



A Synthesis of Safety Implications of
Oversize/Overweight
Commercial Vehicles

December 2009



American Association of State Highway and Transportation Officials

Acknowledgements

UTCA researchers express their deep appreciation to members of the Advisory Panel for providing advice and for identifying resource people and appropriate literature resources. Many members of the VSW Scan Tour team participated on the Panel, but other experts in heavy commercial vehicles were also members. In addition, Tom Kearney of FHWA was especially helpful in identifying sources of heavy commercial vehicle crash data. Ken Agent of the Kentucky Transportation Center, and Tom Petrolino of the National Transportation Research Center, Inc. provided much useful information about large trucks and OS/OW truck safety.

The students and staff of the University Transportation Center for Alabama provided wonderful support to the authors during the preparation of the synthesis by assisting with the literature review, analyzing data, preparing tables and figures, and otherwise supporting the authors.

© 2009 by the American Association of State Highway and Transportation Officials. All rights reserved. Duplication is a violation of applicable law.

ISBN: 978-1-56051-466-4

Publ. Code: OSOW-1

Preface

This synthesis report was prepared as a follow-up to the *Commercial Motor Vehicle Size and Weight Enforcement in Europe* international scan which was conducted from June 17, 2006 through July 2, 2006. It is timely given the pressures of the increasing need to move loads that exceed the established vehicle size and weight limits. While studies have addressed the impact these larger than normal loads have on pavement and bridges, much less information is available on their safety implications. As a supplement to the scan, this report describes what is known and what more needs to be known about the safety implications of overdimensional and overweight loads.

The American Association of State Highway and Transportation Officials (AASHTO) is grateful to the Federal Highway Administration International Technology Scanning Program and the National Cooperative Highway Research Program for their co-operation and partnership in the International Scanning Program.

AASHTO also very much appreciates the willingness of the Alabama Department of Transportation to sponsor this report through the University Transportation Center for Alabama. AASHTO thankfully acknowledges the hard work of Dr. Daniel S. Turner and Ms. Leslie Anne Nicholson and their support staff at the University of Alabama in Tuscaloosa in preparing this report.

Executive Committee

2009–2010

Voting Members

OFFICERS:

President: Larry “Butch” Brown, Mississippi

Vice President: Susan Martinovich, Nevada

Secretary-Treasurer: Carlos Braceras, Utah

REGIONAL REPRESENTATIVES:

REGION I: Joseph Marie, Connecticut
Gabe Klein, District of Columbia

REGION II: Dan Flowers, Arkansas
Mike Hancock, Kentucky

REGION III: Nancy J. Richardson, Iowa
Thomas Lorei, Minnesota

REGION IV: Paul Hammond, Washington
Lorenzo Saenz, Jr., Texas

Nonvoting Members

Immediate Past President: Allen Biehler, Pennsylvania

Executive Director: John Horsley, Washington, DC

Advisory Panel

Jeff G. Honefanger

Panel Chair

Ohio Department of Transportation

John Nicholas

Washington State Patrol

Ric Athey

Arizona DOT

Michael P. Onder

FHWA

Jodi Carson

Texas Transportation Institute

Leo Penne

AASHTO

George Conner

Alabama DOT

Ted Ferragut, PE

FHWA

Michael Griffith

Federal Motor Carrier Safety Administration

Joseph A. Petrolino

National Transportation Research Center

Currently in preview, click buy full version

Table of Contents

List of Tables	x
List of Figures	ii
Executive Summary.....	1
Section 1. Introduction	5
Objective.....	5
Background	5
The Project.....	6
Content of This Report	6
Section 2. The Concern—Heavy Commercial Truck Growth.....	7
Reason for Concern.....	7
Explosion in Growth of Large Commercial Vehicle.....	7
Summary of Commercial Vehicle Growth.....	10
Case Study—Minnesota Investigation of Larger Commercial Vehicles	10
Summary of Case Study	12
Section Summary	12
Section 3. Heavy Vehicle Types, Weights, and Sizes	13
Types of Vehicles	13
Size and Weight Regulations.....	14
Legal OS/OW Trucks	17
Section Summary	18
Section 4. Truck Characteristics Affecting Crashes	19
Introduction	19
Truck Weights and Loads	19
Truck Types and Sizes	21
Truck Brake Systems	21
Antilock Brakes	22
Speed	22
Vehicle Roadway Interaction.....	23
Drivers	24
Prominent Crash Types	24
Section Summary	27

TABLE OF CONTENTS

Section 5. Heavy Truck Crashes in General29

 Early Large Truck Safety Research 29

 More Recent Large Truck Safety Research 30

 Enforcement..... 33

 Roadside Inspections 35

 Weigh Stations 35

 Overview of Fatal Large Truck Crashes 37

 Trend in Fatalities 37

 Distribution of Fatalities 37

 Crash Most Harmful Event 38

 Speed 39

 Prevalent Characteristics..... 39

 Driver Factors in Fatal Crashes 39

 Truck Configurations 40

 Weight and Size of Trucks in Fatal Crashes..... 41

 Section Summary 42

Section 6. Data Associated with OS/OW Heavy Vehicles.....45

 Two Meanings for OS/OW Vehicles..... 45

 Comprehensive Data Is Necessary 46

 Data Sets with Promise 47

 WIM 47

 LTCCS 48

 TIFA 48

 Individual Research Studies 49

 Data for Which OS/OW Was Established or Probable 49

 Summary of Data for Which OS/OW Was Established or Probable..... 53

 Data for LCVs and Other Large, Heavy Commercial Vehicles 53

TRB Special Report 225: Truck Weight Limits: Issues and Options 53

 LCVs on the Alberta, Canada Sub-Network, 1995–1998 54

 Subsequent LCV Study in Alberta, 1999–2005..... 56

 Ontario L-Train Safety Study 59

 Proposed New Vehicles in Minnesota..... 61

 Section Summary 62

Section 7. Illustrative Case Studies65

 Case Study: States with Special Overweight Exemptions 65

 Kentucky..... 65

 Special Highway Designation..... 65

 Truck Crash Study..... 66

 Overweight Trucks..... 66

Truck Violations..... 67

Truck Braking Field Test..... 68

Other Kentucky Findings 70

West Virginia..... 70

 Special System Designation 70

 Decrease in Citations and Crashes..... 71

Section Summary 71

Section 8. Summary, Findings, and Recommendations 73

 Summary by Topic 73

 Growth of Commercial Vehicles 73

 Truck Size and Weight Laws (TSWs) 73

 Heavy Truck Crashes in General..... 73

 OS/OW Compared with Normal Heavy Vehicles 74

 Minnesota, Kentucky, and West Virginia Case Studies 75

 Project Findings..... 77

 Primary Findings Regarding OS/OW Commercial Vehicles and Safety..... 77

 More Specific Findings 78

 Additional, More-Specific Data Needed..... 78

 Effect of Weight on Crash Cause and Severity 79

 Speed 80

 Size–Speed–Weight 80

 Enforcement 80

 Enhanced Research Needed 81

 Build an Ideal Data Set 81

 Recommendations 82

Bibliography 85

Glossary of Terms Related to Heavy Trucks..... 95

Acronyms 99

List of Tables

2-1	U.S. Freight Shipments by Mode	8
2-2	Large Truck Registrations, Mileage, Crashes, and Crash Rate	9
3-1	Approximate Lengths/Weights of Prominent Types of LCVs.....	14
5-1	Roadside Safety Inspection Activity Summary by Inspection Type.....	36
5-2	2005 Large Truck Crashes, Most Harmful Event and Crash Severity	38
5-3	2005 Fatal Involvements by Truck Configuration	40
5-4	2005 Fatal Involvement by Truck Length and Weight.....	41
6-1	Fatal Truck Involvements That Might Be Oversize or Overweight	50
6-2	Common LCV Fatal Involvements	51
6-3	Fatal Truck Involvement and Fatalities, Selected Combination Types.....	51
6-4	Fatal Truck Involvement by GVW and LCV Type	52
6-5	Collision Rates by Vehicle Type for Alberta Sub-Network, 1995–1998	55
6-6	Fatal, Injury, and PDO Rates by Vehicle Type for Alberta Sub-Network, 1995–1998	56
6-7	Collision Rates by Vehicle Type for the Alberta LCV Network, 1999–2004.....	57
6-8	Fatal, Injury, and PDO Rates by Vehicle Type for Alberta LCV Network, 1999–2005.....	58
6-9	Eleven-Year Composite Crash Rates and Crash Severity, Vehicles in Collisions on the Sub- and LCV Networks, 1995–2005	59
6-10	Ontario Analysis of Collision Rates by Truck Classification	60
6-11	Effect of Truck Configuration and Vehicle Miles of Travel on Fatal Involvement Rates	61
7-1	Allowable Weights on Kentucky Coal Haul Roads	66
7-2	Kentucky Truck Inspection for 1997 and 1998	68
7-3	KTC Truck Braking Field Test	69

List of Figures

2-1	Truck and Infrastructure Growth Trends	10
3-1	Examples of FHWA Truck Classifications	14
3-2	Illustration of the Effects of Axle Weights and Spacings	17
4-1	Three Types of Locked-Wheel Crashes	26
4-2	Truck Rollover Factors	26
5-1	Fatalities in Crashes Involving Large Trucks, 1975–2005.	37
6-1	Fatal Crash Rates from <i>TRB Special Report 225</i> , Adjusted to Minnesota Truck-Crash Rates	62
7-1	Six-Axle Trucks Weighing Over 80,000 Lbs.	67

Executive Summary

This synthesis was prepared to support an International Technology Scanning Tour conducted by the U.S. Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), and the National Cooperative Highway Research Program (NCHRP). This implementation project was associated with a scanning tour of several European countries to investigate commercial motor vehicle size and weight enforcement programs (Honefanger, et al., 2007).

The objective of this project is to identify known relationships between commercial vehicle safety and crash causation factors and to prepare a synthesis of safety implications of oversize/overweight (OS/OW) commercial vehicles. This information can be used to support commercial vehicle enforcement and permitting practices. Another purpose for this information is to justify expenditures and investments on size and weight enforcement to enhance safety.

University Transportation Center for Alabama (UTCA) researchers examined over 100 research reports and journal articles to prepare this synthesis. More than 50 interviews were conducted with domestic and international agency, industry, and enforcement officials.

Insight was gained into the impacts of truck size and weight (TSW) regulations through three case studies. This included the Kentucky Coal Haul Road System and a similar system in West Virginia where legislative exemptions allowed semi-trailer trucks to haul up to 120,000 lbs of coal to keep the states' economies competitive. The third case study involved Minnesota, where agriculture and industries were at an economic disadvantage due to larger TSW limits in adjacent states and Canada. The Minnesota DOT conducted a thorough study of increasing TSWs and found that four new truck configurations would be cost beneficial.

The state of practice in estimating large truck crash rates is complicated because of the many configurations and the wide range of possible weights for any particular configuration. It appears that for single-unit trucks, tractor semi-trailers, and doubles, the findings of *TRB Special Report 225* (1990) can be used in the absence of agency specific rates. For longer combination vehicles (Rocky Mountain doubles, Turnpike doubles, A-, B-, and C-train doubles, triples, and unique international heavy vehicles with multiple axles), three Canadian studies between 1995 and 2004 appear to have developed acceptable estimates of crash rates and crash severity rates (Woodrooffe, 2001; Corredor, et al., 2005; Montufar and Associates, 2007).

During this project, UTCA researchers identified four primary findings regarding the contributions of OS/OW to commercial vehicle crashes:

- In general, crash rates decrease but crash severity increases as commercial vehicles become larger and heavier. This synthesis project did not identify scientific measures of reliability for this trend. The lack of a confirmed relationship suggests *neither* a positive (larger, heavier vehicles are safe) nor a negative (larger, heavier vehicles are unsafe) relationship between CMV size and weight and safety. It suggests *only* that additional research is needed to understand the complex relationships.
- No existing truck crash data set was found to have sufficient information for a scientific analysis of the contributions of size and weight (especially OS/OW) to crash causation or severity. The complex, confounding relationships between the contributing factors and the small sample sizes for different configurations of the largest commercial vehicles are two examples of why existing data is not sufficient.
- Studies in Canada have indicated that the longest combination vehicles, (LCVs), have lower crash rates (all severities) than other trucks and all vehicles as a group. Additional research is required to isolate and identify the reasons for this, but it could be because operation of these vehicles is restricted to higher level roadways, involved shipping firms assign better drivers, or similar reasons.
- Another study in Canada found that large truck performance measures (static roll stability, off tracking, etc.) are highly correlated to large truck crash rates. Controlling truck safety through performance thresholds might offer a better way to enhance U.S. large truck safety than some current programs.

Based upon these findings and many more-detailed findings within the synthesis, UTCA researchers made several recommendations to increase the collection of pertinent data and to otherwise enhance the opportunity to understand the relationship of large commercial vehicle size and weight to crash causation and severity. These recommendations are intended to address the need for additional data and for enhanced awareness of the complexity of heavy truck crashes:

- Make data available, if possible online, from weigh stations, weigh-in-motion (WIM), and virtual WIMs, especially when weight and dimensional data can be attributed to specific vehicles that are later involved in traffic crashes. This data can add significant scientific merit to truck safety studies. The weight data can also be used for state and federal planning and enforcement activities.
- Expand the number of WIM and virtual WIM stations to provide more data at relatively small incremental costs compared with alternative labor intensive methods to collect the same data.
- Expand the “Truck Involvement in Fatal Accidents” and “Large Truck Crash Causation” databases. They are prepared by supplementing crash data with specific information about the configuration of each involved truck, driver information, citation information, load information, and much more. It seems realistic to use weight databases to expand these files for individual truck crashes.
- Conduct a regional study of OS/OW vehicles. Since triples are restricted to the northwest, that might be a good location for such a study. One desirable outcome of such a study is to distinguish between legal and illegal OS/OW vehicles in crashes.

- Inventory states with categorical exclusions to TSWs that allow very heavy commercial vehicles, to see if any of them have comprehensive records of crashes of OS/OW vehicles. If a significant number of states contribute data, it might provide a suitable national database.
- Examine load and weight distribution of commercial vehicles involved in collisions to find the relationship between weight and factors like braking capacity and handling characteristics. That could provide a breakthrough in CV safety knowledge.
- Conduct an intensive project to gather significant, high-quality data to analyze OS/OW commercial vehicle crashes, including follow-up crash-site investigations to collect truck-specific data using a crack team of experts. This can be patterned after the Fatality Analysis Reporting System (FARS), a data collection system.
- Where needed, provide specialized training to troopers, police officers, and other personnel to help them determine the cause or contributing causes of heavy-truck crashes. This can affect the type and amount of data that they collect.
- Encourage FHWA and FMSCA to continue to work together to develop and administer policies and programs that address the big picture of roadway safety, of which heavy truck safety an important element. This would include sharing of agency specific data and research programs to optimize the results.

SECTION 1

Introduction



Objective

The specific objective of this research project was to prepare a synthesis of safety implications of over-size/overweight (OS/OW) commercial vehicles. The purpose was to identify and document known relationships between commercial vehicle safety and causal factors like vehicle type, weight, length, speed, load, driver, etc. This information can be used to modify commercial vehicle enforcement and permitting practices, and it can justify investments and expenditures on size and weight enforcement in the interests of safety. A secondary purpose of this project was to identify research needed to guide future safety and enforcement enhancements.

Background

This project was conducted as part of implementation efforts associated with an International Technology Scanning Tour conducted by the U.S. Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), and the National Cooperative Highway Research Program (NCHRP). Scanning tours seek innovative solutions for U.S. transportation challenges. This implementation project was associated with a scanning tour of several European countries to investigate commercial motor vehicle size and weight enforcement programs (VSW Scan Tour).

When granting permits to OS/OW vehicles, U.S. officials make their decisions based primarily on minimizing infrastructure damage (bridges and pavements). However, European officials include safety when making similar permit decisions. Members of the VSW Scan Tour were impressed with the European approach and made safety a priority research recommendation upon returning to the United States (Honefanger, et al. 2007).

One of the pivotal observations by the scan team occurred in Belgium, where officials had observed a safety relationship involving excessive weight and excessive speed of OS/OW vehicles. As a result, regional administrative regulations had been directed toward commercial vehicles to diminish crashes.