ANALYSIS OF PUBLICLY AVAILABLE DATA ON ACCIDENTS INVOLVING HEAVY VEHICLES

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ABSTRACT

The paper reports the results of a study on data extracted from: Level 1 accident reports; files of a police agency in the Province of New Brunswick for the years 1984 to 1986; and, the Transport Canada Passenger Car Study (PCS). The data selected relate to incidents involving heavy tractors, semi-trailer units and other freight vehicles operating on provincial highways. From the New Brunswick data, 30 cases involving fatalities were chosen and a search was made for additional information from police investigation files, mechanical inspection reports, blood alcohol analyses, witness statements, accident reconstruction reports, scene and vehicle photographs and the PCS data file.

The findings clearly indicate that the basic police reports contained misleading information. Variables relating to truck and trailer identification, accident configuration, location of heavy truck damage and assignment of fault were found to contain numerous coding errors.

The Level 1 police accident reports will continue to be the primary source of frequency data for all types of vehicle accidents. The data they contain can be made more useful for monitoring and countermeasure development by minor additions to the variables reported and the establishment of improved quality control.

The coding discrepancies suggests some of the information quality limitations and how they might be included in the application of these data. The results suggests that a method for quality control of routine reports could be developed by follow-up studies using police investigation files and/or modification of the PCS reports.

It appears that Level 2 and/or Level 3 accident studies are required and can produce good levels of detail of heavy vehicle safety factors.

The analysis confirms many previous reports of such factors as the over involvement of heavy vehicles in fatal accidents, under involvement in total accidents, the aggressiveness of heavy vehicles and the major role of the driver.

1.0 INTRODUCTION

So called accidents can be considered as one of the failure modes of a transport system. Relating accidents to component design, quality, and operational procedures is one of the fundamental methods used to monitor and improve system quality. The notion that large/heavy vehicles used for highway transport should include some meaningful accident investigation attention was the motivation for this work. The focus has been on examining some of the information which is in the public domain for the province of New Brunswick in eastern Canada.

An ongoing problem for monitoring and improving the performance of accident data reporting is the scarcity of available reliable information on which to take decisions. Other problems such as data interpretation and the formulation of acceptable actions, etc. are accepted, but these are not the focus of this study. Detailed data are especially sparse for involvement rate by heavy trucks in accidents because these incidents are relatively rare occurrences and the population of both vehicles and their usage are highly variable. The occurrences also tend to be localized. The nature of the problem was effectively described by Sparks et al in their paper ("The Safety Experience of Large Trucks in Saskatchewan", 1987) given at the 1988 CTRF annual meeting.

Assuming that available data on heavy truck accidents were reliable then analyses of these data could reveal areas requiring corrective actions, research requirements, and the effectiveness of countermeasures and standards, etc.

Motor vehicle safety levels can be quantified in terms of such factors as the numbers of fatalities, number and severity of injuries, amount of property damage and other claims relating to collisions. Whatever safety dimensions are chosen they are only useful if accurate and timely data of occurrence are available.

The primary source of safety data for Canada are the investigation reports filed by the police. This information is available in machine readable form for all provinces. The report format and content are not fully standardized, but there are marked similarities. These data are compiled into a national data base by Transport Canada which is referred to as the TRAID file (TRaffic Accident Data). These are the 'Level 1' data and are the major source for national as well as local strata. As 'Level 1' suggests, these data provide elemental information on all reported accidents. Expansion of any accident sample to local or national significance will usually rely on these data.

Of the many methods used to collect data for accidents three levels are usually identified. Level 1 is as noted above earlier. Level 2 is a more detailed post accident investigation and Level 3 is a very detailed investigation which includes visiting the scene as quickly as possible subsequent to the event.

Because the primary purpose of 'Level 1' data is in support of enforcement, these data are known to be weak in terms of detailed coverage and accuracy. These data should be cost effective, and are essential because they include complete, and continuous coverage of the accident population. They are also maintained at public expense in machine readable format and are generally accessible because of public information legislation.

The Level 1 data could be made more effective by improving their reliability by better quality control/assessment and by extending the range of detail covered.

The New Brunswick Level 1 data were examined to determine reliability and detail on large/heavy truck accidents. Accidents involving fatalities are routinely investigated more intensely. The additional evidence which could be matched with a sample of large truck accidents were compared with the Level 1 data on these occurrences.

Level 2 data is developed by the Transport Canada 'Passenger Car Study' (PCS). These data for the years 1984, 85 and 86 were also examined for information on heavy truck accidents. The PCS data is focussed on passenger car damage, especially relating to vehicle occupant protection. The sample is small, about 100 cases per year in each of ten locations across the nation and includes a considerable effort on quality control. The PCS developed similarly and operated in parallel with the 'National Accident Sampling System' in the United States. The PCS case data examined lacked detailed weighting. Only fatal and personal injury accidents which involved one or more passenger cars are included. The examination therefore reveals mostly the potential of these data and suggestions for how the population covered could be expanded to large/heavy trucks, etc. The data bank includes vehicle and scene photographs which were not examined but are known to be a source of additional detailed information.

To assist in matching the heavy vehicle components and systems which affect safety, the nature and frequency of related incidents should be continuously monitored. This poses problems because of the data difficulties. It appears that only superficial frequency information will be available under any reasonable routine data collection scheme. Level 1 data should be supplemented by more detailed information from Level 2 and/or Level 3 studies. The data will however remain sparse and will have to be interpreted on an anecdotal basis. It appears especially important to be able to link the available data on a case by case basis to monitor and quantify reliability. Suggestions for improving the data situation are included in section 5.

2.0 BACKGROUND

Commercial vehicles are often considered to be over represented in accidents and are typically thought to be at fault. The drivers and these vehicles often travel in excess of 160,000 km and/or 2000 hrs per year. These travel levels increase their exposure to accident situations. The vehicle operators often drive as their main occupation and tend to be more experienced and qualified than passenger car drivers. The vehicles often travel at night on high class highways when traffic is relatively light. Should commercial vehicles, especially large/heavy ones be involved proportionally in fewer accidents than passenger cars which often travel during peak hours in congested urban areas?

Previous studies have determined commercial vehicle accident rates to range from 0.45 to 1.1 per million km travelled, compared with 0.81 to 1.8 for passenger cars (1:ix), (2:12) and (3:21). However these relative relationships do not hold true for fatal accidents. Commercial vehicles appear three times more likely than passenger vehicles to be involved in a fatal accident (8.2 vs 2.8)(4.1). To better understand involvement, these factors must some how be appropriately quantified and be adjusted for exposure.

Another aspect to consider in cases where the heavy truck is determined to be at fault is whether it is the truck operator's fault, or simply the characteristics of the vehicle being driven. Factors such as relative vehicle length, width, elastic and plastic stiffness, mass, etc. contribute to high fatal accident involvement. For example the typical bumpers on trucks are relatively much stronger and stiffer than for passenger cars and in most instances are mounted at different heights. Consequently impact with an oncoming heavy truck is similar to striking an approaching non-yielding wall at best or a moving narrow nearly rigid object at worst. The gross vehicle mass is often ten or more times that of a passenger car. Finally, the overall length can be over five times the length of a passenger vehicle, implying that the probability these vehicles will be struck on the side by other vehicles will be relatively higher. Because the greatest part of the length of a large vehicle is at a different height than the stiff components of a passenger car, rather catastrophic results occur from side impact collisions.

The above obvious situations are well known but vehicle improvements to help remedy the situations are slow to develop. The difficulties appear to be: a) the cost effective solution is not obvious, b) there are questions about the seriousness of the problem. It is the latter question that can be addressed by quality information. Even the nature of the solution may be more obvious if the nature of the problem is better understood.

The Level 1 data base for a jurisdiction can be enormous containing many variables relating to all accidents for a time period. The level of detail cannot be expanded indefinitely because the investigating officers have other responsibilities and the main concern is with supporting information for police work. The reliability of the variables recorded under these circumstances is of concern. A Level 1 study has the potential to produce statistically significant results for certain variables if the segmentation is not excessive.

Research by Sparks (1:7) has shown the enormous sample sizes required to produce statistically significant results for certain vehicle classes of heavy truck accidents. This is due to the many and ever changing variables associated with these vehicles.

Presently Transport Canada maintains a Canada wide Level 2 accident study sample of serious passenger car accidents to support a data base for monitoring and developing the Canadian motor vehicle safety standards. The study was designed as a statistically significant accident sampling plan which would provide data on all involved vehicles, damage, scene, conditions, driver and occupants, injuries and certain special components of interest. All of these data are obtained after the accident. This study has definite limitations because it is not a so called 'General Level 2' but it does include vehicles other than passenger cars if they have been involved. Large/heavy trucks are therefore included to a limited extent.

It is the nature of large/heavy trucks to be relatively resistant to structural damage. Trucks are often driven from the accident scene while passenger vehicles, if involved, may be totally destroyed and removed to a salvage yard. Also, since time is more valuable for trucks and their drivers, they are back on the road as soon as possible. This adds to the difficulties of locating and inspecting the vehicles and interviewing the operators who generally receive less severe injuries and are therefore more mobile.

A Level 3 study as described by Wolkowicz (5:171-186), is an indepth on-the-scene investigation in which investigators are on call 24 hours per day. Often this type of study involves a sample biased towards accidents involving extensive vehicle damage as does the Level 2 study mentioned above.

There are marked differences in cost between these three Levels of investigation. Each data collection method has its specific and appropriate application. Ideally, analysis of the Level 1 data should provide guidance and control for safety action and research in the areas, classes of vehicles. etc. which appear to provide opportunities for improvements. It appears obvious that quality Level 1 data are essential and that careful and systematic analysis of these data should be part of all vehicle performance improvement efforts. As often happens the obvious is overlooked in favor of the esoteric.

3.0 STUDY METHODOLOGY

To evaluate the Level 1 data all variables were examined and a limited set was selected and compared. Those selected required that additional information be available for follow-up investigation. These variables were also considered to be of major importance as input to safety improvement programs and research. Originally vehicle identification variables were to be used only for case selection. However, early analysis showed that they were not necessarily coded according to coding specifications. This created case selection difficulties from the Level 1 data base and therefore the two vehicle identification variables were added to the list. (Table 1).

TABLE 1. Heavy Truck Level 1 and Follow-up Investigation Comparison Variables
1. Cause and Contributing Factors
2. Accident Location
3. Intersection Related
4. Accident Impact Configuration
5. Number of Axles- Heavy Truck
6. Pre-Collision Vehicle Action
7. Heavy Truck Identification
8. Location of Damage -Heavy Truck

The Level 1 data, i.e. police report data, were acquired from the New Brunswick Department of Transportation and transferred to a mainframe computer. The accidents covered 1984, 1985 and a portion of 1986. Using SPSSX all highway accidents involving a truck tractor and/or a semi-trailer were selected for analysis. By specifying "or", many accidents involving the vehicle identification miscodings, as mentioned previously were selected. A total of 1323 accidents (45 fatal), were then examined using SPSSPC on a microcomputer.

The primary resource for the follow-up or simulated Level 3 investigation was the police accident case files. The procedure followed by the police force which made its files available, was indepth and follow-up investigations of all accidents which involved fatalities. Fifteen of the above 45 fatal accident files were not located and consequently dropped from the analyses. The 30 cases, all involving tractor semi-trailers (TST), were on average, found to contain the information to confidently determine fault and in many cases, the factors contributing to the accident.

Information used from the police files included:

1. Witness statements
2. Driver statements

3. Accident scene diagrams
4. Mechanical vehicle inspections
5. Autopsy results
6. Tachographs (two occasions)
7. Investigating officers summaries
8. Vehicle photographs
9. Scene photographs

4.0 VARIABLE IDENTIFICATION, COMPARISON AND DISCUSSION

4.1 Variables: Causes and Major Contributing Factors (MCF's)

Four MCF's are allocated for each vehicle involved in an accident. The accident report coding manual for New Brunswick (6:Sect. 1 to 11) specifies the first MCF to represent the cause and the remaining three to represent the contributing factors. The variable is specific and disaggregated to:

1. human conditions;
2. human action;
3. vehicular;
4. environmental.

Table 2 shows the causes and contributing factors for the 30 fatal accidents as compiled from the police report and follow-up data.

TABLE 2. Results: Heavy Truck MCF's for 20 TST Accidents

cause/contributing factor	Level 1 frequency cause	Level 1 frequency c.f.	Follow-up frequency cause	Follow-up frequency c.f.
driver inattention	4	0	1	1
extreme fatigue	1	0	1	0
driving too fast for road conditions	3	0	6	1
passing/lane usage improper	1	1	1	0
pedestrian/error confusion	1	0	1	0
following too closely	0	0	1	0
mechanical failure (trailer tandem)	1	0	1	0
jackknife	0	3	0	2
load shift	2	1	0	3
surface slippery	2	2	0	2
view obstructed	0	3	0	3
hydroplaning	0	1	0	0
uninvolved vehicle	0	1	0	0
not applicable	11	0	17	0
unknown	4	0	1	0

There were eight accidents in which the vehicle approaching the TST simply crossed the center line for no apparent reason and struck the TST. In many cases the road surfaces were dry, autopsies revealed no alcohol or drugs and subsequent mechanical inspections cleared the vehicle of any mechanical defect. Causes appear to include driver inattention, distraction and fatigue. In these cases, although fault was easily determined, the actual cause was not and therefore required the authors assessment based upon personal experience and available data. On no occasion was alcohol or drug use found to be a factor for the truck operator. Table 3 contains a summary of the frequency of fault to an involved vehicle operator by Level 1 as compared to data extracted from follow-up investigations of the 30 TST accidents.

Table 3. Comparison: Fault Assignment 30 Fatal TST Accidents

	Level 1 frequency			Level 1 frequency		
	TST	other	unkn	TST	other	unkn
All Accidents (30)	14	12	4	11	18	1
Single Vehicle Accidents (5)	4	1	0	4	1	0
Multi-Vehicle Accidents (25)	10	11	4	7	17	1

The Level 1 data reported "unknown" as the cause for the TST in four cases. Further investigation revealed that the tractor driver was not at fault in any of these accidents and that the correct coding would be "not applicable".

4.2 Variable: Accident location

Since heavy truck exposure is greatest on highways it was reasonable to assume this is where most of the accidents would occur. Level 1 results revealed that 23 of the 30 fatal accidents occurred on rural provincial highways and six on urban provincial highways. The remaining accident took place on rural private property.

The follow-up study revealed that the majority of accidents (26) occurred on rural provincial highways. Three took place on urban provincial highways while one occurred on rural private property.

Three coding errors were found when comparisons were made for this variable. The errors were made consistently and involved a highway section being coded as "highway urban" when coding should have been "highway rural".

4.3 Variable: Intersection Related

The coding manual defines an intersection related accident as one which occurs at an intersection and where at least one vehicle was entering or exiting the intersecting roadway. There are very few miles of divided, low access highways in the study area. In fact there are over 2000 entrances/exits onto the Trans Canada Highway in the study area, a highway that handles a significant amount of heavy truck traffic. Results from the accident report data revealed only seven TST accidents to be intersection related.

The follow-up investigation identified nine accidents to be intersection related. Six of these accidents occurred in areas where the highway intersected with a rural road. Three of these involved vehicles entering the highway from the secondary roadway with the other three involving vehicles slowing and in the process of making a left turn. The other accidents occurred at a railway crossing, private driveway and commercial driveway entrance.

Seven accidents from Level 1 analyses were found to be intersection related compared with nine for the Level 3 investigation.

4.4 Variable: Accident Configuration

The accident configuration variable describes the nature of the first impact in an accident. Level 1 analyses of this variable indicated that head-on collisions (7 occurrences) and angle collisions (5 occurrences) occurred most often. Sideswipe-type impacts occurred in three cases. Three collisions occurred where the investigating officer was unable to define the configuration (i.e. the configuration could not be represented by one of the 11 available codes).

The follow-up investigation revealed that head-on collisions were the most common type of impact occurring in 11 cases. The right-angle collision type occurred seven times, and the "other" configuration coding was used for five accidents. The remaining seven accidents involved five difference impact configurations. The five impact configurations coded as "other" involved two types of collisions. The first one was a jackknife type of impact. On both occasions the semi-trailer swung around into the other lane and struck an oncoming vehicle. The other three involved TST load shift cases. Loads spilled were 50 cm diameter steel pipe, bundled lumber and gyproc sheets. The coding manual does not clearly and specifically address the proper configuration coding for these five accident types and therefore requires the use of the "other" category for the accident configuration code. The use of the "other" category does not provide sufficient data to track such important factors as load shift.

Comparisons of these results indicated nine coding errors. These errors were found to exist in only the multivehicle accidents. Two of these nine miscoded accidents should have been coded as head-on collisions but were miscoded as sideswipe collisions. Two others coded as turning conflict accidents involved semi-trailer jackknife and subsequent impact with the oncoming vehicle. Coding of this variable for these four accidents appears to be based upon the configuration schematic placed on the police report instead of the coding manual definition.

4.5 Variable: Number of Axles

The police report coding manual states the number of axles recorded for a heavy truck should be the total number of axles on the vehicle including the towed semi-trailer, if one is present. Typically a TST will have five or six axles, three for the tractor unit and two or three on the semi-trailer. Analyses revealed that only 20 accidents were recorded with the TST having five or six axles on the TST. Of the remaining 10 accidents, there was one listing two axles, eight reporting three axles and one listed as four axles.

The authors investigation, based on actual photographs of the vehicles involved revealed that all TST had five or six axles. This certainly was expected as accident selection was made knowing a TST was involved.

Comparisons in the coding of this variable revealed errors in 10 cases. Eight were coded as having only three axles. These errors should not be present in the data since selection criteria was based upon a TST and there are very few three axle units in this region.

4.6 Variable: Pre-collision Vehicle Action

Pre-collision vehicle action is intended to indicate the vehicle motion prior to an impact, an evasive manoeuver or loss of control of the vehicle. Level 1 results revealed the TST to be moving straight ahead in 25 of the 30 accidents. The remainder of the cases involved the following vehicle actions; overtaking (1), changing lanes (1), turning (2) and slowing or stopping (1).

Accident files indicated that on 27 occasions the motion of the TST prior to impact, was "going straight ahead". On two occasions the TST was passing another vehicle and was subsequently involved in an accident. On one occasion the TST was slowing in preparation to make a left turn onto a secondary road when it was struck from behind by a car.

Four coding errors were found to exist when these variables were compared. Two of the four miscoded accidents should have been coded as "going straight ahead" and "slowing or stopping". The latter of the two required familiarity with the coding manual. The two remaining accidents involved pre-collision actions that were coded with the correct intent. They, however, did not depict the precise motion that the researcher was able to determine from the accident files. The final accident involved a TST overtaking a motorized two wheel vehicle. Police coding indicated the TST to be "changing Lanes" while the follow-up investigation revealed that the lane change had been completed.

4.7 Variable: Vehicle Identification

For heavy trucks this variable requires two codes, one to identify the drive vehicle and one for the towed vehicle. Reference was made earlier in this paper to the problems encountered when this variable was examined. Table 4 lists the various configurations as indicated from the accident report data.

TABLE 4. Level 1 Results - Tractor Semi-Trailer Identification Codes

Code	Name of Vehicle Identification Code	Frequency
"4-7"	truck > 5000kg w/semi-trailer (flat bed)	1
"5-8"	tractor semi-trailer (van)	20
"5-7"	tractor semi-trailer (flat bed)	3
"5-9"	tractor w/double trailer	1
"5-10"	tractor semi-trailer (tanker)	1
"5-97"	tractor w/not applicable for towed unit	3
"5-98"	tractor w/unknown to towed unit	1

The follow-up investigation revealed that 20 accidents involved TST (van type semi-trailer), nine involved TST (flat beds) and one involved a TST (tanker).

If safety researchers are to address a specific road user group they must be able to confidently identify and perhaps isolate the group for analysis. The analyst would, in all probability assume that case selection, based upon the two vehicle identification variables, selected all vehicles of concern. The cases not selected due to miscoding, should not be significant enough to affect results. This however was not found to be the case. A significant number of rare truck configurations and bobtail units were found to be present in the Level 1 data. For example, 228 "trucks over 5000 kg were found to be towing semi-trailers and 150 bobtail units were identified. These researchers are confident based on other traffic studies that these numbers are not representative of the true heavy truck configurations involved in accidents. Unfortunately, no other data exists to determine the actual configurations of units involved in accidents. Using the data in the existing accident report files would result in errors in significant magnitude.

4.8 Variable: Location of Damage

The report coding manual allows recording up to three damaged areas for each vehicle involved in an accident. The first area recorded is intended to represent the first area contacted during the collision. The two remaining variables locate other damaged areas, if applicable. To address the proper coding for a vehicle towing another (e.g. TST) the coding manual states that "99" should be used to indicate that a towed vehicle was struck. Analysis of the frequencies of this variable representing initial contact revealed the front end of the truck tractor was struck on 16 occasions. The remaining cases were approximately evenly distributed among the other available codes. On one occasion only, was the "99" used indicating the semi-trailer to be the initial contact object.

Examination of accident file data revealed the front end of the TST to be the primary impact location on 16 occasions. Ten accidents involved primary impact on the TST and the remaining cases were evenly distributed among other available codes representing damage to the tractor unit.

Comparisons revealed 10 coding errors for the "primary location of damage" variables. Results are detailed in Table 5. In eight of the 10 miscoded accidents primary impact from the other vehicle was made with the semi-trailer. The above procedure of coding "99" to indicate contact with a towed vehicle is

TABLE 5. Results: Location of Damage to TST

Damage Location	frequency Level 1	frequency follow-up
* right side (truck tractor)	5	1
rear end (truck tractor)	1	0
left side (truck tractor)	3	1
front end (truck tractor)	16	16
semi-trailer	1	10
undercarriage (truck tractor)	1	0
roof (truck tractor)	1	2
more than 3 areas	2	0

* -right side represents the passengers side

essential to prevent damage locations from the towed vehicle being misrepresented as damage to the vehicle doing the towing. These four accidents were coded as representing primary damage to the tractor. From inspection, it became apparent officers were coding without the knowledge of the "99" coding procedure. On two other occasions the number "12" was coded as primary impact indicating more than three areas were damaged. The manual states that this coding can only be used for the third of the three available codes when more than three areas sustain damage.

5.0 EXAMINATION OF THE PCS DATA FOR INFORMATION ON LARGE TRUCKS

The other data examined were from the Passenger Car Study (PCS). These can be summarized as follows:

Number of accident cases by year are:

1984	622
1985	899
1986	919

The total number of cases in the file at time of analysis was 2440. The target set was 1000 cases per year.

The extent of the data base is evident by the fact that each case can potentially contain 24 data forms. These are listed below to indicate the breadth of data collected.

1. Case
2. Scene
3. Vehicle
4. Damage
5. Non-occupant
6. Cargo
7. Occupant
8. Injury
9. Trailed vehicle
10. Child restraint
11. Driver
12. Active restraint
13. Seat-back
14. Entrapment
15. Defect
16. Rear-seat
17. Instability
18. Steering
19. Fire
20. Tire
21. Braking
22. Rollaway
23. Ejection
24. Case management

The number of cases referenced to each of the variable values in the case files also gives an indication of this data resource. Table 6 presents these data.

TABLE 6. Number of Cases Containing Data on Variable			
Variable	No.of Cases	Variable	No.of Cases
no answer	1227	seven vehicle	0
population less than 2500	224	eight vehicle	0
population 2500-5000	84	unknown vehicle	0
population 5000-10000	68	rollover	223
population 10000-25000	49	submersion	12
population 25000-50000	215	hit & run	26
population 50000-100000	56	non-collision fire	0
population 100000-250000	192	other non-collision	24
population greater than 250000	325	rear end	395
fatal accident	933	head on	475
injury accident	1507	rear rear	6
pedestrian/cyclist	375	angle 90-180 deg.	583
motorcycle	100	t-intersection	352
passenger car	883	side swipe and side	
truck less than 5 tons	282	swipe direction	58
truck 5-25 tons	54	opposite direction	28
truck greater than 25 tons	56	other collision	253
bus	17	unknown collision	5
train	9	on roadway	1874
fixed object	413	on shoulder	94
moveable object	30	in median	51
other object	220	on roadside	307
unknown object	1	out of right of way	56
one vehicle	1005	parking lot	10
two vehicle	1262	bus lane	1
three vehicle	138	other location	43
four vehicle	26	unknown location	4
five vehicle	7	no description	704
six vehicle	2	description	1736

These data are sampled for a number of jurisdictions by ten teams located in eight of the ten provinces to attempt national coverage. The concept is to expand the data using local sampling information and the provincial Level 1 data. It becomes clear that the level of precision possible will be low and the quality of the Level 1 data makes the accuracy for large trucks suspect. However, estimates produced by this process are the best possible are the best estimates available at this time. For example, there are 56 cases which include data on heavy trucks. The weighted number for this variable is 821.5. Similarly the cases that include fatalities are 933 with the weighted number being 2336. The non fatals number was 1507 with the weighted number 89105. This indicates that the sampling rate is about 38 to 1. Property damage only cases are not included.

The ratio of fatalities by involvement with various vehicles was calculated from the sample weighted PCS data. The ratios are presented in Table 7. These ratios confirm a much higher rate of fatalities when a large/heavy truck is involved.

TABLE 7. Ratio of Fatalities by Vehicle Involvement

Descriptive Involvement	Ratio
Pedestrian, cyclist and fatal by pedestrian cycle	.0414
Motorcycle and fatal by motorcycle	.0850
Passenger car and fatal by passenger car	.0077
Truck less than 5 tons and fatal by truck less than 5 tons	.0212
Truck 5-25 tons and fatal by truck 5-25 tons	.0392
Truck greater than 25 tons and fatal by truck greater than 25 tons	.1753
Bus and fatal by bus	.0175
Train and fatal by train	.0217
Fixed object and fatal by fixed object	.0311
Moveable object and fatal by moveable object	.0481
Other object and fatal by other object	.0892
Unknown object and fatal by unknown object	.0000

6.0 FINDINGS

6.1 New Brunswick Level 1 Data Analysis

The research on the data collected in the study area using the Level 1, accident report data revealed numerous errors in reporting of accidents involving heavy trucks. The conclusion was reached that the present quality control for Level 1 accident report data is inadequate and the use of these data for research and analyses of truck accidents could yield misleading results and subsequent incorrect conclusions.

The analysis revealed 45 coding errors on eight variables examined in 30 TST accidents involving heavy trucks. Many of these errors appeared to arise from the officer not being familiar with the coding manual for the accident report form.

Five of the eight variables examined were found to be coded inadequately and if data on these variables were used in safety research they could not have contributed in a positive manner to any study. The five variables, which would likely be requested for most research projects, were:

- accident fault assignment
- heavy truck identification
- heavy truck number of axles
- accident configuration
- heavy truck location of damage

Countermeasures based upon analysis of data on these five variables would be extremely misleading and thus have the potential to direct safety research in the wrong direction.

The operator of the heavy truck was found to be "at fault" in 11 out of 30 fatal accidents examined. The cause and contributing factors were determined to be human related in eight of these 11 occurrences. The remaining three were load shift cases with one being related to mechanical problems.

These conclusions relate to the specific study area. However, a review of operating procedure in other jurisdictions indicate that the probability is high that the quality control in these areas is basically similar to that found in this study area.

6.2 Passenger Car Study (PCS) Data

The PCS data confirmed the high involvement rates in fatalities relative to heavy vehicle/truck accidents. The data base contains more detail related to heavy vehicles than the study name implies. Analysis of these data confirms that heavy vehicles are a significant factor in overall highway safety by the frequency and nature of their involvement in collisions with passenger cars.

The PCS technique could be modified to better reflect safety aspects of heavy vehicle use and an expanded analysis of the PCS data is required to extract the available information (especially from the case photographic records). The extent of the 'unknowns', and 'others' related to heavy vehicle data indicate the problems with obtaining information on this class of vehicle by the technique used. While the data do not provide reasons for these difficulties, it is known that commercial vehicles in general tend to be returned to service very quickly so that the investigation response time must be much quicker than for passenger vehicles.

7.0 RECOMMENDATIONS

The research reported in this paper has generated several recommendations considered to have the potential to increase the quality and therefore, use of accident report data.

1. Accident Report Form: Clarification/Expansion

- The need exists to clarify certain variable definitions in the accident report coding manual to reduce interpretation errors (e.g. accident configuration, pre-collision vehicle motion, major contributing factors, number of axles, location of damage).

- The data collected should be expanded on the accident report form to enable additional, reliable and useful data associated with heavy truck accidents to be collected on a large scale basis. Variables added should be relatively simple, factual and within the capability of traffic officers. Possible additions include:

  - overall accident fault
  - if a vehicle crossed the centerline
  - load (if applicable) type and mass
  - gross vehicle weight
  - driving experience with this particular vehicle configuration
  - hours driving (e.g. less than 4, 4 to 8, more than 8 hours)
  - number of lanes, divided or undivided, high/low access
  - driver familiarity with this route
  - driver relationship to truck tractor, e.g. owner operator, company driver
  - heavy truck distance travelled per year
  - National Safety Code reference number

- Various jurisdictions should be encouraged to produce and adopt a form which is uniform and more complete. The cooperation should exist within Canada and between countries allowing these data to be combined and/or interchanged.

2. Accident Report Data: Quality Control

- Accident report data reliability should be improved considerably and monitored closely to ensure analyses of these data yield worthy results.

- Police officers should receive coding manual refresher courses as often as required to maintain a comprehensive understanding of accident report variable definitions. These persons should be informed on a regular basis of common coding errors being identified by others.

- An extensive auto-check system should be put in place to provide quality control on accident data as they are entered into provincial computer files.

- Use should be made of the Transport Canada sponsored "Passenger Car Study" data to monitor the accuracy of accident report coding for a selected class of accidents.

3. Heavy Truck Characteristics

- Heavy trucks are very unforgiving. Given, they are too important to Provincial economies to reduce their mass or length, their front end could be made more friendly. Side and rear guards could be placed on the trailer to prevent underride situations.

- Front brakes should be installed on all tractor units.

- Promotion for the use of anti-lock braking systems on heavy truck units should be undertaken. A general improvement in braking characteristics for both loaded and unloaded trucks is needed, especially for unloaded tractors which appear to be a special hazard.

4. Data for Regulation, Enforcement, and Safety

The data continue to show that driver action can be considered as the major contributing factor to safe operation of highway transportation. Some level of driver error has to be acceptable but situations with serious potential consequence should be minimized. The data also show that high levels of detail are required to monitor the effects of normal operations, countermeasures, design and operational changes, etc.

Reliable local and national Canadian data with sufficient coverage of details to improve the levels of transport efficiency and safety requires more effort and better coordination than now prevails. As stated previously, the Level 1 data system should be supported with more rigorous quality control. It should be supported by a general Level 2 system and there should be some Level 3 activity to provide special details as required. These data should be linked to other information sources including medical, court, insurance, and other records so that a more cost effective data system can be developed.

In particular, the results of the recent changes in heavy vehicle regulations should be monitored by providing a Level 2 or 3 study of this class of vehicles. This could be obtained by modifications to the current passenger car Level 2 study, that is by making it a general Level 2 study with special sampling rates for accidents involving heavy vehicles. The economies of scale for this move would be significant.

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