

NCHRP

REPORT 671

NATIONAL
COOPERATIVE
HIGHWAY
RESEARCH
PROGRAM

Review of Canadian Experience with the Regulation of Large Commercial Motor Vehicles

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**Review of Canadian Experience
with the Regulation of Large
Commercial Motor Vehicles**

**John Woodrooffe
Peter Sweatman**

UNIVERSITY OF MICHIGAN TRANSPORTATION RESEARCH INSTITUTE
Ann Arbor, MI

**Dan Middleton
Ray James**

TEXAS TRANSPORTATION INSTITUTE
TEXAS A&M UNIVERSITY
College Station, TX

John R. Billing
Toronto, Ontario, Canada

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Mr. John Woodrooffe, Head of the Transportation Safety Analysis Division at UMTRI was the Project Director. The other authors of this report are Dr. Peter Sweatman, Director of UMTRI; Dr. Dan Middleton, Program Manager, System Monitoring Program at TTI; Dr. Ray James of Major Highway Structures at TTI; and Mr. John R. Billing, an independent consultant based in Canada. The work was done under the general supervision of Mr. Woodrooffe at UMTRI, at TTI, and in Toronto, Ontario, Canada.

FOREWORD

By Christopher J. Hedges

Staff Officer

Transportation Research Board

This report documents the process used in Canada to harmonize heavy truck size and weight regulations across the country and provides insights on how lessons learned from the Canadian experience might be applied in a U.S. context. It will provide a valuable contribution to the ongoing discussion of truck size and weight regulation in the United States. The authors include a summary of the regulatory framework for truck size and weight regulation in the United States and the efforts that have been made over time to achieve greater uniformity. This report will be of interest to truck size and weight regulators in the United States, who face similar jurisdictional challenges to develop and implement regulations that permit common configurations of heavy trucks that can operate legally across the country without compromising safety concerns or creating excessive impacts on road pavement.

Interest is building across the United States in allowing heavier and larger commercial vehicles across the national road network. The U.S. Department of Transportation and AASHTO (Association of American State Highway and Transportation Officials) want to be in a position to advise the Administration and Congress on whether or not there should be changes to the current federal size and weight provisions.

Canada offers a readily available source of data and insight into the impacts of allowable (non-permit) vehicle size and weight limits that are greater than those allowed nationally in the United States today. Furthermore, the unique process used in Canada for the national harmonization of truck size and weight limits in the 1980s will provide considerable insight to policy makers who are evaluating changes to truck regulations in the United States.

The process included a major research effort that fed technical information to a multi-jurisdictional committee charged with national consensus-building on truck size and weight regulation. The result was a National Memorandum of Understanding on Vehicle Weights and Dimensions that defined specific vehicle configurations that all provinces and territories of Canada would permit to operate on their road systems. The committee continues its work to this day, pursuing national and regional uniformity of policies, regulations, and enforcement practices.

Under NCHRP Project 08-63 “Review of Canadian Experience with Large Commercial Motor Vehicles,” a research team led by John Woodrooffe of the University of Michigan Transportation Research Institute conducted a thorough review and analysis of the Canadian experience with changes in truck size and weight limits and evaluated the potential applicability of this experience to size and weight regulation in the United States.

Canada has ten provinces and three territories, each with responsibility for truck size and weight regulations. These regulations became increasingly diverse by the mid 1970s and resulted in many vehicles with undesirable dynamic performance and/or excessive impact

on infrastructure. The provinces and territories determined that the diversity in regulations was a barrier to internal trade, and collectively, created a process that has now effectively harmonized them.

A large research effort was carried out between 1980 and 1983 that examined the impacts of truck size and weight configuration on safety (vehicle stability) and on pavement damage. The research involved both field testing and computer simulation. The study's Technical Steering Committee summarized the results and developed a set of principles for configuration of vehicles based on the findings. The ultimate result was an agreement on truck configurations that could legally operate in all Canadian jurisdictions.

CONTENTS

1	Summary
7	Chapter 1 Background
7	1.1 Problem Statement and Research Objective
7	1.2 Scope of Study
7	1.3 Terminology
9	Chapter 2 Truck Size and Weight Regulation in Canada
9	2.1 Recent History and Evolution
9	2.1.1 Regulations in the Late 1960s
10	2.1.2 The Ontario Bridge Formula, 1970
11	2.1.3 Intermediate Steps, 1970–1982
12	2.1.4 Canadian Council of Motor Transport Administrators/ RTAC Vehicle Weights and Dimensions Study, 1981–1986
13	2.1.5 Development of National Standards, 1986–1988
14	2.1.6 Implementation of the M.o.U.
15	2.1.7 Influence of the North American Free Trade Agreement
15	2.1.8 Amendments to the M.o.U. since 1988
17	2.1.9 Québec and Ontario Size and Weight Changes
18	2.1.10 Phasing Out Lifiable Axles
18	2.1.11 Other Vehicle Configurations
20	2.1.12 Summary
20	2.2 Provincial Truck Size and Weight Limits
20	2.2.1 The M.o.U.
21	2.2.2 Size and Weight Limits of the Provinces and Territories
21	2.2.3 LCV Operations
21	2.2.4 A Novel LCV Special Permit System
22	2.3 Canadian Institutional Mechanisms and the Size and Weight Harmonization Process
22	2.3.1 Background
22	2.3.2 Political Organization of Canada
23	2.3.3 Role of the Government of Canada in Truck Transportation
23	2.3.4 Role of Provincial Governments in Truck Transportation
23	2.3.5 Intergovernmental Coordination
24	2.3.6 The Task Force on Vehicle Weights and Dimensions Policy
24	2.3.7 Regional Groups Within the Task Force
25	2.3.8 Passing Law and Regulations in Canada
25	2.3.9 Taxation and Financing
25	2.4 Compile Literature
26	Chapter 3 Findings
26	3.1 Economic Impacts
27	3.2 Changes in Truck Fleets

27	3.2.1 Domestic Fleet, 1999
28	3.2.2 Cross-Border Fleet
29	3.2.3 Unanticipated Impacts
30	3.2.4 Cost Recovery
30	3.2.5 Changes in Compliance and Enforcement
31	3.3 U.S. Truck Size and Weight Regulation
31	3.3.1 Introduction
31	3.3.2 The Turner Proposal
33	3.3.3 The Comprehensive Truck Size and Weight Study
35	3.3.4 Review of Truck Size and Weight Limits
36	3.3.5 The Western Uniformity Scenario
37	3.3.6 Research Recommendations and Results
38	3.3.7 National Legislative Actions
40	3.3.8 State Legislative Actions
40	3.3.9 Regional Initiatives
41	3.3.10 The Corridor Perspective
41	3.3.11 The Bridge Perspective
44	3.4 Application of Canadian Experience to the United States
44	3.4.1 Freight and Trucks
45	3.4.2 The Need for Uniform Definitions
45	3.4.3 The Need for a Complete Vehicle Specification
46	3.4.4 The Need to Monitor Outcomes
46	3.4.5 The Need for Dimensional Compatibility
47	3.4.6 Weight Tolerances
47	3.4.7 Winter Weight Allowances and Spring Weight Restrictions
48	3.4.8 Vehicle Modifications
48	3.4.9 The Scientific Approach
49	3.4.10 Grandfather Rights
50	3.4.11 The NAFTA Partnership
50	3.4.12 The Institutional Contrast
52	Chapter 4 Conclusions
54	References
57	List of Abbreviations
58	Definition of Terms
A-1	Appendix A Heavy Truck Weight and Dimension Limits for Interprovincial Operations in Canada
B-1	Appendix B Truck Size and Weight Limits of the Provinces and Territories
C-1	Appendix C Bibliography of Canadian Truck Size and Weight Research
D-1	Appendix D Recommended Regulatory Principles for Interprovincial Heavy Vehicle Weights and Dimensions

S U M M A R Y

Review of Canadian Experience with the Regulation of Large Commercial Motor Vehicles

Background

Canada's ten provinces and three territories allowed significant non-uniform increases in allowable gross weight in the early 1970s, and their diverse regulations quickly became barriers to internal trade. The provinces therefore established a committee to address the issue. The committee identified roads and bridges that would need to be strengthened to allow for trucks at higher weights on all major highways. The necessary strengthening of the infrastructure was accomplished by the early 1980s. Some of the regulations in this early period led to vehicle configurations with large and undesirable impacts on roads and bridges and/or poor dynamic performance. The committee undertook the Canadian Council of Motor Transport Administrators/Roads and Transportation Association of Canada (CCMTA/RTAC) Vehicle Weights and Dimensions Study, a major research study to identify vehicle configurations suitable for the desired weights that had both minimal impact on infrastructure and satisfactory dynamic performance. The research was completed in 1986 and produced a set of principles for configuration of vehicles. The committee used these principles to develop a national Memorandum of Understanding on Vehicle Weights and Dimensions ("the M.o.U."). All provinces agreed to allow the vehicle configurations defined in the M.o.U. on a set of highways defined by each province with weights and dimensions that would not infringe on the limits in the M.o.U. The provinces implemented the M.o.U. in 1989, though Ontario inhibited full implementation in the six eastern provinces by restricting two key dimensions until 1994. The M.o.U. has been amended five times since 1989 to add straight trucks, truck-trailer combinations, and an inter-city bus, and also to refine the specifications of vehicles. Provinces can and do allow non-M.o.U. configurations for domestic and regional needs, but the national configurations now form the backbone of the truck fleet in Canada. By 1999, over 95% of truck trips in the four western provinces were M.o.U. configurations, as were about 80% of trips in the six eastern provinces. This difference is partly because of the delay in implementation, and also because Ontario and Québec allow some tractor-semitrailer configurations with a higher gross weight than the M.o.U. The M.o.U. was achieved from a process of negotiation to consensus among the provinces, and was based on findings of the research project. The process has generally achieved the desired outcomes, and the few unexpected outcomes have been curtailed, particularly by identifying and responding to them quickly, and by refining the vehicle configuration specifications. All provinces continue to use the process for assessing vehicles developed in the research project when they consider a new configuration for regulation or special permit.

The United States may consider allowing larger and/or heavier trucks across the national road network. The process used in Canada to harmonize truck size and weight regulations in the 1980s

can provide considerable insight to policy makers evaluating changes to truck regulations in the United States. The research reported here therefore had two objectives:

- Review and summarize the most current information on the Canadian experience with changes in truck size and weight limits and
- Evaluate the applicability of this experience to truck size and weight limits in the United States.

Provincial Truck Size and Weight Limits

All provinces have implemented the Canadian national M.o.U. Each either adopted the M.o.U. vehicle configurations into their regulations, or adapted their regulations so that they do not restrict a vehicle meeting the specification of the M.o.U., and these vehicles can operate within the province on a road network specified by the province. A province may allow less restrictive values for certain limits set in the M.o.U., and some do, generally higher for a weight limit, shorter for a minimum dimension, longer for a maximum dimension, or may not regulate a particular limit at all. A province may allow for other configurations not covered by the M.o.U., either as new vehicles, or as existing vehicles grandfathered from a previous set of regulations, by regulation, or by special permit, and they do. The vehicles may also be allowed to operate on other roads at lower weights, where roads, pavement, or bridges may require the lesser weight. The M.o.U. defines configurations for

- Tractor-semitrailers, from 3 to 6 axles;
- A-train doubles, from 5 to 8 axles;
- B-train doubles, from 5 to 8 axles;
- C-train doubles, from 5 to 8 axles;
- A straight truck, with 2 or 3 axles;
- A truck-pony trailer, from 3 to 6 axles;
- A truck-full trailer, from 4 to 7 axles; and
- An intercity bus, with 2 or 3 axles.

A straight truck may be 12.5-m (41-ft) long, a tractor-semitrailer or truck-trailer combination may be 23-m (75-ft 6-in.) long, an A-, B- or C-train double may be 25-m (82-ft) long, and an intercity bus may be 14.0-m (46-ft) long. A semitrailer may be 16.20-m (53-ft) long, and a pony trailer or full trailer may be 12.50-m (41-ft) long. The M.o.U. includes a number of internal dimensions for each configuration that are necessary for satisfactory dynamic performance, and to ensure proper bridge loading. The steer axle of a tractor is allowed 5,500 kg (12,125 lb), the steer axle of a straight truck is allowed 7,250 kg (15,983 lb), a tandem axle is allowed 17,000 kg (37,478 lb), and a tridem axle is allowed 21,000 to 24,000 kg (46,296 to 52,910 lb) depending on the spread, from 2.4 to 3.7 m (94 to 146 in.). The six eastern provinces allow 18,000 kg (39,682 lb) on a tandem axle, and 26,000 kg (57,320 lb) for a tridem axle with a spread from 3.6 to 3.7 m (142 to 146 in.). The allowable gross weight of a vehicle is the sum of its allowable axle loads, though the gross weight of some configurations is capped to ensure adequate dynamic performance. Dimensions of M.o.U. configurations are consistent in all provinces. Axle and gross weights are uniform in the four western provinces, and also uniform, but higher, in the six eastern provinces for vehicles outside of the M.o.U.

Coordination of Truck Size and Weight Regulations

The Canadian federal government has no truck size and weight regulations. Each province sets its own truck size and weight regulations, and they apply to all roads within the province, except where road or bridge condition may require a restriction.

The Task Force on Vehicle Weights and Dimensions Policy—national committee composed of officials from the federal, provincial, and territorial transportation departments, reports to the Council of Deputy Ministers Responsible for Transportation and Highway Safety, and has been assigned responsibility for

- Pursuing greater national and/or regional uniformity of policies, regulations, and enforcement practices for heavy vehicle weight and dimension limits within Canada and
- Representing Canada in regulatory harmonization discussions being carried out under the North American Free Trade Agreement (NAFTA).

The Task Force usually meets once a year in an open forum with stakeholders. Recommendations from the Task Force go forward to the Council of Ministers, and, if approved, each minister undertakes the implementation of the changes necessary in their province.

Economic Impacts of the M.o.U. on Canada

A study conducted 5 years after implementation of the M.o.U. estimated annual net benefits of about \$142 million for 1992, \$180 million for 1997, and \$222 million for 2002. These estimates were in 1992 Canadian dollars for operations on the Canadian National Highway System, and may have been double that if operations on other highways were also considered. The benefits were almost entirely in transportation costs, as most of the road and bridge improvements necessary to accommodate the higher weights of the M.o.U. were completed between 1975 and 1985.

In commenting on an earlier study, the railways suggested they would experience substantial annual losses from the M.o.U. In fact, they have done very well, acquiring U.S. lines, abandoning unprofitable branch lines in Canada, sharing track, and developing intermodal service into the single fastest growing transportation sector. Interestingly, the railways were actually the single largest early purchasers of new M.o.U. configurations, buying one standard design of container chassis for all their terminals across the country.

Impacts on the Truck Fleet

According to a national truck survey in 1999, over 95% of all truck trips in the four western provinces are taken by trucks of M.o.U. configuration, with about 80% in the six eastern provinces. The primary difference between the two exists because Québec allows 4-axle tractor-semitrailers, and Ontario allows 4-, 5- and 6-axle tractor-semitrailers that are often used instead of an 8-axle B-train. The proportion of M.o.U. configurations in the six eastern provinces has increased somewhat, as the provinces have moved to phase out non-M.o.U. configurations with liftable axles. From the 1999 survey, about 91% of cross-border trips were taken by M.o.U. configurations, even though two-thirds of these trips were to, from, or through Ontario.

Cost Recovery

Cost recovery was not an issue for the provinces through this process. All government revenue from all sources go into general revenue, where they are disbursed to the departments in accordance with the provincial finance minister's budget. Under general revenue, there is no relationship between, for example, fuel taxes and license fees, and expenditures on highway transportation.

U.S. Truck Size and Weight Regulation

Truck size and weight limits were the sole jurisdiction of the states until the Federal-Aid Highway Act of 1956 established truck size and weight limits for the Interstate system, but states with weight limits higher than the new federal limits were allowed to retain those limits under

grandfather authority. Federal weight limits were increased in 1974 to help offset a large increase in fuel prices, but not all states adopted the higher limits. The Surface Transportation Assistance Act (STAA) of 1982 required all states to allow twin trailers and prevented all states from restricting weights and dimensions of certain configurations more than existing specified values. The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 limited the increased use of double trailer combinations with a gross weight greater than 36,287 kg (80,000 lb). There have been no broad changes since 1991, though a number of states have continued to exercise their rights by allowing larger vehicles on state roads.

A number of proposals have been advanced since 1991, with many interesting approaches, but there has been no movement. Bridge capacity severely restricts options, and it has been shown repeatedly that it would be very expensive to provide the U.S. bridge system with the capability to accept vehicles at Canadian M.o.U. on a national basis.

Application of Canadian Experience to the United States—Conclusions

Truck size and weight regulation is abstruse, complex, highly technical, and has multiple close linkages with roadway, pavement, and bridge design; construction, maintenance and management; road safety, road capacity, and congestion; energy, emissions, rail transportation, and others. The public at large does not view trucks favorably, and especially does not like the concept of a larger or heavier truck. Making rational changes to truck size and weight in the United States is both technically and politically challenging.

The essential lessons learned from the Canadian size and weight experience are as follows:

1. There was national agreement among stakeholders that Canadian size and weight regulation was inconsistent and outdated, which contributed to cross-country transport inefficiency. Recognition of this problem provided a clear focus for action.
2. A formal body including federal and provincial government representation was established to develop and oversee the process of rationalizing size and weight policy based on scientific analysis. The basis for technical input was the “Vehicle Weights and Dimensions Study” that was specifically conducted to provide scientific input.
3. The size and weight study provided an understanding of vehicle infrastructure interaction and produced a set of vehicle performance metrics that were used to specify vehicle configurations that had desirable vehicle dynamic characteristics and could operate within the load capability and geometric constraints of the road network.
4. The study also validated the tridem axle group, which is the cornerstone upon which many of the higher productivity vehicles are built.
5. Canadian policy is structured through weight allowance limits to provide an incentive for the development and use of vehicles with favorable dynamic characteristics.
6. A formal body was established to oversee the implementation of harmonized size and weight policy among the provinces and it continues to monitor and respond to needs as required.
7. Size and weight regulation needs to be thorough and comprehensive so that the desired outcomes are achieved and undesirable outcomes are prevented.

The U.S. federal government has not made significant change to its truck size and weight regulations since 1991, when it moved to limit the opportunity of states to make changes. Nevertheless, since then, states have continued to make changes that allow larger and/or heavier trucks on roads that are not part of the national network, and these changes have increased the diversity of regulations across the nation. This has created a condition not unlike what existed in Canada before it began its size and weight harmonization effort. Furthermore, having frozen the

federal size and weight policy for the past 19 years, as other countries have progressed and made refinements to policy, the United States can benefit from the experience of these other jurisdictions by developing instruments that have a proven record of success.

In the United States, federal, state, local, toll road, and maybe other agencies have authority to set, monitor, and ensure compliance to truck size and weight limits. It would seem practical to identify one or more ranges of gross weight above 36,287 kg (80,000 lb), define new configurations to address each gross weight range, and require these vehicles be allowed on national network roads that are suitable for them.

Canada has three ranges of allowable gross weight higher than 36,287 kg (80,000 lb), essentially for trucks with 6, 7 and 8 axles. If a U.S. jurisdiction were to consider a higher allowable gross weight, it would be appropriate to define weight ranges and vehicle configurations for each. This approach could potentially reduce the number of trucks by maybe 10% to 15%, by judicious definition of weight ranges and suitable vehicle configurations.

U.S. specifications are highly influenced by the Federal Bridge Formula, which tends to define the number of axles in a vehicle, the allowable weights, and overall length. There is the potential for an approach based on the bridge formula to result in undesirable outcomes for vehicles with 6 or more axles. Unless otherwise prohibited it is likely that lift axles would flourish which would be threatening to the infrastructure. The approach in Canada was to provide a complete specification for the vehicle, including internal dimensions critical to both infrastructure and vehicle dynamic performance.

When truck size and weight regulations are changed, it is not uncommon for industry to find a loophole that provides an unintended, and possibly undesirable, outcome. The vehicle configurations that arise from the change should be monitored carefully, and if unintended vehicles with undesirable infrastructure impacts or dynamic performance are appearing, a mechanism should be available to close the loophole quickly to prevent these vehicles becoming common.

Dimensional compatibility is more important than the same allowable weights. Jurisdictions should respect the dimensions agreed upon for the specified vehicle, so that it can travel freely among the jurisdictions that have adopted it. If jurisdictions agree to accept a configuration, they may wish to allow less restrictive dimensions than the specification, but they should not have any more restrictive dimensions. In addition, if the jurisdictions have different allowable axle group weights, or allowable gross weight, the configuration should be able to be loaded to its allowable gross weight in each jurisdiction within the allowable axle loads and internal dimension limits.

Canada's process developed a performance-based method to assess the dynamic performance of vehicles, which was used as the basis for the national configurations, and has been used subsequently by all provinces when considering new configurations, either for regulation or for special permits. This is applied rigorously by all provinces, and it is not uncommon that proposed new configurations are rejected due to deficiencies in their dynamic performance. On the other side, if a new configuration can be shown to have better, or at least not worse, dynamic performance than existing vehicles it might replace, this provides a strong argument against those who oppose higher weights "on principle."

Grandfather rights and state permit programs allow for a variety of vehicles, some with evidently undesirable effects on infrastructure, dynamic performance, or both. If the federal government, or a state or region, would define configurations with greater allowable gross weight and more range, the diverse configurations operating under grandfather rights and permit programs would simply disappear. Any carrier wanting to continue to operate vehicles under the old grandfather right or permit program could continue to do so, but most of these local-use vehicles would quickly be replaced by vehicles with greater range that would be more efficient.

The United States, Canada, and Mexico are equal partners in NAFTA. The NAFTA treaty identified that truck size and weight regulations were potentially a barrier to trade, so it provided a mechanism for the three partners to harmonize their truck size and weight regulations. The United States has essentially not made any changes to its size and weight regulations since NAFTA became effective, while Canada and Mexico have both continued to develop their own truck size and weight regulations, which, coincidentally, have many similarities and considerable domestic benefit. Harmonization with the NAFTA partners to the extent possible with the intent of achieving more uniform transportation efficiency within North America could present a compelling argument for change.

CHAPTER 1

Background

1.1 Problem Statement and Research Objective

Interest is building across the United States in allowing longer and heavier trucks access to the national road network.

Canada's provinces and territories have all agreed to allow a set of heavy truck configurations with specified dimensional and weight limits on specific highways defined by each jurisdiction. The trucks are allowed considerably higher weight than those required by federal regulation in the United States, and double trailer combinations are allowed slightly greater length. While provinces allow other configurations for domestic and regional needs, the national configurations now form the backbone of the truck fleet in Canada. The process to achieve this was put in place when the provinces realized that the increasingly diverse limits and configurations arising from provinces acting independently, or regionally, were leading to significant barriers to internal trade. The result was achieved from a process of negotiation to consensus among the provinces, and was based on a substantial research project to address significant road, bridge, and vehicle configuration and performance issues.

The process used in Canada for the national harmonization of truck size and weight limits in the 1980s can provide considerable insight to policy makers who are evaluating changes to truck regulations in the United States, and particularly, the need to understand how vehicle configurations should be specified so that specific regulatory changes actually result in the desired outcomes.

This research therefore had two objectives:

1. Review and summarize the most current information on the Canadian experience with changes in truck size and weight limits and
2. Evaluate the applicability of this experience to truck size and weight limits in the United States.

1.2 Scope of Study

The study was divided into two phases, which together included five major tasks, as follows:

- Truck size and weight regulations in Canada:
 - Some history of the evolution of size and weight regulation in Canada,
 - A summary of current size and weight limits, and
 - An outline of the institutional framework for truck size and weight regulation in Canada, and
- Impacts and lessons of harmonization of truck size and weight limits in Canada:
 - Summary of the impacts of changes in truck size and weight regulations in Canada, and
 - Identification of areas where the Canadian truck size and weight limits have resulted in particular successes or problems and the identification of constraints that might limit that applicability of Canadian practices in the United States.

The study was based primarily on available research and institutional documentation focusing primarily from 1980 onward.

1.3 Terminology

The term “size and weight regulations” is used throughout this report to describe the body of rules for configuration, sizes, and allowable weights of heavy trucks set by a given jurisdiction.

Canada has ten provinces and three territories. The term “provinces” or “provincial” is used as a simplification throughout this report, and, where used, includes the Canadian territories.

A number of organizations, pieces of legislation and other things are widely known by an abbreviation of their name. A

list of common abbreviations used here may be found at the end of the report, after the references.

This work uses a number of terms to identify or describe vehicle configuration, components, axle groups, dimensions, and other aspects of heavy trucks. Definitions of terms may be found at the end of this report, after the table of abbreviations.

CHAPTER 2

Truck Size and Weight Regulation in Canada

Truck size and weight regulation in Canada has always been under the jurisdiction of the provinces. Regulations were developed by each province in the early part of the 20th century, with the growth of the provincial highway systems. There was little interprovincial trucking at this time, so differences between the truck size and weight regulation of different provinces were not a significant issue. However, the development of a modern highway system in the 1960s and 1970s led to growth in interprovincial trucking, and significant and differing changes to the size and weight regulations made by provinces rapidly became a barrier to inter-provincial trade. This led the provinces into a lengthy cooperative process to harmonize the regulations. This chapter presents

- Some history of the evolution of size and weight regulation in Canada,
- A summary of current size and weight limits, and
- An outline of the institutional framework for truck size and weight regulation in Canada.

2.1 Recent History and Evolution

Truck size and weight regulations in Canada are now founded on the “Federal-Provincial-Territorial Memorandum of Understanding on Interprovincial Weights and Dimensions,” hereafter referred to as “the M.o.U.” (1). This section describes

- The history and evolution of truck size and weight regulations in Canada from the 1960s through to the mid-1980s,
- The process followed to create and implement the first national agreement on truck size and weight in 1988,
- Subsequent changes to the M.o.U., and
- Other changes in size and weight regulations that have happened since implementation of the M.o.U.

2.1.1 Regulations in the Late 1960s

Truck size and weight regulations in the 1960s were generally rather similar in the provinces of Canada and the states in the United States. The regulations were completely prescriptive, and allowable weights and dimensions were similar. For example, the principal size and weight limits in Ontario in the 1960s were as follows:

- Maximum overall length was 19.81 m (65 ft);
- Maximum semitrailer length was 13.72 m (45 ft);
- Allowable axle loads were:
 - 4,536 kg (10,000 lb) for a steer axle;
 - 8,165 kg (18,000 lb) for a single axle;
 - 14,515 kg (32,000 lb) for a tandem axle; and
 - 19,051 kg (42,000 lb) for a tridem axle;
- Allowable gross weights were:
 - 19,051 kg (42,000 lb) for a 3-axle vehicle;
 - 33,566 kg (74,000 lb) for a 3-axle tractor with a 2-axle semitrailer; and
 - 36,287 kg (80,000 lb) for 3-axle tractor with a 3-axle semitrailer; and
- Higher weights were possible for double trailer combinations, up to 55,338 kg (122,000 lb) for a 3-axle tractor with two 3-axle trailers.

The limits were so restrictive that there was really little choice of configuration. The predominant configuration was a tractor-semi-trailer with a 13.72-m (45-ft) semi-trailer, as seen in Figure 1 and Figure 2, and there were also a few double trailer combinations, as seen in Figure 3 (2). These trucks were similar to those that existed at the same time in the other provinces in Canada, and in many states in the United States. Uniformity of size and weight regulations between provinces was not a big issue, because prior to closing the last gap in the Trans-Canada Highway in 1962, the only highway connection



Figure 1. Tandem semitrailer from the 1960s.

between eastern and western Canada was through the U.S. Uniformity between provinces and states was also not a big issue, as cross-border trucking was much more restricted than now.

2.1.2 The Ontario Bridge Formula, 1970

The Ontario trucking industry campaigned for higher legal weights through the 1950s and 1960s to improve the competitive edge of Ontario truckers, and it won increases in 1960 and 1966. Studies by the Ontario Department of Economics and Development in 1966 concluded there was no economic basis for an increase in the single axle load (3). The majority of weight enforcement at that time was through the weighing of an entire vehicle on a large platform scale for gross weight. The Ontario Department of Transport conducted a survey of truck size and weight in 1967 and found significant overloading of axles on vehicles that were within or only slightly over their allowable gross weight. It also found that a lack of axle spacing control in the then-current law had resulted in a large proportion of very short trucks with closely spaced axles that could be very damaging to bridges. However, these vehicles and their overloading did not appear to cause the distress



Figure 2. Tridem semitrailer from the 1960s.

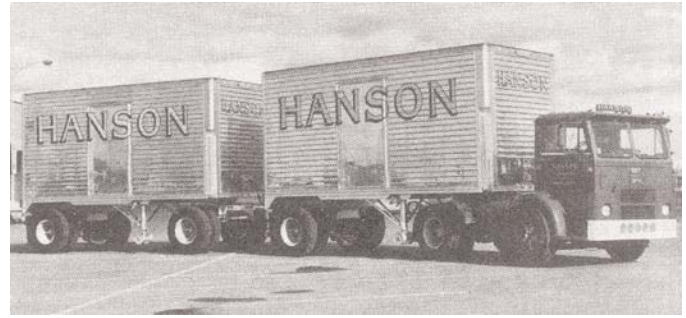


Figure 3. A-train double, 6.1-m (20-ft) trailers from the 1960s.

either to roads or bridges that would have been expected. The Ontario Department of Transport undertook a series of studies of the load carrying capacity of existing bridges on the basis of the traffic observed in the load survey (4), (5). This resulted in the development of the Ontario Bridge Formula (OBF) as a safe operational load limit for bridges (6).

The OBF introduced the concept of greater allowable weight on an axle group with greater spread and became the means to control axle weights in Ontario, especially those of the short heavy vehicles mentioned above. The allowable load on a single axle was obtained from pavement considerations, and the formula extended this to provide a safe load for bridges for a group of consecutive axles on the basis of the spacing between the axles. The formula allowed an increase in axle loads of about 10% over the prior law, as follows:

- 9,071 kg (20,000 lb) for a single axle;
- 15,875 to 17,690 kg (35,000 to 39,000 lb) for a tandem axle, depending on spread from 1.22 to 1.83 m (48 to 72 in.); and
- 19,958 to 27,215 kg (44,000 to 60,000 lb) for a tridem axle, depending on spread from 2.44 to 4.88 m (48 to 192 in.).

The bridge formula resulted in a corresponding increase in allowable gross weight, to a cap of 63,503 kg (140,000 lb), though it was difficult to reach this as the maximum overall length remained at 19.81 m (65 ft).

The OBF was introduced into the Highway Traffic Act (HTA) in 1970 to govern axle group and gross weight. Motor carriers persuaded the ministry that they needed some time to adjust to the new weight regulations, so a regulated tolerance was introduced for axle group weights. This initially allowed 1,587 kg (3,500 lb) per axle for a single, tandem, or tridem axle, but the tolerance decreased at 227 kg (500 lb) per year to 454 kg (1,000 lb) per axle by 1975.

The OBF was simply a means to evaluate a vehicle, and it did not control axle arrangement or vehicle configuration in any way. Vehicle designers quickly mastered the formula, and developed a variety of axle and vehicle configurations to maximize the allowable gross weight. These included semitrailers



Figure 4. Ontario tri-axle semitrailer from the early 1970s.



Figure 5. Ontario 4-axle semitrailer from the early 1970s.

with widely spaced axles, as shown in Figure 4 and Figure 5, with one or more liftable axles, truck-trailer combinations, as shown in Figure 6, and double trailer combinations, as shown in Figure 7 and Figure 8. The new configurations provided industries shipping heavy or bulk commodities with a significant improvement in transportation productivity (7). The failure to control axle arrangement or vehicle configuration may have been an oversight, though there is some evidence of an intention to allow truck designers to innovate (3), though there may have been little idea as to where this innovation might lead. The growth in use of liftable axles, and their consequences in damage to the infrastructure, were not foreseen. The rest of this story is really about the years of effort needed to undo this step.



Figure 6. Ontario truck-trailer combination from the early 1970s.



Figure 7. Ontario A-train double from the early 1970s.

The allowable gross weight of a vehicle under the OBF had to be evaluated by extensive manual calculations using a worksheet and tables. It was difficult, time consuming, and perhaps too complex for some enforcement staff at truck inspection stations and for carriers to perform these calculations. A regulation was therefore developed that provided “look-up” tables that gave allowable gross weights for ranges of axle spacing of the most common configurations. The industry quickly realized that weight enforcement would not be possible if a configuration was not covered in the regulation so many new and unusual configurations were developed. These examples show the forces that drive unintended consequences.

2.1.3 Intermediate Steps, 1970–1982

Trade restrictions made it efficient for U.S. manufacturers to establish branch plants in Canada, and to distribute the products in Canada by truck and rail. Freight transportation in Canada was therefore primarily east–west in this period. Ontario’s axle weight increases in 1970, and the resulting large gross weight increase, put pressure on other provinces for similar changes.

The other provinces increased maximum gross weight limits during the 1970s, to between 49,900 kg (110,000 lb) and 57,150 kg (126,000 lb). Unlike Ontario, these provinces all provided a prescriptive specification for vehicle configuration



Figure 8. Ontario B-train double from the early 1970s.



Figure 9. Prairie 7-axle A-train double from the late 1970s.

and allowable weights. British Columbia introduced a limited number of configurations similar to some in Ontario, but required a liftable axle to be self-steering. The three Prairie Provinces (Alberta, Saskatchewan, Manitoba) allowed double trailer combinations, and 7- or 8-axle A-trains, as shown in Figure 7 and Figure 9, respectively, and a 7-axle B-train, shown in Figure 10, became the heavy-haul vehicles of choice. The 8-axle A-train was particularly favored, as it fared better under spring weight restrictions than the 7-axle B-train, even though the latter had a higher allowable gross weight outside the thaw period. The vehicle of choice in Québec and the Atlantic Provinces (Newfoundland and Labrador, New Brunswick, Nova Scotia, Prince Edward Island) became the tri-axle semi-trailer, as shown in Figure 4, and the 7-axle B-train, as shown in Figure 10, also became common in Québec. The three Prairie Provinces as a group, and the four Atlantic Provinces, also as a group, each developed their regulations to provide considerable regional uniformity in format and allowable size, axle group weights and gross weights, though significant differences remained between these two regions and the other three provinces.

These changes tended to increase, rather than decrease, the diversity in size and weight. The 1973 oil crisis brought into focus a need to increase the efficiency of truck transportation



Figure 10. Prairie Provinces 7-axle B-train double from the late 1970s.

in Canada. The Roads and Transportation Association of Canada (RTAC) coordinated highway engineering standards, and the provincial highway departments were the principal sponsors of the association. RTAC therefore formed a Vehicle Weights and Dimensions Committee, with a charge to rationalize truck configurations, and their sizes and weights, across Canada (8). The committee quickly established that enough was known to upgrade roads for heavier axle loads, and a highway strengthening program was undertaken in the Prairie and Atlantic Provinces, with significant federal funding. It also found that the live-load capacity of bridges was unclear, particularly with respect to overload permits. This resulted in a national study of bridge capacity (8), which showed that despite considerable apparent diversity in provincial weight and dimension regulations, the consequent vehicles were generally compatible with bridges in all provinces (9). This was to be expected as the provinces generally designed their bridges to AASHTO (10) or Canadian Standards Association (CSA) codes (11), which resulted in bridges of roughly equivalent capacity. The provinces were able to identify a small number of bridges which needed strengthening, and these were upgraded or replaced, relatively quickly, again with some federal funding.

By 1981, highway and bridge strengthening programs on the primary highway systems of the provinces had allowed an increase in axle loads and gross weights in other provinces to 80% to 90% of Ontario's, with British Columbia and Yukon matching Ontario's 63,500 kg (139,992 lb). Overall lengths reached 21 to 23 m (69 to 75 ft 6 in.), and double trailer combinations became much more popular, particularly in western Canada.

2.1.4 Canadian Council of Motor Transport Administrators/RTAC Vehicle Weights and Dimensions Study, 1981–1986

By 1981, improvements to highways and bridges across Canada allowed travel coast-to-coast for vehicles with a gross weight of 60,000 kg (132,276 lb) or more. However, there were two significant impediments. First, other provinces and territories (except Yukon) were not prepared to adopt the same form of regulation as Ontario, nor were they prepared to accept many of the truck configurations or axle arrangements commonly used in Ontario to generate these weights, particularly those with liftable axles. Second, a tridem axle group (three equally spaced axles) would be required for an increase in allowable gross weight, and this axle group was not recognized in a number of provinces, especially in the Prairie Provinces.

The Canadian Council of Motor Transport Administrators (CCMTA)/RTAC Vehicle Weights and Dimensions Committee developed the Vehicle Weights and Dimensions Study

from 1980 through 1983 to address these issues (8). The study was developed with a clear intention that the research findings would be implemented. The study was funded jointly by all provinces and territories (50%), the federal government (25%), and industry, as represented by the Motor Vehicle Manufacturers Association, the Canadian Trucking Association, the Truck Trailer Manufacturers Association, and the Private Motor Truck Council (25%). The project was managed through a small Technical Steering Committee made up of representatives of the funding partners. The CCMTA/RTAC Vehicle Weights and Dimensions Study included:

- A simulation study of candidate-vehicle configurations (18), (19), supported by a small amount of full-scale testing (19), and other assessments of simulation methodology (20), (21);
- A full-scale test program (22), (23), supported by a simulation study to compare simulation results of test conditions (24), and a specific examination of C-train stability (25);
- An evaluation of rollover thresholds of heavy vehicles using a tilt table (26), supported by a study of simplified means to assess the roll threshold (27); and
- A pavement test program (28), (29) and (30), supported by an investigation of heavy truck suspension characteristics (31).

After completion of the research, a technical seminar was held to report the findings to stakeholders. The work was also presented to the international community at the first International Symposium of Heavy Vehicle Weights and Dimensions (32). It is a measure of the significance of the CCMTA/RTAC Vehicle Weights and Dimensions Study that this first symposium has been followed by nine others, as the 10th International Symposium on Heavy Vehicle Transport Technology took place in Paris during 2008.

The Technical Steering Committee summarized the results and developed a set of principles for configuration of vehicles based on the findings of the technical studies (33).

2.1.5 Development of National Standards, 1986–1988

After the research phase was completed, the CCMTA/RTAC Vehicle Weights and Dimensions Committee formed an Implementation Planning Subcommittee in 1986 with a charge to

- Develop a plan that will assist each jurisdiction in implementing vehicle weight dimension and configuration regulatory principles that will lead to national uniformity,
- Develop schedules for proposed implementation of recommendations, and
- Monitor the progress of implementation of the recommendations as they may be agreed to by the Council of

Ministers Responsible for Transportation and Highway Safety at its meeting in September 1987.

The Implementation Planning Subcommittee was formed with one member from each province and territory. The chairman was independent, and Transport Canada attended as an observer. Meetings were closed to stakeholders.

The CCMTA/RTAC Vehicle Weights and Dimensions Study provided a rational and objective means to define weight and dimension parameters and vehicle configurations on the basis of considerations of vehicle dynamic performance and pavement loading (33). Previous work had established that bridge capacity would allow an increase in allowable weights (8), (9), but the provinces still had diverse approaches to assessment of the impacts of vehicles on bridges. The Implementation Planning Subcommittee met with the provincial bridge engineers as a group and achieved agreement on allowable axle group weights for defined spreads, for minimum inter-axle spacings necessary to maintain axle group weights, and for allowable gross weights.

The Implementation Planning Subcommittee developed detailed specifications for tractor-semitrailers from 3 to 6 axles, and A-, B-, and C-trains from 5 to 8 axles, which were considered the most common vehicles for interprovincial highway transportation. The specifications included a drawing of the configuration, a table of dimensions, and a table of allowable weights. These specifications were necessarily detailed, to ensure that pavement, bridge and dynamic performance were all within acceptable limits. The specifications were attached to and formed part of the M.o.U., which was concluded in 1988 at that year's meeting of the Council of Ministers Responsible for Highway Safety. The M.o.U. was simply an understanding that the ministers would make their best efforts to implement the content within their own jurisdiction (1). All provinces have done this, without significant deviations.

The M.o.U. defined size and weight limits for tractor-semitrailers and A-, B-, and C-train double trailer combinations, and required each jurisdiction to allow vehicles within these limits to operate freely on a highway system designated by that jurisdiction as suitable for operation of the vehicles. The M.o.U. set the following axle group loads (1):

- 9,100 kg (20,061 lb) for a single axle;
- 17,000 kg (37,478 lb) for a tandem axle; and
- 21,000, 23,000 or 24,000 kg (46,296, 50,705 or 52,910 lb) for a tridem axle with a spread of 2.44, 3.05 or 3.66 m (96, 120 or 144 in.), respectively.

These axle loads were increases for the four western provinces, but were generally consistent with, or less than, weights previously allowed in the six eastern provinces. There was essentially no effect on single and tandem semitrailers,



Figure 11. M.o.U. tandem semitrailer.

the latter shown in Figure 11. The tridem semitrailer, shown in Figure 12, introduced a configuration with an intermediate weight capacity.

Short and medium length A-train doubles like that shown in Figure 9, were found to have undesirable vehicle dynamic characteristics, and, therefore, these vehicles were limited in the allowable gross weight of 53,500 kg (117,946 lb), though this limit still allowed for unrestricted access by the U.S. Surface Transportation Assistance Act (STAA) twin trailer, shown in Figure 13. The allowable gross weight of C-train doubles was provisionally limited to 53,500 kg (117,946 lb), pending further work to define key properties of the C-dolly. The 8-axle B-train double, shown in Figure 14, was found to have excellent vehicle dynamic characteristics with a gross weight of up to 62,500 kg (137,787 lb). With the weight advantage, it immediately became the configuration of choice for heavy loads in the four Western Provinces. The box length of A- and C-train doubles was limited to 18.5 m (60 ft 8 in.), while the B-train double was allowed 20 m (65 ft 7 in.), to encourage use of B-trains for light- and moderate-density freight. A number of key internal dimensions were specified for each configuration, to ensure that they met bridge loading and dynamic performance standards.

It is important to note that the M.o.U. did not require that all provinces adopt these configurations as their only vehicles. It



Figure 13. STAA twin trailer.

did require that all provinces allow the configurations it defined, with their dimensional restrictions, at the specified weights.

The 1988 M.o.U. (1) was similar in form to the current version (34), which is reproduced in Appendix A. However, the 1988 M.o.U. only included specifications for a tractor-semi-trailer, and A-, B- and C-train doubles, and some of the detailed provisions for these configurations were different than the current version. The increase in overall vehicle length from 23 to 25 m (75 ft 6 in. to 82 ft) was a concern and was reviewed in detail (34). While there were issues with a number of traffic standards, these issues were also present for current vehicles. In particular, while sight distance and road marking standards were questionable in passing situations, drivers interpreted the road markings in a much more conservative manner than the standard (36).

2.1.6 Implementation of the M.o.U.

Each province had the freedom to designate what portions of its highway system the M.o.U. configurations would operate. British Columbia and Ontario each designated their entire highway system, because their prior rules already allowed vehicles at weights no less than those specified by the M.o.U. Alberta, Saskatchewan, and Manitoba each had significant amounts of highway with thin flexible pavement, or second-



Figure 12. M.o.U. tridem semitrailer.



Figure 14. M.o.U. 8-axle B-train.

ary highway, which did not have the pavement strength for full M.o.U. loads. Their designated highway systems therefore excluded these lower strength highways, though M.o.U. configurations were allowed to operate on them, but at weights lower than those prescribed by the M.o.U. Québec designated its primary highway system, but initially only allowed B-trains up to a gross weight of 58,500 kg (128,969 kg) and an overall length of 23 m (75 ft 6 in.) off divided highways, generally because of the geometry and condition of the primary highways in the northern part of the province. The Atlantic Provinces generally designated their primary highway systems, with significant weight restrictions on other highways, primarily because of the large numbers of older bridges with inadequate or unknown capacity.

Since 1989, Alberta has designated essentially its entire highway system at M.o.U. loads. Other provinces have added highway links on the basis of demand for service and after upgrades to roadway, pavement and bridges. At this point, while M.o.U. configurations certainly cannot use all roads in all provinces at their full M.o.U. loads, they can go essentially everywhere they need to go at those loads, and can go almost everywhere at whatever reduced load is specified for the roads involved.

The provinces took different approaches to adopt the M.o.U. British Columbia, Alberta, Saskatchewan, and Manitoba simply adopted the M.o.U. as their size and weight regulation, and they grandfathered existing noncompliant configurations at their existing weights for a specified period. Ontario initially adjusted its rules in 1989 to allow M.o.U. configurations without restriction up to a semitrailer length of 14.65 m (48 ft) and an overall length of 23 m (75 ft 6 in.). It finally increased the semitrailer length to 16.2 m (53 ft), and the overall length of doubles to 25 m (82 ft), in 1994, and defined these vehicles as specific configurations subject to all the dimensional limitations of the M.o.U. Québec was unable to make changes until Ontario had set its regulations and, in 1991, amended its dimensions to allow M.o.U. configurations at the same restrictive lengths as Ontario, made other changes to ensure M.o.U. configurations would not be restricted, and reduced the allowable gross weight on A-train doubles to the M.o.U. value of 53,500 kg (117,946 lb). The Atlantic Provinces initially allowed the M.o.U. configurations as additional configurations, but subsequently in 2001, in concert, adopted the M.o.U. and grandfathered existing configurations (37).

When provinces implemented the M.o.U., they took diverse approaches to noncompliant vehicles from other jurisdictions that arrived at their borders. Some simply rejected the non-compliant vehicles and others allowed them a trip permit to deliver their current load. Québec developed a restriction on semitrailer wheelbases for tractors with a wheelbase over the 6.20 m (244 in.) limit in the M.o.U. (38).

2.1.7 Influence of the North American Free Trade Agreement

The Free Trade Agreement between Canada and the United States became effective in 1988, and was superseded by NAFTA in 1994. Previous to these agreements, it was effective for a U.S. manufacturer to maintain a branch plant in Canada to manufacture products, which were then distributed east and west across Canada from the branch plant. After free trade, it became more effective for the manufacturer to maintain the most efficient plant, whether in the United States or Canada, and to distribute the products to the other country as necessary. Within a relatively short time, as branch plants closed, a significant amount of east-west freight transportation in Canada changed to a north-south orientation. A consequence was that the importance of harmonization among Canada's provinces tended to decrease, and the importance of harmonization between Canada's provinces and their neighboring U.S. states increased. This was felt most strongly in Ontario, as 60% of all Canada's imports and exports pass through Ontario.

The 16.2-m (53-ft) semitrailer became the standard semitrailer in the United States. within a couple of years after passage of the M.o.U., just as the freight pattern was changing from east-west to north-south. Again, as with the 14.65-m (48-ft) semitrailer after the STAA in 1982, there were difficulties as some carriers brought 16.2-m (53-ft) semitrailers into Ontario, while others moved freight destined for Canada into 14.65-m (48-ft) semitrailers before crossing the border. The Ontario Trucking Association built a strong coalition of shippers, carriers and others in support of 16.2-m (53-ft) semitrailers. A study identified that the 14.65-m (48-ft) length limit was costing Ontario Can\$100 million annually in additional transportation costs (39). Ontario then finally accepted this length for semitrailers, and the 25-m (82-ft) overall length for double trailer combinations in 1994. The M.o.U. was finally amended with the semitrailer and overall length changed to the original agreed-upon lengths of 16.2 m (53 ft) and 25 m (82 ft), respectively, in July 1994. Québec and the Atlantic Provinces immediately facilitated 16.2-m (53-ft) semitrailers and 25-m (82-ft) B-trains by special permit, and subsequently put them into regulation at these lengths.

2.1.8 Amendments to the M.o.U. since 1988

The CCMTA/RTAC Vehicle Weights and Dimensions Study defined a standard process for assessing the dynamic performance of vehicles against base performance standards that were objectively related to highway safety (18), (33) and Appendix D. The M.o.U. defined vehicle configurations for tractor-semitrailers and A-, B- and C-train doubles with dimensions and allowable weights on the basis of this process. However, each province also had a range of other configurations,



Figure 15. M.o.U. straight truck.

principally for truck-trailer combinations. Collectively, the provinces asked, now that tractor-semitrailers and doubles had been configured to ensure they met objective standards for dynamic performance, should other vehicles also be configured in a similar manner?

The range of straight trucks and truck-trailer combinations was defined, and the dynamic performance of these vehicles was assessed by computer simulation using the same methods as used during the CCMTA/RTAC Vehicle Weights and Dimensions Study (40). This identified that the truck hitch offset, trailer wheelbase and trailer drawbar length were significant parameters. A limited test program was conducted to verify the variations in performance measures due to variation in these parameters (40). From this work, configurations for a straight truck, shown in Figure 15, a truck-full trailer, shown in Figure 16 and a truck-pony trailer combination, shown in Figure 17, were defined. These configurations, and a 14-m (46-ft) long intercity bus, were added to the M.o.U. in the first amendment in 1991. The front axle weight of a straight truck was restricted to 5,500 kg (12,125 lb), the same as the allowable front axle weight for a tractor, due to concerns about flexible pavements primarily in Saskatchewan. The four Western Provinces immediately adopted the new configurations.

An early proposal was made for what was essentially a jeep dolly to pull a 14.65-m (48-ft) semitrailer, a combination that



Figure 16. M.o.U. truck-trailer combination.



Figure 17. M.o.U. truck-pony trailer combination.

met the dimensional constraints for a B-train as defined in the M.o.U. However, the combination had substantially greater offtracking than the largest tractor-semitrailer allowed under the M.o.U., so a restriction to limit the sum of the wheelbases of the two semitrailers of a B-train to 17.0 m (55 ft 9 in.) was also introduced in the 1991 amendment.

The M.o.U. initially limited the gross weight of C-train doubles pending clear definition of the desired properties of a C-dolly. These were developed in a subsequent study (41), supported by federal safety standards for the dolly (42) and its hitches (43). Features of this work were added into the C-train specification in the M.o.U.; its allowable gross weight was increased to 58,500 kg (128,969 lb), and its box length was increased to 20 m (65 ft 7 in.) when the M.o.U. was amended in 1991. It had become clear by this time that the B-train was the configuration of choice for heavy loads, and that the C-train was simply a means for carriers, mostly in the Prairie Provinces, to get a useful payload out of specialized trailers originally built as an A-train and modified to become a C-train.

The second amendment to the M.o.U. was made in July 1994, when the semitrailer length was increased to the originally agreed upon length of 16.2 m (53 ft), and the overall length of double trailer combinations was increased to the originally agreed upon length of 25 m (82 ft). It also included two clarifications, as follows:

- A dromedary box may be used to carry load on a tractor, and
- A B-train may use a tridem axle group on the rearmost semitrailer.

The third amendment to the M.o.U. was made in June 1997, and consisted of minor changes to simplify and rationalize details of the M.o.U. The following amendments were made:

- The box-length limit for truck-pony trailer and truck-full trailer configurations was increased to 20 m (65 ft 7 in.), primarily for compatibility with the so-called Maxi-cube truck-pony trailer combination introduced into U.S. regulations (44);

- The maximum hitch offset was standardized at 1.8 m (71 in.) for all configurations;
- The minimum wheelbase for a semitrailer, pony trailer or full trailer was standardized at 6.25 m (246 in.);
- An inter-axle spacing less than 3.0 m (118 in.) between the lead trailer and an A- or C-dolly was allowed, subject to a weight restriction on the two axle groups;
- The fifth wheel on the lead trailer of a B-train was restricted to no more than 0.3 m (12 in.) behind the center of the rearmost axle of the lead semitrailer. This was because existing semitrailers in some provinces were being modified with a low-mounted fifth wheel behind their rearmost axle, which towed a pony trailer fitted with a kingpin. This combination met the dimensional limits for a B-train, but the significant hitch offset of the lead trailer fifth wheel resulted in poor dynamic performance for the pony trailer;
- The allowable weight on the steer axle of a straight truck was increased to 7,250 kg (15,983 lb);
- The caps on the weight of the second trailer of A- and C-train doubles were replaced by a requirement that the combined weight of the tractor drive axles and the lead trailer axles must be greater than the weight of the second trailer;
- A clarification was added that a vehicle fitted with any liftable axles was recognized as meeting the “national standards,” provided that when the liftable axles were raised, all other requirements were met; and
- A clarification was added that each jurisdiction continued to retain authority to allow more liberal weights and dimensions, or different vehicle configurations, for trucking operations within their jurisdiction. In addition, when trucking operations took place between adjacent jurisdictions with compatible weight and dimension regulations, which are more liberal than those specified in the M.o.U., the local regulations can prevail.

The fourth amendment to the M.o.U. was made in September 2004, as follows:

- The box length of an A-train double was increased to 20 m (65 ft 7 in.);
- The kingpin setback of the second semitrailer of a B-train double was limited to the same 2.0-m (79-in.) radius as other semitrailers; and
- The intercity bus category was amended to include a recreational vehicle on a bus chassis, allowing the recreational vehicle an overall length of 14 m (46 ft).

Finally, a fifth amendment to the M.o.U. was made in April 2008, as follows:

- An axle fitted with two wide single tires, each 445 mm or wider, was allowed 7,700 kg (16,975 lb) on a single axle, or 15,400 kg (33,950 lb) on a tandem axle;

- The minimum track width for a trailer axle fitted with wide single tires was reduced to 2.3 m (90.5 in.) for trailers built in 2007 or earlier, but remained at 2.5 m (98.4 in.) for all axles on trailers built in 2008 or later;
- An aerodynamic device installed at the rear of a truck, trailer or semitrailer was excluded from measurement of overall length, trailer length, semitrailer length, box length and effective rear overhang; and
- A clarification was added to exclude from measurements of overall width:
 - Auxiliary equipment and/or devices not designed or used to carry cargo that do not extend more than 10 cm beyond each side of the vehicle, and
 - Rearview mirrors that do not extend more than 30 cm beyond each side of the vehicle.

2.1.9 Québec and Ontario Size and Weight Changes

In the mid 1980s, Québec began allowing multi-axle semitrailers from Ontario to operate into Québec at Ontario weights by special permit. Québec began to realize that many of these vehicles, with one or two liftable axles, could operate with their liftable axles raised and produce excessive loads on both roads and bridges. The permit program rapidly became very popular and also became difficult to administer. A computer simulation study identified significant dynamic performance deficiencies with many of these configurations (45). Québec therefore rewrote its regulations in 1991 and made a first step to categorize its configurations and reduced the allowable loads on those considered less desirable from the point of view of roadway impacts and stability and control. It eliminated the permit program for Ontario multi-axle semitrailers and defined a quad-axle semitrailer with a single axle and a fixed tridem axle, as seen in Figure 18, as the preferred semitrailer configuration for high payloads by penalizing the allowable load on all other arrangements of four or more axles on a semitrailer (46). Québec recognized that the tri-axle



Figure 18. Ontario and Québec self-steer quad semitrailer.

semitrailer, as seen in Figure 4, which has a single liftable axle ahead of a fixed tandem, was also highly damaging to roads and bridges and also had significant deficiencies in dynamic performance. Québec therefore reduced the allowable load on the tri-axle group, to reduce the economic attraction of the configuration. Unfortunately, it overlooked that it allowed an even higher load on a tri-axle with a 4.88-m (192-in.) spread and did not reduce the allowable load on this axle group because it was not being used at this time. Manufacturers quickly adopted this axle group, and the intention of the change in regulation was negated.

When Ontario increased semitrailer length to 16.2 m (53 ft) and double trailer overall length to 25 m (82 ft) in 1994, any vehicle longer than the previous limit was subject to a strict regulation that ensured conformity to the national M.o.U. This was the first use of a prescriptive regulation for vehicle configuration in Ontario. Further, it specifically excluded use of liftable axles on any of these longer vehicles.

2.1.10 Phasing Out Liftable Axles

In 1994, New Brunswick introduced a policy calling for a total phase-out of liftable axles by 2005. The six eastern provinces therefore began discussing their own issues of size and weight regulations, which revolved around a transition from variable tandem axle load for variable spread through control of liftable axles to common enforcement strategies to ensure the same effective rules in each jurisdiction. The principal outcomes were a proposal to increase the tandem axle load from 17,000 to 18,000 kg (37,478 to 39,682 lb), and the 3.66-m (144-in.) spread tridem axle load from 24,000 to 26,000 kg (52,910 to 57,319 lb). These changes would allow a tridem semitrailer to carry a payload competitive to that of the tri-axle semitrailer, which would allow the tri-axle semitrailer to be phased out. Québec and Ontario also agreed on a configuration for the quad-axle semitrailer. This initiative was agreed by the provinces, and was to be ratified by the Ministers of Transportation of the six provinces, as a sub-group of the Council of Ministers, at their meeting in 1995 (47). The Ontario Trucking Association was concerned that the measures would be damaging both to their members and the economy of Ontario, and persuaded Ontario's minister not to support the agreement pending further study. Two studies were commissioned, one into the economic impacts of the proposed and alternative truck size and weight options (48) and the other on the impacts of the options on roads and bridges (49). The studies, and subsequent review, took so long that Québec proceeded independently to make changes to its regulations. Principally, it restricted the allowable load on a tri-axle with a 4.88-m (192-in.) spread to the same as for lesser spreads, increased its tandem and wide-spread tridem axle loads as had been previously agreed upon with the other provinces, and mandated

that all quad-axle semitrailers from 2001 should have a self-steering single axle, as shown in Figure 18.

2.1.11 Other Vehicle Configurations

Stinger-steer car carriers are used principally to distribute new vehicles from car plants to terminals, and from terminals to dealers. The United States increased the allowable length of a car carrier to 25 m (82 ft) by allowing the cars to overhang a 22.86-m (75-ft) long vehicle at the front and rear. This allowed more cars on a car carrier within the 4.15-m (13-ft 6-in.) overall height in the eastern states. The provinces did not initially allow overhang to achieve the additional length, but allowed the same number of vehicles to be carried by accepting an overall height up to 4.27 m (14 ft) by special permit. This caused significant difficulty when a car carrier crossed the border, when an overhanging load for the United States had to be transformed into an over-height load for Canada, or vice versa. The Task Force considered the issue, and developed a detailed vehicle specification for a car carrier that would allow it to meet the same dynamic performance standards as a tractor-semitrailer while carrying an overhanging load in accordance with U.S. federal regulation. This specification became the model for a standard special permit that all provinces now issue for this class of vehicle.

The forestry industry in Alberta and British Columbia had developed log trucks of many diverse configurations, with just one example shown in Figure 19. The provinces had been allowing them to operate under permit at weights above the legal limits on certain roads and at certain times of the year. The two provinces believed that these configurations should also be subject to the same principles as other legal vehicles, in the same way that trucks and truck-trailer combinations were brought into the M.o.U. A study team of government and forestry industry representatives from each province sponsored an extensive computer simulation study of these configurations that identified a reasonable gross weight for each configuration, which effectively encouraged those configurations with satisfactory dynamic performance and discouraged those



Figure 19. Western tractor tri-axle trailer log truck.

with poor dynamic performance (50). This work still continues, where the industry supports development of new configurations and enhancement of others to improve productivity and dynamic performance. This has provided a sound technical basis for the provinces to set permit conditions.

In the same time period, it became clear that as the gross weight of log trucks operating on mountain roads in winter conditions in British Columbia and Alberta increased, drive traction was becoming a significant issue. A study assessed drive options for tractors and recommended use of a tandem drive tractor with a liftable pusher axle. The provinces would not countenance use of a liftable axle, so industry elected to develop a tridem drive tractor for forestry uses. The tractor was subject to extensive testing, and computer simulations were conducted to determine appropriate trailer combinations for use with a tridem drive tractor (51). The tridem drive tractor was adopted into regulation in British Columbia, operates widely under special permit for forestry and other purposes in Alberta, and is also in limited use in other provinces under permit. It was recently also adopted into regulation in Ontario (52). The tridem drive tractor has substantially addressed the traction issues that caused its development. It is shown in Figure 20.

The Road and Bridge Study conducted in Ontario after 1995 became the basis for a projection that use of liftable axles on trucks and trailers combined with allowances and requirements for different weight on different axles was necessitating Can\$300 million in road and bridge maintenance and repairs that would not occur if the freight would be moved in vehicles without liftable axles. The Ontario Ministry of Transportation defined a four-phase program to eliminate the use of rigid liftable axles. Phase 1 dealt with tri-axle semitrailers, and became effective in 2001. It reduced the gross weight for any new tri-axle semitrailer, and reduced the allowable gross weight for existing tri-axle semitrailers by 3,000 kg (6,613 lb) from 2006, and 4,500 kg (9,920 lb) from 2011. End-dump trailers were excluded, and tank and cryogenic trailers had longer periods before the gross weight reductions took effect.



Figure 20. Tridem drive tractor.



Figure 21. Ontario self-steer tri-axle semitrailer.

Phase 1 introduced the self-steer tri-axle semitrailer, as shown in Figure 21, and the self-steer quad semitrailer, as shown in Figure 18, where the single axle on the semitrailer was required to be self-steering with a lift mechanism that could not be operated by the driver from the cab. It included an agreement with Québec that each would issue permits to accommodate the various configurations of quad and self-steer quad that were possible under the regulations of the other province. Phase 2 extended the Phase 1 weight reductions to end-dump semitrailers with liftable axles. Phase 3 dealt with multi-axle trailers. An extensive simulation study was used to define feasible configurations for use within Ontario, and as a compromise between the regulations of Ontario and Michigan (53), two vehicles with different arrangements of two self-steering axles and a fixed tridem axle group, as shown in Figure 22 and Figure 23, were built and tested (54). These configurations were embodied in a new regulation that extended the format of the M.o.U. to a new range of “Safe, Productive and Infrastructure-Friendly” (SPIF) configurations (52). Phase 3 became effective in 2006. It reduced the allowable gross weight for any new non-SPIF multi-axle semitrailer built in 2006 or thereafter by 4,500 kg (9,920 lb), or 9,000 kg (19,841 lb) for a semitrailer with two or more liftable axles. The same weight reductions apply after 2016 to any non-SPIF multi-axle semitrailer built before 2006. Phase 4, now under way, addresses straight trucks and truck-trailer combinations, as well as other configurations not covered in Phases 1 through 3.



Figure 22. Ontario 113 SPIF 5-axle semitrailer.



Figure 23. Ontario 131 SPIF 5-axle semitrailer.

2.1.12 Summary

In the late 1960s, Ontario introduced weight regulation based only on a complex bridge formula, which allowed a substantial improvement in truck productivity but also created many unintended consequences. The regulation had no controls on axle or vehicle configuration, and a wide range of configurations came into use with widely spaced liftable axles, many of which also had poor dynamic performance and were ultimately shown to have a serious and very detrimental impact on roads and bridges. This was compounded when a change in the form of regulation allowed weights above the bridge formula, and length increases intended for compatibility with U.S. tandem semitrailers also allowed new and heavier configurations. This approach, where vehicle configuration was not specified, resulted in significant outcomes that were both unexpected and undesirable.

The large discrepancy in size and weight regulation among the Canadian provinces and the transportation inefficiencies rapidly became a barrier to internal trade. The provinces together, supported by the federal government and industry, sponsored a research program to identify the significant issues of truck size and weight regulation. This allowed vehicles to be configured on the basis on objective standards for dynamic performance. Detailed specifications that control internal dimensions found in the M.o.U. are necessary for this and have generally resulted in the desired outcomes.

Vehicle configurations have been monitored closely since the M.o.U. to ensure that the rules are resulting in the desired outcomes. When a loophole is evidently allowing configurations with undesirable properties, the rules are changed as quickly as possible to close the loophole before those configurations become widely used and popular.

Provinces have continued to develop other configurations beyond those defined in the M.o.U. for domestic use, or for use with an adjoining jurisdiction, for operation either in regulation or by special permit. All provinces include an assessment of the dynamic performance of any proposed or new configuration as part of the assessment of cost and benefit of that configuration.

2.2 Provincial Truck Size and Weight Limits

2.2.1 The M.o.U.

All provinces and territories have implemented Canada's national M.o.U. (34). Each province and territory allows a vehicle meeting the dimensional specifications of the M.o.U. to operate at a weight not more restrictive than specified in the M.o.U. on a road network specified by the province or territory. The vehicles may also be allowed to operate on other roads at lower weights, where roads, pavement or bridges may require that lesser weight.

The M.o.U. defines configurations for

- Tractor-semitrailers, from 3 to 6 axles;
- A-train doubles, from 5 to 8 axles;
- B-train doubles, from 5 to 8 axles;
- C-train doubles, from 5 to 8 axles;
- A straight truck, with 2 or 3 axles;
- A truck-pony trailer, from 3 to 6 axles;
- A truck-full trailer, from 4 to 7 axles; and
- An intercity bus, with 2 or 3 axles.

The M.o.U. provides that the maximum overall length for a

- Tractor-semitrailer is 23 m (75 ft 6 in.);
- A-, B- or C-train double is 25 m (82 ft);
- Straight truck is 12.5 m (41 ft);
- Truck-trailer combination is 23 m (75 ft 6 in.); and
- Intercity bus is 14.0 m (46 ft).

The maximum length for a semitrailer is 16.20 m (53 ft), and for a pony trailer or full trailer is 12.5 m (41 ft). There are a considerable number of internal dimensional limits for vehicles and combinations, primarily to ensure adequate dynamic performance.

The M.o.U. provides for an allowable axle load of

- 5,500 kg (12,125 lb) for the steer axle of a tractor;
- 7,250 kg (15,983 lb) for the steer axle of a straight truck;
- 17,000 kg (37,478 lb) for a tandem axle;
- 21,000 kg (46,296 lb) for a tridem axle with a spread from 2.4 to 3.0 m (94 to 118 in.);
- 23,000 kg (50,705 lb) for a tridem axle with a spread from 3.0 to 3.6 m (118 to 142 in.); and
- 24,000 kg (52,910 lb) for a tridem axle with a spread from 3.6 to 3.7 m (142 to 146 in.).

The six eastern provinces allow 18,000 kg (39,682 lb) on a tandem axle, and 26,000 kg (57,320 lb) for a tridem axle with a spread from 3.6 to 3.7 m (142 to 146 in.).

The allowable gross weight of a vehicle is the sum of its allowable axle loads, though the gross weight of an A-train double is capped at 53,500 kg, the weight on a full trailer is capped, and depending on the configuration, the combined weight on the lead trailer axle group and the converter dolly of an A- or C-train double is limited if the inter-axle spacing is less than 3.0 m (118 in.), and a tridem pony trailer is restricted to a maximum axle spread of 2.5 m (98 in.).

The full text of the 2008 version of the M.o.U. is presented in Appendix A.

2.2.2 Size and Weight Limits of the Provinces and Territories

Each province and territory has either adopted each M.o.U. vehicle configuration into its regulations, or has adapted its regulations so that a vehicle meeting the specification of the M.o.U. can operate within the province or territory on a road network specified by the respective province or territory. A province and territory may allow other configurations not covered by the M.o.U., either as new vehicles, or as existing vehicles grandfathered from a previous set of regulations, by regulation, or by special permit. A province or territory may allow less restrictive values for certain limits set in the M.o.U.—generally higher for a weight limit, shorter for a minimum dimension, longer for a maximum dimension—or may not regulate a particular limit at all.

The truck size and weight regulations of the provinces and territories are summarized in a series of tables in Appendix B, according to the M.o.U. configurations. These tables present the regulated limits for new vehicles. They do not address other configurations that may be allowed by regulation or by special permit. These tables are necessarily a summary, and the values given for some of the weights are the typical maximum and may depend on certain dimensions having a minimum value, or other conditions. In some cases it may be theoretically possible to achieve a higher weight than shown, but such vehicles are rare or unknown.

The four western provinces, and the four Atlantic Provinces, have all adopted the M.o.U. as their form of regulation, though the Atlantic Provinces allow 18,000 kg (39,682 lb) on a tandem axle, and 26,000 kg (57,320 lb) for a tridem axle with a spread from 3.6 to 3.7 m (142 to 146 in.). Ontario and Québec have adopted M.o.U. configurations into their regulations, and also allow 18,000 kg (39,682 lb) on a tandem axle, and 26,000 kg (57,320 lb) for a tridem axle with a spread from 3.6 to 3.7 m (142 to 146 in.).

Québec allows a self-steer quad semitrailer, as shown in Figure 18, with 34,000 kg (74,956 lb) on the 4 axles on the semitrailer. The self-steering axle, which is usually liftable, is required to carry the same load as each of the fixed axles. Ontario allows

- The same self-steer quad as Québec;
- A self-steer tri-axle semitrailer, as shown in Figure 21, with 27,000 or 28,650 kg (59,524 or 63,162 lb) on the tri-axle, depending on whether the self-steering axle has single or dual tires;
- 5-axle semitrailers, as seen in Figure 22 and Figure 23, with 37,500 kg (82,672 lb) on the five axles on the semitrailer, and the liftable self-steering axles must carry the same load as each fixed axle;
- 6-axle semitrailers, similar to those seen in Figure 22 and Figure 23, and intended for operation between Ontario and Michigan, with a quadruple axle group instead of a tridem, and an allowed 39,000 kg (85,979 lb) on the semitrailer axles; and
- A tridem drive tractor, which may pull any M.o.U. semitrailer, or a self-steer tri-axle or self-steer quad semitrailer.

Alberta and British Columbia allow a wide range of specialized log-haul configurations, with two examples shown in Figure 19 and Figure 20.

2.2.3 LCV Operations

Longer combination vehicles (LCVs) in Canada tend to be longer and heavier than those found in the United States. Turnpike Double LCVs are allowed by special permit in Alberta, Saskatchewan, Manitoba, Ontario, Québec, New Brunswick, and Nova Scotia. Rocky Mountain doubles are allowed by special permit in Alberta, Saskatchewan, Manitoba, and Québec. Triples are allowed by special permit in Alberta and Saskatchewan. A wide variety of specialized equipment is allowed by special permit in Alberta to support the oil and gas industries. Saskatchewan allows a number of larger and heavier configurations by special permit, including the innovative program described below.

Studies have shown (87), (88), (89) that the safety performance of LCVs operating under special permit in Canada has been very encouraging when compared with tractor semitrailers. Turnpike doubles have the lowest crash rate of all LCVs, between 2.5 and 5 times less than standard tractor semitrailers (87), (88), (89), (90). LCVs also have significant environmental benefits due to the improved efficiency of the vehicles. Fuel consumption, CO₂, and NO_x emissions are reduced by about 30% when tractor trailers are replaced with LCV operations (87), (88), (91).

2.2.4 A Novel LCV Special Permit System

Saskatchewan, in 1977, became the first jurisdiction in North America to use truck weight and dimension policy as an economic development tool. The Bulk Commodity Policy enabled industry to use trucks with weights and/or dimensions that

exceeded legal limits on the condition that the motoring public and taxpayers were not adversely affected by this traffic. This policy reduced transportation costs and also reduced Canadian rail rates for potash movement by providing a truck connection to the U.S. rail system. There were incremental road and bridge costs to the province, but otherwise, all the benefits accrued to the private sector.

In 1994, the Saskatchewan Department of Highways and Transportation announced a vision for moving Saskatchewan's freight transportation system into the 21st century. The Transportation Partnership Policy was intended to ensure that the highway system was safe, reliable, efficient, environmentally sound, and financed by a combination of public- and private-sector funds. The cornerstone of this initiative was to forge partnerships with private-sector companies to reduce truck transportation costs. The savings from these partnerships enabled the company to be more competitive and provided revenue for making improvements to the highways used by their vehicles. The objectives of the Transportation Partnership Policy were to (55)

- Support economic development in Saskatchewan,
- Provide additional revenue for road improvements on specific routes used by a particular transport company,
- Promote the use of more efficient road-friendly vehicle technology, and
- Ensure that the taxpayer and motoring public are not adversely affected by industrial traffic.

The new policy provides a mechanism that enables the Department to work with private industry to custom design truck haul systems that meets the objectives within the province. New vehicle configurations are identified that will reduce trucking costs by optimizing the vehicle with the highway system as well as the material handling facilities. All new vehicles are evaluated from a safety performance, road and bridge infrastructure, and haul savings perspective. The Transportation Association of Canada (TAC) performance measures described in this paper are used to pre-screen vehicle alternatives. If the vehicle concept represents a major departure from existing vehicles, field demonstration projects are undertaken to confirm the analysis prior to full implementation. If the study results are favorable, the Department enters into a comprehensive transportation partnership agreement with the industry that contains

- Vehicle configurations including weights and dimensions,
- Vehicle standards and specifications,
- Haul routes,
- Vehicle operating and maintenance procedures,
- Driver qualifications,

- Truck haul savings to be used for road improvements, and
- Highway improvement projects.

After the agreement is signed, the Department issues permits that enable the client to operate vehicles within the terms and conditions of the agreement. The Department conducts safety and financial audits to ensure compliance.

Truck haul savings are determined by taking the difference in transportation costs between legal vehicles and permit vehicles. All incremental road and bridge costs associated with the permit vehicles, and any incremental costs to the client, are deducted from the truck haul savings. The client retains 50% of the residual, and the other 50% is put in a separate account that is used for road improvement projects mutually agreed by the Department and the client. The road contributions do not go into provincial consolidated revenue.

2.3 Canadian Institutional Mechanisms and the Size and Weight Harmonization Process

2.3.1 Background

Section 2.1 outlined the recent history and evolution of truck size and weight regulations in Canada. The original unilateral move by Ontario in 1970 has been replaced by a cooperative process between the provinces that addresses truck configurations and issues of common interest, while allowing the jurisdictions to pursue configurations of interest only to them.

This section describes the process used to address truck size and weight issues that are a common interest of the provinces and the process used to amend the M.o.U. This process is determined by the roles and responsibilities of governments in Canada, so the section contains a primer on the organization of government in Canada and the process of passing law and regulations in the provinces, which differ in key respects from U.S. federal and state processes.

2.3.2 Political Organization of Canada

Canada is a federation of ten provinces, and there are also three territories. The task of governing the country is shared by the federal, provincial and territorial governments. The Constitution Act of 1867 gives the federal government responsibility for matters that concern all Canadians. These are principally matters that cross interprovincial and/or international borders, such as defense, foreign affairs, regulation of interprovincial and international trade and commerce, criminal law, citizenship, central banking and monetary policy.

Provincial governments have responsibility for matters of local interest, for example, primary and secondary education,

health and social services, property and civil rights, provincial and municipal courts and municipal institutions. Schools are generally run by school boards or commissions elected under provincial education acts.

Some areas of responsibility are shared by both levels of government. For example, in the area of transportation, the federal government has jurisdiction in matters involving movement across provincial or international borders (aviation, marine transport and rail), whereas the provinces look after provincial highways, vehicle registration and driver licensing. Control over agriculture, immigration and certain aspects of natural resource management are also shared. If federal and provincial laws conflict in an area of shared responsibility, the federal law prevails.

The three territorial governments, Yukon Territory, Northwest Territories, and Nunavut, have responsibilities similar to the provinces but do not control land or natural resources. Their powers are not guaranteed by the Constitution, but are granted by the federal government, which can change them when it is considered necessary.

2.3.3 Role of the Government of Canada in Truck Transportation

The federal government has overall responsibility for highway safety and for interprovincial and international transportation. The federal government is responsible for road safety, standards for new and imported vehicles, and transportation of dangerous goods. The federal government delegated responsibility for interprovincial and international highway transportation to the provinces and territories in 1954.

The federal government directly funds and maintains a small number of interprovincial and international bridges, and also funds roads and bridges on federal lands such as national parks and military bases. It also provides funding for other highway and infrastructure projects under a succession of medium- and longer-term programs since the late 1960s, and has explicitly provided ongoing funding for cooperative highway projects on the National Highway System since 2002. Canada has a national highway network, but the highways that make up that system are designated by the Council of Ministers, and there are explicit criteria that must be met. Decisions on additions or deletions to the network require federal, provincial, and territorial consensus.

The federal government sets standards for new and imported vehicles, in the same way as the National Highway Traffic Safety Administration in the United States. The federal government has no control over truck size and weight, so there are no federal regulations that govern truck size and weight. Nevertheless, the federal government does have an overall interest in the efficiency of the transportation system in

Canada, and it has from time to time become involved as a funding partner in highway transportation projects that were evidently a common interest of the provinces.

2.3.4 Role of Provincial Governments in Truck Transportation

Canada's provinces and territories have always been responsible for all matters relating to roads, road safety, driver licensing, vehicle registration and taxation, and commercial vehicle regulations and enforcement. The provinces and territories are also responsible for motor carriers and vehicles in interprovincial and international operation, under authority delegated by the federal government in 1954.

Each province and territory funds and controls design, construction, maintenance and management of the highways within its borders, set limits on vehicle size and weight, and licenses and controls drivers, vehicles and the transportation companies that use its highways.

2.3.5 Intergovernmental Coordination

Each province and territory is sovereign within its boundaries, but they have common transportation interests, so there is a need to coordinate policies and practices relating to these interests. The primary means of coordination is through the Council of Ministers Responsible for Highway Transportation and Safety (55), which is supported by the CCMTA (58).

The Council of Ministers Responsible for Transportation and Highway Safety comprises the federal, provincial and territorial ministers with these responsibilities (55). The Council directly sponsors a range of policy studies, including those relating to national highway policy (59), (60). The Council is supported by the Council of Deputy Ministers Responsible for Transportation and Highway Safety, which comprises the senior federal, provincial and territorial civil servants reporting to each minister on the Council of Ministers. The Council of Deputy Ministers sponsors four programs: the Engineering and Research Support Committee, the Policy and Planning Support Committee, the Task Force on Vehicle Weights and Dimensions Policy, and the Canadian Council of Motor Transport Administrators. The Council of Ministers meets annually to deal with issues addressed to it by the Council of Deputy Ministers.

The TAC is a national, nonprofit organization with primary interest in development of engineering guidelines and best practices in the highway transportation sector used by all governments (57) and its mandate precludes addressing management or policy issues, or taking advocacy positions. TAC began in 1914 as the Canadian Good Roads Association, founded to promote the establishment of a superior national

road network. It became more involved with specialized technical activities, and as its role broadened, it became the RTAC in 1970, and it finally assumed its current name in 1990 (57). TAC membership includes federal, provincial and territorial transportation departments, municipal transportation departments, private-sector firms, academic institutions, associations and individuals, all with an interest in road and urban transportation issues (57).

The CCMTA is the body that coordinates administration, regulation and control of motor vehicle transportation and highway safety (58). CCMTA was originally formed in 1940 by the four western provinces, and all provinces had joined by 1956 in response to perceived needs for uniformity due to increasing traffic and travel (58). CCMTA established a permanent secretariat in 1975. The members of CCMTA are the provincial, territorial and federal ministries responsible for administration of highway transportation. CCMTA also extends associate membership to national and provincial associations, companies, law enforcement, health and safety organizations, other government departments, educational organizations, and others, from both Canada and the United States (58).

The Task Force on Vehicle Weights and Dimensions Policy is a national committee comprising officials from the federal, provincial, and territorial transportation departments, reporting to the Council of Deputy Ministers Responsible for Transportation and Highway Safety. The Task Force has been assigned responsibility for

- Pursuing greater national and/or regional uniformity of policies, regulations and enforcement practices for heavy vehicle weight and dimension limits within Canada, and
- Representing Canada in regulatory harmonization discussions being carried out under NAFTA (61).

Conveniently, the secretariats for the Council of Ministers, TAC, CCMTA and the Task Force all share the same physical location, in Ottawa.

2.3.6 The Task Force on Vehicle Weights and Dimensions Policy

The Task Force maintains the M.o.U. (34), which sets national standards for the size and weight of trucks used in interprovincial transportation. It is a direct descendant of the original Implementation Planning Subcommittee of the CCMTA/RTAC Vehicle Weights and Dimensions Committee, formed in 1986 to transform the research from the CCMTA/RTAC Vehicle Weights and Dimensions Study into the M.o.U. Task Force members are expected to have a detailed knowledge of truck size and weight issues, have sufficient authority to represent the position and interests of their jurisdiction in a national discussion, and represent the national

interests as agreed upon within the Task Force back to their jurisdiction so that it can be implemented. Most members of the Task Force have relatively ready access to their Deputy Minister, who is the senior civil servant in the department.

The Task Force addresses national matters at an open meeting attended by its members from all provinces and territories, and by the federal government, each with additional staff as necessary. These meetings are also attended by representatives of stakeholders with an interest in the issues. Meetings are held as required, with one each year for the past several years. The agenda generally consists of a status report on continuing issues, a status report of changes and new initiatives by each jurisdiction, and open discussion of continuing issues from previous meetings and new issues tabled at the meeting. The Task Force members then meet in a closed session to review the discussion and to decide on a course of action for each issue. This is summarized in a report to the Council of Deputy Ministers.

The Council of Ministers generally meets in conjunction with the TAC annual meeting in September. The Task Force in recent years has generally met a couple of months later, which allows it to address issues arising from the meeting of the Council of Ministers. Members can then ensure that any necessary work is done on these issues, and on matters arising from its own meeting, so that the Task Force can report to the Council of Deputy Ministers at its meeting, which is generally in March. Members can then do any further work required by the Council of Deputy Ministers, reporting again to their meeting just prior to the meeting of the Council of Ministers, and then reporting on to the Council of Ministers.

2.3.7 Regional Groups Within the Task Force

The four western provinces, British Columbia, Alberta, Saskatchewan and Manitoba, have met regularly as a sub-group of the Task Force to address regional harmonization issues. They developed more uniform special permit conditions for movement of over-dimensional and over-weight indivisible vehicles and loads in 2002, and more recently have met to rationalize their permit conditions for longer combination vehicles, such as Turnpike Doubles, Rocky Mountain doubles and triple trailer combinations.

The four Atlantic Provinces, New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador, have also met regularly. They developed a regional agreement modeled on the M.o.U., which each province has adopted as its own regulation (37). They are now developing more uniform special permit conditions for movement of over-dimensional loads.

Ontario and Québec have also met occasionally on their own issues.

2.3.8 Passing Law and Regulations in Canada

There are no federal size and weight rules in Canada, so each province must take the steps necessary to enact agreed changes into their own regulations. This section outlines in general terms the procedures necessary for a change to the law and regulations in a province or territory. The procedures may vary somewhat between jurisdictions.

In general, the Council of Ministers can agree that each member should proceed with an initiative set before it. However, a minister cannot undertake the implantation of an initiative that is agreed upon at a meeting of the Council. The ministers must take the initiative back to their own jurisdiction for analysis and review, then for development of the necessary law and/or regulations. The result must be approved by cabinet, or a committee of cabinet. The initiative must then compete for time on the legislative and regulatory agenda, which is determined by the government.

A proposal for a new regulation or an amendment to an existing regulation must go through cabinet as well. If the proposal is approved, department and legislative council staff develop the regulation. Department staff may consult stakeholders for their views on the proposed subject of regulation, either in open or private meetings, or by asking for written submissions, but they need not do any of these things. Once the regulation is developed, it is reviewed by a committee composed of members of the legislature in a meeting where department staff may be questioned on details of the regulation. Once approved, the regulation is published in the provincial gazette (some provinces have mandatory consultation with stakeholders as part of the gazette process). It goes into force when filed, or on a date specified in the regulation. In most provinces, the exact text of a proposed regulation is not published for public comment but is confidential until the regulation is passed and published.

It is much easier to make or amend a regulation than it is to amend legislation. Since provincial size and weight rules have become both highly technical and complex, and most changes since introduction of the M.o.U. in 1988 have been matters of detail, it has been much easier for provinces to introduce amendments agreed by the Task Force and ratified by the Council of Ministers since the rules have been in regulation. This has also helped keep the various provincial rules relatively closely synchronized.

2.3.9 Taxation and Financing

All levels of government in Canada operate under consolidated revenue. Virtually all revenue, whether from taxes, duties,

fees, etc., goes into the treasury. The federal government collects substantial revenue from taxes on fuel, vehicles, and equipment. The provincial governments also collect substantial revenue from the same sources, plus license and registration fees, fines, and other sources. These funds all go into general revenue and are disbursed to departments in accordance with budget allocations. There are a few examples of dedicated funding of federal infrastructure programs, such as 5 cents of the 10 cents federal excise tax on motor fuels is permanently dedicated for use by municipalities (\$2.5 billion per year) and British Columbia has a dedicated tax of 12 cents/liter that is applied to fuel sales in the lower mainland for use by the TransLink (the regional transportation agency); this 12 cents/liter tax generates close to \$300 million per year.

The provinces do, of course, evaluate the costs and benefits of proposed changes to size and weight regulations. However, the provinces do not adjust tax rates or fees as a consequence of any changes. Such adjustments are almost always made when a provincial Ministry of Finance identifies a need for more revenue. A Ministry of Transportation may decide which fees are to be changed, and by how much, to ensure they contribute their allocated share of the additional revenue. Thus, in Canada, there is no debate about who pays, or who benefits, when changes in truck size and weight regulations are considered.

2.4 Compile Literature

All relevant published literature, research in progress, and current practice on the subject of Canadian truck size and weight was compiled. This task focused principally on work since 1983, though a few earlier documents of particular historical significance are included.

The results have been categorized by the impact of changes in size and weight limits in Canada on key issues, such as the following:

- Safety,
- Productivity,
- Pavement impacts,
- Bridge impacts,
- Modal shift,
- Environmental impacts,
- Changes in truck fleet design and configuration,
- Traffic congestion and roadway capacity,
- Public perception, and
- Impacts on trucking operations or regulations in U.S. border states.

CHAPTER 3

Findings

This chapter is based on an analysis of the information and literature presented in the preceding Chapter, to obtain an understanding of the impacts resulting from the changes in Canadian truck size and weight regulations on trucking in Canada, and in cross-border trucking. This consists of the following steps:

- Economic impacts;
- Estimates of the changes in truck fleet size and the mix of configurations;
 - For the domestic fleet, and as it was affected by the regulations in U.S. Border States.
 - Impacts that were not anticipated;
 - Cost recovery; and
 - Changes in compliance and enforcement;
- U.S. truck size and weight regulation; and
- Application of Canadian experience to the United States.

3.1 Economic Impacts

The CCMTA/RTAC Committee on Vehicle Weights and Dimensions commissioned a study of the potential economic impacts of changes to size and weight regulations in 1986 and 1987—after completion of the Vehicle Weights and Dimensions Study but before the M.o.U. was finalized—to assist in the formulation of the M.o.U. (62). This study included three candidate regulatory scenarios: Scenario A considered an 18.7-m (61-ft) semitrailer, doubles with a 19.0-m (62-ft 4-in.) box length, and 7-axle B-trains. Scenario B considered a 16.8-m (55-ft) semitrailer, doubles with a 19.0-m (62-ft 4-in.) box length, and 8-axle B-trains. Scenario C considered an 18.7-m (61-ft) semitrailer, doubles with a 20.8-m (68-ft 3-in.) box length, and 8-axle B-trains. All scenarios included a tridem semitrailer and used axle and gross weights rather similar to those that ultimately appeared in the M.o.U.

Scenarios A and C each resulted in estimated annual net benefits of about \$220 million in 1985 Canadian dollars,

where the net benefit was the ultimate trucking productivity benefit less increased road and bridge costs after transition. Scenario B resulted in an estimated net benefit of about \$165 million, and the difference from the other two scenarios was principally due to the shorter semitrailer length.

The two national railways together estimated annual losses ranging from \$108 to \$192 million for the three scenarios. The study considered these to be reasonable estimates, on the assumption that other changes would not occur.

A survey of carriers and shippers showed that they would immediately take advantage of whatever regulatory scenario would be put in place.

For other impacts, it was concluded there would be a modest benefit to highway safety, that railways would develop new equipment to facilitate intermodal operations, and that there would be small impacts on energy use, the environment, and traffic, even if the full diversion from rail occurred.

A second study was commissioned by the Task Force on Vehicle Weights and Dimensions Policy, 5 years after the M.o.U. was put in place. It essentially followed the form of the previous study, except it did not consider the impacts on the railways (63).

This study estimated annual net benefits of about \$142 million for 1992, \$180 million for 1997, and \$222 million for 2002, in 1992 Canadian dollars, for operations on the Canadian National Highway System. It was estimated the actual net benefit would be about double if operations on other highways were also considered. The net transportation cost benefit for the 15 years from 1988 through 2002 was 328 times the \$5.7 million cost of the research project.

The second study was made more difficult by the presence of significant confounding factors. The M.o.U. was implemented essentially concurrently with three other events:

- Deregulation of trucking in Canada in 1987,
- Periods of recession from 1987 through to 1995, and
- The free trade agreement between Canada and the United States in 1988, which was supplanted by the NAFTA in 1994.

These events caused changes to carriers, the amount of freight, and freight flows that affected the truck fleet size of the preferred configurations. As each occurred essentially simultaneously, it was rather difficult to disaggregate the effects of the M.o.U. from these other effects. However, it is probably likely that the entry and growth of new, agile carriers accelerated the introduction of M.o.U. configurations into the fleet.

The railways were opposed to the M.o.U. as a matter of principle. However, the railways tend to move bulk and heavy freight over long distances, and trucks move anything over short and medium distances. Since the M.o.U., the railways have made substantial changes, acquiring U.S. lines, abandoning unprofitable branch lines in Canada, sharing track, and developing intermodal service into the single fastest growing transportation sector. Interestingly, the railways were actually the largest single early purchasers of new M.o.U. configurations, buying one standard design of container chassis for all their terminals across the country.

3.2 Changes in Truck Fleets

3.2.1 Domestic Fleet, 1999

The 1999 National Roadside Survey provides a wealth of detailed insight into the truck fleet in Canada (65). The database contains information on truck configurations, weights, dimensions, payloads, and trips from a survey conducted on the National Highway System, in addition to significant links. It provides a good national view of trucking on major highways but may significantly underestimate local trips in and around urban areas, and in rural areas.

A total of 311 distinct vehicle configurations were found during the 1999 National Roadside Survey (65). Table 1 presents the breakdown of these. All possible M.o.U. configurations of straight truck, tractor, and tractor-semi-trailer were found, but only 12 of 14 possible truck-trailer combinations, six of eight possible A-train configurations, six of 12 possible B-train configurations, and five of eight possible C-train configurations, were found.

The tractor-tandem semi-trailer (T12-2) was the most common configuration in all provinces, by a wide margin, and made up 40.05% of all truck trips in Canada. The proportion

of trips varied from 29.44% in the Atlantic Provinces to 51.90% in Manitoba and 45.62% in Ontario, reflecting regional differences in freight and routes. The T12-12 is a general purpose vehicle for carriage of payloads of moderate and low density and is fully compatible with the U.S. Interstate system. Tandem semi-trailers were also towed by a tractor with a single drive axle (T11-2), which was the ninth most common configuration, making up 1.42% of all trips.

Two- and 3-axle straight trucks (S11 and S12) were the second and fourth most common configurations, and made 16.44 and 6.20% of all trips in Canada, respectively. These are primarily local use vehicles in both urban and rural areas.

The tractor-tridem semi-trailer (T12-3) and tri-axle semi-trailer (T12-12) were the third and sixth most common configurations, respectively, and together they made 13.70% of all trips in Canada. Together these configurations made about 12% to 16% of all trips in the four western provinces and Québec, about 10% in Ontario, and just over 28% in the Atlantic Provinces. These are general purpose configurations for payloads of moderate weight. The tridem semi-trailer has three equally spaced load-sharing axles, while the tri-axle semi-trailer has a single liftable axle mounted ahead of a tandem axle group. Tridem semi-trailers did not exist in the four western provinces prior to the M.o.U., but now clearly are an important configuration. Tridem semi-trailers were legal in the six eastern provinces prior to the M.o.U., but were not common as the tri-axle semi-trailer had a higher allowable gross weight. The lower proportion of tridem semi-trailers in Ontario and Québec is partly due to the tri-axle semi-trailers that were operating prior to the M.o.U., particularly in specialized body styles like tank and dump applications, and also partly due to the availability of quad-axle semi-trailers and 5- and 6-axle semi-trailers in Ontario, which allow even higher payloads. All six eastern provinces have now set schedules to phase out tri-axle semi-trailers, and these vehicles will gradually disappear over the next 15 years or so, though the self-steer tri-axle recently allowed in Ontario may continue to serve a niche market in that province.

The 8-axle B-train (T12-3-B2) is the principal vehicle for heavy haul across Canada. It was the fifth most common configuration, and made 5.45% of all trips. This configuration made about 8% of trips in British Columbia, 14% to 17% in Alberta, Saskatchewan and Manitoba, only just over 3% in Ontario and Québec, and 10% in the Atlantic Provinces. It is clearly the vehicle of choice for heavy haul in the four western provinces and in the four eastern provinces, where it did not exist prior to the M.o.U. The proportion is low in Ontario because many carriers have opted for a 5- or 6-axle semi-trailer over an 8-axle B-train. The allowable gross weight and overall length of this B-train was restricted in Québec for routes off freeways, and consequently it offered little benefit for most carriers over the quad-axle semi-trailer.

Table 1. Number of configurations.

Configuration	Top 35	All	M.o.U.
Straight Truck	4	12	2
Bobtail Tractor	1	4	2
Tractor-semi-trailer	18	106	6
Truck-trailer	5	53	10
A-train	5	61	6
B-train	2	57	6
C-train	0	18	5
Total	35	311	37

The quad or self-steer quad semitrailer (T12-13) was adopted by Québec as a heavy haul vehicle in 1991. It is also commonly used between Ontario and Québec, and some are also operating by permit in New Brunswick. It can also travel as a tridem semitrailer in other provinces if its liftable axle is raised. The quad was the seventh most common configuration, responsible for 4.56% of all trips. It is the principal heavy haul semitrailer in Québec, where it was responsible for 11.95% of all trips, and is also significant in Ontario where it was responsible for 3.02% of all trips.

The bobtail tandem tractor was the eighth most common configuration, responsible for 2.50% of all trips.

The pusher (or tri-axle) straight truck (S112) was the tenth most common configuration, responsible for 1.06% of all trips. This is essentially an Ontario configuration, where it made 1.89% of all trips, but was also found in Québec and the Atlantic Provinces, where it can operate with its liftable axle raised as a three-axle straight truck. The single axle is commonly a rigid liftable axle, though some of these vehicles are fitted with a self-steering axle that does not need to be lifted when the vehicle makes a turn.

The M.o.U. introduced the tridem semitrailer and the 8-axle B-train, and these are now the third and fifth most common configurations across Canada. The impact is more striking in the four western provinces because these provinces have all adopted the M.o.U. as their form of regulation in 1989. Change was inhibited in the six eastern provinces due to Ontario's refusal to increase the semitrailer length to 16.20 m (53 ft) and doubles combination overall length to 25 m (82 ft) until 1994. While the tridem semitrailer replaced many of the former tri-axle semitrailers, the availability of the quad and self-steer quad semitrailer at a 16.20-m (53-ft) length has inhibited its growth, as these alternatives provide a greater payload for some commodities, and they can still bring back a load that would normally travel in a tandem semitrailer.

Change in the fleet within the Prairie Provinces has been substantial since the M.o.U. was implemented in 1989. The adoption of the tridem allowed 6-axle semitrailers to emerge as an important configuration penetrating the fleet mix to a level of about 25% by 1997. Eight-axle B-trains made up about 15% of the fleet while 7-axle B-trains and A-trains all but vanished. The fleet mix distribution on the Trans-Canada Highway east corridor consists of about 60% 5-axle tractor semitrailers, 20% 6-axle tractor semitrailers, and 10% B-trains (2).

There have not been significant changes in regulations in the four western provinces since 1999, so the proportion of the fleets would be expected to be maintained. The tridem drive tractor and straight truck have come into use in the forestry industry and in other heavy haul applications in British Columbia and Alberta, and these now have a small presence, displacing some tandem drive equipment and cre-

ating new configurations, though their numbers are probably still quite small.

Ontario began restrictions on new tri-axle semitrailers in 2001, and the first stage of gross weight reduction began in 2006 (52). The self-steer tri-axle semitrailer was introduced into regulation, but this has seen limited uptake, essentially only with an end-dump body. Semitrailers that without these restrictions would have been tri-axle vans either became tridem, quad or self-steer quad semitrailers. The numbers of tri-axle van semitrailers will gradually diminish through 2010. Cryogenic and other high-value tri-axle semitrailers used for transportation of compressed gas may remain in service until 2021, but any new equipment will either be a tridem, self-steer quad or M.o.U. B-train. Thus, as the proportion of the tri-axle semitrailer fleet diminishes, the proportions of the alternative configurations will increase. Semitrailers with more than three axles must meet Ontario's SPIF requirements from 2006, and gross weight reductions for existing non-SPIF multi-axle semitrailers begin in 2016 (52). This has had little impact to date. It will ultimately cause a transition from about a dozen existing 4-, 5- and 6-axle semitrailer configurations to the five specified SPIF configurations. It will also greatly reduce the number of pure Michigan configurations seen in Ontario. Michigan and Ontario carriers that operate pure Michigan configurations will either have to transition to the two 6-axle SPIF configurations provided, add liftable axles to other SPIF configurations, or accept a large reduction in gross weight for the existing Michigan configuration.

Québec began its restrictions on tri-axle semitrailers in 1991, and the proportion of these semitrailers seen in the 1999 survey would be expected to have diminished substantially, as they have been replaced by tridem and self-steer quad semitrailers.

The four Atlantic Provinces harmonized their size and weight regulations in 2001 (37). They have also transitioned from tri-axle semitrailers to tridem semitrailers, and possibly also to some B-trains. The quad and self-steer quad semitrailers have also been introduced under permit, principally in New Brunswick, to accommodate trade with Québec. The proportion of this configuration would be expected to increase. Turnpike Double operations are also just getting started by special permit in New Brunswick and Nova Scotia.

3.2.2 Cross-Border Fleet

The 1999 National Roadside Survey also provided insight into the trucks used between Canada and the United States (65). Data were downloaded for all trips that indicated travel on roads in the United States, which provided an overview of cross-border truck traffic. However, not all data could be used for a border-crossing analysis, because it included records that did not indicate the origin, destination, or both, or indicated

the origin and destination were both in Canada, or both in the United States. This excluded about 15.72% of all cross-border trips from this analysis.

A total of 154 distinct configurations were found making cross-border trips during the 1999 National Roadside Survey (65).

The top ten configurations accounted for 92.45% of all trips, and coincidentally included all configurations that individually contributed more than 1% of the total number of trips. Seven of the top ten configurations were specified in the M.o.U. The other three were the tri-axle semitrailer that was widely used in the six eastern provinces, the quad-axle semitrailer that was widely used in Ontario and Québec, and a 9-axle A-train that was used between Ontario and Michigan. The remaining 25 configurations individually contributed between 0.08 and 0.52% of the total number of trips, and collectively contributed 5.89% to the total number of trips.

The tractor-tandem semitrailer (T12-2) was the most common configuration, by a wide margin, in all provinces, and made almost two-thirds of all cross-border truck trips, a proportion more than 60% higher than for all trips in Canada. This effectively depressed the proportion of all other configurations.

Two- and 3-axle straight trucks (S11 and S12) were the second and fifth most common configurations, and made 9.88 and 2.38% of all cross-border truck trips, respectively. These are primarily local use vehicles in both urban and rural areas.

The tractor-tridem semitrailer (T12-3) and 8-axle B-train (T12-3-B2) were the third and fourth most common configurations, respectively, and together they made 4.77 and 2.82% of all cross-border truck trips, respectively. The numbers of B-trains crossing the borders of the four western provinces from their neighboring states is rather striking.

The bobtail tandem tractor was the sixth most common configuration, responsible for 2.24% of all trips.

The tractor-tri-axle semitrailer (T12-12) was the seventh most common configuration, responsible for 1.29% of all trips, from Ontario, Québec, and the four Atlantic Provinces. These vehicles can operate as a 6-axle vehicle in New York by special permit, and may also cross the border with the liftable axle raised, carrying a tandem semitrailer load.

The tractor-split tandem semitrailer (T12-11) was the eighth most common configuration, responsible for 1.21% of all trips from Manitoba eastward. This is a common heavy haul vehicle in the United States that is outside the M.o.U. but continues to operate either by trip permit, by accommodation in regulation, or under old regulations.

The STAA double, with twin 8.53-m (28-ft) trailers (T11-1-A11), was the ninth most common configuration, responsible for 0.79% of all trips. This is a U.S. configuration used for light-package freight in the U.S. A 9-axle A-train double (T12-3-A111) was the tenth most common configuration, re-

sponsible for 0.61% of all trips, only between Ontario and Michigan.

The four western provinces each replaced their previous regulations with a set of regulations that were based directly on the M.o.U. The only significant variation was that British Columbia allowed 24,000 kg (52,910 lb) on any tridem spread from 2.44 to 3.70 m (96 to 146 in.), whereas the other three provinces used the loads specified in the M.o.U. These provinces all took a principled approach to vehicles entering from other jurisdictions, which were principally from or through neighboring U.S. states. Vehicles that did not meet the new regulations in these provinces were denied entry. Consequently, the fleets in these provinces have not been affected by the regulations in the various neighboring states. These states, from Washington to North Dakota, regulate gross weight by an uncapped bridge formula, which has tended to result in long A-train configurations. The M.o.U. excludes these by length, but not necessarily by their gross weight limit of 53,500 kg (117,946 lb). However, the form of regulation has allowed these states to accommodate M.o.U. configurations, such as tridem semitrailers and 8-axle B-trains. Tridem semitrailers with an added liftable axle operate between British Columbia and Washington at a gross weight up to about 45,360 kg (100,000 lb), and B-trains operate at a gross weight up to 47,854 kg (105,500 lb). B-trains also operate on limited routes within Montana, some at their Canadian weights.

3.2.3 Unanticipated Impacts

3.2.3.1 Assessment of Dynamic Performance of Vehicles

The CCMTA/RTAC Vehicle Weights and Dimensions Study developed the concept that the dynamic performance of heavy vehicles could be assessed against objective standards, and developed a process for doing this. Several provinces use the performance measures to evaluate vehicles that fall outside of the M.o.U. definitions. These vehicles typically run under special permit programs specifically designed to promote efficient transport.

The M.o.U. configurations and allowable weights were based strictly on assessments of the performance of vehicles during the CCMTA/RTAC Vehicle Weights and Dimensions Study. However, the M.o.U. addressed only tractor-semitrailers and double trailer configurations. The regulations of each province address all vehicle configurations. After the provinces had amended their regulations to implement the M.o.U., they all had essentially the same question: Now that we know the vehicles covered by the M.o.U. meet objective standards for dynamic performance, how about all the other vehicles that are allowed by our regulations? Most of these vehicles were

straight trucks and truck-trailer combinations, so a study was conducted to assess their dynamic performance, standards were drawn up, and the vehicle configurations were added to the M.o.U. (40). The same process is now used by all provinces when configurations are added to their regulations (45), (53), (54). It is also used by most provinces as part of the assessment of an application for a new configuration special permit. The outcome is that there is some uniformity in the dynamic performance of vehicles, and it is now unlikely that a truly poorly performing vehicle, like some that arose in the 1970s in Ontario, would get approval to operate. The staff of the provincial departments are now very well aware of the important parameters and can make good early judgments on whether a vehicle is likely to be feasible or not.

A similar process was used in New Zealand from the early 1990s to develop weight and dimension standards and in Australia for a wide range of studies of vehicles that operate under regulations or by special permit. Australia has now gone so far as to codify a process that allows vehicles outside regulated limits to operate if they are certified to meet specified performance standards by a third-party assessor (66).

3.2.3.2 Implications for Trailer Manufacturers

When Ontario first began to consider adoption of the M.o.U., an immediate outcome would have been the introduction of 16.20-m (53-ft) semitrailers. These trailers were already widely used in the United States, and U.S. carriers with these semitrailers would have gained an immediate advantage in cross-border service. Carriers with a current order for 14.65-m (48-ft) semitrailers either cancelled the order, or put it on hold pending the change so that it could be converted to 16.20-m semitrailers. Three significant manufacturers who primarily produced van trailers suddenly lost almost their entire order books, rapidly went into bankruptcy, and closed their plants. As the difficulty worsened, Ontario finally agreed to issue a limited number of permits to allow 16.20-m (53-ft) semitrailers and 25.0-m (82-ft) B-trains to operate while the change was made. By 1994, when it became clear that it was untenable to restrict 16.20-m (53-ft) semitrailers, the Ministry of Transportation announced it would change the law to allow 16.20-m (53-ft) semitrailers and 25.0-m (82-ft) B-trains, and also announced it would issue permits for new vehicles immediately. Manufacturers did not face a wave of cancelled orders, and many existing orders were converted from 14.65- to 16.20-m (48- to 53-ft) semitrailers.

3.2.4 Cost Recovery

There has been little if any direct cost recovery from any of the changes in vehicle size and weight made in Canada. All provincial governments in Canada, and the federal govern-

ment, operate under consolidated revenue, whereby virtually all income from all sources goes to the treasury, and the treasury disburses funds to the various operating ministries, departments, agencies, and others in accordance with the funding budgeted annually by the provincial treasurer for the particular entity. In this process, there is no relationship between the origin of any revenue and the allocation of funding. So, all income derived from all aspects of trucking goes entirely into general revenue, and expenditures on highways and other aspects of highway transportation come from general revenue, but there is no requirement or expectation that income from and expenditure on these accounts should balance. The same goes for any other accounts. There is one current exception to this. A carrier operating under a special permit through Saskatchewan's Transportation Partnerships Program must put part of its income from the special permit operation into a fund held by the province for improvements to the roads used by the carrier under the permit (55).

It has been a source of concern to some that the federal government has considerable income from fuel taxes, but spends very little on highway transportation, in part because the highway networks fall under provincial jurisdiction. The federal government has virtually no roads under its jurisdiction but it does fund, or partially funds, various transportation related projects and programs. In general, the fuel tax portion collected by the federal government goes to general revenue for the operations and programs of the federal government.

Cost recovery was not an issue for the provinces through this process, as the departments of transportation do not have the means to impose fees or taxes. Under consolidated revenue, even if additional taxes on trucking had been introduced, the provincial departments of transportation would not have had any means to capture those funds, and would have had no authority to channel them into highway programs.

3.2.5 Changes in Compliance and Enforcement

When the M.o.U. was agreed upon, a tridem axle group, consisting of three equally spaced load sharing axles, was not legal in any of the four western provinces. Truck inspection stations in these provinces were generally fitted with a short platform scale used to weigh a single or tandem axle, by moving each axle group successively onto the scale, weighing it, and then summing the axle group weights to obtain the gross weight. The tridem axle spread was longer than most of the platform scales, and trials quickly determined that the split-weighing of tridem axle groups did not produce a reliable result. It was therefore necessary to replace the scale at those inspection stations, where the platform was so short that it could not weigh a tridem axle group, with a spread of 3.66 m (144 in.).

The M.o.U. includes some specific dimensional limits that did not exist previously in some or all provinces. Several carriers specified dimensions to the nearest inch of the actual metric dimension, and the manufacturers built the vehicle, either a tractor or trailer, to the specified dimension plus or minus an inch or so. This was not a problem when the error was within the legal range, but it did become a problem the other way. The first step was to measure the vehicle as accurately as possible. For wheelbase, axle spacings, or inter-axle spacings, this meant ensuring the vehicle was as straight as possible, measuring both sides carefully to allow for axles that set up not square to the vehicle, and then averaging the results from the two sides. When a vehicle was found that was specified correctly but built out of tolerance, some provinces would issue a special permit for it at no charge, while others simply recommended that a copy of the specification be carried in the cab. It was recommended that carriers specify dimensions at least 0.025 m (1 in.) on the safe side of any specified dimension, to ensure vehicles would be built within the limits, including any manufacturing tolerances.

In general, the M.o.U. has increased the proportion of vehicles in each province that are standard configurations. It has become almost unnecessary to measure vehicles that evidently conform to the M.o.U., as they can reasonably be presumed to have been built to comply with the specified dimensions.

3.3 U.S. Truck Size and Weight Regulation

3.3.1 Introduction

In order to identify areas in which the Canadian truck size and weight experience might be of benefit to the United States, it is necessary to understand the U.S. truck size and weight environment, and recent truck size and weight research in the United States.

Truck size and weight limits were the sole jurisdiction of the states up to 1956. Since then, federal legislation has been instrumental in shaping the sizes, weights, and configurations of trucks allowed today, some nationally, and others on designated and more limited networks. The Federal-Aid Highway Act of 1956 established truck size and weight limits for the Interstate system, but states with weight limits higher than the new federal limits were allowed to retain those limits under grandfather authority. Federal weight limits were increased in 1974 to help offset a large increase in fuel prices, but not all states adopted the higher limits. The STAA of 1982 required all states to allow twin trailers and required all states to allow weights and dimensions of certain configurations not less than specified values. The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 limited the authority of states to increase use of double trailer combinations

with a gross weight greater than 36,287 kg (80,000 lb). There have been no broad changes since 1991, though a number of specialized configurations have been defined.

There have been a number of research studies addressing truck size and weight issues, and the following are briefly reviewed here:

- The Turner Proposal (67),
- The U.S. Department of Transportation (U.S.DOT) Comprehensive Truck Size and Weight (CTSW) Study (68),
- Review of Truck Size and Weight Limits (69), and
- The Western Uniformity Scenario (70).

3.3.2 The Turner Proposal

Former Federal Highway Administrator Francis Turner suggested a new approach to truck size and weight regulation in an address to the American Association of State Highway and Transportation Officials (AASHTO) in 1984. The Turner Proposal envisaged trucks with lower axle and axle group weights, on more axles than current vehicles, and with greater allowable gross weights. AASHTO asked the Transportation Research Board to establish a committee to conduct a comprehensive study of the proposal and to advise states on its merits (67).

The committee designed a package of changes in size and weight limits, safety restrictions, and procedures pertaining to bridge deficiencies, routing, and enforcement as a means of implementing the Turner proposal. The committee anticipated that Turner trucks, if adopted in most or all states, would reduce the cost of shipping freight and would not compromise safety. It further anticipated that the total cost of maintaining the road network would be reduced, although pavement-wear savings would be partially offset by higher bridge costs. States would incur a fiscal risk because upgrading bridges would have to begin before Turner trucks could begin extensive operations, so pavement savings would lag behind the investment in bridges.

During the study, the committee altered the original concept in two ways. First, the adoption of Turner trucks by states would be completely voluntary, and motor carriers could either continue to operate currently legal trucks or they could adopt the newer trucks. Second, the new trucks would be required as a fleet to be as safe, or safer, than existing trucks and be compatible with roadway design on major roads throughout the country.

The most common large truck was a 5-axle tractor-semitrailer with a maximum weight of 36,287 kg (80,000 lb) and length of 15.24 to 19.81 m (50 to 65 ft). The most common multi-trailer combination had two 8.53-m (28-ft) trailers, 5 axles, a maximum weight of 36,287 kg (80,000 lb), and an overall length of about 21.34 m (70 ft). The truck

configurations considered by the study utilized a wide range of possible values for axle weights, length limits, and other vehicle characteristics in order to achieve the best performance in terms of productivity, pavement wear, bridge costs, and safety. The study considered the following prototype Turner truck configurations:

- A 7-axle tractor-semitrailer with maximum weight of 41,277 kg (91,000 lb) and length of 18.29 m (60 ft);
- A 9-axle A-train double trailer combination with two 10.06-m (33-ft) trailers, 51,710-kg (114,000-lb) maximum weight, and 24.69-m (81-ft) overall length;
- A 9-axle B-train double with similar dimensions and weights to the preceding prototype; and
- An 11-axle A-train double trailer combination with maximum weight of up to 63,957 kg (141,000 lb).

The Turner study evaluated the impacts of these prototypes on productivity, safety and traffic, bridges, and pavements. The nine-axle A-train double trailer combination was considered the most attractive to motor carriers. The adoption of Turner trucks nationwide was expected eventually to result in a 23% reduction of the existing combination truck miles, within 5 to 10 years after the trucks became legal. Turner trucks would attract 2% of freight ton-miles from existing trucks, and 4% of rail ton-miles. Combining the larger payloads of the new vehicles with the rail diversion would yield a slight net decrease in the annual U.S. miles of combination truck travel. Turner trucks were expected to offer a small decline in truck crashes and a small reduction in truck interference with traffic flow, because the total annual miles of combination-truck travel would decline. The major cost to highway agencies resulting from the Turner proposal would be bridge costs. The proposal would require replacement of 7,000 Interstate and primary highway bridges, 4% of the total, at an estimated total cost of \$2.8 billion, with an additional \$4.1 billion to replace bridges on the non-primary system, although some of these routes would not be critical. There would also be an additional \$110 million per year needed for new bridge construction and \$28 million annually once Turner truck traffic reached its long-term level. Savings in pavement wear was estimated to reach \$729 million annually once Turner trucks reached long-term levels. Turner trucks would reduce the annual highway agency costs to maintain the road system by \$326 million, once they reached full utilization nationwide.

The estimates of impacts of Turner trucks were considered highly uncertain at the time of this study. Although some of the uncertainty might be less today, it still exists. Also, the report points out that some of the uncertainty, especially pertaining to safety, could be minimized by strict rules for operating the proposed trucks. The state of knowledge of the

effects of large trucks is such that the impacts cannot be forecast with certainty beforehand.

Major recommendations pertaining to Turner trucks were made regarding: weight, dimensions, and equipment; route restrictions and driver qualifications; deficient bridges; state, federal, and industry coordination; enforcement and monitoring; and finance. The report encouraged a national program perspective and coordination to make the Turner proposal successful, and the recommendations needed to be implemented as a package for the proposal to achieve its intended benefits.

The study recommended the following maximum axle group weights: single axle—6,804 kg (15,000 lb), tandem axle—11,340 kg (25,000 lb), tandem drive axle—12,700 kg (28,000 lb), tridem axle—40,000 lb, and 4-axle group—22,680 kg (50,000 lb). The study established a “bridge formula” but there was no “cap” or gross combination weight limit applied. Restrictions stipulated in this section related to ensuring a high level of safety were as follows:

- Minimum and maximum trailer lengths, with a kingpin-to-rear-axle limit;
- Antilock brakes on power units;
- Minimum speed on all grades;
- B-train configuration required for tank trucks; and
- Newer coupling options should not be adopted until the appropriate standards could be developed.

The report recommended against allowing Turner trucks on routes with substandard bridges or on routes that would otherwise not adequately serve the needs of these trucks in terms of safety or traffic operations. Each state should establish a mechanism with criteria to develop a route network.

The report recommended a minimum of 5 years experience for drivers, with a driver training course on the specific vehicle being considered.

The report encouraged states to develop a plan for replacing deficient bridges through development of a priority ranking for replacement, a timetable, a finance plan, short-term measures for mitigating bridge obstacles, postings more accurately based on actual capacities, and use of Turner trucks as the actual design vehicle.

Coordination would be essential between state, federal, and industry components to make the Turner truck operating environment viable. Turner trucks would exceed the current 36,287-kg (80,000-lb) gross weight cap applied to most of the Interstate system, except for grandfather exemptions. AASHTO would need to seek action by Congress to direct the U.S.DOT to adopt standards defining Turner trucks. States would also need to make the necessary changes to allow for Turner trucks and to determine routing and bridge posting practices. State motor carrier advisory committees and shippers

would need to provide input related to bridge postings, limits, and enforcement.

The Turner study recommended that carriers declare their intent to operate Turner vehicles at the time of registration or when applying for a special permit. The owner should also certify that vehicles and drivers comply with all restrictions that apply to Turner trucks. States should develop procedures that would help the state monitor and document factors associated with Turner truck safety. These procedures could include licensing and certification procedures for driver qualification and training, developing report forms that identify the number of trailers and axles, and collecting travel data to be used for monitoring weight compliance, use, and safety of Turner trucks.

Recommendations pertaining to finance included initial bridge expenditures and truck taxes. The principal financial obstacle to implementing the Turner proposal would be the cost to remove bridge deficiencies on major truck routes. The study recommended that states should seek congressional action on setting program funding levels to match the accelerated spending for bridges in the early years after adoption of Turner trucks. This accelerated spending would be offset by reduced need for pavement maintenance in later years. Truck taxes assessed by states, toll authorities, and the federal government should reflect the differences among all vehicles. If adjustments are needed, they should provide the appropriate incentives to operators to choose trucks that are the most efficient, considering both highway and truck operating costs.

3.3.3 The Comprehensive Truck Size and Weight Study

The U.S.DOT's Comprehensive Truck Size and Weight Study was not primarily focused on any policy initiative, but more on development and testing of analytical tools to estimate potential diversion of traffic from one type of truck to another, or diversion between truck and rail, if truck size and weight limits were changed. The study also made significant improvements over previous studies by explicitly considering inventory and other logistics costs to shippers in making transportation decisions. Impacts of proposed size and weight changes considered to be most critical were: safety, productivity, infrastructure (pavements, bridges, and geometrics), traffic congestion, environment, and railroads (68).

Because safety was and continues to be a contentious issue in relation to increased truck size and weight limits, this study included an extensive review of past safety studies and developed a consensus of results. The reason previous studies might still continue to raise doubts is that previous crash statistics come from operating environments that are significantly different from those proposed. Therefore, this study developed tools to evaluate stability and control properties of different vehicle configurations at different weights and di-

mensions. These tools were intended to provide a measure of the relative safety compared to vehicles in widespread use.

The impacts of various vehicles on safety, productivity, and so forth were assessed for five truck size and weight scenarios. These scenarios were

- Uniformity—Imposed federal weight limits on all non-network highways and removed grandfathered vehicles under provisions in current federal law. This resulted in a gross weight cap of 36,287 kg (80,000 lb) on all national network routes, and LCVs were impractical.
- North American Trade—Increased allowable tridem axle loads to be more consistent with limits in Canada and Mexico. Tridem loads of 19,958 kg (44,000 lb) and 23,133 kg (51,000 lb) were considered.
- LCVs Nationwide—Allowed LCVs on a nationwide network, with the largest LCVs restricted to a designated network, but triples combinations and doubles with 10.06-m (33-ft) trailers allowed more flexibility.
- H.R. 551—Three provisions related to federal truck size and weight limits in this scenario would phase out trailers longer than 16.20 m (53 ft), would freeze state grandfather rights, and it would freeze weight limits on noninterstate portions of the National Highway System.
- Triples Nationwide—Allow triple trailer combinations to operate nationwide at a gross weight up to 59,875 kg (132,000 lb), the same as in LCV nationwide scenario.

Table 2 summarizes the estimates of the diversion of truck traffic for each scenario. VMT is vehicle miles of travel, in millions, and rail car-miles are also in millions. The four scenarios allowing heavier vehicle weights all indicate large percentage reductions in travel by 5-axle tractor-semitrailers and large increases in LCV travel. Total VMT for all scenarios is greater than current levels due to the predicted overall growth in the national economy over the study period. Impacts of the various truck size and weight scenarios on infrastructure, shipper costs, and the environment were related to the traffic diversion estimates in Table 2.

Table 3 shows the estimated percentage change from the base case for key areas. The study assumed that all bridges with stress exceeding that underlying the Federal Bridge Formula would ultimately be replaced, which is consistent with previous truck size and weight studies sponsored by U.S.DOT and TRB, though some states commented that it may overestimate bridge-related costs. Safety impacts are not shown in Table 3 due to the difficulty in determining the impact of proposed changes on safety. As noted elsewhere, crash rates for vehicles with increased weight and length would need to be extrapolated from environments that are significantly different from some of those being considered.

The CTSW study showed significant productivity gains for each scenario that allowed heavier vehicle weights, with the

Table 2. Estimated diversion for selected vehicle configurations for CTSW scenarios.

Vehicle Class	5-axle Tractor-semitrailer		6-axle Tractor-semitrailer		LCVs		Total Truck ²		Rail	
	VMT	%	VMT	%	VMT	%	VMT	%	Car-miles	%
Base Case	83,895		6,059		1,517		128,288		25,555	
Uniformity	91,205	8.7	3,519	-41.9	542	-64.3	132,351	3.2	NA ³	NA ³
N.A. (1)	22,274	-73.5	6,209	2.5	49,837	3185	114,671	-10.6	24,354	-4.7
N.A. (2)	24,997	-70.2	6,246	3.1	47,453	3028	114,632	-10.6	24,073	-5.8
LCVs	19,611	-76.6	NA ¹	NA ¹	40,980	2601	98,562	-23.2	20,546	-19.6
H.R. 551	83,915	0.0	6,051	-0.1	1,517	0.0	128,311	0.0	NA ³	NA ³
Triples	23,405	-72.1	NA ¹	NA ¹	39,647	2513	102,400	-20.2	24,533	-4.0

Note:

N.A. (1)—North American Trade Scenario 1, with 19,958-kg (44,000-lb) tridem axle (90,000 lb gross vehicle weight).

N.A. (2)—North American Trade Scenario 2, with 23,133-kg (51,000-lb) tridem axle (97,000 lb gross vehicle weight).

¹ Six-axle tractor-semitrailers were not included in the two scenarios involving LCVs.

² The total does not equal the sum of the three vehicle classes shown in the table because other vehicle classes included in the total are not shown in the table.

³ Potential diversion from truck to rail under the Uniformity and H.R. 551 Scenarios could not be estimated because of lack of data on rail pricing.

Source: Reference (68).

greatest gains generated by LCVs. There were concerns that LCVs would increase infrastructure costs, adversely affect railroads, and possibly reduce safety. States differed considerably on changes in truck size and weight and on changes related to LCVs. Many states that did not currently operate LCVs were opposed to relaxing restrictions on their use. States that allowed LCVs on state highways generally favored removing the LCV freeze and liberalizing the rules under which LCVs operate. They maintained that LCVs have demon-

strated that they are safe, that LCVs improve productivity, and that current grandfather laws often result in LCVs having to operate on roadways that are not as safe as the Interstate system. Still other states wanted to increase the gross weight for 6-axle tractor-semitrailers, and also for single-unit trucks like dump trucks, garbage trucks, and specialized haul vehicles. Such vehicles would not be expected to cause additional pavement damage on Interstate highways, nor would they increase the cost of geometrics.

Table 3. Estimated impacts of scenarios (percent change from base case).

	Uniformity	N.A. Trade (1)	N.A. Trade (2)	LCV	H.R. 551	Triples
Pavement Costs	-0.3	-1.6	-1.2	-0.2	0	0
Bridge Costs	-13.0	+33.1	+42.2	+34.4	0	+10.4
Geometric Costs	0	+13.3	+13.3	+965.0	0	0
Congestion Costs	+0.6	-1.2	-1.2	-2.9	0	-7.6
Energy Costs	+2.1	-6.2	-6.3	-13.8	0	-12.8
Shipper Costs	+3.0	-5.1	-7.0	-11.4	0	-8.65
Rail Contribution*	N/A	-42.8	-49.7	-55.8	N/A	-38.2

Note:

N.A. Trade (1)—19,958-kg (44,000-lb) tridem axle;

N.A. Trade (2)—23,133-kg (51,000-lb) tridem axle.

*The amount of rail revenue available to pay fixed costs after freight service (variable) costs have been covered.

Source: Reference (68).

There have been a number of state-specific exemptions to federal gross or axle weight limits authorized since 1982, including four states granted exemptions by the Transportation Equity Act for the 21st Century (TEA-21) in 1998. Increasing the semitrailer length in some states has resulted in increased cubic capacity. Since 1981, the standard semitrailer length has increased from 13.72 m (45 ft) to 14.65 m (48 ft) to 16.20 m (53 ft). Some states allow semitrailers up to 18.29-m (60-ft) long. A decrease in cargo density has actually driven the average operating weight of tractor-semitrailers downward slightly in recent years. The increase in semitrailer length to 16.20 m (53 ft) has not had serious consequences, because even in the absence of a state limit on wheelbase, or the equivalent kingpin-to-axle dimension, most of these semitrailers operate with the bogie in a forward position to control off-tracking. Overall, however, these changes have only increased the diversity in truck size and weight nationwide. Increasing trade with Canada and Mexico will exert pressure to increase limits in the United States. The Uniformity Scenario would virtually eliminate this lack of uniformity, but there is little sentiment to roll current limits back to these levels.

Cost recovery is another significant issue when considering an increase in truck size and weight limits, which will undoubtedly increase the cost to maintain the infrastructure. Some states capture a large share of these costs through permit fees, but other states undercharge for increases and barely cover their administrative costs. There is no means at the federal level to recover the cost of larger and heavier trucks.

3.3.4 Review of Truck Size and Weight Limits

The 1998 TEA-21 directed the Secretary of Transportation to request TRB “conduct a study regarding the regulation of weights, lengths, and widths of commercial motor vehicles operating on Federal-aid highways to which Federal regulations apply . . . and develop recommendations regarding any revisions to law and regulations that the Board determines appropriate” (71). TRB formed the Committee for the Study of the Regulation of Weights, Lengths, and Widths of Commercial Motor Vehicles to conduct the work (69).

The major conclusions of this study were as follows:

- Opportunities exist for improving the efficiency of the highway system through reform of federal truck size and weight regulations, which reform may involve allowing larger trucks to operate.
- Federal truck size and weight regulations should facilitate safe and efficient freight transportation and interstate commerce, establish highway design parameters, and help manage consumption of public infrastructure assets.

- Changes in truck size and weight regulations, in coordination with complementary changes in the management of the highway system, offer the greatest potential to improve the functioning of the system.
- The methods used in past studies have not produced satisfactory estimates of the effect of changes in truck weights on bridge costs.
- It is not possible to predict the outcomes of regulatory changes with a high degree of confidence.
- It is important to examine the safety consequences of size and weight regulation. Research is needed to understand the relationship of truck characteristics and truck regulations to safety and other highway costs.
- Violations of size and weight regulations are considered an expensive problem, but monitoring of compliance with the regulations is too unsystematic to allow the costs involved to be estimated.

The major recommendations of this study were as follows:

Congress should create an independent public organization charged with observing and evaluating commercial motor vehicle performance and the effects of size and weight regulation, which the committee called the Commercial Traffic Effects Institute. The Institute could enter into agreements with private sector entities to conduct joint programs of data collection and research. The legislation creating the Institute should define the scope of its activities by specifying three distinct functions:

- The conduct of pilot studies of proposed new vehicles and related operating principles;
- Monitoring and ongoing program evaluation to measure whether practices intended to control safety and operations were functioning as intended; and
- Support for state implementation of federal size and weight regulations.

Congress should authorize the Secretary of Transportation to approve pilot studies of temporary exemptions from federal size and weight regulations. A pilot study is defined as a controlled experiment designed to measure the effects of changes in truck size, weights, or operating practices.

Federal law should allow any state to participate in a federally supervised permit program for the operation of vehicles heavier than the present federal gross weight limit, provided the state meets the requirements of the program. The Commercial Traffic Effects Institute should monitor the consequences of the federally supervised permit program, but the overall federal role in defining numerical dimensional limits would be diminished. Instead, the federal government would have greater involvement in ensuring that state regulations pertaining to vehicles on federal-aid highways were

contributing to national objectives. States would be allowed to issue permits for 6-axle tractor-semitrailers with maximum weight of 40,823 kg (90,000 lb), and double trailer combinations with each trailer up to 10.06 m (33 ft) in length with seven, eight, or nine axles, and weights governed by the present Federal Bridge Formula. The definition of vehicles eligible for permitting would be subject to revision over time, but federal review of the performance of the permitting program would be permanent and ongoing.

The federal government would require states to provide suitable and specified levels of enforcement, user fees, safety, and bridge management. Enforcement requirements might require states to effectively hold accountable the parties responsible for placing overweight loads on the highways and to target repeat offenders. Examples might be “relevant evidence” statutes and information systems to facilitate identifying offenders. User fees should be structured to cover both the administrative and infrastructure costs associated with the program. Safety requirements should be proposed by states, reviewed by the Commercial Traffic Effects Institute, and approved by the Secretary. Bridge management requires that each state develop a plan for cost-effectively alleviating the constraints on permit vehicles due to deficient bridges.

Federal law should allow operation of LCVs under the provisions of the federally supervised permit program in a manner consistent with other recommendations.

The committee did not recommend general revision in the network of roads to which the various federal dimensional regulations are applicable. In particular, the committee did not recommend extending federal weight regulation to the non-interstate portion of the National Highway network, which are currently under state regulation for most aspects of truck operations.

The preceding recommendations call for data collection for systematic monitoring of truck traffic and truck costs to evaluate regulatory effectiveness, pilot studies to test new vehicles, and basic research on the relationship of truck characteristics to highway costs. Specific research topics were:

- Evaluation of the effectiveness of enforcement of size/weight regulations,
- Air quality impacts of changes in truck characteristics,
- Relation of truck performance to crash involvement,
- Risk-based bridge costs,
- Freight transportation market research,
- Costs of mixed automobile and truck traffic arising from nuisance/stress, and
- New infrastructure development and truck-only facilities.

3.3.5 The Western Uniformity Scenario

Following the CTSW study, the Western Governors’ Association requested that U.S.DOT analyze an additional sce-

nario that would be limited to western states already allowing LCVs. Specifically, the governors asked U.S.DOT to analyze a policy option that would allow 13 western states (Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington and Wyoming) to harmonize LCV weights and dimensions at levels that meet existing federal axle load limits and the Federal Bridge Formula and that were consistent with guidelines established by the Western Association of State Highway and Transportation Officials (WASHTO). The ten impact areas were the same as those used in the CTSW study. These states contain a higher percent of rural roads than urban roads as compared to the nation as a whole (70).

The Western Uniformity Scenario analysis included several substantial improvements to data and methods used in the CTSW study to estimate scenario impacts. These included improvements in the truck and rail data, and methods used to analyze pavement, bridge, and safety impacts. One of the biggest improvements was the use of the freight analysis framework (FAF) commodity-flow data in place of the very limited truck-flow data that was available at the time the CTSW study was undertaken.

The analysis includes the following vehicles: 5-axle tractor-semitrailers, twin 8.69-m (28.5-ft) trailers, and five LCVs, including Rocky Mountain doubles, turnpike doubles, triples, a 10-axle resource-hauling double, and 8-axle B-trains. The base case for the analysis was:

- 9,071 kg (20,000 lb) for a single axle on the Interstate system,
- 15,422 kg (34,000 lb) for a tandem axle on the Interstate system,
- Application of the Bridge Formula for other axle groups, up to the maximum of 36,287 kg (80,000 lb) for gross vehicle weight on the interstate system,
- 2.59-m (102-in.) vehicle width on the national network,
- 14.65 m (48 ft) minimum semitrailer length in a semitrailer combination on the National Network, and 8.53-m (28-ft) minimum length for trailers in a twin-trailer combination on the national network,
- Grandfather rights under which certain LCVs are allowed to operate in each scenario state, and
- LCVs that were permitted by state law but subject to the LCV freeze.

The conclusions of the Western Uniformity Scenario analysis were similar in some ways to previous study findings. First, the proposed scenario vehicles and routes varied significantly, but basically allowed more generous gross weight and additional routes compared to the base case. Like previous studies that examined the potential impacts of changing truck size and weight limits, this study found several benefits from allowing more widespread use of LCVs. The benefits included

a reduction in fuel consumption, emissions, and noise-related costs. However, the full benefits estimated in this study would probably not be realized because not all states would allow LCVs to operate as widely as assumed in the study. One difference with this study compared to previous studies is that infrastructure and related costs should not be as great because LCVs already operate on at least some highways in each of the 13 states. So, to a certain extent, states have already considered LCV size and weight in pavement, bridge, and geometric design.

The study found that few of the states charge enough for LCV operations to cover the infrastructure costs, and when heavy trucks do not pay their share, other motorists must make up the difference. The study recommended that plans should be developed for financing those improvements that include how the longer, heavier trucks would contribute to paying those costs before making changes in truck size and weight limits that could increase highway improvement needs. The report cited a conclusion from *TRB Special Report 267*, “federal legislation creating the permit program should specify a quantitative test for the revenue adequacy of the permit fees imposed by states that wish to participate. . . . Fees should at least cover estimated administrative and infrastructure costs for the program . . .” (69).

On the critical topic of safety, this report concluded that the available data are simply not sufficient for developing reliable estimates of changes in the number of crashes or fatalities that might result from the proposed changes. States that currently allow LCV operation have not noted particular safety problems with LCVs, but they have no formal processes in place to monitor safety. Therefore, one suggestion in the conclusions was to require such processes before any substantial changes in federal truck size and weight limits were implemented. Another suggestion was to consider requirements to ensure that proposed vehicles meet some minimum thresholds for stability and control, and that companies operating these vehicles have good safety records and vehicle maintenance programs.

The Western Uniformity Scenario conclusions also point out some of the salient points of harmonization, which was a central theme of the study. Some of its points favor harmonization but others appear to justify a more neutral position. For example, in a statement that seems to justify the status quo, it states that the pattern of truck size and weight limits that has evolved over the years among states involved in the study may not be optimal, but it allows for some appropriate regional variation without compromising safety. Somewhat to the contrary, it refers to recent state-specific exemptions from federal truck size and weight laws that have been enacted, stating that the U.S.DOT does not support a piecemeal approach. Reasons not to support this approach include: it makes enforcement and compliance with truck size and weight laws more complicated, it may have unintended consequences for

safety and highway infrastructure, it often contributes little to overall productivity, and it reduces willingness to work for more comprehensive solutions that could have greater benefits. A regional approach such as the Western Uniformity Scenario could have greater benefits than a series of individual exemptions, but it also could have much more serious adverse consequences unless closely monitored.

It also contended that strong support for the TRB recommendations in *Special Report 267: Regulation of Weights, Lengths, and Widths of Commercial Motor Vehicles* (69) has not been evident, except for certain segments of the trucking industry and several states that are interested in size and weight increases. The Department has not taken a formal position on the TRB study, partly because it does not favor change in federal truck size and weight policy. However, if changes should occur, the U.S.DOT favors strong monitoring and evaluation as recommended by the TRB study.

Finally, the conclusions emphasize that strong support from elected state officials within the region is essential and critical for successful change in truck size and weight limits. Without such support, it will be difficult to achieve a carefully controlled and monitored evaluation of changes in truck size and weight limits such as those in the Western Uniformity Scenario. Such state support has not been evident to date, and there is no compelling federal interest in promoting changes that are not strongly supported by the affected states.

3.3.6 Research Recommendations and Results

This section looks at the recommendations of each of the four studies just discussed, and provides information on results of major recommendations.

3.3.6.1 The Turner Proposal

The Turner proposal recommended lower axle group weights and more axles so that a higher gross weight is achieved, which would require the 36,287 kg (80,000 lb) to be removed (67). Industry did not believe there was enough payload gain to justify the expense of different equipment, so this major recommendation of the study was not implemented. Most of the other recommendations were contingent upon adoption of Turner truck. The recommendation for antilock brakes on power units has happened, but due to other federal safety requirements, none of the other safety recommendations were adopted.

3.3.6.2 The CTSW Study

The primary goal of the CTSW study was the development and testing of analytical tools to estimate potential diversion

of traffic from one type of truck to another, or diversion between truck and rail, if truck size and weight limits were changed. Even though this study included an extensive review of past safety studies and developed a consensus of results, there was still a lack of confidence in these results. The use of crash statistics from operating environments that are significantly different from those proposed was a major source of this doubt. This study developed tools to evaluate stability and control properties of different vehicle configurations at different weights and dimensions. These tools were intended to provide a measure of the relative safety compared to vehicles in widespread use. Since the major emphasis of the CTSW study was the development of analysis tools, it did not make strong recommendations for change related to truck size and weight (68).

3.3.6.3 Regulation of Weights, Lengths, and Widths of Commercial Motor Vehicles

The recommendation to form a Commercial Traffic Effects Institute would have, in a general sense, followed the Canadian example in creating a less political, or nonpolitical entity, for addressing, in a highly technical manner, issues with truck size and weight. This was not acted upon, so other recommendations contingent on formation of the Institute did not happen.

It is unclear whether this study was the impetus of some of the research that has ensued, but some of the topics identified in the study have been topics of ongoing research (69).

3.3.6.4 The Western Uniformity Scenario

The Western Uniformity Scenario emphasized findings and conclusions more than recommendations. It advocated developing plans for financing those improvements to infrastructure, including how the new trucks that are responsible for additional costs would contribute to paying those costs (70).

The Western Uniformity Scenario noted that a recommendation in the TRB review of truck size and weight limits would essentially result in conducting experiments with vehicles that were known not to be safe. This study advocates, to the maximum extent possible, giving assurances that the vehicles to be used would be at least as safe as vehicles on the road today and that the companies to be operating those vehicles would have excellent safety records.

The Western Uniformity Scenario advocated a regional approach to truck size and weight change, which could have greater benefits than a series of individual exemptions, but it also could have much more serious adverse consequences unless closely monitored. Also, such an approach for a carefully controlled and monitored evaluation of changes in truck size

and weight limits must have strong support from elected state officials.

These positions presented in the Western Uniformity Scenario have not found fulfillment to date.

Regional application of size and weight issues is already being done successfully through AASHTO subgroups, although it can have negative consequences such as heavier trucks on roads that may not be the safest. Regional permitting is discussed in more detail elsewhere.

3.3.7 National Legislative Actions

By the end of the 1970s, there was something of a patchwork of state truck size and weight limits. Not all states allowed doubles, and overall length limits in others either restricted semitrailer length or effectively limited doubles. Some states still retained the 33,240-kg (73,280-lb) gross weight, and axle weights lower than current federal limits. The 1982 STAA required states to allow larger trucks on the national network, which is comprised of the Interstate system plus the non-Interstate federal-aid primary system. "Larger trucks" included

- Doubles with a trailer length not less than 8.53 m (28 ft);
- A semitrailer not less than 14.65-m (48-ft) long;
- Unlimited length for tractor-semitrailer and double trailer combinations;
- Width up to 2.59 m (102 in.);
- A single axle weight not less than 9,072 kg (20,000 lb), a tandem axle weight not less than 15,422 kg (34,000 lb), and a gross weight determined by Bridge Formula B, up to 36,287 kg (80,000 lb), as is shown in Figure 24 (71).

The current truck weight limits for most major U.S. highways are based on Bridge Formula B:

$$W = 500 \left(\frac{LN}{N-1} + 12N + 36 \right)$$

where W = the maximum allowable weight (lb) on the N axle group being considered and L = the extreme axle spacing (ft) of this group. Additionally, a maximum gross vehicle weight of 80,000 lb applies, with a 20,000-lb limit on a single axle and a 34,000-lb limit on a tandem axle with a spread of 4 ft (71).

This formula was recommended in the 1964 House Document 354 and was adopted in 1975. The reported basis for this formula was an allowable overstress of 5% in bridges designed for HS20 loadings and 30% in bridges designed for H15 loadings. A footnote in the House Document also incorporated in the resulting legislation prohibited certain vehicles, otherwise legal according to Bridge Formula B, from operating on H15 bridges, but these prohibitions are not often enforced.

- (a) The provisions of the section are applicable to the National System of Interstate and Defense Highways and reasonable access thereto.
- (b) The maximum gross vehicle weight shall be 80,000 pounds except where lower gross vehicle weight is dictated by the bridge formula.
- (c) The maximum gross weight upon any one axle, including any one axle of a group of axles, or a vehicle is 20,000 pounds.
- (d) The maximum gross weight on tandem axles is 34,000 pounds.
- (e) No vehicle or combination of vehicles shall be moved or operated on any Interstate highway when the gross weight on two or more consecutive axles exceeds the limitations prescribed by the following formula, referred to as the Bridge Gross Weight Formula:

$$W = 500 \left(\frac{LN}{N-1} + 12N + 36 \right)$$

except that two consecutive sets of tandem axles may carry a gross load of 34,000 pounds each if the overall distance between the first and last axle is 36 feet or more. In no case shall the total gross weight of a vehicle exceed 80,000 pounds.

(f) Except as provided herein, States may not enforce on the Interstate System vehicle weight limits of less than 20,000 pounds on a single axle, 34,000 pounds on a tandem axle, or the weights derived from the Bridge Formula, up to a maximum of 80,000 pounds, including all enforcement tolerances. States may not limit tire loads to less than 500 pounds per inch of tire or tread width, except that such limits may not be applied to tires on the steering axle. States may not limit steering axle weights to less than 20,000 pounds or the axle rating established by the manufacturer, whichever is lower.

(g) The weights in paragraphs (b), (c), (d), and (e) of this section shall be inclusive of all tolerances, enforcement or otherwise, with the exception of a scale allowance factor when using portable scales (wheel-load weighers). The current accuracy of such scales is generally within 2 or 3 percent of actual weight, but in no case shall an allowance in excess of 5 percent be applied. Penalty or fine schedules which impose no fine up to a specified threshold, i.e., 1,000 pounds, will be considered as tolerance provisions not authorized by 23 U.S.C. 127.

(h) States may issue special permits without regard to the axle, gross, or Federal Bridge Formula requirements for nondivisible vehicles or loads.

(i) The provisions of paragraphs (b), (c), and (d) of this section shall not apply to single-, or tandem-axle weights, or gross weights legally authorized under State law on July 1, 1956. The group of axles requirement established in this section shall not apply to vehicles legally grandfathered under State groups of axles tables or formulas on January 4, 1975. Grandfathered weight limits are vested on the date specified by Congress and remain available to a State even if it chooses to adopt a lower weight limit for a time.

Figure 24. Excerpts of code of federal regulations part 658. Source: Reference (71).

The STAA set minimum limits, and most states chose not to exceed them, bringing a significant measure of uniformity to the truck traffic on the National Network. It did nothing for other vehicles that operated on state roads under state legislation, and states increasingly exploited their grandfather rights to allow more and different vehicles on more roads. The ISTEA of 1991 therefore imposed two separate freezes:

- On the maximum weight of LCVs, which consist of any combination of a truck tractor and two or more trailers or semitrailers operating on the Interstate system at a gross weight over 36,287 kg (80,000 lb).

- On the overall length of the cargo carrying units of combination vehicles with two or more such units where one or both exceed 8.69 m (28.5 ft) in length on the national network.

The LCV freezes applied to combination vehicles in actual and legal operation in a state on June 1, 1991, and the routes and conditions in effect on that date were also frozen for vehicle combinations subject to the freeze (73).

National policy on truck size and weight has not changed significantly since the 1991 ISTEA, except that a small number of specialized vehicle configurations have been added to the regulation, and details for some of these have been amended.

3.3.8 State Legislative Actions

Limits on truck size and weight appear in state regulations as early as 1913, when weight limits were introduced in Maine, Massachusetts, and Washington, and weight and width limits were introduced in Pennsylvania. The last state to enact a weight limit was North Dakota, in 1933. States were slower to adopt limits on length, width, and height than they were on weight, but by 1929, most states restricted these dimensions as well as weight (74). Size and weight limits have generally increased over time to allow for larger and heavier vehicles and have varied significantly from state to state, and have changed frequently. A 1941 federal study documented 300 changes in individual state size and weight laws between 1913 and 1941, or about one change every 4 years per state (75). State to state variation in some limits has narrowed over time, but uniformity of combination truck length limits has not improved. The recommended policies of AASHTO have been a model for many states since the first policy was adopted in 1931, when AASHTO urged states to adopt uniform regulations to promote efficiency and safety and to allow for standardized highway design. Even though some states have used AASHTO policies, their appeal for uniformity has had limited effect (74).

A shift of some truck size and weight regulatory authority from the states to the federal government occurred at the start of the Interstate construction era in the 1950s, and since then, the distribution of this shared authority has shifted back and forth. As the Interstate construction era draws to a close, the transportation community is again reassessing the federal role in the context of future highway transportation needs.

The federal size and weight rules in the 1982 STAA superseded many state limits, at least as they applied to the designated network where trucks meeting the federal standards may operate. Primary elements of these rules included the operation of twin trailer combinations, 14.65-m (48-ft) semitrailers, and vehicle width of 2.59 m (102 in.). At the end of 1982, 36 states allowed 19.81-m (65-ft) long twin trailer combinations on at least some roads. Several states required special permits for their operation, and 14 states restricted the operation of twins to designated highways. Semitrailers 14.65-m (48-ft) long were legal on some roads in 35 states in 1982, and 10 states allowed 2.59-m (102-in.) wide trucks. The federal requirement that no overall length limit be imposed for the affected combination vehicles overturned such limits in all 50 states (74).

The 1982 STAA mandated a nationwide network of routes for the operation of 8.53-m (28-ft) double trailers and 14.65-m (48-ft) semitrailers. Some states have been reluctant to push the size and weight issue even to federal maximums in all cases, while other states have sought increases beyond federal maximums—even if on less safe roads. These differences

will continue to force a piecemeal approach to size and weight and will force many bigger and heavier trucks onto roadways not designed for their use.

Another variable among states is the use of permits. Many states allow exemptions for certain classes of vehicle, or commodities, either with or without permits. Many northeastern states allow higher weight limits through a special truck registration or permit. Other states issue permits for divisible loads under grandfather authority. In 1985, 37 states issued 153,642 divisible load permits, and in 1995, this same number of states issued 380,511 permits. The number of permits issued for specific commodities continues to increase as well. For example, in 1995, Pennsylvania added two new overweight permits for 42,638 kg (94,000 lb) gross weight and 9,525 kg (21,000 lb) per axle on state highways, but only for steel coils and milk. In 1996, the Pennsylvania legislature added bulk animal feed (68). Such exemptions and exceptions are pervasive throughout the United States and seem to continue as time goes on.

3.3.9 Regional Initiatives

AASHTO is interested in investigating size and weight issues. The major goal of AASHTO efforts to date has been harmonization among states in a given region. AASHTO developed a position at its 2007 meeting pertaining to regional harmonization, encouraging states to harmonize on a regional basis. An example of this regional cooperative arrangement is the WASHTO, which consists of the following states: Arizona, Idaho, Montana, Oregon, Utah, Washington, Texas, New Mexico, Colorado, Oklahoma, Nevada, Alaska, California, Hawaii, North Dakota, South Dakota, and Wyoming. One of the options under this arrangement is a multistate single-trip permit issued under the Western Regional Permitting Agreement. Under the terms of the agreement, each member state may issue regional permits allowing operation in any other member state (76). Both WASHTO and the Southern Association of State Highway and Transportation Officials (SASHTO) have done a considerable amount of (divisible load) permitting as well. Neither the Mississippi Valley nor Northeastern Association of State Highway and Transportation Officials (NASHTO) have been as active as other regions in promoting regional divisible load permitting, according to an AASHTO spokesman. All interested states must agree to harmonization to get something meaningful started, and to make the efforts an ongoing success.

In a May 2000 workshop involving stakeholders following the U.S.DOT CTSW study, participants spoke favorably regarding regionalism and trade corridors (77). The majority of participants favored more state flexibility for regional policies, and a special permit system with strong enforcement was generally viewed as a must for regional truck size and weight limits. Multi-state agreements are recognized as a means of

promoting and implementing regional truck size and weight policies. Participants recognized, however, that to avoid states having total control over truck size and weight limits, a federal umbrella would be needed to impose some overall limits on flexibility.

3.3.10 The Corridor Perspective

The American Road and Transportation Builders Association (ARTBA) recently articulated a vision for the future to be included in the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) legislation. The heart of that vision was a new, more accountable, structure for the federal highway program consisting of two components, one to preserve and improve the current highway and transit systems through a significant increase in federal user fees and the second, and more critical to this topic, the creation of an integrated, national strategy that ARTBA refers to as “Critical Commerce Corridors.” The program, sometimes referred to as the “3C Proposal,” would facilitate the safe and efficient movement of freight and reduce the impact of truck traffic (78).

This ARTBA vision was borne, at least partly, out of a sense of global competition. China has a massive strategic transportation plan underway to build 68,000 km (42,000 mi) of new interstate highways in 20 years, India is building 40,000 km (25,000 mi) of expressways, and the European Union is adding nearly 16,000 km (10,000 mi) of new highway and rail capacity. The ARTBA initiative stresses that the United States is in a global economy and must also establish a competitive plan to meet future transportation needs.

The Critical Commerce Corridors Proposal is intended to address America’s freight challenges and handle the expected doubling of truck traffic over the next 25 years. The 3C program would provide new surface transportation system capacity and operational improvements focused on safe and efficient movement of freight. A secondary use of these corridors might be for evacuation purposes in times of national emergencies or disasters.

Financing of the program could come from dedicated and protected user fees levied on freight shipments and could involve public-private partnerships and debt financing. The U.S.DOT would lead this effort in collaboration with public and private sector stakeholders. This cooperative public-private sector process would develop the costs and specific components of the program. Components of this program as envisioned by ARTBA are:

- Most, if not all, of the existing Interstate highway system and a portion of the non-Interstate national highway system;
- New multimodal trade corridors;

- New “truck only” lanes allowing increased productivity and improved safety through separation of commercial vehicles from personal vehicles;
- “Last mile” military base, port, airport, inland waterway and rail connections;
- Tunneled and elevated roads and railways on existing right-of-way;
- International gateways;
- Bottleneck relief;
- Multimodal freight transfer centers; and
- Integrated telecommunications corridors.

The issue of trade corridors was also discussed at length at the stakeholder workshop noted above (77). These participants believe that, under carefully controlled conditions, such corridors could be candidate sites for operations of larger vehicles at higher weights. Some expressed concerns, however, about cost and the potential for off-corridor operations, such as trucks not staying in specified lanes or corridors. On high volume freight corridors there may be opportunities for separate truck lanes. Some workshop participants felt that consideration should be given to liberalizing federal truck size and weight limits for some trade corridors. Due to uncertainties concerning potential impacts of liberalizing size and weight limits, there was a consensus that any initiative would probably have to be in the form of a demonstration project with a well defined termination date and strong controls so that the project could be ended if necessary (77).

3.3.11 The Bridge Perspective

3.3.11.1 Design Loadings

The H and HS truck live-load model was adopted in 1944, and since then, variations of this basic model (H15-44, H20-44, HS15-44, HS20-44) have been the basis of the live load model used by designers of almost all bridges in the United States. The “-44” indicates the series by year of adoption, 1944. The HS model consists of a two-axle truck plus a semitrailer with a variable trailer wheelbase of 4.27 to 9.14 m (14 to 30 ft). The total weight on the first two axles of the H and HS trucks is designated (in tons) by the numeral following the H or HS designator, with 20% on steering axle and 80% on the drive axle, with the weight on the third (trailer) axle identical to that on the tractor drive axle. The gross vehicle weight of an HS20-44 then is 32,658 kg (72,000 lb), or 36 tons, with 20 tons on the tractor and a 16 ton trailer axle. The HS20 live-load model also includes a uniformly distributed lane loading of 952 kg/m (640 lb/ft) plus a concentrated load of 8.164 kg (18,000 lb) when checking moment, or 11,793 kg (26,000 lb) when checking shear. The live-load model uses the truck or lane loading that creates the maximum

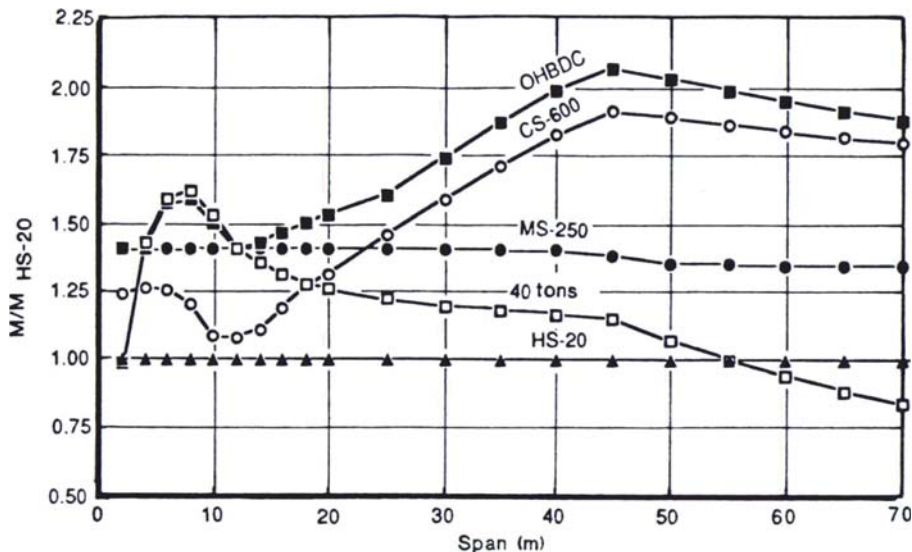


Figure 25. Comparison of simple span moments of Canadian design vehicle versus HS20.

value of the load effect being checked. For example, when checking moments in a simple span bridge, the truck governs for spans of 140 ft and shorter, while the lane load governs for longer spans. Most on-system bridges designed today in the United States are designed for HS-20 loading.

Canadian bridges are designed for one of two live load models, the Ontario Bridge Design Code (OBDC) within Ontario or the CSA in other Canadian provinces. The OBDC uses the Ontario Highway Bridge Design (OHBD) live-load model, which is a 5-axle vehicle currently of gross vehicle weight 740 Kn (166,400 lb). This vehicle has evolved and has been calibrated to surveys of actual truck traffic, particularly maximum observed overloads. Figure 25 compares the simple span moments caused by the then current OHBD design vehicle with the HS20-44 design vehicle (79).

The current OHBD design vehicle is heavier after a recent recalibration against current truck weight surveys. Figures 26

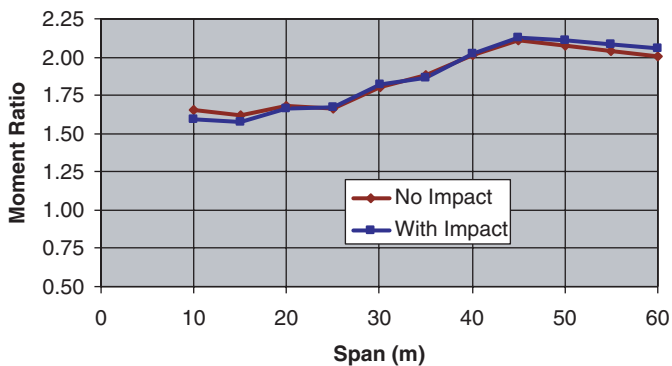


Figure 26. Ratio of unfactored design moments by current OHBD and HS20 design vehicles on simple spans, with and without impact.

and 27 report the ratio of the simple span moments of the OHBD design vehicle and the HS20 design vehicle. The difference, due to the most recent changes in the OHBD vehicle, is most noticeable in short span bridges (10 to 20 m), whereas the ratio to HS20 moments has increased significantly with the recalibration.

Bridge design in other Canadian provinces follows the CAN/CSA-S6-06 Code. The design vehicle in this Code is currently the CL-625 5-axle vehicle with a gross weight of 625 Kn (140,456 lb) and an 18-m (59-ft) wheelbase. There are minor differences in the application of the design vehicle between the CSA and OHBD codes, specifically in the way superimposed lane loadings are handled, in the way impact or dynamic load allowances are handled, and in the load factors used in load factor design (LFD). The end result is that the two Canadian design codes result in very similar design moments on simple span bridges of a given span length, and the moments resulting from these two design codes are significantly greater than those resulting from the AASHTO LFD design process that uses the HS20 design vehicle. With the exception of short span bridges, with a span up to 15 m (49 ft), designed for CL-625 loadings, Canadian bridges are designed for significantly greater loadings than U.S. bridges designed for HS20 loadings.

The OHBD design vehicle is based on maximum observed overloads, and is multiplied by a live-load factor of 1.40, whereas the CAN/CSA-S6 design vehicle is based on regulatory loadings and is multiplied by a live-load factor of 1.60. The HS20 loads are multiplied by a live-load factor of 1.67 in the AASHTO LFD design procedure.

It is observed in Figure 28 that the design loadings for HS20, OHBD, and CL-625 are also different in the way in

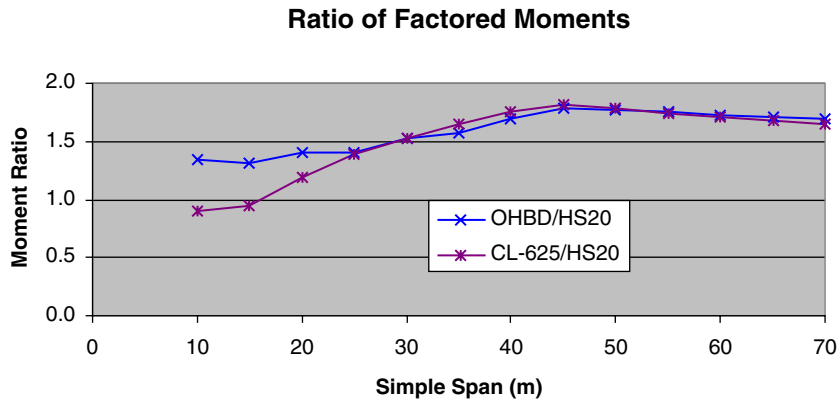


Figure 27. Comparison of factored design moments by Canadian design Loads on simple spans to HS20 factored design moments, with impact.

which truck loads and lane loads are combined. In the case of AASHTO design with HS20 vehicles, truck loads are used alone until lane loads with a single concentrated 8,164 kg (18,000 lb) axle load take precedent. For simple spans, this means that truck loads govern for spans shorter than 42.67 m (140 ft), and lane loads govern for spans longer than this. Both the OHBD and CL-625 design vehicles are combined with lane loadings (the loading may be governed by an unfactored truck or a reduced truck combined with a lane loading). For the OHBD, the combined truck/lane loading begins to govern at about 35 m (115 ft), and the CL-625 combined loading governs at even shorter spans. (See Figure 28.)

3.3.11.2 Bridge Population in the United States

The National Bridge Inventory documents the bridge population of the United States (80). Data from that inventory are summarized in Figure 29, which breaks down the approximately 597,000 bridges by year of construction. This shows

that few bridges were constructed during World Wars I and II, and much of the current inventory dates from the 1960s, when most of the Interstate highway system was under construction. Figure 29 also shows the bridges classified as structurally deficient as of May 2006.

Table 4 shows a summary of the design loadings used for design of the nation’s 682,482 bridges in the National Bridge Inventory as of 2006 (80). Nationwide, about 14% of the nation’s existing bridges were designed for HS15 or lighter loadings, with another 18% having “other or unknown” design loadings. Of all currently existing bridges in the nation, 45% are designed for HS20 or a modified HS20 loading. However, only 3.30% are known to be designed for HS25 or heavier loadings.

Most bridges built in the United States today are designed for HS20 loadings, but this is not true for all bridges in the existing bridge inventory. As an indication, consider the following statistics for the inventory of 49,593 bridges in Texas from the National Bridge Inventory data files (80). Seventy-four percent of the 10,237 bridges built in Texas in 1990–2006 were

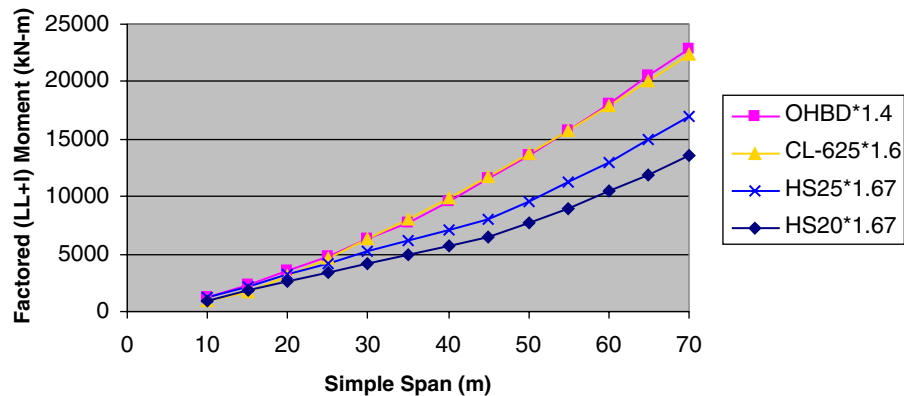


Figure 28. Factored design moments by current Canadian and HS20 design vehicles on simple spans, with impact.

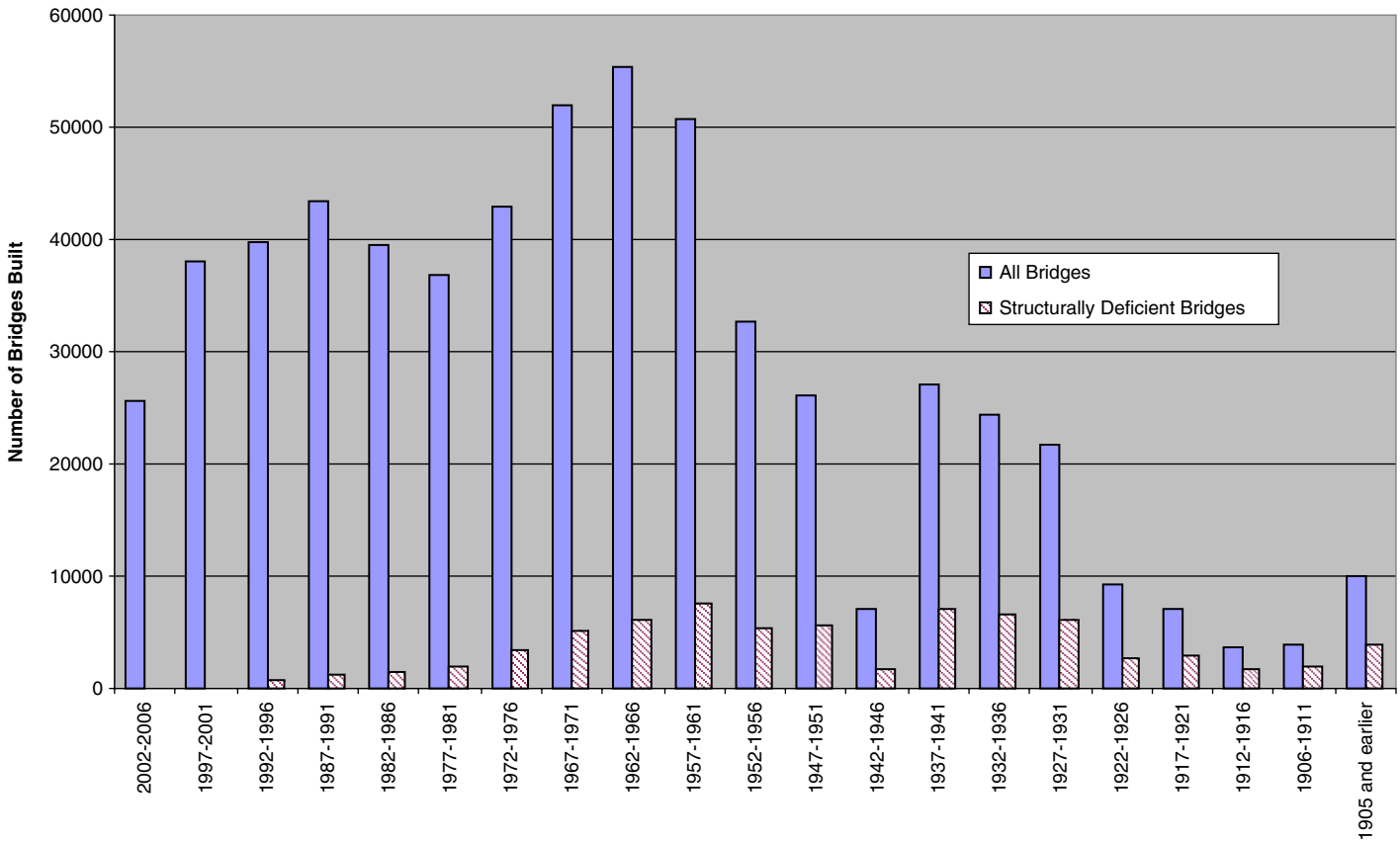


Figure 29. Year of construction of U.S. bridges as of 2006.

designed for HS20 loadings. The design load is indicated as “other or unknown” in the database for most of the remaining bridges (23%), though essentially all highway bridges in Texas were probably designed for HS20 loadings during this period. However, before 1960, 34% of the existing 16,527 bridges built in Texas at the time were designed for H15 loadings. And, in the 1960s, during the Interstate highway construction boom, 9,327 existing bridges were built in Texas with about 11% designed for H15 loadings. Consequently, in 2006, about 15% of the state bridge inventory presently in use was originally designed for a loading less than HS20.

3.4 Application of Canadian Experience to the United States

This section summarizes elements of the Canadian experience, both the impacts of the size and weight limits and the process used to harmonize them, which may have relevance for U.S. regulators. It identifies areas in which the Canadian truck size and weight limits have resulted in particular successes, or problems.

3.4.1 Freight and Trucks

In Canada, low-density freight moves in 5-axle tractor-semitrailers below mass capacity, however, when loads of higher density freight are traveling to or from the United States in 5-axle tractor-semitrailers, they tend to be loaded close to the maximum permissible weight of 36,287 kg (80,000 lb). The allowable gross weight of this vehicle is 39,500 kg (87,082 lb) in the four western provinces, and 41,500 kg (91,491 lb) in the six eastern provinces. Generally, if a commodity would challenge the weight capacity of a 5-axle tractor-semitrailer, then more of it can be carried in a vehicle with greater weight capacity, so that is how it moves. The 6-axle tractor-semitrailer, with a tridem semitrailer, has an allowable gross weight from

Table 4. National Bridge Inventory system bridge-design loads as of 2006.

Design Load	Count of Bridges	Fraction
Other, or unknown	120,497	17.66%
H10	11,389	1.67%
H15	70,244	10.29%
HS15	11,997	1.76%
H20	53,977	7.91%
HS20	229,486	33.63%
HS20+Mod	64,210	9.41%
Pedestrian	534	0.08%
Railroad	253	0.04%
HS25	22,514	3.30%

43,500 to 49,500 kg (95,900 to 109,127 lb), depending on the tridem spread and whether it operates in western or eastern Canada, and 6-axle A- or B-train doubles are suitable for freight of moderate density. The 7-axle B-train, with an allowable gross weight of 56,500 kg (124,560 lb) in the four western provinces, and 59,500 kg (131,173 lb) in the six eastern provinces, and the self-steer quad 7-axle tractor-semi-trailer, with an allowable gross weight of 57,500 kg (126,764 lb) in Ontario and Québec, are suitable for higher density freight. Seven-axle doubles are not common, but the self-steer quad is very significant because it has had greater range in Québec than the 8-axle B-train. The 8-axle B-train, 8- and 9-axle tractor-semi-trailers, and other doubles in Ontario, all with an allowable gross weight from 62,500 to 63,500 kg (137,787 to 139,992 lb), move dense and heavy freight. The truck size and weight regulations in Canada therefore provide a range of payload weight bands that allow shippers and carriers to optimize a truck configuration for a payload.

In the United States, the same light freight moves in 5-axle tractor-semi-trailers as in Canada, at the same gross weights. The 5-axle tractor-semi-trailer also moves medium and heavy freight, both locally and between states, usually at a gross weight close to 36,287 kg (80,000 lb). Medium and heavy freight also moves locally in diverse other configurations that operate under grandfather or LCV rights, principally within one state, or possibly by permit into neighboring states. Michigan is really the only state that has a range of configurations that address a range of freight like Canada, though most of these would not be contemplated as candidates for the M.o.U. in Canada.

In Canada, about 60% of trips are made by trucks that carry light freight, such as the 5-axle tractor-semi-trailer with a typical actual gross weight up to 36,287 kg (80,000 lb). About 13% of trips are made by 6-axle tractor-semi-trailers with an allowable gross weight of up to 49,500 kg (109,127 lb). About 7% of trips are made by 7-axle tractor-semi-trailers and doubles with an allowable gross weight up to 59,500 kg (131,173 lb). About 15% of trips are made with vehicles that can carry heavy freight, such as the 8-axle B-train, with an allowable gross weight from 62,500 to 63,500 kg (137,787 to 139,992 lb). The remaining 5% or so of trips are made by trucks of diverse configuration, and many of them are made with a special permit, either for an LCV, such as a turnpike double, or to carry an indivisible large or heavy load.

Canada has a greater proportion of dense freight and heavy loads because its economy is proportionately more dependent on natural resources than the United States. Nevertheless, if the distribution of freight density would be the same in the United States as in Canada, and the United States would adopt the M.o.U. configurations and weights, then it would require about 15% fewer trucks to move the freight that moves in vehicles with 6 or more axles in Canada. This calculation is a very rough estimate. U.S. bridge analysis suggests

load restrictions would need to be applied to Canadian vehicles. If, however, the vehicles were reconfigured to maximize their weight in accordance with the capacity of U.S. bridges, then the vehicles would have only a slightly diminished capacity compared to the Canadian vehicles.

When Ontario and Québec allowed 16.2-m (53-ft) semi-trailers in 1994, 5 years after the effective date of the original M.o.U., they allowed only those semi-trailers longer than the prevailing length of 14.65 m (48 ft) if they met the exact requirements of the M.o.U., so they were only allowing a tandem or tridem axle group. Semi-trailers with other axle groups were restricted to 14.65 m (48 ft), which quickly limited their utility. Many carriers use a van semi-trailer as a general-purpose vehicle, regardless of its number of axles. So, a tridem semi-trailer will take a load that uses all or a substantial part of the weight capacity of the vehicle. However, a similar load may not be available for the return trip, so the vehicle will take a load that could otherwise go in a tandem semi-trailer. This improves the utilization of the tridem and diminishes the need for tandem semi-trailers. However, this was not possible at a time when tandem loads were increasingly being packaged for 16.20-m (53-ft) semi-trailers, so the utilization of van semi-trailers that were not of an M.o.U. configuration was less than ideal. Ontario and Québec subsequently realized the necessity to allow all semi-trailer configurations in regulation and with a secure future length of 16.20 m (53 ft), so that a carrier could optimize the utilization of all vehicles in its fleet.

3.4.2 The Need for Uniform Definitions

It cannot reasonably be expected that a desired outcome will be achieved if terms in which vehicles are described have different meanings in the regulations of different jurisdictions. The terms include those for vehicle configurations, axle groups and axle arrangements, dimensions, components, and anything else relevant to description of a vehicle.

The M.o.U. included a set of definitions of terms, and all provinces have adopted these. If the U.S. federal government would set further truck size and weight regulations, these would be interpreted uniformly if it also required states to adopt all the definitions in the federal regulations, in the same manner as the STAA. If a group of states agrees to harmonize aspects of their regulations, then this should also include an agreement to adopt definitions of terms, in a similar manner to the M.o.U.

3.4.3 The Need for a Complete Vehicle Specification

When Ontario introduced regulation by its bridge formula in 1970, it was intended that the provincial economy should benefit from the substantial increase in allowable gross weight. It was expected that new configurations would arise

to exploit the new form of regulation, but not all those that arose were foreseen. Nor was the widespread use of liftable axles foreseen, with the consequent road damage and risk to bridges that amounted to Can\$300 million in additional maintenance costs per year by about 2000. They could not foresee the poor dynamic performance of some of the configurations, as heavy vehicle dynamics was still in its infancy at that time. It took 30 years for Ontario to start a process to revise what it did in 1970, another 10 years for this process to address all configurations, and it may be another 20 years before all the old configurations are finally retired.

The M.o.U. provided comprehensive definitions of terms, and detailed and complete specifications for vehicles, to guard against the unexpected outcomes that occurred in Ontario. These vehicles have, generally, achieved the intended outcomes.

Some jurisdictions have a tendency to write vehicle specifications as “A vehicle with (so many) axles shall . . .” followed by some general dimensional limits and allowable weights. Such a vague form does not define a vehicle configuration, and may result in a straight truck, truck-pony trailer, truck-full trailer, tractor-semitrailer, A- or B-train double trailer combination, or some other configuration depending on the number of axles and length allowed. Even if the configuration is specified, as more axles are allowed, the number of ways the axles can be arranged within each vehicle unit, and over the vehicle as a whole, increases exponentially. There is a dramatic range of difference in the dynamic performance of the possible configurations, which may have some bearing on the crash rate and the types of crash. Certain dimensions are important to the dynamic performance of some configurations, and these should have strict limits, but this vague form of specification generally does not address these. If 6 or more axles are available, then some of these axles will certainly be liftable, as is evident in states that allow use of the Federal Bridge Formula without other constraints, such as in Washington and Ohio, where vehicles with one or more liftable axles are common. Michigan allows up to 11 axles, with allowable gross weight determined simply by the sum of allowable axle group loads, and has vehicles with 5 or more liftable axles.

When a vehicle has a liftable axle with an independent suspension, the driver sets the load on the liftable axle. Experience in Canada suggests that a liftable axle is usually down when it needs to be down, but it is often loaded less than it needs to be, based on the overall load on the vehicle, so other axles are overloaded. It is possible that the driver sets the liftable axle to that load that makes the vehicle easiest to drive, rather than the load necessary based on the total load on the vehicle. Many load controls are also not very reliable, so the set load may vary during a trip. The actual axle loads arising from the way the liftable axle is set determine the amount of pavement resource consumed on a trip, and the risk to bridges. When liftable axles are used, this will be considerably

higher than expected, based on the amount of freight carried and the vehicle configuration. The actual outcome will be far worse than the desired outcome.

3.4.4 The Need to Monitor Outcomes

Highway departments put much thought into a new or amended truck size and weight regulation. Once a new regulation is in place, vehicle designers, sales personnel, carrier fleet managers, and drivers put considerable effort into looking for ways to use the regulation that will give them a commercial advantage over their competitors. These people are very innovative and spend a lot of time thinking, so it may not be surprising that the outcomes may not always be those intended. It is critical therefore to monitor the effects of the regulations to ensure that negative, unintended consequences can be rectified early.

The intention of the B-train specification in the M.o.U. was that vehicles meeting the specification should look and perform like B-trains. One of the earliest vehicles proposed was essentially a jeep dolly towing a 14.65-m (48-ft) semitrailer, which met the then-current B-train specification, but took much more space to turn than a tractor-semitrailer. It was shortly followed by a tractor-semitrailer with a low-mounted stinger fifth wheel towing a pony trailer, which also met the specification, but had much less desirable dynamic performance than a proper B-train. Once these configurations were observed, the Task Force on Vehicle Weights and Dimensions Policy moved quickly to change the B-train specification to preclude them. In the first case, no vehicles were built. In the second case, a small number were built, but only in one province.

Monitoring the outcomes of the regulations determined the presence of the deviant configurations. The response prevented an unintended outcome as it prevented these vehicles becoming numerous, and avoided a need to grandfather those that had been built for the rest of their useful lives.

Monitoring the evolution of the fleet resulting from changes in regulation provides valuable insight into the effectiveness of a given regulatory initiative. A recent study (88) on the impact of Canadian size and weight regulation change in the Prairie Provinces describes how the new policies have influenced the fleet mix, resulting in more productive vehicles. It also found that when the new policies were implemented, it took 8 to 12 years for the carriers to fully adjust their fleet.

3.4.5 The Need for Dimensional Compatibility

A vehicle may travel between jurisdictions if it is within the dimensional limits allowed in each jurisdiction. It cannot travel where it is not within the dimensional limits of a jurisdiction. A fundamental aspect of harmonization of truck size and weight

requires that no jurisdictions have more restrictive dimensions than the national standard. This allows vehicles meeting the dimensions of the national standard to travel in all jurisdictions. A jurisdiction may be more liberal than the national standard, for its own purposes, as it knows that other jurisdictions are not obligated to accept such vehicles. A jurisdiction would always remain at liberty to restrict roads to vehicles with lesser dimensions than the national standard in cases where road conditions are not suitable for larger vehicles, such as, for example, in California, where a number of mountain roads are restricted to semitrailers no longer than 8.53 m (28 ft).

Dimensional compatibility must extend beyond overall length, and must also include regulated internal dimensions. U.S. federal regulations require states to allow a semitrailer at least 14.65 m (48 ft) in length, and all states conform to this. However, many states also regulate the semitrailer wheelbase, either directly by a measurement from the kingpin to the last axle, which is most commonly 13.11 m (43 ft), or by another measurement. The 13.11-m (43-ft) kingpin-to-rear-axle is not an issue for 14.65-m (48-ft) semitrailers, or for tandem axle semitrailers. It may be an issue for a 16.20-m (53-ft) semitrailer with a 3.07-m (121-in.) spread tandem. It is certainly an issue for a Canadian 16.20-m (53-ft) semitrailer with a 3.66-m (144-in.) spread tridem, where a 13.11-m (43-ft) limit on kingpin-to-rear-axle forces the tridem bogie forward further than even the most forward setting allowed in Canada. California has a maximum semitrailer wheelbase of 11.58-m (38-ft), and Michigan limited the wheelbase of a 16.20-m (53-ft) semitrailer to 12.34 m (40 ft 6 in.) plus or minus 0.15 m (6 in.), so it was simply not possible to configure a semitrailer with fixed axles that could operate legally in both states. Michigan's rule was also much more restrictive than the Canadian M.o.U. limits. However, it was recently amended, and now provides a range of wheelbase that is close to the Canadian M.o.U., and compatible with California's limit.

Both overall and secondary, or internal, dimensions need to be specified to ensure compatibility of vehicles with the highway system, and satisfactory low-speed and high-speed dynamic performance. The dimensions that need to be specified vary with the vehicle configuration. National standards must address all these dimensions. Experience with state regulation of wheelbase suggests that the STAA approach of requiring that no state set a dimensional limit more restrictive than the specified value may not be sufficient to achieve the required outcome. It may also require a general stipulation that no state can regulate another dimension in a manner that would be more restrictive than a nationally specified dimension.

3.4.6 Weight Tolerances

By the 1990s, the most common tractor-semitrailer in the six provinces of eastern Canada was a 3-axle tractor pulling a

tri-axle semitrailer, where the semitrailer had a single liftable axle ahead of a fixed tandem axle. The semitrailer had some slight dimensional differences between provinces and was allowed a gross weight of 49,000 kg (108,025 lb) in Nova Scotia and New Brunswick, about 51,000 kg (112,434 lb) in Québec, and about 52,500 kg (115,741 lb) in Ontario. However, Nova Scotia had a legislated gross weight tolerance of 3,000 kg (6,614 lb), New Brunswick had an administrative tolerance of the same value, Québec had a mandatory administrative tolerance of 1,500 kg (3,307 lb), and Ontario had an administrative tolerance at the discretion of the officer, which industry generally considered zero. When the tolerance in each province was added to its allowable gross weight, a tri-axle semitrailer could be operated freely through the six provinces at an actual gross weight of 52,000 to 52,500 kg (114,639 to 115,741 lb) without fear of a gross weight offense, so the configuration was harmonized for practical purposes between the provinces. However, a simple reading of the regulations of the provinces did not exactly spell out what could be done.

It is clear that significant tolerances can skew outcomes. The provinces have agreed there should be no published or legislated weight tolerances, and there are now none. They all retain administrative tolerances that are used at truck inspection stations at the discretion of enforcement staff in accordance with enforcement policies, to reflect variability in scale equipment.

3.4.7 Winter Weight Allowances and Spring Weight Restrictions

Some provinces allow additional weight to be carried during a defined period of freeze-up during the winter. Some provinces allow winter weights for all vehicles, while others allow them only for a specific commodity, such as logs, in a number of provinces. Winter weight allowances may vary by highway and vehicle configuration and may require a special permit, depending on the province.

All provinces impose spring weight restrictions during the thaw period that occurs after a real winter. The provinces have different and distinct approaches to spring weight restrictions, and the onset and duration varies widely by location, between and within provinces, depending on the severity of the freeze-up. Québec applies its spring weight restriction to all highways, even though its main highways may not require a weight restriction. It takes the point of view that if vehicles were allowed at normal weight on main highways, some of these vehicles would also operate on other roads where the full weight restriction is necessary, and those roads would suffer undue damage. Consequently, Québec applies the same spring weight restriction to all roads. Ontario built its primary highway system for full loads all year round. It

allows travel at legal weights on these highways during the thaw period, but applies a standardized axle weight limit to secondary highways and other roads. Other provinces, such as Alberta and Saskatchewan, may apply a specific weight restriction to axle groups, or to gross weight for a specific highway.

By the early 1980s, after a couple of rounds of response by other provinces to Ontario's change in 1970, the preferred vehicle in the Prairie Provinces from the regulations would have been a 7-axle B-train. However, when spring weight restrictions were considered, an 8-axle A-train was the most productive on a year-round basis, so this was the configuration of choice for heavy haul. The A-train rear trailer is prone to roll over in an evasive maneuver, and repairing damaged pup trailers was a good business for trailer manufacturers.

Winter weight allowances and spring weight restrictions mean that the configuration that can move the greatest weight of a particular commodity in a particular part of a particular province over a whole year is not necessarily the configuration that has the highest allowable gross weight in the summer. The actual outcome is not necessarily the obvious outcome from a simple reading of the rules, and the outcome may differ depending on how a jurisdiction imposes the weight allowance or restriction.

Winter weight allowances and spring weight restrictions all result in differences from the standard legal weights, which generally serve as the basis for most evaluations of vehicles, and evaluations of their impacts on roads and bridges.

3.4.8 Vehicle Modifications

When the truck size and weight regulations change, carriers may have to buy new vehicles, or they may be able to modify an existing vehicle to the proper configuration. A new vehicle should meet all pertinent safety standards at the time of manufacture so that is not a problem later. Suppose a vehicle is being modified to have a higher gross vehicle weight rating than it was built with. The gross axle weight ratings of the existing axles may not be sufficient for the new vehicle. The structure may need to be reinforced for higher payload weights. The brake system may be modified and may not comply with the current timing requirements of FMVSS 121, and so on. There are many things that might need to be modified so that the vehicle would be equivalent to a newly manufactured vehicle. Not all owners might want to spend the amount of money on a vehicle to ensure the job would be done properly. Not all entities that might undertake the work would necessarily understand, or be able to do, all that would be required.

When Ontario introduced self-steer tri-axle and self-steer quad semitrailers in 2001, these could readily be modified from existing tri-axle or quad semitrailers. To ensure that

modified semitrailers would be equivalent to a newly manufactured semitrailer, the regulation required the company doing the work to affix its own compliance label beside that of the original manufacturer, with the new gross vehicle weight rating and gross axle weight ratings. Thus, only a manufacturer registered with Transport Canada as qualified to manufacture and modify, a semitrailer in this case, with air brakes would be allowed to do the work. The manufacturer was therefore required to certify that the modified semitrailer would meet the pertinent safety standards at the time the vehicle was modified.

3.4.9 The Scientific Approach

The CCMTA/RTAC Vehicle Weights and Dimensions Study produced a set of principles for the configuration of vehicles (18), based on a procedure for evaluating the dynamic performance of vehicles. The procedure is straightforward:

1. The vehicle makes a standard maneuver under specified conditions;
2. Performance measures are computed from the responses to this maneuver; and
3. Each performance measure is compared to a corresponding performance standard, to determine whether performance is satisfactory or not.

There CCMTA/RTAC Vehicle Weights and Dimensions Study used seven performance measures (18) that related to the dynamic performance of semitrailers. The seven original performance measures are also more broadly applicable to other vehicle configurations. However, some vehicle configurations have critical performance measures that were not included in the original seven, and new performance measures have been developed to address the characteristics of these vehicles. The original seven performance measures, and others developed since, are outlined in Appendix D, with commentary.

After the M.o.U. was put in place in 1989, each province also had a range of other configurations, principally truck-trailer combinations. Collectively, the provinces asked, now that tractor-semi-trailers and doubles had been configured to ensure they met objective standards for dynamic performance, should other configurations also be treated in a similar manner? The same procedure for evaluating the dynamic performance of vehicle was therefore used to add straight trucks and truck-trailer combinations to the M.o.U. in 1991 (40), for Québec to eliminate Ontario multi-axle semitrailers in favor of the self-steer quad semitrailer (45) also in 1991, and subsequently for the forestry industry in British Columbia and Alberta to work with the provincial governments to identify preferred configurations for legal and permit operations at the highest allowable gross weights (50). All provinces have used the same process

when adding a vehicle to regulation (53), (54), and when considering a vehicle for a special permit, and they continue to do this. A province's assessment of a proposed new configuration is not just based on the assessment of dynamic performance, but also on the impacts on infrastructure, on safety, and on the economic benefit to industry and to the province. It is not uncommon for a province to reject a proposed new configuration because it perceives deficiencies in the dynamic performance of the vehicle outside the range of the fleet as a whole. However, some provinces use the process to allow vehicles configured for weights higher than legal limits to operate by permit on remote highways where they can operate safely. For example, Alberta and Saskatchewan allow some log trucks a 2.89-m (114-in.) track width.

When Canada's provinces approached the task of harmonizing size and weight regulations, many of the axle arrangements and configurations that had become common in Ontario were not allowed by most other provinces. The research conducted during the CCMTA/RTAC Vehicle Weights and Dimensions Study showed conclusively that this position was well-justified. The study identified the deficiencies of these vehicles in numerical terms. Vehicle manufacturers and carriers had long since reached exactly the same conclusions and understood the characteristics of these vehicles very well, though in non-numerical terms. Thus, the decision not to allow these configurations was quite reasonable to carriers. When Ontario ultimately began to deal with the issue of liftable axles, as discussed in section 2.1.10, manufacturers and carriers again accepted the scientific evidence that the province had very good grounds for their eventual elimination, both as vehicles and for the damage they did to the infrastructure.

The process described here is an administrative process used by staff in the provincial highway departments. They all use the same performance standards and essentially the same process. It is not known to be formally documented, though it could be.

This type of process is not used widely in the United States, however, it is clearly applicable to any vehicle that would be considered. It is also clear that some of the vehicles that states allow to operate in the U.S. might not be allowed to operate by Canadian provinces, as they are unlikely to meet the performance standards. Canadian provinces have assessed, in some cases, the same vehicles that would be considered for more widespread use in the United States. The assessment protocols are well established but would need to be reviewed and formalized if being used as part of a federal, or even regional, initiative to change truck size and weight regulations. Such an assessment methodology would allow decision makers to determine preferred configurations and to set allowable weights and limits on dimensions critical to performance. There might also be route restrictions, special driver qualifications, a requirement, perhaps, for a B-train over an A-train, and technology or equipment requirements. After all, if the public at large does

not like trucks, then they will not like a larger or heavier truck. However, if the larger or heavier truck can be shown objectively to have better dynamic performance than existing trucks, and will reduce the number of trucks by (say) 10%, with attendant reductions in congestion, fuel consumption and emissions, the public might (grudgingly) concede that there might be a benefit to the larger or heavier truck. Most members of the public have a range of objections to trucks that relate simply to the fact that they are trucks, most of which have little or no relationship to the size or weight of the truck. These issues must be disconnected from the discussion.

Technology for improving safety on large trucks is being introduced, but unless there is a government mandate, market penetration will depend on industry anticipating a return on investment. Technology could be a prerequisite for allowing larger or heavier trucks, to ensure that safety improvements occur simultaneously with greater productivity. There have been studies in Canada consistently showing the safety benefits of adopting LCVs. It boils down to adopting policy that encourages safety benefits. Also, the use of technology can be a prerequisite to allowing bigger vehicles (86).

3.4.10 Grandfather Rights

In Canada, it has become apparent that when a province changes its regulations to allow a configuration with a higher allowable gross weight than existing vehicles, the new configuration appears immediately and grows rapidly in numbers. Most examples of the previously preferred configurations disappear, though some that are ideally suited for their mission and would not benefit from the new regulation may remain in service for an extended period.

A similar result might be expected if the United States would change its size and weight regulations. Suppose, for example, that a configuration would be mandated nationally at a gross weight of, say, 43,091 kg (95,000 lb), in the same way that STAA mandated the twin trailer combination. This configuration would be expected to displace all the diverse configurations operating under state permits or state grandfather rights at weights between 36,287 and 43,091 kg (80,000 and 95,000 lb), and may also displace some vehicles with a slightly higher allowable gross weight. The same thing would happen if new configurations would be mandated, for example, 49,896 or 54,431 kg (110,000 or 120,000 lb). Vehicles configured under grandfather rights and state permits would quickly diminish in numbers. The new vehicles would be more efficient, as they could travel on all highways, and would open up new business opportunities for many carriers. The resale value of the older vehicles would plummet.

The grandfather rights of states are perceived as an impediment to changes in U.S. truck size and weight regulations. However, there would be no need for the federal government

to override any state grandfather rights. Existing state regulations would not need to be repealed, nor would permit programs need to be dismantled. The new vehicles would simply render these irrelevant, and they could continue in place until all the subject vehicles had disappeared, when they could be repealed or terminated.

3.4.11 The NAFTA Partnership

Canada and Mexico are sovereign nations and partners with the United States in NAFTA, which became effective in 1994. The NAFTA treaty identified that truck size and weight regulations were potentially a barrier to trade, so it provided a mechanism for the three partners to harmonize their truck size and weight regulations. The United States has essentially not made any changes to its size and weight regulations since NAFTA became effective, while Canada and Mexico have made continuous refinements.

Canada and Mexico have both gone to considerable lengths to develop their own truck size and weight regulations, which, coincidentally, have many similarities, and considerable domestic harmonization. Harmonization with the NAFTA partners to the extent possible and with the intent of achieving more uniform transportation efficiency within North America may be a compelling argument for change.

3.4.12 The Institutional Contrast

3.4.12.1 Jurisdiction

In Canada, ten provinces and three territories have the authority to set, monitor, and enforce truck size and weight regulations. Provincial limits on truck size and weight apply to all roads within a province, except to the extent that a province or local authority may set access restrictions due to roadway design, or weight restrictions due to bridge condition.

In the United States, the federal government, 50 states, the District of Columbia, toll road authorities, local authorities, and maybe others, have the authority to set, monitor and enforce truck size and weight regulations. Truck size and weight are closely related, yet the Senate Environment and Public Works Committee controls weight, while the House Transportation and Infrastructure Committee controls size (86). Federal regulations apply to the national network, state regulations apply to state roads, and regulations of other bodies may apply to roads they control. Again, there may be access restrictions due to roadway design, or weight restrictions due to bridge condition.

3.4.12.2 Status

In Canada, the provinces have been discussing truck size and weight issues together for over thirty years, and have devoted much of that time to a process of harmonization. They

have managed to make large changes without significant organized opposition, except in one province where there was a 5 year delay. Most recent changes have been minor, and highly technical, refinements, which would not be expected to generate opposition. The process to develop proposals is cooperative between provincial civil servants and industry, with the provinces ultimately taking their decision by consensus.

In the United States, jurisdictions with authority over truck size and weight may have differing views on the subject. For example, states that allow LCVs generally want the LCV freeze lifted, while states that do not allow LCVs mostly want the freeze to remain. The jurisdictions are also subject to enormous pressure from outside groups, from proponents of a specific change, to a wide range of groups strongly opposed to any increase in truck size or weight. For example, the Association of American Railroads will oppose any proposals to modify the current provisions through 2009 (82). The U.S. federal government *ex parte* rulemaking process can be somewhat adversarial.

3.4.12.3 Taxes and Cost Recovery

In Canada, there are no trust funds or dedicated taxes. All fuel and sales taxes, license and permit fees, and other income all go into general revenue of the treasury. Disbursements from the treasury are for budget allocations, and there is no relationship between the source of funds and/or expenditures on programs.

In the United States, who pays what to whom, and how and where that payment is used, are very significant issues.

3.4.12.4 The Process

In Canada, when the provinces began to make changes in their regulations in response to Ontario's substantial increase in allowable gross weight in 1970, each exercised its sovereignty and made changes that reflected its own existing form of regulation and the needs and wishes of its strongest stakeholders. When it became evident that the diversity of the changes was making interprovincial trucking more difficult, the provinces agreed they needed a common process that would lead to uniform regulations. Uniformity may not have been achieved, and it may never have been more than an idealistic hope. But substantial *de facto* uniformity has been achieved. It was achieved because the Council of Ministers expected an outcome. The committee that formulated the approach was composed of provincial representatives who understood what the Council of Ministers wanted, and had access to the provincial deputy minister (the senior civil servant in the department), and through him to the minister. There was never any doubt that something would be done. It was helpful that the research produced results of lasting value and

principles that could be, and were, used to configure vehicles, then and since. If the research had not produced meaningful results, the committee still fully intended to harmonize provincial truck size and weight regulations.

In the United States, when Congress acted on STAA in 1982, and ISTEA in 1991, there was no doubt that it intended to do something. However, when Congress mandated the CTSW study, there was no clear intention that there would be any outcome, and there has been none. A number of other studies have been done, but none has produced any direct outcome. At this time, the federal government does not appear to have expressed any view on a direction for truck size and weight regulations. The states have may have differing, or strongly differing, views. In the absence of a clear vision and strong leadership, it is difficult to see significant progress to harmonize truck size and weight regulations from the federal level downward. Meanwhile, states continue to make changes that are putting larger and/or heavier trucks on local roads, when the vehicles truly would be more efficient and might operate with less risk if they had access to the national network. The longer states continue to develop their own permit systems, the more diverse the national patchwork of size and weight regulations will become. There has certainly been worthwhile progress by some of the regional groups of AASHTO, and their process appears closer to the Canadian process than any federal process. It would seem possible that the AASHTO process could be adapted into something with a mandate like that proposed

for the proposed Commercial Traffic Effects Institute, discussed in section 3.3.6.3 above. However, it is difficult to see the federal legislators giving up their role to define size and weight regulations to an administrative and technical body, and the proponents or opponents of change allowing them to give up that role.

3.4.12.5 Opposition

In Canada, the process of implementation of the M.o.U. proceeded relatively smoothly. The only delay was due to public concern in Ontario with an increase in semitrailer length and overall length for doubles, which restricted full implementation in the six eastern provinces for five years. The trucking industry supported removal of regulatory differences, and shippers supported increased truck productivity. The railways were opposed as a matter of principle, but in fact, there is not a lot of real competition between road and rail for most of the freight that moves in Canada. In addition, the railways made intermodal services the single fastest growing transportation sector with trucking companies as partners and customers, and were actually the largest single early purchasers of M.o.U. configurations, with one design of container chassis for all their terminals across the country.

In the United States, there are a number of advocacy groups who may oppose proposals to change the truck size and weight regulations.

CHAPTER 4

Conclusions

Truck size and weight regulation is abstruse, complex, highly technical, and has multiple close linkages with roadway, pavement and bridge design, construction, maintenance and management, road safety, road capacity and congestion, energy, emissions, rail transportation, and others. The public at large simply does not like trucks, and especially does not like the concept of a larger or heavier truck, whether or not they would know what that would actually entail and what the benefits may be. So making rational changes to truck size and weight in the United States is both technically and politically challenging.

The essential lessons learned from the Canadian size and weight experience are as follows:

1. There was national agreement among stakeholders that Canadian size and weight regulations were inconsistent and outdated, which contributed to cross country transport inefficiency. Recognition of this problem provided a clear focus for action.
2. A formal body, including federal and provincial government representation, was established to develop and oversee the process of rationalizing size and weight policy based on scientific analysis. The basis for technical input was the Vehicle Weights and Dimensions Study, which was specifically conducted to provide scientific input.
3. The size and weight study provided an understanding of vehicle infrastructure interaction and produced a set of vehicle performance metrics that were used to specify vehicle configurations that had desirable vehicle dynamic characteristics and could operate within the load capability and geometric constraints of the road network.
4. The study also validated the tridem axle group that is the cornerstone upon which many of the higher productivity vehicles are built.
5. Canadian policy is structured through weight allowance limits to provide an incentive for the development and use of vehicles with favorable dynamic characteristics.
6. A formal body was established to oversee the implementation of harmonized size and weight policy among the provinces, and it continues to monitor and respond to needs as required.
7. Size and weight regulation needs to be thorough and comprehensive so that the desired outcomes are achieved and undesirable outcomes are prevented. There is a need for monitoring of the fleet as it evolves to ensure that undesirable vehicles are kept in check and that the objectives of the policy can be fully achieved.
8. The Canadian experience points to the simultaneous achievements of productivity, safety and environmental effects—aspects that are sometimes viewed as trade-offs.

The U.S. federal government has not made significant change to its truck size and weight regulations since 1991, when it moved to limit the opportunity of states to make changes. Nevertheless, since then, states have continued to make changes that allow larger and/or heavier trucks on roads that are not part of the national network, and these changes have increased the diversity of regulations across the nation. This has created a condition not unlike what existed in Canada before it began its size and weight harmonization effort. Furthermore, having frozen the federal size and weight policy for the past 19 years as other countries have progressed and made refinements to policy, the United States can benefit from the experience of these other jurisdictions by developing instruments that have proven records of success.

In the United States, federal, state, local, toll road and maybe other agencies have authority to set, monitor, and ensure compliance to truck size and weight limits. It would seem practical to identify one or more ranges of gross weight above 36,287 kg (80,000 lb), define new configurations to address each gross weight range, and require these vehicles be allowed on national network roads that were suitable for them.

Canada has three ranges of allowable gross weight higher than 36,287 kg (80,000 lb), essentially for trucks with 6, 7 and

8 axles. If a U.S. jurisdiction were to consider a higher allowable gross weight, it would be appropriate to define weight ranges and vehicle configurations for each. This approach could potentially reduce the number of trucks by maybe 10% to 15%, by judicious definition of weight ranges and suitable vehicle configurations.

U.S. specifications are highly influenced by the Federal Bridge Formula, which tends to define the number of axles in a vehicle, the allowable weights, and overall length. There is the potential for an approach based on the bridge formula that could result in undesirable outcomes for vehicles with 6 or more axles. Unless otherwise prohibited, it is likely that lift axles would flourish, which would be threatening to the infrastructure. The approach in Canada was to provide a complete specification for the vehicle, including internal dimensions critical to both infrastructure and vehicle dynamic performance.

When truck size and weight regulations are changed, it is not uncommon for industry to find a loophole that provides an unintended, and possibly undesirable, outcome. The vehicle configurations that arise from the change should be monitored carefully, and if unintended vehicles with undesirable infrastructure impacts or dynamic performance are appearing, a mechanism should be available to close the loophole quickly to prevent these vehicles becoming common.

Dimensional compatibility is more important than the same allowable weights. Jurisdictions should respect the dimensions agreed upon for the specified vehicle, so that it can travel freely among the jurisdictions that have adopted it. If jurisdictions agree to accept a configuration, they may wish to allow less restrictive dimensions than the specification, but they should not have any more restrictive dimensions. In addition, if the jurisdictions have different allowable axle group weights, or allowable gross weight, the configuration should be able to be loaded to its allowable gross weight in each jurisdiction within the allowable axle loads and internal dimension limits.

Canada's process developed a performance-based method to assess the dynamic performance of vehicles, and this method was used as the basis for the national configurations, and has been used subsequently by all provinces when considering new configurations, either for regulation or for special permits. This is applied rigorously by all provinces, and it is not uncommon that proposed new configurations are rejected due to deficiencies in their dynamic performance. On the other side, if a new configuration can be shown to have better, or at least no worse, dynamic performance than existing vehicles it might replace, this provides a strong argument against those who oppose higher weights "on principle."

Grandfather rights and state permit programs allow for a variety of vehicles, some with evidently undesirable effects on infrastructure, dynamic performance, or both. If the federal government, a state, or region would define configurations with greater allowable gross weight and more range, the diverse configurations operating under grandfather rights and permit programs would simply disappear. Any carrier wanting to continue to operate vehicles under the old grandfather right or permit program could continue to do so, but most of these local use vehicles would quickly be replaced by vehicles with greater range that would be more efficient.

The United States, Canada, and Mexico are equal partners in NAFTA. The NAFTA treaty identified that truck size and weight regulations were potentially a barrier to trade, so it provided a mechanism for the three partners to harmonize their truck size and weight regulations. The United States has essentially not made any changes to its size and weight regulations since NAFTA became effective, while Canada and Mexico have both continued to develop their own truck size and weight regulations, which coincidentally have many similarities and considerable domestic benefit. Harmonization with the NAFTA partners, to the extent possible, with the intent of achieving more uniform transportation efficiency within North America could present a compelling argument for change.

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LIST OF ABBREVIATIONS

This section contains a list of abbreviations of the names of government departments, other organizations, legislation, agreements and other items, which are used in this report.

AASHTO	American Association of State Highway and Transportation Officials
ARTBA	American Road and Transportation Builders Association
CCMTA	Canadian Council of Motor Transport Administrators
CSA	Canadian Standards Association
CTSW	U.S. Department of Transportation's Comprehensive Truck Size and Weight Study
FAF	Freight analysis framework
HTA	Highway Traffic Act
ISTEA	Intermodal Surface Transportation Efficiency Act, 1991
LCV	Longer combination vehicle. In the United States, either a double trailer combination with an allowable gross weight over 36,287 kg (80,000 lb), or a combination of two or more trailers that is much longer than a legal double; in Canada, only the latter.
LFD	Load factor design
M.o.U.	Federal-Provincial-Territorial Memorandum of Understanding on Inter-provincial Weights and Dimensions
NAFTA	North American Free Trade Agreement
NASHTO	Northeastern Association of State Highway and Transportation Officials
OBDC	Ontario Bridge Design Code
OBF	Ontario Bridge Formula
OHBD	Ontario Highway Bridge Design
RTAC	Roads and Transportation Association of Canada, became TAC in 1990
SASHTO	Southeastern Association of State Highway and Transportation Officials
SPIF	Safe, productive and infrastructure friendly
STAA	U.S. Surface Transportation Assistance Act, 1982
TAC	Transportation Association of Canada
TEA-21	Transportation Equity Act for the 21st Century, 1998
TRB	Transportation Research Board
U.S. DOT	U.S. Department of Transportation
WASHTO	Western Association of State Highway and Transportation Officials

DEFINITION OF TERMS

This section contains a list of definitions of terms used to identify or describe vehicle configuration, components, axle groups, dimensions, and other aspects of heavy trucks.

A Dolly	Means a trailer converter dolly that is towed from a single hitch located on the center line of the towing unit (34)
A-Train Double	Means a combination of vehicles composed of a tractor, a semitrailer, and either an A Dolly and a semitrailer or a full trailer attached to the lead semitrailer in a like manner as if an A Dolly were used (34)
Axle	Means an assembly of two or more wheels whose centers are in one transverse vertical plane that transmits weight to the highway (34)
Axle Spread	Means the longitudinal distance between the extreme axle centers of the axle group (34)
Axle Group	Any number of axles, within a single vehicle unit, that equalize loads on adjacent axles within 1,000 kg (34)
Axle Weight	Means the total weight transmitted to the highway by the axle or axle group (34)
B-Train Double	Means a combination of vehicles composed of a tractor, a semitrailer, followed by another semitrailer attached to the first semitrailer by the means of a fifth wheel mounted on the rear of the first semitrailer (34)
Base Length	Means the distance measured between the centers of the first axle of the front axle of a vehicle or combination of vehicles and the last axle of a vehicle or combination of vehicles (12)
Belly Axle	Means an axle located ahead of the rear fixed axle group on a trailer that is usually a liftable axle
Box Length	Means the longitudinal dimension from the forward most part of the cargo carrying unit(s) or load(s) to the rearmost part of the cargo carrying unit(s) or load(s), exclusive of any extension(s) in the dimension caused by auxiliary equipment or machinery at the front that is not designed for the transportation of goods (34)
C Dolly	Means a trailer converter dolly, with a rigid frame in the horizontal plane that is towed from two hitches located in a horizontal transverse line on the towing unit, that precludes any rotation in the horizontal plane about the hitch points, and which satisfies all requirements of the Canadian Motor Vehicle Safety Standards applicable to such devices (34)

C-Train Double	Means a combination of vehicles composed of a tractor, a semitrailer, and followed by another semitrailer attached to the first semitrailer by the means of a C Dolly (34)
Drawbar	Means a structural member of a full trailer, pony trailer or trailer converter dolly that includes a device for the purpose of coupling with a trailer hitch or fifth wheel (34)
Drawbar Length	Means the longitudinal distance from the center of the hole in the fifth wheel of a converter dolly to the center of the hitching device on the towing vehicle (34)
Drive Axle	Means the axle or axle group that is or may be connected to the power source of a motor vehicle and that transmits power to the wheels (34)
Effective Rear Overhang	Means the longitudinal distance calculated from the trailer turn center to the rearmost point including load on the trailer or semitrailer (34)
Fifth Wheel	Means a coupling device that is mounted on the vehicle chassis and that consists of a skid plate, associated mounting brackets and latching mechanism that couples or connects to a kingpin located on the other vehicle or component, for the purpose of supporting and towing a semitrailer (34)
Fifth Wheel Offset	Means the longitudinal distance calculated from the center of the hole for the kingpin in the fifth wheel/kingpin assembly to the center of the drive axle unit (34)
Full Trailer	Means a vehicle that is designed to be towed by another vehicle and is designed and used so that the whole of its weight and load is carried on its own axles and includes a combination consisting of a semitrailer and a trailer converter dolly (34)
Gross Vehicle Weight	Means the total weight transmitted to the highway by a vehicle or combination of vehicles (34)
Height	Means the vertical distance from the highest point on the vehicle to the ground (34)
Hitch Offset	Means the longitudinal distance from the towing-vehicle turn center to the articulation point of the hitch or fifth wheel used to tow the trailing unit (34)
Inter-axle Spacing	Means the longitudinal distance separating two axle or axle groups calculated from the centers of the two adjacent axles (34)
Inter-vehicle-unit-distance	Means, for a combination of vehicles, the distance between the centers of the last axle of the motor vehicle . . . and the first axle of the towed vehicle, and the distance between the centers of the last axle of the towed vehicle and the first axle of the second towed vehicle (12)
Intercity bus	Means a vehicle designed to carry more than fifteen passengers and equipped with facilities to allow extended travel without stopping. (34)
Lift Axle	See Lifiable Axle
Lifiable Axle	Means an assembly of two or more wheels whose centers are in one transverse plane that is equipped with a device for altering (other than by longitudinal movement of the assembly only) the weight transmitted to the highway surface and that may be able to lift its tires from contact with that surface (34)

Kingpin Setback	Means the horizontal distance from the vertical axis through the center of the kingpin to any point on the semitrailer ahead of the kingpin, including load but exclusive of any extension to the length caused by auxiliary equipment or machinery that is not designed for the transportation of goods (34)
Length (Full Trailer)	Means the longitudinal dimension from the front of the cargo carrying section of the full trailer to its rearmost point (34)
Length (Pony Trailer)	Means the longitudinal dimension from the front of the drawbar of the pony trailer to its rearmost point (34)
Length (Semitrailer)	Means the longitudinal dimension from the front of the cargo carrying section of the semitrailer to its rear, exclusive of any extension in length caused by equipment or machinery at the front that is not designed for the transportation of goods (34)
Overall Height	Means the greatest overall vertical distance from the highest point on the vehicle or load to the ground (34)
Overall Length	Means the greatest overall longitudinal dimension of a vehicle or combination of vehicles including load (34)
Pony Trailer	Means a vehicle that is designed to be towed by another vehicle and is equipped with a drawbar that is rigidly attached to the structure of the trailer, and is so designed and used that the preponderance of its weight and load is carried on its own axles (34)
Pusher Axle	Means an axle located ahead of the drive axle group on a power unit that is usually a liftable axle.
Rear Overhang	Means the longitudinal distance calculated from the center of the last axle to the rearmost point, including load, on the trailer or semitrailer (34)
Semitrailer	Means a vehicle that is designed to be towed by another vehicle and is so designed and used that a substantial part of its weight and load rests on or is carried by the other vehicle or a trailer converter dolly through a fifth wheel and kingpin combination (34)
Single Axle	Means one or more axles whose centers are included between two parallel transverse vertical planes 1.2 meters apart (34)
Steering Axle	Means the articulated lead axle or axles of a motor vehicle which govern the direction travelled by the vehicle (34)
Self Steering Axle	Means an axle which articulates in response to forces generated between the tire and the road or through mechanisms or linkages operating independently of the driver of the vehicle (34)
Tag Axle	Means an axle located to the rear of the rear fixed axle group on a power unit or trailer that is usually a liftable axle.
Tandem Axle Group	Means an axle group containing two consecutive axles whose centers are not less than 1.2 meters apart and are attached to the vehicle in a manner which achieves equalized loading between the axles (34)
Tractor	Means a motor vehicle designed to and normally used to pull a semitrailer or a semitrailer and a full trailer or a semitrailer and a semitrailer (34)
Track Width	Means the overall width of an axle across the outside edges of the tires (34)

Tractor Wheelbase	Means the longitudinal distance from the center of the steering axle to the geometric center of the drive axle unit (34)
Trailer Converter Dolly	Means a vehicle unit consisting of one or more axles, a fifth wheel and a drawbar used to convert a semitrailer to a full trailer (34)
Trailer Wheelbase	Means the longitudinal distance from the center of the kingpin of a semitrailer, or the center of the turntable of a full trailer, or the center of the hitching device on a pony trailer, to the trailer turn center (34)
Tri-Axle Group	Means an axle group containing three consecutive axles whose extreme centers are not less than 2.4 meters apart, are not equally spaced, and may be attached to the vehicle in a manner which does not achieve equalized loading among the three axles
Tridem Axle Group	Means an axle group containing three consecutive axles whose extreme centers are not less than 2.4 meters apart, are equally spaced and are attached to the vehicle in a manner which achieves equalized loading among the three axles (34)
Truck	Means a motor vehicle, other than a bus, that is either permanently fitted with a special purpose device, or is designed to and normally used to carry a load, that may operate as a single unit or may pull a trailer other than a semitrailer (34)
Turn Center	Means the geometric center of the axle group on a semitrailer or pony trailer or the rear axle group on a truck, tractor or full trailer (34)
Width of Tire	Means the width of the tire as customarily measured and rated by manufacturers of motor vehicles and tires (34)

APPENDIX A

Heavy Truck Weight and Dimension Limits for Interprovincial Operations in Canada

Task Force on Vehicle Weights and Dimensions Policy

Heavy Truck Weight and Dimension Limits for Interprovincial Operations in Canada

**Resulting From
The Federal-Provincial-Territorial Memorandum of
Understanding
on Interprovincial Weights and Dimensions**



Summary Information

April 2008

Table of Contents

Introduction.....	A-3
The Federal - Provincial - Territorial Memorandum of Understanding on Interprovincial Weights and Dimensions	A-5
General Conditions	A-5
Additional Conditions and Restrictions	A-6
Interpretations and Clarifications	A-7
Exceptions.....	A-8
Category 1: Tractor Semitrailer	A-9
Category 2: A Train Double	A-11
Category 3: B Train Double.....	A-13
Category 4: C Train Double.....	A-15
Category 5: Straight Truck.....	A-17
Category 6: Truck - Pony Trailer Combination.....	A-19
Category 7: Truck - Full Trailer Combination.....	A-21
Category 8: Intercity Bus and Recreational Vehicles	A-23
Designated Highway Systems.....	A-25
Yukon.....	A-25
British Columbia	A-25
Alberta.....	A-25
Manitoba	A-25
Ontario	A-25
Québec	A-26
New Brunswick	A-26
Nova Scotia	A-26
Prince Edward Island	A-26
Newfoundland and Labrador.....	A-26
Saskatchewan	A-27
Northwest Territories	A-28

Introduction

In February 1988, the Council of Ministers Responsible for Transportation and Highway Safety endorsed a Memorandum of Understanding designed to improve uniformity in regulations covering weights and dimensions of four types of commercial vehicles operating between provinces and territories on a nationwide highway system. The original MOU included the following configurations:

- Category 1: Tractor Semitrailer
- Category 2: A Train Double
- Category 3: B Train Double
- Category 3: C Train Double

Since the original agreement was established, five amendments have been prepared and endorsed by the Council of Ministers.

Amendment 1:

In September 1991 the number of vehicle configurations covered by the national standards agreement was increased from four to eight to include:

- Category 5: Straight Truck
- Category 6: Truck - Pony Trailer
- Category 7: Truck - Full Trailer
- Category 8: Intercity Bus

Amendment 2:

In July 1994 changes were made to the dimensional limits applicable to Categories 1 through 4 as follows:

- the maximum length of semitrailers was increased from 14.65 metres (48 feet) to 16.2 metres (53 feet)
- the overall length limit applicable to double trailer combinations was increased from 23 metres (75 feet) to 25 metres (82 feet)

Amendment 3:

In June 1997 amendments to the standards contained in the MOU included the following:

Dimension Limits:

- the box length limit for truck-pony trailer and truck-full trailer configurations was increased to 20 metres.
- the maximum hitch offset was standardized for all configurations at 1.8 meters.
- the minimum wheelbase requirement for all semitrailers, pony trailers and full trailers was standardized at 6.25 m.
- the interaxle spacing between the axle(s) on the lead trailer and the converter dolly of A and C Train Doubles can be less than 3.0 m, but weight limit restrictions apply.
- the fifth wheel position on the lead trailer of a B Train must not be located more than 0.3 meters behind the center of the last axle on the lead semitrailer.

Weight Limits:

- the steering axle weight limit on straight trucks was increased to 7250 kg.
- weight limit caps on the second trailer of A and C train double trailer combinations were removed and replaced by the requirement that the weight of the tractor drive axles + the weight of the lead trailer axles must be greater than the weight of the second trailer.

Amendment 4:

In September 2004 additional amendments were made as follows:

- *A Train Double Trailer Combinations:* The box length limit was increased to 20 metres
- *B Train Double Trailer Combinations:* A kingpin setback limit of a maximum 2.0 m radius is applied to the second semitrailer.
- *Recreational Vehicles:* The Intercity Bus category was amended to include recreational vehicles, thereby allowing them to be up to 14 metres long

Amendment 5:

In April 2008 changes and additions were made as follows:

- *Use of Wide Base Single Tires:* For axles fitted with two single tires, each of which has a width of 445 mm or greater, the weight limits were increased to 7700 kg for Single Axles and 15,400 kg for Tandem Axle Groups.
- *Minimum Track Width for Trailer Axles Fitted with Single Tires:* The minimum track width for trailer axles fitted with single tires was reduced to 2.3 m for trailers built in 2007 or earlier (the minimum track width for all axles on trailers built in 2008 or later remains at 2.5 m).
- *Aerodynamic Devices on Rear of Trucks and Trailers:* Aerodynamic devices installed at the rear of trucks, trailers and semitrailers were excluded from measurement of overall length, trailer length, semitrailer length, box length and effective rear overhang (within specific dimensional limits outlined in the MOU)
- *Exclusions from Determination of Overall Width:* A clarification was added to exclude from measurements of overall width:
 - auxiliary equipment and/or devices not designed or used to carry cargo which do not extend more than 10 cm beyond each side of the vehicle, and
 - rear view mirrors which do not extend more than 30 cm beyond each side of the vehicle

Implications

Under the terms of the Memorandum of Understanding, each of the provinces and territories will permit vehicles which comply with the appropriate weights and dimensions described in the following section to travel on a designated system of highways in their jurisdiction.

It should be recognized that each jurisdiction continues to retain authority to allow more liberal weights and dimensions, or different types of vehicle configurations, for trucking operations within their jurisdiction. In addition, for trucking operations which take place between adjacent jurisdictions with compatible weight and dimension regulations which are more liberal than those specified in this document, the local regulations will prevail.

For further information on the Memorandum of Understanding, please contact the appropriate authority in each participating jurisdiction.

THE FEDERAL - PROVINCIAL - TERRITORIAL MEMORANDUM OF UNDERSTANDING ON INTERPROVINCIAL WEIGHTS AND DIMENSIONS

The Provincial and Territorial governments in Canada have authority over the weight and dimension limits which apply to the highways within their boundaries. The Memorandum of Understanding on Interprovincial Weights and Dimensions (MOU) is intended to provide improved uniformity in weight and dimension limits through establishment of minimum and/or maximum thresholds acceptable to all jurisdictions for eight configurations of vehicles commonly used in interprovincial transportation.

GENERAL CONDITIONS

1. It has all of the characteristics provided for below for the following eight categories:

Category 1:	Tractor Semitrailer
Category 2:	A Train Double
Category 3:	B Train Double
Category 4:	C Train Double
Category 5:	Straight Truck
Category 6:	Truck - Pony Trailer
Category 7:	Truck - Full Trailer
Category 8:	Intercity Bus and Recreational Vehicles

2. Its height, including load, does not exceed 4.15 metres

3. Its width, including load but excluding mirrors, lamps, and load covering or securing devices, does not exceed 2.6 metres

4. Its length, including load, does not exceed:

Category 1:	Tractor Semitrailer	23 metres
Category 2:	A Train Double	25 metres
Category 3:	B Train Double	25 metres
Category 4:	C Train Double	25 metres
Category 5:	Straight Truck	12.5 metres
Category 6:	Truck - Pony Trailer	23 metres
Category 7:	Truck - Full Trailer	23 metres
Category 8:	Intercity Bus and Recreational Vehicles	14 metres

5. Its Gross Combination Weight does not exceed:

Category 1:	Tractor Semitrailer	46 500 kg
Category 2:	A Train Double	53 500 kg
Category 3:	B Train Double	62 500 kg
Category 4:	C Train Double	58 500 kg
Category 5:	Straight Truck	24 250 kg
Category 6:	Truck - Pony Trailer	45 250 kg
Category 7:	Truck - Full Trailer	53 500 kg

Category 8: Intercity Bus and Recreational Vehicles 24 250 kg

6. Its axle weight does not exceed the weight limit stipulated for each axle type in its vehicle category, it being understood that the load shared between adjacent axles in a group must not vary by any more than 1000 kg.
7. Its axle weight does not exceed the lesser of the maximum rated capacity of any single component of the axle, suspension or braking system, the rated capacity of the tires, or 10 kg/mm of tire width (with a minimum tire width of 150 mm).
8. Each semitrailer has only one axle group consisting of either a single axle or a tandem or tridem group that will achieve equalized load sharing between axles in the group. This does not necessarily preclude the use of independently suspended axles or axle groups in the tandem or tridem categories, provided load equalization can be demonstrated.
9. Its axle weights and Gross Combination Weight do not exceed the limits stipulated for each axle and vehicle type, recognizing that jurisdictions will not have legislated or published tolerances concerning the enforcement of the local legislation.
10. Its axle weights, when an axle is fitted with two single tires, each of which has a width of 445 mm or greater, do not exceed 7700 kg for Single Axles and 15,400 kg for Tandem Axle Groups.

ADDITIONAL CONDITIONS AND RESTRICTIONS

The weight limits of several jurisdictions are also subject to seasonal restrictions, primarily during the spring thaw period. As the timing and nature of these restrictions vary by province, carriers should contact provincial authorities directly for specific details.

The use of liftable axles is discouraged or prohibited in a number of jurisdictions, primarily in western Canada.

The province of British Columbia requires that highway tractors use engines which meet a minimum ratio of gross weight to horsepower of 150 kg/hp. In addition, vehicle combinations with gross weights in excess of 38,000 kg must employ tractors with tandem drive axles.

INTERPRETATIONS AND CLARIFICATIONS

In July 1994 an additional section was added to the MOU to elaborate on, or clarify, specific provisions of the agreement, based on consensus reached through discussion by the participating jurisdictions. As issues or questions arise in the future, this section is expected to be expanded to include the consensus reached on each issue.

As of April 2008, six issues are addressed in this section:

1. **Dromedary Boxes on Tractors (July 1994):**

It is understood that all jurisdictions will permit load to be carried on tractors for vehicles which comply with the provisions applicable to Category 1 - Tractor Semitrailer.

2. **Category 3 - B Train Configurations (July 1994):**

It is understood that the provisions applicable to Category 3 - B Train Double do not preclude the use of a tridem axle configuration on the second semitrailer.

3. **All Categories - Vehicles Fitted with Lifiable Axles (June 1997):**

It is understood that vehicles which are fitted with liftable axles will be recognized as meeting the requirements of this Memorandum of Understanding provided that, *when the lift axles are raised, all other requirements are met.*

It is further understood that participating jurisdictions can chose to eliminate any liftable axles from the determination of axle and/or gross vehicle weight limits for a vehicle.

4. **All Categories - Aerodynamic Devices Fitted on Rear of Vehicles (April 2008):**

It is understood that aerodynamic devices installed at the rear of trucks, trailers and semitrailers shall not be included in the measurement of overall length, trailer length, semitrailer length, box length and effective rear overhang, provided:

- any portion of the device more than 1.9 metres above the ground does not protrude more than 0.61 metres beyond the rear of the vehicle, and
- any portion of the device within 1.9 metres of the ground does not protrude more than 0.305 metres beyond the rear of the vehicle, and
- the aerodynamic device is not designed or used to carry cargo.

It is further understood that vehicles fitted with aerodynamic devices must also comply with applicable CMVSS standards and provincial/territorial regulations regarding lighting and conspicuity.

5. **All Categories – Exclusions from Determination of Overall Width (April 2008):**

It is understood that auxiliary equipment and/or devices not designed or used to carry cargo which do not extend more than 10 cm beyond each side of the vehicle shall be excluded from measurements of overall width.

It is further understood that rear view mirrors which do not extend more than 30 cm beyond each side of the vehicle shall be excluded from measurements of overall width.

6. Minimum Track Width for Trailer Axles Fitted With Single Tires (April 2008):

It is understood that the minimum track width for trailer axles fitted with single tires must be no less than 2.3 m for trailers built in 2007 or earlier.

It is further understood that the minimum track width for all axles on trailers built in 2008 or later must be no less than 2.5 m.

EXCEPTIONS

As of April 2008, three exceptions are noted:

1. Northwest Territories - Weight Limit on Single Tires (April 2008):

The weight on a single tire (except on steering axles) cannot exceed 3000 kg.

2. New Brunswick

The weight on a single tire (except on steering axles) having a minimum width of 445 mm cannot exceed 3080 kg on highways rated as Class 3 - Gross Vehicle Weights up to 50,000kg and Class 4 - Gross Vehicle Weights up to 43,500 kg.

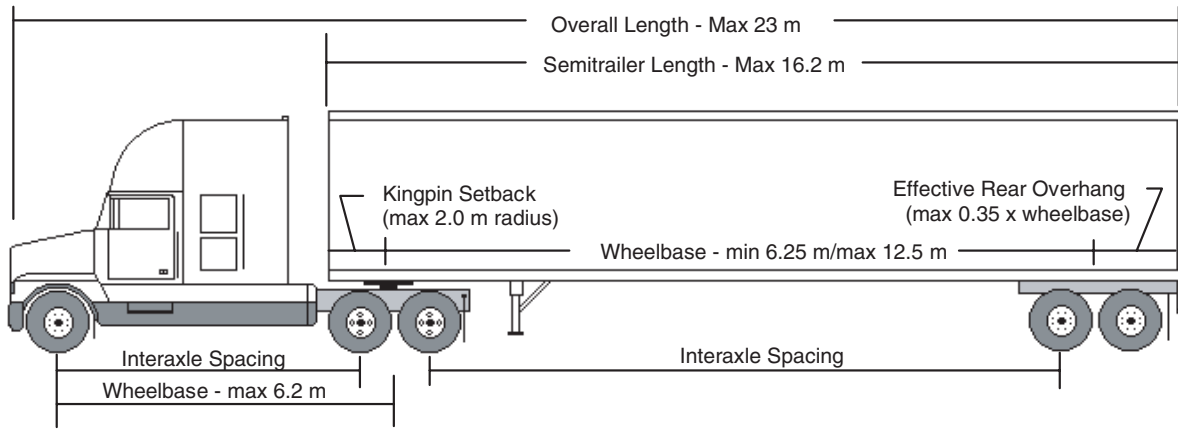
The weight on a single tire (except on steering axles) having a width of less than 445 mm cannot exceed 3000 kg on all New Brunswick highways

3. Newfoundland and Labrador - Weight Limit on Single Tires (April 2008):

The weight on a single tire (except on steering axles) cannot exceed 3000 kg on secondary roads within the designated route network.

CATEGORY 1: TRACTOR SEMITRAILER

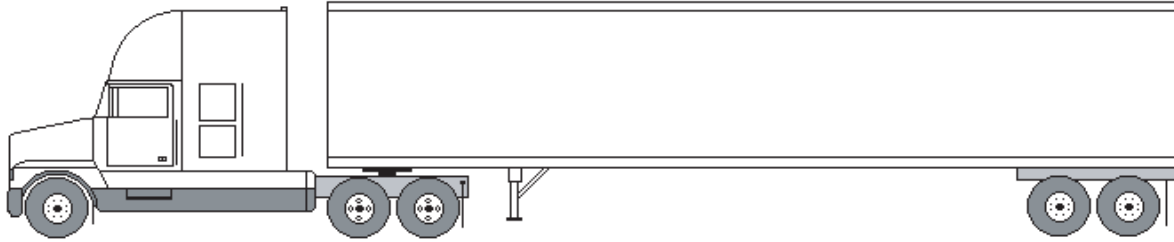
Part 1 - Dimension Limits



DIMENSION	LIMIT
Overall Length	Maximum 23 m
Overall Width	Maximum 2.6 m
Overall Height	Maximum 4.15 m
Tractor:	
Wheelbase	Maximum 6.2 m
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Semitrailer	
Length	Maximum 16.2 m
Wheelbase	
Single, Tandem or Tridem Axle Group	Minimum 6.25 m/Maximum 12.5 m
Kingpin Setback	Maximum 2.0 m radius
Effective Rear Overhang	Maximum 35% of wheelbase
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Tridem Axle Spread	Minimum 2.4 m/Maximum 3.7 m
Track Width	Minimum 2.5 m/Maximum 2.6 m
Interaxle Spacings	
Single Axle to Single, Tandem or Tridem Axle	Minimum 3.0 m
Tandem Axle to Tandem Axle	Minimum 5.0 m
Tandem Axle to Tridem Axle	Minimum 5.5 m

Category 1: Tractor Semitrailer

Part 2 - Weight Limits



Max 5500 kg

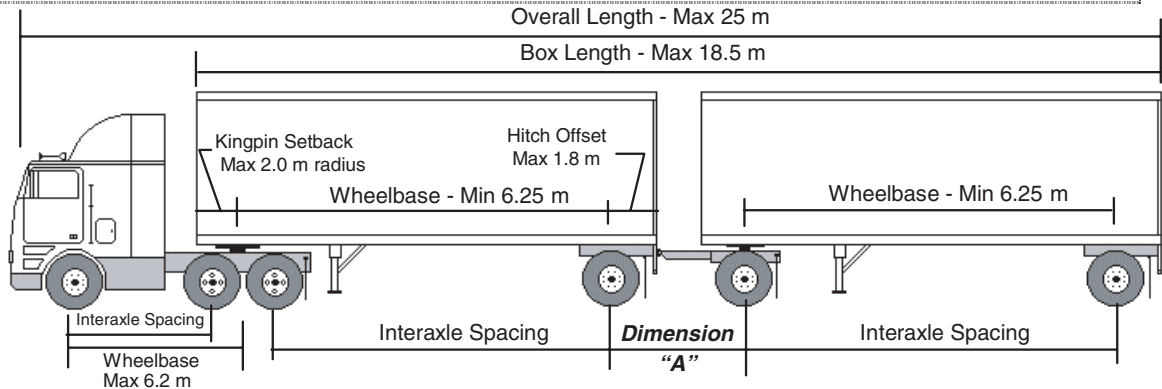
Single Axle - Max 9100 kg
Tandem Axle - Max 17 000 kg

Single Axle - Max 9100 kg
Tandem Axle - Max 17 000 kg
Tridem Axle - Spread:
2.4 m to < 3.0 m - Max 21 000 kg
3.0 m to < 3.6 m - Max 23 000 kg
3.6 m to 3.7 m - Max 24 000 kg

WEIGHT	LIMIT
Axle Weights:	
Steering Axle	Maximum 5500 kg
Single Axle (dual tires)	Maximum 9100 kg
Tandem Axle:	
Axle Spread 1.2 m - 1.85 m	Maximum 17 000 kg
Tridem Axle:	
Axle Spread 2.4 m - less than 3.0 m	Maximum 21 000 kg
Axle Spread 3.0 m - less than 3.6 m	Maximum 23 000 kg
Axle Spread 3.6 m - 3.7 m	Maximum 24 000 kg
Gross Vehicle Weight Limits	
Three Axles	Maximum 23 700 kg
Four Axles	Maximum 31 600 kg
Five Axles	Maximum 39 500 kg
Six Axles - with 2.4 to < 3.0 m spread tridem	Maximum 43 500 kg
with 3.0 m to < 3.6 m spread tridem	Maximum 45 500 kg
with 3.6 to 3.7 m spread tridem	Maximum 46 500 kg

CATEGORY 2: A TRAIN DOUBLE

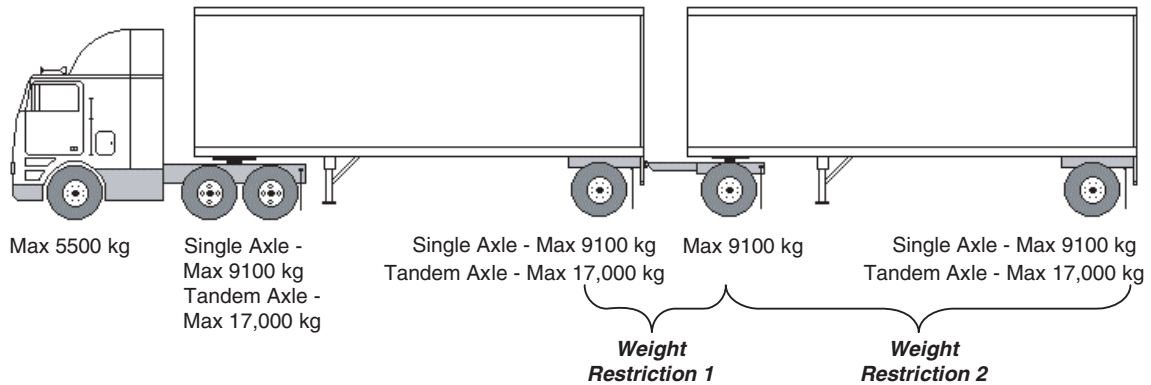
Part 1 - Dimension Limits



DIMENSION	LIMIT
Overall Length	Maximum 25 m
Overall Width	Maximum 2.6 m
Overall Height	Maximum 4.15 m
Box Length	Maximum 18.5 m
Tractor:	
Wheelbase	Maximum 6.2 m
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Lead Semitrailer	
Wheelbase	Minimum 6.25 m
Kingpin Setback	Maximum 2.0 m radius
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Hitch Offset	Maximum 1.8 m
Track Width	Minimum 2.5 m/Maximum 2.6 m
Second Semitrailer or Full Trailer	
Wheelbase	Minimum 6.25 m
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Track Width	Minimum 2.5 m/Maximum 2.6 m
Interaxle Spacings	
Single Axle to Single or Tandem Axle	Minimum 3.0 m
Tandem Axle to Tandem Axle	Minimum 5.0 m
Dimension "A" (from the centre of last axle on the lead semitrailer to the centre of the first axle on the converter dolly or second trailer)	Not controlled

Category 2: A Train Double

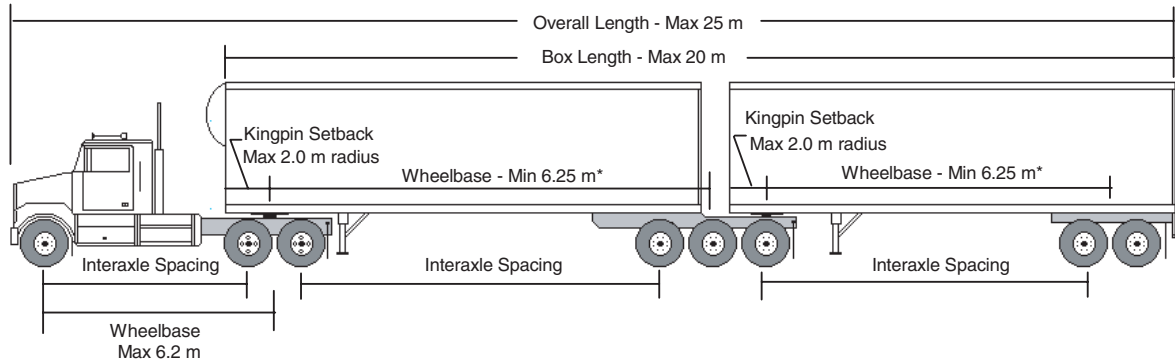
Part 2 - Weight Limits



WEIGHT	LIMIT
Axle Weight Limits:	
Steering Axle	Maximum 5500 kg
Single Axle (dual tires)	Maximum 9100 kg
Tandem Axle:	
Axle Spread 1.2 m - 1.85 m	Maximum 17 000 kg
Weight Restriction 1: Sum of Axle Weights of Lead Semitrailer Plus Weight of Converter Dolly Axle	If Dimension "A" is less than 3 metres, the weight of the axle(s) on the lead semitrailer plus the weight of the converter dolly axle(s) is limited to a maximum of 17,000 kg for a two axle group or a maximum of 23,000 kg for a three axle group.
Weight Restriction 2: Sum of Axle Weights of Full Trailer or Second Semitrailer	The weight of the second trailer must not exceed the weight of the tractor drive axle(s) plus the weight of the axle(s) on the first semitrailer.
Gross Vehicle Weight Limits:	
Five Axles	Maximum 41 900 kg
Six Axles	Maximum 49 800 kg
Seven Axles	Maximum 53 500 kg
Eight Axles	Maximum 53 500 kg

CATEGORY 3: B TRAIN DOUBLE

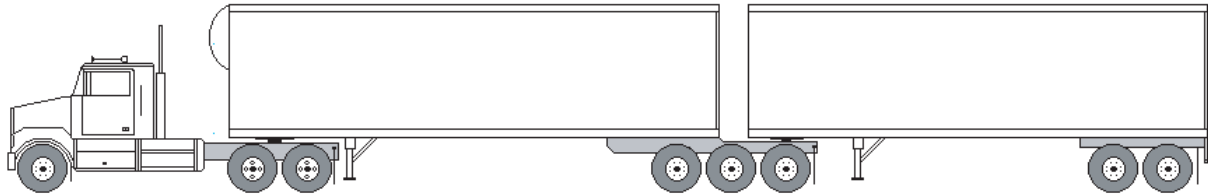
Part 1 - Dimension Limits



DIMENSION	LIMIT
Overall Length	Maximum 25 m
Overall Width	Maximum 2.6 m
Overall Height	Maximum 4.15 m
Box Length	Maximum 20.0 m
Tractor:	
Wheelbase	Maximum 6.2 m
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Lead Semitrailer	
Wheelbase	Minimum 6.25 m
Kingpin Setback	Maximum 2.0 m radius
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Tridem Axle Spread	Minimum 2.4 m/Maximum 3.1 m
Track Width	Minimum 2.5 m/Maximum 2.6 m
Fifth Wheel Position	No more than 0.3 m behind the center of the rearmost axle on the semitrailer
Second Semitrailer	
Wheelbase	Minimum 6.25 m
Kingpin Setback	Maximum 2.0 m radius
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Tridem Axle Spread	Minimum 2.4 m/Maximum 3.1 m
Track Width	Minimum 2.5 m/Maximum 2.6 m
* Sum of Semitrailer Wheelbases	Maximum 17.0 m
Interaxle Spacings	
Single Axle to Single or Tandem Axle	Minimum 3.0 m
Tandem Axle to Tandem Axle	Minimum 5.0 m
Tandem Axle to Tridem Axle	Minimum 5.5 m
Tridem Axle to Tridem Axle	Minimum 6.0 m

Category 3: B Train Double

Part 2 - Weight Limits



Max 5500 kg

Single Axle -
Max 9100 kg
Tandem Axle -
Max 17 000 kg

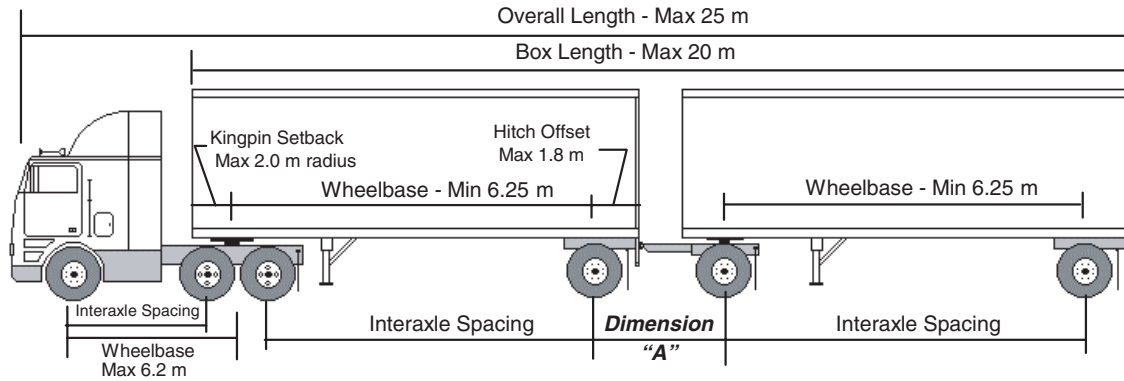
Tandem Axle - Max 17,000 kg
Tridem Axle:
Spread 2.4 to < 3.0 m: Max 21 000 kg
Spread 3.0 to 3.1 m: Max 23 000 kg

Single Axle -
Max 9100 kg
Tandem Axle -
Max 17 000 kg

WEIGHT	LIMIT
Axle Weight Limits:	
Steering Axle	Maximum 5500 kg
Single Axle (dual tires)	Maximum 9100 kg
Tandem Axle:	
Axle Spread 1.2 m - 1.85 m	Maximum 17 000 kg
Tridem Axle:	
Axle Spread 2.4 m to less than 3.0 m	Maximum 21 000 kg
Axle Spread 3.0 m to 3.1 m	Maximum 23 000 kg
Gross Vehicle Weight Limits:	
Five Axles	Maximum 40 700 kg
Six Axles	Maximum 48 600 kg
Seven Axles	Maximum 56 500 kg
Eight Axles	Maximum 62 500 kg

CATEGORY 4: C TRAIN DOUBLE

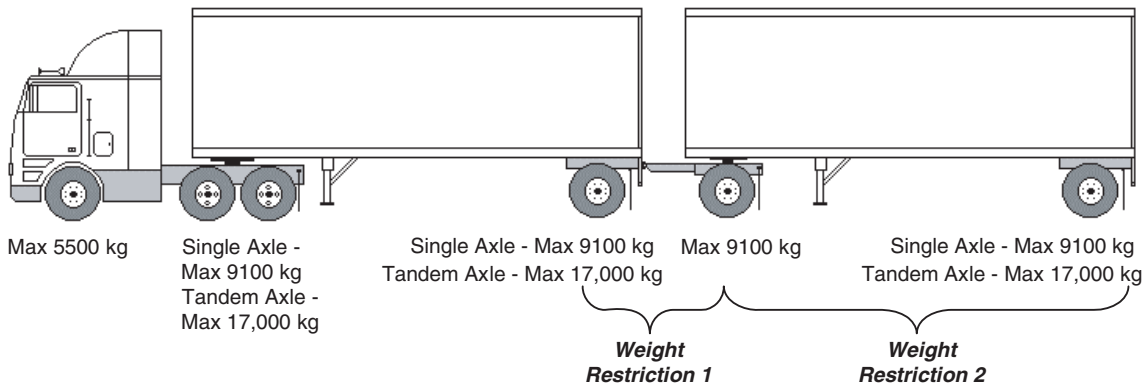
Part 1 - Dimension Limits



DIMENSION	LIMIT
Overall Length	Maximum 25 m
Overall Width	Maximum 2.6 m
Overall Height	Maximum 4.15 m
Box Length	Maximum 20.0 m
Tractor:	
Wheelbase	Maximum 6.2 m
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Lead Semitrailer	
Wheelbase	Minimum 6.25 m
Kingpin Setback	Maximum 2.0 m radius
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Hitch Offset	Maximum 1.8 m
Track Width	Minimum 2.5 m/Maximum 2.6 m
Second Semitrailer or Full Trailer	
Wheelbase	Minimum 6.25 m
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Track Width	Minimum 2.5 m/Maximum 2.6 m
C Dolly Drawbar Length	Maximum 2.0 m
Interaxle Spacings	
Single Axle to Single Axle	Minimum 3.0 m
Single Axle to Tandem Axle	Minimum 3.0 m
Tandem Axle to Tandem Axle	Minimum 5.0 m
Dimension "A" (from the center of last axle on the lead semitrailer to center of the first axle on the converter dolly or second trailer)	Not controlled

Category 4: C Train Double

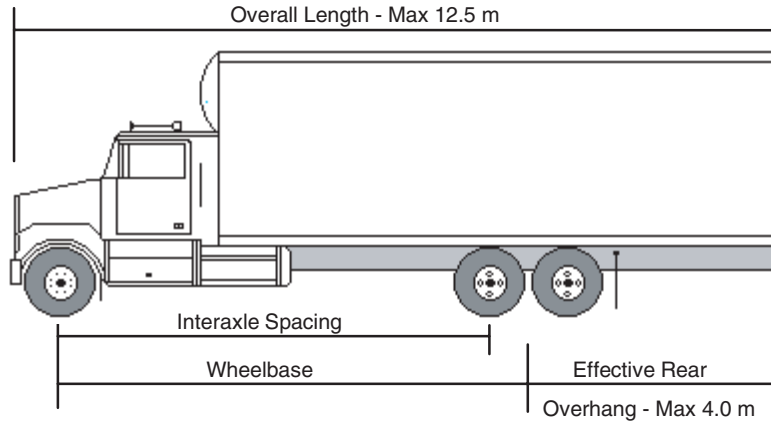
Part 2 - Weight Limits



WEIGHT	LIMIT
Axle Weight Limits:	
Steering Axle	Maximum 5500 kg
Single Axle (dual tires)	Maximum 9100 kg
Tandem Axle:	
Axle Spread 1.2 m - 1.85 m	Maximum 17 000 kg
Weight Restriction 1: Sum of Axle Weights of Lead Semitrailer Plus Weight of Converter Dolly Axle	If Dimension "A" is less than 3 metres, the weight of the axle(s) on the lead semitrailer plus the weight of the converter dolly axle(s) is limited to a maximum of 17,000 kg for a two axle group or a maximum of 23,000 kg for a three axle group.
Weight Restriction 2: Sum of Axle Weights of Full Trailer or Second Semitrailer	The weight of the second trailer must not exceed the weight of the tractor drive axle(s) plus the weight of the axle(s) on the first semitrailer.
Gross Vehicle Weight Limits:	
Five Axles	Maximum 41 900 kg
Six Axles	Maximum 49 800 kg
Seven Axles	Maximum 54 600 kg
Eight Axles	Maximum 58 500 kg

CATEGORY 5: STRAIGHT TRUCK

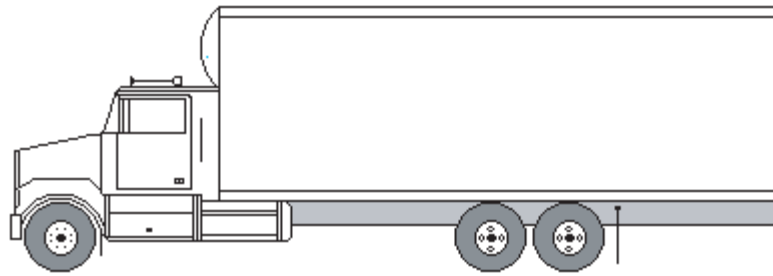
Part 1 - Dimension Limits



DIMENSION	LIMIT
Overall Length	Maximum 12.5 m
Overall Width	Maximum 2.6 m
Overall Height	Maximum 4.15 m
Box Length	Not Controlled
Wheelbase	Not controlled
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Effective Rear Overhang	Maximum 4.0 m
Interaxle Spacings	
Single Axle to Single or Tandem Axle	Minimum 3.0 m

Category 5: Straight Truck

Part 2 - Weight Limits



Max 7250 kg

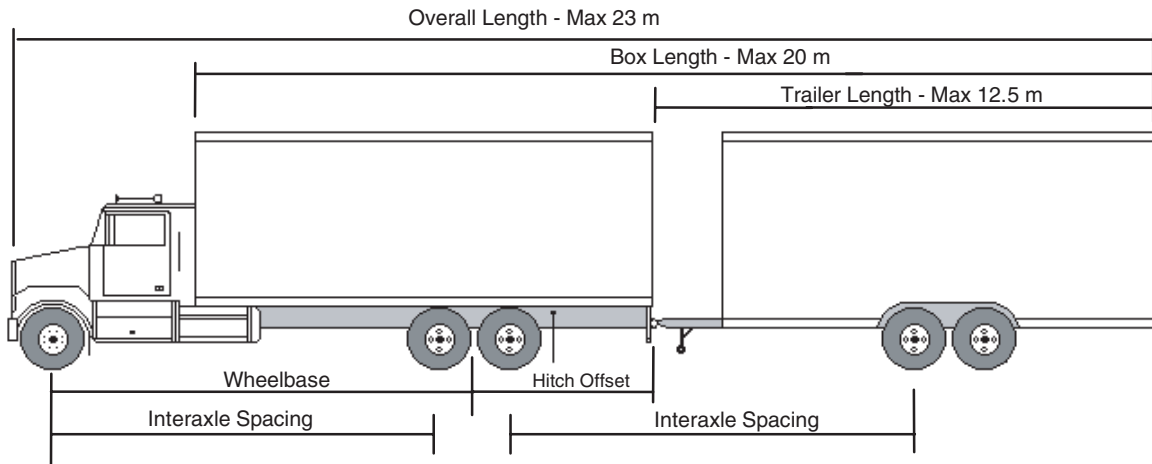
Single Axle - Max 9100 kg

Tandem Axle - Max 17,000 kg

WEIGHT	LIMIT
Axle Weights:	
Steering Axle	Maximum 7250 kg
Single Axle (dual tires)	Maximum 9100 kg
Tandem Axle:	
Axle Spread 1.2 m - 1.85 m	Maximum 17 000 kg
Gross Vehicle Weight Limits:	
Two Axles	Maximum 16 350 kg
Three Axles	Maximum 24 250 kg

CATEGORY 6: TRUCK - PONY TRAILER COMBINATION

Part 1 - Dimension Limits

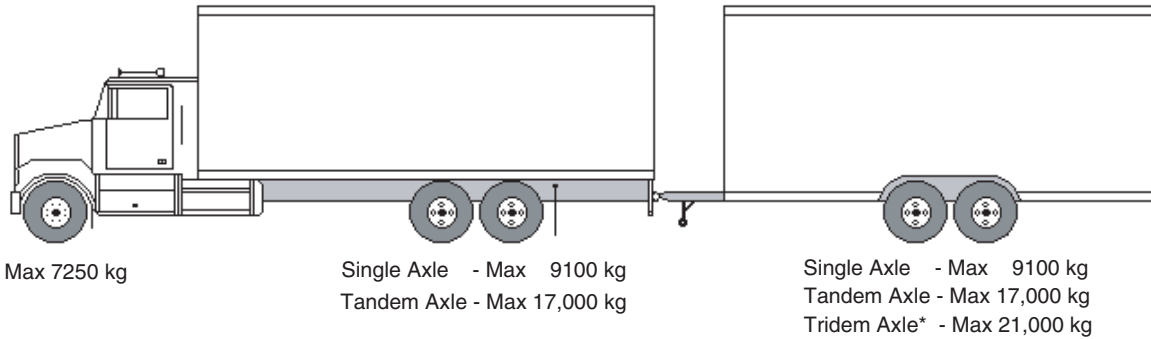


DIMENSION	LIMIT
Overall Length	Maximum 23 m
Overall Width	Maximum 2.6 m
Overall Height	Maximum 4.15 m
Box Length	Maximum 20 m
Truck:	
Length	Maximum 12.5 m
Wheelbase	Not controlled
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Effective Rear Overhang	Maximum 4.0 m
Hitch Offset	Maximum 1.8 m
Pony Trailer*	
Length	Maximum 12.5 m
Wheelbase	Minimum 6.25 m
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Tridem Axle Spread	Minimum 2.4 m/Maximum 2.5 m
Track Width	Minimum 2.5 m/Maximum 2.6 m
Effective Rear Overhang	Maximum 4.0 m
Interaxle Spacings	
Single Axle to Single, Tandem or Tridem Axle	Minimum 3.0 m
Tandem Axle to Tandem Axle	Minimum 5.0 m
Tandem Axle to Tridem Axle	Minimum 5.5 m

* Limits not applicable to pony trailers with Gross Vehicle Weight Rating of less than 10 000 kg.

Category 6: Truck - Pony Trailer Combination

Part 2 - Weight Limits

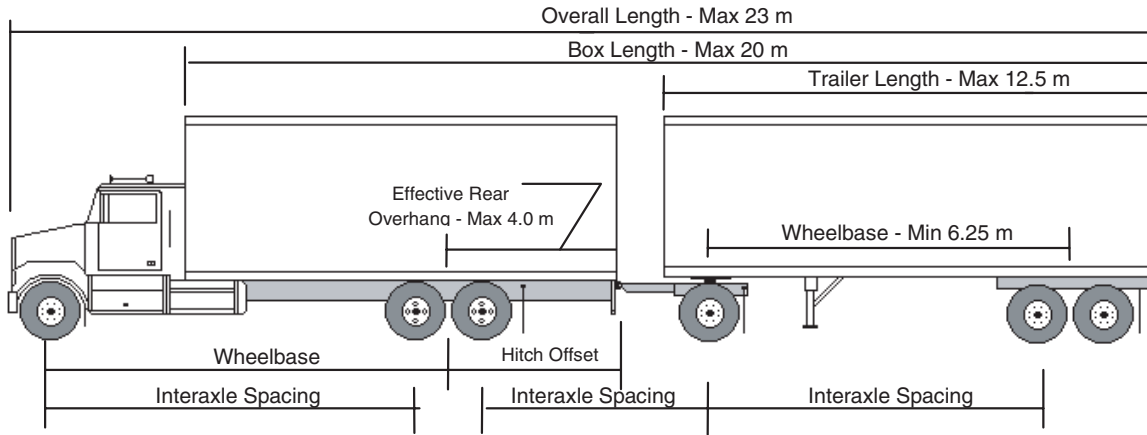


Note: The maximum spread permitted for a tridem axle group on a pony trailer is 2.5 m.

WEIGHTS	LIMITS
Axle Weight Limits:	
Steering Axle	Maximum 7250 kg
Single Axle (dual tires)	Maximum 9100 kg
Tandem Axle:	
Axle Spread 1.2 m - 1.85 m	Maximum 17 000 kg
Tridem Axle:	
Axle Spread 2.4 m - 2.5 m	Maximum 21 000 kg
Gross Vehicle Weight Limits:	
Three Axles	Maximum 25 450 kg
Four Axles	Maximum 33 350 kg
Five Axles	Maximum 41 250 kg
Six Axles	Maximum 45 250 kg

CATEGORY 7: TRUCK - FULL TRAILER COMBINATION

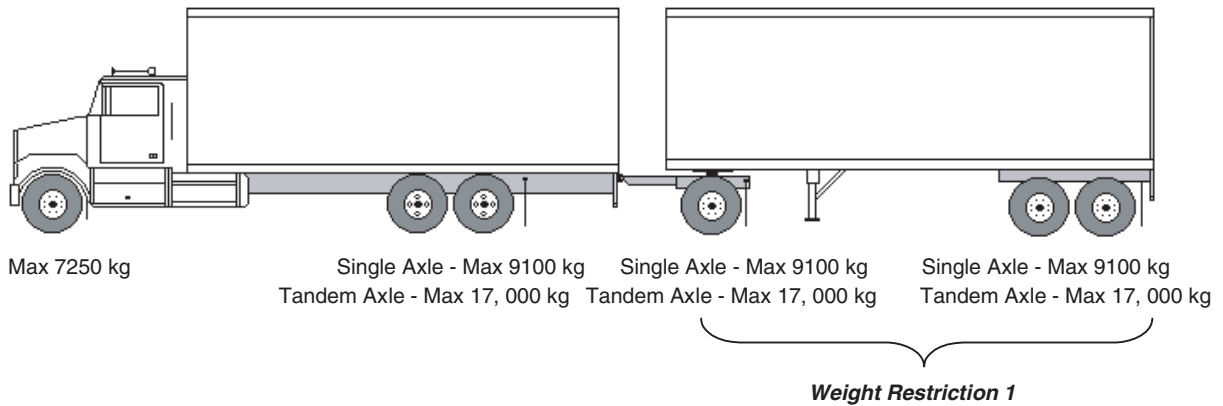
Part 1 - Dimension Limits



DIMENSION	LIMIT
Overall Length	Maximum 23 m
Overall Width	Maximum 2.6 m
Overall Height	Maximum 4.15 m
Box Length	Maximum 20 m
Truck:	
Length	Maximum 12.5 m
Wheelbase	Not controlled
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Effective Rear Overhang	Maximum 4.0 m
Hitch Offset	Maximum 1.8 m
Full Trailer	
Length	Maximum 12.5 m
Wheelbase	Minimum 6.25 m
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Track Width	Minimum 2.5 m/Maximum 2.6 m
Converter Dolly	The use of a double drawbar or C Dolly is not permitted on this combination
Interaxle Spacings	
Single Axle to Single or Tandem Axle	Minimum 3.0 m
Tandem Axle to Tandem Axle	Minimum 5.0 m

Category 7: Truck - Full Trailer Combination

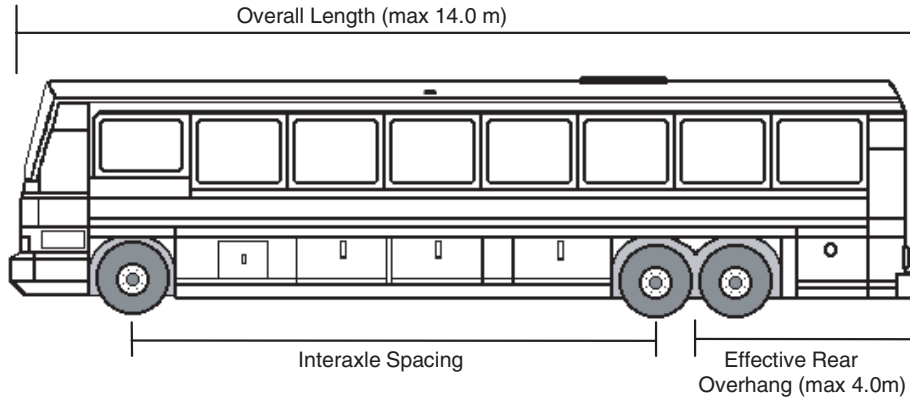
Part 2 - Weight Limits



WEIGHT	LIMIT
Axle Weight Limits:	
Steering Axle	Maximum 7250 kg
Single Axle (dual tires)	Maximum 9100 kg
Tandem Axle:	
Axle Spread 1.2 m - 1.85 m	Maximum 17 000 kg
Weight Restriction 1:	
Sum of Axle Weights of Full Trailer	
4 Axle Truck-Trailer Combination	Maximum 17 000 kg
5 Axle Truck-Trailer Combination	Maximum 17 000 kg
6 Axle Truck-Trailer Combination	Maximum 24 000 kg
7 Axle Truck-Trailer Combination	Maximum 31 000 kg
Gross Vehicle Weight Limits:	
Four Axles	Maximum 33 350 kg
Five Axles	Maximum 41 250 kg
Six Axles	Maximum 48 250 kg
Seven Axles	Maximum 53 500 kg

CATEGORY 8: INTERCITY BUS AND RECREATIONAL VEHICLES

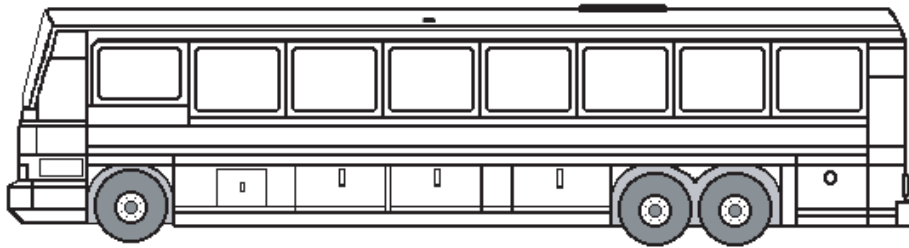
Part 1 - Dimension Limits



DIMENSION	LIMIT
Overall Length	Maximum 14.0 m
Overall Width	Maximum 2.6 m
Overall Height	Maximum 4.15 m
Wheelbase	Not controlled
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Effective Rear Overhang	Maximum 4.0 m
Axle Requirements:	
Overall length 12.5 m or less	Not controlled
Overall length greater than 12.5 m	Minimum 3 axles

Category 8: Intercity Bus and Recreational Vehicles

Part 2 - Weight Limits



Max 7250 kg

Single Axle (single tires) - Max 6067 kg
 Single Axle (dual tires) - Max 9100 kg
 Tandem Axle - Max 17000 kg

WEIGHT	LIMIT
Axle Weights:	
Steering Axle	Maximum 7250 kg
Single Axle (dual tires)	Maximum 9100 kg*
Single Axle (single tires)	Maximum 6067 kg*
Tandem Axle	Maximum 17 000 kg*
Gross Vehicle Weight Limits:	
Two axles	Maximum 16 350 kg
Three axles (8 tires)	Maximum 20 900 kg
Three axles (10 tires)	Maximum 24 250 kg

Note (*) - When there is more than one axle at the rear of the vehicle, the load carried by the group must be distributed between axles in a ratio corresponding to the number of tires on each axle.

DESIGNATED HIGHWAY SYSTEMS

YUKON

Yukon's designated highway system includes:

- Highway 1, Alaska Highway
- Highway 2, Klondike Highway
- Highway 3, Haines Road
- Highway 4, Robert Campbell Highway
- Highway 5, Dempster Highway
- Highway 7, Atlin Road
- Highway 8, Tagish Road Km 0-2 only
- Highway 9, Top of the World Highway
- Highway 11, Silver Trail
- Highway 15, Mitchell Road
- Highway 37, Stewart Cassiar Highway

BRITISH COLUMBIA

British Columbia's designated highway system includes:

- a. highways in unorganized territory, and
- b. arterial highways as designated by authority of Section 45 of the Transportation Act.

The Motor Vehicle Act and Commercial Transport Act defines highway as:

“highway includes every highway within the meaning of the Highway Act, and every road, street, lane or right of way designed for or used by the general public for the passages of vehicles, and every private place or passageway to which the public, for the purpose of parking or servicing of vehicles, has access or is invited.”

ALBERTA

Alberta's designated highway system includes numbered highways from 1 to 99 and 500 to 999.

MANITOBA

Manitoba's designated highway system includes routes classified as “RTAC Routes” and RTAC routes designated under permit.

ONTARIO

Ontario's designated highway system includes all of the King's Highways but excludes secondary roads.

QUÉBEC

Québec's designated highway system includes all public highways but excludes bridges with limited capacity and certain roads which have a limited Gross Vehicle Weight of 59,000 kg.

NEW BRUNSWICK:

New Brunswick's designated highway system includes all public highways. However there are four classes of highways within this system, with Gross Vehicle Weight limits as follows:

Class 1 - Gross Vehicle Weights up to 62,500 kg

Class 2 - Gross Vehicle Weights up to 56,500 kg

Class 3 - Gross Vehicle Weights up to 50,000 kg

Class 4 - Gross Vehicle Weights up to 43,500 kg

The overall length limit is 25 meters on all classes of highways.

NOVA SCOTIA

Nova Scotia's designated highway system includes:

Primary Highway System:

Available to all tractor semitrailer and B Train double trailer combinations.

Secondary Highway System:

Restricted to vehicles with a Gross Vehicle Weight of 41,500 kg or less.

B Train Double trailer combination Network:

Subject to special designation; includes the primary highway system plus additional routes identified from within the secondary network. Carriers may request access to sections of the secondary highway system and approval may be granted if traffic and bridge capacity criteria are met.

PRINCE EDWARD ISLAND

Prince Edward Island's designated highway system includes:

- all public highways for tractor semitrailer configurations
- all highways with paved shoulders for A, B and C Train double trailer combinations

NEWFOUNDLAND AND LABRADOR

Newfoundland and Labrador's designated highway system includes all primary and secondary roads, except those that are otherwise posted.

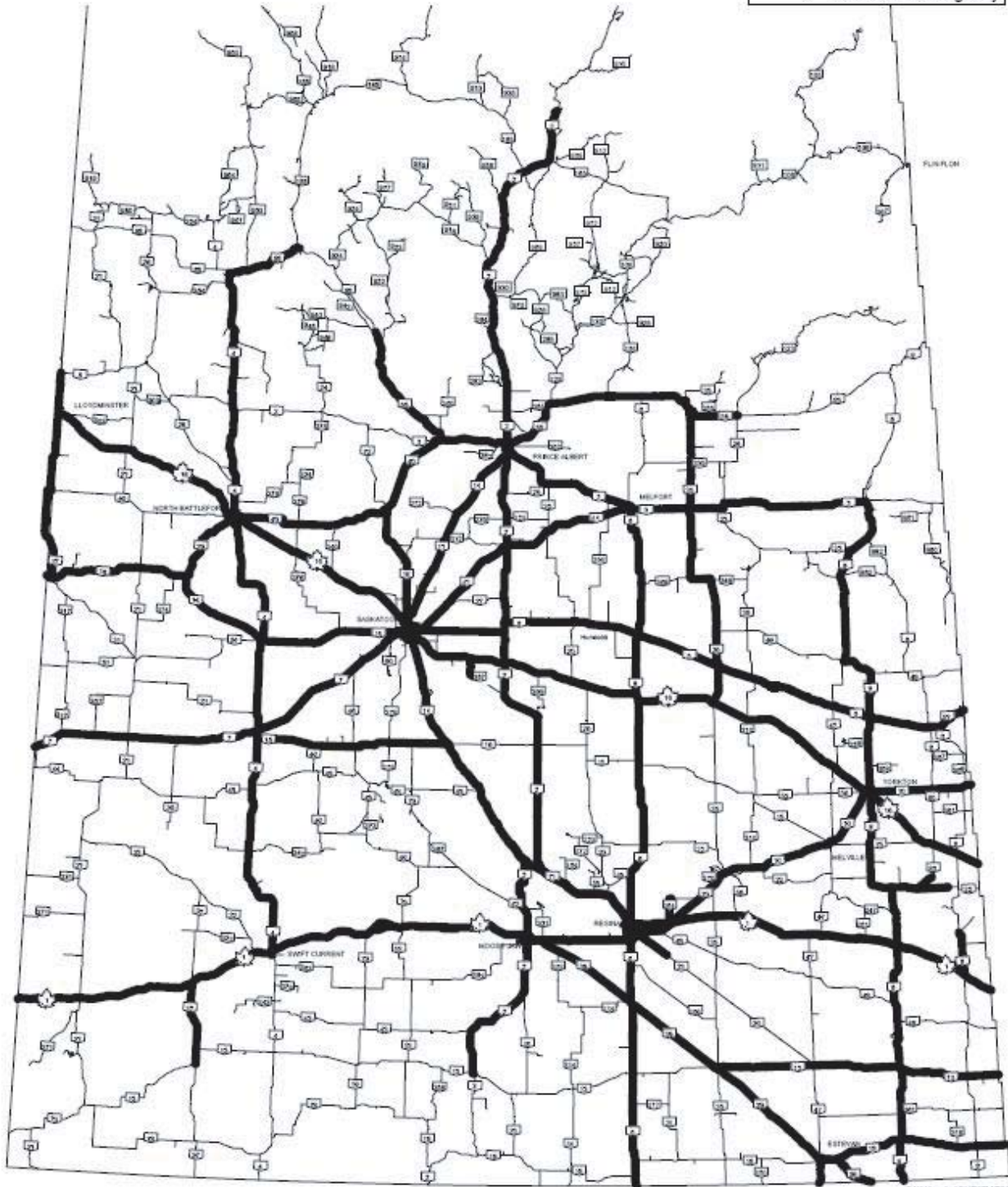
SASKATCHEWAN



Saskatchewan Primary Weight Highway

Legend

- Primary Weight Highway
- Saskatchewan Highway

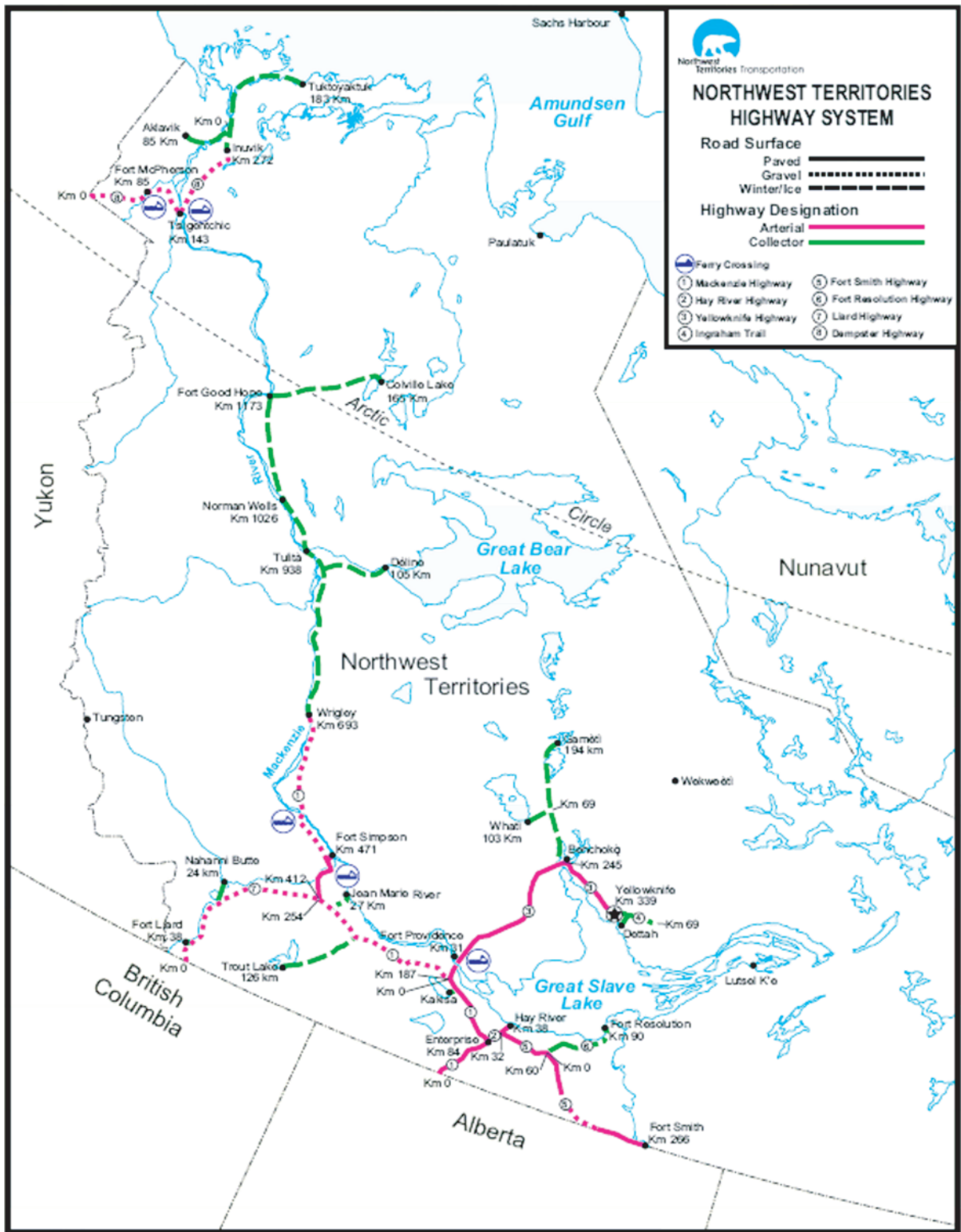


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NORTHWEST TERRITORIES

The Northwest Territories' designated highway system includes: arterial class, collector class and local classes of roads and highways in accordance with the NWT Public Highway Act. A summary of the system and map are included. The system does have seasonal restrictions and limited capacity on some routes.

CLASS	HIGHWAY (NAME/No.)	RESTRICTIONS/NOTES
ARTERIAL	Mackenzie Highway No.1 – km 0 to km 687 Hay River Highway No. 2 – km 0 to 48.6 Yellowknife Highway No. 3 – km 0 to km 338.8 Yellowknife Highway No. 3 Winter Detour Road – 12.5 km Fort Smith Highway No. 5 – km 0 to km 266 Liard Highway No. 7 – km 0 to km 254.1 Dempster Highway No. 8 – km 0 to km 272.5 [map attached]	Seasonal Weight restrictions (75%) in effect on selected Highways (or Highway sections) as required. Ferry Restrictions (seasonal) due to weight, water levels and ice conditions and must be followed. Winter /Ice Road weight restrictions apply (seasonal) and must be followed. Enhanced Visibility Highways include only the Hwy 1 and 3 Route from the Alberta border to Yellowknife and Hwy 2 Call ahead to the permit issuing office for specific details.
COLLECTOR	Ingraham Trail Highway No. 4 – km 0 to km 69.2 Fort Resolution Highway No. 6 – km 0 to km 90.0 Dettah Road – km 0 to km 11.3 Dettah Ice Road – 6.3 km Aklavik Ice Road – 86 km Colville Lake Winter Road – 165 km Deline Ice Road – 105.3 km Inuvik-Tuktoyaktuk Ice Road – 194 km Mackenzie Valley Winter Road – 486.4 km Nahanni Butte Winter Road – 22.3 km Trout Lake Winter Road – 126 km Whati Winter Road – 105 km Gameti Ice Road – 138 km Various Community Access Roads [map attached]	Seasonal Weight restrictions (75%) in effect on selected Highways (or Highway sections) as required. Winter /Ice Road weight restrictions apply (seasonal) and must be followed. Call ahead to permit issuing office for specific details.
LOCAL	Kakisa Access Road – 12.9 km Salt River Access Road – 15.5 km Vee Lake Road – 5.1 km Various Local Roads [map attached]	As per the NWT Public Highways Act



APPENDIX B

Truck Size and Weight Limits of the Provinces and Territories

Table B1: Tractor Semitrailer Dimension Limits by Province and Territory

Summary of Provincial/Territorial Dimension Limits - TT + SemiTrailer													
Metres	MOU	BC	ALTA	SASK	MAN	ONT	QUE	NB	NS	PEI	NFLD	Yukon	NWT
Overall Width	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
Overall Height	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15
Overall Length	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Box Length (max)	16.20	16.20	16.20	16.20	16.20								
Truck Tractor													
Interaxle spacing (min)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	
Wheelbase (max)	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20
Tandem Axle Spread (max)	1.85	1.85	1.85	1.85	1.85	1.85	nc	1.85	1.85	1.85	1.85	1.85	1.85
Tridem axle spread (min)		2.40				2.40							
Tridem axle spread (max)		2.80				2.80							
Front Overhang (max)										1.00			
Semi-trailer													
Length (max)	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20
Wheelbase (min)	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25	
Wheelbase (max)	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50
Kingpin Setback	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Effective Rear Overhang (max)	35% wb	35% wb	35% wb	35% wb	35% wb	35% wb	35% wb	35% wb	35% wb	35% wb	35% wb	35% wb	35% wb
Tandem Axle Spread (max)	1.85	1.85	1.85	1.85		3.10	nc	p2	>1.85	1.85	1.85	1.85	1.85
Tridem Axle Spread (max)	3.70	3.70	3.70	3.70		3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70
Triaxle Spread (max)						5.80		4.80	4.80				
Track Width (max) restricted to 2.5m (min)	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
End-Dump Semi-trailer Bed Length (max)						14.65	14.65						
Inter-vehicle unit distance (min)						Varies	Varies						
Rear Overhang (max)										2.00			
Interaxle Spacings													
Single Axle to Single, Tandem or Tridem Axle (min)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Tandem Axle to Tandem Axle (min)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Tandem Axle to Tridem Axle or Triaxle (min)	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50
Tridem Axle to Tridem Axle or Triaxle (min)		6.00				6.00							

Note: MOU = Memorandum of Understanding, BC = British Columbia, ALTA = Alberta, SASK = Saskatchewan, MAN = Manitoba, ONT = Ontario, QUE = Québec, NB = New Brunswick, NS = Nova Scotia, PEI = Prince Edward Island, NFLD = Newfoundland and Labrador, NWT = Northwest Territories, nc = not controlled, and wb = wheelbase.

Table B2: Tractor Semitrailer Weight Limits by Province and Territory

Summary of Provincial/Territorial Weight Limits													
Kilograms	MOU	BC	ALTA	SASK	MAN	ONT	QUE	NB	NS	PEI	NFLD	Yukon	NWT
Axle Mass Limits													
Steering Axle	5,500	5,500	5,500	5,500	5,500	7,700	9,000	5,500	5,500	5,500	5,500	5,500	5,500
Single Axle (4 tires per axle)	9,100	9,100	9,100	9,100	9,100	10,000	10,000	9,100	9,100	9,100	9,100	10,000	10,000
Tandem Axle													
Axle Spread < 1.2m								9,100					
Axle spread 1.2 to 1.85m	17,000	17,000	17,000	17,000			18,000	18,000	18,000	18,000	18,000		
Axle spread 1.2 to 1.6m					17,000	18,000						17,900	17,900
Axle spread 1.6 to 1.7m						18,300						18,300	18,300
Axle spread 1.7 to 1.8m						18,700						18,300	18,300
Axle spread > 1.8m												19,100	
Axle Spread >1.85m							9,100	9,100	9,100				
Axle spread 1.8 to 3.1m						19,100							19,100
Tridem Axle													
Axle Spread < 2.4m		21,000		21,000				18,000					
Axle Spread 2.4 to 3.0m	21,000	24,000	21,000	24,000	21,000		21,000	21,000	21,000	21,000	21,000	24,000	24,000
Axle Spread 2.4 to 2.8m						21,300						24,000	24,000
Axle Spread 2.8 to 2.9m						21,700						24,000	24,000
Axle Spread 2.9 to 3.0m						22,000						24,000	24,000
Axle Spread 3.0 to 3.6m	23,000	24,000	24,000	24,000	23,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000
Axle Spread 3.6 to 3.7m	24,000	24,000	24,000	24,000	24,000	26,000	26,000	26,000	26,000	26,000	26,000	24,000	24,000
Axle Spread > 3.7m							18,000	18,000	18,000				
Tridem drive axle 2.4 to 2.7 m						21,300							
Tridem drive axle 2.7 to 2.8 m						22,000							
Triaxle													
Axle Spread 2.4 to 4.9m						18,000	18,000	18,000	18,000				
Self-steer tri-axle													
Single tire on self-steer axle (2.5 - 3.0 m + > 1.8 m tandem)						24,000							
Dual tires on self-steer axle (2.5 - 3.0 m + > 1.8 m tandem)						28,650							
Self-steer quad													
2.5 - 3.0 m + 3.0 - 3.6 m tridem						32,000	32,000						
2.5 - 3.0 m + > 3.6 m tridem						34,000	32,000						
5-axle group													
131						37,500							
113						37,500							
5-axle group													
141						39,000							
114						39,000							
GVM Limits													
3 Axles	23,700	23,700	23,700	23,700	23,700	25,500	25,500	23,700	23,700	23,700	23,700	25,500	25,500
4 Axles	31,600	31,600	31,600	31,600	31,600	33,500	33,500	32,600	32,600	32,600	32,600	34,600	34,600
5 Axles	39,500	39,500	39,500	39,500	39,500	42,600	41,500	41,500		41,500	41,500	43,700	
5 Axles - Tandem Spread									41,500				43,700
5 Axles - Tridem Spread									40,600				43,700
5 Axles - Triaxle Spread									32,600				43,700
6 Axles		46,500										48,600	
6 Axles on Tridem or Tridem Equivalent Axle													48,600
Axle Spread 2.4 to 3.0m	43,500		43,500	43,500	43,500	44,800	44,500	44,500	44,500	44,500	44,500		
Axle Spread 3.0 to 3.6m	45,500		46,500	44,500	44,500	27,500	47,500	47,500	47,500	47,500	47,500		
Axle Spread 3.6 to 3.7m	46,500		46,500	46,500	46,500	49,500	49,500	49,500	49,500	49,500	49,500		
Axle Spread > 3.7m								41,500	41,500				
Six Axles on Triaxle						52,150	41,500	41,500	41,500				48,600
7 axles, narrow self-steer quad (with 3.05 m tridem)						55,500	55,500						
7 axles, wide self-steer quad (with 3.66 m tridem)						57,500	55,500						
8 axles (131 or 113)						61,000							
9-axles (141 or 114)						61,800							

Table B5: B-Train Dimensions Limits by Province and Territory

Summary of Provincial/Territorial Dimension Limits - B Train Double													
Metres	MOU	BC	ALTA	SASK	MAN	ONT	QUE	NB	NS	PEI	NFLD	Yukon	NWT
Overall Width	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
Overall Height	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15
Overall Length	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Box Length	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Truck Tractor													
Wheelbase (max)	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20
Tandem Axle Spread (max)	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85
Inter-axle spacing (min)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00		
Front Overhang (max)										1.00			
Lead Semi-trailer													
Wheelbase (min)	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25
Kingpin Setback	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Tandem Axle Spread (max)	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85
Tridem Axle Spread (max)	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10
Track Width (max) restricted to 2.5m (min)	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
Effective Rear Overhang (max)					35% wb								
Fifth wheel setting behind last axle (max)	0.30	0.30		0.30	0.30	0.30		0.30	0.30	0.30	0.30		
Second Semi-trailer of Full Trailer													
Wheelbase (min)	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25
Kingpin setback (max)	2.00		2.00			2.00			2.00				
Tandem Axle Spread (max)	1.85	1.85	1.85	1.85	1.85	1.85	1.85	p2	1.85	1.85	1.85	1.85	1.85
Tridem Axle Spread (max)	3.10	3.10	3.10	3.10		3.10	3.10	p2	3.10	3.10	3.10	3.10	3.10
Track Width (max) restricted to 2.5m (min)	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
Rear Overhang (max)										2.00			
Sum of Semi-trailer Wheelbases (max)	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00
Interaxle Spacings													
Single Axle to Single or Tandem Axle (min)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Tandem Axle to Tandem Axle (min)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Tandem Axle to Tridem Axle (min)	5.50	5.50	5.50	5.50	5.50	5.50		5.50	5.50	5.50	5.50	5.50	5.50
Tridem to Tridem Axle (min)	6.00	5.50	5.50	5.50		6.00						6.00	6.00

Table B6: B-Train Weight Limits by Province and Territory
Summary of Provincial/Territorial Weight Limits

Kilograms	MOU	BC	ALTA	SASK	MAN	ONT	QUE	NB	NS	PEI	NFLD	Yukon	NWT
Axle Mass Limits													
Steering Axle	5,500	5,500	5,500	5,500	5,500	7,700	5,500	5,500	5,500	5,500	5,500	5,500	5,500
Single Axle (4 tires per axle)	9,100	9,100	9,100	9,100	9,100	10,000	10,000	9,100	9,100	9,100	9,100	10,000	10,000
Tandem Axle													
Axle Spread < 1.2m		17,000		17,000			9,100	9,100					
Axle Spread 1.2 to 1.6m												17,900	
Axle spread 1.2 to 1.85m	17,000	17,000	17,000	17,000	17,000		18,000	18,000	18,000	18,000	18,000		
Axle Spread 1.6 to 1.8m												18,300	
Axle Spread > 1.8m												19,100	
Axle Spread >1.85m		17,000		17,000			9,100	9,100					19,100
Tridem Axle													
Axle Spread < 2.4m							18,000	18,000					
Axle Spread 2.4 to 3.0m	21,000	21,000	21,000	21,000	21,000		21,000	21,000	21,000	21,000	21,000	24,000	24,000
Axle Spread 2.4 to 2.8m						21,300						24,000	24,000
Axle Spread 2.8 to 2.9m						21,700						24,000	24,000
Axle Spread 2.9 to 3.0m						22,000						24,000	24,000
Axle Spread 3.0 to 3.1m	23,000	24,000	24,000	23,000	23,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000
Axle Spread > 3.1m												24,000	
GVM Limits													
4 Axles							32,800	32,800	32,800	32,800			
5 Axles	40,700	40,700	40,700	40,700		44,600	41,700	41,700	41,700	41,700		44,600	44,600
6 Axles	48,600	48,600	48,600	48,600		52,600	50,600	50,600	50,600	50,600	50,600	53,700	53,700
7 Axles	56,500	56,500	56,500	56,500	56,500	60,300	59,500	59,500	59,500	59,500	59,500	62,800	62,800
8 Axles	62,500	63,500	63,500	63,500	62,500	63,500	62,500	62,500	62,500	62,500	62,500	63,500	63,500
9 Axles						63,500	62,500	62,500		62,500	62,500		

Table B8: C-Train Weight Limits by Province and Territory

Summary of Provincial/Territorial Weight Limits													
	MOU	BC	ALTA	SASK	MAN	ONT	QUE	NB	NS	PEI	NFLD	Yukon	NWT
Kilograms													
Axle Mass Limits													
Steering Axle	5,500	5,500	5,500	5,500	5,500	7,700	5,500	5,500	5,500	5,500	5,500	5,500	5,500
Single Axle (4 tires per axle)	9,100	9,100	9,100	9,100	9,100	10,000	10,000	9,100	9,100	9,100	9,100	10,000	10,000
Tandem Axle													
Axle Spread 1.2 to 1.85m	17,000	17,000	17,000	17,000	17,000		18,000	18,000	18,000	18,000	18,000		
Axle Spread 1.2 to 1.6m						18,000						17,900	17,900
Axle Spread 1.6 to 1.7m						18,300						18,300	17,900
Axle Spread 1.7 to 1.8m						18,700						18,300	18,300
Axle Spread 1.8 to 1.85m						19,100							19,100
Axle Spread > 1.8m												19,100	
Tridem Axle (Trailer)													
Axle Spread 2.4 to 3.0m					21,000								
Axle Spread 3.0 to 3.6m					23,000								
Axle Spread 3.6 to 3.7m					24,000								
GVM Limits													
5 Axles	41,900	41,900	41,900	41,900	41,900	41,900	45,500	41,900	41,900	41,900	41,900	45,500	45,500
6 Axles	49,800	49,800	49,800	49,800	49,800	49,800	53,500	50,800	50,800	50,800	50,800	54,600	54,600
7 Axles	54,600	54,600	54,600	54,600	54,600	54,600	53,500	55,600	55,600	55,600	55,600	60,500	60,500
8 Axles	58,500	60,500	60,500	60,500	60,500	58,500	53,500	58,500	58,500	58,500	58,500	60,500	60,500

Table B9: Straight Truck Dimension Limits by Province and Territory

Summary of Provincial/Territorial Dimension Limits - Truck

Metres	MOU	BC	ALTA	SASK	MAN	ONT	QUE	NB	NS	PEI	NFLD	Yukon	NWT
Overall Width	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
Overall Height	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15
Overall Length	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50
Box Length	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc
Tandem Axle Spread (max)	1.85	1.85	1.85	1.85		nc	nc	p2	1.85	1.85	1.85	1.85	1.85
Effective Rear Overhang (max)	4.00	4.00	4.00	4.00	4.00	nc	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Rear Overhang (max)										2.00			
Front Overhang (max)										1.00			
Interaxle Spacings													
Single Axle to Single or Tandem Axle (min)	3.00	3.00	3.00	3.00	3.00	nc	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Tandem Steering Axle to Tandem Axle (min)						nc	3.65	3.65	3.65	3.65	3.65		

NOTE: nc = not controlled.

Table B10: Straight Truck Weight Limits by Province and Territory

Kilograms	MOU	BC	ALTA	SASK	MAN	ONT	QUE	NB	NS	PEI	NFLD	Yukon	NWT
Axle Mass Limits													
Steering Axle - single axle	9,100	7,300	7,300	7,300	7,300	9,000	9,000	8,000	8,000	8,000	8,000	7,300	7,300
Tandem Axle (max)	17,000	17,000	13,600	13,600	16,000	18,000	16,000	16,000	16,000	16,000	16,000		
Tridem Axle (max)		24,000											
Single Axle (dual tires)	9,100	9,100	9,100	9,100	9,100	10,000	9,100	9,100	9,100	9,100	9,100	10,000	
Tandem Axle													
Axle Spread < 1.2m		17,000		17,000			9,100	9,100					
Axle spread 1.2 to 1.6m						17,000						17,900	
Axle spread 1.2 to 1.85m	17,000	17,000	17,000	17,000			18,000	18,000	18,000		18,000		
Axle spread 1.6 to 1.8m						18,300						18,300	
Axle Spread >1.8m						19,100						19,100	
Axle Spread >1.85m		17,000		17,000			9,100	9,100					19,100
GVM Limits													
2 Axles (based on 5,500 kg front axle weight)	14,600	14,600	14,600	14,600	14,600	15,500	17,250	17,100	17,100	17,100	17,100	17,300	17,300
3 Axles (based on maximum front axle weight)	24,250	26,100	24,300	24,300	23,300	27,800	25,250	26,000	26,000	26,000	26,000	26,400	26,400
4 Axles (based on maximum front axle weight)		34,000	30,600	30,600		37,300	32,000	34,000	34,000	34,000	34,000	32,700	32,700

Table B11: Truck and Pony Trailer Dimension Limits by Province and Territory

Summary of Provincial/Territorial Dimension Limits - Truck & Pony Trailer

Metres	MOU	BC	ALTA	SASK	MAN	ONT	QUE	NB	NS	PEI	NFLD	Yukon	NWT
Overall Width	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
Overall Height	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15
Overall Length	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Box Length	20.00	20.00	20.00	20.00	20.00	nc	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Truck													
Front Overhang (max)										1.00			
Length (max)	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50
Wheelbase	nc	nc	nc	nc	nc	nc	nc		nc	nc	nc	nc	nc
Tandem Axle Spread (max)	1.85	1.85	1.85	1.85		nc	nc	1.85	1.85	1.85	1.85	1.85	1.85
Effective Rear Overhang	4.00	4.00	4.00	4.00		nc	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Hitch offset (max)	1.80	1.80	1.80	1.80	1.80	nc	1.80	1.80	1.80	1.80	1.80	1.80	1.80
Rear Overhang (max)						nc				2.00			
Pony Trailer													
Length (max)	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50
Wheelbase (max)	6.25	6.25	6.25	6.25	6.25	nc	6.25	6.25	6.25	6.25	6.25	6.25	6.25
Tandem Axle Spread	1.85	1.85	1.85	1.85		nc	p2	p2	1.85	1.85	1.85	1.85	1.85
Tridem Axle Spread	2.50	2.50	2.50	2.50		nc	p2	2.50	2.50	2.50	2.50	2.50	2.50
Track Width (max) restricted to 2.5m (min)	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
Effective Rear Overhang	4.00	4.00	4.00	4.00	4.00	nc	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Rear Overhang (max)						nc				2.00			
Interaxle Spacings													
Single Axle to Single, Tandem or Tridem Axle or Triaxle (min)	3.00	3.00	3.00	3.00	3.00	nc	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Tandem Axle to Tandem Axle (min)	5.00					5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Tandem Axle to Tridem Axle (min)	5.50					5.50	5.50	5.50	5.50		5.50	5.50	5.50

NOTE: nc = not controlled.

Table B12: Truck and Pony Trailer Weight Limits by Province and Territory

Summary of Provincial/Territorial Weight Limits													
Kilograms	MOU	BC	ALTA	SASK	MAN	ONT	QUE	NB	NS	PEI	NFLD	Yukon	NWT
Axle Mass Limits													
Steering Axle - single tires	7,300	7,300	7,300	7,300	7,300	9,000	8,000	8,000	8,000	8,000	8,000	7,300	7,300
Single Axle - dual tires	9,100	9,100	9,100	9,100	9,100	10,000	9,100	9,100	9,100	9,100	9,100	10,000	10,000
Tandem Axle													
Axle Spread < 1.2m							9,100	9,100					
Axle spread 1.2 to 1.6m						17,000						17,900	
Axle spread 1.2 to 1.85m	17,000	17,000	17,000	17,000	17,000		18,000	18,000	18,000	18,000	18,000		
Axle spread 1.6 to 1.8m						18,300						18,300	
Axle Spread >1.8m						19,100						19,100	
Axle Spread >1.85m							9,100	9,100					
Tridem Axle													
Axes Spread 2.4 to 2.5m	21,000	21,000	21,000	21,000	21,000	21,300	21,000	21,000	21,000	21,000	21,000	24,000	24,000
GVM Limits													
3 Axles	25,450				25,500	27,800	26,200	26,200	26,200	26,200	26,200	27,300	27,300
4 Axles	33,350				33,400	37,300	35,100	35,100	35,100	35,100	35,100	36,400	36,400
5 Axles	41,250				41,300	46,000	44,000	44,000	44,000	44,000	44,000	45,500	45,500
6 Axles	45,250				45,300	55,600	47,000	47,000	47,000	47,000	47,000	50,400	50,400
7 Axles						62,900							
8 Axles						63,500							

Table B14: Truck and Full Trailer Weight Limits by Province and Territory

Summary of Provincial/Territorial Weight Limits

Kilograms	MOU	BC	ALTA	SASK	MAN	ONT	QUE	NB	NS	PEI	NFLD	Yukon	NWT
Axle Mass Limits													
Steering Axle - single tires	7,250	7,300	7,300	7,300	7,300	9,000	8,000	8,000	8,000	8,000	8,000	7,300	7,300
Single Axle - dual tires	9,100	9,100	9,100	9,100	9,100	10,000	9,100	9,100	9,100	9,100	9,100	10,000	10,000
Tandem Axle													
Axle Spread 1.2 to 1.85m						17,000				18,000			
Axle Spread 2.4 to 3.0m							9,100	9,100					
Axle spread 3.0 to 3.6m		17,000	17,000									17,900	17,900
Axle spread 3.5 to 3.7m	17,000	17,000	17,000	17,000	17,000		18,000	18,000	18,000		18,000		
Axle spread 1.6 to 1.80m		17,000	17,000			18,300						18,300	18,300
Axle Spread >1.80m		17,000	17,000			19,100						19,100	19,100
Axle Spread >1.85m							9,100	9,100					
Tridem Axle (Trailer)													
Axle Spread 2.4 to 3.0m					21,000	21,300							
Axle Spread 3.0 to 3.6m					23,000	23,000							
Axle Spread 3.6 to 3.7m					23,000	24,400							
GVM Limits													
4 Axles	33,350				33,400	37,300	34,100	34,100	34,100	34,100	34,100	36,400	36,400
5 Axles	41,250				41,300	47,000	43,000	43,000	43,000	43,000	43,000	45,500	45,500
6 Axles	48,250	50,000	50,000		48,300	55,600	50,000	50,000	50,000	50,000	50,000	50,400	50,400
7 Axles	53,500	53,500	53,500		55,300	62,900	53,500	53,500	53,500	53,500	53,500	57,400	57,400
8 Axles					62,500	63,500							

APPENDIX C

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APPENDIX D

Recommended Regulatory Principles for Interprovincial Heavy Vehicle Weights and Dimensions

SEPTEMBER 1987

IMPLEMENTATION PLANNING SUBCOMMITTEE

Chairman: H.K. Walker, Alberta Transportation and Utilities

Secretary: J.B.L. Robinson, Roads and Transportation Association of Canada

Technical Advisor: J. Pearson, Roads and Transportation Association of Canada

Members:

T.M. Prim, Newfoundland Department of Transportation

S.M. Ali, Nova Scotia Department of Transportation

T.W. Walker, Prince Edward Island Department of Transportation and Public Works

R.D. Macintosh, New Brunswick Department of Transportation

P. Perron, Ministère des Transports du Québec

W. Keen, Ontario Ministry of Transportation and Communications

J.B. Rowley, Manitoba Highways and Transportation

M.F. Clark, Saskatchewan Highways and Transportation (to May 1987)

B.D. Martin, Saskatchewan Highways and Transportation (from May 1987)

P. Toogood, British Columbia Ministry of Transportation and Highways

J.A. de Raadt, Yukon Community and Transportation Services

J. Bunge, Northwest Territories Department of Public Works and Highways

T.M. Burtch, Transport Canada

Alternates:

P.S. Askie, Ontario Ministry of Transportation and Communications

R.O. Houston, Alberta Transportation and Utilities

Preface:

The report which follows constitutes the draft final report of the Implementation Planning Subcommittee of the Joint RTAC/CCMTA Committee on Heavy Vehicle Weights and Dimensions. Following the completion of the Vehicle Weights and Dimensions Research Program, marked by the delivery of the Technical Steering Committee Report in December 1986, the Implementation Planning Subcommittee was charged with the following responsibilities:

1. To develop a plan that will assist each jurisdiction in implementing vehicle weight, dimension and configuration regulatory principles that will lead to national uniformity.

2. To develop schedules for proposed implementation of the recommendations.
3. To monitor the progress of implementation of the recommendations as they may be agreed to by the Council of Ministers Responsible for Transportation and Highway Safety at its meeting in September 1987.

With due consideration to the findings of the research program, and in recognition of the safety of the users of the system, engineering, economic and operational constraints of the highway system, the operational requirements of the trucking industry, and the capabilities of the truck and trailer manufacturing industries, the committee has developed a proposed regulatory environment which provides improved opportunities to safely exploit the available capacities of both the highway system and the motor transport fleet on a national basis.

The regulatory principles and recommended limits have been developed in the context of the following objectives:

1. To encourage the use of the most stable heavy vehicle configurations through the implementation of practical, enforceable weight and dimensions limits.
2. To balance the available capacities of the national highway transportation system by encouraging the use of the most productive vehicle configurations relative to their impact on the infrastructure.
3. To provide the motor transport industry with the ability to serve markets across Canada using safe, productive, nationally acceptable equipment.

The regulatory framework and principles described herein represent the work and collective efforts of all jurisdictions involved in the regulation of highway transport in Canada.

H.K. Walker
Chairman, Implementation Planning Subcommittee

1.0 Introduction

1.1 Background

In 1984 a joint government/industry research program was launched with the goal of achieving uniformity in interprovincial weights and dimensions regulations. The research was intended to provide insight into and answers to technical questions which stood in the way of obtaining agreement between jurisdictions on acceptable vehicle configurations, axle loadings and spacings, and overall dimensions.

The research conducted under the Vehicle Weights and Dimensions Study constitutes a major advancement in understanding the influence of heavy vehicle weights and dimensions on the stability and controllability of the vehicles which use the highway system and the impacts they have on the system's infrastructure. The research findings have also served to highlight the limitations of the capacities and capabilities of both the vehicles and the highway system itself, while providing direction on opportunities which exist to improve the productivity of the highway transport system.

Weights and dimensions regulations have traditionally been established primarily in consideration of the capacities or expected rate of consumption of the highway system infrastructure. The research program confirmed that a direct relationship also exists between weights, dimensions and vehicle stability. Consequently, any revision of existing limits has implications for the stability of heavy combination vehicles and for the safe operation of the highway system as a whole.

1.2 Vehicle Stability and Control Performance Criteria

The extensive programs of testing and computer simulation carried out under the research program served to document the wide range of stability and control characteristics of vehicles currently found in the commercial transport fleet. In reviewing the findings of the program, it was recognized that both the configuration of the vehicle and the manner in which it is loaded profoundly influence its stability and control characteristics and its compatibility with the highway geometry.

The regulatory principles and proposed weight and dimension limits which appear in the following sections have been selected in consideration of each vehicle configuration's demonstrated performance against seven measures. As recommended by the Technical Steering Committee of the research program, vehicles which exhibit performance which meets or exceeds the reference levels for the following measures should be encouraged for use in interprovincial carriage.

It is recognized that the desired targets for vehicle stability and control performance cannot, and will not, be achieved solely through the application of weight and dimension limits. However, the influence of weight and dimensions on vehicle stability was carefully considered in developing and selecting the limits proposed in this document. It is recommended that the seven measures of performance described in the following section be considered in any future revisions to heavy truck weights and dimensions, and that the recommended minimum or maximum levels within each be held as desired targets, achievable through judicious application of regulatory control developed in concert with the manufacturing and operating industries.

Stability and Control Measures:

A. Static Rollover Threshold

The Static Rollover Threshold defines the maximum severity of steady turn which a vehicle can tolerate without rolling over. The measure expresses the level of lateral acceleration, in units of g's of lateral acceleration, beyond which overturn occurs. In general, loaded trucks exhibit rollover threshold values in the range of 0.25 to 0.40 g, a range which lies modestly above the severity levels encountered in the normal driving of passenger cars. This measure of truck roll stability is known to correlate powerfully with the incidence of rollover accidents in highway service.

Target Performance Level:

Vehicles, in the loaded condition, should exhibit a static rollover threshold of 0.4 g or better.

B. Dynamic Load Transfer Ratio

Dynamic Load Transfer Ratio characterizes the extent to which a vehicle approaches the rollover condition in a dynamic steering manoeuvre such as in avoiding an obstacle in the roadway. This measure is expressed in terms of the fractional change in tire loads between left- and right-side tires in the manoeuvre, thus indicating how close the vehicle came to lifting off all of its tires on one side, and rolling over. The value which is determined reflects the amplification tendencies by which multiple-trailer combinations tend to "crack the whip" in rapid steering manoeuvres. The Load Transfer Ratio is calculated as follows:

$$\text{Load Transfer Ratio} = \frac{\sum |F_L - F_R|}{\sum (F_L + F_R)}$$

where: F_L = Left side tire loads

F_R = Right side tire loads

Target Performance Level:

When a vehicle in the loaded condition negotiates an obstacle avoidance, or lane change manoeuvre at highway speeds, the load transfer ratio should not exceed 0.60.

C. Friction Demand in Tight Turns

The measure termed, Friction Demand in a Tight Turn, pertains to the resistance of multiple, nonsteered axles to travelling around a tight-radius turn, such as at an intersection. Especially with semitrailers having widely spread axles, the resistance to operating in a curved path results in a requirement, or demand, for tire side force at the tractor's tandem axles. When the pavement friction level is low, such vehicles may exceed the friction which is available and produce a jackknife-type response. The friction demand measure describes the minimum level of pavement friction on which the vehicle can negotiate an intersection turn without suffering such a control loss. When the vehicle design is such that a high friction level is demanded, the vehicle is looked upon as inoperable under lower-friction conditions such as prevail during much of the Canadian wintertime.

Target Performance Level:

When a vehicle negotiates a 90 ° turn with an outside radius of 11 m, the peak required coefficient of friction of the highway surface to avoid loss of traction by the tractor drive tires should not exceed 0.1.

D. Braking Efficiency

A Braking Efficiency measure is used to indicate the ability of the braking system to fully utilize the tire/pavement friction available at each axle. It is defined as the percentage of available tire/road friction limit that can be utilized in achieving an emergency stop without incurring wheel lockup. For example, a vehicle achieves only a 50% braking efficiency level when it suffers wheel lockup while braking at 0.2 g's on a surface which could ideally support a 0.4 g stop. The braking efficiency measure is meant to characterize the quality of the overall braking system as the primary accident avoidance mechanism.

It is recognized that in-service heavy vehicle braking characteristics are influenced by a multitude of factors including the state of adjustment of the mechanical elements of the braking system, the response characteristics of the air supply system, the type and condition of tires on the vehicle, the load distribution between axles and the characteristics of the road surface. As a consequence, the performance measure described above is somewhat theoretical in nature, and may not be easily verified through physical testing of appropriately configured vehicles. Nonetheless, the Braking Efficiency measure as determined using simulation or analysis techniques does provide a valuable, consistent basis upon which valid comparisons of the braking performance of differing vehicle configurations can be made, and provides a reasonable target performance level which vehicles in the fleet should be capable of achieving.

Target Performance Level:

Vehicles in the loaded or unloaded condition should exhibit braking efficiencies of 70% or better. Braking efficiency is defined as the percentage of available tire/road friction limit that can be utilized in an emergency stop of 0.4 g's deceleration without incurring wheel lockup.

Offtracking Measures:**E. Low Speed Offtracking**

Low-Speed Offtracking is defined as the extent of inboard offtracking which occurs in a turn. In a right-hand turn, for example, the rearmost trailer axle follows a path which is well to the right of that of the tractor, thus making demands for lateral clearance in the layout of pavement intersections. This property is of concern to compatibility of the vehicle configuration with the general road system and has implications for safety as well as abuse of roadside appurtenances.

Target Performance Level:

When a vehicle negotiates a 90 ° turn with an outside radius of 11 m, the maximum extent of lateral excursion of the last axle of the vehicle, relative to the path followed by the tractor steering axle, should not exceed 6 m.

F. High Speed Offtracking

A High-Speed Offtracking measure has been defined as the extent of outboard offtracking of the last axle of the truck combination in a moderate steady turn of 0.2 g's lateral acceleration. This measure is expressed as the lateral offset, in meters, between the trailer and tractor paths. Recognizing that the driver guides the tractor along a desired path, the prospect of trailer tires following a more outboard path that might intersect a curb, or an adjacent vehicle or obstacle poses a clear safety hazard.

Target Performance Level:

When a vehicle negotiates a turn with a radius of 393 m at a speed of 100 km/h, the maximum extent of outboard lateral excursion of the last axle of the vehicle, relative to the path followed by the tractor steering axle, should not exceed 0.46 m.

G. Transient High Speed Offtracking

The Transient High-Speed Offtracking measure is obtained from the same obstacle avoidance manoeuvre as that used to define the dynamic rollover stability level and is defined as the peak overshoot in the lateral position of the rearmost trailer axle, following the severe lane-change-type maneuver. The amount of overshoot in the rearmost-axle path can be viewed as a relative indication of the extent of potential intrusion into an adjacent lane of traffic, or the potential for striking a curb (risking an impact-induced rollover). In layman's terms, this measure quantifies the magnitude of the "tail-wagging" in response to a rapid steer input.

Target Performance Level:

When a vehicle negotiates an obstacle avoidance, or lane change, manoeuvre at highway speeds, the maximum lateral excursion of the rearmost axle of the vehicle, relative to the final lateral path displacement of the steering axle, should not exceed 0.8 m.

1.3 Regulatory Approach, Rationale and Application

The regulatory principles were established on the basis of the findings of the research program and were used to select weight and dimension limits which have been developed in the context of the following objectives:

1. To encourage the use of the most stable heavy vehicle configurations through the implementation of practical, enforceable weight and dimensions limits.
2. To balance the available capacities of the national highway transportation system by encouraging the use of the most productive vehicle configurations relative to their impact on the infrastructure.
3. To provide the motor transport industry with the ability to serve markets across Canada using safe, productive, nationally acceptable equipment.

The regulatory principles and limits proposed in this document are intended to apply only to those vehicles engaged in interprovincial carriage. These vehicles will fall into one of the following four categories:

- a. Tractor Semitrailer
- b. A Train Double
- c. B Train Double
- d. C Train Double

If implemented, the regulatory agreement would permit vehicles which are in compliance to travel unrestricted across each jurisdiction in Canada on a designated system of highways. The regulatory proposals are not intended to inhibit the ability of individual jurisdictions to meet the needs of the transportation system in their region, and to develop appropriate heavy vehicle weights and dimensions for intraprovincial goods movements.

2.0 Discussion of Proposed Regulatory Controls and Limits

Vehicle stability and infrastructure impacts are influenced to varying degrees by many components of the vehicle and the physical configuration of the components. In some cases the research demonstrated a clear and significant correlation between a vehicle parameter and a performance measure, thereby providing an opportunity for effective regulatory control. In other cases the research findings were to a certain extent inconclusive, or raised issues or concerns for which weight and dimension regulatory controls would be ineffective, inappropriate or premature. However, many findings in the latter category should be considered by the manufacturing and operating sectors of the trucking industry in view of the potential benefits to stability and productivity voluntary action would provide.

The research findings and proposed regulatory controls are discussed by vehicle component as follows:

2.1 Tractors:

Terminology:

Wheelbase: The longitudinal distance from the center of the front or steering axle to the geometric center of the driving axle(s). For tandem drive axle tractors, from the steering axle to the center of the drive tandem.

Tandem Axle Spread: The longitudinal distance between the axle centers.

Fifth Wheel Offset: The longitudinal distance from the center of the fifth wheel to the center of the tandem drive axle group (for two axle tractors, to the center of the drive axle). Convention: ahead of center is positive setting, behind center is negative setting.

Interaxle Spacing: The longitudinal distance between the centers of two adjacent axles.

2.1.1 Wheelbase:

The research demonstrated that the stability of combination vehicles improves with increasing tractor wheelbase. However, the tractor wheelbase also directly influences low speed offtracking performance, i.e., longer wheelbases result in a greater degree of offtracking. In consideration of the trucking industry's expressed desire for operational flexibility and interchangeability of tractors between configurations, the proposed regulatory controls apply to the tractor in each of the four vehicle categories.

It is proposed that the minimum tractor wheelbase be determined by interaxle spacing requirement (section 2.1.3) and the maximum be 6.2 m because of the resultant low speed offtracking performance of a tractor semitrailer configuration consisting of a 6.2 m tractor coupled to a 12.5 m wheelbase semitrailer.

2.1.2 Tandem Axle Spread:

The research demonstrated that vehicle stability generally improves with decreasing axle spreads in tandem and tridem groups. On the tractor, the drive axle spacing should be kept as short as possible to reduce the forces required by the steering axle to overcome the "tire scuffing" of the drive axles which occurs in tight turns.

It is proposed that the spacing between the tandem drive axles be controlled, with a minimum of 1.2 m and a maximum of 1.85 m. The intent is to encourage the use of closely spaced axle groups, while providing flexibility to operators who require wider spreads for other reasons.

2.1.3 Interaxle Spacing:

The research determined that vehicle stability degrades with decreasing tractor wheelbase and that a minimum spacing must be maintained between the steering axle of the tractor and the first drive axle with respect to concern for bridge distress under load. A minimum interaxle spacing requirement is proposed on the basis of encouraging the use of more stable vehicle configurations, while reducing the demands on bridge structures.

It is recommended that the interaxle spacing on a tractor be a minimum of 3 m.

2.1.4 Fifth Wheel Offset:

Many tractors are equipped with moveable fifth wheels which enable load distribution between axles on the vehicle to be adjusted. In other instances, the position of the fifth wheel is selected to accommodate special requirements of the vehicle configuration or commodity carried (e.g., automobile carriers).

The location of the fifth wheel on the tractor does influence the stability of the entire vehicle configuration. It is recognized that operational flexibility is required by the industry, and for this reason no regulatory control is proposed at this time. However, should industry practice in positioning fifth wheels result in significant degradation of vehicle stability, regulatory control may become necessary.

No control of fifth wheel offset is proposed at the present time.

2.1.5 Track Width:

Research has demonstrated that the stability of the tractor and the combination vehicle as a whole improves with increases in the track width, or overall width across the tires. Wider track axles are not currently available in quantity for tractor steering and drive axles, and their use would require engineering modifications to existing tractor designs.

Although it is not proposed to control the track width of tractors at this time, it is recommended that the industry be encouraged to use wider track axles which provide a nominal width across the tires of 2.6 m to obtain the benefits of improved stability. It is further recommended that the Government of Canada work with the Government of the United States to pursue more rapid development of wider track axles for tractors.

2.1.6 Weight to Power Ratio:

While no regulatory requirement is proposed at this time respecting the horsepower of the tractor relative to the Gross Combination Weight, it should be recognized that interprovincial carriage through the province of British Columbia must meet that jurisdiction's regulatory requirement of a maximum of 150 kg/hp and the requirement for tandem drive axles on the tractor if the vehicle's Gross Combination Weight exceeds 38 000 kg.

2.2 Semitrailers:

Terminology:

Length: The longitudinal distance from the front to the rearmost point of the semitrailer.

Kingpin Setback: The longitudinal distance from the front of the semitrailer to the center of the kingpin.

Wheelbase: The longitudinal distance from the kingpin to the turn center of the semitrailer. For the purposes of this regulatory proposal, the turn center is considered to be the geometric center of the axle group on the semitrailer.

Rear Overhang: The longitudinal distance from the center of the last axle to the rearmost point on the semitrailer (or load).

Effective Rear Overhang: The longitudinal distance from the turn center of the semitrailer to the rearmost point on the semitrailer (or load).

Hitch Offset: The longitudinal distance from the turn center of the semitrailer to the center of the hitching mechanism provided for towing an additional trailer (typically a pintle hook).

2.2.1 Length:

The research did not illustrate any direct relationship between trailer length and any of the performance measures. However, there are other criteria which must be considered in establishing size and weight limits, including enforcement concerns, the influence of overall vehicle length on highway capacity and level of service, and operational and manufacturing limitations.

It is recommended that the length of semitrailers be controlled under the limits developed for each type of configuration addressed in this proposal.

2.2.2 Wheelbase:

The research demonstrated that the wheelbase of a semitrailer has a direct influence on the stability of combination vehicles. Longer wheelbases improve dynamic stability while providing an opportunity to reduce the height of the center of gravity of the payload. However, as wheelbases are increased the low speed offtracking is also increased. Generally, semitrailer wheelbases should be kept as long as possible, within the constraint of acceptable limits of low speed offtracking. As wheelbases decrease, the dynamic stability degrades and the friction demands on tractor drive axles in low speed turns increase (for multiple axle semitrailers).

It is recommended that the minimum and maximum wheelbases of semitrailers be controlled in all configurations, with appropriate limits selected in consideration of the inherent stability characteristics of the configuration.

2.2.3 Kingpin Setback:

As the distance from the front of the semitrailer to the kingpin is increased, the potential for the front corner of the semitrailer to intrude into adjacent traffic lanes in tight turning manoeuvres increases.

It is recommended that the kingpin setback on semitrailers in tractor semitrailer configurations and the first semitrailer in double configurations be controlled to limit lane intrusion in turning manoeuvres. It is recommended that no part of the trailer forward of the kingpin protrude beyond an arc of 2.0 m radius drawn about the center of the kingpin.

2.2.4 Effective Rear Overhang:

The length of the trailer or load which extends beyond the turn center of a semitrailer determines whether intrusion into adjacent lanes of the rear corner of the trailer or load will occur when a turn is negotiated. Because of the turning characteristics of longer wheelbase semitrailers, this problem is only of concern with the tractor semitrailer configuration.

It is recommended that the effective overhang on semitrailers in tractor semitrailer configurations be limited to a maximum of 35% of the wheelbase.

2.2.5 Rear Overhang:

In consideration of the proposed control of effective rear overhang, there is no proposed control of rear overhang. However, it is recommended that the development and implementation of standards for improved rear underride protection be undertaken by the Federal Government in concert with the Provincial Governments and the manufacturing industry.

2.2.6 Tandem and Tridem Axle Spreads:

The research demonstrated that the stability of semitrailers improves with decreasing axle spreads on multiple axle groups. Increased axle spreads also demand higher friction levels between tractor drive axles and the road surface in tight turning manoeuvres, consequently the maximum spread which can be recommended for a tandem or tridem is also dependent on the wheelbase of the semitrailer on which it is installed. However, bridge capacity considerations require that axle spreads be increased to accept particular loading levels. In addition, pavement damage increases with very wide axle spreads. To accommodate these conflicting objectives, and to provide maximum utility of vehicles in the trucking fleet, minimum and maximum axle spread limits are proposed for both tandem and tridem axle groups.

It is proposed that the maximum and minimum spreads of tandem and tridem axle groups be controlled with limits established for each vehicle configuration.

2.2.7 Track Width:

The research demonstrated that significant improvements in vehicle stability can be obtained by increasing the track width, or overall width across the tires, of all axles on a semitrailer. The full stability benefit of the increased axle width is only realized with a commensurate increase in the spacing between the attachment points of the suspension on the axle. While this dimension is considered to be outside the practical limits of enforceable weights and dimensions controls at the present time, manufacturers are encouraged to exploit the full stability enhancement available through increased axle and suspension width.

It is recommended that wider track axles be used on trailers and semitrailers in all configurations, and that a nominal width across the tires of 2.6 m be required.

2.2.8 Hitch Offset (Double Trailer Configurations):

Where semitrailers are used in double trailer operations, the distance from the turn center of the semitrailer to the hitching mechanism for the dolly drawbar(s) is related to the stability of the combination. Generally, this dimension should be kept as short as possible for the A Train Double and in particular for the C Train Double. As this dimension increases, the dynamic stability of both A and C Train Doubles, in terms of load transfer ratio and transient high speed offtracking, degrades markedly.

It is proposed that the distance from the effective turn center of the semitrailer to the location of the hitching mechanism for dolly drawbars be kept as short as possible, and be limited to a maximum of 1.8 m.

2.3 Converter Dollies:

2.3.1 Drawbar Length: A Converter Dollies

The research did not provide conclusive evidence that the length of the drawbar on A Converter Dollies directly affected the stability and control performance of combination vehicles. As a consequence, and in view of other overall dimensional constraints on the A Train category, no control is recommended for the length of drawbar on A Converter Dollies.

2.3.2 Drawbar Length: B Converter Dollies

The research established a direct relationship between the length of the drawbar on the double drawbar or B converter dolly and the stability of the second trailer in a double configuration. Generally, as the drawbar length decreases, the dynamic high speed offtracking improves. There are practical limits to the minimum length of drawbar, dictated in part by inter-trailer clearance requirements and by minimum interaxle spacing requirements determined by bridge capacity considerations.

It is recommended that a maximum allowable drawbar length of 2.4 m be established for B Converter Dollies.

2.3.3 Double Drawbar or B Dolly Converters:

The research determined that significant stability improvements can be achieved in double trailer configurations through the substitution of a properly designed and installed B Dolly for a conventional A Dolly. However the research also highlighted the complexities of the B Dolly design, and demonstrated instances where improperly designed dollies can render the stability performance of the "C Train" inferior to that of the "A Train".

In the absence of design and operational guidelines for the B Converter Dolly, it is recommended that the use of the C Train not be encouraged at the present time and that the size and weight restrictions on this configuration remain as described for the A Train Double. It is further recommended that high priority be given to developing such guidelines and implementing a means of ensuring manufacturing and operational compliance.

2.3.4 Number of Axles:

While the research did not provide evidence to suggest that multiple axle dollies exhibit undesirable performance characteristics, the stability limitations of the A Train Double and the as yet uncertain engineering requirements of the B Converter Dolly would suggest that additional load carrying capability by the dolly is unnecessary, and generally not desirable. The proposed weight restriction on the second trailer of A and C Train Doubles provides no incentive or requirement for additional load carrying capability.

To discourage excessive loading of the second trailer of A Train Doubles, and in view of the uncertain requirements of B Dolly design, it is proposed that only single axle converter dollies be allowed on A and C Train Double Configurations.

2.4 General Considerations:

2.4.1 Interaxle Spacing:

The distance between axles and axle groups on a heavy vehicle affects the response of the pavement and bridge structure to the loading of the vehicle, and hence its destructive effects. From the standpoint of bridge capacity constraints, there are minimum spacing requirements between axles which must be respected, regardless of vehicle configuration.

It is proposed that interaxle spacings be controlled in accordance with the following table:

<i>Single Axle -</i>	<i>Single Axle</i>	<i>Min 3.0 m</i>
<i>Single Axle -</i>	<i>Tandem Axle</i>	<i>Min 3.0 m</i>
<i>Tandem Axle -</i>	<i>Tandem Axle</i>	<i>Min 5.0 m</i>
<i>Tandem Axle -</i>	<i>Tridem Axle</i>	<i>Min 5.5 m</i>
<i>Tridem Axle -</i>	<i>Tridem Axle</i>	<i>Min 6.0 m</i>

2.4.2 Suspension Type and Mix:

The research demonstrated that stability performance can be significantly affected by the varying characteristics of the range of suspensions commonly available to the fleet operator. In particular, it is evident that the stability of all four categories of vehicles can be improved through careful selection of compatible tractor and semitrailer suspensions. Conversely poor compatibility of suspensions can significantly degrade vehicle stability.

The research also provided preliminary insights to the relative potential damaging effects of differing suspension types on the infrastructure due to dynamic loadings. The research suggested that certain types of suspensions would appear to inflict unnecessarily high dynamic loadings on the pavement and bridges as road roughness and vehicle speeds increase.

While no regulatory controls are proposed at this time for suspension types or mixes, it is recommended that further research be conducted in this area to determine whether regulatory controls are appropriate or warrant development.

2.4.3 Tire Type:

The research demonstrated that the use of radial tires can improve the dynamic stability of heavy vehicles, particularly the double trailer configurations.

While no regulatory controls are proposed at this time for the type of tire to be used on combination vehicles, the use of radial tires in all axle locations is encouraged.

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI-NA	Airports Council International-North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation