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16. Abstract

This study examines six general classes of truck regulations in terms of their impacts on urban freeway safety and traffic operations. The truck restrictions and regulatory practices examined were: 1) Lane restrictions; 2) Time-of-day restrictions; 3) Speed restrictions; 4) Route restrictions; 5) Driver licensing and certification programs; and 6) Increased enforcement of existing regulations. Of the six classes of regulations examined, only two appear capable of producing any substantial improvement in the safety and operational aspects of truck usage of urban freeways in Texas. Reduced speed limits, either for all vehicles or trucks only, appear to merit consideration on a trial basis. In terms of long-term actions, the areas of driver licensing/training and incident management techniques should be emphasized.

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TRUCK OPERATIONS AND REGULATIONS

ON URBAN FREEWAYS

By

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Research Report 338-1F

Statewide Evaluation of Truck Operations
and Regulations on Urban Freeways
Research Study Number 2-10-83-338

Sponsored by

State Department of Highways and Public Transportation
in cooperation with the
U. S. Department of Transportation, Federal Highway Administration

TEXAS TRANSPORTATION INSTITUTE
The Texas A&M University System
College Station, Texas 77843

August 1984

METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

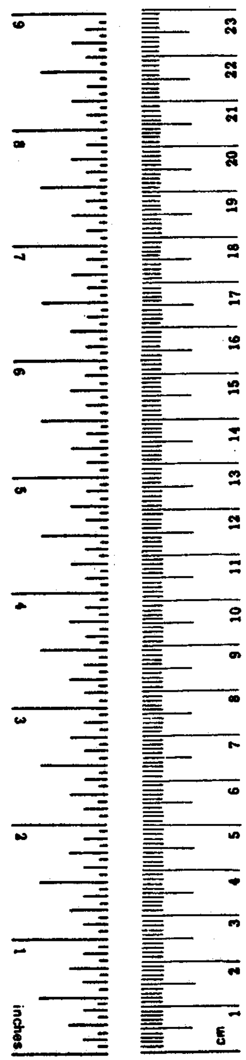
Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
in	inches	2.54	millimetres	mm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
	AREA			
in^2	square inches	645.2	millimetres squared	mm^2
ft^2	square feet	0.0929	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
mi^2	square miles	2.59	kilometres squared	km^2
ac	acres	0.395	hectares	ha
	MASS (weight)			
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
	VOLUME			
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.0328	metres cubed	m^3
yd^3	cubic yards	0.0765	metres cubed	m^3

NOTE: Volumes greater than 1000 L shall be shown in m^3.

TEMPERATURE (exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

* SI is the symbol for the International System of Measurements



APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
	AREA			
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
km^2	kilometres squared	0.39	square miles	mi^2
ha	hectores (10 000 m^2)	2.53	acres	ac
	MASS (weight)			
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T
	VOLUME			
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
m^3	metres cubed	1.308	cubic yards	yd^3

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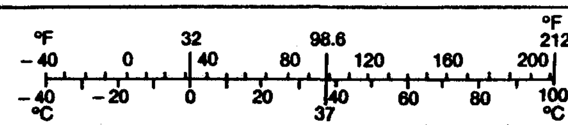

These factors conform to the requirement of FHWA Order 5190.1A.

ABSTRACT

This study examines six general classes of truck regulations in terms of their impacts on urban freeway safety and traffic operations. The truck restrictions and regulatory practices examined were: 1) Lane restrictions; 2) Time-of-day restrictions; 3) Speed restrictions; 4) Route restrictions; 5) Driver licensing and certification programs; and 6) Increased enforcement of existing regulations. Of the six classes of regulations examined, only two appear capable of producing any substantial improvement in the safety and operational aspects of truck usage of urban freeways in Texas. Reduced speed limits, either for all vehicles only, appear to merit consideration on a trial basis. In terms of long-term actions, the areas of driver licensing/training and incident management techniques should be emphasized.

DISCLAIMER

SUMMARY

Six regulations with the potential to improve the safety and operational aspects of truck operations on urban freeways in Texas were examined in this study. Table S-1 summarizes these regulations in terms of actions required, limitations, and probable impacts. A general assessment of the applicability of each regulation to urban freeways in Texas is presented in the following summary.

1. Lane Restrictions. Based on consideration of the constraints and limitations associated with lane restrictions, it is the conclusion of this study that the restriction of truck traffic to one mix flow lane probably would not improve freeway safety or operations. There are variations of this regulation that could be considered, however. The prohibition of truck traffic in the left lane would be acceptable for roadways of 3 or more lanes. For roadways of 4 or more lanes, trucks may be restricted to the two right lanes, except to pass. These two alternatives could be applied throughout the freeway networks in major Texas Cities, except at some interchange areas, where "lane drops" require trucks to travel in lanes other than the extreme right or left-lane. However, preliminary results from a Florida study suggest that the overall effects of this type of restriction on freeway operations and safety are negligible.

2. Time-of-Day Restrictions. It is the conclusion of this study that prohibiting all trucks from the freeway network, either totally for some sections or for peak periods only, would not contribute to improved safety. Such regulations could increase truck travel, encourage the use of roadways of lower design standards, and create a truck storage (parking) problem.

Table S-1. Summary of Impacts.

ACTION	CONSTRAINTS/LIMITATIONS	IMPACTS
Lane Restrictions	o Lane drops at freeway-freeway interchanges limit application. o Could be difficult to enforce. o Could accelerate pavement deteriorations. o Could reduce visibility of overhead signing (if trucks were restricted to outside lanes).	o For freeway segments with lane drops,would concentrate lane changes in short section of freeway. o Would increase merging conflicts (if trucks were restricted to outside lane).
Time-of-Day Restrictions	o Truck traffic peaks do no coincide with typical commuter peaks. o Could be difficult to enforce. o Could be challenged on legal basis (e.g., alleged interference with interstate commerce).	o Negligible impact on operating speeds. o Could divert trucks to other less congested time periods, or other, lower quality roadways. o Could negatively impact trucks that must travel during restricted period(s).
Speed Restrictions	o Differential speed limits for trucks and non-trucks could be difficult to enforce. o Could require extensive enforcement program. o May require use of innovative detection, apprehension, and citation strategies.	o Reduction in speed (differentials) could have positive safety impacts.
Route Restrictions	o Efficient routing plan could not exclude freeways.	o Negligible impact on safety and operations. o Could have positive impacts if applied to transport of hazardous materials.
Driver Training/ Certification	o Requires strict application and enforcement of regulations.	o Short-term impacts minimal. o Long term impacts could be significant.
Increased Enforcement of Existing Regulations	o Would require additional enforcement personnel. o Could require incorporation of enforcement requirements in design/re-design of freeways.	o Increased enforcement could lead to increased compliance with traffic laws. However, there is no conclusive proof that increased compliance reduces accidents.

3. Speed Restrictions. It is the conclusion of this study that lower speeds on urban freeways could improve safety and operations. Three general types of speed restrictions were considered. They are: 1) Reduced speed limits for all vehicles; 2) Reduced speed limits for trucks only; and 3) Strict enforcement of existing speed limits. Regardless of which of the three options is used, a major effort in law enforcement would be required.

4. Route Restrictions. Since the efficient routing of trucks would certainly include the freeway system, this particular type of restriction would probably have little or no effect on freeway safety and operations. However, route restrictions could be beneficial in controlling the transport of hazardous materials.

5. Driver Licensing/Certification. It is the conclusion of this study that recent revisions to the Texas driving statute on truck drivers could substantially improve the safety of truck operations on urban freeways in Texas. However, the impacts of the changes are probably long-term in nature. Much depends upon how stringently the new regulations are applied and enforced.

6. Enforcement. It is the conclusion of this study that, with the possible exception of more stringent enforcement of existing speed limits, the restrictions evaluated in this study would be difficult to enforce on most urban freeways in Texas. Enforcement problems relating to detection, apprehension, and citation of violators may only compound the existing problem.

Though this study presents no conclusive findings regarding regulations or restrictions to improve the safety or operational aspects of truck traffic on urban freeways, several general recommendations are offered. In terms of their implementation and probable effects, these recommendations can be classified as either short-term or long-term in nature.

Short-term recommendations are:

1. Institute a strong speed enforcement program on all urban freeways.

2. Consider on a trial basis a speed limit reduction of 5 to 10 mph for all vehicles.

3. Consider on a trial basis a speed limit reduction of 5 to 10 mph for trucks only. Such demonstration projects could be limited to critical freeway sections of sufficient length to measure driver compliance with the speed reduction.

4. Consider on a trial basis the prohibition of trucks on the inside lane(s) of the freeway. Since the inside lanes are, by the rules of the road, generally the faster lanes, prohibiting trucks in these lanes could result in a reduction in truck speeds. One freeway route through an urban area could be designated for the demonstration.

Long-term recommendations are:

1. The provision of interactive warning devices to alert truck drivers of unusual conditions.

2. Improvements in accident control units responding to freeway accidents

3. Stringent enforcement and monitoring of driver licensing procedures.

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CONTENTS (Cont.)

1. INTRODUCTION

1.1 PROBLEM STATEMENT

The transportation of goods and services in urban areas, interacting with other traffic on public thoroughfares, can create or aggravate a variety of transportation problems. For example, over the past several years, a number of spectacular truck-related accidents have occurred on urban freeways in Texas. Many of these accidents have resulted in loss of life and all have caused massive traffic congestion. As a result, local leaders are seriously discussing implementing some type of restriction on truck travel. However, the question remains: What, if any, truck regulations could be effective in improving the safety and operations of urban freeways in Texas.

1.2 STUDY OBJECTIVES

The overall objective of this study is to identify problems associated with trucks on urban freeways in Texas and examine regulations directed at reducing the adverse impacts of truck traffic.

Specific objectives are:

1. Identify truck traffic characteristics and problems on urban freeways in Texas;
2. Survey existing truck regulations being imposed by Federal, State and Local governments;
3. Develop a comprehensive list of alternative truck regulations;
4. Assess the impacts of these truck regulations on traffic operations, safety, the environment, and commerce;
5. Evaluate driver-related factors influencing truck operations and safety; and
6. Identify possible test regulations for evaluation on one or more urban freeways in Texas.

2. TRUCK USAGE OF URBAN FREEWAYS IN TEXAS

2.1 TRAFFIC VOLUMES

Tables 1-4 summarize the results of two recent truck studies conducted by the Texas Transportation Institute (TTI) on urban freeways in the Houston, San Antonio, and Dallas/Fort Worth areas[1]. The information presented in Tables 1-4 suggests several important trends regarding truck usage of urban freeways in Texas. For example, for the Houston freeways studied, trucks typically account for only about 5% of the peak hour and peak period traffic volumes (Tables 1 and 2). Notice in Table 3 that for the Houston freeways studied the peak hour for truck traffic does not coincide with the commuter peak period. Generally, truck traffic tends to peak "mid-morning" between 9 and 11 a.m., and "mid-afternoon" between 12 and 3 p.m. These general trends suggest that trucks either simply avoid the congested commuter peaks or that the nature of their operations is such that their travel demands are greatest during the off-peak periods. The second possibility seems to be the more likely of the two.

On a daily basis, the State's major north-south and circumferential (loop) freeways have the highest percentages of truck traffic. Truck traffic on these facilities typically accounts for 11-15% of daily traffic (Table 4). Truck traffic on the State's east-west freeways typically accounts for about 5-8% of daily traffic (Table 4).

The distributions of truck traffic by lane shown in Table 4 suggest that trucks prefer the middle lanes of a freeway. This seeming preference for the middle lanes could be attributed to several operational factors. For

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[1] See Appendix A for detailed listings of the data summarized in this section

Table 1. Trucks[a] as a Percent of Peak Hour Traffic on Houston Freeways.

Freeway and Location	Direction	Peak Hour	Peak Hour Vol.		Percent Trucks
			Trucks	Non-trucks	
US 59S (between Kirby & Shepherd)	SB[b]	4-5 pm	120	6250	1.9
US 59S (between Kirby & Shepherd)	NB[c]	5-6 pm	285	7105	3.8
I-45N (at Little York)	SB	6-7 am	165	4980	3.2
I-45N (at Little York)	NB	6-7 pm	195	4315	4.4
I-45S (at Monroe)	SB	6-7 pm	105	3775	2.7
I-45S (at Monroe)	NB	6-7 am	110	4805	2.2
W. Loop I-610 (at Buffalo Bayou)	SB	7-8 am	160	6560	2.4
W. Loop I-610 (at Buffalo Bayou)	NB	2-3 pm	425	6965	5.8
I-10W (at Bunker Hill)	EB	6-7 am	160	5200	3.0
I-10W (at Bunker Hill)	WB	12-1 pm	340	4450	7.1
I-10E (between Holland & Mercury)	EB	5-6 pm	170	2985	5.5
I-10E (between Holland & Mercury)	WB	11-12 am	315	2525	11.0
E. Loop I-610 (at Buffalo Bayou)	SB	5-6 pm	320	4185	7.1
E. Loop I-610 (at Buffalo Bayou)	NB	4-5 pm	495	3510	12.4
Total			3365	67610	4.7

[a]Truck defined as vehicle with 3 or more axles (exclusive of buses).
[b]SB = Southbound
[c]NB = Northbound

Table 2. Truck[a] as a Percent of Peak Period Traffic on Houston Freeways.

Freeway and Location	Direction	Peak Period[b]	Peak Period Traffic		Percent Trucks
			Trucks	Non-trucks	
US 59S (between Kirby & Shepherd)	SB[c]	3-6 pm	390	18325	2.1
US 59S (between Kirby & Shepherd)	NB[d]	4-7 pm	700	18470	3.7
I-45N (at Little York)	SB	5-8 am	555	12560	4.2
I-45N (at Little York)	NB	5-8 pm	515	11710	4.2
I-45S (at Monroe)	SB	5-8 pm	305	10180	2.9
I-45S (at Monroe)	NB	5-8 am	300	11105	2.6
W. Loop I-610 (at Buffalo Bayou)	SB	6-9 am	460	17325	2.6
W. Loop I-610 (at Buffalo Bayou)	NB	1-4 pm	1035	18630	5.3
I-10W (at Bunker Hill)	EB	5-8 am	460	10960	4.0
I-10W (at Bunker Hill)	WB	11-2 pm	1090	12425	8.1
I-10E (between Holland & Mercury)	EB	4-7 pm	545	7920	6.4
I-10E (between Holland & Mercury)	WB	10 am-1 pm	900	6955	11.5
E. Loop I-610 (at Buffalo Bayou)	SB	4-7 pm	830	11085	7.0
E. Loop I-610 (at Buffalo Bayou)	NB	3-6 pm	1380	9210	13.1
Total			9465	176860	5.1

[a]Truck defined as vehicle with 3 or more axles (exclusive of buses).
[b]Peak Period assumed = Peak Hour ± 1 hr.
[c]SB = Southbound
[d]NB = Northbound

Source: Vehicle Distribution Study, TTI, August 1983.

Table 3. Peak Hour Traffic Volumes on Houston Freeways

Freeway and Location	Direction	Trucks[a]				Non-Trucks			
		A. M.		P. M.		A. M.		P. M.	
		Pk. Hr	Vol.	Pk. Hr.	Vol.	Pk. Hr.	Vol.	Pk. Hr.	Vol.
US 59S (between Kirby & Shepherd	SB	10-11	305	2-3	215	11-12	5115	4-5	6250
US 59S (between Kirby & Shepherd)	NB	10-11	245	2-3	330	8-9	6980	5-6	7105
I-45N (at Little York)	SB	9-10	425	2-3	435	6-7	4980	1-2	4050
I-45N (at Little York)	NB	9-10	450	12-1	415	11-12	3695	6-7	4315
I-45S (at Monroe)	SB	11-12	405	1-2	290	11-12	3340	6-7	3775
I-45S (at Monroe)	NB	10-11	345	2-3	345	6-7	4805	3-4	3365
W. Loop I-610 (at Buffalo Bayou)	SB	10-11	330	2-3	325	7-8	6560	6-7	6400
W. Loop I-610 (at Buffalo Bayou)	NB	10-11	355	2-3	425	8-9	5875	2-3	6965
I-10W (at Bunker Hill)	EB	10-11	410	2-3	395	6-7	5200	3-4	4225
I-10W (at Bunker Hill)	WB	9-10	455	1-2	335	8-9	4245	6-7	4555
I-10E (between Holland and Mercury)	EB	9-10	410	1-2	300	11-12	2220	5-6	2985
I-10E (between Holland and Mercury)	WB	9-10	340	2-3	325	11-12	2525	4-5	2160
E. Loop I-610 (at Buffalo Bayou)	SB	10-11	620	3-4	455	6-7	2925	5-6	4185
E. Loop I-610 (at Buffalo Bayou)	NB	10-11	520	2-3	660	6-7	3470	4-5	3510

[a]Truck defined as vehicle with 3 or more axles (exclusive of buses).

Source: Vehicle Distribution Study. TTI, August 1983.

example, by traveling in the middle lanes, the truck driver has more freedom to maneuver. Also, in the case where the freeway design incorporates an inside median barrier, the truck driver may choose to travel in one of the middle lanes because these lanes may be perceived as providing greater lateral clearance. Finally, since truck traffic is frequently through-traffic, trucks may prefer the middle lanes to avoid conflicts with vehicles entering or exiting the freeway. Figure 1 shows a summary of the distribution of truck traffic by lane ddd time of day for the three metropolitan areas combined.

Table 4. Percentage Trucks[a] By Lane (5 a.m. - 10 p.m.)

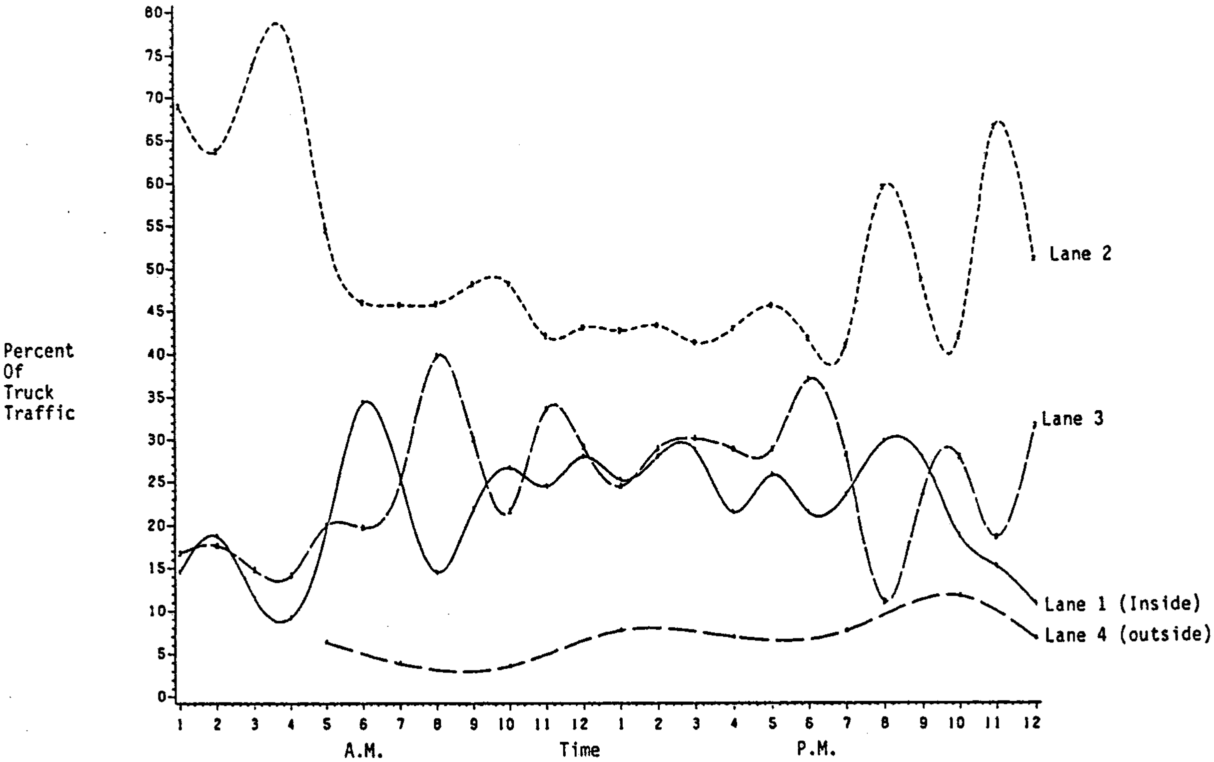
City/Location	Lane 1 (inside)	Lane 2	Lane 3	Lane 4 (outside)	Total (all lanes)
Dallas:					
I-30E at Loop 12 (inbound)	3.9%	6.8%	8.4%	5.0%	6.2%
I-35E at Valley View (inbound)	3.3%	7.6%	8.3%	---	6.4%
I-45S at I-635S (inbound)	8.4%	18.5%	13.8%	---	14.9%
Fort Worth:					
I-35W at Northside Dr. (inbound)	7.5%	8.0%	7.0%	---	7.6%
Houston:					
East Loop I-610 at Buffalo Bayou (southbound)	9.2%	12.2%	17.6%	15.0%	13.6%
I-10W at Dairy Ashford (inbound)	5.5%	8.2%	3.9%	---	6.1%
I-45N at N. Belt (inbound)	4.3%	8.7%	7.0%	---	6.7%
US 59S at Bellaire (inbound)	3.7%	5.5%	3.1%	---	4.3%
San Antonio:					
Loop 410 at McCullough (westbound)	1.2%	2.0%	1.1%	---	1.4%
I-10W at Huebner (inbound)	4.2%	5.2%	---	---	4.7%
I-35N at Loop 1604 (inbound)	7.1%	13.6%	---	---	11.0%

[a]Truck defined as vehicle with 3 or more axles (exclusive of buses).

Source: Truck Operations Study. TTI, July 1983.

In examining truck usage of Texas freeways it is useful to consider the relative traffic volumes of the truck types which constitute the truck population. Figure 2 summarizes the average percentages of light and heavy trucks on urban freeways in Houston, San Antonio, and Dallas/Fort Worth. As shown in Figure 2, heavy trucks are the major constituent of the truck population in the Texas cities studied.

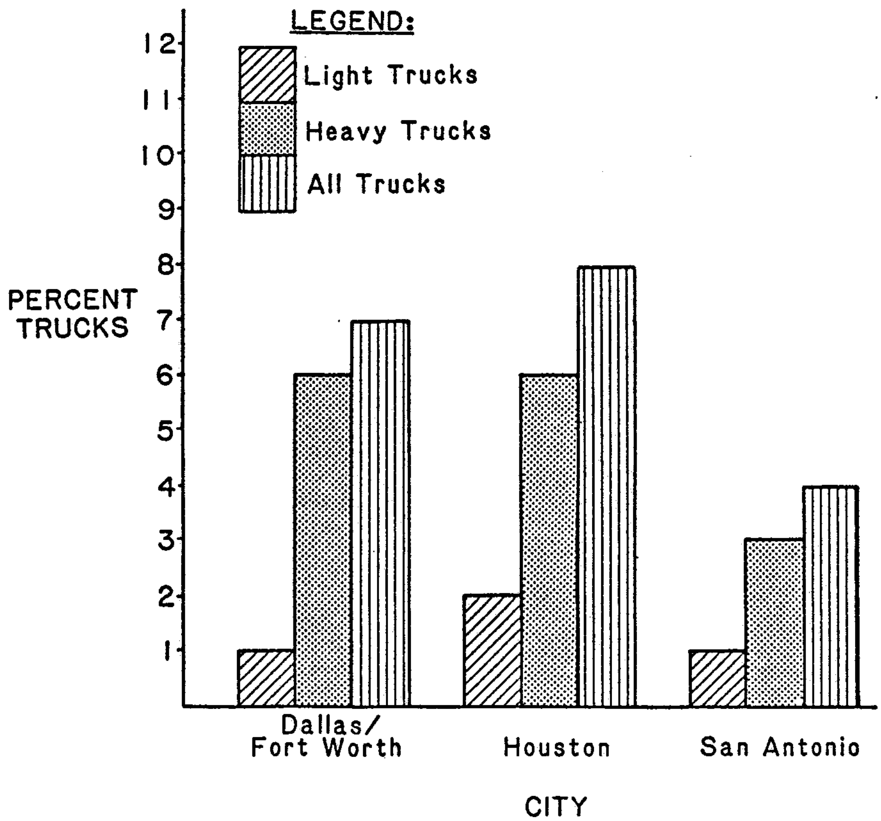
Though discussion of potential truck regulations is deferred until Section 4, some preliminary observations can be drawn from Tables 1-4 regarding the types of regulations which could be considered. First, trucks typically account for only about 5% of the peak hour and peak period traffic on



Source: Truck Operations Study. TTI, July 1983.

Figure 1. Combined Distribution of Truck Traffic by Lane for Three Metropolitan Areas in Texas.

the major freeways studied. Consequently, even a complete prohibition of trucks on urban freeways would probably have little effect on peak period freeway operations. Second, truck traffic tends to concentrate on the middle lanes of a freeway. Considering the performance capabilities of trucks, the middle lanes would seem to be the most desirable travel lanes. Consequently, when considering possible lane restrictions for truck traffic, the performance capabilities of trucks need to be considered. Third, peak hour and peak period truck traffic typically consumes less than one lane of freeway capacity. Hence, restricting truck traffic to a single lane could result in an under-utilization of available capacity as passenger vehicles may tend to avoid the lane.



Source: Truck Operations Study. TTI, July 1983.

Figure 2. Light and Heavy Trucks as a Percentage of Total Weekday Freeway Traffic in Three Metropolitan Areas in Texas.

2.2 SPEEDS

Since state agencies no longer compile speed data by vehicle type, no comprehensive state-wide data on relative truck speeds is available. However, by using data from two recent truck speed studies conducted in Houston it is possible to develop a general picture of truck operating speeds. While the speed data were collected in Houston, a number of freeways were studied and it does not appear to be unreasonable to assume that the results are representative of truck speeds in other major Texas cities.

In March and April of 1984, TTI conducted off-peak period speed studies on five radial freeways and at three locations on the I-610 Loop Freeway in Houston. Speeds of trucks and non-trucks were estimated by measuring travel times over distances ranging from 500 to 1000 ft. The speed data were collected on a per-lane basis.

A sample of 1502 trucks and 700 non-trucks was taken on the five radial freeways in approximately 24 hours of observations. All of the radial freeway study sites were outside the I-610 Loop Freeway. A sample of 155 trucks and 565 non-trucks was taken at the three I-610 study sites. Tables 5-8 and Figures 3 and 4 summarize the study results.

As shown in Table 5, the average speed of the 1502 trucks sampled on the five radial freeways was 54 mph, with an 85th percentile speed of 60 mph. The average speed of the 700 non-trucks sampled was 60 mph, with an 85th percentile speed of 65 mph. On the average, 38% of the trucks sampled were exceeding 55 mph, though considerable variation exists between the study sites. For the non-trucks in the sample 78% were exceeding 55 mph.

Table 5. Off Peak Speeds On Five Radial Freeways in Houston

Freeway and Location	Direction	TRUCKS No. of Veh.	TRUCKS % > 55	TRUCKS Avg. Speed (mph)	TRUCKS 85th % - ile Speed (mph)	NON-TRUCKS No. of Veh.	NON-TRUCKS % > 55	NON-TRUCKS Avg. Speed (mph)	NON-TRUCKS 85th % - ile Speed (mph)
1. US 290 Between Mangum and 34th Street	WB	115	10	50	59	---	---	---	---
2. US 290 Between Mangum and 34th Street	EB	144	29	52	58	120	92	61	66
3. US 290 Between Hollister and Tidwell	WB	129	59	58	67	120	85	60	65
4. US 290 Between Hollister and Tidwell	EB	114	55	56	60	---	---	---	---
5. IH 45 Between College and Monroe	NB	119	4	49	53	---	---	---	---
6. IH 45 Between College and Monroe	SB	120	35	53	60	---	---	---	---
7. US 59 Between Bissonnet and Gessner	NB	105	47	55	64	120	87	61	67
8. US 59 Between Bissonnet and Gessner	SB	112	39	54	61	100	95	65	73
9. IH 45 Between Tidwell and Parker	NB	132	15	49	55	---	---	---	---
10. US 59 Between Cross-timbers and Laura Koppe	NB	169	72	59	64	120	73	59	64
11. US 59 Between Crosstimbers and Tidwell	NB	120	43	56	61	---	---	---	---
12. US 59 Between Crosstimbers and Tidwell	SB	123	52	56	60	120	36	54	58
Totals		1502	38	54	60	700	78	60	65

NOTE: Speed limit is 55 mph at all study locations.

Source: TTI Survey, March-April 1984.

Table 6. Off-Peak Speeds by Lane of Travel on Five Radial Freeways in Houston.

Freeway and Location	Direction	TRUCKS Average Speeds (mph)				NON - TRUCKS Average Speeds (mph)			
		Lane 1 (inside)	Lane 2	Lane 3	Lane 4 (outside)	Lane 1 (inside)	Lane 2	Lane 3	Lane 4 (outside)
1. US 290 Between Mangum and 34th Street	WB	54	52	48	45	---	---	---	---
2. US 290 Between Mangum and 34th Street	EB	59	56	48	47	63	61	60	60
3. US 290 Between Hollister and Tidwell	WB	63	60	55	47	62	61	60	57
4. US 290 Between Hollister and Tidwell	EB	61	55	54	---	---	---	---	---
5. IH 45 Between College and Monroe	NB	50	48	46	---	---	---	---	---
6. IH 45 Between College and Monroe	SB	56	54	47	---	---	---	---	---
7. US 59 Between Bissonnet and Gessner	NB	62	55	43	---	62	62	61	---
8. US 59 Between Bissonnet and Gessner	SB	59	54	46	---	68	66	61	
9. IH 45 Between Tidwell and Parker	NB	48	49	49	---	---	---	---	---
10. US 59 Between Cross-timbers and Laura Koppe	NB	63	58	56	---	63	56	57	---
11. US 59 Between Cross-timbers and Tidwell	NB	58	54	52	---	---	---	---	---
12. US 59 Between Cross-timbers and Tidwell	SB	58	54	54	---	57	52	52	---
Totals		57	54	50	46	63	60	58	58

NOTE: Speed limit is 55 mph at all study locations.

Source: TTI Survey, March-April 1984.

Table 7. Off-Peak Speeds on I-610 in Houston.

Location	Direction	TRUCKS				NON-TRUCKS			
		No. of Veh.	% > 55	Avg. Speed (mph)	85th %-ile Speed (mph)	No. of Veh.	% > 55	Avg. Speed (mph)	85th %-ile Speed (mph)
1. S. Loop IH 610 Between Long and Telephone	EB	25	84	61	67	95	97	65	72
2. S. Loop IH 610 Between Long and Telephone	WB	44	59	56	66	76	75	61	69
3. E. Loop IH 610 Between Mesa and Wallisville	SB	29	76	57	59	91	51	56	59
4. E. Loop IH 610 Between Mesa and Wallisville	NB	25	100	65	68	95	100	64	68
5. N. Loop IH 610 Between Ella and Shepherd	EB	15	80	60	65	105	64	57	63
6. N. Loop IH 610 Between Ella and Shepherd	WB	17	70	56	63	103	69	58	64
Totals		155	76	59	65	565	76	60	66

NOTE: Speed Limit is 55 mph at all study locations.

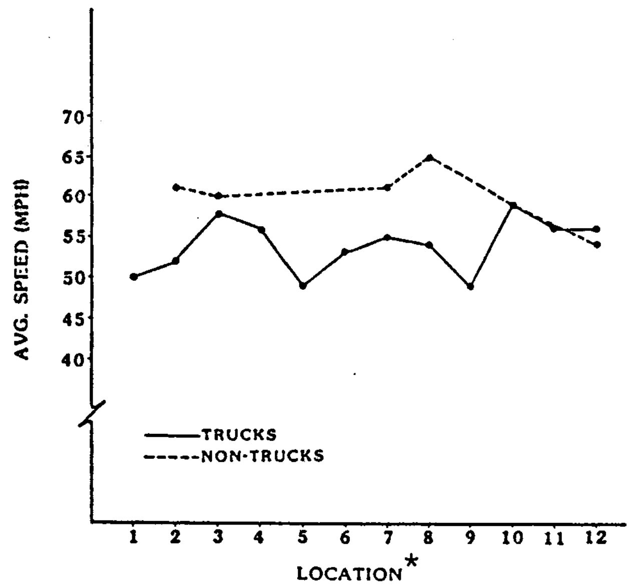
Source: TTI Survey. March-April 1984.

Table 8. Off-Peak Speed by Lane of Travel on I-610 in Houston.

Location	Direction	TRUCKS Average Speeds (mph)				NON-TRUCKS Average Speeds (mph)			
		Lane 1 (inside)	Lane 2	Lane 3	Lane 4 (outside)	Lane 1 (inside)	Lane 2	Lane 3	Lane 4 (outside)
1. S. Loop IH 610 Between Long and Telephone	EB	64	64	60	58	70	68	64	61
2. S. Loop IH 610 Between Long and Telephone	WB	61	59	47	--	64	64	54	--
3. E. Loop IH 610 Between Mesa and Wallisville	SB	57	56	54	--	58	56	55	52
4. E. Loop IH 610 Between Mesa and Wallisville	NB	66	63	64	56	66	64	63	61
5. N. Loop IH 610 Between Ella and Shepherd	EB	62	56	--	56	59	58	56	51
6. N. Loop IH 610 Between Ella and Shepherd	WB	58	60	52	48	59	58	56	54
Totals		61	60	55	55	63	61	58	56

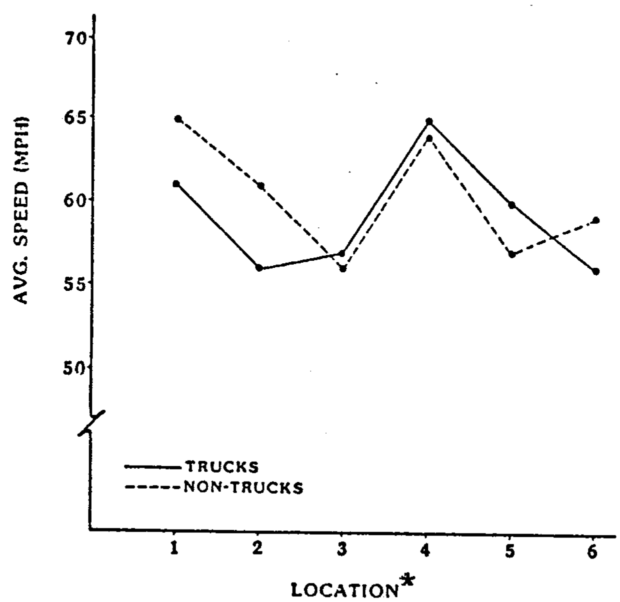
NOTE: Speed limit is 55 mph at all study locations.

Source: TTI Survey. March-April 1984.



* See Table 5 for description of location codes.

Figure 3. Average Off-Peak Speeds on Five Radial Freeways in Houston.



* See Table 7 for description of location codes.

Figure 4. Average Off-Peak Speeds on the I-610 Loop Freeway in Houston.

The speeds on the five radial freeways were sampled by lane on a random basis. Thus, the sample data reflect the distributions of volumes and speeds by lane. Table 6 summarizes the distributions of average speed by lane for the five radial freeways sampled. The distribution of average speeds by lane for each vehicle type (i.e., trucks and non-trucks) follow a pattern consistent with the basic rules of the road. That is, the slower traffic for each vehicle type appears to be concentrated in the outside lanes, while the higher speed traffic tends to be on the inside lanes of the freeway.

Table 7 summarizes the off-peak speeds for trucks and non-trucks as sampled at three locations on the I-610 Freeway. The average and 85th percentile speeds for the trucks in the sample were 59 mph and 65 mph, respectively. The average speed for the non-truck traffic sampled was 60 mph with an 85th percentile speed of 66 mph. The percentage of vehicles traveling in excess of 55 mph was 76% for both vehicles types (i.e., trucks and non-trucks). The distributions of average speed by lane and vehicle type at the I-610 study sites (Table 8) exhibit the same general trend as observed on the radial freeways; that is, a tendency for average speeds to increase from the outside to the inside lanes of the freeway.

The data from the Houston speed studies suggest that, on the average, truck speeds do not differ substantially from those of non-trucks. Based on the sample percentages of vehicles traveling in excess of 55 mph, it would appear that trucks are less likely to exceed the speed limit than are non-trucks, at least on the radial freeways studied. In fact, with a 5 to 7 mph leeway for enforcement, only 10 to 12 percent of the trucks sampled on the radial freeways would be considered in violation of the 55 mph speed limit.

The concern for high speed on urban freeways, however, is with the ability of the trucks to maneuver and take evasive action when conditions require. With the traffic volumes that exist on most urban freeways during the daytime off peak period, the room to maneuver is critical. The trends are for the volumes to increase, which will restrict movement but not greatly reduce speeds. Though the speeds of trucks and non-trucks may not differ substantially, the performance capabilities of the two vehicle types are substantially different. That is, in terms of their performance capabilities, truck speeds may well be excessive for the prevailing freeway conditions.

The Houston Area Transportation Safety Association (HATSA) conducts safety patrols and makes observation reports on truck operations and driver performance within the Houston Area. The organization is composed of member trucking companies operating in or through the Houston Metropolitan Area. The members are brought together in a cooperative effort by the increasing traffic congestion and the problems created by the overcrowding of the roadway systems which they have to use. The purpose of the organization, as stated in its Constitution, is to "promote the safe and uninterrupted transportation of hazardous materials in the Houston, Harris County, Texas Area".

The Association has adopted the following four-point program to aid in the accomplishment of its stated objectives:

1. Through assistance to and cooperation with the various public safety organizations, to provide for the needed emergency response in the event of a transportation-related emergency.

2. Through cooperative information programs to provide for the enactment and enforcement of logical, effective laws and ordinances to promote safety on the highway system throughout the area.

3. Through an ongoing public information program, keep the public informed of the positive nature of their activities and the professionalism of their industry.

4. Through mutual aid programs, to provide for the improvement of safety activities within the member companies. These programs include a cooperative training effort, cooperative road observations and a continuing transfer of information for the betterment of the industry.

Tables 9-11 summarize the data from the HATSA observation reports for the period between June 1982 and June 1983. Since the reports were compiled by various individuals it is recognized that no uniform standards for reporting driver violations were applied. However, these reports were made by individuals knowledgeable of the trucking industry, usually a carriers safety supervisor.

As shown in Table 9, the most frequently observed violation was excessive speed. Nearly 32% of the trucks observed were found to be traveling in excess of the posted speed limit[2]. The speed was determined by either "tracking" the truck or by use of radar. A review of the reports indicated that some observers would indicate a speed violation at any speed above the posted speed while others might allow in excess of 5 mph before indicating a speed violation.

Table 10 presents a cross tabulation of the HATSA data in terms of posted vs observed speeds. The data in Table 10 indicate that nearly 25% of the trucks observed were exceeding the posted speed limit by at least 10 mph. Since no comparable data were collected for non-trucks it is not known if the excessive speed violations observed by HATSA represent a significant speed differential between trucks and non-trucks. However, as shown in Table 9, the second most frequently reported violation was "follows too close". This would suggest that a substantial number of trucks are traveling at speeds which could be considered excessive for the prevailing traffic conditions.

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[2] Notice that this value is in agreement with the 38% violation rate reported in Table 5 (p. 9).

Table 9. Summary of HATSA Safety Reports: Truck[a] Driver Violations

Driving Violation	Number		Percent	
	Observations	Violations	Observations	Violations
1. None Observed	269	--	45.8	--
2. Excessive Speed	185	185	31.5	58.2
3. Follows Too Close	67	67	11.4	21.1
4. Weaving	12	12	2.0	3.8
5. Blocks Traffic	2	2	0.3	0.6
6. Pass on Hill	1	1	0.2	0.3
7. Pass on Curve	1	1	0.2	0.3
8. Pass Intersection	--	--	--	--
9. Improper Passing	6	6	1.0	1.9
10. Does Not Signal	34	34	5.8	10.7
11. Improper Turn	--	--	--	--
12. Signal Violation	--	--	--	--
13. Sign Violation	--	--	--	--
14. Improperly Parked	1	1	0.2	0.3
15. Passenger	1	1	0.2	0.3
16. Cuts In	8	8	1.4	2.5
Total	587	318	100.0	100.0

[a]i.e. 18-wheelers

Source: Houston Area Transportation Safety Assoc. (June 1982-June 1983)

Table 11 presents information relating to the highway location of the observation and the type of violation, if any. More than 60% of the trucks observed were traveling on the I-610 Loop. The proportion of trucks observed speeding on the Loop was about 32%, approximately the same as for all observations. However, nearly 60% of all the observed speeding violations were observed on the Loop. The results of the TTI speed studies (see Tables 5 and 7) also indicate a higher percentage of speed violations on the Loop than on the radial freeways.

Table 10. HATSA Safety Reports: Observed Truck[a] Speed vs Posted Speed.

Posted Speed	Observed Speed										
	0-19	20-29	30-39	40-44	45-49	50-54	55-59	60-64	65-70	+70	
Less than 20											
20											
25											
30			1								
35		1	1	1	2						
40							1				
45				2		4	2	1			
50					2	2		1			
55	7		4	5	11	55	139	139	109	4	120
Total	7	1	6	8	15	61	142	141	109	4	494

Observed speed > posted speed by 10 or more mph.

[a]i.e. 18-wheelers.

Source: Houston Area Transportation Safety Assoc. (June 1982-June 1983).

In summary, the results of the TTI and HATSA studies indicate that trucks (and non-trucks) are traveling at speeds in excess of the posted limit on most Houston freeways. This certainly was not unexpected. However, the possibility that almost one-third of the trucks may be speeding on some of the most congested freeways in the state should be of major concern in attempting to develop any effective truck regulations.

Table 11. HATSA Safety Reports: Location of Observation and Truck Driver Violations.

Location	Violation Code[a]																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
I-45 N	8	5	3	-	-	1	1	-	-	2	-	-	-	3	-	1	24
I-45 S	30	12	8	-	-	-	-	-	-	4	-	-	-	-	-	1	55
I-10 W	20	19	2	3	1	-	-	-	-	3	-	-	-	-	-	-	48
I-10 E	14	17	4	1	-	-	-	-	-	3	-	-	-	-	-	-	39
I-610 N	27	24	6	2	-	-	-	-	-	2	-	-	-	-	-	-	61
I-610 S	73	46	23	3	-	-	-	-	1	12	-	-	-	-	1	6	165
I-610 W	24	13	10	2	-	-	-	-	-	1	-	-	-	-	-	1	51
I-610 E	47	27	4	1	-	-	-	-	1	-	-	-	1	-	-	1	82
US 59 N	2	3	2	1	-	-	-	-	2	2	-	-	-	-	-	1	13
US 59 S	4	9	3	-	-	-	1	-	1	-	-	-	-	-	-	-	18
US 290 W	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	2
US 90 W	5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
US 90 E	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
SH 225	3	2	-	-	-	-	-	-	1	-	-	-	-	-	-	-	6
SH 288	7	7	-	-	-	-	-	-	1	-	-	-	-	-	-	-	15
Total	268	185	65	13	1	1	2	0	7	30	0	0	1	3	1	11	588

[a]1 = None Observed
2 = Excessive Speed
3 = Follows to Close
4 = Weaving
5 = Blocks Traffic
6 = Pass on Hill
7 = Pass on Curve
8 = Pass Intersection
9 = Improper Passing
10 = Does Not Signal
11 = Improper Turn
12 = Signal Violation
13 = Sign Violation
14 = Improperly Parked
15 = Passenger
16 = Other

Source: Houston Area Transportation Safety Assoc. (June 1982-June 1983).

2.3 HEADWAYS

A common complaint of trucks on urban freeways is 'tailgating' or following too close. As noted in the preceding section, the HATSA Safety Report lists this violation as the second most frequently observed at 21.1 percent. Table 9. A study of vehicle headways in a lane restriction project in Florida also determined that trucks follow automobiles more closely than automobiles follow trucks. Section 3.2.

Vehicles that follow too close are in violation of the V.C.S. 6701d Article 6, Section 61a.

2.4 ACCIDENTS

Of approximately 145 million motor vehicles in operation in this country today, nearly 7 million are trucks with empty gross vehicle weights of 10,000 pounds or more. When these trucks are "involved" in accidents with the passenger cars in the traffic stream, the results can be disastrous. Although heavy trucks comprise less than 2% of the vehicle population, they were involved in accidents which accounted for almost 9% of all traffic fatalities in 1976. Of these, 91% were persons in other vehicles which conflicted with the trucks. More recent statistics for the State of Texas indicate that trucks were involved in 3% of the total number of accidents which accounted for 9% of all traffic fatalities for the period 1979-81.

The problem is further complicated by an increasing polarization of the vehicle mix into very small cars and very large trucks. The trend toward smaller, more efficient passenger cars is evident. In 1963, automobiles made up 84.3% of the total vehicle fleet and included about 8% autos with registered vehicles weights of 3,000 pounds of less. By 1978, autos were down to 79% of the vehicle total and the small car portion had risen to 22%. The percentage of automobiles is expected to further decrease to 75% with more than 50% of those having registered weights of less than 3,000 pounds.

2.4.1 State Wide-Overview

In 1983 there were 5,786 truck related accidents on freeways in Houston, San Antonio, and the Dallas/Fort Worth area. Table 12 presents a summary of these accidents by city and accident severity. Table 13 shows a comparison of the truck accident rates for the three metropolitan areas examined. As shown in Table 13, the Houston freeways appear to have a substantially higher truck

Table 12. Truck Related Accidents for Three Metropolitan Areas in Texas by Accident Severity (1983).

Severity / Area	Non-Injury	Possible Injury	Non-Incapacitating	Incapacitating	Fatal	Total
Dallas/Fort Worth	1659 28.67 67.00 41.23	374 6.46 15.11 46.46	325 5.62 13.13 44.77	93 1.61 3.76 51.67	25 0.43 1.01 49.02	2476 42.79
Houston	2306 39.85 71.61 57.31	413 7.14 12.83 51.30	389 6.72 12.08 53.58	86 1.49 2.67 47.78	26 0.45 0.81 50.98	3220 55.65
San Antonio	59 1.02 65.56 1.47	18 0.31 20.00 2.24	12 0.21 13.33 1.65	1 0.02 1.11 0.56	0 0.00 0.00 0.00	90 1.56
Total	4024 69.55	805 13.91	726 12.55	180 3.11	51 0.88	5786 100.00

Legend:

FREQUENCY
TOT %
ROW %
COL %

Table 13. Freeway Vehicle Miles of Travel (VMT) and Truck Accidents for Three Metropolitan Areas in Texas.

Area	1980 Freeway VMT (Millions)		1983 Truck Accidents[c]		Truck Accidents/ 100 Million VMT (Annual)	
	Daily[a]	Annual[b]	Fatal	Total	Fatal	Total
Dallas/Fort Worth	22.55	5637	25	2476	0.44	43.9
Houston	18.40	4601	26	3220	0.57	70.0
San Antonio	7.12	1779	0	90	----	5.1

[a]Source: Lomax, T.J. and D.L. Christiansen, Estimates of Relative Mobility in Major Texas Cities, TTI Res. Rept. 323-1F, August, 1982, p. 37.

[b]Estimated from 250 X Daily VMT.

[c]Source: Table 12.

accident rate than those in Dallas/Fort Worth. Recall from the previous discussion that the average percentage of trucks on the urban freeways in Houston and Dallas/Fort Worth is approximately equal (see Figure 2). Hence, the differences in accident rates shown in Table 13 for Houston and Dallas/Fort Worth are probably attributable to factors other than exposure rates. Notice, however, that the vehicle miles of travel (VMT) measures and the accident data are from different years. Consequently, the accident rates shown in Table 13 should be viewed as only a general indication of the relative rates between the cities studied.

In discussing the safety aspects of truck operations it is important to consider the relative safety records of the truck types which make up the truck population. Table 14 summarizes total truck-related accidents for Houston, San Antonio, and Dallas/Fort Worth by truck type (i.e., 18-wheelers vs other trucks). An interesting observation which can be drawn from Table 14 is that over two-thirds of the fatalities, and nearly 80% of total truck-related accidents, involved trucks other than 18-wheelers. This observation is particularly interesting when one considers that there are considerably more 18-wheelers in the traffic stream than other, smaller trucks (see Figure 2, p. 7). The data in Table 14 seems to suggest that 18-wheelers have a relatively better safety record than other trucks.

An examination of truck-related accidents by location within the freeway cross-section is important in terms of evaluating the safety effects of lane restrictions which might be imposed on truck traffic. Table 15 shows a summary of truck-related accidents by location for the cities of Houston, San Antonio, and Dallas/Fort Worth combined. As shown in Table 15, almost one-third of the truck related accidents where the specific location of the acci-

Table 14: Summary of Truck-Related Accidents for Three Metropolitan Areas in Texas by Truck Type and Accident Severity (1983).

Accident Severity \ Truck Type	Eighteen Wheelers	Other Trucks	Total
Non-injury	823 14.22 20.45 69.80	3201 55.32 79.55 69.48	4024 69.55
Possible Injury	146 2.52 18.14 12.38	659 11.39 81.86 14.30	805 13.91
Non-Incapacitating	161 2.78 22.18 13.66	565 9.76 77.82 12.26	726 12.55
Incapacitating	33 0.57 18.33 2.80	147 2.54 81.67 3.19	180 3.11
Fatal	16 0.28 31.37 1.36	35 0.60 68.63 0.76	51 0.88
Total	1179 20.38	4607 79.62	5786

Legend:

FREQUENCY
TOT %
ROW %
COL %

Table 15. Summary of Truck-Related Accidents for Three Metropolitan Areas in Texas by Accident Severity and Location (1983).

Accident Severity \ Location	Inside Lane	Middle Lane(s)	Outside Lane	Ramps and Shoulders	Total
Non-Injury	48 7.54 11.68 61.54	127 19.94 30.90 62.56	166 26.06 40.39 70.04	70 10.99 17.03 58.82	411 64.52
Possible Injury	14 2.20 14.89 17.95	29 4.55 30.85 14.29	32 5.02 34.04 13.50	19 2.98 20.21 15.97	94 14.76
Non-Incapacitating	13 2.04 13.98 16.67	33 5.18 35.48 16.26	31 4.87 33.33 13.08	16 2.51 17.20 13.45	93 14.60
Incapacitating	3 0.47 10.71 3.85	7 1.10 63.64 3.45	7 1.10 25.00 2.95	11 1.73 39.29 9.24	28 4.40
Fatal	0 0.00 0.00 0.00	7 1.10 25.00 3.45	1 0.16 9.09 0.42	3 0.47 27.27 2.52	11 1.73
Total	78 12.24	203 31.87	237 37.21	119 18.68	637 100.00

NOTE: Data are for those accidents where the specific location of the accident was reported.

Legend:

FREQUENCY
TOT. %
ROW %
COL. %

dent was reported occurred in the middle lane(s) of the freeway. Since truck traffic tends to concentrate on the middle lane(s) this finding is not surprising. A more useful finding, in terms of lane restriction considerations, is that 37% of the truck-related accidents occurred in the outside lane of the freeway. In fact, nearly 56% of the truck-related accidents occurred on the outside lane and the ramp and shoulder areas of the freeway.

2.4.2 Truck Accidents on Houston Freeways

As noted in the previous section, Houston freeways appear to have a higher truck accident rate than freeways in the Dallas/Fort Worth area. In this section truck accidents on Houston freeways are examined in detail.

A survey of 12 Houston freeways found that 20,397 accidents occurred during 1979. Of these accidents, 3,686 (18.1%) involved trucks. Table 16 summarizes the accident data for the 12 freeways studied. As shown in Table 16, accident rates varied from a low of about 13% for the West Loop of I-610 to a high of about 30% for the East Loop of I-610.

Average annual daily traffic (AADT) and the percent of trucks on each freeway were obtained from counts made at permanent stations during the summer of 1978. These volumes can be compared with truck related accidents to investigate the frequency of truck related accidents relative to their exposure on the freeways. Table 17 summaries data from eight Houston freeways from which a comparison of exposure rates and accidents can be made. Unweighted averages indicate that trucks were involved in 18.5% of all accidents while they only contributed 5.9% of total traffic.

Table 16. Truck Accident Experience on Houston Freeways, 1979.

Freeway	Length of Freeway Miles	Total Number Accidents	Number Involving Trucks	Percent Truck Accidents
Katy I-10	17.9	2231	435	19.5
East I-10	11.9	1537	404	26.3
North I-45	18.3	2529	492	19.5
Gulf I-45	14.7	2775	395	14.2
Southwest U.S. 59	15.6	3299	437	13.2
Eastex U.S. 59	18.6	1774	350	19.7
North Loop I-610	6.0	496	153	30.8
East Loop I-610	13.8	1791	407	22.7
South Loop I-610	10.6	1755	265	15.0
West Loop I-610	7.0	1660	216	13.0
Pasadena S.H. 290	4.2	30	9	30.0
Northwest U.S. 290	3.2	520	123	23.6
Total	141.8	20,397	3,686	18.1

Note, however, that the data presented in Table 17 does not explicitly account for the vehicle miles of travel (VMT) of the truck population relative to other vehicles. Data from a 1975 Urban Mass Transportation Administration (UMTA) Study[3] indicate that trucks typically account for about 14% of total urban freeway VMT. Using the UMTA data and the accident percentages given in Table 17 two aggragate "accident factors" can be calculated as defined below.

Truck Accident Factor = % of Truck Accidents/ % VMT by Trucks

Non-Truck Accident Factor = % Non-Truck Accidents/ % VMT by Non-Trucks

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3 Urban Goods Movement Demonstration Project Design Study. A.T. Kearney Inc, Nov. 1975.

Table 17. Truck Accident Experience on Houston Freeways

Freeway	Volume (1978)		Accidents (1979)	
	AADT	Percent Trucks	Number Involving Trucks	Percent of Total Accidents
Katy I-10	163,090	5.6	435	19.5
North I-45	128,750	5.1	492	19.5
Gulf I-45	155,340	4.6	395	14.2
Southwest U.S. 59	214,720	4.7	437	13.2
North Loop I-610	159,360	6.6	407	22.7
East Loop I-610	110,970	11.7	496	30.8
South Loop I-610	136,370	4.8	265	15.1
West Loop I-610	215,620	4.0	216	13.0
Unweighted Average		5.9		18.5

The resulting truck accident factor is 1.32 (18.5% / 14%) and the non-truck factor is 0.95 (1-.185 /1-.14). The ratio of the truck to non-truck factors suggests that truck accidents are about 40% higher than for non-trucks.

Using the same sets of data for 1978 and 1979 the temporal distribution of truck accidents can be examined. Figure 5 shows the vehicle distribution by time-of-day for 9 Houston freeways based on 1978 count data. Typical morning and evening peaks can be observed for non-truck traffic (mostly autos). The high morning peak hour begins at about 7:00 a.m. while the high evening peak hour begins at about 4:00 p.m. Truck traffic, however, rises early in the morning, stabilizes after 8:00 a.m., and gradually declines after 5:00 p.m.

Figure 6 shows the accident distribution by time of day for 9 Houston freeways, based on a sample of 1979 accident reports. Like vehicle distribution, non-truck accidents rise rapidly early in the morning and peak after 7:00 a.m. Non-truck traffic accidents peak again between 4:00 p.m. and 6:00 p.m. The distribution of truck accidents is somewhat more uniform, without the pronounced peaks of non-truck traffic. However, they rise rapidly from early morning hours until about 8:00 a.m., when they increase more gradually.

Notice that truck accidents seem to increase toward the late afternoon hours while truck volumes do not. One possible explanation for this increase in truck related accidents in the afternoon involves the general operating conditions of the freeway during this time period. Notice in Figures 5 and 6 that truck related accidents tend to peak as total traffic volumes increase. During periods of high total volume and relatively high travel speeds, it seems reasonable to expect an increase in the numbers of total and truck-related accidents.

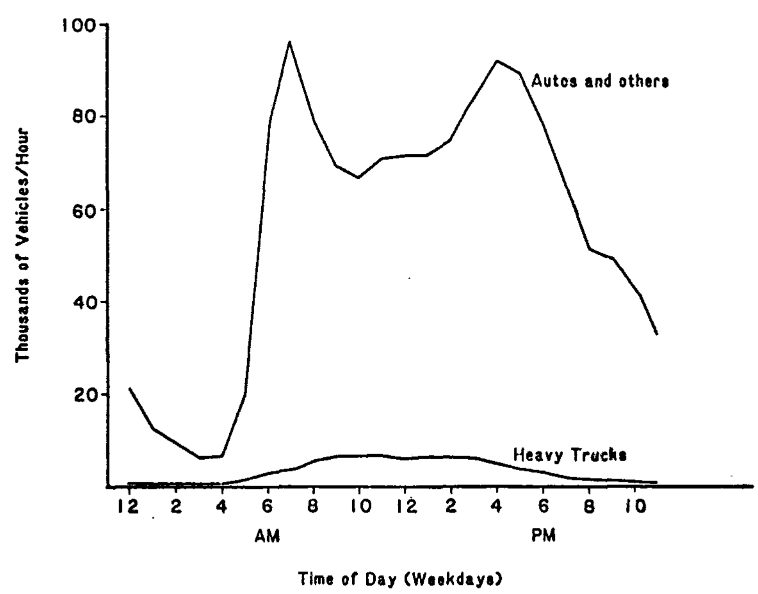

Figure 5. Vehicle Distribution for Nine Houston Freeways (1978).

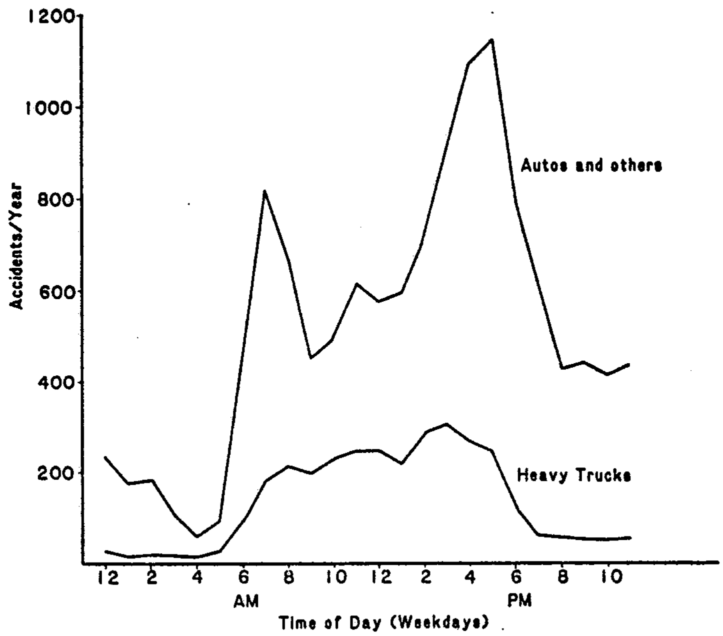

Figure 6. Vehicle Accidents for Nine Houston Freeways (1979).

3. REVIEW OF REGULATORY PRACTICES

3.1 LITERATURE REVIEW

An automated literature search was conducted to retrieve publications dealing with truck related problems and truck restrictions/regulations on urban freeways. The Transportation Research Information Service was used. Pertinent references are summarized in Appendix B, Section B.1.

Of the more than 100 publications which were reviewed, only one paper dealt directly with urban freeway truck problems, regulations, or restrictions. This report was produced by the National Transportation Safety Board in 1978 and described the investigation of a multiple vehiclecollision involving a tractor-semitrailer [B.1(1)]. The accident occurred on I-285 in Atlanta on June 20, 1977. The existing prohibition of through trucks inside the Atlanta Loop is partially a consequence of this incident.

Transportation of hazardous materials was adddressd in four publications. Battelle Memorial Institute described its assessment of the risk associated with transporting gasoline by truck [B.1(2)]. Another publication presented the legal aspects of a maximum age and increased physical requirements for drivers of hazardous cargoes [B.1(3)]. The third publication described the results of a safety effectiveness evaluation conducted by the National Transportation Safety Board [B.1(4)]. This effort assessed the effectiveness of federal and state enforcement efforts regarding hazardous materials transported by truck. A fourth publication followed up on work done by an AASHTO task force which investigated the movement of hazardous materials on highways and what States were doing in this area [B.1(5)].

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* Denotes Appendix Section and reference number.

A series of articles assessed the involvement of and severity associated with trucks in accidents [B.1(6-20)]. Three other articles discuss operational and design practice involving trucks [B.1(21-23)].

In terms of the safety-related objectives of this study, the literature review revealed the following:

1. Since 1974 (the year of the introduction of the 55 mph speed limit) there has been a significant increase in the proportion of front-to-rear crashes involving an automobile and tractor trailer in which the tractor trailer struck the automobile in the rear on higher speed roads [B.1(6)]. This finding suggests that the 55 mph speed limit has had a greater effect on automobile speeds than on truck speeds.

2. In 1978, the fatal crash involvement rate for heavy trucks was twice that of passenger cars [B.1(7)].

3. Most collisions in which passenger cars strike the side or rear of tractor-semitrailers occur at night [B.1(8)].

The literature on driver-related factors in truck operations and safety was also reviewed. Pertinent references are summarized in Appendix B, Section B.2.

The truck regulations and licensing section (B.2.1) presents a collection of articles pertaining to present problems in programs for licensing truck drivers. Suggestions for upgrading the effectiveness of qualification and monitoring systems are also outlined. Areas of concern are related to the driver's knowledge and skill levels required to receive a license. Most articles indicate a problem with the lack of adequate regulations as well as their enforcement. Regulation topics include non-driver related factors such as truck braking and lighting systems, as well as driver related factors such as regulations restricting his or her driving hours, skills, and physical/medical related requirements. The topic of inspections as a form of monitoring and enforcing regulations is also discussed.

The driver training and safety section (B.2.2) is essentially an extension of regulations and licensing systems. The demonstration of proficiency in both written and driving skills tests is recommended as a licensing requirement. The articles contain references to several different driver training programs and methods of implementing these programs. Lack of professional training is frequently cited as a major cause of accidents. Most articles contend that truckers should have a greater level of safety education. Topics in training programs include how to handle an emergency situation, how to operate controls and safety devices, maintenance and repair, instructions in truck maneuvering, and skid control training.

The truck driver profile and performance section (B.2.3) discusses factors of the driver that relate to his/her driving performance. Studies include driver vision and audition, fatigue, decision-making capabilities, awareness levels, drug and alcohol factors, sleep and rest requirements, and physical/medical requirements.

The fourth section of the driver-related portion of the literature review (Section B.2.4) is comprised of two types of articles. The first type addresses accident investigation reports. Information presented generally includes the number of fatalities and injuries, the amount of property damage, the types of vehicles involved, the environmental circumstances, a description of the accident, and most importantly, the probable cause of the accident. Causes of accidents listed range from truck defects to driver error.

The second type of accident material presented is studies summarizing causes of accidents and available truck related accident statistics. Collision factors in the data analysis include truck size, weight, speeds, structure, safety devices, braking systems, times of day, day of the week, road type, accident type and severity, injury and fatalities, driver

driver characteristics (both physical and mental) as contributory factors in accidents, and cost of property damage resulting from accidents.

The fifth section of the review (Section B.2.5) is concerned with the transport of hazardous materials. Very little literature is available. However, the hazardous material most often carried is flammable or combustible. Safety performance standards for the carrying of hazardous materials are discussed.

3.2 SURVEY OF STATE POLICIES

In order to evaluate various policies relating to truck restrictions on urban freeways, other states were surveyed by File D-10 and File D-18T of the Texas State Department of Highways and Public Transportation to identify those policies which have been in effect. The results of the D-10 and D-18T surveys are presented in detail in Appendix C.

Although forty-three states responded to the request for information, very little objective data was obtained concerning the enforceablility or effectiveness of truck restrictions and regulations in urban areas. Those states which did comment on enforceability or effectiveness gave subjective opinions generally not based on quantitative analysis.

Most of the responding states did not comment on the enforceability of the truck restrictions. Only Indiana reported success in enforcement (due to motorist adherence to posted regulations). Louisiana stated that enforcement of their lane use restrictions was practically impossible. Arkansas has reported little success in moving trucks to the leftmost lane. Kentucky reported enforcement problems due to a lack of local enforcement. In Arizona, two municipalities have had trouble passing truck ordinances concerning the transport of hazardous materials due to problems with alleged interference with interstate commerce.

The Department of Transportation for the City of Dallas conducted a study of traffic operations on sections of I-35 E and I-30 near the business district in 1983. The objectives of the study were to analyze the operational problems on these freeway sections and to recommend changes in design and operations to improve the safety and efficiency of the freeways. The study determined the following: truck volumes on these freeways range from 4 to 9%; with an average of 6%; truck accidents comprised 19% of the total; the freeways have significant weaving and capacity problems.

The study recommended several improvements, one of which was to lower the truck speed limit on the freeways. The reason for proposing this restriction is that the truck accident rate was found to be three times that of other traffic. Additionally, the difficulty in stopping and maneuvering in the high volume sections with weaving problems could be reduced by lowering truck speeds.

The study has been expanded to the entire Dallas freeway network. A study of truck accidents and costs to respond to these accidents was conducted. The City of Dallas Police Department estimated that an incident involving a truck could cost from $165 for accident investigation for a minor accident, to $4,000 to clear the roadway for an overturned 18-wheel truck. No attempt was made to estimate the costs to the general public in terms of delay.

Based on these two studies, the Transportation Committee of the City Council proposed lowering truck speed limits on all freeways as shown below.

Freeway Zone	Proposed Truck Speed Limit
Outside I-635	55 MPH
Inside Loop 12	50 MPH
Between I-635 and Loop 12	45 MPH
On I-635 From I-35 to Garland	50 MPH

The proposed truck speed limits have not been implemented as the following legal issues have not been resolved.

1. Can differential speed limits be established below the national speed limit of 55 mph.

2. Can traffic studies conducted using current procedures for establishing speed limits be used to determine these discretionary speed limits.

3. If differential speed limits for trucks are approved, would the City be required to share in the cost for signing.

The State of Florida is now conducting a traffic engineering study of the effects of prohibiting trucks with three or more axles in the median lanes of three and four lane urban freeway sections of I-95 in Broward County Florida. "Before" conditions for several traffic variables (travel time, lane occupancy, vehicle classification, speed) as well as accident statistics were collected. In the Florida study, a 25 mile section of I-95 in Broward County has been monitored since May 1982 to determine the impacts on traffic operations resulting from restricting truck traffic to the center and right lanes of a 3-lane roadway. The restrictions were imposed during a 7:00 am - 7:00 pm period each day. Thirty-eight ground mounted and overhead regulatory signs (Figure 7) were used to inform truck drivers of the restriction. Preliminary results of the study indicate the following[4]:

1. Compliance levels were close to 100%. During the first six months, only 77 citations were issued for violation of the lane restriction.

2. Total volume distribution by lane was not affected by the restriction. Truck percentage in the left lane was reduced from 0.9% to 0% of the total traffic, but automobile traffic distribution was unchanged.

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[4] Material on the Florida Study was provided by J. Temple of the Florida DOT (2/23/84).

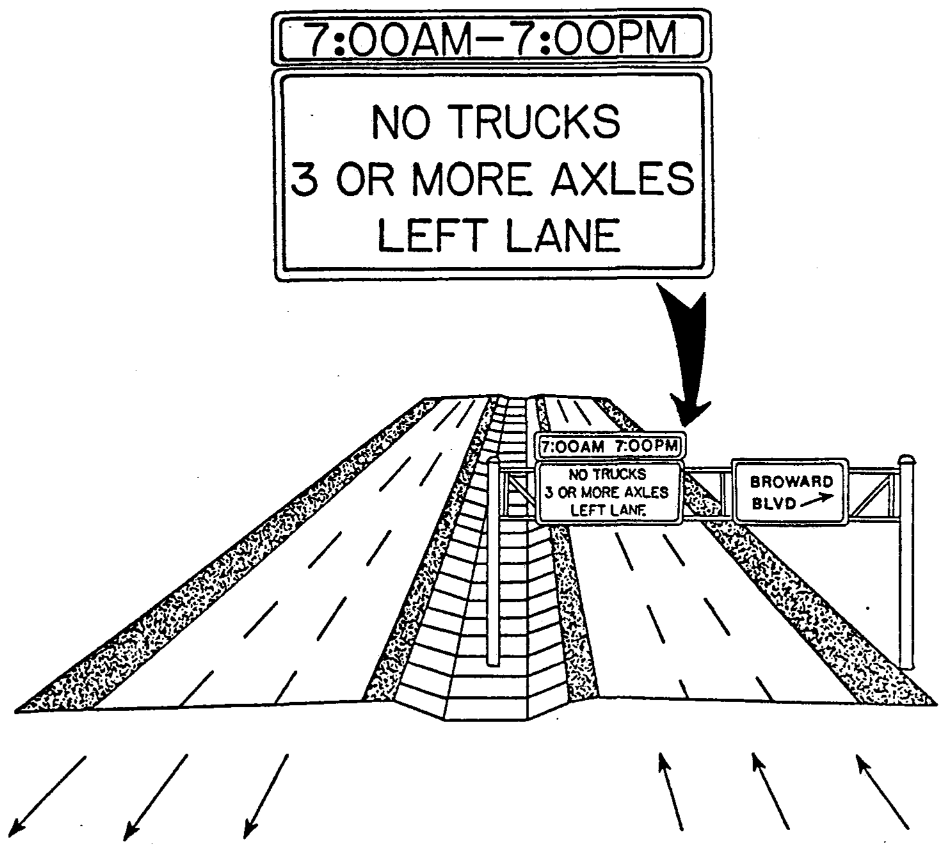

Figure 7. Overhead Regulatory Signing Used in Lane Restriction Project on I-95 in Florida.

3. Vehicle speeds changed slightly after the restrictions were implemented but less than 2 mph in most cases (Table 18). Therefore, the overall impact on speeds was negligible and cannot be attributed to the lane restriction control.

4. A study of vehicle headways in the two lanes used by trucks indicated that trucks follow automobiles more closely than automobiles follow trucks.

5. A study of merging maneuvers indicated that there was no change in the ability of the automobiles to merge onto the freeway from entrance ramps.

6. Travel times of trucks over the 25 mile section were unchanged.

7. There has been no significant change in the accident rate involving trucks.

Table 18. Speeds on I-95 Before and After Implementation of Lane Restriction.

Station	Lane	Vehicle Type	Mean Speed (Before)	Mean Speed (After)	Change	Significance of Change	85%ile Speed (Before)	85%ile Speed (After)
North	Left	Truck	63.3	NA	NA	NA	66	NA
		Auto	64.1	64.3	+0.2	NO	67	67
	Center	Truck	58.6	59.4	+0.8	NO	61	62
		Auto	59.4	60.3	+0.9	YES	63	63
	Shoulder	Truck	54.1	56.7	+2.6	YES	57	62
		Auto	56.0	58.1	+2.1	YES	60	62
Central	Left	Truck	59.5	NA	NA	NA	64	NA
		Auto	59.6	60.5	+0.9	YES	63	64
	Center	Truck	55.3	54.2	-1.1	YES	59	58
		Auto	55.8	57.1	+1.3	YES	60	61
	Shoulder	Truck	51.3	51.9	+0.6	NO	55	57
		Auto	54.0	54.4	+0.4	NO	59	60
South	Left	Truck	60.9	NA	NA	NA	64	NA
		Auto	61.7	61.4	-0.3	NO	64	64
	Center	Truck	56.7	56.5	-0.2	NO	60	59
		Auto	57.9	57.9	0.0	--	61	61
	Shoulder	Truck	50.4	53.9	+3.5	YES	59	60
		Auto	55.6	55.0	-0.6	NO	60	59

Source: Florida DOT. Feb. 1984

The conclusion drawn from the Florida studies is that this type of truck regulation on a high volume freeway (ADT = 113,460) with a typical percentage of trucks (4.2% trucks with 3 or more axles) is implementable and enforceable. However, the effects on traffic operations are inconclusive at this time, but indications are that they will be insignificant.

The results of the literature review and the survey of state policies show no conclusive evidence that truck restriction/regulations have significantly affected traffic operations or accidents in any of the states that have implemented such restrictions or regulations.

3.3 ALTERNATIVE TRUCK REGULATIONS

Based on the results of the literature review, the survey of state practices, and discussions with local officials, the following truck restrictions and regulatory practices were selected for evaluation:

1. Lane restrictions;
2. Time-of-day restrictions;
3. Speed restrictions (trucks and/or all vehicles);
4. Route restrictions;
5. More stringent driver licensing/certification procedures; and
6. Increased enforcement of existing regulations.

A general assessment of the applicability of each of these alternatives to urban freeways in Texas is presented in the following section.

4. EVALUATION OF ALTERNATIVES

4.1 LANE RESTRICTIONS

Intuitively, separation of trucks from all other vehicles on a freeway should result in safer operations. Therefore, if a lane was specified as a truck lane, and travel in that lane did not affect other traffic, then this regulation would be acceptable. However, this would require a lane physically separated from other traffic. The designation of a mixed flow lane as a truck lane has been used in other states. However, the effectiveness of this type of restriction is not known at this time.

In evaluating lane restrictions for trucks on Texas freeways the following issues should be considered.

4.1.1 Constraints, Limitations, and Impacts

The continuous frontage road design with numerous entrance and exit ramps on the right side of the freeway results in a large number of weaving and merging maneuvers on many Texas freeways. A high concentration of truck traffic in these conflict areas may adversely impact freeway operations and safety. Also, the Houston freeway network, and the Dallas and San Antonio networks to a lesser extent, have frequent freeway-to-freeway interchanges and lane drops that require trucks to travel in lanes other than the extreme right or left lanes (Figures 8-10). As noted previously (see Table 4, p. 5), truckers seem to be aware of this tend to utilize the center lanes of the freeway.

Implementation of an inside or outside lane restriction for trucks would require the establishment of transition areas before and after lane drops so

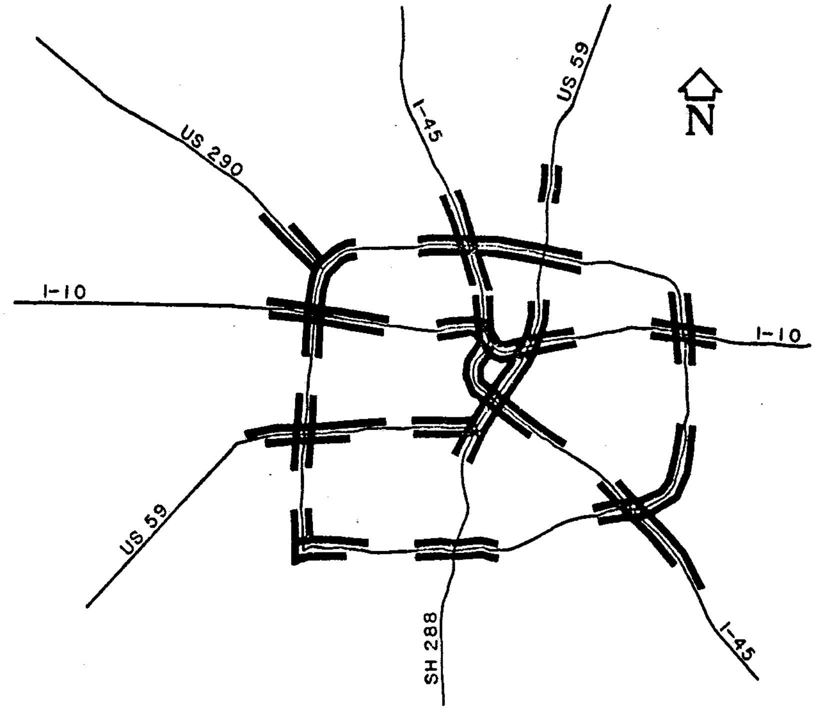

Figure 8. Sections of Houston Freeway System With "Lane Drops."

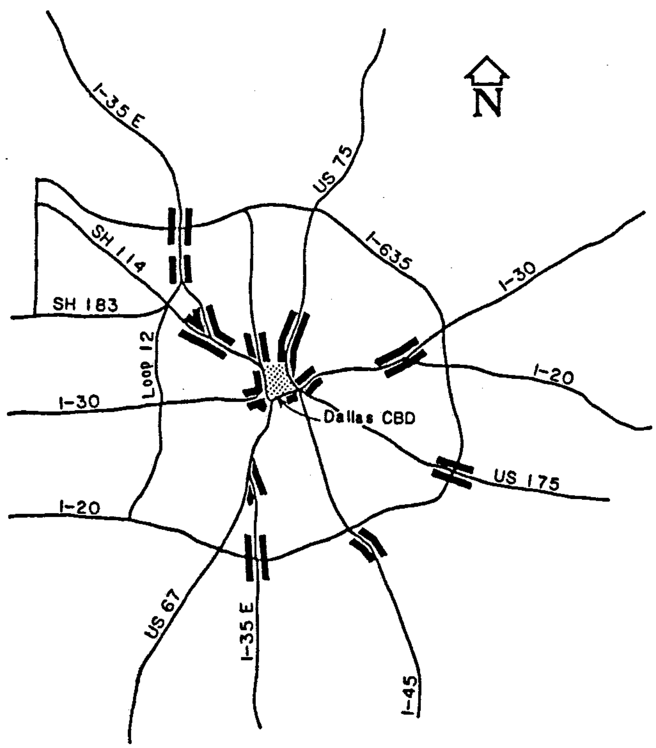

Figure 9. Sections of Dallas Freeway System With "Lane Drops".

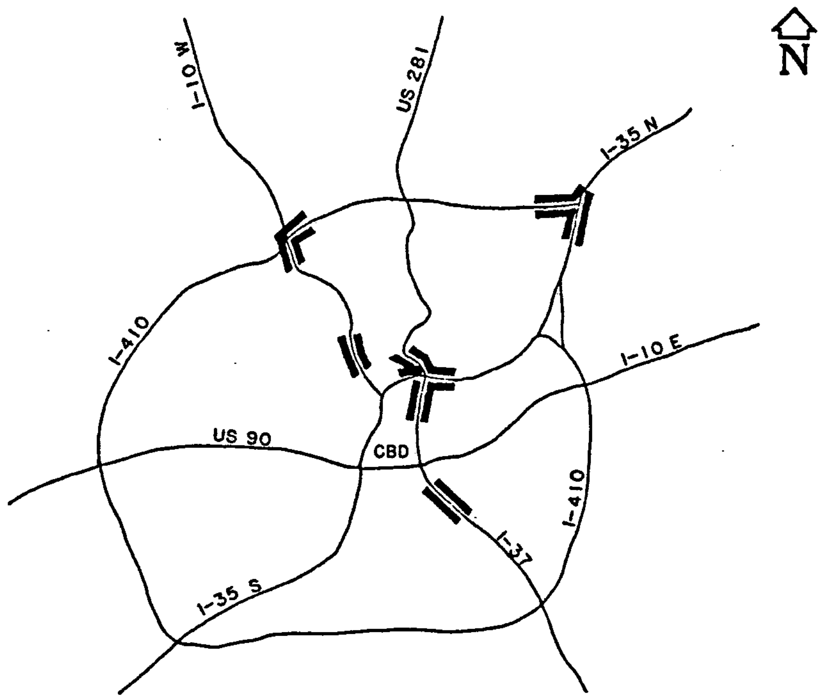

Figure 10. Sections of San Antonio Freeway System With "Lane Drops".

trucks could move to other lanes in anticipation of the lane drop. The narrowing of the roadway cross section at lane drops obviously requires traffic in the affected lane(s) to switch lanes. If truck traffic were to be restricted to the left- or right-most lanes, these lane changes would be concentrated in a short (and constricted) section of the freeway. In addition to the operational and safety problems inherent in a strategy that could result in a large number of lane changes in a relatively short distance, the necessity for transition areas in the vicinity of lane drops would certainly add to the enforcement problems associated with lane restrictions in general.

Since most exit signing is above the right lane, exiting vehicles could have the visibility of these signs reduced if there were a large number of trucks in the right lane. Compounding this problem, pavements may not be designed to accommodate the concentrated loads that would result from restricting trucks to a single lane.

In terms of the traffic safety implications of lane restrictions, only one general observation can be made at this time. As noted earlier, it appears that the majority of truck related accidents in Texas occur on the outside lanes of the freeway (refer to Table 15, p. 23). Hence, restricting truck traffic to the outer lanes may only compound the problem.

4.1.2 Assessment

Based on consideration of the constraints and limitations associated with lane restrictions, it is the conclusion of this study that the restriction of truck traffic to one mix flow lane probably would not improve the operation or safety of the freeway. There are variations of this regulation that could be considered, however. The prohibition of truck traffic in the left lane would be acceptable for roadways of 3 or more lanes. For roadways of 4 or more lanes, trucks may be restricted to the two right lanes, except to pass. These two alternatives could be applied throughout the freeway networks in major Texas cities, except at some interchange areas. However, preliminary results from a Florida study suggest that, while such restrictions may reduce truck speeds slightly, the overall effects of this type of restriction on freeway operations and safety are negligible.

4.2 TIME-OF-DAY RESTRICTIONS

Time-of-day restrictions involve prohibiting truck traffic on freeways during certain, critical time periods (e.g., during the a.m. and p.m. commuter peak periods). The basic rationale behind these restrictions is that the costs to the trucking industry due to such restrictions would be offset by the safety and operational benefits realized by non-truck traffic. The general ban of truck traffic for the primary purpose of improving safety and operations has been applied in Atlanta, but information on the effectiveness of the ban is not available at this time.

4.2.1 Constraints, Limitations, and Impacts

The specific implications of time-of-day restrictions are difficult to quantify precisely. However, several general points deserve note. First, truck traffic tends to peak at time periods between the typical a.m. and p.m. commuter peaks. Consequently, prohibiting trucks on the freeway during the commuter peaks may produce only marginal improvements in freeway traffic flow. Given the latent travel demands which exist from many urban freeways in Texas, removing trucks from the freeway during peak periods probably would not reduce peak period traffic volumes significantly. Even if latent travel demand could be disregarded, prohibiting trucks during the commuter peaks would probably reduce peak period traffic volumes by only about 5% (an average of about 250 trucks/hour/freeway for Houston freeways).

The results of a 1975 UMTA study suggest that a complete ban of truck traffic on urban freeways during daylight hours could potentially increase average network speeds by about 10 mph during the peak hours (Table 19). This estimate, of course, assumes that the additional capacity provided by the removal of trucks would not be consumed by latent travel demands. Given the latent peak period travel demands which probably exist for many urban freeways in Texas (especially in Houston) the effects of removing trucks from the traffic stream would probably be considerably less than suggested in Table 19.

The road safety benefits of time-of-day restrictions also appear somewhat questionable. For example, truck accidents (like truck traffic) tend to peak during the off-peak time periods. The fact that off-peak period opera-

Table 19. Estimated Effects of Trucks on Urban Freeway Operating Speeds

Freeway Location	Average Network Speeds (MPH)				Change in Network Speeds Without Trucks			
	Peak-Hours		Mid-Day		Peak-Hours		Mid-Day	
	w/trks.	w/o trks.	w/trks.	w/o trks.	mph	%	mph	%
CBD	28	31	30	34	3	10.7	4	13.3
Non-CBD	34	45	50	54	11	32.4	4	8.0
Total	33	44	48	53	11	33.3	5	10.4

NOTE: The estimated effects of trucks on operating speeds are based on analyses of travel data from 14 urbanized areas with populations > 1.5 million persons (1970).

Source: Urban Goods Movement Demonstration Project Design Study. Prepared for Urban Mass Transportation Administration by A.T. Kearney, Inc., November, 1975, p. d-26.

ting speeds are generally much higher than peak period speeds suggests that the real problem is speed. Prohibiting trucks on the freeway during a particular time period may merely divert truck traffic to other routes which, due to their lower design standards, are less suited to truck traffic than the freeway. Increased traffic congestion, higher accident rates, and accelerated pavement deterioration could result if truck traffic were to be diverted from the freeway to city streets. Additionally, prohibiting trucks during certain time periods may merely divert them to other less-congested time periods; conceivably producing an overall increase in the number of truck-related accidents.

Finally, the enforceability and legal issues (e.g., interference with interstate commerce) associated with time-of-day restrictions could prove to be serious obstacles in implementing such restrictions.

4.2.2 Assessment

It is the conclusion of this study that prohibiting all trucks from the freeway network, either totally for some sections or for peak periods only, would not contribute to improved safety. Such regulations could increase truck travel, encourage the use of roadways of lower design standards, and create a truck storage (parking) problem.

4.3 SPEED RESTRICTIONS

Excessive speed is frequently cited as the primary cause of traffic accidents. This factor is particularly critical for large vehicles. The problems of stopping distance and lane changing maneuvers in heavy traffic become especially serious when accompanied by excessive speed for the prevailing highway conditions.

Three general types of speed restrictions can be considered. They are:

1. Reduced speed limits for all vehicles.
2. Reduced speed limits for trucks.
3. Strict enforcement of existing speed limits for all vehicles.

4.3.1 Constraints, Limitations, and Impacts

Most truck accidents during off peak periods when speeds are high. A speed reduction for all vehicles could result in a reduction in total accdents as well as truck accidents.

The alternative of reducing trucks speeds only is more complicated. It can be argued that differential speed limits increase the accident experience. However, most of the studies that support this position were conducted on non-freeway facilities. A lower speed limit for trucks would encourage travel in the right lanes, thus combining some of the features of lane restrictions as well.

Since the institution of the 55 mph speed limit the proportion of accidents where heavy trucks rear-end autos has increased [B.1(6)]. The total number of traffic accidents, however, has decreased. The increase in the proportion of rear-end accidents suggests that trucks have not slowed-down as much as autos. This implies that the problem is one of enforcing existing speed limits, not imposing additional (or differential) speed restrictions.

Average speeds could be lowered if the enforcement agencies and the courts would agree to lower the allowable speeds in excess of the post limits. At the present time vehicles 10 mph over the posted speed limits are not being issued citations.

4.3.2 Assessment

It is the conclusion of this study that lower speeds on urban freeways could improve safety and operations. However, regardless of the type of speed restriction used, an increased level of law enforcement would be required.

4.4 ROUTE RESTRICTIONS

There are two basic types of truck routes. The first includes the designation of bypass and business routes. The primary intent of this designation is to direct through-trucks to the best available route. To the extent possible, trucks should be able to follow routes that bypass areas of intense congestion. Desirably, truckers should be able to enter an urban area and travel to any side of that urban area without being routed to areas of large-scale traffic congestion. This type of routing can be beneficial to both the carriers and the general public.

The second type of truck route is designed to guide trucks along specific roadways to downtown areas, industrial facilities, or major commercial areas. While such routings can concentrate truck volumes onto roadways designed and constructed to serve the heavier vehicles, this type of routing can increase the costs to carriers of operating in an urban area due to greater circuity in delivery and service travel patterns.

Since the efficient routing of trucks would certainly include the freeway system, this particular type of restriction would probably have little effect on freeway safety and operations. However, route restrictions could be beneficial in controlling the transport of hazardous materials.

Current procedures for routing vehicles which transport hazardous materials is to assign such vehicles to routes which minimize the risk to persons and property. In Houston, this procedure routes hazardous materials carriers along the I-610 Loop Freeway, thus by-passing the major residential and commercial areas located inside the Loop. Appendix D describes the basic procedures used in hazardous material vehicle routings and presents a sample application of the procedures for the Houston area.

4.5 DRIVER TRAINING/CERTIFICATION

A number of studies have addressed the licensing requirements for drivers of heavy trucks and the feasibility of federal licensing of these drivers. Several studies have also examined the need for uniform state licensing and permit requirements for commercial interstate truckers. Most of these studies indicate that lack of professional training is a major cause of truck accidents. Hence, more stringent licensing, training, and monitoring procedures could do much to improve the safety of truck operations on urban freeways.

In this regard, recent revisions to Texas State law governing licensing of truck drivers are of particular interest. House Bill 1273 makes the following revisions regarding the licensing of drivers of heavy trucks.

1. A person may not receive a Texas driver's license until he surrenders a license issued by another state, or a license of a different class issued by Texas.

2. Driving skill examinations must be taken in the class of vehicle for which the license is being obtained. Vehicles are classed by type and weight.

3. Drivers from States which have reciprocity with Texas may not have to take the skill examination part of the drivers license test to obtain an equivalent Texas license.

4. Those possessing current licenses in Texas are "grandfathered" without testing into the new classification of license. Thus a person possessing a Commercial Operator license would be issued a Class B license, good for four years. He gets this license whenever his old one expires.

5. The truck driver skills examination has been upgraded and scoring is more quantitative. However, only those being licensed for the first time, upgrading their license, or applying for a license from a State not having reciprocity with Texas would be affected by either the more stringent skills test or by the requirement to take that test in a vehicle representative of the class of license being applied for.

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[5] See Appendix B (Sections B.2.1 and B.2.2) for listings of recent studies in the areas of licensing and training.

6. The minimum age for licensing as a Class A or Class B driver (roughly equivalent to Chauffeur and Commercial Operator, respectively) is 17, if he or she has completed an approved driver training program. At 18, a driver may be licensed at any level.

4.5.1 Constraints, Limitations, and Impacts

The short-term impact of changes to the Texas driving statute on truck drivers will probably be minimal. However, with 80 to 100,000 upgradings of licenses occurring every year, long-term impacts may be more significant. Much depends upon how stringent the new skills tests are. Certainly the requirement to take that test in a vehicle or vehicle combination which is comparable to the vehicle which the applicant will be driving should rule out the grossly unfamiliar driver. No longer may a would-be truck driver take the test in a 1-ton straight truck and then take to the road behind the wheel of an 18 wheeler.

Meanwhile, those already licensed will go on without further evaluation. Enforcement of many of the provisions of the new law remain a question.

4.5.2 Assessment

It is the conclusion of this study that revisions to the Texas driving statute on truck drivers could substantially improve the safety of truck operations on urban freeways in Texas. However, the impacts of the changes are probably long-term in nature. Much depends upon how stringently the new regulations are applied and enforced.

4.6 ENFORCEMENT

The effectiveness of any restriction or regulation is dependent upon the extent to which those affected by the regulation comply with the stipulations of the regulation. Consequently, for a restriction or regulation to be effective it must be enforceable. Enforcement is a primary issue in assessing the potential effectiveness of the restrictions considered in this study.

4.6.1 Constraints, Limitations, and Impacts

The restrictions directed at prohibiting or limiting truck usage of freeways would be extremely difficult to enforce. Experience with concurrent flow high-occupancy vehicle lanes, for example, has shown that general lane restrictions are virtually unenforceable, particularly during peak periods. Although evidence strongly suggests a direct relationship between the presence of law enforcement personnel and traffic law compliance rates, it cannot be stated categorically that increased law enforcement has a positive road safety value. However, of the regulations, restrictions, and policies evaluated in this study, increased enforcement of existing regulations, particularly existing speed limits, appears to offer the greatest potential for improving freeway safety. The reduction in freeway accidents which could be realized from more stringent enforcement of existing speed limits could also have positive traffic flow benefits.

4.6.2 Assessment

It is the conclusion of this study that, with the possible exception of more stringent enforcement of existing speed limits, the restrictions evaluated in this study would be difficult to enforce on most urban freeways in Texas. Enforcement problems relating to detection, apprehension, and citation of violators may only compound the existing problem.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

Several truck regulations with the potential to improve freeway safety and operations have been examined in this study. The study found no convincing evidence that any of the regulations considered offer the potential to significantly improve freeway safety or operations; at least not in the short-term.

Truck lane restrictions such as limiting truck traffic to outer (right) lanes may be perceived as safer by auto through-traffic. However, preliminary analysis indicates that there may be no reduction in truck related accidents, and in fact, this action may increase overall accidents on urban freeways in Texas.

Banning trucks during peak hours has been proposed as a way to reduce peak hour accidents. Since most truck travel takes place during off-peak hours, restricting trucks during peak periods would probably have minimal effects on freeway safety and operations.

Speed regulations have been studied and perhaps offer the greatest potential for reducing accidents. Previous studies have found that speed differentials result in an increased incidence of accidents. Hence, institution of differential speed limits has generally been discouraged. However, with the institution of the 55 mph speed limit, and for urban freeways operating at or near capacity, differential speed limits for cars and trucks may be an effective means of reducing conflicts.

Route restrictions are currently in place for hazardous cargoes. These regulations are considered beneficial along heavily populated corridors utilized by truck traffic.

Recent revisions to the Texas driving statute on truck drivers could substantially improve the safety of truck operations on urban freeways in Texas. However, the impacts of these revisions are probably long-term in nature. Much depends upon how stringently the new regulations are applied and enforced.

Overall it seems that little can be accomplished in the short-term to reduce truck related accidents on urban freeways by means of regulations. Truck accidents are not an abnormal situation peculiar to urban freeways and new or additional regulations may prove to be counter-productive. Highway regulations should be instituted with a specific objective in mind and should be limited to those that are enforceable, equitable, and effective.

5.2 RECOMMENDATIONS

Though this study presents no conclusive findings regarding regulations or restrictions to improve the safety or operational aspects of truck usage of urban freeways, several general recommendations can be offered. In terms of their implementation and probable effects, these recommendations can be classified as either short-term or long-term recommendations. These recommendations are presented below.

5.2.1 Short-Term Recommendations

In terms of potential speed restrictions, the following would appear to merit consideration.

1. Institute a strong speed enforcement program on all urban freeways.
2. Consider on a trial basis a speed limit reduction of 5 to 10 mph for all vehicles.

3. Consider on a trial basis a speed limit reduction of 5 to 10 mph for trucks only. Such demonstration projects could be limited to critical freeway sections of sufficient length to measure driver compliance with the speed reduction.

4. Consider on a trial basis the prohibition of trucks on the inside lane(s) of the freeway. Since the inside lanes are, by the rules of the road, generally the faster lanes, prohibiting trucks in these lanes could result in a reduction in truck speeds. One freeway route through an urban area could be designated for the demonstration.

If any changes in speed limits or enforcement practices are implemented, before-and-after studies should be conducted to measure the effects of these changes on the following operational and safety variables.

a) Average speeds (trucks and autos);

b) Vehicle headways (truck-auto, and auto-truck);

c) Lane changing patterns; and

d) Accidents (number, type, and location).

5.2.2 Long-Term Recommendations

Long-term recommendations include: (1) The provision of interactive warning devices to alert truck drivers of unusual conditions; (2) Improvements to accident control units responding to freeway traffic accidents; and (3) Stringent enforcement and monitoring of driver licensing procedures. Specific recommendations in each of these general areas are outlined below.

1. Interactive Warning Devices. These are systems to alert a truck driver of improper driving of unusual roadway conditions. They include:

a) Visual devices - special lights, signs or signals including variable messages signs[6].

[6] Dorsey, W. Variable Message Signing For Traffic Surveillance and Control, for Federal Highway Administration, Washington, DC, January 1977, FHWA-RD-77-98.

b) Auditive devices - noise devices such as sirens or bells to alert or awaken drivers.

c) Other - Vibration devices such as rumble strips, mountable curbs, etc.

d) Combination devices- more than one of the above.

These devices can be installed in proximity to hazardous areas where accident rates are higher than average. Such warning devices should alert the driver of unusual roadway conditions. Most efforts have been devoted to devices that assume drivers can respond to them. Interactive warning devices to alert motorists of unusual roadway conditions which they may not otherwise perceive, unless wide-awake, may prove more beneficial in truck accident reduction than more regulations.

2. Improvements to Accident Control Units. Sometimes a freeway accident creating extensive traffic delays goes undetected by the police much longer than desirable. Then, depending on the extent of traffic congestion, it may take considerable time for accident control units to exercise some action. Measures to improve the accident reaction time could include:

a) Coordination between emergency units, including tow truck companies, with emphasis on those located close to freeway access ramps.

b) Revision of operating procedures related to emergency staff specializing in freeway accident control.

c) Dispersion of emergency equipment to locations closer to freeway ramps.

Some jurisdictions have already implemented some of the above measures. However, where freeway accidents are a major community concern greater emphasis could be placed on measures geared to react to such incidents.

3. Driver Licensing Procedures. The literature review suggests that many truck-related accidents can be attributed to lack of professional driver

training. Recent revisions to the Texas driving statute on truck drivers provide an excellent opportunity to assess the long-term effects of more stringent licensing procedures on truck safety. The effects of the revised licensing procedures should be monitored and evaluated on an on-going basis.

APPENDIX A

TTI VEHICLE DISTRIBUTION AND TRUCK OPERATIONS STUDIES: DATA SUMMARIES

TABLE A-1. TRAFFIC COMPOSITION EB I-10W AT BUNKER HILL

TIME PERIOD	TRAFFIC VOLUME TRUCKS	NON-TRUCKS*	TOTAL	PERCENT TRUCKS
12:00 TO 1:00 AM	65	479	544	11.95
1:00 TO 2:00 AM	46	265	311	14.79
2:00 TO 3:00 AM	108	173	281	38.43
3:00 TO 4:00 AM	71	154	225	31.56
4:00 TO 5:00 AM	108	248	356	30.34
5:00 TO 6:00 AM	134	1468	1602	8.36
6:00 TO 7:00 AM	158	5202	5360	2.95
7:00 TO 8:00 AM	169	4290	4459	3.79
8:00 TO 9:00 AM	286	4435	4721	6.06
9:00 TO 10:00 AM	360	4637	4997	7.20
10:00 TO 11:00 AM	408	4459	4867	8.38
11:00 TO 12:00 AM	370	4119	4489	8.24
12:00 TO 1:00 PM	360	3755	4115	8.75
1:00 TO 2:00 PM	378	3933	4311	8.77
2:00 TO 3:00 PM	396	3587	3983	9.94
3:00 TO 4:00 PM	345	4227	4572	7.55
4:00 TO 5:00 PM	260	3949	4209	6.18
5:00 TO 6:00 PM	189	3731	3920	4.82
6:00 TO 7:00 PM	151	3565	3716	4.06
7:00 TO 8:00 PM	105	2947	3052	3.44
8:00 TO 9:00 PM	81	2612	2693	3.01
9:00 TO 10:00 PM	75	2306	2381	3.15
10:00 TO 11:00 PM	81	1471	1552	5.22
11:00 TO 12:00 PM	60	1051	1111	5.40
TOTAL VEHICLES	4764	67063	71827	6.63

* NON-TRUCKS INCLUDE : PASSENGER CARS, PICKUPS, VANS, MOTORCYCLES AND BUSES

TABLE A-2. TRAFFIC COMPOSITION WB I-10W AT BUNKER HILL

TIME PERIOD	TRAFFIC VOLUME			PERCENT
	TRUCKS	NON-TRUCKS*	TOTAL	TRUCKS
12:00 TO 1:00 AM	55	633	688	7.99
1:00 TO 2:00 AM	51	350	401	12.72
2:00 TO 3:00 AM	71	262	333	21.32
3:00 TO 4:00 AM	47	190	237	19.83
4:00 TO 5:00 AM	107	213	320	33.44
5:00 TO 6:00 AM	122	1090	1212	10.07
6:00 TO 7:00 AM	199	3763	3962	5.02
7:00 TO 8:00 AM	268	3955	4223	6.35
8:00 TO 9:00 AM	411	4246	4657	8.83
9:00 TO 10:00 AM	454	3685	4139	10.97
10:00 TO 11:00 AM	410	3580	3990	10.28
11:00 TO 12:00 AM	414	3887	4301	9.63
12:00 TO 1:00 PM	341	4449	4790	7.12
1:00 TO 2:00 PM	336	4089	4425	7.59
2:00 TO 3:00 PM	266	4243	4509	5.90
3:00 TO 4:00 PM	227	4301	4528	5.01
4:00 TO 5:00 PM	175	4204	4379	4.00
5:00 TO 6:00 PM	142	4117	4259	3.33
6:00 TO 7:00 PM	143	4554	4697	3.04
7:00 TO 8:00 PM	108	3728	3836	2.82
8:00 TO 9:00 PM	82	3122	3204	2.56
9:00 TO 10:00 PM	91	2890	2981	3.05
10:00 TO 11:00 PM	66	2231	2297	2.87
11:00 TO 12:00 PM	54	1275	1329	4.06
TOTAL VEHICLES	4640	69057	73697	6.30

* NON-TRUCKS INCLUDE : PASSENGER CARS, PICKUPS, VANS, MOTORCYCLES AND BUSES

TABLE A-3. TRAFFIC COMPOSITION SB US 59S BETWEEN KIRBY AND SHEPHERD

TIME PERIOD	TRAFFIC VOLUME			PERCENT
	TRUCKS	NON-TRUCKS*	TOTAL	TRUCKS
12:00 TO 1:00 AM	70	1055	1125	6.22
1:00 TO 2:00 AM	45	605	650	6.92
2:00 TO 3:00 AM	73	447	520	14.04
3:00 TO 4:00 AM	55	312	367	14.99
4:00 TO 5:00 AM	74	337	411	18.00
5:00 TO 6:00 AM	119	1211	1330	8.95
6:00 TO 7:00 AM	171	3915	4086	4.19
7:00 TO 8:00 AM	184	4550	4734	3.89
8:00 TO 9:00 AM	259	4857	5116	5.06
9:00 TO 10:00 AM	270	3671	3941	6.85
10:00 TO 11:00 AM	304	4784	5088	5.97
11:00 TO 12:00 AM	227	5117	5344	4.25
12:00 TO 1:00 PM	193	5153	5346	3.61
1:00 TO 2:00 PM	209	4592	4801	4.35
2:00 TO 3:00 PM	213	5225	5438	3.92
3:00 TO 4:00 PM	173	5990	6163	2.81
4:00 TO 5:00 PM	122	6248	6370	1.92
5:00 TO 6:00 PM	94	6085	6179	1.52
6:00 TO 7:00 PM	61	5239	5300	1.15
7:00 TO 8:00 PM	68	4314	4382	1.55
8:00 TO 9:00 PM	76	3732	3808	2.00
9:00 TO 10:00 PM	51	3156	3207	1.59
10:00 TO 11:00 PM	60	1984	2044	2.94
11:00 TO 12:00 PM	51	1943	1994	2.56
TOTAL VEHICLES	3222	84522	87744	3.67

* NON-TRUCKS INCLUDE : PASSENGER CARS, PICKUPS, VANS, MOTORCYCLES AND BUSES

TABLE A-4. TRAFFIC COMPOSITION NB US 59S BETWEEN KIRBY AND SHEPHERD

TIME PERIOD	TRAFFIC VOLUME			PERCENT
	TRUCKS	NON-TRUCKS*	TOTAL	TRUCKS
12:00 TO 1:00 AM	77	922	999	7.71
1:00 TO 2:00 AM	66	581	647	10.20
2:00 TO 3:00 AM	60	448	508	11.81
3:00 TO 4:00 AM	39	262	301	12.96
4:00 TO 5:00 AM	59	380	439	13.44
5:00 TO 6:00 AM	54	1361	1415	3.82
6:00 TO 7:00 AM	74	4573	4647	1.59
7:00 TO 8:00 AM	75	6412	6487	1.16
8:00 TO 9:00 AM	122	6980	7102	1.72
9:00 TO 10:00 AM	160	5509	5669	2.82
10:00 TO 11:00 AM	246	5058	5304	4.64
11:00 TO 12:00 AM	181	4907	5088	3.56
12:00 TO 1:00 PM	186	5012	5198	3.58
1:00 TO 2:00 PM	216	5498	5714	3.78
2:00 TO 3:00 PM	332	5773	6105	5.44
3:00 TO 4:00 PM	256	5774	6030	4.25
4:00 TO 5:00 PM	244	6362	6606	3.69
5:00 TO 6:00 PM	284	7104	7388	3.84
6:00 TO 7:00 PM	172	5003	5175	3.32
7:00 TO 8:00 PM	125	3719	3844	3.25
8:00 TO 9:00 PM	97	2823	2920	3.32
9:00 TO 10:00 PM	89	2532	2621	3.40
10:00 TO 11:00 PM	98	2665	2763	3.55
11:00 TO 12:00 PM	52	2179	2231	2.33
TOTAL VEHICLES	3364	91837	95201	3.53

* NON-TRUCKS INCLUDE : PASSENGER CARS, PICKUPS, VANS, MOTORCYCLES AND BUSES

TABLE A-5. TRAFFIC COMPOSITION SB I-45S AT MONROE

TIME PERIOD	TRAFFIC VOLUME			PERCENT
	TRUCKS	NON-TRUCKS*	TOTAL	TRUCKS
12:00 TO 1:00 AM	31	893	924	3.35
1:00 TO 2:00 AM	26	384	410	6.34
2:00 TO 3:00 AM	28	253	281	9.96
3:00 TO 4:00 AM	38	258	296	12.84
4:00 TO 5:00 AM	29	175	204	14.22
5:00 TO 6:00 AM	118	880	998	11.82
6:00 TO 7:00 AM	178	2370	2548	6.99
7:00 TO 8:00 AM	209	3116	3325	6.29
8:00 TO 9:00 AM	311	3099	3410	9.12
9:00 TO 10:00 AM	309	2863	3172	9.74
10:00 TO 11:00 AM	305	3110	3415	8.93
11:00 TO 12:00 AM	404	3339	3743	10.79
12:00 TO 1:00 PM	271	2530	2801	9.68
1:00 TO 2:00 PM	291	3065	3356	8.67
2:00 TO 3:00 PM	232	2605	2837	8.18
3:00 TO 4:00 PM	228	2442	2670	8.54
4:00 TO 5:00 PM	165	2803	2968	5.56
5:00 TO 6:00 PM	112	3152	3264	3.43
6:00 TO 7:00 PM	106	3773	3879	2.73
7:00 TO 8:00 PM	87	3253	3340	2.60
8:00 TO 9:00 PM	71	2487	2558	2.78
9:00 TO 10:00 PM	35	2305	2340	1.50
10:00 TO 11:00 PM	44	1964	2008	2.19
11:00 TO 12:00 PM	40	1542	1582	2.53
TOTAL VEHICLES	3668	52661	56329	6.51

* NON-TRUCKS INCLUDE : PASSENGER CARS, PICKUPS, VANS, MOTORCYCLES AND BUSES

TABLE A-6. TRAFFIC COMPOSITION NB I-45S AT MONROE

TIME PERIOD	TRAFFIC VOLUME			PERCENT
	TRUCKS	NON-TRUCKS*	TOTAL	TRUCKS
12:00 TO 1:00 AM	32	555	587	5.45
1:00 TO 2:00 AM	28	371	399	7.02
2:00 TO 3:00 AM	38	246	284	13.38
3:00 TO 4:00 AM	42	209	251	16.73
4:00 TO 5:00 AM	50	322	372	13.44
5:00 TO 6:00 AM	74	1725	1799	4.11
6:00 TO 7:00 AM	109	4806	4915	2.22
7:00 TO 8:00 AM	118	4576	4694	2.51
8:00 TO 9:00 AM	259	4029	4288	6.04
9:00 TO 10:00 AM	291	3280	3571	8.15
10:00 TO 11:00 AM	346	2971	3317	10.43
11:00 TO 12:00 AM	340	2935	3275	10.38
12:00 TO 1:00 PM	309	3033	3342	9.25
1:00 TO 2:00 PM	312	3238	3550	8.79
2:00 TO 3:00 PM	346	3191	3537	9.78
3:00 TO 4:00 PM	313	3365	3678	8.51
4:00 TO 5:00 PM	265	3269	3534	7.50
5:00 TO 6:00 PM	188	2869	3057	6.15
6:00 TO 7:00 PM	134	3111	3245	4.13
7:00 TO 8:00 PM	96	2542	2638	3.64
8:00 TO 9:00 PM	71	1918	1989	3.57
9:00 TO 10:00 PM	56	1692	1748	3.20
10:00 TO 11:00 PM	32	1247	1279	2.50
11:00 TO 12:00 PM	41	883	924	4.44
TOTAL VEHICLES	3890	56383	60273	6.45

* NON-TRUCKS INCLUDE : PASSENGER CARS, PICKUPS, VANS, MOTORCYCLES AND BUSES

TABLE A-7. TRAFFIC COMPOSITION SB I-45N AT LITTLE YORK

TIME PERIOD	TRAFFIC VOLUME			PERCENT TRUCKS
	TRUCKS	NON-TRUCKS*	TOTAL	
12:00 TO 1:00 AM	100	587	687	14.56
1:00 TO 2:00 AM	121	413	534	22.66
2:00 TO 3:00 AM	102	291	393	25.95
3:00 TO 4:00 AM	125	292	417	29.98
4:00 TO 5:00 AM	166	317	483	34.37
5:00 TO 6:00 AM	185	2936	3121	5.93
6:00 TO 7:00 AM	164	4982	5146	3.19
7:00 TO 8:00 AM	204	4640	4844	4.21
8:00 TO 9:00 AM	314	4603	4917	6.39
9:00 TO 10:00 AM	423	4638	5061	8.36
10:00 TO 11:00 AM	375	4238	4613	8.13
11:00 TO 12:00 AM	422	4488	4910	8.59
12:00 TO 1:00 PM	334	3972	4306	7.76
1:00 TO 2:00 PM	397	4049	4446	8.93
2:00 TO 3:00 PM	437	3840	4277	10.22
3:00 TO 4:00 PM	221	2676	2897	7.63
4:00 TO 5:00 PM	246	2492	2738	8.98
5:00 TO 6:00 PM	200	2618	2818	7.10
6:00 TO 7:00 PM	174	2982	3156	5.51
7:00 TO 8:00 PM	171	3082	3253	5.26
8:00 TO 9:00 PM	133	2657	2790	4.77
9:00 TO 10:00 PM	115	2313	2428	4.74
10:00 TO 11:00 PM	106	2155	2261	4.69
11:00 TO 12:00 PM	103	1315	1418	7.26
TOTAL VEHICLES	5338	66576	71914	7.42

* NON-TRUCKS INCLUDE : PASSENGER CARS, PICKUPS, VANS, MOTORCYCLES AND BUSES

TABLE A-8. TRAFFIC COMPOSITION NB I-45N AT LITTLE YORK

TIME PERIOD	TRAFFIC VOLUME			PERCENT
	TRUCKS	NON-TRUCKS*	TOTAL	TRUCKS
12:00 TO 1:00 AM	193	646	839	23.00
1:00 TO 2:00 AM	102	488	590	17.29
2:00 TO 3:00 AM	61	373	434	14.06
3:00 TO 4:00 AM	107	270	377	28.38
4:00 TO 5:00 AM	76	240	316	24.05
5:00 TO 6:00 AM	94	838	932	10.09
6:00 TO 7:00 AM	202	2912	3114	6.49
7:00 TO 8:00 AM	306	2885	3191	9.59
8:00 TO 9:00 AM	377	2568	2945	12.80
9:00 TO 10:00 AM	450	3312	3762	11.96
10:00 TO 11:00 AM	416	3495	3911	10.64
11:00 TO 12:00 AM	388	3695	4083	9.50
12:00 TO 1:00 PM	414	3934	4348	9.52
1:00 TO 2:00 PM	340	3443	3783	8.99
2:00 TO 3:00 PM	294	3385	3679	7.99
3:00 TO 4:00 PM	221	3647	3868	5.71
4:00 TO 5:00 PM	208	3907	4115	5.05
5:00 TO 6:00 PM	194	3586	3780	5.13
6:00 TO 7:00 PM	197	4317	4514	4.36
7:00 TO 8:00 PM	126	3807	3933	3.20
8:00 TO 9:00 PM	137	3001	3138	4.37
9:00 TO 10:00 PM	129	2871	3000	4.30
10:00 TO 11:00 PM	119	2198	2317	5.14
11:00 TO 12:00 PM	82	1478	1560	5.26
TOTAL VEHICLES	5233	61296	66529	7.87

* NON-TRUCKS INCLUDE : PASSENGER CARS, PICKUPS, VANS, MOTORCYCLES AND BUSES

TABLE A-9. TRAFFIC COMPOSITION NB W LOOP 1-610 AT BUFFALO BAYOU

TIME PERIOD	TRAFFIC VOLUME TRUCKS	NON-TRUCKS*	TOTAL	PERCENT TRUCKS
12:00 TO 1:00 AM	33	1512	1545	2.14
1:00 TO 2:00 AM	24	884	908	2.64
2:00 TO 3:00 AM	37	755	792	4.67
3:00 TO 4:00 AM	32	302	334	9.58
4:00 TO 5:00 AM	55	386	441	12.47
5:00 TO 6:00 AM	69	1460	1529	4.51
6:00 TO 7:00 AM	122	4276	4398	2.77
7:00 TO 8:00 AM	124	4909	5033	2.46
8:00 TO 9:00 AM	245	5877	6122	4.00
9:00 TO 10:00 AM	290	5243	5533	5.24
10:00 TO 11:00 AM	355	5290	5645	6.29
11:00 TO 12:00 AM	287	5696	5983	4.80
12:00 TO 1:00 PM	311	5448	5759	5.40
1:00 TO 2:00 PM	289	5860	6149	4.70
2:00 TO 3:00 PM	427	6964	7391	5.78
3:00 TO 4:00 PM	317	5806	6123	5.18
4:00 TO 5:00 PM	234	5899	6133	3.82
5:00 TO 6:00 PM	181	6464	6645	2.72
6:00 TO 7:00 PM	92	5711	5803	1.59
7:00 TO 8:00 PM	89	5304	5393	1.65
8:00 TO 9:00 PM	72	4097	4169	1.73
9:00 TO 10:00 PM	83	4402	4485	1.85
10:00 TO 11:00 PM	73	4175	4248	1.72
11:00 TO 12:00 PM	40	2762	2802	1.43
TOTAL VEHICLES	3881	99482	103E3	3.75

* NON-TRUCKS INCLUDE : PASSENGER CARS, PICKUPS, VANS, MOTORCYCLES AND BUSES

TABLE A-10. TRAFFIC COMPOSITION SB W LOOP 1-610 AT BUFFALO BAYOU

TIME PERIOD	TRAFFIC VOLUME			PERCENT TRUCKS
	TRUCKS	NON-TRUCKS*	TOTAL	
12:00 TO 1:00 AM	45	1191	1236	3.64
1:00 TO 2:00 AM	28	660	688	4.07
2:00 TO 3:00 AM	28	535	563	4.97
3:00 TO 4:00 AM	35	308	343	10.20
4:00 TO 5:00 AM	62	369	431	14.39
5:00 TO 6:00 AM	104	1747	1851	5.62
6:00 TO 7:00 AM	104	5327	5431	1.91
7:00 TO 8:00 AM	158	6561	6719	2.35
8:00 TO 9:00 AM	197	5437	5634	3.50
9:00 TO 10:00 AM	206	5407	5613	3.67
10:00 TO 11:00 AM	329	5904	6233	5.28
11:00 TO 12:00 AM	249	5892	6141	4.05
12:00 TO 1:00 PM	222	5998	6220	3.57
1:00 TO 2:00 PM	218	5835	6053	3.60
2:00 TO 3:00 PM	324	6181	6505	4.98
3:00 TO 4:00 PM	283	5675	5958	4.75
4:00 TO 5:00 PM	191	5806	5997	3.18
5:00 TO 6:00 PM	154	6088	6242	2.47
6:00 TO 7:00 PM	77	6398	6475	1.19
7:00 TO 8:00 PM	84	6043	6127	1.37
8:00 TO 9:00 PM	80	4045	4125	1.94
9:00 TO 10:00 PM	48	3416	3464	1.39
10:00 TO 11:00 PM	36	3040	3076	1.17
11:00 TO 12:00 PM	45	1842	1887	2.38
TOTAL VEHICLES	3307	99705	103E3	3.21

* NON-TRUCKS INCLUDE : PASSENGER CARS, PICKUPS, VANS, MOTORCYCLES AND BUSES

TABLE A-11. TRAFFIC COMPOSITION EB I-10E BETWEEN HOLLAND AND MERCURY

TIME PERIOD	TRAFFIC VOLUME			PERCENT TRUCKS
	TRUCKS	NON-TRUCKS*	TOTAL	
12:00 TO 1:00 AM	110	539	649	16.95
1:00 TO 2:00 AM	124	350	474	26.16
2:00 TO 3:00 AM	103	286	389	26.48
3:00 TO 4:00 AM	85	185	270	31.48
4:00 TO 5:00 AM	121	192	313	38.66
5:00 TO 6:00 AM	121	612	733	16.51
6:00 TO 7:00 AM	169	1585	1754	9.64
7:00 TO 8:00 AM	215	1648	1863	11.54
8:00 TO 9:00 AM	305	1356	1661	18.36
9:00 TO 10:00 AM	409	1773	2182	18.74
10:00 TO 11:00 AM	353	2006	2359	14.96
11:00 TO 12:00 AM	362	2219	2581	14.03
12:00 TO 1:00 PM	269	1461	1730	15.55
1:00 TO 2:00 PM	300	1627	1927	15.57
2:00 TO 3:00 PM	270	1602	1872	14.42
3:00 TO 4:00 PM	252	2833	3085	8.17
4:00 TO 5:00 PM	199	2639	2838	7.01
5:00 TO 6:00 PM	172	2984	3156	5.45
6:00 TO 7:00 PM	174	2297	2471	7.04
7:00 TO 8:00 PM	156	1436	1592	9.80
8:00 TO 9:00 PM	135	1471	1606	8.41
9:00 TO 10:00 PM	125	1318	1443	8.66
10:00 TO 11:00 PM	102	1097	1199	8.51
11:00 TO 12:00 PM	105	996	1101	9.54
TOTAL VEHICLES	4736	34512	39248	12.07

* NON-TRUCKS INCLUDE : PASSENGER CARS, PICKUPS, VANS, MOTORCYCLES AND BUSES

TABLE A-12. TRAFFIC COMPOSITION WB I-10E BETWEEN HOLLAND AND MERCURY

TIME PERIOD	TRAFFIC VOLUME			PERCENT
	TRUCKS	NON-TRUCKS*	TOTAL	TRUCKS
12:00 TO 1:00 AM	90	396	486	18.52
1:00 TO 2:00 AM	74	297	371	19.95
2:00 TO 3:00 AM	89	177	266	33.46
3:00 TO 4:00 AM	73	183	256	28.52
4:00 TO 5:00 AM	111	332	443	25.06
5:00 TO 6:00 AM	123	1245	1368	8.99
6:00 TO 7:00 AM	163	1630	1793	9.09
7:00 TO 8:00 AM	187	1654	1841	10.16
8:00 TO 9:00 AM	293	2335	2628	11.15
9:00 TO 10:00 AM	338	2354	2692	12.56
10:00 TO 11:00 AM	314	2428	2742	11.45
11:00 TO 12:00 AM	313	2526	2839	11.03
12:00 TO 1:00 PM	274	1999	2273	12.05
1:00 TO 2:00 PM	245	1693	1938	12.64
2:00 TO 3:00 PM	324	1697	2021	16.03
3:00 TO 4:00 PM	276	1939	2215	12.46
4:00 TO 5:00 PM	236	2158	2394	9.86
5:00 TO 6:00 PM	194	2098	2292	8.46
6:00 TO 7:00 PM	227	1903	2130	10.66
7:00 TO 8:00 PM	158	1799	1957	8.07
8:00 TO 9:00 PM	124	1385	1509	8.22
9:00 TO 10:00 PM	115	1273	1388	8.29
10:00 TO 11:00 PM	104	1138	1242	8.37
11:00 TO 12:00 PM	98	719	817	12.00
TOTAL VEHICLES	4543	35358	39901	11.39

* NON-TRUCKS INCLUDE : PASSENGER CARS, PICKUPS, VANS, MOTORCYCLES AND BUSES

TABLE A-13. TRAFFIC COMPOSITION NB E LOOP I-610 AT BUFFALO BAYOU

TIME PERIOD	TRAFFIC VOLUME			PERCENT
	TRUCKS	NON-TRUCKS*	TOTAL	TRUCKS
12:00 TO 1:00 AM	40	442	482	8.30
1:00 TO 2:00 AM	66	293	359	18.38
2:00 TO 3:00 AM	27	153	180	15.00
3:00 TO 4:00 AM	55	129	184	29.89
4:00 TO 5:00 AM	61	206	267	22.85
5:00 TO 6:00 AM	109	892	1001	10.89
6:00 TO 7:00 AM	198	3471	3669	5.40
7:00 TO 8:00 AM	351	3217	3568	9.84
8:00 TO 9:00 AM	375	2690	3065	12.23
9:00 TO 10:00 AM	427	1676	2103	20.30
10:00 TO 11:00 AM	522	1675	2197	23.76
11:00 TO 12:00 AM	491	2056	2547	19.28
12:00 TO 1:00 PM	444	1624	2068	21.47
1:00 TO 2:00 PM	538	1963	2501	21.51
2:00 TO 3:00 PM	662	2031	2693	24.58
3:00 TO 4:00 PM	464	2809	3273	14.18
4:00 TO 5:00 PM	496	3510	4006	12.38
5:00 TO 6:00 PM	421	2893	3314	12.70
6:00 TO 7:00 PM	220	2486	2706	8.13
7:00 TO 8:00 PM	151	1602	1753	8.61
8:00 TO 9:00 PM	105	1424	1529	6.87
9:00 TO 10:00 PM	85	1423	1508	5.64
10:00 TO 11:00 PM	91	1341	1432	6.35
11:00 TO 12:00 PM	76	977	1053	7.22
TOTAL VEHICLES	6475	40983	47458	13.64

* NON-TRUCKS INCLUDE : PASSENGER CARS, PICKUPS, VANS, MOTORCYCLES AND BUSES

TABLE A-14. TRAFFIC COMPOSITION SB E LOOP I-610 AT BUFFALO BAYOU

TIME PERIOD	TRAFFIC VOLUME			PERCENT TRUCKS
	TRUCKS	NON-TRUCKS*	TOTAL	
12:00 TO 1:00 AM	49	394	443	11.06
1:00 TO 2:00 AM	40	188	228	17.54
2:00 TO 3:00 AM	40	163	203	19.70
3:00 TO 4:00 AM	41	194	235	17.45
4:00 TO 5:00 AM	78	211	289	26.99
5:00 TO 6:00 AM	130	1092	1222	10.64
6:00 TO 7:00 AM	251	2924	3175	7.91
7:00 TO 8:00 AM	405	2663	3068	13.20
8:00 TO 9:00 AM	469	2292	2761	16.99
9:00 TO 10:00 AM	524	1803	2327	22.52
10:00 TO 11:00 AM	619	1976	2595	23.85
11:00 TO 12:00 AM	495	1816	2311	21.42
12:00 TO 1:00 PM	409	1410	1819	22.48
1:00 TO 2:00 PM	390	1786	2176	17.92
2:00 TO 3:00 PM	418	1947	2365	17.67
3:00 TO 4:00 PM	454	2919	3373	13.46
4:00 TO 5:00 PM	323	4104	4427	7.30
5:00 TO 6:00 PM	320	4184	4504	7.10
6:00 TO 7:00 PM	187	2795	2982	6.27
7:00 TO 8:00 PM	139	1653	1792	7.76
8:00 TO 9:00 PM	114	1232	1346	8.47
9:00 TO 10:00 PM	88	1303	1391	6.33
10:00 TO 11:00 PM	65	1096	1161	5.60
11:00 TO 12:00 PM	77	821	898	8.57
TOTAL VEHICLES	6125	40966	47091	13.01

* NON-TRUCKS INCLUDE : PASSENGER CARS, PICKUPS, VANS,
MOTORCYCLES AND BUSES

Table A-15.

TRUCK OPERATIONS STUDY

CITY : DALLAS
HIGHWAY : IH 30 E
LOCATION : LOOP 12
DIRECTION : INBOUND
DATE : 07/13/83

VEHICLE TYPE	LANE 1 INSIDE	LANE 2	LANE 3	LANE 4 OUTSIDE	ALL LANES
PASSENGER	3179	4035	4133	4631	15978
% VEH TYPE	19.90	25.25	25.87	28.98	93.85
% OF LANE	96.07	93.19	91.64	94.98	
% TOTAL SAMPLE	18.67	23.70	24.28	27.20	
LIGHT TRUCKS	16	42	23	35	116
% VEH TYPE	13.79	36.21	19.83	30.17	0.68
% OF LANE	0.48	0.97	0.51	0.72	
% TOTAL SAMPLE	0.09	0.25	0.14	0.21	
HEAVY TRUCKS	114	253	354	210	931
% VEH TYPE	12.24	27.18	38.02	22.56	5.47
% OF LANE	3.45	5.84	7.85	4.31	
% TOTAL SAMPLE	0.67	1.49	2.08	1.23	
ALL TRUCKS	130	295	377	245	1047
% VEH TYPE	12.42	28.18	36.01	23.40	6.15
% OF LANE	3.93	6.81	8.36	5.02	
% TOTAL SAMPLE	0.76	1.73	2.21	1.44	
ALL VEHICLES	3309	4330	4510	4876	17025
% TOTAL SAMPLE	19.44	25.43	26.49	28.64	

TOTAL HAZ. MAT. TRUCKS = 29

SAMPLE SIZE = 7 HOURS

LIGHT TRUCKS = VEHICLE WITH THREE AXLES
HEAVY TRUCKS = VEHICLE WITH MORE THAN THREE AXLES

Table A-16.
TRUCK OPERATIONS STUDY

CITY : DALLAS
HIGHWAY : IH 35 E
LOCATION : VALLEY VIEW
DIRECTION : INBOUND
DATE : 07/14/83

VEHICLE TYPE	LANE 1 INSIDE	LANE 2	LANE 3	LANE 4 OUTSIDE	ALL LANES
PASSENGER	3500	4498	2727	0	10725
% VEH TYPE	32.63	41.94	25.43	0.00	93.12
% OF LANE	96.69	92.36	90.09	.	
% TOTAL SAMPLE	30.39	39.06	23.68	0.00	
LIGHT TRUCKS	26	47	41	0	114
% VEH TYPE	22.81	41.23	35.96	0.00	0.99
% OF LANE	0.72	0.97	1.35	.	
% TOTAL SAMPLE	0.23	0.41	0.36	0.00	
HEAVY TRUCKS	94	325	209	0	628
% VEH TYPE	14.97	51.75	33.28	0.00	5.45
% OF LANE	2.60	6.67	6.90	.	
% TOTAL SAMPLE	0.82	2.82	1.81	0.00	
ALL TRUCKS	120	372	250	0	742
% VEH TYPE	16.17	50.13	33.69	0.00	6.44
% OF LANE	3.31	7.64	8.26	.	
% TOTAL SAMPLE	1.04	3.23	2.17	0.00	
ALL VEHICLES	3620	4870	3027	0	11517
% TOTAL SAMPLE	31.43	42.29	26.28	0.00	

TOTAL HAZ. MAT. TRUCKS = 32

SAMPLE SIZE = 7 HOURS

LIGHT TRUCKS = VEHICLE WITH THREE AXLES
HEAVY TRUCKS = VEHICLE WITH MORE THAN THREE AXLES

Table A-17.
TRUCK OPERATIONS STUDY

CITY : DALLAS
HIGHWAY : IH 45 S
LOCATION : IH 635 S
DIRECTION : INBOUND
DATE : 07/12/83

VEHICLE TYPE	LANE 1 INSIDE	LANE 2	LANE 3	LANE 4 OUTSIDE	ALL LANES
PASSENGER	653	1159	455	0	2267
% VEH TYPE	28.80	51.12	20.07	0.00	85.13
% OF LANE	91.58	81.50	86.17	.	
% TOTAL SAMPLE	24.52	43.52	17.09	0.00	
LIGHT TRUCKS	9	12	16	0	37
% VEH TYPE	24.32	32.43	43.24	0.00	1.39
% OF LANE	1.26	0.84	3.03	.	
% TOTAL SAMPLE	0.34	0.45	0.60	0.00	
HEAVY TRUCKS	51	251	57	0	359
% VEH TYPE	14.21	69.92	15.88	0.00	13.48
% OF LANE	7.15	17.65	10.80	.	
% TOTAL SAMPLE	1.92	9.43	2.14	0.00	
ALL TRUCKS	60	263	73	0	396
% VEH TYPE	15.15	66.41	18.43	0.00	14.87
% OF LANE	8.42	18.50	13.83	.	
% TOTAL SAMPLE	2.25	9.88	2.74	0.00	
ALL VEHICLES	713	1422	528	0	2663
% TOTAL SAMPLE	26.77	53.40	19.83	0.00	

TOTAL HAZ. MAT. TRUCKS = 20

SAMPLE SIZE = 6 HOURS

LIGHT TRUCKS = VEHICLE WITH THREE AXLES
HEAVY TRUCKS = VEHICLE WITH MORE THAN THREE AXLES

Table A-18.
TRUCK OPERATIONS STUDY

CITY : FORT WORTH
HIGHWAY : IH 35 W
LOCATION : NORTHSIDE DRIVE
DIRECTION : INBOUND
DATE : 07/15/83

VEHICLE TYPE	LANE 1 INSIDE	LANE 2	LANE 3	LANE 4 OUTSIDE	ALL LANES
PASSENGER	3653	4149	2429	0	10231
% VEH TYPE	35.71	40.55	23.74	0.00	92.40
% OF LANE	92.46	91.98	93.03	.	
% TOTAL SAMPLE	32.99	37.47	21.94	0.00	
LIGHT TRUCKS	15	26	14	0	55
% VEH TYPE	27.27	47.27	25.45	0.00	0.50
% OF LANE	0.38	0.58	0.54	.	
% TOTAL SAMPLE	0.14	0.23	0.13	0.00	
HEAVY TRUCKS	283	336	168	0	787
% VEH TYPE	35.96	42.69	21.35	0.00	7.11
% OF LANE	7.16	7.45	6.43	.	
% TOTAL SAMPLE	2.56	3.03	1.52	0.00	
ALL TRUCKS	298	362	182	0	842
% VEH TYPE	35.39	42.99	21.62	0.00	7.60
% OF LANE	7.54	8.02	6.97	.	
% TOTAL SAMPLE	2.69	3.27	1.64	0.00	
ALL VEHICLES	3951	4511	2611	0	11073
% TOTAL SAMPLE	35.68	40.74	23.58	0.00	

TOTAL HAZ. MAT. TRUCKS = 73

SAMPLE SIZE = 7 HOURS

LIGHT TRUCKS = VEHICLE WITH THREE AXLES
HEAVY TRUCKS = VEHICLE WITH MORE THAN THREE AXLES

Table A-19.
TRUCK OPERATIONS STUDY

CITY : HOUSTON
HIGHWAY : EAST LOOP
LOCATION : BUFFALO BAYOU
DIRECTION : SOUTHBOUND
DATE : 01/14/83

VEHICLE TYPE	LANE 1 INSIDE	LANE 2	LANE 3	LANE 4 OUTSIDE	ALL LANES
PASSENGER	2672	3606	3156	1892	11326
% VEH TYPE	23.59	31.84	27.87	16.70	86.46
% OF LANE	90.82	87.91	82.38	85.03	
% TOTAL SAMPLE	20.40	27.53	24.09	14.44	
LIGHT TRUCKS	94	210	287	182	773
% VEH TYPE	12.16	27.17	37.13	23.54	5.90
% OF LANE	3.20	5.12	7.49	8.18	
% TOTAL SAMPLE	0.72	1.60	2.19	1.39	
HEAVY TRUCKS	176	289	388	151	1004
% VEH TYPE	17.53	28.78	38.65	15.04	7.66
% OF LANE	5.98	7.05	10.13	6.79	
% TOTAL SAMPLE	1.34	2.21	2.96	1.15	
ALL TRUCKS	270	499	675	333	1777
% VEH TYPE	15.19	28.08	37.99	18.74	13.56
% OF LANE	9.18	12.16	17.62	14.97	
% TOTAL SAMPLE	2.06	3.81	5.15	2.54	
ALL VEHICLES	2942	4102	3831	2225	13100
% TOTAL SAMPLE	22.46	31.31	29.24	16.98	

TOTAL HAZ. MAT. TRUCKS = 0

SAMPLE SIZE = 7 HOURS

LIGHT TRUCKS = VEHICLE WITH THREE AXLES
HEAVY TRUCKS = VEHICLE WITH MORE THAN THREE AXLES

Table A-20.
TRUCK OPERATIONS STUDY

CITY : HOUSTON
HIGHWAY : KATY FREEWAY
LOCATION : DAIRY ASHFORD
DIRECTION : INBOUND
DATE : 04/27/83

VEHICLE TYPE	LANE 1 INSIDE	LANE 2	LANE 3	LANE 4 OUTSIDE	ALL LANES
PASSENGER	4903	5482	4387	0	14772
% VEH TYPE	33.19	37.11	29.70	0.00	93.64
% OF LANE	94.47	91.84	95.02	.	
% TOTAL SAMPLE	31.08	34.75	27.81	0.00	
LIGHT TRUCKS	29	53	59	0	141
% VEH TYPE	20.57	37.59	41.84	0.00	0.89
% OF LANE	0.56	0.89	1.28	.	
% TOTAL SAMPLE	0.18	0.34	0.37	0.00	
HEAVY TRUCKS	258	434	121	0	813
% VEH TYPE	31.73	53.38	14.88	0.00	5.15
% OF LANE	4.97	7.27	2.62	.	
% TOTAL SAMPLE	1.64	2.75	0.77	0.00	
ALL TRUCKS	287	487	180	0	954
% VEH TYPE	30.08	51.05	18.87	0.00	6.05
% OF LANE	5.53	8.16	3.90	.	
% TOTAL SAMPLE	1.82	3.09	1.14	0.00	
ALL VEHICLES	5190	5969	4617	0	15776
% TOTAL SAMPLE	32.90	37.84	29.27	0.00	

TOTAL HAZ. MAT. TRUCKS = 78

SAMPLE SIZE = 7 HOURS

LIGHT TRUCKS = VEHICLE WITH THREE AXLES
HEAVY TRUCKS = VEHICLE WITH MORE THAN THREE AXLES

Table A-21.

TRUCK OPERATIONS STUDY

CITY : HOUSTON
HIGHWAY : NORTH FREEWAY
LOCATION : NORTH BELT
DIRECTION : INBOUND
DATE : 04/28/83

VEHICLE TYPE	LANE 1 INSIDE	LANE 2	LANE 3	LANE 4 OUTSIDE	ALL LANES
PASSENGER	16472	17731	11411	0	45614
% VEH TYPE	36.11	38.87	25.02	0.00	93.35
% OF LANE	95.76	91.31	93.22	.	
% TOTAL SAMPLE	33.71	36.29	23.35	0.00	
LIGHT TRUCKS	77	179	253	0	509
% VEH TYPE	15.13	35.17	49.71	0.00	1.04
% OF LANE	0.45	0.92	2.07	.	
% TOTAL SAMPLE	0.16	0.37	0.52	0.00	
HEAVY TRUCKS	663	1509	607	0	2779
% VEH TYPE	23.86	54.30	21.84	0.00	5.69
% OF LANE	3.85	7.77	4.96	.	
% TOTAL SAMPLE	1.36	3.09	1.24	0.00	
ALL TRUCKS	740	1688	860	0	3288
% VEH TYPE	22.51	51.34	26.16	0.00	6.73
% OF LANE	4.30	8.69	7.03	.	
% TOTAL SAMPLE	1.51	3.45	1.76	0.00	
ALL VEHICLES	17202	19419	12241	0	48862
% TOTAL SAMPLE	35.21	39.74	25.05	0.00	

TOTAL HAZ. MAT. TRUCKS = 143

SAMPLE SIZE = 24 HOURS

LIGHT TRUCKS = VEHICLE WITH THREE AXLES
HEAVY TRUCKS = VEHICLE WITH MORE THAN THREE AXLES

Table A-22.
TRUCK OPERATIONS STUDY

CITY : HOUSTON
HIGHWAY : SOUTHWEST FREEWAY
LOCATION : BELLAIRE
DIRECTION : INBOUND
DATE : 04/26/83

VEHICLE TYPE	LANE 1 INSIDE	LANE 2	LANE 3	LANE 4 OUTSIDE	ALL LANES
PASSENGER	5070	6004	3864	0	14938
% VEH TYPE	33.94	40.19	25.87	0.00	95.71
% OF LANE	96.28	94.51	96.89	.	
% TOTAL SAMPLE	32.49	38.47	24.76	0.00	
LIGHT TRUCKS	12	42	28	0	82
% VEH TYPE	14.63	51.22	34.15	0.00	0.53
% OF LANE	0.23	0.66	0.70	.	
% TOTAL SAMPLE	0.08	0.27	0.18	0.00	
HEAVY TRUCKS	184	307	96	0	587
% VEH TYPE	31.35	52.30	16.35	0.00	3.76
% OF LANE	3.49	4.83	2.41	.	
% TOTAL SAMPLE	1.18	1.97	0.62	0.00	
ALL TRUCKS	196	349	124	0	669
% VEH TYPE	29.30	52.17	18.54	0.00	4.29
% OF LANE	3.72	5.49	3.11	.	
% TOTAL SAMPLE	1.26	2.24	0.79	0.00	
ALL VEHICLES	5266	6353	3988	0	15607
% TOTAL SAMPLE	33.74	40.71	25.55	0.00	

TOTAL HAZ. MAT. TRUCKS = 70

SAMPLE SIZE = 7 HOURS

LIGHT TRUCKS = VEHICLE WITH THREE AXLES
HEAVY TRUCKS = VEHICLE WITH MORE THAN THREE AXLES

Table A-23.

TRUCK OPERATIONS STUDY

CITY : SAN ANTONIO
HIGHWAY : LOOP 410
LOCATION : MCCULLOUGH
DIRECTION : W
DATE : 06/08/83

VEHICLE TYPE	LANE 1 INSIDE	LANE 2	LANE 3	LANE 4 OUTSIDE	ALL LANES
PASSENGER	5814	5660	4405	0	15879
% VEH TYPE	36.61	35.64	27.74	0.00	98.49
% OF LANE	98.81	97.87	98.88	.	
% TOTAL SAMPLE	36.06	35.11	27.32	0.00	
LIGHT TRUCKS	22	23	12	0	57
% VEH TYPE	38.60	40.35	21.05	0.00	0.35
% OF LANE	0.37	0.40	0.27	.	
% TOTAL SAMPLE	0.14	0.14	0.07	0.00	
HEAVY TRUCKS	48	90	36	0	174
% VEH TYPE	27.59	51.72	20.69	0.00	1.08
% OF LANE	0.82	1.56	0.81	.	
% TOTAL SAMPLE	0.30	0.56	0.22	0.00	
ALL TRUCKS	70	113	48	0	231
% VEH TYPE	30.30	48.92	20.78	0.00	1.43
% OF LANE	1.19	1.95	1.08	.	
% TOTAL SAMPLE	0.43	0.70	0.30	0.00	
ALL VEHICLES	5884	5783	4455	0	16122
% TOTAL SAMPLE	36.50	35.87	27.63	0.00	

TOTAL HAZ. MAT. TRUCKS = 9

SAMPLE SIZE = 7 HOURS

LIGHT TRUCKS = VEHICLE WITH THREE AXLES
HEAVY TRUCKS = VEHICLE WITH MORE THAN THREE AXLES

Table A-24.

TRUCK OPERATIONS STUDY

CITY : SAN ANTONIO
HIGHWAY : IH 10 W
LOCATION : HUEBNER
DIRECTION : INBOUND
DATE : 06/07/83

VEHICLE TYPE	LANE 1 INSIDE	LANE 2	LANE 3	LANE 4 OUTSIDE	ALL LANES
PASSENGER	3459	2911	0	0	6370
% VEH TYPE	54.30	45.70	0.00	0.00	95.32
% OF LANE	95.76	94.79	.	.	
% TOTAL SAMPLE	51.76	43.56	0.00	0.00	
LIGHT TRUCKS	6	37	0	0	43
% VEH TYPE	13.95	86.05	0.00	0.00	0.64
% OF LANE	0.17	1.20	.	.	
% TOTAL SAMPLE	0.09	0.55	0.00	0.00	
HEAVY TRUCKS	147	123	0	0	270
% VEH TYPE	54.44	45.56	0.00	0.00	4.04
% OF LANE	4.07	4.01	.	.	
% TOTAL SAMPLE	2.20	1.84	0.00	0.00	
ALL TRUCKS	153	160	0	0	313
% VEH TYPE	48.88	51.12	0.00	0.00	4.68
% OF LANE	4.24	5.21	.	.	
% TOTAL SAMPLE	2.29	2.39	0.00	0.00	
ALL VEHICLES	3612	3071	0	0	6683
% TOTAL SAMPLE	54.05	45.95	0.00	0.00	

TOTAL HAZ. MAT. TRUCKS = 15

SAMPLE SIZE = 7 HOURS

LIGHT TRUCKS = VEHICLE WITH THREE AXLES
HEAVY TRUCKS = VEHICLE WITH MORE THAN THREE AXLES

Table A-25.

TRUCK OPERATIONS STUDY

CITY : SAN ANTONIO
HIGHWAY : IH 35 N
LOCATION : LOOP 1604
DIRECTION : INBOUND
DATE : 06/09/83

VEHICLE TYPE	LANE 1 INSIDE	LANE 2	LANE 3	LANE 4 OUTSIDE	ALL LANES
PASSENGER	2267	3205	0	0	5472
% VEH TYPE	41.43	58.57	0.00	0.00	96.46
% OF LANE	98.91	94.79	.	.	
% TOTAL SAMPLE	39.96	56.50	0.00	0.00	
LIGHT TRUCKS	9	64	0	0	73
% VEH TYPE	12.33	87.67	0.00	0.00	1.29
% OF LANE	0.39	1.89	.	.	
% TOTAL SAMPLE	0.16	1.13	0.00	0.00	
HEAVY TRUCKS	154	396	0	0	550
% VEH TYPE	28.00	72.00	0.00	0.00	9.70
% OF LANE	6.72	11.71	.	.	
% TOTAL SAMPLE	2.71	6.98	0.00	0.00	
ALL TRUCKS	163	460	0	0	623
% VEH TYPE	26.16	73.84	0.00	0.00	10.98
% OF LANE	7.11	13.61	.	.	
% TOTAL SAMPLE	2.87	8.11	0.00	0.00	
ALL VEHICLES	2292	3381	0	0	5673
% TOTAL SAMPLE	40.40	59.60	0.00	0.00	

TOTAL HAZ. MAT. TRUCKS = 28

SAMPLE SIZE = 7 HOURS

LIGHT TRUCKS = VEHICLE WITH THREE AXLES
HEAVY TRUCKS = VEHICLE WITH MORE THAN THREE AXLES

APPENDIX B

LITERATURE REVIEW

B.1 EFFECTS OF TRUCKS ON FREEWAY OPERATIONS AND SAFETY

1. HIGHWAY ACCIDENT REPORT CATES TRUCKING, INC., TRACTOR-SEMI-TRAILER/MULTIPLE-VEHICLE COLLISION AND OVERRIDE, I-285, ATLANTA, GEORGIA, JUNE 20, 1977

National Transportation Safety Board; Bureau of Accident Investigation; Washington, D.C.; 20594

#NTSB-HAR-78-5; 14 September 78; 23 p.

By 3:05 p.m., e.d.t., on June 20, 1977, traffic had backed up and stopped in the right lane of I-285, eastbound, just south of downtown Atlanta, Georgia, and west of a construction zone which was located on connecting I-75 southbound. An eastbound Cates Trucking, Inc., tractor-semitrailer combination vehicle approached the standing traffic at between 35 and 45 mph and collided with and overrode the last automobile in the queue. The automobile was pushed into the vehicle ahead, and two other vehicles to its front were subsequently involved. No fire ensued. Four persons in the automobile were killed, and one was hospitalized; a second driver received minor injuries. The National Transportation Safety Board determines that the probable cause of this accident was the failure of the truckdriver to maintain the proper level of attention to the driving task and perceive the standing vehicles on the roadway and stop his vehicle short. Contributing to the accident was the failure of the Georgia Department of Transportation to implement existing standards and guidelines for controlling traffic through construction zones, which permitted a 3 1/2-mile backup of slow moving and stopping traffic.

2. ASSESSMENT OF THE RISK OF TRANSPORTING GASOLINE BY TRUCK

Battelle Memorial Institute/Pacific Northwest Labs; Battelle Boulevard, P.O. Box 999; Richland, Washington; 99352
Department of Energy; 1000 Independence Avenue, SW; Washington, D.C.; 10585

November 78; 190 p.

FT-Contract; CN-EY-76-C-06-1830

Based on shipping assumptions and the current accident rate of 2.5 x 10 exp -6 per mile, it is estimated that gasoline tank trucks will be involved in 1,781 accidents in 1980, and that 110 of the accidents (about one in 15) will result in a release of 3,000 gallons of gasoline or more from the tank truck. About one in four of the releases in 1980 is 29, with 12 of these fatalities being drivers of gasoline tank trucks, and the other 17 being occupants of other vehicles involved in the accident. Fatalities of other members of the public were found to occur infrequently. An additional 26 persons are expected to be fatally injured from the accident forces, regardless of the hazardous nature of the cargo. These total fatality figures (55) were compared to the prediction of 43 deaths of the Bureau of Motor Carrier Safety.

3. *DRIVERS OF HAZARDOUS CARGOES--LEGAL ASPECTS OF A MAXIMUM AGE AND INCREASED PHYSICAL REQUIREMENTS*

Hricko, AR

Federation of Insurance Counsel Quarterly; Federation of Insurance Counsel; 1205 Red Rambler Road; Jenkintown, Pennsylvania; 19046

V31 N2; 81; pp 126-134
#HS-032 474

Due to the increasing involvement of heavy duty trucks in fatal crashes, there has arisen a movement to correct the highway environment and the trucks themselves, along with proposals to upgrade the standards for drivers of these vehicles, including proposals concerning stricter age and physical requirements for initiation and renewal of drivers' licenses. The purpose of this paper is to review some of the legal arguments which may arise from these proposals. These three questions are addressed: (1) Can the state establish a maximum age beyond which it would not issue a driver's license? (2) Can applicants for commercial drivers' licenses, as part of a periodic physical examination program, be required to pass certain strength tests relating to their ability to physically operate commercial vehicles? (3) Can truck drivers be required to undergo physicals by certain physicians approved by the licensing authority rather than a physician of their own choosing?

4. *SAFETY EFFECTIVENESS EVALUATION--FEDERAL AND STATE ENFORCEMENT EFFORTS IN HAZARDOUS MATERIALS TRANSPORTATION BY TRUCK*

National Transportation Safety Board; Office of Evaluation and Safety Objectives; Washington, D.C.; 20594; 3184

#NTSB-SEE-81-2; 19 Feb 81; 110p; Figs.; Tabs.; Apps.
#HS-032 610

The National Transportation Safety Board, at the request of the Senate appropriations committee, has just completed a safety effectiveness evaluation of Federal and State enforcement efforts in the area of bulk hazardous materials transportation by commercial motor vehicle. As a result of this evaluation, the Board found that there are several improvements that should be made to the enforcement activities of the Bureau of Motor Carrier Safety (BMCS) in the Federal Highway Administration (FHWA). In its evaluation, the Board staff interviewed BMCS officials in the headquarters office and in eight of the nine FHWA Regions. In addition, the Board staff interviewed State enforcement officials in 24 states, including 3 of the 4 States participating in the BMCS "Commercial Motor Carrier Safety Inspection and Weighing Demonstration Program." Federal Hazardous Materials Regulations is not separate from its enforcement of the Federal Motor Carrier Safety Regulations, the board found that, in general, the same deficiencies undermine the effectiveness of both efforts. Thus, the major findings of the Board concerning BMCS enforcement apply equally to enforcement of the motor vehicle-related Federal Hazardous Materials Regulations and the Federal Motor Carrier Safety Regulations.

5. *REGULATION OF THE MOVEMENT OF HAZARDOUS CARGOES ON HIGHWAYS (ABRIDGMENT)*

Baldwin, DM; Private consultant

Transportation Research Record; Transportation Research Board; 2101 Constitution Avenue, NW; Washington, D.C.; 20418

N833; 81; pp 37-40; 6 Ref.

This paper follows up on the work of an American Association of State Highway and Transportation Officials (AASHTO) task force that looked into the movement of hazardous materials on the highway and what states were doing about it. The current work reviews the AASHTO effort and supplements it with further field contacts. A number of conclusions are reached, and a series of recommendations for state action are offered. Principal conclusions are that the problem is serious but not major when compared with the total traffic safety problem. There are great similarities between safety problems for hazardous material and other traffic safety problems. The existence of many agencies at all official levels as well as in the private sector makes the problem more difficult, and therefore, the need for better communications is obvious. A final conclusion is that all states need adequate legislation, an administrative program, enforcement capability, an educational program, and incident-response capability. Recommendations to the states include the following: (a) adopt appropriate state regulations for motor carrier safety and highway transportation of hazardous materials; (b) identify administrative elements that have responsibilities in the area, define the role of each, and develop effective communications among them; (c) develop an effective incident-response capability; (d) provide training for all personnel; (e) adopt a statewide policy on routing of hazardous materials; (f) institute a data collection system to provide information needed: (g) include hazardous materials considerations in bridge and highway design; (h) conduct a public information program; and (i) consider research in at least three other areas. (Author)

6. *THE 55 MPH LIMITS AND FRONT-TO-REAR COLLISIONS INVOLVING AUTOS AND LARGE TRUCKS*

Zaremba, LA; Insurance Institute for Highway Safety
Ginsburg, MJ; Insurance Institute for Highway Safety

Accident Analysis and Prevention; Pergamon Press; Maxwell Houston, Fairview Park; Elmsford, New York; 10523; 0001 4575

V9 N4; December 77; pp 303-314; 1 Fig.; 10 Tab.; 28 Ref.

The effects of the establishment of 55 mph limits on front-to-rear crashes involving automobiles and trucks were examined. Since the establishment of 55 mph limits resulted in a reduction in the difference between the reported average speed of automobiles and large trucks, it provided an opportunity to examine the effects of speed differences on the frequency of crash involvement of these vehicles. Principal results of the study were as follows: in 1974, the year of the introduction of 55 mph speed

limits, a substantial reduction in the number of front-to-rear crashes involving an automobile and tractor trailer on higher speed roads occurred in the states whose experience was examined. A substantial decline in the number of front-to-rear crashes involving an auto and single body truck on higher speed roads also occurred in 1974 in these states. The decline in the number of front-to-rear crashes involving an automobile and tractor trailer on higher speed roads was primarily the result of a major decline in the number of crashes in which an auto struck a tractor trailer in the rear. The number of crashes in which a tractor trailer struck an auto in the rear declined by a much smaller percentage. The decline in the number of front-to-rear crashes involving an automobile and single body truck on higher speed roads resulted from comparable decreases in the number of crashes in which an auto struck a single body truck in the rear and those in which a single body truck struck an auto in the rear. Prior to the establishment of 55 mph limits, tractor trailers struck automobiles in the rear in more than half of the front-to-rear crashes involving these vehicles on both higher and lower speed roads. Because the major decline in the number of crashes in which autos struck tractor trailers in the rear following the introduction of the new limits was not matched by as large a decline in the number of crashes in which tractor trailers struck autos in the rear, there was a significant increase in the proportion of front-to-rear crashes involving an automobile and tractor trailer in which the tractor trailer struck the automobile in the rear on higher speed roads. Prior to the establishment of 55 mph limits, single body trucks struck autos in the rear in a lower proportion of their front-to-rear crashes with autos than did tractor trailers. The proportion of front-to-rear crashes involving an automobile and single body truck in which an auto was struck in the rear by a single body truck was not significantly affected by the establishment of 55 mph limits.
(a)
/TRRL/

Transport and Road Research Laboratory; IRRD-232716

7. HEAVY TRUCKS AND FATAL CRASHES: AN UNRESOLVED DILEMMA

Li, LK; North Carolina University
Waller, PF

Society of Automotive Engineers Preprints; Society of Automotive Engineers; 400 Commonwealth Drive; Warrendale, Pennsylvania; 15096; SEPPA8

#SAE 810518; 81; 9p; 7 Ref.

Heavy trucks are an integral part of the transportation system of the eighties. However, analyses of crashes from FARS, BMCS and North Carolina crash files indicate that heavy trucks pose great danger for occupants of vehicles with which they collide. Furthermore, during the past few years, fatal crash involvement rates have been dramatically increasing and in 1978, the rate was twice that of passenger cars. To account for the safety hazards associated with heavy trucks, three hypotheses have been suggested. Changes in design and in qualifying drivers are recommended to improve heavy truck safety.

8. *COLLISIONS OF CARS WITH TRACTOR-SEMITRAILERS*

Kubacki, MS

Highway Safety Research Institute Research Review; University; Huron Parkway and Baxter Road; Ann Arbor, Michigan; 48109

V10 N3; 79; pp 1-7; Figs.; 9 Tab.; 8 Ref.

The NHTSA Fatal Accident Reporting System file was analyzed to identify conditions under which passenger cars struck the side or rear of tractor-semitrailers. The chief finding was that most such collisions occur at night. This suggests that car drivers do not see the semitrailer soon enough to avoid striking it. Making semitrailers more visible at night should prevent some car-into-semitrailer collisions. (Author)

National Safety Council, Safety Research Info Serv; 800950 R

9. *CAR-TRUCK FATAL ACCIDENTS IN MICHIGAN AND TEXAS*

Minahan, DJ
O'Day, J

Highway Safety Research Institute; Huron Parkway and Baxter Road; Ann Arbor, Michigan; 48105
Motor Vehicle Manufacturers Association; 320 New Center Building; Detroit, Michigan; 48202

#UM-HSRI-77-49; Oct 77; 46 pp

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

10. FATAL CAR-INTO-TRUCK/TRAILER UNDERRIDE COLLISIONS

Minahan, DJ
O'Day, J

HSRI Research Review; Highway Safety Research Institute; Huron Parkway and Baxter Road; Ann Arbor, Michigan; 48105

V8 N3; December 77; pp 1-16; Figs.

To estimate the current national frequency of underride collisions and to assess the effectiveness of underride guards used on large trucks and tractor-tailers, HSRI examined all fatal car-truck collision cases in Michigan (1972-1976) and Texas (1975-1976). The impact configurations and degree of underride were established by examining the police accident reports and photos and, when possible, interviewing the investigating police officers. Relative impact speed was estimated for each case. An estimate based on the multi-year data puts the current number of fatal car-into-truck underride collisions at 456 nationally. This includes 261 rear impacts and 195 side impacts. An estimate based on only the 1976 data puts the current national total at 571. This includes 308 rear impacts and 263 side impacts. Of the 181 car-truck/trailer fatal crashes studied, underride occurred in more than 90 percent of the cases. Among the study conclusions: the frequency of such collisions would be reduced if trucks and trailers were made more conspicuous, and the frequency of underrides in car-into-truck collisons would be reduced if trucks and trailers were equipped with improved underride guards. (Author)

11. THE EFFECT OF TRUCK SIZE AND WEIGHT ON ACCIDENT EXPERIENCE AND TRAFFIC OPERATIONS. VOLUME I: EXECUTIVE SUMMARY

Vallette, GR
Hanscom, FR

Biotechnology, Incorporated; 3027 Rosemary Lane; Falls Church, Virginia; 22042
Federal Highway Administration; 400 7th Street, SW; Washington, D.C.; 20590

Final Rpt.; #FHWA-RD-80-135; July 81; 20p
#FCP 31U1-022

FUNDING AGENCY:
FHWA Code E-0572

FT-Contract; CN-DOT-FH-11-8835

This report describes two major studies that were conducted to determine the effect of truck size and weight on accident experience and traffic operations. The first study involved a field evaluation of the effect of truck size and weight on traffic operations. The second study addressed the effect of truck size and weight on accident experience. The field study examined traffic operational effects associated with truck size and weight. Selected highway geometric conditions were: upgrades (short, long; slight, steep), downgrades (long, steep), curves (freeway, non-freeway), grade/curve combinations, merge areas, ramps, and urban intersections. Matched weight and operational data were gathered on nearly 6,000 trucks ranging in gross weight from approximately 20,000 to 160,000 pounds. Extensive traffic operations measures obtained via electronic roadway sensors included: flow (e.g., speed, acceleration), perturbations (e.g., speed variance, deviation from traffic speed), accident potential (e.g., closure rate, projected collision time), delay (e.g., speed delays by following vehicles), and passing behavior (e.g., relative passing speed). The objective of the accident study was to determine the effect the size and weight of large trucks has on accidents and traffic operations. The effect on accidents was determined by comparing the accident rates for a variety of truck types defined in terms of configuration, size, and weight. The accident rate is obtained by dividing the number of accidents of a specific truck type, size, and weight by the exposure mileage (opportunity to have an accident) for that same truck type, size, and weight. Data were collected for all large truck accidents occurring on 78 roadway segments in six states. In total, 2,112 accident involvements were investigated in-depth over a 1-1/2-year period in 1976-1977. (FHWA)

12. *THE EFFECT OF TRUCK SIZE AND WEIGHT ON ACCIDENT EXPERIENCE AND TRAFFIC OPERATIONS. VOLUME II. TRAFFIC OPERATIONS.*

Hanscom, FR

Biotechnology, Incorporated; 3027 Rosemary Lane; Falls Church, Virginia; 22042
Federal Highway Administration; 400 7th Street, SW; Washington, D.C.; 20590

Final Rpt.; #FHWA-RD-80-136; July 81; 222p
#FCP 31U1-022

FUNDING AGENCY:
FHWA Code E-0569

FT-Contract; CN-DOT-FH-11-8835

This field study examined traffic operational effects associated with truck size and weight. Selected highway geometric conditions were: upgrades (short, long; slight, steep), downgrades (long, steep), curves (freeway, non-freeway), grade/curve combinations, merge areas, ramps, and urban intersections. Matched weight and operational data were gathered on nearly 6,000 trucks ranging in gross weight from approximately 20,000 to 160,000 pounds. Extensive traffic operations measures obtained via electronic roadway sensors included: flow (e.g., speed, acceleration), perturbations (e.g., speed variance, deviation from traffic speed), accident potential (e.g., closure rate, projected collision time), delay (e.g., speed delays by following vehicles) and passing behavior (e.g., relative passing speed). Three analytical procedures determined: operational differences between truck groupings (e.g., loaded versus empty, single-versus double trailer combination), correlations between truck characteristic and operational measures, and the predictive effect of truck weight on speed. Despite numerous operational differences associated with truck size and weight, the observed effects were weak. Typical truck grouping differences were: generally reduced speeds, higher deviations from traffic mean speeds, and higher closures with following vehicles, all exhibited by loaded and double trailer rigs (by comparison with empties and singles, respectively). The correlative analysis demonstrated that higher gross weight was often found to be associated with lower truck speed, poor acceleration performance, and both delay and high closures with respect to following vehicles. Negligible operational effect was associated with truck length. Adverse safety effects were most pronounced on upgrades; certain safer behavior was noted for heavier trucks on downgrades. The analyses demonstrated that a maximum of only 37 percent of truck operational effects were explainable by truck size and weight. (FHWA)

13. THE EFFECT OF TRUCK SIZE AND WEIGHT ON ACCIDENT EXPERIENCE AND TRAFFIC OPERATIONS. VOLUME III: ACCIDENT EXPERIENCE OF LARGE TRUCKS.

Vallette, GR
McGee, H
Sanders, JH
Enger, DJ

Biotechnology, Incorporated; 3027 Rosemary Lane; Falls Church, Virginia; 22042
Federal Highway Administration; 400 7th Street, SW; Washington, D.C.; 20590

Final Rpt.; #FHWA-RD-80-137; Jul 81; 145p
#FCP 31U1-022

FUNDING AGENCY:
FHWA Code E-0523

FT-Contract; CN-DOT-FH-11-8835

The objectives of this study was to determine the effect the size and the weight large trucks have on accidents and traffic operations. The effect on accidents was determined by comparing the accident rates for a variety of truck types defined in terms of configuration, size and weight. The accident rate is obtained by dividing the number of accidents of a specific truck type, size, and weight by the exposure mileage (opportunity to have an accident) for that same truck type, size, and weight. This volume documents the methodology used to obtain the accident and VMT exposure data. Tables of accident distributions and accident rate calculations are presented. Data were collected for all large truck accidents occurring on 78 roadway segments in six states. In total, 2,112 accident involvements were investigated in-depth over a 1-1/2-year period in 1976-1977. (FHWA)

14. COMMERCIAL VEHICLE ACCIDENT FACTORS

Fleischer, GA; University of Southern California

Transportation Research Record; Transportation Research Board
2101 Constitution Avenue, NW; Washington, D.C.; 20418

N706; 79; pp 28-36; 2 Fig.; 4 Tab.; Refs.

The results of a 12-month study of commercial vehicle accidents in California are reported. Statistics on approximately 3000 accidents were studied. The objectives were to establish and evaluate appropriate procedures for developing the data base and associated statistical analysis techniques. Other objectives included deriving inferences about accident causation and evaluating the potential of possible countermeasures. The characteristics of the sample and the format and procedures used in data collection and reduction are summarized, and selected results are presented. /Author/

15. STATISTICAL ANALYSES OF COMMERCIAL VEHICLE ACCIDENT FACTORS. VOLUME I, PART I

Philipson, LL
Rashti, P
Fleischer, GA

University of Southern California; University Park; Los Angeles, California; 90007
National Highway Traffic Safety Administration; 400 7th Street, SW; Washington, D.C.; 20590

Final Rpt.; #DOT-HS-803-419; Mar 78; 56 p.
#78/2

FT-Contract; CN-DOT-HS-7-01565

The report presents the results of a study of commercial vehicle accident statistics, with the objectives of establishing and evaluating appropriate data base development procedures and statistical analysis techniques, and of deriving inferences about accident causation and the potential of possible countermeasures. Special aspects of the study are the estimation and introduction into the causation analysis of (a) the exposure of commercial vehicles to accidents, and (b) surrogates for accident economic costs. (Portions of this document are not fully legible).

16. STATISTICAL ANALYSES OF COMMERCIAL VEHICLE ACCIDENT FACTORS. VOLUME II: SUMMARY REPORT

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Philipson, LL

University of Southern California; University Park; Los Angeles, California
90007

National Highway Traffic Safety Administration; 400 7th Street, SW; Washington, D.C.; 20590

Final Rpt.; #DOT-HS-803-418; Feb 78; 403 p.
#78/1

FT-Contract; CN-DOT-HS-7-01565

Procedures for conducting statistical analyses of commercial vehicle accidents have been established. A file of some 3,000 California Highway Patrol accident reports from two areas in California during a period of about one year in 1975-76 provides the data base. While necessarily limited in scope, certain initial accident causation and countermeasure implications were established from the analyses. These related to multi-unit jackknife and brakes-related accidents and accident severity. Finally, the effect of considering economic costs of accidents instead of only the frequency of their occurrences was briefly investigated.

17. COMPARISON OF CALIFORNIA ACCIDENT RATES FOR SINGLE AND DOUBLE TRACTOR-TRAILER COMBINATION TRUCKS

Yoo, CS
Reiss, ML
McGee, HW

Biotechnology, Incorporated; 3027 Rosemary Lane; Falls Church, Virginia; 22042
Federal Highway Administration; 400 7th Street, SW; Washington, D.C.; 20590

Final Rpt.; #FHWA-RD-78-94; Mar 78; 70p

FT-Contract; CN-DOT-FH-11-8835

This report provides a comparison of the relative safety of two types of truck combination vehicles, singles and doubles. The single referred to in this report is a tractor unit attached to a semi-trailer, and the double analysed consists of a tractor, semi-trailer, and full trailer, in that order. 1974 accident data for California, the state having the closest to a 50-50 split between the two truck classifications, was combined with estimates of truck exposure to arrive at accident and injury rates based on vehicle miles of travel. Also, estimates of average cargo weights were determined to evaluate the safety of the two vehicles on the basis of cargo ton-miles of travel. The results of the analysis show that doubles resulted in more fatalities per million vehicle miles of travel, but that singles had higher accident rates on the basis of cargo ton-miles of travel. (FHWA)

18. REPORT ON TRUCK ACCIDENTS

PERFORMING AGENCY:
Texas Transportation Institute, Texas A&M University System; 307 West 9th Street; Austin, Texas; 78701

INVESTIGATOR:
Griffin, LI,III: #(512) 479-0895

FUNDING AGENCY:
National Highway Traffic Safety Administration; 400 7th Street, SW; Washington, D.C. 20590

AS-Completed; RD-05, Nov 81; SD-Jan 81; TF-$9830; FT-Contract; CN-DTNH22-81-P-07156

To describe for Texas and the U.S. the number of truck accidents and their characteristics. Among the characteristics to be considered are body style, most severe injury in accident, driver age and sex, contributing factors, driver citation, accident type, damage extent, impact type, etc. The analyses will be based on the 1979 Texas Accident File and the 1979 NASS File; the output of the data processing will be typically in tabular or cross-tabular form.

19. EFFECT OF NATIONAL SPEED LIMIT ON THE SEVERITY OF HEAVY-TRUCK ACCIDENTS

Radwan, AE; Purdue University
Sinha, KC; Purdue University

Traffic Quarterly; Eno Foundation for Transportation, Incorporated; P.O. Box 55, Saugatuck Station; Westport, Connecticut ; 06880

V32 N2; Apr 78; pp 319-328; Figs.; 4 Tab.; 9 Ref.

This article presents an analysis of the effect of the 55-mile-per-hour speed limit on the severity of heavy-truck accidents in Indiana. In addition, a cost analysis of such accidents is given on the basis of estimates of direct costs on Indiana rural state highways. Specifically, the scope and objectives to this study are as follows: 1. Compute the fatality, property damage, and personal injury accident rates involving heavy trucks for the highway sections under study. 2. Analyze statistically the changes in the computed rates for each type of accident since the imposition of the 55-mile-per-hour speed limit. 3. Compute total cost of accidents in terms of current dollars. 4. Analyze statistically the change in accident costs due to imposition of the 55-mile-per hour speed limit.

National Safety Council, Safety Research Info Serv; 780234 J

20. ACCIDENTS AND THE NIGHTTIME CONSPICUITY OF TRUCKS FINAL REPT. JUL 78-JUL 79

Green, P
Kubacki, M
Olson, PL
Sivak, M

Highway Safety Research Institute; Huron Parkway and Baxter Road; Ann Arbor, Michigan; 48105
Motor Vehicle Manufacturers Association; 320 New Center Building; Detroit, Michigan; 48202

Final Rpt.; #UM-HRSI-79-92; Dec 79; 57p

Three papers related to the conspicuity of trucks and collisions between cars and trucks are published. The first paper, a review of the Fatal Accident Reporting System (FARS) data, indicates that most fatal car-into-truck accidents occur during hours of darkness, pointing to a potential lack of nightime truck conspicuity. The third report, an exploratory field study, indicates that conspicuity-enhancing retroreflective treatments applied to the rear and sides of trucks caused drivers to look at the trucks more often and at greater distances.

21. MOTOR VEHICLE SIZE AND WEIGHT REGULATIONS, ENFORCEMENT, AND PERMIT OPERATIONS

NCHRP Synthesis of Highway Practice; Transportation Research Board; 2101 Constitution Avenue, NW; Washington, D.C.; 20418

N68; Apr 80; 45p; 8 Fig.; 21 Tab.; 8 Ref.; 3 App.

Many of the problems associated with enforcing oversize and overweight limits derive from the confusing variety of requirements--for applications, fees, issuance, signs, and flags, escorts, actual limits, fines--from state to state and within states. This lack of uniformity sometimes leads truckers to believe that it is cheaper and less time consuming to risk being caught than to conform to law. The report strongly recommends that uniform standards for interstate overlimit travel be sought. Enforcement efforts and permit procedures also need to be coordinated. (Author)

22. VEHICLE SIZE AND WEIGHT REGULATIONS, PERMIT OPERATION, AND FUTURE TRENDS

Layton, RD; Oregon State University
Whitcomb, WG; Oregon State University

Transportation Research Record No 687; Transportation Research Board; 2101 Constitution Avenue, NW; Washington, D.C.; 20418

N687; 78; pp 39-45; 9 Fig.; 5 Tab.; 12 Ref.

This paper reviews current limits on truck sizes and weights, present practices in permit issuance, and current trends in vehicle sizes and weights. Present legal limits on sizes and weights are summarized, and the permit operations of several states are reviewed. Future trends in the sizes and weights of trucks are indicated. Problems of and implications for the present highway system are identified and discussed. (Author)

23. *HIGHWAY SIGHT-DISTANCE REQUIREMENTS: TRUCK APPLICATIONS*

Gordon, DA

Federal Highway Administration; Traffic Systems Division, Office of Research; Washington, D.C.; 20590

Final Rpt.; #FHWA-RD-79- 26; Feb 79; 40 p.
#FCP 21J1-122

FUNDING AGENCY:
FHWA Code T-0332

This report is concerned with problems of vehicle eye-height, with particular reference to trucks. The analysis indicates that the inferior braking of truck on vertical curves is compensated for, on the average, by increased visibility due to raised eye-height. However, this is not true for the long stopping distances required in the case of heavily loaded trucks. In particular, the cab-under truck design, with eye-height barely above .91 meters does not have the visibility advantage of conventional trucks and consequently does not have any compensation for inferior braking ability. Passing zone markings, standardized for passenger cars, are not adequate for trucks. Trucks require 50 percent more distance than passenger cars to pass on two-lane roads. The higher eye-height advantage does not fully compensate on crest vertical curves for the passing disadvantage. It is suggested that an explicit procedure be designated for determining the geometric design eye-height standard. The methodological considerations underlying such a procedure are discussed. It is shown that the adoption of the 1.07 meters (3.5 foot) eye height standard, presently under consideration, would result in a 2 1/2 percent reduction in design sight distance on vertical curves barely long enough to meet geometric construction standards. (FHWA)

B.2 DRIVER RELATED FACTORS IN COMMERCIAL VEHICLE SAFETY AND OPERATIONS*

The following is a compilation of articles, reports, and studies pertaining to driver aspects of overall Safety and Traffic operations of larger trucks. Articles related to five areas have been included: truck driver regulations and licensing; truck driver training and safety; driver profile and performance; trucker related accidents; and trucker transport of hazardous materials.

The truck regulations and licensing section represent a collection of articles pertaining to present problems in programs for licensing truck drivers and suggestions for upgrading the effectiveness of qualification and monitoring systems. Areas of concern are related to the driver's knowledge and skill levels demonstrated in requirement to receive a license. Most articles indicate a problem with the lack of adequate regulations as well as their enforcement. Regulation topics include such non-driver related physical aspects of the trucks such as braking systems and lighting systems as well as aspects of driver such as regulations restricting his or her driving hours, skills, and physical/ medical related requirements. The topic of inspections as a form of monitoring and enforcing the regulations is discussed.

The driver training and safety is essentially an extension of regulations and licensing systems. The demonstration of proficiency in both written and skill demonstration tests is recommended as a licensing requirement. The articles contain references to several different driver training programs; curricula, and methods of implementing these programs. Lack of professional training is cited as a major cause of accidents that do occur. Most articles contend that truckers should have a greater level of safety education. Topics in training programs include how to handle an emergency situation, how to operate controls and safety devices; education of maintenance and repair, instructions in truck maneuvering, and skid control training.

The truck driver profile and performance section discusses factors of the driver that relate to his/her driving performance. Studies include driver vision and audition, fatigue, decision-making capabilities, awareness levels, drug and alcohol factors, sleep and rest requirements, and physical/medical requirements.

The fourth section of this literature review is mainly comprised of two types of articles. The first type is accident investigation reports. Information presented generally included the number of fatalities and injuries, the amount of property damage, the types of vehicles involved, the environmental circumstances, a description of the accident, and most importantly the probable cause of the accident. Causes of accidents listed range from truck defects to inadequate truck driver performance.

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*Prepared by L. Lampen and K. Palko, Human Factors Division TTI.

The second type of accident material presented is studies and articles summarizing causes of accidents and available truck related accident statistics. Collision factors in the data analysis included statistician truck size, weight, speeds, structure, safety devices, braking systems, times of day, day of the week, road type, accident type and severity, injury and fatalities, driver characteristics, both physical and mental, as contributory factors in accidents, and cost of property damage resulting from accidents.

The fifth section of this report is concerned with the transport of hazardous materials. Very little literature is available. However, the hazardous material most often carried is flammable or combustible. Safety performance standards for the carrying of hazardous materials are discussed.

B.2.1 Truck Regulations and Licensing

1. Winsor, Jim. "The High Cost of Poor Driver Licensing". Commercial Car Journal v118 n4 1969 Monograph p-73-8 . Report No. HS-009-220; Subfile: HSL

The need for uniform commercial driver licensing in all the states is discussed. Differing laws for truck drivers, motorcycle operators, chauffeur's license, commercial buses, and school buses are mentioned. The "class license" as specified in the Uniform Vehicle Code, and if accepted by all the specified in the Uniform Vehicle Code, and if accepted by all the states is seen as the solution to conflicting standards and gross vehicle weight limits for the classes are continuing problems. Motor Carrier Safety Regulations and their proposed changes are given. Comments on these regulations include: a point system be used as a basis for disqualifying a driver; periodic re-testing of drivers be required; minimum age be lowered to 18. Fleetmen are urged to support legislation favoring "one driver-one license" concept with the class system built in.

2. Richardson, Bellows, Henry and Company, Inc. "The Development of Written Examinations on the Motor Carrier Safety Regulations". 1140 Connecticut Avenue, NW; Washington; D.C.; 20036, July 1972 Final Report 142 p. 1972. AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22151. Report No.: RBH-TR-72-1; PB-213402/ CONTRACT No.: DOT-FH-11-7807; Contract. Subfile: NTIS

This report describes the construction of a set of written examinations designed to adequately sample the Motor Carrier Safety Regulations. Interstate commercial vehicle driver candidates are recommended to be required to correctly answer 70% of the items in whatever examination form is utilized before they are considered qualified to drive, in terms of safety regulations knowledge. Four standarized multiple-choice test forms were developed, two to be used by carrier whose drivers will not transport hazardous materials, two to be used by carriers whose drivers will transport hazardous materials. The test forms are considered to meet the technical requirements for such measuring instruments in terms of reliability, internal consistency and equivalency. Under the distinctions provided in the Equal Employment Opportunity Commission "Guidelines on Employee Selection Procedures", the office of Federal Contract Compliance "Employee Testing and Other Selection Procedures" and the American Psychological Association "standards for Education and Psychological Tests and Manuals", the examinations should be considered content valid achievement tests. (Author)

3. Pollock, W.T.; McDole, T.L. "Development of A National Item Bank for Tests of Driving Knowledge. Final Report. Michigan Univ., Ann Arbor. Hwy. Safety Res. Inst. 1974 319p. AVAILABLE FROM: NTIS Report No.: HS-801 159; Contract No.: FH-11-7616; Contract Subfile: HSL

Materials for driving knowledge test development use by operational and licensing and education agencies were prepared. Candidate test items were developed, using literature and operational practice sources, to reflect current state-of-knowledge with respect to principles of safe efficient driving, legal regulations, and traffic control devices. Such multiple-choice item pools

were developed for testing drivers of passenger cars and light trucks, motorcycles, and buses and trucks. Subsequent to item review by batteries of highway safety experts, field tests to collect psychometric, normative, and validation data for the passenger car and light truck items were conducted, along with similar evaluations and tests for motorcyclists. An operational manual is provided. Report for July 1970-September 1973.

4. Hutchinson, B.M.; Sanders, B.A.; Galuz, W.D. "Effects of Current State Licensing, permit and Fee Requirements on Motor Trucks Involved In Interstate Commerce". Midwest Research Institute; .425 Volker Boulevard; Kansas City; Washington; Missouri; D.C.; 64110; 20590 April 1975 Final Report 249 pp 1975. AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161. REPORT NO.: FHWA-RD-75- 40; PB-241983/6ST CONTRACT NO.: DOT-FH-11-7989; Contract SUBFILE: NTIS; HRIS.

The study examined nonuniform state licensing and permit requirements on commercial interstate truckers as well as taxes and fees associated with those requirements. Over 750 truck drivers, were interviewed at 10 locations across the country to determine the extent to which current license, permit, tax, and fee requirements pose a trucking industry problem. Eleven motor carriers and several officials from each of nine states were also interviewed. The following areas were studied: (1) registration, fuel, and third structure tax requirements; (2) utilities commission requirements; (3) industry procedures and activities for compliance including obtaining permits, record keeping, report filing, and enforcement activities; (4) out-of-pocket costs of trucker compliance including taxes, permit costs and bond expenses; (5) differences in costs among private, exempt and regulated carriers; (7) apportionment, prorating and reciprocity; and (8) the effect of a federally administered system of taxes.

5. Waller, Patricia, F., et al. "Classified Licensing: Development of Procedure and Materials". Vol. 3. Appendices. Licensing of Operabors of Large Trucks and Buses; University of North Carolina, Hwy. Safety Research Center, Chapel Hill, N.C. 12pp-1976.

A summary of information is provided by the North Carolina Bus Association on the selection and training of bus operators, and information on North Carolina trucks and buses in crashes and on the vehicle registration file. Also provided are the truck operator manual with proposed illustrations, truck operator knowledge tests with answer keys, and bus operator knowledge test with answer key. Under a system of classified licensing, operators of large trucks would be required to demonstrate special knowledge and skill.

6. Taylor, R.C. "Driver Control in The Trucking Industry". American Association for Automotive Medicine. Proceedings of the 21st Conference p. 154-9. Morton Grove, Ill. 1977.

The accident involvement rate for the motor carrier industry is the best of any highway user group due to the industrys' driver control procedures and the regulations of the Bureau of Motor Carrier Safety (BMCS). Physical requirements for interstate truck and bus drivers are tougher than those for any other drivers. The BMCS has guidelines to help physicians specializing in industrial medicine to administer the physical exams. A driver may also be tested for his knowledge of Federal regulations and for his driving skills.

Driving records of applications must be checked. Federal regulations place a limit of 10 hrs of driving followed by 8 hrs of rest. Motor carriers have cooperative highway patrols to report both good and bad performance. Consolidated Freightways has its own road patrol system as well as a mobile training and retraining unit. They have also organized truck stop safety meetings.

7. Cox, Ernest G. "From the Beginning Safety was the Goal Commercial Vehicle Industry, Safety Progress During the Past 50 Years". Fleet Owner (Anniversary Issue 1928-1978) p119-21 1978 Monograph (Mid-Oct 1978) REPORT NO.: HS-024 662; SUBFILE: HSL

Truck and bus industry safety progress during the past 50 years or so has paralleled regulation, principally Federal regulation resulting from an subsequent to the 1935 enactment of the Motor Carrier Act. The major purpose of the Act was to establish economic stability in the rapidly growing transportation industry; safety was incidental. Regulation of the motor carrier industry was entrusted to the Interstate Commerce Commission (ICC), and in 1940, the ICC really began exercising its safety authority. In addition to driver qualifications and hours of service permitted, legal rulings encompassed the safety of operation and equipment of motor carriers as well as proper reporting of accidents. The rules applied to common and contract carriers at the outset, and eventually included private carriers. Hazardous loads came under much closer scrutiny as carrying of munitions and other types of explosives by truck became commonplace. Flammable liquids, compressed gases, poisons, and acids were subject to jurisdiction derived from the Transportation of Explosives Act, which originally related to railroads. As the complexities of regulating hazardous materials transportation grew, the size of the safety inspector staff failed to keep pace. Nevertheless, nore stringent rules were put into effect and better methods of stimulating carrier compliance were found. During the 1950's, a series of downhill runaway accidents revealed that certain brake components sometimes were being neglected by fleets engaged in hazardous-materials transport. Industry and government cooperated to make mandatory brake protection devices on tractors, as well as means of emergency activation of trailer brakes on all hazardous-materials rigs. During the 1960's, lighting regulations and hours of service were revised. Drastically strengthened specifications for the type of steel used in cargo tanks, and in their design and fabrication, were adopted. In spite of all precautions, the hazardous-hauling problem is far from solved. Management, labor, and government are all aware that reliable data must be assembled to determine where progress has been made in highway safety, and what directions to take next.

8. Waller, P.F.; Li, L.K. "Requirements Analysis For A Heavy Vehicle Licensing System". North Carolina University at Chapel Hill. Highway Safety Research Center.; National Highway Traffic Safety Administration, Washington, D.C. September 1980, 239p. AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161. REPORT NO.: DOT-HS-805-553; PB81-109753, CONTRACT NO.: DOT-HS-7-01807; Contract. SUBFILE: NTIS.

The project addressed the licensing requirements for drivers of heavy trucks and the feasibility of federal licensing of these drivers. Data analysis indicate that heavy trucks pose a problem, but many of the key questions cannot be adequately answered on the basis of available data. Although the Bureau of Motor Carrier Safety (BMCS) and state regulatory authorities have responsibility for the qualification and monitoring of many of the drivers of concern, in actual practice they are unable in insure that all drivers are qualified. This situation underscores the need for an effective licensing and monitoring system. Licensing recommendations cover verifications of driver identity; medical requirements; vision, knowledge, and skills testing; and an interstate identification field that is checked whenever license is first issued in any state. It is recommended that existing state programs in licensing, records, and enforcement be used in establishing an effective licensing program. Federal Standards with enforceable sanctions will probably be necessary to encourage states to upgrade their programs. However, a cooperative state program should be far more effective and less costly than a federal licensing program.

9. National Highway Traffic Safety Administration. "Classified Driver Licensing In The United States". Report NO: HS-805-532, 1980.

A review was made to identify weakness in State driver licensing systems. The data indicated that the cost of implementing a classified licensing program is less than $100,000 for the first year of operation. More uniformity is needed in medical aspects of licensing. It should be required by all states that the driving test be conducted in a vehicle comparable to the type the driver intends to operate. Pre-trip inspection as part of the driving test for heavy duty truck driver applicants should be required by all states. More uniformity in vehicle classifications is needed.

10. American Association of Motor Vehicle Administration. "Multiple Licensing and Interstate Truck Drivers--A Problem Statement". Report NO.: HS-805-645, 42p. 1981.

Data collected to date and the information supplied by the truck drivers indicate that the level of multiple licenses and records may be alarmingly high. An initial analysis of the drivers' records from only 5 states showed that from 10% to 32% of the drivers held licenses in more than one jurisdiction. The implication is that the states are unable to maintain current, complete data on this driver population and that a large percentage of these drivers are avoiding state driver improvement actions. The states should use the Social Security number as the primary or secondary driver identifier, participate fully in the National Driver Register, and improve and increase their efforts in applicant screening to determine prior license issuance, and in information and driver record interchange.

11. McDonald, N. "Safety and Regulations Restricting the Hours of Driving of Goods Vehicle Drivers". <u>Ergonomics</u>, Vol. 24, No. 6, HS-032-352, pp 474-485, June 1981.

Evidence suggests that both long hours of work and driving at night may be associated with an increased risk of accident; and a small part of recent improvements in the heavy goods vehicle accident rate may be due to regulations governing, amongst other things, drivers' hours. However, some drivers may be increasingly at risk because of high mileages and driving at night.

12. IIHS Status Report. "Danger Seen In Gap Between Truck, Auto Braking Requirements". Vol. 18, No. 9, June 21, 1983.

The Insurance Institute for Highway Safety testifies that a braking gap between passenger cars and heavy trucks poses a constant danger for car occupants. It was pointed out that while passenger cars must be able to stop from a speed of 60 mph in 216 feet or less, the only federal rule for air-braked trucks is that they be capable of stopping in 35-40 feet from a speed of 20 mph. In 1980 in a truck/car collision the car occupant was 30.6 times more likely to be killed. It is noted that the braking technology is not to blame for the disparity between car and truck stopping distances but rather NHTSA's failure to pursue the necessary rulemaking that would lead to the application of this braking technology. It was also suggested that designs be instituted in trucks to prevent them from going 65 and 70 mph on the highways due to the tremendous risks for the occupants of cars if they are hit.

B.2.2 Training and Safety

1. Darmstadter, Neil. "Truck Driver Training. A Manual For Driver-Trainers". American Trucking Associations, Inc. 1968.

This manual for truck fleets covers the essential elements of a fleet training program, included are: setting up a training program; public relations; safe driving rules; federal safety regulations; familiarity with the truck; inspection of equipment; basic operating techniques; operation of semi trailers and tractor trailers; training and testing of drivers; driver conduct at accident scenes; fire prevention and fire fighting; first aid; evaluation of training.

2. Heavy Duty Trucking. "Small Fleet Safety Program". v52 n7 Monograph p34-7. REPORT NO.: HS-018-575; SUBFILE: HSL

The American Trucking Association's Safety Department has developed a Small Carrier Safety Program for fleets with 25 trucks and under. The program, which is adaptable to both intra- and interstate operations, is designed to help small fleet operators to reduce insurance premiums, accident possibilities, lost equipment, repair costs, and cargo damage. This safety program includes sound hiring procedures, personnel orientation and training, driver controls and supervision guidelines, vehicle inspection and maintenance programs, methods for maintaining desirable employee attitudes and morale, records and reports, and occupational safety programs. An outline of Department of Transportation regulations in each of these areas and of sources of information or recommendations for compliance and/or procedures in each aspect of the total safety program and a basic outline of recommended practices and of references for further information and suggestions for compliance and improvement of present practices are provided.

3. Aic Newsletter. "Fleet Training Program Adds To Trucking Safety and Efficiency". 1973, p 2. SUBFILE: HRIS.

One contributor to making the U.S. Motor fleet drivers the safest in the world, and the mechanics able to keep down-time to a minimum is the national committee for motor fleet training, non-profit, public service based organization. The program is designed to train thousands of young new drivers entering the motor fleet industry and upgrade the skills of tens of thousands of older employees by training their supervisors and trainers. Areas of training include fleet supervision training, maintenance of commercial vehicles, motor fleet management, and graining of motor fleet trainers. The motor fleet training committee was created and financed by businesses and organizations in the motor transportation, highway safety and insurance fields. As an example of the economic results of this type program, the New Mexico state highway dept. claimed a saving of over one million dollars of the taxpayer's money over program, after seven of their safety supervisors had attended one of the courses.

4. Roland, G.E.; Kao, H.S.R.; Kennedy, J.C.; Kurzenabe, R.A. "A Driver Training Program For Commercial Vehicle Drivers (Minimum Standard Novice Truck Driver Training)". Rowland and Company; .P.O. Box 61; Haddonfield; New Jersey; 08033. Dec 1974, Final Report, 49pp Tabs. 1974. REPORT NO.: R&C 74-12-120; BMCS RD 75-1; CONTRACT NO.: DOT-FH-11-7988; Contract. SUBFILE: HSRI; HRIS

The fundamental objective of the study was to develop a performance-based curricula for novice truck drivers based upon an analysis of the motor carrier driver's task. Further objectives include a curricula of detailed training to be performed in the classroom as well as behind the wheel; entry level requirements; requirements for successful completion of the training program; guidelines for training programs; specification of a long-term plan for test evaluation and validation of the training program. Sponsored by the Federal Highway Administration, Bureau of Motor Carrier Safety.

5. National Safety News. "Programming Motor Fleet Safety". 1974 Monograph. Report No.: HS-014 708; SUBFILE: HSL.

Guidelines for a motor fleet safety program are presented. They include suggestions on recruitment, training, motivation, and recognition for operators of trucks, buses, postal, transit, and similar vehicles. The corporate obligation to protect employees and the public is stressed. Safety devices, information gathering techniques for driver evaluation, and specific training courses are outlined. Safety driving incentives are also given.

6. Williams, Frank M. "The Dilemma of The Fleet Safety Professional". Professional Safety 1975 Monograph. Report No.: HS-017 269; SUBFILE: HSL.

The special problems of the fleet safety professional and how they can be effectively handled are discussed. Problems inherent in the trucking industry include: lack of professional training; equal rates of pay for beginners and veterans; lack of loyalty to company because of unions or the independent nature of the task; and lack of supervision at any point on the job. Fleet safety directions deal with people; the machines are generally out of their control. Methods for preventing accidents (safety awards, competent hiring procedures, improving the prestige of professional drivers, a knowledge of industrial safety practices and governmental regulations) are discussed. Attempts that have been made to certify safety professionals are considered. It is concluded that it is best for a fleet safety professional to begin his career with the thorough grounding of a proven safety education and then go on to learn his specialty.

7. Wingate, Roger H. "Regarding Highway Safety Today. Statement by the Senior Vice President and General Manager, Loss Prevention Department, Liberty Mutual Insurance Company, Before the Senate Committee On Public Works, Subcommittee On Transportation, March 26, 1974. REPORT NO.: HS-017 268; SUBFILE: HSL.

The highway safety problems that result from truck/passenger car interaction, and both existing and projected trucking regulations, are discussed. The accident record (1947-1972) of the trucking industry is examined and it is concluded that safety can be best improved by concentrating on driver selection, driver training, and the auditing of driver performance. Studies of the accident records of twin-trailer combinations compared to those of conventional tractor-trailers are presented. A study of the records of an interstate trucking company 1970-1973 shows that the accident frequency rate per million miles of twin-trailers (2.61) was less than that for tractor-trailers (3.36). Data on the accident rates of full-loaded twin-trailers on the Indiana Tollroad, the Ohio Turnpike, the Massachusetts Turnpike, and the New York Thruway are presented

8. Pulling, N.H. "How To Train Drivers In Skid Control". Society of Automotive Engineers: .400 commonwealth Drive; Warrendale; Pennsylvania; 15096. Liberty Mutual Insurance Company. March 1977 11 pp 1977. REPORT NO.: SAE 770436; SUBFILE: HRIS

This paper explains the various types of skids and how to control them in cars and tractor-trailer trucks. Specific instructions are provided for classroom presentation, and for conducting hands-on-the-wheel practice sessions on a skid training area, using both cars and tractor-trailer trucks. Detailed directions are included for constructing a skid pad and modifying vehicles for skid control training. Essentially this paper is a condensed manual for setting up driver training instruction for skid control. /GMRL/

9. Davis, Tom, ed. "Outline For Training of Powered Industrial Truck Operators". National Inst. for Occupational Safety and Health, Div. of Technical Services, C. 1978 40p. AVAILABLE FROM: GPO, Stock No. 017-033-00322-0 $1.50 REPORT NO.: DHEW-(NIOSH)-78-199; HS-024 845; SUBFILE: HSL

Hands-on training should include driving over obstacle courses to practice turns, stops, driving on ramps, and to experience falling loads, as well as to practice maneuvering in difficult situations, recharging or refueling, and truck inspection. Verbal or classroom training should cover the following topics; differences between powered industrial trucks and cars, and between sidewalk pedestrians and plant pedestrians; operating controls and safety devices; attachments, inspections, picking up the load; travelling in various situations; setting down the load; loading and unloading boxcars and highway trucks; leaving the truck; refueling and recharging; restricted used of trucks; maintenance and repair; and information on hazardous materials and areas, as needed. Guidelines and rules are listed under each subject heading.

10. "Truck Safety Act". Hearings before the Committee on Commerce, Science, and Transportation. United States Senate, 96th Congress, 1st Session, 1979.

In 1978, 5,075 Americans were killed in accidents involving heavy trucks. The Highway Safety Act of 1966 provides financial assistance to States to enable them to upgrade their highway safety programs designated to regulate motor vehicle registration, driver training and licensing, police services and other aspects of highway operations and control. It was noted that the Federal program reaches less than 1 percent of the interstate commercial vehicles and less than 3 percent of the business entities. John S. Hassell of the Federal Highway Administration proposed these percentages could be increased to 5% and 10%, respectively. Lawrence Shein, chairman of the Safety Committee on Research and Environment states that the bottom line on equipment safety is the extent to which defects are the cause of accidents. BMCS statistics show that 6% of truck accidents are caused by defects. Shein also addressed the matter of State reliability stating, "Our next project in the State of New Jersey will probably be to start our driver training schools. I personally feel, in the area of driver education, that there is a lot to be gained."

11. Sprunger, John L. "But Are They Safe Drivers...? (Trucking Safety)". California Highway Patrolman v43 n12 1980 Monograph p 11, 49 REPORT NO.: HS-028 551; SUBFILE: HSL

The use of Citizens Band (CB) radio by truck drivers is discussed in terms of its negative and positive aspects. Too often CB radios are used for the truck driver's amusement (i.e. conversing with fellow truckers), thus distracting him from his task. Used properly and with courtesy, the CB can be (and often has been) a boon to both truckers and motorists in emergencies. Also discussed are truck drivers' schools. Some are fly-by-night operations with inferior curriculum and/or instruction. Many teach a trainee everthing except how to handle an emergency. Others are very comprehensive and use instructors with extensive trucking experience. Despite intensive training, it is pointed out that a minority of drivers display a callous disregard for other motorist's rights. Far too many gruesome and mindless crashes have been recorded recently which point to truck driver misjudgment.

B.2.3 Driver Profile/Performance

1. Henderson, R.L., et al. "The Role of Vision and Audition in Truck and Bus Driving". Santa Monica California: System Development Corporation, 1973. Report No. TM(L)-5260/000/00

The visual and auditory requirements of commercial carrier driving were studied based on a review of literature, a detailed examination of the driving task, and observations of an interview with drivers. New visual performance measures dealing with perception of motion and dynamic performance of the total visual system were identified as important to driving. Performance on vision tests and on a standard audiometric test of hearing loss was measured and compared with past accident records. Results show that poor performance on several of the new vision tests is associated with poor driving record. No similar results were obtained for auditory measures.

2. Moe, G.L., et al. "Truck and Bus Driver Task Analysis". Final Report. Michigan University Highway Safety Research Institute. Human Factors Research, Incorporated, 1973. Contract No: FH-11-7616.

The task involved in driving large trucks and buses are reviewed and evaluated by expert truck and bus drivers, and ranked according to the criticality of a given task in context with operational situations. Tasks analyzed include trip planning, inspection, 3-mile vehicle performance check, accelerating to roadway speed,and gear shifting.

3. Rabideau, G.F. and Young, P.B. "Identification of Safety-Critical Truck Driving Behavior By Means of Task Analysis". Ottawa, Ontario, Canada: Traffic Injury Research Foundation of Canada. Scientific Session of the Annual Meeting (10th) Proceedings, 1973.

Identification of safety-critical truck driving behavior was attempted by employing task analysis. The task was identified as maintaining required forward motion and path within the posted speed limit. Display problem included driving the truck at the speed limit on a straight road and assuming various roadway grades. Critical stimulus variables include speed limit, road grade, loading of vehicle, obstacles, etc. Other information categories used in task analysis were: time values, display noise, required decisions, controls, control activation, feedback and characteristic errors. Also a critical review of fatigue measurements is given.

4. Byczynski, S. "Can 10 Hours Cause Accidents?". Fleet Owner 69(4), p 76-79, 1974.

This study prepared for the Bureau of Motor Carrier Safety on driver fatigue and hours of services was examined to determine whether the existing rules needed changing. The study contends that the system of paying truck drivers is structured to conflict with highway safety and should be changed. It was found that: there are real increases in driver errors during the latter part of a 10-hour shift, rest breaks become less effective as the shift progressed, sleeper drivers seem to be aided less by the rest breaks than relay drivers, several days of duty without extended time off has a cumulative effect in reducing driver's awareness, older drivers are more adversely affected by prolonged driving, awareness various by time of day, more drivers approve of the present hours than disapprove.

5. Harris, Dick. "Drunk Drivers: The Truckers' Greatest Menace". Commercial Car Journal v133, NB, p 88-95 (Aug) 1977.

Since professional drivers often cover more than 100,000 miles a year, exposure to the drunk driver is at least ten times greater than the average motorist. Much of their mileage is logged at night when the increased presence of frunk drivers causes increased accident risk. Every fiftieth car is driven by a drunk driver, with one in six cars being driven by someone who has been drinking. Commodity carrier accidents often involve a drunk driver. Most of the studies respondents felt that regulations were not sufficiently strict to keep drunk motorists and truck drivers off the road. The trucking industry can support efforts to control drunk driving by pushing for uniform laws and regulations; utilization of CB radio networks for safety purposes; required blood tests for all drivers involved in accidents; and programs that seeks to identify problem drinkers. Other efforts on the part of truck drivers should involve intensification of company safety supervision on the highway; monitoring local court and police action; and supporting public information and education.

6. Sanders, M.S. "Anthropometric Survey of Truck and Bus Drivers: Anthropometry, Control Reach and Control Force. A Final Report. Westlake, California: Canyon Research Group, Inc., 1977. Report No: FHWA/BCMS-77-2-1; PB-273514

A mobile lab was constructed to collect antropometric data on static and dynamic antropometry, reach envelope, steep envelope, and force production to steering wheel and brake-clutch pedals. There were essetnially no differences found between truck and bus drivers on the static measures. It was found current samples were larger on all measures, except two static measures than in samples collected in 1950. For all static and dynamic measures (for example, sitting height, sitting knee height) a statistical analysis is given. Statistics for various reach envelopes an force (torque on wheel) are also given. Recommendations include evaluation of current truck/bus driver stations and increasing minimum sleeper berth width requirement.

7. Sanders, M.S. "A Nation Wide Study of Truck and Bus Drivers". Westlake, California: Canyon Research Group, Inc. Bureau of Motor Carrier Safety, 1977. Report No.: FHWA-BMCS-77-2-2

A 21-item mail survey was distributed to 3926 truck and bus drivers in the continental United States. Items covered: bibliographical data (sex, age, height, weight, and home state of the drivers), nature of employment (type of carrier, fleetsize, type of operation worked, and pay scheme), vehicle (type, cargo, equipment), and hours of service (notification of trips, start time, hours worked per week, and four days of log book pages).

8. Taylor, J.F. "Some Aspects of The Health of Long-Distance Drivers". Proceedings of the Royal Society of Medicine 70(4), 243-6. 1977.

Since long-distance drivers of heavy commercial and public service vehicles are subject to particular medical problems which can affect both driving safety and insurance needs, British law has set various requirements. None of these special vehicle drivers may have had an epileptic attach since age 3 or suffer from any other disease likely to endanger driving safely; the wearing of contact lenses is discouraged; each drivers hearning must be good; and drivers msut have no heart trouble.

9. Lewis, H. "Fatigue: A Problem on The Road...And Off. Has The Truck and Bus Industry Properly Analyzed The Factors of Fatigue?". Steering Wheel p. 10-11, 1978.

Fatigue elements of the truck and bus drivers are outlined. The article maintains that a driver's off-duty lifestyle can be as important as driving performance, when combating fatigue. D.O.T. suggestion of altering the hours of service is not likely to improve the fatigue factor. Solutions to the fatigue problem suggested include: teaching drivers the danger of fatigue and how to identify fatigue and way it affects their abilities to function mentally, stress to drivers of the health factor, and instill in drivers the necessity of stopping at the first sign of fatigue.

10. Ranney, T. (Investigators). "Identification and Testing of Countermeasures For Specific Alcohol Accident Types and Problems". Calspan Corporation, P.O. Box 400, Buffalo, New York, 14225. SPONSORING ORG.: National Highway Traffic Safety Administration, Department of Transportation. CONTRACT NO.: DOT-HS-9-02085, Contract. SUBFILE: HRIS, PROJECT START DATE: 1978.

The objectives of this project are to evaluate what is currently known about the scope and nature of the driving-drinking problem among vehicle drivers in general and regulated heavy truck drivers in particular, and to assess prospective countermeasures for the dual aspects of the prospective countermeasures for the dual aspects of the problem. The project is to progress through three phases, the first of which examines extant research and data in order to determine specific alcohol-driving problems defined by accident types and target areas (kinds of drivers, trucking operations, etc.). As much has been studied already about the general driving-alcohol problem, that aspect of Phase I will be studied through examination of research reviews and countermeasure reports. Since much less data is known to exist on the truck-alcohol problem, a more extensive search will be made to locate and review existing data sets and research reports. In the project's second phase, prospective countermeasures will be considered on the basis of various criteria (technical feasibility, social acceptance, etc.) and a set recommended for empirical testing. Test procedures will be specified. The sponsor will then select a small number of potential countermasures for empirical evaluation, which will be conducted in the third phase. The final report will draw conclusions about the indicated merits of the evaluated countermeasures.

11. Mackie, R.R.; Miller, J.C. "Effects of Hours of Service Regularity of Schedules, and Cargo Loading On Truck and Bus Driver Fatigue". Human Factors Research, Incorporated; .6780 Cortona Drive; Goleta; Washington; California; D.C.; 93017; 20590. Oct 1978 Final Report. 282 p. 1978. AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road, Springfield, Virginia 22161. REPORT NO.: DOT-HS-803-799; 1765-F; PB-290957/OST. CONTRACT NO.: DOT-HS-5-01142; Contract. SUBFILE: NTIS: HRIS

A literature review, a nationwide survey of commercial truck and bus driver work patterns, an analysis of accident data, and three extensive field experiments were conducted to establish evidence concerning driver fatigue as a function of regularity or irregularity of work schedules, duration of on-duty cycles, participation in supplemental cargo loading work, and types of operation (relay versus sleeper). Data are presented concerning the relative amounts of fatigue experienced by truck and bus drivers under these various conditions, as reflected in their subjective ratings, in various measures of physiological status and in the quality of their driving performance. The results are related to accident data in which fatigued, drowsy or inattentive drivers were reportedly involved. Conclusions are drawn regarding current DOT regulations on hours of service.

12. "Safety Plus Regs. A Vital Relationship Trucking Industry". Fleet Owner, p 95-7 (Aug 1978) 1978 Monograph. REPORT NO.: HS-024 334; SUBFILE: HSL.

A recent nationwide survey of thousands of intercity truck drivers in the U.S. indicates that, in most cases, safety and compliance with trucking regulations increases with the degree of economic regulation of the carriers an the degree of control exercised by the trucking company over the driver. The survey was sponsored by the California Trucking Activities Inc., Regular Common Ca-rier Conference, Union 76, the Teamsters, Assoc. of American Railroads, United Parcel Service, and Harvard University. The survey revealed that over 10% of the drivers of the exempt carriers (those that haul exempt commodities, such as unprocessed food, and are not subject to any economic regulation) regularly use pep pills to stay awake while driving, in contrast to 0.2% of the drivers for common carriers (those that are subject to the most economic regulation). The survey reports that nearly 1/2 of the company-employed drivers for exempt carriers report they regularly drive beyond the 10-hour limit, and that 1/3 use multiple log books to circumvent hours-of-service rules. Only 2.48% of the company drivers of common carriers said that they regularly violate hours-of-service regulations, and less than 2% reported using multiple logs. The cruising speed for company drivers of exempt haulers was found to average 63 mph vs. 58.85 mph for common-carrier drivers. Data concerning moving violations indicate a similar trend, an average of 1.33 moving violations per 100,000 miles for exempt owners-drivers vs. 0.41 violations per 100,000 miles for common-carrier drivers. The results show that continued economic regulation would be in order, and raise serious questions about the unregulated sector. The survey results often conflict with data published by the Bureau of Motor Carrier Safety, in part because the unregulated sector underreports accidents.

13. Wyckoff, D.D. "Truck Drivers in America". Heath Lexington Books, (0-669-02818-5) 138p. 1979.

This book reports the perceptions and views of a large cross-section of professional intercity truck drivers, one of the largest unsupervised workforces in the United States. Among the issues addressed are driver training, union status, attitudes about equipment and working conditions the handling of hazardous materials, owner-operators, women drivers, and the implications of economic regulation. The author builds a data-base of the experiences of drivers in order to compare conditions and points of view from different parts of the industry.

14. Fuller, R.G.C. "Effects of Heavy Goods Vehicles Drivers on Different Work Demands". Human Factors in Transport Research (ed. Oborne, D.J., Lewis, J.A.) pp 117-125, 1980.

Experiments were done which measured driver performance using time headway measures. The main conclusion in terms of the performance measure employed: no unambiguous evidence of a relationship between driving riskiness and hours of driving has been found.

15. Fuller, R.G.C. "Determinants of Time Headway Adopted By Truck Drivers". Ergonomics 24, 111-148, 1981.

This paper presents the results of a field experiment on the effects on time headway (way of representing total interaction between a driver, his vehicle, and the road) of prolonged driving in a continuous convoy situation. Conditions under which the drivers' following performances were measured were different types of gollowing maneuvers, prolonged driving, and early and late shifts. It was found that time headways in convoy driving are much slower than in naturally-occurring situations and drivers need a certain amount of time to adjust to demands of convoy driving. No evidence of an increase in performance riskiness was found (during) either an 11-hour driving day or after driving cumulatively over 4 days.

16. Bureau of Motor Carrier Safety. "1980/1981 Roadside Vehicle Inspection Report". U.S. Department of Transportation, Div. Federal Highway Administration.

This report is a compilation of the results of the Bureau's roadside inspection activities during the years 1980 and 1981. The Federal roadside inspection program is designed to: (1) remove potential hazardous vehicles and/or fatigued drivers from the highways, (2) identify motor carriers previuosly unknown to BMCS personnel, and (3) familiarize and advise motor carriers of their responsibilities under the FMCSR and HMR. Roadside inspections have found vehicles to have both imminently hazardous defects and lesser defects, mainly deficiencies in the lighting and electrical systems and brake systems. Also inspected are the driver's credentials and qualifications and his/her daily log to see if he or she has exceeded the maximum hours of driving time defined by regulations. In many cases the driver or truck has been put out of service until the violation has been corrected such as repair to the defect or sleep for the driver. The goal of this roadside inspection program is a reduction in the risk of commercial motor vehicles involved in accidents. A summary of violations that the inspections uncovered during this time period are presented in the report.

B.2.4 Accidents

1. "Motor Carrier Accident Investigation". Alfred A. Mercer-Accident--
March 16, 1968--Benson, N.C.
Bureau of Motor Carrier Safety, Washington, D.C. 1968, 5p
AVAILABLE FROM: Corporate Author
REPORT NO.: 68-6; HS-006 001;
SUBFILE: HSL

Six fatalities, injury to one, and approximately $22,000 property damage resulted from a -ractor-trailers overturning onto an approaching vehicle. The accident was attributed to disregard of hours of service regulations. The truck driver apparently fell asleep.

2. National Transportation Safety Board; Department of Transportation.
Washington; D.C.; 20591. "Railroad/Highway Accident Report: Boston and Maine Corporation Single Diesel-Powered Passenger Car 563 Collision with Oxbow Transport Company Tank Truck at Second Street Railroad-Highway Grade Crossing Everett, Massachusetts, December 28, 1966.
Feb 1968 56 pp Figs. Phots. 5 App. 1968
AVAILABLE FROM: National Technical Information Service 5285, Port Royal Road, Springfield, Virginia 22151
PB-190212
SUBFILE: RRIS

At 12:10 A.M. on December 28, 1966, eastbound firstclass passenger train No. 563, consisting of a single car diesel-powered passenger unit operated by the Boston and Maine Corporation collided with a northbound motor tank truck owned and operted by the Oxbow Transport Corporation stopped across the Second Street grade crossing at Everett, Mass. The collision resulted in the death of 11 of a total of 28 passengers and 2 of the 3 train crew members and other injuries and damage to property. The semi-trailer of the tank truck containing 8,200 gallons of fuel oil ruptured on impact, covering the forward end of the passenger car with the oil. A spread of flames immediately covered the forward section of the car. The fatalities were due to thermal burns and smoke inhalation. There was a lack of emergency exits in the car, in addition to an inward opening rear door which became jammed in a closed position while people were attempting to escape. The truck driver had left the vehicle prior to impact and was not injured. The probable cause of the accident was the loss of air pressure in the brake systems of the tractor-trailer which resulted in an automatic application of the brakes that could not be released from the cab of the tractor and therefore held the tractor-trailer directly across the Boston and Maine track at the collision point.

3. Motor Carrier Safety Bureau /US/. "Motor Carrier Accident Investigation".
Report No. 69-10, 9 pp, 2 PHOT 1969
SUBFILE: HRIS

A multivehicle collision involving a tractor-semitrailer combination and two automobiles was investigated. The truck had veered into the oppoisng lane on a left curve and collided with an oncoming automobile; a second automobile, too close to stop, collided with the right side of the tractor. The investigation showed the accident was clearly the result of the operation of a commercial vehicle by a driver who was seriously fatigued. The driver's past record had indicated previous disregard to safety regulations concerning hours of service. Although the driver had been admonished by the Motor Carrier, the carrier was unaware that the driver had had three license withdrawals and one license probation within a ten-year period. Revisions of Part 391 of the Motor Carrier Safety Regulations are contemplated to include greater responsibilities for both motor carrier and driver.

4. Pierson, Kenneth L. "Motor Carrier Accident Investigation. Trans-American Van Service, Inc. Accident of June 16, 1969, Greeley, Colo.
Bureau of Motor Carrier
1970 9p
REPORT NO.: HS-009 292; SUBFILE: HSL

A moving van transporting household goods collided head-on with an auto being towed, killing three occupants of the towed vehicle. The truck had swerved into the wrong side of a two-lane road in the path of opposing traffic. The truck driver was highly intoxicated and had a criminal record, but not a bad driving record. He had never had the physical examination required by motor carrier safety regulations. He had been on duty in excess of the allowable time under safety regulations. This accident illustrates both driver misconduct and lack of meaningful safety supervision by the motor carrier.

5. National Transportation Safety Board. "Highway Accident Report. Accidental Mixing of Incompatible Chemicals, Followed by Multiple Fatalities, During a Bulk Delivery", Berwick, Maine, April 2, 1971.
1971 13p
AVAILABLE FROM: NTIS
REPORT NO.: HS-012 214;
SUBFILE: HSL

Six tannery workers died from inhalation of a toxic gas formed by the reaction of incompatible chemicals mixed during the delivery of a bulk liquid chemical. The transfer hose from the tank semitrailer had been connected to the wrong plant fill line connection. A need to identify risks existing at bulk delivery transportation receiving interfaces was established and a investigation recommended. The National Transportation Safety Board determined that the cause of this accident was the failure of the carrier's drivers and the tannery foreman to establish an error-free exchange of information required to accomplish the safe transfer of the cargo from the vehicle into a plant storage tank. The likelihood of this failure was increased by the absence of instructions or training in information validation procedures to be followed during such exchanges, and by the absence of markings, devices or other measures on the vehicle or tannery property which would have permitted such validation to be made unilaterally by either party.

6. National Transportation Safety Board. "Railraod/Highway Accident Report: Illinois Central Railroad Company Train No. 1 Collision with Gasoline Tank Truck at South Second Street Grade Crossing, Loda, Illinois, January 24, 1970".
Bureau of Surface Transportation Safety; Washington, D.C.: 20591
July 1971 28 pp Phots. Apps. 1971
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road, Springfield, Virginia 22151
REPORT NO.: NTSB-RHR-71-1; PB-202869
SUBFILE: RRIS

About 9:55 a.m., on January 24, 1970, Illinois Central Railraod southbound passenger train No. 1, moving at a speed of 79 miles per hour on track No. 1, struck a motortruck loaded with gasoline on the South Second street crossing in Loda, Illinois. The tank of the truck was split open, spilling the gasoline which exploded and caught fire. The burning gasoline covered the exterior of the locomotive unit and entered the control compartment through the nose door, damaged nose, and other openings. Three employees of the railroad, who were occupying the control compartment of the lead locomotive unit at the time of the accident, and the driver of the motortruck received fatal injuries from the burning gasoline. The National Transportation Safety Board determines that the probable cause of this accident was that the operator drove the gasoline-laden truck, without stopping, onto the tracks immediately in front of the approaching train, while the crossing warning devices was indicating the train's approach.

7. National Transportation Safety Board /US/; . 1971 "Highway Accident Report. Truck Automobile Underride Collision on Interstate I-495 New Carrollton, Maryland June 19, 1970.
Sept 1971 No Ntsb-har-71-9, 36 pp, 1 Fig, 6 Photo, 8 App
Subfile: HRIS

A rear-end underride collision involving a truck and an automobile is reported and analyzed. The probable cause of this rear-end underride collision was the stopping of a truck in a high-speed traffic lane by an untrained driver operating an unsafe truck with A makeshift hood fastener that failed, allowing the hood to obstruct the driver's foward view. The driver of A following automobile was not warned by the truck's emergency flasher lights due to a faulty light switch, and the driver's attempt to stop was unsuccessful. Two contributing factors are emphasixed: (1) the need for rulemaking relating to rear-end underride protection devices on trucks, trailers, and semitrailers; (2) the almost total lack of compliance by the private carrier with applicable motor carrier safety regulations.

8. National Transportation Safety Board. "Railraod/Highway Accident Report. Atchison, Topeka and Sante Fe Passenger Train No. 212 Collision with Stillwater Milling Company Motortruck at 116th Street North Grade Crossing Near Collinsville, Oklahoma, April 5, 1971".
1972 44p
REPORT NO.: HS-012 209;
SUBFILE: HSL

The truck struck the second diesel unit. The first chair car and the remaining cars of the passenger train were derailed; one rail car overturned. Railroad employees and passengers in the train were injured. Two passengers on the train were killed, as was the driver of the truck, and 21 passengers were injured. The probable cause of the accident was the failure of the driver to stop his truck prior to impact with the passenger train, while crossing warning signals were indicating the approach of the train. The driver misperceived the hazard presented by the approaching train. The causes of the fatalities and the injuries are attributed to the speed of the vehicles at impact, separation and excursion of the train from the right-of-way, overturn of the rail passenger car, and inadequate crashworthiness of the rail passenger coach and the truck. The report suggests improvements in grade crossing controls, equipment design, and emergency communications procedures.

9. National Transportation Safety Board. "Highway Accident Report. Truck-Automobile Collision Involving Spilled Methyl Bromide on U.S 90 near Gretna, Florida, August 8, 1971."
1972 15 58p
AVAILABLE FROM: Corporate Author
REPORT NO.: NTSB-HAR-72-3; SS-H-; HS-012 211;
SUBFILE: HSL

An automobile making a left turn at an intersection was struck by a tractor-van type semitrailer combination which was attempting to overtake and pass the automobile. Both Vehicles entered a roadside ditch after the collision. Several unsecured large steel cylinders, containing a mixture of methyl bromide and chlorpicrin pressurized with air, broke out of the trailer and sustained damages which resulted in leakage of the contents. Four of the automobile occupants exposed to the resultant contaminated atmosphere did not survive. The National Transportation Safety Board determined that the cause of this accident was the passing maneuver of the truck driver and the execution without signaling of a left turn by the automobile driver into the path of the overtaking truck. The probable cause of the fatalities was the prolonged exposure of the disabled occupants of the automobile to high concentrations of the poison chemical mixture which escaped from damaged containers. Applicable federal regulations are included.

10. National Transportation Safety Board. "Highway Accident Report. Airport Police Cruiser-Automobile Collision on Dulles Airport Access Road, Exit No. 1, Near Chantilly, Virginia, April 22, 1971".
Bureau of Surface Transportation Safety, W
1972 30p
AVAILABLE FROM: Corporate Author
REPORT NO.: NTSB-HAR-72-1; HS-019 687;
SUBFILE: HSL

An eastbound Dulless Airport Police cruiser stopped on the exit ramp in response to a signal from the driver of a truck. An eastbound passenger automobile was approaching the exit ramp; the driver, distracted by the truck. was slow to observe the police car, applied the brakes and struck it in the rear at a speed of 15 to 25 mph. The fuel tank of the police car developed a leak resulting in a fire. As a result of the impact, the two officers were thrown back against the front seat causing the anchorage system to fail and seat-back to bend rearward. The police cruiser was totally destroyed by the fire. Occupants of both vehicles received minor injuries. Probable cause of the collision was the unnecessary stopping of the cruiser on the travelled lane of the exit ramp and the distraction of the automobile driver from her primary driving task. Contributory were the stopping of the cruiser without operating its overhead rotating warning light and the stopping of the truck in the area. The total loss of the cruiser was caused by the failure of the fuel tank in a relatively low-speed impact, resulting in fuel leakage and fire. Recommended are enforcement of standards to ensure fuel tank integrity; revision of Standard 207 to provide for increased strength of seat anchorages and for more protection against gross seat deflection; the revised standard should provide for a rear end impact performance test with the maximum expected passenger weight positioned appropriately in the seat; and establishment of a formal training program and a screening procedure to assure that officers possess qualifications commensurate with job assignments.

11. National Transportation Safety Board. Washington: D.C. "Highway Accident Report. Tank-Truck Combination Overturn Onto Volkswagen Microbus Followed by Fire: U.S. Route 611, Moscow, Pennsyvlania. September 5, 1971."
October 1972 34p 1972.
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22152
REPORT NO: NTSB-HAR-72-6; PB-213616/
SUBFILE: NTIS

The national Transportation Safety Board determine that the cause of this crash was the upset of the tractor and cargo-tank semitrailer due to grossly excessive speed in a turn and to the resultant dynamic surge of the liquid cargo. Contributing factors included: the failure of the truckdriver to comply either with the posted speed limit or with State laws and Federal regulations prohibiting coasting out of gear and the failure of his employer to investigate his past driving record. There were 4 deaths and the truckdriver sustained 3rd degree burns over 40% of his body. (Author).

12. Bureau of Motor Carrier Safety, Washington, D.C. "Motor Carrier Accident Investigation. Hernando Packing Company and Osborne Truck Line, Inc., Accident--August 27, 1973--Memphis, Tennessee. Report No. 73-8; 1973; 12p.

The case report of a four-truck collision which resulted in one fatality three injuries, and $57,000 property damaged is presented. The tractor trailer went out of control, sideswiped a southbound pickup truck, crossed the median and collided head-on with another tractor trailer in the opposing traffic lane, which then collided with a second pickup. Concluded that a sheering link failure in the first tractor trailer truck was probable cause of the accident. There was evidence of a lack of proper periodic inpsection.

13. Ballenger, M. "Motor Carrier Accident Evaluation (Medical Aspects)
Bureau of Motor Carrier Safety, Washington
HS-014 519, Conference of the American Association 1973
Monograph for Automotive Medicine (17th), Proceedings, OKLAH
AVAILABLE FROM: In HS-014 519
REPORT NO.: HS-014 543;
SUBFILE: HSL

Some general activities of DOT in evaluation of medical aspects of motor carrier accidents are reviewed. Examples of truck accident are cited to illustrate causative factors. Consideration is given to problems associated with diabetic drivers, drivers with monocular vision, and research studies of visual and auditory response, vehicular stress, and driver fatigue. The hours-of-service rules are examined along with other factors such as heat, vibration, noise, intoxication, and driver training. Conference held in Oklahoma City, 14-17 Nov 1973.

14. Cooley, P.; O'Day, J.; Schultz, S. "Tri-Level Accident Investigation Study, Vol.1. Final Report".
Michigan University, Hwy. Safety Res. Inst., Ann Arbor, Michigan 48105
1973 198p refs
AVAILABLE FROM: NTIS
REPORT NO.: HSRI-010111-1; HS-800 912;
CONTRACT NO.: DOT-HS-031-1-135; Contract
SUBFILE: HSL

The First year of a tri-level accident study is described. Program design and methodlogy, level three accident data characteristics, accident data analysis, and topical areas relating to highway safety are discussed. Of the 85 tri-level indepth accidents investigated, four involved destructive fires, 13 involved trucks, two were determined to be vehicular suicides, and three were vehicle train collisions. These accidents and an accident involving wrongway driving are discussed in some detail. The trilevel concept of incorporating various levels of detail in accident data, with a broad program of field accident investigations within a fixed geographic area, was found to be an effective approach toward identifying problem areas in highway safety, including assessing the effectiveness of vehicle safety performance as well as evaluating standards and new safety features. Recommendations to improve motor vehicle safety derived from the study are included. Report for 1 Jun 1971 - 30 Jun 1972.

15. National Transportation Safety Board, Washington, D.C. 1974. "Highway Accident Report: WILMETH Cattle Company; Truck/Bridge/Transportation Enterprises, Inc., Bus, U.S. 60-84, Fort Summer, New Mexico, Dec. 26, 1972. Report No: NTSB-HAR-74-1; SS-H-26.

Analyzed collison involving a tractor-semitrailer and a school bus-type vehicle at a narrow bridge site in New Mexico. There were 19 fatalities and 15 injuries in a cattle truck. The probable cause of the initial collision (truck/bridge end-post) was the failure of truck driver to keep his vehicle in the proper lane of travel. Contributing factors were: influence of the two on-coming vehicles on the truck driver; absence of light-reflecting traffic control devices; absence of solid center line on the bridge; the narrow width of the bridge and the truck driver's concern that braking would cause his vehicle to jackknife. Federal recommendations are included.

16. Indiana University, Bloomington. Inst. for Res. in Public Safety "A Study to Determine The Causes of Accidents: An In-Depth Case Report--Case No. TAC-SP-73-3, Tractor-Trailer/School Bus--Right Angle (Fatal). Final Report".
1974 90p 2 refs
AVAILABLE FROM: NTIS
REPORT NO.: TAC-SP-73-3; HS-801 202;
CONTRACT NO.: DOT-HS-034-3-535; Contract
SUBFILE: HSL

A fatal tractor trailer/school bus accident is described in an in-depth, multidisciplinary report. The principle cause of the accident was the bus driver's failure to maintain a proper lookout crossing a U.S. highway, resulting in failure to observe the oncoming truck. His vision was partially limited by a fogged windshield. Recommendations are offered regarding; school bus driver training programs, defroster performance, heavy truck stopping capabilities occupant restraints and energy absorbing seat backs for school buses, laminated glass in side and rear windows, improved seat cushion mountings, interior panels, and truck cab crush resistance. Precrash, crash, and postcrash phases for humans and vehicles are described, along with the environmental precrash phase. Appendices include photographs, driver records, police report, film slide index, scene diagram, seating arrangement and injury levels, window frame and glass configuration, bus exterior and interior deformation schematic, and present and recommended highway configurations.

17. Hall, J.W.: Dkickinson, L.V., Jr. "Truck Speeds and Accidents on Interstate Highways". Traffic Accident Analysis, pp 19-33, 1974. Transportation Research Record 486. National Research Council, Washington, D.C.

The research in this paper was designed to evaluate the effectiveness and desirability of the differential truck speed limit on Interstate facilities in Maryland and to examine the operational implications of changing this limit. This study used four sets of data - speed, volume,accidents, and geometrics - as the basis of the analysis. Geometric design of the facility is clearly an important factor in determining vehicular speed and the percentage of grade has a minimal effect on limiting truck speeds. The existence of a posted differential speed limit that contributed to an actual speed differential was not found to be related to truck accidents. Models developed to predict truck accident rates on limited - access facilities indicated that lower truck accident rates can be expected with higher truck speeds. Though removal of the differential truck speed would result in higher truck speeds on some roadway sections, it would not bring about increased speeds on extended up grades, where truck speeds are limited by the vehicles' capabilities. This study recommended that the truck speed limit be temporarily increased to 70 mph on two segments of the Interstate System in Maryland so that the results of the change, effects on both speeds and accidents, could be examined.

18. Forsythe, Margaret; Hanscom, Fred; Reiss, Martin; Vallette, Gerald, Yoo, Chang. "Accident and Traffic Operations Implications of Large Trucks". State-of-The-Art Review of Truck Related Literature. Department of Transportation, Washington, D.C. Vol. I. Literature Report, Sept 1975, pp III 1-19.

This report is an overview of the literature on truck accidents. The report summarizes and lists data sources for truck accident information and variables involved. The literature indicates that a positive relationship appears to exist between truck weights and accident severity although caveats are in order in drawing general conclusions from the data base used in the analysis. The literature also indicates that truck fatal accidents frequently occur in rural areas on Federal - aid primary (non-interstate) roadways. There is no data that is currently available which indicates whether longer trucks or heavier trucks are over-involved or under-involved in accidents. Based on 1973 NSC estimates, concerning miles traveled, trucks in general have a lower accident rate than other vehicle types. It can be hypothesized, however, that the professional driver and the well-maintained vehicle may be the primary factors in reducing truck accident rates. A review of the literature concerning truck size and weight concluded that the fatality rate of non-truck occupants increases as the weight of the truck increases, but the injury rate of non-ruck occupants is contant over the various weights. Trucks of 50-59 ft. accounted for 66% of the total number of accidents whereas trucks less than 50 ft. in length accounted for 24%. Collision with another vehicle accounts for the majority of total number of truck accidents (the amount varies widely between information/data source). Data summarys are also presented for hourly and daily accident occurrences and proportions of accidents on urban as opposed to rural and highway systems. Accident type is also considered. Classification of type includes: collision with another vehicle, fixed object, pedestrian, other object, and non-collision (i.e., ran-off road, overturned). This study does noté problems with the reliability of these figures.

19. Bureau of Motor Carrier Safety, Washington, D.C. "Motor Carrier Accident Investigation. Cowboy's Produce Company, Accident--April 2, 1975--Tifton, Georgia".
1975 11p
REPORT NO.: HS-017 758;
SUBFILE: HSL

A night-time accident involving a cab-over-engine tractor trailer truck's co-lision with the rear of a passenger automobile is reported. The truck, travelling at 60 mph overtook and struck a slower-moving 1961, 4-door, Chevrolet Belair station wagon on a Interstate highway (with a 55 mph speed limit), in Georgia. The fuel tank of the car ruptured, and, as the truck veered to its left and overturned on the highway median, the automobile ran off the road to the right, down an embankment, and overturned onto its roof and burned. The driver of the truck, a 38-year-Old male with 15 years trucking experience, has been convicted of speeding 17 times from 1956 to 1973 and his Georgia driver's license had been suspended twice. He was injured in the crash. The 39-year old male driver of the automobile was accompanied by eight relatives. He and six of his relatives were killed and the car was virtually destroyed. It is concluded that the probably cause of the accident was the operation of a tractor trailer truck by a fatigued truck driver dozing at the wheel. The driver was in violation of Federal regulations regarding hours of on-duty time for drivers. He was operating the truck without a proper driver's license, was using a fraudulently prepared medical certificate, and was not preparing his daily log.

20. Federal Highway Administration, Bureau of Motor Carrier Safety, "Motor Carrier Accident Investigation. General Industries, Inc. Accident--June 27, 1974--Charles Town, West Virginia".
Washington, D.C. 20590
REPORT NO.: BMCS-74-5; HS-017 187
SUBFILE: HSL

An accident involving a tractor flatbed trailer combiantion and a Volkswagen is reported. The road--West Virginia State Route 9--consists of two 12 foot blacktop lanes and contains sharp curves leading down a mountainside. Advisory traffic warning sign are mounted, on the same post, denoting a right curve and a maximum safe spee of 40 mph. Weather conditions were daylight, slightly foggy, and dry pavement. At about 6:45 am on June 27, 1974, the truck, travelling northbound, was negotiating the right hand curve on a 10¢ downgrade, when the driver applied the trailer brakes. The empty flatbed trailer skidded and bounced into the opposing traffic lane, leaving 186 feet of skid marks. At this point, the southbound Volkswagen collided with, and ran under the truck, bursting into flame when the forward mounted fuel tank hit the truck. The car was dragged for a distance of 224 feet. The car's three passengers were killed. Accident investigation discolosed that the driver of the truck has been on the job only three months. Prior to that time, he had had no truck driving experience, and had only recenlty completed a truck driver training course, which consisted of only 30 hours of actual driving. It was concluded that the accident occurred due to a loss of control of a truck by an inexperienced driver who utilized his trailer brakes only, and that the truck was not being driven in accordance with the posted 40 mph. limit. In all probability, the driver could have maintained the proper speed and control of his vehicle either through the use of the truck's full braking system or gears. It is recommended that a driver not be considered either experienced or trained after three weeks of instruction. Moreover, some truck driving training schools have been lax in providing proper training. In order to reduce accidents of this type, motor carriers are urged to institute programs of monitoring newly employed drivers to ensure that the novice drivers are capable and qualified to handle the equipment and responsibilities of a professional driver.

21. Vargas, Lilia, Jones, Karen, Powers, Jean. "Work Injuries in Trucking-California". Department of Industrial Relations, California Div. of Labor Statistics and Research, San Francisco, California, 1975.

The accident factors in the trucking industry in California are analyzed. More than 1000 of the disabling injuries reported were sustained by employees of companies engaged in long distance or "over the road" trucking service, either as common carriers or under special contracts. 36% of the injuries were to employees of local trucking firms. A total of 362 work-connected injuries were sustained by employees of moving and storage companies 63% of the recorded injuries were drivers hurt on the job, with more than half of the accidents associated with loading and unloading activities. 8% occurred while driving and 8% occurred while the worker was climbing on or off the vehicle or dock. Three out of ten workers were injured as a result of "strain of overexertion" accidents. "Struck by or striking against" accidents accounted for 25%. A total of 228 accidents involving moving motor vehicles were reported. Strains, sprains, dislocations, and hernias were the most frequent types of injuries, accounting for 1,014 injuries or 46% of the total. Study reports lost work day cases incidence rates. The study reviews the 230 registered fatalities in the California trucking industry for period 1969-1973. The drivers accounted for 86% of the fatalities. Accidents involving highway motor vehicles accounted for 188 deaths. Forty-two, or 18%, of the fatailties involved causes other than highway vehicles. Tables provide further details of the accidents, their nature and cause and injury description.

22. Federal Highway Administration, Bureau of Motor Carrier Safety. "1975 Accidents of Motor Carriers of Property".
Washington, D.C. 2
REPORT NO.: HS-020 195;
SUBFILE: HSL

A report on accidents which occurred in 1975 is based on information submitted by motor carriers of property operating in interstate of foreign commerce, Bureau of Motor Carrier Safety (BMCS) regulations require a report to be filed when an accident invovles a motor vehicle engaged in the interstate, foreign, or intrastate operations of a motor carrier subject to the Dept. of Transportation Act. An accident is defined as an event resulting in: the death of a human being; bodily injury to a person who, as a result receives medical treatment away from the scene of the accident; or total damage to all property aggregating $2,000 or more. In 1975, there were 24, 274 accidents reported to BMCS. These resulted in 2,232 fatalities, 26,374 injuries, and $158 .2 million in property damage. Of those killed in reported accidents, 351 were truck drivers, 93 were other truck occupants, and 1,788 were pedestrians, or occupants of other types of vehicle. Distribution of accident statistics by type of trip and type of accident shows that collision accidents which occurred on over-the-road trips accounted for 54% of the total number of accidents, 74% of the fatalities, 60% of the injuries, and 52% of the property damage. Non-collision accidents which occurred on over-the-road trips accounted for 23% of the accidents, 10% of the fatalities, 15% of the injuries, and 37% of the property damage. Some 19% of the accidents reported were collisions of vehicles engaged in local pickup and delivery operations, and these accounted for 14% of the fatalities, 22% of injuries, and 8% of property damage. Noncollision accidents which occurred on local pickup anddelivery trips were lowest in all aspects, accounting for 3% of accidents, 1% of the fatalities, 2% of injuries, and 3% of property damage. Accident severity is expressed in the report in the following terms: fatality rate is the number of injuries per accident; and property damage rate is the amount of property damage per accident. A tabulated summary of 1975 data is provided, including total numbers of accidents, fatalities, injuries and property damage for the year. Additional data are divided into sections of tables, charts, and graphs detailing who was involved in accidents, the type of vehicle involved, where accidents occurred, what hour they occurred, what caused them, and what the results were.

23. Reidy, J.C.; Costenoble, K.C. "An Analysis of Commercial Motor Vehicle Accidents in Commercial Zones." Center for the Environment and Man, Inc., Northrop, GM.
REPORT NO.: CEM-4176-546; FHWA-BMCS-76-1; PB-261085/5ST
CONTRACT NO.: DOT-FH-11-8560; Contract
SUBFILE: NTIS

Motor vehicle carriers engaged in the transport of interstate goods within Commercial Zones (CZs) are exempt from the Motor Carrier Safety Regulations (MCSR) of the U.S. Department of Transportation (Parts 390-397). There has been concern that disqualified drivers and poorly maintained vehicles may be contributing excessively to motor vehicle accidents in CZs. It was the objective of the study to (1) collect accident data from CZs and identify accidents attributed to disqualified drivers; (2) compare the accident rates of qualified and disqualified drivers; (3) identify CZ accidents caused by vehicle defects; (4) determine how much vehicle mechanical condition non-compliance limits vehicle use to CZ operations; (5) determine the extent that CZ vehicles are subject to state vehicle inspection laws; (6) determine exposure to CZ drivers to various types of highways; (7) determine the number of interstate carriers operating under the CZ exemption; and (8) determine the cost to carriers, using the CZ exemption of implementing the MCSR in all CZs. To answer these questions, six Commercial Zones were surveyed; Atlanta, Philadelphia, Louisville, Kansas City, Houston, and Los Angeles. Forty-nine motor carriers provided 1974 data on 1460 drivers, who had 387 traffic accidents. These data are used as a basis for extrapolations to the national level.

24. Mason, R.L. "Analysis of Tractor-Tailer and Large Truck Accident Data". Southwest Research Institute, (11-4390), June 1976
Final Report No: AR-1081

Twenty-one hypothesis alleging to the existence of a national problem with large truck involvement in highway safety were reviewed, evaluated, and critiquedinrelation 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.

25. National Transportation Safety Board, Washington, D.C. 1976. "Collision of Reading Company Commuter Train and Tractor-Semitrailer Near Yardley, Pennsylvania, June 5, 1975".
March 1976 26p
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161
REPORT NO.: NTSB-RAR-76-4; SS-R-38; PB-251938/7ST
SUBFILE: NTIS

About 11:06 p.m. on June 5, 1975, a Reading Company commuter train struck a tractor-semitrailer (truck) at a grade crossing near Yardley, Pennsylvania. The truck was transporting three coils of steel, two of which penetrated the first commuter car. The three occupants of the lead car were killed and an occupant of the second car was injured slightly. The truck driver was uninjured. The semitrailer was torn from the tractor and damaged beyond repair and the lead commuter car was damaged extensively. At the time of the collision. the automatic grade crossing signal system was functioning. The truck driver said he had not seen or heard the warning signals. The National Tranportation Safety Board determines that the probable cause of the accident was the failure of the truck driver to stop the truck in accordance with the warning signals.

26. National Transportation Safety Board, Bureau of Surface Transportation Safety, W. "Highway Accident Report. Surtigas, S.A., Tank-Semitrailer Overturned, Explosion, and Fire, near Eagle Pass, Texas, April 29, 1975".
1976 23p
AVAILABLE FROM: NTIS
REPORT NO.: NTSB-HAR-76-4; HS-019 673;
SUBFILE: HSL

About 4:20 p.m., a Surtigas, S.A., Tractor-tank-semitrailer, westbound on U.S. Route 277 near Eagle Pass, Texas, swerved to avoid an automobile ahead that was slowing for a turn. The tank-semitrailer separated from the tractor, struck a concrete headwall, and ruptured; vaporized LPG (liquid propane gas) was released. The ensuring fire and explosion destroyed a building and 51 vehicles. Fifty-one persons in the area were burned and 16 persons, including the truck driver, were killed. The National Transportation Safety Board (NTSB) determined that the probable cuase of this accident was the evasive action taken by the truck driver to avoid a slowing vehicle in his path of travel. The cause of the fatalities and injuries to persons in the vicinity was the explosive force and fire, from which they had no time to escape. The rapid development of the explosive force and fire was caused by the gross rupture of the tank. As a result of its investigation of this accident, the NTSB made recommendations to the Federal Highway Administration (FHA) to promulgate a regulation making the criteria established in the Handbook of Highway Design for Operating Practices mandatory for all modified and new designs; and to compile and evaluate accident data related to unprotected, raised concrete headwalls, and sidewalls that because of their location, are roadside fixed objects, to determine whether added emphasis for their modifivation or protection is warranted. To the Texas State Department of Highways and Public Transportation, theNTSB recommended conducting an inventory of existing unprotected, raised concrete culvert endwalls and headwalls to establish a priority with their highway safety improvement program for their modification in accordance with FHA recommended practices. To the U.S. DOT the NTSB recommended initiating a research program to identify new approaches to reduce the injuries and damages caused by the dangerous behavior of pressurized, liquified flammable gases released from breached tanks on bulk transport vehicles.

27. Shertz, Robert H. "Key Issues In Heavy Truck Safety". American Trucking Associations, Inc. Safety Comm. on Res. and Environment, Washington, D.C. 1976.

A discussion of various aspects of highway safety with regard to heavy trucks is presented. Included are truck-tractor registration, discrepancies in varoius statistics on accidents involving trucks, the advantages of glider kits, and the need for increased appropriation of funds for the inspection of trucks. Also discussed are truck safety defects, comparative stopping distances of cars and trucks, jackknifing of tractor-trailors, number of fatalities in truck accidents compared to those involved in car and train accidents, and advantages of the cab over engine (COE) configuration.

28. Bureau of Motor Carrier Safety, Federal Highway Administration, Washington, D.C. 1976. "Motor Carrier Accident Investigation. Benton, Trucking Company, Accident--Jan 3, 1976--Lovington, New Mexico".
REPORT NO.: 76-1

The report is an investigation of the resulting collision when a tractor semitrailer combination crossed the centerline of U.S. Highway 82 and collided with the left front and side of an automobile. The accident caused five fatalities, one injury, and $20,000 in property damage. The probable cause of the accident was intoxication of the truck driver and the physical limitations of a severe heart condition. Estimated speed of the truck at impact was between 70-75 mph and other drivers testified the truck was weaving back and froth in the other lane. Insurance on the truck was in the process of being cancelled by the insurance company because the driver had falsified application for insurance by failing to disclose his heart condition. Five violations of the Federal Motor Carrier Safety Regulations were identified; driving while intoxicated, driving while physically unqualified; speeding, nonuse of seat belts, and failure to keep current log. The driver also had several traffic violations in recent years.

29. Bureau of Motor Carrier Safety, Federal Hwy. Administration, Washington, D.C. 2 "Motor Carrier Accident Investigation. SECO, Inc. Accident--February 18. 1976--Washington, D.C.".
REPORT NO.: BMCS-76-2; HS-019 503;
SUBFILE: HSL

An accident involving a tractor semitrailer combination operated by Seco, Inc., of Marlow Heights, Maryland (referred to as the truck) and an automobile occurred at 6:15 p.m. on 18 February 1976 at the intersection of Naylar Road, 22nd Street, and Minnesota Avenue, Southeast, Washington, D.C. The truck entered the intersection, collided with the rear of the automobile, overrode the traffic control island and signal support, then left the roadway striking and penetrating a nearby apartment building. The accident resulted in five fatalities, three injuries, and approximately $90,000 property damage. Probable cause was assigned to inattentiveness of the part of the truck driver and a deficient vehicle which was improperly inspected and maintained. Environmental conditions were not ideal (the weather was cloudy with light rain and temperature of 66¢, and the accient location was dark with wet pavement), but no major fault was assigned to these. Additional information is given on events preceding the accident (relating to the truck driver and condition of the truck), the accident, and driving records of the two drivers involved. Details of defects found in the truck are given with primary emphasis on brake condition. Violations of the Federal Motor Carrier Safety regulations which were found included:

driver traffic violations which had not been reported, failure to investigate driver's employment record, failure to maintain driver qualification file, failure to maintain driving log properly, and failure to inspect and maintain vehicle to insure safe and proper operating condition.

30. Federal Highway Administration, Bureau of Motor Carrier Safety, Washington, D.C. "Motor Carrier Accident Investigation. Thunderbird Motor Freight Lines, Inc., Accident - August 11, 1976 - East Alton, Illinois".
1976 14p
REPORT NO.: BMCS-76-8; HS-020 784;
SUBFILE: HSL

A motor carrier accident investigation report is made on a 1976 nighttime collision on a city street in East Alton, Ill. involving a commercial tractor semitrailer combination vehicle and passenger vehicle. The truck collided head-on with a 1972 Chevrolet Vega, ran off the road, crashed through a fence, and penetrated a private residence, killing one resident. The accident resulted in one fatality and six injuries, with property damage estimated at $20,000. Probable cause of the accident was reckless operation of the commercial vehicle by an intoxicated driver. Driver admitted having had no sleep for the proceeding 48-hour period; Post-accident investigation revealed no mechanical defects for the truck, or involvement of the passenger vehicle in accident responsibility. Contributing factors include the carrier's (Thunderbird Motor Freight Lines, Inc.) apathy toward numerous violations by the driver, use of the truck for personal purposes, and noncompliance with the Federal Motor Carrier Safety Regulations on nine counts. The driver was charged with and convicted of reckless homicide and driving while under the influence of alcohol. Photographs of the accident are included. Report on Thunderbird Motor Freight Lines, Inc., Accident - 11 Aug 1976, East Alton, Ill.

31. National Motor Vehicle Safety Advisory Council, 1976. "Motor Vehicle Safety Seminar. Key Issues in Heavy Truck Safety Transcript of Proceeding, July 12, 1976".
REPORT NO.: HS-802 115 and HS - 802 116

The National Highway Traffic Safety Administration (NHTSA) presented statistics on heavy truck accidents. Accident severity is high and increases with truck weight in truck collisions with other vehicles, 97% of the fatalities being non-truck occupants when a truck and passenger car are involved. The Motor Vehicle Manufacturers Association (MVMA) suggested future safety research be concentrated in the areas of better accident reporting and evaluation distinguishing between large and small trucks, of police reporting and data collection techniques, of more effective truck inspection procedures and of comprehensive driver training, registration and licensing procedures. The National Transportation Safety Board representative cited a 1973 study of commercial vehicle braking, outlined the problem of the difference in stopping capabilities between passenger cars and commercial vehicles. Reluctance of manufacturers and carriers to accept major or changes is based on cost/benefit factors and the problem of maintaining interchangeability between tractors and trailers. But the high fatality rate for passenger car occupants in truck-car accidents justifies the effort to revise truck braking to the performance levels of passenger cars. The Highway Safety Research Institute reported new findings suggesting that the yaw stability of truck and tractor trailers is relevant to truck safety. The Freightliner Corporation suggested that accident avoidance techniques, improved driver skills and highway improvement are factors of great potential for highway safety, and that underride protection on trucks should not be relied upon in accident prevention.

32. National Transportation Safety Board; Department of Transportation; Washington, D.C. 20591. "Railroad Accident Report: Collision of Reading Company Commuter Train and Tractor - Semitrailer, New Yardley, Pennsylvania, June 5, 1975".
Mar 1976 24pp 8 Fig. 1976
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161
REPORT NO.: NTSB-RAR-76-4
SUBFILE: RRIS

About 11:06 p.m. on June 5, 1975, a Reading Company commuter train struck a tractor-semitrailer (truck) at a grade corssing near Yardley, Pennsylvania. The truck was transporting three coils of steel, two of which penetrated the first commuter car. The three occupants of the lead car were killed and an occupant of the second car was injured slightly. The truck driver was uninjured The semitrailer was torn from the tractor and damaged beyond repair and the lead commuter car was damaged extensively. At the time of the collision, the automatic grade crossing signal system was functioning. The truckdriver said he had not seen or heard the warning signals. The National Transportation Safety Board determines that the probable cause of the accident was the failure of the truck driver to stop the truck in accordance with the warning signals.

33. National Transportation Safety Baord, Bureau of Surface Transportation Safety, W. "Railroad/Highway Accident Report. Collision of A Crown-TRYGG Construction Company Truck with An Amtrack Passenger Train, Elwood, Illinois, November 19, 1975".
1976 26p
AVAILABLE FROM: NTIS
REPORT NO.: NTSB-RHR-76-2; HS-019 679;
SUBFILE: HSL

Amtrak turboliner passenger train No. 301 was struck by a loaded dump truck in Elwood, Ill., at 9:10 a.m. The crossing was unprotected and had limited sight clearance between the road and track. Four cars of the five-car train were derailed and 41 persons were injured. The train was owned by Amtrak and was operated by an Illinois Central Gulf Railroad (ICG) crew over the ICG track. The road was a county highway maintained by the Will County Highway Department. The National Transportation Safety Board determines that the probable cause of the accident was the failure of the truck driver to stop his vehicle short of the track until it was safe to proceed. Contributing to the accident was the inadequate sight clearance between the road and the track on the approach to the unprotected grade crossing. NTSB found further that additional advance warning devices and a reduced speed limit would decrease the likelihood of conflict at this crossing. Active protection for the crossing should have been installed while the road was being reconstructed and before it was opened. The impact by the truck, in combination with the dumping of large amounts of asphalt on and about the rails, caused the train to detrail. High priority should be afforded to improving the safety at grade crossing highway-railroad intersections on all high-speed passenger train corridors. The NTSB recommended the following to the Federal Highway Administration; procedures should be included in the guidebook and training course for highway/railroad engineers to insure that active grade crossing protection devices are operational when ungraded or newly constructed streets or highways are opened; states should be urged and assisted to initiate without delay a comprehensive field review of high-speed passenger train corridors; and a schedule of projects should be established to insure that each grade crossing receives appropriate safety treatment. The NTSB recommended to the Federal Railroad Administration that improvements to be coupler assembly on the French-manufactured turbotrains currently in service be required to minimize the possibility of uncoupling.

34. Minahan, Daniel J.; O'Day, James. "Car-Truck Fatal Accidents in Michigan and Texas".
University of Michigan, Hwy. Safety Res. Inst.
Ann Arbor, Michigan, 1977
REPORT NO.: UM-HSRI-77-49

Current estimates of the frequency of underride in car-into-truck accidents were compared with 1970 estimates of 200 annually nationwide by studying all such accidents in Michigan in 1972-1976 and in Texas in 1975-1976. Averaging the data from police accident reports resulted in the expected annual number of rear-end car/truck fatal collisions of 261, pluse 195 side collisions, or a total of 456 nationwide. Of the rearends, 90% result in underride; of the side impacts, 75% result in underride. Such accidents usually occur at night on straight rural roads; the drivers are usually male, with drinking involvement about the same as that for other types of fatal accidents. Relative impact speeds, especially in side impacts, are usually over 30 mph. Better underride guards with energy absorbing capabilities and enhanced conspicuity of trucks and trailers would reduce but not eliminate such accidents.

35. McDole, Thomas L. "Inspection, Defect Detection, and Accident Causation in Commercial Vehicles". Highway Safety Res. Inst. 1977 12p Grefs
AVAILABLE FROM: SAE
REPORT NO.: SAE-770116; HS-021 964
SUBFILE: HSL

Effects of proper commercial vehicle identification and maintenance procedures on safety were studied. and the need was shown for improved or modified inspection and maintenance requirements in the Federal Motor Carrier Safety Regulations (FMCSR) Section 396, Inspection and Maintenance. An identifiable relationship was shown to exist between good commercial vehicle inspection and maintenance practices and a reduction in defect-related accidents. The better maintenance practices were usually associated with larger firms, and poorer maintenance practices with smaller firms or individual owner operators. Vehicles should receive a thorough pre-trip inspection, responsibility resting with the driver but accomplished by driving through a checklane or by utilizing an inspector in a careful walkaround with a checklist. The written record of this inspection should be carried in the vehicle, and could be audited by the Bureau of Motor Carrier Safety (BMCS); other evidence of inspection and maintenance activities should also be available in the vehicle. The BMCS should also develop a management program based on data available from the collection of their Safety Accident Report form MCS-63, to prepare reports of enforcement activity by region and for the U.S. generally, on types of vehicle defects by several independent variables, such as make, model, year, region, etc., to prepare reports and notifications to companies and manufacturers on frequent defects, and activity reports for field management personnel. These data would be of more value if a set of data were collected on an unbiased sample of the truck population periodically, for comparison. To communicate with smaller firms, increasing their awareness of BMCS regulations and knowledge of sound safety practices, instructional materials could be provided at truck stops, weight stations, or included in state licensing examinations (for those states with classified driver's licenses). Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977. Based on a Hwy. Safety Res. Inst. Study, "Effects of Commercial Vehicle Systematic Preventive Maintenance on Specific Causes of Accidents."

36. National Transportation Safety Board; Bureau of Accident Investigation; Washington, D.C. 20594. "Railroad/Highway Accident Report. Collision of An Amtrak/Atchison, Topeka and Santa Fe Railway Train and A Tractor-Cargo Tank Semitrailer, Maryland, Oklahoma, December 15, 1976."
28 pp 1977
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Sprinfield, Virginia 22162
REPORT NO.: NTSB-RHR-77-3; PB-277960/1st
SUBFILE: NTIS, RRIS

About 8:58 a.m., C.S.T., on December 15, 1976, Amtrak passenger train No. 15, operating on the Atchison, Topeka and Santa Fe Railway, collided with an oil-laden tractor-semitrailer (tank) at the Kay-Noble County Line Road grade crossing near Maryland, Oklahoma. The truck driver and 2 train crewmembers were killed; 11 other persons on the train were injured. The truck and its lading were destroyed. Two locomotive units and two cars of the train were damaged. Total accident damage was estimated to be $880,700. The National Transportation Safety Board determines that the probable cause of this accident was the lack of adequate warning of the approach of a high-speed train to enable the truck driver to ascertain when it was safe to enter the crossing. Contributing to the accident was the crossing's unsuitability for joint use by high-speed trains and heavily loaded trucks.

37. Bureau of Motor Carrier Safety, Washington, D.C. 20590 "1977 Accidents of Motor Carriers of Property".
1978 84p
REPORT NO.: HS-025 964
SUBFILE: HSL

Statistics on 1977 motor carrier accidents in the U.S are tabulated, graphed, and charted. The data were based on accident reports submitted to the Bureau of Motor Carrier Safety by carriers of property subject to the Federal Motor Carrier Safety Regulations. Reportable accidents are those involving a motor vehicle engaged in the interstate, foreign, or intrastate operations of a motor carrier subject to the Dept. of Transportation Act, resulting in the death of a human being, or in bodily injury requiring medical treatment away from the scene of the accident, or in total damage to all property aggregating $2000 or more. In 1977, of the 29,936 accidents reported, 2293 were fatal accidents which resulted in 2983 deaths, 2631 injured persons, and over $39 million in property damage. Of those killed, 485 were truck drivers, and another 184 were other truck occupants, while 2314 were pedestrians or occupants of other type vehicles. There were 18.169 nonfatal injury accidents which resulted in 29,067 injured persons and over $132 million in damages. The 9474 property-damage-only accidents caused another $72 million in damages. Collision accidents which occurred on over-the-road trips accounted for 56% of the total number of accidents, 75%

of the fatalities, 62% of the injuries, and 55% of the property damage. Noncollision accidents which occurred on over-the-road trips accounted for 23% of accidents, 11% of fatalities, 16% of injuries, and 34% of property damage. Some 18% of the accidents were collisions of vehicles engaged in local pickup delivery operations (accounting for 13% of fatalities, 20% of injuries, 8% of property damage). Noncollision accidents (local pickup/delivery) accounted for 3% of accidents, 1% of fatalities, 2% of injuries, and 3% of property damage.

38. Hackman, K.D.; Larson, E.E.; Schinder, A.E. "Analysis of Accident Data and Hours of Service of Interstate Commercial Motor Vehicle Drivers".
Bureau of Motor Carrier Safety 400 7th St, S.W. Washington, D.C. 20590
Genasys Corporation 11300 Rockville Pike Rockville Maryland 20852,
Safety Management Institute 7979 Old Georgetown Road, Suite 600 Bethesda Maryland 20014
Aug 1978 Final Rpt. 74 p.
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Sprinfield, Virginia 22161
PB-286718/2ST
SUBFILE: NTIS: HRIS: TSRF: TSC

The report presents the results of an analysis of the relationship between commercial motor vehicle accidents and the hours of service and rest of drivers regulated by the Bureau of Motor Carrier Safety. A total of 25,666 single and two-man truck accidents and 483 bus accidents, occurring during 1976, were analyzed with data from the Motor Carrier Accident Report Froms (50T and 50B) and a special supplementary driver service and rest report form. A limited volume of driver exposure data was available for comparative regulations; driving, duty fatigue and accidents occurring between periods of extended rest; rest and the use of a sleeper berth; driver age, experience and physical condition; cyclic pattern; and, carrier and vehicle characteristics.

39. Simpson, H.M.; Warren, R.A.; Page-Valin, L.; Collard, D. "Analysis of Fatal Traffic Crashes in Canada, 1976 Focus: The Impaired Driver".
Traffic Injury Res. Foundation of Canada, 1765 St. Laurent Blvd., Ottawa Ont. K.
1978 38p
REPORT NO.: HS-022 412;
SUBFILE: HSL

Statistical information on alcohol consumption among fatally injured drivers and pedestrians in seven of the Canadian provinces (British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, New Brunswick, Prince Edward Island) During 1976 is presented. Data from 1974 and 1975 are also provided for comparative purposes. For purposes of comparison and consistency, drinking drivers (or pedestrians) have been defined as those with positive BAC's (greater than 10 MG% W/V), and impaired victims are those with BAC's over 80 MG% (the current Canadian legal limit). In calculating the proprotion or percentage of those who had been drinking, or were impaired, one crucial assumption was made, namely, that those victims who were not tested for blood alcohol had zero blood alcohol. Thus, estimations of impairment were calculated as follows: number of persons (E.G. Drivers) tested for blood alcohol and found to have BAC levels in excess of 80 MG%, expressed as a portion or percentage of all fatally injured drivers. In Summary, data on fatally injured drivers by vehicle type for all seven provinces reveal the following information on alcohol consumption/impairment: car drivers, at least 47% had been drinking (HBD) and at least 38% impaired;

truck and van drivers, at least 49% HBD, at least 42% were impaired; motorcycle operators, at least 40% HBD, at least 29% impaired; tractor-trailer operators, at least 25% HBD, at least 25% impaired; and snowmobile operators, at least 60% HBD, at least 52% impaired. With regard to the drinking driver problem, the following recommendations are made: reassess and critically evaluate existing impaired-driving countermeasure programs, consider further research of the abuse of alcohol in the workplace (especially with respect to professional drivers), initiate an in-depth investigation of the impact of motorcycle drivers, conduct research to determine the extent to which low BAC levels inflate disproportionately the risk of collision for motorcycle drivers, and provide considerably more public information/education programs in the area of alcohol involvement in snowmobile fatalities. With regard to pedestrains, the following results were found: approximately one fourth of total pedestrian fatalities under 14 years of age; approximately one fourth of total 65 years of age and over; alcohol consumption very infrequent among the preceding two groups; among the remaining 52% of pedestrian fatalities, 43% having consumed alcohol (highest in age range 18-19 with 68% having positive BAC's and 53% having in excess of 80 MG%). BAC's of pedestrian fatalities were generally higher than those of drivers; 72% of pedestrians had bac's in excess of 150 MG% (57% in excess of 200 MG% and 15% in excess of 300 MG%). Funded in part by non-medical use of drugs directorate, health and welfare Canada and the Motor Vehicle Manufacturers Association.

40. Cassidy, Mark E. "Heavy Trucks. Fatal Accident Reporting System Special Report". National Highway Traffic Safety Administration National Center for Statistics and Analysis, Washington, D.C. 1978
GPO, STOCK NO: 050-003-00313-1

The Fatal Accident Reporting System (FARS) of the NHTSA represent the most comprehensive and detailed data available on the National Motor Vehicle fatality toll, and provides the capability to separate fatal accidents according to size or type of truck involved. FARS has three categories of heavy trucks (Single-unit trucks Gross Vehicle Weight (GVW) greater than 26,000 lbs, two-unit trucks, and multi-unit trucks). In 1976 the deaths in motor vehicle traffic accidents that involved heavy trucks was 8.9% of all traffic fatalities. In 1976 there was a 15.7% increase in fatalities from heavy truck accidents over those in 1975, and a similar increase in tonnage carried. Half the fatalies in truck/car collisions are passenger car occupants and less than a quarter are in heavy trucks. Hourly accident rates are up to 3 x higher on weekdays than on weekends with Saturday having 2 times accident occurrence as Sundays. In fatal accidents involving only a heavy truck and a passenger car, 97% of the deaths are to car occupants. A fire or explosion is more probable in a heavy truck than in other vehicles in all fatal accidents.

41. National Transportation Safety Board; Bureau of Accident Investigation; Washington, D.C.; 20594. "Highway Accident Report - Usher Transport Inc., Tractor-Cargo-Tank-Semitrailer Overturn And Fire, State Route 11, Beattyville, Kentucky, September 24, 1977".
July 1978 29 p. 1978
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161
REPORT NO.: NTSB-HAR-78-4; PB-284817/4ST
SUBFILE: NTIS: HRIS

About 9:35 A.M., e.s.t., on September 24, 1977, an Usher Transport, Inc., tractor-cargo-tank semitrailer was descending a 12.6-percent, 720 foot-long grade approaching a left curve and a railroad/highway grade crossing on Kentucky State Route 11 in Beattyville, Kentucky. The truck, which was hauling 8,255 gallons of gasoline, crossed the tracks against the flashing red lights and in front of an approaching tain, and struck buildings adjacent to the edge of the road. It then overturned on top of a parked car. Escaping gasoline ignited and the fire destroyed 6 buildings and 16 parked vehicles. Seven persons died in the fire. The National Transportation Safety Board determines that the probable cause of this accident was the loss of vehicle control because of speed excessive for highway geometry. Contributing to the accident was the truckdriver's lack of judgment when he failed to respond to the warnings and obey the rules on the road.

42. Pruber, D.G., et al. "Wyoming Truck Accident Facts 1977". Wyoming State Highway Department, Highway Safety Analysis Section, P.O. Box 1708, Cheyenne, Wyo. 82001, 1978.

The report presents statistical data relating to commercial-type truck-involved accidents. The data analyzed originated from individuals' accident reports and investigating officers' reports. During 1977, 1486 truck-involved accidents occurred in Wyoming resulting in 53 fatalities, 796 injuries, and + $14 million economic loss. The number of truck -involved accidents increased 12% in 1977 over 1976.

43. Kubacki, Michael S. "Collisions of Cars with Tractor-Semitrailers". The HSRI Research Review, Nov-Dec 1979, Vol. 10, No. 3 pl-7.

This study examined the 1977 data from the Fatal Accident Reporting System (FARS) and discovered that car-into-semitrailer collisions were over-represented under night time and other adverse lighting conditions. Two thirds of such rear-end collisions occur at night, while only 42.1% of all fatal car/TST accidents occur at night. Drinking involvement was also overrepresented in rear-end and side car-into-TST collisions compared with other types of collisions. More than half of the fatal car/TST collisions o-cur on interstate highways limited- access roads, and U.S. routes. It was suggested that making trucks and semitrailers more conspicuous through addition of lights or reflective paints should reduce the frequency of such accidents. They also noted that low levels of nighttime conspicuity of trucks and semitrailers may pose increased danger for motorists whose vision is chronically impaired or has been temporaily impaired by consumption of alcohol.

44. Khasnabis, Snehamay, Atabak, Ali. "A Comparative Analysis of Truck Accidents in The State of Michigan".
Wayne State University, Department of Civil Engineering, Detroit, Michigan 1979
REPORT NO. MVMA-WSU-7904 Cl. 56

An analysis of accident and travel data was conducted comparing Michigan truck accident expereince with that of other motor vehicles (non trucks), Used three severity schemes (fatal, personal injury, and property damage) for trucks and nontrucks. Trucks were further classified in to pickups/panels Vans (PPV's), straight trucks, and truck tractors. Annual accident rates were computed from historical accident and exposure data. For fatal and property damage, trucks had a higher rate than nontrucks. For injury accidents, trucks had a lower rate. In almost all accident categories, PPV's and straight trucks had a higher accident rate than nontrucks, while truck tractors had a higher rate for fatal accidents only. Straight rucks had the highest accident record overall, followed by PPV's and truck tractors. Truck tractors had a higher fatal accident rate than PPV's.

45. National Transportation Safety Board, Bureau of Accident Investigation, Washington, D.C. 20594, 1979. "Highway Accident Report. Osterkamp Trucking, Inc., Truck/Full Trailer and Dodge Van Collision, U.S. 91, Near Scipio, Utah, August 26, 1977."
Report No. NTSB-HAR-79-1

The head-on collision between a truck/trailer and van occurred during a heavy rainstrom. The eight occupants of the van were killed and the truck driver was injured. The truck driver testified that the van was coming in his lane so he applied both truck and trailers brakes which put him in a skid during which he attempted to engaged the "jake brake," a device which increases the engines braking capability but is intended for energy absorption during downhill operations. Evidence was limited and probable cause of the accident was inconclusive. During the evaluation, a significant lack of research data on the performance of lightly loaded truck tires, and the potential effect of varing pavement frictional quality was noted. The pavement surface was found to have a progressively lower and widely fluctuating wet frictional quality and an average wet frictional quality below recommended values. Standard pavement inventory test procedures would not have detected these pavement problems at the accident site.

46. Schultz, Mort. "How We'll Run Killer Trucks Off the Roads". Popular Mechanics. V. 152 n3 p77, 80-1, 211 (Sept 1979)

Fatalities in U.S. truck -related accidents increased consistently from 3483 in 1975 to 5120 in 1978. On-the-spot investigation found that many accidents resulted from mechanically deficient trucks and/or irresponsible operation. Other contributing factors were driver negligence, drinking, fatigue, and highway conditions in one spot safety check in Pennsylvania in 1978, 382 out of 711 trucks were found in hazardous condition. Brake defects are the major culprit. NTSB urges construction of runaway "escape ramps" to avert brake-loss accidents on steep grades. The new Federal Motor Vehicle Safety Standard set requirements in such areas as better resistance of truck brakes to heat buildup, a reasonable 60 mph stopping distance, and backup breaking. To reduce heavy-truck accidents the NHTSA also propses self-adjusting brakes for new trucks, better policing to get illegal/unsafe drivers off the road, stricter operating hours, speed-governing devices, installing tachographs, and underride barrier standards. The industry's self regulation efforts are no substitute for the removal from the highway of incompetent and unsafe drivers.

47. Bureau of Motor Carrier Safety, Washington, D.C. 20590. "Motor Carrier Accident Investigation. NL Industries, Inc. and Thurston Motor Lines, Inc. Accident, April 27, 1978, Morganton, North Carolina".
1979 17p
AVAILABLE FROM: Corporate author
REPORT NO.: BMCS-78-1; HS-025 733;
SUBFILE: HSL

On 27 Apr, 1978, Thursday at 4:10 a.m., on Interstate 40, 7 mi west of Morganton, N.C., a tractor-semitrailer combination, operated by Southern Screw Div. of NL industries, Inc. (N.Y., N.Y.), collided with the rear of a slower-moving tractor-semitrailer combination, operated by Thurston Motor Lines, Inc. (Charlotte, N.C.), which was in the right lane of travel. Upon collision, the Thurston truck veered to the left, crossed one lane of travel, ran partially onto the grass median, then returned to the roadway, coming to rest in the right lane and partially on the right shoulder, its final position was 756 ft from the point of impact. The NL truck, after the collision, continued its forward motion straight ahead, and came to rest 432 ft from the point of impact. The driver of the NL truck was crushed in the cab of his tractor and killed instantly. The driver of the Thurston truck was injured. Property damage was $32,600. The probable cause of the accident was inattention as the result of fatigue or use of drugs on the part of the NL driver, and excessive speed (estimated to be between 70 mph and 75 mph). The Thurston driver claimed that he was traveling at 45 mph prior to the accident. The NL driver had covered about 700 mi to the accident scene in 17 hrs without any appreciable rest. Sometime during the trip, he relied on amphetamines to stay awake. The speed of the NL truck and the slower-moving and mechanically-deficient Thurston truck contributed to the serious consequences of the rear-end collision. Both drivers had previously had their licenses suspended and revoked and both drivers had prepared false logs, indicating a callous disregard for compliance with state and Federal regulations. The Thurston driver was operating without a valid chauffeur's license, a fact unknown to his employer.

48. Krall, F.L., Rossow, G.W. "Heavy Truck Safety...The Need to Know". <u>Traffic Quarterly</u>, Vol. 35 No. 3, pp 337-358, July 1981

Several sources of statistics of accidents involving heavy trucks are reviewed supporting the idea that far more detailed accident and exposure data are necessary to identify specific truck safety problems, their causes and possible countermeasures. Different agencies and groups critize different factors as causes of accidents: some say the truck design is deficient; others say the lack of maintenance is the cause; others blame it on deficiencies of the operator; others critize the highway and its environment. The relative contribution of all these factors to heavy truck accident, injury, and fatality statistics is largely unknown.

50. Danner, M. Langivieder. "Results of an Analysis of Truck Accidents and Possibilities of Reducing Their Consequences Discussed On the Basis of Car-To-Truck Crash Tests." Society of Automotive Engineers, Inc. Conf. Paper 811027, HS-032 418 pp903-950, 1981

Almost 40% of the fatalities in car/truck collisions result from front-to-front collisions. The inevitably high mass of the truck does not constitute the only problem. The form aggressivity of the trunk front as a contributing factor was investigated. Safety modifications to the truck front included a large impact plate and an energy absorbing front protection. In 10 car-to-truck crash tests, with both unchanged trucks and modified trucks, two collision types were analyzed: truck/car, front/front at 60 kph; truck/car, front/side at 39 kph. The large "impact plate" did not produce any appreciable safety effect in these test conditions, but the effect cannot be ruled out in lower speed ranges. The frontal protection with energy- absorbing construction and mobile design did result in improvements especially by reducing the override of the car by the truck. Quantifying this effect must be reserved for the subsequent series of tests, which should reveal an order of priority on the basis of benefit/cost analysis. The study also indicated that truck front safety modifications may be difficult because of their influence on practical requirements such as bumper clearance angle, length, weight, etc. Recommended further research.

B.2.5 Hazardous Materials

1. Krasner, L.M. "Motor Vehicle Standards For Hazardous Material Transportation".
   Final Technical Report.
   Factory Mutual Res. Corp., Norwood Mass.
   1970 - T-3 35p refs
   AVAILABLE FROM: CFSTI
   REPORT NO.: FMRC-Ser-18696; RC70; HS-800 240
   CONTRACT NO.: FH-11-6897; Contract
   SUBFILE: HSL

The purposes of the study were to establish safety performance standards for reducing the number and seriousness of accidents involving tank trucks carrying hazardous cargoes and to determine areas in which these standards should be implemented. The specific objectives were: to evaluate data on this type of accident; to relate by statistical methods the accidents and their contributing factors, environmental, human, and vehicular; to relate hazard to design of the carriers; to relate accidents to existing regulations; to determine performance standards for minimizing spillage and leakage during transfer processes; to propose standards for reducing accidents and minimizing their effects. The accident data were so faulty that a program for better data colelcting should be emphasized. Driver error was found to be the cause of 75% of the accidents where a truck is at fault. Gasoline and other petroleum products represent the largest hazardous material problem on the highways.

2. Schmidt, J.W., Price, D.L. "The Flow of Hazardous Materials on Virginia
   Highways". National Safety Council, Virginia Polytechnic Institute
   and State University
   Journal of Safety Research VOL. 11 No. 3 1979 pp 109-114 2
   Fig. Tabs. 5 Ref.
   SUBFILE: NSC: HRIS

A survey of trucks carrying hazardous material along Virginia highways was conducted. Trucks were stopped at 38 locations during daylight hours in July and August. Shipping papers and placarding were reviewed and the driver interviewed. Cooperation was voluntary. The study showed that about 13% of all trucks carrying hazardous materials and 10% carrying sufficient amounts to require placarding. Most such traffic is on the interstates and in highly populated areas. Of the hazardous materials carried, 64% were flammable or combustible liquids and 10.7% were corrosive. Of the trucks carrying hazardous materials, 72% required placards by Federal regulations; 41% of such trucks were in violation of placarding requirements. (A).

3. Jackson, L.E. "Railroad/Highway Grade Corssing Accidents Involving Trucks Transporting Bulk Hazardous Materials".
Institute of Transportation Engineers
National Transportation Safety Board
ITE Journal Vol. 52 No. 10 Oct 1982 pp 35-37 2 Fig.
AVAILABLE FROM: Institute of Transportation Engineers 525 School Street, SW, Suite 410 Washington, D.C. 20024
REPORT NO.: HS-033 748
SUBFILE: HRIS: HSL

Following a discussion of the seriousness and magnitude of the problem of railroad/highway grade corssing accidents involving trucks transporting bulk hazardous materials, this article points out two common factors observed in the more recently investigated accidents. The first factor is that these accidents tended to occur near terminals. The second factors is that drivers involved in these accidents appeared to demonstrate an irresponsible or careless attitude at the crossings, which perhaps indicates the need for special licensing for drivers of hazardous materials. The remainder of this article examines several aspects of Operation Lifesaver, the National Safety Council's nationwide program to reduce railroad grade crossing accidents, which could be used to attack the hazardous material truck problem. These aspects include: traffic engineering measures; traffic law enforcement; truck driver education; legislation and regulations; and a uniform coordinated effort by all agencies involved.

APPENDIX C

SURVEY OF STATE POLICIES FOR RESTRICTING TRUCKS ON URBAN FREEWAYS

Table C-1. List of States Responding to D-10 and D-18T Surveys on Truck Regulations and Restrictions.

State	Responded to D-10 Letter	Responded to D-18T Questionnaire
Alabama	Yes *	
Alaska	Yes	
Arizona	Yes	Yes
Arkansas	Yes	Yes
California	Yes	
Colorado	Yes	Yes
Connecticut	Yes	
Delaware	Yes *	
Florida	Yes	Yes
Georgia	Yes	Yes
Hawaii	Yes *	
Idaho	Yes *	
Illinois	Yes	Yes
Indiana	Yes	Yes
Iowa	Yes	
Kansas	No	Yes
Kentucky	Yes	
Louisiana	Yes	Yes
Maine	Yes *	
Maryland	Yes	Yes
Massachusetts	Yes	
Michigan	Yes	Yes
Minnesota	Yes	
Mississippi	Yes	
Missouri	Yes *	Yes
Nebraska	Yes *	
Nevada	Yes	

* Indicates States which responded to the D-10 letter, but have no operational truck regulation or restrictions other than size and weight limitations.

Table C-1. (cont.)

State	Responded to D-10 Letter	Responded to D-18T Questionnaire
New Hampshire	Yes	
New Jersey	Yes	Yes
New Mexico	Yes *	
New York	Yes	
North Carolina	Yes	Yes
North Dakota	Yes	
Ohio	Yes	Yes
Oklahoma	Yes *	Yes
Oregon	Yes	
Pennsylvania	Yes	Yes
Rhode Island	Yes	
South Carolina	Yes *	Yes
Tennessee	Yes	
Utah	Yes	Yes
Virginia	Yes	Yes
Washington	Yes	Yes
West Virginia	Yes	

* Indicates States which responded to the D-10 letter, but have no operational truck regulation or restrictions other than size and weight limitations.

Table C-2. Does your State by Legislation Restrict Trucks of Specified Size/Weight to Designated Lanes On Urban Freeways?

State	All Urban Freeways?	Special Location	Weight Range	Specified Lanes
Arkansas	Yes	All	All	Leftmost
Arizona	---	---	---	---
Colorado	No	Yes	Varies	Rightmost
Indiana	Yes	All	All	Rightmost
Illinois	No	Yes	All	Rightmost
Iowa	---	---	---	---
Kansas	---	---	---	---
Louisiana	No	Yes	All	Rightmost
Maryland	No	Yes	All	Rightmost
Massachusetts	No	Yes	>10,000#	Rightmost
Michigan	---	---	---	---
Minnesota	---	---	---	---
Missouri	Yes	All	All	Rightmost
New Jersey	Yes	All	>10,000#	Rightmost
Oklahoma	---	All	---	---
Oregon	Yes	Yes	> 8,000#	Rightmost
Rhode Island	---	---	---	---
Utah	---	---	---	---
Washington	---	---	---	---

NOTES: Table C-2

Arkansas - Signs have been erected at weight stations entering the State, encouraging use of the left lane on the Interstate system in an effort to equalize pavement wear. This program has not been successful.

Colorado - No legal requirement restricts trucks to certain lanes; however, law allows the Department of Highways to impose lane restrictions based on the results of a traffic engineering survey. For example, trucks over 10,000 lbs. GVW are restricted to the rightmost lane of west-bound I-70, west of the Eisenhower Tunnel.

Illinois - The Illinois DOT has the authority to limit lane usage on freeways having three or more lanes of travel in each direction. In Chicago, trucks are restricted to the two rightmost lanes.

Indiana - Trucks, truck tractors, or road tractors, with trailers, semi-trailers, or pole trailers must travel in the far right lane on that portion of the Interstate Defense Network with two lanes in each direction or the two right lanes when a state highway consists of three or more lanes in one direction.

Louisiana - On Airline Highway between the US 190 Mississippi River Bridge to the Florida Avenue intersection in Baton Rouge, are posted signs which indicate, "Truck Passing Truck Prohibited" and "Trucks Use Right Lane". These signs are also posted on the Huey Long Bridge (U.S. 90) in New Orleans. Although empowered by legislation to do so, the DOT has not established these regulations by legal document since it considers enforcement to be practically impossible.

NOTES: Table C-2 (cont.)

Maryland - Truck travel on sections of some freeways is restricted to the right two lanes only and is so specified by signs (e.g. portions of the Baltimore Beltways). This restriction is generally related to grades and differential speeds and is instituted on specific sections by regulation.

Massachusetts - Heavy trucks (defined as trucks whose weight exceeds 5,000 pounds which are used to transport goods, wares, merchandise, and excluding buses) on freeways are restricted to use of the rightmost lane except when passing.

Missouri - All vehicles are required to keep right except when passing.

New Jersey - Where there are three or more lanes in one direction, all trucks with gross weight of 10,000 lbs or heavier must use the right hand lane.

Oregon - Vehicles with gross weight of 8,000 pounds or more must use the rightmost lane of all roadways having two or more lanes in a single direction.

Table C-3. Does your State by Legislation Restrict Trucks of Specified Size/Weight to Designated Times on Urban Freeways?

State	All Urban Freeways?	Special Location	Weight Range	Hours Not Allowed
Arkansas	No	---	---	---
Arizona	Yes	All	os/ow *	Saturday or Sunday or dusk to dawn
Colorado	Yes	All	os/ow	Sunset to Sunrise
Indiana	Yes	All	os/ow Unspecified	Unspecified
Illinois	No	Yes	os/ow	9:30 am - 3:00 pm
Iowa	Yes	All	os/ow	Sunset to Sunrise Monday - Friday
Kansas	Yes	All	os/ow	Variable
Louisiana	Yes	All	os/ow	Variable
Maryland	No	Yes	Variable	Variable
Michigan	Yes	Yes	os/ow	Spring Variable
Minnesota	Yes	All	os/ow	Sunset to Sunrise Saturday -Sunday
Oklahoma	Yes	Yes	Variable	Variable
Oregon	Yes	Yes	os/ow	Peak Periods
Rhode Island	No	Yes	Variable	Variable
Utah	No	Yes	os/ow	Peak Periods
Washington	Yes	Yes	os/ow	Variable

*os/ow indicates oversize/overweight

NOTES: Table C-3

Arizona - By administrative rule, overweight/oversize vehicles can operate ONLY during the daylight hours, Monday through Friday.

Colorado - Colorado also restricts oversize and/or overweight vehicles to movement between sunrise and sunset. The Department of Highways restricts certain oversize and/or overweight vehic-cles to certain (unspecified) travel times in urban areas.

Illinois - The use of certain freeways and expressways is limited in the oversize/overweight permit regulations. For example, in Chicago oversize permits are limited to a width of 10 feet, and may only travel between the hours of 9:30 am and 3:00 pm.

Indiana - The State is authorized to restrict the use of highways for certain (unspecified) periods by certain vehicles.

Iowa - The operation of all oversize and/or overweight vehicles is restricted to daylight hours, Monday through Friday. This law applies to all highways.

Kansas - The Secretary of Transportation or local authority is authorized to issue or withhold permits for oversize and/or overweight, at their discretion, in order to establish seasonal or other time limitations within which these vehicles must operate.

Louisiana - The Secretary of Transportation can issue permits for the operation of vehicles having dimensions or weights in excess of the limits imposed and can restrict movements as to date and time of day.

<u>NOTES</u>: Table C-3 (cont.)

Maryland - The DOT is empowered to establish time restrictions on state highways.

Michigan - No overweight permits are issued during the spring weight restriction periods. For vehicles or loads wider than 8'10", movement is permitted only for daylight hours; in some instances, other time limitations may be set.

Minnesota - Oversize and/or overweight trucks are restricted to daylight operation during weekdays, statewide.

Oklahoma - Hours of truck operation may be restricted in Oklahoma and Tulsa counties.

Oregon - Operation of oversize and/or overweight loads is prohibited during peak morning and afternoon traffic hours.

Rhode Island - Local and state ordinances restrict truck usage to a certain time (unspecified). These roadways are generally located in residential areas.

Utah - Oversize and/or overweight vehicles are prohibited from operating between sunset and sunrise, Saturday or Sunday, or between 6am - 9am or 3:30 pm - 6:00 pm Monday through Friday in Salt Lake, Davis, and Weber Counties.

Washington - Oversize and/or overweight vehicles may not operate on state highways after 2:00 pm Friday, on the weekend, on holidays, or at night. They are not allowed in incorporated cities of population greater than 15,000 during peak periods. The major cities have larger truck restriction zones.

Table C-4. Through Truck Routes Developed by States

State	Can State develop through truck routes?	For Hazardous Loads Only?	Using Controlled Access Highway Only?
Arkansas	Yes	No	No
California	Yes	Yes	Yes
Florida	Yes	No	Yes
Georgia	Yes	No	Yes
Illinois	Yes	No	No
Indiana	Yes	No	No
Kansas	Yes	No	No
Louisiana	No	---	---
Maryland	Yes	No	No
Massachusetts	Yes	No	No
Michigan	Yes	No	No
Minnesota	Yes	No	No
Mississippi	Yes	Yes	No
Missouri	Yes	No	No
New York	No	---	---
North Carolina	Yes	No	No
Oklahoma	Yes	No	No
Pennsylvania	Yes	No	No
South Carolina	Yes	No	No
Virginia	Yes	No	Yes

NOTES: Table C-4

Arkansas - The Highway Department's District Engineer has the authority to regulate the speed and weight of trucks on State routes which cannot support normal truck traffic.

California - Vehicles containing explosives are required to follow certain routes around heavily populated areas. Laws have been enacted concerning the shipment of hazardous material, following federal regulations and guidelines. Other laws specify shipment methods, packaging, and labeling for trucks hauling hazardous materials.

Florida - The truck routes can only be developed based on load carrying capacities of roads and bridges, or width and/or height limitations of the structures.

Georgia - The Department of Transportation prohibits through trucks with more than six wheels from passing through Atlanta unless they have a scheduled stop within the I-285 perimeter freeway.

Illinois - The use of certain freeways and expressways by oversize/overweight vehicle is limited in the permitting procedure.

Indiana - The Department of Highways, through orders of the Director, restricts and controls truck movement on State Highways.

Kansas - The Secretary of Transportation prohibits the operation of trucks or other commercial vehicles on specific state highways, provided a satisfactory alternate route is designated. He can also impose limitations on the size and weight of the vehicles using a particular state facility, again provided a satisfactory alternate route is specified.

NOTES: Table C-4 (cont.)

Louisiana - The Secretary of Transportation can issue special permits for oversize/overweight vehicles and can impose a specific routing over the State highways of the shipment under the special permit.

Maryland - Trucks carrying hazardous loads are restricted in the Baltimore Harbor Tunnel. Trucks carrying hazardous loads must obtain special permission when crossing the Chesapeake Bay and certain other bridges. The Administration can establish truck routes on State highways if an equal alternate route is found.

Massachusetts - Trucks carrying hazardous materials are prohibited from using the Dewey Square Tunnel in Boston. The Department of Public Works can restrict the use of State highways to certain types or makes of transportation.

Michigan - Trucks carrying hazardous loads are not allowed on the John C. Lodge Freeway. The State can and does develop "Through Truck Routes" and "Local Truck Routes" for all trucks.

Minnesota - Trucks are not allowed in the I-94 Tunnel in Minneapolis if they are transporting hazardous material or if their gross weights exceed 9,000 pounds.

Mississippi - Trucks with hazardous materials may be routed

Missouri - The State Highway Commission may limit weight load for roads which may be damaged by heavy loads.

New York - All trucks are prohibited from using the parkway system in the metropolitan New York City area.

NOTES: Table C-4 (cont.)

North Carolina - The Department of Transportation has the authority to designate and appropriately mark certain highways of the State as truck routes. This law deals mainly with the State Ports Authority Complex in Wilmington, dealing with the movement of bulk fuel carriers to and from major containment facilities located along the Cape Fear River.

Oklahoma - The State may establish truck routes in Oklahoma and Tulsa Counties.

Pennsylvania - The transportation of hazardous substances is regulated by defining the routing and parking of vehicles carrying these substances. Trucks carrying hazardous materials are banned from tunnels. Heavy trucks are not allowed to use three steep hills.

South Carolina - The Department may prescribe size, weight, or speed limits if needed to preserve a road or part of a road. It also may prohibit in whole or in part the operation of an specified class or size of vehicle for the same reason.

Virginia - I-66, between I-495 and the Potomac River, is designated for use by trucks only.

Washington - The State bans oversize/overwight trucks on State highways in incorporated areas during peak periods. No oversize/overweight permits are issued for certain roads during winter months.

West Virgina - Trucks carrying hazardous and/or explosive commodities are prohibited from using the tunnels located on I-70 and I-77. Alternate routes must be taken by such vehicles.

Table C-5. Local, City or County Truck Regulation and/or Restriction Permitted by Legislation.

State	Lane Usage	Time Restriction	Routing Restriction	On State Highways?
Alabama	No	No	Yes	Yes
Arizona	No	Yes	Yes	No
Arkansas				Yes
California	Yes	Yes	Yes	w/Approval
Colorado	Yes	Yes	Yes	w/Approval
Georgia	No	Yes	Yes	Yes
Indiana	No	No	No	No
Kansas	No	Yes	Yes	Yes
Maryland	Yes	Yes	Yes	No
Michigan	Yes	Yes	Yes	No
Nevada	Yes	Yes	Yes	Yes
New Hampshire	Yes	Yes	Yes	Not Limited Access
New Jersey	Yes	No	Yes	w/Approval
North Dakota	No	No	Yes	No
Oklahoma	No	No	Yes	Yes
Pennsylvania	Yes	Yes	Yes	Yes
Rhode Island	No	Yes	Yes	Yes
South Carolina	No	No	Yes	No
Virginia	Yes	Yes	Yes	Not on State Limited Access
Washington	Yes	Yes	Yes	No

NOTES: Table C-5

Alabama - The City of Mobile bans hazardous and/or explosive materials from the Bankhead and I-10 tunnels by city ordinance.

Arkansas - Local jurisdictions cannot impose these regulations on State highways.

Arizona - Local juisdictions may pass ordinances on these restrictions, with the exception of lane usage.

California - Local authorities have the power to restrict trucks on local streets and on State routes with the concurrence of the California Transportation Commission. They also have the power to prohibit certain vehicles on State highways and city streets.

Colorado - Local authorities can impose any restrictions they wish, with the approval of the Department of Highways for State highways.

Georgia - Local authorities may, by ordinance, regulate or prohibit the use of any controlled access roadway within their respective jurisdictions by any class or kind of traffic. This does not apply to lane restrictions.

Indiana - Local authorities are authorized to issue or withhold permits for excessive size and/or weight, at their discretion, in order to establish seasonal or time limitations within which vehicles may be operated on highways under their jurisdiction. They may also prohibit the operation of trucks or other commercial vehicles, or may impose limitations as to size and/or weight on designated highways, provided that a satisfactory alternate

NOTES: Table C-5 (cont.)

route is provided. These regulations do not apply to lane usage.

Maryland - Local authorities may impose all of the restrictions, but they do not apply to State highways.

Michigan - Local authorities and county road commissions may not pass truck restrictions dealing with State trunk highways. For other roads within their jurisdictions, local authorities may, by ordinance or resolution, prohibit the operation of trucks or other commercial vehicles or impose limitations on size and/or weight.

Missouri - County highway engineers can, with approval of the State Highway Department, establish maximum weight limits for roads and bridges.

Nevada - Each local area can regulate truck use of the roadways in its jurisdiction, including routing, restrictions of use, size, and/or weight limitations, and transportation of hazardous commodities.

New Hampshire - State law places the jurisdiction of city streets, excluding limited access highways, under the city or town in areas of 5,000 population or greater.

New Jersey - Local authorities may impose truck lane usage restrictions and truck routing regulations with approval of the D.O.T.

North Dakota - Some urban areas designate streets for truck routes.

Oklahoma - Local authorities may designate local truck routes.

Pennsylvania - Local authorities can impose restrictions on lane usage, time limitation and routing.

NOTES: Table C-5 (cont.)

Rhode Island - Local ordinances restrict truck usage of certain roadways and the time when usage is allowed. These roadways are generally located in residential areas.

South Carolina - Local authorities cannot set limitations on State highways. They may prescribe size and/or weight restrictions, and prohibit operation of specified classes or size of vehicles in whole or in part.

Virginia - Local authorities can impose regulations for all of the truck restrictions except on State maintained controlled access facilities.

Washington - The local governments can close or restrict the use of any road or street under their jurisdiction to protect the facility or prevent dangerous conditions. They cannot, however, impose restrictions on State highways. They must request the State to do this.

Table C-6. Local City or County Truck Regulation and/or Restriction Allowed But Not Specifically Permitted by Legislation

State	Lane Usage	Time Restriction	Routing Restriction	On State Highway?
Arizona	Yes	Yes	Yes	Yes
Arkansas	Yes	Yes	Yes	No
Colorado	Yes	Yes	Yes	No
Florida	No	No	Yes	No
Georgia	Yes	Yes	Yes	No
Indiana	Yes	Yes	Yes	No
Kansas	No	Yes	Yes	No
Michigan	Yes	Yes	Yes	No
Missouri	No	Yes	Yes	No
Ohio	Yes	Yes	Yes	Yes
Oklahoma	No	No	Yes	No
Pennsylvania	Yes	Yes	Yes	Yes
South Carolina	Yes	Yes	Yes	No
Washington	Yes	Yes	Yes	Yes

NOTES: Table C-6

Arizona - The City of Tucson has passed an ordinance regulating the transport of radioactive materials.

Arkansas - Local jurisdictions can set their own restrictions, except on State highways.

Colorado - Local jurisdictions can regulate their own streets and roads, but not State highways.

Florida - Any jurisdiction can impose weight restrictions based on the load carrying capacities of its roads and bridges. However, they cannot prohibit trucks or direct them to certain truck routes except for weight, height or width limitations of the roads and bridges.

Georgia - Local jurisdictions may regulate their own streets and roads, except by lane restriction, and not on State highways.

Indiana - Indiana statute permits local governments to regulate the use of roadways under their jurisdictions in all matters that are not contradictory to State statutes. That is, cities, etc cannot regulate State highways which run through them.

Kansas - Local jurisdictions may regulate truck traffic on their roads and streets, except by lane.

Michigan - There is a case law which establishes the right of local units of government to enact ordinances which are not unreasonable.

Missouri - There are some restrictions on delivery trucks in congested areas during peak hours. Some cities have prohibited trucks on city streets and in some cases have established local truck routes.

NOTES: Table C-6 (cont.)

Ohio- Local jurisdictions may impose any of the suggested restrictions.

Oklahoma - County Commissions can post weight restrictions on county roads and bridges and then advise the State of the action.

Pennsylvania - Local jurisdictions can impose any of the listed restrictions.

South Carolina - Local authorities can impose any of the restrictions, but not on State highways.

Washington - Statute allows local agencies in set restrictions.

Table C-7. State and/or Local Truck Regulation and/or Restrictions Now Used

State	Lane Usage	Time Restriction	Routing Restriction
Alabama	No	Yes	Yes
Arizona	Yes	Yes	Yes
Arkansas	Yes	No	Yes
California	Yes	Yes	Yes
Colorado	No	No	No
Florida	Yes	No	No
Georgia	No	No	Yes
Illinois	Yes	Yes	No
Indiana	Yes	No	Yes
Kansas	No	Yes	Yes
Michigan	No	Yes	Yes
Minnesota	No	Yes	No
New Jersey	Yes	Yes	Yes
New York	No	No	Yes
Ohio	No	No	Yes
Oklahoma	Yes	Yes	Yes
Pennsylvania	Yes	Yes	Yes
Rhode Island	Yes	Yes	Yes
South Carolina	No	No	Yes
Utah	No	Yes	No
Virginia	No	No	Yes
Washington	No	Yes	No
West Virginia	No	No	Yes

NOTES: Table C-7

Alabama - Truck routing is handled by City ordinance in Mobile.

Arizona - The State, as well as the Cities of Phoenix and Tucson, now impose regulations

Arkansas - Certain routes in urban areas prohibit truck traffic. The State is attempting to move heavy truck traffic to the left-most lanes of some highways.

California - The California Highway Patrol restricts hours of operation for certain vehicles, as well as routing.

Colorado - The law allows the State to impose lane usage, time, and route restrictions for specific cases based on traffic engineering studies.

Florida - Florida is experimenting with truck restrictions by prohibiting trucks with three or more axles from entering the median lane on I-95 near Ft. Lauderdale.

Georgia - Heavy trucks are prohibited from going inside I-285 in Atlanta unless they can show they have a scheduled stop in that area.

Illinois - Heavy trucks on freeways in Chicago are restricted to the two rightmost lanes. In addition, oversize/overweight vehicles are limited to a width of 10 feet, and may only travel between the hours of 9:30 am and 3:00 pm.

Indiana - Truck routes and through truck route prohibitions have been established in the larger cities. Truck lane usage on the Interstate system has been established by statute on a statewide basis.

Kansas - Truck operations are restricted both by time and to designated routes.

NOTES: Table C-7 (cont.)

Maryland - Truck lane usage is restricted for climbing lanes. Truck usage is restricted by time in residential areas. Truck routing is applied for residential areas, hilly terrain, toll roads, bridges and tunnels.

Michigan - The State issues a Truck Operators Map which designates operating time and route restrictions.

Minnesota - Oversize and/or overweight trucks are restricted by daylight and non-rush hour periods in Minnesota.

New Jersey - Truck restrictions are imposed based upon requests by local officials and subsequent investigation by DOT engineering staff.

North Carolina - Truck routes are normally established to keep through trucks out of residential areas or central business districts.

New York - All trucks are prohibited from the Parkway System.

Ohio - Several incorporated communities have adopted regulations governing "truck" or "through truck" movements.

Oklahoma - All of the restrictions may be applied if circumstances permit.

Pennsylvania - Restricts truck traffic to the right lane on hills (climbing lanes); by time period in some large cities; and has established truck routing regulations in some urban areas.

Rhode Island - Trucks are restricted to specific lanes and by time of day in residential areas.

South Carolina - Truck routing is used for urban areas

Utah - Oversize/overweight vehicles are restricted by time of day.

Virginia - Trucks must use I-66 between I-495 and the Potomac River.

NOTES: Table C-7 (cont.)

Washington - The State has imposed a curfew on heavy trucks on all State highways around incorporated areas with population greater than 15,000 during commuter hours. Major cities have longer curfew hours. This includes non-Interstate highways.

West Virginia - Trucks are restricted from tunnels on I-70 and I-77

When asked if the State does not presently have legislation which permits establishment of truck routes and/or permits cities and/or counties to establish such routes, is it working toward development of such legislations, Michigan attached Section 726 of the Michigan Vehicle Code to its response. The following States did not respond to this question.

Colorado

Kansas

Oklahoma

North Carolina

Arkansas

Virginia

New Jersey

Maryland

Pennsylvania

All other states responded negatively.

APPENDIX D

HAZARDOUS MATERIAL CARRIER ROUTING PROCEDURES*

* Prepared by Darrell Borchardt, TTI

D.1 INTRODUCTION

A hazardous material has been defined as a "substance or material which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety and property when transported in commerce. . ." (1). Many of these materials are being transported by tractor-trailers (tankers) using major thoroughfares in large metropolitan areas. An accident involving a vehicle carrying a hazardous material may pose a risk to persons within a specified radius. A procedure has been developed for and supported by the Federal Highway Administration (FHWA) which assists in the selection of hazardous material routes through a city. The procedure is summarized in the following sections and an example is presented using the Houston freeway network.

D.2 METHODOLOGY

The methodology used for this analysis is explained in detail by Implementation Package FHWA-IP-80-15 entitled "Guidelines for Applying Criteria to Designate Routes for Transporting Hazardous Materials" (2). This publication serves as a guide for routing vehicles which transport hazardous materials through a city to minimize the risk to nearby populations and property.

The methodology is a step-by-step procedure using various worksheets to simplify the process. The worksheets may also be used in summarizing the results of an analysis. The FHWA publication contains blank reproducable forms which may be used. The routes must also adhere to any physical restrictions which may prohibit such materials on specific roadways or structures.

The first step of the analysis is the selection of the most practical alternative routes to be considered. It is suggested that this step be examined with great care to insure that each alternative route is capable of handling vehicles which may transport hazardous materials. The routes must also adhere to any physical and legal restrictions which may prohibit such materials on specific roadways or structures.

The risk associated with the transportation of hazardous materials is then determined for nearby populations and/or properties. The major criterion for an ideal route is one which has the lowest risk value. The basic formula used to determine the risk value for each route is:

Risk = Probability (A) x Consequences (A) Eq. (1)

(where A denotes a hazardous material accident).

The calculation of the probability of a hazardous material accident is a major step in the analysis procedure. The inputs for this calculation are accident rates along each route segment, segment lengths, and hazardous materials accident ratio. Accident rates for each route are calculated from actual accident data or estimated by one of several methods. Segment lengths are determined when each route is selected for analysis. The hazardous material accident ratio, the ratio of the number of such accidents to all accidents, is given as 2.3×10^{-5} by the FHWA reference document. Local experience and accident data may dictate the use of a different value.

The consequences of a hazardous material accident is then determined for both population and property. The consequences associated with population is based upon the population within a specific impact radius. The choice of an impact radius depends upon the type of material transported along the route. An impact radius of 0.5 miles is commonly used. Both residential and employment populations within the impact zone are then determined along each route. These populations may then be combined and/or factored to determine the overall population consequence values. Property consequences may be measured by determining the value of roadway structures and buildings immediately adjacent to the roadway. This is considered optional because of the overwhelming importance of population risk as the criterion for route selection.

Both the population and property risks (if desired) may be determined by using Equation 1. The total risk for a specific route is then calculated by summing all the risks for each route segment analyzed spearately.

Subjective routing factors may be used in the final route selection process. These factors are useful as "tie-breakers" between two or more alternatives whose risk factors are seemingly equal. Examples of subjective factors might include the locations of pre-school populations, hospitals and nursing homes, emergency response personnel, and large athletic stadiums and other recreational facilities.

Upon completion of all risk value calculations and the determination of any subjective factors, each alternative route must be compared and the most appropriate one selected. The decision sequence as suggested for ranking routes is as follows:

- Eliminate routes with physical mandatory factors;
- Consider legal and political implications of trying to change legal mandatory factors and exclude or reserve judgement accordingly;
- Select route(s) with smallest risk factors; and
- Apply subjective factors, if unable to differentiate on risk (2).

D.3 ANALYSIS OF HOUSTON NETWORK

Step 1: Selection of Alternate Routes

The routes for analysis within Houston consist of the freeway network (Figure D-1). All roadways are of freeway design with the exception of the following: 1) Beltway 8 which is still in the planning stages, 2) SH 225 and 3) SH 288 which are only completed to freeway design standards in sections.

Step 2: Selection of Impact Area

The next step was to select the potential impact area which may be affected by a hazardous material release. For this analysis, a potential impact radius of 0.5 miles was assumed. This radius was considered to be sufficient for most types of hazardous materials.

Step 3: Determination of Impact Area Population

Population values within a 0.5 mile radius along each route for both residential and employment populations were estimated using 1980 census data. These values were increased to estimate 1985 populations by using growth factors determined from projected populations (3). Growth rates of 2.48% and 2.60% per year were assumed for residential and employment populations, respectively. In estimating the populations, the growth rates were assumed to be constant between 1980 and 1985.

Step 4: Determination of Accident Rates

Accident rates for all vehicles on the routes were determined by using the most current accident data and roadway travel data (VMT) available. The accident rates were estimated by

$$ACC/MVMT = No.\ Accidents/Daily\ VMT \times 365 \qquad \text{Eq. (2)}$$

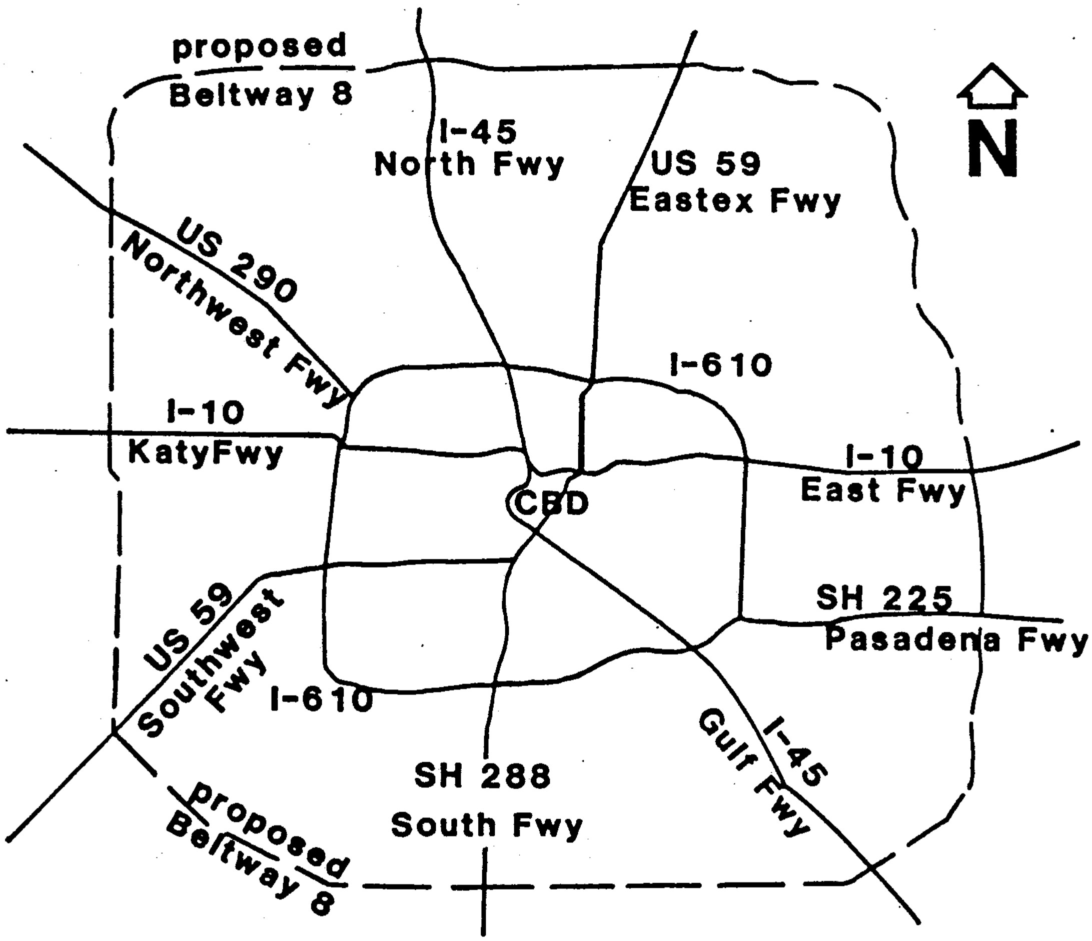

Figure D-1. Houston Freeway Network

It must be noted that the accident rates along any roadway will fluctuate on a yearly basis depending upon prevalent roadway and environmental conditions. These accident rates represent that of all vehicles operating on the freeway only. Accidents which occurred on the frontage road system were omitted from this analysis. These rates were then converted to a measure of probability based upon the estimated accident rate and the length of the segment considered. The probability of an accident involving a hazardous material carrier occurring was then determined by multiplying the determined accident probability by the hazardous materials accident factor. The hazardous materials accident factor suggests that the ratio of hazardous materials accidents to accidents involving all vehicles is 2.3×10^{-5} (2).

Step 5: Determination of Risk Values

Population risk values were then determined for each selected freeway segment using the calculated accident probability and estimated 1985 populations. Due to the large populations which may be affected by a hazardous material accident, it was deemed unnecessary to determine property risk values. Subjective factors will be applied if one is unable to differentiate between alternatives based upon population risk values alone.

D.4 SUMMARY OF RESULTS

The results of this routing procedure as applied to Houston freeways are shown in Table D-1. Due to the large number of alternatives to be considered, the route characteristics, population risk values, and major subjective factors have been summarized in this tabular form from the worksheets which were used on each freeway segment.

A list of alternate routes for through truck traffic transporting hazardous materials was developed. It was determined that truck routing alternatives should be considered based on three major premises: (1) to allow trucks to travel through the CBD (i.e., no truck routing regulation), (2) to require that trucks use I-610 to bypass the CBD, and (3) to require trucks to use Beltway 8 (when completed) as a route around Houston. In this analysis, however, routing on Beltway 8 has not been considered for several reasons: (1) the construction

Table D-1. Freeway Segment Characteristics.

Freeway	Segment Limits	# Lanes	(mi) Length	Est. Acc. Rate (ACC/MVM)	($\times 10^{-10}$) Prob. of HM Acc.	Est. 1985 Total Pop. in Impact Area	($\times 10^{-6}$) Pop. Risk Value
US 59S	Beltway 8 to I-610	6	7.8	2.416	4.33	115,638	50.12
US 59S	I-610 to CBD	6-10	6.6	1.916	2.91	121,833	35.44
I-10W	Beltway 8 to I-610	6-10	6.6	1.859	2.82	52,768	14.89
I-10W	I-610 to CBD	10	6.4	1.288	1.90	92,357	17.55
US 290	Beltway 8 to I-610	6-10	9.3	1.259	2.69	61,472	16.55
I-45N	Beltway 8 to I-610	6-8	9.2	2.174	4.60	66,641	30.66
I-45N	I-610 to CBD	8	4.0	2.181	2.01	64,614	12.99
US 59N	Beltway 8 to I-610	4-8	9.5	1.891	4.13	53,765	22.22
US 59N	I-610 to CBD	6-8	4.7	2.565	2.77	35,027	9.70
I-10E	Beltway 8 to I-610	4-6	6.8	1.746	2.73	28,166	7.69
I-10E	I-610 to CBD	6-8	5.6	2.185	2.81	51,461	14.46
SH 225	Beltway 8 to I-610	6	7.1	1.495	2.44	43,926	10.72
I-45S	Beltway 8 to I-610	6-10	8.1	1.984	3.70	48,826	18.05
I-45S	I-610 to CBD	6-8	5.2	3.094	3.70	110,842	41.02
SH 288	Beltway 8 to I-610	6	5.9	2.352	3.19	9,471	3.02
SH 288	I-610 to CBD	0-8	4.8	2.352	2.60	47,774	12.41
(Gulf) DTN Loop	I-10W/I-45N to I-45S/US 59S	6-8	2.9	3.094	2.06	148,464	30.64
(Eastex) DTN Loop	US 59S/I-45S to US 59N/I-10E	6-8	2.2	2.565	1.30	121,150	15.72
(East) DTN Loop	US 59N/I-10E to I-45N/I-10W	8	1.5	2.185	0.75	67,460	5.09
I-610	US 290 to I-45N	8	4.7	1.440	1.56	54,776	8.53
I-610	I-45N to US 59N	8	2.6	1.649	0.99	19,438	1.92
I-610	US 59N to I-10E	8	5.6	1.267	1.63	24,327	3.97
I-610	I-10E to SH 225	10	5.0	1.372	1.58	16,857	2.66
I-610	SH 225 to I-45S	10	1.4	1.430	0.46	15,696	0.72
I-610	I-45S to SH 288	8	5.8	1.203	1.60	52,803	8.47
I-610	SH 288 to US 59S	8	8.0	1.726	3.18	58,594	18.61
I-610	US 59S to I-10W	8-10	3.7	2.666	2.27	66,907	15.18
I-610	I-10W to US 290	10	1.5	2.102	0.73	14,568	1.06

schedule for the Beltway 8 is not known at this time; (2) estimates of future residential and employment populations along the new facility are not very reliable; (3) regulations which would require such carriers to use a toll road facility may raise legal questions.

Table D-2 shows a summary of population risk values for vehicles transporting hazardous materials along specified routes. Each case consists of origins and destinations near Beltway 8, and routing alternatives of through the CBD and two routes along I-610. Seven specific routes, considered to be "worst condition cross-town movements", were selected for analysis. These consisted of the three major through freeways (i.e., I-10, I-45, US 59) and four other routes with origins and destinations on opposite sides of the CBD. This analysis shows that it is less of a risk to regulate the movement of hazardous materials by requiring carriers to use I-610 when proceeding through Houston. Although the most direct (shortest) alternative for each route is through the CBD, the high concentration of employment population within the CBD substantially increases the total population risk value.

The circuity for each route alternative is also indicated on Table D-2. It is defined as the ratio of the length of each route alternative to the most direct route. A look at these indicates that hazardous material carriers must travel up to 1.5 times farther than the shortest route in order to reduce the risk to the population. However, the cost of the increase in travel distance and travel time is considered minimal when compared to the loss of even one life caused by an accident involving hazardous material carriers.

D.5 SHORT TRIP COMPARISON

The analysis previously conducted compares alternatives of trips through or around a city. A comparison must also be made for short trips which may or may not include an entire section of roadway as was previously analyzed.

Table D-2. Risk Values Associated with Alternative Routes for Hazardous Materials Carriers.

Origin	Destination	Route	Length (mi.)	Circuity	Total Pop. Risk Value (x 10^{-6})
Katy (I-10)	East (I-10)	CBD	25.4	1.00	59.68
Katy (I-10)	East "	I-610N	27.8	1.09	38.06
Katy (I-10)	East "	I-610S	37.3	1.47	68.22
Eastex (US 59)	Southwest (US 59)	CBD	28.6	1.00	133.20
Eastex (US 59)	Southwest "	I-610W	29.8	1.04	99.03
Eastex (US 59)	Southwest "	I-610E	43.1	1.51	106.77
North (I-45)	Gulf (I-45)	CBD	26.5	1.00	133.36
North (I-45)	Gulf "	I-610E	31.9	1.20	57.98
North (I-45)	Gulf "	I-610W	41.0	1.55	100.56
North (I-45)	South (SH 288)	CBD	23.9	1.00	89.72
North (I-45)	South "	I-610W	33.0	1.38	77.06
North (I-45)	South "	I-610E	35.5	1.49	51.42
Northwest (US 290)	Gulf (I-45)	CBD	30.5	1.00	94.23
Northwest (US 290)	Gulf "	I-610N	36.7	1.20	52.40
Northwest (US 290)	Gulf "	I-610S	36.4	1.19	77.92
Katy (I-10)	LaPorte (SH 225)	CBD	26.7	1.00	84.90
Katy (I-10)	LaPorte "	I-610N	33.1	1.24	43.75
Katy (I-10)	LaPorte "	I-610S	32.6	1.22	68.59
Southwest (US 59)	East (I-10)	CBD	26.8	1.00	123.43
Southwest (US 59)	East "	I-610N	32.7	1.22	88.47
Southwest (US 59)	East "	I-610S	34.8	1.30	88.27

One possible method would be to compare selected freeway segments based upon a ratio of the total population risk value to the length of the segment. This population risk per mile value will provide for a comparison of each individual segment and may indicate which segment contributes the greatest risk in case of an accident involving a hazardous material carrier. Table D-3 lists these values for each individual freeway segment examined in the analysis of Houston. It indicates that two of the highest risk areas are near the CBD. This seems to support the conclusion obtained by the results listed in Table D-2. The measures displayed in Table D-3 indicate that substantial risks exist when transporting hazardous materials along short distances.

D.6 CRITIQUE OF METHOD

The procedure contained in Implementation Package FHWA-IP-80-15 (2) provides a fairly straight forward method of comparing routing alternatives for hazardous material carriers. However, the determination of the populations within each impact zone may become a long and tedious process. This is especially true when dealing with a large network such as Houston freeways. It would also appear to be just as time consuming to determine the consequences associated with property risk values. A method for indicating risk values associated with short trips along routes should be implemented in the procedure. A measure similar to that used in Table D-3 is one approach. Overall, the analysis procedure should be used as a basis for selecting the appropriate route when routing hazardous material carriers.

Table D-3. Freeway Segment Average Risk Value

Freeway	Segment Limits	Pop. Risk Value ($x10^{-6}$) Per Mile
Southwest	Beltway 8 to I-610	6.43
Southwest	I-610 to CBD	5.37
Katy	Beltway 8 to I-610	2.26
Katy	I-610 to CBD	2.47
Northwest	Beltway 8 to I-610	1.78
North	Beltway 8 I-610	3.33
North	I-610 to CBD	3.24
Eastex	Beltway 8 to I-610	2.34
Eastex	I-610 to CBD	2.06
East	Beltway 8 to I-610	1.13
East	I-610 to CBD	2.58
SH 225	Beltway 8 to I-610	1.51
Gulf	Beltway 8 to I-610	2.23
Gulf	I-610 to CBD	7.89
South	Beltway 8 to I-610	0.51
South	I-610 to CBD	2.59
Gulf (DTN Loop)	I-10W/I-45N to I-45S/US 59S	10.57
Eastex (DTN Loop)	US 59S/I-45S to US 59N/I-10E	7.15
East (DTN Loop)	US 59N/I-10E to I-45N/I-10W	3.39
I-610	US 290 to I-45N	1.81
I-610	I-45N to US 59N	0.74
I-610	US 59N to I-10E	0.71
I-610	I-10E to SH 225	0.53
I-610	SH 225 to I-45S	0.51
I-610	I-45S to SH 288	1.46
I-610	SH 288 to US 59S	2.33
I-610	US 59S to I-10W	4.10
I-610	I-10W to US 290	0.71

D.7 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of this analysis, it is recommended that all carriers transporting hazardous materials through the Houston urban area be required to use I-610 to bypass the CBD. This only reinforces the regulation which currently exists. It is also suggested that the role which Beltway 8 may have in future carrier routing be analyzed. The question of hazardous carrier routing should be analyzed on a continued basis due to shifting residential and commercial development patterns. It would be appropriate for the analysis to be performed approximately every 10 years as new and updated census material becomes available.

REFERENCES FOR APPENDIX D

1. Title 49 of the Code of Federal Regulations, Chapter 1, Subchapter C: Hazardous Materials Regulations, Section 171.8; October 3, 1979.

2. "Guidelines for Applying Criteria to Designate Routes for Transporting Hazardous Materials, "Implementation Package FHWA-IP-80-15, Federal Highway Administration, November 1980.

3. "Population and Employment Projections for Harris County, "Prepared by Houston-Galveston Area Council Interagency Data Base Task Force, December 1983.