



## **Heavy Truck Safety...The Need to Know**

MVMA Paper Co-Authored By

Gary W. Rossow  
MVMA

and

Farrel L. Krall  
International Harvester Company

Presented to the American Association for Automotive Medicine

October 8, 1980

# HEAVY TRUCK SAFETY...

THE NEED TO KNOW



**Motor Vehicle  
Manufacturers Association  
Of The United States, Inc.**

Published By Motor Truck Manufacturers Division

# HEAVY TRUCK SAFETY...

## THE NEED TO KNOW

Farrel L. Krall  
Manager-Technical Legislation  
International Harvester Company

Gary W. Rossow, Programs Manager  
Motor Truck Manufacturers Division  
Motor Vehicle Manufacturers Association

---

### ABSTRACT

This paper provides an overview of the current state of knowledge on medium and heavy truck safety and reviews the results of truck safety research sponsored by the Motor Vehicle Manufacturers Association.

A number of issues have been raised about the accident experience of trucks, and the injuries and fatalities sustained by occupants. The diverse viewpoints and perceptions which exist on the reasons for these accidents and what countermeasures should be taken are reviewed.

The evolutionary nature of truck accident research is presented, pointing out that sufficient detailed accident and

injury data are lacking. Corresponding information on truck configuration, size, weight and exposure data remain inadequate. The role of the vehicle, driver, and highway environment in accident causation must be known and methods to achieve this goal are examined.

Despite these limitations, there is progress in understanding the causes of truck accidents. MVMA-sponsored studies, including those which led to identification of "conspicuity" as an accident avoidance measure, are reviewed. Finally, recommendations for a comprehensive heavy truck accident causation study are presented.

---

Based on a paper presented to the American Association for Automotive Medicine by Mr. Krall on October 8, 1980 at the Association's annual conference in Rochester, New York.

---

## TABLE OF CONTENTS

	<u>Page</u>
I. Introduction . . . . .	3
II. Heavy Truck Accident Statistics . . . . .	4
III. Current Safety Issues . . . . .	7
IV. MVMA Heavy Truck Accident Research. . . . .	10
V. The Need for a Comprehensive, Continuing Heavy Truck Safety Investigation . . . . .	16

## LIST OF ILLUSTRATIONS

Figure 1	Fatalities: Medium and Heavy Truck Accidents. . . . .	4
Figure 2	FARS Data Fatalities - 1979 (Medium, Heavy and Combination Trucks). . . . .	4
Figure 3	BMCS Accident Data . . . . .	5
Figure 4	Texas Tractor/Trailer Accidents. . . . .	5
Figure 5	Texas Tractor/Trailer Accident Severity - 1977. . . . .	6
Figure 6	Combination Truck Exposure - U.S. and Texas. . . . .	6



---

## I. Introduction

Traffic deaths have been rising steadily since the recession of 1975. Statistics for 1979 show 51,900 fatalities in motor vehicle accidents, compared to 45,853 in 1975. 1975 represented a low point over the 16 year period since 1963, when there were 43,564 fatalities. Despite recent increases, traffic fatalities are still well below the peak of 56,278 in 1972.

Fatalities in accidents where a truck (10,000 pounds or greater gw) was involved increased 56% from a reported 3,970 in 1975 to 6,205 in 1979. With accidents, injuries, and fatalities increasing, clearly the nation must make every reasonable effort to reduce them. Truck manufacturers are concerned about highway fatalities involving trucks, particularly large combination vehicles. The motor vehicle industry and the nation's truck manufacturers have been and remain active participants in efforts to improve highway safety.

The purpose of this paper is to review what is known about the causes of heavy truck accidents and to suggest what steps might be undertaken to help in reducing heavy truck accidents, injuries and fatalities.

The paper is organized in five sections: Following the introduction, accident statistics are presented which outline the scope of the heavy truck safety problem. Current truck safety issues, as viewed from the perspectives of carriers, drivers, police, Federal agencies, insurance companies, the medical profession, highway user groups, and manufacturers are presented. MVMA-sponsored truck safety studies in the late 1960's and early 1970's which give perspective to the limitation of historical attempts to identify truck safety problems are reviewed. Summaries of more recent MVMA issue-oriented research are presented to demonstrate that meaningful results can be obtained leading to identification of accident cause and effect relationships. Finally, recommendations are made concerning the need to collect and analyze truck accident and exposure information which can lead to identification of causative factors and effective countermeasures.

## II. Heavy Truck Accident Statistics

Currently, there are three principal sources of data on truck accident involvement: the National Highway Traffic Safety Administration's Fatal Accident Reporting System (FARS); the Bureau of Motor Carrier Safety Accident Reports; and, individual State data. A future source will be NHTSA's National Accident Sampling System (NASS).

The Fatal Accident Reporting System, established in 1975, is a census of all motor vehicle fatal accidents in the United States. Figure 1 shows the total medium (10,000 to 26,000 lbs. gw), heavy (26,001 lbs. gw and above), and combination truck fatal accident counts for 1975 through 1979 along with truck occupant fatalities. These data show year-to-year increases in fatalities, which total 56% comparing 1975 to 1979. Occupant fatalities rose from a reported 847 in 1975 to 1300 in 1979, or 53%.

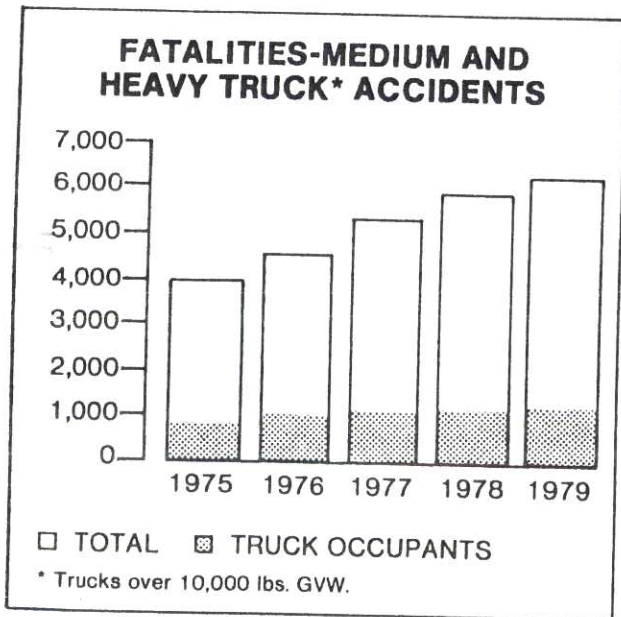


Figure 1

Figure 2 separates the medium and heavy truck totals by truck weight and tractor/trailer(s) combinations for 1979.

These data show the majority of heavy truck accident fatalities involve combination vehicles (80 percent). Medium trucks account for a much smaller number (14 percent) of fatalities, while other "heavy" trucks - (principally straight trucks 26,001 lbs. gw and above) - account for the remaining 6%.

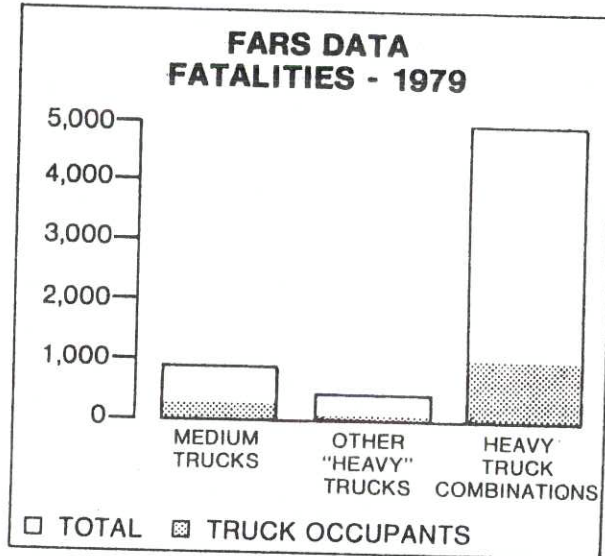


Figure 2

Bureau of Motor Carrier Safety data on accidents, injuries and fatalities for the 1974-78 period are shown in Figure 3. BMCS data include those motor carrier accidents which result in injury requiring medical treatment, a fatality, or involve more than \$2,000 in property damage. They are not representative of nationwide accident totals. For the most recent reported year - 1978 - BMCS reports 33,998 accidents (13 percent increase over 1977) and 32,757 injuries (6 percent increase over 1977). BMCS reports 2,998 fatalities for 1978 only - about half of all medium and heavy truck fatal accidents that year. Noteworthy is the fact 1975 represented a low point for accidents and fatalities in the 1974-1978 period. BMCS data are consistent with FARS in that the majority (84%) of fatalities reported involve tractor semitrailer combinations. This suggests truck safety studies should focus on combinations.



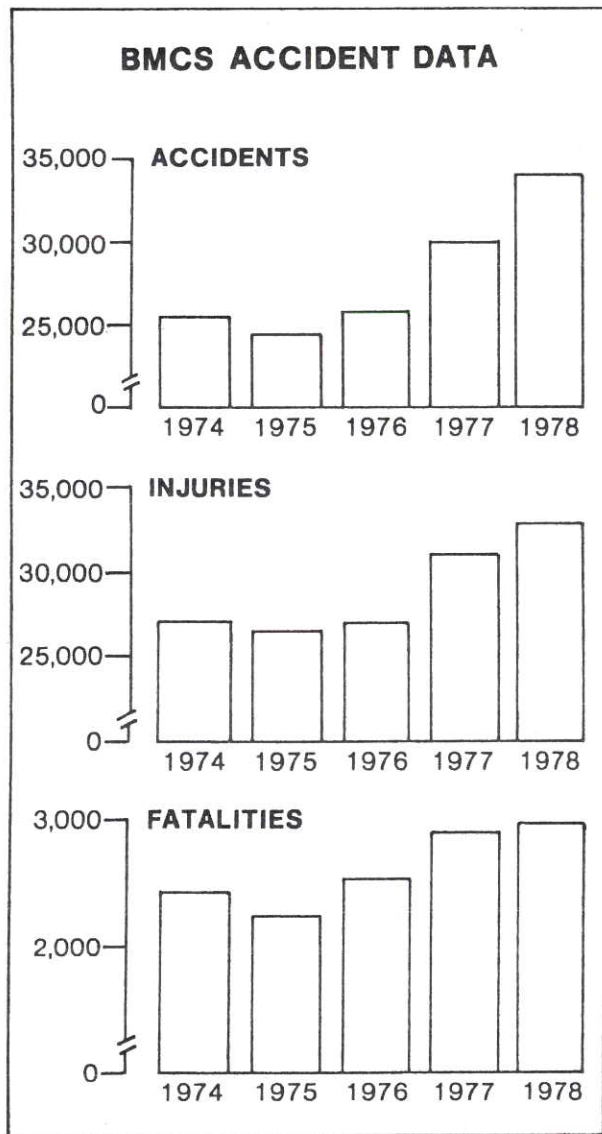


Figure 3

While FARS and BMCS provides valuable data sources, several states also collect and record useful truck accident data. One is Texas, which in 1977 accounted for approximately 8 percent of all trucks registered and 9 percent of all truck miles in the United States.\* Texas ranks second behind California in number of trucks and truck traffic. Texas codes truck accidents in far more detail than most States and the data have been compiled over a long period. Figure 4 presents a five-year summary of

tractor/trailer accident involvement, injuries, and fatalities for the 1973 - 1977 period. 1977 is the last year for which data are available. These data show increasing accidents, injuries and fatalities in 1977 versus 1976 and are thus consistent with BMCS and FARS. They also show substantially fewer accident involvements in 1975 compared to 1973 and 1974,

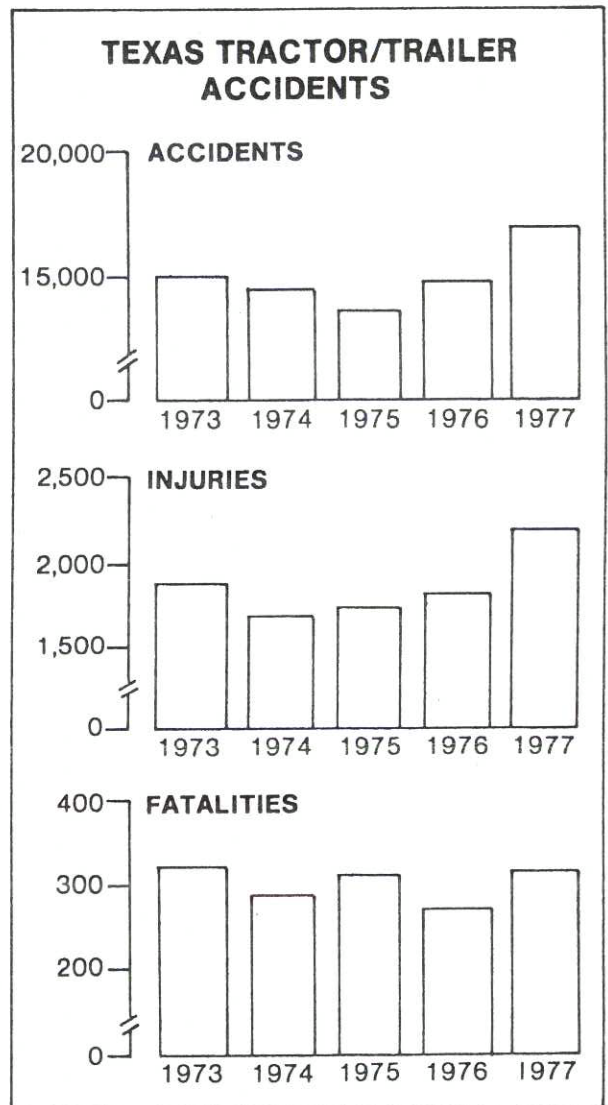


Figure 4

\*1977 Census of Transportation Truck Inventory and Use Survey.

reinforcing the observation that 1975 was a low point in truck traffic accidents. Besides census accident, injury and fatality data covering earlier years than FARS, Texas data can be categorized by injury severity for tractor/trailer occupants and occupants of other involved vehicles. These data are shown on Figure 5 for the year 1977. Only about one-fourth (24.4%) of the fatal injuries were to tractor/trailer occupants. Twenty-nine percent of serious injuries, 38% of moderate injuries and 28% of minor injuries were to the tractor/trailer occupants. These data show that the principal risk of serious and fatal injury is to the occupant of other motor vehicles.

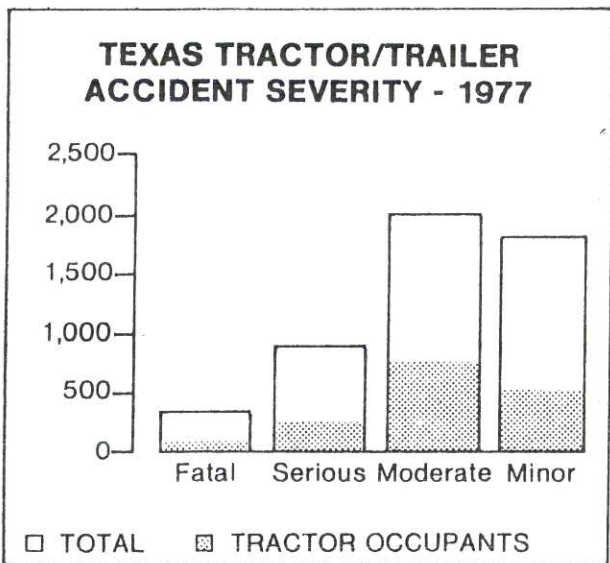


Figure 5

The observed increases in numbers of truck accidents, injuries and fatalities must be considered in perspective, because the level of exposure that such vehicles have in the traffic stream is increasing. Figure 6 presents two commonly used measures of truck exposure. First are Federal Highway Administration estimates of truck combination travel. For the 1976-1978 period for which reasonably accurate fatal accident counts are available, truck combination travel increased 12 percent compared to a 16 percent increase in the number of fatalities. Thus a major portion

of the nationwide increase in fatalities can be explained by the fact there simply were more vehicles in the traffic stream increasing the risk of accidents. Second, in the State of Texas, combination truck traffic counts increased 41 percent between 1973 and 1977 compared to a 3 percent decline in fatalities.

Unfortunately, these statistics alone reveal little or nothing on causes of, or contributing factors to accidents and injuries. Additional truck exposure data are necessary to identify any new problems. Past sources of exposure data have come into question because data have not been available for different truck configurations, road types and other factors. Far more detailed accident and exposure data are necessary to identify specific truck safety problems, their causes and possible countermeasures.

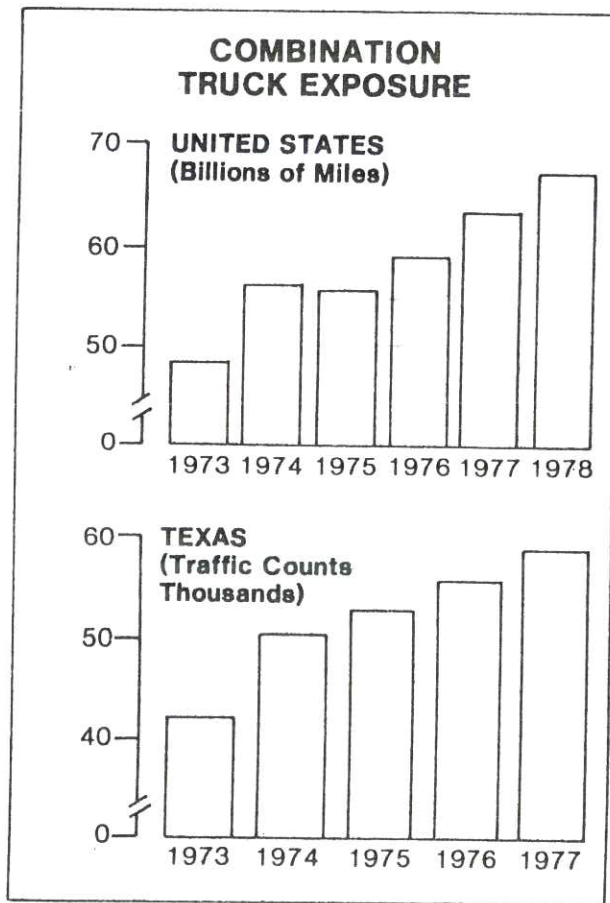


Figure 6



---

### III. Current Safety Issues

The reported increases in heavy truck accidents, injuries, and fatalities have prompted a host of groups to suggest possible reasons for the increases. Government regulators, law enforcement agencies, carriers, owner operators, organized labor, the medical profession, insurance companies and manufacturers have all suggested corrective measures to improve truck safety.

For example, some say truck design is deficient, citing inadequate performance of brakes and tires, instability and loss of control in emergency conditions. Forward and rear vision are said to be restricted, intensity and placement of lighting is questioned, along with signaling methods and addition of reflective markings. Increasing vehicle size, cab-over-engine (COE) tractors and multiple trailer configurations are criticized. The driver's environment, including ride quality and cab space, are said to be substandard. And, factors such as cab structure - to protect occupants in crashes - are said to be in need of upgrading.

Others put emphasis on lack of maintenance as the principal reason for increasing accidents, citing as causation factors brakes out of adjustment, worn-out tires with inadequate inflation and worn-out treads, burned out or dirty lights, and broken suspension or steering mechanisms.

Still others point the finger at the operator, citing speeding and tailgating, the fatigued driver who falls asleep or takes drugs or alcohol, lack of training in safe operating procedures and inadequate controls on licensing.

Truck sizes and weights are also targets for criticism. Increasing weights to higher limits is alleged to make trucks more accident-prone. Overloading beyond vehicle design or legal limitations is also said to compromise safety by increasing the

chance of component failure and degrading control, stability, and stopping capability.

And, the highway and its environment are not without critics. Steep downgrades, short radius curves and hills with intersections just over the crest are said to increase hazards by making vehicles more difficult to control or reducing sight distance. The relationship of deteriorating pavement to vehicle component failures and driver fatigue are also concerns. Inadequate signing and signaling are criticized by drivers. Increased traffic; merging; and, mixing at intersections, on entry ramps and upgrades of smaller cars and larger, heavier trucks are claimed to add to the risk of accidents and injuries to car occupants. Mother Nature herself is not above reproach, considering the effects of rain, snow, ice, reduced visibility and darkness on highway safety.

Each of us can think of a well-intentioned individual, group or organization that has espoused one or more "fixes" to the heavy truck safety problem. But, realistically, the relative contribution of each of these factors to heavy truck accident, injury and fatality statistics is largely unknown.

Truck safety depends on the vehicle, the driver and the highway environment. We can't evaluate the significance of the many factors involved without first accounting for specific accident conditions.

Consider the role of the vehicle. We know little about the specifics and under what circumstances it was involved in an accident. Was it a straight truck, and more specifically, a cement mixer or a "stakebody"? Was it a combination, tractor-semi, double, triple? Was it loaded or unloaded and what was it carrying? Did the load shift? Did a component failure precipitate the accident, or was a failure the result of the impact?

What is the role of the driver? Did his or her action, or inaction, initiate



the accident? Did the driver of another motor vehicle, or circumstances beyond the truck driver's control, create the accident situation? Did the truck driver's subsequent actions contribute to the severity, or was the accident unavoidable? What was the driver's physical condition prior to the accident? Did he or she have adequate rest? Were drugs or alcohol involved? What operating circumstances were involved? Was the truck speeding or going too fast for conditions? Could the accident have been avoided under different operating circumstances or, perhaps, if the vehicle had performed differently?

The 1973-76 summary report of the Bureau of Motor Carrier Safety (BMCS) sheds some light on the driver's role in accidents. A California Highway Patrol analysis of the BMCS data revealed that of the 1,028 vehicles involved in the accidents included in the report, the truck was the vehicle initiating the accident in 398 cases, or one-third. The analysis found that 87 percent were caused by drivers' action and only 13 percent because of mechanical defects. The data were categorized as follows:

Percent of Accidents Caused by Drivers of Interstate Trucks

- 37% were caused by the driver dozing, falling asleep, inattentive, or momentarily distracted.
- 13% were caused by excessive speed in good weather.
- 11% were caused by drinking or drugs.
- 10% were caused by traveling too fast in hazardous weather or low visibility.
- 7% were caused by poor judgement, unsafe maneuver, incapacitated, or inexperienced.
- 6% were caused by failure to downshift on steep downgrade.

- 3% were caused by miscellaneous action.  
87% (347 accidents)

Percent of Accidents Caused by Mechanical Defects Interstate Trucks

- 5% were caused by front tire blowouts.
- 3% were caused by wheel bearing, axle, spring, or steering failure.
- 2% were caused by trailer hitch or fifth wheel failures.
- 2% were caused by air brake deficiencies.
- 1% had miscellaneous causes.

13% (51 accidents)

TOTAL 100% (398 accidents) Initiated by trucks

Although not conclusive, this analysis suggests that the driver's role in heavy truck accident involvement has not received the attention it should. Neither has sufficient study been devoted to highway and weather conditions. Highway and environmental conditions at the time of an accident involving a heavy truck are largely unknown.

Another question without an adequate answer is: what happened to the accident victim, and in particular, the truck driver? What injuries were sustained and what was the severity? What was the source of the injury -- steering column, ejection, collapsed structure?

The simple fact is we lack good, solid answers to nearly all of these questions. Is there a heavy truck safety problem attributable to the design of the vehicle? Are certain vehicles such as cab-over-engine tractors, longer and heavier

---

tractor/trailer combinations, doubles or triples, overinvolved in accidents? Again, we don't have solid data to answer such questions because only piecemeal evaluations have been conducted to address these issues.

Accident and injury data are needed to address current truck safety issues receiving priority consideration by NHTSA. Included are truck braking, driver environment and cab crashworthiness.

Braking performance of heavy commercial vehicles remains the highest truck safety priority of government regulators. Rulemaking plans call for additional braking requirements: e.g., reinstatement of stopping distance requirements, antilock, automatic slack adjusters and load-proportioning. Truck braking systems have improved substantially in recent years as a result of NHTSA's FMVSS 121 brake regulation. A fundamental question is how much further improvement in truck braking performance is needed? A more difficult question is, what aspects of braking improvements will afford a safety benefit. A better understanding of the specific role of truck brakes and stopping capability in accident causation is needed. There are obvious vehicle design tradeoffs involved. For example, shortened stopping distances can affect controllability, reliability and maintenance by making it more difficult to stay within a lane, and adding complexity with more components. Also, the real-world safety benefits of anti-lock braking systems have yet to be proven.

Truck ride quality and driver environment is another issue receiving considerable attention by drivers, manufacturers, and government regulators. Poor ride has been attributed to increased front axle loading, forward fifth wheel position, short cab length, cab-over-engine configuration, and other factors - none of which directly correlate with ride characteristics in all trucks. However, the fundamental question yet to be answered is whether there is an effect on driver health

and safety. MVMA supports cooperative government/industry research to determine the extent to which truck ride affects driver health and safety. Independently of this necessary research, manufacturers have developed and are producing trucks with numerous ride quality and driver environment improvements to provide customers with the products they desire.

Heavy truck occupant crash protection has become a safety concern because of increasing numbers of occupant fatalities. Admittedly, little is known about the causes of accidents and the way in which injuries and fatalities occur to heavy truck occupants. It should be recognized that the crash energy spectrum associated with large commercial vehicles is drastically different from that associated with smaller vehicles. For example, in low speed, low-severity crashes, heavy truck occupants are exposed to minimal injury risk. At the other end of the spectrum, involving extremely severe crashes, such as truck-to-truck or truck-to-fixed objects at high speeds, the crash energy cannot be managed, and fatalities result. Thus, protection can probably be afforded only to a certain threshold or limit of crash severity.

The precise injury mechanisms associated with varying severity-level crashes warrant further investigation. NHTSA has initiated an indepth study to examine accident and injury modes, a necessary first step to developing effective countermeasures.

Certainly, every reasonable effort must be made to reduce truck accidents, injuries and fatalities. However, if we are to find intelligent and effective solutions, we must start with an understanding of what causes or contributes to the accident and its consequences in the first place. Unsafe conditions, whether caused by the driver, the vehicle, or the highway, can then be identified and corrective measures proposed.



---

#### IV. MVMA Heavy Truck Accident Research

MVMA sponsors vehicle safety research with the objective of improving highway safety. In recent years special emphasis has been placed on heavy truck safety. MVMA is committed to working for a better understanding of the role of motor trucks in traffic accidents. MVMA has sponsored research at Michigan's Highway Safety Research Institute (HSRI), Calspan Corporation, the University of North Carolina's Highway Safety Research Center, the University of Southern California, Wayne State University, Southwest Research Institute, Stanford Research Institute, Stevens Institute of Technology and Purdue University.

In 1966 MVMA sponsored an extensive study of existing state accident data through Ernst & Ernst Company of Cleveland, Ohio. Police accident records from ten states were statistically sampled and analyzed. Unfortunately, the data did not provide definitive answers to truck safety problems. However, they did reveal the limitations of state accident records. In many instances the vehicle involved was identified merely as a truck, with no indication of whether a small pickup truck was involved. The vehicle configuration was either not identified or vague in the police reports. Reported "rear-end" collisions did not, in many cases, reveal whether the truck struck the rear of another vehicle or whether the truck itself was rear-ended.

Recognizing the limitations of police records, MVMA initiated indepth accident investigations by Calspan in western New York, HSRI in southwestern Michigan and elsewhere. Accident researchers, using the "clinical approach," made a detailed on-the-scene examination and record of the vehicle, occupant, highway and environmental conditions at the time of the accident. These data provide detail about the accident and injuries sustained. But the population coverage was so limited both

geographically and in absolute numbers of accidents that the representiveness is questionable. Although data collection has improved in recent years, a wider range of detailed clinical data are needed to better identify causes and consequences of high frequency accident situations.

MVMA, while frustrated in its initial attempts to determine the causes of heavy truck accidents, has continued efforts to address concerns expressed by the safety community.

#### Key Issues in Heavy Truck Safety\*

In 1976 a member of the National Motor Vehicle Safety Advisory Council put forward a number of truck safety allegations criticizing heavy trucks as disproportionate contributors to highway accidents, injuries and fatalities. MVMA engaged Calspan Corporation and Southwest Research Institute to evaluate and comment constructively on the allegations.

The investigations were revealing. They found an apparent excessive representation of heavy trucks in highway fatalities. "Apparent" because exposure of heavy trucks, that is, the miles they travel, were not taken into account because such information simply didn't exist. Researchers also found that in collisions with trucks, auto passengers were more likely to be fatally injured and this pointed to the need for measures to avoid accidents.

Exposure data to put the heavy truck safety record in perspective were lacking and they recommended it be collected. Both Calspan and Southwest Research found that many of the unfavorable car/heavy truck

---

\*"Analysis of Truck, Tractor/Trailer Accident Data", Perchonok and Ranney, Calspan Corporation, June, 1976;

\*"Analysis of Tractor/Trailer and Large Truck Accident Data, Mason, Southwest Research Institute, June 25, 1976.



---

safety comparisons simply could not be substantiated because data were not available.

The analysis of "Key Issues In Heavy Truck Safety" represented a new direction for MVMA-sponsored truck research. MVMA began to focus on specific safety issues, such as rulemaking proposals to upgrade underride protection, with the expectation that concentrating resources on specific safety concerns would lead to a better understanding than that afforded by broad, generalized research.

#### Car/Truck Fatal Accidents in Michigan and Texas\*

In response to the 1977 Bureau of Motor Carrier Safety advance notice of proposed rulemaking for improved truck under-ride protection, MVMA asked the Highway Safety Research Institute to carefully examine car into truck fatal accidents and seek to learn why they happen and what can be done to avoid them. The conclusions were revealing:

- Side underride fatalities occurred nearly as often as rear underride.
- Two-thirds occurred at night.
- Most were surprise events with little reaction time on the part of the automobile driver; there was no evidence of skidding, with the struck vehicle often parked along side or straddling the road.
- Closing speeds (the speed that the car hit the truck) were greater than thirty miles an hour in two-thirds of the rear impacts.
- More than two-thirds of the accidents involved tractor/trailer combinations, mostly vans and flatbeds.

---

\*"Car/Truck Fatal Accidents in Michigan and Texas", Daniel Minahan and James O'Day, Highway Safety Research Institute, October, 1977.

HSRI concluded that making the vehicle more conspicuous--more easily recognized--could prevent many underride accidents and might be a better approach to the problem than merely improving the guard.

#### Analysis of Heavy Truck Accident Data\*

In an effort to better understand the accident situations involving different heavy truck configurations, MVMA commissioned Calspan to analyze the so-called "tri-level" accident data from eight western counties in New York State over the period 1969-1975. Data for virtually all heavy truck accidents occurring in that time period were analyzed. Tractor/trailers, straight trucks and tractors without trailers were categorized in tables showing point of impact location and identification of the striking vehicle. Accident frequency and injuries were examined. Here are some of the key findings and conclusions:

- The truck was the striking vehicle in slightly more than half (60%) of the cases, but there was no difference between truck types.
- 63-71% of the accidents resulted in no injury to the occupants of either vehicle. In the case of tractor-trailer accidents, 63% were injury free.
- For collisions with tractor/trailers, injuries sustained by the occupants of the other vehicle were unrelated to its size.
- Roll-over accidents occurred with the same frequency (6%) for both tractor/trailers and straight trucks.
- Only 5% of tractor/trailer accidents involve jack knife.

---

\*"Analysis of Heavy Truck Accident Data", Thomas A. Ranney, Calspan Field Services, Inc., Buffalo, New York, April, 1978.

- 
- Occupants of the tractor/trailer had a lower risk of injury than occupants of other vehicles.

Calspan recommended a more "fine-grained analysis" examining vehicle deformation, and photographs to gain more insight into accident conditions. Calspan also recommended future analyses take into consideration exposure for the purpose of determining accident rates because trucks travel more miles than cars. Alternatively, a "culpability" or causation analysis was suggested.

#### Analysis of Heavy Truck Underride Accident Data\*

Following the HSRI study of fatal underrides, MVMA asked Calspan to examine underride accident statistics, injuries and fatalities using the "tri-level" accident data base. Calspan found:

- Less than 2% of all accidents result in a potential underride.
- The most frequent underride occurrence is an automobile striking a stopped truck both on and off the highway.
- Underride accidents result in a greater level of injuries and incidence of fatalities than non-underride.
- Underrides were most likely on wintry and unlighted roads in rural areas away from intersections and grades.

Calspan's research confirmed the earlier HSRI conclusion that there is potential for eliminating many underride accidents, and that enhanced conspicuity is worth thorough investigation.

---

\*"Analysis of Heavy Truck Underride Accident Data", Thomas A. Ranney, Calspan Field Services, Inc., Buffalo, New York, September, 1978.

#### A Comparative Analyses of Truck Accidents in the State of Michigan\*

In an effort to understand the relationship of truck accident experience to other vehicles, MVMA commissioned Wayne State University to examine recent accident experience in the State of Michigan, where some of the largest and heaviest trucks are in widespread use (65-foot doubles combinations with gross weights ranging up to 157 thousand pounds). Accidents were categorized as to property damage, personal injury and fatality. Exposure data were estimated based on vehicle miles traveled.

Here are some of Wayne State's findings:

- There was no significant difference between the accident rates for all types of trucks compared with all other motorized vehicles.
- In fatal and property damage accidents, trucks had a somewhat higher rate than non-trucks, but for injury accidents trucks had a lower rate.
- Tractor/trailer combinations had lower rates of property damage and personal injury accidents than non-trucks.
- Light and straight trucks had a higher accident rate than non-trucks.
- Tractor/trailer combinations had a higher fatal accident rate than non-trucks.
- Within the three truck categories, straight trucks had the highest accident rates followed by light trucks, then tractor/trailers.

---

\*"A Comparative Analyses of Truck Accidents in the State of Michigan", Snehamay Khasnabis, Wayne State University, August, 1979.



---

Wayne State recommended "micro-level analysis" of truck accident records with emphasis on identification of causative factors such as weather, traffic control, vehicles, drivers, and in-depth analysis of factors contributing to the general upward trend of truck accidents.

#### Comparison of Michigan Fatal and Non-Fatal Car into Truck Accidents\*

Fatal and non-fatal accidents, including those in which underride occurred, were compared by HSRI to determine how non-fatal car-into-truck accidents differ from fatalities. MVMA sponsored this research with a hope that it would provide some insight as to how to reduce the severity of or avoid accidents. HSRI analyzed data from 94 fatal and 100 non-fatal rear and side collisions in the State of Michigan. Data for fatal accidents were drawn from reports covering collisions in which a car struck a truck or tractor/trailer combination during the period 1972 through 1976, and from 100 randomly selected non-fatal crashes of the same kind during 1976. HSRI found:

- Underride occurred much less frequently in non-fatal accidents and is usually of minor or moderate degree.
- Relative impact speeds were much lower in non-fatal accidents averaging 10 mph versus 35 mph in fatalities.
- Non-fatal accidents occurred more often in the daytime.
- Non-fatal accidents more often involve impacts on trucks and trailers of a design which prevents underride.

---

\*"Comparison of Michigan Fatal and Non-Fatal Car into Truck Accidents", Daniel Minahan and James O'Day, Highway Safety Research Institute, University of Michigan, August, 1979.

HSRI again concluded that priority should be given to increasing driver awareness and recognition, i.e., "conspicuity" of trucks and trailers at night and that trailer design should adopt configurations which impede underride.

#### Accidents and the Night-time Conspicuity of Trucks\*

This research was initiated as a follow-up to earlier studies of fatal and non-fatal car into truck accidents involving underride. The first part of HSRI's three-pronged research project examined NHTSA's fatal accident reporting system data for 1977 to pinpoint the conditions under which cars collide with the side or rear of tractor semi-trailers. It reinforced earlier findings that most fatal collisions occur at night -- suggesting that conspicuity of the semitrailer is a problem.

The second study reviewed available data on night-time conspicuity, the benefit of retro-reflectorization, and confirmed that increasing the size or contrast (luminance) of targets, as well as retro-reflectorization, enhances conspicuity at night. The experience in England after commercial vehicles were equipped with reflectorized materials was significantly fewer nighttime accidents. Similarly, studies of buses and postal vehicles in the U.S. showed accident reductions. The evidence supports the conclusion that improved conspicuity can reduce accidents.

The third study was an exploratory field experiment to measure the attention-getting properties of various retro-reflective treatments on a semi-trailer. Volunteer drivers wearing a device which measures eye movement, repeatedly drove past a parked truck

---

\*"Accidents and the Night-time Conspicuity of Trucks" Paul Green, et al, Highway Safety Research Institute, University of Michigan, December, 1979.

---

trailer at night. They were informed of participating in a highway sign study, but the parked truck was not mentioned. The subject saw the standard semi-trailer at a distance of 300-400 feet on low beams. When retro-reflective materials were applied to the rear and side of truck trailers, sight distances increased to 1,000 feet. The drivers looked at the reflectorized trucks more often and at greater distance. These findings indicate eye fixation time is a useful measure of recognition and a tool for conspicuity evaluation.

The HSRI studies offer strong evidence that enhanced conspicuity of truck and trailers can reduce car into truck collisions. However, further research is needed to determine specific configurations and sizes of reflective surfaces. MVMA supports research NHTSA has initiated to determine effective signalling and marking systems (including use of reflective materials) and to evaluate their accident reduction potential.

Combination Vehicles: Five-Year Accident Experience\*

In September, 1979, NHTSA released statistics from its fatal accident reporting system (FARS) suggesting a 47% increase in heavy truck accident fatalities between 1975 and 1978. MVMA asked HSRI to analyze all available fatal accident reporting system data on combination vehicles to learn more about this situation. HSRI also examined accident injury and fatality data on combination vehicles in the state of Texas for the period 1973 through 1977, in addition to FARS data for the period 1975 through 1979. Here are the key findings:

- Fatalities in combination vehicle accidents have been increasing since 1975.

---

\*Combination Vehicle - Five Year Accident Experience. James O'Day, Highway Research Institute, July 1980.

- Coding errors in 1975, and to a lesser degree in 1976, resulted in under-reporting of fatalities. Thus, 1975 is inappropriate for use as a basis for comparison. Increasing truck and passenger car traffic account for most of the increase in fatalities in 1978.
- Careful examination of accident descriptors such as time of day, day of week, hour of day, road class, weather conditions, type of collision, driver variables, etc., reveal little change in the proportion of fatal accidents in each category during the 1975-1979 period.
- The largest number of combination vehicle fatal accidents occurs in 55 mph speed limit areas.
- Combination vehicle fatal accidents are a smaller proportion of moderate-speed-limit fatalities, but become a substantial fraction of those where higher speed limits prevail.
- Rear-end accidents which result in a fatality are quite likely to involve a combination vehicle.
- About 5% of combination vehicle fatal accidents involve fires.
- The combination vehicle is less likely to be damaged in the accident.
- Approximately 5% of combination vehicle fatal accidents in which the truck occupant survived involved roll-over; while slightly more than half (53-56%) of the fatal accidents in which the truck occupant was fatally injured involved roll-over.
- About one-third of the truck occupants in combination vehicle fatal accidents were ejected.



- 
- Most truck occupant fatalities are drivers (85%), but approximately 10% are right hand seat passenger and 5% sleeper occupants.
  - Younger drivers have a higher incidence of injuries.

The systematic analysis of FARS data is beginning to reveal high-frequency accident situations that deserve careful review, such as numbers of occupants ejected and the relationship between occupant fatalities and incidence of rollover. MVMA has recommended that the NHTSA conduct in-depth analysis of such factors as part of the truck cab crash-worthiness research effort the Congress has called for.

#### Analysis of Truck Accident and Exposure Information

As a first step, MVMA and the Western Highway Institute (WHI), along with the American Trucking Associations (ATA), are jointly sponsoring a study of heavy truck accident and exposure information to determine the accident experience of a variety of heavy trucks including straight trucks and single, double and triple trailer combinations vehicles. The report of Phase I of this study\* reviews the current status of information regarding heavy truck accidents and examines existing sources of accident and exposure data. The report delineates the additional data required to provide a basis for calculating valid heavy truck accident incidence rates, accident causation factors, and potential countermeasures.

Phase II of this study is collecting national accident data by creating a complete set of fatal accident information

with the details found on Bureau of Motor Carrier Safety accident forms, e.g., truck configuration, cargo, etc. The data will be collected by retrieving the original accident forms and conducting telephone interviews where necessary.

National and state exposure data are being determined from the 1977 Department of Commerce Truck Inventory and Use Survey (TIU). TIU data samples are sufficient to represent individual states with precision--particularly the larger states such as Texas and California. Other data required of states, particularly information on doubles and triples, will be collected by a system of accident report follow-up at the state level. The Phase II effort will continue for at least two more years and is expected to make a major contribution to understanding the reasons for, and consequences of heavy truck accidents.

---

\*"Analysis of Truck Accident and Exposure Information - Phase I" James O'Day, et al, Highway Safety Research Institute, University of Michigan, November, 1979.

---

## V. The Need for a Comprehensive, Continuing Heavy Truck Safety Investigation

### Conclusions

We recognize that current information regarding heavy truck accidents is far from definitive. Because of this, there is a need for caution in interpreting the analysis of available accident information. We also recognize that a major undertaking will be required to address the important questions and issues raised.

Although the research MVMA has sponsored is beginning to provide insights into the heavy truck safety problem (good examples are the recent studies which led to an understanding of the truck underride problem, the role of conspicuity, and the important conclusion that accident avoidance measures should receive priority), our overriding conclusion is that a continuation of the fragmented, piecemeal approach to studying individual issues in isolation is not the most productive and efficient way to bring about improved truck safety.

We have also learned that restricting truck safety studies to individual issues has limited value. Without knowledge of the overall accident picture, there is no understanding of the relative importance of a particular safety question, e.g., what portion of truck accident injuries and fatalities are car-into-truck vs. truck-into-car collisions. Resources are committed to study what may be an isolated occurrence, or, in other words, a "non-problem", while other, potentially more important safety problems are ignored.

First we must understand how many accidents, injuries and fatalities occur, who ran into whom, when, where, how and under what circumstances, to put safety concerns in perspective. We conclude the following are necessary elements for a successful truck safety research program:

1) Representative National Accident and Exposure Data - A body of detailed

truck accident data, nationwide coverage, and corresponding exposure data by vehicle configuration, highway type, location, time of day, etc., are required to provide representative national statistics. Accident, injury, and fatality data can then be compiled to provide total counts and accident rates. Problem areas can be isolated by observing patterns of high frequency occurrences as a function of vehicle, driver and highway characteristics, and by comparing accident rates to identify those above the norm.

2) Analysis of Contributive/Causative Factors - For each group of high frequency accident situations, multiple-factor statistical analysis methods can be applied to determine contributing factors. Factors which, if not present, would have prevented the accident(s) can also be identified as possible "causes." That is, analysis of conditions which precipitated rollovers - object avoided or impacted - could identify contributing factors for further in-depth study.

3) "Special In-Depth Studies" - Finally, in-depth special studies should be undertaken with sufficiently detailed "clinical" data to probe a limited sample of an identified safety problem to suggest potential countermeasures. Preventing fatalities of combination vehicle occupants could be such a study. In this instance, there must first be an examination of a subset of accident data in which truck occupants were fatalities; a subset that is sufficiently detailed to identify what condition or object caused the fatality. Was the cab crushed? Was the occupant ejected? What was the fatal injury? Such analysis is necessary to identify means of reducing injuries and fatalities.

Our truck safety research program is designed to collect needed information in all three categories. The study we have initiated at HSRI, in cooperation with the Western Highway Institute and the American Trucking Associations, seeks to establish a framework for collecting the required



---

accident and exposure data, and to conduct analyses emphasizing contributing and causative factors whether they be related to the vehicle, the highway, or the driver. Identification of effective countermeasures is dependent on these cause/effect relationships.

#### Recommendations

We believe it essential to maintain an open exchange of truck safety research information among all affected parties. This would include Federal and State safety officials, manufacturers, carriers, organized labor, owner-operators, insurance companies, police officials, researchers, the medical community, etc.

We suggest that NHTSA, FHWA and BMCS join with the private sector to undertake a comprehensive and continuing heavy truck safety analysis. A coordinated effort to compile representative, detailed accident data from Bureau of Motor Carrier Safety accident reports, the Fatal Accident Reporting System, and the National Accident Sampling System, would contribute significantly. Exposure data matching vehicle, highway and driver variables in the accident data sample would be revealing.

A special effort to evaluate driver health and safety as it relates to the truck cab environment should be undertaken to provide a benchmark for continuing industry efforts to enhance the driver's environment.

To do this job properly requires the cooperation and support of all those whose livelihoods are affected by truck accidents, injuries and fatalities. While we have received assurances some Federal data will be made available to HSRI, it will be necessary to supplement these data, increasing the heavy truck sampling rate in the NASS program and adding data elements to accident forms. Special analysis studies at the State level remain unfunded. These will be vital in our effort to obtain answers to heavy truck safety problems.

We urge those concerned to make a commitment, support this necessary research effort, and find effective solutions to whatever heavy truck safety problems exist. We are reminded of what Senator Magnuson, the Chairman of the Senate Committee on Appropriations, said when the Senate approved additional funds for heavy truck safety research by NHTSA in the 1980 fiscal year budget. He said,

..."every reasonable effort must be made to reduce involvement (emphasis added) of heavy trucks in crashes and to reduce the injuries and fatalities of those crashes. These efforts must (emphasis added) be based on a full understanding of all the causative and the contributing factors of these crashes so that corrective and remedial efforts are based on solid evidence with respect to the roles of the highway, the driver, and the vehicle."

We concur with the Senator's thoughts. Let's make sure the countermeasures eventually identified are based on adequate research and understanding of the real truck safety problems. MVMA pledges its continuing support to such an effort and will cooperate with those striving for improved truck traffic safety.