FINAL REPORT

Long Combination Vehicle (LCV) Safety Performance in Alberta 1995 to 1998

John Woodrooffe
Principal, Woodrooffe & Associates

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Woodrooffe & Associates

The findings of this report do not represent the views of any individual, party or organization that commissioned or contributed information to the analysis of the results. The independent consulting team of Woodrooffe & Associates used the best available data within the time and budget constraints. Woodrooffe & Associates as authors of this report are solely responsible for any errors, omissions or conclusions. Readers are urged to fully understand any limitations of this study as outlined in Section 2.2 Study Methodology and Approach and to exercise any caution that may be warranted as a result of this methodology when using the results.

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Executive Summary

Alberta Infrastructure's Transportation Policy and Economic Analysis Branch commissioned Woodrooffe and Associates to undertake an in-depth review of Long Combination Vehicles (LCVs) in Alberta during the period 1995 to 1998. In addition, project funding was received from Western Economic Diversification Canada under the Canada-Alberta Western Economic Partnership Agreement Program. The goals of this study are to:

- Determine road safety performance of commercial trucks including LCVs
- Determine the contributing factors to collisions involving LCVs

Long Combination Vehicles (LCVs) are truck and trailer combinations, consisting of a tractor with two or three trailers, or semi-trailers, in which the number of trailers and/or the combined length of the combination exceeding the regular limit of 25 metres. The maximum weight of LCVs is 62,500 kg with 8 axles. These vehicles have been operating on Alberta highways since 1969 with the introduction of Triple Trailers (overall length 35 m). The two other LCV combinations that operate in Alberta are the Rocky Mountain Doubles (31 m) and Turnpike Doubles (38 m). All LCV equipment operates in Alberta under permits with strict safety requirements. They are generally restricted to travelling on 4-lane highways and subject to driver and vehicle operational restrictions. The LCV route or sub-network is roughly 3000 km in length and consists of approximately 20% of the primary highway network.

The method used in this study to analyze the road safety performance is known as the "C*ollisions by Vehicle Type*" method. It is based upon the type of vehicle involved in an incident. In this analysis, "the vehicle involved in the collision" is the primary investigative factor therefore the "total" number of vehicles involved in the collisions is known. The collision exposure rate equation is as follows:

$$\text{Collisions by vehicle type} = \frac{\text{Number of vehicles of a given type involved in collisions}}{\text{Total kilometers traveled by that vehicle type}}$$

The vehicle types examined in this study were Unit Truck, Tractor Semi-Trailer, Multi Trailer, Rocky Mountain Double, Turnpike Doubles and Triples and Personal Vehicles. Vehicles not included in the analysis of the Long Combination Vehicles Safety Performance in Alberta 1995 to 1998 study were motorcycles, bicycles, scooters, mopeds, buses (school, transit or intercity), recreational vehicles, emergency vehicles (ambulances, fire trucks), farm or construction equipment and off-highway vehicles.

Vehicle Road Safety Performance Findings:

Collision Rates by Vehicle Type
(Within the Sub-Network 1995-98)

Vehicle Type	Estimated Error	Per 100 million km traveled Collision Rate Error Estimate Range: Low	Calculated Rate	High
Unit Truck	± 10%	168	187	206
Tractor Semi	± 10%	72	80	87
Multi Trailer	± 10%	93	104	114
Rocky Mountain	± 10%	9	10	11
Turnpike Doubles	± 10%	18	20	22
Triples	± 10%	15	17	19
Personal Vehicles	± 10%	84	88	93
Total Number of Vehicles	± 10%	84	89	93
All LCV	± 10%	14	16	17

Table Notes (1): PDO stands for Property Damage Only collisions. (2): In this analysis, collisions involving two or more vehicles of the same type will be counted as two or more incidents, that is, a collision involving three personal vehicles will be registered as three events. A collision involving two different vehicle types will be registered as two events.

- LCVs were found to have the lowest collision rate of all vehicle classes, including Personal Vehicles. The vehicle safety performance analysis revealed that during the four-year period 1995 to 1998, there were a total of 53 LCV reportable traffic collisions involving LCV vehicles in the Province of Alberta. This represents less than 14 LCV vehicles involved in collisions per year. The sub-network accounted for 70% (37) and urban locations accounted for 30% (16) of the LCV collision incidents.

- Rocky Mountain Doubles were found to have the best safety performance of all LCV configurations. The performance of the Rocky Mountain Double was better than any other vehicle even though they are permitted on a few 2-lane highways. Collisions with animals accounted for 42% of the total number Rocky Mountain Double collisions. Of the animal collisions involving Rocky Mountain Doubles, 80% of the incidents occurred on 2-lane highways.

- The performance of Triple LCVs when configured as A-trains is only marginally better than Tractor Semi-Trailers. Of the 11 collisions involving Triples, including the urban areas, it is probable that 27% involved configuration design. The configuration related performance of Triples could be improved if they were configured as B-trains or C-trains, which have superior vehicle dynamic characteristics. Collisions occurring at a city intersection within the urban areas accounted for 45% (5 out of 11) of all Triple LCV collisions. Collisions on 4-lane divided highways accounted for 38% of the total.

<u>Contributing Factors to LCV Collisions:</u>

Contributing Factors to LCV Collisions in Alberta 1995 to 1998

Overall Study Results	**Sub-Network**	**Urban Areas**	**Frequency**
53 Collisions	37 Collisions	16 Collisions	
Road surface	Road Surface	Intersection	**High**
Animal	Animal	Road surface	
Weather	Weather	Configuration related	
Intersection	Configuration	Weather	**Medium**
Configuration related	Mechanical	Mechanical	
Mechanical	Other	Animal	**Low**
Note: There may be more than one contributing factor to a collision.			

- When analyzing the contributing factors to collisions the data revealed that adverse conditions (weather and road surface) were present in 42% of all LCV collisions. Adverse conditions (weather and road surface) were present in 67 % of the Rocky Mountain Double collisions, 43% of the total Turnpike Double collisions, and road surface factors in 27% of the total Triple LCV collisions.

- Alberta Infrastructure's permit conditions governing the operation of LCVs was found to be a vital influencing factor in the creation of a safe operating environment in Alberta. The effective conditions include, selective routing, restrictions on vehicle speed, restricted time of day operation, enhanced driver qualification requirements and operating restrictions for adverse road and weather conditions. The particular elements, including road surface factors, driver competence, and adverse weather conditions have been found to be significant factors in collision causation.

1. INTRODUCTION

1.1 Background

Long Combination Vehicles (LCVs)[1] are truck and trailer combinations, consisting of a tractor with two or three trailers, or semi-trailers, in which the number of trailers and/or the combined length of the combination exceed the regular limits of 25 metres. These vehicles have been operating on Alberta highways since 1969 with the introduction of Triple Trailers. Currently in Alberta, the maximum gross vehicle weight applicable to LCVs is 62,500 kilograms while the maximum configuration length is 37 metres (121.4 feet).

LCVs are further defined according to size, with three length classifications:

- **Rocky Mountain Double**- A combination vehicle consisting of a tractor, a 12.2 m (40 feet) to 15.2 m (53 foot) semi-trailer, and a shorter 7.3 m (24 feet) to 5.5 m (28 feet) semi-trailer. The total length does not exceed 31 m (102 feet). These vehicles are typically used when cargo considerations are governed by weight rather than the cubic capacity of the trailer.

- **Turnpike Double**- A tractor plus double trailers. Each trailer is between 12.2 m (40 feet) and 16.2 m (53 feet) long. The Turnpike Double is typically used for carrying cargo that benefits from the additional cubic capacity of the trailer arrangement.

- **Triple Trailer**- This combination consists of a tractor with three trailers of approximately the same length. The typical trailer length is approximately 7.3 m and 8.5 m (24 to 28 feet). The Triple Trailer is used for carrying cargo that benefits from the additional cubic capacity of the trailer arrangement or from the operational flexibility of having three smaller trailers that can be easily redistributed as separate vehicle units at the point of origin and destination.

All LCVs operate in Alberta under permits with strict safety requirements and are generally restricted to travelling on 4-lane highways subject to driver and vehicle operational restrictions. An exception is the Rocky Mountain Double, which is permitted to travel on an expanded route.

Figure 1 illustrates common LCV configurations in comparison to standard configurations of trucks used on roadways. In Alberta the overall length of LCVs varies from greater than 31 m (102 feet) to 37 m (121 feet).

[1] Also known as Energy Efficient Motor Vehicles (EEMVs).

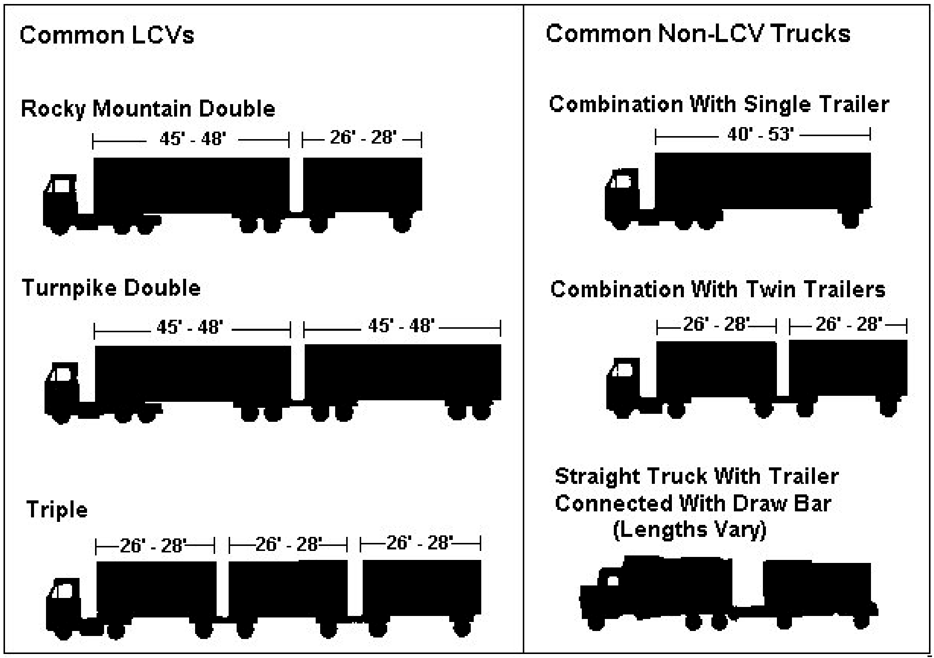


Figure 1. Illustration of Common LCV Configurations and Standard Configurations

(Also referred to in the literature as EEMVs, Energy Efficient Motor Vehicles) *

* Source: Road Management and Engineering Journal

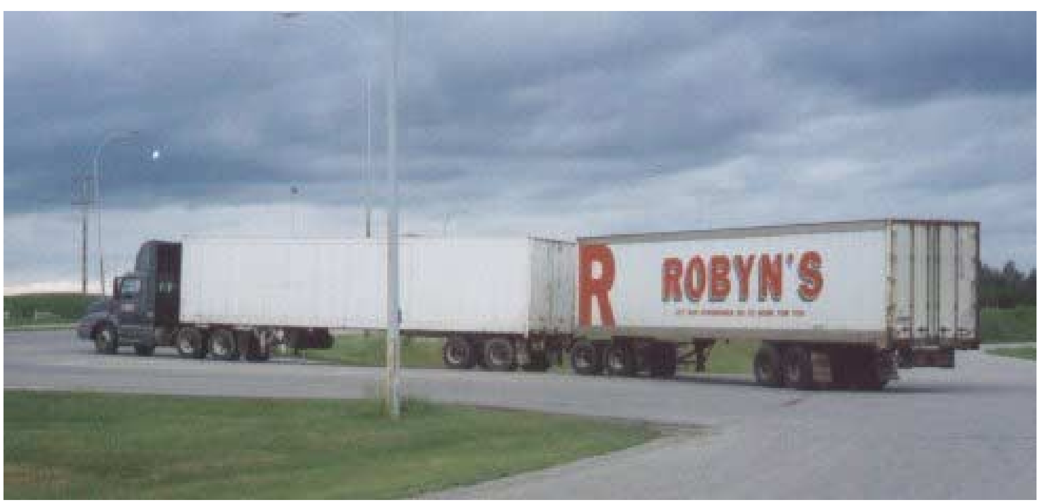


Figure 2. Example of a Turnpike Double Combination

(Photo Copyright Lloyd Ash: Used With Permission)

Figure 3. Example of a Rocky Mountain Double Configuration
(Photo Copyright Lloyd Ash: Used With Permission)

1.2 Project Scope

Alberta Infrastructure's Transportation Policy and Economic Analysis Branch commissioned Woodrooffe and Associates to undertake an in-depth review of Long Combination Vehicles (LCVs) in Alberta during the period 1995 to 1998. In addition, project funding was also received from Western Economic Diversification Canada under the Canada-Alberta Western Economic Partnership Agreement Program. As such, the findings of this report do not necessarily represent the views of any individual, party or organization that commissioned or contributed information to the analysis of the results. The independent research and consulting team used the best available data within the time and budget constraints. Readers are urged to fully understand any limitations of this study as outlined in Section 2.2 Study Methodology and Approach and to exercise any caution that may be warranted as a result of this methodology when using the results.

The goals of this study are to:

- Determine road safety performance of commercial trucks including LCVs
- Determine the contributing factors to collisions involving LCVs

1.3 Provincial Vehicle Registrations

When Alberta vehicle registrations are reviewed in Table 1 and Figures 4 to 7, it is observed that the total number of non-trucks has increased approximately 23% during the period 1987 to 1998. During the same time the total number of all truck configurations declined by 19%. This reflects the time period in which higher gross vehicle weights were introduced thereby reducing the number of trucks required to perform a given transport task.

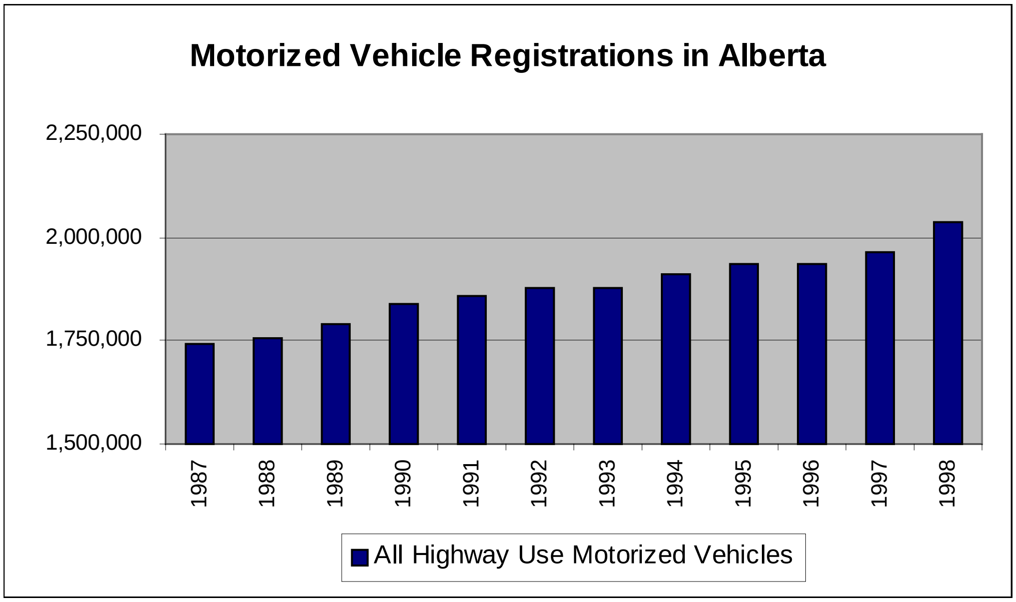
Within the "truck" category, a significant decline has occurred in the number of 3 axle (small straight) trucks, while significant growth has taken place in the larger truck categories. The major change in the composition of trucks occurred in the 3 axles and 6 or more axle configurations. There was a 26% decline in 3 axles and an increase of 221% in 6 or more axle vehicles. The decline in the number of 3 axle wheels represents a significant shift in truck size and productivity in Alberta.

Table 1. Vehicle Registrations in Alberta 1987 to 1998

Year	Total Vehicles	Trucks (> 3,000 kg)				Non Trucks Total
		3 Axle	4,5 Axle	6+ Axle	Total	
1987	1,741,899	245,058	15,447	2,547	263,052	1,478,847
1988	1,757,361	235,012	16,502	3,189	254,703	1,502,658
1989	1,788,739	230,834	17,751	3,926	252,511	1,536,228
1990	1,839,815	226,824	18,287	4,719	249,830	1,589,985
1991	1,857,699	214,489	18,720	5,103	238,312	1,619,387
1992	1,875,212	201,291	18,890	5,045	225,226	1,649,986
1993	1,878,707	191,692	18,988	5,446	216,126	1,662,581
1994	1,910,612	187,995	20,165	6,584	214,744	1,695,868
1995	1,935,076	185,114	21,646	7,551	214,311	1,720,765
1996	1,934,863	178,913	22,029	7,751	208,693	1,726,170
1997	1,962,789	178,730	22,324	7,923	208,977	1,753,812
1998	2,038,687	181,734	24,216	8,174	214,124	1,824,563

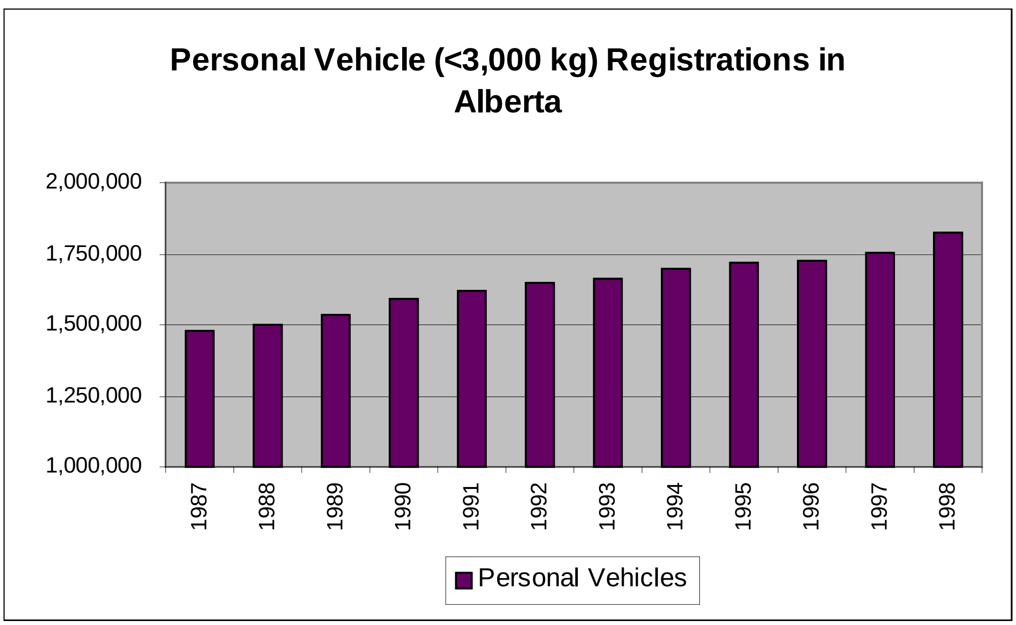
Source: Alberta Infrastructure, Transportation Policy & Economic Analysis estimated from Alberta Registries – Motor Vehicles, based on registered GVW.

Fewer commercial vehicles in total demonstrate that increased truck weights and the use of LCVs have reduced the number of trucks required to haul freight even though the economy has been growing. The reason that fewer trucks are doing more work is that the potential capacity of the transportation system has been increased by size and weight policy initiatives including the use of LCVs. The fact that fewer trucks are required to move the same amount of cargo represents an important benefit particularly given that the carrying capacity of the trucking fleet reflects the growth of the population and the economy. Alberta vehicle registration information is demonstrated graphically in Figures 4 through 7.



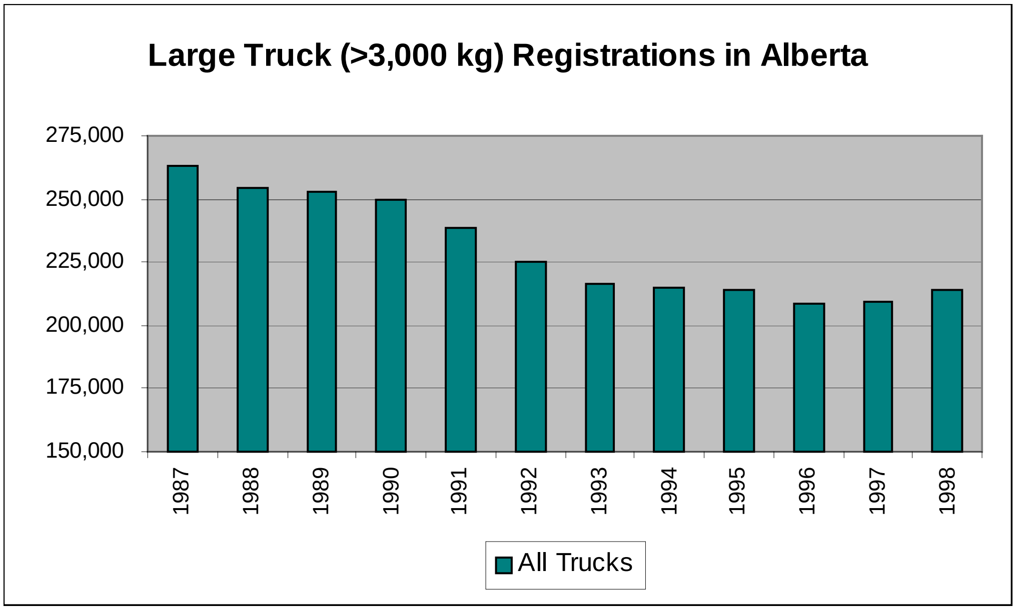
Source: Alberta Infrastructure, Transportation Policy & Economic Analysis estimated from Alberta Registries – based on registered GVW

Figure 4. History Of All Vehicle Registrations In Alberta



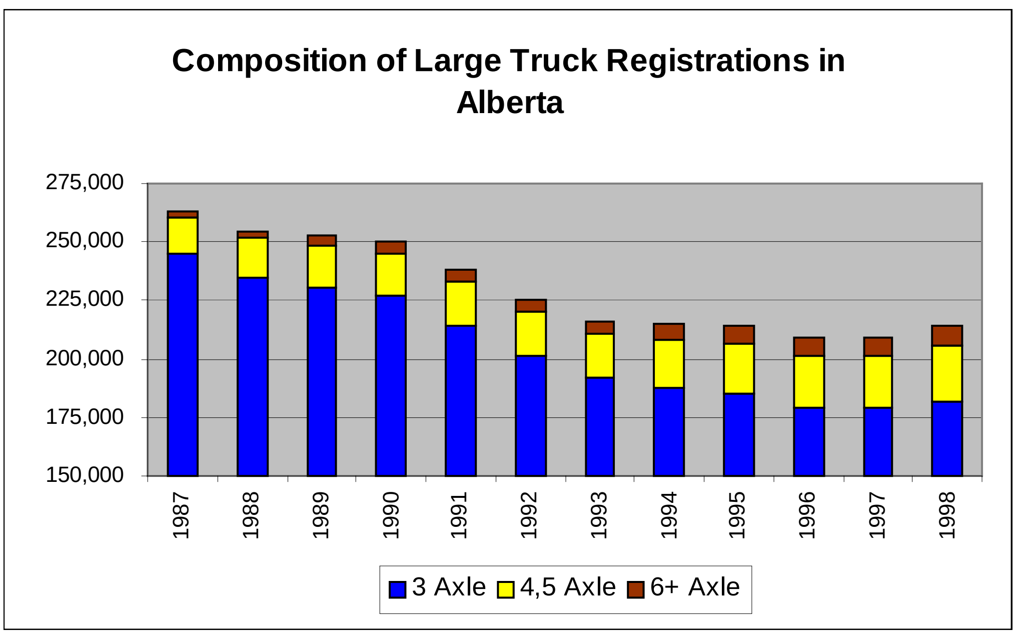
Source: Alberta Infrastructure, Transportation Policy & Economic Analysis estimated from Alberta Registries – based on registered GVW

Figure 5. History Of Personal Vehicle Registrations In Alberta



Source: Alberta Infrastructure, Transportation Policy & Economic Analysis estimated from Alberta Registries – based on registered GVW

Figure 6. History Of Large Truck Registrations In Alberta



Source: Alberta Infrastructure, Transportation Policy & Economic Analysis estimated from Alberta Registries – based on registered GVW

Figure 7. History Of Large Truck Registrations By Number Of Axles In Alberta

2. SCOPE OF VEHICLE OPERATIONS

2.1 The Study Location

The operation of LCVs in Alberta is restricted to specific routes or a sub-network within the entire provincial road and highway system. This is in recognition that the length of LCVs normally exceeds the allowable overall length of 25 metres for truck-trailer combinations. To facilitate safe passing, Turnpike Double and Triple Trailer combinations are only allowed to operate on 4-lane highways. The Rocky Mountain Double is the only LCV that can operate on all 4-lane highways and select 2-lane highways in the province (except for Highway 1A east of Calgary, where Turnpike Doubles and Triples are also permitted).

Of the total provincial network of 13,776 km, this study focuses on the sub-network of 2,800 km in which LCVs are permitted to operate.[2] All routes over which the largest LCV configurations (Turnpike Doubles and Triple Trailers), are permitted to operate, are included. That is, all 4-lane divided highways in the province of Alberta plus those 2-lane highways where Rocky Mountain Doubles may operate. The heavy line in Figure 8 illustrates the sub-network segments for which traffic volume information and collision data was evaluated in this study by the consulting team.

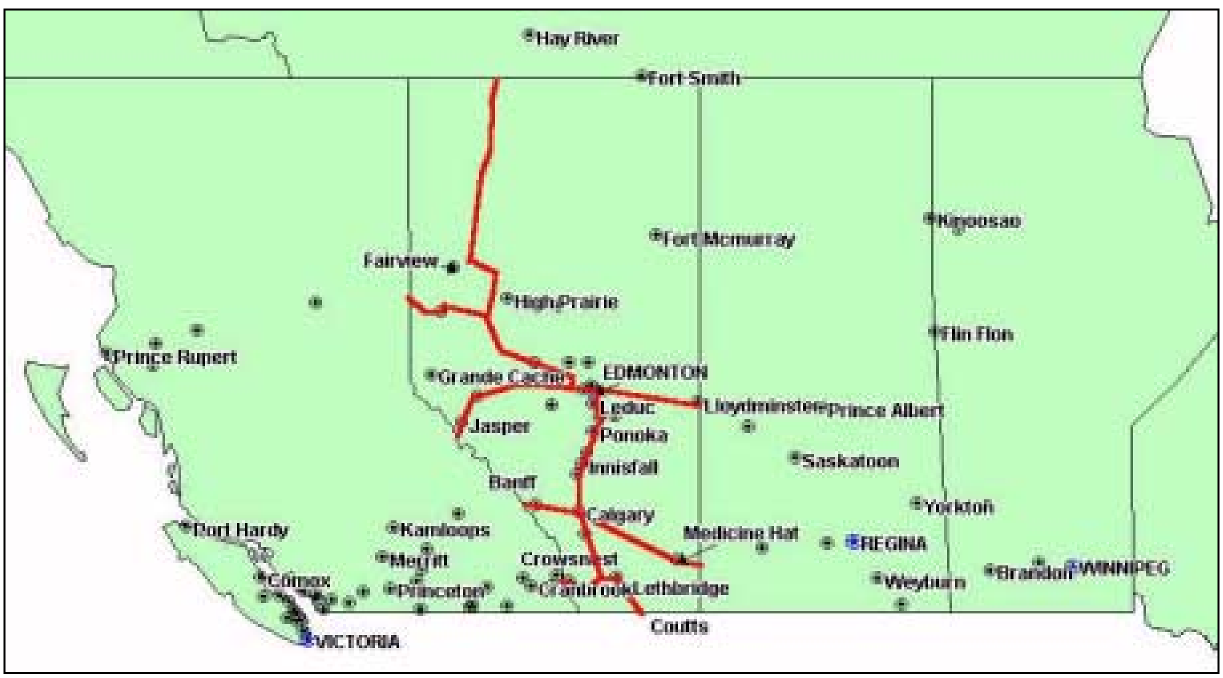


Figure 8. LCV Highway Segments in Alberta

[2]Out of the total provincial road system of 13,776 km, this study focused on the sub-network of approximately 2,800 km in which LCVs are permitted to operate. LCV vehicles can travel at 100 or 110 km/hr. All routes over which the largest LCV configurations (Turnpike Doubles and Triple Trailers), are permitted to operate, were included. That is, all 4-lane divided highways in the province of Alberta plus those 2-lane highways where Rocky Mountain Doubles may operate.

The specific links evaluated in this project are described in table 2.

Table 2. Road Segments Defining the Sub-Network

Area	Highway	Description	# of Lanes
Area 1	Hwy 4	Coutts to Lethbridge	4
Area 2	Hwy 3	Crowsnest Pass to Jct Hwy 2	2
Area 3	Hwy 3	Jct Hwy 2 to Lethbridge	4
	Hwy 2	Jct Hwy 3 to Calgary	4
	Hwy 1	Banff Park Gates to Calgary	4
Area 4	Hwy 1	Calgary to Alberta/Saskatchewan border	4
Area 5	Hwy 2	Calgary to Red Deer	4
Area 6	Hwy 2	Red Deer to Edmonton	4
Area 7	Hwy 16	Jasper Park Gates to Edmonton	4 (mostly)
Area 8	Hwy 16	Edmonton to Alberta/Saskatchewan border	4
Area 9	Hwy 43	Alberta/BC border to Jct Hwy 16	2 + 4
Area 10	Hwy 49	Jct Hwy 43 to Jct Hwy 2	2
	Hwy 2	Jct Hwy 49 to Jct Hwy 35	2
	Hwy 35	Jct Hwy 2 to Alberta/NWT border	2

2.2 Study Methodology and Approach

2.2.1 Method Used to Analyze Vehicle Road Safety Performance

There are two separate methods that may be used to analyze collision data. The collision rate relationships are defined in the following equations:

Equation A

$$\text{Vehicle involvement by collision} = \frac{\text{Number of collisions involving a given vehicle type}}{\text{Total kilometers traveled by that vehicle type}}$$

Equation B

$$\text{Collision by vehicle type} = \frac{\text{Number of vehicles of a given type involved in collisions}}{\text{Total kilometers traveled by that vehicle type}}$$

Equation A is based upon vehicle involvement by collision. In this analysis, “the collision” is the primary investigative factor and is used in the numerator of the collision rate equation. The number of collisions is determined and the vehicle types involved in the collision are recorded.

When examining vehicle involvement, a collision involving two vehicles of the same type would only register one vehicle type. Therefore if there were 100 collisions involving 200 private vehicles, the number of collisions involving private vehicles would be recorded as 100. The analysis method is known as "*Vehicle Involvement by Collision.*"

Equation B is the second method, which can be used to analyze the data. It is based upon the type of vehicle involved in an incident. In this analysis, "the vehicle involved in the collision" is the primary investigative factor therefore the "total" number of vehicles involved in the collisions is known. Thus, the total number of vehicles involved is used in the numerator of this form of the collision exposure rate equation. When examining vehicle involvement, the numbers of all vehicles involved in the collisions are recorded. If there are 100 collisions involving 200 private vehicles, the number of vehicles involved in the collisions will be counted as 200. This method is known as "C*ollisions by Vehicle Type.*"

> The results from these separate methods differ substantially and misunderstanding the definitions can have a deleterious effect on data interpretation. The "V*ehicle Involvement by Collision*" method is useful for collision-based analysis. Questions such as "how many collisions have occurred?" and "where and when did they occur?" are well served by this method.

When examining vehicle involvement in collisions, the "*Collision by Vehicle Type*" method of analysis is preferred. This method fully accounts for the "total" number of vehicles involved in collisions and therefore accurately represents involvement rates for the various vehicle types. Based on the above reasons, this study used the "*Collisions by Vehicle Type*" analysis method because it more faithfully represents the actual collision history of all vehicles of each vehicle class. For completeness, Appendix A includes the results of the analysis using the alternative approach.

The vehicle type definitions used to analyze the collision exposure analysis were derived from the Alberta Collision Report Form and electronic database provided by Alberta Infrastructure. [3] The term "object identification" refers to a box on the Collision Report Form in which the type of vehicle involved in the collision is identified. The vehicle types examined in this study were as follows:

- **Unit Truck**- This was defined as object identification 04. Any unit truck with a trailer attached was eliminated from the data set.

- **Tractor Semi-Trailer**- This was defined as "truck tractor" (object identification 05) plus "large single trailer (attachments 01). That is, all vehicles in data set having "truck tractor" or "truck >4500 kg" and one trailer.

[3] Information on Alberta Infrastructure Traffic Safety Services can be obtained from http://www.infras.gov.ab.ca/

- **Multi Trailer**- This means double trailer. These were identified as "truck tractor" (object identification 05) plus "large double trailer" (attachments 02). That is, all vehicles in data set having "truck tractor" or "truck >4500 kg" and two trailers minus all Turnpike Doubles and Rocky Mountain Doubles.

- **Rocky Mountain Double, Turnpike Doubles and Triples**- These were identified by collision case numbers and were not double counted in the data set. The Collision Report Forms for the LCV vehicle types were individually examined by the consultant. In addition, interviews were undertaken to verify the vehicle type.

- **Personal Vehicles**- These include the following:
  Passenger cars (object identification 01)
  Pick-up/Van <4500kg (object identification 02)
  Mini-Van/MPV (object identification 03)

Vehicles not included in the analysis of the Long Combination Vehicles Safety Performance in Alberta 1995 to 1998 study were motorcycles, bicycles, scooters, mopeds, buses (school, transit or intercity), recreational vehicles, emergency vehicles (ambulances, fire trucks), farm or construction equipment and off-highway vehicles.

Collision exposure rate equations A and B both use the same numbers in the denominator of the formula for calculating the distance-traveled for each vehicle type. The consulting team estimated the distance-traveled for each vehicle type using traffic volume statistics and the length of the individual highway segments in the following manner.

Alberta Infrastructure provided the consultant with highway traffic count statistics (for all highway segments in the sub-network) for each of the years 1995 to 1998. These statistics contain the Annual Average Daily Traffic (AADT) counts for all vehicles traveling on each highway route in either direction. The AADT statistics are given as the daily weighted averages over the entire Highways Control Sections and Traffic Control Sections. The (weighted) daily average traffic volume for a traffic control section is estimated using the travel distances at monitored sites within the traffic control section. The (weighted) daily average vehicle classification for a traffic control section is estimated using the cumulative travel distances and historical classification from manual traffic counts, at monitored sites within the traffic control section.[4]

The AADT statistics measure traffic volumes for the following vehicle types: personal vehicle, recreational vehicle, buses, single unit trucks and tractor-trailer trucks. Thus, it was possible to estimate the total volume for the LCV sub-network.

[4] Details on Alberta's Traffic Volumes, Vehicle Classification, and Travel statistics can be obtained from the Alberta Infrastructure Internet site http://aicm/Content/doctype181/production/hnp004.htm

In order to estimate the volume of commercial vehicles and LCVs using the sub-network highway an additional vehicle survey was required. The LCV vehicle mix on the sub-network was determined from the 1999 Canadian Council of Motor Transport Administrators (CCMTA) National Road Survey. Hourly traffic counts were maintained, on a continuous basis, during the week of July 13-19th. Figure 9 indicates the truck weigh scales that were used at the survey locations. The Data Collection Form for Truck Counts is located in the Appendix C.
The total traffic volume by vehicle type was developed by generating estimates of travel distance for each class of vehicle on the sub-network. The information was used to determine the LCV collision exposure rate relative to other vehicles (as detailed in Section 3 of this report). It included all Turnpike and Triple routes and the expanded Rocky Mountain Double routes.
The routes analyzed are representative of the various highway segments found in Alberta. From this information, the total distance-traveled by each vehicle type was determined and is used as the denominator in both collision exposure rate equations.

Appendix D includes the LCV vehicle classification percentages that were used to balance the total traffic statistics, traffic estimates by highway section, and vehicle type for the LCV sub-network as generated by the information collected by Alberta Infrastructure from the Highway Control Sections.

Figure 9. Weigh Scale Locations

Detailed analysis of collision rates was restricted to the sub-network, given the difficulty in resolving the collisions per kilometres traveled, by vehicle type, within an urban area, which would be essential for comparative purposes. Therefore, urban LCV collisions were considered only in the detailed case-by-case analysis of contributing factors to LCV collisions. This information is detailed in Section 4 of this report.

When comparing exposure levels amongst the different vehicle types from within this study it is important to note that the volume of traffic and the distance-traveled by each vehicle type is based on the total traffic volume as indicated by each of the Control Sections (as defined by Alberta Infrastructure) on the highway. The method used to calculate the vehicle distance by LCVs recognized the time of day operating restrictions on LCV use. Thus, daily traffic count volumes were adjusted to reflect the fact that they could not operate 365 days of the year.

For a given section of highway there are one or more Control Sections used to measure traffic volume. Each Control Section has one or more Traffic Control Sections. A Traffic Control Section is a portion of roadway having similar characteristics. These occur at intersections of roads along a highway Control Section and are used to record the turning movements of vehicles entering or leaving a portion of highway. They act as additional control points for measuring the traffic volume on the respective roads and for classifying vehicles. Appendix B illustrates a typical highway control section that is used to generate the AADT traffic volume counts on the sub-network.

Table 3 summarizes the control sections used in this study to determine total traffic volume and distance-traveled by each vehicle type. It is important to note that the average distance between Control Sections was less than 40 km and the distance between Traffic Control Sections was approximately 12 km.

Table 3: Alberta LCV Sub-Network Highway Control Sections

Description	Kilometres
Total kilometres of highway on LCV sub-network	2,830
Number of Control Sections in sub-network*	73
Average kilometres between Control Sections in sub-network	38.0
Number of Traffic Control Sections in sub-network	219
Average Kilometres between Traffic Control Sections in sub-network	12.3

**Note: includes the highway sections in the National Parks that are part of the sub-network*

2.3 Error and Uncertainty Discussion

The estimated accuracy for LCV activity applicable for the higher traffic volume links (Calgary-Edmonton corridor, Trans-Canada, Yellowhead) would be within ± 2 or ± 3 percent. The accuracy of LCV activity on individual links for the rest of the sub-network would show greater uncertainty, perhaps ± 10 percent due to sample size factors cited. There are statistical sampling considerations required when using roadside commercial trucking surveys to estimate annual movements of vehicle populations.

These considerations are more pronounced for small samples such as “one day roadside surveys” and “low volume route linkages,” where the observed variances in samples point to a significant uncertainty in the overall magnitude of the population being sampled. This being recognized, it is noted in Appendix B1 that “most” of the LCV activity sampled for the province of Alberta occurs on Highway 2 between Calgary and Edmonton as well as on the Yellowhead Corridor and Trans Canada Highway Corridor. For these routes, the “sampling frequency” associated with measurement of AADT values coupled with the “cross checks” from vehicle classification studies, “weigh in motion sampling” and “national parks gate screen counts,” enable considerably better precision in our estimates. The quality of vehicle classification information was maximized by using data from the National Road Survey which was based on a 7 day, 24 hour sample.

The other area of “statistical” uncertainty may relate to “seasonality” of activity, however this type of traffic variation would be more applicable to other types of trucking (e.g. seasonal construction materials, agricultural commodities, etc.) than it would be for the goods known to be moved in LCVs, which tends to be retail store freight, including groceries. Based on the above considerations the estimated error is +/- 10% for the data analyzed.

2.4 Methodological Factors Influencing the Comparative Use of the Study to U.S. Research

The United States Federal Highway Administration publishes its data based on the *“Vehicle Involvement by Collision”* method. For comparative purposes the data for this study has been re-analyzed in Appendix A using this method. There are other methodological differences that may influence the comparative analysis of the U.S. collision rate statistics and the results of this study.

These factors are related to the calculations of the distance-traveled variable. The method used in this study for estimating exposure (vehicle distance-traveled is the denominator in the collision rate equation) is also different than that used in the U.S. where the commodity based database is used to approximate the distance-traveled. This method can be successfully used in the U.S, because of their larger vehicle population. When comparing the collision rate from this Alberta study it is important to note that U.S. calculations include vehicles in both urban and rural area whereas this study only calculated the collision exposure rates for the non-urban areas. Thus, the significant difference must be considered in the interpretation of any results of this report with U.S. findings.

This study and the U.S. collision database both use police collision reports and not property damage reports as the data entry threshold; therefore there is no measurement error from this source in the number of collisions by each of the vehicle types. To address concerns about the relatively small vehicle population in Alberta compared to the U.S. this study analyzed a four-year block of data from 1995 to 1998.

2.4.1 Method Used to Analyze Long Combination Vehicle Collisions

In Section 4 (Analysis of Long Combination Vehicle Collisions), collision reports were individually reviewed by the independent consulting team and analyzed to determine the contributing factors (i.e. overtaking maneuvers, adverse conditions and configuration related) to collisions involving LCVs for the period 1995 to 1998. In addition, for fatal and personal injury LCV collisions a review of "probable fault" was undertaken. There were no estimation errors associated with the analysis given the fact that this study reviewed all LCV collisions that occurred in Alberta during the four-year period.

3. Analysis of Vehicle Road Safety Performance

For the period of 1995 to 1998, there were a total of 53 reportable traffic collisions involving LCVs in the Province of Alberta.[5] This represents less than 14 collisions per year. Within the sub-network study area there were 37 LCV reportable traffic collisions (Table 4). The remaining 16 collision incidents involving LCV vehicles occurred in urban locations. In reviewing collisions in urban areas it is difficult to establish a basis for analyzing the collisions per kilometres traveled, by vehicle type, which is essential for comparative purposes. Therefore, urban LCV collisions are considered only in the analysis of LCV collisions by configuration type.

Detailed analysis is restricted to the sub-network defined in section 2.1 Study Location. It includes all Turnpike and Triple routes and the expanded Rocky Mountain Double routes. These routes are representative of the various highway sections found in the province.

[5] The definition of an LCV collision used for this study is any collision where a police traffic accident report was completed. It is important to note that there may be some instances where a report was completed despite the lack of significant damage. For example, in one case a farm equipment vehicle slid on ice and touched a LCV resulting in no significant damage.

Table 4. Collisions by Vehicle Type Sub-Network 1995-98

Vehicle Type	Total Vehicles in Collisions	Fatal	Injury	PDO	Total Distance Traveled (100 million Km)
Unit Truck	715	14	131	570	3.82
Tractor Semi	918	38	251	629	11.54
Multi Trailer	418	19	123	276	4.03
Rocky Mountain	11	0	2	9	1.07
Turnpike Doubles	20	2	5	13	1.19
Triples	6	0	2	4	0.090
Personal Vehicles	19,206	259	3,560	15,387	217.87
Total Number of Vehicles	21,294	332	4,074	16,888	239.61
All LCV	37	2	9	26	2.34

Note (1): PDO stands for Property Damage Only collisions

Note (2): In this analysis, collisions involving two or more vehicles of the same type will be counted as two or more incidents, that is, a collision involving three personal vehicles will be registered as three events. A collision involving two different vehicle types will be registered as two events.

On the sub-network there were a total of 21,294 vehicles involved in collisions during the four-year period 1995 to 1998. As shown in Table 4, there were 332 vehicles involved in fatal collisions, 4,074 vehicles involved in injury collisions and 16,888 vehicles involved in 'property damage only' (PDO) collisions.

This data represents the total vehicles involved in collisions by distance-traveled for each vehicle type on the ten highway segments during the four-year period.

LCVs were involved in 37 incidents or approximately 9.25 incidents per year. Personal Vehicles were involved in approximately 19,206 annual collision incidents. Based on these absolute measures, LCVs accounted for 0.17 % of all vehicles in collision incidents within the sub-network and Personal Vehicles accounted for 90% of all vehicles in collision incidents during the period 1995 to 1998.

Referring to the absolute number of collisions listed in Table 3, Tractor Semi-Trailers are involved in 28% more collisions than Unit Trucks but the total distance-traveled (exposure) by Tractor Semi-Trailers is 3 times that of Unit Trucks. It is also noted that LCVs average 0.5 fatal collisions per year compared with 65 fatal collisions for Personal Vehicles. In other words, LCVs on average are involved in a fatality once every two years within the sub-network area.[6] Part of this low involvement rate is attributed to less vehicle exposure.

[6] It is important to note that in a 'fatal' collision incident that may be more than one fatality. The Alberta *Traffic Collision Statistics1999* reveal that for the period 1995 to 1998 the average number of people killed per 'fatal collision' incident involving all vehicle types was 1.2 people. The average number of people killed per 'fatal collision' incident involving only truck tractors was 1.3 people. This data represents the entire Alberta road network.

The study revealed that the LCVs accounted for less than one percent, i.e. 0.60%, 0.22% and 0.15% of all vehicles in fatal, injury and PDO collisions respectively on the sub-network. The fatal, injury and PDO collisions involvement in personal automobiles were approximately 78%, 87% and 87%, respectively.

The *Alberta Traffic Collisions Statistics 1998 and 1999* editions reveal that Personal Vehicles were involved in 79% of fatal collisions and 91% of injury collisions when measured across the entire Alberta road network. This finding clearly indicates that Personal Vehicles were involved in a smaller percentage of casualty collisions (fatal and injury) on the sub-network (82%) in which LCVs are permitted to operate than the general road network (91%). The urban area does however present a higher risk to all vehicle types because of the large number of intersecting roadways, road access opportunities and high traffic density within the urban area. The percentage of commercial trucks involved in casualty collisions (fatal and injury) on the sub-network was 13.3% and 1.9% for the general Alberta road network.

To more objectively measure the relative performance of different vehicle classes, it is useful to consider the variable "distance-traveled" by the subject vehicle class. By doing so, the relative safety performance of vehicles can be compared in a meaningful way. Relative safety performance is expressed in events per 100,000,000 km travelled.
Table 5 contains data showing the relative collision involvement of all of the vehicle classes on the sub-network.

TABLE 5. COLLISION RATES BY VEHICLE TYPE

(Within the Sub-Network 1995-98)

Vehicle Type	Per 100 million km traveled			
	Total Vehicles in Collisions	Fatal	Injury	PDO
Unit Truck	187.19	3.67	34.30	149.23
Tractor Semi	79.52	3.29	21.74	54.49
Multi Trailer	103.70	4.71	30.52	68.47
Rocky Mountain	10.31	0.00	1.87	8.43
Turnpike Doubles	20.00	2.00	5.00	13.00
Triples	16.87	1.69	4.22	10.96
Personal Vehicles	88.15	1.19	16.34	70.62
Total Number of Vehicles	88.87	1.39	17.00	70.48
All LCV	15.80	0.85	3.84	11.10

Note (1): PDO stands for Property Damage Only collisions

Note (2): In this analysis, collisions involving two or more vehicles of the same type will be counted as two or more incidents, that is, a collision involving three personal vehicles will be registered as three events. A collision involving two different vehicle types will be registered as two events.

The findings show that LCVs have the lowest collision rate when compared with other commercial vehicles in Alberta. When comparing the collision rate amongst truck configurations, it is noted that the smallest trucks and hence those with the shortest length and least vehicle weight have the highest collision rates.[7] When LCVs are considered as a group they have a collision rate that is 11.85 times lower than that of Unit Trucks.

On a distance-traveled basis, Personal Vehicles including passenger cars, mini vans and pickup trucks, are involved in collisions 5.58 times more frequently than LCVs. Tractor-Semi vehicles collision exposure rate is 5.03 times higher than that of LCVs.

Within the LCV class, Rocky Mountain Doubles have the lowest collision rate. The collision rate for Turnpike Doubles is approximately 1.94 times higher than the Rocky Mountain Doubles. The Triple Trailer LCV collision rate is 1.64 times higher than the Rocky Mountain Doubles.

Despite the relative difference in involvement between the Rocky Mountain Double and the Triple Trailer LCV, the collision rate for Triples was found to be 4.71 times lower than common Tractor Semi-Trailers.

It is important to consider that this data is for collisions occurring on highways at highway speed and they do not include collisions within urban areas.

The above analysis is based on the figures contained in Table 5. However, as Section 2.2 Study Methodology and Approach indicates, the results are subject to measurement errors arising from study design and data limitations. As a result the collision exposure rates are best examined and interpreted from the perspective of the relative range of values as revealed in Table 6.

[7] As noted in section 2.2. Study Methodology, this comparison does not necessarily imply that the collision rate for non–LCV truck configurations in higher than that experienced in other jurisdictions.

Table 6. Error Sensitivity of Collision Rate by Vehicle Type
(Within the Sub-Network 1995-98)

Vehicle Type	Estimated Error	Per 100 million km traveled: Collision Rate Error Estimate Range		
		Low	Calculated Rate	High
Unit Truck	± 10%	168	187	206
Tractor Semi	± 10%	72	80	87
Multi Trailer	± 10%	93	104	114
Rocky Mountain	± 10%	9	10	11
Turnpike Doubles	± 10%	18	20	22
Triples	± 10%	15	17	19
Personal Vehicles	± 10%	84	88	93
Total Number of Vehicles	± 10%	84	89	93
All LCV	± 10%	14	16	17

Table Notes (1): PDO stands for Property Damage Only collisions. (2): In this analysis, collisions involving two or more vehicles of the same type will be counted as two or more incidents, that is, a collision involving three personal vehicles will be registered as three events. A collision involving two different vehicle types will be registered as two events.

Table 6 reveals that the relative ranking of collision rate is not sensitive to the study's methodology and measurement error. In fact, in order for the collision rate rankings to change, a substantial change in the number of collisions or the distanced-traveled would be required.

For example, assuming that the collision rate of the vehicle with the lower rate remained constant, the following events would need to occur before the collision rates of the two vehicles would be equal.

Unit Truck compared to Tractor-Semi:
Collisions reduced by more than 57.5%
Distance-traveled increased by more than 235.4%

Tractor-Semi compared to LCVs:
Collisions reduced by more than 79.2%
Distance-traveled increased by more than 503.3%

4. Analysis of Long Combination Vehicle Collisions

To better understand the factors contributing to LCV traffic collisions, a detailed analysis was conducted for all LCV collisions to determine most probable cause, fault and the influence of vehicle dynamic design factors that may have played a part in the collision. In addition, the LCV collisions were examined to determine if vehicle length or configuration type were contributing factors to the collision.

4.1 General Description of Long Combination Vehicle Collisions

Within the Alberta road network there were 53 collisions involving LCVs, during the period 1995 to 1998. Of this total, 3 were fatal collisions and 2 were within the sub-network, 26% (14) resulted in injury and 68% (36) involved property damage only. Of the 14 injury collisions, 13 resulted in minor injuries (injuries not requiring hospital admission).

There was one LCV collision that involved a major injury. The injury occurred when the passenger vehicle disobeyed a traffic signal and struck the lead trailer of an LCV. Property damage collisions tended to be relatively minor in nature. Of these property damage collisions 25% were single vehicle incidents involving animals such as deer and moose. The remaining property damage collisions (75%) included single vehicle departures from the highway or collisions with other vehicles or objects.

Table 7 reveals that sub-network accounted for 70% (37 out of 53) of the collisions during the period 1995 to 1998. Of this total, 2 were fatal collisions, 24% (9) resulted in injury and 70% (26) involved property damage only.

Table 7. LCV Collision Distribution

Configuration Type	Collisions		
	Sub-Network	Urban	Total
Rocky Mountain Double	11	1	12
Turnpike Double	20	10	30
Triple	6	5	11
Total	37	16	53

Note: The sub-network refers to the LCV Highway Segments referred to in Figure 6.

Table 7 also illustrates the absolute number of LCV vehicle configurations involved in either urban or non-urban (sub-network) collisions. For example, Rocky Mountain Doubles were involved in approximately 30% of the sub-network incidents but only 6% of the urban collisions.

It should be noted that Triples were involved in approximately 8% of sub-network highway incidents but over 31% of the urban collisions investigated.

To obtain more insight and discover possible trends, the details of the network and urban collisions have been compiled in Table 8. All of the LCV collisions on the sub-network occurred on the open road. Almost all (88%) of the urban LCV collisions occurred at intersections where other vehicles disobeying traffic signals and were found to be responsible for 29% of the urban LCV collisions. On average, road surface and weather conditions were possible factors in 49% of all sub-network collisions and 31% of all urban collisions. There were only 2 reported cases of an LCV rear-ending another vehicle. Both of these collisions involved Triples and both occurred at city intersections. Because of the small numbers, this could be a coincidence or it may indicate that brake timing is a factor with some Triples.

Table 8. LCV Collision Details for all Sub-network and Urban Collisions 1995-1998

Configuration	Sub-network	Urban
Rocky Mountain Doubles	**Total collisions = 11** • 8 single vehicle collisions, 5 of which were animal related and 3 were road surface condition related. • 2 involved other vehicles. • 1 related to road construction. • All collisions occurred on the open road. 4 of the 5 animal collisions occurred on 2-lane roads. • In total 8 of the collisions may be related to road surface conditions.	**Total collisions = 1** • LCV sideswiped by a vehicle where alcohol was involved. • Occurred at an intersection. • No collisions were related to road surface condition.
Turnpike Doubles	**Total collisions = 20** • 6 single vehicle collisions, 3 of which were animal related, 2 were road condition related and 1 was fatigue related. • 14 involved other vehicles of which 6 were road condition related. • 1 related to road construction. • All collisions occurred on the open road • All of the animal collisions occurred on 4-lane divided roads. • In total 8 of the collisions may be related to road surface conditions.	**Total collisions = 10** • 8 occurred at intersections. • 8 involved errors by other vehicles, including 3 disobeyed traffic signals and 1 improper turn. • 2 were the fault of the LCV. • In total 4 of the collisions may be related to road conditions.
Triples	**Total collisions = 6** • 4 single vehicle collisions, 1 animal related, 2 were road condition related and 1 was mechanical related (2 occurred on 2-lane roads). • 2 involved other vehicles 1 of which was road condition related. • All collisions occurred on the open road • The animal collision occurred on a 2-lane road. • In total 2 of the collisions may be related to road surface conditions.	**Total collisions = 5** • 5 occurred at intersections. • 3 involved errors by other vehicles including 1 disobeyed traffic signal. • 2 were the fault of the LCV, both were rear end collisions. • In total 1 of the collisions may be related to road surface conditions

4.2 Probable Fault Long Combination Vehicles

For the purposes of the study, probable fault was determined from the collision report information and was verified by studying the particulars of every collision. In all collisions involving wildlife or highway debris, the LCV was not considered to be at fault. Unusual events such as an LCV trailer decoupling or a trailer of an LCV being overturned by wind were assumed to be the fault of the LCV. In all other cases, the LCV was considered to be at fault when the investigating officer indicated that the LCV had not been driven properly.

The analysis determined that LCVs were not at fault in any of the fatal or major injury collisions within the entire network. Out of the total number of collisions involving LCVs three were fatal.

One fatal incident involved a pedestrian attempting to cross a 4-lane divided highway at night. The second fatal collision occurred when a passenger car entered a divided highway travelling in the wrong direction. The third fatality occurred when a passenger car failed to stop at an intersection controlled by a flashing red light and collided with an LCV. In none of the fatality collisions would the LCV be considered at fault.

4.3 Overtaking Maneuvers Long Combination Vehicles

Through the use of a permit system, the shortest of the three types of LCVs, the 31 m Rocky Mountain Doubles, are the only ones allowed on some 2-lane highways. There were no reported incidents involving LCVs on 2-lane undivided roads where vehicle overtaking was sighted as the contributing factor in a collision. However, there were two incidents that occurred during overtaking maneuvers on 4-lane divided roads. One case involved a Tractor Semi-Trailer overtaking an LCV. Snow blowing off the passing Tractor Semi Trailer obscured the vision of a passenger car, which then collided with the LCV. This is a common problem with large vehicles operating during the winter months. As the truck gains speed, aerodynamic forces disturb snow that has accumulated on top of the trailer resulting in a localized whiteout, which can affect vehicles in the immediate traffic stream. The unexpected loss of vision can result in loss of directional reference.

The second incident also occurred on a 4-lane divided highway and resulted in a Pickup Truck losing control while being passed by an LCV. The collision report form indicated that the LCV was driving properly and road surface factors were an issue. Loss of vehicle control on slippery roads is a significant risk to any vehicle.

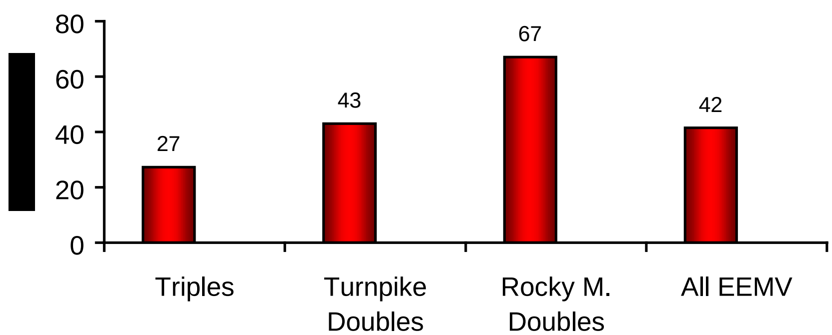
It is possible that factors such as wind pressure or reactive anxiety may have created the initial conditions that may have lead to loss of control, but if they did exist these factors were undetected by the investigating officer. If these factors did indeed exist, it is unlikely that they are related specifically to LCV characteristics. In other words, these influencing factors are common to all large trucks.

4.4 Adverse Conditions Long Combination Vehicle Collisions

The LCV collision data displayed in Figure 10 indicates that a significant number (42%) of collisions occurred under "adverse conditions."[8] For the purpose of this report adverse conditions included "weather" related items such as high wind, fog, snow, sleet and rain conditions as well as "road surface" factors such as snow or ice covered roads. In addition, wet roads or poor road quality (loose gravel in construction zones) were also considered to be adverse road surface factors.

Adverse conditions (weather and road) were present in 67% of the Rocky Mountain Double collisions, 43% of the total Turnpike Double collisions, and road surface factors in 27% of the total Triple LCV collisions.

Figure 10. Percent of LCV collisions occurring under adverse conditions (weather and road)



The study results indicate that imposing restrictions on LCV movements during adverse conditions is an important part of Alberta Infrastructure's LCV operating policy.

[8] For the purposes of this report it is important to note that the definition of 'adverse conditions' (weather and road surface factors) used in this study is more extensive than that contained in Alberta Infrastructure's LCV operating Permit. There may be more than one contributing factor to a collision hence it is not always possible to quantify the percentage attributable to a single factor such as weather or road surface condition.

4.5 Long Combination Vehicle Collisions by Configuration Type

In Table 9, collision rates were determined by separating the collision data for each configuration type and linking it to the exposure data from each survey section in the sub-network.

Table 9. Collision Rates by LCV Configuration

LCV Configuration	Sub-Network events	Distance-Traveled (million of km)	Total Collision Rate/100,000,000 km
Rocky Mountain Double	11	106.695	10.31
Turnpike Double	20	118.584	16.87
Triple	6	8.948	67.05

Note: The numbers of LCV collisions shown in this table represent the number of collisions that occurred on the sub-network studied.

With the LCV configuration and on the basis of the exposure analysis, the Rocky Mountain Double is the configuration least involved in collisions, the Turnpike Double configuration is approximately 1.6 times more likely to be involved in a collision and the Triple configuration is approximately 6.5 times more likely to be involved in an collision than Rocky Mountain Doubles.

4.6 Collisions Involving Rocky Mountain Doubles

Table 10 lists the contributing factors for the 12 incidents (sub-network and urban areas) involving Rocky Mountain Doubles that were identified on the collision report forms as factors in the incident. The numbers contained in the table are small and generalizations based on these numbers may not provide reliable conclusions. The collision reports indicate that there were no collisions attributed to mechanical failures. The remaining data appear to show that collisions with animals occur more frequently on 2-lane highway roads than 4-lane highway roads. This finding is consistent with the fact that the right of way on 2-lane roads is significantly smaller than 4-lane roads resulting in a higher probability of animal crossing and low probability of timely driver perception. Both of these conditions increase the probability of animal strikes on 2-lane highways.

The contributing factor of weather, principally snow and wind occurred less frequently than road surface factors (icy, wet, and contaminated road surfaces) as a cause of collisions. Road surface condition is the most frequently occurring contributing factor for collisions involving Rocky Mountain Doubles.

Table 10. Collisions Involving Rocky Mountain Doubles 1995-1998

Contributing Factor	Collision Location		
	4-Lane	2-Lane	Urban*
Configuration related	1	0	0
Animal	1	4	0
Weather (visibility, wind)	1	2	0
Road surface (icy, wet etc)	2	4	0
Mechanical	0	0	0
Other	0	0	1

** Includes 2-lane access routes*
Note: There may be more than one contributing factor per collision hence the columns are not to be added together

4.6.1 Configuration

Of the 12 collisions, including urban areas, involving Rocky Mountain Doubles, only one collision can be traced to configuration design. In this case the wind apparently blew over the last trailer. This incident occurred on a 4-lane highway. Given the LCV permit conditions regarding operating the vehicle during adverse weather conditions this may suggest that the vehicle should have been off the road. Such events are possible and there is no reason to discount the influence of the wind particularly with respect to independent trailers. The "A" connection of the last trailer cannot produce any corrective roll movement as can the tractor-trailer 5th wheel coupling system. If this Rocky Mountain Double had been configured as a B-train or if a Double drawbar (C-dolly) had been used, this collision may not have occurred. Triple Trailer combinations assembled with "A" dollies also suffer from the same roll coupling deficiency.

The dynamics of the Rocky Mountain Double are passive enough not to warrant the use of C-dollies for most operating conditions.

4.6.2 Animal Collisions

The 5 collisions with animals accounted for 42% of all Rocky Mountain Double collisions. Of the animal collisions, 80% occurred on 2-lane highways. None occurred within the urban areas.

4.6.3 Adverse Conditions

Adverse conditions (weather and road surface) existed in 67% (8 of the 12) Rocky Mountain Double collisions. Given the fact that none of the adverse conditions collisions occurred in an urban area, 73% occurred within the sub-network of 4-lane and 2-lane highways. Road surface factors occurred most frequently as a contributing factor in both 4-lane and 2-lane Rocky Mountain Double collision incidents. Weather related conditions were also a frequent factor in both 4-lane and 2-lane collisions.

Only one Rocky Mountain Double collision was not related to adverse conditions when low impact animal incidents were factored out. In this case, a non-LCV truck where alcohol was involved sideswiped the LCV in an urban area. There were no reported collisions attributed to road surface conditions in the urban areas for Rocky Mountain Doubles.

4.6.4 Road Class

The Rocky Mountain Double is the only LCV that is permitted to travel on selected 2-lane highways (except Highway 1A east of Calgary, where Turnpike Doubles and Triples are also permitted to access the city). Of the 12 Rocky Mountain Double collisions 58 % (7) occurred on 2-lane highways, 57% of these 2-lane incidents were animal strikes. Adverse conditions or animals were primary factors in all of the collisions that occurred on the 2-lane highway system. Only one collision involving a Rocky Mountain Double occurred within an urban area.

Table 11 illustrates that the collision rate for Rocky Mountain Doubles is 53% higher on the 2-lane system than the 4-lane system. However if collisions with animals are excluded, the Rocky Mountain Double collision rate is 35% lower on the 2-lane system than the 4-lane system. This is an important finding because it indicates that if collisions with animals are discounted (these tend to be low risk collisions) the Rocky Mountain Double has a superior collision record on the 2-lane undivided roads. Such a finding is in direct contradiction with the view that collision risk is higher on 2-lane undivided roads than 4-lane divided roads. The reason for this apparent discrepancy may be driver related.

Table 11. Rocky Mountain Double Collision Rate by Road Type

Road Class	Distance-traveled	Number of Collisions	Collision Rate /100,000,000 km	Number of Collisions Excluding Animals	Collision Rate Excluding Animals /100,000,000 km
2-lane undivided	56,879,273	7	12.31	3	5.27
4-lane divided	49,816,273	4	8.03	3	6.02
Totals	106,695,909	11	10.31	6	5.62

Note: The numbers represent the number of collisions that occurred on the sub-network

4.7 Collisions Involving Turnpike Doubles

Table 12 lists the contributing factors for the 30 incidents (sub-network and urban areas) involving Turnpike Doubles that were identified on the collision report forms. The numbers contained in the table are small and generalizations based on these numbers may not provide reliable conclusions. There were no incidents involving configuration factors, mechanical problems, or animals. As with Rocky Mountain Doubles, road surface condition followed by weather were the most frequent contributing factors on 4-lane highways and urban roads.

Table 12. Collisions Involving Turnpike Doubles 1995-1998

Contributing Factor	Collision Location		
	4-Lane	2-Lane	Urban*
Configuration related	0	0	2
Animal	3	0	0
Weather (visibility, wind)	4	0	1
Road surface (icy, wet etc)	5	0	3
Mechanical	0	0	0
Other	0	0	0

** Includes 2-lane access routes*
Note: There may be more than one contributing factor to collisions hence the columns are not to be added together.

4.7.1 Configuration

Of the total 30 collisions, involving Turnpike Doubles (including collisions in urban areas), 33% of the collisions occurred within cities. Of these, 90% occurred at intersections. Of the 10 collisions that occurred in the urban area, only one was judged to be the fault of an LCV. Slippery road surface conditions were present in 40% (4 out of 10) of the Turnpike Double collisions that occurred in the city. There were no Turnpike Double collisions that could be attributed to vehicle dynamic factors.

Two of the collisions that occurred in the city may have been associated with vehicle off tracking, which is related to vehicle length. Insufficient information was available to definitively resolve this question.

4.7.2 Animal Collisions

Only 3 out of 30 or 10% of the total Turnpike Double collisions involved collisions with animals. All of the collisions with animals occurred on 4-lane divided highways. Therefore, they accounted for 15% of the incidents on the sub-network. Turnpike Doubles rarely travel on 2-lane roads.

4.7.3 Adverse Conditions

Adverse conditions (weather and road) were present in 43% (9 out of 30) of the total Turnpike Double collisions. On 4-lane highways outside of urban areas, 45% of the collisions occurred under adverse conditions. Road surface factors and adverse weather conditions were a frequent contributing factor to Turnpike Double collision incidents in both the sub-network and urban areas. This is significant because Turnpike Doubles were involved in 56% of the total LCV collision incidents.

4.8 Collisions Involving Triples

Table 13 lists the contributing factors for the 11 incidents (sub-network and urban areas) involving Triples that were identified on the collision report forms as factors in the incident. There were no collisions where weather was identified as a contributing factor. Road surface factors including, icy, wet, and contaminated road surfaces were the most frequent contributing factors and these were distributed over all collision locations.

Table 13. Collisions Involving Triples 1995-1998

Contributing Factor	Collision Location		
	4-Lane	2-Lane	Urban*
Configuration related	2	1	0
Animal	0	1	0
Weather (visibility, wind)	0	0	0
Road surface (icy, wet etc)	1	1	1
Mechanical	0	1	0
Other	0	0	5

** Includes 2-lane access routes*
Note: There may be more than one contributing factor to a collision hence the columns are not to be added together.

4.8.1 Configuration

Of the 11 collisions involving Triples, including the urban areas, it is probable that 27% (3) of collisions were related to the configuration design. Two incidents occurred on the sub-network and one occurred on a 2-lane highway. In both cases, a trailer became unstable, one because of unexpected braking and the other because of an avoidance maneuver. These collisions may have been preventable by using the B-configuration or Double Drawbar dollies (C-dollies). These special configurations are more stable than A-train configurations particularly when shorter trailers are used. This finding was well documented in the 1986 Canadian study entitled "Vehicle Weights and Dimensions Study" (RTAC) where the Triple-Trailer B and C-trains were found to be approximately 300% more stable than Triple-Trailer A-trains. The findings from the study have been confirmed through experience by the province of Saskatchewan. The B-train or C-dolly systems reduce the number of articulation points in a given vehicle and they also couple the trailers in roll. These design changes produce a significant improvement in vehicle dynamic stability.

In addition to the two previous configuration-related collisions involving Triples, there was also a fifth wheel failure on the lead dolly that occurred on a 4-lane section of highway. Triple A-trains use more fifth wheels and hitch points than any other LCV configuration. Therefore, the probability of a collision involving a fifth wheel failure will be slightly greater than other LCV configurations. It must be noted that if the three trailers of the Triple were reconfigured as three separate Tractor Semi Trailer units, the risk of fifth wheel failure would remain the same because three fifth wheels would still be required. Despite this observation, fifth wheel failures are very rare (sufficiently rare that no statistics of fifth wheel failures could be found) and the real risk of additional fifth wheel failures on Triples remains very low.

Collisions occurring at a city intersection within the urban areas accounted for 45%, (5 out of 11), of all Triple collisions. The Triple was at fault in 2 of these incidents as the result of rear-ending another vehicle. However, 3 incidents involved errors by other vehicles.

4.8.2 Animal Collisions

Of the total number of Triple LCV configuration collisions (11), only one involved a collision with an animal and this collision occurred on a 2-lane highway 1.5km west of the Niton Junction on Highway 16.

4.8.3 Adverse Conditions

Adverse road surface conditions, including icy road surfaces and loose gravel, were factors in 27% (3 out of 11) of the total Triple LCV collisions. Road surface conditions may have been present on 1 urban incident (20%) and were present in 2 (33%) of sub-network incidents.

4.9 Summary of Long Combination Vehicle Collisions

Table 14 summarizes the contributing factors for all 53 LVC combination incidents; (37 incidents within the sub-network and 16 incidents in an urban area.) Table 15 reveals that road surface factors, animal impact and weather were the most frequent contributing factors in all LCV incidents. The data also indicates that “other” factors (such as vehicles disobeying traffic signals at intersections) were the most frequently cited contribution to urban LCV collision incidents. This was followed by road surface factors and configuration related incidents. The analysis determined that LCVs were not at fault in any of the fatal or major injury collisions within the entire network. There were three fatal collisions out of the total number of collisions involving LCVs.

Table 14. Collisions Involving All LCV Collisions 1995-1998

Contributing Factor	Collision Location			
	Sub-Network			
	4-Lane	2-Lane	Urban*	Overall
Road surface	8	5	4	17
Animal	4	5	0	9
Weather	5	2	1	8
Configuration Related	3	1	2	6
Intersection	0	0	6	6
Mechanical	0	1	0	1

** Includes 2-lane access routes*
Note: There may be more than one contributing factor to a collision hence the columns are not to be added together

Table 15. Contributing Factors to LCV Collisions 1995-1998

Overall Study Results	Sub-Network	Urban Areas	Frequency
53 Collisions	37 Collisions	16 Collisions	
Road Surface	Road Surface	Intersection	**High**
Animal	Animal	Road Surface	
Weather	Weather	Configuration related	
Intersection	Configuration	Weather	**Medium**
Configuration related	Mechanical	Mechanical	
Mechanical	Other	Animal	**Low**

Note: There may be more than one contributing factor to a collision.

There were two LCV collision incidents that occurred during overtaking maneuvers on 4-lane divided roads. One case involved a Tractor Semi-Trailer overtaking an LCV. Snow blowing off the passing Tractor Semi-Trailer obscured the vision of a Passenger Vehicle. The Passenger Vehicle then collided with the LCV. This is a common problem with large vehicles operating during the winter months. As the truck gains speed, aerodynamic forces disturb snow, which has accumulated on top of the trailer resulting in a localized whiteout, which can affect vehicles in the immediate traffic stream. The unexpected loss of vision can result in loss of directional reference. The second incident also occurred on a 4-lane divided highway and resulted in a Pickup Truck losing control while being passed by an LCV. The collision report form indicated that the LCV was driving properly and that the other vehicle lost control due to slippery road conditions.

It is important to note that this study's analysis of contributing factors to individual collisions reviewed only LCVs. As such, there may be a circumstance in which an LCV was involved in an overtaking or passing maneuver and this was a contributing factor in the collision of a non-LCV vehicle type. Given the fact that the purpose of this study was to review contributing factors to LCV collisions, analysis of the contributing factors to non-LCVs was considered outside the scope of this study.
The number, type and frequency of collisions for the highway network and urban locations are somewhat different. For example, Rocky Mountain Doubles were involved in approximately 30% of the sub-network incidents but only 6% of the urban collisions. It should be noted that Triples were involved in approximately 8% of sub-network highway incidents but over 31% of the urban collisions investigated. There does not appear to be a vehicle length related issue affecting LCV collisions within the urban area. All of the incidents involving Triples in the urban area (five in total) occurred at intersections. Three involved errors by other non-LCV vehicles including one disobeyed traffic signal, two were the fault of the LCV and only one collision had road condition as a contributing factor. Apart from the fact that all Triple LCV collisions occurred at intersections, there does not appear to be any single causal factor related to vehicle configuration that dominates within the urban area.

Turnpike Doubles also experienced a significant number of collisions within the urban area. Of the ten collisions, eight were the fault of other vehicles including three disobeyed traffic signals. Four of the collisions involved road conditions as contributing factors. The urban area does however present a higher risk to all vehicle types by virtue of the large number of intersecting roadways and road access opportunities, as well as high traffic density.

5. Long Combination Vehicle Operational Considerations

LCVs operate under a special permit program governed by strict operating conditions (see Appendix C). The structure and enforcement mechanisms of the policy engender a level safety consciousness, which far exceeds that found in other vehicle classes. For example, it requires that operators be trained to meet and maintain the requirements outlined in the Canadian Trucking Alliance's " Longer Combination Vehicles Driver's Manual."

Drivers must obtain an annual certificate verifying that they are in compliance with the following requirements. The driver:

1. Holds a valid Class 1 driver's license or equivalent.
2. Has passed a recognized air brake course or has an air endorsement.
3. Has a minimum of 24 months or 150,000 km of driving experience with articulated vehicles.
4. Has passed a recognized driver's medical examination within the past 24 months.
5. Has passed a Professional Driver Improvement Course within the past 48 months.
6. Has passed the Canadian Trucking Alliance's "Longer Combination Vehicles Driver Training Course."

7. The driver's abstract, dated not more than one month prior to the issue date of the Drivers Certificate, must show no driving-related criminal code convictions in the prior 36 months; no more than 2 moving violations in the prior 12 months; and no more than 3 moving violations in the prior 36 months. The date of conviction and the current date will be the dates used to determine time periods.
8. In the past 12 months the driver has been instructed on all current regulations, permit conditions and issues covering the operation of LCVs.

The permit conditions also place controls on where LCVs can operate including hours of operation (time of day), vehicle dimensions such as wheelbase, hitch offset and dolly drawbar length. The policy also contains operational requirements such as adverse weather restrictions, requirements that the vehicles track properly and do not sway, and requirements that vehicles do not cross opposing lanes of traffic unless absolutely necessary.

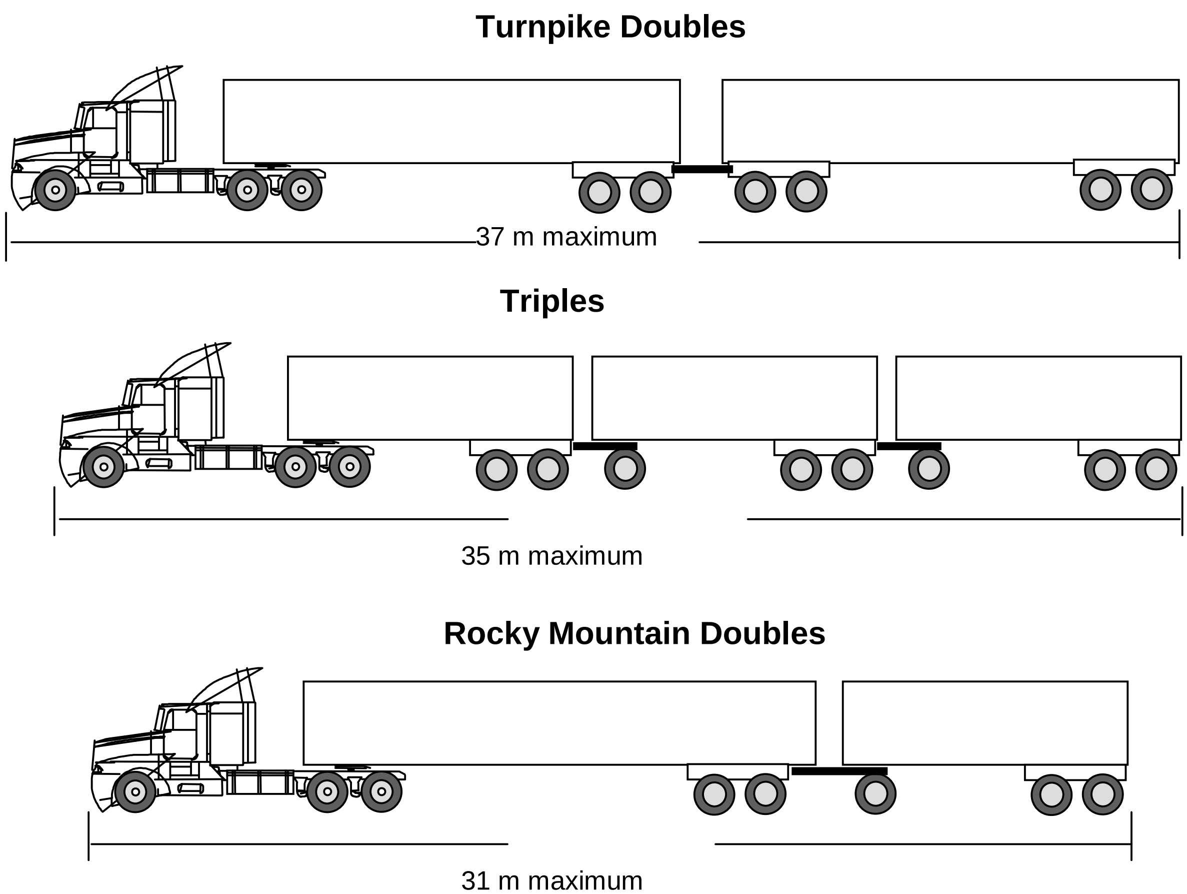
5.1 Vehicle Length and Mass

As shown in Table 16 and Figure 11, LCV length and gross vehicle weight (GVW) is tightly controlled by the Alberta Infrastructure LCV permit, entitled "Conditions Governing the Operation of Long Combination Vehicles in Alberta." The allowable GVW of a Rocky Mountain Double is dependent on the coupling details of the first and second trailer. The A-train connection represents the traditional way the trailers are coupled together. The B-train and C-train connections provide roll coupling and eliminate one point of articulation per coupled trailer. These features greatly improve vehicle stability and in recognition of this, the allowable GVW of the Rocky Mountain Double is dependent on the coupling system.

Table 16. LCV Maximum Length & Gross Vehicle Weight Limits

Configuration Type	Overall Length	Maximum Gross Vehicle Weight
Rocky Mountain Double A-train	31 m	53,500 kg
Rocky Mountain Double B-train	31 m	62,500 kg
Rocky Mountain Double C-train	31 m	60,500 kg
Turnpike Double A-train	37 m	62,500 kg
Turnpike Double A-train	37 m	62,500 kg
Turnpike Double A-train	37 m	62,500 kg
Triples A-train	35 m	53,500 kg
Triples B-train	35 m	53,500 kg
Triples C-train	35 m	53,500 kg

Figure 11: Illustrations of Typical EEMV Configurations



5.2 Adverse Weather Restrictions

1. The LCV policy states that LCVs "shall not operate during adverse weather or driving conditions (including but not limited to rain, snow, sleet, ice, smoke, fog or other conditions) which:
   a. Obscure or impede the driver's ability to drive in a safe manner, or
   b. Prevent the driver from driving with reasonable consideration for the safety of persons using the highway. The company is required to make a reasonable effort to determine the driving conditions on the route. Vehicles must not be dispatched when adverse conditions are known to be present on the route. Drivers encountering unexpected adverse conditions must stop at the next safe location (or as directed by an authorized Alberta Infrastructure staff member or a peace officer) and wait for the adverse conditions to abate."

5.3 Summary of Long Combination Vehicle Operational Considerations

This study revealed that the LCV fleet in Alberta has a superior safety record when compared to other ground transportation vehicles. Within the LCV fleet, there are differences in collision rates by configuration type. However a thorough examination of collision details found no significant link to vehicle design factors such as length or mass. The examination did find that if Triples were configured as B-trains or C-trains, their safety performance would likely be improved. From the collision analysis, of the three LCV classes, Rocky Mountain Doubles represent the safest road transport mode.

This analysis clearly demonstrates that LCVs operating under the current permits represent a significant improvement in transport safety when compared with the general truck transport fleet. It is the opinion of the author that a significant component of this benefit can be attributed to the influence of Alberta Infrastructure's permit conditions governing the operation of LCVs. Therefore, the contents of the LCV permit represent a practical tool for improving transport safety and this policy should be viewed as an essential element of the LCV program.

6. Safety Performance Conclusions

This study concluded that Alberta Infrastructure's permit conditions governing the operation of LCVs was found to be a vital influencing factor in the creation of a safe operating environment in Alberta. The effective conditions include, selective routing, restrictions on vehicle speed, restricted time of day operation, enhanced driver qualification requirements and operating restrictions for adverse road and weather conditions. The particular elements, including road type, driver competence, vehicle speed and adverse weather conditions have been found to be significant factors in collision causation.

This study of vehicle safety specifically demonstrated that:

1. LCVs have the lowest collision rate of all vehicle classes.

2. Rocky Mountain Doubles were found to have the best safety performance of all LCV configurations. The performance of the Rocky Mountain Double was better than any other vehicle even though they are permitted on 2-lane highways.

3. The safety performance of the Rocky Mountain Double was found to be slightly better on 2-lane undivided highways than 4-lane highways when animal strikes were omitted.

4. Within the urban area, Turnpike Doubles have a significantly larger number of collisions than the other LCV configurations. In reviewing collisions in urban areas it is difficult to acquire reliable data for analyzing the collisions per kilometres traveled by vehicle type. Consequently, the study did not have sufficient information to determine the urban collision rate for any of the LCVs. Therefore, comparative safety performance of LCVs within urban areas remains largely unknown.

5. Triple Trailer LCVs have a significantly higher collision rate than Rocky Mountain Doubles. The Triple Trailer LCV safety performance can be improved if coupled in the B-train or C-train configuration.

6. Adverse conditions (weather and road surface) accounted for 42% of all LCV collisions. This point proves the significance of weather and road surface conditions as a frequent contributing factor on the safety performance of all vehicles including LCV operations.

7. APPENDICES

7.1 Appendix A: Vehicle Involvement by Collision

There are two separate methods that may be used to analyze collision data. The collision rate relationships are defined in the following equations:

Equation A

$$\text{Vehicle involvement by collision} = \frac{\text{Number of collisions involving a given vehicle type}}{\text{Total kilometers traveled by that vehicle type}}$$

Equation B

$$\text{Collision by vehicle type} = \frac{\text{Number of vehicles of a given type involved in collisions}}{\text{Total kilometers traveled by that vehicle type}}$$

Equation A is based upon vehicle involvement by collision. In this analysis, “the collision” is the primary investigative factor and is used in the numerator of the collision rate equation. The number of collisions is determined and the vehicle types involved in the collision are recorded.

When examining vehicle involvement, a collision involving two vehicles of the same type would only register one vehicle type. Therefore if there were 100 collisions involving 200 private vehicles, the number of collisions involving private vehicles would be recorded as 100. The analysis method is known as “*Vehicle Involvement by Collision.*”

Equation B is the second method, which can be used to analyze the data. It is based upon the type of vehicle involved in an incident. In this analysis, “the vehicle involved in the collision” is the primary investigative factor therefore the “total” number of vehicles involved in the collisions is known. Thus, the total number of vehicles involved is used in the numerator of this form of the collision exposure rate equation. When examining vehicle involvement, the number of all vehicles involved in the collisions is recorded. If there are 100 collisions involving 200 private vehicles, the number of vehicles involved in the collisions will be counted as 200. This method is known as “C*ollisions by Vehicle Type.*”

Appendix A Table A: Vehicle Involvement by Collision
(Within the Sub-Network 1995-98)

Vehicle Type	Total Collisions	Fatal	Injury	PDO	Total Distance-traveled (100 million km)
Unit Truck	688	13	126	549	3.820
Tractor Semi	879	34	239	606	11.544
Multi Trailer	406	19	119	268	4.031
Rocky Mountain	11	0	2	9	1.067
Turnpike Doubles	20	2	5	13	1.186
Triples	6	0	2	4	0.090
Personal Vehicles	11,800	175	2,434	9,191	217.873
Total Number of Collisions	13,810	243	2,927	10,640	239.609
All LCV	37	2	9	26	2.342

Note (1): PDO stands for Property Damage Only collisions
Note (2): In this analysis, collisions involving two or more vehicles of the same type were counted as one incident, that is, a collision involving three personal vehicles would be registered as one event. A collision involving two different vehicle types would be registered as two events.

Appendix A Table B: Collision Exposure Rate Vehicle Involvement by Collision
(Within the Sub-Network 1995-98)

Vehicle Type	Per 100 million km traveled			
	Total Collisions	Fatal	Injury	PDO
Unit Truck	180.11	3.40	34.30	143.73
Tractor Semi	75.88	2.95	20.70	52.50
Multi Trailer	100.7	4.71	29.52	66.49
Rocky Mountain	10.31	0	1.87	8.43
Turnpike Doubles	16.87	1.69	4.22	10.96
Triples	67.04	0	22.34	44.6
Personal Vehicles	54.16	0.80	11.17	42.19
Total Number of Collisions	57.63	1.02	12.22	44.41
All LCV	15.80	0.85	3.84	11.10

Note (1): PDO stands for Property Damage Only collisions
Note (2): In this analysis, collisions involving two or more vehicles of the same type were counted as one incident, that is, a collision involving two or more personal vehicles would be registered as one event. A collision involving two different vehicle types would be registered as two events.

Appendix A Table C: Error Sensitivity of Vehicle Involvement by Collision (Within the Sub-Network 1995-98)

Per 100 million km traveled				
Vehicle Type	**Estimated Error**	**Collision Rate Error Estimate Range**		
		Low	**Calculated Rate**	**High**
Unit Truck	± 10%	162	180	198
Tractor Semi	± 10%	68	76	83
Multi Trailer	± 10%	96	100	106
Rocky Mountain	± 10%	9	10	11
Turnpike Doubles	± 10%	15	17	19
Triples	± 10%	60	67	74
Personal Vehicles	± 10%	51	54	57
Total Number of Collisions	± 10%	55	58	60
All LCV	±10%	14	16	17

Note (1): PDO stands for Property Damage Only collisions

Note (2): In this analysis, collisions involving two or more vehicles of the same type were counted as one incident, that is, a collision involving three personal vehicles would be registered as one event. A collision involving two different vehicle types would be registered as two events.

Table D detailed below, reveals the annual average collisions exposure rates of vehicle involvement by collision.

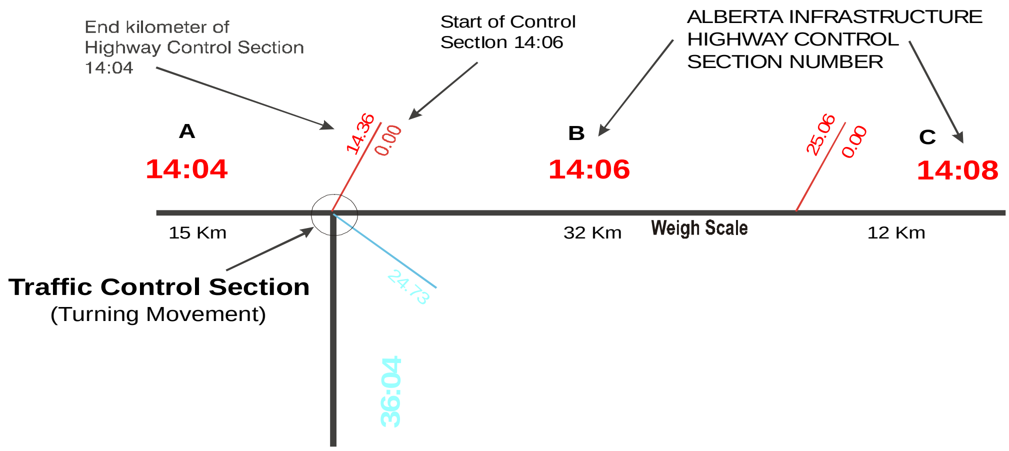
Appendix A Table D: **Annual Average Collisions Exposure of Vehicle Involvement by Collision (Within the Sub-Network 1995-98)**

Per 100 million km traveled				
Vehicle Type	**Estimated Error**	**Collision Rate Error Estimate Range**		
		Low	**Calculated Rate**	**High**
Unit Truck	± 10%	41	45	50
Tractor Semi	± 10%	17	19	21
Multi Trailer	± 10%	24	25	27
Rocky Mountain	± 10%	2	3	3
Turnpike Doubles	± 10%	4	4	5
Triples	± 10%	15	17	19
Personal Vehicles	± 10%	13	14	14
Total Number of Vehicles	± 10%	14	15	15
All LCV	± 10%	4	4	4

Note (2): In this analysis, collisions involving two or more vehicles of the same type were counted as one incident, that is, a collision involving three personal vehicles would be registered as one event. A collision involving two different vehicle types would be registered as two events.

7.2 Appendix B: Traffic Control Section

TYPICAL HIGHWAY CONTROL SECTION ON LCV SUB-NETWORK



NOTE: DISTANCES USED FOR ILLUSTRATION PURPOSES ONLY

There are 345 Automated Traffic Recorder (ATR) traffic-counting stations in Alberta. 219 of these ATR were within the LCV sub-network. ATRs operate 24 hours a day and 365/366 days a year. ATRs only record the number of vehicles by hour and direction. All sites use magnetic induction loops imbedded in the road surface to detect traffic. These recorders are situated on highway Control Sections.

A manual traffic study consisting of observation and recording of vehicle turning movements takes place at intersections (Traffic Control Sections). Each study runs from 8 a.m. to 5 p.m. on a single day and the study is done once every five years. The surveyors make visual observations and record the number of vehicles by movement and vehicle type. The five vehicle classifications are Passenger Vehicles, Recreational Vehicles, Buses, Single Unit Trucks and Tractor-Trailers. This method was used to generate the total traffic volume.

The National Road Side Survey used highway weigh scale locations for the site of their 24-hour per day, one-week visual traffic observation and recording study. This method was used to generate the type of vehicles (i.e. those that were commercial).

7.3 Appendix C: The Data Collection Form for Truck Counts (1999 CCMTA Survey)

National Roadside Survey 99
7-day Traffic Count

Date:__________ Location: __________ Highway: __________ Direction: __________

SINGLE TRUCK	TRUCK & 1 TRAILER	TRACTOR ONLY	TRACTOR & 1 TRAILER	TRACTOR & 2 TRAILERS						TRACTOR & 3 TRAILERS		BUS	TIME
				B TRAIN	TURNPIKE DOUBLE		ROCKY MTN DOUBLE		OTHER	A DOLLY	C DOLLY		1 HOUR PERIODS
					A DOLLY	C DOLLY	A DOLLY	C DOLLY					

Source : Alberta Infrastructure, Transportation Policy & Economic Analysis Branch

7.4 Appendix D: Estimated LCV Movements On Sub-Network by Year*

1998 EEMV Activity				EEMV Daily Movements			EEMV Annual Movements		
Area	Highway	Range	Distance	Turnpike	Rocky	Triples	Turnpike	Rocky	Triples
Area 1:	Hwy 4	Coutts to Lethbridge	104.0	0.0	2.8	0.0	0	1,014	0
Area 2:	Hwy 3	Crowsnest Pass to Jct Hwy 2	101.1	0.6	29.4	0.0	219	10,749	0
Area 3:	Hwy 3	Jct Hwy 2 to Lethbridge &	51.1	10.3	5.1	0.5	3,742	1,871	170
	Hwy 2	Jct Hwy 3 to Calgary &	157.8	10.9	34.6	0.5	3,961	12,620	170
	Hwy 1	Banff Park Gates to Calgary	197.0	34.6	17.3	1.6	12,615	6,308	573
Area 4:	Hwy 1	Calgary to Alberta/Sask border	291.0	37.8	34.2	4.7	13,782	12,490	1,723
Area 5:	Hwy 2	Calgary to Red Deer	152.0	147.6	33.7	8.4	53,885	12,317	3,079
Area 6:	Hwy 2	Red Deer to Edmonton	146.1	207.1	52.5	19.3	75,582	19,148	7,054
Area 7:	Hwy 16	Jasper Park Gates to Edmonton	385.1	30.6	5.5	0.0	11,151	2,007	0
Area 8:	Hwy 16	Edmonton to Alberta/Sask border	229.0	20.8	18.9	2.6	7,604	6,891	950
Area 9:	Hwy 43	Alberta/BC border to Gr. Prairie	88.9	0.0	39.3	0.7	0	14,355	252
	Hwy 43	Grande Prairie to Valleyview	95.0	0.0	39.3	0.7	0	14,355	252
	Hwy 43	Valleyview to Jct Hwy 16	287.6	0.0	62.1	0.7	0	22,667	252
Area 10:	Hwy 49:	Jct Hwy 43 to Jct Hwy 2 &	91.0	0.0	22.8	0.0	0	8,311	0
	Hwy 2:	Jct Hwy 49 to Jct Hwy 35 &	82.9	0.0	22.8	0.0	0	8,311	0
	Hwy 35:	Jct Hwy 2 to Alberta/NWT border	477.4	0.0	19.8	0.0	0	7,227	0
			Total	500.1	440.1	39.7	182,541	160,641	14,475

1997 EEMV Activity				EEMV Daily Movements			EEMV Annual Movements		
Area	Highway	Range	Distance	Turnpike	Rocky	Triples	Turnpike	Rocky	Triples
Area 1:	Hwy 4	Coutts to Lethbridge	104.0	0.0	1.0	0.0	0	372	0
Area 2:	Hwy 3	Crowsnest Pass to Jct Hwy 2	101.1	0.4	20.0	0.0	149	7,297	0
Area 3:	Hwy 3	Jct Hwy 2 to Lethbridge &	51.1	9.8	4.9	0.4	3,581	1,791	163
	Hwy 2	Jct Hwy 3 to Calgary &	157.8	10.2	24.9	0.4	3,730	9,088	163
	Hwy 1	Banff Park Gates to Calgary	197.0	32.3	16.2	1.5	11,796	5,898	536
Area 4:	Hwy 1	Calgary to Alberta/Sask border	291.0	34.3	31.1	4.3	12,521	11,347	1,565
Area 5:	Hwy 2	Calgary to Red Deer	152.0	138.0	31.5	7.9	50,359	11,511	2,878
Area 6:	Hwy 2	Red Deer to Edmonton	146.1	182.5	46.2	17.0	66,603	16,873	6,216
Area 7:	Hwy 16	Jasper Park Gates to Edmonton	385.1	29.0	5.2	0.0	10,585	1,905	0
Area 8:	Hwy 16	Edmonton to Alberta/Sask border	229.0	20.2	18.3	2.5	7,382	6,690	923
Area 9:	Hwy 43	Alberta/BC border to Gr. Prairie	88.9	0.0	37.3	0.7	0	13,606	239
	Hwy 43	Grande Prairie to Valleyview	95.0	0.0	37.3	0.7	0	13,606	239
	Hwy 43	Valleyview to Jct Hwy 16	287.6	0.0	60.2	0.7	0	21,990	239
Area 10:	Hwy 49:	Jct Hwy 43 to Jct Hwy 2 &	91.0	0.0	23.0	0.0	0	8,383	0
	Hwy 2:	Jct Hwy 49 to Jct Hwy 35 &	82.9	0.0	23.0	0.0	0	8,383	0
	Hwy 35:	Jct Hwy 2 to Alberta/NWT border	477.4	0.0	19.0	0.0	0	6,938	0
			Total	456.7	399.1	36.1	166,706	145,678	13,161

1996 EEMV Activity				EEMV Daily Movements			EEMV Annual Movements		
Area	Highway	Range	Distance	Turnpike	Rocky	Triples	Turnpike	Rocky	Triples
Area 1:	Hwy 4	Coutts to Lethbridge	104.0	0.0	1.0	0.0	0	350	0
Area 2:	Hwy 3	Crowsnest Pass to Jct Hwy 2	101.1	0.4	18.9	0.0	141	6,904	0
Area 3:	Hwy 3	Jct Hwy 2 to Lethbridge &	51.1	9.1	4.5	0.4	3,316	1,658	151
	Hwy 2	Jct Hwy 3 to Calgary &	157.8	9.5	23.5	0.4	3,457	8,562	151
	Hwy 1	Banff Park Gates to Calgary	197.0	30.8	15.4	1.4	11,250	5,625	511
Area 4:	Hwy 1	Calgary to Alberta/Sask border	291.0	32.2	29.2	4.0	11,762	10,659	1,470
Area 5:	Hwy 2	Calgary to Red Deer	152.0	127.3	29.1	7.3	46,450	10,617	2,654
Area 6:	Hwy 2	Red Deer to Edmonton	146.1	167.9	42.5	15.7	61,293	15,527	5,721
Area 7:	Hwy 16	Jasper Park Gates to Edmonton	385.1	28.3	5.1	0.0	10,330	1,859	0
Area 8:	Hwy 16	Edmonton to Alberta/Sask border	229.0	18.6	16.8	2.3	6,786	6,150	848
Area 9:	Hwy 43	Alberta/BC border to Gr. Prairie	88.9	0.0	34.8	0.6	0	12,712	223
	Hwy 43	Grande Prairie to Valleyview	95.0	0.0	34.8	0.6	0	12,712	223
	Hwy 43	Valleyview to Jct Hwy 16	287.6	0.0	56.8	0.6	0	20,734	223
Area 10:	Hwy 49:	Jct Hwy 43 to Jct Hwy 2 &	91.0	0.0	22.0	0.0	0	8,022	0
	Hwy 2:	Jct Hwy 49 to Jct Hwy 35 &	82.9	0.0	22.0	0.0	0	8,022	0
	Hwy 35:	Jct Hwy 2 to Alberta/NWT border	477.4	0.0	18.4	0.0	0	6,721	0
			Total	424.1	374.9	33.4	154,785	136,834	12,175

Weekly Vehicle Classification Counts – By Survey Location

National Roadside Survey/Effects of Longer Combination Vehicles in Alberta

Location	Direction	Total Vehicles	NRS Vehicles	Bus	Single Truck	Tractor Only	Truck 1 Trailer	Legal Length		EEMV		
								Tractor 1 Trailer	Tractor 2 Trailers	**Turnpike Doubles**	**Rocky Doubles**	**Tractor Triples**
Grimshaw	N&S	12,637	1,232	16	154	222	115	238	362	**0**	**125**	**0**
Beaverlodge	N&S	19610	2,619	52	835	58	183	1090	289	**0**	**111**	**1**
Hinton	E	17958	2,085	105	129	8	83	1072	581	**90**	**17**	**0**
Leduc	S	83223	7,928	72	776	195	860	3796	1379	**628**	**162**	**60**
Balzac	N	176306	10,466	332	2077	302	404	4772	1770	**624**	**142**	**43**
Jumping Pound	E	74885	5,249	81	814	57	137	2937	966	**167**	**86**	**4**
Strathmore	E	51414	5,429	97	886	135	106	3219	656	**163**	**147**	**20**
Burmis	E	15974	2,533	40	355	40	256	1082	681	**1**	**78**	**0**
Coutts	N&S	38881	3,971	41	118	49	65	3292	386	**0**	**20**	**0**
Grimshaw	% of All Traffic:			0.13%	1.22%	1.76%	0.91%	1.88%	2.86%	**0.00%**	**0.99%**	**0.00%**
Beaverlodge	% of All Traffic:			0.27%	4.26%	0.30%	0.93%	5.56%	1.47%	**0.00%**	**0.57%**	**0.01%**
Hinton	% of All Traffic:			0.58%	0.72%	0.04%	0.46%	5.97%	3.24%	**0.50%**	**0.09%**	**0.00%**
Leduc	% of All Traffic:			0.09%	0.93%	0.23%	1.03%	4.56%	1.66%	**0.75%**	**0.19%**	**0.07%**
Balzac	% of All Traffic:			0.19%	1.18%	0.17%	0.23%	2.71%	1.00%	**0.35%**	**0.08%**	**0.02%**
Jumping Pound	% of All Traffic:			0.11%	1.09%	0.08%	0.18%	3.92%	1.29%	**0.22%**	**0.11%**	**0.01%**
Strathmore	% of All Traffic:			0.19%	1.72%	0.26%	0.21%	6.26%	1.28%	**0.32%**	**0.29%**	**0.04%**
Burmis	% of All Traffic:			0.25%	2.22%	0.25%	1.60%	6.77%	4.26%	**0.01%**	**0.49%**	**0.00%**
Coutts	% of All Traffic:			0.11%	0.30%	0.13%	0.17%	8.47%	0.99%	**0.00%**	**0.05%**	**0.00%**

Source: Alberta Infrastructure, Transportation Policy & Economic Analysis Branch

7.5 Appendix E: Conditions Governing the Operation of Energy Efficient Motor Vehicles in Alberta Transport Engineering Branch

7.5.1 Driver Requirements

October 20, 1999

The following conditions shall apply to the operation of Energy Efficient Motor Vehicles (EEMVs), including Triple Trailer, Turnpike Double and/or Rocky Mountain Doubles. Note that these vehicles may also be referred to as LCVs or ELVs. Also a special permit is required to operate EEMVs in Alberta and the conditions in this document are in addition to those printed on the special permit. In the case of conflict, the conditions printed on the special permit shall take precedence.

General Provisions:

THAT the company and/or permittee shall, upon request of any authorized employee of Alberta Infrastructure or any peace officer, allow and assist such employee or peace officer to make any inspection, test, examination or inquiry as such member may wish to make in regard to the operation of these trailer combinations.

THAT the company undertake and assume full responsibility for the operation of those trailer combinations and will indemnify and save harmless Alberta Infrastructure, its officers and employees, from and against all actions, causes of actions, claims and demands which may arise as a result of these operations.

THAT the company shall abide by the routes, vehicle dimensions, equipment and conditions specified on, attached to or referred to by the permits as well as all applicable legislation unless specifically exempted on the permit or permit attachments.

THAT the company shall carry a copy of the appropriate permit in each power unit.

THAT, upon request, the company will supply to Transport Engineering Branch, Alberta Infrastructure, any reasonable statistics related to EEMV operations.

THAT the company will submit to Transport Engineering Branch, Alberta Infrastructure (phone 403-340-5189 or fax 403-340-5092) the police report number for any reportable collision involving an EEMV within one week of the date of occurrence.

THAT the company ensure, and be able to provide proof, that their drivers and driver trainers meet and maintain the requirements outlined in the Canadian Trucking Alliance's "Longer Combination Vehicle Driver's and/or Instructors Manual."

THAT the carrier is responsible to issue an annual EEMV Driver's Certificate. The Driver's Certificate is valid for a period of 12 months after the date of issue and must be in the possession of the driver at all times when operating an EEMV. Prior to issuing an EEMV Driver's Certificate, the carrier must ensure that the driver meets the following qualifications:

Holds a valid Class 1 driver's license or equivalent.
Has passed a recognized air brake course or has an air endorsement.
Has a minimum of 24 months or 150,000 km of driving experience with articulated vehicles.
Has passed a recognized driver's medical examination within the past 24 months.
Has passed a Professional Driver Improvement Course within the past 48 months.
Has passed the Canadian Trucking Alliance's "Longer Combination Vehicles Driver Training Course."

The driver's abstract, dated not more than one month prior to the issue date of the Drivers Certificate, must show no driving-related criminal code convictions in the prior 36 months; no more than 2 moving violations in the prior 12 months; and no more than 3 moving violations in the prior 36 months. The date of conviction and the current date will be the dates used to determine time periods.
In the past 12 months the driver has been instructed on all current regulations, permit conditions and issues covering the operation of EEMVs.

Upon request, the company must be able to produce all documents to support the driver's qualifications.
Driver's Certificates issued by other jurisdictions, which meet or exceed the Alberta requirements, will be accepted as valid for the term of this agreement.

Instructor Qualifications
The instructor must be certified as a Driver Trainer in their home jurisdiction and be qualified to instruct the CTA Longer Combination Vehicle Driver Training Course.

Equipment Requirements
The equipment must carry a valid CVIP decal or recognized equivalent.
All trucks must feature a maximum gross weight to power ratio of 160 kg per horsepower (120 kg/kW).
All equipment used in extended length combinations shall be equipped with brakes that meet CMVSS 121 Standards. Converter dollies do not require spring brakes.

The rear axle group of the power unit and all axle groups of the trailers and converters must be equipped with mud flaps or splash guards that are constructed to ensure that they remain in a rigid downward position at all times. All mud flaps or splashguards shall be mounted behind the wheels at a distance not exceeding 25.0 cm to the rear of the wheels.

The trailers of the combination shall be joined together by means of no-slack pintle hook(s), equipped with an air or hydraulic ram. The no-slack ram is to be incorporated in either the pintle hook or the pintle hook eye of the coupling apparatus.

7.5.2 Operational Requirements

Where a route falls within a city boundary, the company is responsible for obtaining permission from cities to operate extended length combinations into and out of such cities in accordance with the routes and conditions assigned by the city.

Any breakup or makeup of extended length combination units must be done off public roadways on private property or as directed by an authorized Alberta Infrastructure staff member or a peace officer.
EEMVs shall not operate during adverse weather or driving conditions (including but not limited to rain, snow, sleet, ice, smoke, fog or other conditions) which:

- Obscure or impede the driver's ability to drive in a safe manner, or
- Prevent the driver from driving with reasonable consideration for the safety of persons using the highway.

The company is required to make a reasonable effort to determine the driving conditions on the route. Vehicles must not be dispatched when adverse conditions are known to be present on the route. Drivers encountering unexpected adverse conditions must stop at the next safe location (or as directed by an authorized Alberta Infrastructure staff member or a peace officer) and wait for the adverse conditions to abate.

The vehicles in a combination shall be so loaded and coupled together as to ensure that any such combination traveling on a level, smooth, paved surface will follow in the path of the towing vehicle without shifting, swerving, or swaying from side to side over 10 cm to each side of the path of the towing vehicle when it is moving in a straight line.

- Drivers shall avoid crossing opposing lanes of traffic unless absolutely necessary.
- Maximum speed shall be the lesser of 100 km/h or the posted speed limit.

This permit cannot be combined with any other permit for overwidth, overheight, overhang, or overweight.

Hours of Operation
Operation will be allowed 24 hours per day except in the following cases:

All Highways:
Movement will **NOT** be allowed:

- after 4:00pm on December 24th and December 31st
- at anytime on December 25th, 26th and January 1st

On Multi-lane Highways:
Within 40 km of the corporate boundaries of the cities of Calgary and Edmonton:
Movement will **NOT** be allowed:

- Traveling OUTBOUND from 4:00pm to 8:00pm on Fridays
- Travelling INBOUND from 4:00pm to 8:00pm on Sundays
- When a statutory holiday falls on a Friday, movement will **NOT** be allowed traveling OUTBOUND from 4:00pm to 8:00pm on the preceding Thursday.
- When a statutory holiday falls on a Monday, movement will **NOT** be allowed traveling INBOUND from 4:00pm to 8:00pm on the Monday.

On 2-lane Highways

- a) Movement will **NOT** be allowed from 4:00pm to 8:00pm on Fridays and from 4:00pm to 8:00pm on Sundays
- b) When a statutory holiday falls on a Friday, movement will **NOT** be allowed from 4:00pm to 8:00pm on the preceding Thursday.
- c) When a statutory holiday falls on a Monday, movement will **NOT** be allowed from 4:00pm to 8:00pm on the Monday.

NOTE: a, b and c above do not apply to highway 35 from the southern corporate town limits of High Level to the NWT border.

In addition to, a, b & c, movement will **NOT** be allowed on individual 2-lane highways as follows:
From the Tuesday following the Labour Day Weekend (September) to the Thursday before the Victoria Day Weekend (May):

Highway	**Location**	**Hours**	**Days**
15	Edmonton to Jct. 21	8:00am to 7:00pm	Mon – Fri
		10:00am to 7:00pm	Saturday
		12:00pm to 7:00pm	Sunday

From the Friday before the Victoria Day Weekend (May) to the Tuesday following the Labour Day Weekend (September):

Highway	**Location**	**Hours**	**Days**
15	Edmonton to Jct. 21	7:00am to 11:00pm	Mon – Fri
		7:00am to 11:00pm	Saturday
		10:00am to 10:00pm	Sunday
3	AB/BC border to Jct. 22	12:00 to 5:00pm	Fri & Sat
22	Jct. 1 to Jct. 1A	1:00pm to 3:00pm	Saturday
		1:00pm to 8:00pm	Sunday

Statutory Holidays
(Excerpt from Public Vehicle Dimension and Weight Regulation, AR 127/98)
"Statutory holiday" means:
New Year's Day, Family Day, Good Friday, Victoria Day, Canada Day, Labour Day, Thanksgiving Day, Remembrance Day and Christmas Day and December 26, or when that day falls on a Sunday or a Monday, then December 27.

Turnpike Double and Triple Trailer Routes:

- All multi-lane highways with four or more driving lanes
- Hwy. #1A from the Calgary City Limits east to Jct of Hwy. #1
- Hwy. #11A from Hwy. #2 east to Gaetz Avenue, Red Deer, except between 7:00 a.m. to 9:00 a.m. and 4:00 p.m. to 6:00 p.m. on weekdays.

Extended Length Doubles Routes:

- All multi-lane highways with four or more driving lanes
- The following 2-lane highways:

Highway	Section
1A	Calgary to Jct. 22
	Jct. 1 (Chestermere) to Calgary
	USA boundary to Jct. 5
	Jct. 642 to Jct. 18
	Jct. 49 (West of Donnelly) to Jct. 43 (North of Grande Prairie)
2A	Jct. 2 (Leduc) to Jct. 2 (near Morningside)

- All
- USA boundary to Lethbridge
- Jct. 2 to Lethbridge
- Jct. 36 to Jct. 2
- 11A Jct. 2 to Gaetz Avenue (Red Deer)
- Jct. 2A to Camrose
- Edmonton to Saskatchewan Border
- Edmonton to Jct. 45 (South of Bruderheim)
- West of Hinton to East Jasper Park Gates
- Jct. 14 South to the Saskatchewan Border
- Jct. 2 to Westlock
- Jct. 1 to Jct. 1A
- Jct. 2 to NWT border
- Jct. 16 to BC border
- Jct. 43 (Valleyview) to Jct. 2 (West of Donnelly)

Or additional routes as may be indicated on the permit.

7.5.3 Specific Conditions for Rocky Mountain Doubles

The following lists specific requirements for the equipment. Dimensions or weights, where not specifically listed, shall conform to the Alberta Public Vehicle Dimension and Weight Regulation (AR 127/98) for A, B or C trains.

PARAMETER	LIMIT	LIMIT	LIMIT
	A Converter	**B Converter**	**C Converter**
Overall Length	Max 31 m	Max 31 m	Max 31 m
Trailer One			
Length (box length) Wheelbase	Min 12.2 m Max 12.5 m	Min 12.2 m Max 14.0 m	Min 12.2 m Max 12.5 m
Hitch Offset: * Trailer length 12.2 – 13.7 m Trailer length > 13.7 m	 Max 1.8 m Max 2.8 m	 n/a n/a	 Max 1.8 m Max 2.8 m
Converter Dolly			
Drawbar Length Max Number of Axles	Max 4.65 m 2	n/a n/a	Max 2.0 m** 1
Trailer Two			
Legal dimensions Overall Gross Vehicle Weight	 Max 53,500 kg	 Max 62,500 kg	 Max 60,500 kg

Note: In all cases, the lead semi-trailer of the configuration must be heavier than the second trailer or semi-trailer.

Trailer two may be used as the lead semi-trailer providing the following conditions are met:
Trailer two is heavier than trailer one; and
Only “B” or “C” converters will be allowed on any approved 2-lane highway.
“A” converters will be allowed on all Turnpike/Triple Trailer routes.

- Tridem axle groups are very difficult to fit into A and C train lead trailers less than 13.7 metres in length, because of the hitch offset requirements.

** Note that hitch offset is generally not a concern on B trains and tridem axle groups are easily accommodated.*
*** The 2.0 meter maximum drawbar length is applicable to “C” converters manufactured in 1993 or later, in accord with the compliance requirements to the CMVSS under the Motor Vehicle Safety Act, Canada.*

7.5.4 Specific Conditions for Triple Trailer Combinations

The following lists specific requirements for the equipment. Dimensions or weights, where not specifically listed, shall conform to the Alberta Public Vehicle Dimension and Weight Regulation (AR 127/98) for A, B or C trains.

PARAMETER	**LIMIT**	**LIMIT**	**LIMIT**
	A Converter	**B Converter**	**C Converter**
Overall Length	Max 35 m	Max 35 m	Max 35 m
First Converter Dolly			
Drawbar Length Maximum number of axles	Max 4.65 m 2	n/a n/a	Max 2.0 m* 1
Overall Gross Vehicle Weight	53,500 kg	53,500 kg	53,500 kg

Note: In all cases, the lead semi-trailer of the configuration must be heavier than the second trailer or semi-trailer and the third trailer or semi-trailer is the lightest.

The 2.0 meter maximum drawbar length is applicable to “C” converters manufactured in 1993 or later in accord with the compliance requirements to the CMVSS under the Motor Vehicle Safety Act, Canada.

7.5.5 Specific Conditions for Turnpike Doubles

The following lists specific requirements for the equipment. Dimensions or weights, where not specifically listed, shall conform to the Alberta Public Vehicle Dimension and Weight Regulation (AR 127/98) for A, B or C trains.

PARAMETER	**LIMIT**	**LIMIT**	**LIMIT**
	A Converter	**B Converter**	**C Converter**
Overall Length	Max 37 m	Max 37 m	Max 37 m
Lead Semi-Trailer			
Length (box length)	Min 12.2 m	Min 12.2 m	Min 12.2 m
Wheelbase	Min 9.5 m Max 12.5 m	n/a Max 14.0 m	Min 9.5 m Max 12.5 m
Hitch Offset: * Trailer length 12.2 m to 13.7 m Trailer length > 13.7 m	 Max 1.8 m Max 2.8 m	 n/a n/a	 Max 1.8 m Max 2.8 m
Converter Dolly			
Drawbar length Maximum number of axles	Max 4.65 m 2	n/a n/a	Max 2.0 m** 1
Second Semi-Trailer or Full Trailer			
Length	Min 12.2 m	Min 12.2 m	Min 12.2 m
Wheelbase	Min 9.5 m Max 12.5 m	Min 8.25 m Max 11.5 m	Min 9.5 m Max 12.5 m
Gross Vehicle Weight	Max 62,500 kg	Max 62,500 kg	Max 62,500 kg
MAXIMUM GROSS COMBINATION WEIGHTS 5 Axle 6 Axle 7 Axle 8 or more Axles	 41,900 kg 49,800 kg 57,700 kg 62,500 kg	 40,700 kg 48,600 kg 56,500 kg 62,500 kg	 41,900 kg 49,800 kg 57,700 kg 62,500 kg

Note: In all cases, the lead semi-trailer of the configuration must be heavier than the second trailer of semi-trailer.

Tridem axle groups are very difficult to fit into A and C-train lead trailers less than 13.7 metres in length, because of the hitch-offset requirements. Note that hitch offset is generally not a concern on B-trains and tridem axle groups are easily accommodated.