CAR-TRUCK FATAL ACCIDENTS IN

MICHIGAN AND TEXAS

by

Daniel J. Minahan and James O'Day

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ABSTRACT

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16. Abstract

The objectives of the study were to determine whether current estimates of the frequency of underride in car-truck accidents differ from 1970 estimates (200 annually nationwide) and to learn more about these types of collisions. All fatal accidents for Michigan (1972-76) and Texas (1975-76) were filtered for cases of passenger cars rear-ending or side impacting a large truck or tractor trailer. The police accident reports were examined, accident scene photos were analyzed, and available investigating police were interviewed, to determine accident configurations, whether car underride occurred, and, if so, to what degree. In each case relative impact speed was estimated. The chief finding was that the annual rate of such accidents is at least 450 and may reach 570, and 90% of the rear-ends and 75% of the side impacts result in underride. Among other findings, such accidents usually occur at night on straight rural roads, most involved drivers are males of about any age, drinking involvement is about the same degree found in all fatal accidents, relative impact speeds, especially in side impacts, usually exceeded 30 mph. It was concluded that better underride guards, with energy absorbing capabilities and enhanced conspicuity of trucks and trailers would reduce but not eliminate such accidents.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF EXHIBITS

LIST OF FIGURES

LIST OF APPENDICES

SECTION 1

INTRODUCTION

An accident in which a car underrides the overhanging bed of a truck or trailer is a spectacular event--perhaps comparable in newsworthiness to a crash fire. In about 1970 this type of crash led to a proposed rulemaking by the National Highway Traffic Safety Administration, but after considerable discussion the rulemaking activity disappeared--evidently because of inadequate evidence that the benefits of the proposed countermeasure (a rear underride device) would exceed the costs or penalties. This year the subject has again surfaced. In August of 1977 the Department of Transportation issued an advance notice of proposed rulemaking and about the same time issued a request for proposal for the design of underride devices.

As a part of the discussion of the 1970 rulemaking, several estimates were made of the frequency of underride crashes and the resulting fatalities. Most of these suggested that the annual death toll nationwide in rear end underride crashes was of the order of two hundred. Truck operators argued that strong underride devices would add weight to their vehicles at the cost of displaced cargo, and that there would be a large continuing expense resulting from the sort of underride device proposed.

The purpose of this study is to determine whether current estimates of the frequency of underride accidents are the same as the 1970 estimates, and to provide further detail about the type of collisions under discussion.

Specifically, there seems to be no credible source for many of the factors considered pertinent to countermeasure proposals. Proposed devices would protect belted occupants of passenger cars which impact the rear of a truck or trailer at speeds up to 30 miles per hour, but we have found no source which adequately describes the distribution of relative impact speeds in such accidents. Another proposed device would be set at 21 inches above the ground at the rear of the truck/trailer, but we have found no source which establishes the relationship between this height and the frontal characteristics of passenger cars; nor has anyone described how such a device would work under varying loading conditions.

In this study we attempt to estimate the present frequency of such collisions, how this value has changed in recent years, and the types of vehicles, speeds, crash configurations, drivers, roadways, etc., involved.

SECTION 2

BACKGROUND

There are two general sources of information about underride accidents: (1) selected in-depth case studies developed over the past decade by accident investigating teams sponsored by MVMA, NHTSA, and the Canadian Department of Transport, and (2) the many state and federal files of truck accident reports which, though not always accurate or detailed, do provide an estimate of the number and configurations of truck vs. car collisions.

The most commonly observed rear underguard consists of a horizontal bar welded by vertical connections to the frame or truck bed and varying in height from 18" to 30" above the ground. It is made in the maintenance shop, using any handy pieces of metal and can vary extensively in its capacity to resist impact. Normally it is centered in the rear of the truck or trailer, and is evidently used chiefly as a step ladder for climbing into the truck. Because it does not extend to the rear corners of the truck or trailer, it is often not even contacted by a rear-impacting vehicle.

It should be obvious too that if the passenger car driver at the last minute attempts to avoid a collision by swerving left or right, the currently employed underguard will do little to stop him from underriding the rear corner of the truck/trailer and contacting the A-pillar and roof of his car. Also it should be obvious that the random height of the underguard device can result (depending on the car model) in shearing off the hood and forcing it through the windshield into the passenger compartment.

Police accident reports can be analyzed to determine the number of car-truck collisions and the various configurations, but these reports only rarely indicate whether there was underride. Extrapolations apparently have been made by assuming that fatal car-into-truck rear-end collisions do involve underride, leading to the estimate of about 200 cases per year. Yet in some accident reports, it is not possible even to tell whether the car hit the truck or vice versa. In most cases only witnesses, investigators, police, or photographs can reveal what really happened.

SECTION 3

METHODOLOGY AND SOURCES FOR THIS STUDY

Data sources for this study have been limited to accident reports and supplemental information from the states of Michigan and Texas--mainly because of time constraints (in order to complete the work in a period of about two months). For certain time periods all of the car-truck fatal crashes for those two states were reviewed in the original accident report form to obtain all relevant data. Then, where possible, police photographs of the vehicles and the scene were reviewed and in some cases the investigating officers were interviewed to determine the extent of underride. Crashes in which the truck was the striking vehicle, or in which both vehicles collided head-on, were eliminated as irrelevant and merely tabulated. But all cases in which the car struck the truck in either the side or the rear were reviewed carefully. Pertinent information was recorded on the form shown in Appendix A.

Starting with the digital files of all fatal crashes for each of the two states, all two-vehicle car-truck crashes were listed. Small trucks such as vans, pick-ups, motor homes, etc., were in general filtered out, although in some sets of data it was necessary to go to the accident reports themselves for a final filtering.

Michigan fatal accidents were available for review on microfilm, and ordinarily included a considerable amount of descriptive information about the crash. Descriptions of the fatal injuries sometimes permitted inferences to be drawn about underride (e.g., the cryptic "decapitated"), but in general it was necessary to refer to the case photographs on file with the the original reports. For the majority of the Michigan accidents, then, we reviewed the photographs either at the state police headquarters or at whatever local police or sheriff's department had conducted the on-scene investigation. All police agencies were most cooperative, but it was a time-consuming process, in that generally only negatives were on file and prints had to be made.

In Texas few photographs were available because there is no established policy regarding the taking of accident scene photographs, but the Texas reports usually contain other details which facilitate drawing conclusions about underride. For each case, then, the form shown in Appendix

A was completed as much as possible.

Underride cases were classified according to (1) side or rear collision, and (2)degree of underride (definitely yes, probably yes, probably no, and definitely no). The "probable" categories were kept minimal by careful analyses of the accident reports and photographs.

After compilation on the aforementioned forms, the data were tabulated by hand for this report. A format for an SPSS file of the data was defined, and is shown in Appendix B to this report, but because of the short time available between acquisition of the Texas data and the report due date the necessary keypunching and filebuilding has been deferred.

SECTION 4

RESULTS

Data for this study include all two-vehicle passenger car-large truck fatal collisions in Michigan for the period 1972 through 1976 and in Texas for the period 1975 and 1976. The general results from these data are shown in tables 1, 2, and 3.

In Table 1 car-truck fatal accidents are divided into three types: (1) car into truck (or tractor/trailer) from the rear, (2) car into truck (or tractor/trailer) from the side, and (3) all other (including head-on collisions, and those collisions in which the truck or tractor/trailer struck the car). The total number of accidents for each situation and each state are shown, and for side and rear collisions the number of "underride" collisions is also indicated.

Table 1

Fatal Car-Truck Crashes
Michigan and Texas

Collision Type	Michigan 1972-1976		Texas 1975-1976		Total	
	All	U'ride	All	U'ride	All	U'ride
Car reared truck/trlr	48	41	46	46	94	87
Car angled truck/trlr	46	30	41	35	87	65
All Other . .	396		264		660	
Total . .	490	71	351	81	841	152

The determination of whether underride occurred was made by reviewing on-scene photographs, injury descriptions, and by careful reading of the accident reports. In a later section of this report, underride accidents will be classified as in the four categories described in the introduction. In this table, both the "definite" and "probable" underrides are grouped together in columns 2, 4, and 6.

Perhaps the most interesting finding from Table 1 is that, given a rear-end car-into-truck fatal collision, underride was present in 87 of 94 cases, or 93%. Also for side-impact car-into-truck fatal collisions, underride was identified in 65 of 87 cases, or 75%. Underrides in both configurations account for 18.1% or roughly one-fifth of all car-truck fatal accidents in this population.

While Michigan and Texas do not necessarily represent the national truck accident population, a calculated estimate of the frequency of occurrence of truck underride collisions nationwide, based on these data, can be made by assuming that other states have such collisions in proportion to their relative population. Five years of Michigan data (in a total population of about 8 million) and two years of Texas data (in a population of about 13 million) represent a one-year population of about 66 million or about one-third that of the U.S. As a rough estimate, then, multiplying the totals of Table 1 by three, indicates that there would be 261 rear-end underride car-into-truck fatal collisions per year, and 195 side underrides per year, for a total of 456 fatal underrides per year nationwide. Since this number is based in part on the 1974-75 low years, as indicated in Tables 2 and 3, it may be of interest to extrapolate from the 1976 data alone. This leads to an estimate of 571 underride fatal collisions (of both types) nationwide.[a]

The numbers in Table 1 are summed over the time periods shown. Since this time period, at least for the Michigan data, spans the energy crisis peak of 1974 and the subsequent 55 mile per hour speed limit introduction, it is of interest to look at the data by year. These results are shown for Michigan and Texas in Tables 2 and 3, respectively.

The Michigan data in Table 2 spans the longer period, and the pronounced dip in 1974 and 1975 may be seen. In

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[a]This is calculated by summing the underride collisions for Michigan(14) and Texas (46) for 1976, and multiplying that total by the inverse of the population ratio of these states to the United States (200 million/21 million).

Table 2

Car-Truck/Trailer Fatal Accidents
Michigan 1972-1976

Year	Rear Impact	Side Impact	All Other	Total Accidents	Total U'rides
1972	13	10	81	104	20
1973	14	11	90	115	21
1974	10	6	81	97	11
1975	3	6	64	73	5
1976	8	13	80	101	14
Total	48	46	396	490	71

addition to the lower speed limit introduced at the beginning of 1974, truck traffic was reduced over the same two years. Other studies have also shown that there was a substantial reduction in passenger car mileage--particularly on long trips. The Texas data spans only the two-year period, but the increase from 1975 to 1976 can be noted. All of these factors--lower passenger car speeds, reduced truck traffic, and reduced passenger car travel on "truck" routes--would be consistent with these findings.

Table 3

Car-Truck/Trailer Fatal Accidents
Texas 1975-1976

Year	Rear Impact	Side Impact	All Other	Total Accidents	Total U'rides
1975	22	17	122	161	35
1976	24	24	142	190	46
Total	46	41	264	351	81

SECTION 5

DISCUSSION

In this section of the report more detail will be presented about the distributions of several factors present in the car-into-truck rear and side fatal collisions. Of the total number of car-truck fatal accidents in the data from the two states, 181 qualify for the restricted set discussed here.

The comments are organized into the following topics: who was involved in the accidents, what vehicles were involved, when did the accidents occur, where did the accidents occur, and how (or why) did they occur.

Who

The age range for truck drivers involved in these accidents was from 18 through 61, almost uniformly distributed from about 20 to 55. All of the truck drivers were male except for one 35-year old female in Michigan. There were three instances of truck drivers being cited for drinking. About six were charged with negligent homicide or manslaughter, but the outcome of these cases is unknown.

Passenger car drivers ranged in age from 15 through 90, peaking at the lower ages. About 20% of the car drivers were female, 80% male. The distribution of driver age in Michigan was similar to that of all drivers in police-reported accidents, but in Texas there was an overrepresentation of passenger car drivers above 55 years of age in these crashes. In more than half the cases the passenger car occupant was a lone male.

The Michigan data indicated that blood alcohol levels were determined for only 13 of the 30 "had been drinking" drivers, and these ranged from .07 to .35 gm%. The finding that one-third of the car drivers in these accidents had been drinking is consistent with the reported incidence of drinking involvement in all fatal accidents in Michigan, but, as with all fatal accidents, it is likely that this figure is less than the real one. However, it appears that drinking involvement in these accidents is about the same as in other fatal crashes. In Texas, citations regarding drinking seldom appear on the accident report--especially when the driver is killed. Blood samples of all those killed (including passengers) are reportedly sent to the state laboratories for analysis. However, no test results are entered into the accident report except in the case of surviving drivers, and then only after conviction in court.

Table 4 shows the distribution of injuries and fatalities for the occupants of the cars and trucks in the 181 crashes. It is noted that in accidents of this type the driver of a tractor/trailer is relatively immune to injury. In one case three truck occupants were killed when a passenger car impacted the truck in the side and caused it to roll over.

What

Of the 181 trucks and truck/trailers involved in these crashes, 126 were tractor-trailer combinations, and 55 were straight trucks (including two tractors). The straight trucks were mainly stake or dump trucks. Tractor-trailers were predominantly vans and flat-beds.

Passenger cars were categorized into three groups by size, and this distribution is shown in Table 5. These categories admittedly are not precise. They were determined largely by interpretation of accident reports and analysis of photographs. Perhaps the only remarkable data in the table is that in the Michigan cases more full-size cars were involved, while in the Texas cases more compacts are involved.

When

Car-truck fatal crashes are predominantly nighttime phenomena. Inclement weather is a minor contributor to these accidents, but low visibility at night is a major factor. This will be discussed under "how and why" below, but Table 6 presents here the nighttime and daytime statistics for the two states in the study.

Where

Essentially all of the cases studied involved either straight sections of highway (no curves) or intersections wherein the terrain was mostly level, probably because Texas and Michigan are that way. Straightaway accidents occurred mainly in rural areas, and intersection accidents occurred mainly in urban areas. These distributions are shown in Tables 7 and 8.

Highway types have been categorized into the three

Table 4

Fatality/Injury Characteristics
Car-into-truck Fatal Accidents
Michigan and Texas

Characteristic	Texas 1975-76 (87 cases)	Michigan 1972-76 (94 cases)	Total (181 cases)
Psgr. Car Driver Alone Killed	46	51	97
Psgr. Car Driver Killed + Other Psgr. Killed or Inj. .	24	21	45
Psgr. Car Driver Killed + Other Psgr. Unscathed . . .	0	1	1
Psgr. Car Driver Survived Other Psgr. Killed or Inj. .	11	10	21
Psgr. Car Driver Killed Trk.Dr.or Trk.Occ.Killed or Injured . . .	3	9	12
Psgr. Car Driver Survived Trk.Dr. or Trk. Occ. Killed or Injured . . .	3	2	5

groupings shown in Table 9. All of these accidents occurred on paved roads, either asphalt or concrete. In Michigan, roads of interstate quality (i.e., limited access) predominated, whereas in Texas roads of less than interstate

Table 5

Types of Passenger Cars Involved in
Car-Truck Fatal Accidents
Michigan and Texas

State	Full Size	Intermediate	Compact	Total
Michigan	54	19	21	94
Texas .	46	10	31	87
Total .	100	29	52	181

Table 6

Car-into-truck Accidents by
Light Condition
Texas and Michigan

State	Day	Night	Total
Michigan	27	67	94
Texas .	32	55	87
Total .	59	122	181

quality predominated.

One interesting factor regarding accidents which occurred on straightaway sections of road was the involvement of private driveways or exit ramps, each of which helped generate a surprise encounter for the passenger car driver. Table 10 compares the straightaway accidents with the number of ramp and driveway involvements. Note that these account for about 25% of the straightaway accidents.

Table 7

Car-into-truck Fatal accidents by
Highway Location
Texas and Michigan

State	Straightaway	Intersection	Total
Michigan	61	33	94
Texas .	58	29	87
Total .	119	62	181

Table 8

Car-into-truck Fatal Accidents by
Location
Texas and Michigan

State	Rural	Urban	Total
Michigan	55	39	94
Texas .	54	33	87
Total .	109	72	181

<u>How and Why</u>

Using the methods discussed in the introduction, the findings of underride vs. no underride were developed and summarized in Table 11. In this set of fatal crashes, involvements of trailers outnumbered the straight trucks by over two to one. When a trailer is involved in one of these fatal accidents, underride occurs in 91% of the cases.

A variety of circumstances or combinations of circumstances precipitated the 181 fatal car-truck accidents studied here, and the more common ones are tabulated in

Table 9

Car-into-truck Fatal Accidents by
Highway Type
Texas and Michigan

State	Interstate	4-Lane not Limited Access	2-Lane	Total
Michigan	39	24	31	94
Texas .	21	40	46	87
Total .	60	64	57	181

Table 10

Driveway/Ramp Involvement in
Straightaway Car-truck Fatal Accidents
Michigan and Texas

State	Total Straightaway Accidents	Driveway Related Accidents
Michigan	61	21
Texas .	58	9
Total .	119	30

Table 12. In rear collision situations, the truck most often was slowed or stopped for a signal or waiting to turn. In side collision situations there are three notable circumstances: the tractor/trailer is astride the road jackknifed, astride the road entering or exiting a driveway or ramp, or astride the road making a left turn or attempting a U-turn. About an equal number of times the car driver or the truck driver failed to obey a traffic signal--usually with disastrous results for the car occupants.

Points of impact on the truck or trailer are of

Table 11

Accident Configuration vs. Underride

Configuration	Underride--Yes or Probably Yes	Underride--No or Probably No	Total
Car Reared Truck . .	26	1	27
Car Reared Trailer .	61	6	67
Car Angled Truck . .	11	17	28
Car Angled Trailer .	54	5	59
Total . .	152	29	181

interest in considering the potential efffectiveness of underride devices. While more than half of the rear impacts were relatively direct (i.e., into the center of the truck or trailer rear), 42 of the 94 struck at the rear corner of the truck or trailer. Some side impacts occurred in wheel areas of the truck or trailer, and some struck in places where underride was possible. The counts of these impacts for both straight truck and tractor/trailer impacted objects are shown in figure 1.

Collision Speeds

A technique for estimating collision speeds in underride accidents by analysis of crash damage has yet to be developed. Crash speed information in this study had to be derived from a combination of sources, and therefore is presented with caution. These sources include (1) statements made by the surviving driver (usually the truck driver) to investigating police, (2) occasional witness statements, (3) posted speed limits coupled with indications of skidding or not skidding, and (4) where possible, interpretation of the crash damage to the passenger car and/or the truck as revealed in photographs.

Truck driver estimates of passenger car speeds usually are vague, e.g., "I looked in the mirror and saw the passenger car coming up behind me at a high rate of speed."

Figure 1. DISTRIBUTION OF POINTS OF IMPACT
181 CAR-TRUCK/TRAILER FATAL CRASHES

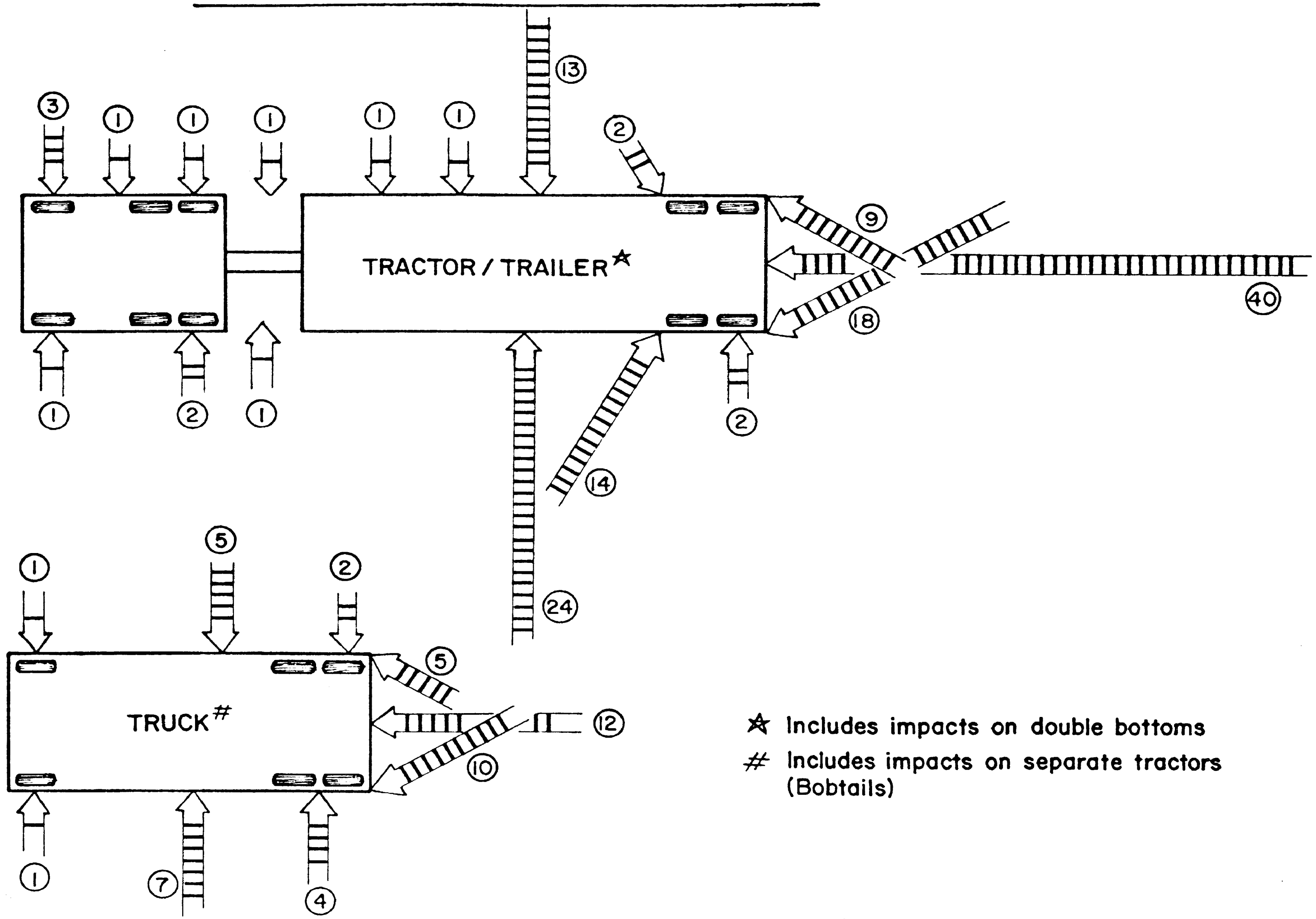


Table 12

Circumstances Leading to
Car-into-truck Fatal Accidents
Michigan and Texas

Circumstance	Rear into Truck	Rear into Trailer	Angle into Truck	Angle into Trailer	To
Truck/Trailer Ahead Leading	7	22	0	0	29
Truck/Trailer Ahead Turning Left	8	19	1	0	28
Truck/Trailer Ahead Slowing or Stopped for Signal . . .	3	11	0	0	14
Truck/Trailer Ahead Stopped or Parked	1	5	0	1	7
Truck/Trailer Astride Psgr. Car Path Jackknifed	0	0	1	11	12
Truck/Trlr Astride Car Path Entering/Exiting D'vway/Ramp	1	5	1	11	18
Truck/Trlr Astride Car Path U- or Left turn . .	2	4	4	7	17
Truck/Trailer ran signal stop sign or failed to yield	1	0	5	7	13
Psgr. Car ran signal stop sign or failed to yield	0	2	5	9	15
Truck/Trailer crossed center line/median or lane line	0	0	2	1	3
Car crossed center line/median/lane line .	0	2	6	13	21

In a few cases a surviving passenger car occupant provided such detail as "The driver was tuning the radio and didn't notice the truck", or "I yelled at the driver to slow down." Police reports and/or photographs of the accident site sometimes gave indication of skidding, but in general there was no evidence of skidding. In some instances the skid marks appear to have occurred after the collision as a result of the car being dragged by the truck. A car-into-truck collision with little or no underride is essentially a barrier type. In a few such cases it was possible to arrive at some estimate of speed from the crush damage to the car.

In Appendix C several cases are presented (with photographs) in which relative impact speed estimates were made by the methods discussed above. The reader must judge for himself the validity of the speed estimation. Using such methods, individual vehicle speeds and relative impact speeds were estimated for each of the 181 rear and side collision cases, and a summary of the relative impact speeds is presented in Table 13. In side collisions the truck speed was essentially zero relative to the car's direction of travel. More than half (54%) of the side collisions are estimated to have occurred with an impact speed greater than 40 miles per hour. In rear impacts, the closing speeds exceeded 30 miles per hour 67 percent of the time, and 40 miles per hour 32 percent of the time. As was noted in Table 12, in a majority of these crashes the truck was essentially stopped at the time of impact.

Table 13

Relative Impact Speeds
Car-Truck Fatal Accidents
Michigan and Texas

Relative Impact Speed	Car Struck Truck/Trailer in Rear	Car Struck Truck/Trailer at Angle	Total
0-20 mph . . .	0	0	0
21-30 mph . . .	31	11	42
31-40 mph . . .	33	29	62
41-50 mph . . .	23	36	59
51-60 mph . . .	6	8	14
More than 60 mph .	1	3	4
Total . .	94	87	181

SECTION 6

SUMMARY

Findings

1. By averaging the data used in this report it appears that the expected annual number of rearend car-into-truck fatal collisions is 261, plus 195 side collisions, for a nationwide total of 456. Projecting only the 1976 data, the total number would be 571.

2. Given a fatal car-into-truck side or rear collision it is very likely that underride will have occurred. More than 90% of the rear collisions and 75% of the side collisions in this study resulted in underride.

3. While drinking on the part of the passenger car drivers was a factor in these accidents, it appears to be no different in frequency than in all other fatal accidents.

4. Seventy percent of the trucks involved in these accidents were tractor-trailer combinations--mostly vans and flatbeds. The remainder were straight trucks, mainly stake and dump trucks.

5. Most of the accidents studied occurred at night in rural areas on straight sections of road.

6. The fatal victim most often was the lone male passenger car driver. In the Texas data older drivers (those over 55) were somewhat overrepresented.

7. In straightaway accidents, driveways and ramps were factors about 25% of the time.

8. The collisions studied were almost always surprise events; the passenger car driver did not expect to find a truck in his path, and had little time to react after he did see it.

9. The relative speed of impact in these fatal collisions was high. In rear impacts the estimated closing speed was greater than 30 miles per hour in 67%

of the cases; in side impacts that speed was greater than 30 miles per hour in 87% of the cases.

10. Present underride guards appear to be mostly non-standard, homemade, of varying strength, height, and width.

Conclusions

1. The nationwide estimate of fatal underride collisions suggests that improved underride devices could reduce but not eliminate the problem of fatal car-into-truck collisions.

2. In this study certain types of trucks and trailers were conspicuous by their absence, e.g., furniture vans and multi-axled double bottom gravel haulers and tankers (the so-called "Michigan Trains")--all of which have little underride potential.

3. The fact that many of these accidents occurred at night and the car drivers were surprised by the sudden presence of a large truck or trailer suggests that making such trucks and trailers highly conspicuous could reduce the frequency of such accidents.

4. Driver impairment, such as drowsiness, being under the influence of alcohol, and reduced nightime vision capability, particularly for older persons, obviously contributed to these fatal accidents. However, driver impairment in these accidents does not appear much different than in all other fatal crashes.

5. Underride guards as presently used did little or nothing to inhibit underride in the high relative impact speed cases included in this study.

Recommendations

1. The high relative impact speeds observed suggest that an effective underride guard should have a high energy-absorbing capability. The data provided in this report may be of value in calculating tradeoffs among different design types.

2. Enhancing the conspicuity of trucks, trailers, and their high bodies or loads--particularly at night-could reduce the occurrence of accidents of the type studied here. While pursuit of means to prevent underride is useful, it is equally important to try to stop such accidents in the first place.

3. The present investigation was limited to a study of two-vehicle car-into-truck fatal collisions, mainly because of the time available. Many other questions of interest could not be answered with these data, for example, why and how some people escape fatal injuries in car-truck side and rear crashes. A similar study of non-fatal crashes ought to provide more clues for developing successful countermeasures.

APPENDICES

APPENDIX A

Data Form Used in this Study

FATAL CAR-TRUCK ACCIDENTS

State ________ Date _____ FARS Case # _____ County ________ Community____________

Accident Type: Psgr. Car into Truck ( ) Truck into Psgr Car ( )

Vehicle Descriptions:

Truck, Mfg: _____ Year _____ Model _____ Wt. ____ Straight Truck ( ) Tractor ( )

Trailer Combination ____________ Cargo Hauler ( ) Special Purpose Vehicle ( )

How loaded or equipped at time of accident____

____

Psgr Car, Mfg. ______ Year ______ Model _______ Type_______ Wt.__________

Sedan ( ) Station Wagon ( ) Van ( ) Sports Car ( ) Other ___________________________

Accident Environment:

Locality (Urban, rural, commercial, etc.) ____

Terrain (Flat, hilly, etc.) ____

Roadway (Interstate, limited access, 2-lane undivided, 2-lane-2-way, paved, unpaved, etc. ________________

____

Intersecting Roadway (if involved) ____

Roadway Surface Condition, (Dry, wet, icy, oil slicked, etc.) ___________________________

Visibility Limitations (None, dark, foggy, raining, sun glare, dusty, etc.) ________________

Sight Distance Limitations (Trees, buildings, hill crest, other traffic,

none, etc.) ____

Accident Site:

Roadway Section (straight, left curve, up hill, bridge deck, etc.)___________________________

____

Roadway Location (right lane, left turn lane, center of intersection, etc.)

____

Intersecting Roadway (thru-way, side road crossing, T-intersection, driveway, etc.)

____

Traffic Controls (signal lights, stop signs, posted speed ___ MPH, etc.)

____

Vehicle Relative Movements Prior to Crash:

Truck (leading straight ahead, changing lanes, turning left, stopped for signal light) ________________

____

Passenger Car (following, passing on right, closing, skidding left, etc.) ___________________

____

Speeds; Truck _____MPH, Psgr. Car _____MPH. How Determined? ____________________________

Crash Configurations:

Impact Codes: Psgr Car_____ Truck_____ Trailer_____

Psgr. Car angle of impact with truck at _____ o'clock.

Point of contact with truck (right rear wheel of trailer, tailgate, left bumper, trailer bed right, etc.) ____________________

____

Psgr. Car Point of Contact (bumper, radiator, right A pillar, roof rail, etc.)

____

If there werea second collision, describe similarly. ____________________

____

Relative Impact Speed _____ MPH, How determined? (Computed, estimated, etc.) ____________________

Skidmarks Made (None, psgr car _____ft, etc.) ____________________

____

Accident Diagram from Police Report:

Unusual circumstances: (Prior accident at scene, psgr car headlights out, inadequate rear lighting on truck, construction zone, truck parked or backing in traffic lane, etc.) ____________________

____

Effect on Vehicle Occupants:

Seat*	Car	Truck	Age	Sex	Lap Belt†	Shldr Belt†	Injury#	Cause of Death

*Use Accident Report Codes: 1,2,3,4,5,6,7,etc. †Use: Y, N, ?, Unk. #Use Accident Report Codes: K, A, B, C, O.

Driver Qualifications and Performance (Experience, physical and mental condition, DUIL(BAC___) drug user, speeding, careless, reckless, etc.) ____________________

Driver Errors or Violations Listed on Accident Report ____________________

Truck Underguard:

Describe (size, inches above ground, make, none, unknown, etc.) ____________________

____

Source of Information (Photos, etc.) ____________________

Psgr Car Under Ride: (Yes, No, possible, probable, unknown, etc.) ____________________

APPENDIX B

SPSS File Structure

for This Study

This is a list of variables defined in the SPSS file being constructed for this study. While as of the present writing the file has been built only for a sample of the cases studied, the data available are intended to complete the file for all cases. The SPSS file has two parts--an occupant file (with one case for each occupant of each truck or car occupant involved in these accidents), and an accident file, with one case for each accident (i.e. a crash between a truck and a car).

The occupant file contains 6 variables. O1,CASE ID/ O2,WHICH VEHICLE/ O3,SEATED POSITION/ O4,AGE/ O5,SEX/ O6,INJURY - POLICE CODE/

The accident file contains sixty-seven variables. V1,CASE NUMBER/ V2,STATE/ V3,DAY OF MONTH/ V4,MONTH/ V5,YEAR/ V6,TRUCK MANUFACTURER/ V7,TRUCK MODEL YEAR/ V8,TRUCK-TRAILER COMBINATION/ V9,TRUCK-TRAILER BODY STYLE/ V10,CARGO/ V11,LOADING STATUS/ V12,PASSENGER CAR MANUFACTURER/ V13,PASSENGER CAR MODEL/ V14,PASSENGER CAR BODY STYLE/ V15,PASSENGER CAR MODEL YEAR/ V16,URBAN OR RURAL/ V17,ACCIDENT LOCALITY/ V18,ROADWAY TYPE - PRIMARY/ V19,TRAFFIC SEPARATION - PRIMARY/ V20,TOTAL TRAFFIC LANES - PRIMARY/ V21,ROAD SURFACE - PRIMARY/ V22,ROADWAY TYPE INTERSECTING/ V23,TRAFFIC SEPARTION - INTERSECTING/ V24,TOTAL TRAFFIC LANES - INTERSECTING/ V25,ROAD SURFACE INTERSECTING/ V26,ROADWAY SURFACE CONDITIONS/ V27,VISIBILITY LIMITS/ V28,HOUR OF DAY/ V29,LIGHTING CONDITIONS/ V30,SIGHT DISTANCE LIMITATIONS/ V31,ROADWAY HORIZONTAL ALIGNMENT/ V32,ROADWAY VERTICAL ALIGNMENT/ V33,TRUCK DIRECTION OF TRAVEL/ V34,PASSENGER CAR DIRECTION OF TRAVEL/ V35,ROADWAY LOCATION OF TRUCK AT TIME OF CRASH/ V36,ROADWAY LOCATION OF PASSENGER CAR AT TIME OF CRASH/ V37,WAS THIS AN INTERSECTION CRASH/ V38,TRAFFIC CONTROLS/ V39,LANE DELINEATION/ V40,TRUCK MOVEMENT PRIOR TO CRASH/ V41,PASSENGER CAR MOVEMENT PRIOR TO CRASH/ V42,TRUCK SPEED PRIOR TO CRASH/ V43,PASSENGER CAR SPEED PRIOR TO CRASH/ V44,CRASH CONFIGURATION/ V45,IMPACT LOCATION - TRUCK TRAILER/ V46,UNUSUAL IMPACT/ V47,PASSENGER CAR DAMAGE AREA/ V48,OCCUPANT COMPARTMENT COMPROMISE/ V49,HOOD PENETRATION/

V5Ø,RELATIVE IMPACT SPEED/ V51,SKID MARKS/ V52,UNUSUAL CIRCUMSTANCES - TRUCK/ V53,UNUSUAL CIRCUMSTANCES - PASSENGER CAR/ V54,NUMBER OF TRUCK OCCUPANTS/ V55,NUMBER OF PASSENGER CAR OCCUPANTS/ V56,TOTAL PERSONS IN CRASH/ V57,TYPE TRUCK UNDERGUARD/ V58,UNDERRIDE/ V59,DEGREE OF UNDERRIDE/ V6Ø,PASSENGER CAR DRIVER - BAC TEST/ V61,PASSENGER CAR DRIVER - BAC LEVEL/ V62,TRUCK DRIVER - BAC TEST/ V63,TRUCK DRIVER - BAC LEVEL/ V64,PASSENGER CAR DRIVER IMPAIRMENTS/ V65,TRUCK DRIVER IMPAIRMENTS/ V66,PASSENGER CAR DRIVER VIOLATIONS/ V67,TRUCK DRIVER VIOLATIONS/

APPENDIX C

Selected Photographs of Car-Truck Fatal Accidents

Photographs taken by investigating police at the accident site were, when available, most useful in determining the incidence and degree of underride in the fatal accident cases included in this study.

In Michigan it is a fixed policy for the State Police to take photos of all fatal accidents. Also sheriffs' departments and local police agencies frequently take photos of these accidents, although for budgetary reasons some do not. Within the City of Detroit the taking of photos of fatal accidents is less universal. In general all Michigan police agencies were most cooperative in granting access to their photo files. However, photo reviewing was time-consuming as it was usually necessary to personally visit the department to establish identity and need to know. Also most of the original photographs had been destroyed once they had served their purpose, and the negatives had to be retrieved from storage to make new prints. In some instances we were able to examine the photos but were not permitted to remove them from the department premises.

In Texas, by contrast, there is no fixed policy regarding the taking of photos of fatal accidents. It was disappointing to learn that the Texas Highway Patrol officers seldom take such photos. Local police agencies do so on a haphazard basis. Of the fatal accidents pertinent to this study only a few photos could be located and none of these were accessible to the authors.

The usefulness of the photos varied according to the skill of the photographer and the quality of his equipment. For example, many photos were blurred by movement, over- or under-exposed, or were taken during inclement weather. Although informaton could be extracted from them, their quality was too poor for reproduction.

Therefore from the better quality photos a sample has been selected to illustrate the predominant types of underride and non-underride situations revealed by this study.

Exhibit C-1 shows a frequent type of rear underride wherein the car driver swerved at the last moment trying to avoid a collision, but instead impacted the rear corner of a trailer.

Exhibit C-2 shows a direct center rear impact, in this case on a parked trailer, wherein the car driver initiated no braking or evasive action.

Exhibit C-3 illustrates a common cause of side impact and underride of a trailer at night--a semi-trailer being backed into a private driveway while blocking all driving lanes on a straightaway section of road. Commonly in such cases the car driver does not see the trailer or comprehend the situation ahead.

Exhibit C-4 shows the results of another situation frequently leading to side impact and underride of a truck or trailer. In this case the truck driver unexpectedly came off a ramp (or could have entered from a side street) across a straightaway to make a left turn. In doing so he blocked the path of the car.

Exhibit C-5 shows a daylight urban side impact and underride which resulted when a semi-trailer jackknifed out of control on wet pavement, blocking the path of a passenger car travelling in the opposite direction.

Exhibits C-6 and C-7 are examples of the more rare cases in which underride did not occur. As indicated in C-6, the passenger car struck the rear of a trailer which had some device which blocked all underride and actually performed as a non-yielding barrier. Whether this device was intended to stop underride or to house a hitch for a second trailer has not been determined.

Exhibit C-7 shows an even rarer instance wherein side impact of a trailer did not result in underride because the passenger car was stopped by a rack normally used to carry a spare tire. Whether a tire, perhaps mounted on a wheel, was in the bracket at the time was not determined.

The photographs presented in this appendix were reproduced through the courtesy of the Michigan Department of State Police, the Muskegon County Sheriff's Department, and the City of Allen Park Police Department.

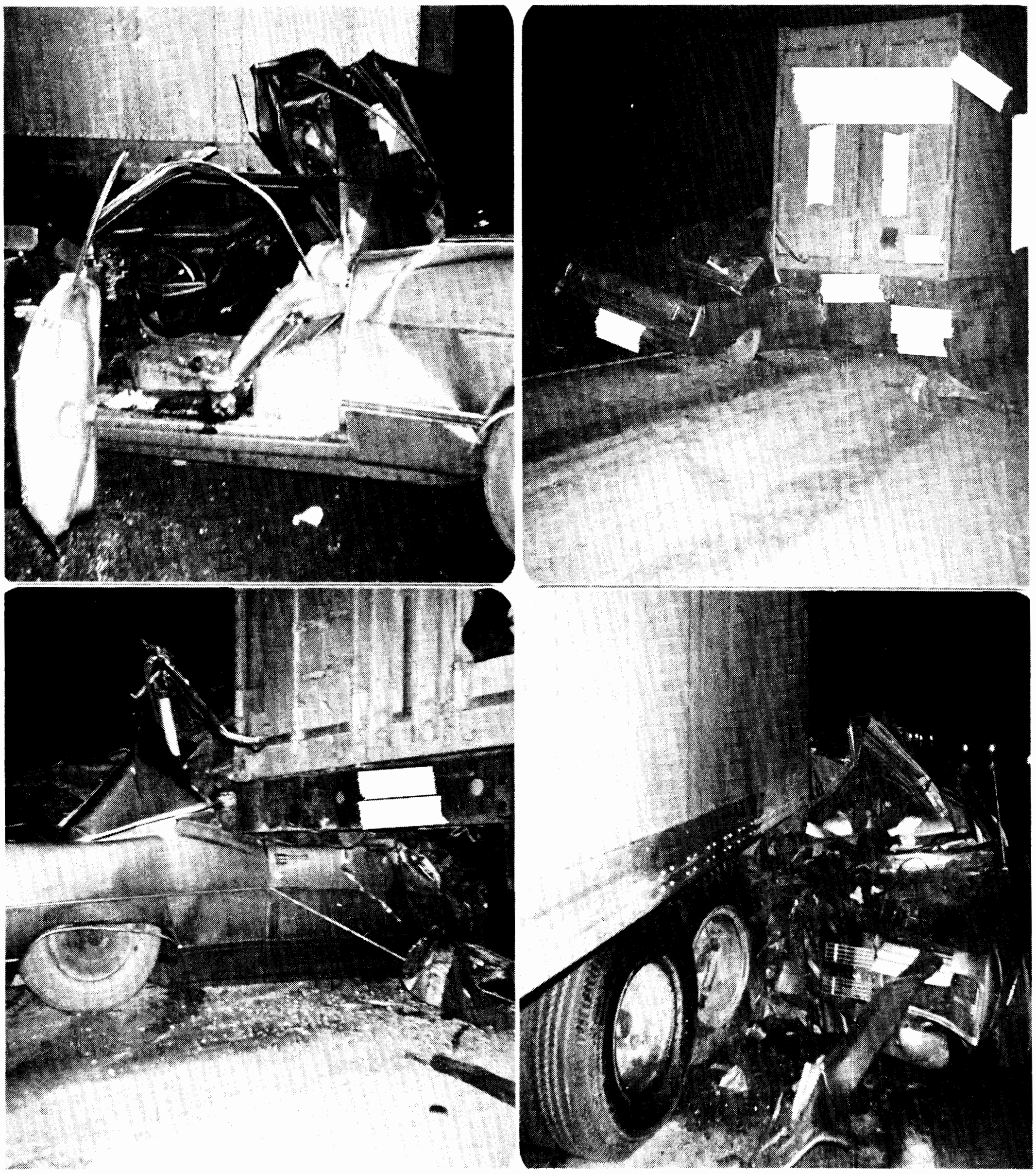


EXHIBIT C-1. The driver of a passenger car (full size Ford Sedan) following traffic in the middle lane of 3 Northbound lanes on I-75 at night, cut into the right lane in order to pass traffic ahead and was confronted by a semi-trailer parked in the right lane with mechanical problems (the truck driver thought he was on the shoulder). The passenger car driver attempted to avoid a collision by cutting back into the center lane and struck the left rear of the trailer, resulting in considerable underride of the front and the right side. The passenger car driver survived with "A" injuries. His right front passenger was decapitated. The truck driver was cited for illegal parking. The passenger car driver was cited for exceeding the posted 55 mph speed limit. Estimated relative speed of impact--55-60 mph.

EXHIBIT C-2. A flatbed semi-trailer, loaded with lumber covered with black tarpaulin, was parked on the black top right shoulder of Northbound (3 lanes) I-75 at night (2:20 am) while the driver was checking tires. A northbound passenger car (full size Mercury station wagon) directly rear ended the trailer bed which had considerable overhang. Underride extended all the way to the B pillars. The lone passenger car driver, a 48 year old male was killed. Poor load illumination, the driver fatigued or asleep, and deceptive highway geometrics at night are possible contributing factors. Estimated relative impact speed-55 mph.

EXHIBIT C-3. A semi-trailer, stake body type, grain hauler, was astride both lanes of a 2-lane 2-way rural road at night (6:30 pm) while being backed into a private driveway. A passenger car (full size Chevrolet sedan), Eastbound on the same road completely underrode the trailer bed. The passenger car driver, a 20 year old male, who had not been drinking, was decapitated. Probable contributing factors were that the tractor, facing westbound with headlights on, appeared to be on-coming traffic, and thereby blinding the passenger car driver so that he did not see the non-illuminated side of the trailer. Estimated relative impact speed -45 mph.

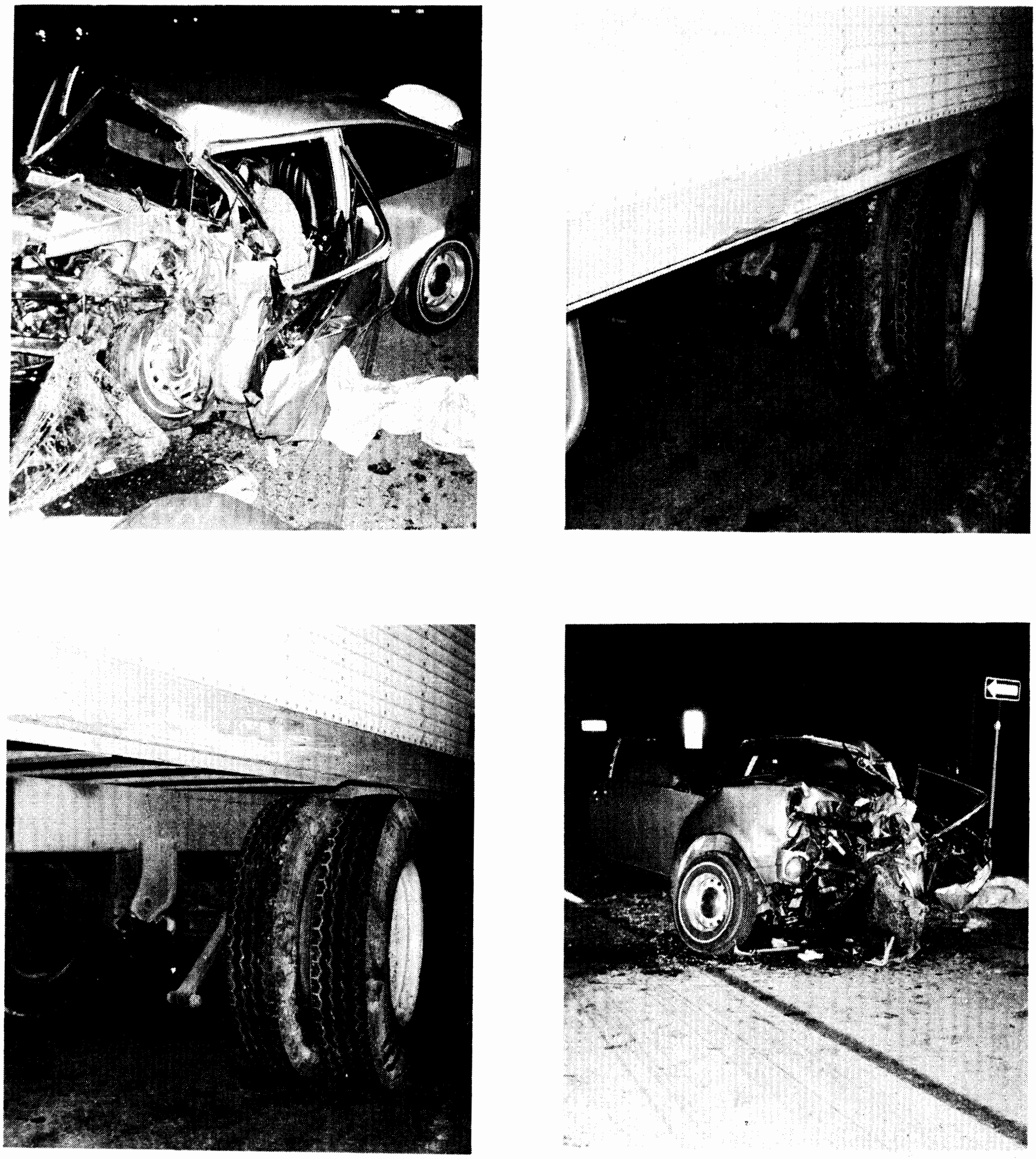
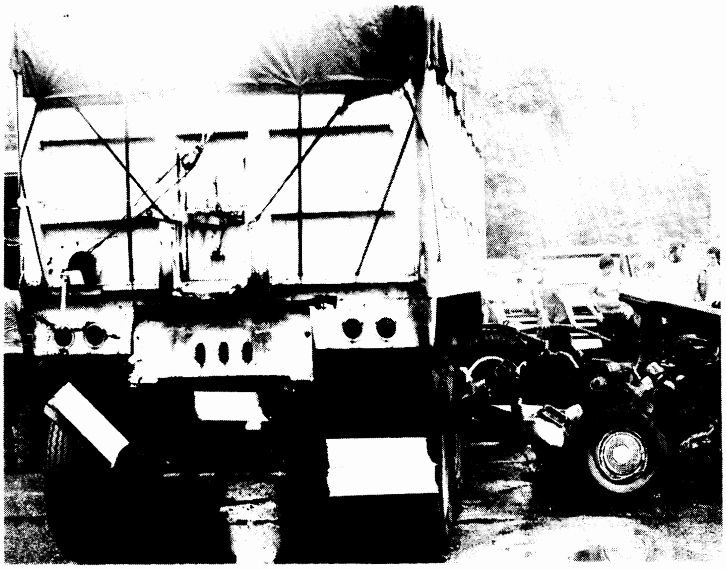


EXHIBIT C-4. A passenger car (Chevrolet compact) was southbound on the left inside lane of a 4-lane, 2-way non-divided road at night, when a semi-trailer exited an I-94 ramp on the right, having run a stop sign, and started a northbound left turn with the trailer astride the path of the passenger car which partially underrode the trailer bed and then was run over by the left rear tandem wheels of the trailer. The 18 year-old female passenger car driver was killed. The right front passenger survived with "A" injuries. The truck driver was cited for failing to yield. Estimated relative impact speed--50 mph.



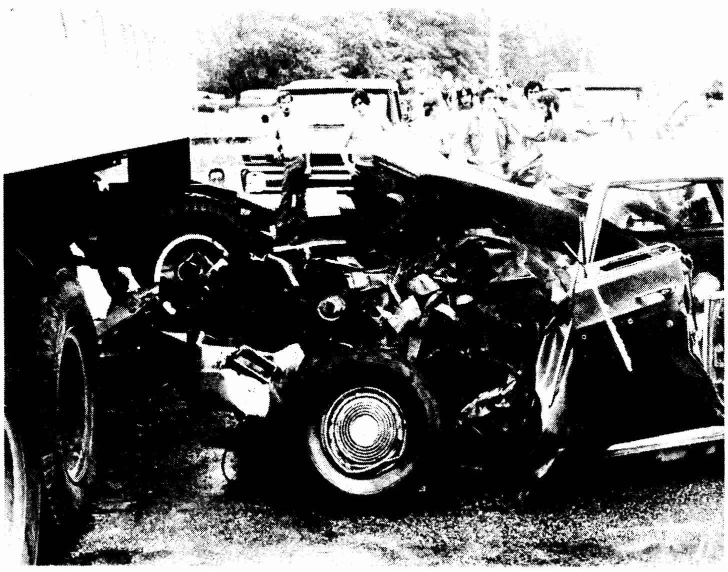


EXHIBIT C-5. The driver of a semi-trailer, northbound on a 2-lane 2-way road in a small town during daylight (4:00 pm), braked when the vehicle in front of him stopped to turn right onto Main Street. The semi skidded out of control on the very wet pavement and jackknifed into the left southbound lane into the path of a southbound passenger car (full size Oldsmobile sedan) which then underrode the right side of the trailer, resulting in severe hood-windshield penetration. The passenger car driver, a 28 year old housewife, died three days later. Estimated relative impact speed-20-25 mph.

EXHIBIT C-6. A flat bet semi-trailer loaded with pulpwood, at night, stopped for opposing traffic before making a left turn from a 2-land-2-way rural road. The driver of a passenger car following rear-ended the trailer. Inadequate lighting of the trailer load plus blinding light from oncoming traffic were possible contributing factors. The non-belted passenger car driver was killed in a barrier type crash. There was no underride. No skid marks were found. Estimated relative speed of impact 30-35 mph.

EXHIBIT C-7. A double bottom grain hauler, southbound on I-75 in the dark (6:45 am in February) had jackknifed on icy pavement and was stopped astride all three southbound lanes. A passenger car (Ford compact sedan), southbound in the center lane, slid on the icy pavement into the left side of first trailer. Underride was prevented by the fortuitous location of a spare tire rack located between the trailer wheels. However, the 67 year old male passenger car driver was killed by impact. Estimated relative impact speed-35 mph.