala. Both vehicles were substantially damaged with rearward structural deformation reaching depths of up to 26 inches on the VW and 34 inches on the Chevrolet.

The unrestrained driver of the VW, the lighter of the two vehicles involved in the crash, sustained injuries which proved fatal. The lap/shoulder belted right front passenger of the VW received a moderate injury. Four occupants were in the rear seat of the vehicle; the center rear position was occupied by two unrestrained adults, one seated on the other's lap. The left rear passenger was unrestrained and the right rear passenger was lap belted. Two of the unrestrained rear seat occupants sustained moderate injuries. The unrestrained occupant seated on the rear center passenger's lap received a serious injury. The lap belted rear seat passenger was critically injured.

The unrestrained driver and right front seat passenger of the Chevrolet received minor injuries. Both unrestrained rear seat occupants of the Chevrolet received moderate injuries.

Restraint and Injury

Seating Location: Driver - VW
Sex: M
Age: 21 years
Height: 5 feet 10 inches
Weight: 170 pounds
Restraint used: None

This driver was not wearing the available lap/shoulder belt. There was substantially rearward deformation of the instrument panel and steering assembly forward of the driver's seat. While the entire frontal area was compressed rearward, the steering wheel and column were pushed upward, with the lower rim circumference displaced forward by several inches. The driver's seatback showed massive structural distortion, primarily confined to the left side of the framework.

Injuries	AIS	Probable Source
Multiple head injury	5	Head liner above windshield
Open fracture, right femur	3	Compressed frontal interior
Fractured pelvis	2	Compressed frontal interior
Cervical injury (unspecified)	7	Force through head impact
Chest injury (unspecified)	7	Steering assembly

This driver was found without vital signs at the accident scene. He might have survived the 35.5 mph Delta V collision if he had been properly restrained by the available lap/shoulder belt. There was sufficient survivable space at his position to make this possible. Although some level of moderate to serious injuries would have been expected, partially due to seatback loading, they probably would have been similar to those of his lap/shoulder belted right front passenger.

Seating Location:	Right front - VW
Sex:	M
Age:	22 years
Height:	5 feet 7 inches
Weight:	160 pounds
Restraint used:	Lap/shoulder belt (ELR)

This occupant was wearing a continuous loop, lap/shoulder belt with an emergency locking retractor sensitive to webbing motion, a free-sliding latchplate, and a push-to-release type buckle mounted on a rigid stalk. There was no evidence of system misuse found. There was extensive rearward displacement of the frontal interior at this seat position. The extreme right side instrument panel, along with the right side A-pillar, was compressed rearward several inches due to the impact force. There was also substantial distortion of this seat's lower and back framework, with forward displacement of the upper left side of the back cushion, due to loading by the rear seat passengers.

Injuries	AIS	Probable Source
Abrasion/contusion, extending from right neck to left chest	2(size)	Shoulder belt
Laceration, left elbow	1	Instrument panel
Laceration, left wrist	1	Instrument panel
Laceration, left hand	1	Instrument panel
Contusion, abdominal area	1	Lap belt
Contusion, right knee	1	Lower instrument panel
Contusion, left knee	1	Lower instrument panel
Sprain, right foot	1	Below instrument panel

This passenger rode down the impact forces (35.5 mph Delta V) with a much lower level of injuries than might be expected in a collision of this severity. His major injury was a contusion, which resulted from the shoulder portion of the belt. Had he been unrestrained, the expected injury from violent impacts with the A-pillar and other frontal interior components could have been fatal. The restraint system's performance at the right front position was excellent.

Seating Location: Left rear - VW
Sex: M
Age: 23 years
Height: 6 feet
Weight: 175 pounds
Restraint used: None

This man was not wearing the available lap belt. There was extensive compartmental distortion which included several inches of forward displacement of the driver's seat framework. Both the upper and lower bench cushions of the rear seat were substantially deformed, at least partially due to impact from cargo stored behind the rear seat.

Injuries	AIS	Probable Source
Fractured right foot	2	Driver's seat framework
Laceration (3 inch), right knee	1	Driver's seat framework
Laceration, right foot	1	Driver's seat framework
Contusion, right foot	1	Driver's seat framework
Multiple unspecified abrasions	1	Driver's seat framework
Contusion, lip	1	Driver's seat framework
Contusion, left foot	1	Driver's seat framework

This passenger was treated and released at a local hospital emergency room. His forward travel was contained by the rear surface of the driver's bucket seat. While it cannot be determined how much this contact contributed to the driver's injuries, it can be stated that it prevented serious injury to the passenger.

Seating Location: Center rear, on lap - VW
Sex: M
Age: 22 years
Height: 5 feet 8 inches
Weight: 160 pounds
Restraint used: None

This man was seated on the lap of another man at the center rear and, corsequently, had no restraint available. Inspection of this compartment area revealed extensive distortion to both the rear seat cushions and the framework of the front seats. The back cushion of the rear seat was deformed forward several inches, due to displaced cargo positioned behind it before the crash, and the inboard side of the left front seatback was pushed forward.

Injuries	AIS	Probable Source
Abrasion, forehead	1	Left front seat framework
Closed head injury with defect	3	Left front seat framework
Laceration, right hand	1	Left front seat framework
Unspecified intra-abdominal injury	7	Left front seat framework

This man required more that 2 weeks of hospitalization and lost more than 5 weeks of work. His injuries were undoubtedly made worse by loading from the man whose lap he was sitting on. Furthermore, his forward travel could be only partially contained by the front bucket seats, due to the open space between the seatbacks. Consequently, his head was free to move between the seatbacks to a point of violent deceleration.

Seating Location: Center rear - VW
Sex: M
Age: 23 years
Height: 5 feet 10 inches
Weight: 175 pounds
Restraint used: None

This passenger was riding unrestrained with an adult male sitting on his lap. Substantial compartment distortion was noted at this seat position, with both the back cushion of the rear seat and back framework at the front seats deformed forward several inches.

Injuries	AIS	Probable Source
Displaced fracture, left mandible	2	Front seat framework or man on lap
Large contusion, left face	2	Front seat framework or man on lap
Contusion, left forehead	1	Front seat framework or man on lap
Abrasion, left cheek	1	Front seat framework or man on lap
Contusion, nose	1	Front seat framework or man on lap
Contusion, left ribs	1	Front seat framework or man on lap
Contusion, left knee	1	Front seat framework or man on lap
Contusion, right knee	1	Front seat framework or man on lap

This man spent an unspecified period in the hospital. He lost approximately 30 days work. His forward travel was contained and cushioned by the occupant seated on his lap; therefore, use of the available static lap belt would probably not have increased nor reduced his minor to moderate injuries.

Seating Location:	Right rear - VW
Sex:	M
Age:	25 years
Height:	5 feet 8 inches
Weight:	185 pounds
Restraint used:	Lap belt (ALR)

This man was restrained by a lap belt that incorporated an automatic locking retractor, a sewn-in latchplate attached to the retractable webbing, and a push-button release type buckle. The buckle webbing entered the seating area by passing between the junction of the upper and lower seat cushions, at a point 17 inches inboard from the right interior sidewall, while the latchplate webbing entered from between the right interior sidewall and the lower bench. The buckle webbing was 13 inches long. There was extensive deformation of the bench seat framework at this position. The rear-most framework of the lower cushion was distorted forward and up, resulting in the seat cushion angling downward at the front edge. The framework of the right front bucket seat was also extensively deformed directly forward of this seating area. Lower framework components of that seat were displaced forward and up, while the back cushion was pushed forward several inches.

Injuries	AIS	Probable Source
Small contusion, left side of head	1	Right front seatback
Ruptured aorta (common iliac, 3-inch graft required)	5	Lap belt
Ruptured colon (18 inches removed)	5	Lap belt
Fracture, 3rd lumbar vertebra	3	Lap belt
Laceration, from behind left kidney around to left side of abdomen	2	Lap belt
Contusion across abdomen	2	Lap belt
Head injury, with amnesia, 6-7 days unconscious	5	Impact force

This passenger spent an extended period in area hospitals; as of 5 1/2 months after the crash, he had not returned to service with the Armed Forces.

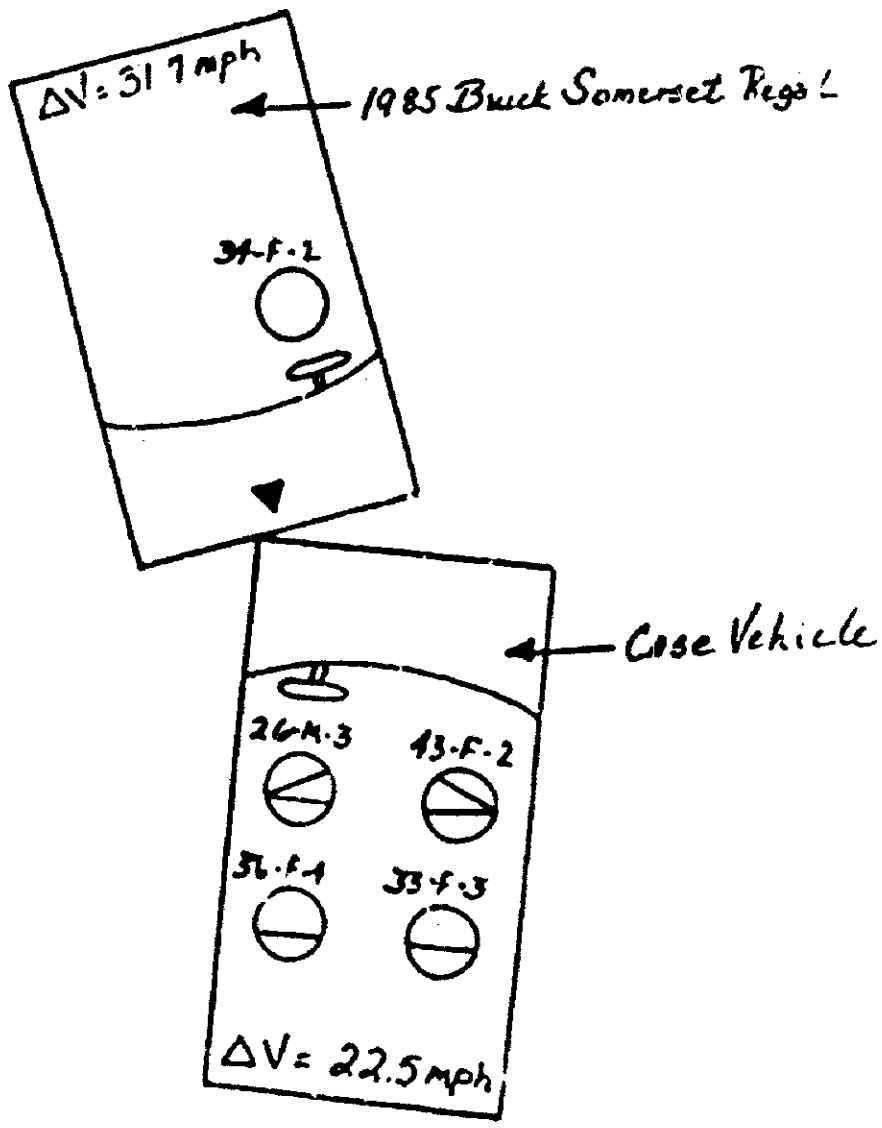
His critical internal injuries can be attributed directly to the lap belt. While medical records were not obtained for detailed injury location description, the verbal descriptions given by the victim and family members seem to indicate that the lap belt penetrated his abdominal cavity above that area which is generally considered as proper lap belt placement. This location of penetration does not necessarily mean that the lap belt's pre-impact placement was improper. His lower pelvic area was forced forward, due to rear compartment cargo deforming the bench seat lower framework at the cushion junction. The forward edge of the lower cushion was also deformed downward. The combined effects of the seat framework distortion would contribute to some degree of submarining by the occupant. This analysis is reinforced by consideration of his injuries, which appear to start low at the frontal abdominal area and rise to the level of the 3rd lumbar vertebra at the rear.

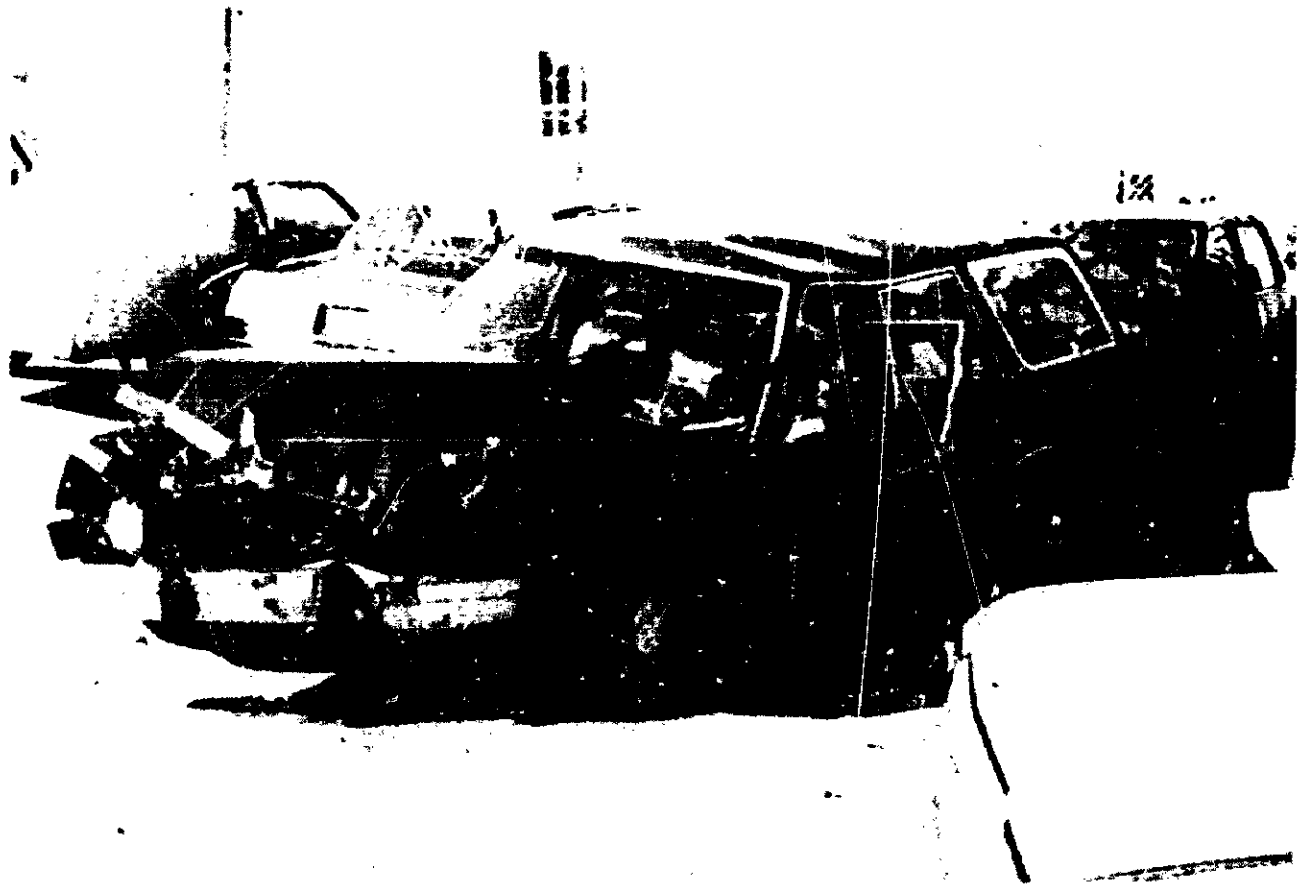
It is not known whether his loss of consciousness was due to a forceful head impact or was the result of hypoxia.

Had this passenger not been restrained by the lap belt, but by a properly fitted lap/shoulder belt, the life-threatening internal injuries would not have occurred.

CASE 176 - (MKC 86-H-0R01)

Case Vehicle: 1981 Ford Fairmont station wagon
Case Vehicle Weight: 3,583 pounds
Case Vehicle Delta V: 22.5 mph





Circumstances

A 1985 Buick Somerset Regal collided front first into the left front corner of a 1981 Ford Fairmont station wagon. The collision resulted in substantial front structural damage to both vehicles with rearward deformation of over 30 inches at the Ford's left front and over 23 inches at the left front side of the Buick.

The lap/shoulder belt-restrained Ford driver received serious injuries, and the lap/shoulder belt-restrained right front seat passenger received moderate injuries. The lap belt-restrained left rear occupant received severe injuries, and the right rear lap belt-restrained passenger received serious injuries. The unrestrained Buick driver received moderate injuries.

Restraint and Injury

Seating Location: Driver
Sex: M
Age: 26 years
Height: 5 feet 10 inch
Weight: 2[illegible] pounds
Restraint used: Lap/shoulder belt (ELR)

This man was wearing the continuous loop, lap/shoulder belt with an emergency locking retractor, a free-sliding latchplate, and a push-button release type of buckle attached to a flexible stalk. The emergency locking retractor was sensitive to vehicle motion and did not have a tension-relief mechanism. He described the placement of the lap belt portion as being across his abdomen with a snug tension. The shoulder strap was reported as snug, positioned across the mid-chest area. The steering assembly was deformed outboard due to front structural collapse, and the lower instrument panel was distorted forward of her seating position.

Injuries	AIS	Probable Source
Laceration (4 cm), right knee	1	Lower instrument panel
Fracture, right tibial plateau	2	Lower instrument panel
Comminuted fracture, right radius	3	Steering assembly
Contusion, central chest area	1	Shoulder strap
Contusion, lower left leg	1	Lower instrument panel

This man spent 3 1/2 days in an area hospital and lost 6 1/2 days of work.

(See comments at the end of this case summary.)

Seating Location: Right front
Sex: F
Age: 40 years
Height: 5 feet 6 inch
Weight: 170 pounds
Restraint used: Lap/shoulder belt (ELR)

This woman was wearing a lap/shoulder belt identical to the driver's. The lower instrument panel was distorted forward of her seat position. No evidence of system misuse or failure was found.

Injuries	AIS	Probable Source
Contusion, left lower chest	1	Shoulder portion of belt
Contusion, across entire abdomen	2	Lap portion of belt
Abrasion, left flank	1	Lap portion of belt buckle
Contusion, left mid forearm	1	Steering wheel
Contusions and abrasions, right knee	1	Lower instrument panel
Contusions and abrasions, left knee	1	Lower instrument panel
Contusion, right side neck	1	Shoulder portion of belt

This woman was treated at the emergency room of a local hospital for several hours before being released. She was unable to work for 9 days.

Seating Location: Left rear
Sex: F
Age: 36 years
Height: 5 feet
Weight: 205 pounds
Restraint used: Lap belt (ALR)

This woman was wearing a lap belt with an automatic locking retractor, a sewn-in latchplate attached to a 35-inch length of retractable webbing, and a push-button release type of buckle attached to a length of webbing extending 8 inches through the junction of the bench seat cushions. There was no deformation of the passenger compartment at this position. The plastic covering of the lap belt retractor was broken due to force loading. This woman said her belt was about her abdomen with a "snug" tension.

Injuries	AIS	Probable Source
Contusion, left triceps	1	Left sidewall
Abrasion, distal right tibia	1	Rear surface driver's seat
Abrasion/contusion, lower abdomen	2	Lap belt
Avulsion injury, abdominal wall	2	Lap belt
Avulsion injury, abdominal fascia	2	Lap belt
Avulsion injury, small bowel mesentery	4	Lap belt
Abrasion, left iliac crest	1	Lap belt
Abrasion, right iliac crest	1	Lap belt
Large bruise, lower right leg	2	Driver's seat lower frame
Laceration, lower right leg	1	Driver's seat lower frame
Contusion, posterior right thigh	1	Rear seat frame
Contusion, posterior left thigh	1	Rear seat frame

This woman spent 11 days in an area hospital and lost an unspecified number of days' work.

(See discussion at the end of this case summary.)

Seating Location: Right rear
Sex: f
Age: 33 years
Height: 5 feet 4 inch
Weight: 118 pounds
Restraint used: Lap belt (ALR)

This woman was wearing a lap belt identical in design to the left rear passenger's. There was no permanent compartment deformation at this seat position. Again, the plastic retractor covering was broken, due to force loading. This woman said she had her lap belt low across her hips and "snug."

Injuries	AIS	Probable Source
Fracture, second and third lumbar vertebrae	3	Force through lap belt
Contusion, lower abdomen	1	Lap belt
Contusion, upper left arm	1	Contact w/lower extremities
Contusion, lower right leg	1	Rear of front seatback
Contusion, lower back	1	Impact forces

This woman spent 10 days in a hospital before release in a body cast. At the time of the Safety Board investigation (late 1985), she expected the body cast to be necessary for 2 to 6 months.

This crash cannot be considered a severe collision for the Ford occupants. A much higher level of injuries was sustained by each of them than would be expected with a Delta V of approximately 22.5 mph.

There were no indications of improper belt use. The nature of the Ford's belt systems, both front and rear, should provide a snug tension, with automatic tensioning of the front belts and ALRs on the rear lap belts. The most seriously injured of the Ford's occupants, the woman wearing a lap belt in the left rear, had abrasions on both the right and left iliac crests, indicating a lap belt positioning in the area generally considered to be proper. Yet she sustained an intra-abdominal injury severe enough to require removal of more than 30 inches of small intestine. In addition, a large area of her abdominal subcutaneous tissue was avulsed by the lap belt's penetration.

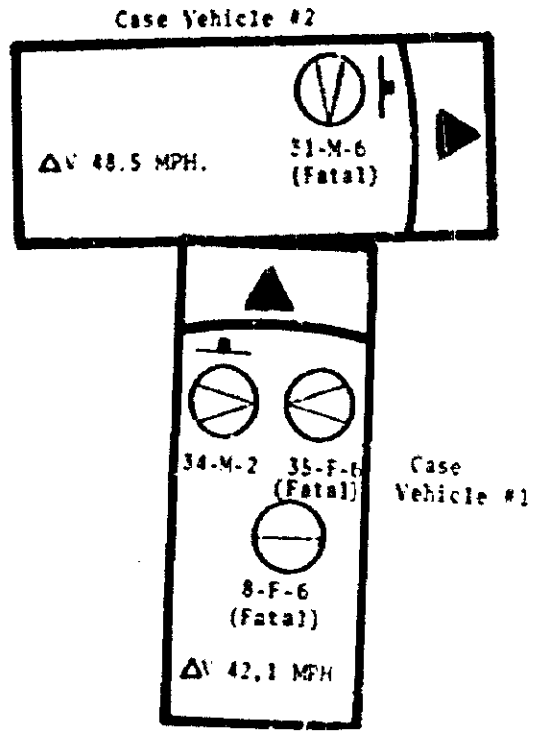
The other lap belted woman in the rear said she had the belt positioned low and snug. Medical record description of her abdominal contusions and abrasions were not sufficient to make an independent evaluation of proper or improper fit. She received multiple fractures of the mid-lumbar vertebrae, necessitating 10 days hospitalization and the fitting of a body cast for an extended period.

All the documented serious injuries sustained by the rear seated Ford passengers can be attributed directly to the lap belts in use. All but one of the documented injuries not attributed to the lap belts were minor. The nonuse of lap belts by these two women might have resulted in a few additional contusions, as the impact forces were contained by the rear surface of the front bench seat. However, the serious internal and spinal injuries would not have occurred. Properly fitted lap/shoulder belts would also have prevented these injuries.

CASE 178 - (SEA 85-H-OR27)

Case Vehicle #1: 1985 Dodge Caravan
Case Vehicle Weight: 3,636 pounds
Case Vehicle Delta V: 42.1 mph

Case Vehicle #2: 1983 Ford Thunderbird 2-door
Case Vehicle Weight: 3,156 pounds
Case Vehicle Delta V: 48.5 mph



Circumstances

A 1983 Ford Thunderbird rounded a slight left curve, went out of control, crossed into the opposite traffic lane, struck the left side of a 1983 Chevrolet, then slid sideways and struck a 1985 Dodge Caravan directly across the front. The Thunderbird received extensive structural damage with inward collapse reaching depths of up to 29.5 inches over a 90-inch area of the right side. The Dodge Caravan received extensive structural damage with maximum inward crush of 38 inches to the front end.

The Thunderbird driver was restrained by a lap/shoulder belt but was killed due to intrusion of the passenger compartment at his seating position by the right side of the striking vehicle. The Caravan driver, also restrained by a lap/shoulder belt, sustained moderate injuries. Two passengers were in the Caravan. The right front passenger, restrained by a lap/shoulder belt, died of a severed spinal cord. The child passenger in the right rear, restrained by a lap belt only, died of a severed spinal cord.

Restraint and Injury

Case Vehicle #1 - Dodge Caravan
Seating Location: Driver
Sex: M
Age: 34 years
Height: 5 feet 10 inches
Weight: 190 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was restrained by a continuous loop restraint system which used an emergency locking retractor, a cinching latchplate, and a push-button release buckle mounted to a rigid stalk. The buckle stalk was mounted to the nonmovable seat pedestal. A windowshade tension-relief device was provided for occupant comfort. The interior sustained forward and upward displacement of the steering assembly along with distortion of the lower instrument panel surface. Force loading marks were found on the shoulder portion of the webbing and distortion was noted at the D-ring mounting area. The driver's seat was found in its rearmost adjustment position on a track of 7 inches. The uppermost inboard portion of the driver's seat back was deformed forward slightly and the seat's entire lower framework was pitched forward due to distortion of the van's lower structure.

This driver declined to give information regarding the adjustment of his lap/shoulder belt.

Injuries	AIS	Probable Source
Closed head injury	2	Steering assembly
Multiple small lacerations over right eye	1	Steering assembly
Superficial abrasion, nose	1	Steering assembly
Small laceration, lower lip	1	Steering assembly
Laceration, left frontal scalp	1	Steering assembly
Contused scrotum	1	Impact force
Abrasion, left hip	1	Lap portion of belt
Contusion, left knee	1	Instrument panel
Contusion, left hand	1	Instrument panel
Laceration, left hand	1	Instrument panel
Laceration, left elbow	1	Instrument panel
Laceration, right knee	1	Instrument panel
Abrasion, left index finger	1	Instrument panel
Contusion, left abdomen	1	Lap portion of belt
Contusion, upper left chest	1	Shoulder portion of belt

The driver was admitted to an area hospital for 5 days and reported a loss of work of over 7 weeks. His use of the available lap/shoulder belt prevented uncontrolled movement into the area of major collapse. Considering the dynamics and forces (42.1 mph Delta V) of this collision, it is very likely that the lap/shoulder belt prevented the driver from receiving additional and more serious injuries.

Case Vehicle # 1 - Dodge Caravan
Seating Location: Right Front
Sex: F
Age: 35 years
Height: 5 feet 2 inches
Weight: 130 pounds
Restraint Used: Lap/shoulder belt (ELR)

This passenger was using a lap/shoulder belt identical in design to the driver's belt. Interior damage in front of this passenger's position was noted on the lower portion of the instrument panel. There were force loading marks upon the belt webbing. No description of the restraint adjustment was available as the passenger was fatally injured.

Injuries	AIS	Probable Source
Superficial abrasions, right temple	1	Interior sidewall
Avulsion, right anterior shoulder and neck	2	Shoulder portion of belt
Major contusion, diagonal across chest	2	Shoulder portion of belt
Fractures, right side 1,2,3 ribs	2	Shoulder portion of belt
Fractures, left side ribs 3 - 10 with hemothorax	3	Shoulder portion of belt

Transverse sternum fracture	2	Shoulder portion of belt
Major contusion, lower abdomen	2	Lap portion of belt
Abrasion, over right iliac crest	1	Lap portion of belt
Avulsion, lower abdominal tissue	2	Lap portion of belt
Laceration, colon serosa muscle	5	Lap portion of belt
Contusion, right colon wall	3	Lap portion of belt
Basilar skull fracture	3	Hyperextension - force
Fracture, right posterior fossa	2	Hyperextension - force
Sub-total transection of brain stem	6	Hyperextension - force
Subarachnoid hemorrhage	3	Hyperextension - force
Atlanto-occipitol subluxation	3	Hyperextension - force
Multiple contusions/abrasion over all extremities	7	Hyperextension - force

Case Vehicle # 1 - Dodge Caravan
Seating Location: Right Rear
Sex: F
Age: 8 years
Height: 4 feet 5 inches
Weight: 81 pounds
Restraint Used: Lap belt (ALR)

This child was restrained by a lap belt which incorporated an automatic locking retractor, a sewn-in latchplate attached to the retractable webbing, and a push-button release buckle. A scuff was found upon the vinyl covering of the inboard top rear surface of the driver's seat back. There was an area of vinyl transfer, from the lower bench cushion upholstery, on the retractable webbing just above its exit point from the retractor housing. This passenger was killed during the impact from a severed spinal cord caused by hyperextension forces.

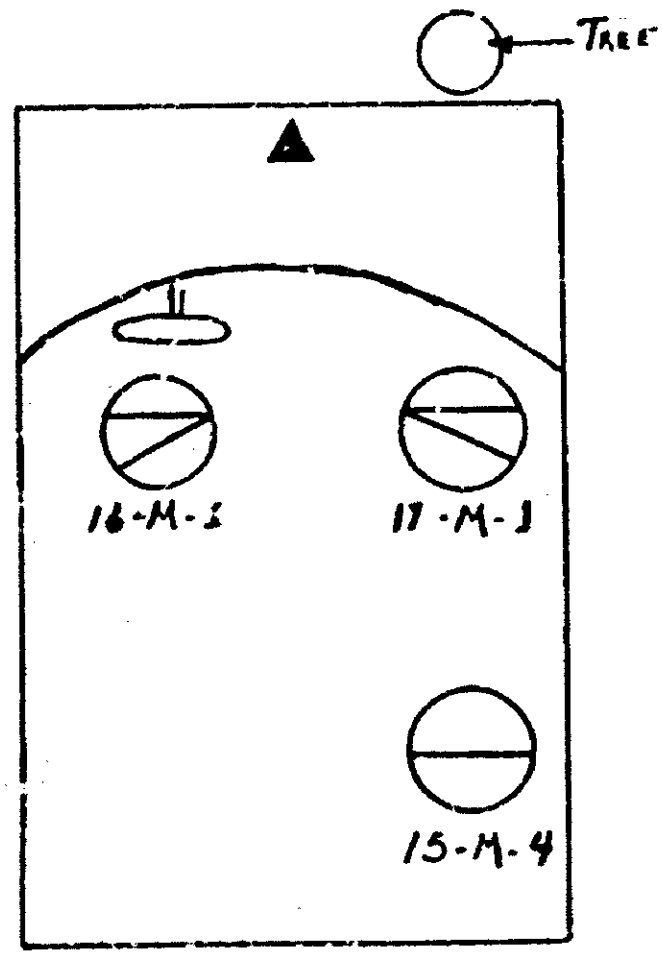
Injuries	AIS	Probable Source
Large abrasion, left forehead	2	Driver's seat frame
1 1/2 inch laceration, left forehead	2	Driver's seat frame
Abrasions, right eye area	1	Driver's inboard armrest
Abrasions, right cheek	1	Driver's inboard armrest
Abrasion/contusion, left mid cheek	1	Driver's seat frame
Contusions, lower lip	1	Driver's seat frame
Occipital dislocation	3	Hypertension, force
Diffuse subarachnoid hemorrhage	3	Hypertension, force
Brain stem laceration	6	Hypertension, force
Cerebral hemorrhage, midbrain, pons, and medulla	4	Hypertension, force
Cerebral edema	3	Hypertension, force
Diffuse hemorrhage - upper cervical spinal cord	3	Hypertension, force
Contusion, entire lower abdomen	2	Lap belt

Abrasion, left inguinal area	1	Lap belt
Abrasion, right inguinal area	1	Lap belt
Gaping laceration, right inguinal area	2	Lap belt
Avulsion, abdominal wall muscles	3	Lap belt
Non-displaced fracture, T_3	2	Hypertension, force
Multiple contusions/abrasions over body and extremities	7	Interior surfaces, impact forces, and lap belt

NOTE: The Dodge Caravan driver's survival could be termed miraculous or it could be attributed to a force dissipation which was distributed both into the lap/shoulder belt and into the frontal interior. Had the other Dodge occupants had the benefit of their deceleration being evenly distributed, survival might have been possible. Air bag equipment would have provided this type of benefit by allowing both the right front and right rear passengers to decelerate without the fatal head injuries.

CASE 179 - (SEA 85-H-OR23)

Case Vehicle: 1980 Dodge Colt, 2-door
Case Vehicle Weight: 2,311 pounds
Case Vehicle Delta V: 27.7 mph



Circumstances

A 1980 Dodge Colt collided head-on into a tree. The collision resulted in substantial damage to the front of the Dodge with deformation of up to 22 inches.

The Dodge was occupied by a lap/shoulder belted driver, a lap/shoulder belted right front seat passenger, and a lap belted passenger seated in the right rear. Both front seat occupants received minor injuries. The rear seat occupant received severe injuries.

Restraint and Injury

Seating Location: Driver
Sex: M
Age: 16 years
Height: 5 feet 7 inches
Weight: 160 pounds
Restraint used: Lap/shoulder belt (ELR)

This driver was using a lap/shoulder belt with an emergency locking retractor and free-sliding latchplate. There was no evidence of belt malfunction, improper fit, or improper use. He described the fit as "snug." Although the steering wheel was deformed about 2 1/2 inches at the 4 o'clock position, there were no driver injuries that could be related to the deformation. The driver said he had been using seat belts for about 15 months.

Injuries	AIS	Probable Source
Abrasion, left shoulder	1	Shoulder portion of belt

The restraint performed very well in this 27.7 mph Delta V collision, preventing the driver from violent, uncontrolled contact with the steering assembly, instrument panel, and windshield. Had he been unrestrained, he would undoubtably have received additional and more serious injuries.

Seating Location: Right front
Sex: M
Age: 17 years
Height: 5 feet 10 inches
Weight: 135 pounds
Restraint used: Lap/shoulder belt (ELR)

This passenger was also using the lap/shoulder with a free-sliding latchplate that was provided at his seat. There was no evidence of malfunction, improper fit, or improper use. This boy said that he never wears a seat belt, but that he was "talked into" it on this trip by the rear seat passenger. He was not admitted to a hospital.

Injuries	AIS	Probable Source
Bruise, forehead	1	Instrument panel or A-pillar
Strained ankle	1	Floor
Bruise, right shoulder	1	Shoulder portion of belt
Bruise, chest	1	Shoulder portion of belt
Bruise, abdomen (below umbilicus)	1	Lap portion of belt

Seating Location: Right rear
Sex: M
Age: 15 years
Height: 5 feet 8 inches
Weight: 135 pounds
Restraint used: Lap belt (locking latchplate, webbing retractor one unit)

This boy was using a lap belt that incorported a locking latchplate combined with a webbing retractor in one unit. (The retractor automatically takes up webbing slack and the latchplate locks the webbing in place when buckled.) There were no defects found in the system. The boy said he was wearing the belt "snug" and that it was routed "across the waist but below the navel." He said he had been using seat belts for 12 months before this crash.

Injuries	AIS	Probable Source
Fractured vertebrae (L2, L3)	3	Flexion over lap belt
Perforations (two), small bowel	4	Lap belt and/or retractor
Ruptured spleen	4	Lap belt retractor
Bruise, left hip	1	Lap belt
Bruise, right hip	1	Lap belt
Abrasion, about 1 inch below umbilicus	1	Lap belt

The performance of the front seat lap/shoulder belts was exceptionally good in this Delta V 27.7 mph crash, especially when compared to the rear seat lap belt. Forces acting at the right front were very similar to those acting at the right rear, allowing a direct comparison of lap/shoulder belt performance to lap-only belt performance. The crash resulted in AIS level 1 injuries at the right front, which required only 1 hours 15 minutes of observation and treatment before the occupant was released from medical care. In comparison, the crash induced injuries sustained by the lap-belted boy in the right rear position were at an AIS 4 level and required two operations during the course of more than 1 month's hospitalization.

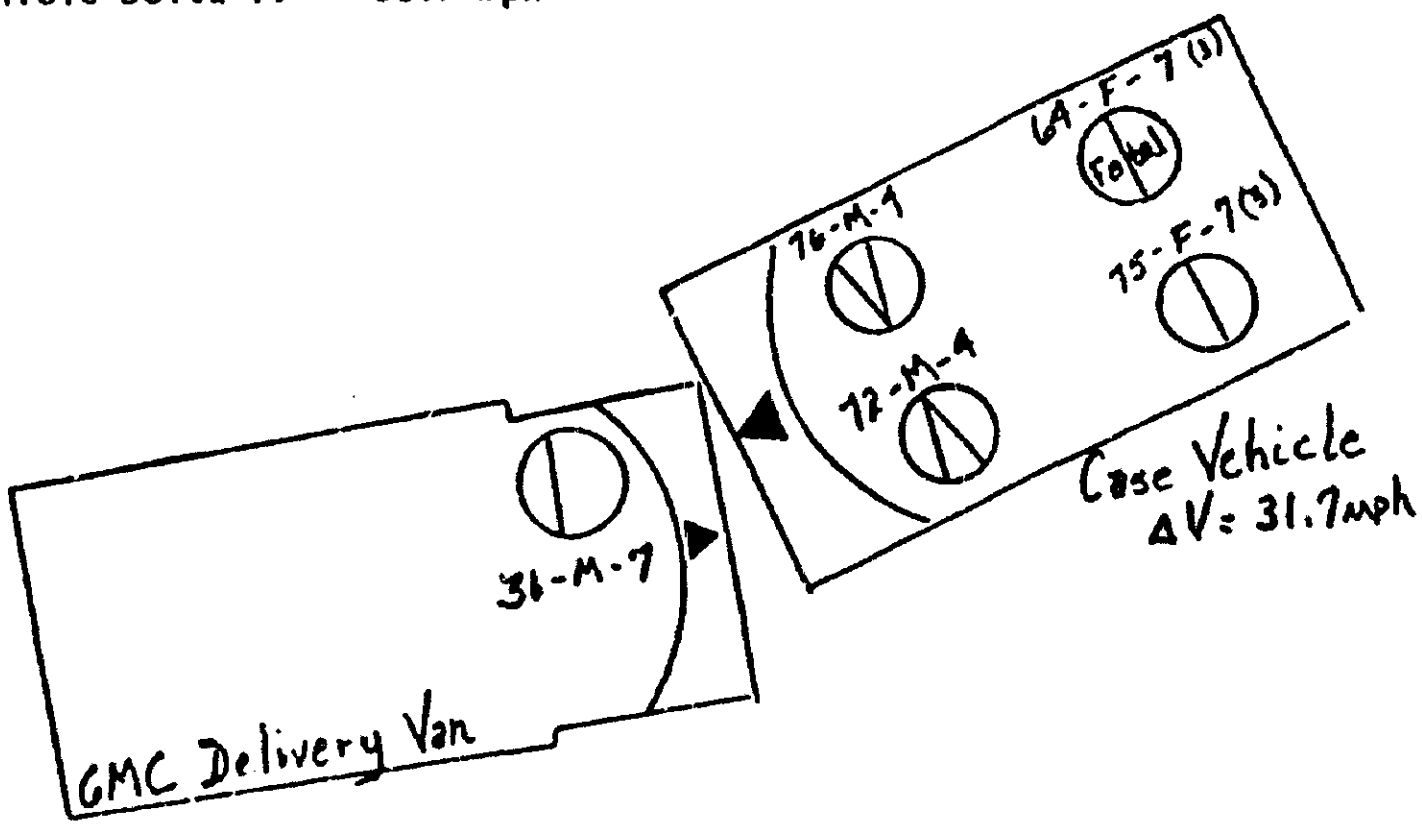
Prompt initial diagnosis and treatment might have reduced the period of hospitalization required for the lap-belted occupant. It appears that, at initial injury evaluation, the attending physician "ruled out" all of the serious injuries that were, in fact, present. As a result, the fractures of two lumbar vertebrae

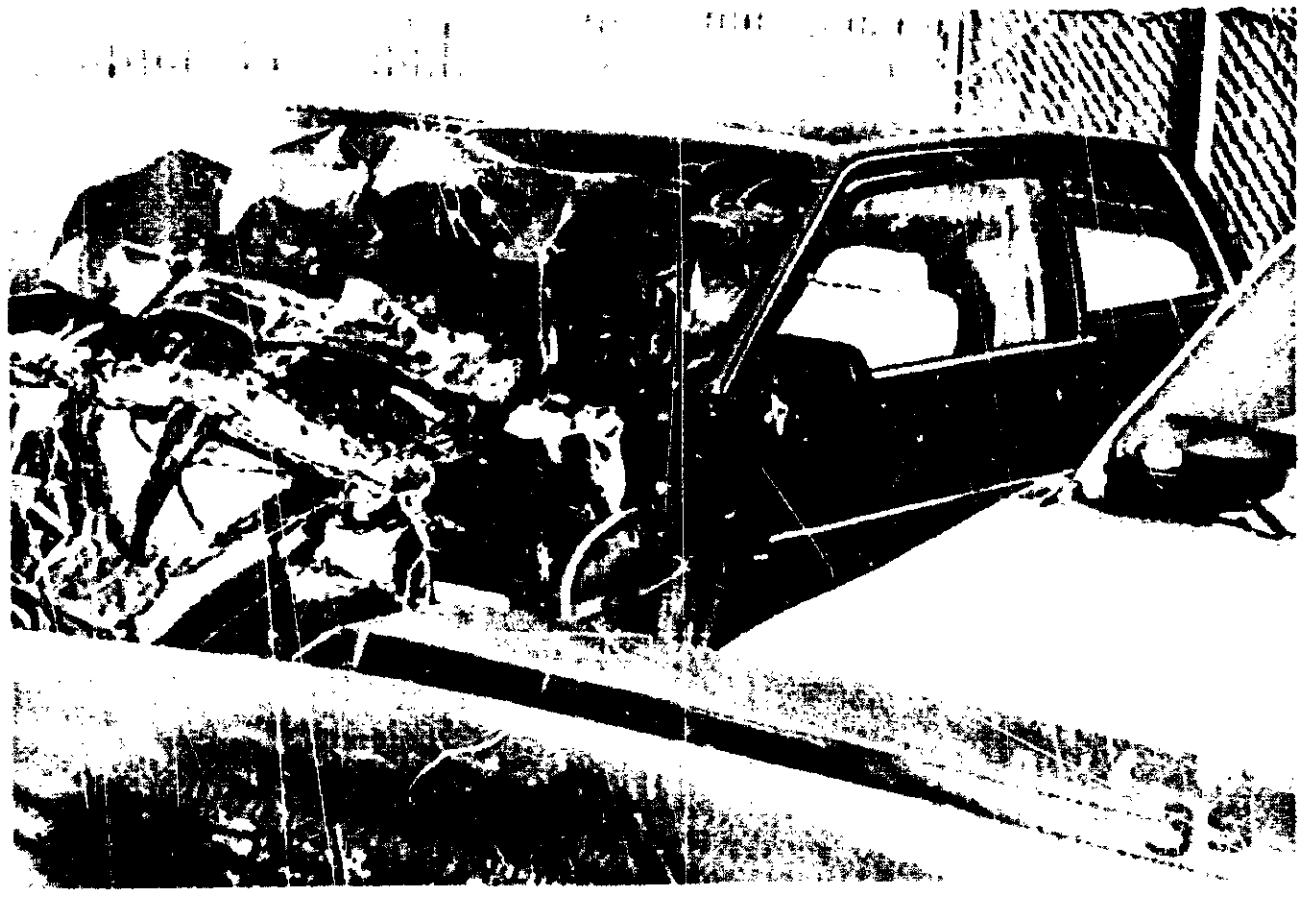
were not identified for at least a day and the major internal organ damage was not identified for nearly 2 weeks following admission to the hospital. From that point, two major operations were required for repair of perforated intestines, severe abscessing, and finally, removal of the damaged spleen.

If this occupant had a lap/shoulder belt available at his seating position, and had been properly wearing the 3-point belt, he would not have sustained the spinal injuries or the internal injuries induced by the lap belt.

CASE 180 - (SEA 86-H-0R04)

Case Vehicle: 1984 Buick Century Custom, 2-door
Case Vehicle Weight: 3,488 pounds
Case Vehicle Delta V: 31.7 mph





Circumstances

A 1984 Buick Century struck front first into the left front of a GMC delivery van. Both vehicles sustained extensive frontal damage; the Buick received frontal structural deformation of more than 28 inches.

The Buick was occupied by a lap/shoulder belted driver, a lap/shoulder belted right front passenger, a lap belted passenger seated in the right rear, and a lap belted passenger in the left rear. The front seat occupants of the Buick received severe injuries. The right rear seated passenger of the Buick sustained injuries which proved fatal. The left rear seated passenger of the Buick received serious injuries. The GMC van driver received unspecified injuries.

Restraint and Injury

Seating Location:	Driver
Sex:	M
Age:	72 years
Height:	5 feet 10 inches
Weight:	198 pounds
Restraint used:	Lap/shoulder belt (ELR)

This driver was wearing a continuous loop, lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a cinching latchplate, a pushbutton release buckle attached to a flexible stalk, and a windowshade tension-relief feature. The instrument panel was broken and distorted forward of this seating position and the steering wheel assembly was deformed forward and upward.

Injuries	AIS	Probable Source
Myocardial contusion	4	Steering assembly and shoulder portion of belt
Fractured sternum	2	Shoulder portion of belt and steering assembly
Contusion across chest	2	Shoulder portion of belt
Fractured right toe	2	Floor panel controls
Contusion, right knee	1	Instrument panel
Contusion, left knee	1	Instrument panel
Small lacerations, left hand	1	Instrument panel

This driver spent 10 days in the hospital and was released to his personal physician. The degree of deformation to the steering wheel assembly suggests there was slack in the shoulder portion at impact. There were no defects noted in the lap/shoulder belt, so it is likely this slack was introduced by the windowshade tension-relief feature.

Seating Location: Right front
Sex: M
Age: 76 years
Height: 5 feet 11 inches
Weight: 200 pounds
Restraint used: Lap/shoulder belt (ELR)

This passenger was wearing a lap/shoulder belt identical to that worn by the driver. There was no evidence of system misuse or failure found. It appears likely that he was wearing it properly.

Injuries	AIS	Probable Source
Myocardial contusion	4	Shoulder portion of belt
Fracture, 1st left rib	1	Impact force
Displaced fracture, left wrist	3	Instrument panel

The lap/shoulder belt restraint system performed well in preventing this occupant from making violent contact with the dashboard. Considering this passenger and the driver's ages, it is likely they would have been fatally injured had they not been restrained in this 31.7 mph Delta V collision. The myocardial contusions sustained by these two lap/shoulder belted men are unusual among the Safety Board's cases; the occupant's age may have been a factor.

Seating Location: Left rear
Sex: F
Age: 75 years
Height: 5 feet 7 inches
Weight: 170 pounds
Restraint used: Lap belt (ALR)

This woman was wearing a lap belt with an automatic locking reactor, a sewn-in latching tongue attached to the retractable webbing, and a push-button release type buckle attached to a short length of webbing. Both webbing components entered the seating area by passing through the junction of the upper and lower cushions. There was no apparent compression or deformation of the compartment at this position.

Injuries	AIS	Probable Source
Comminuted and displaced fracture, right proximal humerus	3	Compression force
Comminuted nasal fracture	2	Right front seat frame
Bilateral fracture, iliac crests	3	Lap belt
Displaced fracture of spine at L4	3	Lap belt
Retroperitoneal hematoma	3	Lap belt
Blunt abdominal trauma	7	Lap belt
Closed auxiliary nerve injury	7	Unknown
Massive contusion/abrasion lower abdomen	2	Lap belt
Laceration, left iliac crest	1	Lap belt

This woman was in the hospital for 20 days before being released to an extended care facility for an additional 3 weeks of treatment.

With the single exception of the upper arm fracture, all of the injuries sustained by this woman can be attributed directly to the lap belt restraint that was worn. These injuries were considered life-threatening by hospital personnel even after 10 days of care, shown by the orders for transfer with life support equipment onboard the ambulance. If she had been wearing a properly fitted lap/shoulder belt, she would most likely not have sustained any of these injuries.

Seating Location:	Right rear
Sex:	F
Age:	64 years
Height:	5 feet 3 inches
Weight:	165 pounds
Restraint used:	Lap belt (ALR)

This woman was wearing a lap belt identical to the one used by the left rear passenger. Information was not available for determination of proper versus improper use. There were hairs embedded at various points about the rear surface of the right front seat. Body fluids were found on the lap belt webbing.

Injuries	AIS	Probable Source
Large laceration above right iliac crest	3	Lap belt
Intra-abdominal injury	7	Lap belt
Massive facial injuries	7	Right front seat frame
Large ecchymoses, anterior chest	7	CPR

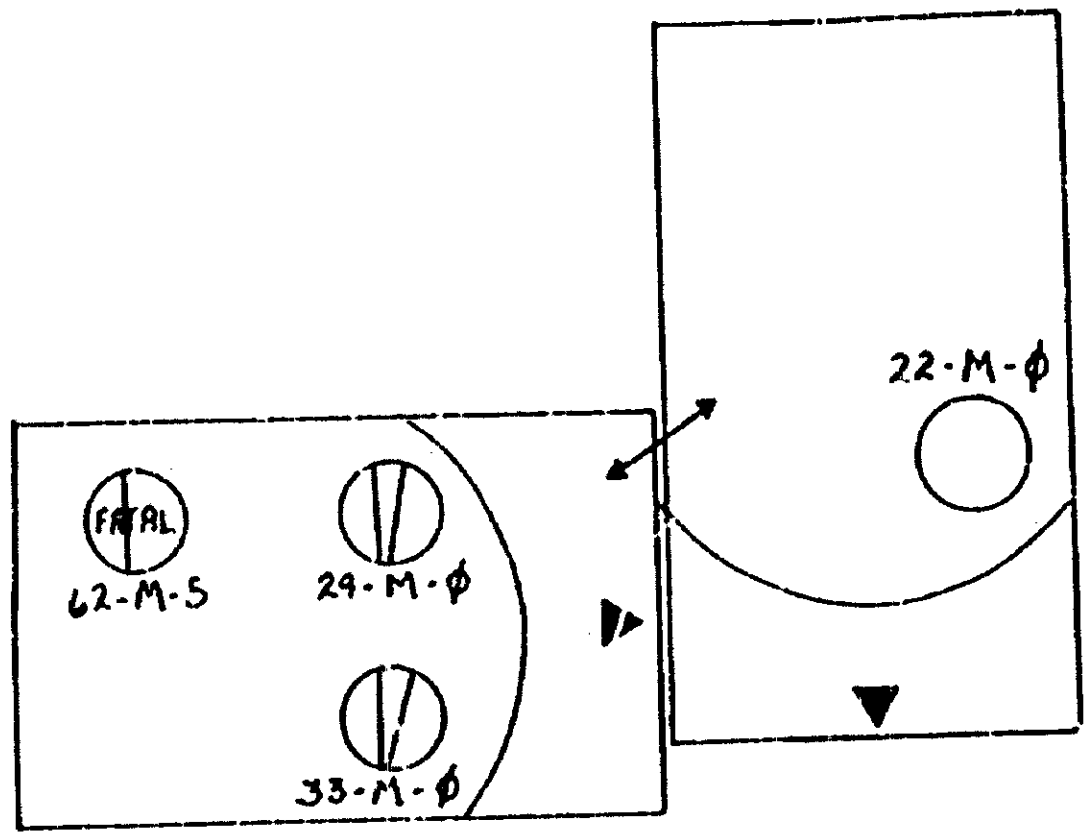
This woman's injuries were evaluated by emergency medical personnel at the accident scene as being "not life-threatening." Her condition deteriorated while enroute to the hospital and she was in full cardiac arrest upon arrival. Revival attempts failed and she was pronounced dead approximately 2 hours after the crash. The medical examiner noted that her death was probably the result of a ruptured great vessel of her heart.

The woman's death probably resulted from injuries sustained as a direct result of the forces transmitted through the lap belt. This cannot be stated with certainty, however, due to the lack of medical information. The forces necessary for fatal intra-abdominal injuries were certainly present, shown by the large gaping laceration completely into her abdominal cavity. Decreasing blood pressure while enroute to the hospital indicates a loss of blood at some point within her system.

This woman almost certainly would have survived the 31.7 mph Delta V collision if she had been wearing a properly fitted lap/shoulder belt.

CASE 181 - (LAX 86-H-0R04)

Case Vehicle: 1985 Oldsmobile Firenza, 4-door
Case Vehicle Weight: 2,968 pounds
Case Vehicle Delta V: 25.7 mph



Circumstances

A 1985 Oldsmobile struck, front first, into the right side of a 1977 Chevrolet Camaro at an intersection. The collision resulted in substantial damage to both vehicles with rearward structural deformation reaching depths of more than 15 inches on the front of the Oldsmobile and inward deformation reaching depths up to 13 inches on the right side of the Chevrolet.

The unrestrained driver of the Chevrolet and both lap/shoulder belted occupants of the Oldsmobile were uninjured. The lap belt restrained rear seat occupant of the Oldsmobile received critical, massive intra-abdominal injuries which proved fatal.

RESTRAINT AND INJURY

Seating Location: Driver
Sex: M
Age: 29
Height: Unknown
Weight: Unknown
Restraint used: Lap/shoulder belt (ELR)

This driver was wearing a 3-point lap/shoulder belt equipped with an emergency locking retractor, sensitive to vehicle motion, a cinching type latchplate, a push button buckle attached to a flexible stalk, and a windowshade type of tension-relief feature. The driver and right front passenger returned to their home country before information regarding system adjustment could be obtained. However, no evidence of system misuse or failure was found.

This driver was not injured.

Seating Location: Right front
Sex: M
Age: 33
Height: Unknown
Weight: Unknown
Restraint used: Lap/shoulder belt (ELR)

This passenger was wearing a lap/shoulder belt identical to that worn by the driver. He was not injured.

The 3-point restraints worn by both front seat occupants performed very well in preventing the occupants from making uncontrolled movement into the interior surfaces of the vehicle. They probably would have received moderate to serious injuries if they had not been restrained in this 25.7 mph Delta V collision.

Seating Location: Left rear
Sex: M
Age: 62
Height: 5 feet 4 inches
Weight: 130 pounds
Restraint used: Lap belt (ALR)

This man was wearing a lap belt with an automatic locking retractor, a sewn-in latchplate attached to the retractable webbing, and a pushbutton buckle attached to a short length of webbing. The buckle webbing entered the seating area by passing between the junction of the upper and lower cushion, while the latchplate webbing entered from between the lower and interior sidewall. There was no compartment distortion of compression at this seating position, and no evidence of system misuse was found.

Injuries	AIS	Probable Source
Fragmented fracture, right iliac wing	3	Lap belt
Torn right iliopsoas muscle	2	Lap belt
Retroperitoneal hemorrhage	3	Lap belt
Complete severance, proximal ileum	5	Lap belt
Large laceration/tear, distal ileum	5	Lap belt
Laceration of omentum	4	Lap belt
Multiple large lacerations, mesentery	4	Lap belt
Gaping tear (1.5 cm), small bowel	5	Lap belt
Extensive contusions, mesentery	3	Lap belt
Contusion, ascending colon	3	Lap belt
Contusion, transverse colon	3	Lap belt
Contusion, descending colon	3	Lap belt
Contusion, right iliac crest	2	Lap belt
Contusion, left iliac crest	2	Lap belt
Contusion, right hip to right flank	2	Lap belt
Contusion, left thigh to knee	2	Interior sidewall
Contusion, left occipital region	2	Interior sidewall

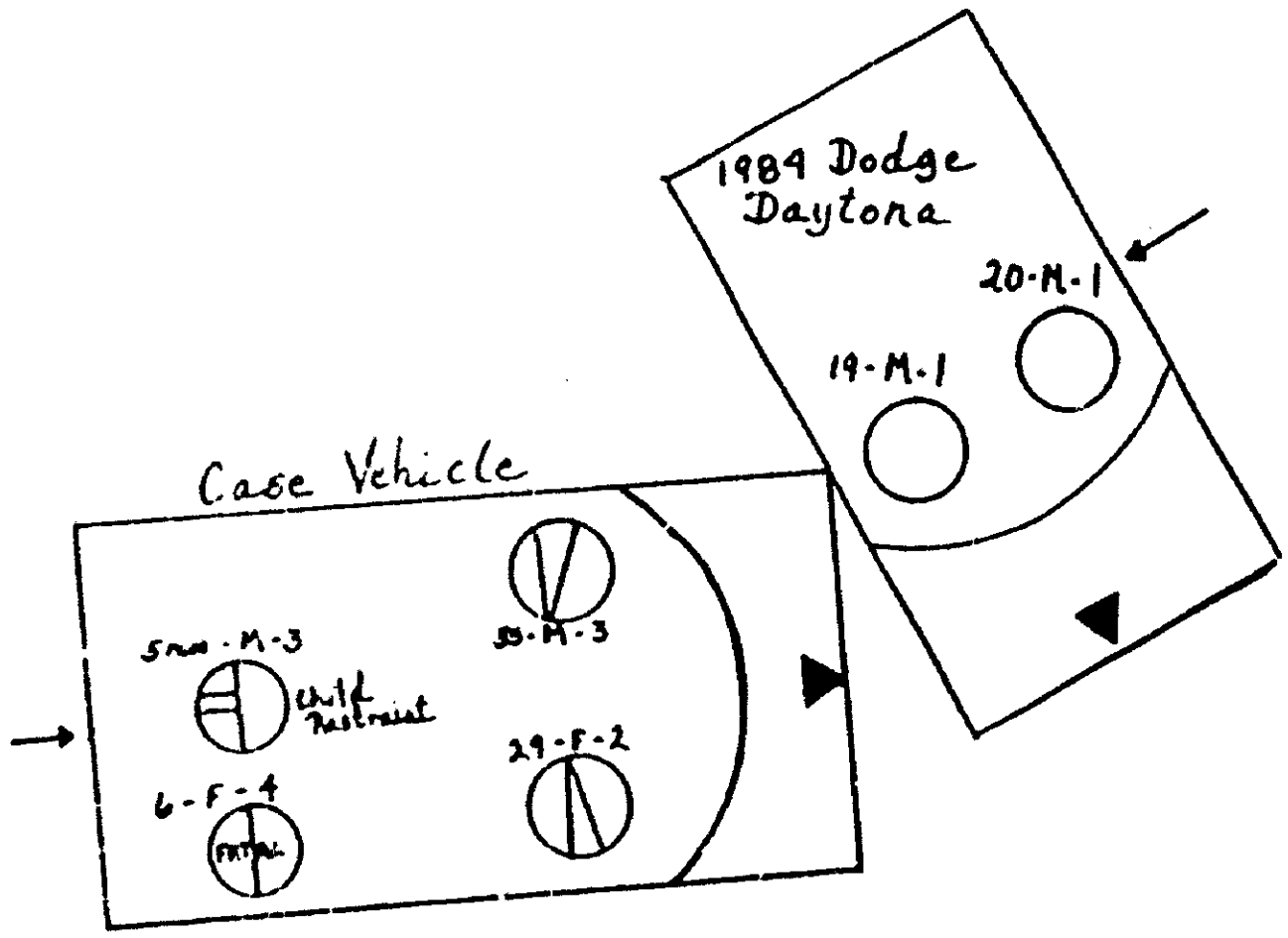
This man was in intensive care for 39 hours at two hospitals before he died from his injuries. A laparatomy was performed approximately 4 hours after his initial admission to a hospital; however, no additional surgery was undertaken, even though blood pressure could not be maintained at adequate levels. At the time of the autopsy, approximately 4000 grams of blood clots were found within his abdominal cavity due to intra-abdominal hemorrhaging. In addition, the autopsy noted hemorrhagic material within his stomach and fecal matter within his abdominal cavity. A blood clot of approximately 300 grams was found in the liver area.

From the injuries indicated in the hospital and autopsy records, it seems likely that the lap belt rose above this man's left iliac crest during the crash and penetrated the abdominal cavity from left to right.

This man would have survived this 25.7 mph Delta V collision, with much reduced injuries, had he been wearing a properly fitted lap/shoulder belt.

CASE 182 - (NYC 85-H-OR04)

Case Vehicle: 1984 Nissan Sentra station wagon
Case Vehicle Weight: 2,330 pounds
Case Vehicle Delta V: 33.6 mph



Circumstances

A 1985 Dodge Daytona 2-door slid broadside into the front of a 1984 Nissan Sentra station wagon. The collision resulted in extensive frontal deformation to the Nissan. The Dodge was occupied by an unrestrained driver and an unrestrained passenger seated in the right front. The Nissan was occupied by a lap/shoulder belt-restrained driver, a lap/shoulder belt-restrained right front seat passenger, an infant in a misused child safety seat secured by a lap belt in the center rear, and a lap belt-restrained child seated in the right rear.

The lap/shoulder belted Nissan driver and his infant son in the safety seat received serious injuries. The lap/shoulder belted right front passsenger, received moderate injuries, and the lap belted child received injuries which proved fatal.

The unrestrained occupants of the Dodge received minor injuries and were released from the hospital within a few hours.

Restraint and Injury

Seating Location:	Driver
Sex:	M
Age:	33 years
Height:	5 feet 10 inches
Weight:	160 pounds
Restraint used:	Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with a free sliding latchplate and an emergency locking retractor. There was no evidence that the restraint failed or was defective.

Injuries	AIS	Probable Source
Severe depressed complex fracture of left zygomatic maxillary	3	Left A-pillar
Abrasion, left shoulder	1	Shoulder portion of belt
Abrasion, left chest	1	Shoulder portion of belt
Abrasion, sternum	1	Shoulder portion of belt
Hematoma, right ankle	1	Unknown

The left side of the driver's face was the only part of his body that contacted the interior surfaces of the vehicle. The lap/shoulder belt performed well in preventing the driver from making contact with the steering assembly and dashboard. If he had not been restrained in this 33.6 mph Delta V collision, he probably would have sustained additional and more serious injuries.

Seating Location:	Right front
Sex:	F
Age:	29 years
Height:	5 feet 2 inches
Weight:	105 pounds
Restraint used:	Lap/shoulder belt (ELR)

This passenger was wearing a lap/shoulder belt identical to the driver's. There was no evidence of restraint failure or defect.

Injuries	AIS	Probable Source
Displaced fracture, right clavicle	2	Shoulder portion of belt
Fractured rib, 1st, right side	1	Shoulder portion of belt
Fractured ribs, 5-8, left side	2	Shoulder portion of belt
Contusions, left/right iliac crests	1	Lap portion of belt
Contusions, from right clavicle to left mid-sternum	2	Shoulder portion of belt

The lap/shoulder belt prevented this passenger from striking the interior surfaces of the vehicle. If she had not been restrained, she would have made uncontrolled movement into the instrument panel and would probably have received more serious injuries.

Seating Location:	Center rear
Sex:	M
Age:	5 months
Height:	23 inches
Weight:	15 pounds 8 ounces
Restraint used:	Misused child safety seat secured by a static lap belt

This infant was seated in a child safety seat; however, it was improperly installed. The lap belt was routed through the lower section of the safety seat's tubular frame, rather than around the front of the entire seat, as it was supposed to be.

Injuries	AIS	Probable Source
Depressed skull fracture of left frontal bone	3	Left rear window frame
Linear fracture, left parietal bone	3	Left rear window frame
Abrasion/contusion, left cheek around left eye	1	Left rear window frame
Hematoma, left orbital area	1	Left rear window frame

This child moved forward and to the left at impact, striking the left rear window frame. If the lap belt had been properly routed through the child seat frame, the child's movement might have been more restricted and his injuries probably reduced.

Seating Location: Right rear
Sex: F
Age: 6 years
Height: 41 inches
Weight: 50 pounds
Restraint used: Lap belt (ALR)

This child was wearing a manual lap belt with an automatic locking retroctor. During the crash, the seat cushion was displaced forward about 1 inch.

A photograph of the child's abdomen showed a deep bruise across the area slightly above the iliac crests but below the umbilicus. These marks indicate that at peak loading, the lap belt was above the iliac crests, above the area considered to be proper fit.

Injuries	AIS	Probable Source
Contusion, abrasion of forehead	2	Unknown
Linear fracture of frontal bone	2	Unknown
Contusion, right frontal cerebral cortex	3	Unknown
Occipital/cervicle dislocation	2	Unknown
Laceration, occipital/cervical ligaments, transection of vertebral arteries	3	Unknown
Contusion, abrasions, anterior abdominal wall	2	Lap belt
Laceration of mesentery	3	Lap belt
Unconscious	4	Unknown

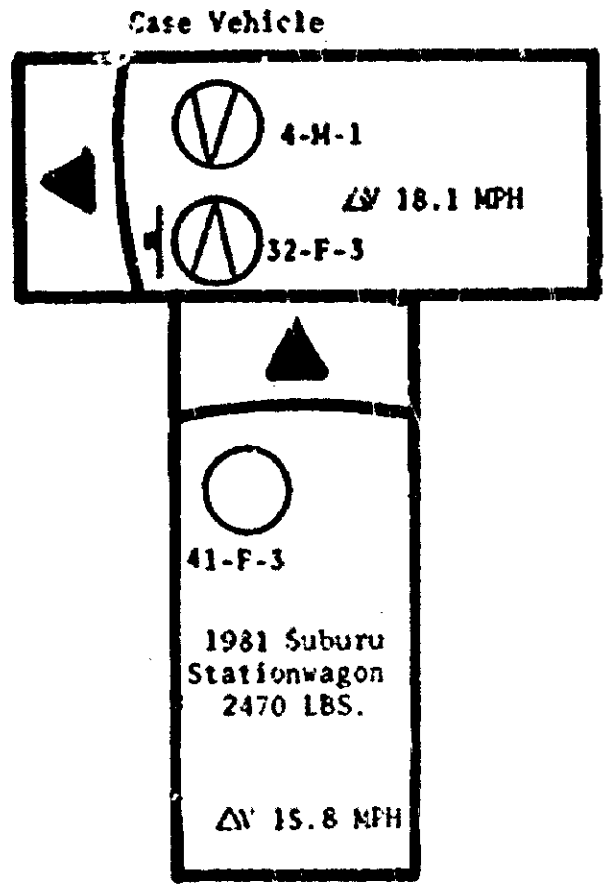
The upper torso of this child pitched forward and downward at impact, over the lap belt, and the child's head struck the vehicle's interior. Although no evidence identifying the contact point was found, it is suspected, based on the child's head injuries, probable kinematics, the seat cushion softness, and the child's size, that her head struck the forward edge of the metal platform near the floor, on which the rear seat bottom cushion rests.

The patholgist listed the cause of this child's death as the dislocation of the occipital/cervical junction and resulting injuries to the vascular supply to the base of the brain. He believed that these injuries most likely resulted in death within a few minutes. The frontal skull fractures and serious intra-abdominal injuries may have contributed to her death, but he regarded the head/neck separation as the primary cause of death.

While there is insufficient evidence to predict what injuries she would have received had she been unrestrained, there is sufficient evidence to conclude that she almost certainly would have survived this 33.6 mph Delta V collision had she been restrained by a lap/shoulder belt.

CASE 183 - (LAX 85-H-0R07)

Case Vehicle: 1984 Dodge Colt, 4-door
Case Vehicle Weight: 2,158 pounds
Case Vehicle Delta V: 18.1 mph



Circumstances

A 1984 Dodge Colt entered an intersection and was struck on driver's door by the front of a 1981 Subaru station wagon. The Dodge received substantial damage with collapse of up to 22 inches.

The Dodge driver, restrained by a lap/shoulder belt, received serious injuries. A child passenger in the front seat, also restrained by a lap/shoulder belt, sustained minor injuries. The unrestrained Subaru driver was seriously injured.

Restraint and Injury

Case Vehicle

Seating Location:	Driver
Sex:	F
Age:	32 years
Height:	5 feet 5 inches
Weight:	135 pounds
Restraint Used:	Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk mounted buckle. The driver described the lap belt adjustment as being snug. The shoulder portion was reportedly adjusted tightly across her chest. Force loading marks were found on the webbing in the area of the free-sliding latchplate.

Injuries	AIS	Probable Source
Undefined closed head injury > 15 minutes unconsciousness	3	B-pillar
Laceration, left side of scalp	1	B-pillar
Contusion, left kidney	3	Left armrest

The driver was admitted to an area hospital for an undetermined period of time. Due to lateral intrusion at the driver's position, which resulted from side impact, the driver received little benefit from use of the lap/shoulder belt. Restraint use can not prevent contact with an adjacent interior sidewall. If she had been unrestrained she probably would have received similar injuries.

Case Vehicle
Seating Location: Right Front
Sex: M
Age: 4 years
Height: 3 feet
Weight: 35 pounds
Restraint Used: Lap/shoulder belt (ELR)

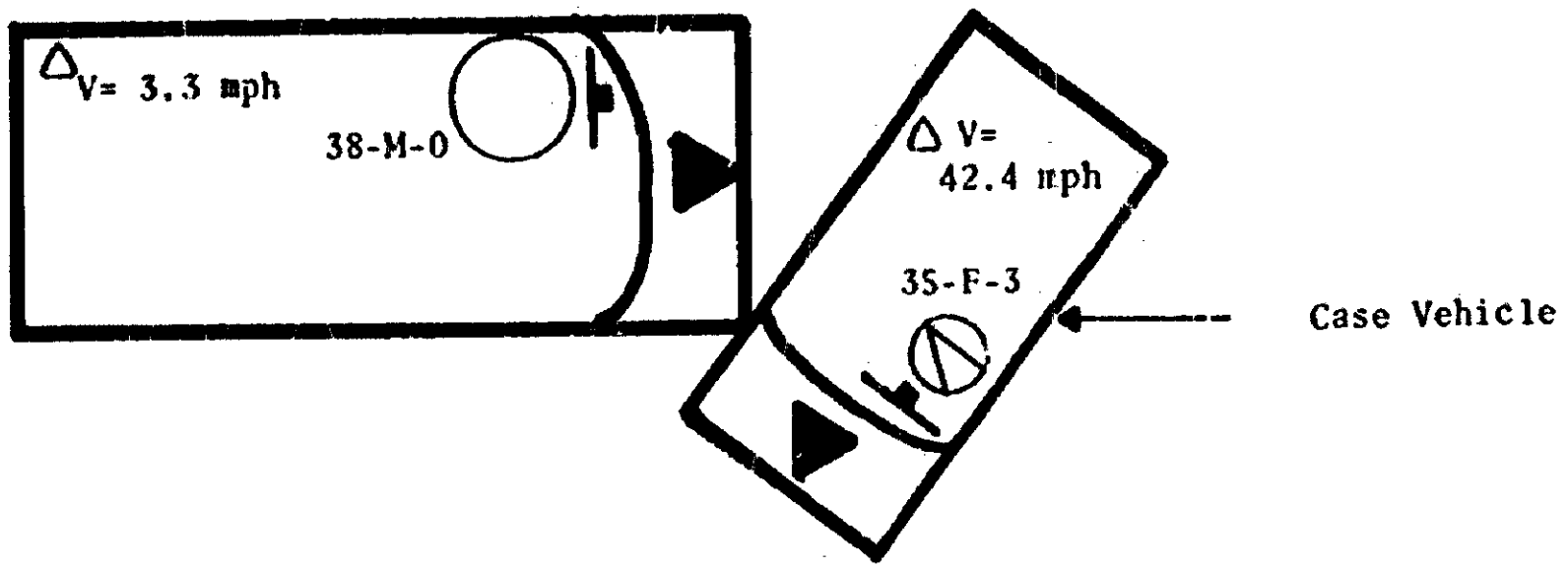
The child seated in the right front was wearing a continuous loop lap/shoulder belt identical to that worn by the driver. The driver, who was the child's mother, described the adjustment of the lap portion of the belt as being snug. The shoulder portion was reportedly adjusted tightly across his chest.

Injuries	AIS	Probable Source
Laceration, left elbow	1	Right side of driver's seat frame

This occupant was treated at an area hospital and released. If this passenger had not been wearing a lap/shoulder belt he would have been thrown toward the impact area and most likely would have received more serious injuries in this 18.1 mph Delta V collision.

CASE 184 - (LAX 85-H-ORI2)

Case Vehicle: 1984 Ford Mustang, 2-door
Case Vehicle Weight: 2,800 pounds
Case Vehicle Delta V: 42.4 mph



Circumstances

A 1984 Ford Mustang 2-door was struck on the right side by a 1979 MCI three-axle bus. The collision resulted in substantial damage to a 132-inch-wide area of the Ford's right side, with deformation of up to 21 inches.

The Ford was occupied by a driver wearing a lap/shoulder belt who received serious injuries. The bus driver, restrained by a lap belt, was not injured.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 35 years
Height: 5 feet 7 inches
Weight: 155 pounds
Restraint Used: Lap/shoulder belt (ELR)

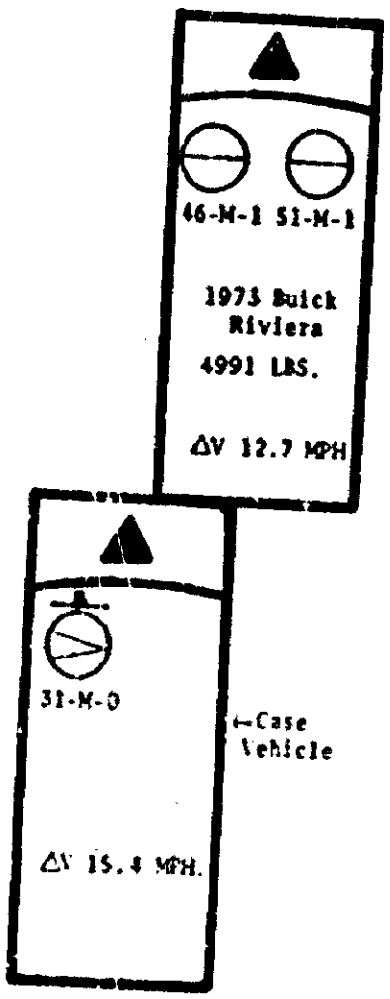
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a cinching latchplate, a windowshade tension-relief feature, and push-button release buckle attached to a flexible stalk. The driver stated that the adjustment of the lap portion was snug, positioned low on her hips, and the shoulder strap snug against her midchest area. Marks were on the webbing attributed to loading at the D-ring and within the retractor. The right side of the case vehicle was severely deformed.

Injuries	AIS	Probable Source
Laceration, scalp	2	Sun visor mirror
Contusion, right side of face	1	A-pillar
Concussion, with memory loss	3	A-pillar
Contusion, left shoulder	1	Shoulder portion of belt
Fracture, several ribs, right side	1	Interior side wall
Contusion, right thigh	1	Console
Contusion, right side	1	Interior side wall
Contusion, right shoulder	2	A-pillar
Laceration, right knee	2	Gearshift lever
Avulsion, abdominal wall	2	Lap portion of belt

This driver was admitted to a hospital for 14 days. This was a very severe impact (Delta V of over 42 miles per hour), and the restraint system performed well overall. The lap portion of the belt prevented the driver's entire body from moving into the area of intrusion. The shoulder portion probably did little to restrain the driver's upper torso in this severe side impact; however, she might have sustained additional and much more severe injuries had she not been restrained.

CASE 185 - (LAX 85-H-OR-09)

Case Vehicle: 1983 Ford LTD, 4-door
Case Vehicle Weight: 4,138 pounds
Case Vehicle Delta V: 15.4 mph



Circumstances

A 1983 Ford LTD was attempting to change lanes to the left when traffic ahead slowed and the Ford impacted the left rear of a 1973 Buick Riviera. The Ford sustained moderate damage across the front with deformation of up to 26 inches at the right front corner.

The Ford driver was restrained by a lap/shoulder belt and was uninjured. The Buick driver was restrained by a lap belt, as were his two passengers. None of the three sustained injury.

Restraint and Injury

Case Vehicle

Seating Location:	Driver
Sex:	M
Age:	31 years
Height:	5 feet 11 inches
Weight:	190 pounds
Restraint Used:	Lap/shoulder belt (ELR)

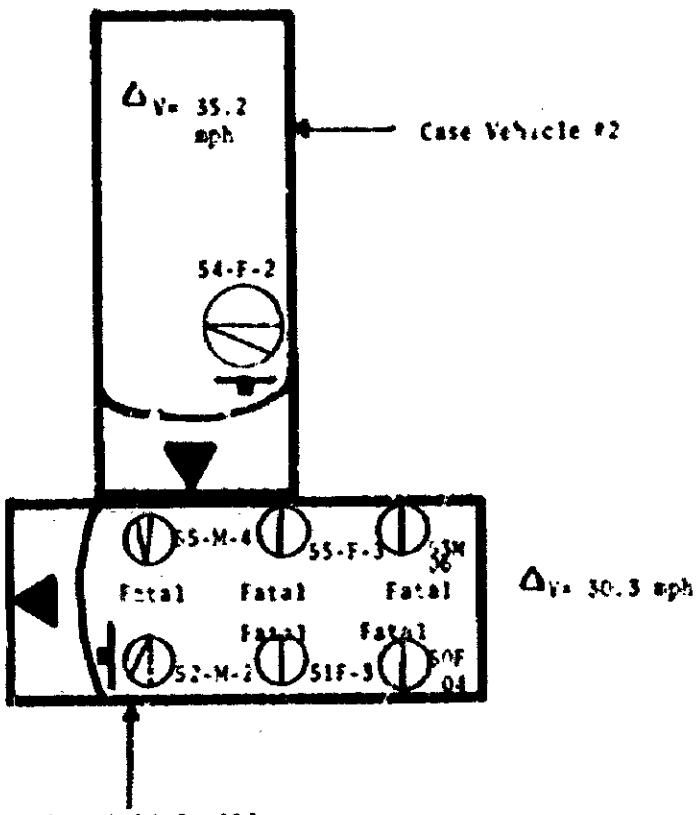
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a tunnel-mounted flexible buckle assembly. The driver stated that the precrash adjustment was snug, positioned "across his waist," and the shoulder portion as being adjusted snug across the chest. No load marks were found on the system.

This driver was not injured in this 15.4 mph Delta V collision. If he had been unrestrained, he may have sustained injury due to contacts with the frontal interior components. If crash forces had been more severe, the improperly positioned lap portion of the 3-point belt could have proved injurious.

CASE 187 - (MKC 85-H-OR32)

Case Vehicle #1: 1985 Dodge Caravan
Case Vehicle Weight: 4,420 pounds
Case Vehicle Delta V: 30.3 mph

Case Vehicle #2: 1984 Buick Riviera
Case Vehicle Weight: 3,800 pounds
Case Vehicle Delta V: 35.2 mph



The driver was the only survivor.

CASE VEHICLE #2

CASE VEHICLE #1

Circumstances

A 1985 Dodge Caravan was passing through an intersection when it was struck broadside on the right by a 1984 Buick Riviera. The Dodge went off the roadway and rolled onto its left side. The Dodge, with extensive contact damage along the right side, received a maximum crush of 22 inches. The Buick was substantially damaged along the front with deformation up to 34 inches.

The driver of the Dodge Caravan, wearing a lap/shoulder belt, sustained moderate injuries. The right front passenger was restrained by a lap/shoulder belt and the remaining four passengers were restrained by lap belts only. All five passengers sustained fatal injuries.

The driver of the Buick, restrained by a lap/shoulder belt, sustained moderate injuries.

Restraint and Injury

Case Vehicle #1 - Dodge Caravan
Seating Location: Driver
Sex: M
Age: 52 years
Height: 5 feet 9 inches
Weight: 160 pounds
Restraint Used: Lap/shoulder belt (ELR)

The driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver stated that the precrash position of the belt was "tight." Force loading marks were found on the webbing in the vicinity of the latchplate.

Injuries	AIS	Probable Source
Laceration, right side of head	1	Rear view mirror
Rib fractures, right side	2	Right front bucket seat (displaced) or right front passenger.

The driver was taken to a nearby hospital where he spent 2 days. He was then off work for approximately 1 month. The restraint system performed well in reducing this driver's injuries during the 30.3 mph Delta V collision, even though the impact was from the side. Had he been unrestrained, he would have been thrown violently toward the right side of the interior and probably would have received a much higher level of injuries. The right front bucket seat rotated approximately 1/8 turn clockwise as the driver was being thrown forward and to the right within his restraint. It is likely those dynamics resulted in his broken ribs.

Case Vehicle #1 - Dodge Caravan
Seating Location: Right Front
Sex: M
Age: 55 years
Height: Unknown
Weight: 180 pounds
Restraint Used: Lap/shoulder belt (ELR)

The right front passenger was restrained by a lap/shoulder belt identical to that worn by the driver. There was no indication of the position of the lap/shoulder belt. The webbing was found separated in the latchplate area following the collision.

Injuries	AIS	Probable Source
Head injury (unspecified)	7	Roof and A-pillar
Chest injuries (unspecified)	7	Right front door

The passenger died from his injuries. No autopsy was performed on this passenger or any other occupant who died in this crash; the coroner was not an M.D., thus limiting specific injury description.

The right front passenger likely sustained his fatal injuries from contact with the right side of the vehicle. Other than ejection prevention, a lap/shoulder belt can provide limited protection, at the most, in a side impact at the occupant's seating position. In this case, intrusion negated even this limited protection.

Case Vehicle # 1 - Dodge Caravan
Seating Location: Left side, first bench
Sex: F
Age: 51 years
Height: Unknown
Weight: 130 pounds
Restraint Used: Lap belt (ALR)

This passenger was wearing a 2-point lap belt with an automatic locking retractor with a sewn-in latchplate and buckle. The anchors are mounted to the bench seat frame and the entire seat broke loose from the floor during the impact. There was no evidence to suggest how the belt was worn.

Injuries	AIS	Probable Source
Closed head injury (unspecified)	7	Right rear roof
Chest injury (unspecified)	7	Contact with other occupant

The fact that the bench seat broke loose was probably a major factor in the fatal injuries sustained. Once the seat broke loose, she was unrestrained within the vehicle as it rolled over. If the seat had not broken loose, there may have been some question as to whether the lap belt would have prevented fatal injuries; considering the 30 mph Delta V, the 22 inches of deformation in the vicinity of the rear door, and the forces exerted against the body by the lap belt.

Case Vehicle # 1 - Dodge Caravan
Seating Location: Right rear, first bench
Sex: F
Age: 55
Height: Unknown
Weight: 220 pounds
Restraint Used: Lap belt (ALR)

This passenger was wearing a lap belt, the same type as the passenger on the left side. Although she was reportedly unbuckled by the police, there is no evidence to indicate how the belt was worn.

Injuries	AIS	Probable Source
Closed head injury (unspecified)	7	Roof of vehicle
Internal injuries (unspecified)	7	Lap belt
Compound fracture of left wrist	2	Body weight crushing wrist against interior
Compound fracture lower left leg	2	Interior right side of vehicle
Compound fracture of right leg	2	Interior right side of vehicle

Since the vehicle was struck on the right side with the 22 inches of deformation, it is reasonable to assume that no seat belt would have protected this occupant from intrusion related injuries.

Case Vehicle # 1 - Lodge Caravan
Seating Location: Left side, 2nd bench
Sex: F
Age: 50 years
Height: Unknown
Weight: 135 pounds
Restraint Used: Lap belt (ALR)

This passenger was wearing a lap belt, the same type as the other rear passengers. There is no evidence to suggest how it was worn but the police officer at the scene related that he unbuckled this passenger.

Injuries	AIS	Probable Source
Head injury (unspecified)	7	Unknown
Chest injury (unspecified)	7	Unknown
Severely bruised right hip	1	Impact with passenger
Compound fracture, right lower leg	2	Impact with passenger

According to the police this passenger was dead when unbuckled. The lap belt was of of no benefit to this passenger due to the severe impact dynamics.

Case Vehicle # 1 -Dodge Caravan
Seating Location: Right side, 2nd bench
Sex: M
Age: 53 years
Height: Unknown
Weight: 220 pounds
Restraint Used: Lap belt (ALR)

This passenger was wearing a lap belt, the same type as the other rear seated passengers. There was no evidence to suggest how it was worn, however, use was verified by the police officer who unbuckled this passenger.

Injuries	AIS	Probable Source
Skull fracture (unspecified)	7	Contact with right vehicle interior
Chest injuries (unspecified)	7	Unknown

Again, since the impact was from the right side and there was considerable intrusion, the lap belt was incapable of preventing injury. It is unlikely that even a lap/shoulder belt could have prevented the fatal injuries of this passenger.

In summary, because of the intrusion on the right side of the van, it is unlikely that the passengers on the right would have survived, irrespective of the type of belt system.

Case Vehicle #2 - Buick Riviera
Seating Location: Driver
Sex: F
Age: 54 years
Height: 5 feet 3 inches
Weight: 123 pounds
Restraint Used: Lap/shoulder belt with dual retractors (ELR/ELR)

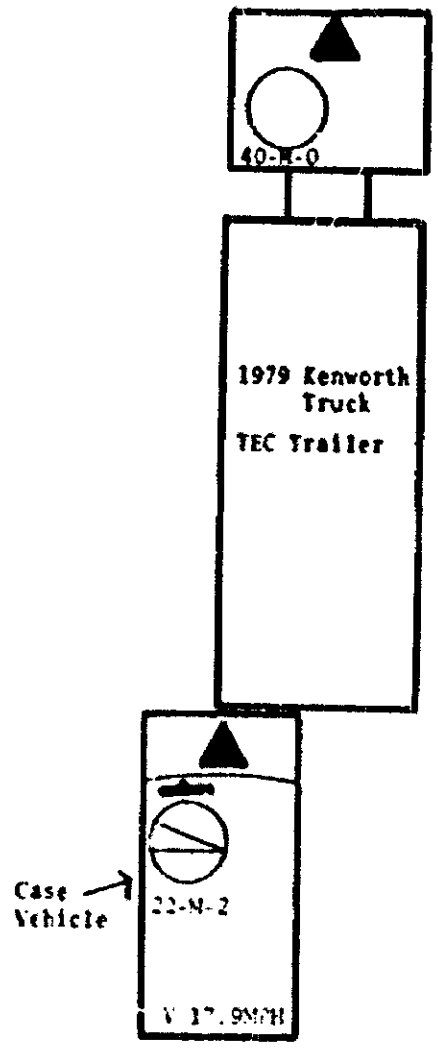
This passenger was wearing a continuous loop lap/shoulder belt with dual emergency locking retractors sensitive to vehicle motion, a sewn-in latchplate, and a flexible tunnel mounted buckle. The driver stated that the self-tensioning system fit "comfortably." It should be noted that there was no means by which this system could be manually adjusted.

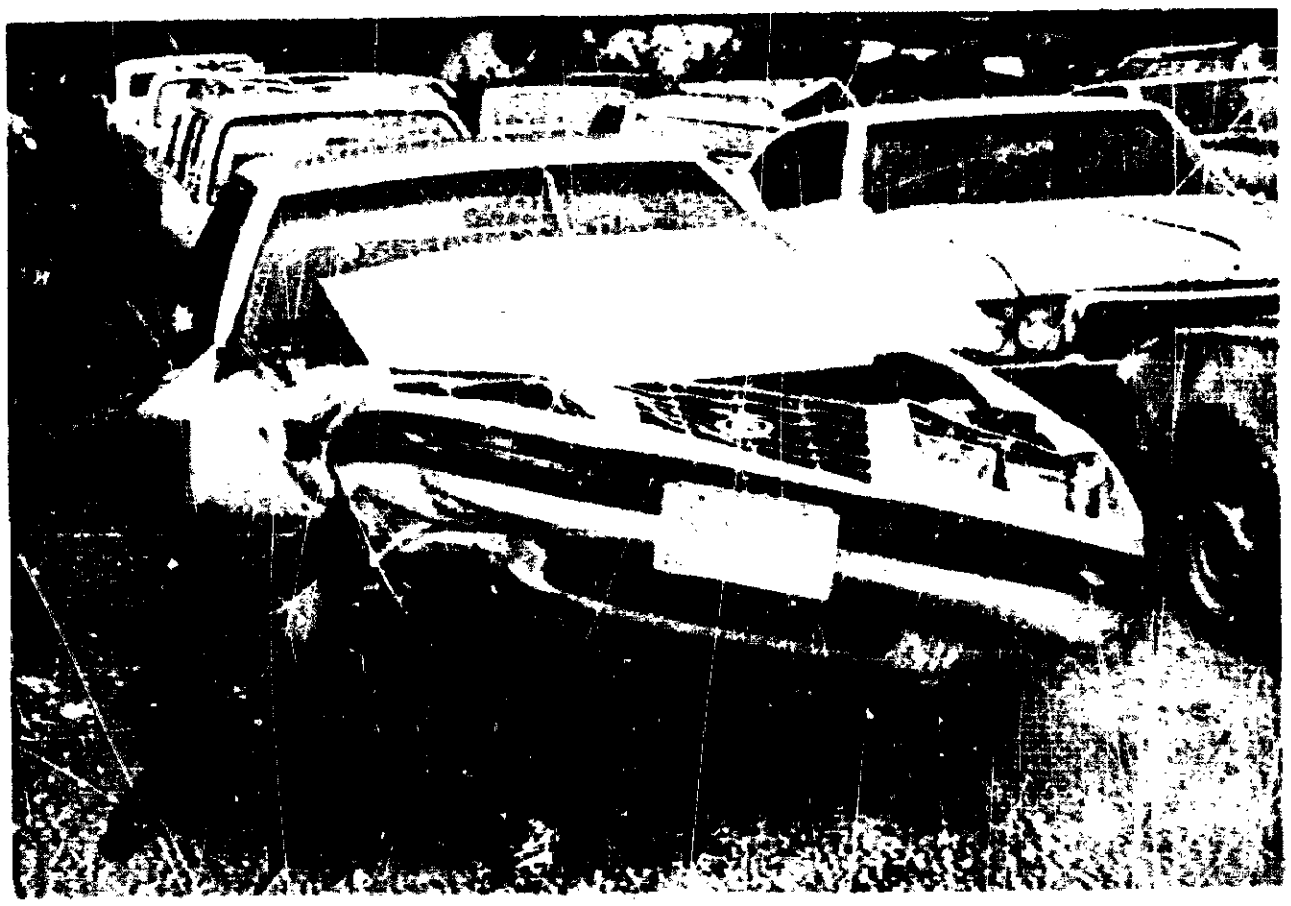
Injuries	AIS	Probable Source
Closed head injury (unspecified)	7	A-pillar
Fractured pelvis	2	Unknown
2 fractured ribs	2	Left door
Right ulna fracture	2	Left door
Left wrist sprain	1	Steering wheel
Right wrist sprain	1	Steering wheel
Multiple facial abrasions and contusion	1	Unknown

This driver was admitted to a hospital where she stayed 3 weeks. She was then off work for an unspecified amount of time. Considering this was a 35 mph Delta V crash for the Buick, the injuries sustained by the restrained driver are not unexpected. If this driver had not been restrained by a lap/shoulder belt, it is very possible that she would have been fatally injured.

CASE 188 - (MKC 85-H-OR22)

Case Vehicle: 1984 Ford Mustang
Case Vehicle Weight: 2,864 pounds
Case Vehicle Delta V: 17.9 mph





Circumstances

A 1984 Ford was proceeding straight when the driver's attention was diverted to a roadside establishment. As the driver turned back, he noticed a slow moving truck ahead, braked, but was unable to stop before striking the left rear of the truck. The Ford sustained substantial damage across its front, with deformation of up to 18 inches at the right front.

The Ford driver, restrained by a lap/shoulder belt, sustained moderate injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 22 years
Height: 6 feet 2 inches
Weight: 200 pounds
Restraint Used: Lap/shoulder belt (ELR)

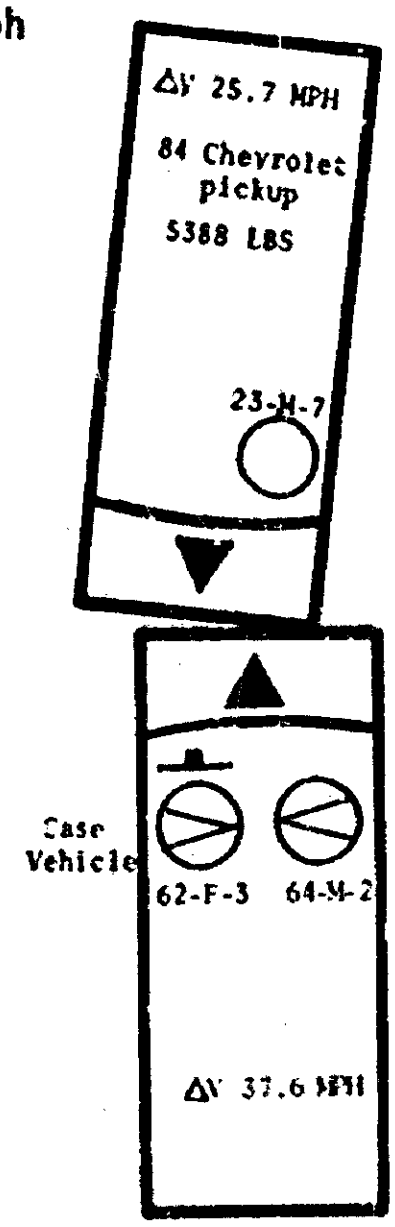
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver stated that the adjustment of the lap portion of the belt was "across the waist," and the shoulder portion adjustment was "very loose," probably due to the use of the windowshade device. Load marks were found on the webbing in the latchplate area.

Injuries	AIS	Probable Source
Concussion (unspecified)	2	Windshield
Laceration, lip	1	Steering wheel
Laceration, left hand	1	Windshield glass
Laceration, right hand	1	Windshield glass

The driver sought medical attention immediately after the crash. Misuse of the available lap/shoulder belt allowed his travel into the windshield. If he had been properly restrained in this 17.9 mph Delta V collision, without such slack, he may have avoided the moderate injury.

CASE 189 - (MKC 85-H-0R23)

Case Vehicle: 1978 Mercury Monarch, 4-door
Case Vehicle Weight: 3,688 pounds
Case Vehicle Delta V: 37.6 mph



Circumstances

A 1978 Mercury Monarch was struck head-on by a 1984 Chevrolet C10 pick-up which had crossed the centerline. The Mercury sustained substantial damage across the entire front, with deformation of up to 46 inches above the bumper. The Chevrolet truck sustained substantial damage also with deformation of up to 62 inches.

The driver and the passenger of the Mercury were both restrained by lap/shoulder belts. The passenger may have had his belt misrouted. The driver received serious injuries and the passenger sustained a moderate injury. The unrestrained driver of the pickup sustained injuries which were reported as serious.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 62 years
Height: 5 feet 4 inches
Weight: 152 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver stated that the adjustment of the lap portion was positioned "across her abdomen" and snug. The shoulder portion was reportedly adjusted so that it was not "loose," but "comfortable." Since there was no tension-relief device present, the shoulder portion should have been fairly tight. Force loading marks were found on the webbing in the area of the latchplate.

Injuries	AIS	Probable Source
Fracture, right ulna	2	Steering wheel
Fracture, left radius	2	Steering wheel
Fracture, left ulna	2	Steering wheel
Fracture, left ankle	3	Foot pedals
Lacerations, right knee	2	Instrument panel
Lacerations, left knee	2	Instrument panel

The driver was admitted to an area hospital for 23 days. Considering the severe collision forces (Delta V of over 37 miles per hour), the restraint system performed as well as could be expected. Had she been unrestrained, it is likely that she would have sustained additional and more serious injuries due to more violent contacts with the frontal interior components.

Case Vehicle
Seating Location: Right Front
Sex: M
Age: 64 years
Height: 5 feet 8 inches
Weight: 178 pounds
Restraint Used: Lap/shoulder belt (ELR)

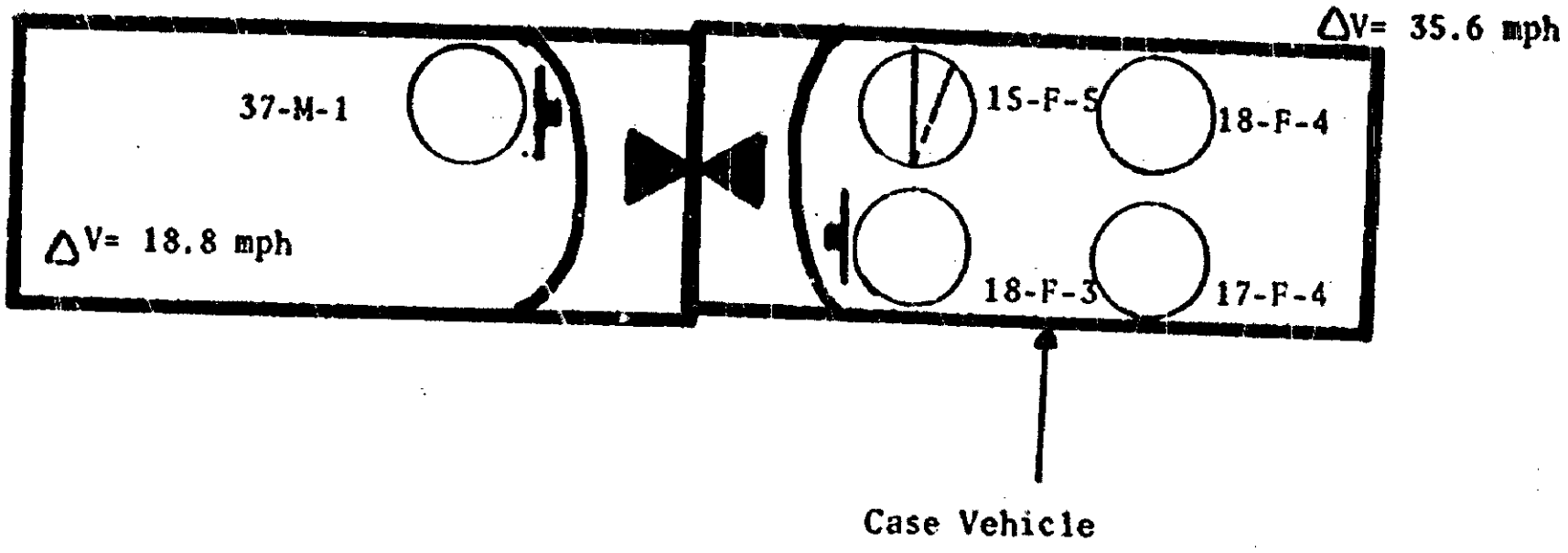
This passenger was wearing a continuous loop lap/shoulder belt identical to that worn by the driver. He described the adjustment of the lap portion as being positioned "across his waist, near his navel," and snug. The shoulder portion was reportedly adjusted so that the palm of a hand could be placed between the webbing and the chest. Force loading marks were found on the webbing in the areas of the B-pillar mounted D-ring and the latchplate.

Injuries	AIS	Probable Source
Laceration, lip	1	Instrument panel
Contusion, around left eye	1	Instrument panel
Laceration, forehead	1	Instrument panel
Fracture, zygoma	2	Instrument panel
Laceration, lower left leg	1	Lower instrument panel
Contusion, right side of chest	1	Door interior
Laceration, left elbow	1	Instrument panel
Laceration, right elbow	1	Instrument panel
Contusion, right wrist	1	Instrument panel

The right front passenger was admitted to an area hospital and stayed for 3 days. The lap portion was reportedly worn too high and may have introduced slack into the system. It is uncertain, but, judging from the type and location of injuries, it is possible that this occupant may have been wearing the shoulder portion misroute under his right arm. If he had not been wearing the restraint at all, he likely would have received much more serious injuries in this 37.6 mph Delta V collision.

CASE 191 - (SEA 86-H-OR03)

Case Vehicle: 1980 Toyota Tercel, 2-door
Case Vehicle Weight: 2,420 pounds
Case Vehicle Delta V: 35.6 mph



Circumstances

A 1975 Chevrolet van crossed the centerline and collided head on with a 1980 Toyota Tercel 2-door. The collision resulted in extensive damage to both vehicles, with crush reaching a maximum of 20 inches at the front of the Toyota and 22 inches at the front of the Chevrolet.

The Toyota was occupied by an unrestrained driver, a child restrained by a misrouted lap/shoulder belt (shoulder portion behind back) seated in the right front, an unrestrained passenger seated in the left rear, and an unrestrained passenger seated in the right rear. The Chevrolet van was occupied by an unrestrained driver. The driver of the Toyota received serious injuries, the right front seat passenger received critical injuries, and both rear seat passengers of the Toyota received severe injuries. The driver of the heavier Chevrolet van reportedly received only minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 18 years
Height: 5 feet 3 inches
Weight: 130 pounds
Restraint Used: None

The driver was not wearing the lap/shoulder belt available at her seating position.

Injuries	AIS	Probable Source
Laceration, right forehead	1	Unknown
Displaced fracture, left femur	3	Instrument panel
Fracture, right femur	3	Instrument panel
Fracture, left knee cap	2	Instrument panel
Fracture, left tibia	2	Instrument panel & floor
Major laceration, left knee	2	Instrument panel
Contusion, left elbow	1	Unknown
Sprained left wrist	1	Steering wheel rim
Laceration, right knee	1	Instrument panel
Fractured, right tibia	2	Instrument panel
Fracture, left ankle	2	Floor
Laceration, left leg	1	Instrument panel
Laceration, right hand	1	Unknown

This driver was admitted to a hospital for 11 days and reportedly remained at home recuperating for an additional month. If she had used the lap/shoulder belt, uncontrolled impact into the frontal interior should have been prevented, and it is likely that her injuries would have been less serious.

Case Vehicle
Seating Location: Right Front
Sex: F
Age: 15 years
Height: 5 feet 3 inches
Weight: 130 pounds
Restraint Used: Misrouted lap/shoulder belt (ELR): shoulder portion behind back

This passenger was restrained by a lap/shoulder belt but she had placed the shoulder portion behind her back. The reported adjustment of the lap portion was snug, positioned low on her hips. There were tears in the webbing attributed to force loading during impact. The right front seat came off its track during impact. This seat was struck from the rear by an unrestrained passenger.

Injuries	AIS	Probable Source
Contusion, right forehead	1	Instrument panel
Laceration, back of head	1	Unknown
Contusion, back of head	1	Unknown
Avulsed tooth	1	Instrument panel
Contusion and abrasions, abdomen	1	Lap portion of the belt
Fracture, L-3 and L-4 vertebrae	3	Impact force and lapbelt
Severed spinal cord	5	Impact force and lapbelt
Torn rectus muscles	2	Lap portion of the belt
Torn abdominal muscles	2	Lap portion of the belt
Ascending colon, contusion	3	Lap portion of the belt
Torn mesentery	3	Lap portion of the belt
Torn mid ileum	4	Lap portion of the belt
Torn abdominal wall	2	Lap portion of the belt
Bruised kidneys	3	Lap portion of the belt
Contusion, left ankle	1	Floor

This passenger required a prolonged period of hospitalization. A check by Safety Board investigators, 40 days after the collision, revealed that this passenger had lower body paralysis and remained confined to a hospital.

At impact, the unrestrained right rear seat passenger struck the front seat back, creating an excessive load which resulted in the right front seat coming off its track. The right front seat lap/shoulder belt was anchored in the floor and remained secure.

If this passenger had worn the available shoulder portion, the forces should have been more evenly distributed, even though the seat was displaced from its track, and the severity of her injuries might have been reduced.

It is interesting to note that the unrestrained driver, who experienced similar collision forces (Delta V of 35.6 miles per hour), escaped with less serious injuries. The intra-abdominal injuries sustained by this right front seat occupant are similar to other lap belt injuries documented in investigations conducted by the Safety Board. However, some of the lap-belt associated injuries may have been aggravated by the rear passenger striking this seat.

Case Vehicle
Seating Location: Left Rear
Sex: F
Age: 17 years
Height: 5 feet 8 1/2 inches
Weight: 140 pounds
Restraint Used: None

This passenger was not wearing the lap belt available at her seating position. There was deformation on both front seatbacks from contact by this passenger.

Injuries	AIS	Probable Sources
Deep laceration, right forehead	2	Right front seat back
Multiple skull fractures with cerebrospinal leak	4	Right front seat back
Ruptured right ear drum	1	Right front seat back
Laceration, left cheek	1	Unknown
Contusion, left knee	1	Left front seat back
Contusion, right knee	1	Left front seat back
Laceration, left lower leg	1	Left front seat back
Laceration, right lower leg	1	Left front seat back

This passenger was admitted to a hospital, requiring 8 days of treatment. The availability and use of a lap/shoulder belt probably would have substantially reduced the severity of injuries sustained.

Case Vehicle
Seating Location: Right Rear
Sex: F
Age: 18 years
Height: 5 feet 7 inches
Weight: 150 pounds
Restraint Used: None

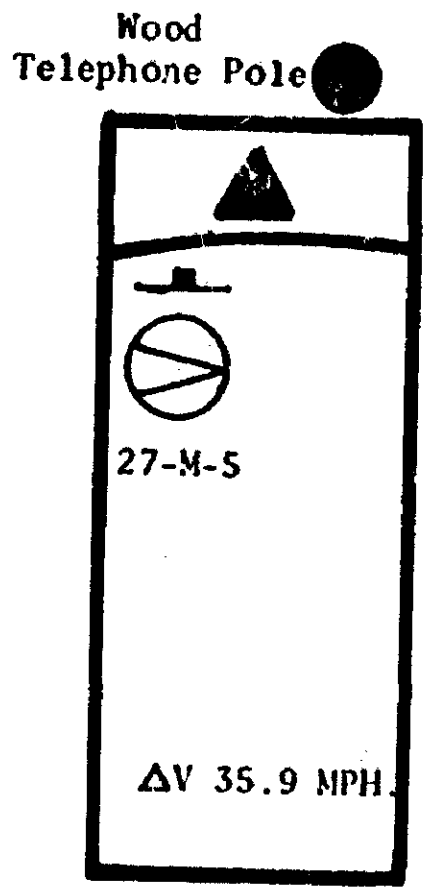
This passenger was not wearing the lap belt available at this seating position. There was deformation to the right front seatback forward of this passenger.

Injuries	AIS	Probable Source
Extensive laceration, right ear	2	Side window and B-pillar
Abrasion, right cheek	1	Side window and B-pillar
Laceration, back of head	1	Unknown
Avulsed top and bottom front teeth	1	B-pillar
Laceration, liver	4	Right front seat back and interior side wall
Contusion, mesentery	3	Right front seat back and interior side wall
Deep laceration, left knee	2	Right front seat back
Laceration, left wrist	1	Unknown
Sprained right ankle	1	Right front seat back

This passenger was admitted to the hospital for 6 days. The availability and use of a lap/shoulder belt would probably have substantially reduced the level of injuries sustained by this passenger. It might also have prevented the excessive force load on the right front seat and helped to reduce the severity of injuries sustained by the occupant of the right front seat.

CASE 192 - (LAX 85-H-OR19)

Case Vehicle: 1985 Nissan pick-up
Case Vehicle Weight: 2,701 pounds
Case Vehicle Delta V: 35.9 mph



Circumstances

A 1985 Nissan pick-up driver lost control of his vehicle, causing the pick-up to leave the roadway and strike a wooden utility pole. The impact caused major structural damage to the pick-up with collapse reaching a depth of 48 inches in the front.

The pick-up driver, restrained by a misrouted lap/shoulder belt (shoulder portion behind back), sustained critical injuries.

Restraint and Injury

Seating Location: Driver
Sex: M
Age: 27 years
Height: 5 feet 7 inches
Weight: 150 pounds
Restraint Used: Misrouted lap/shoulder belt (ELR): shoulder portion behind back

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver stated that he was wearing the lap portion of the belt snug across his hips. He had placed the shoulder portion behind his back. No reason was given for the improper routing.

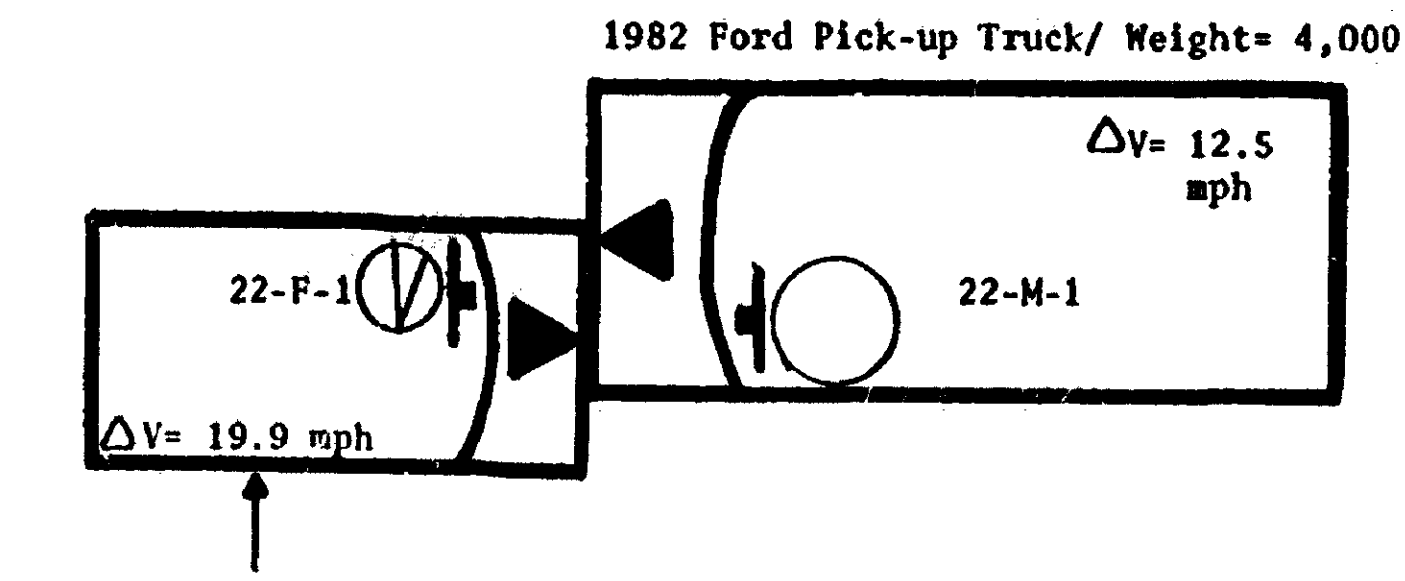
There was substantial interior damage to the instrument panel, floor components, and steering assembly.

Injuries	AIS	Probable Source
Laceration under right eye	2	Top of steering wheel rim
Laceration, center forehead	2	Hub and bottom of steering wheel rim
Laceration, right side chin	1	Steering wheel rim
Laceration, left side chin	2	Steering wheel rim
Acute strain lumbar spine area	1	Impact force
Multiple laceration, right knee (into knee joint)	2	Emergency brake handle and heater controls
Laceration, left knee	2	Lower instrument panel
Minor abrasions, right inside elbow	1	Unknown
Avulsion of colon	5	Lap portion of belt

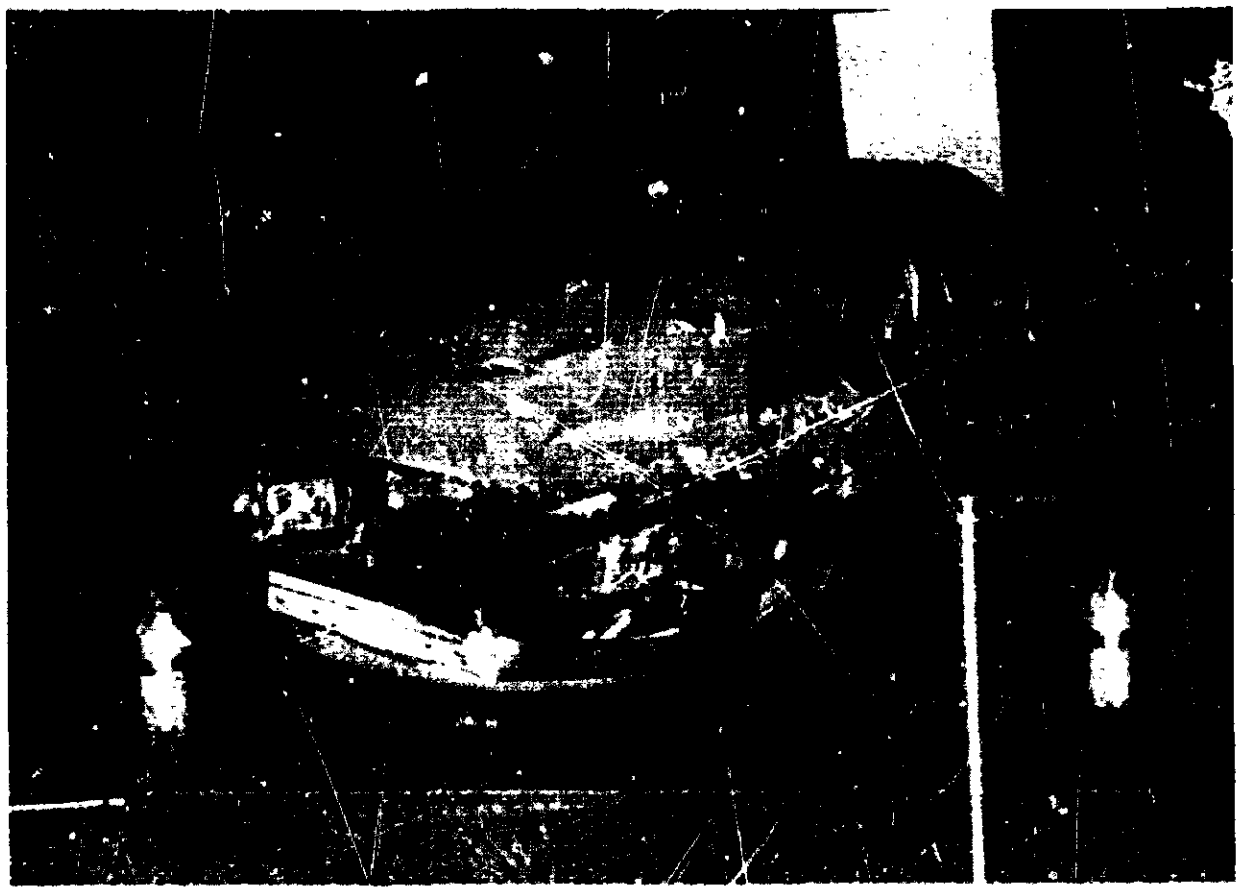
The driver was admitted to an area hospital for 11 days and was advised by doctors that he would be off work for approximately 6 months. When the driver misrouted the shoulder portion of his belt, he essentially eliminated any upper torso restraint, degrading his restraint to a lap belt only. Without the shoulder portion to help diffuse the 35.9 mph Delta V crash forces, the lap portion absorbed the full load, exceeding his body's injury tolerance. The misrouted belt also, no doubt, permitted the driver's upper torso to pivot forward and strike the steering assembly with greater force than would be expected with a properly worn 3-point belt. It was the abdominal loading which ultimately proved most injurious, though. Such critical abdominal injuries would not be expected had the lap/shoulder belt been worn properly.

CASE 193 - (NYC 85-H-OR15)

Case Vehicle: 1985 Ford Tempo, 4-door
Case Vehicle Weight: 2,501 pounds
Case Vehicle Delta V: 19.9 mph



Case Vehicle
Also Air-Bag Equipped



Circumstances

A 1985 Ford Tempo was negotiating a right curve when the vehicle went out of control, crossed over the centerline, and struck an oncoming 1982 Ford propane truck. The Ford Tempo sustained major damage across 68 inches of the front with a maximum deformation of 28 inches.

The Ford Tempo driver, restrained by a lap/shoulder belt and additionally protected by an air bag, received minor injuries.

Restraint and Injury

Seating Location: Driver
Sex: F
Age: 22 years
Height: 5 feet 3 inches
Weight: 105 pounds
Restraint Used: Lap/shoulder belt (ELR) and air bag system

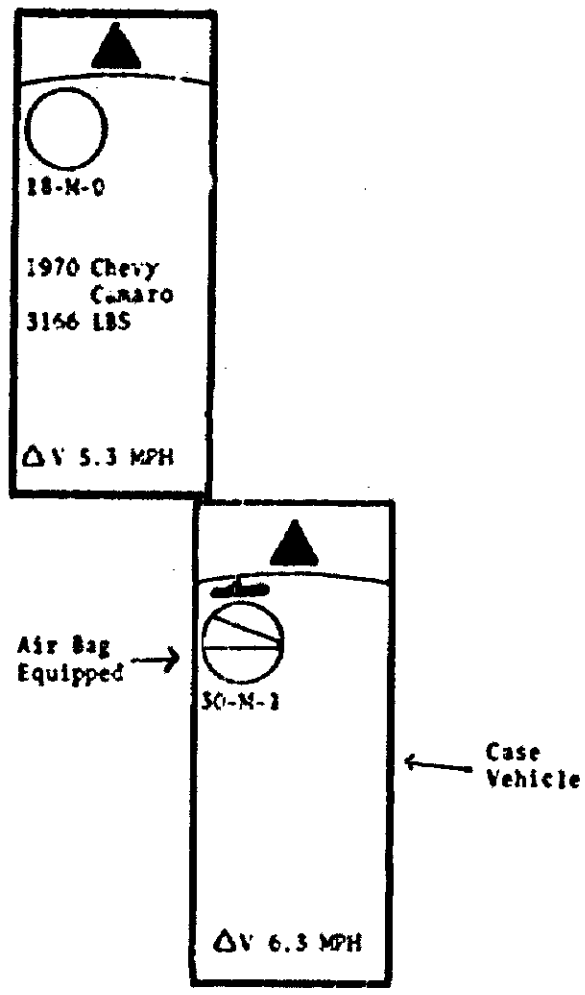
The driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver described the adjustment of the lap portion as tight "across the abdomen" and the shoulder portion as snug across the chest. There were no load marks observed. The vehicle was also equipped with an air bag system mounted in the steering column of the car, which deployed on impact.

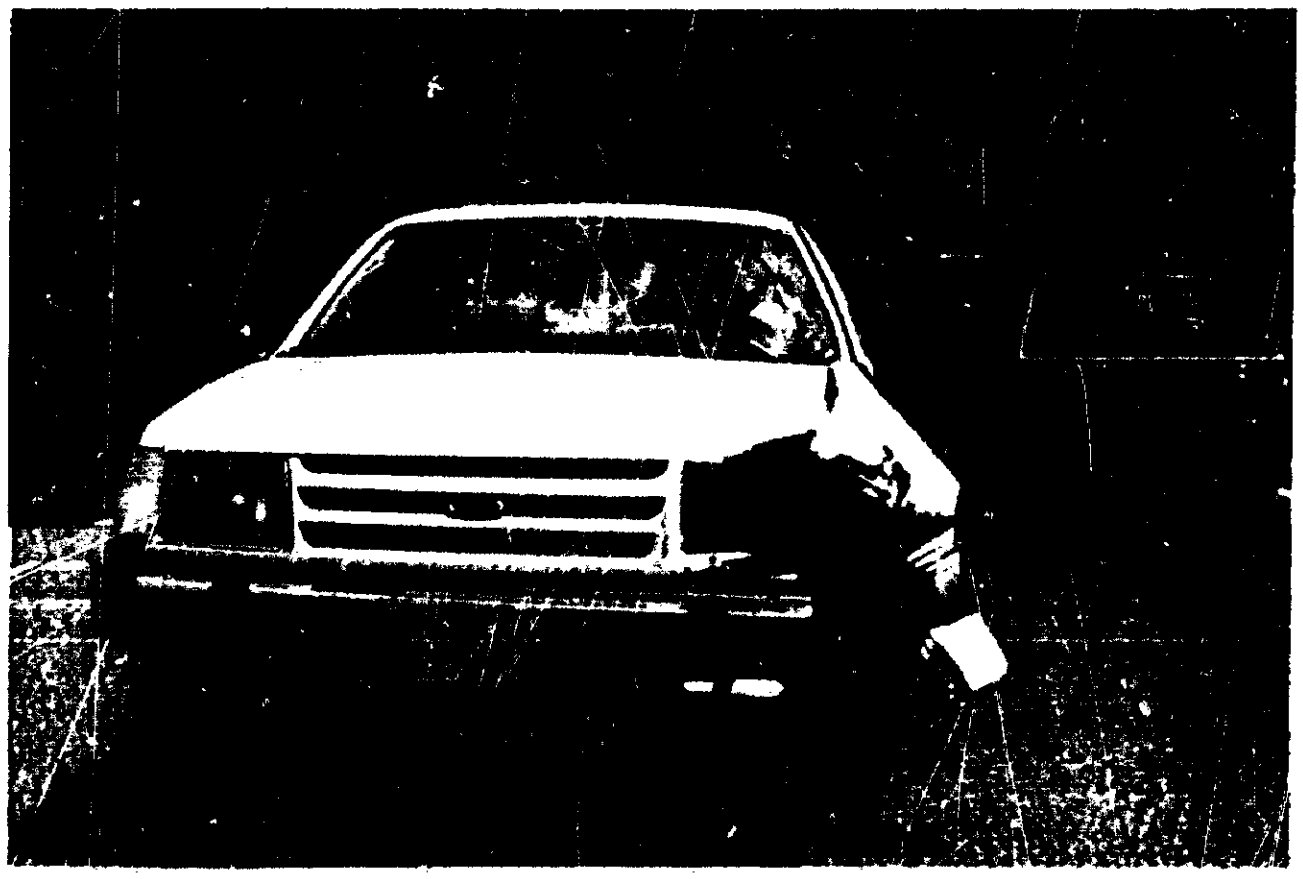
Injuries	AIS	Probable Source
Contusion, left knee	1	Left door panel
Contusion, right knee	1	Lower instrument panel
Abrasion, right arm	1	Air bag
Contusion, left pelvis	1	Lap portion of belt
Contusion, right pelvis	1	Lap portion of belt
Contusion, abdomen	1	Lap portion of belt

The driver was treated at a local emergency hospital and missed 1/2 day of work. Use of the available lap/shoulder belt, along with the air bag deployment, prevented occupant excursion, and probable contact with the steering wheel/column, and the instrument panel in this moderate collision (Delta V of 19.9 miles per hour). The combination of restraints provided in this vehicle prevented additional and more serious injuries in this crash.

CASE 194 - (NYC 85-H-OR14)

Case Vehicle: 1985 Ford Tempo, 4-door
Case Vehicle Weight: 2,668 pounds
Case Vehicle Delta V: 6.3 mph





Circumstances

A 1985 Ford Tempo struck the rear of a stopped 1982 Chevrolet Camero. The Ford sustained minor damage across 18 inches of the left front, with a maximum crush depth of 10 inches. The Camero was not available for inspection.

The Ford driver, restrained by a lap/shoulder belt and additionally protected by an air bag, sustained minor abrasions to the arms from the air bag. No information was available on the driver of the Camero.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 32 years
Height: 5 feet 10 inches
Weight: 150 pounds
Restraint Used: Lap/shoulder belt (ELR) and air bag system

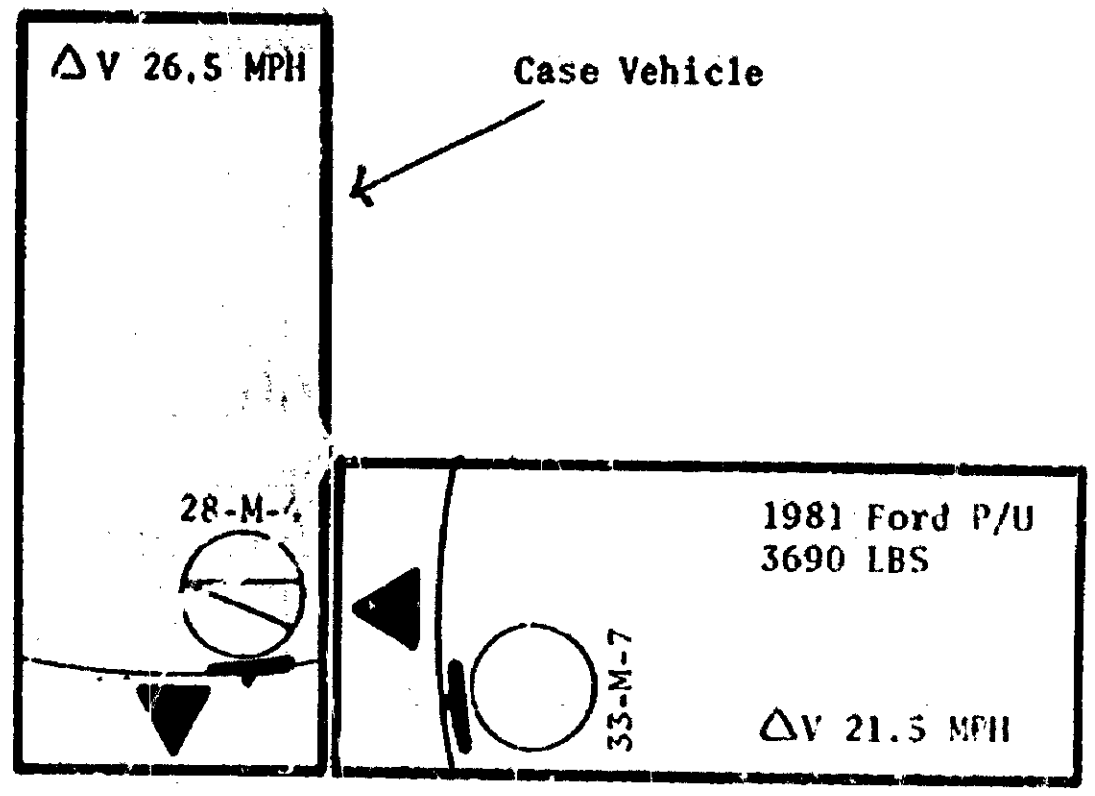
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver described adjustment of the lap portion as "across his waist" with a "loose" adjustment of the shoulder portion. In addition, the vehicle was equipped with a steering wheel hub-mounted air bag system which deployed in the collision. (Note: NHTSA's Calspan investigation team estimated the collision to be 9.1 mph Delta V using spinout trajectories and damage. The Delta V of 6.3 mph was based on damage only.)

Injuries	AIS	Probable Source
Abrasion, left wrist	1	Air bag material
Abrasion, right forearm	1	Air bag material

The driver was not treated for his injuries. The combination of the lap/shoulder belt and air bag retained the driver firmly in his seat away from injury-causing contacts with the interior, preventing injuries other than contact with the air bag material. Given the relatively low velocity change involved in this collision, a more serious level of injury would probably not have been expected even if the driver had been unrestrained.

CASE 195 - (ATL 85-H-0R06)

Case Vehicle: 1985 Chrysler New Yorker, 4-door
Case Vehicle Weight: 3,000 pounds
Case Vehicle Delta V: 26.5 mph



Circumstances

A 1981 Ford F-150 pick-up truck struck the left front side of a 1985 Chrysler New Yorker 4-door. The collision resulted in extensive damage to both vehicles with inward crush reaching a maximum of 14 inches on the left side of the Chrysler and 21 inches on the front of the Ford.

The Chrysler was occupied by a lap/shoulder belt-restrained driver who sustained severe injuries. The Ford was occupied by an unrestrained driver who received unspecified minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 28
Height: 5 feet 11 inches
Weight: 200 pounds
Restraint Used: Lap/shoulder belt (ELR)

The driver's position was equipped with a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a cinching latchplate, and a push-button release buckle attached to a flexible stalk. The driver described the adjustment of the lap portion as snug, positioned low on the hips, and he indicated the shoulder portion was adjusted tightly across his mid-chest area. There were no loading marks on the webbing to substantiate belt use. The instrument panel forward of the driver's seating position was substantially deformed and the steering wheel was broken.

Injuries	AIS	Probable Source
Laceration, forehead	1	A-pillar and side window
Laceration, upper lip and cheek	1	Left door glass
Laceration, spleen	4	Interior side wall
Laceration, pancreas	4	Steering wheel assembly
Laceration, sigmoid colon	4	Steering wheel rim or lap portion of belt (uncertain)
Laceration, posterior abdominal wall near liver	2	Steering wheel rim or lap portion of belt (uncertain)
Contusion, liver	3	Steering wheel rim or lap portion of belt (uncertain)

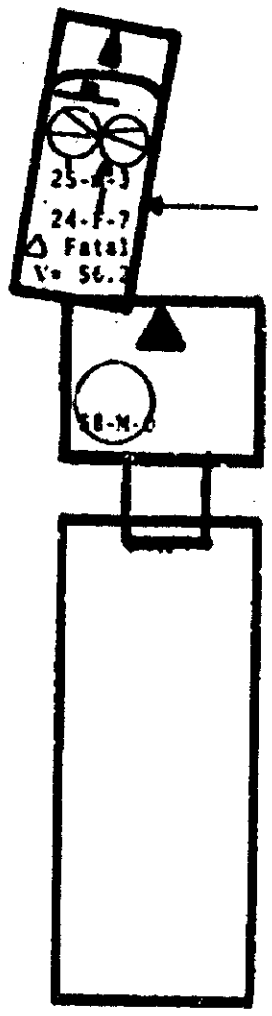
This driver was admitted into the intensive care unit where he remained for 5 days. He reportedly lost 3 months of work due to his severe internal injuries.

The presence of the severe upper abdominal organ injuries seems inconsistent with proper lap/shoulder belt adjustment and positioning. The principal direction of force, coming from approximately 10 o'clock, would have caused the driver to move forward and to the left at impact.

The presence of the broken steering wheel column could account for the upper abdominal organ damage and could indicate improper use of the lap portion of the belt. However, the case vehicle has a flexible buckle stalk which is positioned well above the seat cushion level and it has soft leather seats. These two factors could allow excessive slack in the lap/shoulder belt, allowing the lap portion to ride too high and cause the described injuries above. Considering the Delta V of over 26 miles per hour, the impact location, and the intrusion into the driver's area, it is likely that an unrestrained driver would have received injuries of similar severity.

CASE 196 - (CHI 85-H-OR13)

Case Vehicle: 1982 Mercury LN7, 2-door
Case Vehicle Weight: 2,501 pounds
Case Vehicle Delta V: 56.2 mph



Circumstances

A 1982 Mercury LN7 was traveling on a snow-covered roadway when the operator lost control and the vehicle began sliding, rear-end first, into the opposite lane of travel. A 1984 Ford truck pulling an auto hauler semi-trailer approached from the opposite direction and struck the rear of the Mercury. The Mercury received extensive damage with structural collapse reaching depths of up to 53 inches on the rear.

The Mercury driver, restrained by a lap/shoulder belt, received serious injuries while the passenger, also restrained by a lap/shoulder belt, sustained injuries which proved fatal.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 25 years
Height: 5 feet 8 inches
Weight: 150 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. This occupant, who received serious head injuries in the crash accompanied by memory loss, could not tell investigators if she had been wearing the belt or how it was positioned, but the location of the injuries, plus the condition of the restraint, indicate that it was worn. Force loading marks were found on the webbing in the area of the latchplate.

Injuries	AIS	Probable Source
Closed head injury with neurological defect	3	Interior contact
Large laceration, left side of head	2	Interior contact
Laceration, back of head	1	Interior contact
Displaced fracture, left clavical	2	Shoulder portion of belt

The driver was admitted to an area hospital for about 5 days. The lap/shoulder belt probably prevented additional and more serious, possibly fatal, injuries in this rearend collision with an estimated Delta V of over 56 miles per hour.

Case Vehicle
Seating Location: Right Front
Sex: F
Age: 24 years
Height: 5 feet 5 inches
Weight: 110 pounds
Restraint Used: Lap/shoulder belt (ELR)

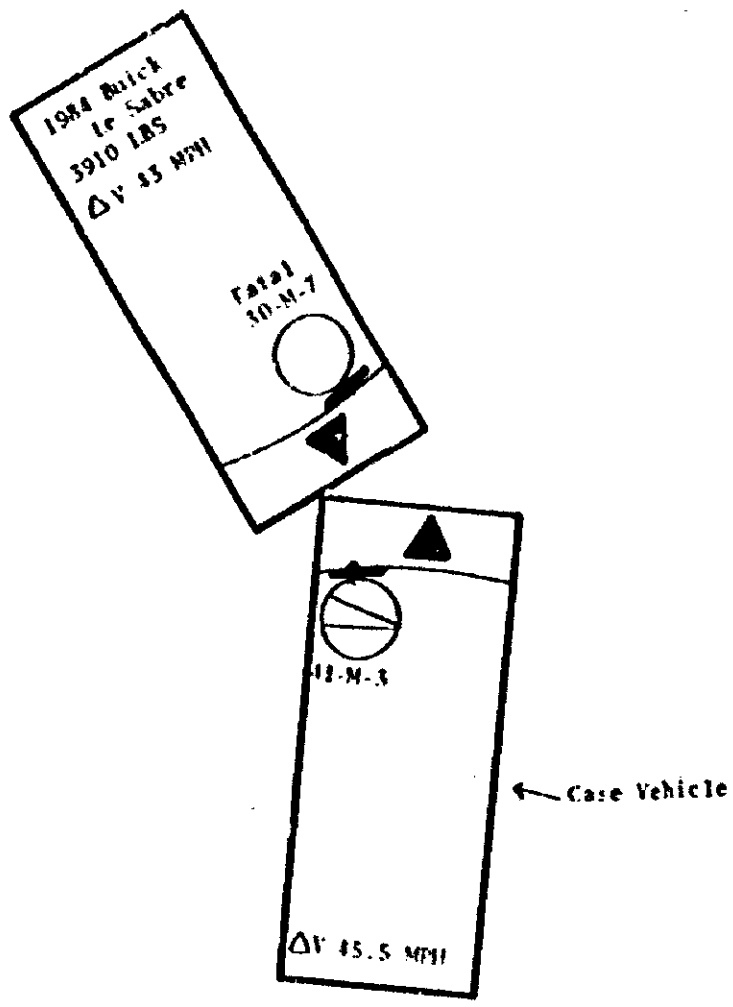
This passenger was wearing a lap/shoulder belt identical in design to the driver's. The abrasion marks on this occupant's hips indicated that the lap portion of the belt was positioned low and snug across the hips. Force loading marks were found on the webbing in the area of the latchplate.

Injuries	AIS	Probable Source
Extensive cartilage damage of the esophagus and laranyx	7	Forces through head rest
Undefined cervical fracture	7	Forces through head rest
Undefined abrasions about the hips	1	Lap portion of belt

This occupant was pronounced dead at the scene. Due to the massive crush, and resultant intrusion into the right side occupant compartment, it is unlikly that the collision was survivable for this passenger.

CASE 197 - (CHI 85-H-OR24)

Case Vehicle: 1984 Buick Le Sabre, 4-door
Case Vehicle Weight: 3,910 pounds
Case Vehicle Delta V: 43 mph



Circumstances

A 1984 Buick Le Sabre struck head-on into a 1970 Chevrolet Malibu that had crossed over into the Buick's traffic lane. The Buick received extensive structural damage with inward crush reaching depths of up to 59.5 inches at the front end. The Chevrolet also received extensive structural damage with maximum crush reaching depths of up to 54.8 inches to the front.

The Buick driver, restrained by a lap/shoulder belt, sustained serious injuries. The unrestrained driver of the Chevrolet was fatally injured.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 41 years
Height: 5 feet 10 inches
Weight: 210 pounds
Restraint Used: Lap/shoulder belt (ELR)

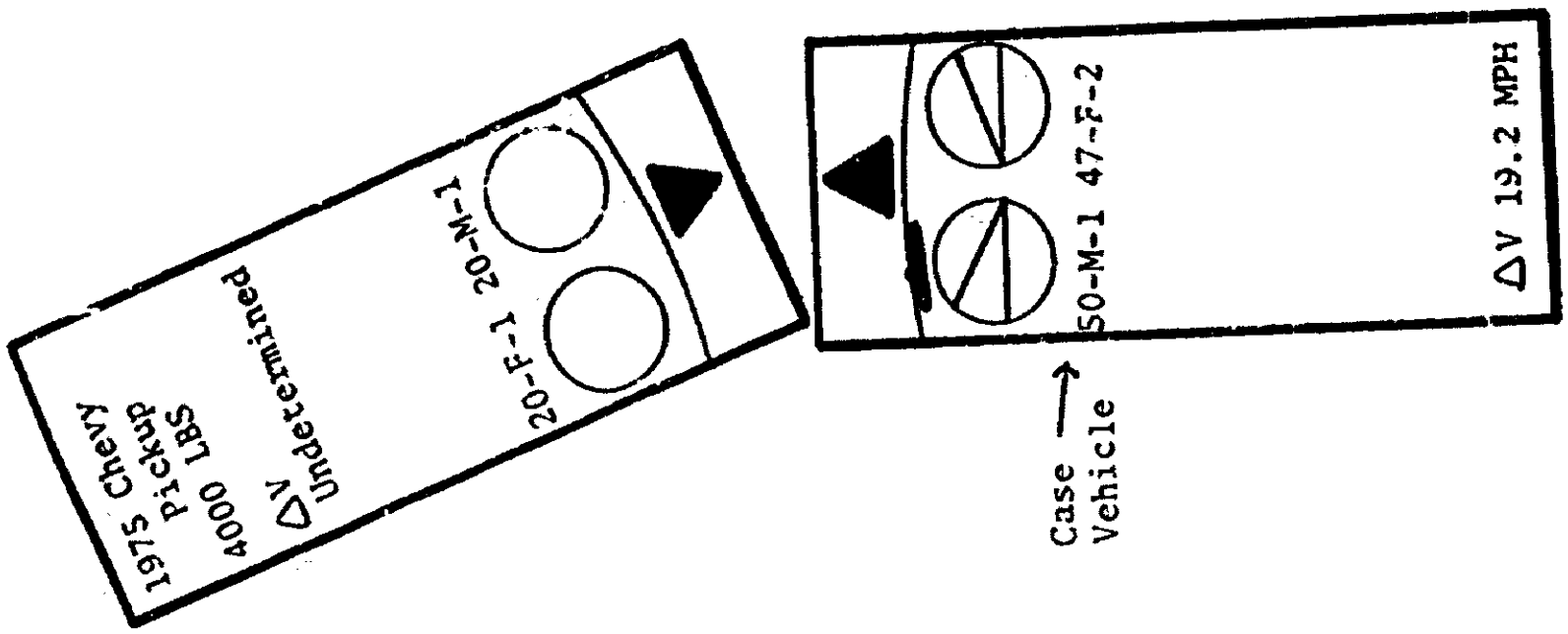
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver described the restraint as fitting snug across his lower hips and chest areas. This was substantiated by rescue personnel who had to cut the shoulder portion of the belt during rescue. The plastic covering over the D-ring had friction burn marks. There was extensive interior damage as the floor was buckled, the steering wheel bent, deformed, and pushed back into the driver's seat, and the dash twisted and deformed toward the driver's seat.

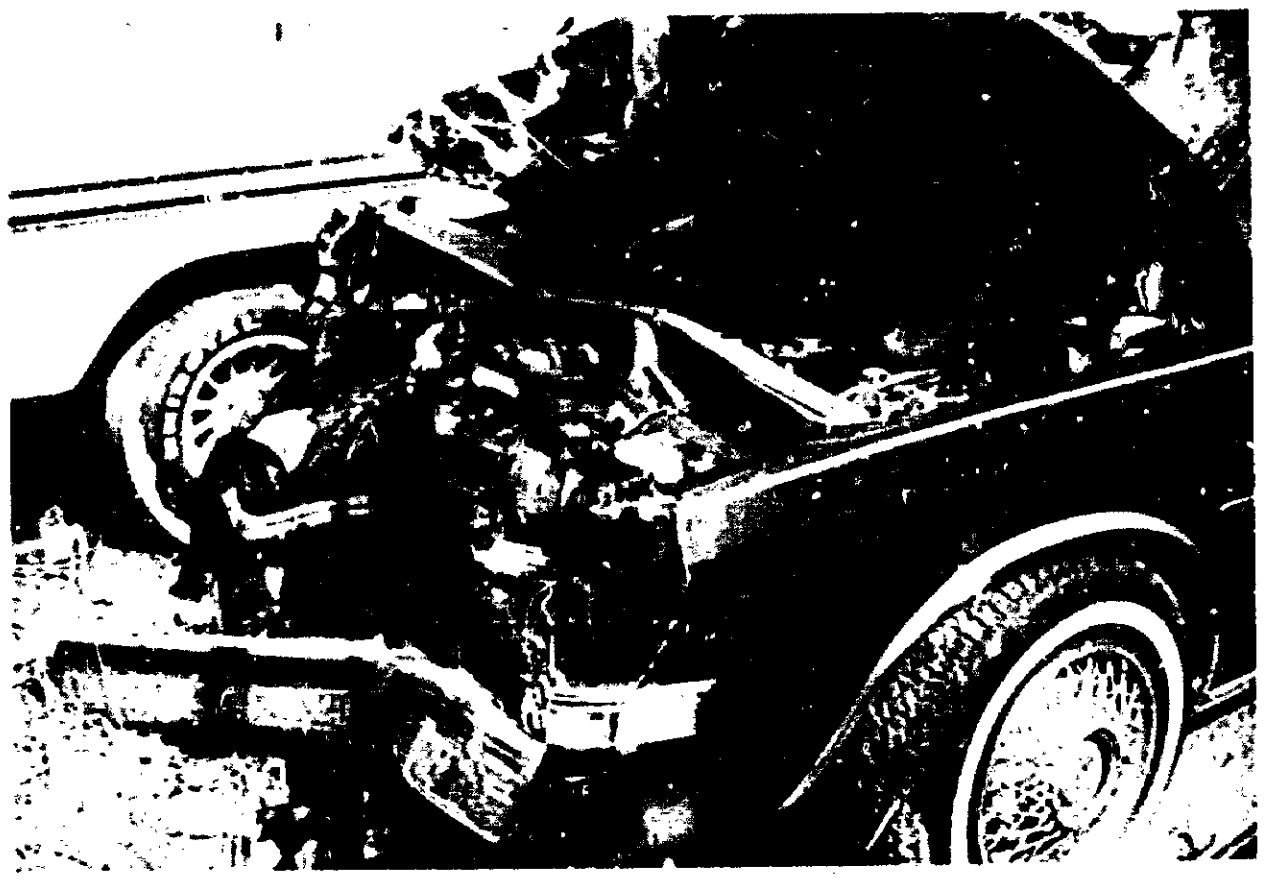
Injuries	AIS	Probable Source
Abrasion of the forehead	1	Unknown
Contusion, left maxilla	1	Dash
Compound fracture, right ankle	3	Foot pedals
Compound fracture, left distal humerus	3	Steering wheel
Compound fracture, left olecranon process	3	Steering wheel
Pulmonary contusion (left side)	3	Steering wheel column
Bladder contusion	3	Unknown
Comminuted fracture, right patella	2	Dash
Closed head injury (mild)	7	Unknown
Abrasion, lower right leg	1	Dash
Abrasion, lower left leg	1	Dash

The driver was admitted to an area hospital for approximately 20 days and reported he would be off work for about 4 months during rehabilitation. His use of the available lap/shoulder belt helped arrest his forward movement and reduced the severity of injuries. The injuries he received were from interior components of his vehicle moving rearward and impacting him, rather than his body being thrown forward. Had he not been using the restraint, it is doubtful he would have survived the 43 mile per hour Delta V collision.

CASE 199 - (ATL 85-H-0R10)

Case Vehicle: 1934 Plymouth Gran Fury
Case Vehicle Weight: 4,200 pounds
Case Vehicle Delta V: 18.1 mph





Circumstances

A 1984 Plymouth Gran Fury was approaching an intersection when a 1975 Chevrolet pick-up truck initiated a left turn across the Plymouth's path of travel. The Plymouth struck the right front of the truck, resulting in moderate damage across the entire width of the Plymouth's front with inward crush reaching a maximum depth of 29 inches.

The Plymouth driver, restrained by a lap/shoulder belt, sustained minor injuries. The right front passenger, also restrained by a lap/shoulder belt, sustained moderate injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 50 years
Height: 5 feet 8 inches
Weight: 210 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver reported the adjustment of the lap portion as low on the hips and the shoulder portion as being tight across his chest.

Injuries	AIS	Probable Source
Laceration, upper lip	1	Window glass
Contusion, chest	1	Steering wheel
Laceration, right finger	1	Window glass

The driver was treated at a local hospital and released. Use of the available lap/shoulder belt prevented significant forward motion into the steering column, instrument panel, and the fractured windshield (broken by hood contact). An unrestrained driver would probably have received additional and more serious injuries in this 18.1 mph Delta V collision.

Case Vehicle
Seating Location: Right Front
Sex: F
Age: 47 years
Height: 5 feet 6 inches
Weight: 280 pounds
Restraint Used: Lap/shoulder belt (ELR)

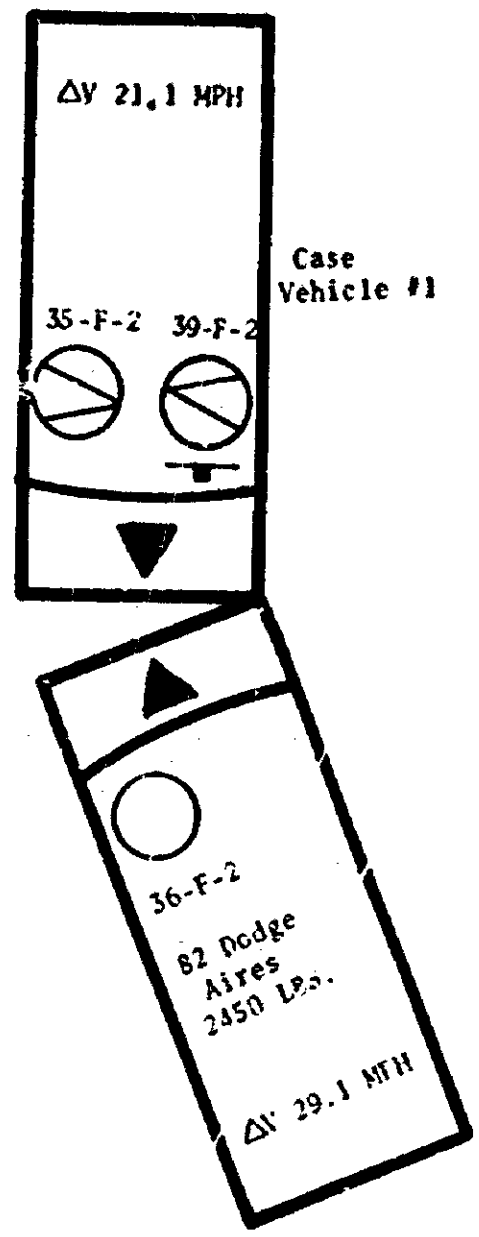
This occupant was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. The driver reported the passenger's adjustment of the lap portion as low on the hip and the shoulder portion as "loose" across the chest. Since the latchplate was free-sliding, and thus apportions slack equally, the lap portion also probably was "loose."

Injuries	AIS	Probable Source
Lacerations, left knee	1	Lower instrument panel
Lacerations, right knee	1	Lower instrument panel
Fracture, right humerus	2	Upper instrument panel
Fracture, left foot	2	Lower instrument panel

The passenger was admitted to a local hospital for an unspecified time and reportedly remained off work for a minimum of 6 months. The use of the lap/shoulder belt prevented more significant forward motion, more serious contact with the instrument panel, and probable impact with the windshield. However, it is likely that slack interacting with the occupant's size and weight affected the performance of the lap/shoulder belt in this moderate speed collision (Delta V of 18.1 miles per hour).

CASE 201 - (ATL 85-H-OR17)

Case Vehicle: 1978 Buick Regal, 2-door
Case Vehicle Weight: 3,375 pounds
Case Vehicle Delta V: 21.1 mph



Circumstances

A 1978 Buick Regal was in a curve to the left when an oncoming 1982 Dodge Aries braked, crossed the centerline, and struck the Buick in the front. The Buick received substantial structural damage with crush reaching depths of up to 20.5 inches across the front end. Damage to the Dodge was also substantial with a maximum crush of 18 inches at the front end.

The Buick driver and right front passenger, both restrained by lap/shoulder belts, received moderate injuries. The unrestrained driver of the Dodge also received moderate injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 39
Height: 5 feet 2.5 inches
Weight: 110 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver described the adjustment of the lap portion as being positioned low across her hips and snug. The shoulder portion was reportedly adjusted so that a clenched fist could be placed between the webbing and the chest. No force loading marks were found on the webbing.

Injuries	AIS	Probable Source
Long laceration, forehead	2	Steering wheel hub
Laceration, chest	1	Shoulder portion of belt
Laceration, right knee	1	Lower instrument panel
Laceration, right foot	1	Foot controls
Abrasion, left knee	1	Steering wheel/lower instrument panel
Abrasion, right knee	1	Steering wheel/lower instrument panel
Abrasion, left side lower abdomen	1	Lap portion of belt
Abrasion, right side of lower abdomen	1	Lap portion of belt
Abrasion, lower right side of chest	1	Steering wheel
Abrasion, mid chest	1	Shoulder portion of belt
Acute cervical strain	1	Impact forces

The driver was treated at an area hospital as an out-patient and reported a 2-week absence from work. In spite of some slack in the shoulder portion, it is probable that the lap/shoulder belt prevented more serious injuries in this 21.1 mph Delta V collision. An unrestrained driver would have been free to contact the forward interior components with much greater force.

Case Vehicle
Seating Location: Right Front
Sex: F
Age: 35 years
Height: 5 feet 3.75 inches
Weight: 115 pounds
Restraint Used: Lap/shoulder belt (ELR)

The right front passenger was wearing a continuous loop lap/shoulder belt equipped just like the driver's restraint. This occupant described the adjustment of the lap portion as being positioned "across her abdomen" and snug. The shoulder portion was reportedly adjusted so that the palm of a hand could be placed between the webbing and the chest. No force loading marks were found on the webbing.

Injuries	AIS	Probable Source
Fracture, #6 & 7 ribs left side	2	Shoulder portion of belt
Cervical spine strain	1	Impact force
Abrasion, left knee	1	Instrument panel
Abrasion, right knee	1	Instrument panel
Abrasion, right lower leg	1	Instrument panel
Abrasion, right side upper chest	1	Shoulder portion of belt
Abrasion, left side lower abdomen	1	Shoulder portion of belt
Abrasion, right ankle	1	Unknown

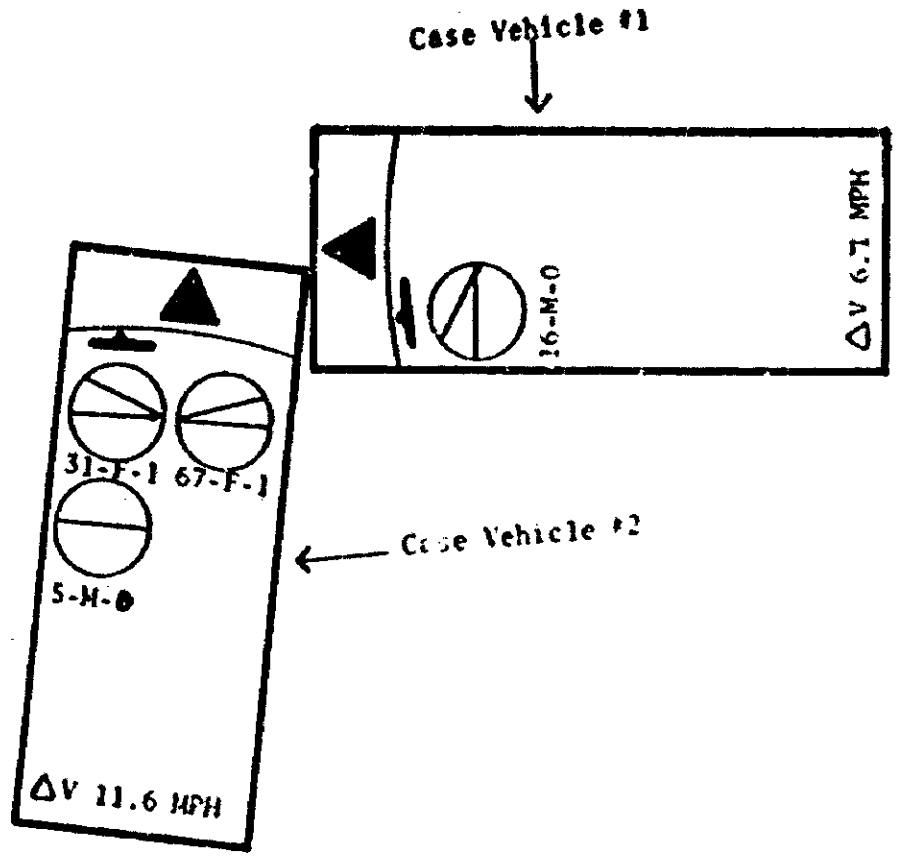
This occupant was treated as an out-patient at an area hospital and reported a delay of 2 weeks in beginning a new job. Even with the lap portion possibly being worn a little high, the lap/shoulder belt probably helped to reduce the overall severity of injury sustained by this passenger.

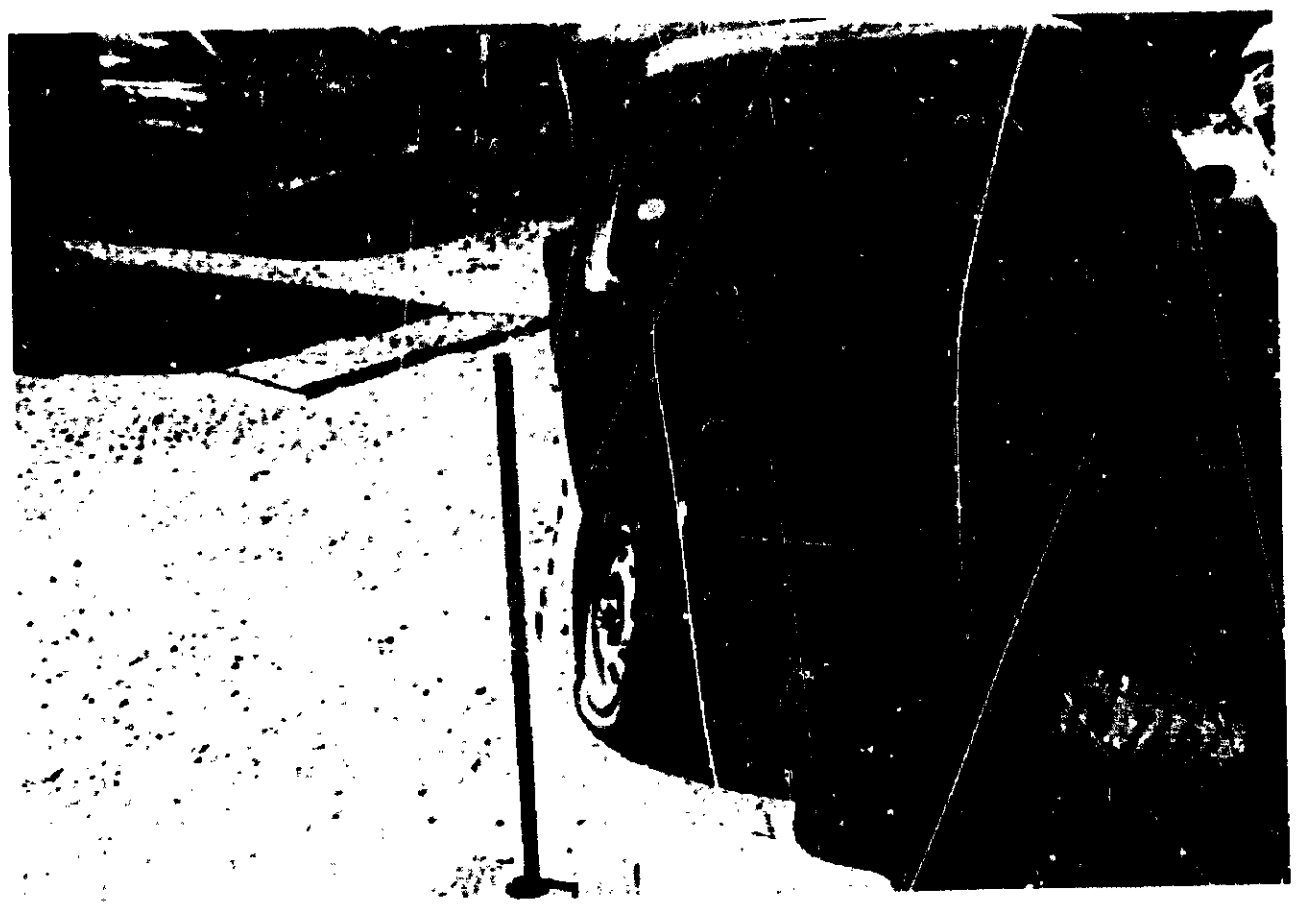
CASE 206 - (CHI 85-H-0R22)

Case Vehicle #1: 1975 Chrysler Newport, 2-door
Case Vehicle Weight: 4,640 pounds
Case Vehicle Delta V: 6.1 mph

Case Vehicle #2: 1984 Chevrolet Chevette, 2-door
Case Vehicle Weight: 2,440 pounds
Case Vehicle Delta V: 11.6 mph

Case Vehicle #3: 1976 Toyota Corolla, 2-door
Case Vehicle Weight: 2,435 pounds
Case Vehicle Delta V: Undetermined (sideswipe accident)





Circumstances

A 1975 Chrysler Newport 2-door, traveling at a driver-estimated speed of 35 to 40 mph, struck the right front of a 1984 Chevrolet Chevette 2-door. After impact, the Chrysler swerved to the right and sideswiped the left side of a 1976 Toyota Corolla 2-door which was stopped in its traffic lane. The collision resulted in minor damage to the Toyota, moderate damage to the Chrysler, and substantial damage to the Chevrolet.

The Chrysler driver, restrained by a lap/shoulder belt, was not injured. Both lap belt-restrained front seat occupants of the Chevrolet received minor injuries. The lap belt-restrained rear seat occupant of the Chevrolet was not injured. The driver of the Toyota, restrained by a lap/shoulder belt, was not injured.

Restraint and Injury

Case Vehicle #1 : Chrysler
Seating Location: Driver
Sex: M
Age: 16
Height: 5 feet 9 inches
Weight: 150 pounds
Restraint Used: Lap/shoulder belt with dual retractors (ALR/ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an automatic locking retractor for the lap portion, an emergency locking retractor for the shoulder portion, a sewn-in latchplate, and a push-button release buckle attached to a flexible stalk. The driver described the precrash adjustment of the lap portion as snug, positioned low on the hips, and the shoulder strap as snug across the midchest area. Fraying on the webbing and scratches on the latchplate indicated frequent use of the belt. No force loading marks were found on the webbing.

This driver reported that he was not injured. Restraint use was probably of little benefit in this minor collision (Delta V of 6.1 mph for the Chrysler).

Case Vehicle #2: Chevrolet
Seating Location: Driver
Sex: F
Age: 31
Height: 5 feet 1 inch
Weight: 115 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor, a cinching latchplate, a windowshade tension-relief feature, and a push-button release buckle attached to a flexible stalk. She described the adjustment of the lap portion as snug on her lower hips and the shoulder portion as being snug across her mid-chest area. There were marks found on the webbing, attributed to force loading at the D-ring. The driver stated she made contact with the steering wheel and instrument panel at impact, but no deformation was noted.

Injuries	AIS	Probable Source
Contusion, left knee	1	Dashboard
Contusion, right knee	1	Dashboard
Contusion, left forearm	1	Steering assembly

The use of the lap/shoulder belt prevented this driver from making uncontrolled movement into the dashboard and steering assembly. However, lap/shoulder belt use was probably of little overall benefit in this low Delta V side angle collision.

Case Vehicle #2: Chevrolet
Seating Location: Right front
Sex: F
Age: 67
Height: 5 feet 2 inches
Weight: 190 pounds
Restraint Used: Lap/shoulder belt (ELR)

This passenger was wearing a lap/shoulder belt identical in design to the driver's. This passenger described the adjustment of the lap portion as snug and low on the hips and she indicated that the shoulder portion was snug on her midchest area. There were marks found on the webbing attributed to force loading at the latchplate. The interior sidewall of the right front door was moderately deformed outboard.

Injuries	AIS	Probable Source
Contusion, left side of head	1	Unknown
Contusion, right side of face	1	Side window
Contusion, right thigh	1	Passenger door
Contusion, lower right leg	1	Passenger door
Contusion, right elbow	1	Passenger door

This passenger was examined at an outpatient medical facility and released. Had this passenger not been restrained, her injuries probably would have been similar in that the restraint offered little protection in this low-speed side angle impact. Restraint use can not prevent occupant contact with an adjacent interior sidewall.

Case Vehicle #2: Chevrolet
Seating Location: Left rear
Sex: M
Age: 5
Height: 3 feet 7 inches
Weight: 45 pounds
Restraint Used: Lap belt (ALR)

This passenger was wearing a lap belt equipped with an automatic locking retractor, a sewn-on latchplate, and a push button release buckle attached to the webbing. The child's mother described the adjustment of the lap belt as snug, positioned low on the child's hips. There were abrasions found on the webbing, attributed to force loading at the plastic retractor housing. Although the boy stated that he hit his head on the right front seatback, there was no deformation to the seatback forward of this seating position.

This occupant was not injured. Considering the impact location of this 11.6 mph Delta V collision, it is doubtful that the injury outcome would have been any different if the seat belt had not been used in this collision.

Case Vehicle #3: Toyota
Seating Location: Driver
Sex: M
Age: 41
Height: 5 feet 11 inches
Weight: 165 pounds
Restraint Used: Lap/shoulder belt with dual retractors (ALR/ELR)

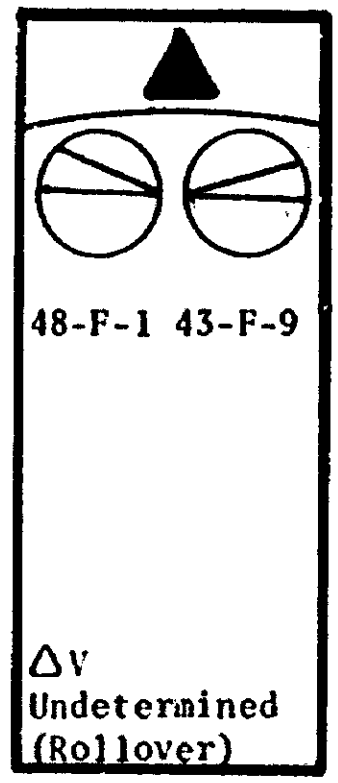
This driver was wearing a continuous loop lap/shoulder belt equipped with an automatic locking retractor for the lap portion and an emergency locking retractor for the shoulder portion, a sewn-in latchplate, a self-tensioning feature, and a push-button release buckle. The driver described the adjustment of the lap portion as snug on his lower hips and he indicated the shoulder portion was snug across his midchest area.

The driver's door collapsed inward, pressing the webbing against the seat so the belt would not retract after the collision.

This driver was not injured. The lap/shoulder belt was probably of little benefit in this low speed sideswipe collision.

CASE 208 - (LAX 85-H-OR11)

Case Vehicle: 1984 Toyota Van
Case Vehicle Weight: 4,800 pounds
Case Vehicle Delta V: 90° rollover (no Delta V)



Circumstances

A 1984 Toyota van pulled onto an exit ramp and the driver lost control of the vehicle. The van impacted and surmounted a 6-inch road edge berm, then entered the upslope median that divides the freeway from the exit ramp. It traveled about 190 feet along the median, struck a 2-inch sign post, rotated counterclockwise 70° and then rolled over onto its left side. The van received moderate structural damage to the roof, front, and sides. Interior damage consisted of a deformed instrument panel, the steering column was forced upward, and the steering wheel rim was deformed.

Both occupants of the van were restrained by lap/shoulder belts. The driver received minor injuries; injury outcome for the right front passenger was unknown.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 48
Height: 5 feet
Weight: 130 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a free-sliding latchplate and a stalk-mounted buckle assembly. The driver described adjustment of the lap portion as being positioned "across her abdomen" with just a little slack. The shoulder portion was reportedly adjusted where the palm of her hand fit between the belt and her chest. There were multiple D-ring transfers on the restraint webbing, indicating that the lap/shoulder belt retractor let out numerous times during the different impacts and rollover.

Injuries	AIS	Probable Source
Multiple minor face lacerations	1	Windshield glass
Neck strain	1	Interior roof
Contusion left side of head	1	Interior roof
Contusion front of chest	1	Steering wheel
Multiple body contusions	1	Source unknown

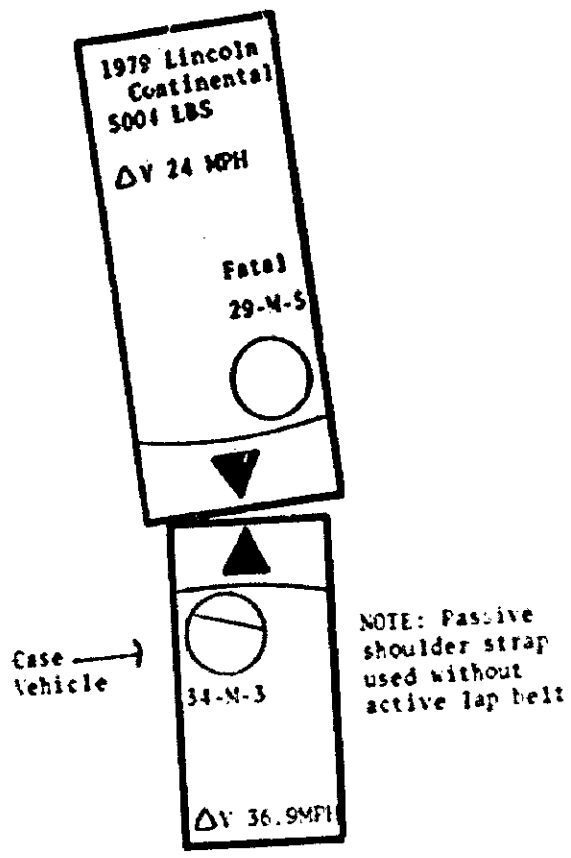
The driver was admitted to an area hospital for 2 days. Use of the available lap/shoulder belt helped control movement during the 90 degree rollover. This was in spite of a serious integrity defect of the webbing. The defect occurred when the engine compartment hatch opened and then closed; the carpeting caught on the webbing stitching at the floor anchor bolt and captured the webbing under the latchplate of the engine housing. Under loading, the trapped webbing can be pulled out from under the cover, thus introducing slack into the lap/shoulder belt. Even with the apparent system defect, it is probable that this driver could have received additional and more serious injuries if she had not been fully restrained.

Case Vehicle
Seating Location: Right front
Sex: F
Age: 43
Height: Unknown
Weight: Unknown
Restraint Used: Lap/shoulder belt (ELR)

This passenger was wearing a lap/shoulder belt identical in design to the driver's. No precrash adjustments nor injury information were available as the passenger refused to provide information. The integrity defect of the webbing was not a problem with this restraint. Loading marks on the webbing indicated use of restraint during the collision. Use of the available lap/shoulder belt probably prevented serious injuries to this passenger in this 90 degree rollover accident.

CASE 209 - (LAX 85-H-OR20)

Case Vehicle: 1985 Toyota Cressida, 4-door
Case Vehicle Weight: 3,250 pounds
Case Vehicle Delta V: 36.9 mph



Circumstances

A 1985 Toyota Cressida struck a 1979 Lincoln Continental head-on as the Lincoln was traveling the wrong direction in the Toyota's lane of travel. The Toyota received extensive front structural damage with deformation damage reaching depths of up to 44 inches. Damage to the Lincoln was also extensive with the maximum crush being measured at 34 inches.

The Toyota driver, restrained by a 2-point passive belt, received serious injuries. The unrestrained driver of the Lincoln sustained fatal injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 34 years
Height: 5 feet 10 inches
Weight: 165 pounds
Restraint Used: 2-point shoulder strap (automatic); available manual lap belt not used

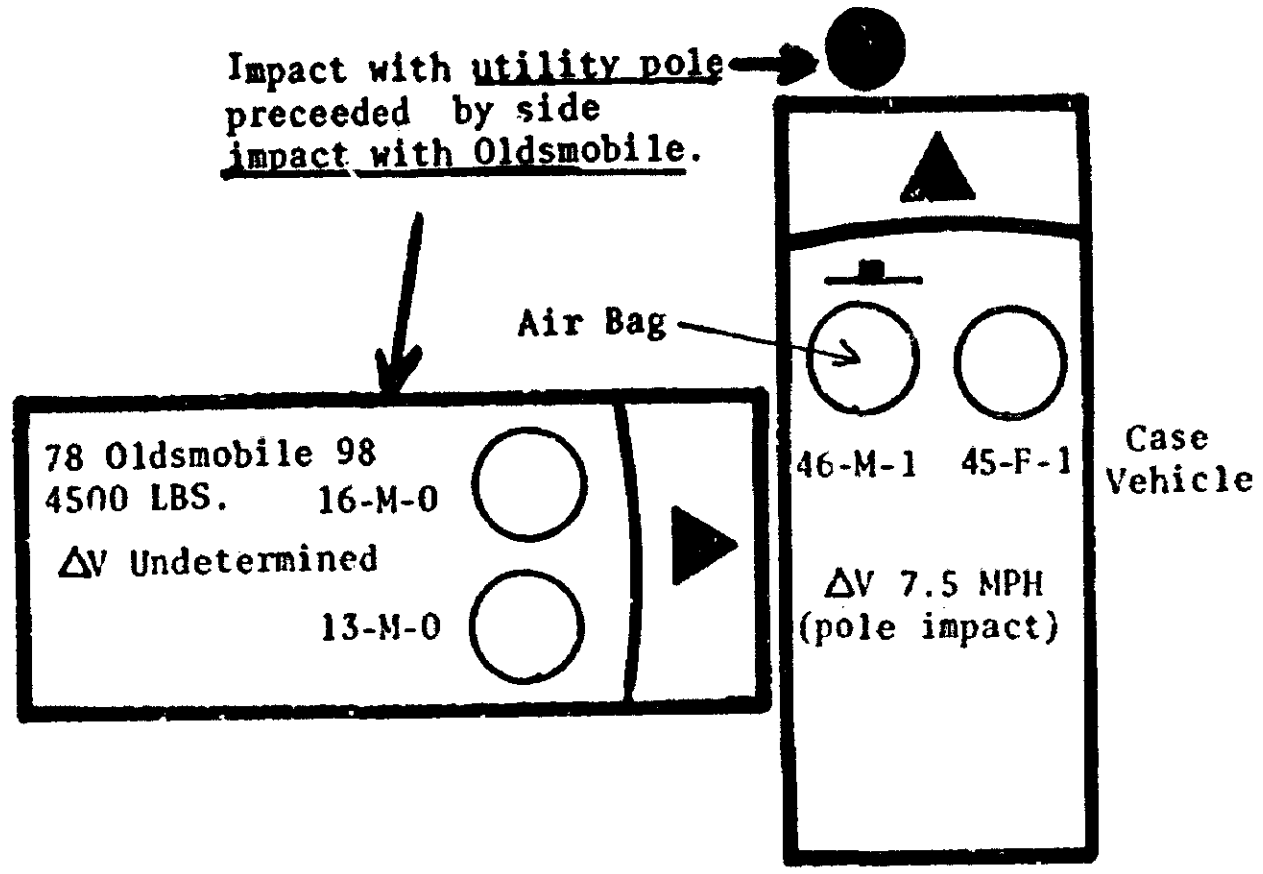
This driver was wearing a 2-point automatic shoulder belt but was not using the available manual lap belt. The shoulder portion was equipped with an emergency locking retractor mounted on the driveline tunnel, a movable anchor which travels from the A-pillar to the B-pillar, and an emergency release lever. The driver described the shoulder belt adjustment as being positioned so that a clenched fist could be placed between the webbing and the chest. Stretch marks were found on the shoulder strap webbing in the area of shoulder and body contact.

Injuries	AIS	Probable Source
Laceration, lung	3	Shoulder strap
Fracture, rib	1	Shoulder strap
Contusion, kidney	3	Shoulder strap
Contusion, right side of chest	1	Shoulder strap

The driver was admitted to an area hospital for 4 days and reported a loss from work of 3 weeks. In spite of the reported slack in the shoulder belt, it should have been snug due to the self-tensioning retractor. The automatic shoulder strap performed well in this 36.9 mph Delta V collision, and most likely prevented the driver from receiving more serious and additional injuries. If this driver had been wearing the available lapbelt along with the automatic shoulder strap, it is possible that his injuries may have been reduced due to the forces being distributed over a wider area of his body.

CASE 210 - (MKC 85-H-OR28)

Case Vehicle: 1985 Ford Tempo
Case Vehicle Weight: 2,733 pounds
Case Vehicle Delta V: Undetermined



Circumstances

A 1985 Ford Tempo entered an intersection and was impacted on the left side by a 1978 4-door Oldsmobile 98. The impact redirected the Ford to the right and into a light pole standard. The Ford sustained moderate damage to the left side in the initial collision and minor damage to the left front from the pole impact. The much heavier Oldsmobile sustained minor damage.

The Ford driver, not wearing a seat belt but in an air-bag equiped car, sustained moderate injury. The occupants of the Oldsmobile were uninjured.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 46 years
Height: 6 feet
Weight: 170 pounds
Restraint Used: Airbag only

The driver was not wearing the available manual lap/shoulder belt but received passive protection when the air bag deployed.

Injuries	AIS	Probable Source
Laceration, left head	1	Door frame
Closed head injury with unspecified loss of consciousness	2	Door frame
Cervical muscle strain	1	Impact forces
Abrasions, left hand	1	Air bag material

The driver was transported to a local hospital, admitted, and released the next day. He reportedly lost 1 week of work. The driver probably received his moderate head injury during the initial collision, a side impact. The lap/shoulder belt, if worn, would not have been able to prevent his head from making contact with the left door frame; in a left side impact he would slide out of the shoulder portion. The air bag deployment could have occurred either during the side impact, which involved substantial sheet metal engagement or snagging that which may have provided longitudinal forces sufficient to close the sensors, or during the secondary impact, the impact with the light pole standard. (Even if it had been deployed at the time of the initial side collision, the driver could have made contact with the door frame.) The air bag may have prevented some head and facial injuries from contact with the steering wheel.

Case Vehicle
Seating Location: Right Front
Sex: F
Age: 45 years
Height: 5 feet 4 inches
Weight: 120 pounds
Restraint Used: None. Air bag not available at his position.

The passenger was not wearing the available lap/shoulder belt.

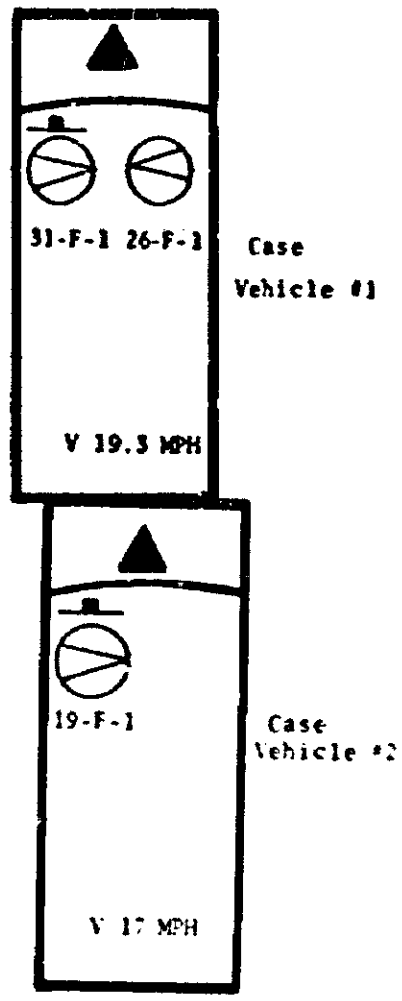
Injuries	AIS	Probable Source
Abrasions, face	1	Air bag material
Contusion, jaw	1	Front interior
Contusion, face	1	Front interior

The passenger was transported to a local hospital for treatment and released within 24 hours. There was no loss of work reported. Use of the available lap/shoulder belt would probably have prevented some of the minor injuries sustained by the occupant.

CASE 211 - (CHI 85-H-OR23)

Case Vehicle #1: 1984 Cadillac Cimmaron, 4-door
Case Vehicle Weight: 2,823 pounds
Case Vehicle Delta V: 19.3 mph

Case Vehicle #2: 1979 Chevrolet Malibu, 2-door
Case Vehicle Weight: 3,209 pounds
Case Vehicle Delta V: 17 mph



Circumstances

A 1979 Chevrolet Malibu failed to notice traffic stopped ahead and struck the rear of a 1984 Cadillac Cimarron. The Chevrolet sustained moderate damage across 60 inches of the front to a maximum depth of 14 inches. The Cadillac sustained moderate damage across a 59-inch wide area of its rear with deformation reaching a maximum depth of 7 inches.

The driver and right front passenger of the Cadillac, both wearing lap/shoulder belts, sustained minor injuries, as did the lap/shoulder-belted driver of the Chevrolet.

Restraint and Injury

Case Vehicle #1: Cadillac
Seating Location: Driver
Sex: F
Age: 31
Height: 5 feet 7 inches
Weight: 145 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver stated that the lap portion belt was adjusted low on the hips and the shoulder portion was "comfortably" adjusted across the mid-chest.

Injuries	AIS	Probable Source
Cervical strain	1	Impact force
Contusion, left lower leg	1	Lower instrument panel
Contusion, right lower leg	1	Lower instrument panel

The driver was treated in the emergency room of a local hospital and released, reportedly losing 4 days of work. The lap/shoulder belt apparently functioned as designed. However, its benefits in this 19.3 mph Delta V rear-end collision are difficult to assess. In a rear-end collision, the driver would first accelerate into the back seat, with the seat receiving much of the crash load. The driver may have received some benefit from the 3-point belt during rebound, which is generally a much weaker force.

Case Vehicle #1: Cadillac
Seating Location: Right front
Sex: F
Age: 26
Height: 5 feet 4 inches
Weight: 120 pounds
Restraint Used: Lap/shoulder belt (ELR)

This passenger was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The passenger described adjustment of the lap portion as aligned "across the waist," fitting "loose," and stated that the shoulder portion was loose enough to allow a clenched fist between it and her chest.

Injuries	AIS	Probable Source
Neck strain	1	Impact forces
Back strain	1	Impact forces

The passenger was treated at a local emergency hospital and subsequently treated by a chiropractor, reporting a 4-day loss of work. The benefits of lap/shoulder belt use in this rear-end collision are difficult to assess. The passenger's injuries probably occurred at initial impact as she accelerated back into her seat.

Case Vehicle #2: Chevrolet
Seating Location: Driver
Sex: F
Age: 19
Height: 5 feet 4 inches
Weight: 125 pounds
Restraint Used: Lap/shoulder belt (ELR)

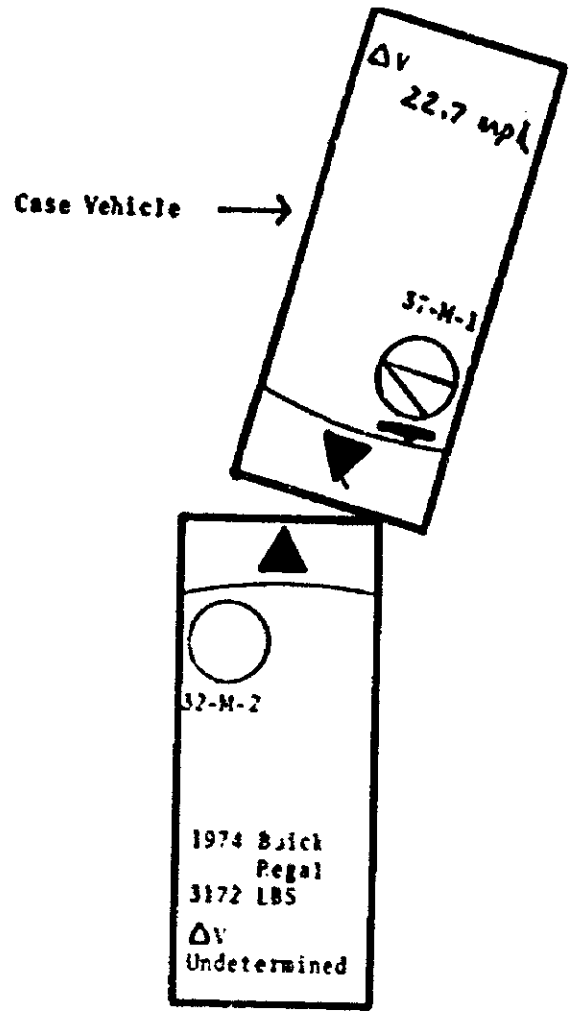
This driver was restrained by a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver described lap portion as adjusted low across the hips and "loose" across the chest.

Injuries	AIS	Probable Source
Contusion, pelvis	1	Lap portion of belt

The driver was transported to a local emergency room, treated, released, and reported missing 1 day of work. Considering the 17 mph Delta V for this vehicle, the lap/shoulder belt probably prevented the driver from going forward into the steering wheel and other components, thereby preventing additional and possibly more serious injury.

CASE 212 - (SEA 85-H-0R16)

Case Vehicle: 1981 Dodge Diplomat, 4-door
Case Vehicle Weight: 3,965 pounds
Case Vehicle Delta V: 22.7 mph



Circumstances

A 1981 Dodge Diplomat was struck head-on by a 1984 Buick Regal 2-door that had crossed over into the Dodge's traffic lane. The Dodge received extensive structural damage with maximum inward crush reaching depths of up to 42 inches at the left front. The Buick reportedly received extensive structural damage to the right front, however, crush measurements were not available for this vehicle as it had been dismantled before the Safety Board investigation.

The Dodge driver, restrained by a lap/shoulder belt, sustained minor injuries. The unrestrained Buick driver received serious injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 37
Height: 6 feet
Weight: 195 Pounds
Restraint Used: Lap/shoulder belt (ELR)

The driver, a Washington State Patrol Trooper, was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver described adjustment of the lap portion as being "snug fitting," worn across the lower part of his hips. The shoulder portion was worn across the chest area and over the driver's heavy winter jacket. Contusion injuries, diagonally across the chest and abdomen areas, were consistent with lap/shoulder belt use.

Force loading marks were found on the webbing and a worn/burned section was noted on the plastic-covered D-ring. The webbing of the shoulder portion separated during impact (see discussion to follow). The steering column was bent forward and broke away from its anchoring.

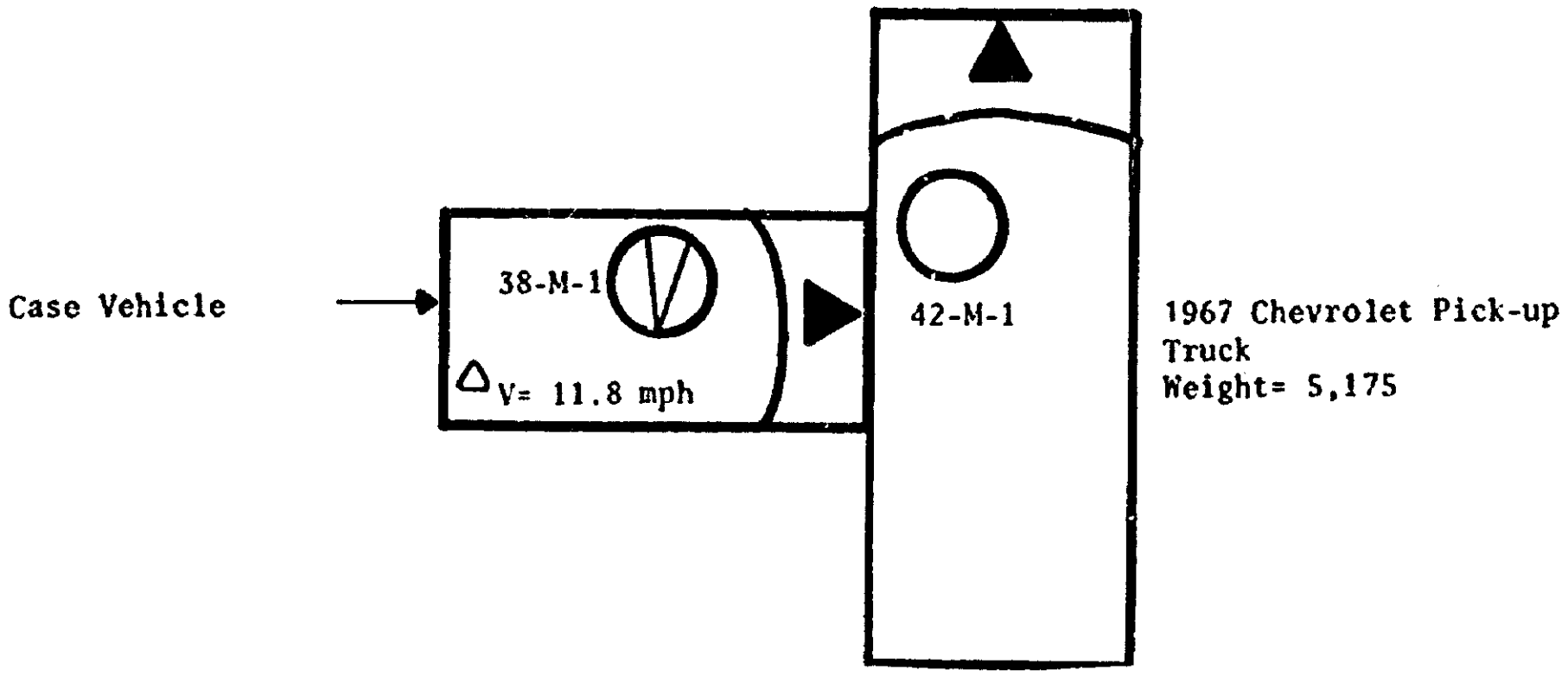
Each Washington State Patrol vehicle is equipped with an after-market, perforated steel protective cage placed between the rear and front seats. When installed, it is necessary to remove and reinstall the belt restraint D-rings as the D-ring bolt is the attachment point for the cage. In some cases, the reinstalled D-ring's free movement is restricted, which prevents even belt distribution across the D-ring. This vehicle had a D-ring which had its rotation restricted. At impact, the belt slid forcefully forward, splitting the plastic covering and exposing the metal base. This exposed metal base cut the shoulder portion webbing when the system was loaded by impact forces.

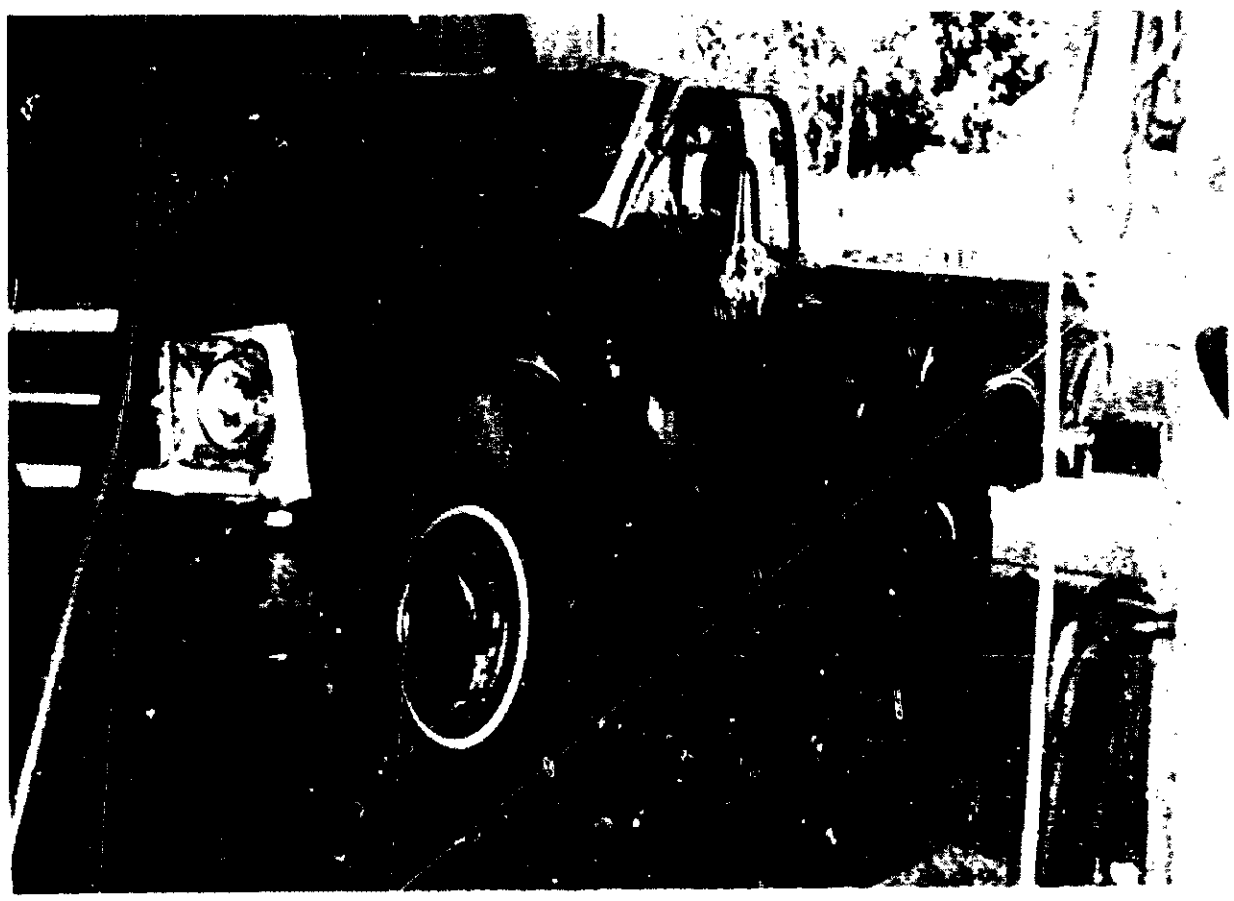
Injuries	AIS	Probable Source
Contusion on nose	1	Steering wheel rim
Laceration inside lower lip	1	Steering wheel rim
Laceration chin	1	Steering wheel rim
Contusion across chest	1	Shoulder belt
Laceration right leg	1	Right hand mirror control and/ or frame from cigarette lighter/ashtray

This driver was admitted to an area hospital for 1 day and reported loss of work for 6 weeks. His use of the available lap/shoulder belt did help restrain his movement, before the failure, and served to reduce the overall severity of his injuries in this 22.7 mph Delta V collision.

CASE 213 - (NYC 85-H-OR13)

Case Vehicle: 1985 Ford Tempo
Case Vehicle Weight: 2,668 pounds
Case Vehicle Delta V: 11.8 mph





Circumstances

A 1985 Ford Tempo 4-door sedan collided front-first into the left side of 1967 Chevrolet pick-up truck. Following the initial impact, the pick-up overturned to its roof. The collision resulted in moderate damage to the Ford across its entire front end with inward crush reaching a maximum depth of 8.5 inches. The heavier pick-up truck sustained damage over a 86-inch wide area of its left side with a maximum crush depth of 5.5 inches.

The lap/shoulder belted-driver of the Ford, additionally protected by an airbag, received minor injuries. The unrestrained driver of the much heavier pick-up truck also sustained minor injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: M
Age: 38 years
Height: 6 feet 2 inches
Weight: 225 pounds
Restraint Used: Lap/shoulder belt (ELR) and air bag

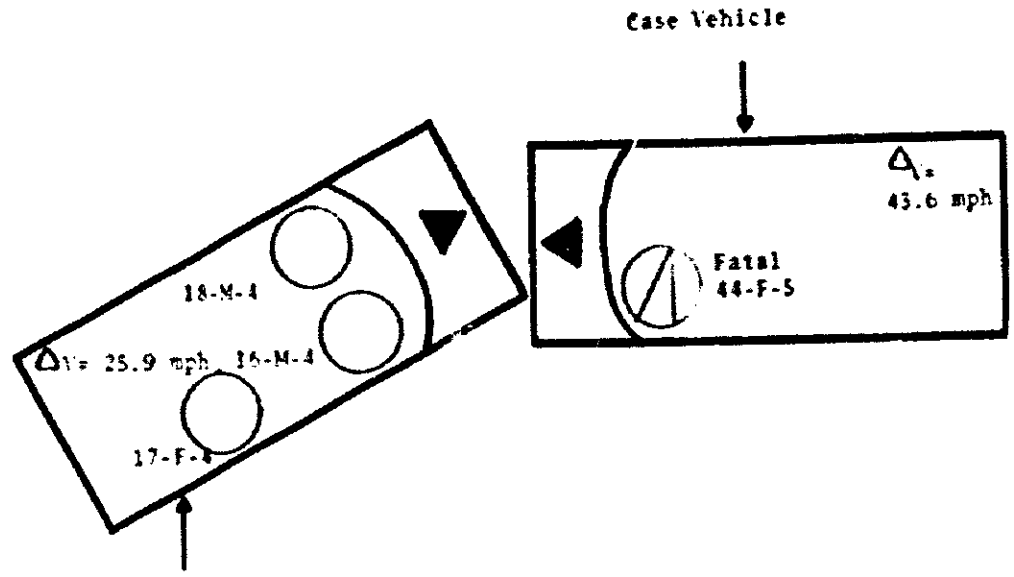
This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to vehicle motion, a windowshade tension-relief device, a cinching latchplate, and a stalk-mounted buckle assembly. The driver was additionally protected by an air bag system which deployed at impact. This driver described the adjustment of the lap belt as snug, positioned low across his hips. He indicated that the shoulder portion adjustment allowed him to place his clenched fist between the belt webbing and his chest. A loading mark was found upon the system D-ring. Additionally, the trim on the lower instrument panel was displaced and a crack was found in the windshield forward of the driver's position.

Injuries	AIS	Probable Source
Fracture, right side 10th rib	1	Shoulder portion of belt
Contusion right forearm	1	Airbag
Abrasions, left neck	1	Shoulder portion of belt

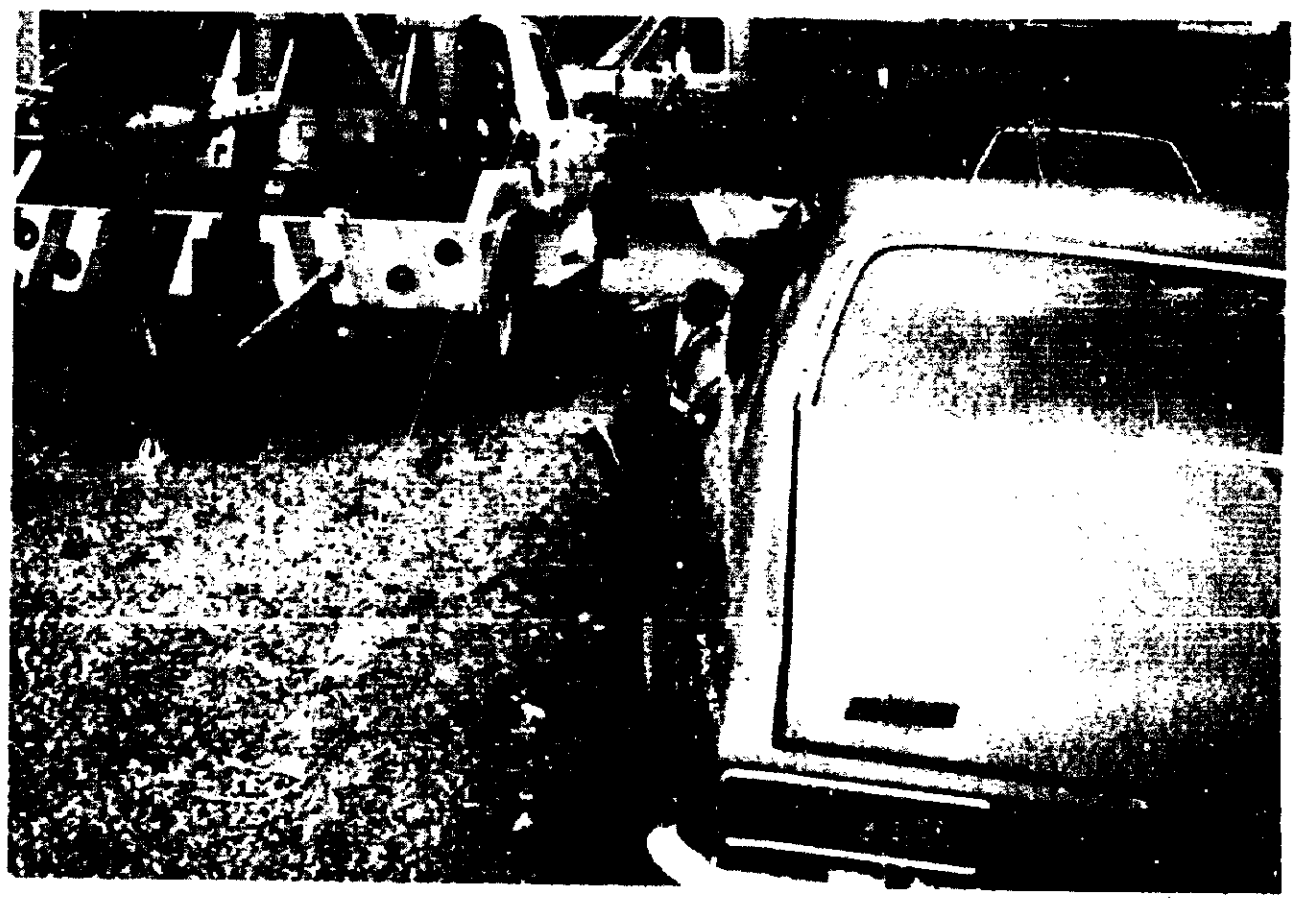
This driver did not require hospitalization for his minor injuries. The combination of the air bag and lap/shoulder belt use protected the driver from all but minor injuries in this 11.8 mph Delta V collision. The driver had introduced slack into the shoulder portion of his 3-point belt so the deployed air bag may have prevented head or facial injuries from contact with the steering wheel.

CASE 214 - (NYC 85-H-OR12)

Case Vehicle: 1981 Datsun 210, 2-door
Case Vehicle Weight: 2,050 pounds
Case Vehicle Delta V: 43.6 mph



1972 Chevrolet Nova 2-door
Weight= 3,465



Circumstances

A 1972 Chevrolet Nova, traveling at what witnesses described as a high speed, crossed a center grass median and struck head-on into the front of a 1981 Datsun 210. The Datsun was pushed backwards from impact, and eventually vaulted through the air, rotating 220° before coming to rest against a wooden utility pole. The initial collision resulted in massive damage to the front of the Datsun with structural collapse reaching a depth of over 27 inches. The heavier Chevrolet received extensive damage also with crush depths of over 35 inches measured at its right front.

The lap/shoulder belted-driver of the Datsun received critical injuries which proved fatal due to extensive intrusion of the steering assembly into her seating area. The three unrestrained occupants of the Chevrolet all sustained severe injuries.

Restraint and Injury

Case Vehicle
Seating Location: Driver
Sex: F
Age: 44 years
Height: 5 feet
Weight: 171 pounds
Restraint Used: Lap/shoulder belt (ELR)

This driver was wearing a continuous loop lap/shoulder belt equipped with an emergency locking retractor sensitive to webbing motion, a free-sliding latchplate, and a stalk-mounted buckle assembly. As the driver did not survive, no description of precrash adjustment was available; however, the self-tensioning retractor should have ensured a snug fit. Webbing damage due to tow-a-way operations precluded the location of crash-related loading marks which might have enabled Safety Board investigators to judge the precrash fit; however, the locations of belt-induced contusions described on an autopsy report were consistant with proper belt placement.

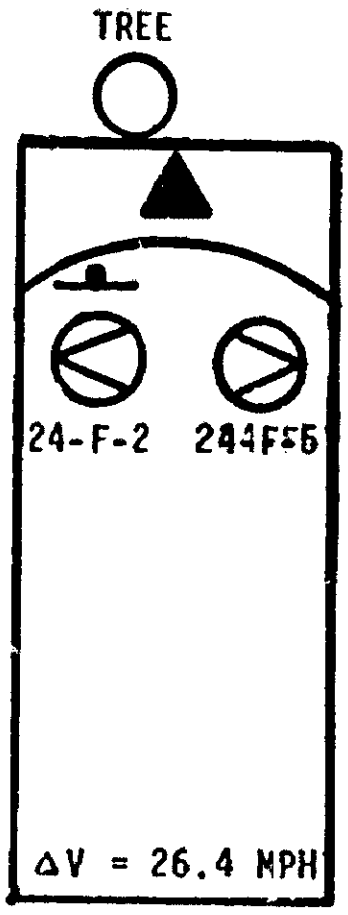
Injuries	AIS	Probable Source
Bilateral orbit plate fractures	2	Steering assembly
Avulsed teeth	1	Steering assembly
Fractured maxilla	2	Steering assembly
Bilateral mandible fractures	2	A-pillar & steering assembly
Laceration, aortic arch	5	Impact forces/steering wheel
Lacerated liver	4	Punctured by fractured ribs
Contusion, left lung	3	Steering assembly
Contusion, right lung	3	Steering assembly
Fracture, thoracic spine	3	Impact forces

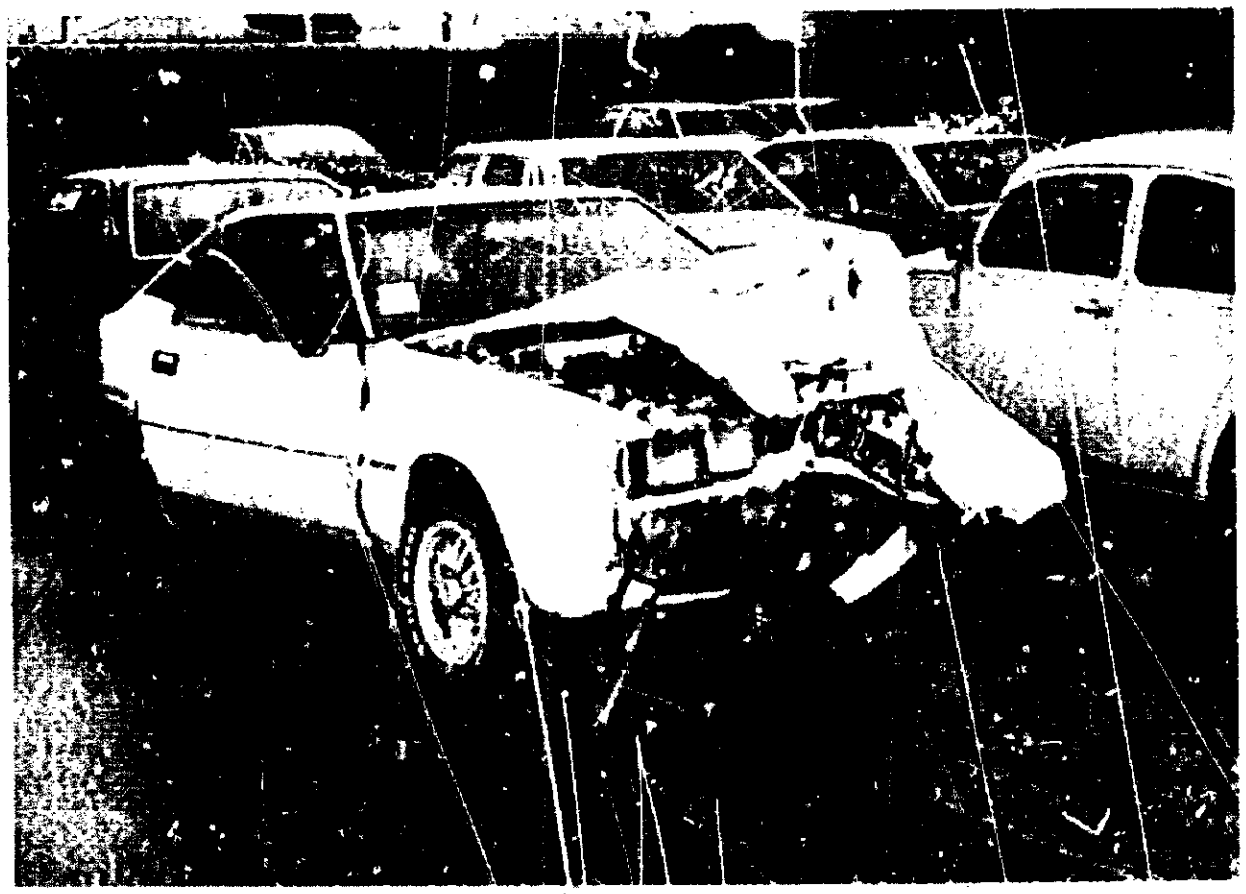
Fractured ribs		
Left side, 1-4	2	Interior sidewall
Left side, 7&8	2	Interior sidewall
Left side, 10&11	2	Interior sidewall
Fractured left femur	3	Frontal interior
Fractured right femur	3	Frontal interior
Multiple fractures, right wrist	3	Frontal interior
Fractured right ankle	2	Floor and foot controls
Large laceration, right occipital	2	Frontal interior
Subarachnoid hemmorrage	3	Frontal interior
Large abrasion diagonally across chest	2	Shoulder portion of belt
Large abrasion across lower abdomen	2	Lap portion of belt

This driver never regained consciousness and, subsequently, was pronounced dead at the accident scene. The use of the lap/shoulder belt was not a factor in this collision due to the massive intrusion into the driver's compartment. The accident was not survivable for the Datsun driver.

CASE 215 - (NYC-85-H-OR03)

Case Vehicle: 1982 Datsun, 2-door
Case Vehicle Weight: 2,861 pounds
Case Vehicle Delta V: 26.4 mph





Circumstances

A 1981 Datsun sedan with two occupants ran off the left side of the roadway and struck a tree head-on. Maximum collapse to the front end was 31.5 inches. There was no passenger compartment intrusion.

The driver, who was restrained by a lap/shoulder belt, received moderate injuries. The right front seat passenger, who was restrained by a misrouted lap/shoulder belt, received critical injuries which proved fatal. Evidence and injury patterns indicated that the passenger's shoulder belt was routed under her right arm, instead of over her right shoulder.

Case Vehicle
Seating Location: Driver
Sex: F
Age: 24 years
Height: 4 feet 10 inches
Weight: 108 pounds
Restraint Used: Lap/shoulder belt (ELR)

The driver was wearing a continuous loop lap/shoulder belt that was equipped with a vehicle sensitive emergency locking retractor, a free-sliding latchplate, and a stalk mounted buckle. There were load scars on the D-ring, belt webbing and on the lower left side of the seatback.

Injuries	AIS	Probable Source
Fractured nasal bone	1	Hub of steering wheel
Cerebral concussion	1	Steering wheel
Laceration of forehead	1	Steering wheel
Laceration of right knee	1	Instrument panel
Abrasion of left knee	1	Instrument panel
Fractured 3rd metacarpal	2	Instrument panel

The driver would not make any statements regarding this accident. Proper use of the lap/shoulder belt was based on an evaluation of the driver's injury pattern, seatbelt loading evidence, and the vehicle's Delta V of over 26 miles per hour. Had she not been properly restrained, she probably would have sustained additional and more serious injuries. She was hospitalized for three days.

Case Vehicle
Seating Location: Right front
Sex: F
Age: 24 years
Height: 4 feet 11 inches
Weight: 108 pounds
Restraint Used: Misrouted lap/shoulder belt: shoulder portion under arm

This passenger was wearing a continuous loop lap/shoulder belt that was equipped with a vehicle sensitive emergency locking retractor and a free-sliding latchplate. There were loading scars on the seatbelt webbing, D-ring, the top right side of the seatback, alongside of the head restraint, and on the lower left side of the seatback.

Injuries	AIS	Probable Source
Transection of upper lumbar spinal chord	5	Shoulder portion of belt
Laceration of pancreas	5	Shoulder portion of belt
Almost complete transection of duodenum	5	Shoulder portion of belt
Laceration of splenic artery and vein	5	Shoulder portion of belt
Portal vein-superior mesenteric vein junction is transected	5	Shoulder portion of belt
Hematoma of right lobe of liver	3	Shoulder portion of belt
Fractured 12th thoracic vertebra	3	Shoulder portion of belt
Fractured ribs-left side 8, 9, 10, 11	2	Shoulder portion of belt
Fractured ribs-right side 10, 11	1	Shoulder portion of belt
Laceration of left diaphragm	1	Shoulder portion of belt
Oblique linear abrasion across abdominal wall	1	Shoulder portion of belt
Abrasions to back of left and right forearms	1	Dashboard
Abrasions of both hands	1	Dashboard
Contusion of front of left thigh	1	Unknown
Contusion of right knee	1	Dashboard

The passenger died as a result of injuries received in the crash.

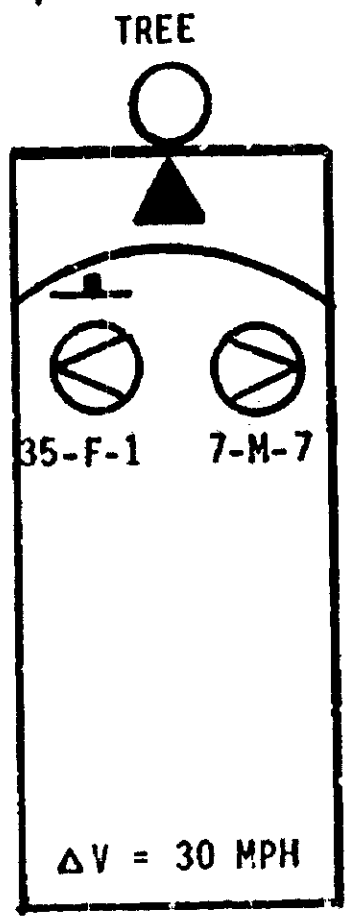
Immediately after the crash, a passerby observed that the passenger was seated, her upper body was slumped forward and leftward, and that her head was toward the console. He said that she was wearing the seatbelt, but did not remember how the shoulder belt was routed.

Based on the passenger's injury pattern and the location of the webbing impressions on the top right of the passenger's seatback, it was determined that the shoulder portion of the seatbelt system was improperly routed under her right arm instead of over her right shoulder.

Had the lap/shoulder belt been properly worn, there is no doubt, based on the driver's injuries, that the passenger would have survived this 26.4 mph Delta V collision.

CASE 216 - (NYC-85-H-OR01)

Case Vehicle: 1977 Honda, 2-door Sedan
Case Vehicle Weight: 2,218 pounds
Case Vehicle Delta V: 30.9 mph



Circumstances

A 1977 Honda sedan ran off the right side of the roadway at a left curve when its driver became incapacitated. The Honda traveled across a grass field and crashed head-on into a tree. Maximum deformation to the front end was 26 inches.

The driver, restrained by a lap/shoulder belt, was seriously injured. Her 7-year-old son, who was also restrained by a lap/shoulder belt, received a neck injury which proved fatal. He had been asleep in a reclined position in the right front seat. The reclinable seatback was adjusted to an approximate 43 degree angle.

Restraint and Injury

Case Vehicle

Seating Location:	Driver
Sex:	F
Age:	37 years
Height:	5 feet 5 inches
Weight:	175 pounds
Restraint Used:	Lap/shoulder belt (ELR)

The driver was wearing a continuous loop lap/shoulder belt that was equipped with a vehicle sensitive emergency locking retractor, a free sliding latchplate and a stalk-mounted buckle. The driver described the lap belt position as being "snugly" fitted "across her waist near the navel." The shoulder strap portion of the restraint was reported to be adjusted so that the palm of her hand could be placed between the webbing and the driver's chest. Load abrasions were on the D-ring. A witness who went to the vehicle immediately after the crash stated that the driver was belted.

Injuries	AIS	Probable Source
Facial lacerations	1	Steering assembly
Fractured nose	1	Steering assembly
Broken tooth	1	Steering assembly
Lung contusion	3	Shoulder portion of belt or or steering assembly
Llaceration of right knee with torn ligaments	2	Lower dash
Abrasion to left knee	1	Lower dash
Small puncture lower right leg	1	Under dash hardware
Fractured metatarsis	2	Toe pan
Sore neck	-	Unknown
Tenderness of sternum	-	Seatbelt or steering assembly

The driver was hospitalized for 12 days. Since the driver was incapacitated before the crash, she may not have been erectly seated. Given that she may have been slumped forward, the seat was adjusted to within a half inch of the full forward position, and the Delta V of 30.9 mph, Safety Board investigators believe the lap/shoulder belt use prevented this driver from being critically or fatally injured.

Case vehicle
Seating Location: Right front
Sex: M
Age: 7 years
Height: 4 feet
Weight: 54 pounds
Restraint Used: Misused lap/shoulder belt (ELR): worn in a reclined while vehicle was in motion

This passenger was wearing a continuous loop lap/shoulder belt that was equipped with a vehicle sensitive emergency locking retractor, a free-sliding latchplate on a stalk-mounted buckle. However, the seatback was reclined to an approximate 43 degree angle which resulted in there being a substantial space between the passenger's upper torso and the shoulder belt which was suspended between the D-ring and the latchplate. Although this passenger was using the lap/shoulder belt, he was not seated erectly and the belt was not appropriately positioned against his body.

A witness described the post-accident position of this passenger as being slumped down in the seat with his head hanging over the shoulder belt which was across his neck.

Injuries	AIS	Probable Source
Soft tissue hemorrhage of anterior neck	7	Shoulder portion of belt
Neck abrasions	1	Shoulder portion of belt
Fractured left clavicle	2	Shoulder portion of belt
Contusion of lower lobe of right lung	3	Lap portion of belt
Transverse brushburn of right axilla (armpit)	1	Lap portion of belt

The passenger died as a result of injuries received in the crash. The medical examiner attributed the boy's death to a shoulder strap blow to the neck that probably induced a vago-vagal reflex (carotid body reflex).

Had the seatback not been reclined, this passenger would have been seated in an erect position and the lap/shoulder belt would have held him in position during the crash deceleration. Instead, he apparently submarined under the lap portion of the belt while his upper torso rotated forward and impacted the shoulder belt that was suspended diagonally across his body.

U.S. G.P.O. 1988-201-610:81002

END
DATE
FILMED
7-25-88
NTIS