

Environmental Activities Week



Title: RESTRAINT SYSTEM EFFECTIVENESS -
A STUDY OF FATAL ACCIDENTS

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Restraint System Effectiveness - A Study Of Fatal Accidents

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One facet to the effectiveness of automotive occupant restraint systems is their potential to reduce the number of fatalities which are occurring. Accidents involving over seven hundred fatally injured occupants in 1967 to 1972 cars were examined case-by-case and occupant-by-occupant to assign the fatality reduction potential of four candidate restraint systems.

- Lap Belt Alone
- Air Cushion Alone
- Lap and Shoulder Belt
- Air Cushion Plus Lap Belt

The primary results of this field accident study are as follows:

If all the fatalities had been wearing a lap belt, 17% could have been saved.

If all the fatalities had been wearing a lap and shoulder belt, 31% could have been saved.

If all the cars had been equipped with air cushions, 18% of the fatalities could have been saved.

If all the cars had been equipped with air cushions, and all the fatalities had been wearing a lap belt, 29% could have been saved.

INTRODUCTION

The choice of occupant restraint systems for cars has been the subject of much debate in recent years. Although the ultimate choice will involve many factors, fatality reduction seems to surface whenever discussions on restraint system alternatives arise. The national highway fatality figures keep coming up as the one visible statistic upon which goals are set and performance is judged. For this reason, the General Motors Safety Research and Development Laboratory initiated an in-depth, case-by-case field accident fatal study. Utilizing technical expertise from GM's Fisher Body Division, and the Safety Research and Development Laboratory, 706 fatalities in 1967 through 1972 passenger cars were studied. The specific and unique details surrounding each fatality were carefully studied. Using this information, an estimate was made of the ability of the four candidate restraint system combinations to mitigate each fatality.

Knowing the ability of a restraint system to prevent fatalities is very important. The extent of this particular study attests to

that. However, the overall effectiveness of a restraint system must include other facets: How often will it be used?, How soon can it be put into all cars?, What is its injury reduction potential?, Can it cause injuries?. These and other issues must be remembered in order to keep the implications of this fatal case study in perspective.

RESTRAINT SYSTEM EFFECTIVENESS

Each passenger car fatal collision is a discreet and unique chain of events which can only partially be described by such measurements as impact speed, crush, acceleration, etc. The merits of air cushion and belt systems have been primarily compared by the use of these measurements as they perform under limited, controlled, test conditions; conditions which are not necessarily representative of all real-world accidents. The uniqueness of this study is that actual in-the-field fatalities were studied in depth to determine what caused each fatality. After determining the series of events and complications which led to an occupant's death, each restraint system considered was rated for its likelihood of fatality prevention for each particular fatal case. The restraint systems chosen for evaluation during this study were:

- a) Lap belt alone
- b) Lap and shoulder belt
- c) Air cushion alone
- d) Air cushion with lap belt

This study was limited to these four systems since they are either in production today, or are being considered for production, and they appear to be the most likely candidates for occupant restraint in the future.

DATA FILES USED

A jury of four engineers, whose backgrounds included experience in the design, development, and testing of both active and passive restraint systems, were chosen to conduct this study. These individuals, working together, analyzed accident cases involving the 706 fatally-injured occupants.

Accident information available to GM was searched for passenger car fatal cases. The cases used had sufficient information to permit analysis of the crash and resultant injuries. Typical information included Collision Performance and Injury Reports (CPIR), Multi-Disciplinary Accident Investigation reports (MDAI), 35 mm slides, photographic prints, and the like.

CPIR's are filled out by Motors Insurance Corporation Adjusters while they are investigating claims involving an injury-producing accident in a current model vehicle. Included in a

CPIR is information on environmental conditions, locality, alleged mechanical malfunctions, collision details, vehicle damage, steering wheel and column performance, occupant statistics, occupant injury, and so on. This information is compiled from police reports, medical reports, witness accounts and measurements taken of the vehicle and at the accident scene.

MDAI reports are in-depth studies of highway crashes compiled under government contract by Multidisciplinary Investigation teams. These teams consist of various medical specialists such as pathologists, toxicologists, and psychiatrists, and members of other safety-related disciplines, such as highway or traffic engineers, mechanical or automotive engineers, human factors engineers, police technicians, lawyers, and psychologists. The result was 706 passenger car fatalities:

File	No. of Cases
Motors Insurance Corporation (CPIR)	309
Department of Transportation (MDAI)	157
University of California (MDAI)	80
University of Michigan (MDAI)	64
Miscellaneous GM files (CPIR)	51
Cornell Aeronautical Laboratories (MDAI)	31
D. F. Huelke (pre-U of M file) (MDAI)	6
Oakland County (MDAI)	5
GM Company Fleet Cars (CPIR)	3
Total Cases	706

We believe that this collection of 706 fatalities in late model year passenger vehicles represents a valid sample that can be used to extrapolate results.

Although there are continuing efforts to establish a National Accident Data Survey, no such national accident file yet exists to compare the representativeness of this study.

FATAL CASE PROFILE

The results of this study will have more meaning if the type of accidents that are causing fatalities are understood. Figure 1 shows the distribution of fatalities by collision configuration.

This study's proportion of frontals in fatal accidents may appear a bit low. Three factors account for this difference: first, the in-depth analysis of this study allowed the determination of a more valid category for each case. Other studies have defined collision configuration by the vehicle's area of damage. This study defined collision configuration by occupant trajectory. For instance, a side impact to the front 1/3 of the

Fatals by Collision Configuration

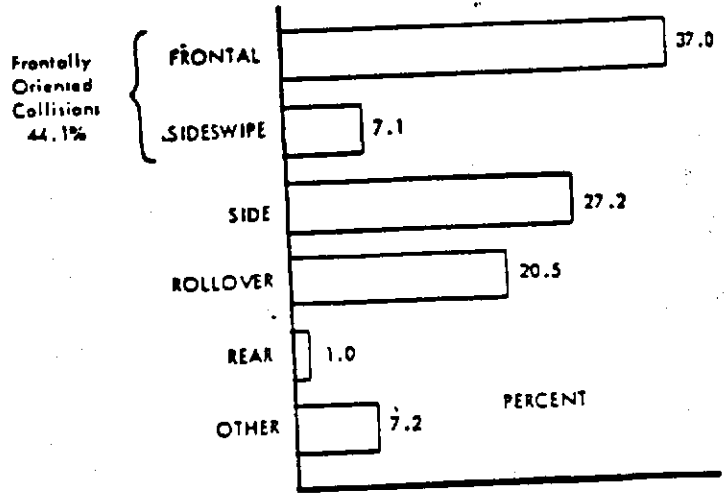


Figure 1

car would have primarily frontal damage, but the occupant would have the lateral trajectory of a side impact. For a restraint system to be effective, it would have to offer lateral (side) restraint. We, therefore, would classify this as a side impact, although some studies may have classified it as a frontal.

A second factor producing differences is that this study has two categories that involve frontal kinematics: frontals and sideswipes. These categories were separated because frontals were defined as involving major structural components of the car, whereas sideswipes were defined as involving only sheet metal parts, missing the frame and engine. This differentiation was made since these differences can significantly affect sensing times for the air cushion and passenger compartment intrusion.

A third factor was that this study contains exclusively 1967 through 1972 vehicles which possess safety features beyond those in the total car population used in other studies. Many of these improvements deal with frontal collisions and would tend to reduce the proportion of frontals in a newer-car fatal file. This study focused on newer cars to allow for more accurate extrapolation into the future.

Whether or not an accident becomes a fatal accident is greatly influenced by the objects the vehicle strikes and by the objects that the passengers strike. A breakdown of objects contacted by the automobile involved in this fatal case study is shown in Figure 2. It is interesting to note that 51% involve objects that are not on the roadway. This is also implied by the result that 52.4% of the fatal accidents involved only one motor vehicle.

Number of Vehicles Contacted by Case Vehicle in Fatal Accidents

	(Case Vehicle Only)					
Number of vehicles contacted	0	1	2	3	4	5+
Number of Fatalities	370	288	38	9	1	0
Percent of 706 Cases	52.4	40.8	5.4	1.3	.1	0

Objects Contacted by Automobile Containing Fatality

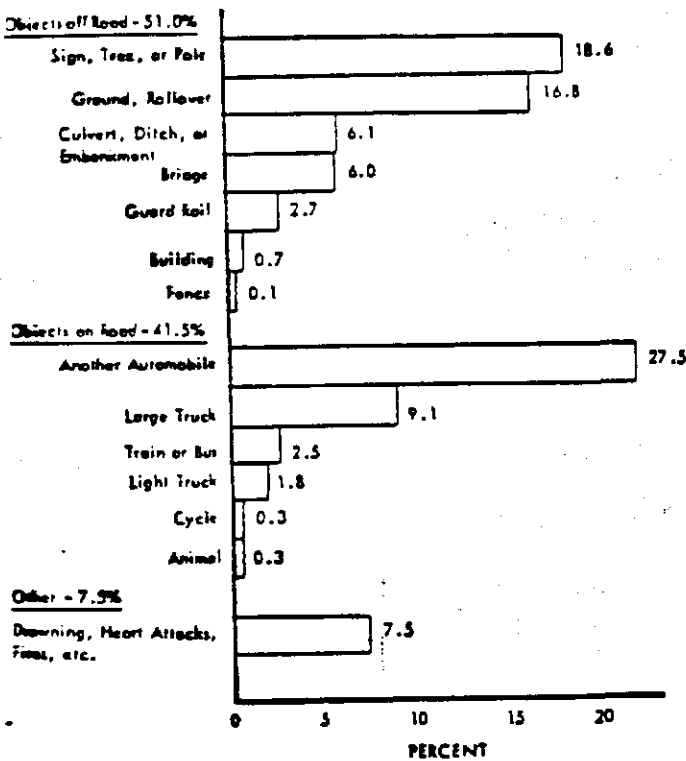


Figure 2

What the automobile strikes, along with the impact speed, determines the severity of the crash; and whatever the occupant strikes during the crash sequence influences the fate of the occupant. Figure 3 shows the objects which were involved with the occupants' fatal injuries by their frequency of occurrence.

Objects Involved with Occupants' Fatal Injuries

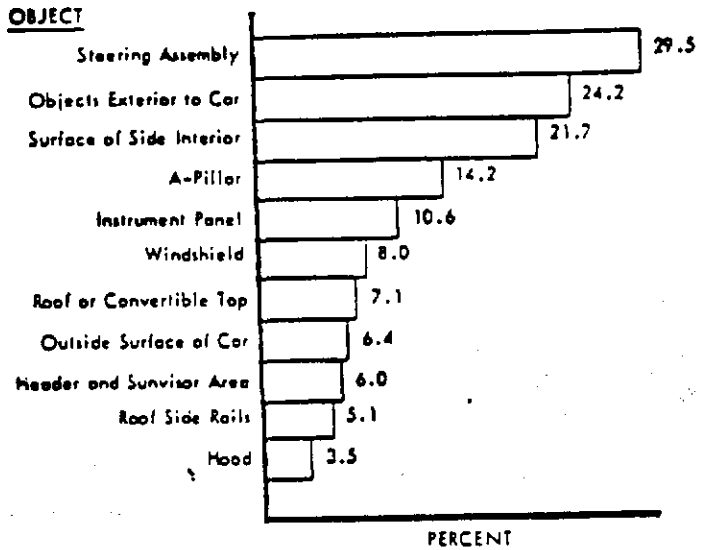


Figure 3

This distribution is influenced by the number of occupants using each seating position as shown in Figure 4.

Distribution of Fatalities by Occupant Seating Position

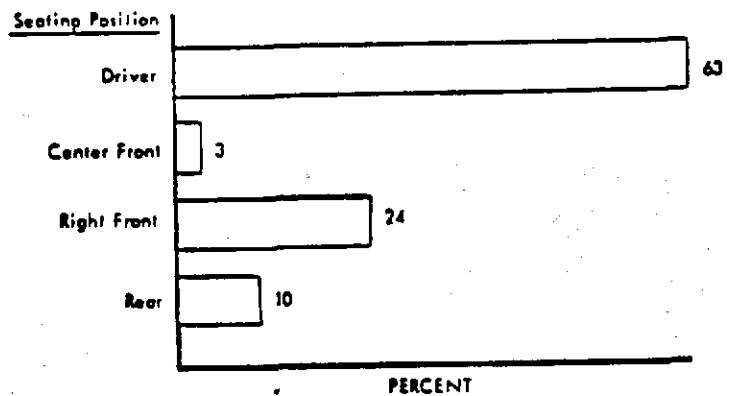


Figure 4

There were 74 fatalities actually using belt restraints in the 706 cases; three were lap and shoulder belted, and 70 were lap belted only. This represents 10.5% of the study. Figure 5 shows the distribution of actual belted fatalities by collision configuration.

Belted Fatalities by Collision Configuration

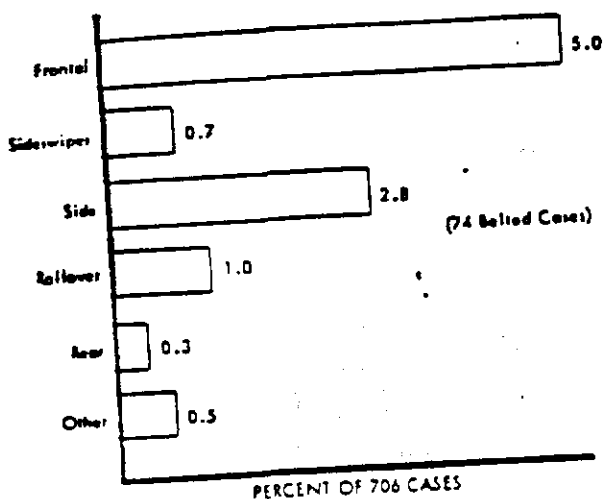


Figure 5

A distribution of actual belted fatalities by seating position is shown in Figure 6.

Distribution of Belted Fatalities by Occupant Seating Position

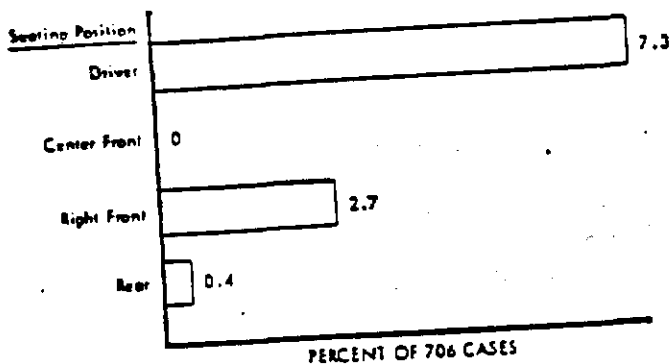


Figure 6

BELT RESTRAINTS - DEFINITIONS AND ASSUMPTIONS

To establish the fatal case profile accurately required careful study of each fatal accident, but to rate each restraint system's fatality reduction potential required more information than was supplied by the accident files alone. Realistic definitions and assumptions of restraint system performance were necessary to permit a meaningful and consistent analysis. Considerable effort went into summarizing available information on each restraint system and its performance. The following is a summary of the definitions and assumptions which were

derived from this investigation and were used in this study.

The 1973 General Motors 3-point belt system was chosen to represent a typical belt restraint system. This system has a detachable shoulder belt and can be used as a lap belt only, or as a lap and shoulder belt combination. It provides performance typical of other belt designs currently being produced and can be considered as a representative belt system. No attempt was made to estimate the performance of possibly more advanced future belt systems.

To maintain continuity throughout the study, the belt system performance was carefully defined. The belt system was assumed to be worn properly unless the case being studied actually indicated improper usage. When improper usage was identified, the effects of this improper usage were considered in rating the restraint systems. This guideline was established to help reflect any possible belt-induced injuries.

Present belt systems are designed to remain intact over 5,000 lbs., which is in excess of expected belt loading. For this reason, the webbing and associated hardware were assumed to remain intact unless the case indicated that they would have been obviously damaged by the accident.

Although information is limited, searches of accident files do not indicate that belt rebound contributes significantly to occupant injury. Since accurate analysis of occupant rebound would have been very difficult, if not impossible, occupant rebound was assumed *not* to contribute to injury.

The vehicles in this study were all equipped with an energy-absorbing (EA) steering column of some type. To simplify analysis, they were all assumed to be equipped with a 1973 General Motors EA steering column, regardless of the vehicle's actual make or model year.

When a fatally injured occupant was actually wearing a seat belt system, *that* system was rated as being 0% effective for *that* single accident.

There is a lack of knowledge on small children wearing belt restraints. Because of this, and the fact that small children do have soft bone structures, it was assumed that belts worn by small children would not be as effective in mitigating injury as those worn by adults. As the severity of accidents increased, the child's save rate was sharply decreased. The exception to this assumption was in rollovers, where ejections could be prevented by the use of belts. Special child restraints were not evaluated in this study.

AIR CUSHION RESTRAINTS — DEFINITIONS AND ASSUMPTIONS

Using the air cushion system for this study proved to be difficult. No rear seat air cushion system was developed at the time of this study, and there was no field experience on the proposed front seat air cushion. As a result, the following assumptions had to be based on a considered judgment of the estimated performance of a front and rear seat air cushion system.

The front seat air cushion was assumed to be composed of General Motors proposed components which included: a third generation, step-load steering column; a Delco Electronics Shock Sensing System with a 10 mph equivalent barrier impact level sensor, and an 18 mph equivalent barrier impact high level sensor; a steering wheel air cushion with a metal and foam knee restraint for the driver, and a separate air cushion for the front seat passengers. The third generation step load steering column is a revision of the present energy-absorbing ball joint column used in GM vehicles. Included in the design is an EA member and an improved column mounting. A companion report prepared by Oldsmobile explains details and significance of these revisions. The imaginary rear seat system was assumed to provide performance comparable to a front seat air cushion.

The total air cushion system was assumed to meet FMVSS 208 injury criteria which included the requirements of meeting injury criteria in a 30 mph frontal barrier, angled up to 30° and in 20 mph side moving barrier tests. Frontal impacts at angles that exceeded 30° from head-on were rated as follows: a) 30° to 60° impacts with sufficient longitudinal acceleration to deploy the air cushion were treated with sharply reduced effectiveness; b) impacts that exceeded 60° were generally considered not to have produced deployment. These assumptions were based on present sensor design and are supported by Hyge sled tests and full scale crash tests.

In frontal impacts of a 30 mph barrier equivalent severity or less, survival was considered to be virtually certain unless there were extenuating circumstances. As the case severity exceeded 30 mph frontal barrier equivalent, the ratings were reduced until a 60 mph barrier impact severity was reached. In excess of a 60 mph equivalent barrier speed, survival was considered to be virtually impossible due to the lack of survival space as shown in Figure 7.

It should be stressed that there is a difference between field potential and barrier-dummy test performance as discussed in "Occupant Protection Research Needs," D. E. Martin, Manager, Automotive Safety Engineering.

Assumed Air Cushion Fatality Reduction Ratings in Frontal Impacts

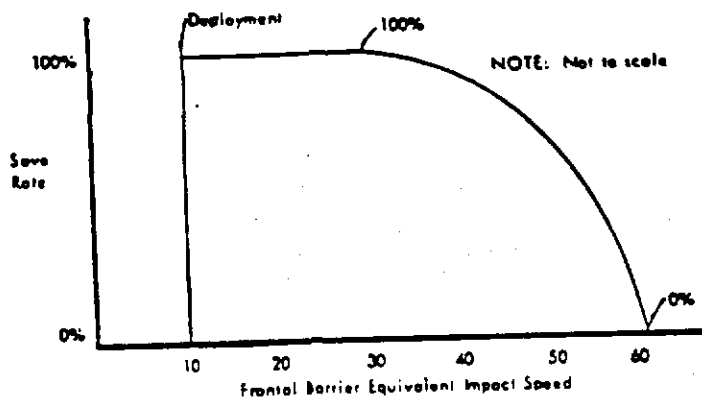


Figure 7

There is considerable air cushion test information available on the performance of three 50th percentile dummy occupants, and less performance knowledge on other sizes and combinations of occupants. But, for the sake of simplicity, the air cushion was assumed to provide equal protection for all sizes and combinations of normally-seated occupants.

The air cushion system was assumed to offer multiple impact protection, for though limited, the test data that does exist shows that the proposed air cushion system offers potential for multiple impact protection.

High reliability is essential in any air cushion system. Therefore, it was assumed that this air cushion system had no component defects and remained intact unless it would obviously be damaged by the impact. In other words, the air cushion was assumed to deploy, whenever the sensor threshold was reached. When the sensor threshold was not reached, the occupant's injury was assumed to remain unaltered unless he was also considered to be lap belted.

Hyge sled and full scale crash tests indicated that when the air cushion is deployed, it could prevent ejection through the windshield. This factor was included in air cushion assumptions on ejection prevention. The air cushion was generally assumed not to prevent ejections through side windows, doors, roofs, etc., since the present design is primarily a frontal impact protection device.

ACCIDENT CONSIDERATIONS

As discussed earlier, each passenger car fatality is a distinct and unique series of events. For instance, in any given accident, different people would have different likelihoods for survival simply because of their unique physical characteristics. Add this to all the other variables in a passenger car fatality and it

early shows why as many factors as possible were included in a restraint system effectiveness study. The following is a listing of some of the accident considerations that were applied:

1. Interior compartment intrusion – was there sufficient survival space at each case occupant's seating position?
2. Crash severity – very severe accidents (beyond 60 mph frontal barrier equivalent) were rated as having little chance for survival.
3. Age of occupant – for older occupants (65 years and older) the survival potential was lowered.
4. Health of occupant – including the effects of medication, alcohol, or drugs.
5. Occupant height and weight, and his likelihood of striking objects in the interior.
6. Effects of other occupants in vehicle on the occupant being evaluated.
7. Interior loose objects which struck the occupant.
8. After-market add-ons – These were assumed not to interfere with restraint system hardware or bag deployment. If they contributed to the injury, their effect was considered in evaluating restraint system performance.
9. Non-collision related causes of fatality – heart attacks, drownings, fire, etc.

RATING METHOD

After applying the restraint system assumptions and accident considerations, the evaluation team arrived at a fatality-reduction effectiveness rating for each restraint system when applied to each fatality, regardless of seated position. Because the many factors which influence occupant injury, simply rating the occupant as surviving or not surviving was not sufficient. Rather, each fatality was given a probability of survival as if he had been using each restraint system in turn. The range of probabilities was defined as:

- 0% – Essentially no chance for survival;
- 10%, 20%, 30% – Survival possible, but unlikely;
- 40%, 50%, 60% – Survival definitely possible;
- 70%, 80%, 90% – Survival very likely;
- 100% – Survival essentially certain.

The overall process is shown schematically in Figure 8. Case number 1 was analyzed and the effectiveness estimates were

tabulated for each restraint system in turn. For example, lap belt was rated 0%, lap and shoulder belt, 70%; air cushion, 90%; and air cushion with lap belt, 90%.

RATING METHOD

CASE NO.	LAP	LAP/SH.	AIR	AIR/LAP
1	0%	70%	90%	90%
2	10%	30%	0%	20%
-	-	-	-	-
-	-	-	-	-
706				

$$\text{POTENTIAL EFFECTIVENESS} = \frac{\text{SUM \%}}{706}$$

Figure 8

This is about the same as saying that if this identical accident with an identical occupant were to happen 10 times, there would still have been no survivals with a lap belt only, maybe 7 survivals with a lap and shoulder belt, 9 survivals with an air cushion, and 9 survivals with an air cushion plus lap belt. This process was repeated for Case Number 2, and so on, until the analysis was complete on all 706 occupants. The potential effectiveness of each restraint system was then calculated by summing the effectiveness percentages for all occupants and dividing by the total number of occupants.

EXAMPLE CASES

A list of all 706 fatal cases included in this study is provided in the appendix. Included in this list are a few of the many parameters which were recorded for each case. What this listing does not show is the inter-action of these parameters and how they jointly affected the analysis of each case. A brief discussion of some example cases can give a better idea of how the parameters were considered, and how the analysis was made.

The first case is a frontal collision involving a 1972 Chevrolet Impala (Figure 9). The vehicle was driven off the right side of the road and collided with the left rear of a car parked on the shoulder.

The estimated speed at impact was 70 mph, or equivalent to a 35 mph barrier impact. The driver was the only occupant, a 49-year-old, 5 ft. 11-inch tall, 165 lb. male. He was in good health and had no unusual physical or mental characteristics that should have adversely affected his chances for survival.

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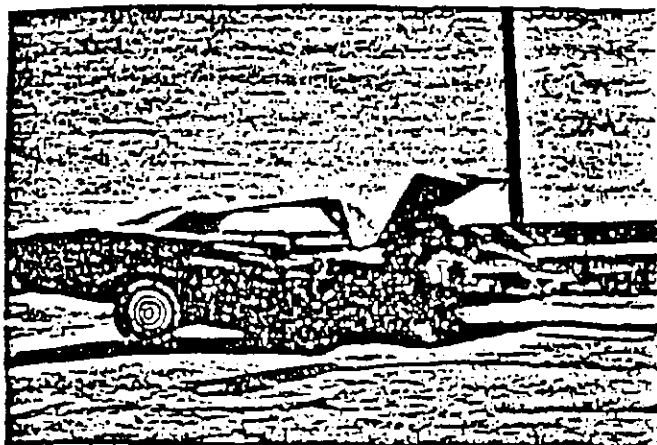


Figure 9

His fatal injury was a ruptured aorta resulting from a chest impact with the steering system, shown in Figure 10. The E/A column compression was 3.5 inches.

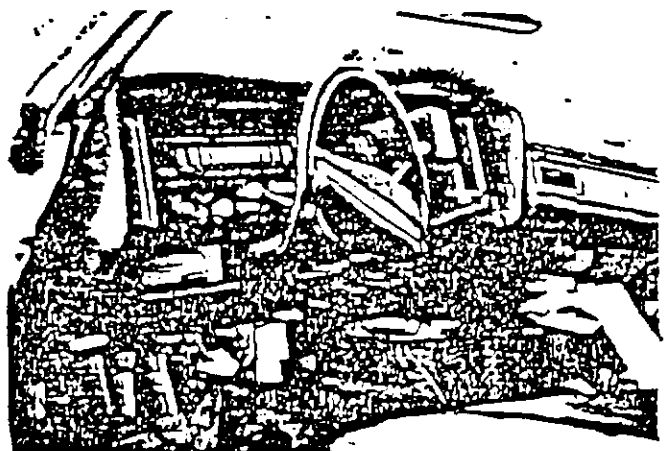


Figure 10

The driver had defeated the belt buzzer system and was not belted at the time of the collision. If he had been lap belted, he would have loaded the column more axially. This probably would have increased column collapse and reduced his chest loading. It was estimated that his chance for survival with the lap belt was better than 50-50, so a 60% chance for survival was given. With both the lap and a shoulder belt, the involvement with the column would have been greatly reduced. A 90% chance for survival was assigned. A 90% survival was also assigned to the air cushion only and to the air cushion with lap

It for the same reason as the lap and shoulder belt. The higher severity of this case did not support a 100% chance of survival for the last three conditions.

The second example is a 1972 Oldsmobile Delta 88 shown in Figure 11 which was struck in the side by a pickup truck traveling at 35 mph. Impact was centered on the rear passenger compartment.

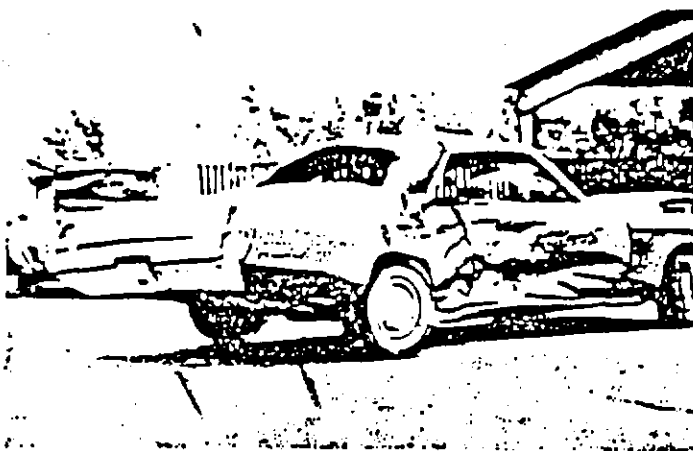


Figure 11

There were four occupants in this car. The right rear passenger, a 63-year-old female died from chest injuries. Her fatal injury resulted from chest impact with the stub B-pillar and/or side interior shown in Figure 12.



Figure 12

It is significant to note that a small child was sitting on the lap of the fatally injured woman. Furthermore, the child received no serious injuries, even though the child probably struck the same area of the car as was contacted by the fatality. This implies that the fatality was particularly susceptible to chest injury. A lap belt would not have prevented or reduced the

oman's impact with the side interior so it was rated as being 0% effective. The lap and shoulder belt was rated at 20% since it would only slightly reduce the severity of impact with the side interior, and survival would still be unlikely. The air cushion ratings were 0% since the sensors are not designed to fire in this type of impact, and the addition of a belt would not have helped.

The third case involved a 1972 Chevrolet station wagon shown in Figure 13, which went off the road in a curve, and rolled over in a field. The 51-year-old male driver and only occupant of this vehicle was partially ejected through the left front window opening and was crushed by the vehicle.

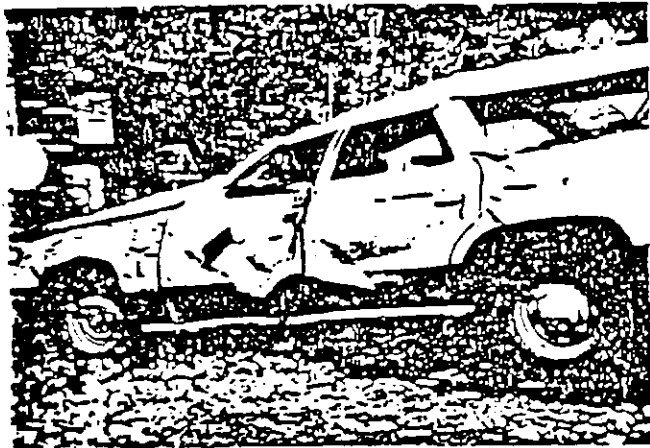


Figure 13

The indentation in the door was made by the occupant. If he had been wearing a lap belt, this driver's chances of survival would have been improved. A 40% effectiveness rating was assigned for the lap belt because test experience has shown that partial ejection with a lap belt still can occur in rollovers. The lap belt and shoulder belt was assigned a 60% rating because it was felt that the added torso restraint would have reduced ejection potential, but not necessarily have prevented it. The air cushion alone was rated as 0% effective because current sensors do not fire on this type of rollover. The air cushion with lap belt was rated the same as the lap belt only. The ratings were affected by the fact that even if ejection were fully prevented, there is some chance that he could have been fatally injured inside the car.

Of 706 cases underwent this sort of analysis, but in much more detail. The whole spectrum of passenger car fatalities was reviewed and studied. This study confirmed something that we have been suspicious of for some time. Forty-six percent of the 706 fatalities had no chance for survival with any of the

restraint systems considered. These accidents are either very severe, or involve unusual circumstances such as heart attacks, drownings, fires, etc. They look like the ones shown in the next two figures.

Example Case No. 4, a 1972 Chevrolet, shown in Figure 14, ran under the rear of a slow-moving truck at a closing velocity of 65+ mph.



Figure 14

The fatally injured driver suffered massive head and chest injuries directly from the truck bed, and was given 0% chance for survival with any of the restraint systems considered.

Figure 15 shows a 1968 Camaro traveling at 60 mph, which skidded sideways into a tree. The right passenger suffered a crushed chest due to intrusion of the tree. He was wearing a lap and shoulder belt.

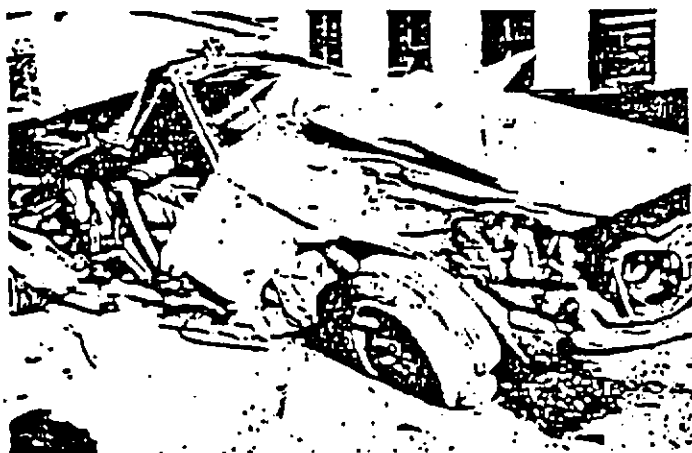


Figure 15

He also was rated 0% chance of survival for the restraint systems considered.

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RESULTS AND CONCLUSIONS

The potential fatality reduction for each restraint system, if it were used, was as follows:

Restraint System	Potential Fatality Reduction (% of Lives Saved, Rounded off to Nearest Percent)
Lap Belt	17%
Lap and Shoulder Belt	31%
Air Cushion Only	18%
Air Cushion Plus Lap Belt	29%

If a person wears his lap belt, his potential for fatality reduction is 17%. If he wears his lap and shoulder belt, his potential for fatality reduction is 31%. If his car is equipped with an air cushion, his potential for fatality reduction is 18%. If his car is equipped with air cushions and he wears his lap belt, his potential for fatality reduction is 29%.

As these results were studied further, it was realized that for the restraint systems considered, fatality protection could be separated into three categories:

- Ejection Control — keeping the occupant inside the vehicle.
- Constraint — reducing the occupant's excursion within the vehicle's interior.
- Frontal Impact Protection — reducing the acceleration the occupant experiences during impact but not necessarily reducing occupant excursion.

The lap belt benefits primarily from the effect of ejection control and constraint, while the air cushion benefits result primarily from the effect of frontal impact protection. These effects produce about equal benefits for lap belts or air cushions. The lap and shoulder belts or the air cushion plus lap belts combine these effects to produce nearly double the benefits of either the lap belt or air cushion alone. These conclusions are supported by this effectiveness breakdown.

Potential Fatality Protection by Collision Configuration*

	Lap Belt Only	Lap and Shoulder Belt	Air Cushion Only	Air Cushion w/Lap Belt
Frontals	14%	37%	38%	40%
Sideswipes	9%	21%	10%	18%
Sides	12%	12%	3%	14%
Rollovers	36%	48%	9%	40%
Rear	14%	20%	0%	14%
Other	4%	6%	8%	9%

*Rounded off to nearest percent.

The lap belt alone does little to reduce the head and torso accelerations the occupant experiences during frontal impacts and is less than half as effective as the other systems.

Air Cushion with a lap belt	40%
Air Cushion only	38%
Lap and Shoulder Belt	37%
Lap Belt only	14%

In sideswipes, ejection control, constraint, and frontal impact protection are all important, so the restraint systems which offered all three did best.

Lap and shoulder belt	21%
Air Cushion with lap belt	18%
Air Cushion only	10%
Lap belt only	9%

In side impacts, constraint was most important. The air cushion offered little constraint, whereas the lap belt offered considerably more. Combining the two resulted in the best combination.

Air Cushion with a lap belt	14%
Lap and shoulder belt	12%
Lap belt only	12%
Air Cushion only	3%

The lap and shoulder belt did not perform better than the lap belt only in side impacts because the shoulder belt offers little in the way of lateral constraint.

In rollovers, ejection prevention was the most significant; therefore, any system using a lap belt performed better than the air cushion alone.

Lap and shoulder belt	48%
Air Cushion with lap belt	40%
Lap belt only	36%
Air Cushion only	9%

In rear impacts, constraint again proved to be the most important factor. By keeping the occupant in his designated seating position, head restraints could perform as designed. Due to the complexity of the rear impacts and the small sample size, the lap and shoulder belt was rated better than the lap belt alone.

Generalizations about the reasons for restraint performance in the "Other" category would not be proper because of the many unrelated types of fatalities in this category. It will suffice to say that air cushion restraints were slightly more effective in reducing fatalities in this category.

Air Cushion with lap belt	9%
Air Cushion only	8%
Lap and shoulder belt	6%
Lap belt only	4%

Figure 16 shows the percentage of air cushion deployments as a function of collision configuration.

Percent of Air Cushion Deployments by Fatal Collision Configuration

KEY: Deployment as Percentage of Collision Configuration

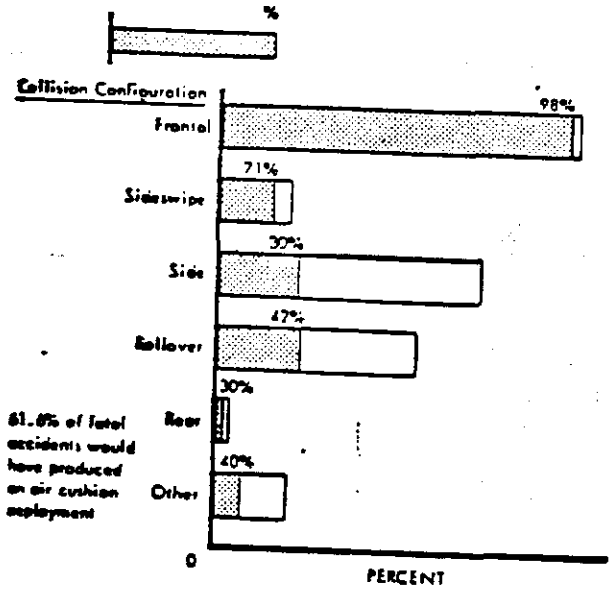


Figure 16

Restraint System Combinations

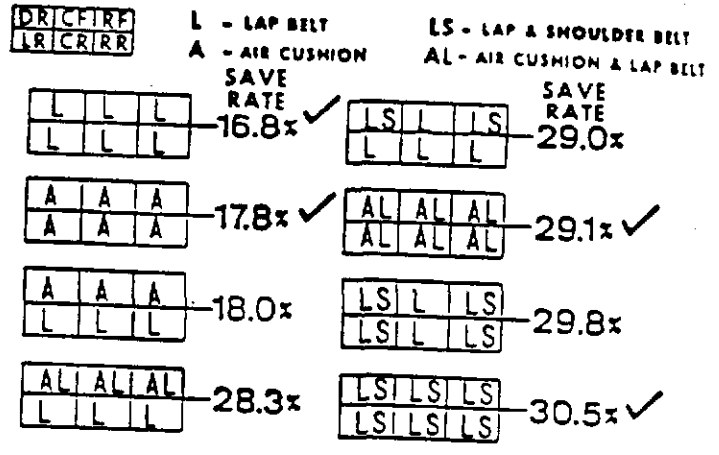


Figure 17

The differences in the save rates reflect both the judged effectiveness and seat position occupancy rate for the 706 fatality cases. A check is placed next to the numbers that were rounded off and shown above. These values do not reflect current belt or bag usage.

SUMMARY

Fatality reduction is important. Projecting this study to the real world, however, is a complex process influenced by factors such as current belt usage, the effect of belt usage incentives, air cushion introduction timetable effects, injury reduction, the possibility that various restraint systems can cause injuries, cost of the various systems, and dollar benefits of injury and fatality reduction. A subsequent paper has taken this fatal case study as a starting point to factor these and other issues into an overall, nationwide benefit comparison of various restraint system concepts.

restrain system effectiveness numbers assumed that each fully injured occupant in a designated seating position had the restraint system available. Figure 17 shows the net effectiveness for a variety of restraint system mixes.

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Dale A. Webber	Sr. Design Engineer	Fisher Body Division
Terry G. Wingblad	Project Engineer	Safety Research and Development Laboratory Environmental Activities Staff
Robert A. Sinke	Section Engineer	Safety Research and Development Laboratory Environmental Activities Staff



Carl M. Savage, Jr.

Carl M. Savage, Jr. graduated from the University of Toledo where he received the degree of Mechanical Engineering (B.S.M.E.) in 1968. He joined General Motors Safety Research and Development Laboratory in 1968 where he was involved with Fisher Body air cushion testing, Oldsmobile air cushion testing, air pillow design and development, Engineering Staff air bag development testing and lap and shoulder belt testing. Mr. Savage is currently project engineer with the Safety Research and Development Laboratory and active in the areas of the field trial program (1000 car air cushion accident investigation) and vehicle structural crashworthiness. He has authored papers involving air pillow concept development.

APPENDIX I

A List of the 706 Fatal Cases Including Ratings For Potential Fatality Protection

KEY

Restraint System Actually Used

- None - No restraint used
- Lap - Lap belt only
- L/S - Lap and shoulder belt

Air Cushion Deployment

- Hi - High Level Deployment
- Lo - Low Level Deployment
- None - No Deployment

Fatal Occupant Seating Position

- DR - Driver
- CF - Center Front
- RF - Right Front
- LR - Left Rear
- CR - Center Rear
- RR - Right Rear



Richard A. Wilson

Richard A. Wilson is Engineer-in-Charge of the Safety Research and Development Laboratory at the General Motors Proving Ground, Milford, Michigan. He is responsible for all laboratory activities which include crash safety evaluation, damage and repair evaluation, field accident research, and crash test operations.

Mr. Wilson joined General Motors Proving Ground in 1955 after receiving a Bachelor of Science in Mechanical Engineering from Bucknell University.

In 1965, Mr. Wilson supervised instrumentation, data analysis, and impact dynamics work. He assumed the position of Staff Engineer for Impact Testing in 1968 when the department was designated as the Safety Research and Development Laboratory.

Mr. Wilson is a member of the Society of Automotive Engineers and has served as Chairman of the Passenger Compartment Energy Absorption Subcommittee. Presently, he is Chairman of SAE's Safety Test Instrumentation subcommittee, and is a member of the Automotive Safety Committee and the Human Factors Engineering Committee. Mr. Wilson has authored numerous papers about safety and impact testing.

System Considered

- LB - Lap Belt
- L/S - Lap and Shoulder Belt
- AC/L - Air Cushion and Lap Belt
- A/C - Air Cushion Only

AREAS OF CONTACT INVOLVING FATAL INJURIES TO HEAD AND TORSO

CODES FOR AREAS OF OCCUPANT CONTACT

Front of Passenger Compartment

- (05) Instrument Panel
- (09) Steering Assembly
- (12) Windshield
- (02) Glove Compartment Area
- (03) Hardware Items (Ashtray, Instruments, Knobs, Etc.)
- (01) Air Conditioning or Ventilation Outlets
- (06) Mirrors
- (07) Parking Brake
- (08) Radio
- (10) Sunvisors & Fittings, and/or Top Molding (Header)
- (11) Transmission Selector Lever

Sides

- (20) Surface of Side Interiors
- (19) Hardware
- (13) Armrests
- (22) Window Glass
- (21) Window Frames
- (14) A-Pillar
- (15) B-Pillar
- (16) C-Pillar
- (17) D-Pillar
- (18) Courtesy Lights

Interior

- (29) Back of Seats
- (33) Restraint System Hardware
- (34) Restraint System Webbing
- (30) Head Restraints
- (12) Other Occupants
- (31) Interior Loose Object

Roof

- (16) Roof Side Rails
- (10) Sunvisors & Fittings and/or, Top Molding (Header)
- (25) Roof or Convertible Top
- (24) Coat Hooks

Floor

- (11) Transmission Selector Lever
- (40) Floor
- (28) Foot Controls
- (27) Console

Rear

- (23) Backlight (Rear Window)
- (39) Backlight Header

Exterior to Passenger Compartment

- (35) Hood
 - (36) Objects Exterior to Car
 - (37) Outside Surface of the Car
 - (38) Other:
(May indicate more than one item)
 - (00) Unknown.
-

FILE NAME:	1967 MIC		Fatal Collision Configuration (Multiple Impacts (a))	Restraint System Used	Fatal Occup. Sqr. Pos.	Areas of Contact Involving Fatal Injuries			Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (2)				
	Case No.	Description				DR	CR	RF				Head	Torso	L/S	AC/L	AC
E-396	Rollover, Hi speed down embankment	None	DR	00	00	00	00	00	Yes	None		0	0	0		
"	"	"	CR	00	00	00	00	00	No	"		0	0	0		
"	"	"	RF	00	00	00	00	00	"	"		0	0	0		
564	Right front to bridge abutment. 70% overlap	"	DR	00	00	00	00	00	"	NI		0	10	30	20	
560	Frontal to truck	"	"	00	00	00	00	00	"	"		10	20	40	40	
495	Frontal to pole & tree	"	"	10	00	00	00	00	"	"		20	40	60	50	
406	SS median curb & light pole	"	"	36	00	00	00	00	Yes	None		70	90	70	0	
324	hit @ 10:00 front left door	"	"	00	00	00	00	00	"	NI		0	0	0	0	
"	"	Lap	RF	00	00	00	00	00	"	"		0	0	0	0	

Case No.	FILE NAME: MIC '68 Fatal Collision Configuration (Multiple Impacts (A))	Restraint System Used	Fatal Occup. Sec. Pos.	Area of Contact Involving Fatal Injuries			Ejection	Air Cushion Deployment	Comments	Potential Fatality Reduction Rating (%)		
				Head	Torso	Total				LB	I/S	AC/L
A-2667	Rollover	None	DR				No	None	0	0	0	0
2669	Right sidewipe to bridge	"	RF 36				"	HI	0	0	0	0
2782	Right sidewipe to guard-rail	Lap	RF	34			"	None	0	0	0	0
2878	Multiple rolls A	None	DR	30			Yes	Lo	80	90	80	40
"	" A	"	RF	36			"	"	0	60	0	0
2880	Right side roll A	"	RF	5,25			No	HI	0	60	0	0
2931	Left offset, head-on, car-to-car	Lap	DR	00			"	"	0	60	50	50
2933	Multiple right side roll A	None	DR	00			Yes	None	50	60	50	0
"	" " A	"	CF	00			"	"	60	70	60	0
2954	Left offset frontal	"	DR	9			No	HI	60	70	80	80
2970	Left 75% offset frontal	"	DR				"	"	0	0	0	0
"	" " "	"	CF				"	"	0	50	10	10
"	" " "	"	LR				"	"	0	0	0	0
"	" " "	"	CR				"	"	0	60	20	20
"	" " "	"	RR				"	"	0	NA	NA	NA
MIC '69												
B3014	Left side-car @ door to tree	None	DR	99	99		No	None	0	0	0	0
2698	Left side-car to embankment	Lap	"				"	"	0	0	0	0

Driver died from old age complications after accident. Thought to have had heart attack prior to impact

FILE NAME: MIC'69

Case No.	Fatal Collision Configuration (Multiple Impacts [a])	Restraint System Used	Fatal Occup. Sgr. Pos.	Areas of Contact Involving Fatal Injuries		Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (E)			
				Head	Torso				LB	L/S	AC/L	AC
3044	25X offset to right *	None	DR			No	HI		0	0	0	0
0017	Car to rock embankment	"	"	00	00,9	"	"	Fire	0	0	0	0
0093	75X left head-on car to car	None	DR		9,5	"	"		0	30	30	20
0176	SS car to trunk *	"	DR	00		"	"		0	0	0	0
0337	Rt. front corner to bridge	Lap	"		00	"	Lo	Driver's back & spine broken	0	30	20	40
0434		None	RF	00		"	None	Probably murdered	0	0	0	0
0443	Rt. side impact *	"	"	32,37	32	"	"	Possible heart attack	0	10	0	0
0554	Ground Rollover *	"	DR		9	Yes	"		40	50	40	0
2454	Hit in RF by car	"	CF	38		No	HI		0	20	10	10
0573	Struck in right rear	"	RF	12,5,25		"	"		30	40	40	10
2959	Lf. side off road rollover	"	DR	25		Yes	Lo		50	70	50	0
0821	Frontal to Pole *	"	"		20	no	None		0	20	0	0
0832	Rt. side car to pole	"	RF	00		No	None		0	10	0	0
0838	Lf. side off-road rollover	"	DR	20,38		Yes	"		60	90	60	0
1274	Struck LF by truck *			26,36		No	"		0	0	0	0
1344	Rt. side rollover *	Lap	"	22,38	9	"	HI		0	70	50	40
1356	Rt. side car mid to pole											
1367	Lf. car to guard rail *	Lap	DR	00		Yes	None		0	0	0	0
1500	Lf. car to bridge support	None	"	12,5		No	HI		10	30	30	20
1929	Lf. car to guard rail	"	"	9		"	"		0	0	0	0

Case No.	FILE NAME: MIC'69 Fatal Collision Configuration (M11) (M11)	Restraint System Used	Fatal Occup. Sec. Pos.	Area of Contact Involving Fatal Injuries	Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (I)			
								LB	L/S	AC/L	AC
2037	Rt. Front car to bridge support	None	DR 9	9	No	NI		40	80	80	60
2085	Lt. side door area to parked car	"	"	20	Yes	None		20	40	20	0
2161	MIC in rt. side by car A	"	RF 38	20	No	"		0	0	0	0
2220	Center Front car to bridge abutment	"	DR 9	9	"	NI		0	20	30	30
3057	Rt. side sliding car to dirt embankment	"	"	14	"	None		90	100	90	0
1171	Spun and hit pole	"	"	00	"	"	Fire	70	90	70	0
1545	Hit lf. side by 1/2 ton	"	"	20	"	"		0	0	0	0
2064	Rt. side to guard rail & Post	"	RF 00	00	Yes	NI		0	0	0	0
2695	Frontal to embankment	"	DR 9	9	No	"	Severe vertical component	0	0	0	0
2698	Lt. side hit wall of ditch	Lap	RF		"	None	Death probably caused by old age	0	0	0	0
3052	1/4 roll to lt. side A	None	DR		"	"		0	0	0	0
MIC '70											
C-0198	Offroad rollover	Lap	RF 25,26	25,26	No	None		0	0	0	0
0290	Offroad to concrete culvert	None	DR 00,14	00	Yes	NI		0	0	0	0
0632	12:30 frontal into overturned truck	"	"	00	00	No	NI	0	30	30	20

Case No.	Total Collision Configuration (Multiple Impacts [s])	Restraint System Used	Fatal Occup. Sec. Pos.	Areas of Contact Involving Fatal Injuries		Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (I)			
				Head	Torso				LB	L/S	AC/L	AC
0632	12:30 frontal into overturned truck	None	RF	00	00	No	HI		0	20	30	20
3194	Car vent in water, front first	"	DR			No	None	Panic caused drowning	0	0	0	0
3273	Rollover *	"	L.R		36	Yes	HI		70	90	70	20
3465	Hit depressed median	Lap	DR	00		No	Lo		0	0	0	0
3615	Head-on into gas pipe	None	DR	38	38	No	HI	Explosion	0	0	0	0
3692	Offroad frontal into tree	"	"		9	No	HI		40	60	80	80
4058	Side impact	W/A	RR	00		Yes	None		0	0	0	0
3837	Side impact into Rt. Front	None	LR			No	"		100	100	100	0
4302	Down bank into lake	"	DR	00	00	"	"	Drowned	0	0	0	0
4373	Frontal into oncoming car	Lap	RF	\$		No	HI		0	0	0	0
4463	Sideswiped by truck	None	DR	00		"	"		0	60	80	80
4499	Rollover *	"	"	00	00	Yes	"		0	0	0	0
4575	End over end roll	"	DR	00		"	Lo		10	40	80	60
4933	Offroad frontal into pole	"	DR	00,25	00	No	HI		0	0	0	0
4945	Rear impact	"	RR	00	00	"	None		10	40	50	50
4980	Hit tree, front Lt.Ctr.	"	DR	00	09,05	"	HI		10	10	10	0
5059	Very minor guardrail SS	"	DR	00	00	No	None	Fatality unrelated to accident--- heart attack after accident	0	20	40	40
5191	Hit in lt. side by car	"	DR	00	00	No	None		0	0	0	0
"	"	"	RR	00	00	"	"		10	20	10	0

FILE NAME	NIC#	Case No.	Fatal Collision Configuration (Multiple Impacts [A])	Restraint System Used	Fatal Occup. Sec. Pos.	Areas of Contact Involving Fatal Injuries		Reaction	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (%)			
						Head	Torso				L/S	AC/L	AC	
5201		5201	SOX offset frontal to left	Lap	DR	00	00	No	HI		0	0	0	0
5223		5223		None	DR	9		No	Lo		0	90	100	100
3021		3021	Frontal car to back of moving seal truck	None	DR	9	9	"	HI		20	20	20	20
3069		3069	Side--car to side of moving car "	"	"	20,14,9		"	None		0	0	0	0
3409		3409	Rollover into ditch	"	"	37		Yes	"		70	70	70	70
3073		3073	Frontal car to culvert	"	"	9	9,20	No	HI		2	9	9	9
3212		3212	Car to offset truck, head-on	"	"	14	9,5	"	"		0	0	0	0
3238		3238	Rear car to bridge support	"	"	38,30		"	None		0	0	0	0
3258		3258	Side Slide into oncoming car	"	RF	5,12	20,12,5	"	"		0	0	0	0
3268		3268	Head-on	"	DR	12		"	HI		0	0	0	0
3322		3322	Head-on	"	"	12,32	9	"	HI		0	0	0	0
3358		3358	Side to tree *	"	"	0	0	"	"		0	0	0	0
3363		3363	End over end roll *	"	"	0	0	Yes	Lo		70	90	70	20
3070		3070	Head-on	"	"	9		No	HI		0	0	0	0
3431		3431	Frontal, Car to pole	"	RF	0	0	"	"		0	0	0	0
3531		3531	Head on bus	"	DR	9		"	"		30	70	70	70
3657		3657	Side impact *	"	"	12	9	"	HI		70	100	100	100
3685		3685	Car to pole sideswipe *	"	"	0		Yes	"	Fire	0	20	30	20
				"	"	12,14		"	"		20	40	50	40

FILE NAME: MIC '70

Fatal Collis. Configuration (Multiple Injuries (M))

Case No.	Fatal Collis. Configuration (Multiple Injuries (M))	Restraint System Used	Fatal Occup. Sec. Pos.	Area of Contact Involving Fatal Injuries	Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Ratio (S)		
								LB	L/S	AC/L
3731	Rt. front to tree	None	RF 0		No HI			0	0	0
3771	Lft. side rollover	"	DR 60		Yes None			60	80	60
3903	Rt. side rollover	"	" 14		" Lo			60	80	60
4010	Head on to truck	"	" 0 0		" HI			0	0	0
		"	CP 0 0		" "			0	0	0
4031	Rollover to other car *	"	RF 0 0		" "			0	0	0
4063	10' Rt. angle, 50% offset to DR side	"	" 12 9		No None			0	0	0
4151	Frontal car to side of horse	"	DR 9,14		" HI			20	90	90
4216	Side of car to tree	"	" 25 14,20		No Lo			0	0	0
4270	Rt. corner to tree	"	RF 0 0		" None			70	70	70
4282	Roller into creek *	"	DR		" HI			0	50	50
		"	RF		" Lo Browning			0	0	0
4317	Head-on car to car	"	DR 0 0		" "			0	0	0
4335	Rollover into ditch	"	DR		" HI			0	0	0
4348	Rt. front side swipe by car	"	" 26		Yes None			70	80	70
4537	Rt. side to side of truck *	"	RF 00		No Lo			20	60	40
4642	Lf. Frt. offset to guardrail	"	DR 00 00		Yes None			100	100	100
4673	Head-on car to car	"	" 9		" BI			0	0	0
4693	End over end roll *	"	" 0 0		No "			30	60	90
		"	" 0 0		Yes HI			60	80	80

Case No.	FILE NAME	MIC '70	Fatal Collision Configuration (Multiple Impacts [A])	Restraint System Used	Fatal Occup. Scr. Pos.	Area of Contact Involving Fatal Injuries			Ejection	A/C Cushion Deployment	Comments	Restraint Effectiveness Rating (%)			
						Head	Torso	Other				LB	L/S	AC/L	AC
4716			Moving car side impact	None	DR 36	36		No	None		0	20	0	0	
4752			Sideswipe -- Driver side	"	" 20	20		"	III		0	30	30	10	
4785			Rt. side impact -- Large truck	"	" 20	20		"	None		30	60	30	0	
4794			Side car to side of moving car	"	" 20,36	36		Yes	"		0	0	0	0	
4868			Frontal car to bridge	"	" 9	9		No	III		10	20	30	20	
4872			Frontal car to 30' LF offset-- truck	"	" 00	00		"	"		0	0	0	0	
5041			End roll *	None	RF 36	36		Yes	"	Driver had lap belt on	60	90	80	60	
4611			LF side sliding car to oncoming truck	Lap	DR 9	9		No	"	Fire	0	0	0	0	
5050			Head-on 10X offset to DR side	None	DR 38	38		"	"		0	0	0	0	
5053			Rollover	"	" 37	37		Yes	None		80	90	80	0	
5088			Rollover	"	" 00	00		"	III		20	40	30	20	
5239			Rollover *	"	RF 00	00		"	III		20	30	40	40	
5121			Head-on 10X offset to DR side	"	" 9	9		No	"		20	80	60	0	
5133			Side slide into tree	"	" 20,25	25		"	None		0	0	0	0	
5211			Car to ditch to culvert	"	CF 12	12		"	"		20	30	20	0	
					LR 00	00		"	"		40	60	40	10	
5211			Car to ditch to culvert	"	CF			"	III		0	50	80	80	

Case No.	-E NAME- MIC '70 Fatal Collision Configuration (Multiple Impacts (M))	Fatal Collision Configuration	Restraint System Used	Fatal Occup Sec. Pos.	Areas of Contact Involving Fatal Injuries		Reaction	Comments	Restraint Effectiveness Rating (R)			
					Head	Torso			LB	L/S	AC/L	AC
5212	Rt. front fender mid to pole	None	None	CF	12,14,26		Yes HI		50	70	80	70
5219	DR side rollover	"	"	DR	12	00	" None		30	50	30	0
1168	Rollover *	"	"	RF	00	00	" HI		50	60	60	20
3033	LF side to tree *	"	"	DR	25,30		No None		40	50	40	0
4899	DR side sideswipe	"	"	"	00	9	" HI		0	0	0	0
				LR	25		" "		0	0	0	0
				RR	25		" "		0	0	0	0
4970	Rt. front to ditch *	"	"	RF		00	Yes "		10	30	30	0
				CF	00		No "		10	20	30	20
				LR		00	" "		0	0	0	0
				LR		00	Yes "		0	0	0	0
				CR		00	No "		0	0	0	0
				CR		00	Yes "		0	0	0	0
				RR		00	" "		0	0	0	0
				RR		00	No "		0	0	0	0
				RR		00	" "		0	0	0	0
1041	Rt. Front corner to tree	"	"	DR	12	36	" "		50	80	90	80
1035	LF rollover *	"	"	"	36,36		Yes Lo,		80	80	80	0
0969	RF side center car to tree *	"	"	"	12	9	No HI		0	0	0	0
0424	Car to offset right rear moving truck *	"	"	"			" "	Intrusion of truck rear	0	0	0	0

Case No.	FATAL COLLISION CONFIGURATION (Multiple Impacts [A])	Restraint System Used	PACAL OCCUP. SEAT POS.	Areas of Contact Involving Fatal Injuries			Ejection	Air Cusion Deployment	Comments			Restraint Effectiveness Rating (X)			
				Head	Torso	Total			No	Lo	Hi	LB	L/S	AC/L	AC
0192	Pass. side, car to moving car S8	None	RF	20			No	None				0	20	0	0
0309	LF corner head-on to oncoming truck	None	DR	35			"	HI				0	0	0	0
4915	Hit in RF by tractor truck ^A	"	RF	36			"	"				0	0	0	0
MIC 1971															
D322F	Frontal into tree	None	DR	12			No	Lo				100	100	100	0
D455	Side-offroad to mail box & ditch	"	"	12			"	None				0	0	0	0
D523	Hit ditch broadside	"	"	14	20		Yes	"				50	50	50	0
D540	Frontal into tree	Lap	"	9			No	HI				20	70	90	80
D817	Truck to side of car	None	"	36	20,26,36		"	None				0	0	0	0
D828	LF side to pole ^A	"	"	9,5,25			"	"				0	0	0	0
D1043	Roll to top of oncoming car ^A	"	"				Yes	"				0	0	0	0
D1093	Head-on to truck	"	RF				"	"				0	0	0	0
D1093	Head-on to truck	"	DR	9			No	HI				0	0	0	0
D1310	Frontal to side of car	Lap	RF				No	HI				0	0	0	0
D1322	Frontal to Bridge ^A	Lap	DR	36			No	HI				0	0	0	0

FILE NAME: MIC'70

Fatal Collision Configuration (Multiple Impacts [A])

Restraint System Used

PACAL OCCUP. SEAT POS.

Areas of Contact Involving Fatal Injuries

Ejection

Air Cusion Deployment

Comments

Restraint Effectiveness Rating (X)

LB

L/S

AC/L

AC

FILE NAME: MIC '91

Fatal Collision Configuration (Multiple Occupants (M))

Case No.	Restraint System Used	Fatal Occup. Pos.	Area of Contact Involving Fatal Injuries			Ejection	Comments	Restraint Effectiveness Rating (Z)			
			Head	Torso	Other			LB	L/S	AC/L	AC
D1438	None	DR	12,10	9		No	NI	0	0	0	0
D1491	"	RF	10	12		"	"	0	0	0	0
D1491	"	RR	26			No	NI	0	0	0	0
D1491	"	DR	00	00		"	"	0	40	40	40
D1702	"	"	00	00		"	Lo	0	0	0	0
D1702	"	"	36			Yes	None	0	0	0	0
D1835	"	RF	20			No	"	70	90	70	0
D1836	"	DR	14,5	9,5,20		"	NI	0	30	0	0
D1857	"	RF	36,38			"	None	0	0	0	0
D1961	Lap	"	00			"	"	0	0	0	0
D2086	None	DR	37	37		Yes	NI	0	0	0	0
	"	RF				No	None	60	70	60	40
	"	CR				"	"	0	0	0	0
	"	CR				"	"	0	0	0	0
	"	LR				"	"	0	0	0	0
D2102	"	RF	00	37		Yes	"	0	0	0	0
D2125	"	DR	14	9		No	NI	50	80	50	0
D2132	"	"	10			"	None	10	30	40	30
D2145	Lap	"	36	36		Yes	NI	30	30	30	0
	"	"				"	"	0	0	0	0

A

FILE NAME	MIC '71	Fatal Collision Configuration (Multiple Injuries (A))	Restraint System Used	Fatal Occ. Sec. Pos.	Areas of Contact Involving Fatal Injuries			Action	Air Cusion Deployment	Comments	Restraint Effectiveness Rating (2)			
					Head	Torso	Other				LB	L/S	AC/L	AC
D2162		Side to abutment	Lap	DR	20,26,36	20	No	NI			0	0	0	0
D2188		Side rollover	None	"	25,14		"	None			0	0	0	0
D2189		RT offset frontal to car	"	"	10,5,6	5,14,9	"	NI			40	60	60	50
D2204		Frontal to ditch & fish pond	"	"	10		"	"			50	90	90	90
D2275		LT side to brick pile *	"	"	00,36,14		"	Lo			0	0	0	0
D2286		Offroad rollover	"	"	00		Yes	None			50	80	50	0
D2293		End for end & side roll	"	RR	37		"	Lo			30	30	30	0
D2298		10:00 frontal to side of skidding car	"	RF	5		No	NI			0	60	70	70
D2299		Hit in RT side @ 2:00	"	"	00	00	"	Lo			0	0	0	0
DU003		Hit by car while inspecting accident	"	DR	00	00	"	None			0	0	0	0
D1459		Car to car head-on	"	RF	5,32		"	NI			0	0	10	10
D1416		Head-on to end of guardrail	"	DR	36	36	"	Lo			0	0	0	0
D1165		DR side rollover	"	"	37	37	Yes	None			80	90	80	0
D1851		Car to 2 trees, RT & LF corners	"	RF	10		No	NI			70	100	100	100
D1828		LF corner to bridge support	"	DR	5,12	9	"	"			0	0	0	0
D1803		RT side rollover	"	"			Yes	Lo			50	70	70	0
D1787		LF frontal ditch to culvert	"	CR	36	36	"	"			70	90	80	50
D1710		End to end rollover *	"	RF	36		"	"			50	70	50	0
			"	RR	36	36	"	"			60	70	70	30

Fatal Collision Configuration (Multiple Injuries [1])

Case No.	Restraint System Used	Fatal Occur. Pos.	Areas of Contact Involving Fatal Injuries		Ejection	Air Cushion Deployment	Restraint Effectiveness Rating (1)			
			Head	Torso			LB	L/S	AC/L	AC
D1543	None	DR 00	9		No	HI	0	50	60	50
D1544	"	" 00,12			"	"	0	60	70	60
D1666	"	RF 36			Yes	Lo	50	80	50	10
D0959	"	DR 00	00		"	None	60	90	60	0
D0980	"	" 14,37			"	Lo	90	100	100	40
D1046	"	" 14	9,20		No	HI	0	0	0	0
D1084	"	" 36,37	36,37		Yes	None	80	90	80	0
D1263	"	RF 00			No	Lo	0	30	0	0
D1324	"	DR 00, 9	00,9		"	HI	0	40	50	40
D0603	"	" 00			Yes	"	0	0	0	0
D0738	"	" 00,14			No	None	0	10	0	0
D0234	"	LR 26			"	"	0	0	0	0
D0399	"	DR 37			Yes	Lo	80	100	100	40
D0747	"	" 9			No	HI	0	0	0	0
D0748	"	" 00			"	"	80	100	100	100
D0137	"	" 14,36			"	"	0	0	0	0
D0180	"	RF 20	20		"	None	0	0	0	0
D0395	"	DR 14			"	HI	0	0	0	0
	"	"			"	"	0	0	0	0

Fatal puncture wound in face

Case No.	Fetal Collision Configuration (Multiple Injuries [all])	NIC '71	Restraint System Used	Fatal Injuries Head Torso	Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (I)			
								LB	L/S	AC/L	AC
D002J	Rollover A		None	DR 00	Yes	HI		60	80	80	50
D0426	LF side rollover A		"	RF 00 00	"	"		60	80	80	50
D0584	LF front corner to trailer A		"	" 12,12	No	None		60	80	60	0
D0081	LF rollover A		"	" 00,20	Yes	HI		0	0	0	0
D0099	RT 50% offset to bridge support		"	RF 14	No	None		50	50	50	0
D0302	LF rollover A		"	DR 26,25	"	HI		0	0	0	0
D1496	LF sideswipe car to tree		"	RF 26,25	"	"		0	0	0	0
D1309	RT side car to tree		"	CR 27	"	"		0	0	0	0
D0858	Head-on 50% LF offset		"	RR 26,36 20,32	"	None	7 month infant	0	0	0	0
D0824	Rollover		"	LR 24	"	HI		0	0	10	10
D0300	Rollover		"	RR 36,34	Yes	None		80	90	80	0
D0255	Hit RT side by truck		"	RR 25	"	"		30	50	30	0
			"	CR 00	No	"		70	90	70	0
NIC '72											
J0064	Left side rollover A		None	DR	Yes	HI	Occupant possibly unconscious before accident	10	20	20	10
0129	Left SS to oncoming car		"	" 16,36 20	No	"		0	60	70	50

FILE NAME: NIC '78

Total Collision Configuration (Multiple Injuries (A))

Case No.	Total Collision Configuration (Multiple Injuries (A))	Restraint System Used	Fatal Occup. Sec. Pos.	Areas of Contact Involving Fatal Injuries Head Torso	Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (2)			
								LB	L/S	AC/L AC	
0132	Off road end rollover	None	DR J6		Yes	Lo		60	80	60	20
0139	Off bridge into pond *	"	"		No	None	Drowned	0	0	0	0
0166	Off road, left rollover	"	" 26		Yes	"		40	60	40	0
0211	Right side to tree *	"	RF 25,26,36 20,36		No	"		0	0	0	0
0246	Frontal head on car-to-truck	"	DR 9		"	H1		20	50	60	60
0278	Car to rear moving car	"	" 10,35,36 9,35,36		"	"		0	0	0	0
0463	Car to side mid-moving car *	"	" 00		"	None	Driver had stroke before accident	0	0	0	0
0460	Car to ditch *	"	" 36		Yes	H1		50	60	80	70
0431	Left A-pillar to tree *	"	"		No	None	No obvious injuries	0	0	0	0
0398	Car to 3' high tree stump	"	LR		"	H1	DR lap belted, minor injury	30	80	80	80
0370	H1 speed roll	"	"		"	"		0	0	0	0
0360	Head-on car to car	"	DR		Yes	"	Ejection in question	10	20	30	20
0154	Head-on 50X offset to Left	"	" 9		No	"		0	0	0	0
0276	Right side impact	"	LR 29		"	"		20	50	50	50
0368	Head-on car to car	"	LP 20		"	None	DR lap belted, minor injury	0	0	0	0
0346	Frontal to bridge support	"	DR 00 00		"	H1		0	30	40	30
0446	Left side to bridge *	"	" 00		"	"		0	20	20	20
		"	DR 00		Yes	None	Car in three pieces	0	0	0	0
		"	CF 00		"	"		0	0	0	0
		"	RF 00		"	"		0	0	0	0

A

FILE NAME: NIC '72

Fatal Collision Configuration (Multiple Injuries (6))

Case No.	Fatal Collision Configuration	Restraint System Used	Fatal Occup. Sec. Pos.	Area of Contact Involving Fatal Injuries			Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (Z)			
				Head	Torso	Other				LB	L/S	AC/L	AC
J0387	Rollled into canal *	None	DR				No	None	Drowned	0	0	0	0
0498	Train	Lap	DR	36	00		No	"		0	0	0	0
0504	Side impact at door	None	CF	36	00		"	"		0	0	0	0
0511	Side impact at pillar	"	RF	36	00		"	"		0	0	0	0
0573	Offset right frontal	"	CF	36	00		"	"		0	0	0	0
0641	Multiple sides *	"	DR	38	20,38		"	"		0	0	0	0
0757	Left front @ 1:00 to car	"	RR	20			"	"		0	20	0	0
0914	Slid into pine tree	"	DR	9			"	HI		60	90	90	90
0791	Head-on to tractor truck	"	"				Yes	None		20	50	20	0
0830	Rollled end over end *	"	"	12	9		"	None	Crushed legs; marrow in bloodstream	20	70	90	80
0701	Hit in Rt. side by 1/2 Ton PU.	"	RF	36	20		Yes	"		20	40	50	40
0617	Frontal hit RR of 2 T. truck	"	DR	36,35	9		No	HI	Possible DR was RF	10	50	10	0
0921	Center front to tree	"	RF				"	"		20	40	50	40
0953	Downhill roll into tree *	Lap	DR	36,26	36,37		Yes	None		70	90	100	100
1031	Hit right side by car	None	RR	20			No	"		0	0	0	0
1055	Head-on to bus	"	DR	35,12	00		"	HI		0	0	0	0

FILE NAME: MIC '72

Case No.	Fatal Collision Configuration (Multiple Impacts (A))	Restraint System Used	Fatal Occup. Sec. Pos.	Area of Contact Involving Fatal Injuries		Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Ratios (2)			
				Head	Torso				LB	L/S	AC/L	AC
J1076	Side-rod into side of truck bed None	None	RF 00			No	NI		0	0	0	0
1090	Head-on	"	DR			"	"		60	80	90	90
1092	Rollover to tree	"	RR			"	None		0	0	0	0
1125	Rollover A	"	DR 00	00		"	III		0	0	0	0
		"	RR 00	00		"	"		0	0	0	0
DOT #1												
69-39	Frontal--lost control into car	"	RF 12,5			No	NI		60	80	90	80
69-46	Loss control into roll A	"	DR	37		Yes	None	Inertia shock, not at wheel when car left road	30	40	30	0
69-49	Right front to tree	"	"	00		No	NI		0	0	0	0
		"	RF			"	"		0	0	0	0
69-55A	Frontal, car to car	Lap	DR	9		"	"		-	0	0	0
69-58	Side, loss control into tree	"	"	38	2	Yes	None		90	90	90	0
69-59	Side, through brush into tree	"	"	10,25		No	NI		90	90	90	0
70-3	Side: burst tank, tire	"	"			"	None	fire	0	0	0	0
70-6	Off road roll A	"	"	36		Yes	Lo		20	20	20	0
70-8	Left rolls off road	"	"	36		"	None		80	80	80	0
70-10	Severe side impact	"	"	37	37,32	"	"		0	0	0	0
		"	RF	20,26,37		"	"		0	0	0	0

FILE NAME:	DOT	Fatal Collision Configuration (Multiple Impacts (4))	Restraint System Used	Fatal Occup. Scr. Pos.	Areas of Contact Involving Fatal Injuries		Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (2)			
					Head	Torso				LB	L/S	AC/L	AC
RTI-0		Side by train	None	DR	38	38		None	Occupant run over by train and	0	0	0	0
-10		Head-on	"	CF	00	00	"	"	car	0	0	0	0
-24		Head-on to Train	"	DR	10	9	"	HL		10	60	70	70
Georgia 658		Head-on	"	RF	12	2	"	"		0	70	80	80
50		SS by truck to side of truck	"	"	00	00	"	"	Previous medical history contr. to fatal	40	70	60	50
59		Off-road into trees, then fire	"	DK	00	00	Yes	"		10	70	90	90
61		Other: would have survived frontal	"	CF	36		"	"		0	0	0	0
Miami 32		Severe rear with multiple impact	Lap	RR	00		"	"		0	0	0	0
105		Loss control into water	None	LR	00	00	"	"		0	0	0	0
6970-02		Offset frontal to bus rear	"	DR			No	"	Fire	10	30	30	30
011		End over end roll	"	"			"	"	Heart attack before impact	0	0	0	0
019		Offset frontal	"	RF	00	00	"	HL		0	0	0	0
			"	"	21		Yes	Lo		30	80	60	30
			"	DR	9,35		No	HL		0	0	0	0
			"	RF	6,12		"	"		0	80	70	70

NAME	DOT	Case No.	Fatal Collision Configuration (Multiple Impacts [A])	Restraint System Used	Fatal Occur. Sec. Pos.	Areas of Contact Involving Fatal Injuries Head Torso	Ejection	Air Cushion Deployment	Restraint Effectiveness Rating (X)			
									LB	L/S	AC/L	AC
6970-034		Tuland	Motorcycle to side of car	None	DR	20,22	No	None	0	0	0	0
1382-870			Side of vehicle into front of truck	"	"	00 20	"	NI	0	0	0	0
1802-770			Sidewipe then L. side slide	"	"	36	Yes	None	0	0	0	0
19211-70A			Left side impact	"	"	21,13 20,9	"	NI	60	90	90	30
Ohio -4			Side slide into truck	"	"	00 00	No	None	10	20	10	0
-7			Right side car to car	"	RF	00	"	"	0	0	0	0
Indiana MCR-69-7			Left side to tree	"	DR	00 00	"	"	40	50	40	0
69-9			Slid rear side into bridge	"	"	20,26	"	"	0	0	0	0
69-2			Right side impact followed by fire	"	LR	00	Yes	"	20	40	20	0
69-3			RC. side impact to tree	"	DR	00 00	No	"	0	0	0	0
No. 9 H. Mex.			LF corner to horse	"	RF	21,22,14 20,13	"	Lo	0	0	0	0
No. URM 12			Rollover	"	DR	36	"	"	0	0	0	0
16			Frontal to bridge	"	"	36	Yes	NI	70	90	80	60
20			Right side to bridge	"	RF	36	"	"	50	80	70	0
012-70 UT			Rollover	"	"	14	No	None	0	0	0	0
				"	"	00	Yes	"	40	70	40	0
				"	CF	00	"	"	n/a	n/a	n/a	0
				"	RF	00	"	"	40	60	40	0
				"	CR	00	"	"	60	80	60	0

Side impact caused fatality

Motor's head into DR side

CF ejected with minor injury

FILE NAME:	DOT	Fatal Collision Configuration (Multiple Impacts [all])	Restraint System Used	Fatal Occup. Sgr. Pos.	Areas of Contact Involving Fatal Injuries		Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (Z)			
					Head	Torso				LB	L/S	AC/L	AC
68-19,193966		Left front to pole	None	DR		38	No	Lo	Heart attack	0	0	0	0
69-1		Front to bridge abutment	"	"			"	HI		0	0	0	0
69-4		Front to tree *	"	RF	12	5	"	"		10	40	60	50
69-8		Front to pole	"	DR		38	"	Lo	Heart Attack	0	0	0	0
69-11		Right front to pole	"	"		9	"	HI		20	60	80	80
69-16,HS600-750		Airborne to tree	"	"	10,36	9	"	"		0	0	0	0
69-22,HS600-598		End over end roll *	"	"		38	"	"	Death due to drowning in own stomach fluid	70	80	90	90
69-23,HS600-649		Hit in front at 11:00 *	"	"	9	9	"	"		10	50	60	50
69-28,HS600-142		Left frontal offset	"	DR		20	"	"		0	0	0	0
69-29,HS600-143		Left side rollover	"	"	36		Yes	None		80	90	80	0
69-34,HS600-283		Frontal, underrode truck	"	"	36		No	Lo		0	0	0	0
69-33,HS600-284		Hit by car in Rt. door *	"	"			Yes	None		10	20	10	0
69-36,HS600-287		Lo speed frontal to tree	"	"			No	"	Heart Attack	0	0	0	0

FILE NAME:	DOT	Fatal Collision Configuration (Multiple Impacts (A))	Restraint System Used	Fatal Occup. Scr. Pos.	Area of Contact Involving Fatal Injuries			Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (Z)			
					Head	Torso	L/S				AC/L	AC		
													LB	L/S
70-06 HS600-676		Lf. Side to guardrail	None	DR	36			Yes	Lo		70	80	70	0
70-03 HS600-406		Angled left side frontal	"	"	9			No	HI		0	30	70	60
70-05- HS600-483		Frontal to guardrail	"	"	14			Yes	"	Possible suicide	0	0	0	0
70-10 HS600-677		Frontal to stone wall	"	"	00	00		No	"		0	0	0	0
71-07 HS600-781		Right sideswipe *	"	RF	05,20			"	"		0	0	0	0
71-08 HS600-782		Car to rear of truck	"	DR	9			"	"		0	0	0	0
"		"	"	CF	20			"	"		0	10	10	10
"		"	"	CR	12			"	"		0	10	20	20
8605 Geo.12		Low speed rollover.	"	DR	00			"	None		10	30	10	0
FB199-132 34		Side to bridge *	"	"	14			"	HI		30	40	30	40
B603 GEO.29		Frontal car to car	"	"	9			No	HI		0	40	60	50
FB199-132 38		Car to side of car *	"	"	14	9,20		"	"		0	0	0	0
HS600-498 83		Side to curb *	"	"	36			Yes	None		70	90	70	0
HS600-496 81		Frontal bridge	"	"	00	00		No	HI		0	0	0	0
Boat, 69-13 FB193-966		Car under side of moving truck	"	"	36			"	None		0	0	0	0
69-5		Right side to pole *	"	"	20			"	"		40	40	40	0
69-6		Lf. side to pole	Lap	"	36			"	"		0	10	0	0
69-12		Rt. sideswipe to bridge	None	RF	36	36		Yes	"		20	40	20	0

FILE NAME: DOT

Case No.	Fatal Collision Configuration (Multiple Impacts (M))	Restraint System Used	Fatal Occup. Sec. Pos.	Area of Contact Involving Fatal Injuries		Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (T)		
				Lead	Torso				L/S	AC/L	AC
81924 01	RAL-2 Left side to pole	None	DR 36	20	No	None		0	0	0	0
ROCH "	" -J Side to oncoming car	"	RF 5		"	"		0	0	0	0
"	" -2J Rollover "	"	DR 37	37	Yes	"		50	70	50	0
"	" -37 "	"	" 25	25,9	No	Lo		0	0	0	0
"	" -38 Left frontal	"	" 9		"	Nil		10	60	70	70
"	" " " "	"	RF		"	"		50	80	90	90
"	" -52 Hit in Lt. Rear Qtr. by Truck	"	DR 00	00	Yes	None		0	0	0	0
"	" " " "	"	RF 00	00	No	"		0	0	0	0
"	" -53 Sideswipe to truck	"	DR 00	00	"	"		0	0	0	0
"	" " " "	"	CF 00	00	"	"		0	0	0	0
"	" " " "	"	RF 00	00	"	"		0	0	0	0
"	" " " "	"	" 00	00	Yes	"	Severe intrusion	0	0	0	0
HS600-613	ROC1167 Hit in Rt. side at 2:00	"	RR 36	20	"	"		0	0	0	0
"	" " " "	"	DR 9		No	Nil		0	30	50	50
"	655 " -88 Center frt. to stump at 2:00	"	RF 20,38	20,38	Yes	None		60	80	60	0
"	540 " 92 Lt. side rollover	"	" 20		No	None		10	30	10	0
"	661 " 114 Hit in right door	"	DR 16,20		Yes	"	19I CO in blood	0	0	0	0
"	733FLA 072- HI speed rollover in Left side	"	RF 36,25		"	"	20I CO in blood	0	0	0	0
"	" " " "	"	DR 9		No	Nil		0	40	40	40
513FLA 124	Front to sign post	Exp	CF 10		"	"		20	60	60	50
"	511 " 119 Lt. frt. to train-10:00	"			"	"					

FILE NAME:	DOF	Fatal Collision Configuration (Full/Partial/None)	Restraint System Used	Fatal Occup. Sg. Pos.	Areas of Contact Involving Fatal Injuries		Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (1)			
					Head	Torso				LB	L/S	AC/L	AC
HS600-628 FLA 103		Rt. side impact to 15" palm + None	None	RF 00			Yes	Lo		10	40	20	10
HS600-212 FLA 69 7005		Rt. side to pole ?	"	DR 38,36			"	None		90	100	90	0
HS600-633 FLA 127		Hit in Lt. door at 10:00 "	"	" LR 21	9,30		No	"		10	30	10	0
HS600-346 TUL 26F 14-70		Frontl. to flower pot & pole	"	DR			"	Lo	Heart Attack	0	0	0	0
HS600-368 UTAH 016-70		Lt. side to pole *	"	LR 20	20		Yes	None		0	0	0	0
"		"	"	RF 39,38			"	"		50	50	50	0
PR183-864 TUL 01		Partial Lt. side rollover	"	DR			No	"		0	0	0	0
"		"	"	CF			"	"		0	0	0	0
"		"	"	RF			"	"		0	0	0	0
PR191-767 06		Rt. side to car *	"	DR			"	HI		0	0	0	0
HS600-210 MARYL 70-3		Head on *	Lap	RF 14,35	14,20		"	"		0	0	0	0
PR191-767 TUL 10 & 11		Lt. side to fire hydrant	None	DR			Yes	None		40	50	40	0
HS600-429 MARYL 70-9		Rt. sideswipe to tree *	"	" 14			No	HI		60	70	80	0
HS600-532 DSU-21		Spin, Lt. sideswipe	"	" 00	20,29		"	None		0	0	0	0
"		"	"	RF 16	29		"	"		10	10	10	0

FILE NAME: DOT	Fatal Collision Configuration (Multiple Injuries (AI))	Restraint System Used	Fatal Occup. Sec. Pos.	Areas of Contact Involving Fatal Injuries	Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (%)					
								LB	L/S	AC/L	AC		
IS600-547													
SVRI 70-39	Frontal, head-on	None	DR	5,4	No	NI		20	60	70	50		
IS600-553													
SVRI 70-50	Shot in head	"	"	38	"	None	Suicide	0	0	0	0		
IS600-764													
SVRI 71-41	Lt. side roll	"	"	36,37	Yes	"		40	40	40	0		
IS600-770													
SVRI 71-47	Pickup to side of car	Lap	"	37,38	"	NI		20	30	20	0		
IS600-738													
SVRI 71-55	Car to rear of car	"	DR	00	"	None		0	0	0	0		
IS600-707													
SVRI 71-66	Frontal to Car	None	DR	9	"	NI	Possible suicide	60	90	90	90		
IS600-711													
SVRI 71-74	Frontal to bridge abutment	"	"	36	Yes	None		60	60	60	0		
STANTFORD													
500 255 SRI	Engine compartment fire while stopped	"	"		No	None	Fatal due to acute CO intoxication	0	0	0	0		
500-524 UNM	Right front to bridge abutment	"	"	7,12	"	NI		0	10	10	10		
500-650	Hit in Lt. Frt. door	"	"	20	"	None		0	0	0	0		
IMH-54	1/2 Ton Pickup	"	RF	20	"	"		30	40	30	0		
500-368-													
1780 UC	Sideswipe chain-link fence	Lap	DR		"	"	Heart attack prior to accident	0	0	0	0		
PA183455													
MAT 2 KE-1	Frontal to tree	None	RF	10	"	NI		20	70	80	80		

FILE NAME: DOT #2	Fatal Collision Configuration (Multiple Injuries [1])	Restraint System Used	Fatal Occur. 58. Post.	Access of Contact Involving Fatal Injuries Head Torso		Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (2)			
				LB	L/S				AC/L	AC		
P8191768												
MAY 3 ME 3	Hit in rt. door by truck	None	RR 39	20	None	No	None		0	10	0	0
P8191768												
MAY 3 ME 11	Hit Lt. door by car	"	DR 14	20	"	"	"		0	0	0	0
HS600 792												
ROCB MAI 5366	Side Impact--Intersection	"	RF 14,3		"	"	"		90	90	90	0
DOT #1												
P8183-802-1	Car to rear of stopped truck	"	DR 9	9	No	HI			0	30	40	40
183-802-2	Hit in rear *	"	"	38	"	None			0	0	0	0
183-802-6	Side--Lt. frt. to pole *	"	"	9,25	Yes	HI	Severe Lt. side intrusion		0	0	0	0
183-802-7	Rt. front to pole *	"	RF 5		"	"			0	40	50	50
183-802-9	Rt. Front to tree	Lap	"	34	"	"	Loosely worn lap belt		0	70	80	50
UN-1-1967-69												
UN248-69	Head on	Lap	DR 9	00	No	HI			0	20	20	10
0081-068	Frontal to concrete post *	"	CR	00,00	"	"			0	60	50	90
96-68	25X offset Frt. car to parked truck	None	RF	5	"	"			20	70	70	70
116-68	Right frontal	"	DR 36		"	None			0	0	0	0
201-69	Head on car to car	Lap	"	31	9,31	HI			0	0	0	0

A

FILE NAME: DM 1967-69

Fatal Collision Configuration (Multiple Impacts (A))

Case No.	Fatal Collision Configuration (Multiple Impacts (A))	Restraint System Used	Fatal Occup. Sec. Pos.	Area of Contact Involving Fatal Injuries		Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (S)			
				Head	Torso				LB	L/S	AC/L	AC
238A-69	Head on car to car	None	DR	9		"	"		20	70	70	70
251-69	Rt. sidewipe to tree A	"	RR	29,32		"	"		0	0	0	0
	"	"	RF	10		"	"		0	0	0	0
289-69	Lf. front car to guardrail	"	DR	14,11,27		"	None		10	40	10	0
64-68	Rollover A	"	"	00		Yes	"		0	0	0	0
102-68	Frontal car to crane	"	"	00		No	HI	May have had heart attack prior to accident	0	0	0	0
106-68	Rt. side to tree (SS) A	L/S	RF	00		Yes	"	DR wore S. belt only; NF wore L/S	0	0	0	0
127-68	LF side truck to car (OD)	None	DR	36,20	20	No	Lo		0	0	0	0
215-69	End for end roll A	"	RF	00	00	Yes	HI	Roll, dug in ground	0	0	0	0
237-69	LF side rollover	"	DR	36		"	None		30	80	40	10
418-71	50% LF rear impact of vehicle	"	"	25,30,38		No	"		40	50	40	0
417-71	RT front & side impact	Lap	RF	38,14	20	"	"		20	40	20	0
415-70	RT side roll A	None	"	36	36,37	Yes	Lo	DR, RR, RE wore lap belt	0	10	0	0
386-70	Frontal to tree A	"	DR	38,9		No	None		0	0	0	0
369-70	Center frontal to tree	Lap	"	9,34		"	HI		0	0	0	0
367-70	RT side door to DBL guardrail	None	RF	20,13,32		"	None		0	0	0	0
318-70	RT side to ground & tree A	"	DR	36		Yes	HI		0	0	0	0
"	"	"	RF	36		"	"		0	0	0	0
"	"	"	RR	36	36	"	HI		0	0	0	0
334-70	Frontal to embankment	"	RF	36		No	"		0	70	70	60
"	"	"	RR			"	"		10	70	70	60

A

FILE NAME:	UM	1967-69	Fatal Collision Configuration (Multiple Injuries All)	Restraint System Used	FATAL OCCUP. SEAT POS.	Areas of Contact Involving Fatal Injuries			Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (%)			
						Head	Torso	Other				LB	L/S	AC/L	AC
UM331-70			LF side to ditch, sign & pole	None	DR	10, 4			No	None		20	40	20	0
330-70			Frontal to bridge support	Yes	"	9			"	HI		0	0	0	0
325-70			LF side rollover	None	"	36			Yes	None		30	50	30	0
310-70			Frontal to bridge support	"	"	5, 30	9		No	HI		0	0	0	0
359-70			Sliding car (RT side) to Guardrail	"	"	38	38		Yes	None		0	0	0	0
343-70			RT side impact	Lap	"	36			No	HI		0	0	0	0
03-68A			50X offset frontal car to car	None	"	00	00		"	"		10	40	40	40
"				"	RF	00	00		"	"		0	50	50	50
18-68			6:00 side impact car to car	"	DR		10		"	None		0	0	0	0
136-68			Head-on-car	"	"				Yes	HI		50	60	80	70
138-68			50X offset head-on with Pickup	"	"	9	9		No	"		0	0	0	0
UM									Yes	HI	Intrusion prior to inflation	0	0	0	0
UM64-68			Right side rollover	"	DR	00			Yes	HI		20	70	90	90
92-68			Head-on by car	"	RF		5		No	Lo		0	0	0	0
114-68			Truck into R. while stopped	"	DR		9		"	HI		0	0	0	0
130-68			Side impact by car into RT door	"	RF	38	20		"	None		0	0	0	0
178-69			Car to bridge abutment	"	DR	00	00		Yes	HI		0	0	0	0

FILE NAME: UN

Case No.	Fatal Collision Configuration (Multiple Impacts [A])	Restraint System Used	Fatal Occup. Sgs.	Area of Contact Involving Fatal Injuries		Ejected	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (1)			
				Head	Torso				LB	L/S	AC/L	AC
224-69	Hit in RT side by car A	None	DR 00	9		No	HI		20	30	20	0
230-69	RT offset frontal	"	RF	5		"	"		10	70	70	70
234-69	Car to side of car	"	00	00		"	None		0	0	0	0
273-69	Rt. Rt. & Quarter to tree	None	20,36	20		"	"		80	90	80	0
278-69	Sideswiped two cars on LF side	"	00	00		"	HI		20	50	70	60
329-70	Hit in LF side by train A	"	36,16, 10			Yes	None		0	0	0	0
434-71	Hit in RT side by train	"	"	20 38		No	"		30	30	30	0
"	"	"	RF	37,38 20,37		Yes	"		0	0	0	0
437-71	LT side rollover	"	DR	36,37		"	"		70	80	70	0
466-71	RT side rollover	"	"	38 37		"	"		50	50	50	0
472-71	30X overlap to LF front	"	"	9,20 9,20		No	HI		0	0	0	0
489-71	40X " " "	Lap	"	35 9		"	"		0	0	0	0
490-71	" " " "	None	"	14,5 9		"	"		0	0	0	0
499-71	3/4 rollover	"	"	10,38		Yes	None		70	90	70	0
"	"	"	RF	38,37 38,47		"	"		60	80	60	0
501-71	LT side rollover	"	"	38		"	"		30	40	30	0
509-71	Rollover, 3 times to RT	"	DR	37		"	"		70	90	70	0
510-71	Airborne-flipped to left	"	CR	38		"	"		50	60	50	0
"	"	"	RF	00 38,20		"	"		40	50	40	0
520-71	Hit concrete base, RT side	"	DR	9		No	HI		0	0	0	0
358-71	LT side rollover	"	"	26,37,10		"	None		50	70	50	0
603-71	LT side rollover	"	RF	38		"	No		60	60	70	60

Case No.	FILE NAME: UC Fatal Collision Configuration (Multiple Impacts (all))	Restraint System Used	Fatal Occup. Scr. Pos.	Areas of Contact Involving Fatal Injuries			Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (1)			
				Head	Torso	Limb				LB	L/S	AC/L	AC
UC 148	Rollover *	---	DR 10	No NI	No NI	No NI			10	60	60	60	
160	Rollover	None	RR 36,37	Yes	None	No deployment			40	60	40	0	
393	Rollover	---	DR 36	"	NI	"			10	20	20	10	
278A	LF side to Pole *	None	" 14	"	"	"			0	0	0	0	
"	"	"	RF 5	No	"	"			20	70	50	40	
276	---	Yes	DR 9	"	"	Possible lap belt use by fatal			0	80	90	80	
261	---	None	" 9	"	"	"			0	70	90	90	
260A	Head on LF side *	"	RF 12	"	"	"			40	90	90	90	
260B	Crossed centerline & struck in front side	"	DR	Yes	"	"			20	40	40	20	
"	"	"	RF	"	"	"			0	0	0	0	
"	"	"	RR	"	"	"			30	50	60	40	
236	Frontal underride of crane off road	"	DR 36,00,37	No	"	"			0	0	0	0	
386	20% overlap	"	" 9	"	"	"			0	0	0	0	
383	Sideswipe *	"	RF 5	"	"	Subject on lap			0	0	0	0	
377	Pole into A-pillar area	"	DR 25,14	"	"	"			90	100	90	70	
378	Frontal offset into pole	"	" 36,5	"	"	"			0	0	0	0	
370	Crush along fender	"	" 12 31	"	"	95 lb. iron in back of wagon			0	0	0	0	
367	Hit in side by pickup	"	" 20,19,38	"	"	None			0	0	0	0	
359	Hit in side by car *	"	" 14,36 20	"	"	Severe intrusion			0	10	0	0	
"	"	"	RF 5	"	"	"			40	80	40	0	
354	Side Impact	"	" 20	"	"	"			0	20	0	0	

FILE NAME: UC

Fatal Collision Configuration (Multiple Injuries [4])

Case No.	Fatal Collision Configuration	Restraint System Used	Sec. Pos.	Area of Contact Involving Fatal Injuries		Yes	No	Yes	No	Comments	Restraint Effectiveness Rating (3)			
				Head	Torso						LB	L/S	AC/L	AC
UC 346	Rollover A	Lap	DR	38	38					Partial ejection of arms & possibly head	0	0	0	0
344	Head-on	None	"	9	9					Drunk: could have caused death	70	90	100	100
348	Severe side	"	"	20, 19	20, 19						0	0	0	0
316	Right side roll	"	"	36, 37	36, 37	Yes					70	90	70	0
315	LT front corner frontal	Lap	RF	34	34						0	60	70	90
421	Right side roll	None	DR	36, 37	36, 37	Yes				Belt possibly improperly worn	0	60	70	90
428	Left side roll A	"	"	36	36						10	10	10	0
430	Left side impact	"	LR	36, 16	36, 16						90	100	90	0
465	Frontal to truck	"	DR	9	9						0	0	0	0
469	Sidewipe A	Lap	RF	35	35						0	30	40	30
474	Frontal to tree	None	DR	9	9						0	70	0	0
475	Car to rear of truck	"	"	9	9						60	80	90	90
490	Frontal to tree	"	"	9, 5	9						80	90	100	100
495	Frontal to Pole	Lap	"	9	9						90	100	100	100
507	Left side roll	None	RF	37, 36	37, 36	Yes					0	60	70	70
516	Sidewiped guardrail	"	DR	36	36						40	40	40	0
"	"	"	RF	36	36						0	0	0	0
539	Rollover A	"	DR	36	20, 36						30	40	30	0
570	Rollover A	"	RR	38	38						80	90	80	0
571	Side slide into tree	"	RF	14	38, 20	No					0	20	0	0

FILE NAME	UC	Fatal Collision Configuration (Multiple Impacts (A))	Restraint System Used	Fatal Occur. Sec. Pos.	Areas of Contact		Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (2)			
					Fatal Injuries Head	Involving Torso				LB	L/S	AC/L	AC
UC 389		Loss control downhill-- underride impact	None	DR 20,38	No	None	Drunk			80	100	80	0
504		Rollover *	"	" 36,00	Yes	Lo				30	30	30	0
"		Slid into wall *	"	RF " "	"	"				10	10	10	0
512		50X front overlap	"	DR 35	No	HI	80% probability of deployment			0	0	0	0
519		Landed on front right corner *	"	" 2	"	"				70	90	70	70
538		Rollled *	"	" 38	Yes	Lo				70	90	70	0
559		Right side impact *	Lap	" 20	"	HI				0	0	0	0
1003 D-A		Car to Car right side	"	" 38,20	No	None				0	0	0	0
"		"	"	RF 38	"	"				0	0	0	0
1023 D		Jumped guardrail & into side of bridge abutment	None	DR 36	"	"				0	0	0	0
1075 D-B		Sideswipe	"	" 21,26,36	"	"				10	40	10	0
1107 D		Roll into abutment *	"	" 25	"	Lo				50	70	50	0
1120 D		Right side to pole	"	" 10	"	None				0	0	0	0
"		"	"	RF 14	"	"				0	0	0	0
"		"	"	CF 38	"	"				0	0	0	0
1143 D		Frontal impact with cable	Lap	DR 14,10	"	HI				0	0	0	0
1164 D		Head-on	None	" 35,14	"	"				0	0	0	0
1172 D		Rt. side impact by car	"	RF 38	"	None				0	0	0	0
1176 D		Right side roll *	"	DR 36,00	Yes	"				90	90	90	0
1181 D		Front to truck	"	CF 35	No	HI				30	80	80	70

FILE NAME:	UC	Fatal Collision Configuration (Multiple Insects (all))	Restraint System Used	Area of Contact Involving Fatal Injuries	Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (Z)			
								LB	L/S	AC/L	AC
								Head	Torso		
1188 D		Frontal override of curb	Lap	DR 5 9	No	HI	No impact	0	40	50	50
1212 D		Fired due to repair work	None	CF Burns	"	None		0	0	0	0
1224 D		Frontal to Bus	"	DX 9 9	"	HI		10	60	70	50
1240 D		Frontal to pole	"	" 9	"	"		30	90	90	90
1261 D		Lt. side angled frontal to car	"	" 14,36,35 9,20	"	"		0	20	0	0
"		"	"	RF 35,5 5	"	"		30	80	80	60
1273 D		Rollover off cliff	"	DR 36	Yes	"		0	0	0	0
"		"	"	RF 00	"	"		0	0	0	0
"		"	"	36	"	"		0	10	0	0
"		"	"	RR 00	"	"		0	10	0	0
1294 b		Rollover off cliff	Lap	DR 38	No	"		0	10	0	0
1146 D		Frontal to chain-link fence	None	" 25	Yes	"		0	0	0	0
1183 D		Struck in side by car	"	" 38 20	"	None		0	0	0	0
CAL											
UC 147		Sidewiped pole left side A	"	" 36	No	None		0	0	0	0
"		"	"	RR 36	Yes	"		0	0	0	0
"		"	"	" 36	"	"		0	0	0	0
250		Left side frontal to car A	"	RF 00	No	HI		20	90	90	90
525		Lf. offset frontal to car A	Lap	DR 35	"	"		0	50	30	30
464		Car to side of car	None	" 14,36 20,36	"	"		0	0	0	0
CAL 56		Lf. side hit side of other car A	"	" 36	Yes	Lo		30	80	30	0
370-A		Right side rollover	"	" 36 36	"	None		60	70	60	0

FILE NAME: CAL	Fatal Collision Configuration (Multiple Impacts [a])	Restraint System Used	Fatal Occup. Sqr. Pos.	Area of Contact Involving Fatal Injuries			Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (2)			
				Head	Torso	AC				LB	L/S	AC/L	AC
CAL 35	Right side impact	None	DR 00	00	00	No	Lo		50	50	60	20	
480-A	SS Lt. side @ 11:00 frt. wheel to rear wheel	"	"	"	"	"	None		0	20	0	0	
337-I	Head on-75% offset right	"	RF 38	38		"	HI		0	40	30	30	
192-A	Head-on @ 12:00	"	DR 38	38		"	"		30	70	70	70	
"	"	"	RF 38	38		"	"		0	70	70	70	
288-A	Head on towards left @ 12:00	"	DR	9	9	"	"		0	0	0	0	
287-A	Head on towards left @ 12:00	"	"	9	9	"	"		0	0	0	0	
256-A	End to end roll a'	"	"			Yes	"		70	80	80	40	
296-A	Left front 50% offset @ 12:00	"	"	00	9	No	"		0	10	10	10	
74 A	Car hit on top of hood by airborne vehicle from 11:00	"	RF	00,5	00,5	"	"	DR had minor injuries with lap belt	10	50	60	60	
"	"	"	CR	25		"	"		30	50	50	40	
"	"	"	RR	25		"	"		30	50	50	40	
72-A	Left roll a	"	RF	38,10	38	Yes	"	DR. ejected through left door	60	80	80	80	
40-A	Vehicle into side of oncoming car	Lap	"	12		No	"		0	100	100	100	
3-A	Car to tree	None	"	00	00	Yes	"		20	40	40	40	
97	LF. frontal to rear of trailer truck	Lap	DR	9,14		No	"		0	0	10	10	
84	30' car to side of truck tractor	None	"	9		"	"		10	20	20	20	
"	"	"	RF	5		"	"		0	0	0	0	
76	Head on into embankment a	"	"	25,14		"	"		10	50	60	60	

Case No.	FATAL COLLISION CONFIGURATION (Multiple Impacts (All))	Restraint System Used	Fatal Occup. Sct. Pos.	Area of Contact Involving Fatal Injuries		Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (I)			
				Head	Torso				LB	L/S	AC/L	AC
CAL 72	Head on to 4 1/2" diameter tree	None	DR 9			No	NI		30	80	90	90
53	50% offset car to car head-on	Lap	" 9			"	"		0	50	70	70
37	Car frontal to bridge support	None	" 9			"	"	Probable heart attack caused acc.	0	20	40	40
431	Right side door to tree	"	RF 20,26,36	22,36		"	None		0	20	0	0
429A	Off road RT side rollover	"	DR 36,10	36,9		Yes	"		60	90	60	0
"	"	"	RF 36,14	36		"	"		60	90	60	0
456A	Rollover	"	DR 00,26,25			No	"		50	90	50	0
216A	Trailer rolled over on car	"	" 25			"	"		0	0	0	0
227A	Car hit right side	"	" 00			Yes	NI		30	60	70	50
71-221A	Right side to pole	"	" 38			No	None		0	0	0	0
MISCELLANEOUS--												
CM FLEET, OAKLAND COUNTY & HUELER												
H-060	Rt. frt. sideswipe to tree	L/S	RF 20			"	NI		0	0	0	0
M-305	Frontal to exit sign	None	DR 10,12	9		"	"		0	70	80	70
333	Right side (4) rolle	"	" 25			Yes	None	Ejected through sun roof	70	90	70	0
331	Lt. Frt. SS to bridge support	"	" 20,38	38		"	NI	Bridge penetrated DR door	0	0	0	0
317	LI. Frt. to oncoming truck	Lap	"	9		No	"		0	50	50	30
241	"	"	" 00	00		"	"		0	20	20	20
222	Slid into tree	None	" 00	00		"	"		0	0	0	0
177	Frontal to oncoming car	"	" 9			"	"		20	50	60	50
"	"	Lap	" RR			"	"		0	60	50	80

7

FILE NAME	MISCELLANEOUS	Fatal Collision Configuration	Restraint System Used	Fatal Occup. Srg. Pos.	Area of Contact Involving Fatal Injuries Head Torso	Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (I)				
									LB	L/S	AC/L	AC	
Case No.	Multiple Injuries (A1)												
H-440	Frontal to truck	Lap	DR	9	No	NI		Possible heart attack, or asleep	0	20	20	20	20
447	Severe impact right side	None	RR	00	"	None			0	0	0	0	0
449A	Hit in RT side by car	Lap	DR	00	Yes	"			0	0	0	0	0
449B	Hit in Frt. LT. by car	"	"	00	No	NI			0	50	70	60	60
467	Direct head-on car to car	None	RF	00	"	"			20	50	70	60	60
"	"	"	"	00	"	"			20	70	80	70	70
473	Frontal to rear of stalled car.	"	DR	00	"	"		Underrode rear of modified Camaro	20	60	70	60	60
484	Right front to tree--HI speed	"	RF	00	"	"			50	0	90	90	90
499	LT front to oncoming car	L/S	DR	9	"	"			0	30	30	20	20
502A	"	Lap	"	36,14	9	"			10	40	50	40	40
109	"	None	"	14	9	"			40	70	90	80	80
"	"	"	RF	10	"	"			70	80	70	0	0
113	Right side to tree	"	DR	14	"	None			0	0	0	0	0
166	Hit cluster of large trees	Lap	"	00	"	"			0	0	0	0	0
171	SS guardrail & Bridge Support	None	"	00	Yes	NI			30	70	30	0	0
186	RT side frontal by car	"	"	9,20	"	None			0	0	90	90	90
274	Direct frt. to embankment	Lap	RF	5	"	NI			30	70	80	80	80
278	SS guardrail & pole *	Mo	DR	14	"	"			30	70	80	80	80

FILE NAME:

Case No.	Fatal Collision Configuration (Multiple Impacts [a])	Restraint System Used	Fatal Occup. Sec. Pos.	Area of Contact Involving Fatal Injuries		Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (2)			
				Head	Torso				LB	L/S	AC/L	AC
M-321	Direct frontal to oncoming car	None	DR 00	00	00	No	HI		0	0	0	0
"	"	"	RF 00	00	00	"	"		0	10	10	10
337	Left front to oncoming car	"	"	00	"	"	"		40	70	90	80
354	Right side SS to pole	"	"	14	"	"	"		0	50	30	10
371	Left SS to mailbox & Pole	"	DR 35	"	"	"	"		0	0	0	0
143	Lt. Frt. underrode rear of dump truck	"	"	14	"	"	Lo		0	0	0	0
181	Distributed frontal to ditch	"	"	"	"	"	HI	Died of exposure in freezing water	40	80	90	90
187	Off road into bridge abutment	"	"	5,9,12,20	5,9,12,20	"	"		0	0	0	0
197	Frontal centerline car-to-car	"	"	"	"	"	"		30	60	70	60
"	"	"	RF	"	"	"	"		20	70	70	70
217	SS tree on left	"	DR 38	"	"	Yes	Lo		50	80	50	0
245	Off front into rail	"	"	36	"	No	None		0	0	0	0
252	Side Lt. Frt. into culvert	"	"	"	"	"	HI		40	60	70	50
259X	Rollover	Lap	"	00	00	Yes	None		0	0	0	0
281	Hit in right side by Volvo	None	"	20	20	No	"		40	50	40	0
301	Direct frt. to bridge support	"	"	00	9	Yes	HI		0	0	0	0
310	Frontal to pole--offset left	"	"	00	"	No	HI		50	60	80	70
360	Rt. side to embankment	"	"	00	00	"	"		0	20	20	10
"	"	"	RF 00	00	00	Yes	"		0	0	0	0
342A	Direct frontal to car	"	"	"	"	No	"		10	40	50	50
349X	Right side rollover	"	"	25,26	"	"	None		0	0	0	0

FILE NAME1	MISCELLANEOUS	Fatal Collision Configuration (Multiple Impacts (all))	Restraint System Used	Fatal Occup. Sec. Pos.	Areas of Contact Involving Fatal Injuries Head Torso	Ejection	Air Cushion Deployment	Comments	Restraint Effectiveness Rating (1)			
									LB	L/S	AC/L	AC
M-351A	Frontal to car	None	DR	9	"	HI			70	90	90	90
357A	Frontal to car	"	"	00	"	"			70	90	90	90
387X	1/4 roll to right side	"	RF	00	Yes	None			0	0	0	0
OK-082	Hit in Mt. Front wheel *	---	RF		No	None			10	20	10	0
121	Frontal offset lt. 40% overlap Lap	Lap	DR	36	"	HI			0	20	20	20
136	Rollover, lft. side *	None	RF	5	"	None			40	40	40	0
147	Rollover, lft. side	Exp	DR	14,25,26	"	"		Cirrhosis--bad health	0	0	0	0
197	Hit 3:00 in lft. side door	None	"	20	"	"			0	0	0	0
H-061A	Sideswiped @ 11:00 to lft.lt.	"	"	20,14	No	HI			20	50	60	50
057	Frontal to concrete sign support	---	"		No	HI		6-mo. fetus stillborn	50	90	90	90
045	Frontal to rear of slow-moving truck	None	"	9	"	"			0	40	40	60
042	Frontal to tree	Lap	"	00	"	"		Mother restrained; ruptured uterus from belt	0	0	0	0
036	Frt. underside rear of truck *	None	RF	36	"	None			0	40	40	60
038	Frontal to oncoming car	---	RF		"	HI			10	40	50	40
G-076	Glancing frontal to truck	None	DR	14	Yes	"			0	0	0	0
118	SS of bridge support	Lap	"	00	No	"			30	30	30	0
415	Rollover *	None	"		Yes	None						