HEAVY TRUCK SAFETY IN THE PRAIRIE REGION: APPLYING EXPOSURE-BASED ANALYSIS AND THE SYSTEM SAFETY REVIEW CONCEPT

By

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A Thesis
Submitted to the Faculty of Graduate Studies
in Partial Fulfillment of the Requirements
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DOCTOR OF PHILOSOPHY

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ISOLDE JEANNETTE MONTUFAR

A Thesis/Practicum submitted to the Faculty of Graduate Studies of The University of

Manitoba in partial fulfillment of the requirement of the degree

of

DOCTOR OF PHILOSOPHY

I dedicate this thesis to:

God,
my daughter Victoria Alexandra,
my husband Luis Escobar,
and my parents Israel and Blanca

ABSTRACT

The thesis researches heavy truck safety in Canada's Prairie region during the 1990s. Its purpose is to reveal issues that should be considered by decision-makers in choosing among alternative courses of action to improve heavy truck safety. Improving heavy truck safety is a principal focus of transportation agencies throughout North America. Canada's Road Safety Vision 2010 envisions decreases in the number of fatalities and serious injuries occurring in commercial vehicle accidents over the next decade, implying large decreases in accident rates. This or any improvement cannot be made when there is limited knowledge about the safety of heavy truck operations, and little is known about the effectiveness of many safety initiatives.

The thesis provides a systems analysis of heavy truck safety and methods used to improve heavy truck safety in the Prairie region between 1993 and 1998. It develops new insights into the region's weight and dimension regulations and their effects on truck operations. It creates a detailed understanding of the entire population of 14,838 heavy truck accidents reported in the region during the study period, as well as the population of commercial vehicle on-road inspections conducted in Saskatchewan and Manitoba between 1995 and 1997. The research applies exposure-based analysis to consider differences in truck accident rates between jurisdictions, volumes of truck traffic, road types, load limits, seasons, times of day, and truck configurations. Gathering and synthesizing expert knowledge from industry officials, regulators, and the engineering community provides critical input to the research. Finally, the thesis formulates and applies the heavy truck system safety review concept, a formal procedure to serve as a practical tool in heavy truck safety investigations.

The thesis reveals a significant increase in heavy truck accidents, including fatal and injury accidents, over the research period, throughout the region on both provincial highways and urban streets. The frequency, severity and exposure-based rate of heavy truck accidents in urban areas offer a new, large target for future initiatives to improve heavy truck safety. The region experiences strong geographical concentrations of heavy truck accidents, particularly at intersections. On Manitoba provincial highways, the winter period experiences significantly higher numbers and accident rates than summertime trucking. Adverse road surface conditions account for nearly one-half of all heavy truck accidents. Also, nighttime trucking experiences significantly higher rates than daytime trucking. Single trailer combinations have higher accident rates than double trailer combinations. When all heavy truck accidents are considered, the heavy truck accident rate is lower on divided highways than on undivided highways. However, when intersection heavy truck accidents are excluded, the rate is about the same for divided and undivided highways. Existing heavy truck safety programs do not address these imbalances.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY OF TERMS

AADT	Annual Average Daily Traffic
AADTT	Annual Average Daily Truck Traffic
AASHTO	American Association of State Highway and Transportation Officials
AVC	Automatic Vehicle Classifier
BFB	Bridge Formula B
BWR	Basic Weight Regulation
CFS	Commodity Flow Survey
CCMTA	Canadian Council of Motor Transport Administrators
CVSA	Commercial Vehicle Safety Alliance
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
GIS	Geographic Information Systems
GPS	Global Positioning Systems
GVW	Gross Vehicle Weight
HTA	Heavy Truck Accident
ISTEA	Intermodal Surface Transportation Efficiency Act
ITS	Intelligent Transportation Systems
LCV	Longer Combination Vehicle
MCSAP	Motor Carrier Safety Assistance Program
MHTIS	Manitoba Highway Traffic Information System
MoU	Memorandum of Understanding
MVTA	Motor Vehicle Transport Act
NHTSA	National Highway Traffic Safety Administration
NSC	National Safety Code
NTA	National Transportation Act
OOS	Out-of-Service
PR	Provincial Road
PTH	Provincial Trunk Highway
RTAC	Roads and Transportation Association of Canada
SGI	Saskatchewan Government Insurance
STAA	Surface Transportation Assistance Act
SWR	Spring Weight Restriction
TAC	Transportation Association of Canada
TKT	Truck-kilometers Traveled
TS&W	Truck Size and Weight
UMTIG	University of Manitoba Transport Information Group
VKT	Vehicle-kilometers Traveled
WIM	Weigh-in-Motion
WWP	Winter Weight Premium

CHAPTER 1

INTRODUCTION

1.1 THE RESEARCH

The thesis is a systems analysis of heavy truck safety and methods used to improve heavy truck safety in the Prairie region between 1993 and 1998. The analysis reveals issues that should be considered in defining, evaluating, and choosing among alternative courses of action to improve heavy truck safety in the region.

The thesis applies traffic-based exposure analysis to investigate heavy truck accident rates in the region. Factors considered are jurisdiction, truck volume, road type, load limit, season, time of day, and configuration category. It formulates and demonstrates an application of the heavy truck system safety review concept. This is a formal procedure designed to serve as a practical tool for helping to understand heavy truck safety in a given situation, and evaluating potential initiatives intended to improve heavy truck safety.

1.2 BACKGROUND AND NEED FOR THE RESEARCH

The safety performance of heavy trucks has become a focus of most transportation agencies in North America. Coupled with the effective demise of economic regulation of trucking in the 1980s, initiatives have been developed and implemented to improve heavy truck safety in Canada and the rest of North America (Nix, 2001a; Montufar, 1999). These efforts are intensifying as safety becomes the primary concern of those transportation agencies.

In Canada, the efforts to improve road safety are addressed by continuing expansion of National Safety Code (NSC) programs, and the comprehensive initiative "Road Safety Vision 2010" undertaken by the Ministers responsible for transportation and highway safety. This initiative identifies a target of a 20 percent reduction in fatalities or serious injuries in accidents involving commercial vehicles by the year 2010, compared to the period 1996-2001(CCMTA, 2000). This new initiative also identifies the need for "broad-based benchmark data of key road safety indicators, against which intervention efforts can be measured" (CCMTA, 2000). Applying this initiative to heavy truck safety on provincial highways in the Prairie region, assuming this outcome is directly linked to the frequency of heavy truck accidents (HTAs), the target means that:

- The number of heavy truck accidents on provincial highways will have to decrease by 20 percent, or about 250 HTAs per year by 2010.
- The HTA rate per million truck-kilometers traveled (TKT) on provincial highways will have to decrease by about 50 percent assuming continuing growth in truck traffic of four percent per year over the next 10 years, and the 20 percent reduction in HTAs in the region (as intended by this initiative).

In the U.S., truck safety concerns are illustrated by the goal of the U.S. Federal Motor Carrier Safety Administration (FMCSA) to reduce truck-related fatalities on U.S. highways by 50 percent by 2010, and truck-related injuries by 20 percent by 2008 (FMCSA, 2001; Transport Topics, 1999), compared to 1998.

During the period considered in this research, two methods were specifically applied in the Prairie region (and the rest of Canada) intended to improve the safety of heavy truck operations: (1) regulating truck size and weight limits to improve the safety-related performance of individual truck types and the heavy truck fleet; and (2) conducting on-road vehicle inspections of heavy trucks (National Safety Code Standard No. 12). Also during this period, the safety of heavy truck operations has been affected by the operating environment comprised of highways, traffic signs, traffic signals, and other highway engineering elements. This becomes, in essence, a third method, where highway engineering (road design, road maintenance, and traffic control) plays a role in heavy truck safety. Each of these methods are the principal responsibilities of provincial and municipal highway and transportation agencies, who build and maintain roads, and regulate their use.

There are three fundamental problems with the safety programs that have been adopted in the Prairies. The first is that not much is known about the safety of heavy truck operations in the Prairie region. This has also been stated by Nix (2001a) (although not specifically referring to the Prairie region but to Canada in general). Without this knowledge it is difficult to appreciate how or when (even if) one or another of the programs might impact the safety of heavy truck operations. The second problem is that little is known about the actual impact of some of those programs on safety. Hauer (1987) indicates that "(the) difference between public relations and management is knowledge. The question is why so little is known about the safety effect of so many costly programs?". Similarly, commenting on the NSC, Nix (1999) states that "a decade ago, federal, provincial and territorial governments agreed to new commercial vehicle safety standards–the NSC. As yet, there has been no real attempt to measure the impact". The third problem is that much of the highway mileage in the Prairie region involves low truck traffic volumes and covers large areas of sparsely populated land. Yet, many truck safety programs are designed for high-volume highways in densely-populated areas (Montufar et al., 1998a).

There is need to obtain better knowledge and understanding about heavy truck safety in the Prairie region, and the methods used or available to influence heavy truck safety. This will allow decision-makers to better allocate the resources available to improve the safety of heavy truck operations in the Prairies, and intelligently pursue the safety targets identified.

1.3 RESEARCH OBJECTIVES AND SCOPE

The specific objectives of the research are:

1. To understand the three methods used for improving heavy truck safety in the Prairie region in the 1990s, their origins, their intentions, their application, and their limitations. This requires an extensive literature review and intelligence gathering based on personal interviews with industry officials, truck drivers, truck regulators, compliance officers, and highway engineers and planners.

2. To understand the road network upon which the heavy truck accidents considered in the research occurred, the basic and seasonal weight regulations governing trucking on this network, and to deduce key implications for heavy truck operations and potential safety considerations. This objective utilizes geographical information system platforms of regional road networks.

3. To obtain comprehensive knowledge and understanding of heavy truck safety in the region through the following:

   - Analysis, including geo-coding, of the heavy truck accidents that were reported to have occurred on provincial highways in Manitoba, Saskatchewan, and Alberta, and on urban truck routes in Winnipeg, Regina, Saskatoon, Calgary, and Edmonton during the period 1993 to 1998.

- Analysis of Commercial Vehicle Safety Alliance (CVSA) inspections in Manitoba and Saskatchewan for the period 1995 to 1997.
- Analysis of heavy truck accident rates based on exposure as measured by truck traffic, considering differences between jurisdictions, truck volume, road type, load limits, seasons, time of day, and truck configuration.
- Obtaining and applying industrial intelligence to help interpret and understand the findings of these analyses.

4. To reveal issues that should be considered in defining, evaluating and choosing among alternative courses of action to improve heavy truck safety in the region.

5. To develop and apply a methodology for conducting system safety reviews of heavy truck operations, building on experiences gained in this and other trucking research, and the principles formalized in the road safety audit concept. The methodology is aimed at providing a practical tool for understanding heavy truck safety in various situations, and evaluating and reaching decisions about actions directed at improving heavy truck safety.

The scope of this research is constrained as follows:

1. It relies on a mixture of raw, semi-processed and fully processed databases about HTAs, truck traffic, and CVSA inspections. Discussions with data providers are necessary to clarify issues/problems in the databases, to understand the databases, and to normalize differences between them.

2. Heavy truck accident data is for the period between 1993 and 1998. CVSA inspection data is for the period between 1995 and 1997. Truck traffic flow data is for the period between 1995 and 2000.

3. Two types of exposure data are available for the research. The first involves the creation and analysis of new truck traffic data providing spatial, temporal and configuration details on Manitoba provincial highways. The second involves exposure data obtained from readily-available sources.

4. The research does not deal with economic considerations or social implications of heavy truck safety.

1.4 RESEARCH APPROACH

The research approach is designed with the specific purpose of fully understanding and analyzing heavy truck safety in the Prairie region. Industry and engineering insights and opinions, practical experience, and participation in relevant professional workshops, symposia and conferences are fundamental aspects of this approach. The research involves:

1. Creation and systematic analysis of three primary data sources: (1) raw heavy truck accident data; (2) raw, semi-processed and fully processed truck volume and classification data; and (3) semi-processed CVSA inspection data. This requires discussions with many officials throughout the region.

2. Field inspections of road conditions and truck traffic on most of the region's primary highways, and many of its major urban truck routes.

3. Designing, conducting and synthesizing personal surveys of major regional trucking firms, shippers and intermodal (rail) operators (33 in total), directed at discovering industry intelligence concerning trucking and truck safety in the region.

4. Designing, conducting and synthesizing personal surveys of truck regulators and transportation engineers throughout the region, to develop the first comprehensive understanding of seasonal weight regulations governing regional trucking.

5. Participation in on-road truck inspections at the Emerson weigh scale in Manitoba.

6. Designing and conducting a system safety review application involving the 90-km Perimeter highway around Winnipeg. This was done with input by a commissioned expert truck driver of long experience in Prairie region trucking.

7. Organizing and conducting personal interviews of road design and highway safety engineers, and organizing/chairing workshops/symposia directed at discovering the sensitivity of highway engineering endeavors to heavy truck safety.

8. Conducting research assignments concerning the application of intelligent transportation systems to commercial vehicle operations (at the Texas Transportation Institute) and exposure-based analysis needs and methods (at the University of Michigan Transportation Research Institute).

9. Site visits of heavy truck accident locations.

1.5 THESIS ORGANIZATION

This thesis is comprised of eight chapters. Chapter 2 discusses regulatory methods used to improve the safety of heavy truck operations in the Prairie region. The chapter begins by providing a historical review of truck regulation in Canada, including a discussion on government involvement in the economic and safety regulation of trucking, and the shift of emphasis from economic regulation to safety regulation. Two of the methods of specific interest to this research are then discussed: (1) basic truck size and weight regulations; and (2) on-road vehicle inspections.

Chapter 3 defines the regional road network upon which the heavy truck accidents considered in the research occurred. It analyzes the basic and seasonal weight regulations governing truck operations on these roads. Based on an extensive field survey, carrier intelligence about these roads and their safety-oriented regulation are presented. Implications for regional trucking and related safety considerations are then deduced and summarized.

Chapter 4 presents the results of a comprehensive analysis of heavy truck accidents in the Prairies. The chapter begins by providing information about the accident databases used in the analysis. It then provides separate analyses for accidents reported to have occurred on provincial highways, and accidents reported to have occurred in urban areas.

Chapter 5 presents the development and analysis of CVSA inspections conducted in Manitoba and Saskatchewan in the period between 1995 to 1997.

Chapter 6 develops and analyzes relationships between heavy truck accidents occurring on provincial highways in the region and exposure as measured by estimates of truck traffic and truck traffic characteristics. The chapter presents an analysis of heavy truck accident rates based on exposure as measured by truck traffic, considering differences between jurisdictions, truck volume, road type, load limits, seasons, time of day, and truck configuration.

Chapter 7 discusses the development of the system safety review concept for heavy truck operations, and illustrates its application. The chapter begins with a discussion of the need for system safety reviews for heavy truck operations, followed by the development of the procedure to use when conducting these reviews. The chapter concludes with an example of how this concept can be applied to improve heavy truck safety.

Chapter 8 provides conclusions.

1.6 TERMINOLOGY USED IN THE THESIS

For the purposes of this research the following definitions are used:

Heavy Truck (HT): Defined as any articulated combination using a truck-tractor for propulsion. Such combinations include two and three-axle tractors with a single, tandem or tridem-axle semitrailer; a double-trailer combination; or a triple-trailer combination. This also includes truck-tractors with no units attached (bobtails).

Heavy Truck Safety: Defined as: (1) heavy truck accidents reported to have occurred on provincial highways and in the region's five major urban centers during the study period; and (2) heavy truck accident rates based on estimates of truck traffic exposure. This definition of safety is consistent with that discussed in Hauer (1997). The phrase "heavy truck safety" is used interchangeably with "the safety of heavy truck operations".

Accident: This is an accident identified in a traffic accident report completed by the police and recorded in the accident database of the corresponding jurisdiction. The databases are maintained by Manitoba Transportation and Government Services for provincial highway accidents in Manitoba; Saskatchewan Government Insurance (SGI) for provincial highway accidents in Saskatchewan and for accidents in Regina and Saskatoon; Alberta Transportation for provincial highway accidents in Alberta and for accidents in Edmonton and Calgary; and City of Winnipeg Public Works Department for accidents on Winnipeg streets. Accidents are recorded if they involve a fatality, injury, or property damage generally specified by each jurisdiction at $ 1,000 or more (this reporting level is the same for all jurisdictions and remained constant over the research period). However, some of the accidents included in the Winnipeg database involve property damage of less than $1,000. In this research, an accident is taken to be the same as a collision or a crash.

Heavy Truck Accident (HTA): This is any accident which has occurred on the road sections under consideration and, which—as best as could be determined from the accident report—involved a heavy truck (HT). Because some HTAs involve two or more HTs, some of the results distinguish between the number of HTAs and the number of HTs involved in HTAs. For example, in 1998 there were 213 HTAs on Manitoba provincial highways involving 226 heavy trucks. The specific definition according to the police report form for each province is discussed in Section B.1 in Appendix B.

Provincial Highways: These are highways under the authority of the Province as of December 1998, which is the last year for which heavy truck accident data was obtained for this analysis. In Manitoba, provincial highways include all Provincial Trunk Highways (PTHs) and Provincial Roads (PRs). In Saskatchewan, they are all primary and secondary highways, and in Alberta, provincial highways are all primary highways. In the case of Alberta, the secondary highway network returned to being under the authority of Alberta Transportation on April 1, 2000 . This network had been under the control of local authorities (Cities, Counties, and Municipal Districts) during the research period.

Prairie Region: Is the region that encompasses the provinces of Manitoba, Saskatchewan, and Alberta.

Truck Configurations: Figure G-1 in Appendix G shows the common truck configurations discussed in this thesis.

Traffic-based Exposure: This refers to using truck traffic volume as the measure of exposure to calculate accident rates.

CHAPTER 2

REGULATORY METHODS USED TO IMPROVE HEAVY TRUCK SAFETY IN THE PRAIRIE REGION

This chapter provides a historical review of truck regulation in Canada. It also discusses the three methods used in the Prairie region to improve heavy truck safety: (1) truck size and weight regulations; (2) on-road vehicle inspections; and (3) road-related initiatives for safe trucking.

2.1 HISTORICAL REVIEW OF TRUCK REGULATION IN CANADA

In discussing truck policy and regulation, there is a need to distinguish between policy and regulation at the federal level and at the provincial level. This discussion focuses on policy issues that took place at the federal level over the last 50 years and hence affected international and interprovincial trucking throughout Canada.

2.1.1 Transportation Policy and Trucking

In the past, Canadian transportation policy was largely concerned with railway problems. At the federal level, railway issues were nearly always the driving force for new transportation policies (Darling, 1972). It was in the midst of these problems that trucking began to grow and became an industry. The expansion of trucking and its increasing competition with the railways on certain links, resulted in the introduction of economic regulation (Darling, 1972), which lasted for about 50 years.

In the economically-regulated environment of truck operations in Canada, there were five key transportation policy elements that affected trucking (Montufar, 1999):

- *The Motor Vehicle Transport Act of 1954*, which delegated to the provinces the authority to regulate extra-provincial or out-of-province trucking operations.
- *The McPherson Royal Commission*—appointed in 1959, which recognized that competition was critical in transportation and recommended: (1) complete freedom of rate-making for railways; (2) abolition of concepts of unjust discrimination and undue preference; (3) unification of transport regulation in a single board; and (4) a series of measures for compensating the railways for burdens created by demands of public policy (Darling, 1972).
- *The National Transportation Act (NTA) of 1967*, which came as a result of the recommendations provided by the McPherson Royal Commission. The NTA established the Canadian Transport Commission as the single body to regulate all modes under federal jurisdiction. In addition, the NTA recognized trucking as a legitimate mode of transport, which had to be seen as a competitive element in the system (Nix, 1986; Haritos and Elliot, 1983).
- *The U.S. Motor Carrier Act of 1980*, which was a major turning point for trucking in North America. The initiation of economic deregulation in the U.S. introduced by this Act had a significant effect on Canadian policy. The potential for competition with U.S. carriers emerged, and with it, concerns regarding truck safety in the two countries (Boisjoly and Corsi 1982). The Act was the first step towards economic deregulation of the Canadian trucking industry.
- *The Motor Vehicle Transport Act of 1987*, which introduced deregulation of the Canadian trucking industry. This came as a result of the U.S. Motor Carrier Act of 1980, and after the release of the discussion paper by the Minister of Transport entitled "Freedom to Move." This paper stated the government's principles for the economic regulatory reform of transportation: (1) the safety of the transportation system is the first priority; (2) the transportation system is there to serve the shippers and travelers; (3) competition is an important part of transportation; and (4) the regulatory process needs to be open, accessible, and not time-consuming. The document recommended the introduction of "reverse onus"—shifting the burden of proof from the applicant to the respondent in license applications, and moved towards a "fit, willing and able" requirement (Transport Canada, 1992).

Even though the list of policy developments that affected trucking is longer than that presented above, those are the five key elements that shaped the Canadian trucking industry. There were many parallel issues that also had a great impact on trucking operations. Principal examples are: (1) growth of the industry; (2) truck size and weight regulations; (3) technological developments; (4) road construction; and (5) the economy itself (Montufar, 1999). In addition, the most recent event that has begun to have an impact on trucking, and is expected to have a greater impact in the future, is the September 11th attack of the World Trade Center in New York. After this event, more security measures are expected to take place with the trucking industry both in the U.S. and Canada.

2.1.2 Government Involvement in the Economic and Safety Regulation of Trucking

Economic regulation of the trucking industry in Canada was primarily introduced by the provinces. Provincial governments introduced licensing systems to regulate for-hire trucking operations in the late 1920s and early 1930s (MTA, 1997; Nix and Clayton 1980).

In the "Winner Case" of 1954, extra-provincial regulation was challenged, revised, and turned over to the federal government, which in turn chose to delegate to the provinces the authority to regulate extra-provincial trucking operations with the introduction of the Motor Vehicle Transport Act (MVTA) of 1954 (Nix and Clayton, 1980).

Regarding safety regulation, most of the activity was of a general nature applied to all vehicles and motorists and took place at the federal level. The provinces (and states) had their own Safety Acts and safety programs since the early days of trucking. However, the majority of laws and regulations came from the federal government. The U.S. led the way with the introduction of the Federal Motor Carrier Safety Regulations in 1935, and several other Acts in the 1960s, 1970s, and 1980s. As a result of the U.S. Highway Safety Act of 1970, Canada introduced its first safety-related federal Act—the Canada Motor Vehicle Safety Act of 1971 (Transport Canada, 1999). This Act was introduced to allow the Road Safety Directorate of Transport Canada to establish national safety standards for the design and construction of motor vehicles.

The 1950s were a decade of road construction and development, and not much attention was paid to safety (Montufar, 1999). However, in the 1960s and 1970s, road design standards, as well as vehicle standards improved with the idea of designing and building "safer roads and vehicles" (Ogden, 1996). This prompted governments to introduce legislation that would address these issues. As a result came the U.S. Highway Safety Act of 1970 (which introduced the National Highway Transportation Safety Administration—NHTSA), and the Canada Motor Vehicle Safety Act of 1971 (which introduced motor vehicle safety standards).

The largest federal government involvement in safety regulation probably took place in the 1980s and 1990s, as a follow up to deregulation of the trucking industry in the United States. The idea that with deregulation, safety was going to decrease and the public would be placed at greater risk, obliged federal and provincial (and state) governments to introduce a myriad of safety programs, some of which have yet to be evaluated. However, as indicated by Hauer (1987) "regulation can force a trucking company to spend more money on safety-related inspections or to control the working hours of its drivers. However, the number of accidents in which its truck fleet is involved will still be heavily influenced by the grade of the roads, by the snow-clearing practices of the state, by what stability designers and manufacturers have built into trucks or by the norms of behaviour of all drivers. Over these, the trucking company has little control".

Almost immediately following the beginning of economic deregulation in the U.S., a complex set of economic, operational and regulatory forces culminated in the passage of the Surface Transportation Assistance Act (STAA) in 1982. In addition to changing federal size, weight and configuration regulations, this Act initiated the Motor Carrier Safety Assistance Program (MCSAP) (MCSAP, 1999). The objective of MCSAP is to reduce the number and severity of accidents and hazardous material incidents involving commercial motor vehicles. Its aim is to substantially increase the level and effectiveness of enforcement activity and the likelihood that safety defects, driver deficiencies, and unsafe carrier practices will be detected and corrected. The concept of this program expanded to Canada in the form of commercial vehicle roadside inspections under the umbrella of the National Safety Code. But as indicated by Nix (2001a), "Canadian jurisdictions have spent more than a decade implementing the National Safety Code. They still have some way to go to finish the process". The provinces have implemented most of the standards, but they have failed to apply each standard uniformly and consistently, province to province.

2.1.3 The Shift of Emphasis from Economic Regulation to Safety Regulation

Based on the literature and interviews with government officials and safety experts, there has been a clear shift of emphasis from economic regulation to safety regulation of trucking in the past two decades. As time progressed and the trucking industry was economically deregulated, governments saw a need to regulate the industry with something that could replace economic regulation. Safety regulation had always been there, and was seen as an attractive way of portraying a good image. With the introduction of new safety legislation, and a myriad of programs to address truck safety, governments are still able to "control" operations of carriers based on their fitness and safety rating.

Over the last two decades, there have been many truck safety-related programs introduced—mainly as a result of the concerns raised with economic deregulation. While the intention is good, there is still a need to objectively evaluate those programs. As indicated by Nix (2001a), ". . . Little effort, particularly in Canada, is put into trying to understand the effectiveness of these regulations". Are these programs legitimately being introduced to improve road safety or just as an excuse to keep control of the industry—or to portray a good image?

There is also the issue of CVSA inspections under the NSC. Research indicates that the role of vehicle defects in truck accidents in provinces like Manitoba and Saskatchewan is not extensive (Montufar and Clayton, 1998). As revealed from the accident analysis discussed in Chapter 4, there is little evidence in Manitoba that vehicle defects play an important role in truck accidents. This is consistent with research by Massie and Campbell (1996) using national truck accident databases from the U.S. It is also consistent with research by Bell et al. (1996) for some vehicle defects (e.g., frames, windshield wipers, coupling devices, suspension). Given this, is the current level of emphasis on vehicle defect identification and correction encompassed in the NSC and its enforcement a cost-effective enhancement of truck safety in places like Manitoba and Saskatchewan? Baldwin (1977) stated, that "safety is a changing concept and standards move higher to meet social expectations but with no exact measurement of national demand. Many times, the reaction to an accident is the establishment of a new rule or technical requirement, until requirements become so complex that the rules become self-defeating because of the limitations of human understanding and enforcement". This very notion reflects what many believe happened in economic regulation—the creation of a system so complex that it was beyond understanding, reason, and enforcement. Could this also be happening with truck safety regulation in Canada?

2.2 BASIC TRUCK SIZE AND WEIGHT REGULATIONS

Basic truck size and weight (TS&W) regulations refer to regulations which apply in a manner where trucks can operate without obtaining special overweight and/or over-dimension permits, and seasonal exemptions. Truck size and weight regulations greatly influence the types of trucks that move on a highway, their characteristics, their performance, and the impact of those vehicles on the infrastructure, the economy, the environment, and safety (Clarke, 1998).

Because of these regulations, there are situations in which there are more trucks than necessary handling the available freight; in other situations, there are trucks handling freight where logic would say that rail would be much more efficient, and could relieve truck traffic from the highways; and in other situations, the industry is obliged to utilize vehicles which unnecessarily raise the center of mass of the unit, or limit the vehicle's stability because of restrictive width limitations. The critical point is that TS&W regulations have the potential of impacting the safety of heavy truck operations. This effect might over-ride the impacts of other truck safety initiatives which may be considered to be more important.

2.2.1 The RTAC MoU on Vehicle Weights and Dimensions

In 1988, the Council of Ministers Responsible for Transportation and Highway Safety signed a Memorandum of Understanding (MoU) on truck weights and dimensions. With the development of the Roads and Transportation Association of Canada (RTAC) MoU, the provinces of Canada explicitly incorporated provisions into their TS&W regulations specifically aimed at enhancing truck safety (Pearson, 1996). This was done by encouraging the design and use of inherently more stable vehicles. This was the first time that performance-based characteristics of trucks were explicitly considered in Canada for basic TS&W regulation. The RTAC study analyzed approximately 20 performance measures that take place under 7 different operating conditions: (1) acceleration from a stop condition; (2) driving on a straight level road; (3) driving on a grade; (4) low-speed turn; (5) high-speed turn; (6) braking; and (7) high-speed obstacle avoidance (Billing, 1991).

2.2.2 Performance Measures

The main performance measures analyzed in the RTAC study are (Billing, 1991; TAC,1986):

Rollover Threshold: This measure refers to the magnitude of lateral acceleration required to produce vehicle rollover. Lateral acceleration on a curve is affected by speed, and the speed required to produce rollover increases as curve radius increases (TAC, 1986 and Woodrooffe et al., 1998). The most important factor affecting the roll stability of heavy trucks is the height of the center of mass (Pearson, 1996). Roll stability improves with increased trailer wheelbase and width, and fewer connection points. Static rollover refers to steady turning, for example a truck traveling on a curve. Dynamic rollover refers to dynamic steering maneuvers such as avoiding an obstacle on the highway.

Friction Demand: This refers to the resistance of multiple, non-steering axles to traveling around a tight-radius turn, such as at an intersection. Friction demand is a measure of the lateral shear force between the tires and the road resulting from the vehicle negotiating a curve (TAC, 1986).

Braking Efficiency: This is defined as the percentage of available tire/road friction limit that can be utilized in achieving an emergency stop without incurring wheel lockup (TAC, 1986). This measure was intended to characterize the quality of the vehicle's braking system as the primary mechanism to avoid accidents.

Offtracking: Three types of offtracking were evaluated in the RTAC study: low-speed, high-speed, and transient high-speed. Low-speed offtracking is defined as the measure of the swept path of the vehicle and its lateral road space requirement when turning at intersections or when turning into loading areas (Woodrooffe et al., 1997). It is "the extent of inboard offtracking observed in a 90-degree, 11-meter radius intersection turn" (TAC, 1986). In low-speed offtracking, the rearmost trailer follows a path that falls "inward" with the tractor. High-speed offtracking is defined as the "extent of outboard offtracking of the last axle of the truck combination in a moderate steady turn of 0.2 g's lateral acceleration" (TAC, 1986). Because there is the potential for a trailer to follow an "outward" path with the tractor, high-speed offtracking is said to pose a safety hazard (TAC, 1986). Similar to dynamic rollover stability, transient-speed offtracking is also related to obstacle-avoidance. It is defined as "the peak overshoot in the lateral position of the rearmost trailer axle, following the sever lane change-type maneuver" (TAC, 1986).

2.2.3 Productivity Issues Associated with the RTAC MoU

The most significant safety-related aspect of the 1988 RTAC MoU on vehicle weights and dimensions of relevance to the Prairie region was allowing 8-axle B-train and 8-axle C-train double trailer combinations to operate at significantly higher gross vehicle weights than previously allowed. By doing that, both units had large payload advantages relative to competing 7 and 8-axle A-train vehicles. These advantages were intended to encourage the trucking industry to replace less safe, less-productive vehicles with safer, more-productive vehicles. The productivity advantage was large—up to about 25 percent more tonnes for B-trains versus A-trains (on primary highways, and for new vehicles), and about half this amount on C-trains versus A-trains. In addition to this advantage, this development also allowed the first effective use of tridem-axle groups on semitrailers.

These RTAC regulations have had an important impact on the truck fleet and truck characteristics in the Prairie region of Canada and its low volume highways. In Manitoba, for example, along the Trans-Canada Highway as measured at the Headingley weigh scale, 8-axle B-trains increased from about zero percent of the fleet in 1988 to about 13 percent by 1998 (DS-Lea and UMTIG, 1999). Over the same period, 7/8-axle A-trains decreased from a high of about 16 percent to about two percent today, as detailed in Chapter 6. Similar effects have been observed throughout the Prairie region on major east-west routes. The same, albeit less intense, incentive applied to C-trains had little effect. These units were utilized in only limited circumstances (most significantly in Saskatchewan). Most Prairie region surveys fail to detect many C-trains.

The effect of this productivity incentive on fleet characteristics used on major north-south routes in the Prairie region was very different than that observed on east-west routes. For example, in the only substantial survey of cross-border trucking at the Emerson weigh scale on Manitoba Provincial Trunk Highway (PTH) 75, B-trains accounted for only about two percent of the loaded truck fleet in 1996 (Montufar, 1996). A similarly low adoption of B-trains on Saskatchewan-North Dakota movements is reported in other research (Montufar et al., 1998b).

The reason for the lack of use of B-trains on these two major north-south routes is that the TS&W laws of North Dakota prohibit their effective use (Montufar and Clayton, 1998b). Since according to Bridge Formula B, gross vehicle weight is a function of interaxle spacing and number of axles, it is more feasible to use A-train double trailer combinations than B-trains. On the contrary, B-trains operate frequently between Alberta and Montana, as far south as Shelby (Montufar et al., 1998b and Clayton and Blow, 1996). This is because of a special provision in the U.S. Intermodal Surface Transportation Efficiency Act (ISTEA) legislation which permitted the use of 8-axle B-trains on a short section of I-15 between the Alberta-Montana border and Shelby, Montana.

2.2.4 Dimensional Issues Associated with the RTAC MoU

Regulatory details concerning wheelbases and overhangs were also introduced in the RTAC MoU. Rear overhang was limited to reduce swingout of the rear of the trailer into the adjacent lane of traffic. The length of wheelbases of tractors and trailers was limited to allow for adequate turning movements (Pearson, 1996).

2.3 ON-ROAD VEHICLE INSPECTION PROGRAM

A second method used by highway agencies in the Prairie region to improve heavy truck safety is on-road vehicle inspections. These inspections are one of the elements of the National Safety Code. The Code, which was introduced in 1987 with the new Motor Vehicle Transport Act as a precautionary measure after deregulation of the trucking industry, was designed to establish a set of minimum performance standards for the safe operation of commercial vehicles. The 16 standards included in the NSC are: (1) single driver's license; (2) knowledge and performance tests; (3) driver examiner training; (4) classified driver's license program; (5) self-certification; (6) medical requirements; (7) carrier and driver profiles; (8) short-term suspensions; (9) hours of service; (10) security of loads; (11) commercial vehicle maintenance; (12) commercial vehicle on-road inspections; (13) daily trip inspection report; (14) carrier ratings; (15) facility audits; and (16) first aid training (Transport Canada, 1998 and CCMTA, 1998).

2.3.1 CVSA Inspections

CVSA inspections are one of the standards of the NSC. They consist of a uniform inspection process developed by the Commercial Vehicle Safety Alliance. CVSA is an association of Federal, State, Provincial, and industry representatives that promotes the maintenance and safe operation of commercial motor vehicles in a way that protects the safety of the general public (CVSA, 1996). There are five different levels of CVSA inspections (CVSA, 2001):

Level I: This is a complete inspection of the vehicle and driver, including an inspection of the items underneath the vehicle. This type of inspection may take anywhere from 30 to 45 minutes. A level I inspection includes examination of the driver's license, medical examiner's certificate, alcohol and drugs, driver's record of duty status relating to hours of service (through the log book), pre-trip vehicle inspection report, and the mechanical conditions of the vehicle.

Level II: This is a complete inspection of the vehicle and driver that does not include inspecting the items underneath the vehicle. This type of inspection may take anywhere from 10 to 20 minutes. Level II inspections are called partial inspections or "walk arounds". During a Level II inspection, officers must check driver's license, medical examiner's certificate, alcohol and drugs, driver's record of duty status, hours of service (log book), vehicle inspection report, and those mechanical components that can be inspected without needing to physically get under the vehicle.

Level III: This is the inspection of the driver only. The same driver-related elements as for level I and II inspections are considered.

Level IV: This is an inspection of specific item(s) on the vehicle or driver. This typically includes a one-time examination of a particular item.

Level V: This is an inspection of the vehicle at the motor carrier's terminal. It includes all the elements of a Type I inspection except the driver.

There are three possible outcomes from a CVSA inspection. The vehicle (or driver—depending on the inspection level) may pass the inspection, fail the inspection, or be placed out of service (OOS). When a vehicle fails an inspection, it can continue to operate but the mechanical defects found have to be fixed immediately. The enforcement agency discovering the deficiencies must be notified once the repairs have been completed, (up to a maximum of two weeks from date of inspection). When a vehicle is placed OOS, it can no longer operate and is either towed to a place where it can be fixed, or it is fixed at the location where the inspection was conducted (Manitoba and Saskatchewan interviews, 2000). Chapter 5 presents a detailed analysis of CVSA inspections in Manitoba and Saskatchewan, conducted as part of the research.

2.3.2 Out-of-Service Criteria

The basis for CVSA inspections are 14 critical mechanical items (one of which is for buses only) developed by CVSA using the North American out-of-service (OOS) criteria. An OOS defect is a mechanical condition or loading so imminently hazardous as to likely cause an accident or breakdown. The 13 truck-related items included in the OOS criteria, as well as what needs to be checked under each item are shown in Table 2-1 (CVSA, 2001):

Table 2-1: CVSA Out-of-Service Criteria

ITEM	DESCRIPTION
Brakes	Compressor, brake hose or tubing and fittings, reservoir, brake drums, brake lining or pads, brake chambers, push rods, slack adjustors, front axle brakes, pins, mounting brackets, emergency brake, low air pressure warning device, hydraulic brakes, vacuum brakes, electric brakes.
Coupling devices	Fifth wheels, lower coupler, upper coupler, pintle hooks, drawbar, safety devices, saddlemounts.
Exhaust System	Leaks, broken parts, unsecured mounting, corrosion, location.
Frames	Cracks, broken or loose bolts, sagging, holes into rail flange.
Lighting equipment	Headlamps, tail lamps, lamps on projecting loads, stop lamps, and turn signals.
Load securement	Safe loading and tiedowns, sideboards, stakes, end boards, tarp.
Steering Mechanism	Steering wheel, steering lash, steering column, front axle beam, steering gear box, pitman arm.
Suspension	U-bolts, spring hangers, radius or torque arms, leaf springs, coil springs, air bags, torsion bars, equalizer beam.
Tires	Bulges, leaks, sidewall separation, cuts, exposed fabric, repairs, tread, valve, spare tire, inflation pressure.
Van and open-top trailer bodies	Upper rail, lower rail, floor cross members, and side panels.
Wheels and rims	Elongated stud holes, cracks, additional welds, sprung rim, missing nuts or studs, adequate nut or stud size.
Windshield wipers	
Fuel system	Fuel tank, fuel lines, fill pipe, safety venting system, air vent.

Source: Commercial Vehicle Safety Alliance (2001)

2.3.3 Current Issues Regarding CVSA Inspections in Canada

There are two important observations regarding CVSA inspections and the OOS criteria:

1. Contrary to the case in the U.S., the OOS criteria are not law in Canada. This creates a problem for Canadian enforcement officials when certain types of OOS defects are found on trucks. Even though the vehicle cannot continue to operate, the company cannot be charged with a violation, since there is no law under which to charge the company—or the driver. This is something that Canada has been discussing at CVSA meetings continuously but no change occurs. The Canadian Trucking Alliance and the Ontario Trucking Association have indicated at CVSA meetings to "either make CVSA law, or remove it altogether. Do not have this gray area in which you are making us operate" (Vanderzwaag, 1998). When Canadian jurisdictions conduct CVSA inspections they follow the OOS criteria as closely as possible but charge companies based on their respective safety legislation, (Highway Traffic Acts, where applicable). This has resulted in a lack of consistency across the country because even though all provinces try to follow the OOS criteria, some apply the criteria differently, so as to align with their own rules and regulations.

2. Because the results from CVSA inspections are used to determine the rating of a carrier, there is much controversy within the motor carrier community about the lack of consistency in inspection practices across Canada. For example, a truck that passes an inspection in Manitoba may fail the inspection in Alberta, even though both jurisdictions use the same OOS criteria.

The problem of inconsistent application of the OOS criteria is particularly evident with inspections of brake systems. Different jurisdictions enforce or apply the OOS criteria regarding brakes differently. The OOS criteria states that a truck will be placed out of service if "the number of defective brakes is equal to or greater than 20 percent of brakes on the vehicle or combination . . . steering axle brakes are to be included in the 20 percent criterion". Usually two brakes are required for each axle in a vehicle. For example, a 5-axle tractor semitrailer combination would have a total of 10 brakes. If two of the brakes are defective (20 percent), the combination is placed out of service. Similarly, an 8-axle B-train would have a total of 16 brakes. If three of those brakes are defective, the combination is placed out of service.

Some jurisdictions apply the 20 percent criterion differently. For example, in Manitoba, Saskatchewan and Alberta, a vehicle is placed out of service if 20 percent of the brakes in the combination are defective. In Ontario, a vehicle is placed out of service if 20 percent of the brakes on any individual unit of a combination are defective. British Columbia also applies the CVSA 20 percent criterion differently. In British Columbia, a vehicle is placed out of service if 20 percent or more of the total number of brakes on the combination are defective. However, B.C.'s regulations indicate that "up to 50 percent or half of any one vehicle in a combination must be functioning even if the entire combination is within the 20 percent rule" (British Columbia, 1998). This 50 percent requirement does not seem to effectively apply in combination with the 20 percent criterion.

2.4 ROAD-RELATED INITIATIVES FOR SAFE TRUCKING

This section is based on information gathered from discussions with transportation safety officials from the three provinces, as well as from technical conferences on the subject. Road-related initiatives are those initiatives that address the civil engineering aspect of road safety. This includes road design, maintenance, traffic signs and traffic signals.

Most of the road safety initiatives that are currently in place in the Prairie provinces do not address heavy trucks, nor the civil engineering aspects of road safety. These initiatives are mainly designed to educate passenger vehicle drivers respecting things such as speeding, drinking and driving, seat belt use, and general driving behaviour (Kwan, Ell, and Montufar, 2000). However, there are some initiatives that deal either directly or indirectly with heavy trucks and highway operations. These are discussed in the following sections for each province.

2.4.1 Manitoba

The road-related initiatives which may affect heavy truck operations in Manitoba are:

Road safety audits: Effective as of August 2000, the City of Winnipeg is conducting road safety audits on all major public works projects (Rosin and Escobar, 2000). This may eventually have an impact on urban heavy truck operations, especially in areas with restrictive geometry.

The provincial government, however, is not intending to formally implement road safety audits in the province. Manitoba Highways is in the process of developing road safety audit guidelines (when to conduct audits and the methodologies to use) for informal use in house (Christiansen, 2000).

Black spot analysis: The Province of Manitoba recently implemented a program of black spot analysis to improve safety at certain intersections throughout the province. This initiative involves 1,500 intersections. One particular location that attracted much attention is the intersection of PTH 16 and Highway 1. In the last two years there have been 4 fatal accidents at this location, involving commercial vehicles (Rogers and Larsen).

At-grade crossings: One of the initiatives undertaken by Manitoba Highways is the inspection of 30 at-grade railway crossings with passive controls . The purpose of this is to analyze sight lines and other relevant safety elements and determine what could be done to improve safety at these locations. The analysis of the information is currently underway (Rogers and Larsen, 2000).

Delineation at isolated rural intersections: This is a new program undertaken by the Traffic Engineering Branch of Manitoba Highways. Under this program isolated rural intersections will be illuminated to improve delineation. The program, which is expected to take some years, will start with intersections of Primary with Primary highways, and will follow with intersections of Primary with Secondary highways (Rogers and Larsen, 2000).

Improved signs on divided highways: Manitoba is currently installing over-sized "wrong way" signs on all divided highways at intersections with undivided highways. There have been cases in which left turning vehicles from the undivided highway enter the opposing lane of the divided highway, resulting in head-on collisions. At least two fatal heavy truck accidents of this type occurred over the last 2 years in the province (Rogers and Larsen, 2000).

2.4.2 Saskatchewan

Saskatchewan developed and implemented the Safety Improvement Program (SIP). This is a comprehensive road improvement program which provides a system to identify, evaluate and rank road locations that seem hazardous from a collision perspective. This program is intended to identify and recommend the most cost-effective measures to reduce the number and severity of collisions at these locations (Hunt, 2001). The program is directed at all roads and traffic on Saskatchewan highways.

The potential locations to investigate are reviewed each fall based on either stakeholder complaints, fatal accident analysis, road safety reviews, or new or revised policy/standards. The order of priority is determined based on warrants, traffic volumes, or benefit-cost analysis. The types of projects that Saskatchewan highways has worked on over the years involve illumination concerns, intersections, traffic control, the roadway, and railway crossings. These projects are then evaluated by means of an audit (Hunt, 2001).

2.4.3 Alberta

Alberta has an on-going highway improvement program in which roads being rehabilitated for non-safety specific reasons are also considered for potential safety improvements at the planning and design stages. In addition, the province conducts, on an as-required basis, black spot analyses to improve operations and safety at intersections, curves and bridges throughout the province. Alberta Transportation has also started to use safety audits on major projects as performed by independent consultants, to detect any safety deficiencies through the design stage as well as prior to opening up the new road sections (Lo, 2001).

Pertaining to trucks, the province has done extensive work on the implementation of truck escape ramps, passing lanes, climbing lanes, and other operational aspects of long combination and log trucks (e.g., turning radius). The work on the latter aspect has led to the development of different turning templates for intersection and interchange designs.

Alberta Transportation is currently developing best-practice guidelines for locating and designing new roadside rest areas throughout the province. Other important road safety developments include an internal review of the department's policy on the use of guardrails, and research into wildlife-vehicle countermeasures.

Alberta is also including Intelligent Transportation Systems (ITS) in its current planning. The province currently has some Road Weather Information System (RWIS) stations along the Deerfoot Trail in Calgary, and changeable message signs on Highway 2 (Lo, 2001).

CHAPTER 3

THE ROAD NETWORK AND TRUCK WEIGHT REGULATIONS

This chapter defines the regional road network upon which the heavy truck accidents considered in the research occurred. It analyzes the basic and seasonal weight regulations governing truck operations on these roads. Based on an extensive field survey, carrier intelligence about trucking on these roads is presented. Implications for regional trucking and related safety considerations are then deduced and summarized.

The road network is considered in three parts: (1) provincial highways within the Prairie region (in Alberta, Saskatchewan and Manitoba); (2) major roads in major urban centers (Winnipeg, Saskatoon, Regina, Calgary and Edmonton); and (3) major connecting routes in the northern tier states (Minnesota, North Dakota, and Montana).

3.1 PROVINCIAL HIGHWAYS

In 1998, there were 54,452 kilometers of provincial highways in the Prairie region. The provincial highway network considered in this research is shown in Figure 3-1. Details concerning the number of kilometers in each province, in terms of road category (divided versus undivided), by basic load class, are provided in Chapter 4.

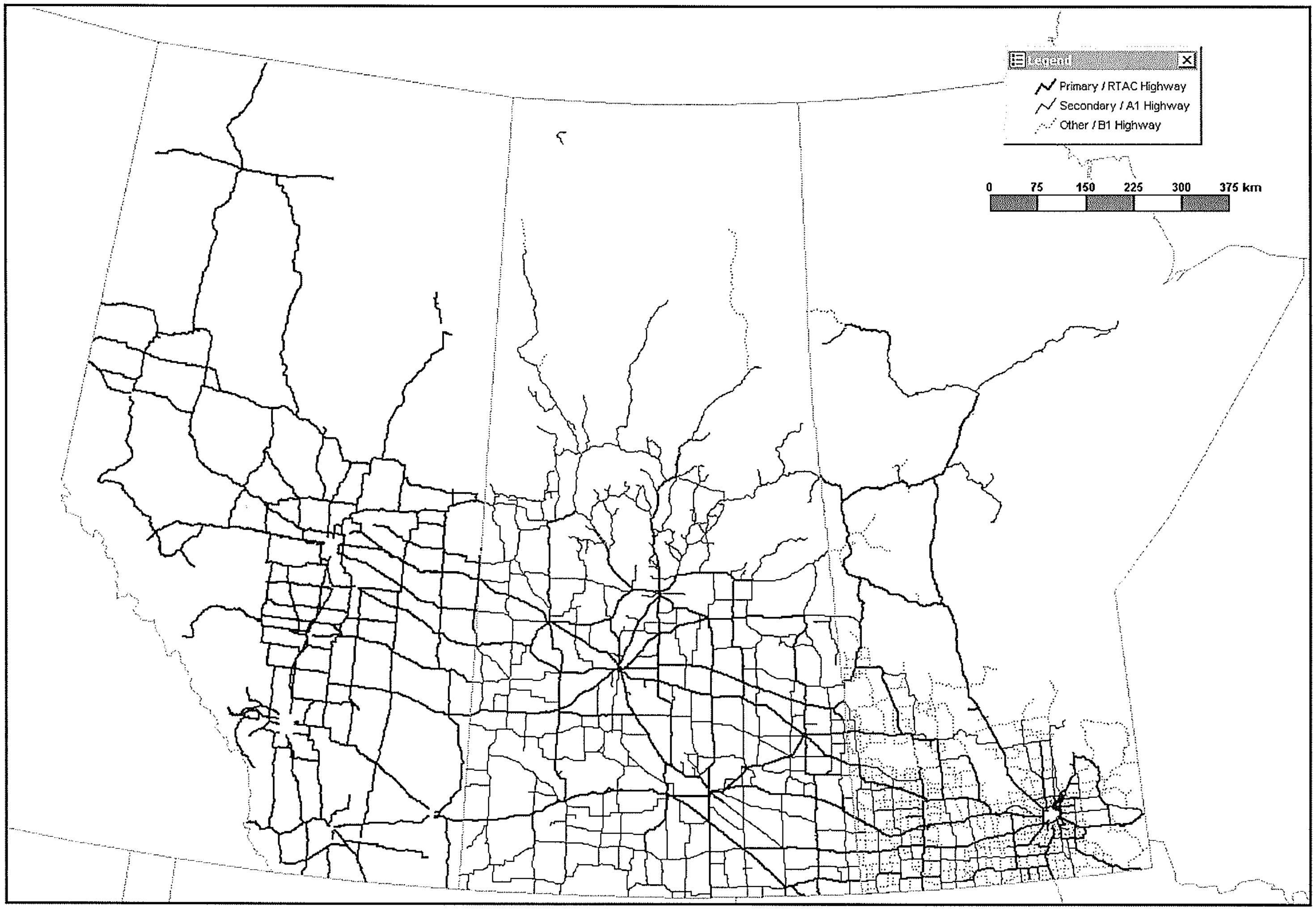


Figure 3-1: Provincial Highway Network Under Consideration

Manitoba's provincial highways are divided into Provincial Trunk Highways (PTHs) and Provincial Roads (PRs). However, from a truck loading perspective, provincial highways are divided into RTAC, A1, and B1 highways. RTAC highways are the primary highways in the province. The maximum truck weight allowed on these highways is 62,500 kg. A1 highways allow a maximum gross vehicle weight of 56,500 kg, and B1 highways allow a maximum gross vehicle weight of 47, 630 kg.

In Saskatchewan, provincial highways are divided into Primary and Secondary highways. Primary highways are those which allow primary truck weights year round (some exceptions apply). The maximum weight allowed on these highways is 62,500 kg. Secondary highways are those which allow truck weights that are not as high as those allowed on primary highways. The maximum weight allowed on these highways is 54,500 kg.

Alberta's provincial highway network includes only primary highways. Those are highways under the control of the Minister. From a truck loading perspective, these are highways that allow a maximum gross vehicle weight of 62,500 kg.

3.2 URBAN TRUCK ROUTES

Much of western Canada's trucking originates in, is destined for, or passes through the region's major urban centers of Edmonton, Calgary, Saskatoon, Regina and Winnipeg. All these cities have truck-related by-laws that significantly influence the routing and sometimes the scheduling of the operations of the heavy trucks of concern to the research.

All cities designate truck route systems or networks in their by-laws. These by-laws typically require heavy trucks to stay on the designated network to the extent possible, only leaving it for pick-up or delivery purposes via the shortest distance from the designated truck route. Most by-laws generally exempt designated industrial land use areas from detailed routing and scheduling regulations. Some routes are open 24 hours per day; others are open only during restricted hours. In some cities, the transport of dangerous goods is specially subjected to more restrictive routes and/or times than other types of freight—both by route, and by time. The urban truck route networks are in turn connected at specific locations to primary provincial highway routes.

While urban truck route networks can be quite sparse in some areas, heavy truck accidents in these same areas can occur over relatively large networks, since the truck route by-laws permit truck operation off-route for pick-up and delivery purposes.

3.3 MAJOR HIGHWAYS IN ADJOINING JURISDICTIONS

Heavy truck operations in the Prairie region are often associated with movements beyond the Prairie region itself. Understanding the connectivity of Prairie region roads to this total system is important to understand many aspects of trucking operations within the region (e.g., configuration and body type characteristics, origin-destination patterns, commodity handlings, and temporal patterns).

The major connecting routes in surrounding Canadian jurisdictions are governed by RTAC TS&W regulations, and as such provide no significant effect, influence, or limitation on Prairie region truck characteristics. The major connecting routes in neighboring states, however, can directly impact truck characteristics in the region.

Manitoba and Alberta have direct connections to the U.S. Interstate System (the I-29 in North Dakota and the I-15 in Montana). This makes major trucking activity between these provinces and the U.S. immediately subject to the dominant Federal U.S. TS&W law—the least-common denominator law governing most truck characteristics operating internationally between the Prairie region and the U.S. Saskatchewan, however, does not have a direct connection to the Interstate System (IS), but in so doing, can deal more directly with an individual state (North Dakota) in TS&W matters.

In the three tier states weight regulations are a function of the type of road. Minnesota's truck route network is comprised of two types of roads: (1) 10-Ton routes; and 9-Ton Routes. 10-Ton routes include IS highways, U.S. highways, state highways, and certain designated local highways. On 10-ton routes, the basic GVW limit is capped at 80,000 pounds (36,287 kg) by Bridge Formula B (BFB). Basic axle weights are: single axle (including the steering axle)-20,000 pounds (9,072 kg); and tandem axle-34,000 pounds (15,422 kg) (Minnesota Department of Public Safety, 2000).

9-Ton routes are generally city, county and township roads. On 9-ton routes, there are two basic GVW limits prescribed in terms of number of axles: for 5-axle trucks—73,280 pounds (33,239 kg); and for trucks with more than 5 axles—80,000 pounds (36,287 kg). Basic axle weights are: single axle (including the steering axle)—18,000 pounds (8,165 kg); tandem axle—34,000 pounds (15,422 kg).

North Dakota's route network is divided into Interstate and non-Interstate highways. On Interstate highways, the basic GVW limit, as dictated by BFB, is 105,500 pounds (47,853 kg). Basic axle weights are: single axle (including the steering axle)—20,000 pounds (9,072 kg); and tandem axle—34,000 pounds.

Montana has three classes of highways: (1) Interstate highways; (2) State primary highways (most designated as U.S. highways); and (3) State secondary highways (Montana roads). The basic GVW limit, as dictated by BFB, is 131,060 pounds (59,448 kg) on IS highways (9-axle vehicles). Basic axle weights are the same as in Minnesota and North Dakota. The state's primary and secondary highway networks also allows the same truck weight limits as on Interstate highways.

3.4 WEIGHT REGULATIONS GOVERNING TRUCK OPERATIONS

There is a myriad of details in the basic truck weight regulations, the winter premiums, and spring restriction policies of each jurisdiction. These regulations are defined, specified, determined, and interpreted in different ways among jurisdictions, using different independent variables and different definitions of the same variable. For the purposes of this research, certain simplifications are made:

- The discussion addresses five vehicle classes: (1) 3-axle straight trucks-SUT-3; (2) 5-axle tractor-semitrailers-3-S2; (3) 6-axle tractor-semitrailers-3-S3; (4) 7-axle A-train doubles-3-S2-2; and (5) 8-axle B-train doubles-3-S3-S2.
- The discussion assumes that the units considered meet all tire, axle spread, inter-axle spacing, king-pin setting, load distribution, and over-hang requirements of each jurisdiction. This covers the majority of real situations in the field.
- This discussion compares the effects of the different regulatory regimes of the different jurisdictions in terms of maximum attainable gross vehicle weights for the five specified vehicle classes. How this weight must be or can be distributed among axles or units is not presented.
- The jurisdictions considered in this research are Manitoba, Saskatchewan, and Alberta , and the five major urban areas in the three provinces.
- For each jurisdiction, the research discusses the following:
  - laws, regulations and policies governing basic truck limits
  - laws, regulations and policies governing winter weight premiums
  - laws, regulations and policies governing spring weight restrictions

3.4.1 Basic Weight Limits in the Prairie Region

Basic weight regulations (BWRs) are weight regulations that govern truck operations without the requirement for a special permit, winter premium allowances, or spring restrictions. Table 3-1 shows basic weight regulations governing regular operations in each of the three Prairie provinces for the five truck configurations of interest.

Manitoba's basic weight regulations are defined in terms of three highway classes and two generic vehicle classes. The highway classes are: (1) RTAC routes; (2) A1 highways; and

Table 3-1: Basic Weight Regulations Governing Operations in the Prairie Region by Highway Class

	MANITOBA			SASKATCHEWAN		ALBERTA	
	RTAC	**A1**	**B1**	**Primary**	**Secondary**	**Primary**	**Secondary***
Tire Weights							
Weight/unit width (kg/mm)	10	10	10	10	10	10	10
Max load per tire (kg)	3000	3000	3000	3625/3000 ^	3000/3000 ^	3650	3650
Axle Weight (kg)							
Steering							
Straight truck	7300	7300	7300	7250	5500	7300	7300
Tractor	5500	5500	5500	5500	5500	5500	5500
Single **	9100	9100	8200	9100	8200	9100	9100
Tandem (1.00 m - 1.85 m)	17000	16000	14500	17000	14500	17000	17000
Tridem #							
2.40 - 3.00 m	21000	21000	20000	21000	20000	21000	21000
3.05 - 3.06 m	23000	23000	20000	23000	20000	23000	23000
3.60 - 3.70 m	24000	23000	20000	24000	20000	24000	24000
Gross Weight (kg)							
3-axle straight truck	24300	23300	21800	24250	20000	24300	24300
5-axle tractor semitrailer	39500	37500	34500	39500	34500	39500	39500
6-axle tractor semitrailer	46500	44500	40000	46500	40000	46500	46500
7-axle A-train double	53500	53500	47630	53500	49000	53500	53500
8-axle B-train double	62500	56500	47630	62500	54500	62500	62500

Note: All limits are subject to proper axle spacing and adequate tire and axle capacity, and required weight distribution between vehicle componensts

* These are secondary highways under the authority of the Minister

^ The top figure applies to steering axles of straight trucks. The bottom figure applies to other axles (other vehicles)

Source: MTGS, SHT, AT

** In Saskatchewan this applies to single axles with dual tires

In Manitoba, these weights apply only to RTAC vehicles.

(3) B1 highways. The generic vehicle classes are: (1) RTAC vehicles—vehicles that meet all requirements defined in the RTAC Memorandum of Understanding (MoU); and (2) non-RTAC vehicles. Table 3-1 shows values only for RTAC vehicles.

Saskatchewan's basic weight regulations are defined in terms of three highway classes: (1) primary highways; (2) secondary highways; and (3) municipal highways. There are two sub-sets of primary highways: (1) those which are primary highways year-round; and (2) those which are primary highways for the period from July 1 to April 30. Any other provincial highway or provincial road is a secondary highway.

In Saskatchewan, the regulations prescribe three types of access situations which are also classified as primary highways for the purposes of determining applicable weight limits:

- Connecting roads to specific locations (potash mines).
- 15 kilometers on any secondary highway or series of secondary highways from the intersection with a primary road.
- 15 kilometers on secondary highways from substantial urban centers (i.e., population greater than 1,000).

The 15 kilometer rule for hauling primary weights on a secondary highway does not apply to highways which are under spring road restriction limits.

Alberta's basic weight limits are prescribed in AR 127/98—Public Vehicle Dimension and Weight Regulation under the Motor Transport Act. In the Alberta Public Highway

Development Act, five classes of roads are listed: (1) primary highways; (2) secondary roads; (3) rural roads; (4) streets; and (5) forestry roads. This discussion of weight limits focuses on weight limits applicable on highways "under the Minister's direction, control and management." as discussed in Section 3.1 (*i.e.*, mainly primary highways).

Regarding basic weight regulations in urban areas, the cities generally follow the leads given by their respective provincial highway departments.

3.4.2 Seasonal Weight Limits in the Prairie Region

Seasonal weight limits are an important aspect of truck transportation regulation in the region. Premium weight allowances in winter provide opportunities to increase truck productivity and lower shipping costs for dense (weight-out) commodities. In doing so, they can attract certain freight movements to periods of higher strength frozen pavement conditions from lower strength (thawing or normal) periods. This can be beneficial to reducing the rate at which infrastructure deteriorates in serving its function of handling required freight movements. By the same token, reduced loading on certain roads during spring thaw helps reduce inordinate deterioration often associated with weak pavement and/or subgrade conditions.

Taking the region as a whole, seasonal weight limits are in effect at one place or another for a 7-month period, with winter weight premiums (WWPs) starting as early as December 1 and spring weight restrictions (SWRs) terminating as late as June 30. Hence, for a significant period of time each year, SWRs and WWPs play a part in determining Prairie region trucking characteristics, volumes, and routing.

As with basic weight limits, seasonal weight limits in urban areas generally follow the lead given by the corresponding provincial highway agency. The effects of these limits on heavy trucks operating in urban areas can be complex. This is discussed in Section 3.6.

3.4.2.1 Winter Weight Premiums

Winter weight premiums are weight limits which are applied during (ostensibly) frozen periods in some systematic manner allowing truck operations at higher than basic weight limits without the use of permits.

A variety of WWP systems are used, varying both among and within jurisdictions. They include: (1) a constant percent increase system (e.g. 10 percent increase in Manitoba), sometimes capped by the basic GVW limit and sometimes uncapped; (2) a flat axle weight increase system (e.g., 1,000 kg per axle group in Alberta); and (3) the up-class system used in Manitoba, where a low basic weight class road (e.g., B1) is increased to a higher basic weight class road in winter (e.g., seasonal RTAC).

Manitoba and Saskatchewan use a fixed time system for starting and ending WWPs. Alberta applies WWPs on a zonal basis (i.e., part of the jurisdiction at one time and another part at another time). Special aspects of WWPs in each jurisdiction follow. More details can be found in Montufar et al. (2000).

Manitoba

Manitoba provides premium weight allowances during the winter period (defined in the Highway Traffic Act as the period from December 1 to the last day of February of the following year) using two methods: (1) the "10 percent premium" method; and (2) the "designated seasonal route" method.

Method 1: Application of a 10 percent premium weight allowance

In the Method 1 approach, Manitoba provides a WWP of 10 percent on Provincial highways (PTHs and PRs) from December 1 in a year to the last day of February of the following year. The 10 percent WWP applies to non-steering single axles and tandem axles having dual tires—subject to a cap on tandem axles of 17,600 kg. For single axles (other than front steering axles), the winter premium load limits by road class are:

- RTAC routes—10,010 kg (9,100 + 10 percent)
- A1 routes—10,010 kg (9,100 + 10 percent)
- B1 routes—9,020 kg (8,200 k + 10 percent).

For tandem axles, the winter premium load limits by road class are as follows:

- RTAC routes–17,600 kg (four percent greater that the base limit of 17,000 kg)
- A-1 routes–17,600 kg (10 percent greater than the base limit of 16,000 kg)
- B-1 routes-15,950 kg (10 percent greater than the base limit of 14,500 kg).

The WWP does not apply to the following:

- Front steering axle loads
- Tridem axle loads
- The 62,500 kg maximum GVW limit on RTAC highways
- The 56,500 kg maximum GVW limit on A1 highways
- The 47,630 kg maximum GVW limit on B1 highways
- The tire limits of 10 kg/mm and 3,000 kg/tire

There is no documented rationale for capping the RTAC tandem load limit at 17,600 kg (four percent more than the basic, rather than 10 percent).

This method provides relatively small increases (one to three percent) in the allowable GVWs of single unit trucks and tractor-semitrailers on Manitoba's RTAC highways. It provides medium increases (seven to nine percent) in allowable GVWs for the same truck types on the lower grade, A1 and B1 highways. This method also provides no increase in allowable GVWs on either a 7-axle A-train or 8-axle B-train on any roads in the network.

Method 2: Designation of selected routes as "Seasonal RTAC" or "Seasonal Class A1"

In the Method 2 approach, Manitoba reclassifies certain routes from a lower class (i.e., B1 or A1) to a higher class (i.e., A1 or RTAC) for the winter period. In so doing, the allowable limits on these routes increase from their basic limits (B1 or A1), to the limits applicable on A1 or RTAC highways in the winter (this includes winter premiums applicable to those routes). Table 3-2 shows maximum GVWs attainable during the winter period on Manitoba provincial highways for the five major truck classes considered (assuming vehicles meet RTAC truck specifications). The winter GVWs are compared with equivalent basic GVWs.

There is also no documented technical rationale behind this method (neither the timing nor the size of the premium). What is known from discussions with Manitoba Transportation officials is that the method was introduced sometime after the RTAC MoU in 1988. Use of the method was driven by industry needs for greater trucking efficiency. Most of the roads on which Method 2 has been applied serve the in-bound movement of raw forest products to pulp and paper plants, and mining sites (Montufar et al., 2000).

Table 3-2: Maximum Allowable GVW in Manitoba (Basic versus Winter)

Truck Type	**RTAC Highways**		**A1 Highways**		**B1 Highways**	
	Basic	Winter	Basic	Winter	Basic	Winter
3-axle straight	24300	24900	23300	24900	21800	23250
5-axle tractor-semitrailer	39500	40700	37500	40700	34500	37400
6-axle tractor-semitrailer	46500	47100	44500	46100	40000	41450
7-axle A-train double	53500	53500	53500	53500	47630	47630
8-axle B-train double	62500	62500	56500	56500	47630	47630

Notes: (1) The figures in this table are effective as of January 1 2000(2) the table refers to RTAC vehicles

This method provides large increases in the allowable GVWs for all truck classes operating on seasonal routes—with the amount of the premium increasing as vehicle size increases. For example, the increases in GVW limits applicable on B1 roads designated as RTAC seasonal routes are: for 3-axle single unit trucks—eight percent; for 5-axle tractor-semitrailers—nine percent; for 6-axle tractor-semitrailers—14 percent; for 7-axle A-train doubles—12 percent; and for 8-axle B-train doubles—31 percent. The percentages were obtained by calculating the differences between the allowable RTAC winter weight GVW including a 10 percent WWP (the Method 2 approach) and the allowable B1 winter weight GVW using the 10 percent WWP only (the Method 1 approach) (e.g., for a 5-axle tractor-semitrailer, 40,700 kg versus 37,400 kg).

Saskatchewan

Saskatchewan provides premium weight allowances during the winter period (defined as December 1 to the first day of March) in the following manner:

- Tire load limits are not increased in the winter. They remain constant at 10 kg/mm, subject to a maximum of 3,625 kg per tire on the steering axle of straight trucks, and 3,000 kg per tire on all other axles.
- Single axle load limits are increased in winter to 10,000 kg. This is from 9,100 kg on primary highways (+10 percent) and from 8,200 kg on secondary highways (+22 percent).
- Tandem axle load limits are increased in winter to 18,000 kg. This is from 17,000 kg on primary highways (+ six percent) and from 14,500 kg on secondary highways (+24 percent).
- Tridem axle load limits are not increased in winter on primary highways, but are increased on secondary highways from 20,000 kg to 24,000 kg on 3-S3s (+20 percent), and from 20,000 kg to 23,000 kg on 8-axle B-trains (+15 percent).
- Irrespective of allowable axle weight increases, the maximum GVW limits on both primary highways (62,500 kg) and secondary highways (54,500 kg) are not increased in the winter period. The GVW limit on a 3-S3 is also held to its primary highway basic limit of 46,500 kg. Table 3-3 shows maximum GVWs attainable during the winter on Saskatchewan provincial highways for the five major truck classes considered (assuming vehicles meet RTAC and other provincial truck specification requirements).

Table 3-3: Maximum Allowable GVW in Saskatchewan (Basic versus Winter)

Truck Type	Primary Highways		Secondary Highways	
	Basic (kg)	Winter (kg)	Basic (kg)	Winter (kg)
3-axle straight	24250	25250	20000	25250
5-axle tractor-semitrailer	39500	41500	34500	41500
6-axle tractor-semitrailer	46500	46500	40000	46500
7-axle A-train double	53500	53500	49000	53500
8-axle B-train double	62500	62500	54500	54500

Alberta

Winter weight premiums are applied in Alberta on a regional basis after a minimum of one meter of frost has entered the pavement structure and subgrade. The WWPs are generally removed when the subsurface thaw for a given area is greater than 30 cm-or will exceed 30 cm within a few days.

Contrary to the practice in Manitoba and Saskatchewan, Alberta does not apply WWPs as a percentage increase on the basic weight limits. Alberta provides fixed increases on the axles and the GVW for each vehicle type. The WWP levels in Alberta are:

- Axle Weight Allowance
  - 500 kg on dual tired single axles
  - 1,000 kg on dual tired tandem axles
  - no allowance on steering axles
  - no allowance on tridem axles

- GVW
  - 1,000 kg for trucks with basic GVWs lower than 53,500 kg, limited by a cap of 53,500 kg

Table 3-4 shows maximum GVWs attainable where/when the WWP is in effect in Alberta's primary and secondary highways under the authority of the Minister for the five major truck classes considered. The winter GVWs are compared with equivalent basic GVWs.

3.4.2.2 Spring Weight Restrictions

Spring weight restrictions (SWRs) are weight limits applied during spring thaw periods in some systematic manner restricting truck operations to lower than basic weight limits.

Table 3-4: Maximum Allowable GVW in Alberta (Basic versus Winter)

Truck Type	Basic (kg)	Winter (kg)
3-axle straight truck	24300	25300
5-axle tractor-semitrailer	39500	40500
6-axle tractor-semitrailer	46500	47500
7-axle tractor-semitrailer	53500	53500
8-axle tractor-semitrailer	62500	62500

Applicable to primary and secondary highways

As with WWPs, a variety of SWR systems are used in the Prairie region: (1) percentage of the basic axle load; (2) specified axle load; (3) reduced tire loading per unit width (Saskatchewan); (4) a down-class system in Saskatchewan (the reverse of the WWP up-class method); and (5) commodity and time of day effects (Manitoba).

The intensity of SWR levels varies widely from jurisdiction to jurisdiction, and from road to road. However, there are three basic categories: c 90 percent of basic, c 75 percent of basic, and c 65 percent of the basic weight regulations. Special aspects of SWRs in each jurisdiction follow. More details can be found in Montufar et al. (2000).

Manitoba

Spring weight restrictions start on March 23 and extend to May 31 of each year. Manitoba regulations prescribe spring weight restrictions in terms of two variables: level of load restrictions (Level 1 and Level 2); and climatic zones (south—zone 1, and north—zone 2). The definition of the two-zone system boundaries is experience-based. Typically, most RTAC highways are not affected by spring weight restrictions.

Level 1 restrictions allow normal loading of 10 kg/mm of tire width on the steering axle up to a maximum of 5,500 kg on all highways (this applies both to truck tractors and straight trucks). Level 1 restrictions restrict all other axle groups as follows: (1) 90 percent of normal loading on Class A1 highways; and (2) 95 percent of normal loading on Class B1 highways.

Level 2 restrictions limit all axle groups to 65 percent of normal loading on Class A1 and B1 highways. Under Level 2 road restrictions, Manitoba regulations allow normal loading of 10 kg/mm of tire width on the steering axle, up to a maximum of 5,500 kg, as well as Level 1 weights on all other axles when transporting essential commodities between midnight and noon. A list of essential commodities is included in the regulations. The list is extensive, covering most heavy commodities moved in Manitoba. All Level 2 restricted roads are restricted to Level 1 commencing March 23. Based on local conditions, a Level 1 route may be downgraded to a Level 2 route.

Saskatchewan

Typically, spring weight restrictions start in the first week of March–generally in the southwest region of the province–and are applied in the remainder of the province over a two to three week period. The application and termination of these restrictions is weather dependent. Primary highways are not subject to any restriction except under extenuating circumstances.

Saskatchewan uses two methods for applying spring weight restrictions: (1) reduction in allowable tire loads from 10 kg/mm to 6.25 kg/mm; and (2) designation of selected primary highways as secondary highways during May and June.

Under the first method, secondary highways specially named in the restriction orders are subject to reductions in allowable wheel loads, as follows:

- There is no reduction on steering axles.
- All other axles are limited to 6.25 kg/mm width of tire, to a maximum load of 1,650 kg per wheel.

Under the second method, a selected group of highways defined in the regulations is re-classified from their primary highway status to secondary highway status for the months of May and June of each year. During this period, maximum allowable weight limits revert to secondary weight limits but are not subject to further spring restrictions. This means that the weight limits on these highways become the same as the basic weight limits on secondary highways with no spring restrictions.

Alberta

Alberta's SWRs are prescribed in terms of "percentage of axle weight" allowed on carrying (i.e., non-steering) axles. The percentage reductions are typically 90 percent, 75 percent, and in extreme cases 50 percent. Allowable axle weights under these restriction levels are:

• Steering axles	No change. Basic 7300 kg or 5500 kg apply
• Single axles	Limited to 8190 kg (90% ban) or 6,825 kg (75% ban)
• Tandem axles	Limited to 15,300 kg (90% ban) or 12,750 kg (75% ban)
• Tridem axles	Limited to 21,600 kg (90% ban) or 18,000 kg (75% ban)

Roads in Primary Subsystem 1 (Highways 1, 2, 3, 4, 9, 16, 35, 43, and 63) are almost never subject to SWR.

3.4.3 Weight Regulations in the U.S. Bordering States

It is important to understand the weight regulations of Minnesota, North Dakota, and Montana, given that these are the major trading partners of the three Prairie provinces. Trucking across the Prairie region Canada-U.S. border increased by 10 percent per year through the 1990s (DS Lea and UMTIG, 1999). Table 3-5 shows the basic weight regulations governing operations in the three adjoining states for the five truck configurations of interest.

Regarding seasonal weight regulations, all three states have SWRs in place but only Minnesota and North Dakota allow WWPs. Minnesota applies WWPs from December of one year to March of the following year. In the northern portion of Minnesota, a 10 percent premium on the weight limits on 10-ton and 9-ton routes is allowed from December 1 through December 31 each year.

On both highway classes, the 10 percent premium applies to tire weight limits, axle weight limits, and Bridge Formula requirements. The 10 percent premium also applies to GVW limits on 10-ton routes. For 9-ton routes, the 10 percent premium is subject to a GVW cap of 80,000 pounds. The same 10 percent premium is applied statewide during the period of

Table 3-5: Basic Weight Regulations Governing Operations in MN, ND, and MT

	MINNESOTA		NORTH DAKOTA		MONTANA		
	10-Ton	**9-Ton**	**IS Hwys**	**Non-IS Hwys**	**IS Hyws**	**Primary**	**Secondary**
Tire Weights							
Wght/unit width (lbs/in) [kg/mm]^							
Steering	600 [10.7]	600 [10.7]	550 [9.82]	550 [9.82]	500 [8.9]	500 [8.9]	500 [8.9]
Non-steering axle	500 [8.9]	500 [8.9]	550 [9.82]	550 [9.82]	500 [8.9]	500 [8.9]	500 [8.9]
Axle Weight (lbs)[kg]							
Single *	20000 [9072]	18000 [8165]	20000 [9072]	20000 [9072]	20000 [9072]	20000 [9072]	20000 [9072]
Tandem	34000 [15422]	34000 [15422]	34000 [15422]	34000 [15422]	34000 [15422]	34000 [15422]	34000 [15422]
Tridem (based on Bridge Formula)							
9-foot spread [2.74 m]	43000 [19504]	43000 [19504]	43000 [19504]	48000 [21772]	42750 [19391]	42750 [19391]	42750 [19391]
Gross Weight (lbs)[kg]							
3-axle straight truck	54000 [24494]	52000 [23587]	54000 [24494]	54000 [24494]	50094 [22722]	50094 [22722]	50094 [22722]
5-axle tractor semitrailer	80000 [36287]	73280 [33239]	84000 [38102]	84000 [38102]	80000 [36287]	80000 [36287]	80000 [36287]
6-axle tractor semitrailer	80000 [36287]	80000 [36287]	97000 [43998]	102000 [46266]	89125 [40426]	89125 [40426]	89125 [40426]
7-axle A-train double	80000 [36287]	80000 [36287]	105500 [47854]	105500 [47854]	120125 [54487]	120125 [55488]	120125 [54487]
8-axle B-train double	80000 [36287]	80000 [36287]	105500 [47854]	105500 [47854]	123124 [55848]	123124 [55848]	123124 [55848]

Source: Minnesota DOT, North Dakota DOT, Montana DOT

Note: All limits are subject to proper axle spacing and adequate tire and axle capacity

Note: In Montana, these regulations exclude the special provisions concerning Sweetgrass-Shelby). Also, the GVWs shown for Montana are the practical/possible maximums. To establish these weights, the practical limits for steering axles are assumed to be: (1) on straight trucks–16,094 pounds (7,300 kg); (2) on tractors in 3-S2 combinations–12,000 pounds (5,443 kg); and (3) on all other tractors–12,125 pounds (5,500).

^ In Montana, this weight per unit width is applicable to wide-base tires only (> 14 inches)

* This includes steering axles in ND and MT

January 1 to March 7. This may terminate earlier depending on the need for springtime load limits.

Minnesota applies SWRs based on when thawing conditions will occur. Once the start of the load restriction is determined, the restriction is put in place for a period of 8 weeks and withdrawn at the end of that period. The restrictions consist of a percent reduction of the basic axle load (Montufar et al., 2000).

North Dakota allows WWPs from December 1 to March 7, unless they are shortened by the application of spring restrictions. A 10 percent winter weight premium is applied in North Dakota only on non-IS highways. Weight limits on IS highways in North Dakota are held constant year round. The North Dakota WWP is applied to tire load limits; single axle load limits; tandem axle load limits; tridem axle load limits; the GVW limit applicable under Bridge Formula B, except on the GVW cap of 105,500 pounds (47,854 kg); and on state highways restricted to 80,000 pounds (36,287 kg) under basic limits. This results in the following maximum allowable weights in the winter:

- The tire load limit is increased by 10 percent to 605 pounds/inch (10.80 kg/mm)
- The single axle load limit—including on the front steering—is increased by 10 percent to 22,000 (9,979 kg).
- The tandem axle load limit is increased by 10 percent to 37,400 pounds (16,964 kg).
- The tridem axle load limit is increased by 10 percent to 52,800 pounds (23,950 kg).

Spring weight restrictions apply in North Dakota on non-IS highways as required. These restrictions do not apply on IS highways. The restrictions are specified in terms of reductions in axle weights (Montufar et al., 2000).

In Montana, state highways may be restricted as required during spring thaw conditions. The start and end dates of restriction are variable. The timing and level of restrictions are generated by field personnel using visual inspection. Where and when bans are applied, they are initially set at a level of 8 tons on single axles and 16 tons on tandem axles, subject to a maximum tire load of 600 lbs/inch. The restriction levels may be increased as needed. Tridem axles are held to their limits established by Bridge Formula B (subject to 400 lbs/inch tire load). Montana also has a spring restriction policy unique to the region which sometimes invokes a speed limit reduction coupled with spring restrictions (Montufar, et al., 2000).

3.5 CARRIER SURVEY

A personal survey of representatives of 13 Prairie-based trucking firms was conducted in July 1998. The objective of the survey was to obtain industry intelligence and insight into issues that affect truck safety in the region. Carrier views about the following matters were of particular relevance:

- truck size and weight regulations
- urban area route or time of day restrictions
- road network structure
- road surface condition
- enforcement practices
- new facilities or upgrades required to alleviate inefficient or unsafe operating conditions

Findings of value to understanding heavy truck safety in the Prairie region are:

- Most of western Canada's international general freight carriers, and U.S. based carriers operating into the west, are 3-S2/80,000-pound/Bridge Formula B operators. These carriers are not influenced by Canada's TS&W regulations encouraging particular vehicle characteristics based on performance considerations. U.S. TS&W law east of the Mississippi River, south of first tier states, and in the south central and west states; and its implications for wheelbases, inter axle spacings, kingpin to rear axle, maximum weights, and weight distribution, are the least common denominator rules governing fleet requirements. These rules control many of western Canada's heavy trucks. This also holds true for many cross-border flat bed operators.

- Portions of the Trans-Canada highway and National Highway System serving western Canada were described as in poor condition. Road sections that were particularly cited in this regard are in northwestern Ontario and east of Regina. Some suggested that certain drivers refuse to be routed over Ontario roads on movements between eastern and western Canada—a factor influencing where, what, and when various types of heavy trucks may be operating. Saskatchewan's secondary highways were particularly cited for their inadequacies (and indeed, have drawn substantial governmental and public attention since 1998, including road closures and reverting thin-pavement surfaces back to gravel roads). Alberta's Highway 2A was described to have poor geometry.

- Border crossing facilities and services (particularly concerning customs and agricultural products movements) restrict/dictate hours of operation of many trucks. These effects can influence the scheduling of pick-ups and deliveries far from the border crossing itself, and the time of day temporal distributions of truck traffic on different routes. This can in turn affect the likelihood of interaction with congested traffic in major urban centers, and the ability of drivers to maintain hours-of-service requirements, exposure of trucks to enforcement, and possibly the potential for heavy truck accidents.

- Many urban truck routes are still not designed to handle the turning movement requirements of 53-foot semitrailers.

- The lack of network continuity or connectivity, height restrictions, and weight-posted bridges may lead to circuitous routing in urban areas. This can add many truck-kilometers of travel for heavy truck operations in these cities, and the resulting potential for more HTAs.

- Portions of the truck route networks in most urban areas in the Prairie region are approaching or are over capacity (at certain hours, on certain days). This capacity problem is principally related to the fact that in most of these urban areas, some of the heaviest total traffic volumes occur on some of the heaviest truck volume routes (e.g., Route 90 in Winnipeg, Deerfoot Trail in Calgary). Heavy trucks operating in congested traffic conditions are exposed to different accident-related influences that are not experienced on the low volume, high speed rural highways typical to the region. This may be a major contributor to the large number of HTAs occurring in urban areas in the region.

- Unique to Winnipeg during the period of the research, the City's trucking by-law required that the movement of any truck with a GVW greater than 36,500 kg (i.e., RTAC 3-S2s, 3-S3s, A-trains, B-trains) between an origin and destination within the city limits had to be routed via the Perimeter Highway. This requirement may have had negative implications for the total amount of TKT operated in and around the city by heavy trucks, their kilometer-based exposure to accidents, and their frequency of accident involvement. (This by-law was changed in 2001, now allowing intra-city movements of these vehicles).

Concerning whether or not to spend more on dividing highways in western Canada to effect safety improvements, from the trucking standpoint, the interviews showed mixed opinions. Some carriers expressed that governments should not waste money dividing more highways, but should spend more money maintaining the existing network of undivided highways and adding passing lanes to highways where needed. Some other carriers expressed that dividing highways may result in improved safety (e.g., divide the Trans-Canada highway). Most carriers agreed that improving traffic flow in urban areas would be more useful than dividing many rural highways.

3.6 IMPLICATIONS FOR HEAVY TRUCK OPERATIONS

Truck route networks and truck weight regulations have significant implications for heavy truck operations in the region as follows:

- The RTAC MoU and related regulation development have significantly affected truck characteristics for local, regional and inter-provincial trucking activity within the region.

- U.S. TS&W regulations govern the weight and dimension characteristics of heavy trucks operating on Prairie region highways that are involved with movements to and from the U.S. This is a major portion of the western Canadian heavy truck fleet, and is the large area of growth in heavy truck operations. The key implication is that Canada's TS&W law, encouraging the use of B (and C)-trains over A-trains, is largely irrelevant in terms of its effect on cross-border trucking (except in Montana between the Alberta border and Shelby). The U.S. law favors A-trains over B-trains in terms of productivity advantages, and to the extent that double trailer combinations are used in cross-border operations, A-trains have been and are the vehicle of choice.

- The WWP policy concept practiced in the Prairie region has four important implications for trucks, truck traffic, and truck operations:

  – It attracts truck traffic to the winter time months (with the objective of reducing movement particularly during the spring season).

  – In Saskatchewan, on secondary highways, it fosters: (1) the operation of single trailer units at primary highway weight limits; and (2) equilizes the payload handling capabilities of A-trains and B-trains.

  – In Manitoba, it allows B-train operations at basic RTAC MoU weights on several low grade highways.

  – It generally allows 3-S2s to operate at higher GVWs than contemplated in the RTAC MoU (40,700 kg in Manitoba; 41,500 kg in Saskatchewan; and 40,500 kg in Alberta—versus 39,500 kg).

  This results in many lower-grade, secondary roads handling larger, heavier trucks. Also, because of the fixed-time system for controlling WWPs (in Manitoba and Saskatchewan), these heavy truck operations may take place when the pavement structure is not yet frozen (due to unusually high temperatures), resulting in potentially unsafe situations.

- Regarding truck operations in urban areas, truck routes and weight limit by-laws, including seasonal weight limits, define or influence the activity system generating trucking movements, the truck movements themselves, their exposure to other traffic, truck-kilometers of travel, and the time of day and day of week distributions of truck traffic in urban areas. All of these factors in turn influence the frequency, severity and rate of HTAs, albeit in largely unknown ways.

CHAPTER 4

HEAVY TRUCK ACCIDENTS IN THE PRAIRIE REGION

This chapter presents findings concerning an analysis of 14,838 heavy truck accidents (HTAs) on provincial highways and major urban centers in Manitoba, Saskatchewan, and Alberta. The analysis is for the period from 1993 to 1998. It does not include accidents occurring in national parks, or on rural, municipal roads. The chapter discusses the following: (1) historical trends of heavy truck accidents; (2) proportion of heavy truck accidents relative to total accidents; (3) severity of heavy truck accidents; (4) heavy truck accidents involving fatalities; (5) heavy truck accidents by number of trailers; (6) major contributing factors for heavy truck accidents; (7) road surface conditions for heavy truck accidents; (8) temporal distribution of heavy truck accidents; and (9) geographical distribution of heavy truck accidents. Differences between urban and rural HTAs are identified. The chapter concludes with a discussion about changes in HTAs over time in the region. Heavy truck accident rates are discussed in Chapter 6.

4.1 DATABASES AND DATA SOURCES

This research makes use of four accident databases obtained from Manitoba, Saskatchewan, and Alberta. These databases were used for the analysis of HTAs on provincial highways and in urban areas in the three provinces. Details about the data sources are in Appendix B.

All databases contain valuable information regarding heavy truck accidents. However, they suffer from a number of problems which originate with the police collision report form itself. Some of the problems arise from how the form is completed by the police, and some are created from coding practices. Coding problems encountered with the provincial highway databases were corrected by going back to the original collision reports and re-coding the raw data. The problems encountered in the Saskatchewan Government Insurance (SGI) database and the Alberta Transportation database were reviewed with staff from the two agencies. However, this work is very time-consuming and also prone to errors. In addition, as is explained in Section 4.2.8, lack of accurate location descriptors is also a problem with the accident databases mainly due to the following reasons: (1) many accident sites are not investigated by the police, and the report therefore relies on location descriptors provided by those involved in the accident; (2) the lack of kilometer posting on highways; (3) reliance on "local" descriptors; and (4) the lack of quality control when transferring raw data descriptors to descriptors in the resulting computer database.

4.2 HEAVY TRUCK ACCIDENTS ON PROVINCIAL HIGHWAYS

Between 1993 and 1998, there were 7,638 heavy truck accidents on the 54,452 kilometers of provincial highways in the Prairie region. These accidents accounted for: (1) six percent of all traffic accidents on these highways; (2) eight percent of all injury accidents (not fatalities); and (3) 18 percent of all fatal accidents. They represent over 400 deaths.

4.2.1 Historical Trend of Heavy Truck Accidents

Figures 4-1 and 4-2 illustrate the historical representation of HTAs on provincial highways in the Prairie region for the period between 1993 and 1998. The first figure illustrates the frequency of HTAs on provincial highways in the three Prairie provinces. The second figure illustrates the proportion of HTAs relative to total accidents.

From Figure 4-1, the frequency of HTAs on provincial highways in the three provinces combined was steady between 1994 and 1998 (averaging 1,321 HTAs per year). Low numbers of HTAs occurred in Alberta and Manitoba in 1993.

From Figure 4-2, the frequency of HTAs is different in the three provinces. However, the relative proportion of HTAs to total accidents on provincial highways (*i.e.*, the number of heavy truck accidents as a function of total accidents) is the same in Saskatchewan and Alberta and twice as high in those two provinces as in Manitoba. In Manitoba, for the period between 1993 and 1998, HTAs accounted for 3.4 percent of total accidents on provincial highways. In Saskatchewan and Alberta, HTAs accounted for 7.6 and 7.7 percent of total accidents on provincial highways respectively.

Table 4-1 shows HTAs and non-HTAs on provincial highways in the three provinces. For the six-year period, Alberta had nearly 60 percent more total accidents on its provincial road network than Manitoba, and 70 percent more than Saskatchewan.

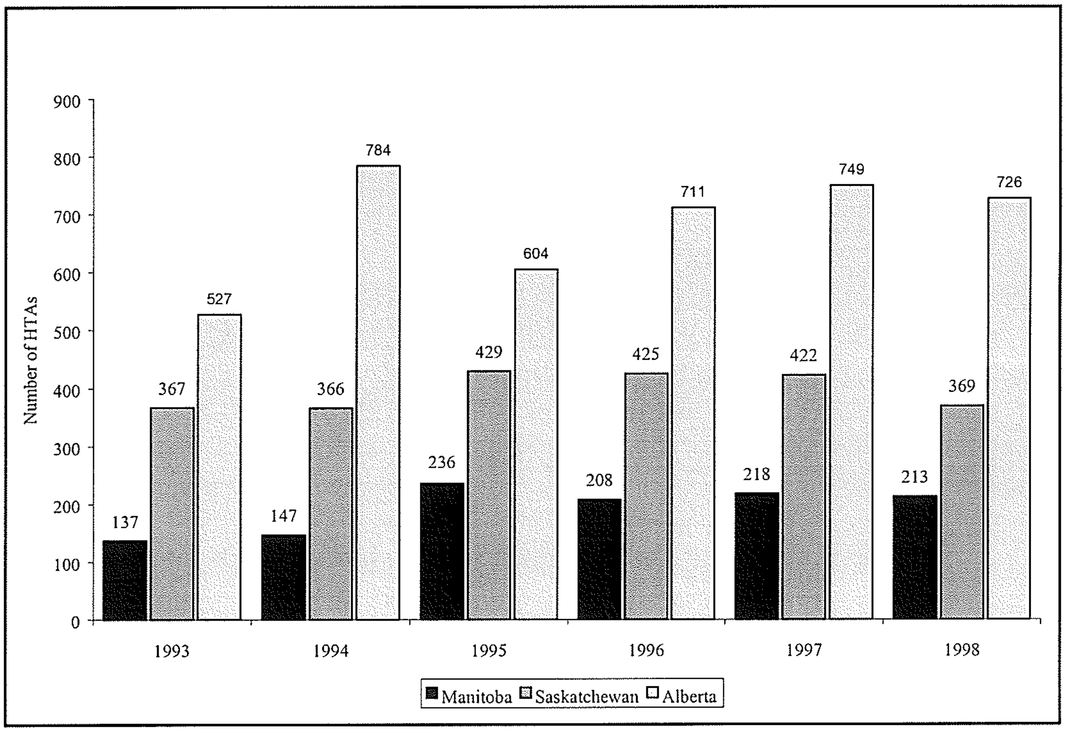


Figure 4-1: Frequency of HTAs on Provincial Highways in the Prairies
Sources: UMTIG, MTGS, SGI, AT

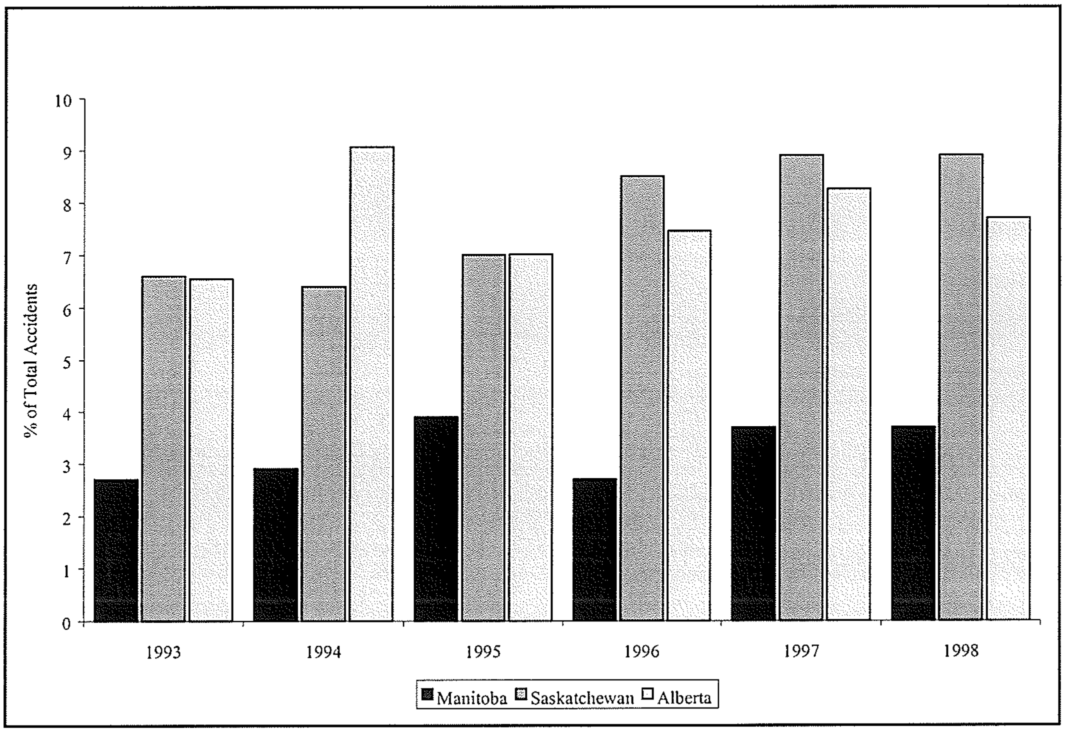


Figure 4-2: Proportion of HTAs Relative to Total Accidents on Provincial Hwys
Sources: UMTIG, MTGS, SGI, AT

Table 4-1: Heavy Truck Accidents and non-Heavy Truck Accidents by Year

Year	MANITOBA			SASKATCHEWAN			ALBERTA		
	HTAs	**non-HTAs**	**Total**	**HTAs**	**non-HTAs**	**Total**	**HTAs**	**non-HTAs**	**Total**
1993	137	4863	**5000**	367	5169	**5536**	527	7522	**8049**
1994	147	4903	**5050**	366	5346	**5712**	784	7868	**8652**
1995	236	5868	**6104**	429	5706	**6135**	604	8007	**8611**
1996	208	6049	**6257**	425	4550	**4975**	711	8826	**9537**
1997	218	5631	**5849**	422	4318	**4740***	749	8325	**9074**
1998	213	5532	**5745**	369	3760	**4129**	726	8705	**9431**
Total	1159	32846	**34005**	2378	28849	**31227**	4101	49253	**53354**

* This is a revised figure provided by SGI in January 2000.

4.2.2 Severity of Heavy Truck Accidents

Table 4-2 and Table 4-3 illustrate total HTAs and total accidents by severity on provincial highways in the three provinces.

The severity of HTAs as a proportion of total accidents is similar in Saskatchewan and Alberta, and higher than Manitoba. These accidents accounted for about 20 percent of all fatal accidents and 10 percent of all injury accidents in each of the two provinces. HTAs represented 11 percent of all fatal accidents and four percent of all injury accidents in Manitoba.

Regarding the severity of HTAs only, four percent of all HTAs that occurred on provincial highways in the Prairie region resulted in fatality, 28 percent resulted in injury, and two-thirds resulted in property damage only.

Table 4-2: Total Heavy Truck Accidents by Severity on Provincial Highways

YEAR	MANITOBA				SASKATCHEWAN				ALBERTA			
	Fatal	**Injury**	**Property Damage**	**MB Total**	**Fatal**	**Injury**	**Property Damage**	**SK Total**	**Fatal**	**Injury**	**Property Damage**	**AB Total**
1993	6	39	92	**137**	14	105	248	**367**	29	144	354	**527**
1994	6	49	92	**147**	15	100	251	**366**	26	203	555	**784**
1995	9	69	158	**236**	12	132	285	**429**	24	138	442	**604**
1996	4	48	156	**208**	20	133	272	**425**	21	196	494	**711**
1997	7	66	145	**218**	16	131	275	**422**	46	221	482	**749**
1998	5	69	139	**213**	15	99	255	**369**	28	214	484	**726**
Total	37	340	782	**1159**	92	700	1586	**2378**	174	1116	2811	**4101**

Table 4-3: Total Accidents by Severity on Provincial Highways

Year	MANITOBA				SASKATCHEWAN				ALBERTA			
	Fatal	**Injury**	**Property Damage**	**MB Total**	**Fatal**	**Injury**	**Property Damage**	**SK Total**	**Fatal**	**Injury**	**Property Damage**	**AB Total**
1993	59	1453	3488	**5000**	72	1066	4398	**5536**	143	1587	6319	**8049**
1994	59	1393	3598	**5050**	76	1119	4517	**5712**	163	1681	6808	**8652**
1995	63	1502	4539	**6104**	72	1196	4867	**6135**	138	1575	6898	**8611**
1996	50	1625	4582	**6257**	63	1129	3783	**4975**	140	1848	7549	**9537**
1997	59	1385	4405	**5849**	70*	1232*	3438	**4740***	158	1798	7118	**9074**
1998	55	1352	4338	**5745**	71	995	3063	**4129**	149	1805	7477	**9431**
Total	345	8710	24950	**34005**	424	6737	24066	**31227**	891	10294	42169	**53354**

* These are revised figures provided by SGI in January 2000.

Tables B-1a, and B-1b in Appendix B illustrate the distribution of HTAs by type of accident (single-vehicle versus multiple-vehicle) and severity. From these tables, 44 percent of HTAs that occurred in Alberta and Saskatchewan were single-vehicle accidents, compared to one-third in Manitoba. Multiple-vehicle HTAs (accidents involving at least one heavy truck) accounted for the remainder.

4.2.3 Heavy Truck Accidents Involving Fatalities

For the six-year period there were 303 fatal HTAs in the Prairie region. Almost 60 percent of those occurred in Alberta, 30 percent in Saskatchewan, and 10 percent in Manitoba. Table 4-4 illustrates details about the fatal HTAs in the three provinces.

From the table, approximately 60 percent of all heavy trucks involved in fatal accidents in each province were single trailer combinations. Double trailer combinations accounted for one quarter of the heavy trucks involved in fatal HTAs in Manitoba, and about 30 percent in Saskatchewan and Alberta. Of the double trailer combinations in Saskatchewan, one-third were A or C-trains and the remaining two-thirds were B-trains. Triple trailer combinations accounted for one percent of HTs involved in fatal HTAs in Alberta. It is not possible to determine from the Saskatchewan database the number of triples involved in accidents.

In relation to the general population, double trailer combinations account for an average of 20 percent of the truck fleet in Manitoba (see Section 6.3.3). In Saskatchewan and Alberta, depending on the region, they can account for between five percent and 30 percent of the truck fleet (DS-Lea and UMTIG, 1999).

Table 4-4: Heavy Truck Accidents Involving Fatalities

	Manitoba	Saskatchewan	Alberta
Total HTAs	37	92	174
HTs Involved	41	96	182
Trailer Configuration*			
Single	24	57	109
Double	10	30	58
Triple	0	n/a	2
Other/Not known	7	9	13
Total Heavy Trucks	**41**	**96**	**182**
Road surface conditions			
Dry	22	58	110
Adverse (icy, snowy or wet)	15	33	59
Total Heavy Truck Accidents ^	**37**	**91**	**169**
Road Geometry			
Undivided	25	67	120
Divided	11	25	49
*Total Heavy Truck Accidents***	**36**	**92**	**169**
Major Contributing Factors ^^			
Human Condition	0	9	7
Human Action	7	10	35
Vehicle Condition	0	4	5
Environmental Condition	4	20	44
Time of Year			
Winter (December to February)	12	27	50
Spring (March to May)	8	25	43
Summer (June to August)	7	17	38
Fall (September to November)	10	23	43
Total Heavy Truck Accidents	**37**	**92**	**174**
Time of Day			
00:01 to 06:00	0	7	39
06:01 to 12:00	6	29	44
12:01 to 18:00	16	34	51
18:01 to 00:00	15	22	39
Total Heavy Truck Accidents ##	**37**	**92**	**173**

* This refers to the number of **heavy trucks** involved in accidents, not the number of **HTAs**

\+ In the three provinces, it is not possible to determine from the database the number of bobtails involved in accidents

^ For one of the HTAs in SK, the road surface conditions were not recorded in the database. For 5 of the HTAs in AB, the information was shown as "unknown"

** For one of the accidents in MB, the road category was not registered. For 4 of the HTAs in AB, the road class was not identified, and for one of the HTAs it was shown as "other".

For one of the HTAs in AB there is no time recorded.

^^ In AB, these categories are not identified as "major contributing factors" but are identified as regular fields.

The Alberta database provides the opportunity to analyze the body type of heavy trucks involved in accidents. The most common body types in fatal HTAs in Alberta were vans, flatbeds (highboys), and tankers. The three body types accounted for two-thirds of all trailers involved in fatal HTAs. Vans were the most common (one-quarter), platforms accounted for 22 percent, and tankers accounted for 20 percent. Comparatively, of a limited survey of 2,101 trucks (DS-Lea and UMTIG, 1999), vans accounted for 40 percent, platforms accounted for 26 percent, and tankers accounted for 13 percent of the truck fleet operating in Alberta.

About 35 percent of the fatal HTAs in the Prairies occurred under adverse road surface conditions (icy, snowy or wet road).

4.2.4 Heavy Truck Accidents by Number of Trailers

Single trailer combinations accounted for two-thirds of all heavy trucks involved in HTAs in the Prairie region. Double trailer combinations accounted for one-third, and triple trailer combinations accounted for one percent. Tables 4-5, 4-6, and 4-7 show the number of heavy trucks in accidents by number of trailers in each of the three provinces for the period between 1993 and 1998. Details are in Appendix B.

4.2.5 Major Factors Contributing to Heavy Truck Accidents

This section presents information regarding major contributing factors for HTAs in Manitoba, Saskatchewan, and Alberta on provincial highways as recorded for the heavy

Table 4-5: HTs in Accidents by Number of Trailers--MANITOBA

Year	Number of Trailers					
	Single	Double	Triple	Unknown	Other*	Total
1993	98	24	3	3	15	143
1994	85	29	3	25	8	150
1995	176	42	2	11	18	249
1996	154	38	1	11	15	219
1997	146	33	2	20	25	226
1998	164	32	3	12	15	226
Total	823	198	14	82	96	1213

* "other" is the sum of trailer codes 08, 12, 13, and 14 from the police reports

"unknown" trailer types are those coded as "N" (no towed vehicle) in the accident database

Table 4-6: HTs in Accidents by Number of Trailers--SASKATCHEWAN

Year	Number of Trailers					
	Single	Double ^	Triple*	Unknown	Other**	Total
1993	211	110	n/a	48	11	380
1994	198	112	n/a	60	10	380
1995	223	149	n/a	67	16	455
1996	243	108	n/a	77	20	448
1997	239	115	n/a	79	17	450
1998	213	107	n/a	57	19	396
Total	1327	701	n/a	388	93	2509

n/a = information not available

* it is not possible to determine from the database the number of triples involved in accidents

** "other" is the sum of trailer codes 01, 02, 03, 04, 05, 06, 11, and 12 from the police reports

"unknown" configurations are those not recorded in the database

Table 4-7: HTs in Accidents by Number of Trailers–ALBERTA

Year	Number of Trailers					
	Single	Double	Triple	Unknown	Other*	Total
1993	281	175	4	77	14	551
1994	470	242	5	87	13	817
1995	333	202	1	94	12	642
1996	391	185	3	153	18	750
1997	418	212	17	113	25	785
1998	388	213	9	94	64	768
Total	2281	1229	39	618	146	4313

* "other" is the sum of trailer codes 04, 05, 06, 07, 08, 09, and 98

"Unknown" refers to codes 97 (no information available), 99 (unknown), and blank records in the database trucks involved in the accidents. Table 4-8 shows the number of HTAs by major contributing factor. The four major contributing factors, as defined and recorded by the police at the time of an accident in Manitoba and Saskatchewan are: (1) *human action/driver action*, which involves things such as vehicle following too closely, fail to yield to the right of way, improper change of lanes, improper turning, driving too fast for road conditions; (2) *human condition*, which includes driver inattentive, loss of consciousness prior to the accident, extreme fatigue, defective eyesight; (3) *vehicle condition* refers to problems such as defective brakes, defective lights, jacknife, defective tires, weight excess (overloaded), load shift, and others; and (4) *environmental condition* refers to things such as intervention of wild life, snow drift, sun glare, construction zone, and weather condition.

In Alberta, there are no "major contributing factor" fields in the database similar to those in the other two provinces. However, there are separate fields that are consistent with each of the contributing factors used in the Manitoba and Saskatchewan databases: (1) *driver action* involves the same elements as the other two provinces; (2) *driver/pedestrian condition* includes fewer options than the other two provinces–had been drinking, impaired by alcohol, impaired by drugs, fatigued/asleep, and medical defect; (3) *vehicle condition* also includes fewer options than the other two databases–defective brakes, tires failed, improper load/shift, and lighting defect; and (4) *environmental condition* includes things like raining, hail/sleet, snow, fog/smog, and high wind. This category does not include wild life intervention, which is a very common contributing factor in the other two provinces, however, there is a different way of arriving at the total number of HTAs involving animal intervention. The analysis was

Table 4-8: Major Factors Contributing to Heavy Truck Accidents

	MANITOBA						
	1993	1994	1995	1996	1997	1998	Total
Human Condition							
SVA	2	5	6	3	5	4	25
MVA	4	5	7	7	2	4	29
Human Action							
SVA	10	9	15	13	21	21	89
MVA	20	26	34	32	29	37	178
Vehicle Condition							
SVA	8	9	15	14	9	15	70
MVA	8	1	4	2	3	6	24
Environmental Condition							
SVA	22	29	47	36	45	43	222
MVA	13	15	24	32	22	19	125

	SASKATCHEWAN						
	1993	1994	1995	1996	1997	1998	Total
Human Condition							
SVA	40	31	43	46	47	47	254
MVA	31	21	27	37	38	38	192
Human Action							
SVA	19	32	36	32	42	36	197
MVA	44	49	50	53	57	50	303
Vehicle Condition							
SVA	22	29	37	39	33	32	192
MVA	7	11	21	17	5	11	72
Environmental Condition							
SVA	131	122	143	104	124	87	711
MVA	30	33	64	71	58	36	292

	ALBERTA						
	1993	1994	1995	1996	1997	1998	Total
Human Condition							
SVA	28	28	22	14	22	26	140
MVA	4	3	5	3	4	4	23
Human Action							
SVA	110	120	98	88	118	100	634
MVA	83	100	94	105	103	115	600
Vehicle Condition							
SVA	12	19	21	12	19	13	96
MVA	6	18	9	16	19	14	82
Environmental Condition*							
SVA	130	209	167	199	160	193	1058
MVA	99	180	104	189	137	125	834

* This includes accidents with animals (object type 7 in AB database) for consistency with MB and SK. There were 619 SVA and 8 MVA involving animals between 1993 and 1998.

done and the results were included under the environmental condition category, for consistency with Manitoba and Saskatchewan. Appendix B shows details about contributing factors for HTAs in the three provinces.

From Table 4-8, *Environmental condition* was reported as a contributing factor in 42 percent of all HTAs, *human action* was reported in one-quarter of all HTAs, *human condition* was reported in nine percent of the HTAs, and *vehicle condition* was reported in seven percent of the HTAs. Appendix B shows details about each of the provinces and the corresponding analysis of factors contributing to HTAs.

4.2.6 Heavy Truck Accidents by Road Surface Condition

Table 4-9 shows the number of HTAs by road surface condition for the three provinces. Adverse road surface conditions (wet, snow, ice, slush) were reported in 38 percent of all heavy truck accidents in the region, and dry road surface conditions were reported in the remaining 62 percent.

The analysis of HTAs by roadway category (divided versus undivided) is in Appendix B.

4.2.7 Temporal Distribution of Heavy Truck Accidents

The temporal distributions of HTAs from 1978 to 1998 for Manitoba, 1988 to 1998 for Saskatchewan, and 1993 to 1998 for Alberta are shown in Figures 4-3a, 4-3b, 4-3c, 4-4a, 4-4b, 4-4c, 4-5a, 4-5b, and 4-5c. These temporal distributions refer to month of year, day of week, and time of day.

Table 4-9: Heavy Truck Accidents by Road Surface Condition

Surface Condition	1993	1994	1995	1996	1997	1998	Total
Manitoba							
Dry	84	90	124	108	130	125	661
Wet	19	12	19	10	20	14	94
Snow	9	18	41	34	28	22	152
Ice	23	21	47	51	34	44	220
Slush	1	3	1	2	0	3	10
Unknown	0	2	2	2	5	3	14
Other *	1	1	2	1	1	2	8
Total HTAs	137	147	236	208	218	213	1159
Saskatchewan							
Dry	236	252	250	225	257	242	1462
Wet	24	18	29	22	30	24	147
Snow	23	24	30	44	20	28	169
Ice	73	61	110	119	95	58	516
Slush	5	1	5	8	6	9	34
Unknown	3	2	2	3	4	2	16
Other *	3	8	3	4	10	6	34
Total HTAs	367	366	429	425	422	369	2378
Alberta							
Dry	315	442	356	320	468	472	2373
Wet	57	66	48	44	64	66	345
Slush/snow/ice ^	138	253	177	308	182	161	1219
Unknown #	14	15	20	25	23	20	117
Other *	3	8	3	14	12	7	47
Total HTAs	527	784	604	711	749	726	4101

* In MB and SK, "other" includes loose gravel or sand, mud, and fresh oil. In AB, "other" includes loose surface material (code 04), muddy (code 05), and "other" (code 98).

^ slush/snow/ice is one category in the AB accident database (code 03--surface condition).

unknown refers to "unknown" (code 99) and to fields that were left blank or were assigned code 97.

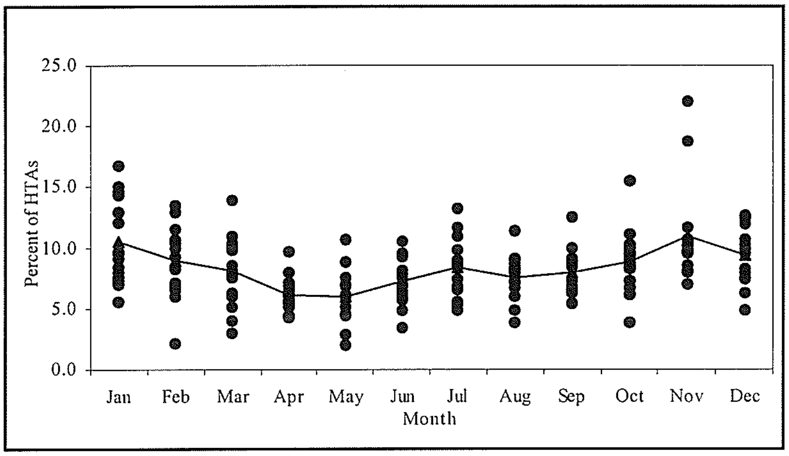


Figure 4-3a: Police-reported HTAs in Manitoba by Month (1978-1998)
Source: Developed from raw data provided by MTGS

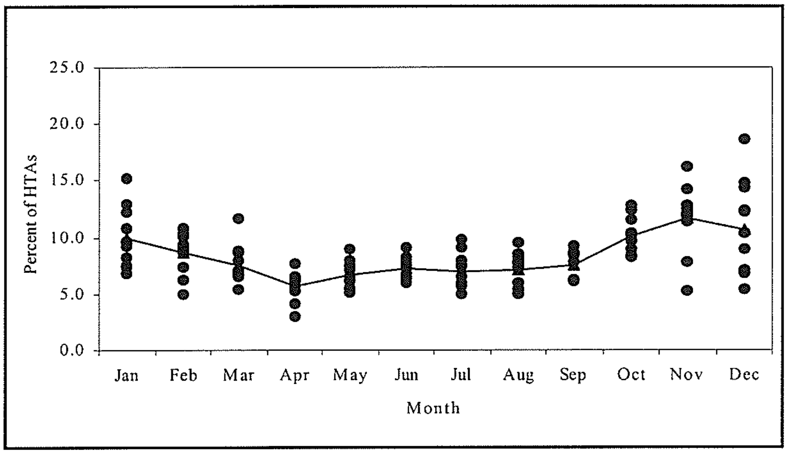


Figure 4-3b: Police-reported HTAs in SK by Month (1988-1998)
Source: Developed from raw data provided by SGI

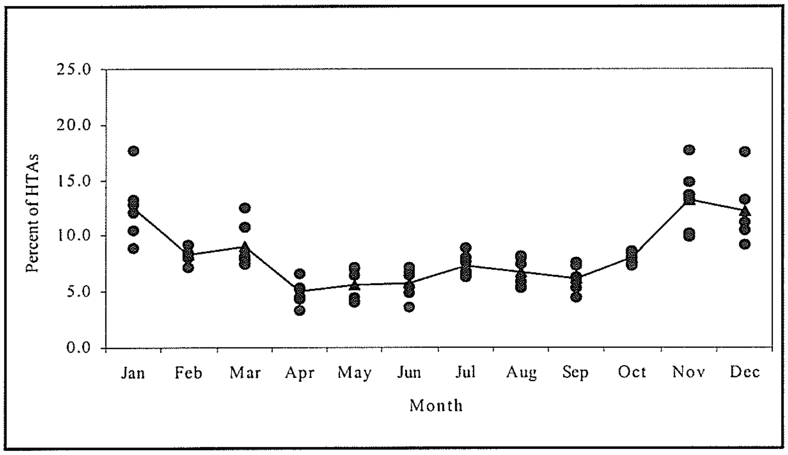


Figure 4-3c: Police-reported HTAs in Alberta by Month (1993-1998)
Source: Developed from raw data provided by Alberta Transportation

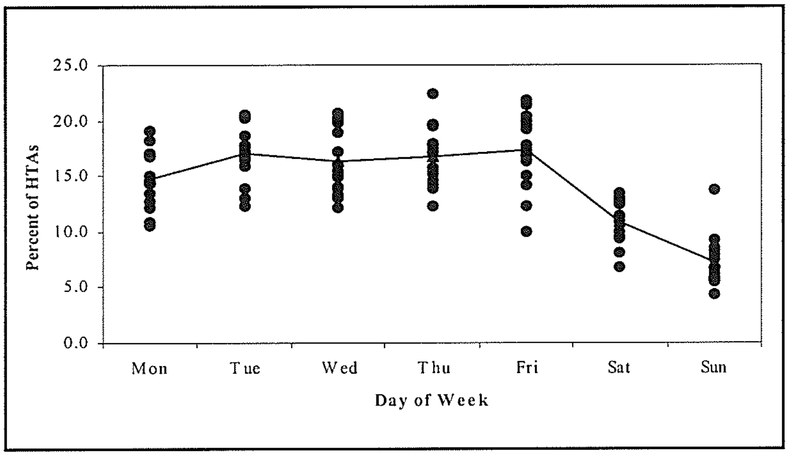


Figure 4-4a: Police-reported HTAs in MB by Day of Week ('78-'98)
Source: Developed from raw data provided by MTGS

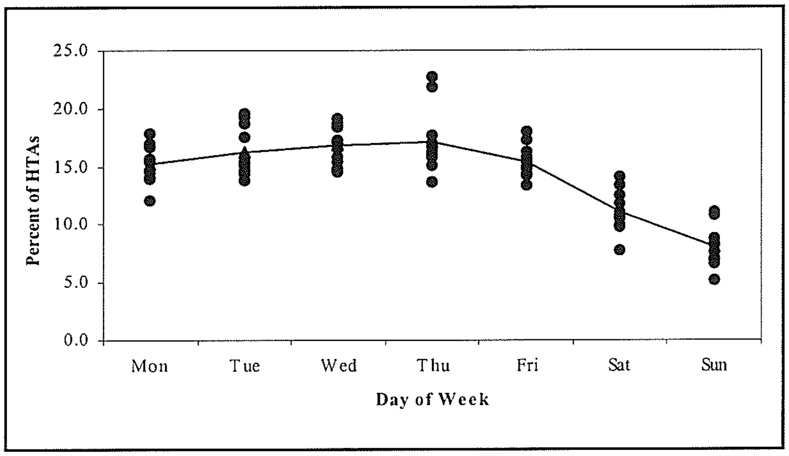


Figure 4-4b: Police-reported HTAs in SK by Day of Week ('88-'98)
Source: Developed from raw data provided by SGI

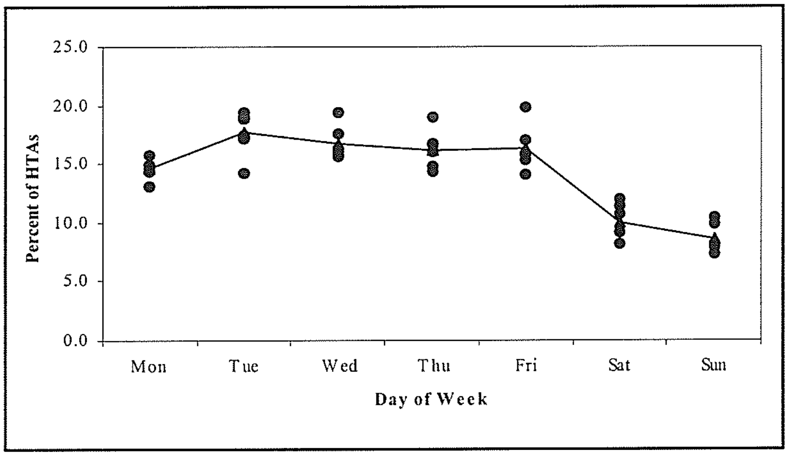


Figure 4-4c: Police-reported HTAs in AB by Day of Week ('93-'98)
Source: Developed from raw data provided by Alberta Transportation

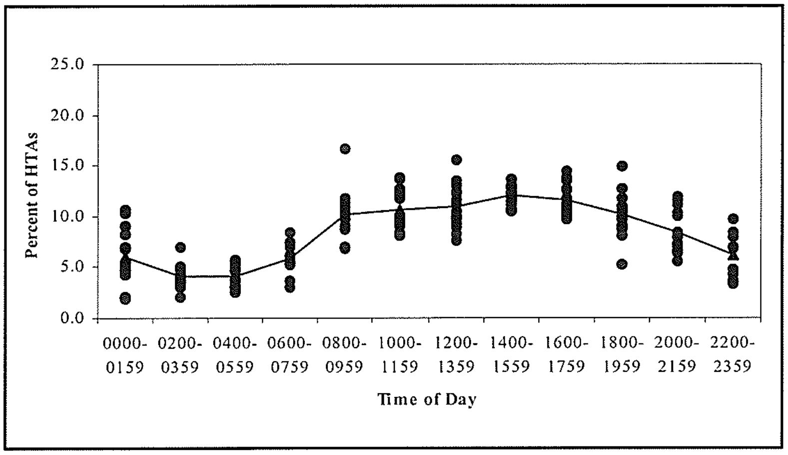


Figure 4-5a: Police-reported HTAs in MB by Time of Day ('78-'98)
Source: Developed from raw data provided by MTGS

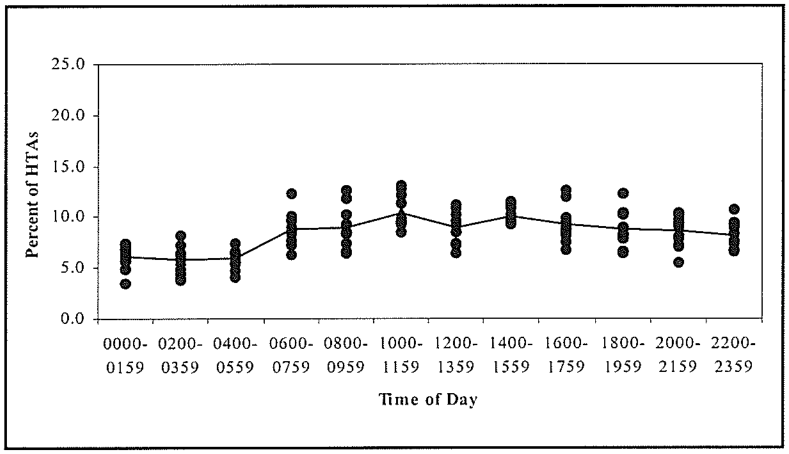


Figure 4-5b: Police-reported HTAs in SK by Time of Day ('88-'98)
Source: Developed from raw data provided by SGI

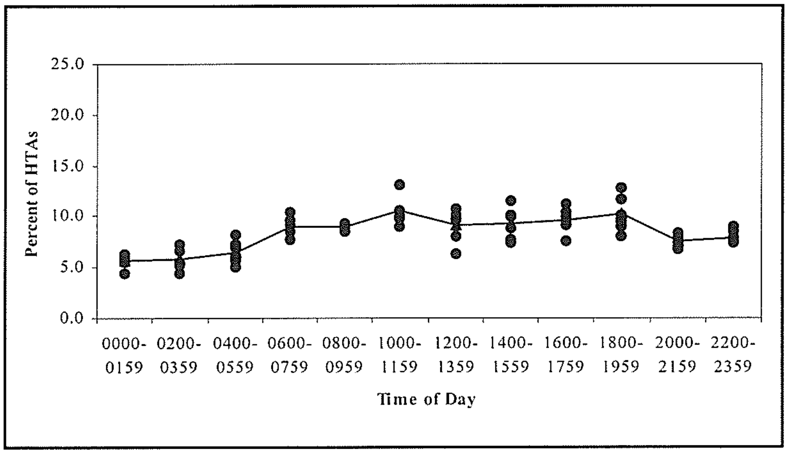


Figure 4-5c: Police-reported HTAs in AB by Time of Day ('93-'98)
Source: Developed from raw data provided by Alberta Transportation

There are consistent patterns in the three provinces relating to monthly and day of week distributions. In all provinces, the distribution of HTAs by month shows higher accident proportions between the months of November and February. In total, these months account for about one-half of all HTAs. The month with the highest number of HTAs in each of the three provinces is November. The month that shows the lowest accident proportion in the three provinces is April, on average accounting for approximately six percent of HTAs.

The distribution of HTAs by day of week is illustrated in Figures 4-4a to 4-4c. The figures show lower accident proportions on the weekends with Sunday being the lowest in all three provinces. On average, each week day accounts for approximately 16 percent of HTAs, and each weekend day accounts for eight to 10 percent in the three provinces.

Figures 4-5a to 4-5c illustrate the distribution of HTAs by time of day. The distribution of HTAs is approximately the same for all provinces. The period between midnight to 6:00 a.m. accounts for the lowest proportion of HTAs in all three provinces.

4.2.8 Geographical Distribution of Heavy Truck Accidents

This section discusses the geographical distribution of HTAs in the Prairie region based on the geocoding of the accident information. Figure 4-6 illustrates all geocoded accidents for the three provinces for the period between 1993 and 1998. Not all HTAs could be plotted in each province due to problems with the databases (*e.g.*, incomplete or inaccurate information). In Manitoba, 1,090 of 1,159 HTAs were plotted. In Saskatchewan 2,335 of

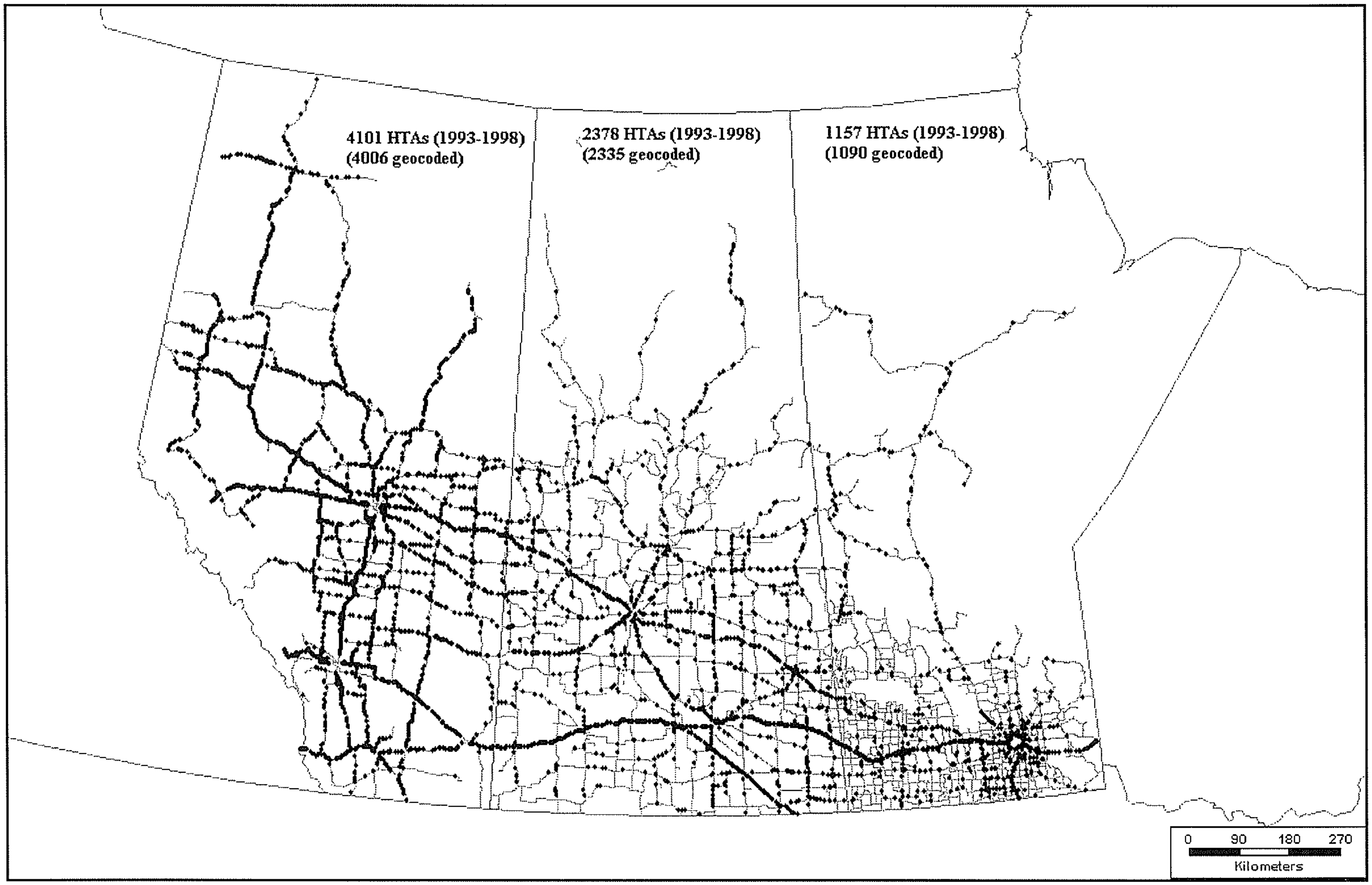


Figure 4-6: Geographical Distribution of HTAs in the Prairie Region (1993-1998)

2,378 HTAs were plotted, and in Alberta, 4,006 of 4,101 HTAs were plotted. Appendix C contains maps of HTAs on provincial highways, as well as a list of all the case numbers of HTAs that could not be plotted for each of the provinces.

Tables 4-10a, 4-10b, and 4-10c illustrate the distribution of highway kilometers and HTAs, as a function of road category (divided versus undivided) and Annual Average Daily Truck Traffic (AADTT) for 1998 traffic for each of the three provinces. Chapter 6 discusses the truck traffic data in detail, and presents the exposure-based analysis. Tables 4-11a, 4-11b, and 4-11c, illustrate the same distribution as a function of highway loading class (RTAC versus non-RTAC). There were 1,116 HTAs occurring on Manitoba provincial highways, 2,280 HTAs occurring on Saskatchewan provincial highways, and 3,808 occurring on Alberta provincial highways in the years 1993 to 1998 for which both the location (highway section) and the AADTT were known.

From Tables 4-10a to 4-10c and Figure 4-6, the following is obtained about the geographical distribution of HTAs by road category in the Prairie Region (Figures C-1, C-2, and C-3 in Appendix C illustrate the location of the accidents that were geocoded):

- Divided highways accounted for one-third of all HTAs, and for six percent of all provincial highway mileage in the region. Undivided highways accounted for two-thirds of HTAs, and 94 percent of the provincial highway mileage.
- Thirty percent of all Manitoba HTAs on provincial highways occurred on sections of the Trans-Canada highway excluding those on the perimeter road. One-quarter of all HTAs on Saskatchewan provincial highways, and 11 percent of all HTAs on Alberta provincial highways occurred on the Trans-Canada highway.

Table 4-10a: Distribution of HTAs on Manitoba's Highway Network by Road Category

Truck Volume (AADTT)	Kilometers of Highway			Number of HTAs (1993-1998)		
1998	Divided	Undivided	Total	Divided	Undivided	Total
0-150	4	15198	15202	1	315	316
151-400	103	1450	1553	24	201	225
401-1000	415	310	725	197	122	319
>1000	241	13	254	252	4	256
Total	763	16971	17734	474	642	1116

Source: Manitoba Transportation and Government Services, UMTIG

Table 4-10b: Distribution of HTAs on Saskatchewan's Highway Network by Road Category

Truck Volume (AADTT)	Kilometers of Highway			Number of HTAs (1993-1998)		
1998	Divided	Undivided	Total	Divided	Undivided	Total
0-150	2	18039	18041	0	726	726
151-400	19	3010	3029	3	503	506
401-1000	344	763	1107	159	256	415
>1000	507	243	750	391	243	634
Total	872	22055	22927	553	1728	2281

Source: Saskatchewan Highways and Transportation, SGI, UMTIG

Note: Due to database structure problems, there is one HTA that is being counted twice in the undivided road category (1727 vs 1728) There are 8 HTAs that fell at the boundary of "divided/undivided" control sequences, causing the accidents to be counted twice in the analysis (once in the undivided section, and once in the divided section). Only the HTA on the "undivided" section was kept for analysis. The case numbers of the 8 HTAs are: 782723, 865025, 867750, 867764, 867858, 868502, 1039565, and 1157267.

Table 4-10c: Distribution of HTAs on Alberta's Highway Network by Road Category

Truck Volume (AADTT)	Kilometers of Highway			Number of HTAs (1993-1998)		
1998	Divided	Undivided	Total	Divided	Undivided	Total
0-150	0	4547	4547	0	412	412
151-400	47	5937	5984	18	1300	1318
401-1000	858	1699	2557	566	723	1289
>1000	637	66	703	729	60	789
Total	1542	12249	13791	1313	2495	3808

Source: Alberta Transportation, UMTIG

Note: There are 4 HTAs that fell at the boundary of two control sequences. Only one of each duplicate was kept for analysis: Case numbers 553205, 554249, 710904, and Z234303

- Approximately 28 percent of all HTAs on provincial highways in the Prairie region occurred at intersections. The provincial figures of intersection HTAs are: 37 percent in Manitoba, 29 percent in Saskatchewan, and 25 percent in Alberta.

- Nearly 10 percent (105 of 1,116) of all provincial HTAs in Manitoba occurred on the Perimeter road around Winnipeg.

- The highway section between Edmonton and Calgary (Highway 2), accounted for the largest number of HTAs on provincial highways in Alberta. There were 491 HTAs on this highway section, accounting for 13 percent of all HTAs on provincial highways in the province.

- About 40 percent of all Manitoba HTAs on provincial highways (422 of 1,116) occurred on highways designated as part of the National Highway System (NHS). NHS-designated highways in Manitoba account for 862 kilometers or five percent of the provincial highway network. Nearly one-half of all Saskatchewan HTAs on provincial highways (1,076 or 2,280) occurred on highways designated as part of the NHS. These highways in Saskatchewan account for 2,114 kilometers or nearly 10 percent of the provincial highway network. Nearly one half (48 percent) of all Alberta HTAs on provincial highways (1,846 of 3,808) occurred on highways designated as part of NHS. These highways in Alberta account for 3,396 kilometers or one-quarter of the provincial highway network.

Regarding the distribution of HTAs by highway load class, Tables 4-11a to 4-11c show that nearly nine of every 10 HTAs in the Prairie region take place on basic RTAC highways. In Manitoba and Saskatchewan, these highways account for 22 percent and 31 percent of the highway network respectively (this research does not deal with secondary highways in Alberta given that they were not classified as provincial highways during the research period).

Table 4-11a: Distribution of HTAs on Manitoba's Highway Network by Load Class

Truck Volume (AADTT)	Kilometers of Highway			Number of HTAs (1993-1998)		
1998	**RTAC**	**NON-RTAC**	**Total**	**RTAC**	**NON-RTAC**	**Total**
0-150	2005	13213	15217	93	223	316
151-400	953	599	1582	156	69	225
401-1000	653	55	725	295	24	319
>1000	224	29	233	245	11	256
Total	3835	13896	17731	789	327	1116

Source: Developed from raw data provided by Manitoba Transportation and Government Services

Table 4-11b: Distribution of HTAs on Saskatchewan's Highway Network by Load Class

Truck Volume (AADTT)	Kilometers of Highway			Number of HTAs (1993-1998)		
1998	**RTAC**	**NON-RTAC**	**Total**	**RTAC**	**NON-RTAC**	**Total**
0-150	2676	15365	18041	254	472	726
151-400	2589	440	3029	462	44	506
401-1000	1078	29	1107	411	4	415
>1000	750	0	750	634	0	634
Total	7093	15834	22927	1761	520	2281

Source: Developed from raw data provided by Saskatchewan Highways and Transportation, and SGI

Table 4-11c: Distribution of HTAs on Alberta's Highway Network by Load Class

Truck Volume (AADTT)	Kilometers of Highway			Number of HTAs (1993-1998)		
1998	**RTAC**	**NON-RTAC**	**Total**	**RTAC**	**NON-RTAC**	**Total**
0-150	4547	n/a	4547	412	n/a	412
151-400	5984	n/a	5984	1318	n/a	1318
401-1000	2557	n/a	2557	1289	n/a	1289
>1000	703	n/a	703	789	n/a	789
Total	13791	n/a	13791	3808	n/a	3808

n/a–not applicable. All primary highways in Alberta are RTAC highways. Secondary highways are not considered in this analysis given that they were not designated as provincial highways during the research period.

Source: Developed from raw data provided by Alberta Transportation

4.3 HEAVY TRUCK ACCIDENTS IN MAJOR URBAN CENTERS

Between 1993 and 1998, there were a total of 7,200 HTAs in the major urban areas of the Prairie region. This is about one half of all HTAs in the Prairie region. This section presents a discussion of HTAs in Winnipeg, Regina, Saskatoon, Edmonton, and Calgary.

4.3.1 Historical Trend of Heavy Truck Accidents

Figures 4-7 and 4-8 illustrate a historical distribution of HTAs in the five major urban centers of Manitoba, Saskatchewan, and Alberta for the period between 1993 and 1998. The first figure illustrates the frequency of HTAs in those urban areas, and the second figure illustrates the proportion of HTAs relative to total accidents in each of the urban areas. Between 1993 and 1998, HTAs accounted for 1.5 percent of total accidents in the major urban areas of the Prairie region.

The proportion of heavy truck accidents, as a function of total accidents, is approximately equal in three of the five cities. Winnipeg, Regina, and Calgary show an average proportion of HTAs relative to total accidents of about 1.3 percent. Saskatoon shows the highest proportion of HTAs relative to total accidents, followed by Edmonton. In those two cities, HTAs account for 1.8 and 1.6 percent of total accidents respectively. This is also illustrated in Table D-1, which shows HTAs and non-HTAs for the five urban areas (Appendix D).

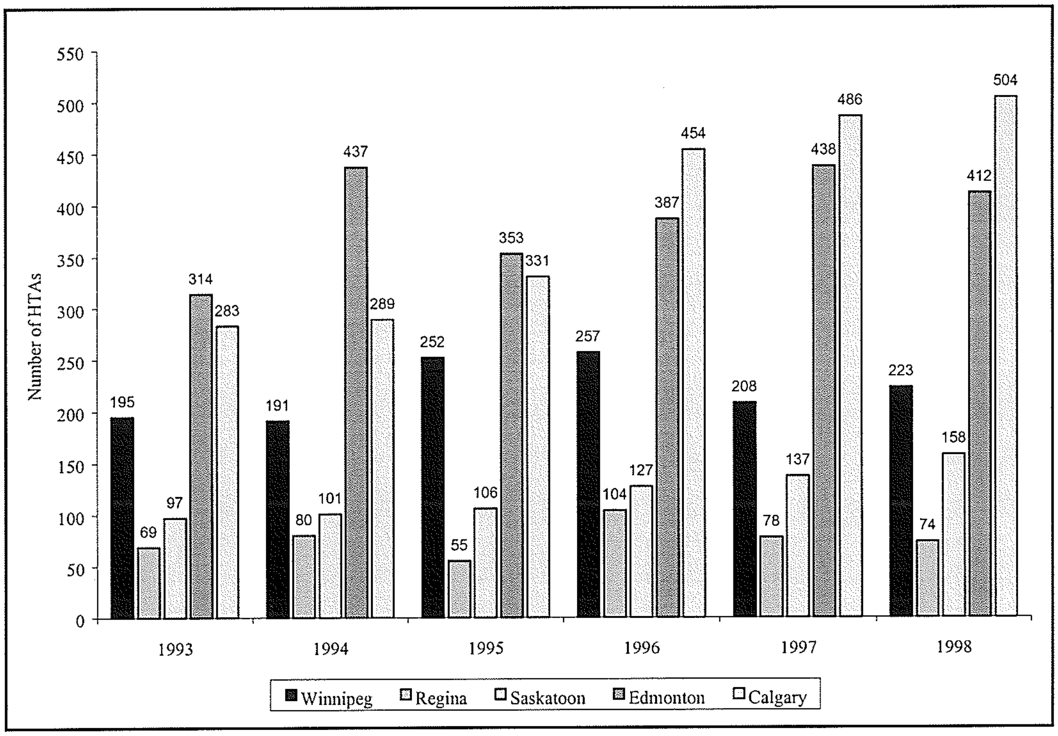


Figure 4-7: Heavy Truck Accidents in Major Urban Centers of the Prairie Region
Source: City of Winnipeg Public Works Department, SGI, and Alberta Transportation

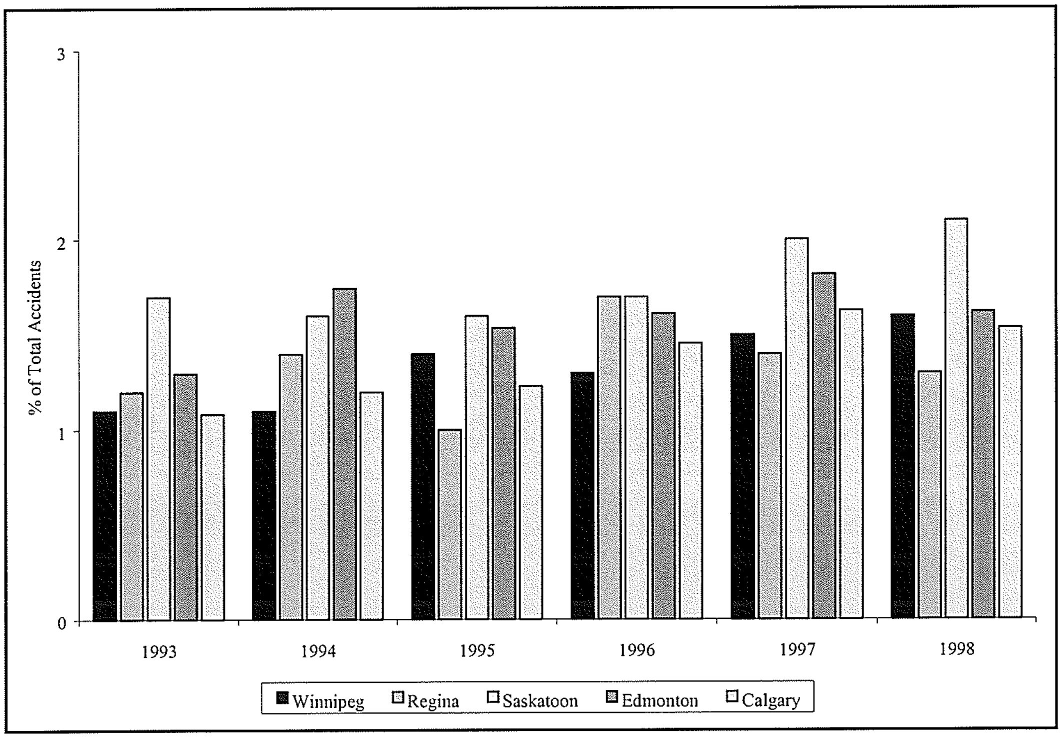


Figure 4-8: Proportion of HTAs Relative to Total Accidents in Major Urban Areas
Source: City of Winnipeg Public Works Department, SGI, and Alberta Transportation

4.3.2 Severity of Heavy Truck Accidents

Table 4-12 and Table 4-13 illustrate the total number of accidents by severity, and the total number of HTAs by severity in each of the five major urban centers. Heavy truck accidents accounted for five percent of all fatal accidents in major urban centers of the Prairie region. They also accounted for one percent of all accidents resulting in injuries in major urban centers in the three provinces.

Regarding the severity of heavy truck accidents only, on average, less than 0.5 percent of all HTAs that occurred in major urban centers of the Prairie region resulted in fatality, 15 percent resulted in injury, and 84 resulted in property damage only.

Tables D-2a, and D-2b in Appendix D illustrate the distribution of HTAs by type of accident (single-vehicle versus multiple-vehicle) and severity. From those tables, and Table 4-13, about one of every 10 HTAs in each city was a single-vehicle accident. Multiple-vehicle HTAs accidents in all cities were dominated by a heavy truck colliding with an passenger car, a pick-up, a van, or a lighter truck. Over the six-year period, about nine of every 10 HTAs were multiple-vehicle accidents.

Regarding the type of accidents involving heavy trucks in urban areas, two types of accidents were most common in all cities—sideswipe and rear end. These two types of accidents accounted for two-thirds of all HTAs in Winnipeg, and about 40 percent of all HTAs in each Regina, Saskatoon, Edmonton, and Calgary.

Table 4-12: Total Accidents by Severity in Major Urban Areas

Year	WINNIPEG				REGINA				SASKATOON				EDMONTON				CALGARY			
	Fatal	Injury	Property Damage	WPG Total	Fatal	Injury	Property Damage	RE Total	Fatal	Injury	Property Damage	SK Total	Fatal	Injury	Property Damage	EDM Total	Fatal	Injury	Property Damage	CAL Total
1993	25	7265	10777	**18067**	9	1625	3934	**5568**	5	1143	4592	**5740**	28	4881	19325	**24234**	31	2456	23635	**26122**
1994	20	6056	10701	**16777**	8	1628	4199	**5835**	6	1209	4921	**6136**	28	5198	19803	**25029**	28	2753	21297	**24078**
1995	19	5190	12390	**17599**	8	1274	4164	**5446**	5	1052	5534	**6591**	23	5207	17732	**22962**	42	3146	23734	**26922**
1996	21	4195	11615	**15831**	8	1247	4774	**6029**	5	914	6581	**7500**	16	5452	18549	**24017**	32	3612	27542	**31186**
1997	21	3570	10423	**14014**	6	1218	4162	**5386**	9	973	6008	**6990**	18	6101	17981	**24100**	33	3900	25957	**29890**
1998	20	3740	10226	**13976**	3	1337	4507	**5847**	5	1081	6433	**7519**	24	6393	19020	**25437**	40	3942	28838	**32820**
Total	126	30016	66132	**96264**	42	8329	25740	**34111**	35	6372	34069	**40476**	137	33232	112410	**145779**	206	19809	151003	**171018**

Source: City of Winnipeg Public Works Department, SGI, and Alberta Transportation

Table 4-13: Total Heavy Truck Accidents by Severity in Major Urban Areas

Year	WINNIPEG				REGINA				SASKATOON				EDMONTON				CALGARY +			
	Fatal**	Injury^	Property Damage*	WPG Total	Fatal	Injury	Property Damage	RE Total	Fatal	Injury	Property Damage	SK Total	Fatal	Injury	Property Damage	EDM Total	Fatal	Injury	Property Damage	CAL Total
1993	1	47	147	**195**	0	12	57	**69**	0	16	81	**97**	2	51	261	**314**	0	29	254	**283**
1994	4	40	146	**190**	0	14	66	**80**	0	23	78	**101**	1	66	370	**437**	0	29	260	**289**
1995	1	45	206	**252**	1	14	40	**55**	0	19	87	**106**	1	52	300	**353**	1	40	290	**331**
1996	1	53	203	**257**	1	10	93	**104**	0	21	106	**127**	0	71	316	**387**	4	50	400	**454**
1997	1	28	179	**208**	0	14	64	**78**	1	12	124	**137**	2	87	349	**438**	2	48	436	**486**
1998	0	38	185	**223**	1	6	67	**74**	0	17	141	**158**	1	87	324	**412**	4	50	450	**504**
Total	8	251	1066	**1326**	3	70	387	**460**	1	108	617	**726**	7	414	1920	**2341**	11	246	2090	**2347**

** The fatal category includes codes 3 (fatal driver of passenger) and 5 (pedestrian fatal) from the Winnipeg accident code forms.

^ The injury category includes codes 1 (injury), 2 (hospitalized), 4 (pedestrian injury), and 8 (pedestrian hospitalized) from Winnipeg's accident code forms.

* These are accidents for which there was no injury or the injury was not stated (injury codes 0 or 7) and that resulted in a property damage of either more than $1,000 (codes 05 to 09 from "property damage" category in Winnipeg's accident code form), or less than $1,000. Accidents for which there was no injury and that resulted in a property damage of less than $1,000 or for which the severity or damage was not stated are as follows for the six years: 1993 = 22, 1994 = 27, 1995 = 28, 1996 = 28, 1997 = 23, 1998 = 25

+ For 2 of the HTAs in Calgary for 1993, it was not specified whether the accident was single vehicle or multiple vehicle.

4.3.3 Heavy Truck Accidents Involving Fatalities

Between 1993 and 1998, there were eight fatal HTA in Winnipeg, three in Regina, one in Saskatoon, seven in Edmonton, and 11 in Calgary. From the databases used in the analysis, it is not always possible to determine what type of movement was being made by the heavy truck at the time of the accident. Following is a discussion about these fatal HTAs.

Nine of the accidents in the five urban centers involved a right angle collision. Four of the accidents involved a head-on collision. A left turn and straight through accident configuration accounted for eight of the accidents in all cities. One of the accidents involved a tractor semitrailer and a pedestrian (this was in Winnipeg). One of the accidents was a sideswipe and two were rear end (these were all in Calgary). For four of the accidents the truck hit an object. In one of the accidents a vehicle was passing and the other was making a right turn (in Calgary).

Five of the fatal accidents in each Winnipeg, Edmonton, and Calgary, as well as the accident in Saskatoon and two of the accidents in Regina occurred under dry road surface conditions. Adverse road surface conditions (ice, snow, or wet road) accounted for three of the eight accidents in Winnipeg, one of the three accidents in Regina, two of the seven in Edmonton, and six of the 11 accidents in Calgary.

Some of the fatal HTAs in Regina, Edmonton, and Calgary involved single trailer combinations (11 of 21). The fatal HTA in Saskatoon also involved a single trailer combination. Similar information was not available from Winnipeg's database.

4.3.4 Heavy Truck Accidents by Number of Trailers

This analysis is for Regina, Saskatoon, Edmonton, and Calgary. In the case of Winnipeg, it is not possible to determine from the database the trailer type of heavy trucks involved in accidents. This is because all heavy trucks are combined under a category called "semi-trailer" (vehicle type code 14 in the database). This category includes single trailer combinations and double trailer combinations together. However, with the new system "On-Trac" introduced in 1999, this type of analysis will be possible to conduct in the future.

Tables 4-14a to 4-14d illustrate the number of heavy trucks in accidents (not heavy truck accidents) by number of trailers for the four cities. This analysis is based on the total number of heavy trucks for which the trailer configuration is known. Although the tables show the number of "unknown" and "other" trailers, the figures presented in this section are based on the total number of single, double and triple trailers only. Over the six-year period, trailer information (i.e., single, double or triple) was available for about two-thirds of all the HTAs in Regina and Edmonton, and for one-half of all the HTAs in Saskatoon and Calgary.

Single trailer combinations accounted for 80 percent of all heavy trucks involved in HTAs in the four cities. Double trailer combinations accounted for 19 percent, and triple trailer combinations accounted for approximately one percent. Details of the analysis are in Appendix D.

Table 4-14a: Number of HTs in Accidents by Number of Trailers (Regina)

Year	REGINA					
	Single	Double^	Triple*	Unknown	Other**	Total
1993	36	14	n/a	18	2	70
1994	37	19	n/a	21	5	82
1995	28	8	n/a	18	2	56
1996	43	21	n/a	38	4	106
1997	28	10	n/a	37	4	79
1998	33	16	n/a	24	2	75
Total	205	88	n/a	156	19	468

^ Of the 88 double trailer combinations for the 6-year period, 42 were A-trains, 31 were B-trains, and 18 were C-trains.

* In SK it is not possible to determine from the database the number of triples involved in accidents

** Other includes all types of trailers that are not single or double (i.e., codes 01, 02, 03, 04, 05, 06, 11, and 12)

Table 4-14b: Number of HTs in Accidents by Number of Trailers (Saskatoon)

Year	SASKATOON					
	Single	Double ^	Triple*	Unknown	Other**	Total
1993	47	12	n/a	36	2	97
1994	38	13	n/a	46	4	101
1995	35	12	n/a	59	4	110
1996	46	16	n/a	61	5	128
1997	37	16	n/a	82	5	140
1998	56	16	n/a	80	6	158
Total	259	85	n/a	364	26	734

^ Of the 85 double trailer combinations for the 6-year period, 26 were A-trains, 37 were B-trains, and 22 were C-trains.

* In SK it is not possible to determine from the database the number of triples involved in accidents

** Other includes all types of trailers that are not single or double (i.e., codes 01, 02, 03, 04, 05, 06, 11, and 12)

Table 4-14c: Number of HTs in Accidents by Number of Trailers (Edmonton)

Year	EDMONTON					
	Single	Double	Triple	Unknown	Other*	Total
1993	177	39	2	105	2	325
1994	228	60	5	158	2	453
1995	212	25	2	126	4	369
1996	216	37	4	141	1	399
1997	287	63	4	102	9	465
1998	233	44	8	75	72	432
Total	1353	268	25	707	90	2443

* Other includes all trailers that are not singles, doubles, or triples (i.e., codes 04, 05, 06, 07, 08, 09, and 98)

Table 4-14d: Number of HTs in Accidents by Number of Trailers (Calgary)

Year	CALGARY					
	Single	Double	Triple	Unknown	Other*	Total
1993	145	37	2	107	3	294
1994	158	38	1	107	0	304
1995	145	42	2	166	3	358
1996	205	38	1	229	6	479
1997	202	39	2	259	6	508
1998	195	31	4	298	8	536
Total	1050	225	12	1166	26	2479

* Other includes all trailers that are not singles, doubles, or triples (i.e., codes 04, 05, 06, 07, 08, 09, and 98)

4.3.5 Major Factors Contributing to Heavy Truck Accidents

This section presents information regarding major contributing factors for HTAs in Regina, Saskatoon, Edmonton, and Calgary. In the case of Winnipeg, the database does not contain information regarding major contributing factors for HTAs. There is a field in the database that provides *indirect causes* associated with a particular accident. However, the "causes" entered in this field range from *stalled vehicle* to *color of pedestrian clothing*, to *out of town driver*.

The four major contributing factors as recorded by the police at the time of an accident are as discussed in Section 4.2.5. Table 4-15 shows the number of HTAs by major contributing factor for the period 1993 to 1998 in the four cities. From the table, *human action* was reported in 45 percent of all HTAs in the four urban areas, *human condition* was reported in 10 percent of the HTAs, *vehicle condition* was reported in three percent of the HTAs, and *environmental condition* was reported in 15 percent of the HTAs (Appendix D details major factors contributing to HTAs in the four urban areas). However, when analyzing each of the contributing factors by city, there are wide variations. *Human condition* was identified as a major contributing factor in just over one-quarter of the reported HTAs in Regina and Saskatoon, nine percent of the HTAs in Calgary, and only one percent of the HTAs in Edmonton. *Human action* was reported as a major contributing factor in one-quarter of the HTAs in Regina, 29 percent of the HTAs in Saskatoon, 43 percent of the HTAs in Edmonton, and 55 percent of the accidents in Calgary. *Vehicle condition* was reported as a major contributing factor in 11 percent of the HTAs in Regina, and two percent of the HTAs in each Saskatoon, Edmonton, and Calgary. In Regina, *environmental condition* was identified as a major contributing factor in 13 percent of the HTAs, compared to nine percent in Saskatoon, and 16 percent in each Edmonton and Calgary.

Table 4-15: Number of Heavy Truck Accidents by Major Contributing Factor

REGINA

	1993	1994	1995	1996	1997	1998	Total
Human Condition	22	19	13	29	22	28	133
Human Action	20	13	14	31	16	21	115
Vehicle Condition	8	12	3	13	4	11	51
Environmental Condition	9	13	7	14	14	5	62

SASKATOON

	1993	1994	1995	1996	1997	1998	Total
Human Condition	34	29	20	33	33	37	186
Human Action	35	31	35	42	41	30	214
Vehicle Condition	4	4	1	4	2	3	18
Environmental Condition	5	10	5	13	14	16	63

EDMONTON

	1993	1994	1995	1996	1997	1998	Total
Human Condition	5	9	1	5	1	7	28
Human Action	152	187	176	138	168	193	1014
Vehicle Condition	3	4	10	5	12	3	37
Environmental Condition	39	87	63	70	63	53	375

CALGARY

	1993	1994	1995	1996	1997	1998	Total
Human Condition	4	7	44	64	40	57	216
Human Action	138	159	183	259	257	287	1283
Vehicle Condition	10	10	2	7	7	6	42
Environmental Condition	55	30	61	72	76	74	368

From the analysis, Alberta seems to show a more frequent use of the "human action" category than Manitoba and Saskatchewan, and a less frequent use of the "human condition" category. This does not necessarily mean that drivers who are involved in HTAs in Alberta are not as good as drivers who are involved in HTAs in Manitoba or Saskatchewan. One possible reason why these differences are evident is the police report form itself. There are specific fields in the Alberta report form for each of the contributing factors, whereas in Manitoba and Saskatchewan, the same fields do not exist. In Manitoba and Saskatchewan there are four categories to choose from when filling out the report, each category being a different contributing factor. Appendix A shows report forms used in each jurisdiction.

4.3.6 Heavy Truck Accidents by Road Surface Condition

Table 4-16 illustrates the number of HTAs by road surface condition from 1993 to 1998 for the five urban areas. For the six-year period, dry road surface conditions accounted for about two-thirds of HTAs in urban areas of the Prairie region. Adverse road surface conditions (wet, snow, ice, slush) accounted for about 36 percent of HTAs in the five cities. Regina was the city where adverse road surface conditions were reported in most HTAs (43 percent), and Calgary was the city where road surface conditions were reported the least (33 percent over the six years).

Table 4-16: Heavy Truck Accidents by Road Surface Condition

Surface Condition	1993	1994	1995	1996	1997	1998	Total
Winnipeg							
Dry	122	112	149	126	120	139	768
Wet	29	22	29	23	35	42	180
Snow	9	22	27	9	9	13	89
Ice	33	28	44	95	43	27	270
Slush	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Other *	2	7	3	4	1	2	19
Total HTAs	195	191	252	257	208	223	1326
Regina							
Dry	48	38	26	54	40	49	255
Wet	9	6	7	9	7	5	43
Snow	2	4	2	3	2	2	15
Ice	8	30	18	34	28	18	136
Slush	2	0	1	2	0	0	5
Other *	0	2	1	2	1	0	6
Total HTAs	69	80	55	104	78	74	460
Saskatoon							
Dry	58	60	54	65	84	95	416
Wet	10	7	11	11	9	19	67
Snow	1	3	3	1	3	5	16
Ice	23	25	29	44	30	27	178
Slush	0	1	1	0	0	0	2
Other *	5	5	8	6	11	12	47
Total HTAs	97	101	106	127	137	158	726
Edmonton							
Dry	198	225	197	184	276	253	1333
Wet	34	34	31	34	45	41	219
Slush/snow/ice ^	59	148	92	124	91	72	586
Unknown #	23	28	31	42	23	37	184
Other *	0	2	2	3	3	9	19
Total HTAs	314	437	353	387	438	412	2341
Calgary							
Dry	167	207	201	233	293	297	1398
Wet	33	26	34	53	57	67	270
Slush/snow/ice ^	58	38	82	133	102	101	514
Unknown #	19	16	13	29	27	36	140
Other *	6	2	1	6	7	3	25
Total HTAs	283	289	331	454	486	504	2347

N/A = this category is not included in the accident form of this city

* In MB and SK, "other" includes loose gravel or sand, mud, and fresh oil. In AB, "other" includes loose surface material (code 04), muddy (code 05), and "other" (code 98).

^ slush/snow/ice is one category in the AB accident database (code 03--surface condition).

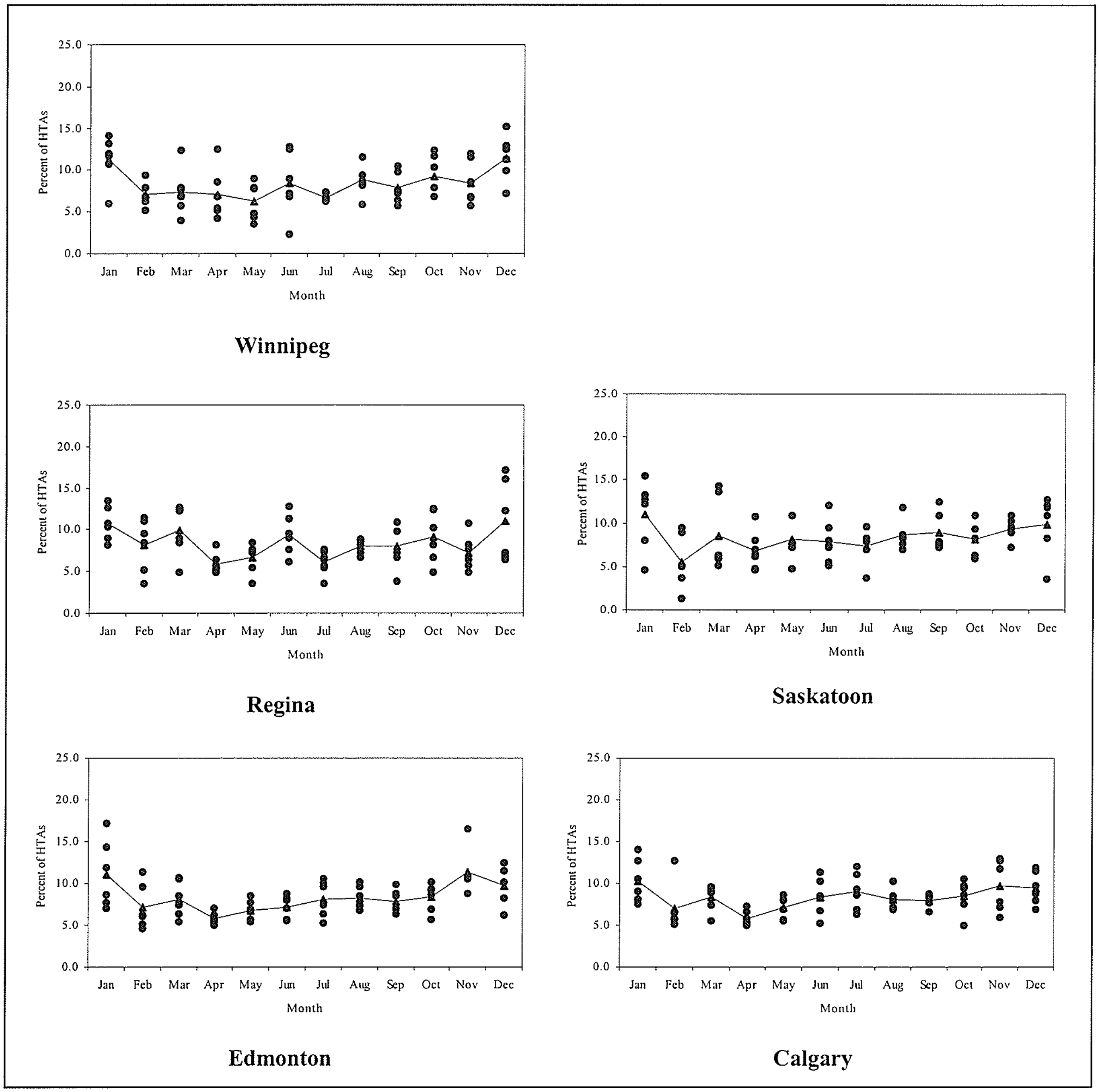
unknown refers to "unknown" (code 99) and to fields that were left blank or were assigned code 97.

4.3.7 Temporal Distribution of Heavy Truck Accidents

The monthly distribution of HTAs from 1993 to 1998 for the five cities is shown in Figure 4-9a. Similarities exist among the five cities, showing a steady accident proportion throughout the year, with January and December being the highest (except in Edmonton and Calgary, where January and November appear as the highest). In all cities, winter months (December to February) account for the highest proportion of HTAs (nearly one-third of all HTAs). Also, with the exception of Saskatoon, spring months (March to May) account for the lowest proportion (about 20 percent) of HTAs. This case is similar to that of HTAs on provincial highways, where December to February also account for 30 percent of all HTAs.

Figure 4-9b illustrates the temporal distribution of HTAs by day of week for the five cities. In all cities, this distribution shows lower accident proportions on the weekends with Sunday being the lowest. Weekdays show a constant accident proportion from Monday to Friday in Calgary and Saskatoon. In Winnipeg, there is a visible increase in the proportion of HTAs on Friday, similar to Edmonton. In all cities, weekends account for approximately 10 percent of all HTAs, and weekdays account for the remaining 90 percent.

There are also similarities regarding the temporal distribution of HTAs by time of day. Figure 4-9c illustrates this distribution. On average, periods of higher traffic activity (8:00 a.m. to 6:00 p.m.) account for most of the HTAs. The four cities show lower proportions of HTAs during night time hours. The urban distribution is unlike the provincial distribution, where there are little peaking characteristics in the HTAs by time of day.



Winnipeg

Regina

Saskatoon

Edmonton

Calgary

Figure 4-9a: Police-reported HTAs in Major Cities of the Prairie Region by Month of Year
Source: City of Winnipeg Public Works Department, SGI, Alberta Transportation

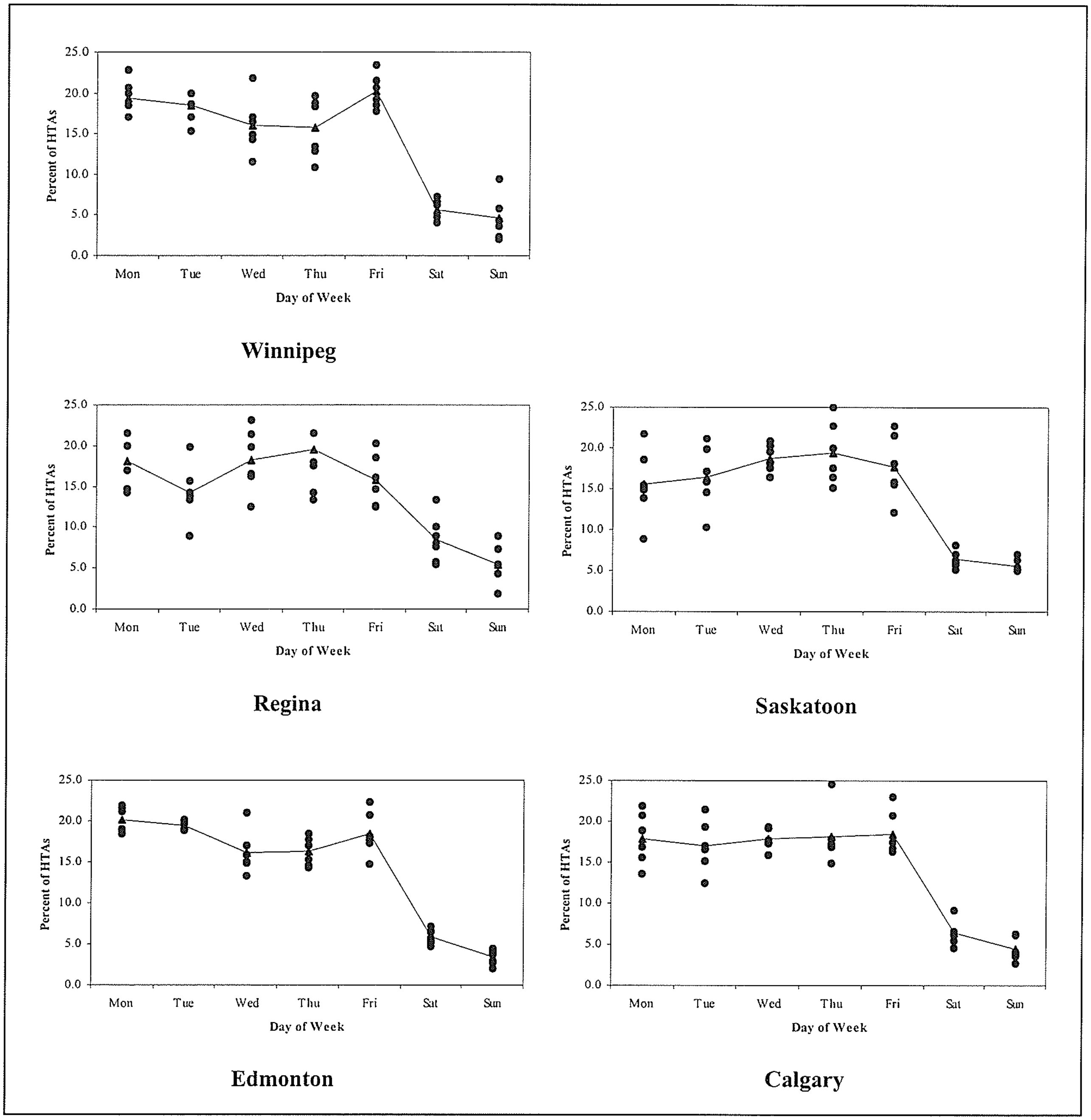
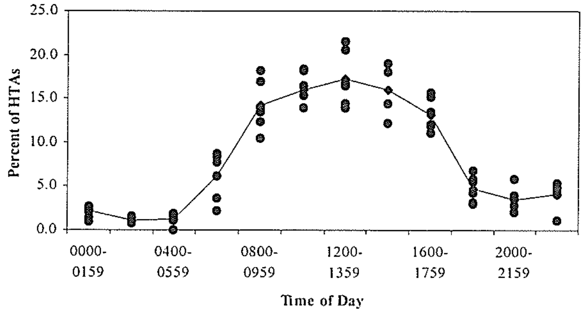
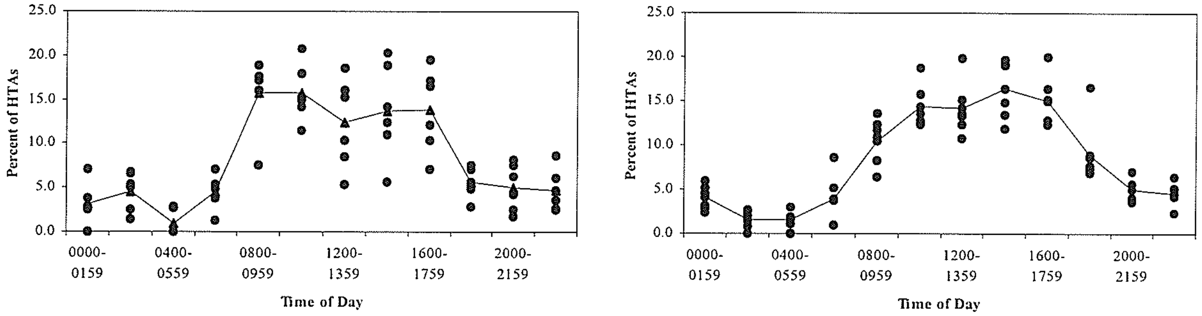


Figure 4-9b: Police-reported HTAs in Major Cities of the Prairie Region by Day of Week
Source: City of Winnipeg Public Works Department, SGI, Alberta Transportation

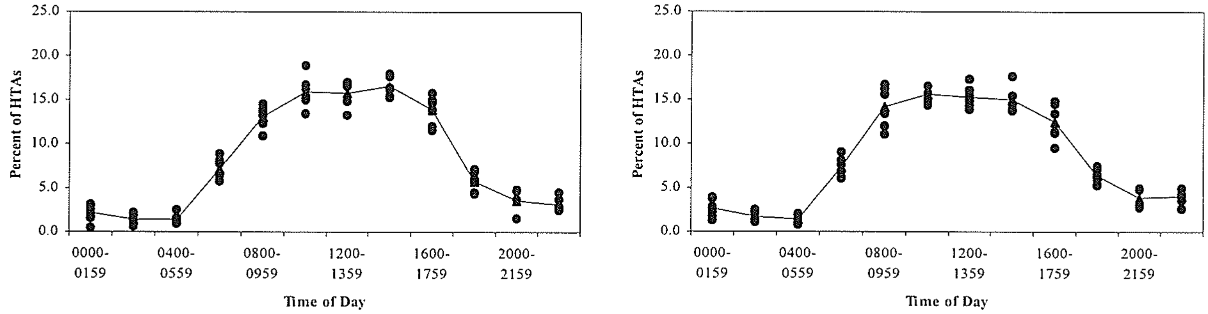


Winnipeg



Regina

Saskatoon



Edmonton

Calgary

Figure 4-9c: Police-reported HTAs in Major Cities of the Prairie Region by Time of Day
Source: City of Winnipeg Public Works Department, SGI, Alberta Transportation

4.3.8 Geographical Distribution of Heavy Truck Accidents

Heavy truck accidents occurring between 1993 and 1998 were assigned to the GIS maps of Saskatoon, Regina, and Winnipeg. Accidents occurring in Edmonton and Calgary were not assigned to maps due to the following reasons: (1) the maps had to be purchased from the cities; and (2) due to the accident database format and the map structures, each HTA had to be positioned manually.

Combining the accidents of the three cities, two-thirds of all reported HTAs occurred at intersections. One-third of these occurred at intersections experiencing one or more HTAs per year on average.

Figure 4-10 shows the geographical distribution of HTAs on Winnipeg's street network. A total of 1,319 HTAs of 1,326 were geocoded for the six-year period. The following is observed:

- The majority of HTAs occurred in the northwest area of the city, where most trucking companies are located.
- Two-thirds of Winnipeg's HTAs (889 of 1,319) occurred at intersections. Twenty-six intersections–listed in Table E-1 in Appendix E–averaged one or more HTAs per year for the six-year period. These 26 intersections accounted for 26 percent (227 of 889) of all intersection-related HTAs and 17 percent of all HTAs within Winnipeg.
- One-third of the city's HTAs occurred away from intersections. Seven road sections—listed in Table E-2 in Appendix E--averaged one or more HTAs per year for the six-year period.
- Route 90, Main Street (downtown), and McPhillips Street (between the CP yards and Notre Dame) had high concentrations of HTAs. The street segment south of the intersection of McPhillips Street and Jarvis Avenue accounted for 16 reported HTAs

over the six-year period. Seven intersections in Winnipeg accounted for seven percent of all HTAs over the last six years.

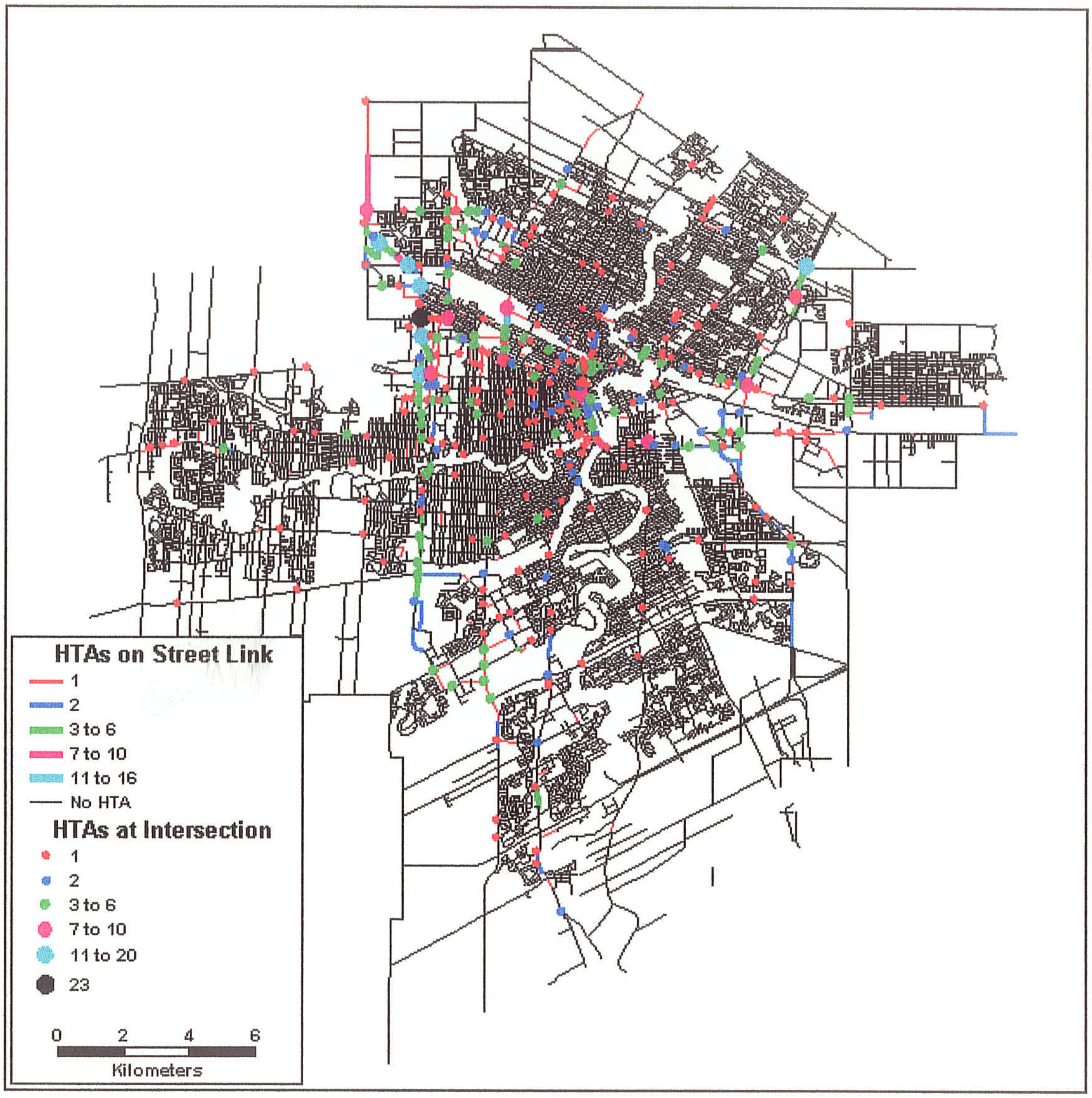


Figure 4-10: Geographical Distribution of HTAs in Winnipeg (1993-1998)

Figure 4-11 shows the geographical distribution of HTAs on Regina's street network. A total of 431 HTAs of 460 were geocoded for the six-year period. The following is observed:

- More than one-half of Regina's HTAs (239 of 431) occurred at intersections. Seven intersections—listed in Table E-3 in Appendix E--averaged one or more HTAs per year for the six-year period. These six intersections accounted for one-quarter (61 of 239) of all intersection-related HTAs and 13 percent of all HTAs within Regina.

- 45 percent of the city's HTAs occurred away from intersections. Five road sections—listed in Table E-4 in Appendix E—averaged one or more HTAs per year for the six-year period.

Street sections and intersections along the Ring Road, McDonald Street, and Ross Avenue experienced particularly high concentrations of HTAs.

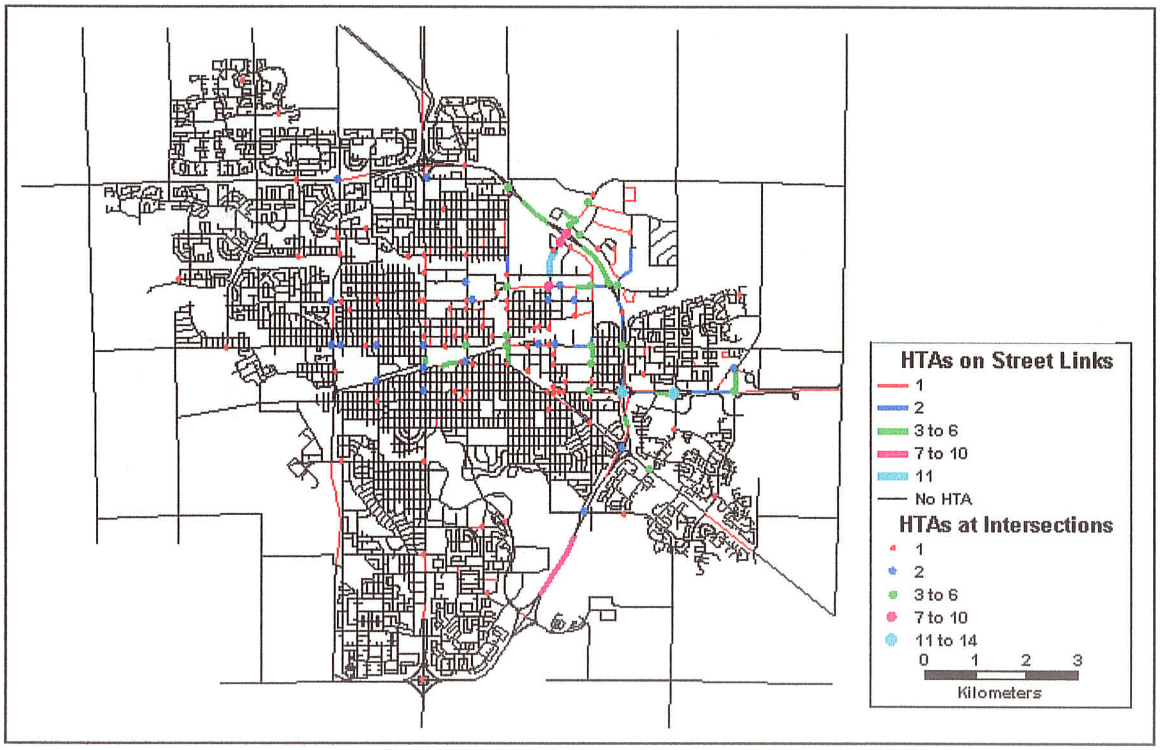


Figure 4-11: Geographical Distribution of HTAs in Regina (1993-1998)

Figure 4-12 shows the geographical distribution of HTAs on Saskatoon's street network. A total of 618 HTAs of 726 were geocoded for the six-year period. The following is observed:

- Two-thirds of Saskatoon's HTAs (411 of 618) occurred at intersections. Nineteen intersections--listed in Table E-5 in Appendix E--averaged one or more HTAs per year for the six-year period. These 19 intersections accounted for 54 percent (220 of 411) of all intersection-related HTAs and 36 percent of all HTAs within the city. Twelve of the 19 accident-prone intersections were along Circle Drive.

- Two intersections accounted for seven percent of all recorded HTAs in Saskatoon between 1993 and 1998. The intersection of Circle Drive and 22nd Street accounted for four percent of all recorded HTAs in Saskatoon, and the intersection of Circle Drive and Millar Avenue accounted for three percent.

- One-third of the city's HTAs occurred away from intersections. One road section—listed in Table E-6 in Appendix E—averaged one or more HTAs per year.

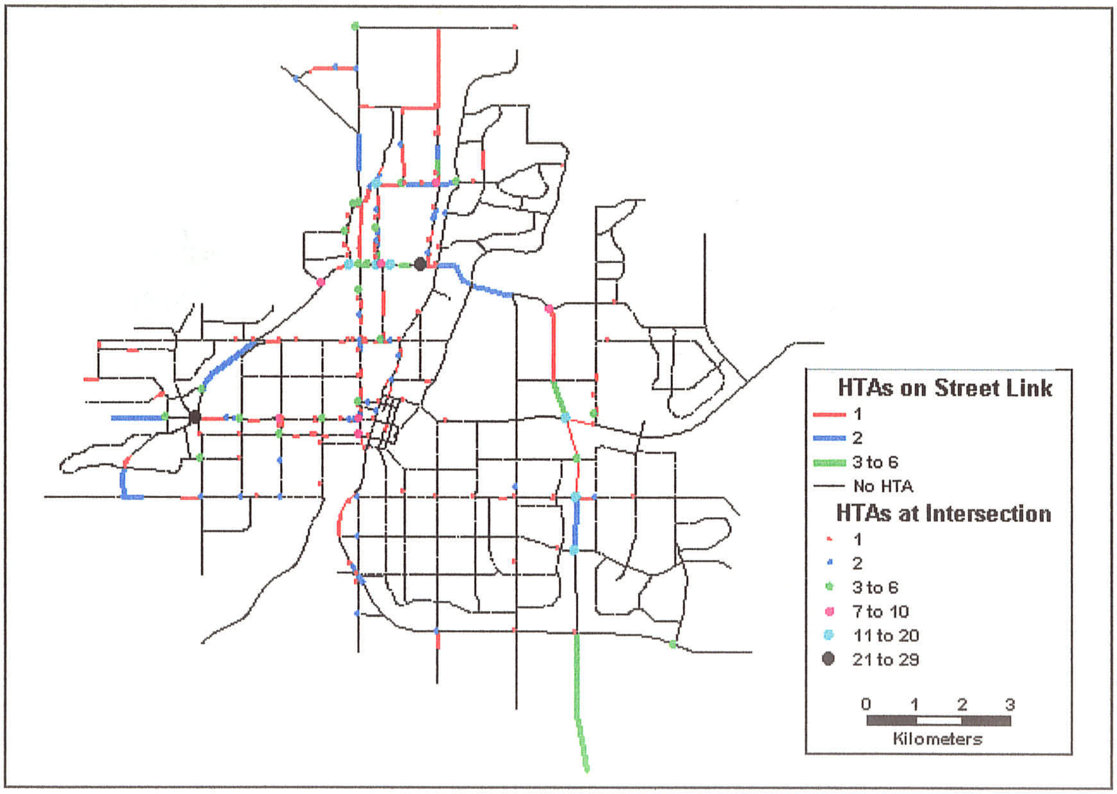


Figure 4-12: Geographical Distribution of HTAs in Saskatoon (1993-1998)

4.4 OBSERVATIONS FROM THE ANALYSIS

This section presents observations regarding similarities and differences between HTAs on provincial highways and HTAs in urban areas. It also compares the two three-year periods of 1993 to 1995 and 1996 to 1998 (first and second half of the study period). The following was found:

- Of the 14,838 HTAs being considered in this research between 1993 and 1998, one half occurred on provincial highways, and one half occurred in urban areas.
- Heavy trucks were involved in a disproportionately high number of fatal accidents. Although they only accounted for 10 percent of all vehicle-miles traveled in the Prairie region, heavy trucks were involved in 18 percent of all fatal accidents on provincial highways. Comparatively, in the U.S., large trucks account for seven percent of all vehicle-miles traveled, and were involved in 13 percent of the fatalities in 1998 (Battelle, 2001). In urban areas, HTAs accounted for six percent of all fatal accidents. Comparative travel data is not readily-available for these areas.
- Four percent of all HTAs that occurred on provincial highways in the Prairie region resulted in a fatality, compared to less than one percent of HTAs in urban areas. More than one-quarter (28 percent) of all HTAs that occurred on provincial highways resulted in injury, compared to 15 percent in urban areas.
- There were more multiple-vehicle HTAs in urban areas than on provincial highways in the prairies. Nearly nine of every 10 HTAs in urban areas were multiple-vehicle accidents, compared to about six of every 10 on provincial highways.
- The most commonly-reported contributing factor for HTAs on provincial highways was environmental conditions (reported in 42 percent of all HTAs), whereas in urban areas it was human action (reported in 45 percent of HTAs in the four cities).
- Both for HTAs occurring in urban areas and for HTAs occurring on provincial highways, adverse road surface conditions (wet, snow, ice, slush) accounted for approximately 40 percent of all HTAs in the region.
- HTAs on provincial highways and in urban areas concentrated on selected road sections and at selected intersections. Such concentrations suggest that there may be opportunities to improve the HTA situation in these areas by addressing geometric design, traffic engineering and maintenance issues.

Comparing the three-year periods of 1993 to 1995 and 1996 to 1998 (the first and second halves of the study period), the following is found:

- The number of heavy truck accidents for the last three years of the period was 20 percent higher than in the first three years (from 2,250 to 2,696 per year). This same increase was experienced for the subset of HTAs that involved fatalities (18 percent higher in the second half of the 6-year period) and injuries (20 percent higher in the second half of the 6-year period). The difference between the first and second half of the period was significant at the 95 percent confidence level.

- One-third of the increase of total HTAs occurred on provincial highways and two-thirds in urban areas.

- The proportion of HTAs occurring in urban areas to all accidents in urban areas increased by 22 percent (from 1.33 percent to 1.62 percent).

- The proportion of HTAs on provincial highways to all accidents on provincial highways increased by 10 percent (from 6.11 percent to 6.76 percent).

CHAPTER 5

ANALYSIS OF COMMERCIAL VEHICLE INSPECTIONS

This chapter discusses Commercial Vehicle Safety Alliance (CVSA) inspections in Manitoba and Saskatchewan for the period 1995 to 1997. This time period was selected for consistency within each province regarding inspection practices, data entry, and storage.

CVSA inspections conducted in Alberta are not included in the analysis because for the research period, inspectors were only required to record information on certain types of inspections. That then shifted towards a more simplified data collection system in which only level I inspections were being recorded by 1997 but no database was being kept (Fuhr, 1997).

The chapter presents the following: (1) a discussion regarding CVSA inspections and data storage in Manitoba and Saskatchewan for the period under investigation; (2) an analysis of CVSA inspections for the two provinces; (3) a discussion regarding the temporal distribution of CVSA inspections; (5) results from a motor carrier survey regarding road safety and the elements of the National Safety Code (NSC); and (6) observations regarding inspection practices in the two provinces.

5.1 CVSA INSPECTIONS IN MANITOBA AND SASKATCHEWAN

Prior to April 1, 1994, CVSA inspections in Manitoba were conducted by the Vehicle Standards Branch of the Manitoba Department of Highways and Government Services. Starting on April 1, 1994, the Transport Compliance Branch became responsible for the program. The first CVSA inspections conducted by Transport Compliance took place in July, 1994. Compliance officers conduct CVSA inspections daily during their routine patrol duties or at permanent weigh scale facilities. Two officers are required for the conduct of a Level I inspection due to safety reasons.

In the research period, the standard data storage procedure followed by Manitoba Transportation regarding CVSA inspections involved two components. After the inspections were completed, the Compliance Branch sent photocopies of the inspection reports to the Transportation Safety and Regulation Branch. This branch was and still is responsible for entering, maintaining, and managing the data from those reports into an electronic format. The process is still the same. Appendix F and Montufar and Clayton (1998a) provide details regarding the analysis of the files for this research.

In Saskatchewan, the Compliance Branch of Saskatchewan Highways and Transportation is responsible for conducting CVSA inspections. These inspections are conducted at the weigh scales or on the roadside. Prior to 1998, there was no specific CVSA database. A set of several files contained the information collected during inspections. These files were maintained by the Compliance branch in semi-processed form. Appendix F and Montufar and Clayton (1998a) provide details regarding the cleaning and analysis of the databases for this research.

As discussed in Chapter 2, in all jurisdictions that conduct CVSA inspections, there are three possible outcomes from these inspections. The vehicle (or driver–depending on the inspection level) may pass the inspection, fail the inspection, or be placed out of service (OOS). There is a basic difference between a "fail" and an "OOS" outcome. When a vehicle fails an inspection, it can continue to operate but the mechanical defects found have to be fixed within a specified period (usually two weeks), and the enforcement agency has to be notified of this upon completion of the work. When a vehicle is placed OOS, it can no longer operate and is either towed to a place where it can be fixed, or fixed at the location where the inspection was conducted.

Because trucks are comprised of different components (*i.e.*, power unit, trailers, converter dollies), each component is inspected separately. The overall outcome of the truck inspection depends on the outcome of the inspections of the individual components. For example, consider a Level I inspection of a tractor-double trailer combination with an A/C connection. This combination has four components (power unit, two trailers, and a converter dolly). If during the inspection all components pass the individual inspections, the overall outcome of the inspection for this combination is a "pass". If the power unit, the converter dolly, and one of the trailers pass the inspection and the other trailer fails, the overall outcome of the inspection for this combination is a "fail". If one trailer is placed OOS, the other trailer fails, the power unit passes, and the converter dolly fails, the overall outcome of this inspection is an "OOS". There are many other combinations of possible outcomes for each unit inspected. The worst possible outcome from an inspection is an OOS.

5.2 CVSA INSPECTION RESULTS IN MANITOBA AND SASKATCHEWAN

This section deals with CVSA inspections conducted in Manitoba and Saskatchewan between 1995 and 1997. Manitoba-based vehicles inspected in jurisdictions other than Manitoba, and Saskatchewan-based vehicles inspected in jurisdictions other than Saskatchewan are not considered in this analysis. Manitoba-based vehicles inspected in Saskatchewan, and Saskatchewan-based vehicles inspected in Manitoba are also considered in the analysis.

5.2.1 Inspection Level and Outcome

Table 5-1 shows a summary of CVSA inspections conducted in the two provinces during the period between 1995 and 1997. The table is based on the Paradox databases provided by the Transportation Safety and Regulation Branch of Manitoba Transportation, and by Saskatchewan Highways. In both cases, the totals obtained from the databases differ from the totals obtained from manual records kept by both agencies. Officials from both jurisdictions could not explain the discrepancies between their data sources.

Table 5-1 indicates that for the three-year period, Manitoba conducted 6,141 inspections and Saskatchewan conducted 15,398. Level I (standard) inspections account for 80 percent of all inspections conducted in Manitoba and 52 percent of all inspections conducted in Saskatchewan. Level II (walk-around) inspections account for 14 percent of all inspections in Manitoba and 45 percent in Saskatchewan. In both provinces, Level III (driver) inspections account for one percent. Level IV (special) inspections account for less than one percent in Manitoba and two percent in Saskatchewan. The last type of inspections (Level V or inspections at the terminal) account for 4 percent in Manitoba and less than one percent in Saskatchewan.

Table 5-1: CVSA Inspections in Manitoba and Saskatchewan for 1995 to 1997

Inspection Level	**Manitoba**				**Saskatchewan**			
	1995	**1996**	**1997**	**Total**	**1995**	**1996**	**1997**	**Total**
Complete/Standard (I)	826	1611	2482	**4919**	3108	2726	2201	**8035**
Partial/Walk Around (II)	87	165	610	**862**	4150	1420	1390	**6960**
Driver Only (III)	0	44	43	**87**	4	36	49	**89**
Special (IV)	12	1	1	**14**	162	87	1	**250**
Terminal/Vehicle Only (V)	0	10	249	**259**	0	40	24	**64**
Total ^	925	1831	3385	**6141**	7424	4309	3665	**15398**

^ The Saskatchewan database does not show the inspection type in 4 of the cases in 1995 and 2 cases in 1997.

Note: Manitoba's database for 1997 was supplied in 3 parts. There were 43 records that were in part one but no associated information was found in part 2 or 3 of the database. These 43 records are not included in this table nor in any further analysis since there is no information associated with them.

Of all the inspections conducted in the two provinces over the three-year period, heavy trucks (articulated tractor trailer combinations) account for 60 percent in Manitoba (3,649 inspections) and one-half in Saskatchewan (7,330 inspections). Of those inspections, Level I inspections account for 78 percent in Manitoba and 46 percent in Saskatchewan. Level II account for 11 percent in Manitoba and 52 percent in Saskatchewan. Other inspection types account for the remaining 11 percent in Manitoba and two percent in Saskatchewan. The analysis that follows deals only with heavy truck inspections conducted in both provinces. Appendix F shows detailed explanations as to how the databases were treated and the analyses conducted, given a series of problems encountered in the databases of the two provinces.

The distribution of the inspection outcomes of the 3,649 heavy trucks inspected in Manitoba and the 7,330 heavy trucks inspected in Saskatchewan between 1995 and 1997 is illustrated in Table 5-2. Nearly one-third of the heavy trucks inspected in Manitoba passed the inspection. This compares with about 13 percent passing the inspections in 1991 and 1992 combined (Carr, 1995). Thirty percent failed the inspection (restricted operation/conditional fail), requiring correction within a specified period of time. This compares with approximately two-thirds in 1991 and 1992 combined (Carr, 1995). Almost 40 percent of the inspected trucks were placed out of service, compared with 21 percent in 1991 and 1992 combined (Carr, 1995). Of the inspected heavy trucks in Saskatchewan, 37 percent passed the inspection, 45 percent failed (restricted operation/conditional fail), and 18 percent were placed out of service.

Table 5-3a and Table 5-3b show the distribution of the 3,649 heavy truck inspections in Manitoba and the 7,330 heavy truck inspections in Saskatchewan respectively. From Table 5-3a, of the 3,649 inspected heavy trucks in Manitoba, tractor semitrailers account for three-quarters, B-trains account for 9 percent, A/C-trains account for one percent, and bobtails account for 14 percent. The configurations are not known for the remaining two percent. Just over two-thirds of the inspected trucks over the three-year period were based in Manitoba. From Table 5-3b, of the 7,330 inspected heavy trucks in Saskatchewan, tractor semitrailers account for 80 percent and tractor-double trailer combinations account for 20 percent (this includes A, B, and C-trains). Over the three-year period there were four tractor-triple trailer combinations inspected, and no bobtails. Almost 60 percent of the inspected trucks between 1995 and 1997 were based in Saskatchewan.

Table 5-2: Inspection Outcomes of Heavy Truck Inspections between 1995 and 1997

Result	**Manitoba**				**Saskatchewan**			
	1995	**1996**	**1997**	**Total**	**1995**	**1996**	**1997**	**Total**
Passed	149	405	591	**1145**	1490	688	500	**2678**
Failed	164	406	536	**1106**	1864	776	675	**3315**
OOS	289	534	570	**1393**	503	438	396	**1337**
Not specified	0	0	5	**5**	0	0	0	**0**
Total	602	1345	1702	**3649**	3857	1902	1571	**7330**

Source: Developed from raw data provided by Manitoba Transportation and Saskatchewan Highways

5.2.2 Frequency of Defects

Table 5-4 summarizes the defects found on tractors and trailers over the three-year period in Manitoba and Saskatchewan. In the case of Manitoba, defects on triple trailer combinations are excluded because it is not possible to determine this from the database. Similarly, defects on converter dollies are also excluded from the table. This discussion distinguishes between trucks receiving a fail rating and those receiving an OOS rating.

Table 5-3a: Heavy Truck Inspections in Manitoba

	1995			1996			1997			Total (95 to 97)		
	MB based	**Other jurisdict**	**Total**	**MB based**	**Other jurisdict**	**Total**	**MB based**	**Other jurisdict**	**Total**	**MB based**	**Other jurisdict**	**Total**
Unit Type												
Truck tractor	420	182	**602**	912	433	**1345**	1135	567	**1702**	2467	1182	**3649**
Trailer	451	216	**667**	750	408	**1158**	1227	557	**1784**	2428	1181	**3609**
Converter dolly	26	10	**36**	7	6	**13**	3	7	**10**	36	23	**59**
Truck Configuration												
Tractor semitrailer	321	129	**450**	607	340	**947**	907	433	**1340**	1835	902	**2737**
A/C-train double	25	9	**34**	5	0	**5**	6	3	**9**	36	12	**48**
B-train double	38	33	**71**	66	32	**98**	99	46	**145**	203	111	**314**
Triple trailer	1	1	**2**	0	0	**0**	0	0	**0**	1	1	**2**
Bobtail	34	10	**44**	231	53	**284**	114	80	**194**	379	143	**522**
Not known *	1	0	**1**	3	8	**11**	9	5	**14**	13	13	**26**
Total HTs inspected	420	182	602	912	433	1345	1135	567	1702	2467	1182	3649

Source: Developed from raw data provided by Manitoba Transportation and Saskatchewan Highways

* In 1995, one combination was reported as a tractor semitrailer towing a converter dolly. In 1996, 8 combinations were reported as a truck tractor towing a converter dolly (2 from MB and 6 from other than MB); 2 combinations were reported as a truck tractor as vehicle 1, a trailer as vehicle 2, nothing as vehicle 3, and a trailer as vehicle 4 (both combinations were from jurisdictions other than MB); one combination was reported as a truck tractor as vehicle 1, nothing as vehicle 2, and a trailer as vehicle 3 (from Manitoba). In 1997, 7 combinations were reported as a truck tractor as vehicle 1 and a full trailer as vehicle 2 (6 from MB and one from other jurisdictions); 4 combinations were reported as a truck tractor as vehicle 1 and a pony trailer as vehicle 2 (2 from MB and 2 from other jurisdictions); and 3 combinations were reported as a truck tractor as vehicle 1, a full trailer as vehicle 2, and a semitrailer as vehicle 3 (one from MB and one from other than MB).

Table 5-3b: Heavy Truck Inspections in Saskatchewan

	1995			**1996**			**1997**			**Total (95 to 97)**		
	SK based	**Other jurisdict**	**Total**	**SK based**	**Other jurisdict**	**Total**	**SK based**	**Other jurisdict**	**Total**	**SK based**	**Other jurisdict**	**Total**
Unit Type												
Truck tractor	2125	1732	**3857**	1100	802	**1902**	1036	535	**1571**	4261	3069	**7330**
Trailer	2272	2076	**4348**	1187	1042	**2229**	1115	657	**1772**	4574	3775	**8349**
Converter dolly	n/a	n/a	**n/a**	n/a	n/a	**n/a**	n/a	n/a	**n/a**	n/a	n/a	**n/a**
Truck Configuration*												
Tractor semitrailer	1705	1382	**3087**	876	596	**1472**	874	436	**1310**	3455	2414	**5869**
Tractor double	420	349	**769**	224	204	**428**	161	99	**260**	805	652	**1457**
Triple trailer	0	1	**1**	0	2	**2**	1	0	**1**	1	3	**4**
Bobtail	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
Not known	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
Total HTs Inspected	2125	1732	3857	1100	802	1902	1036	535	1571	4261	3069	7330

Source: Developed from raw data provided by Manitoba Transportation and Saskatchewan Highways

n/a = it is not possible to obtain this information from the database

* The category "other" includes configurations for which the base jurisdiction is not known (1995 = 67, 1996 = 29, and 1997 = 24)

Note: See Appendix F for details about the generation of this table

Table 5-4: Mechanical Defects by Category on Power Units and Trailers

MANITOBA	**Failed Rating**			**OOS Rating**		
Defect Category	**Defects on PU**	**Defects on Trailers**	**Total**	**Defects on PU**	**Defects on Trailers**	**Total**
Brakes	579	511	1090	1342	991	2333
Coupling Devices	21	18	39	82	40	122
Exhaust/Fuel System	301	5	306	390	13	403
Frame	39	103	142	85	224	309
Lighting Equipment	291	192	483	426	375	801
Load Securement	11	33	44	33	99	132
Steering Mechanism	34	4	38	131	5	136
Suspension	75	83	158	176	212	388
Tires	37	92	129	100	163	263
Trailer Body	13	53	66	16	60	76
Wheels and Rims	17	22	39	36	55	91
Windshield Wipers	9	0	9	23	2	25
Miscellaneous	198	133	331	419	194	613
Total Defects	*1625*	*1249*	*2874*	*3259*	*2433*	*5692*
Total Heavy Trucks			*1106*			*1393*
Defects per Heavy Truck			*2.6*			*4.1*
SASKATCHEWAN						
Brakes	783	1058	1841	415	722	1137
Coupling Devices	60	56	116	12	13	25
Documentation	248	50	298	77	43	120
Frame	51	122	173	9	29	38
Lighting Equipment	794	729	1523	87	278	365
Load Securement	60	187	247	16	52	68
Steering Mechanism	129	1	130	37	0	37
Suspension	156	199	355	39	57	96
Tires/Wheels	221	572	793	73	128	201
Dangerous Goods	15	29	44	2	4	6
Glass/Mirrors/Wipers	167	2	169	11	2	13
Emergency Equipment	111	10	121	9	2	11
Other	319	155	474	54	39	93
Total Defects	*3114*	*3170*	*6284*	*841*	*1369*	*2210*
Total Heavy Trucks			*3315*			*1337*
Defects per Heavy Truck			*1.9*			*1.7*

Source: Developed from raw data provided by Manitoba Transportation and Saskatchewan Highways

5.2.2.1 Trucks Receiving a Fail Rating

Of the 10,979 heavy trucks that were inspected in Manitoba and Saskatchewan between 1995 and 1997, 40 percent received a "fail" rating. The following is observed from Table 5-4:

- For units that failed inspections, there was an average of 1.1 mechanical defects recorded on each power unit in the two provinces combined, and an average of 1.0 mechanical defect recorded on each trailer. Overall, there were 2.1 defects per heavy truck inspected in the two provinces combined. The number of defects per heavy truck was greater in Manitoba than in Saskatchewan.

- On average, 0.43 mechanical defects that triggered a "fail" rating were recorded for each power unit inspected in the two provinces. Similarly, 0.37 mechanical defects that triggered a "fail" rating were recorded for each trailer inspected in the two provinces (4,419 defects on trailers by 11,958 total trailers inspected).

- Of the total mechanical defects found on trucks that failed inspections, two defect categories accounted for approximately 55 percent in both provinces. Brake system defects accounted for 38 percent in Manitoba (almost equally distributed on tractors and trailers), and 29 percent in Saskatchewan (42 percent of those on power units and 58 percent on trailers). Defective lighting equipment accounted for 17 percent in Manitoba (mainly on tractors), and one-quarter in Saskatchewan (almost equally distributed on tractors and trailers).

5.2.2.2 Trucks Receiving an Out-of-Service Rating

Of the 10,979 heavy trucks that were inspected in Manitoba and Saskatchewan between 1995 and 1997, one-quarter received an OOS rating. The following is observed from Table 5-4:

- For power units and trailers of truck combinations that were placed OOS during inspections, there was an average of 2.3 mechanical defects recorded on each power unit in Manitoba and 0.63 defects in Saskatchewan. There was an average of 1.75 mechanical defects recorded on each trailer in Manitoba and 1.02 in Saskatchewan.

- On average, 0.37 mechanical defects that triggered an OOS rating were recorded for each power unit inspected in both provinces combined (4,100 OOS defects on tractors by 10,979 tractors inspected in total). Similarly, 0.32 mechanical defects that triggered an OOS rating were recorded for each trailer inspected (3,802 defects on trailers by 11,958 total trailers inspected). In both cases, the number of mechanical defects that triggered the OOS rating was higher in Manitoba than in Saskatchewan.

- Of the total mechanical defects found on trucks that were placed out of service during CVSA inspections, two defect categories accounted for nearly 60 percent in both provinces. Brake system defects accounted for 40 percent in Manitoba (these defects were mainly found on power units), and one-half in Saskatchewan (principally on trailers). Defective lighting equipment accounted for 14 percent in Manitoba (almost equally distributed on tractors and trailers), and 17 percent in Saskatchewan (principally on trailers).

5.3 TEMPORAL DISTRIBUTION OF CVSA INSPECTIONS

This section examines the temporal distributions of the CVSA inspection activity conducted in Manitoba and Saskatchewan between 1995 and 1997. Table 5-5a and Table 5-5b show the number of CVSA inspections in the two provinces by month, by inspection type. For the two provinces combined, the following observations are relevant:

- Less than 1 in 20 of all Level I inspections (the most intensive inspection type, and the only type of inspection capable of identifying the most common vehicle defect—brakes out of adjustment) take place in the winter period (December to February). From Chapter 4, about one-third of all HTAs in the region take place during these three months.
- About one-quarter of all Level II (walk-around) inspections occur in the winter period.
- The three summer months of June, July and August account for nearly 60 percent of level I inspections, and 30 percent of Level II inspections. These same months account for 20 percent of the HTAs.

5.4 OBSERVATIONS

The following are observations regarding inspection practices in the two provinces and results:

- There are clear differences regarding the number of CVSA inspections in Manitoba and Saskatchewan. Between 1995 and 1997 Saskatchewan conducted twice as many inspections as Manitoba. While there is a large difference in the number of inspections conducted in the two provinces, most of the inspections conducted in Manitoba are Level I (80 percent of all inspections), compared to one-half of all inspections conducted in Saskatchewan. Level II inspections (walk around) account for 14 percent of all inspections in Manitoba, compared to 45 percent in Saskatchewan.

- In both Manitoba and Saskatchewan, about one-third of all heavy trucks inspected passed the inspection. Two-thirds did not pass, receiving either a fail or OOS rating. In the non-pass category, 40 percent resulted in OOS in Manitoba, compared to 18 percent in Saskatchewan.

Table 5-5a: CVSA Inspections of Heavy Trucks in Manitoba by Month

Inspection Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total *
1	12	24	21	55	252	1196	482	426	482	178	17	6	3151
2	9	18	20	13	14	9	25	10	20	25	26	69	258
3	5	3	1	0	3	6	3	2	7	1	1	3	35
5	2	37	7	84	5	1	55	2	4	1	1	2	201
Total	**28**	**82**	**49**	**152**	**274**	**1212**	**565**	**440**	**513**	**205**	**45**	**80**	**3645**

Source: Developed from raw data provided by Manitoba Transportation
* There are 4 records that do not indicate the type of inspection

Table 5-5b: CVSA Inspections of Heavy Trucks in Saskatchewan by Month

Inspection Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total *
1	59	87	103	185	361	1121	313	238	564	334	70	27	3462
2	439	414	396	264	470	440	432	282	161	134	172	171	3775
3	2	7	6	3	5	1	4	2	0	2	3	31	66
5	0	2	12	1	2	3	2	2	0	0	0	0	24
Total	**500**	**510**	**517**	**453**	**838**	**1565**	**751**	**524**	**725**	**470**	**245**	**229**	**7327**

Source: Developed from raw data provided by Saskatchewan Highway
* There are 3 records that do not indicate the type of inspection

- Of the total mechanical defects found on trucks that failed inspections, as well as in trucks that were placed OOS, two defect categories accounted for between 55 and 60 percent of all defects in both provinces—brake system defects and defective lighting equipment.

- In interpreting the facts about CVSA inspections in Manitoba, it is important to remember that prior to 1994, there was a large role played in CVSA inspections by licensed mechanics employed in the Vehicle Licensing Branch—and coincidentally a lesser role played by enforcement personnel. After 1994, enforcement personnel were responsible for these inspections. Manitoba Transportation officials suggested that the mechanics conducted more intense inspections, leading to a lower pass rate and a higher fail rate (Ewanochko, 1997). Officials also suggested that the high number of defects per vehicle experienced prior to 1994 compared to the period between 1995 and 1997 may also reflect the intensity of these inspections. Counteracting this argument is the fact that the proportions of major defects identified in the two different time periods remained constant. Brake items accounted for about 40 percent of defects in both periods. Lighting items accounted for about 20 percent. Both of these items are measured by objective means, and neither the tests themselves nor the implications of the consequences of the tests in terms of pass/fail changed between these time periods. This suggests that rather than the results of CVSA inspections changing because of changing inspection intensity, there may indeed have been a true and significant improvement in the mechanical condition of the vehicles being inspected in Manitoba.

- An unknown variable running through the CVSA inspection process is the extent to which selective selection of vehicles for inspection might influence the results of CVSA inspections in any year. During meetings with motor carriers in Manitoba and Saskatchewan, a number of carriers suggested that selectivity exists unrelated to mechanical integrity of the vehicle.

5.5 MOTOR CARRIER SURVEY

A motor carrier survey was conducted in Saskatchewan in August, 1998 and another in Manitoba in April and May, 1997. Four major Saskatchewan-based carriers and twelve major Manitoba-based carriers were interviewed to obtain their views regarding the NSC. The combined fleet of the surveyed carriers is approximately 5,000 tractors and 7,200 trailers. Each of the items of the NSC was discussed with the carriers to understand the effect that the Code has had on their operations, in terms of safety. The following summarizes the findings:

- All carriers feel that the *Single Driver's Licence* standard has made it easier for companies to keep records of drivers. However, it cannot be definitely said that this standard has improved truck safety in the provinces. The carriers had no comments on the standards regarding *Knowledge and Performance Tests*, *Driver Examiner Training*, and *Classified Driver's Licence.* Regarding *Self-Certification*, none of the carriers has implemented it as part of their program.

- The *Medical Requirement* standard of the NSC of filing medical reports every five years for drivers between the ages of 18 and 44 years has not affected the operations of these carriers. In some cases this is because their operations are also subject to the U.S. requirement of filing medical examination reports every two years. In other cases, it is because longer combination vehicle (LCV) operations require that drivers file medical reports also every two years.

- According to these carriers, *Carrier and Driver Profiles* do not help improve safety. This is because different provinces apply different thresholds which trigger facility audits. These carriers believe that the profiles are only good as an information tool, to keep companies updated of their progress.

- The *Hours of Service* standard is controversial. All carriers oppose the way this regulation is set up because it is based on old studies and not on scientific evidence. All the carriers agree that there is confusion in the way the regulations are set up. There are also inconsistencies in the regulations from province to province. For example, some carriers indicate that for intraprovincial operations in Saskatchewan and Alberta, as well as for operations between those two provinces, carriers are allowed to operate 15 hours per day, seven days per week (with no cap). Manitoba carriers feel that this places them at a disadvantage since they have to comply with the hours of work regulations as stated in the NSC. In terms of what this component of the NSC has done for safety, these carriers are not sure if safety has become better or worse. All carriers think that this regulation is driven by politics and not by trucking needs. The way the regulation is set up reduces productivity of the carriers. All carriers feel that this regulation needs to be improved.

- According to these carriers, *Load Securement* needs to become uniform and more consistently enforced across Canada. Enforcement practices are highly dependent on the officer's own judgment and not on the regulations. All carriers feel that common sense should be used when applying the regulations, but what may be acceptable to one officer may not be acceptable to another. For this reason, carriers believe that this aspect of NSC needs to be improved. A set of minimum requirements for load securement should be introduced, rather than complicated regulations which are not enforceable because of their complexity and level of detail.

- All carriers provide *Commercial Vehicle Maintenance* to their fleet on a regular basis. For one of the carriers, this periodic maintenance exercise resulted from the NSC. This carrier believes that "NSC helped improve the safety of the fleet."

- Regarding *Commercial Vehicle On-Road Inspections*, all carriers agree that the concept of having these inspections as part of the NSC is good. However, there is a lack of consistency between inspectors and between provinces which make it difficult for carriers to operate. In addition, these carriers strongly believe that farm trucks should be inspected more often and should also be subject to the same requirements as regular carriers. None of the carriers think that these inspections have increased safety in terms of fewer accidents on the highway. One states that, "CVSA inspections have not helped improve safety." Another believes that "Roadcheck makes more truckers aware of brake adjustment problems." Three carriers agree that some of the trucking companies maintain their equipment in better condition as a result of these on-road inspections. All carriers feel that the bad publicity received during inspection blitzes does not encourage safe carriers.

- Carriers believe that *Daily Trip Inspection Reports* help improve safety if drivers are properly trained. Drivers are usually responsible for the units they operate and conduct checks while on the road.

- Most carriers agree that *Facility Audits* are useful when they are performed fairly. However, these carriers feel that there is no level playing field when it comes to facility audits. This is because large companies are audited more often than small companies. In the opinion of these carriers, auditors should use common sense when conducting facility audits, and when a company makes a mistake, it should be given the opportunity to correct that mistake.

- In general, none of the carriers suggest that the idea of having a National Safety Code is without value. However, most carriers think that the NSC has not improved truck safety. Some reasons for this are: (1) many of the items included in the Code were implemented by these companies before the introduction of NSC—as some companies state, they "have always been safety-oriented"; (2) the Code "is not enforceable"—the way it is set up makes it difficult for enforcement officers to understand and properly enforce it; and (3) there is no uniformity in the way it is applied throughout Canada—"if it is a national standard it should be uniformly applicable to all provinces". Finally, there are also carriers that believe that while the NSC has not explicitly improved safety, it has made more companies aware of safety issues.

CHAPTER 6

EXPOSURE-BASED ANALYSIS OF HEAVY TRUCK ACCIDENTS

This chapter explores relationships between heavy truck accidents occurring on provincial highways in the region and exposure as measured by estimates of truck traffic and truck traffic characteristics. The chapter presents an analysis of heavy truck accident rates based on exposure as measured by truck traffic, considering differences between jurisdictions, truck volume, road type, load limits, seasons, time of day, and truck configuration.

6.1 EXPOSURE MEASURES

Being able to relate accidents to exposure is a goal of much safety research. Such relationships provide rates of accident occurrence, enhancing understanding of the phenomenon. Many different exposure measures are used in safety research. Typical examples of accident rates are number of driver deaths per licensed driver, number of fatalities per registered vehicle, or per kilometer of highway, or per jurisdiction, and number of fatalities per year. No one rate is superior to any other, and the appropriateness of any particular rate depends on the question being asked and the data available (Evans, 1999)

In recent years, there has been much interest in using traffic as the measure of exposure in highway safety analysis. One particularly active area of research in civil engineering in this regard is the notion of developing “safety performance functions” (SPF) for particular roadway types and characteristics. This idea starts from the proposition that there is reason to think that expected accident frequency "u" (accidents per unit of time) depends in some regular manner on traffic flow "q" (vehicles per unit of time). The research involves developing data about flows and accidents, exploring their dependencies, and seeking useful equations where u is a function of q, linking accident frequency and flow (i.e., safety performance functions) (Mensah and Hauer, 1998). Examples of recent safety performance function work are documented in TAC (1999), and Persaud and Bahar (2000). To date, little if any of this research has been directed to the HTA situation specifically.

This research is concerned with developing an understanding of truck accident frequency in relation to measures of truck traffic.

6.2 UNDERSTANDING TRUCK TRAFFIC

At the heart of understanding truck traffic is the definition of a truck. This research deals with accidents involving heavy trucks as defined in Section 1.6.

Truck traffic is typically characterized in terms of volume (per unit time); temporal variations of volume; vehicle classification mix (by configuration); body type mix; and sometimes operational factors (weight, speed).

The primary measure of truck traffic volume is annual average daily truck traffic (AADTT), which is defined as the (estimated) total annual truck traffic past a point on a road in one year divided by 365. AADTT estimates can be developed from direct observation of truck traffic (e.g., across an automatic vehicle classifier (AVC) or weigh-in-motion (WIM) device) or from estimates of percent trucks in a traffic stream multiplied by Annual Average Daily Traffic (AADT).

A variety of temporal distributions of truck traffic are also of interest, including seasonal distributions (i.e., month to month, winter/summer), day-of-week distributions (i.e., each day, or weekdays/weekends), and time of day (i.e., each hour, or day/night).

Many systems are used to classify vehicles by configuration. Details of classification systems used in Canada are presented in Clayton et al. (2000). Details of national systems used in the United States include the Federal Highway Administration's (FHWA) Class 13 system (common in parts of Canada, see Appendix G) and systems such as that used in the U.S. Comprehensive Truck Size and Weight Study (U.S. DOT, 2000b). Recent research in Canada (Clayton et al., 2000) and the United States (U.S. DOT 2001) has suggested that general truck-related traffic monitoring programs (the heart of traffic-related exposure data) should concentrate on attempting to classify vehicles into four categories: non-trucks, single unit trucks, single trailer trucks, and double trailer trucks. The pursuit of finer detail—except for special purpose research—is trying to dissect the configuration mix too far (with little to be gained in the understanding of exposure).

In this research, for exposure analysis using AADTT values in the three Prairie provinces, truck traffic was taken as defined by each jurisdiction. It was assumed that the term encompassed more or less the same types of vehicles in each jurisdiction. In practice, this means that the term includes some single unit trucks, some truck-trailer combinations, and tractor-trailer combinations (including those having single, double, and triple trailers). For the most part, on most provincial highways in the Prairie region, truck traffic is dominated by the third group—tractor-semitrailer combinations.

6.3 TRUCK TRAFFIC ON PROVINCIAL HIGHWAYS IN THE PRAIRIE REGION

This section discusses truck traffic on provincial highways in the Prairie region. The section addresses the following: (1) annual average daily truck traffic estimates; (2) truck-kilometers of travel estimates; (3) vehicle classification mix; (4) temporal distribution of truck traffic; and (5) problems and limitations with truck traffic data.

6.3.1 Annual Average Daily Truck Traffic (AADTT) Estimates

The AADTT estimates used in the research are based on source material provided by provincial highway agencies. The principal analysis deals with AADTT estimates for 1998. For Alberta, estimates of AADTT were made for 1998 from a data file provided by Alberta Transportation in 2000 (now available on Internet) consisting of AADT by road segment, divided into percent passenger cars, recreational vehicles, buses, single unit trucks, and tractor trailer combination trucks. AADTTs were obtained by multiplying AADT by the sum of the percent of single unit trucks and percent of tractor trailer combination trucks. This was done to be consistent with AADTT estimates from Manitoba and Saskatchewan, both of which include single unit trucks in their 1998 truck traffic databases.

For Saskatchewan, estimates of AADTT were made for 1998 (and 1996) from data files developed in DS-Lea and UMTIG (1999) consisting of AADT by road segment and percent trucks for each road segment. AADTTs were obtained by multiplying the AADT of each road segment by the percent truck.

For Manitoba, estimates of AADTT for each road segment are developed and published by the Manitoba Highway Traffic Information System (MHTIS) on its annual traffic flow map. The methodology used is presented in Clayton et al. (1998).

Figure 6-1 shows the estimated AADTT throughout the provincial highway system of the Prairie region for 1998. The following is observed from the Figure:

- Highways with very low truck volumes (less than 150 AADTT) account for one-half of the region's provincial highway kilometers. Manitoba accounts for 41 percent of these kilometers, Saskatchewan for 33 percent, and Alberta for 26 percent.
- Highways with low truck volumes (151 to 400 AADTT) account for 31 percent of the region's provincial highway kilometers. Manitoba accounts for 14 percent of these kilometers, Saskatchewan for 30 percent, and Alberta for 56 percent.
- Highways with medium truck volumes (401 to 1,000 AADTT) account for 15 percent of the region's provincial highway kilometers. Manitoba accounts for 11 percent of these kilometers, Saskatchewan for 31 percent, and Alberta for 58 percent.
- Highways with high truck volumes (greater than 1,000 AADTT) account for five percent of the region's provincial highway kilometers. Manitoba accounts for 19 percent of these kilometers, Saskatchewan for 11 percent, and Alberta for 70 percent.

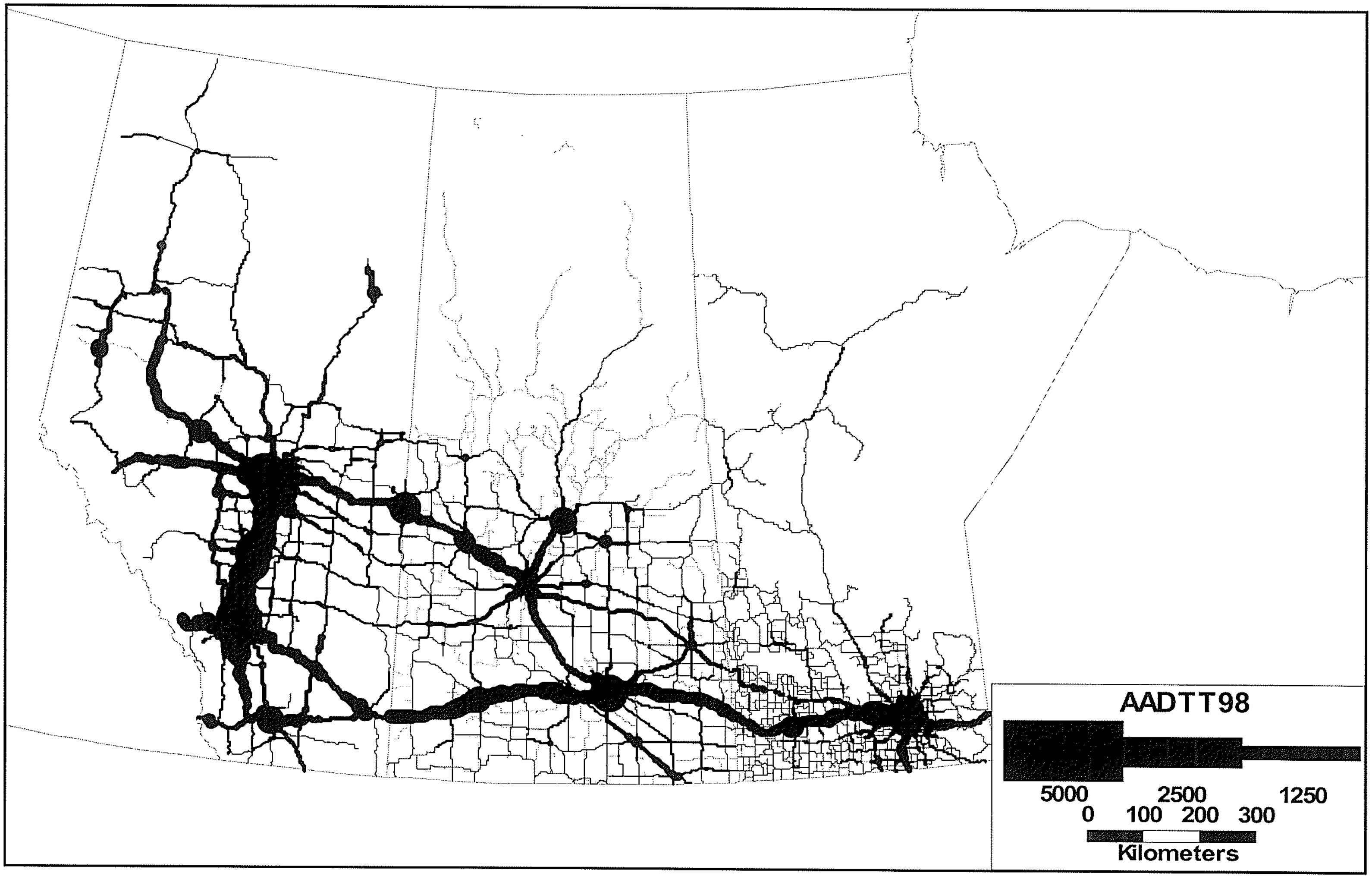


Figure 6-1: Truck Flows on Provincial Highways in the Prairie Region
Produced by J.M. and UMTIG

6.3.2 Truck-Kilometers of Travel (TKT) Estimates

Truck-kilometers of travel (TKT) per year are calculated by multiplying the AADTT of a given road section by the section length. TKT for a paticular road network is determined by adding the TKTs from all road sections in the network.

Based on analysis of traffic information, it is estimated that in Manitoba, TKT on provincial highways grew from 577 million in 1995 to 670 million in 1999, at a rate of about four percent per year. During the same time period, total vehicle-kilometers of travel (VKT) grew at about 2.7 percent per year. Truck-kilometers of travel accounted for 10 percent of all VKT in 1995, rising to nearly 11 percent in 1999.

Tables 6-1a, 6-1b, and 6-1c show the distribution of highway mileage and TKT by road category (*i.e.,* divided versus undivided) and AADTT for provincial highways in the Prairie region. Tables 6-2a, 6-2b, and 6-2c show the same distribution by load class (basic RTAC versus non-RTAC). The following is observed from the tables:

- There were 3.5 billion truck-kilometers of travel on provincial highways of the Prairie region in 1998.
- Medium to high volume highways (AADTT greater than 400 vehicles per day) accounted for 55 percent of the total TKT for the region. At the provincial level, these highways accounted for 46 percent of all TKT in Manitoba, 51 percent of all TKT in Saskatchewan, and 61 percent of all TKT in Alberta.
- Low and very low-volume highways (less than 400 trucks per day) accounted for 45 percent of the TKT in the region in 1998.

Table 6-1a: Highway Mileage and TKT by Road Category in Manitoba

Truck Volume (AADTT)	Kilometers of Highway			Million TKT per Year		
1998	Divided	Undivided	Total	Divided	Undivided	Total
0-150	4	15198	15202	0.18	217	217
151-400	103	1450	1553	10	124	134
401-1000	415	310	725	107	63	170
>1000	241	13	254	125	7	132
Total	763	16971	17734	242	411	653

Derived from raw data provided by MHTIS

Table 6-1b: Highway Mileage and TKT by Road Category in Saskatchewan

Truck Volume (AADTT)	Kilometers of Highway			Million TKT per Year		
1998	Divided	Undivided	Total	Divided	Undivided	Total
0-150	2	18039	18041	0.11	294	294
151-400	19	3010	3029	2	267	269
401-1000	344	763	1107	84	154	238
>1000	507	243	750	240	98	338
Total	872	22055	22927	326	813	1139

Derived from raw data provided by Saskatchewan Highways and Transportation

Table 6-1c: Highway Mileage and TKT by Road Category in Alberta

Truck Volume (AADTT)	Kilometers of Highway			Million TKT per Year		
1998	Divided	Undivided	Total	Divided	Undivided	Total
0-150	0	4547	4547	0	142	142
151-400	47	5937	5984	6	528	534
401-1000	858	1699	2557	231	358	589
>1000	637	66	703	441	34	475
Total	1542	12249	13791	678	1062	1740

Derived from raw data provided by Alberta Transportation

Table 6-2a: Highway Mileage and TKT by Load Class in Manitoba

Truck Volume (AADTT)	Kilometers of Highway			Million TKT per Year		
1998	RTAC	NON-RTAC	Total	RTAC	NON-RTAC	Total
0-150	2005	13213	15217	59	158	217
151-400	953	599	1582	86	48	134
401-1000	653	55	725	156	14	170
>1000	224	29	233	119	13	132
Total	3835	13896	17731	420	233	653

Derived from raw data provided by MHTIS

Table 6-2b: Highway Mileage and TKT by Load Class in Saskatchewan

Truck Volume (AADTT)	Kilometers of Highway			Million TKT per Year		
1998	RTAC	NON-RTAC	Total	RTAC	NON-RTAC	Total
0-150	2676	15365	18041	96	198	294
151-400	2589	440	3029	237	32	269
401-1000	1078	29	1107	233	5	238
>1000	750	0	750	338	0	338
Total	7093	15834	22927	904	235	1139

Derived from raw data provided by Saskatchewan Highways and Transportation

Table 6-2c: Highway Mileage and TKT by Load Class in Alberta

Truck Volume (AADTT)	Kilometers of Highway			Million TKT per Year		
1998	RTAC	NON-RTAC	Total	RTAC	NON-RTAC	Total
0-150	4547	n/a	4547	142	n/a	142
151-400	5984	n/a	5984	534	n/a	534
401-1000	2557	n/a	2557	589	n/a	589
>1000	703	n/a	703	475	n/a	475
Total	13791	n/a	13791	1740	n/a	1740

n/a–not applicable. All primary highways in Alberta are RTAC highways. Secondary highways are not considered in this analysis since they were not designated as provincial highways during the research period.
Derived from raw data provided by Alberta Transportation

- Divided highways account for six percent of the total Prairie region provincial highway kilometers, and over one-third (35 percent) of the TKT in the region. Undivided highways, which represent 94 percent of total Prairie region provincial highway kilometers, accounted for two-thirds of the TKT in the region.

- In Manitoba and Saskatchewan, RTAC roads account for 22 percent and 31 percent of the highway network respectively. Nearly three-quarters of the TKT in the two provinces occur on RTAC roads. In Alberta, all provincial mileage is rated RTAC, and therefore, all TKT occurs on RTAC routes.

- There is a total of 24,719 kilometers of highways designated as basic RTAC in the Prairie region. Of these, one-quarter have truck volumes greater than 400 trucks per day and three-quarters have volumes lower than 400 trucks per day. The TKT on the medium to high volume highways (greater than 400 trucks per day) accounts for 62 percent of the total TKT on basic RTAC roads in the Prairie region.

6.3.3 Vehicle Classification Mix

Table 6-3 shows the fleet mix throughout Manitoba in the year 2000. Section 6.3.4.1 discusses the databases used for this analysis. The following is observed from the table:

- Trucks (Class 5 to 13 FHWA) account for 15 percent of a total of 13,697,606 vehicles classified.

- Of the 2.07 million classified trucks, straight unit trucks (Classes 5 to 7) account for 15 percent; 3-S2s (Class 9) account for 44 percent; 3-S3s (Class 10) account for 16 percent; and double trailer combinations (Classes 11 to 13) account for 21 percent.

- As the AADTT past a station increases the following is observed:
    - the proportion of straight unit trucks decreases from about one in four to one in 10;
    - the proportion of single trailer combinations increases from four in 10 to two in three;
    - the proportion of double trailer combinations remains at about one in five (except on very low volume stations)

- The fleet mix remains approximately constant throughout the year (*i.e.*, the truck fleet distribution in summer is about the same as in winter).

Table 6-3: Truck Fleet Mix in Manitoba

AADTT Group	Station	Total Traffic (Million)	Truck %	Mix of Truck Traffic (Percentage)								
				Class5	Class6	Class7	Class8	Class9	Class10	Class11	Class12	Class13
> 1000	55	4.60	16.3	5.3	4.4	0.3	4.7	47.7	18.3	2.2	1.1	15.9
401 to 1000	86	1.45	20.5	3.9	11.7	0.2	3.7	53.1	15.7	0.9	0.3	10.4
	43	0.65	27.7	3.9	3.7	0.3	3.2	46.4	17.1	0.5	1.0	23.8
	85	1.00	14.6	7.7	15.1	0.1	2.5	29.5	17.1	0.2	0.4	27.4
150 to 400	81	0.39	31.5	4.1	4.8	0.2	4.2	47.3	16.2	0.2	0.1	22.9
	87	0.60	19.5	7.3	10.2	0.3	3.3	53.6	11.7	0.0	0.1	13.5
	51	1.45	7.6	13.9	14.9	0.3	4.4	37.6	17.4	0.0	0.1	11.4
	54	0.79	7.9	11.1	15.8	0.2	5.0	34.1	10.5	0.5	0.2	22.6
	49	0.67	9.2	9.4	10.2	0.3	5.8	32.4	12.9	0.5	0.3	28.4
< 150	53	0.57	8.2	11.5	10.0	0.3	6.4	16.8	12.4	0.7	0.2	41.8
	21	0.44	11.0	7.0	10.9	0.3	7.7	37.3	15.8	0.9	0.3	19.7
	50	0.29	14.3	9.5	9.0	0.3	7.2	16.7	17.7	0.4	0.1	39.2
	84	0.26	13.3	7.9	10.7	0.2	8.2	21.9	11.5	0.5	0.1	39.1
	82	0.24	13.3	6.8	7.1	0.3	6.4	36.3	11.1	0.4	0.3	31.3
	83	0.31	6.4	20.5	9.3	0.2	5.0	14.9	8.0	0.3	0.2	41.5
	Composite (total)	**13.70**	**15.1**	**6.4**	**8.1**	**0.3**	**4.4**	**43.5**	**16.3**	**1.1**	**0.6**	**19.2**
	Summer	**5.30**	**14.2**	**6.8**	**8.7**	**0.2**	**5.8**	**43.4**	**15.3**	**1.2**	**0.6**	**18.0**
	Winter	**3.77**	**15.7**	**6.3**	**7.1**	**0.2**	**3.2**	**44.5**	**16.6**	**0.5**	**0.7**	**20.7**

Developed from raw data from MHTIS by J.M. and D.T. October 2001.

Note: See Appendix G for vehicle classes

Table 6-4 shows the change in fleet mix observed at the Headingley weigh scale in a series of truck surveys conducted between 1974 and 2001. The scale is located on the Trans-Canada Highways just west of Winnipeg. In 2000, the AADTT was 2,065 trucks per day. The following observations are relevant:

- Combinations with 2-axle tractors decreased from about 13 percent of the fleet in 1974 to 0 percent in 2000. Combinations with 3-axle tractors increased from 87 percent of the fleet to effectively all of the fleet in 2000.
- Five-axle tractor semitrailers (3-S2s) decreased from about 90 percent of the fleet in 1974 to 56 percent of the fleet in 2000.
- Six-axle tractor semitrailers (3-S3s) accounted for about one percent of the fleet between 1974 and 1982—and since the RTAC MoU in the late 1980s, increased to nearly one-quarter of the fleet in 2000.
- Five and six-axle A-trains changed from accounting for about one percent of the fleet in 1974, to peaking at about three percent in 1982, and decreasing to zero percent in 2000.
- Seven and eight-axle A-trains went from zero percent of the fleet in 1974, to peaking at about16 percent in 1989, and decreasing to about three percent of the fleet in 2000.
- Seven-axle B-trains accounted for about one percent of the fleet in the late 1970s, increasing to a peak of about 10 percent in 1989, decreasing to one percent in 2000.
- Eight-axle B-trains increased from about four percent of the fleet from shortly after they first became an effective option by the RTAC MoU to 17 percent in 2000.

6.3.4 Temporal Distributions of Truck Traffic

The temporal distributions of truck traffic in relation to HTAs are of interest to many involved in heavy truck safety (Campbell et al., 2000 and TRB, 2001). In many cases, the lack of adequate truck traffic data prohibits the development of these types of relationships. This section develops temporal distributions of truck traffic exposure that are subsequently used in the analysis of seasonal and time-of-day variations in HTA rates on provincial highways in Manitoba.

Table 6-4: Change in Fleet Mix at Headingley Weigh Scale

		1974	1975	1978	1982	1989	1991	1992	1997	2000
Source		a	a	a	a	b	f	c	e	d
Class		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Tractor-Semis	2-S1	3	1	*	*	0	0	1	0	0
	2-S2	9	6	4	2	0	0	2	0	0
	2-S3	0	*	0	0	0	0	0	0	0
	3-S1	0	*	*	*	0	0	1	0	0
	3-S2	87	91	88	85	63	83	65	60	56
	3-S3	*	*	*	1	7	6	11	24	23
A - Trains	2-S1-2	1	1	*	*	0	0	0	0	0
	2-S2-2	0	0	0	0	0	0	0	0	0
	3-S1-2	*	1	3	3	0	0	2	1	0
	3-S1-3	0	0	1	*	0	0	0	0	0
	3-S2-2	0	1	3	4	13	3	6	1	2
	3-S2-3	*	1	*	1	3	0	1	0	1
B- Trains	3-S2-S2	0	0	*	3	10	5	5	1	1
	3-S3-S2	0	0	0	0	4	3	8	13	16
	3-S2-S3	0	0	0	0	0	0	0	0	1
No. of Observ.		**1169**	**990**	**986**	**982**	**148**	**408**	**949**	**845**	**1314**

Sources: a (adapted) - Clayton/Lai Paper, b - Manitoba Special Survey, c - Cordeiro (1992), d - Malbasa (2000), e - Zhi (1998), f - E. Fepke (1993).

* means less than one percent but not zero

6.3.4.1 Development of the Database for Manitoba

There is a network of 24 automatic vehicle classifiers (AVCs) in Manitoba. This network has been created in recent years as part of the design and development of a truck traffic information system for the province (Escobar et al., 1998). While the truck traffic information system will not be fully operational until 2003-2004, it has yielded an extensive amount of data for the research that has allowed exposure-based investigation of Manitoba's HTA situation which was not previously possible.

In developing the database for this analysis, 15 AVC stations were selected based on data availability (see Figure 6-2). Each of these stations was able to produce a full year of truck traffic for the province (365 days, by hour, in each direction, and by vehicle class—FHWA Classes 5-13. See Appendix G). The 15 sites provide a good geographical coverage of the province on a range of highway types (divided, undivided, RTAC, non-RTAC), truck volumes (low, medium, high), trucking types (local, regional, long haul), and freight characteristics (truck load, less than truck load, special commodities).

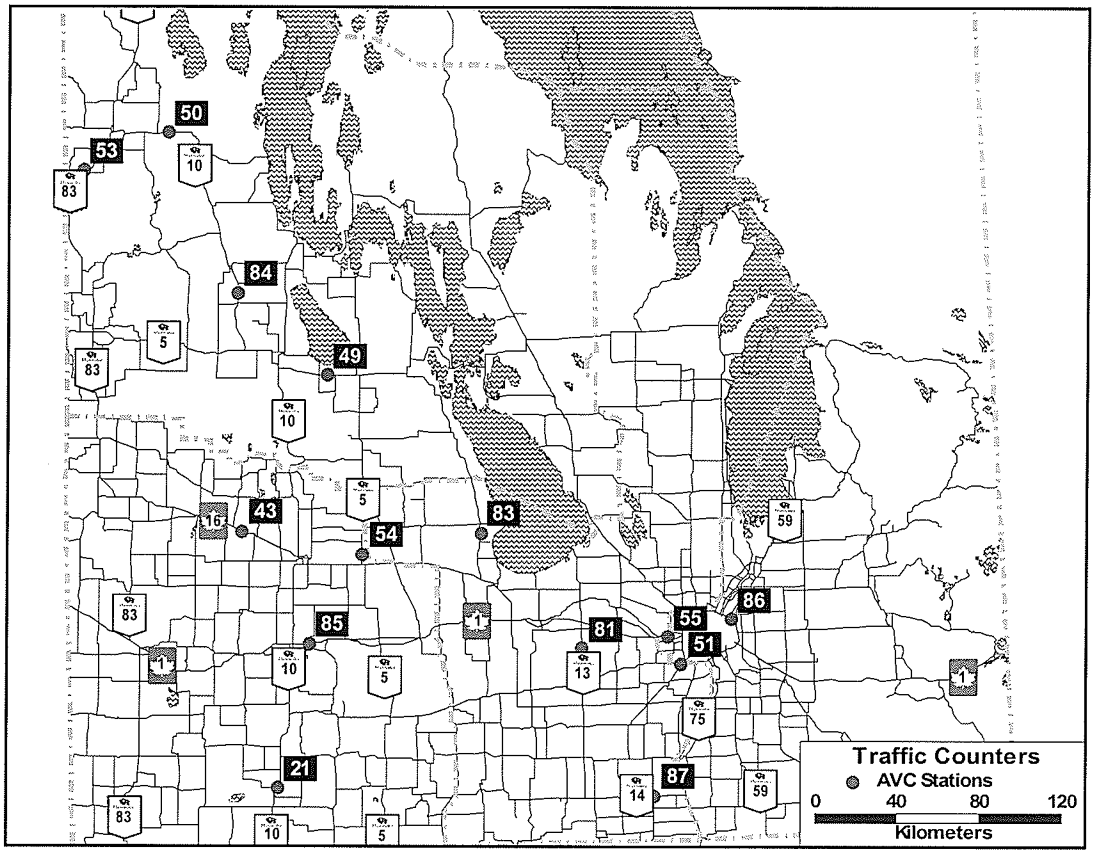


Figure 6-2: AVC Stations Used for the Development of the Database

In some instances (*i.e.,* where equipment failure or malfunction produced either no or questionable results), data from more than a one-year period was blended to create the raw data sets used in the analysis. For example, for Station 43, data from the period June 15 to August 15, 2001 had to be blended into data for the year 2000 because of equipment problems during this same period during the year 2000.

It is assumed that this blending has minimal effect on the temporal patterns of truck traffic. Based on previous research (Clayton et al., 1998) it is further assumed that the temporal patterns evident in this truck traffic database are similar to those patterns that would have been observed through the period 1993 to 1998.

This database is considered in one of two ways: (1) each count station is viewed individually; (2) all count stations are added together to create a composite truck flow for the province. The first case assumes that each station represents 1/15 (6.7 percent) of all truck traffic on the Manitoba provincial highway network. Analyses based on the composite database assume that each of the 15 AVC stations is representative of all truck traffic in proportion to the amount of truck traffic at each station for the year (e.g. Station 84 at Mink Creek on PTH 10 represents two percent of the temporal characteristics of all truck traffic).

The raw database includes a total count of 2.07 million trucks. AADTT estimates for each site by direction are shown in Table 6-5. Six stations experienced very small AADTT (less than 150); five stations showed small AADTT (151-400); three stations showed medium

AADTT (400-1000); and one station experienced large AADTT (greater than 1000).

Table 6-5: AADTT Estimates for AVC Stations in Manitoba

Station No.	Direction	AADTT
21 - Boissevain (Hwy 10, N of PR 448)	EB	67
	WB	63
43 - Strathclair (Hwy 16, E of E Jct PR 354)	EB	247
	WB	249
49 - Ochre River (Hwy 5, E of PTH 20)	EB	84
	WB	83
50 - Swan River L.P. East (Hwy 10, E of PR 268)	EB	54
	WB	58
51 - Oakbluff (Hwy 3, SW of PTH 2)	NB	150
	SB	152
53 - Swan River South (Hwy 83, SW of PR 486)	NB	65
	SB	66
54 - Neepawa (Hwy 5, N of PTH 16)	NB	85
	SB	87
55 - Headingley (Hwy 1, W of PR 334)	EB	994
	WB	1071
81 - Oakville (Hwy 13, S of Oakville)	NB	156
	SB	176
82 - Paint Lake (Hwy 6, S of Paint Lake Access)	NB	44
	SB	45
83 - Langruth (Hwy 50, S of PR 265)	NB	27
	SB	27
84 - Mink Creek (Hwy 10, S of Jct PTH 10A (Ethelbert)	NB	50
	SB	44
85 - Brandon East (Hwy 110, S of PR 457)	NB	200
	SB	200
86 - Wenzel (Hwy 101, E of Wenzel Road)	EB	396
	WB	419
87 - Altona (Hwy 14, E of PTH 30)	EB	166
	WB	159

Developed from raw data from MHTIS by J.M. and D.T. October 2001.

6.3.4.2 Seasonal Distribution of Truck Traffic on Provincial Highways in Manitoba

Monthly estimates of Average Daily Truck Traffic (ADTT) were developed for each of the 15 AVC sites and for the 15-site composite using the conventional method recommended in the new Traffic Monitoring Guide published by the U.S. DOT. Details about the resulting monthly seasonal patterns are shown in Table 6-6 and Figure 6-3.

Table 6-6: Monthly Distribution of Truck Traffic in Manitoba (composite)

Month	Combined Truck Count	Counted Station-Days	Average (Veh/Day)	%AADTT	% of Total Truck Counts
Jan	147624	459	322	85	7
Feb	147786	431	343	90	7
Mar	168269	465	362	95	8
Apr	167366	450	372	98	8
May	203449	462	440	116	10
Jun	180866	450	402	106	9
Jul	178195	465	383	101	9
Aug	193183	465	415	110	9
Sep	182054	450	405	107	9
Oct	204062	465	439	116	10
Nov	155301	443	351	92	8
Dec	140730	458	307	81	7
Total	**2068885**				

Composite Truck Flow

- The months of November to April inclusive experience monthly ADTT factors below 100, ranging from 81 (in December) to 98 (in April).
- May to October inclusive experience monthly ADTT factors greater than 100, ranging from 101 in July to 116 in May and October. The May and October peaking could reasonably be expected to reflect increased agricultural-related trucking at these times—fertilizer and seed in the spring, and grain in the fall.
- The four months of November to February inclusive ("winter months") experience 29 percent of truck traffic. The four months of May to August inclusive ("summer months") experience 37 percent. The four months of spring and fall (March and April, September and October) experience 35 percent of truck traffic.

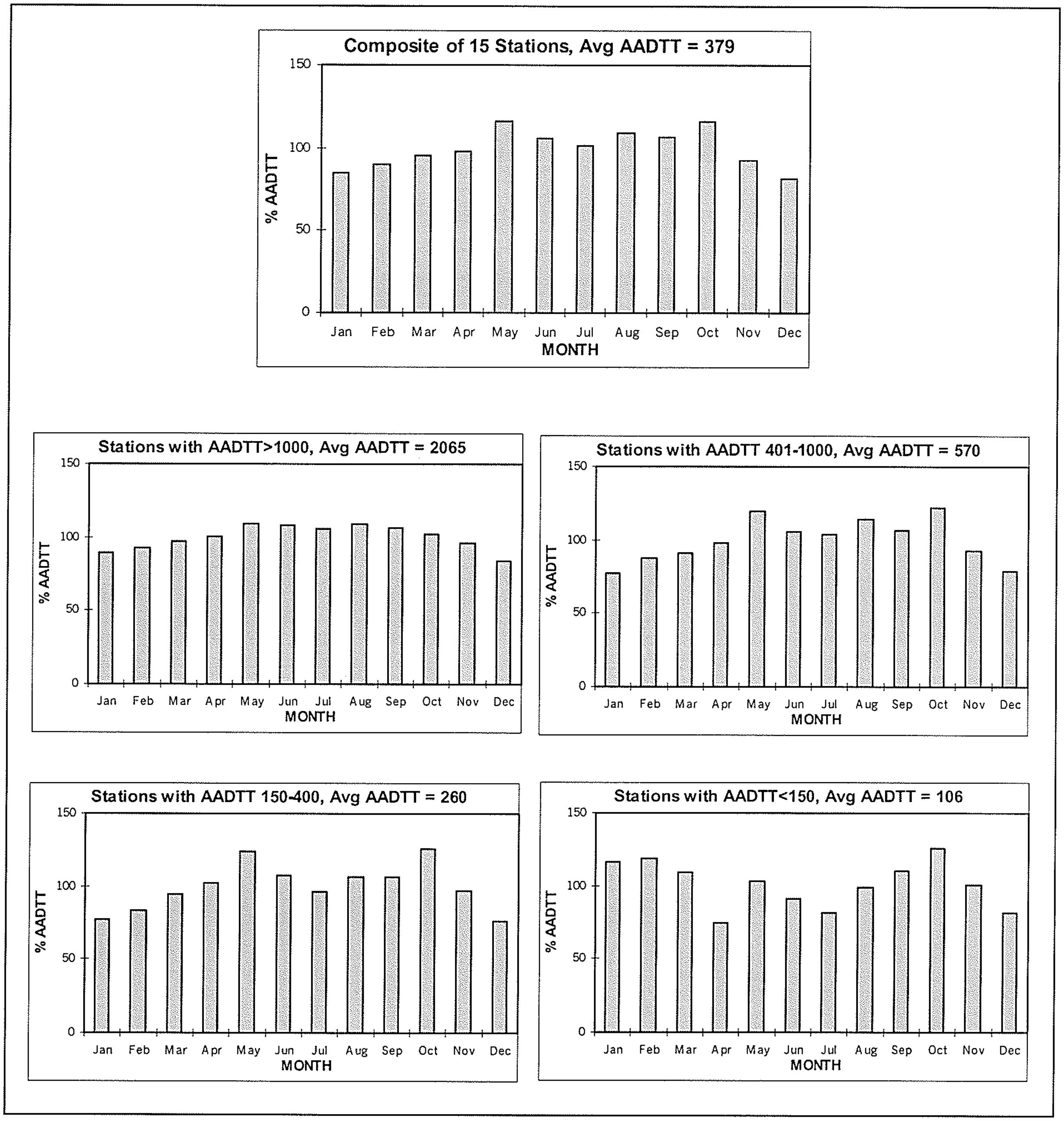


Figure 6-3: Average Daily Truck Traffic by Month

- Table 6-7 shows statistics concerning the summer and winter ADTT values. The two ADTT values of 6144 and 4888 respectively are significantly different at the 95 confidence level. The summer/winter ADTT ratio is 1.28.

Table 6-7: Summer and Winter ADTT in Manitoba

	Summer	Winter
Total Trucks	755693	591441
No. of Days Counted	123	121
Average Daily Truck Traffic	6144	4888
Standard Deviation	1354	1516
Standard Error	122	138
95% Confidence Interval	5905 to 6383	4618 to 5158

Individual Station Truck Flow

- At nearly all stations (except at the very low truck volume sites of Stations 50 and 53), the seasonality factors in the winter period of November, December, January and February are always less that 100 (most are in the 60 to 90 range).

- At nearly all stations (except at the very low truck volume sites of Stations 50, 53, 82, 84), the seasonality factors in the summer period of May, June, July and August are always more than 100.

- At nearly all stations (except at the very low truck volume sites of Stations 50, 82, and 83), the seasonality factor for May and/or October is the highest for the year (most in the 110 to 130 range) .

- As AADTT increases, the seasonal fluctuations in truck traffic dampen. See Figure 6-4. The seasonality of truck traffic at locations with very low AADTT is the most highly varied, although May and October still dominate. At some locations, winter traffic is substantially lower than summer traffic, and May and October peaking is apparent. At the one high volume location included in the data set, the seasonal pattern is quite flat, with summer flows somewhat higher than winter, and no May and October peaking.

- The summer versus winter analysis conducted using the individual stations rather than composite figures examined statistical differences between the ratio of summer ADTT and winter ADTT at each of the sites. In this case, the mean ratio of the summer ADTT to winter ADTT is 1.24 (standard deviation of the mean is 0.246, and the standard error of the mean is 0.064) as shown in Table 6-8. At the 95 percent confidence level, the summer winter ratio varies between a low of 1.10 and a high of

1.38. This is similar to the findings obtained when using the composite database.

Table 6-8: Mean Ratio of Summer and Winter ADTT in Manitoba

Summer/Winter Mean Ratio	1.24
No. of AVC Stations	15
Standard Deviation	0.246
Standard Error	0.064
95% Confidence Interval	1.10 to 1.38

These data and observations are used to analyze the exposure-based HTA rate in Manitoba by season in Section 6.5.

6.3.4.3 Time-of-day Distribution of Truck Traffic on Provincial Highways in Manitoba

Figure 6-4 shows the composite time-of-day distributions of the truck classification surveys conducted at the 15 AVC sites. These data and observations are used to analyze the exposure-based HTA rate in Manitoba by time of day in Section 6.5.

- For the total composite database, hourly truck traffic during daytime hours (08:00 to 18:00) is about three times greater (12 to 13 percent per hour) than hourly night-time traffic (midnight to 06:00), and twice as great as evening and early morning traffic (five to nine percent per hour).
- As AADTT decreases, the proportion of truck traffic moving in daytime hours increases, with correspondingly less traffic in night-time hours.

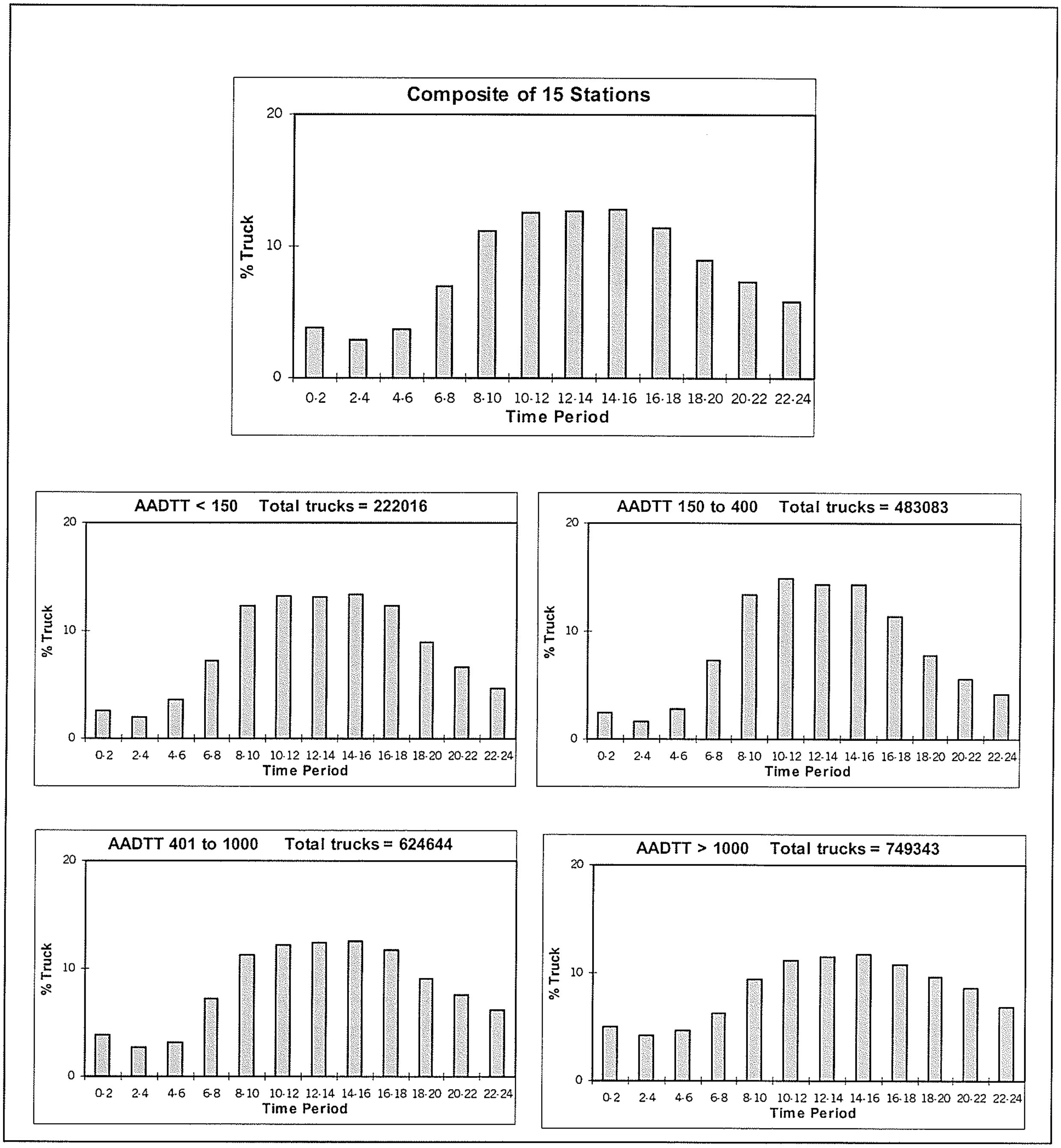


Figure 6-4: Average Daily Truck Traffic by Time of Day

6.3.5 Problems and Limitations to the Truck Traffic Data Used in the Research

Truck traffic continuously changes in response to external factors. In the Prairie region these factors include rail abandonment, shifts in distribution patterns, changes in weight laws, changes in trading arrangements, new security concerns, and economic issues. This research deals with the best estimates of truck traffic available at the time. The following discussion outlines major problems and limitations about the truck traffic data used in the research.

Many AADTT estimates used in the research are based on estimates of AADT and percent trucks. Many of the percent truck observations were obtained from visual surveys taken in the daytime, on weekdays, in the summer months. Similarly, there can be a variety of temporal biases included in the AADT estimates themselves depending on the traffic counting programs and traffic expansion methods used in each jurisdiction (which themselves may change over time). These realities introduce a variety of potential temporal biases into AADTT estimates.

While the AADTT estimates are based on 1998 data, this does not mean they necessarily apply to 1998. AADTT estimates for a given year are often estimates "dragged forward" from previous years, depending on the frequency and methodologies used by different jurisdictions to update their truck traffic estimates. In all provinces, not all AADT, nor percent trucks, or truck traffic are estimated for all road sections in the same year. In Manitoba, for example, AADTTs given for 1998 are on average based on about 1996 data—roughly the midpoint of the accident data set under consideration.

6.4 HEAVY TRUCK ACCIDENT RATES ON PROVINCIAL HIGHWAYS

This section analyzes HTA rates for the Prairie region based on the exposure information developed in Section 6.3. The first analysis of HTA rates is by road category, followed by an analysis by load class as a function of AADTT. An analysis of HTAs rates by seasonal, time of day, and vehicle class variations in Manitoba is also included in the section.

6.4.1 Heavy Truck Accident Rate by Road Category as a Function of AADTT

This deals with HTA rates by road category (divided versus undivided) as a function of AADTT for the Prairie region. Four categories of AADTT were used: (1) highways with very low truck volumes (less than 150 AADTT); (2) highways with low truck volumes (151-400 AADTT); (3) highways with medium truck volumes (401-1000 AADTT); and (4) highways with high truck volumes (greater than 1000 AADTT).

Total TKT values for each category were calculated by multiplying estimates of AADTTs for each link in each category by the length of the link, times 365 days per year. The principal TKT figures developed in the research are for 1998 truck traffic.

Tables 6-9a, 6-9b, and 6-9c illustrate the TKT figures and HTA rates by truck volume and road category for each province. The following is observed from the three tables:

Table 6-9a: TKT by Road Category and HTA Rates in Manitoba

Truck Volume (AADTT)	Million TKT per Year			HTA Rate (HTAs/million TKT)		
1998	**Divided**	**Undivided**	**Total**	**Divided**	**Undivided**	**Total**
0-150	0.18	217	217	*	0.24	0.24
151-400	10	124	134	*	0.27	0.28
401-1000	107	63	170	0.31	0.32	0.31
>1000	125	7	132	0.34	*	0.32
Total	242	411	653	**0.33**	**0.26**	**0.28**

Developed based on raw data provided by Manitoba Transportation and Government Services and MHTIS

* The HTA rate was not calculated for these cells because either the number of HTAs was too low (<=10 in the 6-year period) or the TKT was too small (<=10 million truck-kilometers traveled)

Table 6-9b: TKT by Road Category and HTA Rates in Saskatchewan

Truck Volume (AADTT)	Million TKT per Year			HTA Rate (HTAs/million TKT)		
1998	**Divided**	**Undivided**	**Total**	**Divided**	**Undivided**	**Total**
0-150	0.11	294	294	*	0.41	0.41
151-400	2	267	269	*	0.31	0.31
401-1000	84	154	238	0.32	0.28	0.29
>1000	240	98	338	0.27	0.41	0.31
Total	326	813	1139	**0.28**	**0.35**	**0.33**

Developed based on raw data provided by Saskatchewan Highways and Transportation, and SGI

* The HTA rate was not calculated for these cells because either the number of HTAs was too low (<=10 in the 6-year period) or the TKT was too small (<=10 million truck-kilometers traveled)

Table 6-9c: TKT by Road Category and HTA Rates in Alberta

Truck Volume (AADTT)	Million TKT per Year			HTA Rate (HTAs/million TKT)		
1998	**Divided**	**Undivided**	**Total**	**Divided**	**Undivided**	**Total**
0-150	0	142	142	*	0.48	0.48
151-400	6	528	534	*	0.41	0.41
401-1000	231	358	589	0.41	0.34	0.36
>1000	441	34	475	0.28	0.29	0.28
Total	678	1062	1740	**0.32**	**0.39**	**0.36**

Developed based on raw data provided by Alberta Transportation

* The HTA rate was not calculated for these cells because either the number of HTAs was too low (<=10 in the 6-year period) or the TKT was too small (<=10 million truck-kilometers traveled)

- Highways with medium to high volumes (AADTT greater than 400) accounted for 46 percent of all truck kilometers travelled (TKT) in Manitoba, 51 percent of all TKT in Saskatchewan, and 61 percent of all TKT in Alberta. These highways also accounted for 52 percent of all HTAs on provincial highways in Manitoba, 46 percent in Saskatchewan, and 55 percent in Alberta.

- The overall HTA rate including HTAs at intersections on provincial highways in the Prairie region is 0.34 HTAs per million truck-kilometers traveled. Excluding intersection HTAs from the rate calculation, the HTA rate is 0.25 HTAs per million TKT. About 30 percent of all HTAs on provincial highways occurred at intersections.

- When all HTAs are considered, the HTA rate is lower on divided highways than on undivided highways in the region (0.31 HTAs per million TKT on divided highways, and 0.35 HTAs per million TKT on undivided highways). However, when intersection HTAs are removed, the rate is similar for divided and undivided highways (0.24 HTAs per million TKT for divided and 0.25 HTAs per million TKT for undivided highways). See Tables 6-10a, 6-10b, and 6-10c for HTA rates in the three provinces excluding HTAs at intersections.

- In Saskatchewan and Alberta, the HTA rate for divided highways is lower than the HTA rate for undivided highways. This is not the case in Manitoba, where the HTA rate is higher on divided highways than on undivided highways.

6.4.2 Heavy Truck Accident Rate by Highway Load Class as a Function of AADTT

This deals with HTA rates by highway load class (basic RTAC versus non-RTAC). The AADTT categories are the same as those used in the road category analysis.

Tables 6-11a, 6-11b, and 6-11c illustrate the HTA rate in the three provinces by load class. The following is observed:

Table 6-10a: Intersection versus non-Intersection HTAs in Manitoba by Road Category

Truck Volume (AADTT)	Truck-Kilometers per Year (millions)			Number of HTAs (1993-1998)			Non-Intrsctn Rate (HTA/MTKT)
1998	**Divided**	**Undivided**	**Total**	**Intersection**	**Non-Intrsctn**	**Total**	
0-150	0.18	217	217	104	212	316	0.16
151-400	10	124	134	96	129	225	0.16
401-1000	107	63	170	124	195	319	0.19
>1000	125	7	132	88	168	256	0.21
Total	242	411	653	412	704	1116	**0.18**

Developed based on raw data provided by Manitoba Transportation and Government Services, and MHTIS

Table 6-10b: Intersection versus non-Intersection HTAs in Saskatchewan by Road Category

Truck Volume (AADTT)	Truck-Kilometers per Year (millions)			Number of HTAs (1993-1998)			Non-Intrsctn Rate (HTA/MTKT)
1998	**Divided**	**Undivided**	**Total**	**Intersection**	**Non-Intrsctn**	**Total**	
0-150	0.11	294	294	220	506	726	0.29
151-400	2	267	269	151	355	506	0.22
401-1000	84	154	238	142	273	415	0.19
>1000	240	98	338	138	496	634	0.24
Total	326	813	1139	651	1630	2281	**0.24**

Developed based on raw data provided by Saskatchewan Highways and Transportation, and SGI

Table 6-10c: Intersection versus non-Intersection HTAs in Alberta by Road Category

Truck Volume (AADTT)	Truck-Kilometers per Year (millions)			Number of HTAs (1993-1998)			Non-Intrsctn Rate (HTA/MTKT)
1998	**Divided**	**Undivided**	**Total**	**Intersection**	**Non-Intrsctn**	**Total**	
0-150	0	142	142	127	285	412	0.33
151-400	6	528	534	352	966	1318	0.3
401-1000	231	358	589	309	980	1289	0.28
>1000	441	34	475	160	629	789	0.22
Total	678	1062	1740	948	2860	3808	**0.27**

Developed based on raw data provided by Alberta Transportation

Table 6-11a: TKT by Load Class and HTA Rates in Manitoba

Truck Volume (AADTT)	Million TKT per Year			HTA Rate (HTAs/million TKT)		
1998	RTAC	NON-RTAC	Total	RTAC	NON-RTAC	Total
0-150	59	158	217	0.26	0.24	0.24
151-400	86	48	134	0.3	0.24	0.28
401-1000	156	14	170	0.32	0.29	0.31
>1000	119	13	132	0.34	0.14	0.32
Total	420	233	653	**0.31**	**0.23**	**0.28**

Developed from raw data provided by Manitoba Transportation and Government Services

Table 6-11b: TKT by Load Class and HTA Rates in Saskatchewan

Truck Volume (AADTT)	Million TKT per Year			HTA Rate (HTAs/million TKT)		
1998	RTAC	NON-RTAC	Total	RTAC	NON-RTAC	Total
0-150	96	198	294	0.44	0.4	0.41
151-400	237	32	269	0.32	0.23	0.31
401-1000	233	5	238	0.29	*	0.29
>1000	338	0	338	0.31	*	0.31
Total	904	235	1139	**0.32**	**0.37**	**0.33**

Developed from raw data provided by Saskatchewan Highways and Transportation, and SGI

* The HTA rate was not calculated for these cells because either the number of HTAs was too low (<=10 in the 6-year period) or the TKT was too small (<=10 million truck-kilometers traveled)

Table 6-11c:TKT by Load Class and HTA Rates in Alberta

Truck Volume (AADTT)	Million TKT per Year			HTA Rate (HTAs/million TKT)		
1998	RTAC	NON-RTAC	Total	RTAC	NON-RTAC	Total
0-150	142	n/a	142	0.48	n/a	0.48
151-400	534	n/a	534	0.41	n/a	0.41
401-1000	589	n/a	589	0.36	n/a	0.36
>1000	475	n/a	475	0.28	n/a	0.28
Total	1740	n/a	1740	**0.36**	**n/a**	**0.36**

Developed from raw data provided by Alberta Transportation

n/a = not applicable. All primary highways in Alberta are RTAC highways.

- Basic RTAC highways account for nearly three-quarters of all TKT in Manitoba and Saskatchewan (all primary highways in Alberta were RTAC highways during the course of the research). In Manitoba, nearly two-thirds of all TKT takes place on basic RTAC highways. In Saskatchewan, basic RTAC highways account for 79 percent of all TKT.

- The overall HTA rate on basic RTAC highways in the Prairie region is 0.35 HTAs per million TKT. This is higher than the HTA rate on basic RTAC highways in Manitoba and Saskatchewan (0.31 HTAs per million TKT in Manitoba and 0.32 HTAs per million TKT in Saskatchewan).

- Basic RTAC highways with medium to high truck volumes have an overall HTA rate of 0.32 HTAs per million TKT in the Prairie region. Basic RTAC highways with AADTT less than 400 have an overall HTA rate of 0.39 HTAs per million TKT in the region.

6.4.3 Seasonal Variations in Manitoba

Table 6-12 shows the proportion of HTAs (1993-1998), time, and HTA truck traffic estimated to occur on Manitoba provincial highways, and the relative HTA rate, for each of three seasons (winter, spring/fall, summer) through the course of one year. The following is observed:

- The winter months account for 44 percent of HTAs; 33 percent of the time; and 29 percent of truck traffic. Spring and Fall account for 31 percent of HTAs; 33 percent of the time; and 35 percent of truck traffic. Summer months account for 25 percent of HTAs; 33 percent of the time; and 37 percent of truck traffic.

- Based on time (*i.e.*, the number of months), the winter rate is 1.75 times the summer rate and 1.42 times the spring/fall rate. Based on truck traffic, the winter rate is 2.24 times the summer rate and 1.77 times the spring/fall rate.

6.4.4 Time of Day Variations in Manitoba

Table 6-13 shows time of day variations in Manitoba. The table includes the proportion of HTAs (1993-1998), time, HTA truck traffic estimated to occur on Manitoba provincial highways, and the relative HTA rate, for each two-hour period of the day. The following is observed:

Table 6-12: Relative Heavy Truck Accident Rates by Season in Manitoba

	Winter (Nov to Feb)	Spring/Fall (Mar, Apr/Sep, Oct)	Summer (May to Aug)
Percent of HTAs	44 (512 HTAs)	31 (359 HTAs)	25 (288 HTAs)
Percent of Time	33.3	33.3	33.3
Percent of Truck Traffic	29	35	37
HTA rate per unit time	1.32	0.93	0.75
HTA rate per unit traffic	1.52	0.86	0.68

Based on raw traffic data from MHTIS, J.M. and D.T.

Table 6-13: Time of Day Variations in Manitoba

Time of Day	HTAs (93-98)	% of HTAs	% of Time	% of Truck Traffic	% HTAs/ % Truck Traffic	TKT (million)	HTA Rate
0000-0159	100	8.73	8.33	3.8	2.3	24.79	0.67
0200-0359	40	3.49	8.33	2.91	1.2	18.99	0.35
0400-0559	49	4.28	8.33	3.68	1.16	24.05	0.34
0600-0759	55	4.80	8.33	6.93	0.69	45.24	0.2
0800-0959	111	9.69	8.33	11.19	0.87	73.06	0.25
1000-1159	113	9.86	8.33	12.57	0.78	82.09	0.23
1200-1359	114	9.95	8.33	12.62	0.79	82.42	0.23
1400-1559	131	11.43	8.33	12.78	0.89	83.44	0.26
1600-1759	129	11.26	8.33	11.41	0.99	74.5	0.29
1800-1959	126	10.99	8.33	8.96	1.23	58.48	0.36
2000-2159	105	9.16	8.33	7.37	1.24	48.15	0.36
2200-2359	73	6.37	8.33	5.79	1.1	37.81	0.32
Total	1146	100.00	100	100		653	

All shaded cells represent evening-night time periods.
Note: There are 7 HTAs for which time of day was not associated with them

- The time period between 18:00 and 06:00 (evening-night) accounts for 43 percent of HTAs, 50 percent of time, and one-third of truck traffic The time period 06:00 and 18:00 (morning-day) accounts for 57 percent of HTAs, one-half of time, and two-thirds of truck traffic.

- All two-hour time periods in the evening-night time period have a relative HTA rate per unit traffic greater than one (low of 1.10, high of 2.30, average of 1.32). All two-hour time periods in the morning-day time period have a relative HTA rate per unit traffic less than one (low of 0.69, high of 0.99, average of 0.84).

- On a more focused nighttime period of 00:00 to 06:00 and daytime period of 10:00 to 16:00, the nighttime HTA traffic based rate is 1.93(1.58/0.82) times the daytime HTA traffic based rate.

Figure 6-5 shows the variation in the HTAs per million TKT by time of day. The average evening-nighttime rate is 0.40 HTAs per million TKT. This is 1.67 times the average morning-daytime rate of 0.24 HTAs per million TKT.

In summary, for the 1,159 HTAs that occurred on Manitoba's provincial highways between 1993 and 1998, there is a large difference in the time-of-day HTA traffic based exposure rate, with the average evening and/or nighttime rate being about 60 percent higher than the average morning and/or daytime rate.

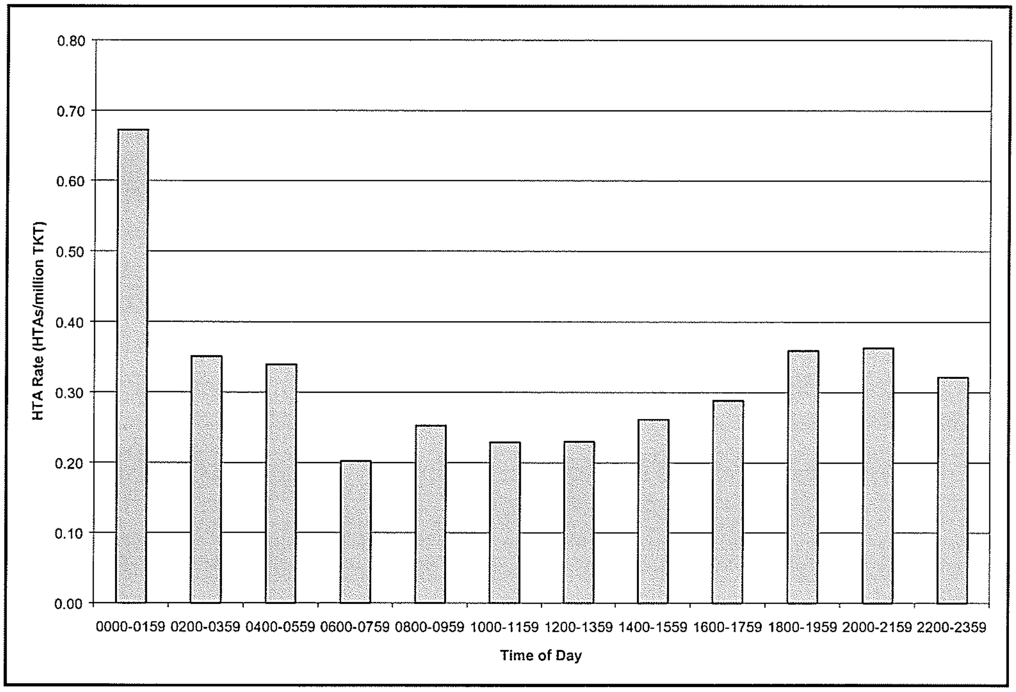


Figure 6-5: HTA Rate by Time of Day on Manitoba Provincial Highways

6.4.5 Vehicle Class Variations in Manitoba

Respecting HTAs, Manitoba accident data distinguishes between single trailer combinations, double trailer combinations, and triple trailer combinations.

6.4.5.1 Single and Double Trailer HTA Involvement versus Their Role in the Fleet Mix

For this analysis, considering Manitoba's TS&W regulations, it is assumed that FHWA classes 8, 9 and 10 are single trailer heavy trucks and that classes 11, 12 and 13 are double trailer heavy trucks (see Appendix G for FHWA vehicle class table). Table 6-14 shows the proportion of heavy trucks involved in HTAs which were known to be single and double trailer combinations respectively. Also shown are the proportions of total truck traffic represented by these two groups of truck classes and the related TKT estimate per group.

Table 6-14: HTA Rates for Single versus Double Heavy Trucks

	Single Trailer Heavy Trucks	**Double Trailer Heavy Trucks**
No. of HTs involved in all HTAs known to be single or double trailer combinations (1993-1998)	823	198
Percentage of HTs involved in all HTAs known to be single or double trailer combinations	81 (823 of 1021)	19 (198 of 1021)
Percentage of trailer combinations in the composite truck traffic stream that are single or double (or more) trailer combinations	75 (64.2/85.1)	25 (20.9/85.1)
TKT per group (millions/year)	419 (0.642*653)	127 (0.209*653)
Involvement rate per TKT (Trailers per million trailer type TKT)	0.33 (823/6/419)	0.26 (198/6/127)
Relative involvement rate	1.07	0.79

Developed from raw data provided by MHTIS and Manitoba Transportation

These calculations indicate that in Manitoba, on provincial highways, single trailer combinations are involved in a higher proportion of HTAs than they are present in the heavy truck traffic stream (seven percent more). Conversely, double trailer combinations are involved in a lower proportion of HTAs than they are present in the traffic stream (21 percent less). Corresponding differences in the involvement rates of single and double trailer combinations in HTAs in relation to the fleet percentage of single and double trailers are also evident (0.33 versus 0.26).

Lack of detail in the accident database and the truck traffic database prohibits investigating the B/C-train versus A-train question concerning vehicle configurations. What can be said is that at sites where extensive visual vehicle classification has been carried out, B-trains typically account for about two-thirds of the double trailer fleet.

6.4.5.2 Seasonal Effects

The composite traffic stream indicates no meaningful change in fleet mix between seasons. This suggests that both single and double trailer combinations experience higher accident involvement rates in winter versus summer.

6.5 HEAVY TRUCK ACCIDENT RATES ON WINNIPEG STREETS

Heavy truck accident rates on Winnipeg streets were estimated in this research for the years 1993 to 1995 (these are the years for which truck volume data was available). Heavy truck accident rate analysis was not possible for Regina and Saskatoon due to lack of truck volume data in those cities.

- City of Winnipeg truck route sections with very low heavy truck volumes (less than 150 AADTT) account for 52 percent of the city's truck route network, about 25 percent of TKT, and about 14 percent of HTAs. Truck route sections with low volumes (151-400 AADTT) account for nearly 27 percent of truck route kilometers, 24 percent of TKT, and 30 percent of all HTAs. Sections with medium and high volumes (greater than 400 AADTT) account for 21 percent of all truck route kilometers, 62 percent of all TKT, and 45 percent of all HTAs (Montufar and Clayton, 1997).

- The overall truck accident rate including HTAs at intersections on Winnipeg truck routes is in the range of 4.42 to 6.19 HTAs per million TKT. The rate excluding HTAs at intersections is in the range of 1.72 to 2.41 HTAs per million TKT. These figures are expected to have remained approximately the same between 1995 and 1998.

- The HTA rate is much higher on Winnipeg streets than on provincial highways. The overall HTA rate on Winnipeg streets is as much as 20 times greater than on provincial highways. Excluding HTAs at intersections, the HTA rate is about 10 times greater in Winnipeg than on provincial highways.

CHAPTER 7

SYSTEM SAFETY REVIEWS FOR HEAVY TRUCK OPERATIONS

This chapter discusses the development of the system safety review concept for heavy truck operations. The chapter begins with a discussion of the need for system safety reviews for heavy truck operations (SSR-HTO), followed by the development of the procedure to use when conducting these reviews. It concludes providing illustrative examples of the application of aspects of the procedure.

7.1 THE NEED FOR SYSTEM SAFETY REVIEWS

In Canada, in recent years, road authorities have began incorporating road safety audits as a pro-active approach to road safety. Road safety audits are defined as "a formal and independent safety performance review of a road transportation project by an experienced team of safety specialists, addressing the safety of all road users." (Ho et al., 2001).

A road safety audit is intended to focus on the physical characteristics of a facility, either at the feasibility, preliminary design, detailed design, pre-opening, or post-opening stages. However, from the heavy truck perspective, many other issues over and above the considerations of road safety audits (truck size and weight regulations, safety regulations, enforcement practices, routing and scheduling alternatives, types and quantities of vehicles operating on the road, commodities being moved, and origin-destination patterns) are also critical to truck safety. Changes in any of these elements may impact the safety of heavy truck operations, as well as the safety of all other road users.

The concept of system safety reviews is developed in this research to help engineers and other safety and trucking professionals evaluate alternatives regarding the safety of heavy truck operations. These reviews can help analyze the safety implications of a situation or decision, providing a solid understanding—and therefore, the basis for informed decision-making—of the different components of the system within which heavy trucks operate.

7.2 THE SYSTEM SAFETY REVIEW CONCEPT

Analyzing heavy truck safety is a complex undertaking because of the nature of trucking. The industry, which is subject to strong economic pressures, is specifically regulated from the safety perspective, uses professional drivers, moves a wide range of commodities using different types of equipment, and in many cases, is multi-jurisdictional.

The purpose of a system safety review is to bring forward important issues that affect the safety of heavy truck operations in a region or in a given situation, and to provide observations respecting the system involving heavy truck operations.

The research defines a system safety review for heavy truck operations as *a formal and comprehensive examination—conducted by a team of experts—of the transportation system, activity system, and flow pattern elements that affect the safety of heavy truck operations in a region or given situation.*

7.3 FRAMEWORK FOR ANALYSIS

Because analyzing heavy truck safety is a complex undertaking, and the system where trucks operate is also complex, a simplified view of the analysis process is needed. The proposed framework is defined by the transportation system (T), the activity system or demand (D), and the flow system (F) (after Manheim, 1979). From the trucking perspective, these are comprised of the following elements.

Transportation System (T)

- road networks where trucks operate
- road design practices specific to trucking
- road condition monitoring and information dissemination
- technology used by trucking industry
- truck size and weight regulations
- safety regulations
- enforcement practices
- location of enforcement facilities
- operating rules specific to trucking (speed limit differentials, lane assignments)

Activity System or Demand (D)

- commodities being moved
- origin-destination patterns
- shipment sizes
- temporal distributions of freight movement (*e.g.*, month of year, time of day, day of week)
- directional characteristics of freight movement (*e.g.*, loaded in one direction, empty in another)
- special handling requirements
- operating practices on the part of the carriers
- routing and scheduling

Flow System (F)

- quantities of vehicles operating by configuration class
- body types of trucks

- temporal distribution of vehicles operating
- directional distribution of vehicles
- frequency and characteristics of heavy truck accidents
- heavy truck accident rates

In addition to those elements, there is also a complex, ever-changing political, social, economic, geographical, and technological environment (E) that has both direct and indirect impacts on the safety of heavy truck operations in a region under certain situations. This environment is a principal determinant of T and D. The proposed framework is illustrated in Figure 7-1.

From Figure 7-1, at time t_0, E_0 has influenced the characteristics of T_0 and D_0 and their resultant flow pattern F_0. The resulting F_0, measured by the changes in truck flow characteristics can generate or stimulate change in T and/or D (ΔT, ΔD). Coupled with relevant changes in E (*e.g.,* implementation of NAFTA, or economic deregulation of trucking), a new E_1, T_1, and D_1 system is created, resulting in a new flow pattern. This is a continuous process. Any change in T or D will result in changes in F over time. Similarly, changes in F may affect T and D and these readjust to accommodate the new F. Therefore, a good understanding of T, D, and F, and their interaction, is important for the analysis of the safety of heavy truck operations for a given situation.

Some trucking-related examples of cases where changes in T (ΔT) or D (ΔD) have affected F in Manitoba are:

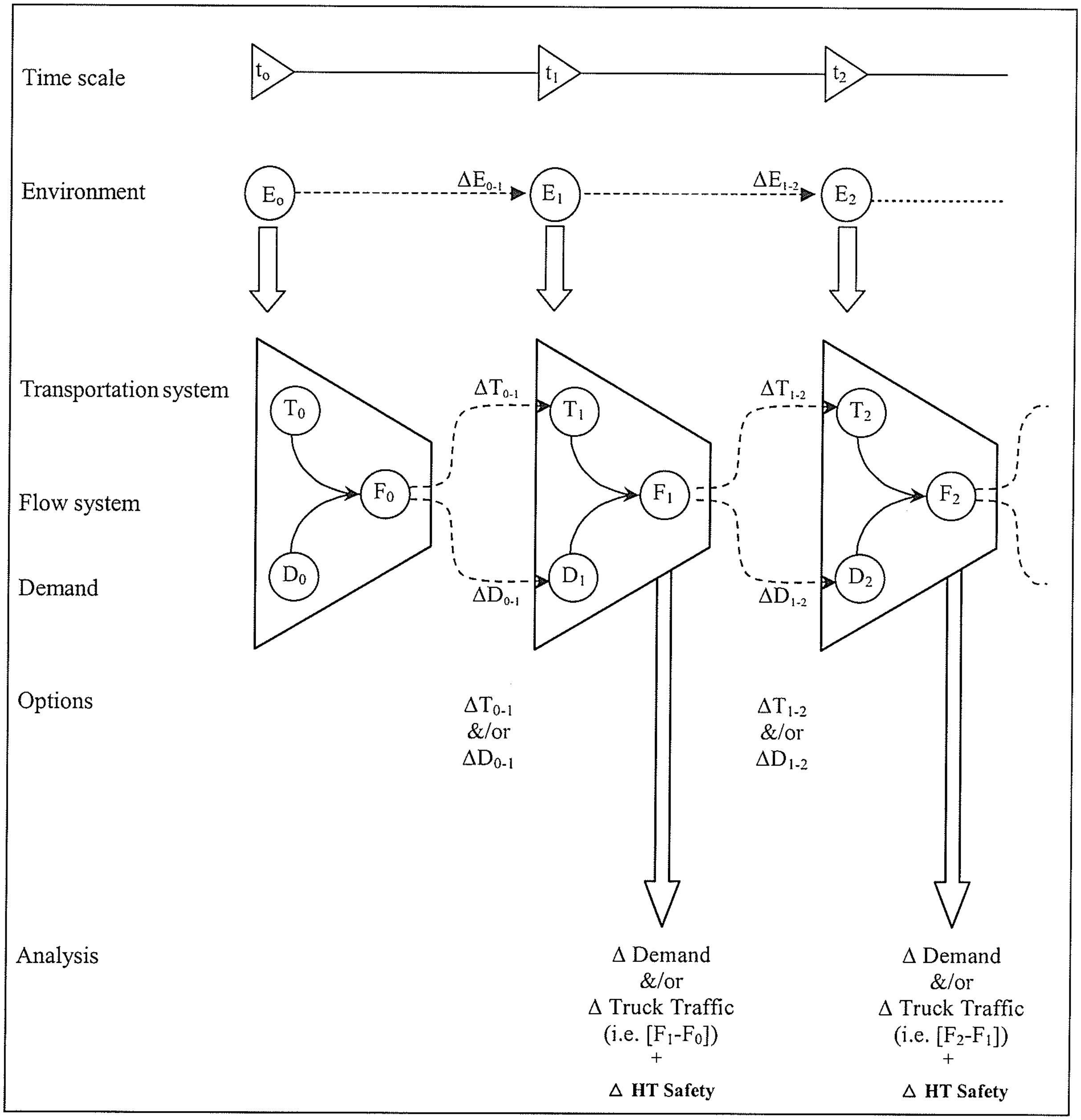


Figure 7-1: Framework for Analysis

1. *Completion of the North Perimeter Highway (ΔT)*: The northeast section of the Perimeter Highway (Highway 101) was completed in 1996. Prior to the opening of this highway section, east-west truck travel across Winnipeg took place around the south Perimeter Highway. Also, some trucking originating in Winnipeg traveled either on Lagimodiere Boulevard (PTH 59) or on Dugald Road (PTH 15) (these are located in the east side of Winnipeg). The opening of the northeast section of the

Perimeter Highway immediately attracted about 1,000 trucks per day, probably rerouted from Lagimodiere Boulevard and Dugald Road, changing the operating patterns of trucking companies that used those links, and possibly affecting the safety of other road users on those same road sections.

2. *Upgrading of Gunn Road (between PTH 101 and Day Street) (ΔT)*: Gunn Road is located in northeast Winnipeg, connecting the Transcona industrial area to Highway 101 (the new section of the Perimeter Highway). Trucking companies which move dangerous goods or large amounts of construction materials are located on Gunn Road. With the completion of Highway 101, efficient transportation of these materials to places out of Winnipeg could be done using Gunn Road via its connection to Highway 101. However, because Gunn road was originally built as a farm road, its geometry and structure was inadequate to allow for the safe operation of large trucks (particularly loaded 8-axle B-trains). There were slope stability problems, and other safety hazards that made travel on that road to the Perimeter Highway unsafe. Because of the inadequacy of the road, the trucking companies located in that area had to travel through residential areas, through school zones, to move the goods out of Winnipeg. This posed a hazard for the people living in those residential areas, as well as for the trucking companies moving those commodities. In 1999, the portion of Gunn road between PTH 101 and Day Street was upgraded to fully accommodate large trucks. The trucking companies located in that area now have direct access to the Perimeter Highway via a road that has been specifically designed to accommodate that type of traffic. This has had a great impact on the movement of dangerous goods from Transcona to outside Winnipeg. These commodities no longer move through residential areas, hence reducing the risk of serious accidents in those areas. Truck traffic has also increased on that section of the Perimeter Highway (MHTIS, 2000), maybe posing a different type of problem.

3. *Movement of Petroleum to North Dakota and Minnesota (ΔD)*: Manitoba exports petroleum to North Dakota and Minnesota. The Shell refinery is located north of Winnipeg on Provincial Road 204. Over the years, Canadian carriers were used for the movement of petroleum to those states. These were large carriers with good safety records and new equipment. However, in the late 1990s, public opinion in North Dakota and Minnesota resulted in a situation in which primarily U.S. carriers would be allowed to haul petroleum from Manitoba into North Dakota and Minnesota. This resulted in new carriers, with unknown safety records, operating on Manitoba roads throughout the year. In this case T remained constant (same regulations, same roads) but the options regarding type of carrier that would handle the freight changed (ΔD) to a certain degree. This change in D, and the types of vehicles used, may have a significant impact on the safety of heavy truck operations on the highway sections where the new carriers operate.

4. *Shift of Distribution Centers (ΔD)*: Historically Winnipeg was recognized as a transportation hub in Western Canada. Almost one-half of Canada's for-hire trucking companies were based in Winnipeg, making the city an attractive location for many distribution centers (MTA, 1997). However, in recent years there has been a shift in the location of these distribution centers. Many have moved to Calgary, partly due to logistical advantages. According to many carriers, Calgary offers 24-hour connections to all of the Prairie region, Vancouver, Salt Lake City, and Minneapolis (DS-Lea and UMTIG, 1998). This shift in demand has resulted in much truck traffic by-passing Winnipeg and traveling directly to or from Calgary. It also resulted in truck traffic traveling through or around Winnipeg at different times of the day, on its way to or from Calgary. The safety implications of this are yet unknown but the change in truck traffic patterns are already apparent.

These examples present situations in which changes in T or D have impacted F. However, the changes were not implemented having an understanding of the impacts on the safety of heavy truck operations. System safety reviews are intended to provide an understanding of the safety implications of decisions or actions like these prior to implementation. In many cases decisions regarding elements of the transportation system or demand, which will affect trucking, are implemented without knowing or considering their safety impacts. In additions, safety may be evaluated without knowledge of the presence of or changes in these fundamental factors affecting safety itself.

7.4 PROCEDURAL COMPONENTS OF A SYSTEM SAFETY REVIEW

The procedure to follow when conducting system safety reviews is presented in Figure 7-2. Three phases are involved in the process: (1) setup phase; (2) analysis phase; and (3) communication phase. The setup phase is comprised of five elements: (1) problem definition; (2) creation of a system safety review team; (3) specification and collection of information pertaining to the situation being analyzed; (4) intelligence gathering from the trucking industry; and (5) field visits. The analysis phase involves the analysis of six elements: (1) the demand for freight movement by truck; (2) applicable truck size, weight, and safety regulations; (3) enforcement practices; (4) the roadway environment; (5) truck traffic; and (6) heavy truck accident history. The communication phase consists of the written report and an oral presentation of the findings. The following sections discuss each of the phases and their elements in detail.

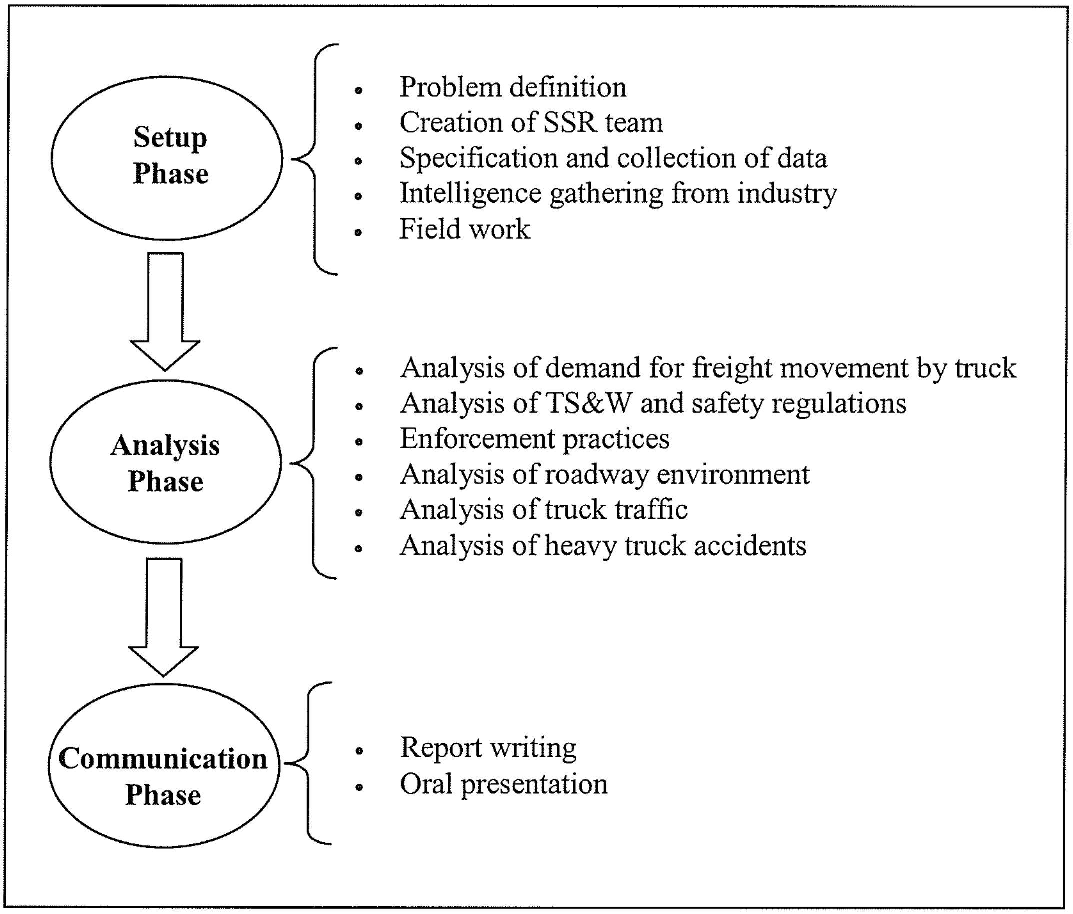


Figure 7-2: Components of a System Safety Review

7.5 SETUP PHASE

This phase precedes the technical analysis. In order to do the analysis, the problem needs to be defined, a SSR team must be created, and data must be collected.

7.5.1 Problem Definition

Before the SSR can begin, the problem needs to be explicitly defined. Clients may have a predetermined problem statement, and a good idea as to what they need to be done. However, it is useful to define the problem jointly with the client, setting the scope and physical boundaries of the situation being analyzed.

7.5.2 Creation of System Safety Review Team

System safety reviews should be conducted by a team of experts in the field of truck safety and operations. The team should include individuals with different expertise and professional background. This may involve individuals with experience in truck enforcement, truck driver training, truck accident reconstruction, truck equipment manufacturing, heavy vehicle design, truck traffic analysis, road design, truck regulation, and human factors. However, not all types of experts need or could be included in all system safety reviews. The team composition will depend on the situation being considered for analysis. However, no less than three members should be included in the team, and desirably, the team should include five members.

When selecting a team, it is important to include a road safety engineer with expertise in truck safety; and a truck equipment and operations expert. Other individuals should be selected based on the situation being analyzed. A "dream" team would include one member from each area of specialization mentioned above. A "desirable" team includes a road safety engineer with expertise in truck safety, a truck equipment and operations expert, a truck traffic expert, a highway and maintenance engineer, and a heavy truck enforcement officer (or a human factors specialist, or a heavy truck driver training specialist).

A road/truck safety engineer is required to provide expertise about the road-vehicle interaction. It should be an individual with knowledge and experience in road design, traffic engineering, and road maintenance; and a strong knowledge about trucking and truck performance. The critical issue about this individual is his/her understanding about trucks and how they perform when operating on the road and with other traffic.

A truck equipment and operations expert is required to provide expertise about the industry and how it works—from an operations stand point. This individual is most likely to be a safety or operations manager with a trucking company or a long-haul truck driver with many years and types of driving experience.

7.5.3 Specification and Collection of Information

The team must decide on the type of information to collect for analysis based on the situation being reviewed. Conducting a system safety review involves the analysis of the six elements from the analysis phase. However, not all elements need to be considered in all reviews.

Determination as to how many elements to include depends on the situation being analyzed.

Care must be exercised when specifying the type of information to be collected for the system safety review. Data collection is not a trivial task. It is expensive and data can be difficult to obtain. Therefore, great care should be taken in the design of any data collection and management exercise. Some of the required information can be obtained by contacting the agencies or institutions that keep the information. However, other data elements must be collected from visits to the field as discussed in Section 7.5.5.

7.5.4 Intelligence Gathering from Industry

Intelligence gathering from industry is a critical part of SSRs. It is from this source that the SSR team will obtain practical insights regarding freight movements, the road, vehicle characteristics, and trucking in general. Professional truck drivers have experience traveling on many different roads. They have experience with the operating characteristics of different truck types, and they also have experience with the handling of different commodities under different traffic and road conditions. Safety and operations managers from trucking companies also have experience obtained from the day to day operation of their companies.

This part of the process includes interviews with industry. The interviews should be conducted in person by team members with ample knowledge about trucking. It is preferred to have a list of topics to discuss with the person being interviewed, as opposed to a list of questions to ask. In cases where the situation being analyzed involves a road segment or road network, it is important to travel the road with a professional truck driver, preferably using a large truck. If it is not possible to obtain a large truck to travel the road, it is acceptable to do it using another type of vehicle, as long as a professional truck driver is in the vehicle with the team members conducting this task.

The information obtained from the intelligence gathering exercise is a good supplement to other information collected during the conduct of a SSR, and should be treated as such when doing the analysis and writing the final report.

7.5.5 Field Work

This part of the process applies to those situations which involve a particular road or road network. It involves visiting the area under consideration to obtain additional information about the elements being considered in the analysis.

In many cases, information about most of the elements can be obtained from transportation departments or other institutions or agencies that keep such information. However, information about the roadway environment can only be obtained by driving the road. As possible, the road should be driven by truck (at least once) to better understand safety concerns from the heavy truck perspective. The road should be traveled under different traffic conditions (peak period, off peak, weekends, weekdays), different times of day, and different weather conditions (rain, snow, dry). If possible, trips must be taken during different times of the year (winter, summer, spring, autumn). As indicated in Section 7.5.4, at least some of the trips must be taken with a professional truck driver on board, and all information collected must be from the heavy truck perspective only.

When conducting field work, detailed notes should be kept and if possible (depending on the situation being analyzed), global positioning systems (GPS) and geographic information systems (GIS) should be used. Also, photographs can better illustrate points, and video can help with the analysis.

7.6 ANALYSIS PHASE

When conducting the analysis of the data it is important to remember that the purpose of analysis is to clarify and summarize issues that should be considered by decision-makers in choosing between alternative courses of action to improve the safety of heavy truck operations (Manheim, 1979). This means that the objective of this exercise is to provide decision-makers with information that was not available to them prior to the conduct of a SSR. The objective is not to provide recommendations but rather to present observations that will help in the decision-making process.

The conduct of a system safety review involves the analysis of six elements (as required). All are part of either D, T, or F as follows:

1. The demand for freight movement by truck (D).
2. Applicable truck size, weight, and safety regulations (T).

3. Enforcement practices, particularly related to safety (T).
4. The roadway environment specifically relating to heavy trucks. This includes design and traffic engineering characteristics, special facilities for heavy trucks, and road maintenance practices (T).
5. Truck traffic in the context of all traffic for the area under investigation, or for the situation being analyzed (F).
6. Heavy truck accident history for the situation under analysis (F).

Table 7-1 illustrates the types of data that would be desirable to obtain for each of the elements. As already stated, not all information is needed for all SSRs. The collection of information is dependent on the situation being analyzed.

Some aspects of the analysis are quantitative and some are qualitative. The quantitative aspects are those involved in establishing the foundation that will provide the understanding of the system at hand (e.g., the analysis of heavy truck accidents; freight movement, including origin-destination patterns, types and quantities of commodities; and truck traffic flows). The safety analysis of the system is based on the expert assessment of the SSR team after all pertinent information has been collected and processed. This type of analysis is to be done separately for each of the elements under consideration—demand for freight, TS&W regulations, truck safety regulations, enforcement, roadway environment, truck traffic, or heavy truck accident history. A table can be used for each of the elements identifying the piece of information available and whether there are any safety concerns regarding that information. There should also be space available for comments to expand on the type of safety concern (in case it exists). Taking as an example the situation where dangerous goods

Table 7-1: Desirable Information by Element of Analysis

Element of Analysis	**Desirable Information**
Demand for Freight	• types and quantities of commodities • generators and attractors of freight • origin-destination patterns • temporal distribution of freight • special handling requirements • routing and scheduling • operating practices
Truck Size and Weight Regulations	• basic regulations • seasonal regulations • permitting of LCVs • permitting of overweight/overdimension vehicles • permitting of other special vehicles • network considerations
Truck Safety Regulations	• hours of work • load securement • dangerous goods • on-road vehicle inspections • other pertinent safety regulations
Enforcement	• enforcement practices • types of facilities used • intensity of enforcement • violation and compliance rates
Roadway Environment	• design overview (facility designation, speed, volume, life) • alignment and cross-section • auxiliary lanes • railway crossings • transition areas • roadside facilities • clear zone • signing and signals • road maintenance practices
Truck Traffic	• truck traffic volumes by truck class • temporal characteristics of truck traffic • truck traffic operating characteristics (weights, dimensions) • trucking within the context of the total traffic stream by temporal characteristics, by direction
Heavy Truck Accident History	• frequency • severity • location • types of trucks involved • contributing factors • accident rates • temporal distribution

moved from Transcona to places outside of Winnipeg prior to the upgrading of Gunn Road (discussed in Item 2 of Section 7.3), the table for the first element of analysis (demand for freight) would look like Table 7-2.

Table 7–2: Sample Table for Analysis of Information
Element of Analysis--Demand for Freight (Dangerous Goods Transcona)

Information Available	**Safety Concerns?**	**Comments**
Generators and attractors of freight	yes	Border Chemicals is generator and attractor
Origin-destination patterns	yes	see generators and attractors of freight
Temporal distribution of freight	yes	affected by origin and destinations, delivery times, customs requirements
Operating practices	yes	see routing and scheduling
Routing and scheduling	yes	travel takes place through residential areas and school zones
Types and quantities of commodities	yes	dangerous goods moving through residential areas

The following sections provide a detailed discussion about each of the six elements of analysis to consider when conducting a heavy truck system safety review.

7.6.1 The Demand for Freight Movement by Truck (D)

Understanding the demand for freight movement by truck is needed in order to obtain insight into elements other than those observed from field visits. This understanding is also important when analyzing F or the effects of a change in T or D.

This element of a system safety review is interested in information regarding the generators and attractors of freight, commodities being moved, origin-destination patterns, shipment sizes, temporal distribution of freight movement (*e.g.*, month of year, time of day, day of week), directional characteristics of freight movement (*e.g.*, paper moves southbound, petroleum products move out of Winnipeg, logs move to pulp and paper plants), special handling requirements, operating practices in the part of the carriers, and routing and scheduling. Safety considerations vary depending on the type of activity taking place in a region or a given situation. For example, situations that involve the movement of less-than-truckload (LTL) freight (*e.g.*, operation of turnpike doubles from Winnipeg to Brandon) need to be addressed differently than situations involving the movement of truckload (TL) freight (*e.g.*, trucking between Winnipeg and the U.S. Midwest). The type of freight (*e.g.*, dangerous, high-density, low-density, grains, special commodities) also plays a significant role regarding the safety considerations for a given situation.

In demand analysis, databases typically fall under two categories: (1) those which are regularly produced (e.g., Canada's for-hire trucking survey, the Canadian Council of Motor Transport Administrators (CCMTA) roadside survey, the U.S. Commodity Flow Survey, and the U.S. Transborder Surface Freight Database); and (2) those which are specially produced as part of a study or as part of a one-time data collection effort (e.g., UMTIG's border crossing survey, UMTRI's national truck trip information survey, and Northwest Minnesota freight flow study). These databases may be updated after some time but this is not usually the case.

Knowing how to analyze the databases, what information to obtain from them, how to obtain and interpret the information, and how to portray it is critical. The following discussion presents guidance about some practical actions to take when analyzing these data sets.

- *Get to know the database*: Before an analysis is conducted, it is necessary to understand the strengths and weaknesses of the databases that will be used. For example, when dealing with the Transborder Surface Freight Database, it is important to know that most of the data is value-related. Weight-related data is only available for imports into the U.S. from Canada or Mexico, but not vice-versa. The U.S. Commodity Flow Survey (CFS) only deals with movements within the U.S. and the entire database is based on a sample of about 800,000 businesses. The Emerson scale survey contains information about all trucks traveling through the scale (loaded and empty).

- *Set an outline for analysis*: It is useful to develop an outline containing the components that will be part of the analysis. The analysis usually starts with the commodities moved (either by tonnage or value, or both), and followed by origin-destination patterns of all commodities combined or specific commodities of interest. Each of those two elements can be further subdivided by region, state, province, or other type of geographical breakdown; and by mode (for-hire truck or private truck) if available. In some instances, the databases allow for the analysis to also be done including vehicle types or body types. In cases where this is possible, it is always helpful to set up a matrix with the truck body type as the rows and the truck configuration as the columns for each commodity group of interest, or for each origin-destination movement of interest. If information about truck routing is available, it can be included as a separate item in the analysis.

- *Be efficient when analyzing data*: For any type of database analyzed, it is useful to apply the "80 percent rule of thumb". With this rule, 80 percent of the commodity movements and the activity can be captured with about 10 percent of the effort. Rather than spending resources trying to find details about commodities or movements that account for one or two percent of the activity, resources may be better spent focussing on the movements and commodities that account for approximately 80 percent or more of the activity. For example, when analyzing the Transborder Surface Freight Database for movements between the U.S. and the Prairie region, there are about 10 commodities that account for more than 80 percent of the movements by value (DS-Lea and UMTIG, 1999). Concentrating on the activity (origin-destination patterns) of these 10 commodities may be more valuable than spending time tracking the movement of all commodities (including those which may account for a minimal amount of the total movements).

- *Translate numbers into something meaningful*: This is particularly important when dealing with movements by weight. In many cases, the numbers resulting from analyses are difficult to visualize. One useful rule of thumb is to translate tonnage into 25-ton equivalent trucks. This measure is selected because it represents a typical maximum semitrailer truck load, based on 80,000 pounds gross vehicle weight. The same value can be used for trucks with a GVW of 39,500 kilograms. By translating tonnage into 25-ton trucks, it is easy to visualize the actual truck activity. For example, in addition to saying that 58,333,811 kilograms of freight moved from Manitoba to Texas in 1999, it is convenient to translate that figure into the equivalent number of 25-ton trucks per day for the year. This results into 2,333 25-ton trucks per year or approximately seven trucks per day.

- *Portray findings schematically*: It is always important to use tables when portraying certain types of information. However, maps or other type of schematics are necessary in any analysis, particularly to show origin-destination patterns, or simply the relative importance of different geographical areas regarding freight generation and/or attraction.

Examples that could be used as guidance for future demand analyses can be found in Abe et al. (2001), Middleton et al. (1998), DS-Lea and UMTIG (1999), Montufar et al. (1998b), Montufar (1996), and Woodrooffe et al. (1995).

7.6.2 Applicable Truck Size, Weight, and Safety Regulations (T)

Truck size and weight (TS&W) regulations greatly influence the types of trucks that move on a highway, and the impact of those vehicles on the infrastructure, the economy, the environment, and highway safety (U.S. DOT, 2000a). The types of trucks resulting from different TS&W regulations determine aspects such as design requirements, vehicle performance properties (stability and control), infrastructure requirements (deterioration), traffic operations, and safety requirements. Also, because of these regulations, there are situations in which there can be more trucks than necessary handling the freight to be handled; in other situations, there are trucks handling freight where logic would say that rail would be much more efficient, and could relieve truck traffic from the highways; and in other situations, the industry is obliged to utilize vehicles which unnecessarily raise the center of mass of the unit, or limit the vehicle's stability. The critical point is that TS&W regulations have the potential of impacting the safety of heavy truck operations.

Because of the impact that TS&W regulations may have on truck safety, there is a need to understand those regulations, how they work through the year, and their implications for trucking. For example, are there special seasonal allowances and restrictions, and if so, how are they applied?, what are the requirements for overweight/overdimension movements?.

Similar to TS&W regulations, safety regulations such as hours of work, load securement, and on-road vehicle inspections have an impact on the safety of heavy truck operations. Understanding these regulations is needed to evaluate the safety fitness of vehicles operating in the areas, or situations under consideration.

Knowledge about TS&W and safety regulations from neighboring jurisdictions (when applicable) or from areas beyond those being considered in a particular analysis is also needed. In many cases, the regulations in other jurisdictions have an effect (maybe the controlling, least common denominator effect) on what takes place in one jurisdiction. Obtaining this information can help understand issues that may not be apparent from a simple analysis of the regulations governing the area under consideration. Some of these issues may include: why certain commodities move the way they do, or why certain routing practices are maintained, or why certain types of vehicles are used. To illustrate this, take a case where petroleum moves from Manitoba to North Dakota and Minnesota. From the TS&W perspective, the determining factor regarding movements into North Dakota is the 105,500-pound maximum GVW allowed in the state. Therefore, even though companies from Manitoba can operate at weights of about 125,000 pounds using A/C-trains, or 138,000 pounds using B-trains, they are prohibited by the regulations in North Dakota. This results in either the selection of different equipment for the movement of the product, or the operation of A/C trains loaded below capacity. In the case of Minnesota, the maximum gross vehicle weight allowed in the state is 80,000 pounds (except in winter, when a GVW of 88,000 pounds is allowed). This means that companies moving petroleum from Manitoba would have no other choice but to move it using standard 3-S2 trucks loaded at 80,000 pounds (except in winter), which is also less than the maximum allowable GVW in Manitoba for those particular vehicles. Another situation may involve cases in which truck movements are restricted by day of week or time of day, as is the case with the movement of over-dimension/over-weight vehicles. Routing preferences may also be affected by issues from jurisdictions or areas beyond the area being analyzed. Therefore, obtaining knowledge about the regulations in areas beyond the study area is needed to clarify issues that may not be apparent from an analysis of the regulations in the area under investigation.

7.6.3 Enforcement Practices (T)

Understanding enforcement practices applicable to the situation under consideration is also required during the conduct of a system safety review. "Without effective enforcement, including the certainty of penalties and sanctions . . . (in this case) weight limit laws become meaningless" (TRB, 1990). Issues of interest for this element include: (1) whether inspection of vehicles and drivers is done at weigh scales or on the roadside; (2) the number of inspections conducted on a typical day on the roadside; (3) seasonal variations regarding enforcement practices; (4) how specific regulations are applied throughout the year; (5) intensity of enforcement (i.e. number of vehicles inspected versus total number of vehicles); (6) interpretation of the regulations; and (7) resources available for enforcement by geographical area. This information is needed to better understand potential safety problems due to current enforcement practices. For example, situations that involve significant volumes of farm trucks would need to be addressed differently than situations that involve mainly TL long-haul vehicles. Similarly, analysis of situations that involve the presence of permanent weigh scales may need to be conducted differently than situations that involve mainly roadside inspections with portable scales.

Another important issue is the interpretation of the regulations by enforcement personnel. How officers interpret the regulations will play a significant role on the enforcement process. In some cases, as indicated by enforcement officers from various jurisdictions, there are officers that do not enforce certain aspects of the regulations simply because they do not understand them or because they do not agree with those aspects of the regulations. Similarly, intensity of enforcement varies by location, time of year, time of day, and from officer to officer (this was discussed in Chapter 5). One good example of this is the conduct of on-road commercial vehicle inspections. In many jurisdictions, fewer inspections are conducted during winter. Also, certain vehicle components (e.g., brakes) are targeted during specific times of the year. Information like this is essential to properly conduct a system safety review.

7.6.4 The Roadway Environment (T)

This element of system safety reviews refers to road design, road maintenance, and traffic operations standards. These three elements have serious implications for the safety of heavy truck operations (Miaou et al., 1993; Donaldson, 1985; and Middleton, 2001). Highway geometric design elements, such as horizontal and vertical alignment, lane width, shoulder width, and presence or absence of medians, are some engineering factors that contribute to the differences in accident rates by road class (Sanderson, 1996; Billing, 1991; and Hu et al., 1992). Similarly, road maintenance factors such as snow removal, ice control, and pavement management also affect road safety (Savenhed, 1995; Ihn, 1998; and Li et al., 2000). Traffic operations considerations such as traffic signing practices, traffic density, operating speed, traffic signal timing, and pavement markings also affect the safety of heavy truck operations (Mason, 1992 and Walbaum, 1998).

As part of this element of SSRs, it is necessary to obtain information about the following—always from the heavy truck operations perspective:

- Facility designation (arterial, expressway, collector, other)
- Design and operating speed

- Horizontal and vertical alignment
- Cross-section
- Auxiliary lanes
- Guardrails
- Railway crossings
- Roadside facilities such as rest areas and weigh scales
- Snow removal and ice control practices
- Signing practices
- Pavement marking
- Traffic signals and their accommodation of truck traffic

Many existing highway design and operational standards and guidelines are based on passenger car characteristics. The American Association of State Highway and Transportation Officials (AASHTO) has recommended that to accommodate large trucks more safely, it is important to consider their performance characteristics when designing highways expected to have large truck traffic (AASHTO, 1997). Critical performance characteristics of trucks that need to be accommodated are acceleration/deceleration characteristics, braking, and articulation properties (Navin, 2001; AASHTO, 1997; and DeCabooter and Solberg, 1989). In Canada and the U.S., some special features have been incorporated into highway design to better accommodate large vehicles. These include longer acceleration/deceleration lanes, truck climbing lanes, truck escape ramps, and wider lanes (TAC, 1999).

Many intersections in urban and rural areas in the Prairies are geometrically inadequate to accommodate large trucks. Previous research has shown that at intersections of undivided streets in urban areas, right-turning encroachment into lanes with moving traffic is a regular occurrence (Beckham, 1994). This becomes a safety problem in cases where there are high traffic volumes, pedestrian activity, and truck activity. In Winnipeg, the City has started to evaluate the geometric adequacy of some of the intersections with high truck traffic volumes (*e.g.*, along Route 90) to better accommodate trucks at these locations (Chimko, 2000).

Regarding road maintenance, the capability of a vehicle to move, turn, and stop is significantly reduced under snowy or icy road conditions (Whitehurst and Ivey, 1984). The impact of these road conditions is most critical for commercial vehicles due to key differences that exist between these vehicles and small passenger vehicles (Griffin and Gillespie, 1984). Accidents involving these vehicles are more severe due to their greater size and mass, and articulated vehicles are more susceptible to rollover. Snow drifting also poses a safety problem to drivers. At certain locations it may obstruct the driver's visibility, posing a hazard. This type of problem is common on many highways of the Prairie region.

The traffic operations aspects of particular interest to this element of system safety reviews are speed limits, signing, pavement markings, and traffic control. It has been found that speed differentials may be a contributing factor in truck accident occurrence (Navin et al., 2001 and Cairney, 1991). Another traffic engineering item of relevance to truck safety is delineation. Clear delineation of curves and other obstacles is critical for truck drivers, specially given the fact that existing delineation is designed for car drivers (Cairney, 1991). Traffic signs, signals, and pavement markings are also important for heavy truck safety. Many of the current standards that address these issues have been developed for small vehicles and little has been done to address truck traffic. The changing traffic volumes and fleet mixes, coupled with the increased truck volumes and sizes of trucks, are resulting in blockage of road signs (resulting in problems with sight lines). This results in an increased likelihood of crashes–possibly involving trucks (Cairney, 1991).

Most of the information required under this element of SSRs must be obtained from field visits. Depending on the issue being analyzed, the road network to consider under this component will include only one highway segment or many highway sections.

7.6.5 Truck Traffic (F)

Truck traffic is typically characterized in terms of volume (*e.g.* number of trucks per average day in a year), temporal variations of volume (*e.g.*, by time of day, by day of week, or by month of year), vehicle class, vehicle body type, and operating characteristics (*e.g,* weight, speed). This element of system safety reviews is concerned with the following information regarding truck traffic:

- Core database of truck traffic flows—vehicle type, by temporal characteristics (seasonal, monthly, daily, weekly, hourly), by direction, and by vehicle body types.
- Truck traffic operating characteristics—operating weights, performance properties, by vehicle type.
- Trucking within the context of the total traffic stream—core database of total traffic, by temporal characteristics (seasonal, monthly, daily, weekly, hourly), by direction

This information is needed to understand truck traffic moving on the highways that fall under the area of interest to the issue being analyzed. Many important points may arise from truck traffic data. For example, in the case of Manitoba, analysis of truck traffic data for the Trans-Canada Highway east of Winnipeg has shown that despite strong seasonality for all traffic (peaks in the summer months), truck volumes remain relatively constant throughout the year (Han et al., 1999). The analysis also shows that night hours account for higher percentages of truck traffic relative to total traffic. Between 1:00 a.m. and 7:00 a.m. truck traffic accounts for between 42 and 50 percent of total traffic moving on the road, compared with between 5 and 20 percent of total traffic during the rest of the day (Montufar et al., 2000). This information is critical for truck safety analysis because it presents an aspect of trucking that cannot be obtained from other sources.

Truck traffic is affected by many factors, including the presence of local economic activity, distribution centers, traffic in general, and origin-destination movements (Hallenbeck et al., 1997). Therefore, when dealing with truck traffic information, it is important to interpret the information within the context of a practical understanding of trucking in the region, or for the given situation being analyzed. Truck volumes vary over time and space differently than total traffic volumes. These variations may also be different from one type of truck to another. In addition, the characteristics of specific truck types, especially vehicle weights, can change significantly between time periods and locations, even within the same truck classification (U.S. DOT, 2000a). For example, in the Prairie region during winter, a variety of winter weight premium systems are applied–varying both among and within jurisdictions, as discussed in Chapter 3 (Montufar et al., 2000). This results in truck traffic with different operating characteristics over space and time within and between jurisdictions.

When analyzing truck traffic data, it is important to understand the strengths and weaknesses of the data being analyzed. Traffic data, as is the case with other types of data, suffers from errors that need to be addressed prior to conducting the analysis (Hu et al., 1997). For this reason, it is also important to understand the methods used to produce traffic estimates, and the limitations of traffic monitoring programs. Most transportation agencies provide traffic volume estimates in terms of: (1) average annual daily traffic; (2) average annual weekday traffic; or (3) average daily traffic. Not many jurisdictions provide specific information on average annual daily truck traffic. This is because the most commonly used type of equipment for traffic counting does not classify vehicles as they are counted. There are, however, other types of equipment that are used for vehicle classification. It is also important to understand the limitations of this equipment.

Traffic data originates from either portable or permanent equipment. The data is collected using automatic traffic recorders (ATRs), automatic vehicle classifiers (AVCs), and/or weigh-in-motion (WIM) equipment. The accuracy of WIM and AVC equipment for classifying vehicles is dependent on many factors including: (1) type of technology used; (2) vehicle speed; (3) truck volume; and (4) pavement temperature (Harvey et al., 1995 and Zhi, 1998). Some classifiers have higher errors at lower speeds, and some show higher errors at higher speeds (Harvey et al., 1995). The percentage of trucks on the road also has some effect on the classifier accuracy. The accuracy may decrease as the percentage of trucks increases (Harvey et al., 1995). The accuracy of the equipment is also affected by the procedures followed for installation, calibration, and maintenance.

When using vehicle classification information for truck exposure and safety analysis, the selection of the segment length used for expansion of the data is also very important. As indicated by Saccommano (1998), as the segment length increases, there is an increased probability of truck flow "leakage" from the highway segment in the vicinity of the counting station. However, if the highway segment is too short, it will include fewer accidents in any given year. There is a trade-off between the estimate of truck exposure (from truck traffic volume) and accident rate. This problem can be partially resolved by developing a truck counting system based on good knowledge of the highway network and understanding of commercial vehicle operations in the area (Hallenbeck, 1999).

During the analysis process, it is important to be transparent. This means that every number that results from the analysis should be reproducible by another analyst at a later time.

7.6.6 Heavy Truck Accident History for the Situation Under Investigation

Historical information about heavy truck accidents provides essential insights when conducting system safety reviews. In many cases, heavy truck accident information provides the safety specialist with knowledge regarding the nature of the accidents taking place at a certain location. Information needed for this element of system safety reviews is the following: frequency of heavy truck accidents, severity, location, types of vehicles involved, types of accidents, temporal distribution of accidents, and contributing factors.

Frequency of accidents is important to identify locations with high concentrations of accidents. In many cases, locations that show high concentrations of property damage accidents may be more hazardous than locations that show only a few injury or fatal accidents. Severity of accidents is also needed to understand the relationship between certain aspects of the accident history and the seriousness of the outcome (*e.g.,* location of accidents by severity, or temporal distribution of accidents by severity). In a system safety review, knowing where accidents occur, the details associated with those accidents, and the accident rates is a key element in understanding the situation being analyzed. The types of accidents taking place at a particular location, as well as the contributing factors to those accidents can also provide strong insights regarding the nature of the problem at that location.

The following presents guidance about some practical actions to take when analyzing heavy truck accident databases.

- *Get to know the database*: As is the case with demand analysis, understanding the strengths and weaknesses of the databases that will be used is critical. For example, when dealing with the City of Winnipeg accident database it is important to know that there is a new system in place which uses the same fields as the Manitoba Highways database. This new system greatly differs from the old system. What this means is that it is not possible to conduct certain types of comparative (year-to-year) analyses from prior to 1999 to after 1999. This is the year when the new system was introduced. Also, when dealing with Alberta's accident database, it is good to know that it is possible to investigate heavy truck accident involvement by vehicle body type. This type of information is neither included in Manitoba's nor in Saskatchewan's accident database.

- *Clean the database*: Before the accident analysis can begin, it is important to ensure that the database is as clean as possible. In many cases, accident databases contain errors which need to be properly corrected prior to analysis. Finding these errors is a challenging but necessary task. By running a series of queries on the database, asking key questions for which the answers are known in advance it is possible to identify errors or anomalies in the database. One effective way of correcting these errors is by going back to the original accident report forms and manually correcting the database. This may be time-consuming but is worth the effort. For example, in the Manitoba accident database, when the cleaning process was conducted, it was found that almost one-half of the heavy truck accidents involved only power units (bobtails with no trailers attached). This anomaly was checked by going back to each of the accident reports that involved these power units. It was found that there was in fact an error in the database, and that in many of the cases, the trailer unit was not entered into the database, but only the vehicle type (which in this case was a power unit). There may also be situations in which it is not possible to go back to the accident report forms to correct the database. In these cases, discussing the problems and concerns with the owners of the database, and obtaining from them possible reasons for the discrepancies in the numbers is the most effective way of accounting for mistakes in the data set.

- *Get used to cross-checking the numbers*: Throughout the analysis, it is important to cross-check as many numbers as possible. This is done by trying to arrive at the same answer from different angles. For example, running a simple query about the number of HTAs in Manitoba in 1998 results in 213 HTAs. This same number can also be obtained by running another query that identifies the total number of HTAs by severity, or by a query that identifies the total number of non-HTAs and subtracts that from the total number of accidents in the province for that year.

- *Be transparent in the analysis*: This means that every number that goes into the tables resulting from the analysis should be reproducible by another analyst. To do this, keep detailed notes of everything that takes place during the anlysis. For example: (1) if there are anomalies that were corrected in the database, keep a record of the numbers that were corrected; (2) if certain accidents are not used in a particular table for a particular reason, indicate that under the table; (3) explain what each column means in the analysis tables, specially when there is ambiguity regarding their meaning; (4) in cases where the numbers in the table do not add up, explain why that is the case.

- *Portray findings on a map*: As possible, use graphics to portray findings. In many situations, accidents concentrate on certain road sections or at particular intersections. A visual representation of this is of much value to a safety analyst or to a decision-maker.

Some examples that could be used as guidance for future heavy truck accident analysis can be found in Montufar and Clayton (1998a), and Popoff (1998).

7.7 COMMUNICATION PHASE

Once each of the elements has been analyzed and a good understanding of the situation is obtained, the system safety review report can be written. An oral presentation should also be part of the communication phase if required.

When preparing the final report, it is important to keep in mind that the report should not provide recommendations but rather present observations that will help in the decision-making process. The SSR report should have one section for each element addressed in the analysis. These sections should contain the information gathered during the data collection process, any quantitative analysis done, and observations obtained from the analysis, as well as the table with the qualitative analysis. There should also be a section addressing the information gathered from industry.

The final report does not need to be brief since it documents all analyses and findings from the system safety review. The report must, however, have a section which summarizes the safety issues identified by the SSR team. It is preferable that this section include a summary table. This table should have two columns: (1) element of analysis; and (2) observations. The observations column should be exclusively limited to safety issues from the heavy truck perspective. This is the table that provides an overview of the results from the system safety review.

Because this is a technical report that will be used by decision-makers, it should also have an executive summary that presents in a succinct manner, the findings of the system safety review.

7.8 APPLICATION OF SSRs FOR HEAVY TRUCK OPERATIONS

This section presents an example of the application of system safety reviews. The purpose of the example is to analyze the safety performance, from the truck operations perspective, of the Perimeter Highway surrounding Winnipeg (PTH 100 and PTH 101) with a view to bring forward issues to decision-makers to help reduce the number of HTAs on this highway section.

7.8.1 The Perimeter Highway

The Perimeter Highway is 90 kilometers long, accounting for 0.5 percent of Manitoba's provincial highway system. Some sections are divided and some are undivided. There are grade separations at some locations, but for the most part, main intersections are at-grade. The Perimeter Highway combines old design with new design practices, having some sections built in the 1970s, and some just completed in the late 1990s. The posted speed limit is 100 kilometers per hour (except in the vicinity of traffic signals, where the speed is reduced to 80 or 70 km/h). It carries between 400 and 2,500 trucks per day (depending on the road section). The TKT is 45 million, which represents seven percent of the total TKT on provincial highways in Manitoba.

The Perimeter Highway is the main thoroughfare for east-west truck traffic traveling across

Manitoba, as well as for north-south truck traffic traveling to and from the U.S. It serves long haul, regional, and local trucking, especially those movements into and out of Winnipeg, and between origins and destinations in Winnipeg. Garbage and gravel trucks use the Perimeter Highway as the principal route for travel. The road also moves truck traffic handling a variety of commodities such as hazardous materials, meat, grain, wood products, LTL freight, and construction material.

7.8.2 Description of the SSR Process

The entire length of the Perimeter Highway was driven by the team six times. This was done during the day, at night, when it was raining, when it was dry, and when there was snow on the ground. Over 100 hours were spent on the road, understanding trucking on this highway, and collecting information on the roadway environment. During all the visits to the Perimeter Highway, a series of GIS maps showing the location of all the heavy truck accidents between 1993 and 1998 were used, as well as truck flow maps and intersection counts for certain locations. Pictures were taken and detailed notes were kept. Also, industry was contacted to obtain insights regarding infrastructure and other issues relating to truck operations.

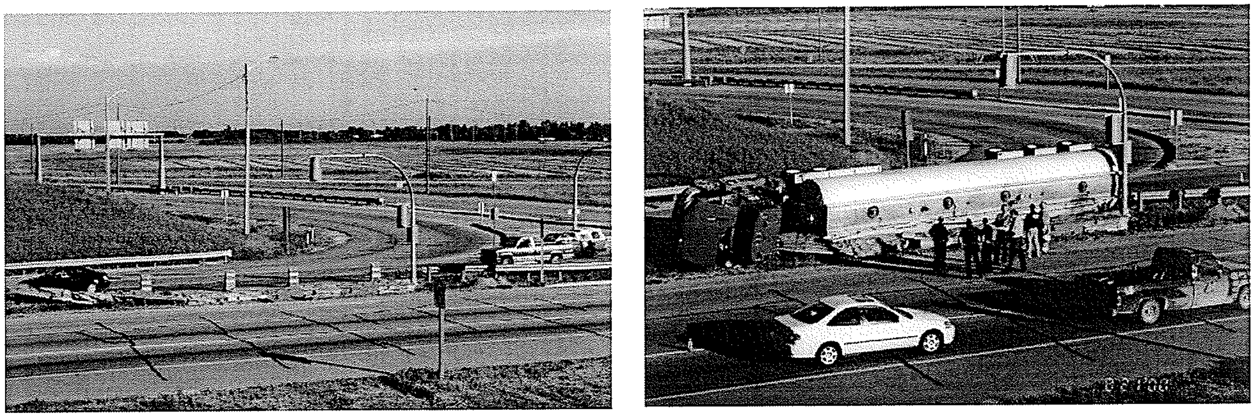
The Perimeter Highway was also visited at times immediately following truck accidents. For example, on October 17, 2000, a driver was injured as his truck rolled over while taking the westbound Roblin Boulevard exit at the southbound Perimeter Highway. On August 21, 2000, a five-axle tractor semitrailer rolled over on the Perimeter Highway when it failed to negotiate a turn onto PTH 59 (see Figure 7-3). On June 27, 2000 a pick-up truck collided with a tractor-semitrailer hauling aviation fuel at the Perimeter Highway and Gunn road (see Figure 7-3). On June 11, 2000, a tanker truck loaded with 33,000 litres of gasoline ignited when the truck rolled over in an attempt to avoid an accident at the Perimeter Highway and St. Anne's road (see Figure 7-3). For most of these and other cases, the site was visited either with a professional truck driver, or with an enforcement officer to obtain insights about potential contributing factors for the collisions.

7.8.3 System Safety Review Team

The team members, which included a professional driver with over 40 years of truck driving experience, and two engineers, had experience in truck operations, truck regulation, truck traffic analysis, freight transportation, traffic engineering, and truck driving. In addition, junior engineers with knowledge about trucking and GIS conducted special analyses which helped with the data collection and field work components.

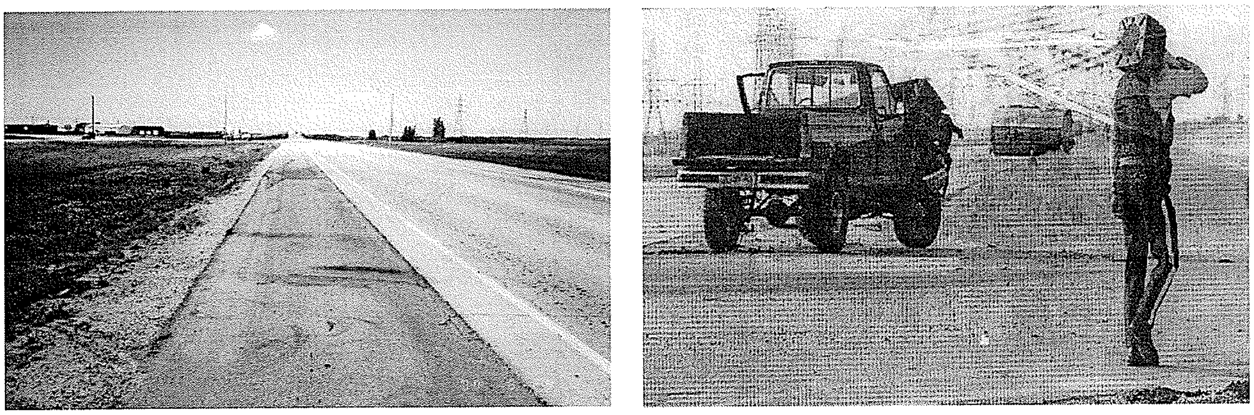
7.8.4 Specification and Collection of Information

For the purposes of this example, four elements of analysis were considered: (1) applicable truck size, weight, and safety regulations; (2) the roadway environment; (3) truck traffic; and (4) heavy truck accident history.



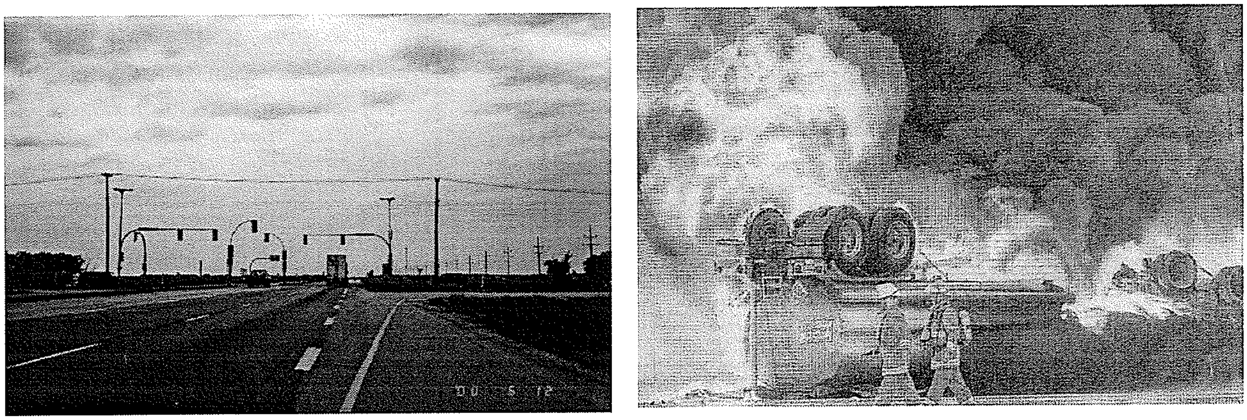
Perimeter Highway and PTH 59

Truck rolled over at the exit ramp (Perimeter and 59)



Perimeter Highway and Gunn Road

Pick-up truck hits tanker (Perimeter and Gunn)
Picture from Winnipeg Free Press, Tue June 27, 2000



Perimeter Highway and St. Anne's Road

Tractor-semitrailer explodes (Perimeter and St. Anne's)
Picture from Winnipeg Free Press, Sun June 11, 2000

Figure 7-3: Heavy Truck Accidents on Perimeter Highway

7.8.5 Intelligence Gathering

The road was driven with a professional truck driver, who provided valuable information as the SSR was conducted. A survey of industry officials had previously been conducted to obtain special insights regarding freight movements, the road, vehicle characteristics, and trucking in general.

7.8.6 Analysis

This section presents a discussion and observations for each of the elements of analysis considered in this example: (1) truck size, weight, and safety regulations; (2) the roadway environment; (3) truck traffic; and (4) heavy truck accident history.

7.8.6.1 Truck Size, Weight and Safety Regulations

The Perimeter Highway is an RTAC route subject to the basic and winter weight premium regulations discussed in Section 3.4.1. No spring weight restrictions apply on this road. This means that the maximum allowable GVW is 62,500 kg (applied to super-B trains) year-round. During the research period, Rocky Mountain doubles, turnpike doubles, and triples were specially-permitted for operations on segments of the northwest quadrant of the Perimeter for limited time periods.

The safety regulations that apply on this road are the same as those applied in the rest of the province. On-road vehicle inspections are conducted following the CVSA OOS criteria, load securement, and hours of work regulations are applied as per the Manitoba Highway Traffic

Act, and dangerous goods regulations are applied as in the rest of the province.

7.8.6.2 The Roadway Environment

As was discussed in Section 7.8.2, the Perimeter Highway was driven six times under different weather conditions, and at different times of the day with a professional truck driver. During each visit, a detailed examination of the road was conducted from the heavy truck perspective. The following issues were considered: (1) horizontal and vertical alignment; (2) cross-section; (3) auxiliary lanes; (4) guardrails; (5) railway crossings; (6) snow removal and ice control; (7) signing practices; and (8) traffic signals. The following observations were obtained.

Alignment and Cross-Section

- Sight distance is, for the most part, adequate for the posted speed limit. However, there are cases where limited sight distance may cause a safety problem, particularly at night. Sight distance is mainly a problem at exit ramps on the Perimeter Highway. Most exit ramps are posted at speed limits of 40 km/hr or 30 kh/hr, and in many cases, this speed reduction from 100 km/hr must take place on the traveling lane, immediately following the crest of a vertical curve. There have been many situations in which truck drivers cannot negotiate the exits and the trucks roll over. This is also a problem for out-of-province truckers, who are not familiar with this road.

- The radius, superelevation, and lane width of the exit ramps for westbound traffic onto Pembina Highway, eastbound traffic onto Pembina Highway, westbound traffic onto Henderson Highway, eastbound traffic onto Henderson Highway, southbound traffic onto Roblin Boulevard, and southbound traffic onto Wilkes Avenue are inadequate. Trucks are not able to stay on the lane and must use the shoulder. This combination of inadequate radius, superelevation, and lane width is particularly hazardous for commercial vehicles handling loads that may shift during the negotiation of the curve.

- There are problems with some side slopes on this highway (steep slopes). There are sections where an errant truck leaving the highway would overturn. An example of this is the section between PTH 59 and Pembina Highway. There are also problems with pavement edge rounding. Many sections of the Perimeter Highway have poorly-rounded pavement edges.

- There is a raised median extending along portions of the Perimeter Highway, which poses a potential safety hazard for heavy trucks. These may hit the curb (traveling at 100 km/hr or more) and possibly cause (or be involved in) an accident. Reasons why this median causes a potential safety hazard are: (1) lack of illumination; (2) the proximity of the curb to the inside edge of the pavement; (3) portions of the raised median are on horizontal curves; and (4) limited visibility during winter—snow accumulates against the curb, hiding portions of it.

Auxiliary Lanes and Turn Lanes

- There are problems regarding the lack of adequate merging lanes. Most acceleration and deceleration lanes on the Perimeter Highway are not long enough for trucks. This poses a safety hazard since trucks have to accelerate from a low speed to 100 km/hr when merging with other traffic. There are also cases where no acceleration lanes have been provided. One example is for eastbound traffic at the intersection of the Perimeter Highway and St. Anne's Road.

- Most intersections have turning lanes. However, these lanes are not long enough for truck traffic wanting to use them. Trucks must start decelerating on the traveling lane, which may pose a safety hazard for other vehicles. The entrance to the Brady landfill site presents a safety hazard due to the high number of trucks turning onto Brady Road. Westbound trucks have to turn from the passing lane, posing a safety problem for other vehicles using the same lane.

Guardrails and Railway Crossings

- Guardrails on the Perimeter Highway are not designed for truck traffic. They are too low and structurally inadequate to stop an errant truck.

Snow and Ice

- There are many sections of the Perimeter Highway where snow accumulation presents a problem. The south section and the recently completed northeast section are particularly prone to snow accumulation and visibility problems during winter. At certain locations, the number of lanes is quickly reduced from two to one during a snow fall. This poses a safety hazard for all vehicles traveling on this road.

Traffic Signs and Traffic Signals

- Traffic signs are, for the most part, properly positioned on the Perimeter Highway. The main safety concern is the location of speed warning signs at the exit ramps. Many of these signs are difficult to see due to their position relative to the highway geometry. In many cases, the exit ramps are located just past the crest of vertical curves. This makes it difficult for drivers to notice the speed warning signs at the exit ramps, and in some cases, results in drivers negotiating the exits at unsafe speeds.

- Traffic signals present a possible safety problem for trucks operating on the Perimeter Highway. The signals are located at most major intersections. There is also a speed reduction zone (100 km/hr to 80 km/hr) and an advance warning signal just prior to the traffic signal at the intersection. There are two problems with traffic signals on the Perimeter Highway: (1) the speed reduction zone is too short for trucks to actually decelerate from the traveling speed to 80 km/hr and then to a complete stop; and (2) priority is given to the secondary road. Because these are traffic-actuated signals, the moment a vehicle stops at the signal on the secondary road, the advance warning signals on the Perimeter Highway start flashing. This indicates that the signal at the intersection will soon turn amber. This poses a safety problem for trucks, since they have to unexpectedly come to a complete stop within a few meters. This problem would be reduced if vehicles on the secondary road had to wait longer before the advance warning signals became active. Truck drivers could see the vehicles on the secondary road from a distance, and start braking from far away.

7.8.6.3 Truck Traffic and Heavy Truck Accident History

The Perimeter Highway accounted for 10 percent of Manitoba provincial highway heavy truck accidents between 1993 and 1998. Of the 109 HTAs that occurred on the Perimeter Highway during this time period, one-quarter resulted in injury and two HTAs resulted in fatality. One-third of the HTAs were single-vehicle accidents and the remaining two-thirds were multiple-vehicle accidents. Road surface conditions played an important role in these accidents. Adverse road surface conditions (wet, mud, snow, ice, slush, and loose sand) were reported in one-half of the HTAs on this road. The most common adverse condition was ice on the road (26 of the 54 cases of adverse road surface conditions).

Regarding the temporal distribution of these HTAs, winter months (November to February) accounted for one-half of the accidents. Summer months (May to August) accounted for one-quarter of the HTAs. This results in a winter-to-summer HTA ratio of 1.86. The winter-to-summer truck traffic ratio for the Perimeter Highway is 0.73 (based on data from Station 86 at Wenzel Road). Daytime hours (08:00 to 18:00) accounted for two-thirds of the HTAs on the Perimeter Highway.

The total HTA rate on the Perimeter Highway is 0.38 HTAs per million TKT (this is higher than the average rate in the province). Excluding intersection HTAs, the rate is 0.24 HTAs per million TKT (the same as the provincial average). Figure 7-4 shows the location of HTAs on the Perimeter, subdivided into two groups: (1) intersection HTAs; and (2) non-intersection HTAs. For both cases, the HTAs are plotted by direction (they are shown on the centerline if the direction is unknown). As is the case with other provincial highways, there are clear concentrations of accidents on certain road sections and at particular intersections. This emphasizes the critical importance of specific locations, including particular intersections, as a key to improving heavy truck safety on this road.

7.8.7 Summary

There are several safety issues associated with the Perimeter Highway. Most of these issues are related to the roadway environment. There are also some safety issues associated with governing truck size and weight regulations in other jurisdictions such as North Dakota.

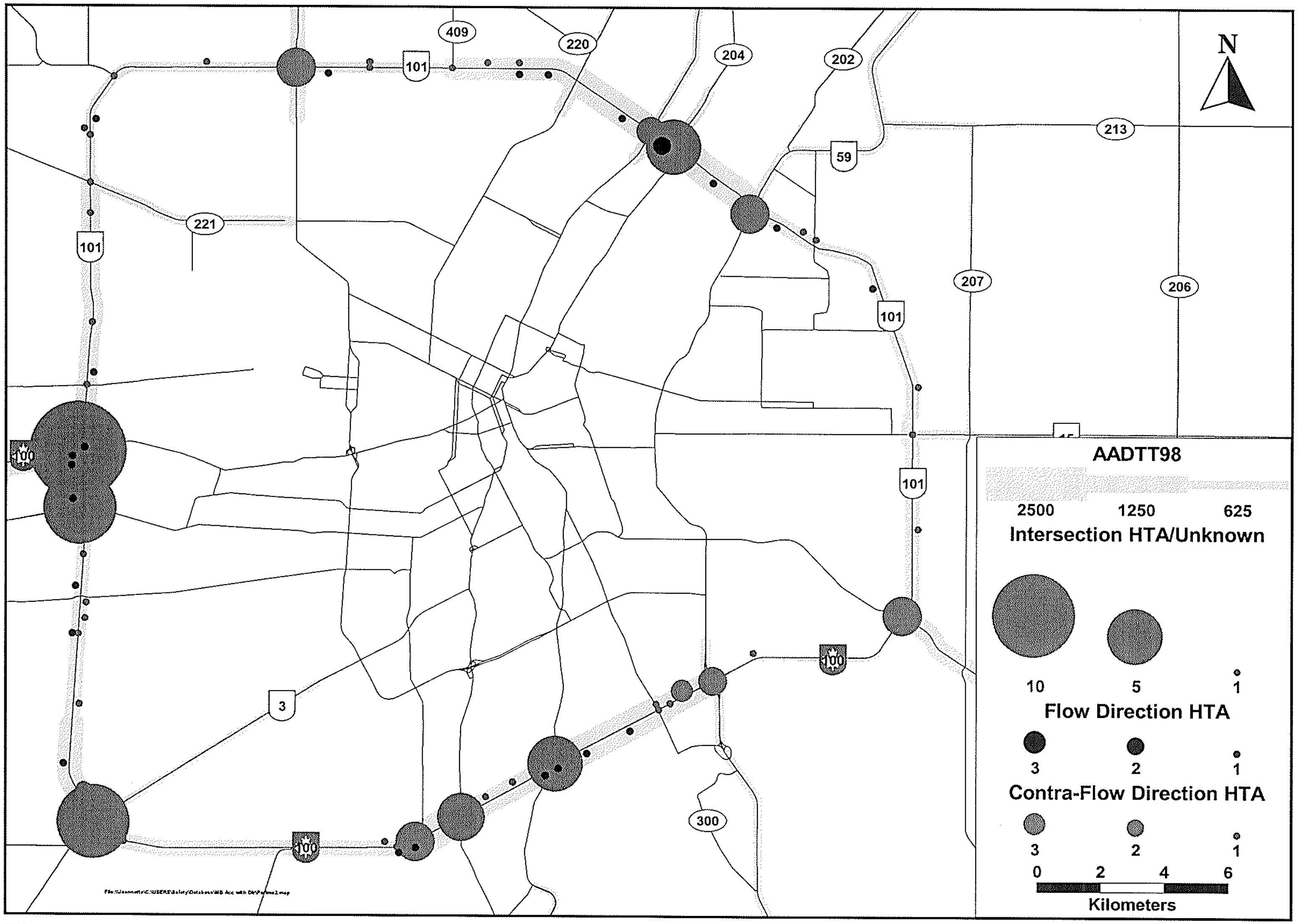


Figure 7-4: Location of Heavy Truck Accidents on the Perimeter Highway

Table 7-3 presents a summary of the safety concerns associated with the Perimeter Highway.

Table 7-3: Heavy Truck System Safety Review of the Perimeter Highway Summary Table

Element of Analysis	**Comments**
Truck size, weight and safety regulations	Trucks traveling to and from the U.S. on this road are governed by U.S. regulations. This results in certain types of vehicles being used to haul commodities that would be hauled with different vehicles if the operation where intra-Canada. For example, some U.S.-bound petroleum and gasoline is hauled using A-train doubles. Drivers of these units, who are unfamiliar with this road may have trouble safely negotiating certain portions of the road.
The roadway environment	There are clear safety problems with the design, operation, and maintenance of this road. The main problems are evident at most exit ramps and at signalized intersections. These problems intensify at night and under adverse weather conditions. See Section 7.8.6.2 for details.
Truck traffic	See heavy truck accident history (next item) for a discussion that combines truck traffic and HTA history.
Heavy truck accident history	There are concentrations of heavy truck accidents on certain road sections and at particular intersections. There is also 86 percent more HTAs in the winter than in the summer, and only 75 percent of the summer truck traffic in the winter. This results in a winter time HTA rate 2.55 times the summer time HTA rate. This indicates that serious safety problems exist for heavy trucks operating on this road in winter. See Figure 7-4.

7.8.8 Other Applications of System Safety Reviews

Other examples of situations where system safety reviews would be useful to apply in Manitoba include:

- Safety implications of allowing long combination vehicles (LCVs) on roads where they are currently not allowed, or extending the hours during which LCVs are allowed to operate.

- Determining the safety performance of particular highways or highway sections for truck operations.
- Safety implications of allowing overweight/overdimension vehicles to operate on major Manitoba highways on Fridays, Sundays and holidays.
- The impact of winter weight premiums and spring weight restrictions on heavy truck safety (e.g., extending the RTAC seasonal network in Manitoba).
- Safety impact of changing the by-laws for RTAC trucks operating in Winnipeg.
- Analysis of the current truck safety situation, alternatives, or benchmark tracking for the purpose of achieving the Canadian goal of 20 percent reduction in fatalities and injuries involving commercial vehicles. This can also be applied to the U.S. goal of a 50 percent reduction in fatalities involving commercial vehicles.

CHAPTER 8

CONCLUSIONS

The purpose of this research is to conduct a systems analysis of heavy truck safety and methods used to improve heavy truck safety in the Prairie region between 1993 and 1998. The analysis clarifies and summarizes issues that should be considered by decision-makers in choosing between alternative courses of action to improve the safety of heavy truck operations in the region.

This chapter presents findings for each of the following: (1) the methods used to improve heavy truck safety in the Prairies; (2) heavy truck accidents; and (3) heavy truck accident rates. The chapter also addresses the development and application of the heavy truck system safety review concept, over-riding issues, and the need for future research.

8.1 METHODS USED TO IMPROVE HEAVY TRUCK SAFETY

The RTAC Memorandum of Understanding and related regulation developments have significantly affected truck characteristics for local, regional and inter-provincial trucking activity within the region. Six-axle tractor-semitrailers and 8-axle B-train doubles now dominate the large end of the heavy truck fleet. However, U.S. truck size and weight regulations govern the weight and dimension characteristics of heavy trucks operating on Prairie region highways that are involved with movements to and from the U.S. This is a major portion of the western Canadian heavy truck fleet, and is the large area of growth in heavy truck operations. The U.S. law prohibits extensive use of RTAC vehicles for cross-border operations in the region.

The seasonal aspect of the truck size and weigh regulations also impacts truck operations in the Prairie region. The winter weight policy concept attracts truck traffic to winter months; allows semitrailers to operate at higher than RTAC base limits; encourages A-trains on secondary highways in Saskatchewan; and results in many lower-grade, secondary roads handling larger, heavier trucks than otherwise allowed.

Regarding commercial vehicle roadside inspections, there are clear differences in the number of inspections conducted in the winter versus summer months in both Manitoba and Saskatchewan. Less than 1 in 20 of all Level I inspections (the most intensive inspection type, and the only type of inspection capable of identifying brake defects) take place in the winter period (December to February). About one-third of all Level II (walk-around) inspections occur in the winter period.

The significant differences observed in commercial vehicle roadside inspection results between Manitoba and Saskatchewan, particularly concerning the numbers of defects being recorded, and the temporal distribution of inspections, give rise to concern about the intensity of inspections, and the mechanical fitness of the fleet depending on where, when, and by whom trucks are inspected.

While each province has a highway improvement plan in place, heavy truck safety is not specifically-addressed in these plans. In fact, most of the road safety initiatives that are currently in place in the Prairie provinces do not address heavy trucks, nor the civil engineering aspects of road safety. These initiatives are mainly designed to educate passenger vehicle drivers respecting things such as speeding, drinking and driving, seat belt use, and general driving behaviour.

8.2 HEAVY TRUCK ACCIDENTS

Over 400 people died and nearly 5,000 were injured in 14,838 accidents involving heavy trucks between 1993 and 1998 in the Prairie region. More than one of every six heavy truck accidents is either a fatal or injury accident.

There was a significant difference in the total number of HTAs from the first half to the second half of the research period. The number of heavy truck accidents for the last three years of the period was 20 percent higher than in the first three years. Increases were experienced in each province, on both provincial highways and in urban areas. The number of heavy truck accidents resulting in fatality or injury also increased, by 18 percent combined.

One-half of all heavy truck accidents in the Prairie region took place in urban areas. Two-thirds of the increase of total heavy truck accidents occurred in these cities, where the outcome of heavy truck accidents is also serious. One of three heavy truck accidents in urban areas results in injury or fatality.

Many heavy truck accidents are geographically-concentrated on readily-identifiable road sections, locations or intersections. The geocoded database and geographic information system (GIS)-based analysis of Chapter 4 highlights several important concentrations. These concentrations provide opportunities for location or geographic-based targeting of heavy truck safety initiatives.

There are many similarities regarding the temporal distribution of heavy truck accidents in urban areas and on provincial highways. However, there are also differences: (1) weekends account for 20 percent of all heavy truck accidents on provincial highways, compared to 10 percent in urban areas; and (2) there is peaking in the time of day distribution of heavy truck accidents in urban areas between 8:00 a.m. and 6:00 p.m., whereas this is not the case on provincial highways.

The most commonly-reported contributing factor for heavy truck accidents on provincial highways is environmental conditions (reported in 42 percent of all heavy truck accidents), whereas in urban areas it is human action (reported in 45 percent of heavy truck accidents). Also, both for heavy truck accidents occurring in urban areas, as well as for heavy truck accidents occurring on provincial highways, adverse road surface conditions (wet, snow, ice, slush) was reported in approximately 40 percent of all heavy truck accidents in the region.

8.3 HEAVY TRUCK ACCIDENT RATES

The heavy truck accident rate analysis reveals five important points. First, when all heavy truck accidents in the region are considered, the heavy truck accident rate is lower on divided highways than on undivided highways (0.31 versus 0.35 heavy truck accident per million truck-kilometers traveled). However, when heavy truck accidents at intersections are excluded, the rate is about the same for divided and undivided highways.

Second, including all heavy truck accidents on provincial highways, the heavy truck accident rate declines somewhat as annual average daily truck traffic increases (0.37 to 0.32, or an average of 0.35 heavy truck accidents per million truck-kilometers traveled). Removing heavy truck accidents at intersections, the rate is fairly consistent across all truck traffic levels (averaging 0.25 heavy truck accidents per million truck-kilometers traveled).

Third, there are significant seasonal and time of day effects on heavy truck accident rates. Nearly one-half of heavy truck accidents on provincial highways occur in the four-month winter period of November to February, and about one-quarter occur in the four-month summer period of May to August. This results in a winter heavy truck accident rate per unit of truck traffic on provincial highways in Manitoba of 2.25 times the summer rate (and 1.75 times the spring/fall rate). Regarding the time of day effect, the evening/night-time heavy truck accident rate per unit of truck traffic on provincial highways in Manitoba is 60 to 90 percent higher than the morning/daytime rate.

Fourth, in Manitoba, single trailer combinations are involved in heavy truck accidents at an exposure-based rate of about 25 percent higher than double trailer combinations. Lack of detail in both accident and truck traffic databases prohibits objective analysis of whether or not the B/C-train encouragement policy incorporated by the RTAC performance-based regulation system may have contributed to this apparent double trailer advantage.

Fifth, the heavy truck accident rate in urban areas is much higher than on provincial highways (20 times higher in Winnipeg than on provincial highways in Manitoba).

8.4 SYSTEM SAFETY REVIEWS

The research develops and applies the heavy truck system safety review concept. The purpose of a system safety review is to bring forward important issues that affect heavy truck safety in a region or in a given situation, and to provide observations respecting the system involving heavy truck operations. Six elements are to be considered when conducting a system safety review: (1) the demand for freight movement by truck; (2) applicable truck size, weight, and safety regulations; (3) enforcement practices, particularly related to safety; (4) the roadway environment, including design characteristics, special facilities for heavy trucks, and road maintenance practices; (5) truck traffic in the area under investigation, or for the situation being analyzed; and (6) heavy truck accident history for the situation under analysis.

The research outlines and applies a system safety review procedure. Use of the procedure would facilitate more informed decision-making about future heavy truck safety initiatives.

8.5 OVER-RIDING ISSUES AND OPPORTUNITIES FOR NEW INITIATIVES

The frequency, severity and exposure-based rate of heavy truck accidents in urban areas demonstrate that new safety initiatives focused on urban trucking offer a large and to date, largely un-addressed, target in the pursuit of Canada's road safety vision concerning commercial vehicle operations. Current truck size and weight regulation and commercial vehicle roadside inspection programs are only incidentally or tangentially targeted at urban trucking. Many aspects of road design and traffic engineering practice in urban areas are largely insensitive to freight flows, heavy truck traffic, and heavy truck characteristics.

Intersection-related heavy truck accidents offer a large spatially-limited target for improving heavy truck safety. The vast majority of these intersections were designed/constructed in an era pre-dating today's common 53-foot semitrailers (and in many cases, 48-foot semis), tridem axles, RTAC weights, contemporary acceleration/deceleration characteristics of large trucks, large increases in truck volumes, expanded networks of highways allowing winter weight premiums, and increased special permitting of overweight/overdimensioned trucking. In the short term, future initiatives directed at intersections must involve targeted maintenance, traffic engineering, enforcement and highly selective resurfacing, restoration, rehabilitation, and reconstruction (4R) projects, preferably based on heavy truck system safety reviews. A further initiative with long range prospects would involve the development and utilization of design guidelines reflecting contemporary truck volumes and characteristics, as well as contemporary total traffic volumes and truck/non-truck mixes in the traffic stream.

Existing heavy truck safety initiatives do not address the winter versus summer heavy truck accident rate imbalance or the prevalence of adverse roadway conditions in heavy truck accidents. From Saskatchewan and Manitoba data, commercial vehicle roadside inspections focus on truck operations in "non-winter" periods. In winter, truck weight limits are significantly increased, using winter weight premiums on nearly all highways in the region. These premiums routinely allow many trucks to operate at weight levels higher than those ever contemplated in the development of RTAC weight standards, and in secondary road situations never envisioned to accommodate the large and heavy combinations now prevalent in the region.

As is the case with significant seasonal differences in the heavy truck accident rate, existing safety initiatives do not address the imbalance in day versus night heavy truck accident rates in any meaningful way. Enforcement efforts including commercial vehicle roadside inspections are generally much less concentrated in nighttime periods.

8.6 FUTURE RESEARCH

The research has identified the following needs for further research:

- Cross-category analysis between the winter/nighttime concentrations of heavy truck accidents to obtain a better understanding of the role that nighttime winter driving plays on heavy truck safety in the Prairies.

- Application of the system safety review concept to heavy truck accident situations that appear as critical and productive targets to identify, evaluate and prioritize feasible actions to reduce heavy truck accident frequency and/or the heavy truck accident exposure-based rate.

- Investigation of opportunities for more truck-sensitive traffic engineering, roadway maintenance, and road design—focusing on the low volume realities of Prairie region highways, and the urban context.

- Determination of the relationship between commercial vehicle roadside inspections and heavy truck accident reduction. This needs to be done using truck traffic exposure knowledge.

- The involvement of double trailer combinations in HTAs, by type of connection (A, B, or C-trains). This needs to be done using truck traffic exposure knowledge.

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APPENDIX A
Accident Report Forms

Traffic Accident Report
(Rev. '92)

Manitoba
Highways and
Transportation
Driver and
Vehicle Licencing

FORM NO.
DATE OF ACCIDENT DAY MO. YR
PAGE OF

All boxes must be completed by Officer completing report.

SCENE ATTENDED BY POLICE ☐ YES ☐ NO
PARTICULARS EXCHANGED ☐ YES ☐ NO
SEVERITY ☐ FATAL ☐ INJURY ☐ PROP. DAMAGE
☐ INFRACTION ☐ HIT & RUN
☐ ORIGINAL ☐ AMENDED REPORT
NUMBER KILLED
NUMBER INJURED
NUMBER OF VEHICLES & PEDESTRIANS INVOLVED
COMMON OFFENCE NOTICE

NAME OF POLICE FORCE | POLICE CODE | R.C.M.P. DETACHMENT AREA | SUB. DIV. | DETACHMENT COLLATOR NO.

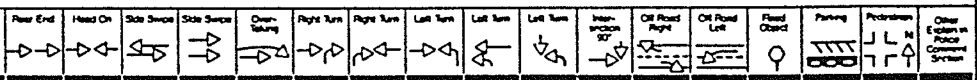
ON HIGHWAY NUMBER /STREET | AT INTERSECTION WITH | LOCATION CODE

Km N ☐ S ☐ E ☐ W ☐ | OF / IN | HOUR OF ACCIDENT AM ☐ PM ☐ | DAY OF WEEK 1 MON ☐ 2 TUES ☐ 3 WED ☐ 4 THUR ☐ 5 FRI ☐ 6 SAT ☐ 7 SUN ☐

VEHICLE NO. 1	**VEHICLE NO. 2**
DRIVER'S SURNAME GIVEN NAME	DRIVER'S SURNAME GIVEN NAME
ADDRESS POSTAL CODE	ADDRESS POSTAL CODE
TELEPHONE HOME BUSINESS	TELEPHONE HOME BUSINESS
PROV./STATE (SEE TEMPLATE) DRIVER'S LICENCE NUMBER	PROV./STATE (SEE TEMPLATE) DRIVER'S LICENCE NUMBER
YEARS / MONTHS AS LICENCED DRIVER YRS. MOS. MALE ☐ FEMALE ☐ BIRTHDATE DAY MO. YR	YEARS / MONTHS AS LICENCED DRIVER YRS. MOS. MALE ☐ FEMALE ☐ BIRTHDATE DAY MO YR
LICENCE VALID YES ☐ NO ☐ CLASS OF LICENCE LICENCE EXPIRY DATE DAY MO. YR	LICENCE VALID YES ☐ NO ☐ CLASS OF LICENCE LICENCE EXPIRY DATE DAY MO YR
REGISTERED OWNER SURNAME GIVEN NAME	REGISTERED OWNER SURNAME GIVEN NAME
ADDRESS POSTAL CODE	ADDRESS POSTAL CODE
TELEPHONE HOME BUSINESS	TELEPHONE HOME BUSINESS
PROV./STATE (SEE TEMPLATE) VEHICLE PLATE NUMBER NUMBER OF AXLES	PROV./STATE (SEE TEMPLATE) VEHICLE PLATE NUMBER NUMBER OF AXLES
SERIAL NUMBER	SERIAL NUMBER
VEHICLE YEAR AND MAKE VEHICLE MODEL/STYLE	VEHICLE YEAR AND MAKE VEHICLE MODEL/STYLE
VEHICLE COLOUR (SEE TEMPLATE) VEHICLE 1 DAMAGE $ DAMAGE CODE	VEHICLE COLOUR (SEE TEMPLATE) VEHICLE 2 DAMAGE $
NO. OF OCCUPANTS INSURANCE POLICY NO.	NO. OF OCCUPANTS INSURANCE POLICY NO.
INSURANCE CURRENT ☐ EXPIRED ☐ INSURANCE EXPIRY DATE DAY MO. YR	INSURANCE CURRENT ☐ EXPIRED ☐ INSURANCE EXPIRY DATE DAY MO. YR
FOR VEHICLES NOT REGISTERED IN MANITOBA NAME AND ADDRESS OF INSURANCE COMPANY	FOR VEHICLES NOT REGISTERED IN MANITOBA NAME AND ADDRESS OF INSURANCE COMPANY
NATIONAL SAFETY CODE NO	NATIONAL SAFETY CODE NO.
ESTIMATED SPEED Km. LEGAL SPEED AT SCENE OF ACCIDENT Km.	ESTIMATED SPEED Km. LEGAL SPEED AT SCENE OF ACCIDENT Km.

DIRECTION OF TRAVEL (V1) N ☐ S ☐ E ☐ W ☐ | CONTROL SECTION NO. | Km. TO NEAREST TENTH | INTERSECTION I.D. | DIRECTION OF TRAVEL (V2) N ☐ S ☐ E ☐ W ☐

ACCIDENT CONFIGURATION



CONFIGURATOR CODE	Rear End	Head On	Side Swipe	Side Swipe	Over-Taking	Right Turn	Right Turn	Left Turn	Left Turn	Left Turn	Inter-section 90°	Off Road Right	Off Road Left	Fixed Object	Parking	Pedestrian	Other Explain in Police Comment Section
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	99

VEHICLE NO. 1 SUSPENSION NOTICE DATE DAY MO. YR | SUSPENSION START DATE DAY MO. YR | VEHICLE NO. 2 SUSPENSION NOTICE DATE DAY MO YR | SUSPENSION START DATE DAY MO YR

VEHICLE NO. 1 ACCIDENT ASSESSMENT/ VIOLATIONS 1 2 3 4 POINTS | VEHICLE NO. 2 ACCIDENT ASSESSMENT/ VIOLATIONS 1 2 3 4 POINTS

80	81	82	83	84	85	86	

ORIGINAL TO DRIVER AND VEHICLE LICENCING PART 1 OF 4

FORM 4020 - 07-B
MG - 9956 (REV. JAN. 92)
←

GENERAL CODES — To be used for all categories listed below, if given codes do not apply.

N – Not applicable
O – Other (Specify in comments)
X – Unknown

→
Refer to manual for proper use of codes.

1 LIGHT CONDITION
1. Day
2. Dawn
3. Dusk
4. Dark – [illegible]
5. Artificial Lighting

2 WEATHER CONDITION
1. Clear
2. Cloudy
3. Raining
4. Snowing
5. Fog or Mist
6. Smoke or Dust
7. Freezing Rain/Sleet/Hail
8. Drifting Snow
9. Strong Winds

3 ROAD SURFACE TYPE
1. Asphalt
2. Concrete
3. Gravel
4. Earth/Dirt
5. Chip-Seal

4 ROAD CONDITION
1. Good
2. Defective
3. Under Repair
4. Under Construction
5. Obstruction Not Lighted
6. Hole/Rut/Bump
7. Pavement Drop Off

5 ROAD SURFACE CONDITION
1. Dry
2. Wet
3. Mud
4. Snow
5. Ice
6. Slush
7. Loose Sand/Gravel/Dirt
8. Fresh Oil

MAJOR CONTRIBUTING FACTORS
DRIVER ACTION
100. (Driving Properly)
101. Following Too Closely
102. Turning Improperly
103. Exceeding Speed Limit
104. Driving Too Fast for Conditions
105. Unsafe Operating Speed (Too Fast or Too Slow)
106. Passing Improperly
107. Changing Lanes Improperly
108. Failed to Yield Right of Way
109. Disobeyed Traffic Control Device/Officer
110. Driving Wrong Way on Roadway
111. Passing a Vehicle at Pedestrian X-Walk
112. Backing Unsafely
113. Parking Improperly
114. Careless Driving
115. Lost Control/Drive Off Road
116. Driverless Vehicle Ran Out of Control
117. Leave Stop Sign Before Safe to Do So
118. Failed to Signal
119. Taking Avoiding Action
120. Driver Inexperience
121. Pedestrian Error/Confusion

PRE-COLLISION VEHICLE ACTION
01. Going Straight Ahead
02. Turning Left
03. Turning Right
04. Making U-Turn
05. Changing Lanes to Left
06. Changing Lanes to Right
07. Merging
08. Reversing
09. Overtaking
10. Slowing/Stopping on Roadway
11. Stopped in Traffic
12. Starting in Traffic
13. Starting from Parked Position/Leaving Roadside
14. Entering Parked Position/Stopped on Roadside
15. Parked - Legally
16. Parked - Illegally
17. Swerving

V1-32
V2-33

FUEL SYSTEM TYPE
1. Gasoline
2. Diesel
3. Liquid Propane
4. Compressed Natural Gas

V1-30
V2-31

HUMAN CONDITION
200. (Apparently Normal)
201. Loss of Consciousness/Blackout Prior to Accident
202. Extreme Fatigue/Fell Asleep
203. Defective Eyesight
204. Defective Hearing
205. Medical Disability
206. Physical Disability
207. Mental Disability
208. Mental Confusion/Inability to Remember
209. Sudden Illness
210. Ability Impaired by Alcohol
211. Ability Impaired by Drugs
212. Had Been Drinking/Suspected Alcohol Use
213. Distraction/Inattention
214. Exceeded Hours of Service (Commercial Drivers Only)

VEHICLE 1 FACTOR
1ST 34
2ND 35
3RD 36

6 ROAD CATEGORY
1. Undivided - One Way
2. Undivided - Two Way, Two Lane
3. Undivided - Two Way, Multi Lane
4. Divided - Barrier Median
5. Divided - With Median (No Barrier)

7 ROADWAY ALIGNMENT
1. Level and Straight
2. Level and Curve
3. Straight with Grade
4. Curve with Grade
5. Top of Hill
6. Bottom of Hill

8 ACCIDENT SITE TYPE
01. Intersection
02. Between Intersections
03. Intersection of Private Drive/Lane
04. Back Lane
05. Parking Lot
06. Railroad Level Crossing
07. Bridge/Overpass
08. Tunnel/Underpass
09. Off-Road
10. Passing/Climbing Lane

V1-20 V2-21 TRAFFIC CONTROL/ADVISORY
01. Traffic Signal/ Control Device
02. Stop
03. Rt. Turn on Red
04. Lt. Turn on Red
05. Yield
06. Officer/Flagman/ School Guard
07. Merge
08. 4-Way Stop
09. Turn Controls
10. Flashing Signal Light
11. Overhead Signs
12. R.R. Gates
13. R.R. Auto Controls
14. R.R. Crossing
15. School Zone
16. Warning Sign
17. Pedestrian Crosswalk
18. Pedestrian Corridor
19. School Crossing
20. Flashing School Signals

VEHICLE CONDITION
300. (No Apparent Defect)
301. Defective Brakes
302. Defective Steering
303. Defective Headlights
304. Defective Brakelights
305. Defective Lighting (Unspecified)
306. Defective Engine Controls/Drive Train
307. Defective Suspension/Wheels
308. Defective Tires
309. Tow Hitch/Yoke Defective
310. Defective Exhaust System
311. Hood/Tailgate/Door/Covering Opened
312. Defective Glazing (Obscured Windows)
313. Vehicle Modifications
314. Fire
315. Overloaded/Oversized
316. Load Shifted/Spilled
317. Jack-Knife/Trailer Swing
318. Hydroplaning of Tires

ENVIRONMENTAL
401. Animal Action - Wild
402. Animal Action - Domestic
403. Slippery Road Surface
404. Snow Drift
405. Obstruction/Debris in Roadway
406. View Obstructed/Limited
407. Glare/Reflection
408. Construction Zone
409. Defective Driving Surface
410. Shoulders Defective
411. Lane Markings Inadequate
412. Defective/Inoperative Traffic Control Device
413. Weather
414. Pedestrian Corridor In Use
415. Uninvolved Vehicle
416. Uninvolved Pedestrian
417. Presence of Prior Accident

VEHICLE 2 FACTOR
1ST 37
2ND 38
3RD 39

VEHICLE TYPE
V1-22 V2-23
PASSENGER VEHICLES
01. Automobile
02. Mini-Van/Multi-Purpose Van
TRUCKS
11. Van Under 4500 kg
12. Pick-Up Under 4500 kg
13. Truck Over 4500 kg (Unit Chassis)
14. Power Unit for Semi-Trailer
15. Truck/Camper
16. Motorhome
17. Truck (Other)
BUSES
21. School Bus
22. Other School Vehicle
23. Transit Bus (Urban)
24. Paratransit Bus
25. Inter-City Bus
26. Bus (Other).
TWO-WHEELED VEHICLES
31. Motorcycle/Scooter
32. Moped
33. Bicycle
EMERGENCY VEHICLES
41. Ambulance
42. Fire
43. Police
OTHER VEHICLES
51. Mobility Vehicle
52. Motorized Snow Vehicle (HTA)
53. Farm Equipment
54. Construction Equipment
55. Train/Other Rail Vehicle
OFF-ROAD VEHICLES (ORVA)
61. Snowmobile
62. Off-Road Motorcycle
63. All-Terrain Vehicle
64. Amphibious Vehicle
65. Dune/Sport Buggy
66. 4-Wheel-Drive Motor Vehicle (Operated Off-Road)

99. PEDESTRIAN

SEQUENCE OF EVENTS - COLLISION WITH:
FIXED OBJECT
01. Ditch/Embankment/Earth Slope
02. Approach
03. Traffic Barricade
04. Sign Post
05. Traffic Signal Standard
06. Street Light Standard
07. Telephone/Power Pole
08. Guard Rail
09. Bridge Structure/Abutment
10. Tree/Bush
11. Parking Meter
12. Building/Wall
13. Curbing
14. Fence
15. Culvert/Drainage Structure
16. Snow Bank/Drift
17. Rock Face
18. Delineator Posts
19. Fire Hydrants/Utility Box
20. Median Barrier/Gore
21. Gate/Moveable Barrier
22. Impact Attenuator

MOVEABLE OBJECT
41. Vehicle
42. Railroad Train
43. Bicyclist
44. Motorcycle
45. Moped
46. Animal
47. Pedestrian
48. Farm Machinery
49. Construction Machinery
50. Snowmobile
51. Off-Road Vehicle

NON-COLLISION EVENT
71. Ran Off Road
72. Overturned
73. Fire/Explosion
74. Skidding/Sliding
75. Jack-Knifing/Trailer Swing
76. Submersion/Immersion
77. Load Spill

V1 1ST EVENT V1-40
V1 2ND EVENT V1-41
V2 1ST EVENT V2-42
V2 2ND EVENT V2-43

V1-24 V2-25 TOWED VEHICLE
01. Camper-Top on Pick-Up Truck
02. Holiday/Tent Trailer
03. Boat Trailer
04. Utility Trailer
05. Farm Equipment
06. Construction Equipment
07. Towed Motor Vehicle
08. Low/High Boy
09. Single Trailer (Semi)
10. Double Trailer (Semi)
11. Triple Trailer (Semi)
12. Petroleum or Other Tanker
13. Over-Dimensioned Pilot Vehicle
14. Over-Dimensioned Non-Pilot Vehicle

VEHICLE DAMAGE
1. No Visible Damage
2. Light (Superficial)
3. Moderate (Unsafe for Further Use)
4. Severe (Not Driveable But Worth Repairing)
5. Demolished (Write Off)

V1-44
V2-45

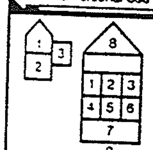
COMMERCIAL VEHICLES

V1-26 V2-27 CARGO OR HAZARDOUS LOAD
01. Explosives
02. Flammable Gases
03. Flammable/Combustible Liquids
04. Flammable Solids/ Spontaneously Combustible/ Dangerous when Wet
05. Oxidizers/Organic Peroxides
06. Poisonous Substances/ Harmful to Food/ Infectious
07. Radioactives
08. Corrosives
09. Miscellaneous Dangerous Substances (includes unspecified waste materials)
10. General Cargo (Non-Hazardous)
11. Empty

V1-28 V2-29 WORK STATUS
1. In Use for Work
2. Personal Use

LOCATION OF DAMAGE
01. Front
02. Engine Hood
03. Windshield
04. Roof
05. Rear (Including Trunk)
06. Left Front Fender
07. Left Door(s)
08. Left Rear Fender
09. Entire Left Side
10. Right Front Fender
11. Right Door(s)
12. Right Rear Fender
13. Entire Right Side
14. Undercarriage
15. Interior
16. Extensive (Several Areas)
17. Trailed Vehicle Struck

V1-46
V2-47



POSITION ON/ IN VEHICLE
1. Driver
2.-7. Passenger
8. Riding or Hanging on
9. Pedestrian

INJURY CODE
1. Minimal (No Hospital Treatment)
2. Minor (Treated and Released)
3. Major (Admitted)
4. Fatal
5. Injured, (Extent Not Specified)

EJECTION FROM VEHICLE
1. Not Ejected
2. Ejected
3. Partially Ejected

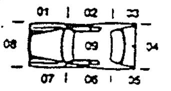
SAFETY EQUIPMENT
SEAT BELTS/AIR BAGS
01. Lap Belt Only Installed and In Use
02. Lap Belt Only Installed and Not In Use
03. Shoulder Belt Only Installed and In Use
04. Shoulder Belt Only Installed and Not In Use
05. Lap and Shoulder Belt Assembly In Use
06. Combined Belt Installed But Not In Use
07. Only Lap Part of Full Assembly In Use
08. Air Bag Deployed and Safety Belt In Use
09. Air Bag Deployed and Safety Belt Not In Use
CHILD RESTRAINTS
21. Safety Seat Properly Installed - In Use
22. Safety Seat Improperly Installed - In Use
23. Safety Seat Installed - Not In Use
SAFETY HELMET
31. Safety Helmet Worn
32. Safety Helmet Not Worn
PEDESTRIAN
41. Reflective Clothing or Item on Pedestrian

99. NO SAFETY DEVICE AVAILABLE

PEDESTRIAN ACTION
01. At Intersection, Crossing With Right-Of-Way
02. At Intersection, Crossing Without Right-Of-Way
03. At Intersection, Crossing, No Traffic Control
04. Between Intersections, Crossing Roadway
05. Walking Along Roadway Against Traffic
06. Walking Along Roadway With Traffic
07. On Sidewalk/Median/Safety Zone
08. Walking on Roadway (Travelled Portion)
09. Coming from Behind Vehicle/Object on Roadside
10. Running Into Roadway
11. Getting On/Off Another Vehicle
12. Pushing/Working on Vehicle
13. Playing on Roadway
14. Working on Roadway
15. Lying in Roadway

V1-50
V2-51

POINT OF INITIAL IMPACT



10 - Undercarriage
11 - Interior
12 - More Than One Area

V1-48
V2-49

VEHICLE NUMBER 30
31
32
33
AGE 34
SEX 35
36

BOXES 30-36 APPLY TO FATAL AND INJURED VICTIMS ONLY

ACCIDENT TYPE (for D.V.L. use) 70

SURNAME
GIVEN NAME
ADDRESS – if deceased also include time [illegible]

SGI Highway Traffic Board

MOTOR VEHICLE ACCIDENT REPORT FORM

PAGE ______ OF ______

GENERAL

ACCIDENT CASE NO.	REPORT TYPE 1. ORIGINAL 2. CONTINUATION 3. AMENDMENT ☐	ORIGINAL ACCIDENT CASE NO.	REPORT STATUS 1. COMPLETE 2. INCOMPLETE, HIT AND RUN 3. INCOMPLETE, OTHER ☐	ACCIDENT SEVERITY 1. PROPERTY DAMAGE 2. PERSONAL INJURY 3. FATAL ☐	POLICE FILE NUMBER
1168779					

DATE OF ACCIDENT YEAR	MONTH	DAY	TIME (24 HOURS) HRS.	MIN.	NUMBER OF VEHICLES	NUMBER INJURED	NUMBER KILLED	SCENE VISITED 1. YES 2. NO ☐	LEGAL SPEED ADVISORY SPEED	TIME REPORTED MONTH	DAY	HOURS	MIN.

POLICE JURISDICTION

1. IN
2. NEAR ☐ COMMUNITY

OWNER OF OTHER PROPERTY NAME

ADDRESS

CITY/PROV. PHONE

TOTAL ESTIMATED DAMAGES ☐

1. LESS THAN $1,000 (NOT REPORTABLE WITHOUT INJURIES OR DEATHS)
3. $1,001 TO $5,000
4. $5,001 TO $10,000
5. $10,001 TO $20,000
6. $20,001 TO $30,000
7. $30,001 TO $50,000
8. OVER $50,000

LOCATION

ROAD AUTHORITY ☐

URBAN MUNICIPALITY
01. STREET
02. LANE / BACK ALLEY

PROVINCIAL HIGHWAYS
03. RURAL / URBAN HIGHWAY
04. PROVINCIAL ROAD (900 SERIES)
05. COMMUNITY ACCESS, SERVICE ROAD / OTHER

RURAL MUNICIPALITIES
06. DESIGNATED GRID ROAD
07. RURAL MUNICIPAL ROAD

OTHER ROAD AUTHORITIES
08. PRIVATE LAND / PARKING LOT
09. INDIAN RESERVE, (GRID OR MUNICIPAL ROAD)
10. NORTHERN FOREST ROADS
11. FEDERAL / PROVINCIAL LANDS
12. NOT KNOWN

URBAN LOCATION

STREET 1 BLOCK/ADDRESS

STREET 2 URBAN GRID

HIGHWAY LOCATION

HIGHWAY CONTROL SECTION	SUBSECTION	KILOMETRE

RURAL LOCATION

R.M. NO.	SIDE OF	QUARTER	SECTION	TOWNSHIP	RANGE	MERID

LOCATION DESCRIPTION ______

DRIVER

VEH. NO. DRIVER LICENCE NO. CLASS PROV. LIC NO. / LIC BLD (×2)

DRIVER NAME LAST GIVEN

ADDRESS

CITY PROVINCE PHONE NO.

DATE OF BIRTH YEAR MONTH DAY SEX REVIEW REPORT SUBMITTED 1. NO 2. MEDICAL 3. LICENCE 4. BOTH

DRIVER NAME LAST GIVEN

ADDRESS

CITY PROVINCE PHONE NO.

DATE OF BIRTH YEAR MONTH DAY SEX REVIEW REPORT SUBMITTED 1. NO 2. MEDICAL 3. LICENCE 4. BOTH

VEHICLE

LICENCE CLASS LICENCE PLATE NO. PROV. YEAR COLOUR CODE

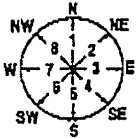
OWNER NAME VEHICLE MAKE

STREET CITY MODEL

PROVINCE PHONE NUMBER OF OCCUPANTS

INSURANCE COMPANY NAME (OUT OF PROVINCE ONLY) TOTAL NO. OF AXLES

ADDRESS DIRECTION OF TRAVEL



LICENCE CLASS LICENCE PLATE NO. PROV. YEAR COLOUR CODE

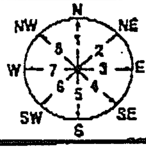
OWNER NAME VEHICLE MAKE

STREET CITY MODEL

PROVINCE PHONE NUMBER OF OCCUPANTS

INSURANCE COMPANY NAME (OUT OF PROVINCE ONLY) TOTAL NO. OF AXLES

ADDRESS DIRECTION OF TRAVEL



TOWED TRAILER(S)

TRAILER NO. 1 OWNER NAME LICENCE PLATE NO.

OWNER ADDRESS PROVINCE

TRAILER NO. 2 OWNER NAME LICENCE PLATE NO.

OWNER ADDRESS PROVINCE

INSURANCE COMPANY NAME / LOCATION (OUT OF PROVINCE ONLY)

TRAILER NO. 1 OWNER NAME LICENCE PLATE NO.

OWNER ADDRESS PROVINCE

TRAILER NO. 2 OWNER NAME LICENCE PLATE NO.

OWNER ADDRESS PROVINCE

INSURANCE COMPANY NAME / LOCATION (OUT OF PROVINCE ONLY)

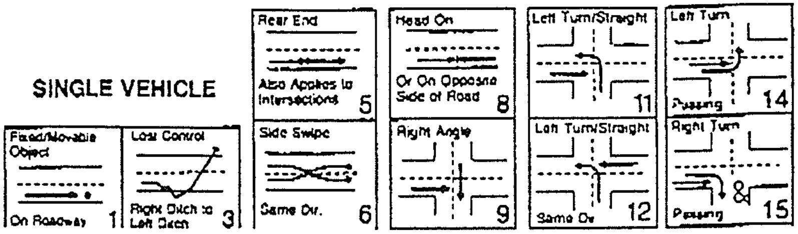
ACCIDENT DESCRIPTI

DESCRIPTION OF ACCIDENT

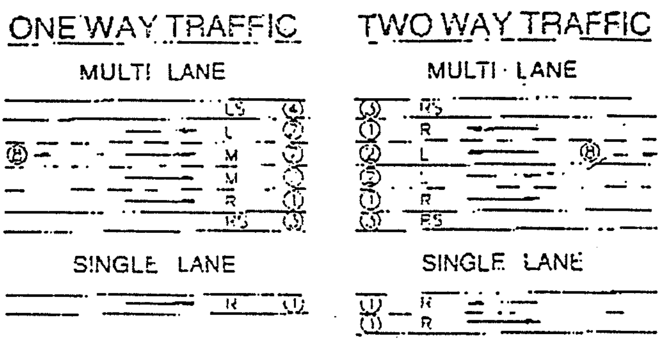
ACCIDENT CONFIGURATION

SINGLE VEHICLE

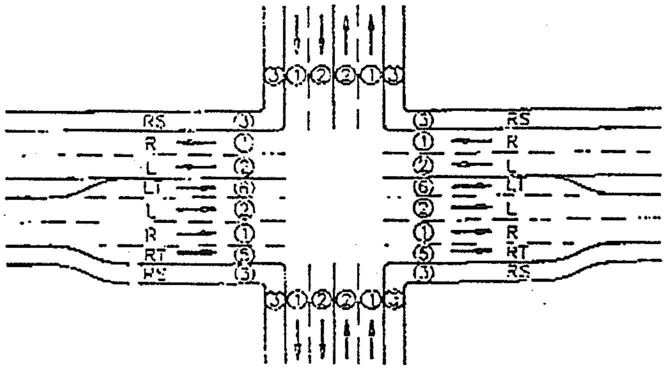
MULTI VEHICLE



DESIGNATED LANE OF TRAVEL



INTERSECTIONS



Code	Abbreviation	Lane
1	R	Right most Driving Lane
2	L	Left most Driving Lane.
3	RS	Right Shoulder
4	LS	Left Shoulder
5	RT	Right Turning Lane
6	LT	Left Turning Lane
7	M	Middle Driving Lane
8	O	Lane of Opposing Traffic

Alberta	AB	Ontario	ON
British Columbia	BC	Prince Edward Island	PE
Manitoba	MA	Quebec	PQ
New Brunswick	NB	Saskatchewan	SK
Newfoundland	NF	Yukon Territory	YT
Nova Scotia	NS	North West Territories	NW
Alabama	AL	Montana	MT
Alaska	AK	Nebraska	NE
Arizona	AZ	Nevada	NV
Arkansas	AR	New Hampshire	NH
California	CA	New Jersey	NJ
Colorado	CO	New Mexico	NM
Connecticut	CT	New York	NY
Delaware	DE	North Carolina	NC
District of Columbia	DC	North Dakota	ND
Florida	FL	Ohio	OH
Georgia	GA	Oklahoma	OK
Hawaii	HI	Oregon	OR
Idaho	ID	Pennsylvania	PA
Illinois	IL	Rhode Island	RI
Indiana	IN	South Carolina	SC
Iowa	IA	South Dakota	SD
Kansas	KS	Tennessee	TN
Kentucky	KY	Texas	TX
Louisiana	LA	Utah	UT
Maine	ME	Vermont	VT
Maryland	MD	Virginia	VA
Massachusetts	MH	Washington	WA
Michigan	MI	West Virginia	WV
Minnesota	MN	Wisconsin	WI
Mississippi	MS	Wyoming	WY
Missouri	MO	Puerto Rico	PR
		Mexico	MX
Canadian Armed Forces	CF		
International Licence	IR		
Other Foreign Licence	FE		

Colour Codes

White	01	Yellow	06	Grey	1
Black	02	Orange	07	Gold	1
Red	03	Purple	08	Silver	1
Green	04	Brown	09	Bronze	1
Blue	05			Other	1

Two-Tone Vehicle use most Predominant Colour

Codes for Charges Laid

CODE	CHARGE
10	Unregistered Vehicle
11	Disobey Stop Sign
12	Fail to Signal
13	Speed too Fast for Conditions
14	Drive Without Due Care and Attention
15	Follow too Closely
16	Passing on Right
17	Improper Lane Change
18	Improper Turn
19	Fail to Yield Right-of-Way
20	Passing When Unsafe
21	Driving Left of Centre
22	Driving Wrong Way on a One Way Street
23	Fail to Yield to Pedestrian
24	Fail to Report
25	Disobey Traffic Signal
26	Improper Parking on Highway or Street
27	Passing School Bus When Forbidden
28	Inadequate Brakes
29	Defective or Unauthorized Lights, Tires, Windshield or Bumper Height
30	Dangerous Driving
31	Drive While Disqualified
32	Criminal Negligence
33	Fail to Remain
34	Impaired Driving / Refuse Breath Test
35	Unsafe Backing
36	No Driver's Licence
37	Operator or Passenger Not Using Seatbelt
38	Speeding Past Highway Worker
39	Stunting
40	24 Hour Suspension
99	Other Offence

Unknown Information

An " X " can be coded to individual data fields if the information is unknown at the time of reporting. However, in cases where no information is known about a complete section such as a hit and run accident where no driver or vehicle data is available, one " x " at the beginning of the section will be sufficient.

LIGHTING

1

Natural

1. Daylight 3. Dusk
2. Dark 4. Dawn

Artifical

1. No Lighting
2. Lighting Available and Not On
3. Lighting On

Weather Conditions 2

1. Clear
2. Cloudy
3. Raining
4. Snowing
5. Sleet / Hail / Freezing Rain
6. Fog / Smoke / Smog
7. Drifting Snow / Dust
8. Strong Winds

Road Surface Condition 3

1. Dry
2. Wet
3. Loose Snow
4. Packed Snow / Ice
5. Loose Gravel or Sand
6. Muddy
7. Slush
8. Fresh Oil

Road Conditions 4

1. Normal / Good
2. Potholes, Ruts, Bumps
3. Under Construction / Repair
4. Uneven Pavement Surface / Sharp Drop Off
5. Obscured or Faded Pavement Markings

Accident Site 5

01. Non-Intersection
02 Intersection With Provincial Highway
03 Intersection With Grid / Municipal Road
04. Intersection With Street
05. Intersection With Private Approach, Driveway
06. Intersection With Lane or Alley
07. Railroad Level Crossing
08. Bridge or Overpass
09. Tunnel or Underpass
10. Parking Lot or Parking Garage
11. Passing Lane or Climbing Lane
12. Ramp
13. Off Roadway (Within Right of Way)
14. Other

Road Character 6 V1 7 V2

1. Undivided – One Way
2. Undivided – Two Way
3. Divided – Raised Median
4. Divided – With Depressed or Painted Median
5. Other

ROADWAY ALIGNMENT

8 V1 9 V2

Horizontal Alignment

1. Straight
urved
ad End

Vertical Alignment

1. Level or Near Level
2. Steep Incline or Decline
3. Top of Hill (Crest)
4. Bottom of Hill (Sag)

Traffic Control 10 V1 11 V2

01. No Control Present
02. Traffic Signals Fully Operational
03. Traffic Signals In Flashing Mode
04. Flashing Beacon – Amber
05. Flashing Beacon – Red
06. Stop Sign
07 Yield Sign
08. Marked Pedestrian Crosswalk
09. Flagman / Police Officer
10. RR Crossing – With Automatic Controls
11. RR Crossing – With No Automatic Controls
12 School Bus - Stopped With Flashing Light
13. School Crossing
14. Reduced Speed Zone
15. No Passing Zone
16. Construction Zone

Vehicle Identification 12 V1 13 V2

01. Automobile (passenger car)
02. Pick-up Truck 4500 kg and Under
03. Panel van 4500 kg and under (Includes Mini Van)
04. Trucks over 4500 kg
05. Power Units for Semi-Trailers (Road Tractor)
06. Transit Bus (Urban)
07. Inter City Bus
08. School Bus – Standard Large Type
09. School Bus – Van Type
10. Other Bus – Unspecified / Private
11. Motorcycle
12. Moped / Power Bicycle
13. Bicycle
14. Ambulance / Police / Fire
15. Snowmobile
16. Construction / Maintenance Equipment
17. Unregistered Farm Equipment
18. Off Highway Vehicle (3 or 4 Wheel ATV's)
19. Motorhome
99. Other Vehicle

Type of Trailer 14 V1 15 V2

01. Camper / Holiday Trailer
02. Boat / Other Rec. Trailer
03. Utility / Home Made Trailer
04. Farm Equipment
05. Maintenance / Construction Equipment
06. Towed Motor Vehicle
07. Single Trailer / Tanker (semi)

Double Trailer (Semi) Units with Second Trailer Attached By:

08. A Single Hitch Drawbar (" A " Train)
09. A Double Hitch Drawbar (" C " Train)
10. A Fifth Wheel (" B " Train)
11. Overdimentional Vehicle With Escort
12. Other Types of Trailer (Including Triple Trailers)

DANGEROUS GOODS CLASS 16 V1 17 V2

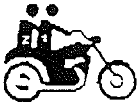
0 None Involved
1 Class 1 Explosives
2 Class 2 Compressed Gases
3 Class 3 Flammable Liquids
4 Class 4 Flammable Solids
5 Class 5 Oxidizers & Organic Substances
6 Class 6 Poisonous and Infectious Substances
7 Class 7 Radioactive Material
8 Class 8 Corrosive Substance
9 Class 9 Miscellaneous Substances

DANGEROUS GOODS SPILL 18 V1 19 V2

1 Yes 2 No

tion In / On Vehicle

Driver, Includes Cyclists and Motor Cyclists
2 & 3. Front Seat Passengers and Cyclists Seated Behind Driver
4, 5 & 6 Rear Seat Passengers
7 Occupants in the Load Area of a Truck or Van, Third Seat Passenger in Station Wagons or Vans and all Bus Passengers
8 Persons Riding or Hanging on the Outside of the Vehicle
9 Pedestrians



Pre Collision Vehicle Action V1 32 V2 33

01. Going Straight Ahead
02. Turning Left
03. Turning Right
04. Making U-Turn
05. Changing Lanes
06. Merging
07. Reversing
08. Overtaking, Passing on Left or Right
09. Slowing or Stopping on the Roadway, (decelerating)
10. Stopped in Traffic (Inc. mechanical breakdown)
11. Starting in Traffic, (accelerating)
12. Starting from Parked Position, Leaving Roadside
13. Entering Parked Position, Stopping On Roadside
14. Parked Legally
15. Parked Illegally
99. Other

Designated Lane of Travel SEE REVERSE SIDE OF TEMPLATE V1 34 V2 35

MAJOR CONTRIBUTING FACTORS

V1 36 37 38 39 V2 40 41 42 43 Ped 44 45

Human Conditions

01. Inattentive
02. Distracted
03. Had Been Drinking
04. Impaired
05. Extreme Fatigue
06. Fell Asleep
07. Driver Inexperience / Confusion
08. Lost Consciousness / Other Illness
09. Physical / Medical Disability
10. Drugs (Prescription or Illegal)
11. Defective Eyesight / Hearing
12. Other Human Conditions

Vehicle Condition

40. Defective Brakes
41. Defective Lights
42. Defective Exhaust System
43. Load Shifted / Spilled
44. Vehicle Overloaded / Improperly Loaded
45. Defective Steering
46. Defective Suspension / Wheel Failure
47. Defective Tires / Tire Blowout
48. Defective Engine / Power Train / Wiring
49. Jackknife / Trailer Swing
50. View From Vehicle Obstructed
51. Other Vehicle Condition / Defect
52 Lights Not On

No Apparent Contributing Factor

99. Did not cause / Contribute to the Accident

Human Action

21. Fail to yield to the Right of Way
22. Traffic Control Device Disregarded
23. Following too Closely
24. Driving too Fast for Road Conditions
25. Exceeding Speed Limit
26. Turning Improper
27. Passing or Lane Usage Improper
28. Backing Unsafely
29. Fail to Signal
30. Driving Wrong Way in One Way Traffic
31. Taking Evasive Action
32. Careless Driving / Stunting
33. Pedestrian Action Contributed
34. Other Human Action

Environment Conditions

60. Animal Action (Wild)
61. Animal Action (Domestic)
62. Road Condition (Surface or Structure)
63. Excessive Loose Gravel
64. Snow Drift
66. Obstruction / Debris On Roadway
67. View obstructed / Limited Outside The Vehicle
68. Sun Glare
69. Construction Zone
71. Soft or Defective Shoulders
72. Lane Marking Inadequate
73. Traffic Control Device Not Working
74. Weather Conditions
75. Uninvolved Vehicle
76. Uninvolved Pedestrian
77. Other Environmental Condition

SEQUENCE OF EVENTS

V1 46 47 48 V2 49 50 51

Moveable Objects

01. Another Road Vehicle
02. Animal
03. Pedestrian
04. Railroad Train
05. Other Movable Object

Fixed Objects

20. Approach
21. Traffic Barricade
22. Building / Wall
23. Bridge Structure
24. Crash Cushions / Impact Attenuator
25. Culvert
26. Curbing
27. Delineator Post
28. Ditch Bottom / Back Slope
29. Debris on Roadway
30. Fence
31. Fire Hydrant, Parking Meter, Utility Box
32. Gravel Pile
33. Guard Rail
34. Lamp Support (Traffic Signals, Street Light)
35. Raised Median / Barrier
36. Power / Telephone Pole
37. Rock Face, Rocks on Road
38. Sign Post
39. Snow Bank / Drift
40. Tree / Bush
41. Other Fixed Object

Non-Collision Events

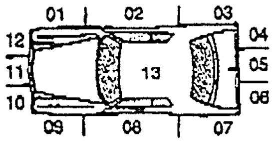
50. Ran off Road
51. Overturned
52. Fire / Explosion
53. Submersion
54. Skidding / Sliding / Spinning
55. Load Spill
56. Jack-knife / Trailer Swing
57. Other Non-Collision Event

Charges Laid – SEE BACK OF TEMPLATE V1 52 53 V2 54 55

Vehicle Damage V1 56 V2 57

1. No Visible Damage
2. Light / Superficial Damage
3. Moderate – Unsafe for Further Use
4. Severe – Not Driveable
5. Demolished – Write Off

LOCATION OF DAMAGE



14 - Undercarriage
15 - Interior

V1 58 59 60 V2 61 62 63

Pedestrian Action 64

01. At Intersection, Crossing With the Right of Way
02. At Intersection, Crossing Without the Right Of Way
03. At Intersection, Crossing. No Traffic Control
04. Crossing Roadway Between Intersection
05. Walking Along Roadway Against Traffic
06 Walking Along Roadway With Traffic
10. Running Into Roadway
11. Getting On Or Off Another Vehicle
12. Pushing, Working On Vehicle
13. Playing On Roadway
14. Working On Roadway
15. Lying On Roadway

[redacted] [redacted]

Alberta COLLISION REPORT FORM

Collision Case No. 073845

Continuation No.

Police Service

Police File No.

Page of

LOCATION

1. ☐ In
2. ☐ Near

City, Town, Village, Hamlet of (Give National Park, Indian Reservation)

On Primary/Secondary Hwy. No. OR Street/Avenue

At Intersection with Primary/Secondary Hwy. No. OR Street/Avenue

If Not at Intersection ☐ metres ☐ km ☐ N ☐ S ☐ E ☐ W of Street, Highway, Town, etc.

Special Reference If location can be described more precisely, enter here

Special Facility	Road Alignment	Road Class	Collision Location
N A			

Do Not Write in This Space

Occurrence Date Y M D

Occurrence Time (24 hour clock)

Reported Date As Above

Time Reported (24 hour clock)

File Status ☐ 1. SUI ☐ 2. Concluded ☐ 3. Forward To

Severity of Collision ☐ 1. Fatal ☐ 2. Injury ☐ 3. Property Damage

Diary Date Y M D

Total No. Veh.

Total No. Injured

Total No. Fatalities

☐ Original Report
☐ Amended Report

Hit and Run ☐ 1. Yes ☐ 2. No

Scene Visited ☐ 1. Yes ☐ 2. No

Special Studies ☐ 1. ☐ 2.

Primary Event ☐

- 01 STRUCK OBJECT
- 02 OFF ROAD LEFT
- 03 RIGHT ANGLE
- 04 PASSING - LEFT TURN
- 05 LEFT TURN - ACROSS PATH
- 06 SIDESWIPE OPPOSITE DIRECTION
- 07 OTHER/SPECIFY
- 08 REAR END
- 09 OFF ROAD RIGHT
- 10 HEAD ON
- 11 PASSING - RIGHT TURN
- 12 SIDESWIPE SAME DIRECTION
- 13 BACKING

DRIVER/PEDESTRIAN

#1 ☐ 1. Driver 2. Pedestrian 3. Motorcyclist 4. Bicyclist 5. Parked Veh. 6. Train 7. Animal 8. Other Veh. 9. Other Property

Surname First Name Initial

Address

City Postal Code

Date of Birth Y M D | Sex | Home Phone | Work Phone

Operator's Licence Number | Prov./State AB | Valid Licence ☐ 1. Yes ☐ 2. No | Proper Class ☐ 1. Yes ☐ 2. No

#2 ☐ 1. Driver 2. Pedestrian 3. Motorcyclist 4. Bicyclist 5. Parked Veh. 6. Train 7. Animal 8. Other Veh. 9. Other Property

Surname First Name Initial

Address

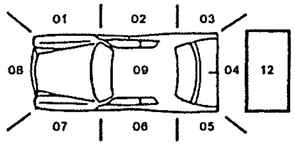
City Postal Code

Date of Birth Y M D | Sex | Home Phone | Work Phone

Operator's Licence Number | Prov./State AB | Valid Licence ☐ 1. Yes ☐ 2. No | Proper Class ☐ 1. Yes ☐ 2. No

Initial Point of Impact

Vehicle # ☐ Vehicle # ☐



10. Undercarriage 11. Rollover 12. Attachment 99. Unknown

VEHICLE

Year | Make | Model | Color

Licence Plate | Prov./State AB | VIN

Dangerous Goods Class PIN

Year | Make | Model | Color

Licence Plate | Prov./State AB | VIN

Dangerous Goods Class PIN

OWNER

Company Name/Leased By

Surname As Above First Name Initial

Address As Above

City Postal Code | Home Phone As Above | Work Phone As Above

Insurance Co. and Agent

Policy Number | Expiry Date Y M D

Company Name/Leased By

Surname As Above First Name Initial

Address As Above

City Postal Code | Home Phone As Above | Work Phone As Above

Insurance Co. and Agent

Policy Number | Expiry Date Y M D

INDEPENDENT WITNESSES

Surname Name

Address

Address

Home Phone | Work Phone

Surname Name

Address

Address

Home Phone | Work Phone

Additional Witnesses on File ☐ 1. Yes ☐ 2. No

ALL INVOLVED

Object #	Position	Safety	Injury	Age	Sex

Position in Vehicle
1. Driver 11. Bicyclist
2.-9. Passenger(s) 12. Pedestrian
10. Motorcyclist 98. Other 99. Unknown

3	6	9
2	5	8
1	4	7

Safety Equipment Used
1. Lap belt only
2. Lap/Shoulder belt assembly
3. Shoulder belt only (i.e. automatic belt)
4. Lap/Shoulder with Air bag
5. Airbag
6. Child safety/booster seat
7. Helmet
8. None
98. Other/Specify
99. Unknown

Injury Severity
1. None
2. Minor (treated but NOT admitted to hospital)
3. Major (admitted to hospital)
4. Fatal (death occurred within 30 days of collision) Include date and time of death

Surname Name Address

Surname Name Address

Surname Name Address

Surname Name Address

Surname Name Address

Surname Name Address

Investigator Reg | Signature | Unit | Approved by Reg. | Signature | Date

Alberta COLLISION REPORT FORM

Collision Case No. 073845

Police Service

Police File No.

Diagram: Use Solid Direction Lines Before Impact and Broken Lines After

North

Description: Include: Direction of Travel, Travelling Lane, Vehicle Movement, Obstructions, Fixed Object, Traffic Signs..

Proposed Police Action

Contributing Road Condition

1	2		1	2	
○	○	01. No Unusual Condition	○	○	05. Oily Pavement
○	○	02. Under Const./Maint.	○	○	06. Soft/Sharp Shoulder
○	○	03. Hole/Ruts/Bumps	○	○	98. Other/Specify
○	○	04. Slippery When Wet	○	○	99. Unknown

Environmental Condition (Choose only one)

○	01. Clear	○	05. Fog/Smog/Smoke/Dust
○	02. Raining	○	06. High Wind
○	03. Hail/Sleet	○	98. Other/Specify
○	04. Snow	○	99. Unknown

Surface Condition (Choose only one)

○	01. Dry	○	05. Muddy
○	02. Wet	○	98. Other/Specify
○	03. Slush/Snow/Ice		
○	04. Loose Surface Mat.	○	99. Unknown

Load Details (Choose one in A and one in B if applicable)

1	2	A	1	2	B
○	○	01. Loaded	○	○	01. Load Not Spilled
○	○	02. Unloaded	○	○	02. Load Spilled
○	○	99. Unknown	○	○	99. Unknown

Attachments (if applicable)

1	2		1	2	
○	○	01. Large Single Trailer	○	○	07. Towed Motor Vehicle
○	○	02. Large Double Trailer	○	○	08. Oversize With Pilot
○	○	03. Large Triple Trailer	○	○	09. Oversize W/O Pilot
○	○	04. Recreation Trailer	○	○	98. Other/Specify
○	○	05. Small Utility Trailer			
○	○	06. Farm Equipment	○	○	99. Unknown

Trailer Type (if Attachments coded as 01, 02, 03)

○	○	01. Van/Box Body	○	○	06. Car Carrier
○	○	02. Lowboy	○	○	07. Livestock Carrier
○	○	03. Highboy	○	○	08. Log Carrier
○	○	04. Tanker	○	○	98. Other/Specify
○	○	05. Dump			

Vehicle Condition/Contributing Factors

○	○	01. No Apparent Defect	○	○	05. Lighting Defect
○	○	02. Defective Brakes	○	○	98. Other/Specify
○	○	03. Tires Failed			
○	○	04. Improper Load/Shift	○	○	99. Unknown

Unsafe Speed

1	2	
○	○	01. Yes
○	○	02. No
○	○	99. Unknown - N/A

Vehicle Appears Repairable

1	2	
○	○	01. Yes
○	○	02. No
○	○	99. Unknown - N/A

Light Conditions (Choose one in A and one in B)

1	2	A	1	2	B
○	○	01. Daylight	○	○	01. No Artificial Light
○	○	02. Sunglare	○	○	02. Artificial Light
○	○	03. Darkness	○	○	99. Unknown
○	○	99. Unknown			

Traffic Control Device

1	2		1	2	
○	○	01. None Present	○	○	07. School Bus
○	○	02. Traffic Signal/Lights	○	○	08. Lane Control Signal
○	○	03. Stop Sign	○	○	09. RR Crossing
○	○	04. Yield Sign	○	○	98. Other/Specify
○	○	05. Merge Sign			
○	○	06. Pedestrian Cross-Walk	○	○	99. Unknown

Traffic Control Condition (if applicable)

1	2		1	2	
○	○	01. Functioning	○	○	04. Missing
○	○	02. Not Functioning	○	○	98. Other/Specify
○	○	03. Obscured	○	○	99. Unknown

Pedestrian Action (if applicable)

1	2		1	2	
○	○	01. Crossing With ROW	○	○	04. Getting On/Off Vehicle
○	○	02. Crossing Without ROW	○	○	98. Other/Specify
○	○	03. Walking/Working On Roadway			

Driver/Pedestrian Condition

1	2		1	2	
○	○	01. Apparently Normal	○	○	05. Fatigued/Asleep
○	○	02. Had Been Drinking	○	○	06. Medical Defect
○	○	03. Impaired By Alcohol	○	○	98. Other/Specify
○	○	04. Impaired By Drugs	○	○	99. Unknown

Object Identification

1	2		1	2	
○	○	01. Passenger Car	○	○	13. Fixed Object
○	○	02. Pick-Up/Van <4500kg	○	○	14. Train
○	○	03. Mini-Van/MPV	○	○	15. Animal
○	○	04. Truck >4500kg	○	○	16. Motorhome
○	○	05. Truck Tractor	○	○	17. Construction Equipment
○	○	06. Motorcycle/Scooter	○	○	18. Emergency Vehicle
○	○	07. Pedestrian	○	○	19. Farm Equipment
○	○	08. Bicycle	○	○	20. Off-Highway Vehicle
○	○	09. School Bus	○	○	21. Motorized Snow Vehicle
○	○	10. Transit Bus	○	○	22. Moped
○	○	11. Intercity Bus	○	○	98. Other/Specify
○	○	12. Other Bus	○	○	99. Unknown

Driver Action

1	2		1	2	
○	○	01. Driving Properly	○	○	10. Improper Lane Change
○	○	02. Stop Sign Violation	○	○	11. Disobey Traffic Signal
○	○	03. Yield Sign Violation	○	○	12. Ran Off Road
○	○	04. Fail To Yield ROW Uncontrolled	○	○	13. Improper Turn
○	○	05. Fail To Yield ROW Pedestrian	○	○	14. Left of Centre
○	○	06. Followed Too Closely	○	○	15. Improper Passing
○	○	07. Parked Vehicle	○	○	98. Other/Specify
○	○	08. Backed Unsafely			
○	○	09. Left Turn Across Path	○	○	99. Unknown

City of Winnipeg Accident Coding System

CODE TIME INTERVAL

01—MIDNIGHT-12:59 A.M.
02—1.A.M. - 1:59 A.M.
03—2.A.M. - 2:59 A.M.
04—3.A.M. - 3:59 A.M.
05—4.A.M. - 4:59 A.M.
06—5 A.M. - 5:59 A.M.
07—6.A.M. - 6:59 A.M.
08—7.A.M. - 7:59 A.M.
09—8.A.M. - 8:59 A.M.
10—9.A.M. - 9:59 A.M.
11—10A.M. - 10:59 A.M.
12—11A.M. - 11:59 A.M.
13—12P.M. - 12:59 P.M.
14—1 P.M. - 1:59 P.M.
15—2 P.M. - 2:59 P.M.
16—3 P.M. - 3.59 P.M
17—4 P.M. - 4:59 P.M.
18—5 P.M. - 5:59 P.M.
19—6 P.M. - 6:59 P.M.
20—7 P.M. - 7:59 P.M.
21—8 P.M. - 8:59 P.M.
22—9 P.M. - 9:59 P.M.
23—10 P.M. - 10:59 P.M.
24—11 P.M. - 11:59 P.M.

CODE PEDESTRIAN SEX

X—NOT APPLICABLE
M—MALE
F—FEMALE
A—NOT STATED

CODE PEDESTRIAN MOVEMENT

00—NOT APPLICABLE
50—IN NORTH CROSSWALK
51—IN SOUTH CROSSWALK
52—IN EAST CROSSWALK
53—IN WEST CROSSWALK
54—WITHIN INTERSECTIO(OUTSIDE X-WALK)
55 OFF ROADWAY OR SIDWALK,APPROACH OR BLVD
56—ON RIGHT SIDE AGAINST TRAFFIC
57—ON LEFT SIDE AGAINST TRAFFIC
58—ON RIGHT SIDE WITH TRAFFIC
59—ON LEFT SIDE WITH TRAFFIC
60—EXITING FROM VEHICLE ON TRAFFIC SIDE
61—PLAYING ON THE STREET
62—FROM BEHIND OR BETWEEN PARKED CARS
63—LYING ON THE ROADWAY
64—ACCROSS ROADWAY OTHER THAN AT INTERSECTION
65—HITCH HIKING
26 OTHER
27 NOT STATED
66 PUSH OR WORKING ON VEHICLE
67 WORKING ON VEHICLE (IE UTILITY)

PEDESTRIAN VIOLATIONS

00 ..... NOT APPLICABLE
01 ..... FOLLOWING TOO CLOSELY
02 ..... CARELESS DRIVING
03 .... EXCEEDING MAX SPEED LIMIT
04 ..... TRAFFIC SIGNAL RED
05 ..... TRAFFIC SIGNAL AMBER
06 ..... FAILURE TO COMPLY WITH
.... PEDESTRIAN CONTROL SIGNAL
07 ..... RIGHT TURN ON RED
08 ..... FAILURE TO STOP FOR STOP SIG
09 ..... FAILURE TO YIELD @ YIELD
10 ..... PROCEEDING BEFORE SAFE TO
11 ..... FAILURE TO STOP @ R.R.SIGNAL
12 ..... FAILURE TO COMPLY WITH TURNCONTROL SIGNALS
13 ..... FAILURE TO COMPLY WITH LANE DESIGNATION SIGNS
14 ..... UNSAFE LANE CHANGE
15 ..... TURNING FROM IMPROPER LANE
16 ..... TURNING BEFORE SAFE TO DO SO
17 ..... CROSSING DIRECTIONAL
...... DIVIDING LINE
18 ..... PROCEEDING IN WRONG
...... DIRECTION
19 ..... FAILURE TO ANTICIPATE
...... HAZARDOUS CONDITIONS
20 ..... ILLEGELLY STOPPED OR
...... PARKED
21 ..... ILLEGAL PROCEDURE @ PED
..... CORRIDOR
22 ..... ILLEGAL PROCEDURE @ X-WALK
23 ..... FAILURE TO COMPLY WITH
.... PEDESTRAIN CONTROL SIGNS
24 ..... PEDESTRIAN RUNNING
25 ..... OTHER
26 ..... NOT STATED

CODE FIXED OBJECTS

00 ..... NOT APPLICABLE
01 ..... UTILITY POLE
02 ..... TREE
03 ..... GUARD RAIL
04 ..... CURB
05 ..... BUILDING
06 ..... BARRICADE
07 ..... DITCH OR EMBANKMENT
08 ..... FENCE
09 ..... OTHER
10 ..... NOT STATED
11 ..... RAILROAD SIGNAL
12 ..... SIGNAL POLE
13 ..... CORRIDOR POLE
14 ..... INERTIAL BARRIER/BRIDGE
15 ..... TRAFFIC SIGN POST
16 ..... RETAINING WALL OR
.... ABUTEMENT
17 ..... FIRE HYDRANT

CODE VEHICLE TYPE

00 ..... NOT APPLICABLE
01 ..... PASSENGER CAR
02 ..... PEDESTRIAN
03 ..... TRUCK
04 ..... BUS
05 ..... MOTORCYCLE
06 ..... BICYCLE
07 ..... EMERGENCY VEHICLE
08 ..... SNOWMOBILE
09 ..... TRAIN
10 ..... FUNERAL PROCESSION
11 ..... ANIMAL
12 ..... OTHER-
13 ..... NOT STATED
14 ..... SEMI-TRAILERS

CODE DIRECTION

X...... NOT APPLICABLE
N...... NORTH
S...... SOUTH
E...... EAST
W ..... WEST

CODE CONTROL DEVICES

00 ..... NOT APPLICABLE
01 ..... TRAFFIC CONTROL SIGNALS
02 ..... PEDESTRIAN CORRIDOR
03 ..... PEDESTRIAN CROSSWALK
04 ..... STOP SIGN-(2-WAY)
05 ..... STOP SIGN (3,4,OR 5WAY)
06 ..... YIELD SIGN
07 ..... UNCONTROLLED
08 ..... UNMARKED LEGAL CROSSWALK
09 ..... RAILROAD GATES (NOT USED)
10 ..... RAILROAD FLASHING LIGHTS
11 ..... LANE DESIGNATION SIGN
12 ..... POLICE OFFICER
13 ..... FLAGMAN
14 ..... OTHER
15. .... NOT STATED
16 ..... FLASHING SCHOOL SIGNALS
17 ..... FLASHING RED STOP SIGNALS

CODE WEATHER

01 ..... CLEAR
02 ..... CLOUDY
03 ..... RAIN
04 ..... SNOW(BLOWING OR FALLING)
05 ..... FREEZING RAIN
06 ..... HAIL
07 ..... FOG
08 ..... EXHAUST FUMES
09 ..... DUST
10 ..... SMOKE
11 ..... OTHER
12 ..... NOT STATED

CODE LIGHT

01 ..... DAYLIGHT
02 ..... DAWN
03 ..... DUSK
04 ..... SUN GLARE
05 ..... DARK (STREET LIGHTS)
06 ..... DARK (NO STREET LIGHTS)
07 ..... OTHER
08 ..... NOT STATED

CODE SURFACE CONDITION

01 ..... DRY
02 ..... WET
03 ..... SLIPPERY
04 ..... SNOWY
05 ..... ICY
06 ..... OTHER

CODE VEHICLE MOVEMENT

00 ..... NOT APPLICABLE

ACCIDENT CODES

01 ..... STRAIGHT THRU
02 ..... LEFT TURN
03 ..... RIGHT TURN
04 ..... U TURN
05 ..... BACKING UP
06 ..... STOPPED
07 ..... PARKED
08 ..... LANE CHANGE TO THE LEFT
09 ..... LANE CHANGE TO THE RIGHT
10 ..... WEAVING
11 ..... ILLEGALLY PARKED
12 ..... INTO ALLEY RIGHT TURN
13 ..... INTO ALLEY LEFT TURN
14 ..... OUT OF ALLEY RIGHT TURN
15 ..... OUT OF ALLEY LEFT TURN
16 ..... INTO DRIVEWAY RIGHT TURN
17 .... INTO DRIVEWAY LEFT TURN
18 ..... OUT OF DRIVEWAY RIGHT TURN
19 ..... OUT OF DRIVEWAY LEFT TURN
20 ..... ENTERING PARKING POSITION FORWARD
21 ..... ENTERING PARKING POSITION REVERSE
22 ..... LEAVING PARKING POSITION FORWARD
23 ..... LEAVING PARKING POSITION REVERSE
24 ..... WRONG DIRECTION
25 ..... VEHICLE MOVED BY OTHER SOURCE OF POWER (TOWED OR PUSHED)
26 ..... OTHER
27 ..... NOT STATED
28 ..... RIGHT TURN ON RED
29 ..... OUT OF ALLEY STRAIGHT THRU
30 ..... INTO ALLEY STRAIGHT THRU
31 ..... OUT OF DRIVEWAY STRAIGHT THRU
32 ..... INTO DRIVEWAY STRAIGHT THRU
33 ..... STALLED VEHICLE

CODE	COLLISION TYPE
01	REAR END
02	RIGHT ANGLE
03	TURNING LEFT WITH STRAIGHT
04	PEDESTRIAN
05	HEAD ON
06	SIDESWIPE
07	FIXED OBJECT
08	OVERTURN
09	LEFT ROADWAY
10	NON-COLLISION

CODE	INJURY
0	NO INJURY
1	INJURY
2	HOSPITALIZED
3	FATAL(DRIVER OR PASSENGER)
4	PEDESTRIAN INJURY
5	PEDESTRAIN FATAL
6	OTHER
7	NOT STATED
8	PEDESTRIAN HOSPITALIZED

CODE	SPECIAL
0	NOT APPLICABLE
1	ROADWAY WORK
2	VISIBILITY OBSCURRED BY HIGH SNOWBANKS

CODE	PARKING
00	NOT APPLICABLE
01	DIRECTLY INVOLVED
02	INDIRECTLY INVOLVED

CODE	MAJOR/MINOR
M	REGIONAL STREET
N	NON-REGIONAL STREET

CODE	INDIRECT CAUSES
00	NOT APPLICABLE
01	PERSON ON STREET (OTHER THAN AT CORRIDOR)
02	STALLED VEHICLE
03	PED CORRIDOR IN USE
04	1 OR 2 LANES STOPPED (RIGHT ANGED COLLISION)
05	HIT & RUN / STOLEN VEHICLE
06	CONFUSING LANE DESIGNATION
07	OUT OF TOWN DRIVER
08	INATTENTION

09 ..... CHECKED TO LEFT & THOUGHT VEHICLE AHEAD HAD PULLED OUT
10 ..... MISTAKING ONE -WAY FOR TWO-WAY
11 ..... COLOR OF PED'S CLOTHING
12 ..... TURNING FROM IMPROPER LANE
13 ..... FIXED OBJECT 2ND CAUSE
14 ..... MULTIPLE VEHICLE ACCIDENT
15 ..... EMERGENCY VEHICLE INDIRECTLY INVOLVED
16 ..... DRIVER BEHAVIOR-ALCOHOL,HEART
17 ..... DROPPED OBJECTS OR MANHOLE COVER
18 ..... BUS FLASHERS OR BUS STOP SIGN
19 ..... RIGHT LANE MUST TURN
20 ..... WOODEN POLES
21 ..... ROAD ENDS
22 ..... SCHOOL BUS ACCIDENT

CODE	PEDESTRIAN AGE
00	NOT APPLICABLE
01	0 -4
02	5 -9
03	10 - 14
04	15 - 19
05	20 -24
06	25 -34
07	35 -44
08	45 -54
09	55 -64
10	65 -74
11	75 AND OVER
12	NOT STATED

CODE	PROPERTY DAMAGE
01	UNDER $200
02	$300.00 TO $400.00
03	$400.00 TO $600.00
04	$600.00 TO $1,000.00
05	$1,000.00 TO $2,000.00
06	$2,000.00 TO $3,000.00
07	$3,000.00 TO $5,000.00
08	$5,000.00 TO $7,500.00
09	OVER $7,500.00
10	NOT STATED

APPENDIX B

Heavy Truck Accidents on Provincial Highways

Table B-1a: Single-vehicle Heavy Truck Accidents by Severity

YEAR	MANITOBA				SASKATCHEWAN				ALBERTA			
	Fatal	**Injury**	**Property Damage**	**MB Total**	**Fatal**	**Injury**	**Property Damage**	**SK Total**	**Fatal**	**Injury**	**Property Damage**	**AB Total**
1993	0	10	36	**46**	4	34	137	**175**	3	63	172	**238**
1994	0	7	39	**46**	1	36	136	**173**	6	71	265	**342**
1995	0	17	70	**87**	2	39	163	**204**	4	48	238	**290**
1996	1	10	59	**70**	0	43	119	**162**	1	59	223	**283**
1997	0	18	64	**82**	1	43	135	**179**	6	81	231	**318**
1998	0	19	61	**80**	2	21	124	**147**	5	80	244	**329**
Total	1	81	329	**411**	10	216	814	**1040**	25	402	1373	**1800**

Table B-1b: Multiple-vehicle Heavy Truck Accidents by Severity

YEAR	MANITOBA				SASKATCHEWAN				ALBERTA			
	Fatal	**Injury**	**Property Damage**	**MB Total**	**Fatal**	**Injury**	**Property Damage**	**SK Total**	**Fatal**	**Injury**	**Property Damage**	**AB Total**
1993	6	29	56	**91**	10	71	111	**192**	26	81	182	**289**
1994	6	42	53	**101**	14	64	115	**193**	20	132	290	**442**
1995	9	52	88	**149**	10	93	122	**225**	20	90	204	**314**
1996	3	38	97	**138**	20	90	153	**263**	20	137	271	**428**
1997	7	48	81	**136**	15	87	140	**242**	40	140	251	**431**
1998	5	50	78	**133**	13	78	131	**222**	23	134	240	**397**
Total	36	259	453	**748**	82	483	772	**1337**	149	714	1438	**2301**

B.1 Specific Definition of a Heavy Truck

Based on the accident report forms used in each of the three provinces (provincial highways and urban areas), a *heavy truck* is defined as follows (Appendix A shows copies of the accident report forms and coding systems of each jurisdiction):

- For accidents on Manitoba's provincial highways, a *heavy truck* is a vehicle type 14 (power unit for semitrailer) towing either a vehicle type 08 (low/high boy), 09 (single trailer-semi), 10 (double trailer-semi), 11 (triple trailer-semi), 12 (petroleum or other tanker), 13 (over dimensioned pilot vehicle), 14 (over dimensioned non-pilot vehicle), or towing no trailer.

- For accidents on Saskatchewan's provincial highways, a *heavy truck* is a vehicle type 05 (power units for semi-trailers) with a trailer type 07 (single trailer/tanker), 08 (A-train), 09 (C-train), 10 (B-train), 11 (overdimensional vehicle), or 12 (other types of trailers including triples).

- For accidents on Alberta's provincial highways, a *heavy truck* is a vehicle type 05 (truck tractor) with attachment type 01 (large single trailer), 02 (large double trailer), 03 (large triple trailer), 06 (farm equipment), 08 (oversize with pilot), or 09 (oversize without pilot).

- For accidents on Winnipeg streets, a *heavy truck* is a code 14 vehicle (semitrailer) as classified by the City of Winnipeg Public Works Department in the accident database. This database is created based on City of Winnipeg police accident reports. As of 1999, the City started using the same coding system as the Province.

- For accidents on Regina and Saskatoon streets, a *heavy truck* is a vehicle type 05 (power units for semi-trailers) with a trailer type 07 (single trailer/tanker), 08 (A-train), 09 (C-train), 10 (B-train), 11 (overdimensional vehicle), or 12 (other types of trailers including triples).

- For accidents on Edmonton and Calgary streets, a *heavy truck* is a vehicle type 05 (truck tractor) with attachment type 01 (large single trailer), 02 (large double trailer), 03 (large triple trailer), 06 (farm equipment), 08 (oversize with pilot), or 09 (oversize without pilot).

B.2 Details About Databases and Data Sources

The Manitoba provincial highway accident database used in this research was obtained from the Traffic Operations Division of the Manitoba Department of Highways and Government Services.

The accident data analyzed in this research concerning Winnipeg streets was obtained from The City of Winnipeg Public Works Department. Some of the data was received in ASCII format and then transferred into Paradox, and some was received already in Paradox. For accidents occurring prior to 1999, the City used the coding system that was in place since the 1970s for accident data storage. With this system, the accident information stored by the City uses different codes than those in the police report form. The Province, however, uses the same codes as those in the police accident report form. Appendix A shows the report form and the coding system used by the City. As of 1999, a new database system–and coding system–was implemented by the City. The new system, called "OnTrac", makes use of the same codes as the Province, which are the same codes used in the police accident report form.

The Saskatchewan databases for accidents on provincial highways and in urban areas were obtained from Saskatchewan Government Insurance (SGI). These databases are based on information from the Highway Traffic Board's Motor Vehicle Accident Report Form that is filled out by the police after an accident occurs.

The Alberta databases for accidents on provincial highways and in urban areas were obtained from Alberta

Infrastructure Driver Safety and Research Branch. These databases are based on information from the Alberta collision report form that is filled out by the police after an accident occurs.

In addition to the four accident databases used in this report for analysis of heavy truck accidents, a series of geographic files were used to create a Geographic Information System (GIS) network for the three provinces. Some of the geographic files were developed as the research progressed, and some had already been integrated into the GIS network. The sources of the geographic files are: (1) UMTIG; (2) City of Regina; (3) City of Saskatoon; (4) City of Winnipeg; (5) Manitoba Highways and Transportation; (6) Saskatchewan Highways and Transportation; and (7) Alberta Infrastructure.

Truck exposure was obtained using truck traffic data. The truck traffic for Saskatchewan and Alberta was obtained from each jurisdiction's Highways Department in the form of percent trucks. Annual average daily traffic (AADT) and the percent trucks were available for each highway section in each jurisdiction. In the case of Saskatchewan, AADTT was obtained by multiplying AADT by percent trucks for each link of highway. In the case of Alberta, AADTT was obtained by multiplying AADT by the sum of percent single unit trucks and percent truck tractors (this was done to be consistent with Manitoba and Saskatchewan estimates). Manitoba's truck volumes were obtained from UMTIG.

TKT values were estimated for the three provinces by multiplying estimates of AADTT by the length of each highway link by 365 days.

B.3 Heavy Truck Accidents by Number of Trailers

Tables 2-5, 2-6 and 2-7 in Section 4.3.4 show the number of Hts in accidents by number of trailers. Although the tables show the number of "unknown" and "other" trailers, the figures presented in this section are based on the total number of single, double and triple trailers only.

In Manitoba, information about the trailer configuration (single, double or triple) was available for 1,035 of 1,213 heavy trucks involved in HTAs. Of the 1,035 heavy trucks for which the trailer configuration was available, 80 percent were single trailer combinations, 19 percent were double trailer combinations, and one percent were triple trailer combinations. Three percent of single trailer combinations, and 5 percent of doubles were involved in fatal accidents. For the same time period, 30 percent of singles, 27 percent of doubles, and 21 percent of triples were involved in injury-producing accidents. Two-thirds of singles, 68 percent of doubles, and nearly all triples were involved in property damage accidents.

In Saskatchewan, information about the trailer configuration (single or double–there is not information for triple trailers) was available for 2,028 of 2,509 heavy trucks involved in HTAs. Of the 2,028 heavy trucks for which the trailer configuration was known to be either a single or a double, single trailer combinations accounted for two-thirds of all heavy trucks involved in HTAs, and double trailers accounted for the remaining one-third. Of the double trailer combinations in Saskatchewan, 43 percent (298/701) were A or C-trains and 57 percent (403/701) were B-trains. It is not possible to determine from the Saskatchewan database the number of triple trailer combinations involved in accidents. Four percent of single trailer combinations, and 4 percent of double trailer combinations were involved in fatal accidents. For the same time period, one-third of singles and 28 percent of doubles were involved in injury-producing accidents. Nearly two-thirds of singles and two-thirds of double trailer combinations were involved in property damage accidents.

In Alberta, information about trailer configuration (single, double or triple) was available for 3,549 of 4,313 heavy trucks involved in HTAs. Of the 3,549, 64 percent were single trailers, 35 percent were double trailers, and one percent were triple trailers. The Alberta database also allows for the analysis of trailer body types. Table B-2 illustrates the distribution of heavy trucks involved in HTAs by trailer body type for the period between 1993 and 1998. As indicated in the table, of all the trucks for which the trailer configuration was known (single, double and triple), van body types were the most common involved in HTAs. They accounted for one-quarter of all HTs involved in HTAs. These were followed by platforms, which accounted for 22 percent; and tankers, which accounted for 18 percent. Of all HTAs involving trucks with single trailers, vans were the most common body type, accounting for 29 percent, followed by platforms, which accounted for 22 percent of all single trailers involved in HTAs. In the case of HTAs involving double trailer combinations, tankers accounted for one-third, followed by platforms, which accounted for 22 percent.

In Alberta, for the period between 1993 and 1998, 5 percent of each single trailer combinations, double trailer combinations, and triple trailer combinations were involved in fatal accidents. For the same time period, 30 percent of each singles and doubles were involved in injury-producing accidents. Triple trailer combinations were involved in 20 percent of injury HTAs. Two-thirds of singles, two-thirds of double trailer combinations, and three-quarters of triples were involved in property damage accidents.

Table B-2: Heavy Trucks involved in HTAs by Trailer Body Type in Alberta

	Single	Double	Triple	Total
Van/box body	653	250	9	912
Lowboy	308	81	9	398
Highboy	512	269	9	790
Tanker	246	402	8	656
Dump	97	52	1	150
Auto carrier	26	3	0	29
Livestock	134	3	1	138
Log carrier	165	54	0	219
Unknown	51	20	1	72
Other ^^	89	95	1	185
Total	2281	1229	39	3549

^^ "other" refers to code 98 ("other") in the police accident report form

B.4 Major Factors Contributing to Heavy Truck Accidents in Manitoba

In Manitoba, of the 54 reported HTAs where human condition was a major contributing factor, *distraction/inattention* was identified in 46 percent of the accidents, *extreme fatigue/fell asleep* was identified in 30 percent of the accidents, and other factors were identified in 23 percent of the accidents. Of the 267 reported HTAs where human action was identified as a major contributing factor, *driving too fast for conditions* was identified in 16 percent of the cases, *taking avoiding action* was identified in 14 percent of the cases, *lost control* was identified in 14 percent of the cases, and *turning improperly* was identified in 12 percent of the cases. Of the 94 reported HTAs where vehicle condition was a major contributing factor, *load shifted* was identified in one-quarter of the cases, *jack-knife/trailer swing* was identified in 23 percent of the cases, and *fire* was identified in 14 percent of the cases. Of the 347 reported HTAs where environmental condition was a major contributing factor, *slippery road surface* was identified in 39 percent of the accidents, *animal action* was identified in one-third of the accidents, *weather* was identified in 22 percent of the accidents, *view obstructed* was identified in 11 percent of the accidents, *snow drift* was identified in 7 percent of the accidents, and other factors were identified in 10 percent of the accidents.

B.4.1 Human Condition

Over the six-year period, human condition was reported as a major contributing factor in 54 of the total 1,159 HTAs. See Table B-3.

Table B-3

Contributing Factor (code)	1993	1994	1995	1996	1997	1998	Total	Percentage (of 54)
Loss of Consciousness	0	0	0	0	0	1	1	2
Extreme fatigue/fell asleep (202)	2	5	2	2	5	0	16	30
Defective eyesight (203)	1	0	0	0	0	0	1	2
Medical disability (205)	0	0	0	0	1	0	1	2
Sudden illness (209)	0	0	1	1	0	0	2	4
Ability impaired by alcohol (210)	0	0	2	0	0	1	3	6
Had been drinking (212)	0	1	1	0	0	1	3	6
Distraction/inattention (213)	3	5	7	8	0	2	25	46
Exceeded hours of service (214)	0	0	0	0	0	1	1	2

B.4.2 Driver Action

Over the six-year period, driver action was reported as a major contributing factor in 267 of the total 1,159 HTAs. See Table B-4.

B.4.3 Vehicle Condition

Over the six-year period, vehicle condition was reported as a major contributing factor in 94 of the total 1,159 HTAs. See Table B-5.

B.4.4 Environmental Condition

Over the six-year period, environmental condition was reported as a major contributing factor in 347 of the total 1,159 HTAs. See Table B-6.

Table B-4

Contributing Factor (code)	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**Total**	**Percentage (of 267)**
Following too closely (101)	0	2	3	3	3	11	22	8
Turning improperly (102)	2	5	7	3	4	9	30	11
Exceeding speed limit (103)	0	0	0	0	1	1	2	1
Driving too fast for conditions (104)	3	6	10	8	7	8	42	16
Unsafe operating speed (105)	4	1	1	3	2	4	15	6
Passing improperly (106)	2	4	3	3	3	1	16	6
Changing lanes improperly (107)	0	0	3	4	5	6	18	7
Failed to yield right of way (108)	1	3	5	3	4	6	22	8
Disobeyed traffic control device (109)	1	3	2	5	1	4	16	6
Driving wrong way on roadway (110)	0	0	1	1	1	0	3	1
Backing unsafely (112)	1	1	2	1	0	2	7	3
Parking improperly (113)	0	1	2	0	0	0	3	1
Careless driving (114)	2	4	2	1	5	1	15	6
Lost control/drive off road (115)	4	4	8	3	10	8	37	14
Leave stop sign before safe (117)	4	1	0	2	1	4	12	4
Failed to signal (118)	0	0	0	1	2	0	3	1
Taking avoiding action (119)	2	6	8	9	8	5	38	14
Driver inexperience (120)	2	2	0	0	2	0	6	2
Pedestrian error/confusion (121)	0	1	0	0	0	0	1	<1

Table B-5

Contributing Factor (code)	1993	1994	1995	1996	1997	1998	Total	Percentage (of 94)
Defective brakes (301)	2	0	3	0	2	1	8	9
Defective headlights (303)	0	0	0	0	0	1	1	1
Defective lighting (305)	0	0	1	0	1	0	2	2
Defective engine controls (306)	0	0	0	0	0	1	1	1
Defective suspension/wheels (307)	2	2	1	1	1	0	7	7
Defective tires (308)	0	2	2	2	2	2	10	11
Tow hitch/yoke defective (309)	0	0	0	2	1	1	4	4
Hood/tailgate/door opened (311)	0	0	1	0	1	2	4	4
Vehicle modifications (313)	0	1	0	1	0	0	2	2
Fire (314)	2	1	2	3	2	3	13	14
Overloaded/oversized (315)	0	1	1	0	1	0	3	3
Load shifted/spilled (316)	5	1	4	4	3	7	24	26
Jack-knife/trailer swing (317)	5	2	4	3	1	6	21	22

Table B-6

Contributing Factor (code)	1993	1994	1995	1996	1997	1998	Total	Percentage (of 347)
Animal action-wild (401)	11	11	22	16	20	19	99	29
Animal action-domestic (402)	1	3	2	2	8	2	18	5
Slippery road surface (403)	16	12	27	30	21	28	134	39
Snow drift (404)	5	0	8	6	4	2	25	7
Obstruction/debris on roadway (405)	0	0	0	0	3	0	3	1
View obstructed/limited (406)	1	4	9	10	8	6	38	11
Glare/reflection (407)	0	2	0	1	0	0	3	1
Construction zone (408)	2	2	0	0	0	2	6	2
Defective driving surface (409)	0	5	3	0	0	1	9	3
Shoulders defective (410)	0	1	0	1	2	0	4	1
Lane markings inadequate (411)	0	0	1	0	0	0	1	<1
Defective traffic control device (412)	0	0	1	0	0	0	1	<1
Weather (413)	5	11	22	12	15	11	76	22
Uninvolved vehicle (415)	1	0	1	0	0	1	3	1
Presence of prior accident (417)	0	0	1	2	0	0	3	1

B.5 Major Factors Contributing to Heavy Truck Accidents in Saskatchewan

In Saskatchewan, of the 446 reported HTAs where human condition was a major contributing factor, *inattention* was identified in 68 percent of the accidents, *fell asleep* was identified in 14 percent of the cases, *driver inexperience/confusion* was reported in 13 percent of the cases, *distraction* was identified in 11 percent of the accidents, and other factors were reported in 10 percent of the cases. Of the 500 reported HTAs where human action was a major contributing factor, *taking evasive action* was identified in 30 percent of the cases, *passing or improper lane usage* was identified in 19 percent of the accidents, *driving too fast for road conditions* was identified in 14 percent of the cases, and other factors, including *fail to yield to the right of way*, *following too closely*, *turning improper*, and *careless driving*, accounted for between 7 and 8 percent of the accidents. Of the 264 reported HTAs where vehicle condition was a major contributing factor, *jack-knife/trailer swing* was reported in one-third of the accidents, *load shifted* was reported in one-quarter of the accidents, *defective tires* was identified in 9 percent of the accidents, and other factors accounted for 45 percent of the reported accidents. Of the 1,003 reported HTAs where environmental condition was identified as a major contributing factor, *animal action* was identified in 38 percent of the accidents, *weather conditions* was identified in 27 percent of the cases, and *road condition* was reported in 27 percent of the cases.

B.5.1 Human Condition

Over the six-year period, human condition was reported as a major contributing factor in 446 of the total 2,378 HTAs. See Table B-7.

Table B-7

Contributing Factor (code)	1993	1994	1995	1996	1997	1998	Total	Percentage (of 446)
Inattentive (01)	50	38	45	49	63	59	304	68
Distracted (02)	4	4	11	9	11	11	50	11
Had been drinking (03)	0	0	0	1	0	1	2	<1
Impaired (04)	1	1	3	1	0	0	6	1
Extreme fatigue (05)	2	4	4	2	3	2	17	4
Fell Asleep (06)	6	9	15	15	7	11	63	14
Driver inexperience (07)	15	6	5	9	9	14	58	13
Lost consciousness (08)	1	0	0	0	0	1	2	<1
Physical/medical disability (09)	0	0	0	1	0	0	1	<1
Drugs (10)	0	0	1	0	0	0	1	<1
Other human conditions (12)	1	0	2	5	7	2	17	4

B.5.2 Human Action

Over the six-year period, human action was reported as a major contributing factor in 500 of the total 2,378. See Table B-8.

B.5.3 Vehicle Condition

Over the six-year period, vehicle condition was reported as a major contributing factor in 264 of the total 2,378 HTAs. See Table B-9.

B.5.4 Environmental Condition

Over the six-year period, environmental condition was reported as a major contributing factor in 1,003 of the total 2,378 HTAs. See Table B-10.

Table B-8

Contributing Factor (code)	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**Total**	**Percentage (of 500)**
Failed to yield right of way (21)	4	9	5	7	8	9	42	8
Traffic control device disregarded (22)	2	3	6	5	7	7	30	6
Following too closely (23)	7	6	7	8	8	4	40	8
Driving too fast for conditions (24)	7	7	13	19	16	10	72	14
Exceeding speed limit (25)	1	4	1	1	0	1	8	2
Turning improperly (26)	4	3	11	3	10	3	34	7
Passing improperly (27)	23	17	7	14	14	19	94	19
Backing unsafely (28)	0	2	1	1	2	1	7	1
Fail to signal (29)	1	0	1	1	0	1	4	1
Driving wrong way on roadway (30)	0	0	1	0	0	0	1	<1
Taking evasive action (31)	10	24	27	22	32	33	148	30
Careless driving (32)	8	5	9	4	8	5	39	8
Pedestrian action contributed (33)	1	0	0	0	0	0	1	<1
Other human action (34)	7	10	8	11	8	8	52	10

Table B-9

Contributing Factor (code)	1993	1994	1995	1996	1997	1998	Total	Percentage (of 264)
Defective brakes (40)	3	3	4	1	6	1	18	7
Defective lights (41)	1	2	3	2	1	0	9	3
Load shifted/spilled (43)	12	10	9	17	8	8	64	24
Vehicle overloaded (44)	1	4	2	4	3	5	19	7
Defective steering (45)	0	1	0	3	2	1	7	3
Defective suspension/wheels (46)	1	3	1	1	2	1	9	4
Defective tires (47)	1	2	11	3	2	5	24	9
Defective engine/power train (48)	0	1	1	1	0	0	3	1
Jack-knife/trailer swing (49)	7	11	21	20	14	13	86	33
View from vehicle obstructed (50)	1	1	2	1	1	3	9	3
Other vehicle condition/defect (51)	5	8	7	10	3	9	42	16
Lights not on (52)	0	0	2	0	0	0	2	1

Table B-10

Contributing Factor (code)	1993	1994	1995	1996	1997	1998	Total	Percentage (of 1003)
Animal action-wild (60)	83	68	56	44	47	31	329	33
Animal action-domestic (61)	7	6	10	7	12	8	50	5
Road condition (62)	32	32	58	58	60	29	269	27
Excessive loose gravel (63)	0	0	1	1	3	1	6	1
Snow drift (64)	4	7	7	10	11	7	46	5
Obstruction/debris on roadway (66)	1	5	4	3	7	3	23	2
View obstructed/limited (67)	11	17	27	23	19	11	108	11
Sun glare (68)	3	1	2	0	4	3	13	1
Construction zone (69)	2	0	2	4	4	5	17	2
Soft or defective shoulders (71)	5	6	8	5	8	8	40	4
Lane markings inadequate (72)	1	0	1	1	0	0	3	<1
Traffic control device not working (73)	0	0	1	0	1	0	2	<1
Weather conditions (74)	30	26	78	58	52	29	273	27
Uninvolved vehicle (75)	11	19	24	12	17	16	99	10
Uninvolved pedestrian (76)	0	2	0	0	0	0	2	<1
Other environmental condition (77)	4	3	3	11	8	4	33	3

B.6 Major Factors Contributing to Heavy Truck Accidents in Alberta

In Alberta, of the 163 reported HTAs where human condition was a major contributing factor, *fatigue/asleep* was identified in 67 percent of the accidents, *alcohol* was identified in 27 percent of the cases, and other factors were reported in 6 percent of the cases. Of the 1,234 reported HTAs where driver action was a major contributing factor, *ran off road* was identified in 45 percent of the cases, and other factors were identified in 57 percent of the cases. Of the 178 reported HTAs where vehicle condition was a major contributing factor, *improper load/shift* was reported in one-quarter of the accidents, *tires failed* was reported in 22 percent of the accidents, *defective brakes* was identified in 14 percent of the accidents, and other factors accounted for 40 percent of the reported accidents. Of the 1,892 reported HTAs where environmental condition was identified as a major contributing factor, *snow* was identified in 39 percent of the accidents, *animal action* was identified in one-third of the accidents. Other conditions were reported in 28 percent of the cases.

B.6.1 Human ("Driver/Pedestrian") Condition

Over the six-year period, human condition was reported as a contributing factor in 163 of the total 4,101 HTAs. See Table B-11.

Table B-11

Contributing Factor (code)	1993	1994	1995	1996	1997	1998	Total	Percentage (of 163)
Had been drinking (02)	5	1	4	3	1	3	17	10
Impaired by alcohol (03)	4	8	1	3	6	5	27	17
Impaired by drugs (04)	1	0	1	0	0	0	2	1
Fatigues/asleep (05)	19	20	19	11	18	22	109	67
Medical defect (06)	1	1	2	0	1	0	5	3
Other (98)	2	1	0	0	0	0	3	2

B.6.2 Driver Action

Over the six-year period, driver action was reported as a contributing factor in 1,234 of the total 4,101 HTAs. See Table B-12.

B.6.3 Vehicle Condition

Over the six-year period, vehicle condition was reported as a contributing factor in 178 of the total 4,101 HTAs. See Table B-13.

B.6.4 Environmental Condition

Over the six-year period, environmental condition was reported as a contributing factor in 1,892 of the total 4,101 HTAs. See Table B-14.

Table B-12

Contributing Factor (code)	1993	1994	1995	1996	1997	1998	Total	Percentage (of 1234)
Stop sign violation (02)	4	5	9	5	8	14	45	4
Yield sign violation (03)	0	0	0	2	2	2	6	1
Failed to yield right of way (04)	1	0	0	1	1	1	4	<1
Followed too closely (06)	21	15	20	13	18	20	107	9
Parked vehicle (07)	17	19	12	12	15	20	95	8
Backed unsafely (08)	6	3	7	3	2	1	22	2
Left turn across path (09)	2	7	3	7	6	8	33	3
Improper lane change (10)	3	14	6	21	11	14	69	6
Disobeyed traffic signal (11)	1	2	1	1	6	2	13	1
Ran off road (12)	93	100	86	86	99	91	555	45
Improper turn (13)	7	5	3	2	5	8	30	2
Left of centre (14)	7	7	7	5	15	7	48	4
Improper passing (15)	12	11	11	13	13	13	73	6
Other (98)	21	35	29	24	23	20	152	12

Table B-13

Contributing Factor (code)	1993	1994	1995	1996	1997	1998	Total	Percentage (of 178)
Defective brakes (02)	5	6	5	2	5	2	25	14
Tires failed (03)	5	3	6	12	7	6	39	22
Improper load/shift (04)	4	6	8	7	7	11	43	24
Lighting defect (05)	1	3	1	3	2	5	15	8
Other (98)	3	19	10	4	17	3	56	32

Table B-14

Contributing Factor (code)	1993	1994	1995	1996	1997	1998	Total	Percentage (of 1892)
Raining (02)	31	30	31	28	38	18	176	9
Hail/sleet (03)	8	0	7	4	8	6	33	2
Snow (04)	70	172	88	191	110	97	728	39
Fog/smog/smoke/dust (05)	23	35	28	22	21	48	177	9
High wind (06)	9	17	5	14	19	10	74	4
Animal involvement (object type 7) *	79	119	103	113	87	126	627	33
Other (98)	9	16	9	16	14	13	77	4

* for consistency purposes with MB and SK, "animal involvement" was included under this category, even though it is not part of the environmental condition category in the police report form. This animal involvement was obtained from analyzing the "object type" field, for which "animal" was object type 7. There were 619 accidents in which a heavy truck hit an animal or was involved in a single vehicle accident because of an animal and there were 8 accidents in which a truck was involved in a multiple-vehicle accident which involved an animal and another vehicle.

B.7 Heavy Truck Accidents by Roadway Category

Table B-15 illustrates the number of heavy truck accidents for the three provinces by road category (divided versus undivided) as reported by the police. The table shows that divided highways account for one-third of all HTAs on provincial highways in the Prairie region, and only 6 percent of all highway mileage in the region. Similarly, undivided highways account for two-thirds of HTAs on provincial highways in the Prairies, and 94 percent of the regional provincial highway mileage.

Table B-15: Heavy Truck Accidents by Road Category

Road Category	1993	1994	1995	1996	1997	1998	Total
Manitoba							
Undivided one way	8	6	10	6	10	9	49
Undivided two way *	80	89	120	119	115	111	634
Divided ^	44	49	100	77	85	84	439
Unknown	5	3	6	6	8	9	37
Other +	0	0	0	0	0	0	0
Total	137	147	236	208	218	213	1159
Saskatchewan							
Undivided one way	20	14	15	10	17	15	91
Undivided two way *	249	262	290	279	285	237	1602
Divided ^	85	79	107	114	105	99	589
Unknown	11	6	16	21	14	14	82
Other +	2	5	1	1	1	4	14
Total	367	366	429	425	422	369	2378
Alberta							
Undivided one way	10	20	10	14	8	20	82
Undivided two way *	330	511	393	411	446	410	2501
Divided ^	186	251	180	241	240	231	1329
Unknown	0	1	16	45	53	64	179
Other +	1	1	5	0	2	1	10
Total	527	784	604	711	749	726	4101

* Undivided two-way includes: undivided 2-way/2-lane and undivided 2-way multilane in MB (codes 2 and 3); undivided 2-way in SK (code 2); and undivided 2-way in AB (code 02).

^ Divided includes: divided with barrier median and divided with median but no barrier in MB (codes 4 and 5); divided with raised median and divided with depressed or painted median in SK (codes 3 and 4); and divided with barrier and divided with no barrier in AB (codes 03 and 04).

\+ Other does not apply to MB. It includes "other" in SK (code 5); and "other" in AB (code 08).

APPENDIX C

Geographical Location of HTAs on Provincial Highways

C.1 Heavy Truck Accidents not Possible to Geocode

There are cases in which it is not possible to geographically position a particular HTA. There are three main reasons for this: (1) data recording problems–the information recorded in the police report is incomplete for positioning purposes; (2) linear-referencing problems–the linear referencing of the geographic files used is sometimes inaccurate; and (3) database coding problems–control sections or mileposts assigned in the accident database during data entry are sometimes non-existent in the highway system. Tables C-1 and C-2 show the HTAs that were not possible to geographically position in Manitoba and Alberta. Because of the software used to geocode the Saskatchewan HTAs, it is not possible to determine the individual case numbers that were not geocoded.

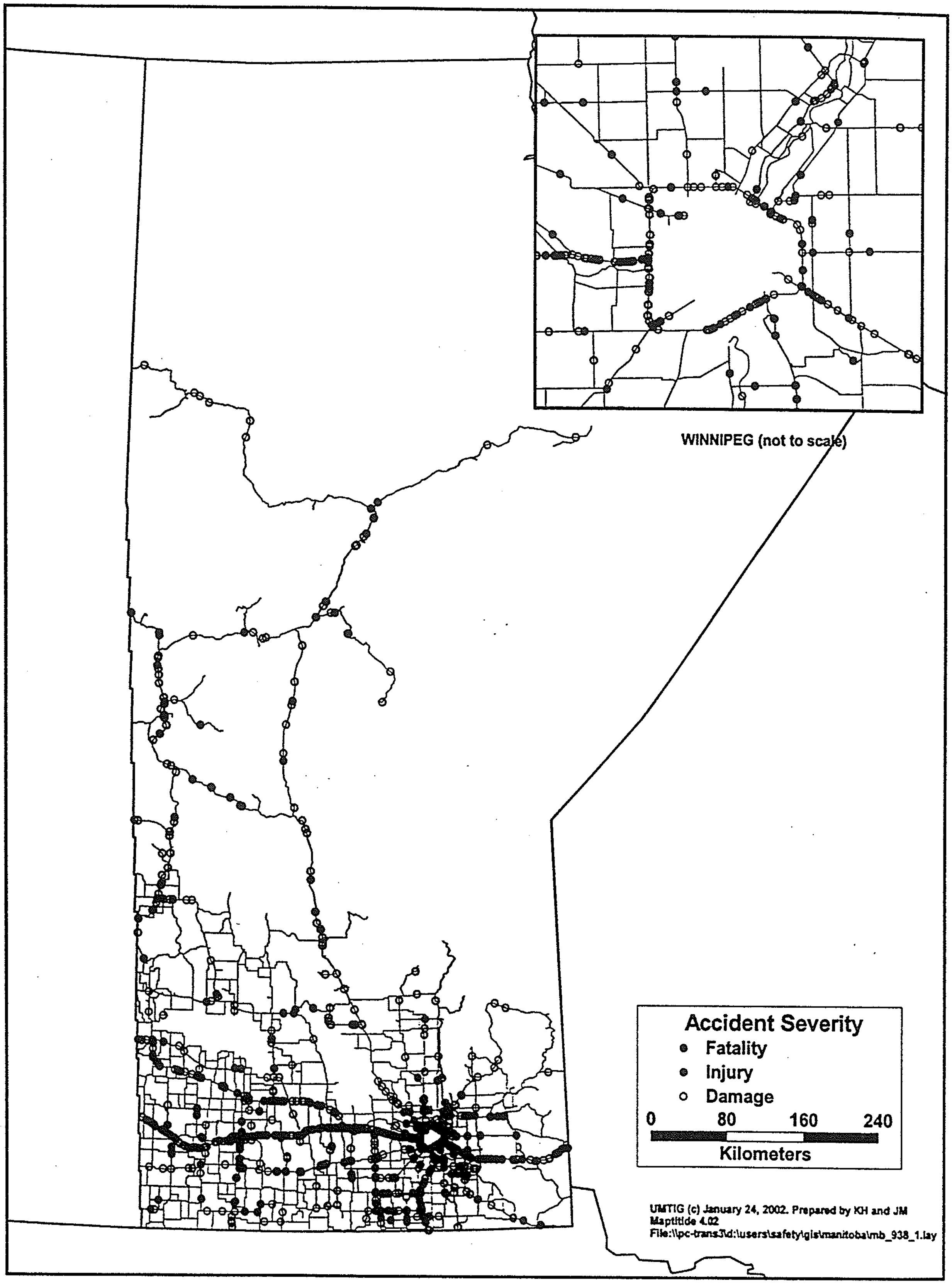
Table C-1: HTAs not Geocoded in Manitoba

CASE NUMBER	DATE	CSECT	ATKM	SEV	CASE NUMBER	DATE	CSECT	ATKM	SEV
6050	1993/02/02	4010270	28.80	D	535471	1996/07/03	5010310	32.80	I
43976	1993/03/15	3001030	6.30	F	536711	1996/02/09	4010240	13.90	D
53525	1993/05/27	2002120	15.60	D	536853	1996/06/04	2651010	0.50	D
68331	1993/06/21	5010310	32.90	D	569082	1996/10/19	2007020	0.00	I
81829	1993/06/29	1059050	12.90	D	584088	1996/08/21	3610020	2.90	D
103316	1993/09/15	2007030	17.60	D	590605	1996/11/28	2039020	17.50	D
109744	1993/09/11	5006250	42.00	D	605014	1996/11/20	3001120	22.50	D
145579	1994/01/03	3010070	8.30	D	610305	1996/12/28	2016140	20.00	F
155781	1993/12/15	2432020	19.80	I	667131	1996/11/20	2050020	8.00	D
183448	1994/02/23	1075050	13.70	F	614676	1997/01/13	3016090	15.00	D
202739	1994/04/26	1009010	1.30	I	658189	1997/05/07	3016120	26.50	D
246045	1994/06/10	2007020	0.00	D	666966	1997/01/30	3321010	7.80	D
247292	1994/10/07	2330030	14.00	D	695648	1997/08/11	5283020	17.90	D
296803	1994/11/14	1008030	10.00	I	716998	1997/10/03	100060	2.60	D
341939	1995/03/09	3610010	1.10	D	719476	1997/10/07	3610020	0.20	D
372922	1995/04/18	1075020	22.20	D	732596	1997/10/22	4006050	10.00	D
375582	1995/05/19	1052020	13.70	I	757333	1997/12/05	2016160	28.20	I
383649	1995/06/14	2003200	14.80	I	761015	1998/01/08	2646010	0.00	D
389292	1995/06/07	2007020	16.50	I	765067	1997/12/30	3001920	6.80	D
405531	1995/09/06	3668010	0.00	D	769785	1998/01/27	3610010	1.60	D
408915	1995/06/01	1059040	19.60	D	780585	1998/02/13	2032010	22.70	I
412086	1995/09/21	3610010	0.90	I	782664	1998/03/03	5010310	32.90	D
437218	1995/09/21	3010070	5.00	I	786461	1998/03/11	3678010	2.20	D
445184	1995/08/15	3010070	4.80	D	833289	1998/07/14	2001201	2.00	D
448576	1995/10/20	3610010	1.40	D	835886	1998/07/02	2245050	24.30	D
456645	1995/10/06	3610020	0.00	D	846139	1998/08/18	2002150	20.90	I
456921	1995/11/18	1221030	6.80	D	851445	1998/09/04	1023140	12.30	D
499296	1995/11/01	4005200	14.80	D	861283	1998/10/05	4006040	1.50	I
468481	1996/01/08	3610020	0.20	D	861372	1998/09/29	2014030	16.70	I
498722	1996/03/27	4010930	3.90	I	888352	1998/12/04	5010940	1.10	D
508811	1996/03/30	3010100	15.30	I	902284	1998/05/05	3010025	5.30	D
512749	1996/04/10	1044070	25.50	D	944067	1998/12/03		0.00	I
515535	1996/03/23	4010220	21.60	D					
519365	1996/04/25	1015010	1.80	I					
525269	1996/06/18	1023140	2.00	D					

Table C-2: HTAs not Geocoded in Alberta

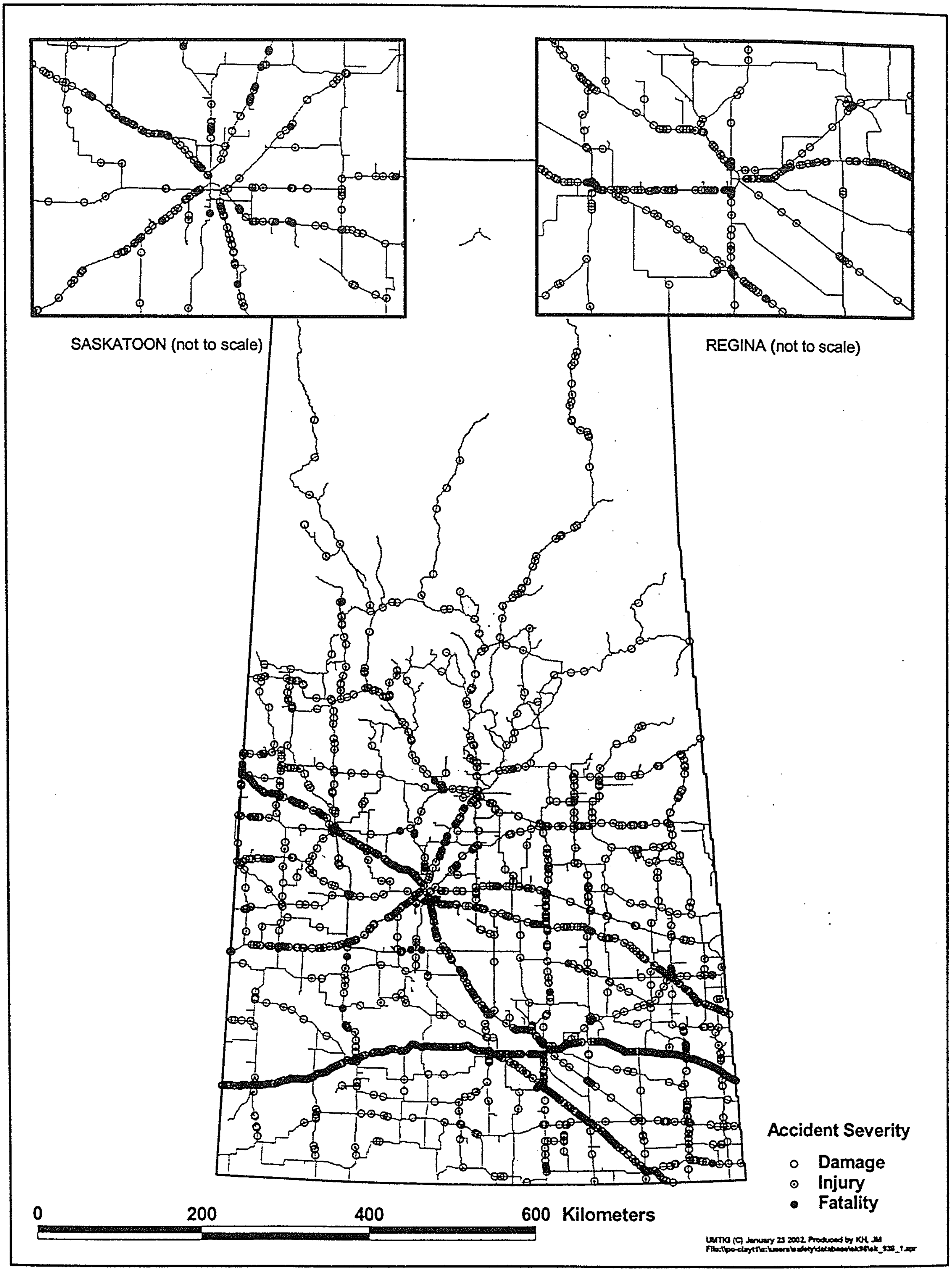
CASE NUMBER	DATE	CSECT	ATKM	SEV	CASE NUMBER	DATE	CSECT	ATKM	SEV
128745	2/24/97	228	31.66	3	412512	7/29/98	4912	37.23	3
129674	8/10/98	3312	11.69	2	424839	3/9/97	1508	47.10	2
135878	3/29/96	220	35.56	3	425281	9/17/98	3A08	5.75	2
157984	11/23/94	2218	27.19	3	425360	11/7/97	3A08	5.60	1
160890	2/23/95	16A20	3.42	2	474057	12/18/96	8814	52.55	3
161018	9/14/96	16X40	26.10	2	511934	11/27/98	4304	51.00	3
161122	9/3/96	16X40	10.36	3	543791	3/4/98	252	39.51	2
161126	1/5/95	16X40	16.67	3	551654	4/7/98	4302	12.94	3
163667	6/9/95	222	27.94	2	555750	7/26/98	4302	32.90	3
174707	1/16/97	16X40	15.40	3	57813	3/20/96	1608	36.24	3
174735	4/2/96	16X40	16.46	3	582853	9/22/98	106	20.43	3
211360	9/1/95	16X40	18.16	2	588551	12/28/98	6302	55.20	3
213692	11/19/96	2008	26.58	3	602513	11/25/98	4912	36.37	3
237854	11/9/98	4912	3.08	3	62276	5/23/95	226	45.18	3
24368	9/12/96	16X40	16.48	1	67095	3/17/95	16A20	0.01	2
247065	10/17/98	1618	7.35	3	703616	3/3/94	16X40	1.60	2
24952	2/10/94	16X42	0.00	3	711408	2/10/94	2A54	27.47	2
24953	2/14/94	16X40	15.24	3	714281	10/27/98	3312	11.69	3
256138	12/18/95	3516	70.55	2	739221	10/10/95	2A04	32.40	3
263380	5/6/96	16X40	22.11	2	74105	2/10/95	16X42	0.00	3
263421	8/17/97	1614	30.44	2	74300	11/1/94	16X40	11.57	3
263426	2/1/96	16X40	21.30	2	74580	12/1/94	1612	51.42	3
289620	4/25/97	1X02	2.60	2	74685	12/28/94	16X40	10.46	3
295234	1/5/96	1616	8.36	3	761528	7/28/93	16X40	14.84	2
295264	11/21/96	16X40	8.73	3	764273	11/19/93	16X40	25.89	3
295269	8/6/96	16X42	0.00	3	764429	5/12/93	16X40	23.90	3
297083	11/6/95	16X40	2.19	3	764489	6/30/93	16X40	26.10	3
30302	3/24/95	1604	49.54	3	766989	9/24/94	16X40	10.36	2
30435	1/4/94	1604	49.53	2	767244	1/15/94	1508	47.10	2
305117	2/22/97	2220	33.51	3	772443	2/16/95	16X40	17.00	3
305214	8/29/97	2220	33.51	2	775568	1/4/94	16A20	1.68	3
306483	9/10/96	220	35.66	3	777322	11/4/93	3312	22.69	2
308538	11/20/96	3312	17.69	3	778172	11/4/93	16A20	1.64	3
313042	11/13/96	220	35.61	2	783090	11/2/93	16A20	1.64	3
322866	4/27/98	2804	36.69	2	881178	12/11/96	122	47.54	3
325709	6/24/97	402	38.51	2	902819	8/26/93	1508	47.10	2
326305	6/29/96	16X40	14.48	3	903014	9/26/93	106	20.42	3
332671	5/3/98	908	60.90	2	920469	8/8/94	16X42	0.00	3
332957	3/9/97	2A54	27.47	3	924067	1/24/94	16X40	23.02	3
334670	7/26/96	5804	68.48	2	924068	1/24/94	16X42	0.50	3
335405	2/12/97	14X02	1.83	3	997019	8/28/93	2A04	25.36	3
353273	1/5/98	1612	51.50	3	999180	11/6/96	16X40	18.12	3
357854	11/29/98	4912	20.23	2	999208	5/27/94	16A20	0.00	3
374056	9/4/98	4304	32.58	3	999834	1/31/94	16A20	0.02	2
378377	9/18/96	2A04	28.30	3	Z158333	11/15/96	220	35.66	3
3883	6/28/94	16X40	16.49	2	Z180493	12/11/96	16X40	7.36	3
393290	12/23/96	1616	8.86	2	Z222664	4/9/97	1X02	2.09	3
41151	10/1/93	3516	70.67	3					

Severity: 3 = property damage; 2 = injury; and 1 = fatal



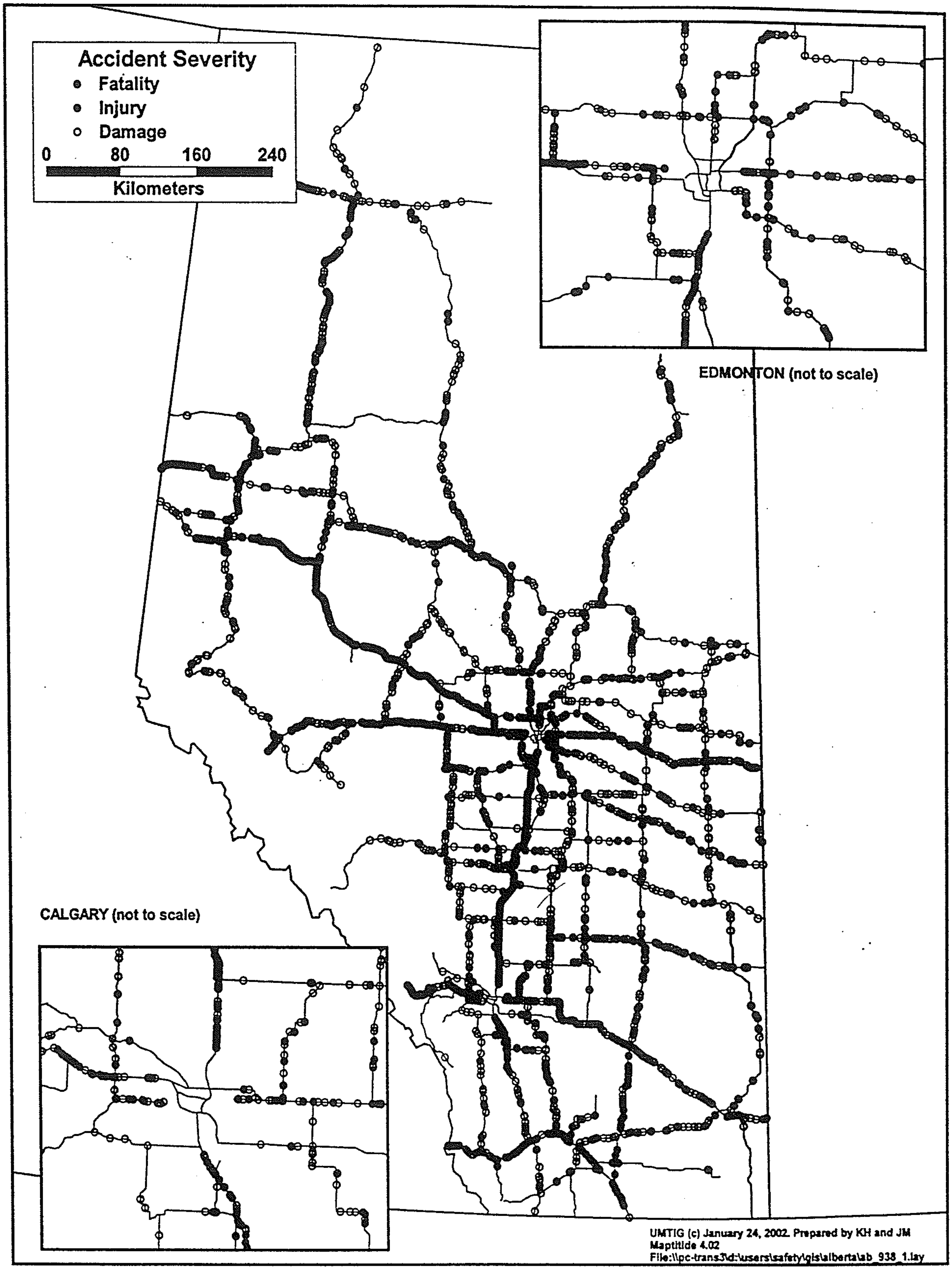
UMTIG (c) January 24, 2002. Prepared by KH and JM
Maptitide 4.02
File:\\pc-trans3\d:\users\safety\gis\manitoba\mb_938_1.lay

Figure C-1: Geographical Distribution of HTAs in Manitoba (1993-1998)



UMTIG (C) January 23 2002. Produced by KH, JM
File:\\po-clayt1\c:\users\safety\database\sk98\sk_938_1.apr

Figure C-2: Geographical Distribution of HTAs in Saskatchewan (1993-1998)



UMTIG (c) January 24, 2002. Prepared by KH and JM
Maptitude 4.02
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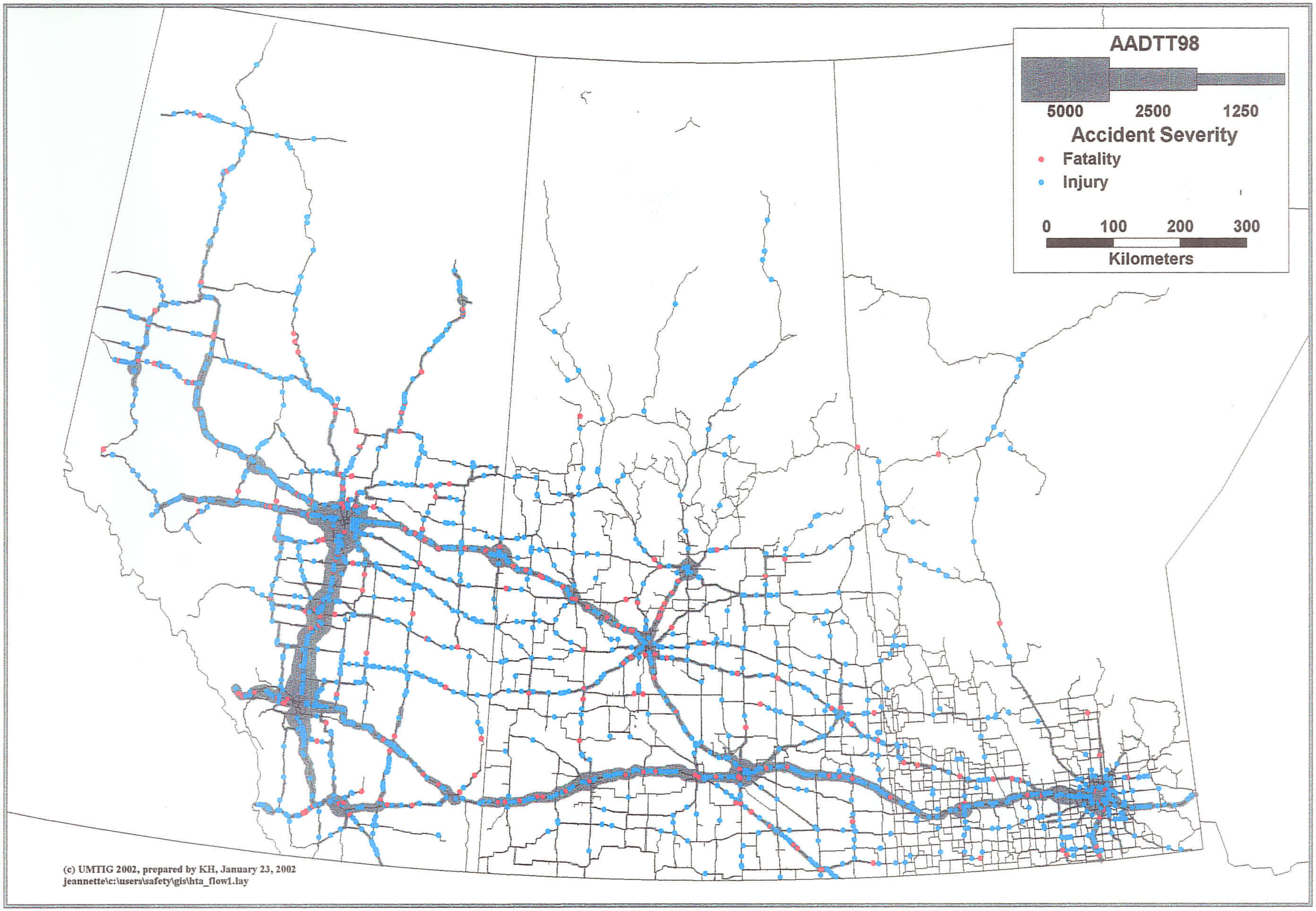
Figure C-3: Geographical Distribution of HTAs in Alberta (1993-1998)



(c) UMTIG 2002, prepared by KH, January 23, 2002
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Figure C-4: Fatal and Injury HTAs Relative to Truck Flows in the Prairie Region

APPENDIX D
Heavy Truck Accidents in Major Urban Centers

Table D-1: Heavy Truck Accidents and non-Heavy Truck Accidents by Year

Year	WINNIPEG			REGINA			SASKATOON			EDMONTON^			CALGARY^		
	HTAs	**non-HTAs**	**Total**	**HTAs**	**non-HTAs**	**Total**	**HTAs**	**non-HTAs**	**Total**	**HTAs**	**non-HTAs**	**Total**	**HTAs**	**non-HTAs**	**Total**
1993	195	17872	**18067**	69	5499	**5568**	97	5643	**5740**	314	23920	**24234**	283	25839	**26122**
1994	191	16586	**16777**	80	5757	**5837**	101	6035	**6136**	437	24592	**25029**	289	23789	**24078**
1995	252	17347	**17599**	55	5391	**5446***	106	6485	**6591**	353	22609	**22962**	331	26591	**26922**
1996	257	15574	**15831**	104	2925	**6029***	127	7373	**7500**	387	23630	**24017**	454	30732	**31186**
1997	208	13806	**14014**	78	5308	**5386***	137	6853	**6990***	438	23662	**24100**	486	29404	**29890**
1998	223	13753	**13976**	74	5773	**5847**	158	7361	**7519**	412	25025	**25437**	504	32316	**32820**
Total	1326	94938	**96264**	460	30652	**34112**	726	39750	**40476**	2341	143438	**145779**	2347	168671	**171018**

* This is a revised figure provided by SGI in January 2000

^ Source of "total accidents" is Alberta Infrastructure

Table D-2a: Single-Vehicle Heavy Truck Accidents by Severity

Year	WINNIPEG				REGINA				SASKATOON				EDMONTON				CALGARY			
	Fatal**	Injury^	Property Damage*	WPG Total	Fatal	Injury	Property Damage	RE Total	Fatal	Injury	Property Damage	SK Total	Fatal	Injury	Property Damage	EDM Total	Fatal	Injury	Property Damage	CAL Total
1993	0	0	17	**17**	0	0	18	**18**	0	2	14	**16**	0	2	32	**34**	0	6	24	**30**
1994	0	1	7	**8**	0	1	7	**8**	0	0	9	**9**	0	2	55	**57**	0	2	31	**33**
1995	0	2	19	**21**	0	2	4	**6**	0	0	6	**6**	0	2	47	**49**	0	4	25	**29**
1996	0	2	28	**30**	0	0	17	**17**	0	0	10	**10**	0	3	39	**42**	0	4	41	**45**
1997	0	2	25	**27**	0	0	8	**8**	0	1	17	**18**	2	8	50	**60**	0	2	46	**48**
1998	0	1	29	**30**	0	0	13	**13**	0	1	14	**15**	0	2	42	**44**	1	3	35	**39**
Total	0	8	125	**133**	0	3	67	**70**	0	4	70	**74**	2	19	265	**286**	1	21	202	**224**

** The fatal category includes codes 3 (fatal driver of passenger) and 5 (pedestrian fatal) from the Winnipeg accident code forms.

^ The injury category includes codes 1 (injury), 2 (hospitalized), 4 (pedestrian injury), and 8 (pedestrian hospitalized) from Winnipeg's accident code forms.

* These are accidents for which there was no injury or the injury was not stated (injury codes 0 or 7) and that resulted in a property damage of more than $1,000 (codes 05 to 09 from "propery damage" category in Winnipeg's accident code form).

Winnipeg single-vehicle accidents for which there was no injury and that resulted in a property damage of less than $1,000 or for which the severity or damage was not stated are as follows for the six years: 1993 = 9, 1994 = 7, 1995 = 5, 1996 = 9, 1997 = 7, 1998 = 7

Table D-2b: Multiple-Vehicle Heavy Truck Accidents by Severity

Year	WINNIPEG				REGINA				SASKATOON				EDMONTON				CALGARY			
	Fatal**	Injury^	Property Damage*	WPG Total	Fatal	Injury	Property Damage	RE Total	Fatal	Injury	Property Damage	SK Total	Fatal	Injury	Property Damage	EDM Total	Fatal	Injury	Property Damage	CAL Total
1993	1	47	108	**156**	0	12	39	**51**	0	14	67	**81**	2	49	229	**280**	0	23	228	**251**
1994	4	39	112	**155**	0	13	59	**72**	0	23	69	**92**	1	64	315	**380**	0	27	229	**256**
1995	1	43	159	**203**	1	12	36	**49**	0	19	81	**100**	1	50	253	**304**	1	36	265	**302**
1996	1	51	147	**199**	1	10	76	**87**	0	21	96	**117**	0	68	277	**345**	4	46	359	**409**
1997	1	26	131	**158**	0	14	56	**70**	1	11	107	**119**	0	79	299	**378**	2	46	390	**438**
1998	0	37	131	**168**	1	6	54	**61**	0	16	127	**143**	1	85	282	**368**	3	47	415	**465**
Total	8	243	788	**1039**	3	67	320	**390**	1	104	547	**652**	5	395	1655	**2055**	10	225	1886	**2121**

** The fatal category includes codes 3 (fatal driver of passenger) and 5 (pedestrian fatal) from the Winnipeg accident code forms.

^ The injury category includes codes 1 (injury), 2 (hospitalized), 4 (pedestrian injury), and 8 (pedestrian hospitalized) from Winnipeg's accident code forms.

* These are accidents for which there was no injury or the injury was not stated (injury codes 0 or 7) and that resulted in a property damage of more than $1,000 (codes 05 to 09 from "propery damage" category in Winnipeg's accident code form).

Winnipeg multiple-vehicle accidents for which there was no injury and that resulted in a property damage of less than $1,000 or for which the severity or damage was not stated are as follows for the six years: 1993 = 13, 1994 = 21, 1995 = 23, 1996 = 19, 1997 = 16, 1998 = 18

D.1 Heavy Truck Accidents by Number of Trailers

In Regina, there were a total of 293 heavy trucks for which the trailer configuration (single or double) was known. Of those, single trailer combinations accounted for 70 percent, and doubles accounted for the remaining 30 percent. As previously indicated, in Saskatchewan, it is not possible to determine from the accident database the number of triple trailers involved in accidents. Of the 88 double trailer combinations involved in accidents, 60 percent were either A or C-trains, and 40 percent were B-trains. For the six-year period, one single trailer and one double trailer were involved in fatalities. Of the 205 single trailers, 14 percent were involved in injury-producing accidents, and 85 percent were involved in HTAs resulting in property damage only. Of the 88 double trailers, 17 percent were involved in injury accidents, and 82 percent were involved in accidents resulting in property damage only.

Trailer information was available for 344 accidents in Saskatoon. Three-quarters of those trucks had single trailers, and one-quarter had double trailers. Of the 85 double trailer combinations involved in accidents, 56 percent were A or C-trains, and 44 percent were B-trains. For the six-year period, one single trailer was involved in a fatality. Of the 259 single trailers, 19 percent were involved in injury-producing accidents, and 81 percent were involved in HTAs resulting in property damage only. Of the 85 double trailers, 26 percent were involved in injury accidents, and 74 percent were involved in accidents resulting in property damage only.

In Edmonton, there were 1,646 heavy trucks for which the trailer configuration (single, double or triple) was known. Of those, 82 percent were single trailers, 16 percent were double trailers, and just over one percent were triple trailers. Trailer configuration was available for 1,287 accidents in Calgary. Of those, 81 percent were single trailers, 17 percent were doubles, and almost one percent were triples.

In Edmonton, three single trailer combinations and one double were involved in fatal accidents over the six-year period. Nearly 20 percent of all single trailers, and one-quarter of all double trailers and triple trailers involved in HTAs were involved in injury accidents. In Calgary, the figures are somewhat different. There were six single trailer combinations, one double, and one triple involved in fatal accidents over the six years. Eleven percent of all single trailers, 13 percent of all double trailers, and one-quarter of all triple trailer combinations involved in HTAs were involved in injury accidents.

The Alberta database also allows for the analysis of trailer involvement by body type. Tables D-3a and D-3b illustrate the body types of single, double or triple trailers involved in HTAs in Edmonton and Calgary. This analysis is also based only on the number of heavy trucks for which the trailer configuration (single, double or triple) is known. In both cities, vans, platforms, and lowboys were the most common body types involved in HTAs, accounting for approximately 40 percent, one-quarter, and 13 percent respectively, of all heavy trucks involved in HTAs in each city. Also in both cities, vans were the most common body type observed in HTAs involving single trailer combinations (41 percent of all single trailers in Edmonton and 45 percent of all single trailers in Calgary). Platforms were the most common body type observed in HTAs involving double trailer combinations (30 percent of all double trailers in Edmonton and 28 percent of all double trailers in Calgary).

D.2 Major Factors Contributing to Heavy Truck Accidents in Regina and Saskatoon

In Regina, of the 133 reported HTAs where human condition was a major contributing factor, *inattentive driving* was identified in 87 percent of the cases, *distracted driver* was identified in 10 percent, and other factors were identified in 11 percent of the cases. Of the 115 reported HTAs where human action was identified as a major contributing factor, *improper turning* was identified in 27 percent of the cases, *backing unsafely* was identified in 16 percent of the cases, *fail to yield to right of way* and *passing improper* were identified in 13 percent and 11 percent of the cases respectively. Other factors were identified in 29 percent of the 115 cases. Of the 51 reported HTAs were vehicle condition was a major contributing factor, *jacknife/trailer swing* was identified in 27 percent of the accidents, *view from vehicle obstructed* was identified in 24 percent of the accidents, and *load shifted* was identified in 16 percent of the cases. Other vehicle condition factors were identified in 37 percent of the cases. Of the 62 reported HTAs where environmental condition was a major contributing factor, *road conditions* were a factor in 48 percent of the accidents, an *uninvolved vehicle* was identified in 19 percent of the HTAs, *limited view outside the vehicle* was identified in 18 percent of the HTAs, and *weather conditions* were identified in 16 percent of the cases.

Table D-3a: Heavy Trucks Involved in HTAs by Trailer Body Type 1993-1998 (Edmonton)

	Single	Double	Triple	Total
Van/box body	562	49	7	618
Lowboy	183	38	4	225
Highboy	374	80	5	459
Tanker	40	46	1	87
Dump	63	24	1	88
Auto carrier	12	0	0	12
Livestock	13	0	1	14
Log carrier	2	1	1	4
Unknown	48	10	0	58
Other ^^	56	20	5	81
Total	1353	268	25	1646

unknown refers to code 97 and blank fields
^^ other refers to code 98 ("other") in the database

Table D-3b: Heavy Trucks Involved in HTAs by Trailer Body Type 1993-1998 (Calgary)

	Single	Double	Triple	Total
Van/box body	481	48	4	533
Lowboy	135	29	2	166
Highboy	264	63	3	330
Tanker	40	40	0	80
Dump	37	26	1	64
Auto carrier	15	1	1	17
Livestock	18	0	0	18
Log carrier	4	1	0	5
Unknown	0	1	0	1
Other ^^	56	16	1	73
Total	1050	225	12	1287

unknown refers to code 97 and blank fields
^^ other refers to code 98 ("other") in the database

In Saskatoon, of the 186 reported HTAs where human condition was a major contributing factor, *inattentive driving* was identified in 90 percent of the cases, *driver inexperience* was identified in 6 percent of the cases, and other factors were identified in 8 percent of the cases. Of the 214 reported HTAs where human action was identified as a major contributing factor, *turning improperly* was identified in 18 percent of the cases, *fail to yield to right of way* was identified in 16 percent of the cases, *traffic control device disregarded* was identified in 15 percent of the HTAs, *passing improperly* was identified in 14 percent of the cases, and *backing unsafely* was identified in 11 percent of the cases. Other factors were identified in 27 percent of the cases. Of the 18 reported HTAs where vehicle condition was identified as a major contributing factor, *jack-knife/trailer swing* was identified in seven of the cases, and *defective brakes* were identified in three of the 18 cases. Other vehicle conditions were identified in 11 of the 18 accidents. Of the 63 reported HTAs where environmental condition was identified as a major contributing factor for the accident, *road condition* was identified in 54 percent of the HTAs, *weather conditions* were identified in 24 percent of the cases, and *limited view outside the vehicle* was identified in 11 percent of the HTAs.

D.2.1 Human Condition

Over the six-year period, human condition was reported as a major contributing factor in 133 of the 460 HTAs in Regina, and 186 of the 726 accidents in Saskatoon. See Table D-4.

D.2.2 Human Action

Over the six-year period, human action was reported as a major contributing factor in 115 of the 460 HTAs in Regina, and 214 of the 726 HTAs in Saskatoon. See Table D-5.

Table D-4

Contributing Factor (code)	**Regina**	**Saskatoon**
Inattentive (01)	116	167
Distracted (02)	13	7
Had been drinking (03)	0	2
Impaired (04)	2	0
Extreme fatigue (05)	0	1
Fell Asleep (06)	0	1
Driver inexperience (07)	6	12
Lost consciousness (08)	1	0
Other human conditions (12)	5	4

Table D-5

Contributing Factor (code)	**Regina**	**Saskatoon**
Failed to yield right of way (21)	15	34
Traffic control device disregarded (22)	8	32
Following too closely (23)	10	19
Driving too fast for conditions (24)	3	11
Exceeding speed limit (25)	1	2
Turning improperly (26)	31	39
Passing improperly (27)	13	31
Backing unsafely (28)	18	24
Fail to signal (29)	2	1
Driving wrong way on roadway (30)	0	1
Taking evasive action (31)	8	7
Careless driving (32)	1	0
Pedestrian action contributed (33)	0	0
Other human action (34)	12	17

D.2.3 Vehicle Condition

Over the six-year period, vehicle condition was reported as a major contributing factor in 51 of the 460 HTAs in Regina, and in 18 of the 726 HTAs in Saskatoon. See Table D-6.

Table D-6

Contributing Factor (code)	Regina	Saskatoon
Defective brakes (40)	1	3
Defective lights (41)	1	0
Load shifted/spilled (43)	8	2
Vehicle overloaded (44)	4	1
Defective tires (47)	0	1
Defective engine/power train (48)	1	0
Jack-knife/trailer swing (49)	14	7
View from vehicle obstructed (50)	12	1
Other vehicle condition/defect (51)	12	6

D.2.4 Environmental Condition

Over the six-year period, environmental condition was reported as a major contributing factor in 62 of the 460 HTAs in Regina, and 63 of the 726 HTAs in Saskatoon. See Table D-7.

Table D-7

Contributing Factor (code)	Regina	Saskatoon
Road condition (62)	30	34
Snow drift (64)	1	1
Obstruction/debris on roadway (66)	3	2
View obstructed/limited (67)	12	7
Sun glare (68)	3	3
Construction zone (69)	3	2
Weather conditions (74)	10	15
Uninvolved vehicle (75)	12	6
Uninvolved pedestrian (76)	1	0
Other environmental condition (77)	0	2

D.3 Major Factors Contributing to Heavy Truck Accidents in Edmonton and Calgary

In Edmonton, of the 28 reported HTAs where human condition was a major contributing factor, *impaired by alcohol* was identified in one-quarter of the cases, *fatigue* was identified in 11 percent of the cases, and other factors were identified in most of the cases (two-thirds). The details about most of the HTAs (197 of 216) involving human condition in Calgary were assigned to the "other" category in the database, and therefore, it is not possible to make similar observations for that city, as made for Edmonton regarding human condition of drivers involved in HTAs.

Of the 1,014 reported HTAs where human action was identified as a major contributing factor in Edmonton, *improper lane change* was identified in 18 percent of the cases, *backed unsafely* was identified in 16 percent of the cases, *followed too closely, parked vehicle,* and *improper turn* were each identified in 13 percent of the HTAs. Other factors were identified in 32 percent of the cases. In Calgary, of the 1,283 reported HTAs where human action was identified as a major contributing factor, *backed unsafely* was identified in 23 percent of the cases, *parked vehicle* was identified in 15 percent of the cases, *improper lane change* was identified in 14 percent of the cases, *followed too closely* and *improper turn* were each identified in 12 percent of the HTAs. Other factors were identified in 30 percent of the cases.

Of the 37 reported HTAs where vehicle condition was identified as a major contributing factor in Edmonton, *defective brakes* were identified in 17 of the cases and *load shift* was identified in seven of the 37 cases. Other vehicle conditions were identified in 13 of the 37 accidents. Calgary showed a similar distribution as Edmonton. There were 42 cases were vehicle condition was identified as a contributing factor. *Defective brakes* were identified in 16 of the cases, and *load shift* was identified in 10 of the 42 cases.

Of the 375 reported HTAs where environmental condition was identified as a major contributing factor for the accidents in Edmonton, *snow* was identified in one-half of the HTAs and *rain* was identified in 28 percent. Other environmental conditions were identified in 23 percent of the HTAs. In Calgary, of the 368 HTAs were environmental conditions were identified as a contributing factor, *snow* was identified in 54 percent of the cases, and *rain* was identified in 31 percent of the cases. Other factors were identified in 15 percent of the cases.

D.3.1 Human ("Driver/Pedestrian") Condition

Over the six-year period, human condition was reported as a contributing factor in 28 of the 2,341 HTAs in Edmonton, and 216 of the 2,347 HTAs in Calgary. See Table D-8.

Table D-8

Contributing Factor (code)	Edmonton	Calgary
Had been drinking (02)	2	7
Impaired by alcohol (03)	7	4
Impaired by drugs (04)	0	1
Fatigues/asleep (05)	3	3
Medical defect (06)	1	4
Other (98)	15	197

D.3.2 Driver Action

Over the six-year period, driver action was reported as a contributing factor in 1,014 of the 2,341 HTAs in Edmonton, and in 1,283 of the 2,347 HTAs in Calgary. See Table D-9.

Table D-9

Contributing Factor (code)	Edmonton	Calgary
Stop sign violation (02)	15	25
Yield sign violation (03)	7	8
Failed to yield right of way (04)	9	10
Failed to yield right of way ped (05)	0	2
Followed too closely (06)	132	160
Parked vehicle (07)	126	190
Backed unsafely (08)	161	291
Left turn across path (09)	54	52
Improper lane change (10)	185	178
Disobeyed traffic signal (11)	43	39
Ran off road (12)	31	45
Improper turn (13)	127	158
Left of centre (14)	9	15
Improper passing (15)	16	16
Other (98)	137	168

D.3.3 Vehicle Condition

Over the six-year period, vehicle condition was reported as a contributing factor in 37 of the 2,341 HTAs in Edmonton, and 42 of the 2,347 HTAs in Calgary. See Table D-10.

Table D-10

Contributing Factor (code)	Edmonton	Calgary
Defective brakes (02)	17	16
Improper load/shift (04)	7	10
Lighting defect (05)	3	1
Other (98)	10	15

D.3.4 Environmental Condition

Over the six-year period, environmental condition was reported as a contributing factor in 375 of the 2,341 HTAs in Edmonton, and 368 of the 2,347 HTAs in Calgary. See Table D-11.

Table D-11

Contributing Factor (code)	Edmonton	Calgary
Raining (02)	105	115
Hail/sleet (03)	7	18
Snow (04)	182	197
Fog/smog/smoke/dust (05)	10	14
High wind (06)	4	4
Animal involvement (object type 7) *	1	1
Other (98)	66	19

* for consistency purposes with MB and SK, "animal involvement" was included under this category, even though it is not part of the environmental condition category in the police report form. This animal involvement was obtained from analyzing the "object type" field, for which "animal" was object type 7. There were 619 accidents in which a heavy truck hit an animal or was involved in a single vehicle accident because of an animal and there were 8 accidents in which a truck was involved in a multiple-vehicle accident which involved an animal and another vehicle.

APPENDIX E

Details About HTAs in Major Urban Centers

Table E-1: One or More HTAs per Year Occurring at Intersections in Winnipeg (1993-1998)

INTERSECTION LOCATION		Number of HTAs	Number of SVAs	Number of MVAs
KING EDWARD ST	NOTRE DAME AV	23	7	16
DUBLIN AV	KING EDWARD ST	15	4	11
LAGIMODIERE BV	SPRINGFIELD RD	12	4	8
KING EDWARD ST	LOGAN AV	12	2	10
KING EDWARD ST	WELLINGTON AV	11	8	3
OAK POINT HW	SELKIRK AV	11	4	7
EAGLE DR	OAK POINT HW	11	0	11
DES MEURONS ST	GOULET ST	9	7	2
JARVIS AV	MCPHILLIPS ST	9	2	7
LAGIMODIERE BV	REGENT AV W	9	1	8
GRASSIE BV	LAGIMODIERE BV	9	0	9
MCPHILLIPS ST	NOTRE DAME AV	8	1	7
CENTURY ST	WELLINGTON AV	7	2	5
BROOKSIDE BV	INKSTER BV	7	0	7
KEEWATIN ST	NOTRE DAME AV	7	0	7
MAIN ST	PORTAGE AV	7	0	7
INKSTER BV	MANDALAY DR	6	4	2
LOGAN AV	PRINCESS ST	6	4	2
LOGAN AV	MCPHILLIPS ST	6	2	4
NAIRN AV	STADACONA ST	6	1	5
CENTURY ST	NESS AV	6	0	6
CHEVRIER BV	WAVERLEY ST	6	0	6
CLARENCE AV	WAVERLEY ST	6	0	6
DAWSON RD N	MARION ST	6	0	6
ELLICE AV	ST JAMES ST	6	0	6
NAIRN AV	WATT ST	6	0	6
TOTAL		227	53	174

Note: SVA = Single-vehicle accidents
MVA=Multiple-vehicle accidents

Table E-2: One or More HTAs per Year Occurring on Street Links in Winnipeg (1993-1998)

STREET LINK LOCATION			Number of HTAs	Number of SVAs	Number of MVAs
MCPHILLIPS ST	JARVIS AV	S	16	13	3
BROOKSIDE BV	JEFFERSON AV	S	9	1	8
OAK POINT HW	EGESZ ST	E	9	0	9
NORWOOD B*	BELL AV	S	8	1	7
BROOKSIDE BV	INKSTER BV	S	8	0	8
KING EDWARD ST	DUBLIN AV	S	8	0	8
KENASTON BV	TAYLOR AV	S	6	0	6
TOTAL			64	15	49

Table E-3: One or More HTAs per Year Occurring at Intersections in Regina (1993-1998)

LOCATION	Number of HTAs	Number of SVAs	Number of MVAs
RING ROAD & VICTORIA AVENUE	14	4	10
FLEET STREET & VICTORIA AVENUE	11	0	11
MCDONALD STREET & RING ROAD	10	0	10
MCDONALD STREET & ROSS AVENUE	7	1	6
MCDONALD STREET & PARK STREET	7	0	7
ROSS AVENUE & WINNIPEG STREET	6	1	5
PRINCE OF WALES & VICTORIA AVENUE	6	0	6
TOTAL	61	6	55

Table E-4: One or More HTAs per Year Occurring on Street Links in Regina (1993-1998)

STREET NAME	Number of HTAs	Number of SVAs	Number of MVAs
MCDONALD STREET 699-361	11	0	11
WINNIPEG STREET 1499-1400	8	7	1
HIGHWAY 1 0-0	7	0	7
TOTAL	26	7	19

Table E-5: One or More HTAs per Year Occurring at Intersections in Saskatoon (1993-1998)

LOCATION	Number of HTAs	Number of SVAs	Number of MVAs
CIRCLE DR. & 22ND ST.	29	0	29
MILLAR AVE. & CIRCLE DR.	21	0	21
AVE. C & CIRCLE DR.	18	1	17
COLLEGE DR & CIRCLE DR (EAST	17	1	16
1ST AVE. & CIRCLE DR.	13	1	12
FAITHFULL AVE. & 51ST ST.	13	0	13
FAITHFULL AVE. & CIRCLE DR.	13	0	13
CIRCLE DR. & TAYLOR ST.	11	3	8
CIRCLE DR. & 8TH ST. (WEST)	11	0	11
QUEBEC AVE. & CIRCLE DR.	10	1	9
IDYLWYLD DR. & 22ND ST.	9	4	5
CIRCLE DR. & AIRPORT DR.	8	2	6
CIRCLE DR. & ATTRIDGE DR.	8	1	7
AVE. P & 22ND ST.	7	1	6
IDYLWYLD DR & 20TH ST	7	0	7
MILLAR AVE. & 51ST ST.	7	0	7
CIRCLE DR. & LAURIER DR.	6	3	3
AVE. C & 45TH ST.	6	1	5
FAITHFULL AVE & 46TH ST	6	0	6
TOTAL	220	19	201

Table E-6: One or More HTAs per Year Occurring on Street Links in Saskatoon (1993-1998)

LOCATION	Number of HTAs	Number of SVAs	Number of MVAs
CIRCLE DR.: 108TH ST - COLLE	6	4	2

APPENDIX F

Notes Regarding CVSA Inspection Analysis

This section presents a series of explanatory notes regarding the analysis presented in Chapter 5. Due to

F.1 Notes Regarding Section 5.3.1 for Manitoba

- In the Paradox database for 1995 and 1996, a truck-tractor is identified as follows: "TRUCK/TRACTOR", "TRUCK TRACTOR", "TRUCK TRACTR", "TRUCK/TRACTR", "TURCK TRACTOR", "TRUCK/TRACTRO", "TRUCK TRACTRO".

- For 1995 and 1996 data, a truck was classified as a bobtail if the database included only data relating to the truck-tractor and did not identify any trailer. A truck was classified as a tractor-semitrailer if it was identified as having a truck-tractor as vehicle 1, and a trailer as vehicle 2. A combination was classified as an A-train if it was identified as having a truck-tractor as vehicle 1, a trailer as vehicle 2, a dolly as vehicle 3, and a trailer as vehicle 4. A truck was classified as a B-train if it was identified as having a truck-tractor as vehicle 1, a trailer as vehicle 2, and a trailer as vehicle 3. A truck was classified as a triple if it was identified as having a truck-tractor as vehicle 1, a trailer as vehicle 2, a trailer as vehicle 3, and a trailer as vehicle 4 (note that convertor dollies were not examined in the triple trailer combinations). Certain trucks were classified with a configuration "not known" because the database was unclear as to the truck's make-up. Examples include: vehicle 1 being a truck-tractor, and vehicle 2 being a dolly convertor; vehicle 1 being a truck-tractor, vehicle 2 being nothing, and vehicle 3 being a trailer.

- In the Paradox database for 1995 and 1996, a dolly is identified as: "CONVERTOR", "CONVERTER", "CONV DOLLY", "CONV. DOLLY", "CONVERTOR DOLLY", "DOLLY".

- In 1995, 1 combination was reported as a tractor-semitrailer towing a converter dolly. In 1996, 8 combinations were reported as a truck-tractor towing a converter dolly (2 from Manitoba, 6 from other than Manitoba); 2 combinations were reported as a truck-tractor as vehicle 1, a trailer as vehicle 2, nothing as vehicle 3, and a trailer as vehicle 4 (both from other than Manitoba); 1 combination was reported as a truck-tractor as vehicle 1, nothing as vehicle 2, and a trailer as vehicle 3 (from Manitoba).

F.2 Generation of Table 5-3b for Inspections in Saskatchewan

Table 5-3b contains information by truck configuration (*i.e.*, tractor semitrailer, tractor double trailer, or tractor triple trailer) and by unit type (*i.e.*, truck tractor, trailer or converter dolly) for the period from 1995 to 1997. Each year presents results on the number of trucks and the number of units by base jurisdiction (*i.e.*, Saskatchewan or other than Saskatchewan). The database used to generate this table (. . . projects\safety98\cvsa\saskatch\hts_9597.db) contains several fields of information. This database contains only inspections conducted on heavy trucks (*i.e.*, code S/T--semi trailer unit and code T--A, B, or C-train, or triple). The fields used for this analysis were the following:

Date	Indicates the date when the inspection was conducted.
Veh_Configuration	Indicates whether the vehicle is a code S/T (semi trailer unit) or code T (A, B, or C-train, or triple) as defined by Saskatchewan Highways.
PU_Jurisdiction	The base jurisdiction for the power unit in the combination.
TR1_Jurisdiction	The base jurisdiction for the first trailer in the combination.
TR2_Jurisdiction	The base jurisdiction for the second trailer in the combination.
TR3_Jurisdiction	The base jurisdiction for the third trailer in the combination.

The method to determine the truck configuration by year by base jurisdiction was straight- forward. For each year, the number of inspected S/T and T trucks based in Saskatchewan was determined, as well as the number of S/T and T trucks based in jurisdictions other than Saskatchewan. The category "other" also includes trucks for which the database does not show a base jurisdiction (in 1995 = 67 trucks, in 1996 = 29 trucks, and in 1997 = 24 trucks).

The method to determine the number of trailers inspected, by base jurisdiction, was more complicated. Using the three fields for base jurisdiction of trailers, the following was done: A count of the number of Saskatchewan-based trailers in each field (TR1_Jurisdiction, TR2_Jurisdiction, and TR3_Jurisdiction) was generated and the three totals were added to obtain the number of SK-based trailers. This was done for each year separately. For example, in 1996, there are 974 trailers in the first field for which the base jurisdiction is SK. There are 213 trailers in the second field for which the base jurisdiction is SK, and there are zero trailers in the third field for which the base jurisdiction is SK. This results in a total of 1,187 trailers for which SK is the base jurisdiction in 1996. Similarly, to obtain the number of trailers based in jurisdictions other than SK, the same approach is taken. This results in 1,042 trailers for which the base jurisdiction is a place other than SK.

Under ideal circumstances (no data-entry errors or any other problems with the database), the following equation would hold for the maximum number of trailers inspected:

$NTm = NS/T + NT*2 + NTT*3$

Where NTm is the maximum possible number of trailers
NS/T is the number of tractor semi trailers
NT is the number of tractor doubles
NTT is the number of tractor triples

Therefore, from Table 5-3b, in 1996, it would be expected that the maximum number of Saskatchewan-based trailers and the maximum number of non Saskatchewan-based trailers inspected were:

$NT(SK) = 876 + 224\ (2) + 0$ $NT(SK) = 1{,}324$
$NT\ (nSK) = 596 + 204\ (2) + 2\ (3)$ $NT(nSK) = 1{,}010$

Instead, the number of trailers shown in the table is 1,187 for SK-based and 1,042 for non SK-based. The discrepancy between the figures for SK-based trailers is explained by the fact that in many cases, the base jurisdiction for the trailers was not entered in the database. However, there is a different explanation for the case of non SK-based trailers. The number of trailers obtained from the analysis by individual field (1,042 trailers total) is greater than the maximum possible number of trailers based on truck configuration. The explanation for this discrepancy is as follows: In the database provided by Saskatchewan Highways, there are cases where a truck code S/T (semitrailer unit) had base jurisdiction information for trailers in two of the fields (*i.e.*, it had two trailers associated with it). Therefore, even though the configuration is entered as a tractor semitrailer, the number of trailers is two as opposed to one. This creates balancing errors in the table since when the count per field is generated, all trailers are counted. However, when the truck configuration is determined, it is done solely on the basis of its code (either S/T or T). The following is an example for 1996.

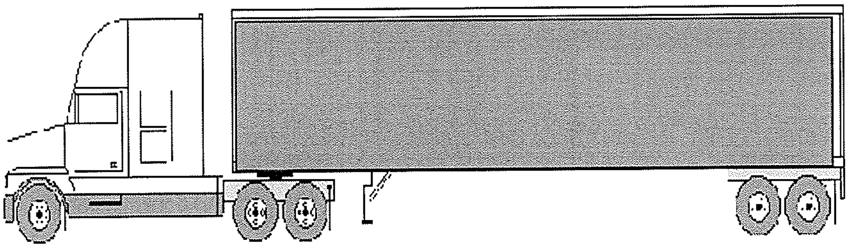
There are 20 SK-based and 15 non SK-based trailers in the second field (TR2_Jurisdiction) for which the truck configuration is a code S/T (semi trailer unit). Further inspection of the data indicates that the 35 S/T trucks should have been recorded in the database as doubles. There are also three single trailer combinations that were recorded as doubles. When these errors are accounted for in the above equation, the following is obtained:

$NT(SK) = 856 + 244\ (2) + 0$ $NT(SK) = 1{,}344$
$NT\ (nSK) = 584 + 216\ (2) + 2\ (3)$ $NT(nSK) = 1{,}022$

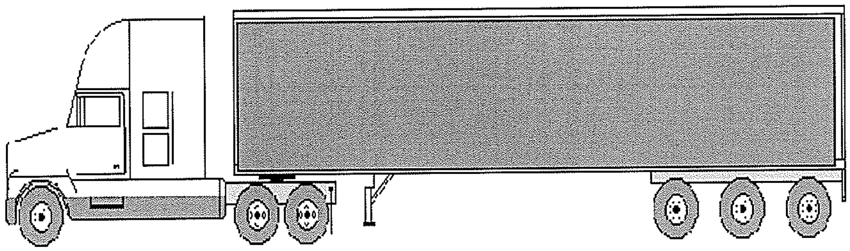
Even though the counted number of trailers is still greater than the maximum possible, it should be noted that there are other problems associated with the database. In 76 of the cases (for 1996) involving a truck configuration S/T (semi trailer unit), there is no base jurisdiction information for the trailer. Also, in 31 of the cases involving a truck configuration T (double or triple), there is no base jurisdiction associated with the second trailer in the combination. This helps explain any inconsistencies found in Table 5-3b since the same situation holds for 1995 and 1997.

APPENDIX G

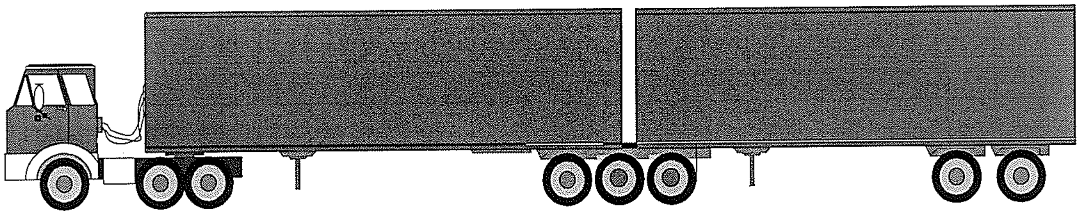
Truck Configurations



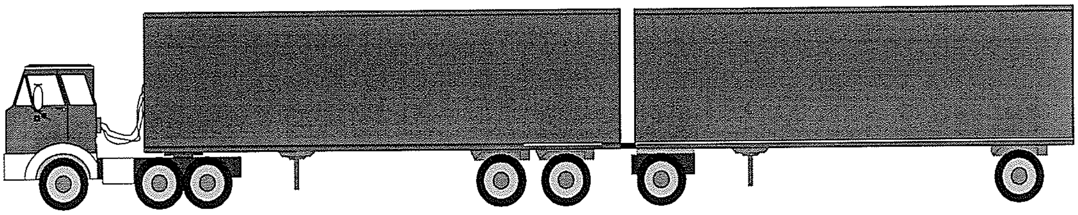
5-axle Tractor-Semitrailer (3-S2)



6-axle Tractor-Semitrailer (3-S3)



8-axle B-Train (3-S3-S2)



7-axle A/C-train (3-S2-2)

Figure G-1: Truck Configurations Discussed in this Thesis

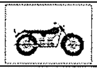
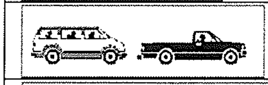
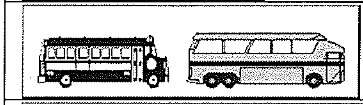
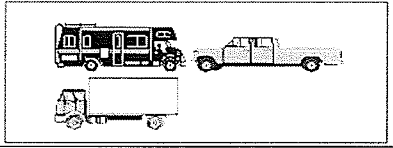
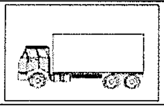
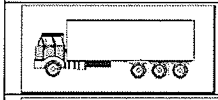
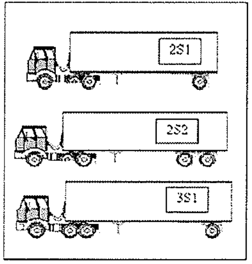
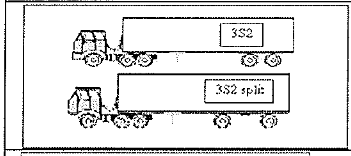
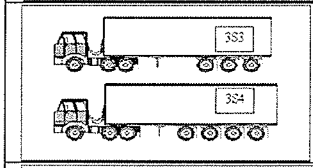
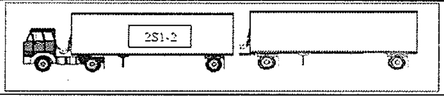
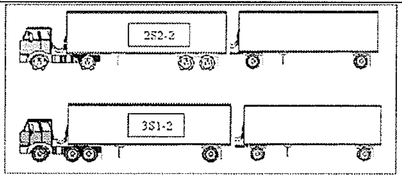
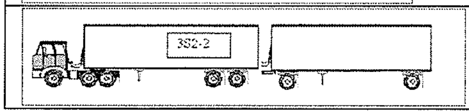
	Class 1: Motorcycles
	Class 2: Passenger Cars (With 1- or 2-Axle Trailers)
	Class 3: 2 Axles, 4-Tire Single Units, Pickup or Van (With 1- or 2-Axle Trailers)
	Class 4: Buses
	Class 5: 2D - 2 Axles, 6-Tire Single Units (Includes Handicap-Equipped Bus and Mini School Bus)
	Class 6: 3 Axles, Single Unit
	Class 7: 4 or More Axles, Single Unit
	Class 8: 3 to 4 Axles, Single Trailer
	Class 9: 5 Axles, Single Trailer
	Class 10: 6 or More Axles, Single Trailer
	Class 11: 5 or Less Axles, Multi-Trailers
	Class 12: 6 Axles, Multi-Trailers
	Class 13: 7 or More Axles, Multi-Trailers

Figure G-2: FHWA Vehicle Classification

Source: http://manuals.dot.state.tx.us/dynaweb/coltrsys/tda/@Generic__BookTextView/20168