THE ANALYSIS OF FLEET SPECIFIC ACCIDENT EXPERIENCE OF FIVE FLEETS OPERATING IN WESTERN CANADA

by

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Second International Symposium On
Heavy Vehicle Weights and Dimensions
Kelowna, British Columbia
June 18 -22, 1989

This research was funded by Saskatchewan Highways and Transportation with cost shared assistance from Transport Canada. The opinions expressed are those of the authors.

ABSTRACT

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In some jurisdictions, vehicle weight and dimension regulations have been relaxed so as to permit larger and heavier vehicles to operate over public roads. This relaxation of regulations governing vehicle size is motivated by substantial improvements in vehicle productivity. There is however some considerable concern with respect to the safety of these larger vehicles.

This paper presents and analyzes the safety experience of five truck fleets that operated nearly 600 million vehicle kms of travel in western Canada in the 1983-86 period. Particular attention is directed to the relative safety of single versus double trailer units and A, B and C-Train configuration for double trailer units.

In general, it was found that doubles had a lower accident rate then singles, however this difference was likely attributable to different usage patterns as opposed to differing stability characteristics of the two types of vehicles. B-Trains appeared to have lower accident rates than either A or C-Train configurations. A and C-Trains did not appear to display significant differences in their stability risks, but there was some evidence that C-Trains may result in more serious accidents than A-Trains.

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INTRODUCTION

The motoring public has perceptible concern about sharing the roadway with trucks. This public concern may be increasing because of the increased number of trucks using the highways, the increased size of trucks and the trend in recent years to smaller and lighter cars. We can anticipate that this public concern will continue to grow as the trend continues towards larger trucks and smaller cars.

Public debate on the safety of large trucks is highly emotional and often not founded on substantive fact. Issues of sharing the road with trucks and the safety of trucks often are confused. Part of the reason for the lack of factual discussion is the lack of detailed, well documented data and analysis.

Specifically, there is a need to understand more fully the safety performance of large trucks currently operating on public highways. This understanding is required if we are to work toward both increasing productivity and efficiency of the trucking industry and increasing truck safety.

To develop an improved data base and understanding of truck related accidents in Saskatchewan, Saskatchewan Highways and Transportation, with cost shared assistance from Transport Canada, implemented a project entitled "The Safety Experience of Large Trucks in Saskatchewan" in the spring of 1986 [1]. This study, of which this paper is in part a summary, was conducted by the Transportation Centre at the University of Saskatchewan in association with the consulting firm of Clayton, Sparks & Associates Ltd. of Saskatoon.

There are three methods of analyzing the safety performance of large trucks, namely:

1) evaluation of vehicle performance under various situations on a test track,
2) computer simulation, and
3) the determination of actual over-the-road performance by calculating accident rates.

This investigation utilizes the method of determining over-the-road accident rates.

The specific objectives of the project were:

1. To quantify the number and type of accidents involving large trucks in Saskatchewan. Particular interest was to be directed toward the larger vehicles permitted under legislative changes in the past 15 years (i.e. double trailers in A, B, C-Train configurations).

2. To develop estimates of accident rates for large trucks operating in Saskatchewan.

3. To compare the accident experience of large trucks operating in Saskatchewan with the experience of other vehicle types in Saskatchewan and large trucks operating in other jurisdictions. This comparison was to provide a measure of the relative safety experience of large trucks in Saskatchewan.

4. To identify and quantify any safety related problem areas respecting large trucks operating in Saskatchewan.

This paper summarizes the results of the accident experience of five large truck fleets operating in Western Canada and the northwest U.S.A. Particular attention is directed to the safety experience of single trailer units versus double trailer units, as well as A versus B versus C-train configurations.

FLEET SPECIFIC EXPERIENCE

As noted, the focus of this project was directed to examining the accident experience of double trailer units versus single trailer units, as well as the accident experience of A, B, and C-Train configurations. It was not possible to explore this subject using the traffic accident database maintained by Saskatchewan Highways and Transportation because the required detail was not available in this database. As a consequence, a number of individual trucking companies were approached for their assistance. Accident and exposure data were obtained and accident rates were calculated for singles versus doubles and for A, B, and C-Train configurations on a fleet specific basis. The level of detail varied from carrier to carrier because the level of detail in the data available varied from carrier to carrier. Further, not all of the detail available can be described here because of the need to maintain carrier confidentiality.

FLEET SPECIFIC ACCIDENT EXPERIENCE

Table 1 and Figure 1 show the overall accident experience of the five large fleets. These fleets are all based in Western Canada. The fleet specific accident rates illustrated are of interest in terms of both their absolute values (i.e. number of accidents per million vehicle km) as well as for their comparative values (i.e. between carriers, singles versus doubles, and A versus B versus C-Trains).

Considerable care must however be taken in making comparisons because not all things are equal on a comparative basis. That is, there are reasons other than vehicle type (i.e. single versus double or A versus B versus C-Train) which could be expected to contribute to differences in accident experience. To illustrate, a number of reasons for these differences are discussed below.

DEFINITION OF ACCIDENT

For carriers 1 through 4, an accident was defined as any incident resulting in property damage of any amount, injury, or fatality. There was no threshold or deductible - all accidents are included.

For carrier 5 the definition of an accident was constrained by the availability of data, which was a function of the severity of the accident and the individuals involved. All data was obtained from the files of the insurance company. In 1983 and 1984, the deductible on reportable accidents was $2000. This was raised to $5000 in 1985. Thus if a vehicle was involved in an accident that resulted in only minor damage (i.e. obviously less than the deductible) the accident may not have been brought to the attention of the insurance company and there would not have been a file prepared. Such accidents are not included in this analysis. On the other hand, if there were any possibility of a third party claim independent of the amount of damages, the incident would have been reported to the insurance company and a file would have been prepared. As a result of this constraint, the definition of an accident for carrier 5 is somewhat "fuzzy".

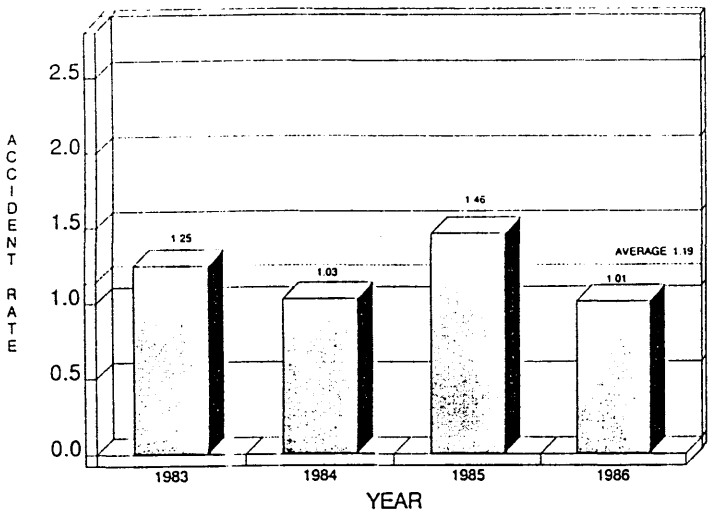
A prerequisite to a meaningful comparison of accident rates is a common definition of an accident. The distribution of fleet specific accident experience relative to severity as measured by accident cost is therefore of obvious interest. This type of information was available for carriers 1, 2, 3 and 5 and is illustrated in Figure 2. As the definition of an accident for carrier 5 is different than that for the other carriers, a direct

TABLE 1
ACCIDENT EXPERIENCE OF FIVE CARRIERS
OPERATING IN WESTERN CANADA
SUMMARY
(ACCIDENTS PER MILLION VEHICLE KM OF TRAVEL)

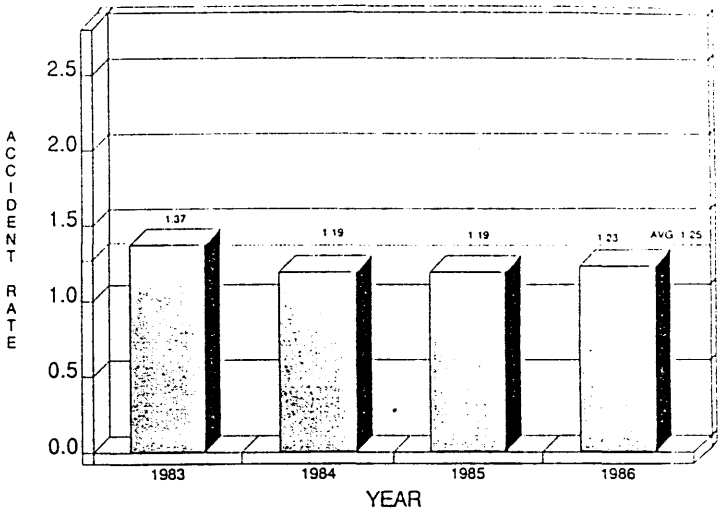
	CARRIER 1					CARRIER 2					CARRIER 3					CARRIER 4					CARRIER 5				
CALCULATED ACCIDENT RATES	1983	1984	1985	1986	TOTAL	1983	1984	1985	1986	TOTAL	1983	1984	1985	1986	TOTAL	1983	1984	1985	1986	TOTAL	1983	1984	1985	1986	TOTAL
SINGLES																									
PROPERTY DAMAGE	1.68	1.13	1.80	1.25	1.48	1.04	0.60	0.51	0.94	0.79	-	-	-	-	-	-	-	-	-	0.00	-	-	-	-	-
INJURY	0.23	0.24	0.27	0.19	0.23	0.12	0.15	0.17	0.38	0.19	-	-	-	-	-	-	-	-	-	0.00	-	-	-	-	-
FATALITY	0.00	0.07	0.17	0.00	0.06	0.00	0.00	0.00	0.00	0.00	-	-	-	-	-	-	-	-	-	0.00	-	-	-	-	-
TOTAL	2.05	1.51	2.45	1.44	1.88	1.15	0.75	0.68	1.32	0.98	-	-	-	-	-	-	1.07	1.27	-	1.16	-	-	-	-	N/A
DOUBLES																									
PROPERTY DAMAGE	0.51	0.64	0.76	0.70	0.66	1.17	0.74	0.91	0.85	0.91	-	1.97	0.60	0.98	1.11	-	-	-	-	0.00	-	-	-	-	-
INJURY	0.20	0.07	0.11	0.02	0.10	0.10	0.40	0.16	0.13	0.20	-	0.66	0.30	0.27	0.38	-	-	-	-	0.00	-	-	-	-	-
FATALITY	0.04	0.00	0.02	0.02	0.02	0.05	0.05	0.00	0.09	0.05	-	0.00	0.00	0.00	0.00	-	-	-	-	0.00	-	-	-	-	-
TOTAL	0.75	0.72	0.99	0.74	0.81	1.32	1.19	1.07	1.16	1.18	-	2.76	0.90	1.25	1.53	-	1.22	1.70	-	1.48	1.48	1.57	0.76	-	1.23
OVERALL ACCIDENT RATE																									
PROPERTY DAMAGE AR'S	0.96	0.83	1.10	0.91	0.95	1.20	0.82	0.99	0.90	0.98	-	1.97	0.60	0.98	1.11	-	-	-	-	ERR	-	-	-	-	-
INJURY AR'S	0.22	0.13	0.17	0.07	0.14	0.14	0.33	0.17	0.18	0.20	-	0.66	0.30	0.27	0.38	-	-	-	-	ERR	-	-	-	-	-
FATALITY AR'S	0.02	0.02	0.07	0.01	0.03	0.04	0.04	0.00	0.07	0.04	-	0.00	0.00	0.00	0.00	-	-	-	-	ERR	-	-	-	-	-
TOTAL	1.25	1.03	1.46	1.01	1.19	1.37	1.19	1.19	1.23	1.25	-	2.76	0.90	1.25	1.53	1.07	1.15	1.53	-	1.25	1.48	1.57	0.76	-	1.23
DOUBLES BY CONFIGURATION																									
A-TRAIN	0.74	0.59	0.85	0.51	0.67	1.46	1.88	1.37	1.15	1.45	-	2.73	0.90	1.25	1.52	-	0.00	0.55	-	0.25	1.48	1.57	0.76	-	1.23
B-TRAIN	0.52	0.50	0.98	1.03	0.76	1.44	0.73	0.87	0.80	0.96	-	-	-	-	-	-	1.45	1.88	-	1.68	-	-	-	-	-
C-TRAIN	3.61	1.19	1.22	1.08	1.20	0.39	0.57	0.88	1.47	0.88	-	-	-	-	-	-	1.73	1.97	-	1.87	-	-	-	-	-

FIGURE 1
ACCIDENT EXPERIENCE OF FIVE CARRIERS
(ACCIDENTS PER MILLION VEHICLE KM OF TRAVEL)

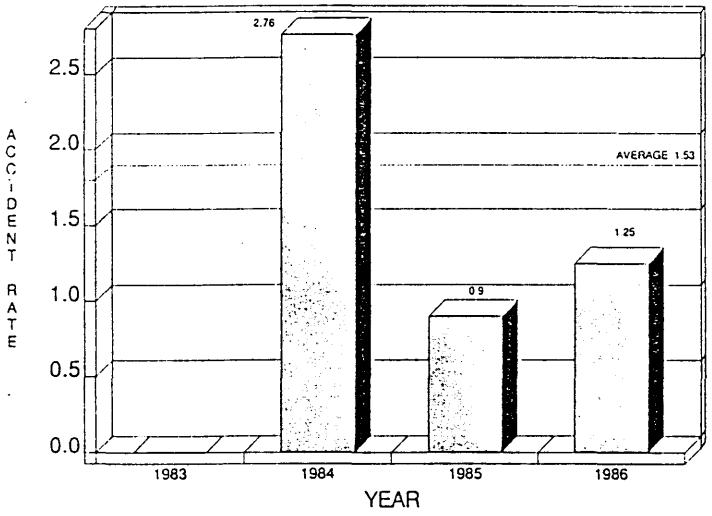
ACCIDENT RATE BY YEAR
CARRIER 1



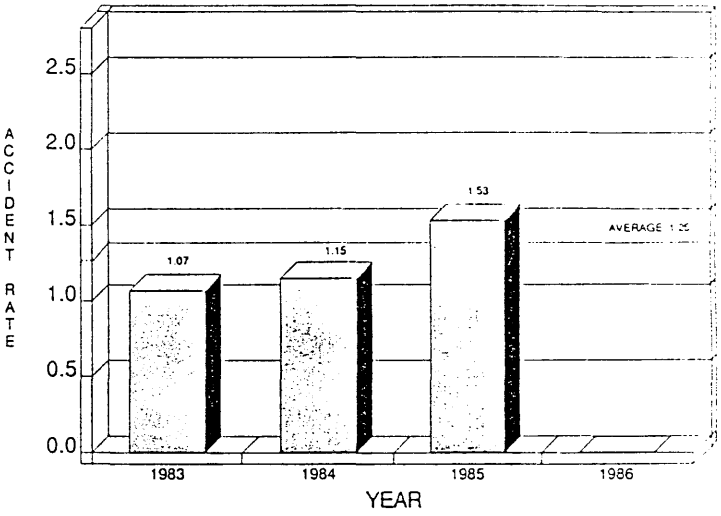
ACCIDENT RATE BY YEAR
CARRIER 2



ACCIDENT RATE BY YEAR
CARRIER 3



ACCIDENT RATE BY YEAR
CARRIER 4



ACCIDENT RATE BY YEAR
CARRIER 5

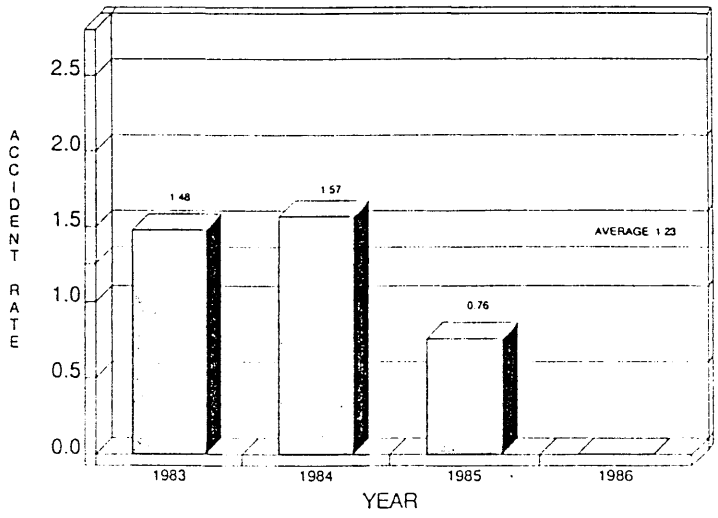
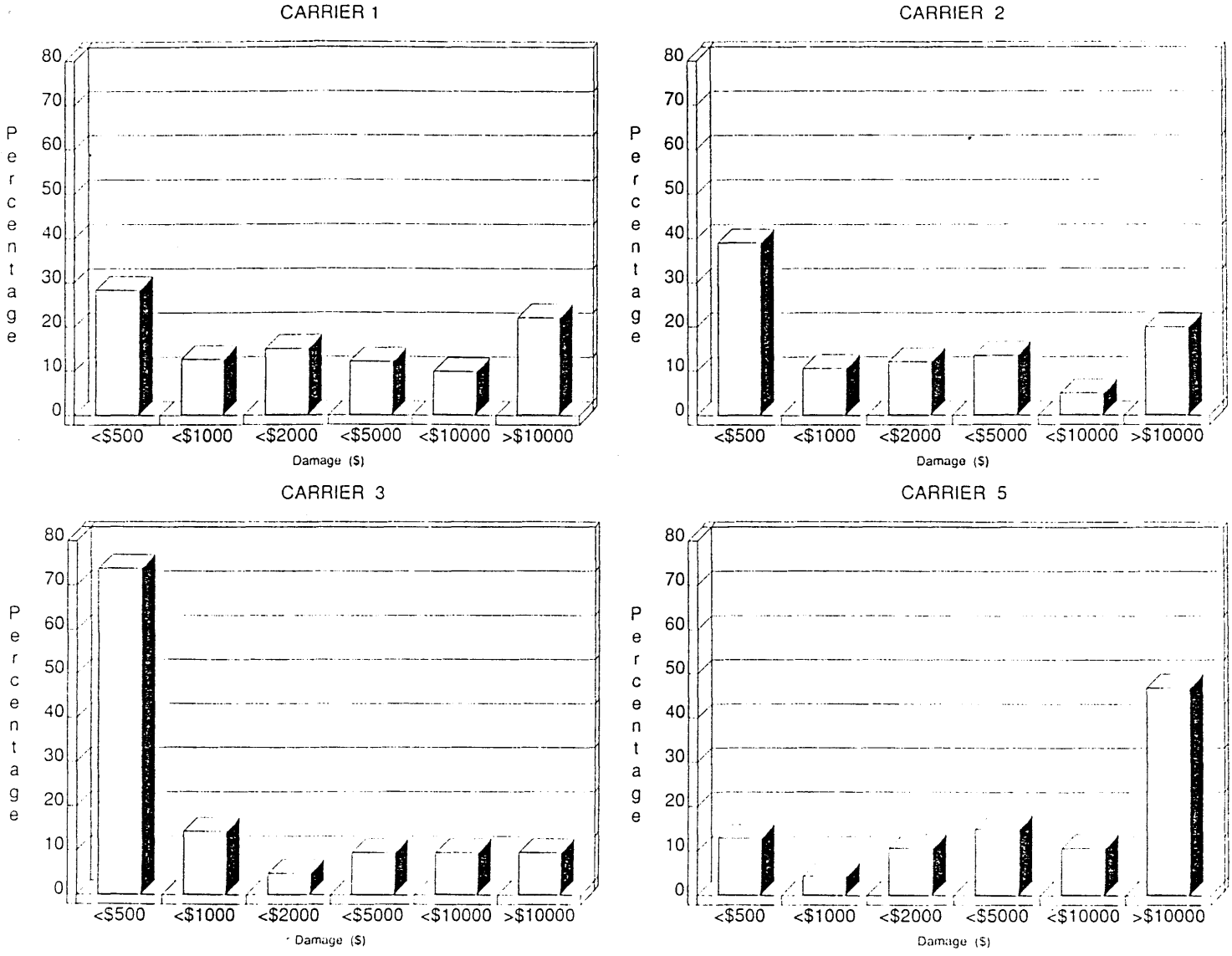


FIGURE 2
DISTRIBUTION OF ACCIDENT COST



comparison is inappropriate. It is noted that between 28% - 72% of all accidents for carriers 1, 2, and 3 involved costs of less than $500.

STANDARD OF ROADS

The issue of absolute and relative accident experience is further complicated by the fact that the accident statistics for all fleets include all accidents in rural areas. That is, accidents on both provincial highways and rural roads are included. Accidents within urban areas or yards, at docks, etc. were excluded from the data prior to analysis.

This inability to segregate rural accidents into those on provincial highways and those on rural roads resulted from the lack of sufficient detail in the description of the location of the accidents in some of the accident files. This detail could have been obtained only with extreme effort through follow-up on an individual accident by accident basis.

It was possible to determine the magnitude of the proportion of total rural accidents associated with provincial highways and rural roads for some of the carriers by combining a review of the information in individual accident files with some judgement. In those cases where an accident occurred on a major highway, the highway number was usually (but not always) included. In some cases where the highway number was not included, it was apparent from the description that it was a major highway (i.e. crossed the median). In other cases, it was reasonably clear from the description that the accident occurred on a rural road. There were however a proportion of total accidents for which it was difficult to determine whether the accident occurred on a provincial highway or rural road. This proportion varied from carrier to carrier because of different level of detail in the accident reports.

Using some judgment, the assessment of the relative proportion of total accidents occurring on provincial highways versus rural roads for carriers 1, 2, 3 and 5 is summarized in Table 2. (Detailed data was not available for carrier 4.) It can be seen that 75% to 80% of all accidents occurred on provincial highways, 5% to 12% on rural roads, and 10% to 19% on roads that were not classified.

Knowing the proportion of rural accidents that occur on provincial highways relative to rural roads is helpful but to be truly useful in terms of determining and analyzing accident rates, the split in total rural travel in terms of the proportion

TABLE 2

DISTRIBUTION OF ACCIDENTS IN RURAL AREAS

	CARRIER 1	CARRIER 2	CARRIER 3	CARRIER 5	AVERAGE
PROVINCIAL HIGHWAYS	75.2%	80.9%	78.6%	80.9%	79%
RURAL (Off highway)	6.4%	5.7%	11.9%	6.4%	8%
UNABLE TO CLASSIFY	18.3%	13.5%	9.5%	12.8%	13%

on provincial highways and proportion on rural roads is also required. This detail was not available from any of the five carriers.

It is, however, possible to gain some insight by making some (reasonable) assumptions. For example, if the accident rate for articulated trucks on rural roads is on average twice that on provincial highways [2] and 8% of a carrier's rural accidents are on rural roads, then one would conclude that approximately 4% of the carrier's total rural travel is on rural roads.

It is important to recognize that the relative proportion of rural travel that is on provincial highways and rural roads is also a function of the carrier operations. A carrier heavily involved in the petroleum haul would have a high proportion of total rural travel on provincial highways (i.e. most fuel goes to cities and towns) relative to a carrier heavily involved in the grain or fertilizer haul (i.e. farm associated). These carrier specific differences in "mix" of travel on provincial highways versus rural roads would be expected to have some effect on overall accident rates for various carriers because, as noted, accident rates on rural roads in Saskatchewan are about twice that on provincial highways.

OPERATING REGION

The five fleets for which accident data was assembled all are based in western Canada and all operate in Saskatchewan. They also operate in other provinces and some operate into the USA. As a result of these different operating areas, the "mix" of operating environments varies substantially from one carrier to the next.

For example, one carrier operates throughout the prairies and British Columbia whereas another operates nearly exclusively in the southern portions of Alberta and Saskatchewan. Another has a heavy proportion of its operation in northern resource areas. These differences create significantly different environments in terms of weather (i.e. snow and therefore visibility), road conditions (i.e. snow pack and ice), and road standard (i.e. grades, curves, paved and gravel) and would therefore be expected to result in different accident experience.

Traffic volumes also tend to vary on a regional basis. That is, traffic levels in Alberta tend to be higher in general than in Saskatchewan. As a result, there is more "third party exposure"

in the Alberta region compared to Saskatchewan. As a result, the accident experience on a regional basis would be expected to vary because of differences in general traffic levels.

VEHICLE TYPE

Truck body type (tanker, hopper, van, bulker, flat deck etc.) would be expected to have some effect upon accident experience. Since the five fleets studied have quite different "mixes" of vehicle types within their respective fleets, variations in accident experience between fleets is expected. Unfortunately it was not possible to determine accident rates by vehicle type because of the lack of exposure data by vehicle type for each of the fleets.

SUMMARY

Accident rates are a function of a (large) number of diverse variables, some of which include:

1) definition of an accident,
2) standard of road,
3) operating region,
4) truck body type, and
5) other.

Since the "mix" of these variables varies from one carrier to the next, as well as from one time period to the next for a particular carrier, carrier specific accident rates would be expected to vary between carriers and between time periods.

The situation is further complicated by the fact that vehicle accidents are probabilistic in nature (i.e. random). Therefore stochastic variation attributable to the probabilistic nature of vehicle accidents are superimposed upon the expected deterministic variations associated with changing circumstances. This results in a very complex situation if any attempt is made to explain observed differences in accident experience.

A review of Figure 1 illustrates that indeed accident rates for particular carriers do vary over time, as well as from carrier to carrier. While temporal variations for some carriers appear relatively small (i.e. about 20% for carrier 1 and 2), these variations can be relatively large (i.e. factor of two) for other carriers (i.e. carriers 3 and 5).

Large changes in accident rates over time are often attributable to deterministic changes in circumstances. For example, there

was a change in management for carrier 3 at the end of 1984. As a result, there was a dramatic shift in operating procedures and attitudes toward safety, maintenance, etc. In the case of carrier 5, there was a change in the definition of an accident as noted earlier (i.e. change in deductible from $2000 to $5000).

In spite of all of these complicating factors, comparisons can be made for the purpose of formulation and implementation of highway safety policies and programs. In this context, fleet specific accident rates for the carriers studied are in the order of 1 - 1.5 accidents per million vehicle km of travel. These accident rates are somewhat higher than those determined for articulated trucks on Saskatchewan provincial highways from Highways Traffic accident database (i.e. 0.7 to 0.8 reported accidents per million vehicle kms) [3]. In addition to all the other complicating factors (area of operation, truck body type, different definitions of accidents, etc.), the major difference between the accident rates for the five carriers and those determined from the Saskatchewan traffic accident database maintained by Highways is that the fleet specific data included <u>all accidents</u> in rural areas (i.e. provincial Highways and rural roads) involving <u>any damage or injury</u> (i.e. no deductible except for carrier 5 where the definition of an accident is somewhat "fuzzy"), whereas the accident rates calculated using Highways database included only reported accidents (i.e. property damage greater than $500, injury or fatality).

While a comparison with all things equal is impossible because of the lack of comparable data, it is possible to make a crude comparison by making adjustments for differences where availability of data permits.

These adjustments might be as follows:

Fleet Specific Rural Area Accident Rate	1 - 1.5 accidents per million vehicle km
Distribution of Accidents by Severity (average for carriers 1,2 and 3 - see Figure 2)	
< $500 damages	45%
> $500 damages	55%

Proportion of Accidents	
on provincial highways	79%
on rural roads	8%
unable to classify	13%
Proportion of Total Travel	
on provincial highways	96%
on rural roads	4%

$$\text{Fleet Specific Provincial Highway Accident Rate >\$500 Damage, Injury or Fatality} = \frac{\text{Fleet specific Rural Area Accident Rate} \times \text{\% of Total Acc >\$500 in Damages} \times \text{\% of Total Accidents on Prov. Highways}}{\text{\% of Total Rural Travel on Provincial Highways}}$$

$$= \frac{1.25 \times 55\% \times 90\%}{96\%} = .64$$

(The 13% of accidents that were unable to be classified were proportioned between highways and rural roads in the same proportion as the ones that could be classified (i.e. %Total Accidents on Highways equals 79% + (13 x 79)/(8 + 79) = 90%.)

It is important to note that adjustments have not been made for all variables in the above, but rather only for those that data availability permitted (i.e. there was no adjustment made for region of operation, mix in truck type - tanker, van, etc.). Further, while the adjustments made are at least intuitively appealing, it must be recognized that the reliability is constrained by the quality of data available and therefore must be viewed as an order of magnitude analysis at best.

Recognizing the above, the adjusted fleet specific provincial highway accident rates were found to be in the order of 0.64 accidents per million vehicle km and therefore compared reasonably well with the rates determined for all vehicles (i.e. .81 - .90 accidents per million vehicle kms for 1983-84 period) and articulated trucks (i.e. estimated to be .713 accidents per million vehicle kms of travel) on provincial highways in Saskatchewan.

SINGLE TRAILERS VERSUS DOUBLE TRAILERS

Table 1 and Figure 3 show the accident experience of the five carriers by year for single and double trailer units. These are for all rural accidents with any damages except for carrier 5 where as previously noted the definition of an accident is somewhat fuzzy.

In the case of carrier 1, the accident rate for single trailers appears to be substantially higher than that for doubles (i.e. average over 1983-86 for singles equals 1.88 accidents per million vehicle km relative to doubles at 0.81). On the other hand the experience of carriers 2 and 4 suggest that the accident rate for doubles may be marginally higher than that for singles (i.e. carrier 2 - doubles 1.18, singles 0.98; carrier 4 - doubles 1.48, singles 1.16).

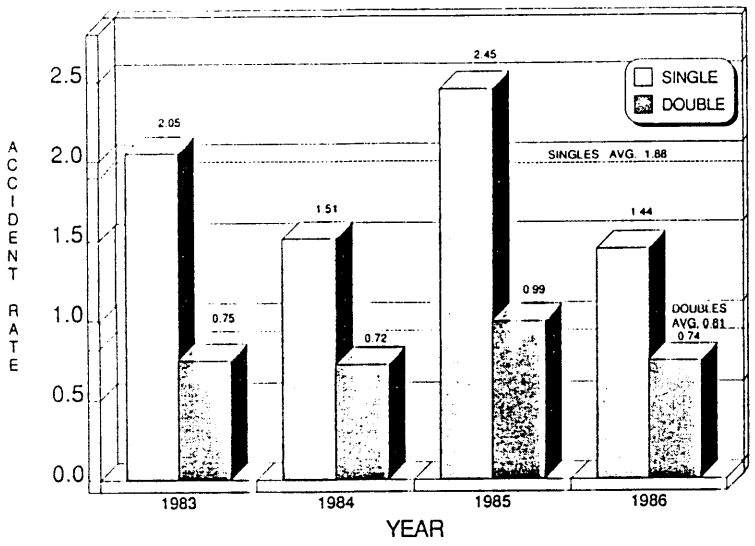
Discussions with officials from carrier 1 indicated that the two types of vehicles are used in substantially different hauls. Single trailer units tend to travel more on secondary highways, rural roads, and resource development roads. Doubles travel more on major highways of high design standard (i.e. shoulders, divided, etc.). It was also noted that the doubles tended to be newer equipment operated by more experienced drivers relative to singles.

In order to compare more fully the accident experience of single versus double trailer units operated by carrier 1, the distribution of the cumulative accident rate versus severity (as measured by costs of damages) was plotted as illustrated in Figure 4. These plots confirm that there is a difference in accident experience between singles and doubles in this particular operation. Given the difference in operating environments, maybe these differences should not be all that surprising.

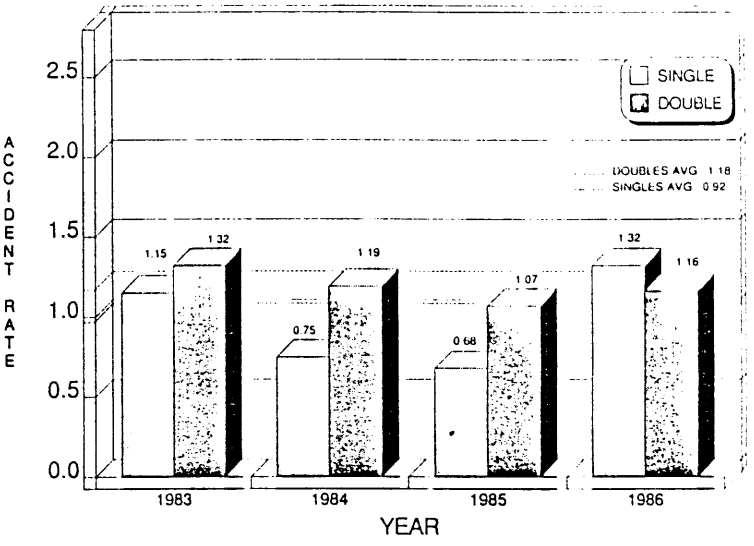
From the above there is some evidence that suggests that the accident experience of singles and doubles can be different. The evidence, however, is not consistent in that doubles appear best in one case, whereas singles appear best in other cases. Intuitively it might have been expected that doubles would have a higher accident rate than singles. This may be true if all other things are equal. However in this case, other determinants (i.e. road type etc.) appear to dominate relative to the issue of vehicle type (i.e. singles versus doubles), in particular for carrier 1 where there are substantial differences and doubles are better than singles.

FIGURE 3
ACCIDENT RATE FOR SINGLES VERSUS DOUBLES
(ACCIDENTS PER MILLION VEHICLE KM OF TRAVEL)

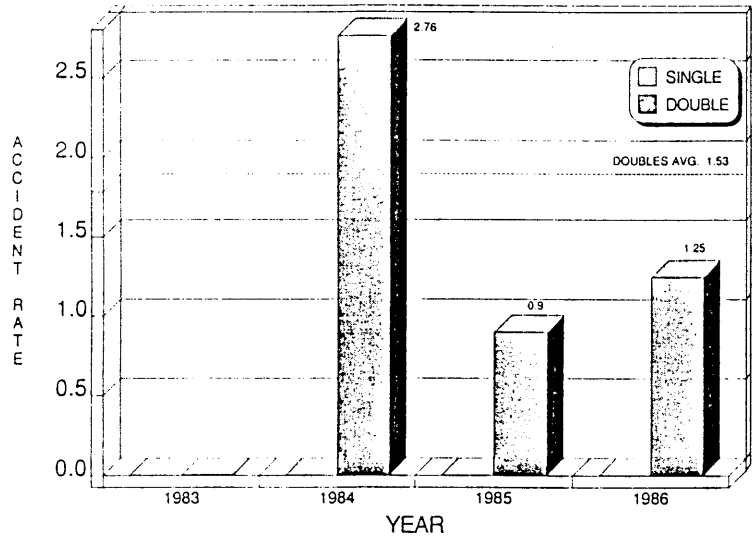
CARRIER 1



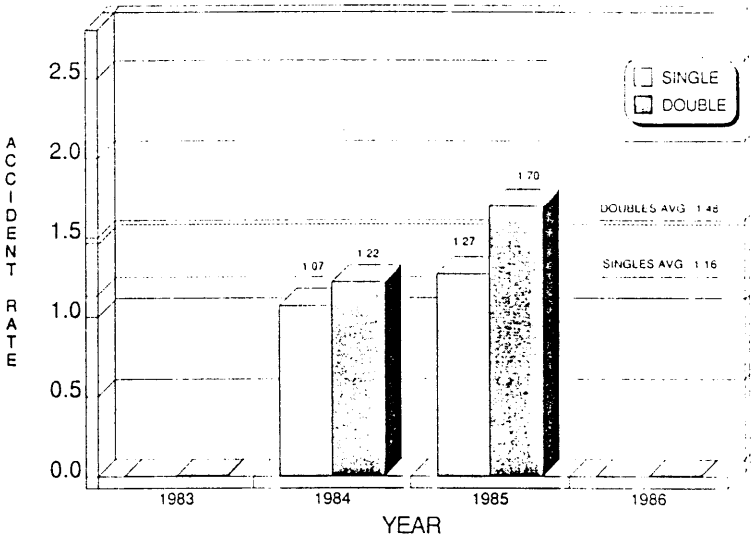
CARRIER 2



CARRIER 3



CARRIER 4



CARRIER 5

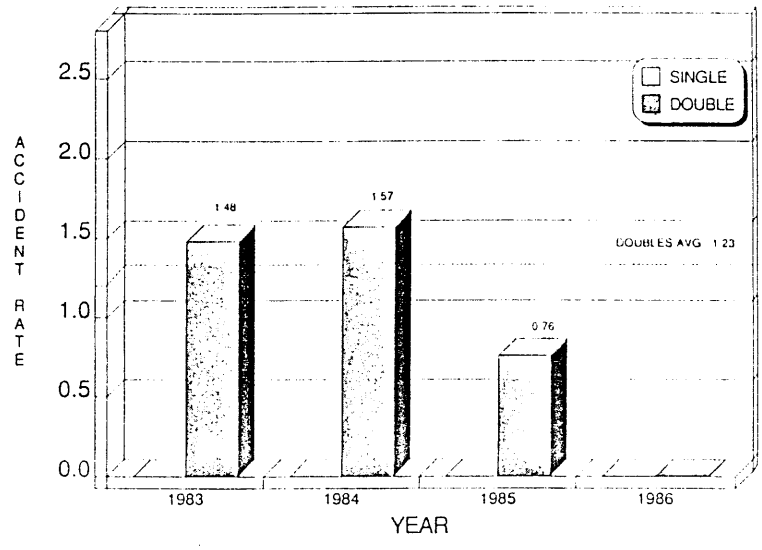
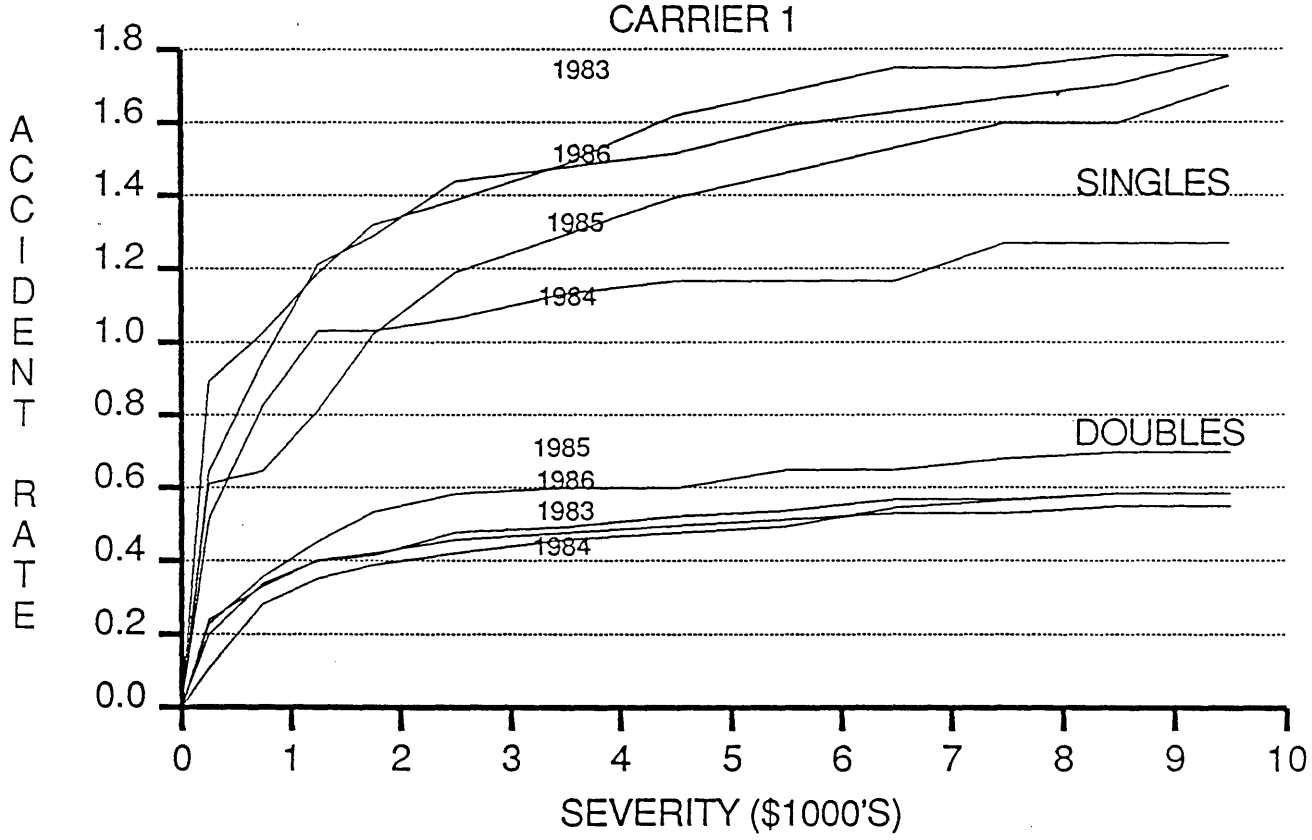


FIGURE 4
CUMULATIVE ACCIDENT RATE VS SEVERITY
CARRIER 1



A VERSUS B VERSUS C-TRAINS BY FLEET

Table 1 and Figure 5 show the accident rates for various configurations by fleet operator by year. These accident rates again include all rural accidents involving any damage except for carrier 5.

Again the statistics illustrate considerable temporal variabiliby for individual configurations operated by specific fleets. There is also considerable variability between carriers for a particular configuration as well as between configurations for a particular carrier. There does not appear to be a particular configuration which consistently dominates in terms of safety experience.

Carrier 1 has had a positive and consistent experience with A-Trains. The experience with B-Trains appears comparable to A-Trains. But, there appears to have been a problem with C-Trains in 1983.

In the case of carrier 2, experience with C-Trains appears to be better than with A-Trains and experience with B and C-Trains appears comparable over the period.

For carrier 4, A-Trains appear to have performed better than B and C-Trains, but B and C-Trains appear comparable.

SUMMARY

The overall experience of the five fleets is summarized in Table 3 and illustrated in Figure 6.

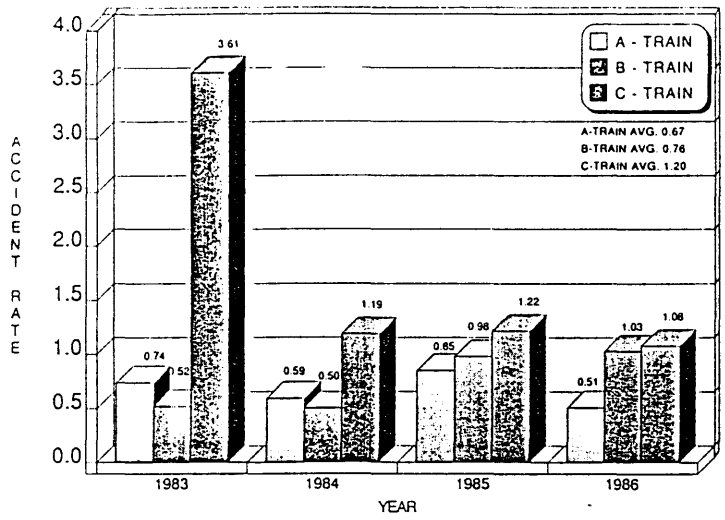
The overall accident rates of these fleets, when adjusted for differences in circumstance appear comparable to accident rates for all vehicles and articulated trucks operating on Saskatchewan provincial highways.

With the exception of carrier 1, there were no obviously consistent differences in accident rates of singles versus doubles. In the case of carrier 1, doubles appeared to perform substantially better than singles. This is probably attributable to different operating environments (i.e. road type) and possible age of equipment and driver experience.

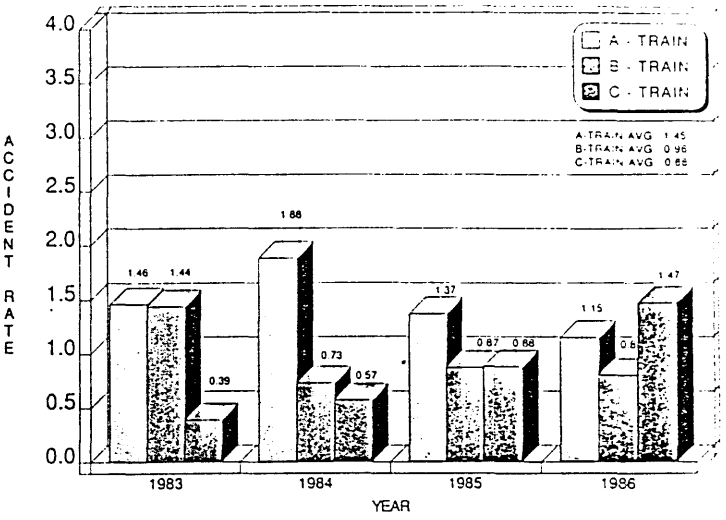
The substantial difference in the performance of singles versus doubles for carrier 1 is reflected in the summary of fleets presented in Table 3 and Figure 6, where doubles appear to have a

FIGURE 5
ACCIDENT RATES BY VEHICLE CONFIGURATION
(ACCIDENTS PER MILLION VEHICLE KM OF TRAVEL)

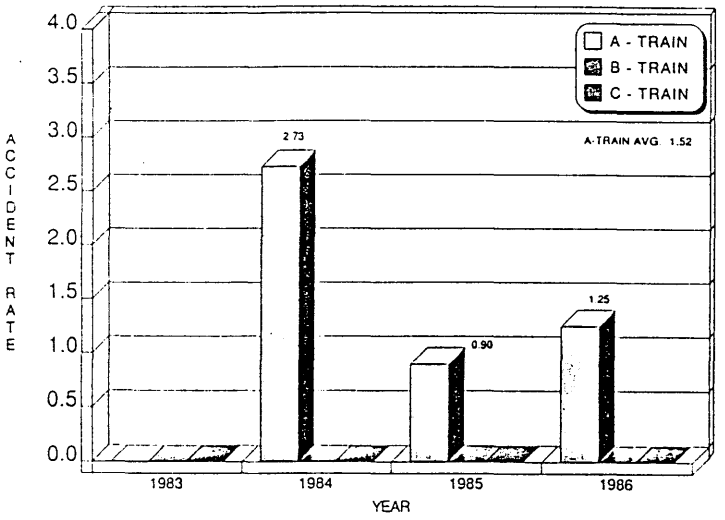
CARRIER 1



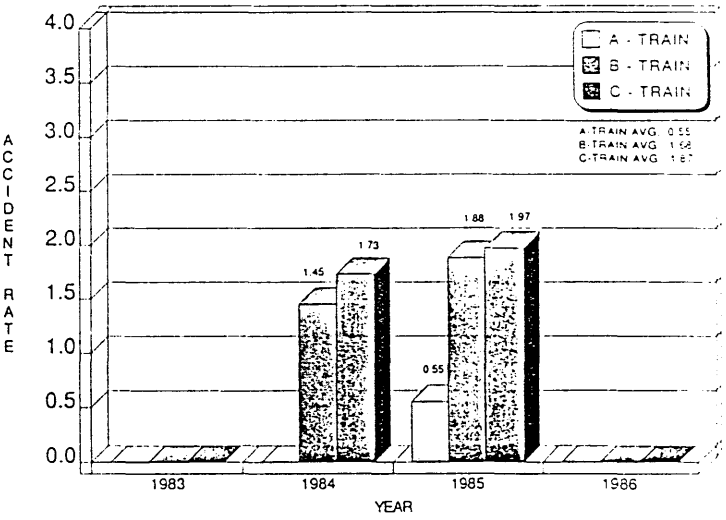
CARRIER 2



CARRIER 3



CARRIER 4



CARRIER 5

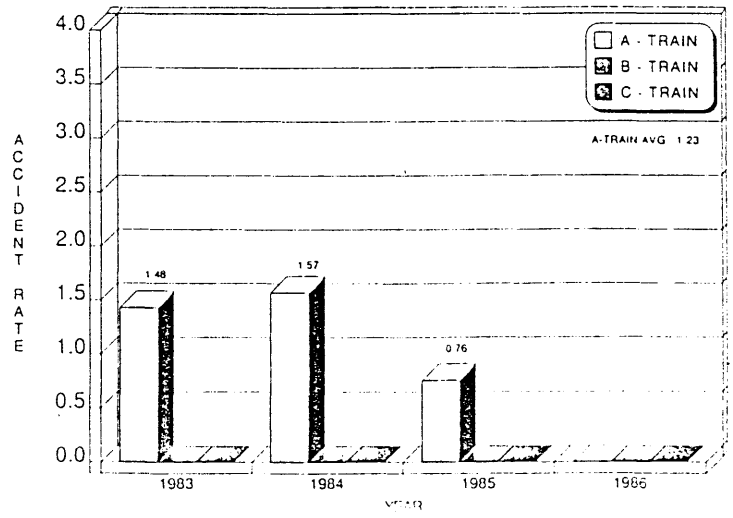


TABLE 3
SUMMARY OF OVERALL EXPERIENCE OF FIVE FLEETS

DESCRIPTION	FLEET		SINGLES		DOUBLES		A-TRAIN		B-TRAIN		C-TRAIN	
TOTAL ACCIDENTS	718	(1)	260	(7)	413	(13)	236	(19)	111	(26)	47	(32)
TOTAL TRAVEL (million vehicle kilometers)	586.3	(2)	157.3	(8)	410.3	(14)	242.9	(20)	130.1	(27)	37.9	(33)
TOTAL INJURY ACCIDENTS	85	(3)	32	(9)	51	(15)	34	(21)	10	(28)	7	(34)
TOTAL FATAL ACCIDENTS	15	(3)	7	(9)	8	(15)	6	(22)	0		2	(35)
OVERALL ACCIDENT RATE	1.22	(4)	1.65	(10)	1.01	(16)	0.97	(23)	0.85	(29)	1.24	(36)
INJURY ACCIDENTS PER MILLION km	0.172	(5)	0.226	(11)	0.145	(17)	0.169	(24)	0.010	(30)	0.035	(37)
FATAL ACCIDENTS PER MILLION km	0.030	(6)	0.049	(12)	0.023	(18)	0.030	(25)	0.0	(31)	0.071	(38)

NOTES:

(1) INCLUDES BOB TAILS, 1983-86 FOR CARRIER 1 AND 2, 1984-86 FOR CARRIER 3, 1983-85 FOR CARRIER 4 AND 5

(2) TOTAL TRAVEL FOR ALL 5 CARRIERS, 1983-86 FOR CARRIER 1 AND 2, 1984-86 FOR CARRIER 3 AND 1983-85 FOR CARRIER 4 AND 5

(3) CARRIERS 1,2,3 ONLY, TOTAL TRAVEL 494.4 MILLION VEH. KM.; TOTAL FLEET INJURY ACCIDENTS INCLUDE 2 BOBTAIL ACCIDENTS.

(4) 718 ACCIDENTS IN 586.2 MILLION VEH. KM.

(5) 85 INJURY ACCIDENTS IN 494.4 MILLION VEH. KM.

(6) 15 FATAL ACCIDENTS IN 494.4 MILLION VEH. KM.

(7) ONLY CARRIERS 1,2,4 OPERATED SINGLES, 1983-86 FOR CARRIER 1 AND 2 AND 1984-85 FOR CARRIER 4, EXCLUDES BOBTAILS.

(8) 1983-86 FOR CARRIER 1 AND 2, 1984-85 FOR CARRIER 4, TOTAL TRAVEL 157.3 MILLION VEH. KM.

(9) 1983-86 FOR CARRIER 1 AND 2 ONLY, TOTAL TRAVEL 141.8 MILLION VEH. KM.

(10) 260 ACCIDENTS, 1983-86 FOR CARRIER 1 AND 2, 1984-85 FOR CARRIER 4, TOTAL TRAVEL 157.3 MILLION VEH. KM.

(11) 32 INJURY ACCIDENTS, 1983-86 FOR CARRIER 1 AND 2, TOTAL TRAVEL 141.8 MILLION VEH. KM.

(12) 7 FATAL ACCIDENTS, 1983-86 FOR CARRIER 1 AND 2, TOTAL TRAVEL 141.8 MILLION VEH. KM.

(13) ALL CARRIERS OPERATED DOUBLES, 1983-86 CARRIER 1 AND 2, 1984-86 CARRIER 3, 1983-85 CARRIER 4 AND 5, 413 TOTAL ACCIDENTS

(14) 1983-86 CARRIER 1 AND 2, 1984-86 CARRIER 3, 1983-85 CARRIER 4 AND 5 FOR A TOTAL TRAVEL OF 410.26 MILLION VEH. KM.

(15) 1983-86 CARRIER 1 AND 2, 1984-86 CARRIER 3, TOTAL OF 51 INJURY ACCIDENTS

(16) 413 ACCIDENTS IN 410.29 MILLION VEH. KM. ON TRAVEL

(17) 51 INJURY ACCIDENTS IN 352.6 MILLION VEH. KM. OF TRAVEL

(18) 8 FATAL ACCIDENTS IN 352.6 MILLION VEH. KM. OF TRAVEL

(19) ALL CARRIERS OPERATED A-TRAINS, 1983-86 FOR CARRIER 1 AND 2, 1984-86 FOR CARRIER 3, 1984-85 FOR CARRIER 4, 1983-85 FOR CARRIER 5, TOTAL OF 236 ACCIDENTS

(20) TOTAL A-TRAIN TRAVEL 242.9 MILLION VEH. KM., SAME PERIOD AS IN NOTE 19

(21) 1983-86 FOR CARRIER 1 AND 2, 1984-86 FOR CARRIER 3, TOTAL OF 34 INJURY ACCIDENTS

(22) SAME CARRIERS AND PERIODS AS NOTE 21: TOTAL OF 6 FATAL ACCIDENTS

(23) 236 ACCIDENTS IS 242.9 MILLION VEH. KM.

(24) 34 INJURY ACCIDENTS IN 200.82 MILLION VEH. KM.

(25) 6 FATAL ACCIDENTS IN 200.82 MILLION VEH. KM.

(26) ONLY CARRIERS 1,2 AND 4 OPERATED B-TRAINS, 1983-86 FOR CARRIER 1 AND 2, 1984-85 CARRIER 4, TOTAL OF 111 ACCIDENTS

(27) TOTAL B-TRAIN TRAVEL 130.1 MILLION VEH. KM., SAME PERIOD AS IN NOTE 26

(28) 1983-86 FOR CARRIER 1 AND 2, TOTAL OF 10 INJURY ACCIDENTS

(29) 111 ACCIDENTS IN 130.1 MILLION VEH. KM.

(30) 10 INJURY ACCIDENTS IN 101 MILLION VEH. KM.

(31) NO FATAL ACCIDENTS

(32) ONLY CARRIERS 1,2 AND 4 OPERATED C-TRAINS, 1983-86 FOR CARRIER 1 AND 2, 1984-85 CARRIER 4, TOTAL OF 47 ACCIDENTS

(33) TOTAL C-TRAINS TRAVEL 37.93 MILLION VEH. KM., SAME TIME PERIOD AS NOTE 32

(34) 1983-86 CARRIER 1 AND 2, TOTAL OF 7 INJURY ACCIDENTS

(35) 1983-86 CARRIER 1 AND 2, TOTAL OF 2 FATAL ACCIDENTS

(36) 47 ACCIDENTS IN 37.93 MILLION VEH. KM.

(37) 7 INJURY ACCIDENTS IN 28.32 MILLION VEH. KM.

(38) 2 FATAL ACCIDENTS IN 28.32 MILLION VEH. KM.

FIGURE 6
OVERALL ACCIDENT EXPERIENCE OF FIVE FLEETS

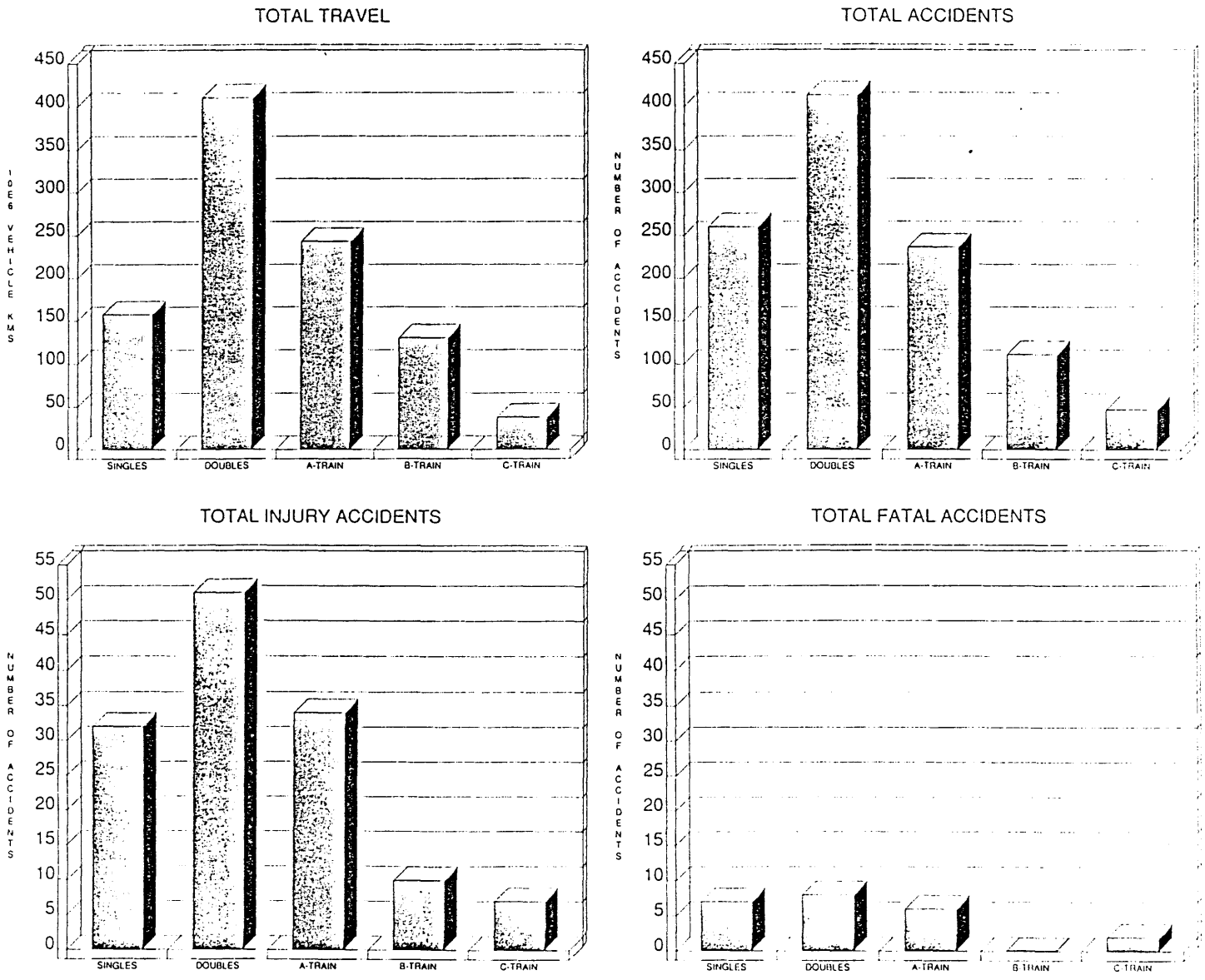
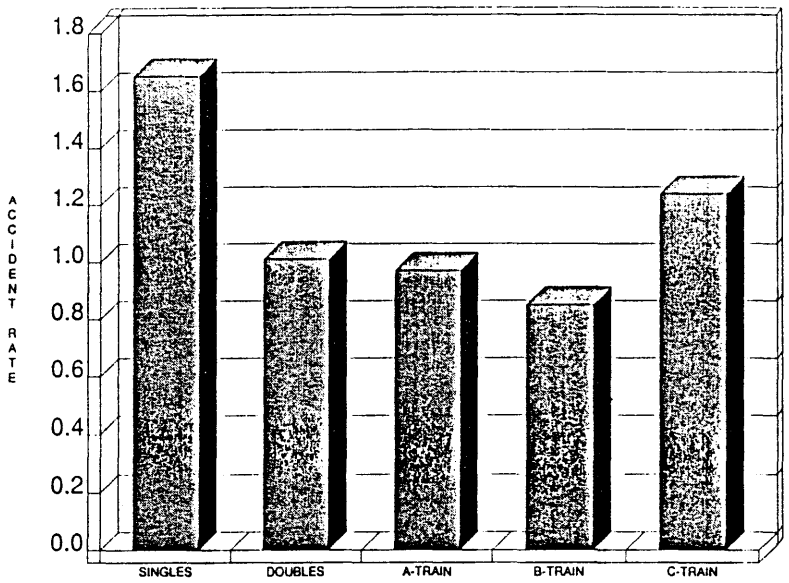
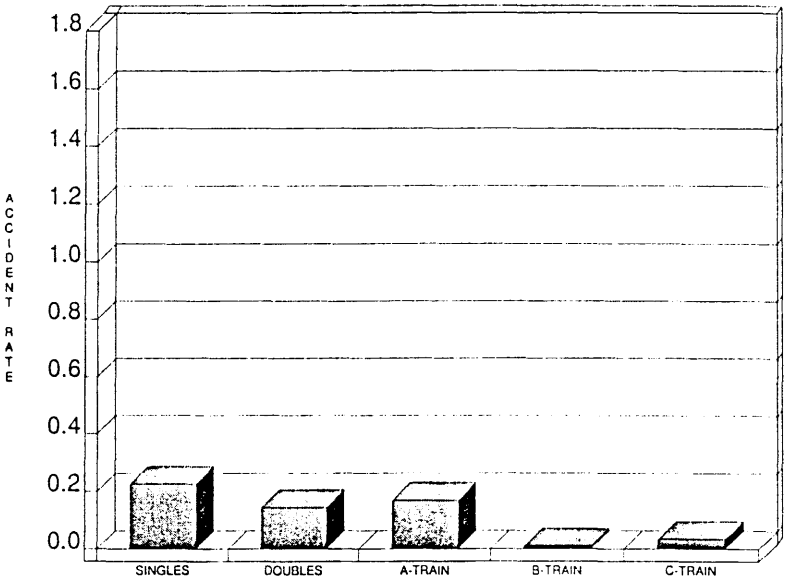


FIGURE 6
(CONTINUED)

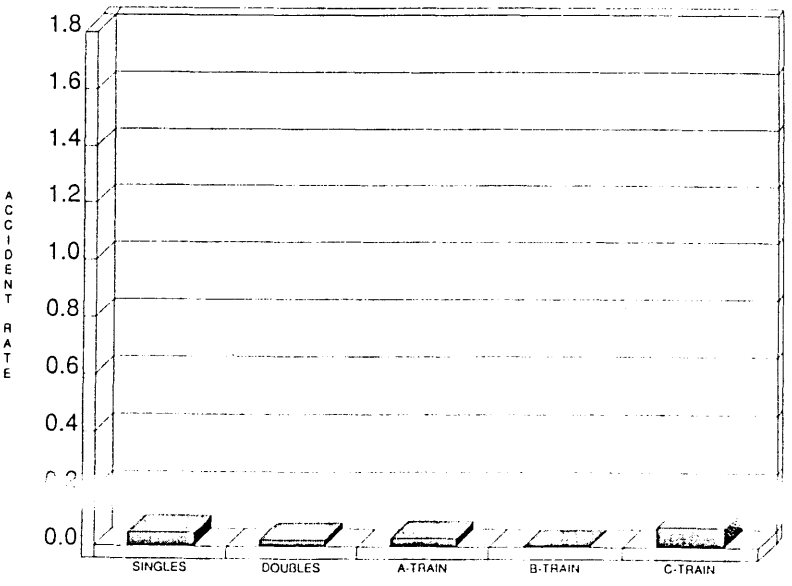
OVERALL ACCIDENT RATE



INJURY ACCIDENT RATE



FATAL ACCIDENT RATE



better overall performance than singles across the fleets (i.e. 1.01 versus 1.65 accidents per million vehicle km).

In terms of the performance of A, B, C-Trains, there were no obvious and consistent difference observed, except for some problem with C-Trains experienced by carrier 1 in 1983 and A-Trains by carrier 3 in 1984. The accident rates for carrier 4 for B and C-Trains appear somewhat higher relative to the experience of the other carriers.

Implicit in the above was the expectation that singles would be observed to perform better than doubles and B and C-Trains would be found to perform better than A-Trains. In this sense, the findings are at best inconclusive and potentially counter-intuitive in some cases.

The important point illustrated by the analysis is the fact that a simplistic approach is obviously inappropriate. That is, there are a large number of important variables involved in determining accident experience generally and for articulated trucks in particular. The issue of single trailers versus double trailers and A versus B versus C-Train configurations are just some of the many variables. In fact the evidence presented here suggests that single versus double or A versus B versus C-Train configurations may not be nearly as important as other variables such as road standards and operating regions.

Safety experience cannot be equated to single versus double or A versus B versus C-Trains as was done at least implicitly in the early sections of this analysis. These parameters may only play a minor role relative to others in terms of overall accident experience of articulated trucks.

To pursue this point, the details of the accidents for carriers 1, 2, and 3 were reviewed in an attempt to determine how important the issue of single versus double or A versus B versus C-Train configurations was in terms of the overall accident experience of articulated trucks. This (subjective) analysis indicated that only 35% of truck accidents have anything to do with vehicle stability (i.e. single versus doubles, A versus B versus C-Trains). That is, the majority of articulated truck accidents involve nonstability related factors only (i.e. hit a deer, third party ran into the back of the truck etc.).

Further, of the accidents in which stability could play a part, it is not always obvious that doubles are always worse than singles or that any particular configuration is always better.

To illustrate, one operator indicated that A-Train pups are maybe less stable than the C-Train configuration but if the wheels of the unit are dropped over the shoulder of the road (which is a common cause of truck accidents in Saskatchewan) a more serious accident is likely to result with a C-Train than an A-Train. This is because in these circumstances the pup on the A-Train may flip but seldom would the whole unit roll. On the other hand, the chances of rolling the whole unit are higher for a C-Train configuration.

The fact that only a small portion of all truck accidents are in any way related to single versus double or A versus B versus C-Train configurations does have potentially important implications to this study. This is because the truck accident data involved all accidents. The intent here was to focus on the differences associated with single versus double or A versus B versus C-Train configurations. As a result the accident data contained considerable "noise" associated with parameters other than those of specific interest herein. This "noise" may have negated the possibility of observing differences that do exist. This issue was pursued using statistical testing techniques and separating the data set into two parts, namely; stability and nonstability related accidents [4]. This detailed statistical analysis of singles versus doubles indicated that differences are not due to stability, but rather probably attributable to differing usage patterns. For double articulated trucks alone though, the stability related data indicated that B-Trains have fewer stability problems than either A or C-Trains. A and C-Trains did not display significant differences in their stability risks, but there was some evidence that C-Trains may result in more serious accidents than A-Trains. The overall accident risks did not follow the same pattern: there are many other important causes of truck accidents that overwhelm the stability effects in these data. However, the overall data did still indicate that C-Trains may result in the most property damage or injuries. Thus although we obtained some provocative results, it is clear that there are so many factors other than stability that only a multivariate analysis can hope to provide a definitive statistical assessment of the relative risks.

Despite the caveats above, it is still important to reiterate that even if a significant difference has not been detected, a small but real difference in risks may exist. It can be demonstrated that effects as large as a 10 percent difference in accident rates between A and C-Trains are very unlikely to be statistically detectable (with significance) unless many years of additional accident data were available. [5]

SUMMARY AND CONCLUSIONS

Great care must be taken in drawing general conclusions from a study of this nature. Analysis of accident rates in general and comparisons in particular are fraught with problems. In this context, the information presented here must be considered as "circumstantial" evidence as opposed to "unquestioned" fact.

In collecting the data and undertaking the analysis, every attempt has been made to be objective. This is tempered, however, by the fact that judgement had to be used in some cases (for example, when assembling data from accident report files to summary sheets).

With the above as background, the following observations are offered:

1) Fleet specific accident experience indicates an overall over-the-road accident rate of 1.22 accidents per million km for five fleets operating articulated trucks over 586 million km during the 1983-86 period. When adjusted for differences in the definition of an accident and highway and rural road travel, the accident rates of the five fleets are in the order of .64 accidents per million vehicle km. This is comparable to the accident rate of all vehicles operating on provincial highways in Saskatchewan.

2) Double trailer units operated by the five fleets throughout Western Canada appear to have an accident rate somewhat lower than single unit trailers. This difference however appears attributable to differences in useage patterns of the two vehicle types rather than the inherent stability characteristics of the two types of vehicles.

3) B-Trains appear to have a lower accident rate than either A or C-Train configurations. A and C-Trains do not appear to display significant differences in their stability risks, but there is some evidence that C-Trains may result in more serious accidents than A-Trains.

4) During the course of the study, there were no obvious major inadequacies identified related to the safety of large trucks operating in Saskatchewan. Most large truck accidents are, like accidents involving other vehicle types, caused by a combination of driver error,

environmental conditions and chance circumstance. As such, there are no apparent "easy quick-fix" solutions to accidents involving large trucks. This is however not to suggest that continued vigilance is not required. Rather, it suggests that the fleet operators that provided data for this study take safety as a very serious matter and as a result, have a safety record at least comparable to that of the vehicle population as a whole. Further, because of a job well done to date, future improvements in large truck safety are likely to be marginal improvements. That is, there is unlikely to be any ways identified to dramatically improve an already respectable safety record.

REFERENCES

1. The Safety Experience of Large Trucks in Saskatchewan, G. Sparks, J. Bielka, A. Smith, D. Marzolf, R. Neudorf, Saskatchewan Highways and Transportation, 1988

2. See Table 3.11, page 62, The Safety Experience of Large Trucks in Saskatchewan, Saskatchewan Highways and Transportation, 1988

3. Chapter 3, op cit

4. For details, see Chapter 5, op cit

5. Safety Experience of Large Trucks - An Analysis of Sample Size Requirements, G. Sparks, A. Horosko, A. Smith, Proceedings of the Canadian Transportation Research Forum, Minaki Lodge, May 1988