ANALYSIS OF TRACTOR-TRAILER AND LARGE TRUCK ACCIDENT DATA

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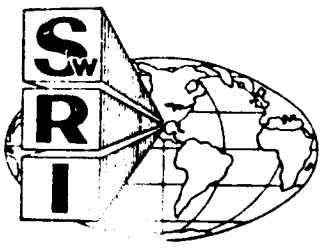

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16. Abstract

Twenty-one hypotheses alleging to the existence of a national problem with large truck involvement in highway safety were reviewed, evaluated, and critiqued in relation to the available research findings and literature. Existing truck accident data from Texas and California were also analyzed and compared to each hypothesis. The findings are assessed and recommendations are presented.

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1. INTRODUCTION

This report contains the results of an SwRI study on the role of tractor-trailer combinations in highway safety. Specifically, twenty-one hypotheses alleging to the existence of a national problem with large truck safety were reviewed, evaluated, and critiqued in relation to the available research findings and literature.

Many of the hypotheses given can be directly traced to specific articles and reports on highway safety. Others are more general in nature and thus must be evaluated in terms of available information. A select few are mere statements having no supportive background in the literature. For each hypothesis the total context and the specific statements in the cited references are examined to determine if the references accurately and fairly support the related hypothesized statements. Included are findings on the degree to which the support documents referenced are in themselves logically developed from their respective data bases and whether such data are representative and consistent with other data examined.

Existing truck accident data, including 1974 collision data from the State of Texas and 1975 truck accident data from two defined areas of California, were analyzed and compared to each hypothesis. The 1974 Texas Accident Data available was obtained from the Collision Data Bank sponsored by MVMA at the Highway Safety Research Institute at the University of Michigan. Three separate files were utilized: the 5% Sample File, derived from a random sampling of the entire state

accident population for 1974 and consisting of 36,517 vehicles in accidents; the Large Truck File, which describes accidents in which at least one of the involved vehicles is a large truck and consists of 53,046 vehicles in accidents; and the Fatal File, which contains all fatal accidents in the State of Texas and includes 3,783 vehicles.

The Texas truck accident data represents the largest police reported data bank available anywhere in the world. The definition of large truck in these files is made in terms of the vehicle body style (beverage, bob-tail, dump, fire truck, flatbed, float, garbage, mixer, pole (log), refrigerator, stake, van, semi-trailer, unknown) and specific body type (truck, truck and trailer, truck-tractor and semi-trailer, truck and house trailer, and other truck combinations). For the purposes of this study, trucks were categorized into three groups: large trucks (defined above), truck-tractor and semi-trailer, and small trucks (vans and pickups).

Collision data assembled by the University of Southern California of truck accidents investigated by the California Highway Patrol and reported in bi-level forms was also utilized. This data is a census sample of all trucks (GVW $\geq$ 10,000 lbs.) involved in accidents occurring in two defined geographic areas of California during the summer of 1975. Out of 925 truck accidents reported, 279 involved tractor-trailer combinations.

Section 2 contains a list of the 21 hypotheses, a review of the literature, a summary of the results of analyzing the Texas and California

accident data and a critique of each hypothesis. The conclusions and recommendations resulting from the study are contained in Section 3. The study was conducted during the period April 12, 1976 to June 25, 1976, with general support funds contributed by the Motor Vehicle Manufacturers Association.

2. ASSESSMENT OF THE HYPOTHESES

This section contains a description of each of the twenty-one hypotheses (titled Hypothesis), a review of the literature (titled Background), a summary of the data analysis conducted on the Texas Files or USC data (titled Data Analysis), and a critique of the results obtained (titled Discussion).

2.1 - HYPOTHESIS 1

> One percent of all registered vehicles are tractor-trailers or other combinations. This one percent is involved in 2.6 percent of all accidents and 7.3 percent of all fatal accidents.

Background. The first hypothesized statement is obtained from data included in references 1 and 2. Reference 1 contains counts from the Federal Highway Administration on the total U.S. truck-tractor registrations (1,064,600) and the total U.S. motor vehicle registrations (129,843,087) for 1974. It follows that 0.8% of all registered motor vehicles in the U.S. are truck-tractors. Note, however, that registrations are not synonymous with vehicles in use since the latter implies a count of vehicles in operation on a specific date or an average for a period of time, while registrations are a count of transactions (with transfers eliminated) during a specific period.

The second statement in H1 is based on accident reports from 19 state traffic authorities as reported in reference 2. Large trucks are classified as either truck-tractor and semi-trailer or other truck

combinations. Truck-tractor and semi-trailer represent 5.7% of all vehicles in fatal accidents and 1.7% of all vehicles in all accidents. Other truck combinations represent 1.6% of all vehicles in fatal accidents and 0.9% of all vehicles in all accidents. Thus, tractor-trailers and other truck combinations account for 2.6% of the vehicles involved in all accidents and 7.3% of the vehicles involved in all fatal accidents.

Data Analysis. In the State of Texas 0.9% of all registered vehicles in 1974 were truck-tractors while 2.7% were large trucks (Table 1). The truck-tractors and semi-trailers composed 7.6% of all vehicles in fatal accidents and 2.0% of all vehicles in accidents. This is comparable to the comments on H1 in reference 2. The large trucks composed 10.5% of all vehicles in fatal accidents and 4.1% of all vehicles in accidents. These results also appear consistent with H1. Large trucks, in contrast to tractor-trailers, have higher counts in both fatal and all accidents, but this is mainly due to differences in definition between the two truck categories.

Discussion. Based on the above information it appears that H1 would be more accurate if it were restated as follows: In 1974, 0.8% of all registered motor vehicles in the U.S. were truck-tractors. Using accident reports from several states, truck-tractor and semi-trailers and other truck combinations account for 2.6% of the vehicles in all accidents and 7.3% of the vehicles in all fatal accidents, i.e., the percentage figures are based on numbers of vehicles, not numbers of accidents.

Table 1

Types of Motor Vehicles Involved in Accidents in the State of Texas, 1974

Type of Vehicle	In Fatal Accidents* Number	%	In All Accidents** Number	%	Per Cent of Total Vehicle Registrations***
All Types	3,783	100.0	730,340	100.0	100.0%
Passenger Cars	2,317	61.2	572,180	78.3	73.3
Small Trucks	696	18.4	100,620	13.8	20.8
Large Trucks	397	10.5	30,140	4.1	2.7
Truck Tractor and Semi-Trailer	286	7.6	14,260	2.0	0.9

*Source: Texas Fatal File

**Source: Texas 5% Accident File

***Source: Texas Department of Highways and Public Transportation

Since these figures do not reflect the same types of vehicles, the number of vehicles-in-use, the places of travel, or the actual miles traveled (all of which affect accident experience), caution must be utilized in concluding an over-involvement rate in accidents for tractor-trailers and other truck combinations. There is a trend, however, toward over-involvement. If it were possible to determine driving exposure of large trucks so that an involvement rate per unit of miles driven, or per unit of hours on the road, etc. could be calculated, then more accurate and meaningful comparisons could be made.

2.2 - HYPOTHESIS 2

> The better safety performance of smaller trucks (pickups, vans, etc.), which constitute about 96 percent of the total number of trucks, completely obscures the safety performance of combination trucks.

Background. This statement stems from references 1-4. The data in reference 1 indicate that for 1974, 95.7% of the total number of trucks registered in the U.S. were not truck-tractors. Also from the data in reference 2, based on the 19-state report, trucks or truck-tractors composed 17.6% of the total vehicle registration but only 10.9% of the vehicles in all accidents and 12.6% of the vehicles in all fatal accidents.

Reference 3 contains results of all truck crashes reported in North Carolina in 1973. The data file contains information on 5,653 large trucks (tractor-trailer and three-axle), 29,076 two-axle trucks and 218,730 cars. The two-axle trucks were categorized as intermediate and

small trucks (with small trucks being defined as two-axle trucks rated at 24,000 pounds GVW or less). On the basis of the accident report information, these small trucks appeared much like cars, particularly with respect to crash types, driver injuries, and accident types.

For instance, 19.4% of the large trucks and 14.4% of the intermediate trucks were involved in single-vehicle crashes as compared to 10.0% of the small trucks and 13.0% of the cars. Also, 16.6% of the large-truck drivers and 14.7% of the intermediate-truck drivers were reported as having some type of injury in their accidents as compared to 19.2% of the small-truck drivers and 24.4% of the passenger car drivers.

In reference 4, data on 1,440 fatal crashes in the state of Maryland during 1970 and 1971 are given. The fatal crash involvement rate (the number of vehicles in fatal crashes per 100,000 registered) was 146.6 for tractor-trailers, 38.3 for non-trailer trucks, and between 24.1 and 31.0 for passenger cars. Further, non-trailer trucks accounted for 95% of the registered trucks in Maryland.

Data Analysis. Non-tractor trucks accounted for 96.1% of the trucks registered in Texas in 1974. And small trucks (vans and pickups) accounted for 88.6% of truck registrations. From the Texas files, small trucks composed 20.8% of the total vehicle registrations but only 13.8% of the vehicles in all accidents and 18.4% of the vehicles in all fatal accidents. The fatal involvement rate (number of vehicles in fatal accidents per 100,000 registered) was 438.4 for tractor-trailers, 205.5 for large trucks, 47.0 for small trucks, and 44.3 for passenger cars.

The collision types and accident types of cars, small trucks, tractor-trailers, and large trucks are contained in Table 2 for single-vehicle accidents. The data indicate small trucks are somewhere between cars and larger trucks, at times favoring car accident types such as hits against parked cars, and at other times favoring larger truck accident types such as overturns. In multiple traffic unit accidents, 98.7% of the car hits, 98.6% of the small truck hits, 99.0% of the large truck collisions, and 98.9% of the tractor-trailer crashes were against other motor vehicles. Thus small trucks tend to have accident types more similar to cars.

The same pattern is evident in the driver injury types for the various classes of vehicles. Table 3 contains the injuries to drivers in Texas accidents recorded by the investigating officer utilizing the Police Injury Code (PIC). Note in multiple traffic unit accidents small truck and car drivers have almost identical injury patterns. In single-vehicle accidents small-truck driver injuries are between those of car drivers and of large-truck drivers.

Discussion. Non-tractor-trailer trucks constitute 90-95% of the total truck registrations in the United States. These vehicles appear to have better safety performance than large trucks with respect to less involvement in fatal accidents and all accidents. How much better, however, is questionable due to: 1) the inconsistencies from study to study of similar definitions for large and small trucks, 2) exposure rates based on registration data rather than actual vehicle use data, and 3) the limitations of

Table 2

Single Vehicle Accident Type by Vehicle Class

Type of Accident	Passenger* Car	Small* Trucks	Large+ Trucks	Tractor-+ Trailers
Railroad Train	1.0	2.0	1.6	1.7
Parked Car	33.3	31.0	21.9	13.0
Bicyclist	0.6	0.2	0.1	0.0
Animal	4.6	7.8	5.6	7.8
Fixed Object	36.2	26.9	32.2	36.0
Other Object	1.5	1.1	1.8	1.9
Overturned in Road	1.8	4.9	9.6	8.6
Ran Off Road	20.2	24.8	19.6	20.1
Other Non-Collision	0.8	2.4	7.5	10.9
N	75,880	16,000	7,234	4,152

*Source: Texas 5% Accident File

+Source: Texas Large Truck File

Table 3

Driver Injury by Vehicle Class by Accident Type

Driver Injury (PIC)	Single Vehicle Accident				Multiple Traffic Unit Accident			
	Passenger Car*	Small Truck*	Large Truck+	Tractor-Trailer+	Passenger Car*	Small Truck+	Large Truck+	Tractor-Trailer+
K	0.8	1.4	0.9	1.1	0.1	0.1	0.1	0.2
A	3.2	4.1	2.7	2.9	0.8	0.8	0.4	0.5
B	11.2	7.9	7.3	7.5	3.0	2.9	1.1	1.3
C	4.8	3.9	4.1	4.2	3.7	2.9	1.3	1.4
Not Injured	5.5	7.1	4.7	4.9	3.5	2.4	1.1	1.1
Not Stated	74.0	75.6	80.2	79.3	88.8	90.9	96.1	95.5
N	75,880	16,000	7,234	4,152	495,160	84,620	23,894	10,272

*Source: Texas 5% Accident File

+Source: Texas Large Truck File

results to subsets of data such as fatal involvements. Generally these trucks are more similar to cars in their collision and accident types and driver injury patterns. It is not evident that the safety performance of smaller trucks completely obscures that of combination trucks, but if the two groups are combined, the accident results are biased toward the smaller trucks due to their predonderance in the truck population.

2.3 - HYPOTHESIS 3

> Comparatively little information has been developed on the unique safety performance of truck combinations.

Background. In general this statement is true. Although yearly demographic data are published by the MVMA in such publications as reference 1, no current in-depth data are readily available on truck combination accidents. The Bureau of Motor Carrier Safety (BMCS) has not published results from large-truck accidents occurring in 1974 and 1975. And the National Highway Traffic Safety Administration (NHTSA) has only recently implemented studies in this area. Recent literature on this topic includes references 3-11. Of these, reference 3 concerning 1973 truck accidents in North Carolina is the most encompassing, and reference 9 concerning toll road accidents is most useful from a speed and exposure viewpoint. All the above studies, however, lack either adequate exposure information, accuracy of their data, or complete details on a representative sample of accidents.

Data Analysis. Data from the Texas file or USC report are not applicable to this statement.

Discussion. The findings indicate that much information is being accumulated and that in the coming years the safety performance of large trucks, including truck combinations, will become more clearly defined. One potentially excellent study recently ended concerned collision data assembled by the University of Southern California of all trucks (GVW over 10,000 lbs.) involved in accidents in two defined areas of California. The data sampled should have major significance since representative sampling was practiced and exposure and involvement rate information were obtained.

2.4 - HYPOTHESIS 4

> With the energy crisis have come two distinct movements: More smaller, economical cars and larger heavier trucks on the roads. With this increasingly adverse vehicle mix, the safety problem cannot get better.

Background. There is a growing disparity in the size and weight of the mixture of vehicles on the road, but no accurate data is available to adequately evaluate this statement. One note that supports H4 is contained in reference 13, which is a digest of activities of the National Highway Traffic Safety Administration for 1974. In this article it is reported that while automobiles are growing at approximately an annual rate of 4%, trucks and buses increased at an 8% rate in 1974. Also, subcompacts and compacts grew in numbers out of proportion to the general car population. It is also stated that in two-car collisions the smaller vehicle and its occupants almost always suffer the greatest

damage. Whether or not the safety problem can become better in such a vehicle mixture depends on many factors. General statements as in H4, however, that indicate the problem cannot improve should be viewed with caution until more accurate and representative data are available.

Data Analysis. The registration data in the State of Texas for 1972-75 is summarized in Table 4. With the energy crisis, small cars (shipping weight = 1,501 - 2,500 lbs.) have increased from 9.6% to 10.7%, while large trucks (GVW over 10,000 lbs.) have decreased from 13.3% to 11.4%. Also, larger cars (shipping weight = 4,500+ lbs.) have actually increased from 7.2% to 11.4%. Thus the consequence of the energy crisis, as noted in H4, is not as severe as indicated.

Tables 5 and 6 contain data on truck-car accidents in Texas. It is evident from Table 5 that drivers of cars weighing less than 4500 lbs. (shipping weight) have almost identical injury patterns in car-truck collisions, with about 1% fatalities, 2% A injuries, and 5% B and C injuries. Drivers of the trucks sustain few injuries with over 98% having no injuries reported.

Table 6 contains data on the TAD damage ratings given to the vehicles in car-truck collisions. Small cars again do not differ from larger cars in the amount of damage sustained. Trucks have little severe damage with over 50% of the TAD ratings in the 0-1 range.

Discussion. The hypothesized statement is a general conclusion and is not based on accurate data. In Texas the energy crisis was accompanied by an increase in small and large cars, but by a decrease

Table 4

Registration Counts for Motor Vehicles in Texas for 1972-75+

	Registration Year			
Passenger Cars	1972	1973	1974	1975
Shipping Weight (lbs.)				
1501-2500	9.6	10.2	10.3	10.7
2501-3500	29.3	27.6	26.5	26.5
3501-4500	53.8	53.5	52.2	51.4
4501+	7.2	8.8	11.0	11.4
N*	5,145,646	5,512,994	5,060,456	5,219,849
Commerical Trucks + Combinations				
Gross Vehicle Weight (lbs.)				
0-10,000	86.7	87.4	89.0	88.6
10,001+	13.3	12.6	11.0	11.4
N*	1,265,768	1,518,128	1,559,822	1,523,373

*N does not necessarily indicate total registrations

+Source: Texas Department of Highways and Public Transportation

Table 5

Driver Injuries in Car-Truck Collisions*

Driver Injury (PIC)	Passenger Car Weight (lbs)				Truck	
	1501-2500	2501-3500	3501-4500	4500+	Large	Tractor-Trailer
K	1.0	1.0	0.8	0.4	0.3	0.3
A	1.9	1.9	2.1	1.8	0.1	0.3
B	5.1	4.8	4.2	3.4	0.7	0.7
C	4.8	4.4	5.1	4.8	0.9	0.9
No Injury	2.8	3.9	5.3	4.6	0.9	0.6
Not Stated	84.4	83.9	82.5	85.0	97.3	97.4
N	1958	3588	7710	1428	10045	7224

*Source: 1974 Texas Large Truck File

Table 6

Vehicle Damage in Car-Truck Collisions*

TAD Damage	Passenger Car Weight (lbs)				Truck	
	1501-2500	2501-3500	3501-4500	4501-5500	Large	Tractor-Trailer
0	0.2	0.1	0.1	0.2	13.8	16.3
1	31.7	30.4	31.6	33.2	38.0	35.6
2	26.3	25.5	25.3	23.4	10.8	8.1
3	16.8	19.0	18.9	18.8	4.0	2.8
4	4.1	5.3	6.4	4.3	1.0	1.1
5	2.8	2.5	3.2	3.3	0.4	0.6
6	1.4	1.9	2.5	1.8	0.2	0.3
7	1.9	2.1	2.2	1.2	0.2	0.4
Not Stated	14.8	13.2	9.7	13.8	31.6	34.9
N	1958	3588	7710	1428	10045	7224

*Source: Texas Large Truck File

in large trucks. Further the Texas accident data indicate small cars do not pose much more of a problem than larger cars, i.e., if a large truck collides with a car, the car size matters little. There is little doubt that a safety problem exists in car-truck crashes, but it does not appear to have been affected by an increase of smaller cars on the road.

2.5 - HYPOTHESIS 5

> Trucks are more likely to be reported as having safety defects than cars. The Department of Transportation's Bureau of Motor Carrier Safety inspects about 30,000 trucks each year, and has listed the most numerous safety violations as follows (in descending order): 1) lighting, 2) brakes, 3) tires, 4) exhaust, and 5) safety appliances.

Background. The context of this statement is important. It results from information in the North Carolina study (3) taken from accident reports completed by the investigating officer (who must often rely on the information given him by the persons involved). In about 75% of the cases, no vehicle defect was noted for trucks and cars. Of the listed defects, brake failure was more commonly reported on trucks while tire defects were more often reported on cars. Eight percent of the large trucks had safety defects compared to only 4% of the cars. The most numerous vehicle defects reported for large trucks in accidents were as follows: 1) brakes, 2) tires, 3) lighting, and 4) steering.

The second statement of H5 stems from safety road checks conducted by the Bureau of Motor Carrier Safety. In its latest report (14) on inspections of 9,581 trucks and 18,169 total units the most numerous

safety violations were as follows (in descending order): 1) brakes (7,539), 2) lighting (7,360), 3) safety and other equipment (2,961), 4) tires (1,748), 5) wheels (1,422), 6) suspension (812), 7) exhaust (642), 8) couplings (195), and 9) fuel (163). It is evident that brakes and lighting are the most numerous problems. Safety and other equipment are the next problem area, followed by tires and wheel problems. Exhaust appears far less important than indicated in H5. Unfortunately no such road checks are conducted on cars, so comparative data is not available and reported car defects are minimized.

Data Analysis. The defects noted by the investigating officer in accidents in Texas are contained in Table 7. In about 86% of the cases no vehicle defect is noted for large trucks or tractor-trailers and in over 95% of the cases no vehicle defect is noted for cars. Of the listed defects brakes and tires were most commonly reported as problem areas, particularly for trucks. Approximately 5% of the large trucks or tractor-trailers in accidents had safety defects compared to only 1% of the cars. Thus H5 is correct in that large trucks or tractor-trailers in accidents in Texas in 1974 were reported as having more safety defects than cars. The most numerous vehicle defects reported for the trucks in accidents were as follows: 1) brakes, 2) tires, 3) wheel, and 4) trailer equipment.

In the USC study, defects were noted only for trucks so no comparisons can be made with cars. Only 6.5% of all the commercial vehicles in the study had equipment violations with lighting the most prominent, followed by brakes, tires, and wheels.

Table 7

Vehicle Defects by Vehicle Class by Crash Type

Vehicle Defect	Single Vehicle			Multiple Traffic Units		
	Passenger* Car	Large+ Truck	Tractor-+ Trailer	Passenger* Car	Large+ Truck	Tractor-+ Trailer
Defect	3.8	11.0	10.1	1.0	3.6	3.3
Brakes	1.6	4.1	3.6	0.8	2.3	1.8
Steering	0.5	0.7	0.8	0.0	0.0	0.0
Improper Lights	0.1	0.1	0.2	0.1	0.2	0.3
Tires	1.4	3.0	3.2	0.0	0.1	0.2
Trailer Equipment	0.0	1.9	1.4	0.0	0.2	0.1
Stop/Turn Signal	0.0	0.0	0.0	0.1	0.3	0.2
Wheel Came Off	0.2	1.2	0.9	0.0	0.5	0.7
No Defect	95.5	86.0	88.4	99.0	96.1	96.4
Other or Missing	0.7	1.8	1.6	0.1	0.3	0.3
N	75,880	7,324	4,132	495,160	23,894	10,272

* Source: Texas 5% Accident File

+ Source: Texas Large Truck File

Discussion. It is possible that trucks are more likely to be reported as having safety defects because truck drivers may be more likely to report a vehicle defect than admit their own negligence since this latter approach could result in a loss of driver privilege and consequently their livelihood. Also, the police officer may be more alert to a truck mechanical failure.

Our experience in accident investigation and research suggests that many types of passenger car and truck defects or hazardous conditions (if one exists) are so subtle that they might normally go undetected in routine investigation. Since many more passenger cars are involved in traffic accidents than trucks, and since it is generally easier to clear the scene in accidents involving cars only, investigation of such accidents is more routine to the investigating officer. Thus the officer is not as likely to probe for contributing car defects, particularly if the driver makes no comment suggesting that a defect existed. Consequently, there may be a significant number of defect-related accident causes, e.g., CO poisoning from a faulty exhaust system, glare on a dirty or damaged windshield, etc. that are not counted in the reported statistics, and these uncounted hazards may be so numerous as to completely change the sparsely reported results.

The observed data suggest that H5 is a general statement that does not accurately reflect the given situation. While safety defects are more likely to be reported on trucks rather than cars, these are noted in less than 25% of accidents. Thus H5 fails to adequately document the obvious

bias in data reflecting truck defects as compared to car defects.

2.6 - HYPOTHESIS 6

> In car-tractor-trailer crashes, the truck driver is more likely to be at fault.

Background. This hypothesized statement is attributed to the North Carolina study (3) which shows that in single vehicle crashes trucks are less likely to be in violation than cars; however, in large truck-car accidents 48.5% of the truck drivers had no violation indicated compared to 64.1% of the car drivers. There were a total of 12 types of violations reported including such errors as speeding, improper turns, and following too closely. Of these the truck driver was at fault more often than the car driver in half of them. The differences observed are due to the many more safe movement violations and speeding-below-65 violations given to the truckers.

The kind of violation is the first violation indicated by the investigating officer and does not necessarily mean the driver was cited for the violation. It appears however to provide a fairly sensitive measure of driver error in comparison to citations or convictions. The above hypothesis, thus, is correct in the sense that truck drivers in North Carolina in 1973 were more likely to be listed for a violation by the investigating officer than were car drivers, given a car-large truck crash.

Data Analysis. The violations given car and truck drivers in accidents in Texas for 1974 are given in Tables 8 and 9. These violations are the first indicated by the investigating officer. In single vehicle

Table 8

Violations Indicated in Two-Vehicle Crashes

Violation	Large Truck* - Car		Car+ - Car	
Speeding Over Limit	6.2	4.1	9.9	1.5
Yield Violation	8.6	8.5	8.9	23.0
Disregard Signal	3.5	2.9	6.9	3.7
Improper Turn	7.6	2.5	1.1	4.5
Following Too Closely	11.3	3.9	19.6	1.7
Improper Passing	1.5	3.2	1.8	0.2
Left of Center	1.3	1.5	1.8	1.2
Improper Start From Parked Position	8.1	1.5	1.4	3.4
Under Influence of Alcohol or Drugs	0.6	1.5	2.2	1.3
No Signal	0.5	0.5	0.1	0.5
No Violation	39.5	64.3	41.9	57.0
N	17,269		196,440	

*Source: 1974 Texas Large Truck File
+Source: 1974 Texas 5% Accident File

Table 9

Violation Indicated by Crash Type and Vehicle Class

Violation	Passenger Cars* in			Large Trucks+ in			Tractor-Trailers+ in		
	Single	Other	Total	Single	Other	Total	Single	Other	Total
Speeding Over Limit	32.3	5.2	8.8	25.8	6.6	11.0	28.5	7.9	13.8
Yield Violation	0.3	15.5	13.5	0.1	8.5	6.6	0.1	6.5	4.7
Disregard Signal	0.8	4.8	4.3	1.0	3.2	2.7	1.0	2.5	2.1
Improper Turn	0.5	2.7	2.4	0.9	6.8	5.4	1.1	9.0	6.8
Following Too Closely	0.2	9.7	8.4	0.2	10.9	7.5	0.1	10.4	7.5
Improper Passing	0.3	1.2	1.1	0.2	1.8	1.5	0.1	2.4	1.7
Left of Center	0.2	1.3	1.2	0.1	1.3	1.0	0.1	1.2	0.9
Improper Start From Parked Position	2.7	2.3	2.3	4.5	7.2	6.6	2.3	5.0	4.3
Under Influence of Alcohol or Drugs	12.7	1.8	3.1	2.5	0.6	1.0	1.6	0.3	0.7
No Signal	0.0	0.3	0.3	0.0	0.5	0.4	0.0	0.3	0.2
No Violation	42.5	52.0	50.7	57.1	42.6	46.0	59.4	42.9	47.3
N	75,880	495,160	571,040	7,234	23,894	31,128	4,152	10,272	14,424

*Source: 1974 Texas 5% Accident File
+Source: 1974 Texas Large Truck File

crashes trucks were less likely to be in violation than cars; however, in large truck-car accidents 39.5% of the truck drivers had no violations compared to 64.3% of the car drivers. There were a total of 15 violations reported with the most common errors being speeding, improper turns, and following too closely. The truck drivers had many more violations due to following too closely and improper turns or improper starts from parked positions than did the car drivers.

In the USC study, violations by the commercial vehicle driver were the primary causal factor in 47.0% of the 925 truck accidents, while car driver violations were the cause in only 31.1% of such accidents. These include both single and multiple truck accidents. The main driver violations were speeding, unsafe lane change, and improper turns.

Discussion. The truck driver is more likely to be listed for a violation by the investigating officer than the car driver in car-truck crashes. These violations center on speeding, improper turns, unsafe lane change, and improper starts from parked positions. In single vehicle crashes, however, truck drivers are less likely to be in violation than car drivers.

2.7 - HYPOTHESIS 7

> a.) The tractor-trailer is more likely to collide into the rear of a car, rather than vice-versa, in rear end crashes. b.) Sixty-three percent of truck collisions with other vehicles involved the truck's braking ability. c.) Tractor-trailers also have greater propensity to "jackknife," turnover and otherwise lose control than passenger cars.

Background. The above hypothesis stems from reference 5 which contains data on 150 fatal crashes involving tractor-trailer trucks in the state of Maryland for 1970-73. Given are the results for each statement, a, b, and c, as reported in this reference.

a.) In 39 rear-end collisions, the truck-tractor struck the back of other vehicles 24 times and the other vehicle struck the back of the trailers 15 times. In 31 rear-end collisions not known to have occurred on an upgrade the tractor-trailer was the striking vehicle in 23 (74%). On the upgrade the tractor-trailer was the lead vehicle in 7 of 8 collisions. Thus, for fatal rear-end collisions between cars and tractor-trailers the tractor-trailer truck was more likely to have collided into the rear of a car rather than vice-versa. This is further supported in the North Carolina study (3). Of 2776 large truck (tractor-trailer or 3-axle)-car accidents the rear of the truck was the initial point of contact in 7.1% of the accidents while on the cars this was the case in 11.7% of the accidents.

b.) Of 131 fatal multi-vehicle crashes reported in reference 5, 82 (63%) involved configurations in which the tractor-trailer's braking ability may have been especially likely to play a role, e.g., overtaking other vehicle; vehicles traveling in opposite directions; other vehicle turning left, emerging from shoulder, or going through a red light. However, the data only imply braking ability is a factor not a cause, and actual brake failure was noted in only 4 of 150 collisions. The configurations chosen are arbitrary and independent of the investigating officer's opinion,

and the sample is unrepresentative.

c.) Tractor-trailer propensity to jackknife, turnover, and otherwise lose control in relation to cars is marginally reported in reference 5. Jackknifing was noted on 11 (7.3%) of the 150 fatal reports, as was loss of control due to blowouts (6%) and brake failures (2.7%). But no comparable data on cars is given. In the North Carolina study (3) better data are available and it is reported that 2.2% of the large trucks (tractor-trailer and three-axle) are involved in rollovers compared to 1.7% of cars. Also, 19.1% of the large trucks ran off the road compared to 14.8% of the cars. Thus large trucks appear to rollover and run off the road in North Carolina more often than cars.

Data Analysis.

a.) The Texas File does not list the striking or struck vehicle in a two-vehicle accident. Thus it is difficult to determine whether trucks collide into the rear of a car more often than vice versa. However, a very crude estimate can be obtained from the Large Truck File by analyzing the vehicle damage to the car and truck in car-large truck accidents where both motor vehicles are going in the same direction. In these situations the cars had front damage in 39.6% and rear damage in 60.4% of the cases. The large trucks had front damage in 73.8% and rear damage in only 26.2% of the crashes.

In the USC study, rear-end collisions were documented between commercial vehicles (GVW $\geq$ 10,000 lbs.) and non-commercial vehicles in 925 accidents. Of these, 5.7% of the collision involved non-commercial

into commercial crashes and 10.1% involved commercial into non-commercial collisions. Thus commercial vehicles are more likely to collide into the rear of a car in rear end crashes rather than vice versa.

b.) The Texas Files do not include data to effectively determine how frequently the truck's braking ability influenced car-truck collisions. However, the USC report contains detailed data on this item. In the 925 reported collisions, 7.1% of the vehicles were braking, 51.6% braking and steering, 11.5% steering and 29.8% undetermined. Thus, overall truck braking ability was a definite precrash maneuver in 58.7% of the collisions, though over 90% had no brake-caused loss of control. Of the vehicles that were braking, 3.6% had brakes inoperative, 2.7% out of adjustment and 1.9% had air loss. Wheel lock-up occurred in 20.7% of the power units and to the towed vehicle in 21.6% of the total vehicles. Parking brakes were blamed in 0.5% and the emergency stop system in 0.2% of the total vehicles.

c.) Truck propensity to jackknife, turnover, and otherwise lose control in relation to cars is summarized for the State of Texas in Table 10. Jackknifing was noted in 10.9% of the single vehicle tractor-trailer collisions, and 6.8% of similar large truck collisions. Overturn occurred in 3.1% of the car collisions but 6.8% of the large truck and 4.7% of the tractor-trailer collisions. Loss of control and hitting objects off the road, however, were more frequent in cars as compared to tractor-trailers and large trucks.

Table 10

Single Vehicle Accidents in the State of Texas*

Vehicle	Passenger Car		Large Truck		Tractor-Trailer	
	Frequency	%	Frequency	%	Frequency	%
Jackknifed	0	0.0	500	6.8	460	10.9
Overturned	2,360	3.1	500	6.8	200	4.7
Lost Control or Skidded	1,760	2.3	160	2.2	20	0.5
Hit Object off Road	35,800	47.2	2,700	36.9	1,740	41.2
Other	35,960	47.4	3,460	47.3	1,800	42.7
TOTAL	75,880	100.0	7,320	100.0	4,220	100.0

*Source: Texas 5% Accident File

The USC data indicate that commercial vehicles jackknifed in 1.6% of the cases prior to collision and 1.4% after collision. Overturn occurred to 7.1% of the trucks but only 0.7% of the other vehicles. Commercial vehicles ran off the road in 7.8% of the cases compared to 3.2% for non-commercial vehicles.

Discussion. Trucks are more frequently the striking vehicle in rear-end collisions between cars and trucks; the striking ratio being approximately two to one. In truck collisions with other vehicles the truck's braking ability plays a prominent role, but there is no representative evidence that 63% of such crashes are traceable to poor brakes. Braking however, is a definite pre-crash maneuver by trucks in the majority of accidents. Trucks are more unstable than cars and thus tend to have a greater propensity to jackknife and turnover. Loss of control is also slightly more frequent in trucks than cars.

The instability of trucks, when they are subjected to lateral accelerations is a characteristic of that type of vehicle. Trucks are larger than cars, weigh more and carry heavier loads, and they usually have a much higher center of mass than cars. Yet trucks are legally limited in maximum width (96 to 102 in. in most states) and therefore they are more likely to acquire a lateral overturning moment of sufficient magnitude to tip the vehicle than are cars. In fact, it is virtually impossible to turn over most modern automobiles in a turn on a flat surface, regardless of forward speed.

The question then becomes a philosophical one: is the tradeoff between the large truck as a means of distributing merchandise and supplies more cost effective than some other (as yet undefined) method of distribution. In considering this question, one factor of concern is, obviously, the relative instability of large trucks limited as they are in geometry. But another facet is the accurate determination of the significance of the problem in the overall transportation network. This question has never been addressed, and probably will not be until an effective means of nationally sampling accidents and determining exposure is constructed.

2.8 - HYPOTHESIS 8

> Trucking is the most costly, in terms of lives, of all the freight modes, four times more costly than railroads, which are the next most costly.

Background. The reference from which this statement was derived is not readily available but may stem from a report by the National Transportation Safety Board entitled "Fatality Rates for Surface Freight Transportation 1963 to 1968." In this report deaths per billion ton miles were recorded for petroleum pipeline (.011), marine (.31), rail (2.5), and highway (10.9) freight modes. As is evident, trucking, in terms of lives, is most costly, 4.4 times more costly than railroads, which are the next most costly.

The above data, however, came from many varied sources and was then combined. In particular, trucking reflected only Federally

regulated interstate carriers which generated from 36 to 39% of the highway ton-miles. The data source was the Bureau of Motor Carrier Safety report on accidents of large motor carriers (operating revenues of $200,000 or more). Thus the death rate for trucks represented only the Federally regulated highway freight death rate. And fatalities included all persons killed as a result of the transportation of freight such as persons in other vehicles, pedestrians, and vehicle operators.

Railroad deaths included all those killed in non-train accidents and in an accident involving a passenger train and another type of train. Marine deaths included all deaths in water transportation, whether on inland waterways or the high seas. The water rate may be understated because the estimate of total ton-miles included ton-miles estimated for foreign water traffic. "Foreign" ton-miles are, of course, non-existent in the other federally regulated surface freight transportation mileage reports. Petroleum transport related fatalities were estimated from a press release by the American Petroleum Institute.

Data Analysis. This statement cannot be evaluated from available data in the Texas files or USC report.

Discussion. In light of the various data sources describing different types of fatalities by different modes of transportation, caution is needed in interpreting H8. Trucking may be most costly in terms of lives, more costly even than railroads, but without adjusting for the differing environment exposures among the modes, such comparisons are inadequate. Surely trucks are exposed to many more accident

situations than any other transportation mode. But if one were to compare the fatal involvement rates of the various modes, railroads would be highest since their accidents, while fewer in number, are more likely to produce a fatality as compared to trucks. Based on information obtained in 1963-68, fatalities per ton-mile were highest in interstate trucking which was four times higher than in railroads. However, until consistent data collection is available among all freight modes, H8 should not be taken as fact.

2.9 - HYPOTHESIS 9

> Trucks are more likely to kill other highway users: two-thirds of the people killed in crashes involving trucks are other highway users.

Background. The source reference for this statement was unavailable. However, reference 6 contains a report on large truck accidents in the state of Texas for 1973. Of 347 fatalities in crashes involving large trucks and cars, 316 (91.1%) of the persons killed were occupants of the car. In the Maryland report (3), 113 (94.2%) of 120 fatalities in tractor-trailer-car collisions were occupants of the car. In a separate Maryland report (4) involving 1440 fatal crashes of motor vehicles in Maryland during 1970 and 1971, 125 (82.8%) of the 151 death vehicles involving tractor-trailers and cars were cars.

Data Analysis. From the Texas Fatal File there were 441 deaths in large truck-car collisions in 1974. Of these deaths 61.5% (271) were to non-large truck occupants. Also, there were 337 deaths in car-tractor-

trailer crashes, of which 76.0% (256) of the persons killed were non-tractor-trailer occupants. In the USC study there were 3 deaths in the trucks and 17 deaths in the cars so that 85% of the deaths were to other highway users.

Discussion. It is not surprising that occupants of cars are more likely to sustain greater injury than occupants of a large truck, in the event of a conflict between the two. First of all, the purpose of a car is to transport people; that of a truck is to transport goods, supplies and equipment. Thus, there is a propensity for more car occupants to be exposed to hazard in an accident than truck occupants. Secondly, trucks are heavier than cars--a 72,000 GVW truck has 16 times greater kinetic energy and linear momentum than a 4500 lb. car traveling at the same speed. If an impulsive force of the same magnitude was applied to each system to reduce the forward speed, a considerably smaller velocity change would be produced in the truck than in the car. Occupants of the truck would not experience nearly as severe a disruption in motion as occupants of the car in this circumstance.

It appears then that H9 is a conservative statement and could be restated as follows: The available data indicate that 60% to 85% of the people killed in large truck-car collisions are occupants of the car. Thus other highway users are more likely to be killed in such collisions than are truck occupants. Note, however, that no data is available to determine if trucks, due to such factors as vehicle defects, driver errors, or vehicle size, actually caused these deaths or if

other factors, such as the environment, the other vehicle, or the other driver, contributed to the accidents.

2.10 - HYPOTHESIS 10

> For each truck occupant fatality in crashes involving trucks, there are 30 to 40 other highway users killed.

Background. The source of this statement was not available. However, in reference 1, based on reports of 19 state traffic authorities, the number of occupant fatalities is listed for trucks and other highway users. In 1974, there were 26,600 occupant fatalities in passenger cars, 4,900 fatalities in trucks, and 4,900 occupant deaths in other vehicles (motorcycles, buses, etc.). In this definition truck includes both large and small trucks. Thus for every truck occupant fatality there were 5.4 car occupants killed, and 6.4 highway users killed.

Assuming the number of truck occupant fatalities is the same for each fatal accident in which a truck is involved, there were 1790 fatalities in truck tractor and semi-trailers and other truck combinations. Thus, for every large truck occupant fatality there were 14.9 car occupants killed and 17.6 highway users killed.

Data Analysis. The number of fatalities in tractor-trailers in Texas in 1974 was 81, while the number of fatalities in all vehicles other than tractor-trailers was 2,939. Thus for each truck occupant fatality in crashes involving tractor-trailers in Texas, there were approximately 36 occupant fatalities in all other vehicles.

Discussion. The hypothesized statement must be viewed with some degree of caution since fatality rates of truck occupants and non-truck occupants are not compared. Further, the data observed relate all types of fatality accidents for all types of vehicles. No comparisons are included for specific accident types, crash configurations, or vehicle types. The Texas accident data do support H10 when all fatalities from all types of vehicles in all accidents are considered, i.e., when all traffic fatalities are totaled. However, approximations made from references (1) and (2) indicate only 6 to 18 other highway users are killed for each truck fatality in crashes involving trucks.

2.11 - HYPOTHESIS 11

> a.) Some studies have shown that fatal collisions of cars with tractor-trailers resulted in occupant deaths in the cars 10 times as high as in trucks.
> b.) Other studies have shown that a tractor-trailer accident is three times more likely to result in a fatality than a passenger car accident.

Background.

a.) In H11a, the Maryland report (5) was the source reference. It showed that in 101 collisions between tractor-trailers and cars or station wagons, 55.9% of the car occupants died while only 6.0% of the tractor-trailer occupants died. Thus the occupant death rate in the cars was 9.3 times as high as in the tractor-trailers. The hypothesized statement is somewhat incorrect in that it refers to actual deaths but means death rates.