

OVERSIZE/OVERWEIGHT COMMERCIAL VEHICLE SAFETY



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Abstract

This paper presents a review of US research dealing with the safety of oversize/over weight (OS/OW) commercial vehicles. The research was conducted to allow greater consideration of safety in enforcement programs for large trucks and when evaluating applications for permits to allow (OS/OW) vehicles to utilize public highways. In general, the study found that the number of large trucks in the U.S. is increasing rapidly, and the number of fatalities in large truck crashes is on an extended slow increase. Limited studies were identified on OS/OW safety, but they showed that crashes decline with increasing vehicle gross weights, while severity increases with weight. The paper includes a case study of crash rates and severities, citations, suspensions and infrastructure damage in a state that allows overweight coal haul vehicles.

Keywords: Commercial motor vehicle (CMV), Oversize, Over weight, Motor vehicle crashes, CMV enforcement.

Résumé

Cet article présente un panorama des recherches américaines sur la sécurité des véhicules utilitaires au-delà des limites de dimensions et de poids (OS/OW). Cette recherche a été conduite pour mieux prendre en compte la sécurité dans les programmes de contrôle des poids lourds de grande taille et l'évaluation des demandes de permis dérogatoires aux règles de poids et dimensions sur les voies publiques. Les études montrent en général que le nombre de poids lourds de grande taille augmente rapidement aux États-Unis, tandis que le nombre de morts dans les accidents de ces camions a tendance à augmenter mais plus lentement. On a trouvé des études limitées sur la sécurité des poids lourds OS/OW, qui ont montré que la fréquence des accidents diminue avec l'augmentation des poids totaux des véhicules, tandis que leur gravité augmente. Cet article présente une étude de cas des taux et gravité d'accident, des procès verbaux et suspensions de permis de conduire, et des dommages aux infrastructures dans un état qui autorise des surcharges aux véhicules de transport de charbon.

Mots-clés : Véhicule à moteur utilitaire, dimensions excessives, surcharge, accidents de véhicule à moteur, contrôle des véhicules commerciaux.

1. Introduction

The goal of this research project was to prepare a synthesis of safety implications of oversize/over weight (OS/OW) commercial vehicles, so that this information could be used to evaluate applications for permits to move OS/OW vehicles on public highways, and to modify commercial vehicle enforcement practices.

This project is part of implementation of an International Technology Scanning Program conducted by the US Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), and the National Cooperative Highway Research Program (NCHRP). Scanning tours are conducted to seek innovative solutions for US 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, US officials make their decisions based primarily on minimizing infrastructure damage to bridges and pavements. However, European officials include safety as a primary consideration 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 US (Honefanger, 2007).

2. U.S. Heavy Commercial Vehicle Growth Trends

The number of large commercial vehicles on American highways has grown rapidly. “Just in time” delivery decreases costs associated with owning and operating large warehouses. The time value of merchandise also contributes. For example, an inventory of \$2 million that sits on store shelves for a month represents interest costs of over \$10,000. In today’s tight markets, wholesalers can restore that margin by doing away with warehouses and by moving goods quickly from the manufacturer to the consumer. Since delivery by truck is normally more rapid than delivery by either train or water, trucking firms have absorbed more and more of freight delivery. Table 1 indicates the current truck volume and share of freight shipments, along with a projection of the future values.

Table 1 - US Freight Shipments by Mode (Mallett, et al, 2006).

	2002 17.5 billion tonnes	2033 33.8 billion tonnes
Truck	59.7%	61.4%
Rail	9.7%	9.5%
Water	3.6%	2.8%
Air; air & truck	0.1%	0.1%
Intermodal ¹	6.7%	7.0%
Pipeline & unknown	20.2%	19.3%
Total	100.0%	100.0%

¹U.S. Postal Service and courier shipments

Between 1982 and 2002, the number of registered trucks increased 42% and the vehicle kilometers traveled (VkmT) almost doubled (Truck Safety Coalition, 2007). This amounts to annual growth rates of about 1.8% for truck registrations and 3.5% for VkmT. This was

extreme growth on a roadway system that was already saturated in many places. By 2004, there were 8.2 million large commercial trucks on the nation’s highways, traveling some 435 billion km annually. Twenty years of data from 1982-2002 (Truck Safety Coalition, 2007) and the 10 years of data from 1995-2004 (NHTSA, 2005) were compared to examine rates of growth. In addition, the final five years of data from 1995-2004 were examined. The comparison is shown in Table 2. It is clear that the rate of growth is slowing for both indicators. This might be from infrastructure limitations (congestion), market saturation (when there are no additional goods left to be shipped by trucks), or other reasons.

Table 2 - Rates of Growth for Registered Trucks and Vehicle Km Driven.

Dates	Period	Truck Annual Growth	V.km.T Annual Growth	Data Source
1982-2002	20 years	1.8%	3.7%	Truck Safety Coalition, 2007
1985-2004	10 years	2.0%	2.4%	
2000-2004	5 years	0.5%	2.0%	NHTSA, 2005

The research team’s projections for the coming 25-30 years are shown on Figure 1. Growth in truck travel was taken from Mallet, et al for 1980-2004. Growth from 2004 onward was estimated two ways, a linear extension of the 2000-2004 rate, and an annual percentage growth of the 2000-2004 period. These estimates show that the 2035 truck travel will be 363% to 452% of the 1980 rate. Infrastructure growth was estimated in the same manner, and was shown to be 113% of the 1980 value. With such truck growth it is no wonder that heavy commercial vehicles seem so prevalent on today’s highways, and why this is such a challenge for enforcement officers. There is another vivid finding in the figure; growth of truck travel is much faster than highway infrastructure growth. It will clearly reach such a level that existing infrastructure can not support further growth. Said another way, the expense and time delays associated with congestion of highway infrastructure may soon curtail the growth of truck freight, and perhaps the U.S. national economy.

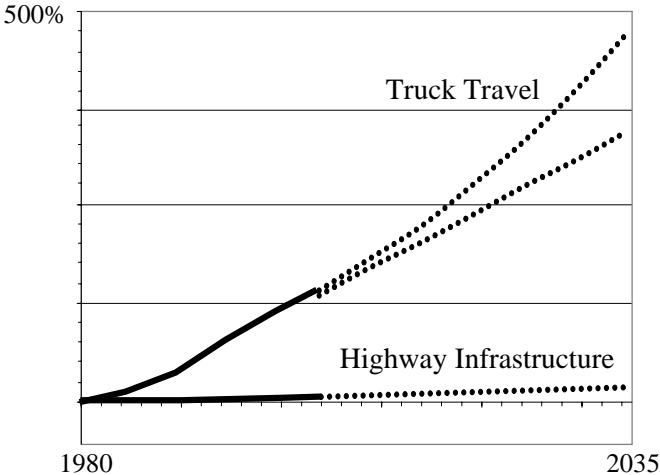


Figure1 – Truck and infrastructure growth trends (Mallett, 2006).

3. Literature Review of Large Truck Crashes

In the past decade, enhancements in data bases and computational tools, data mining, better control of variables in a study, and a better understanding of the application of statistical methodologies have improved the confidence that can be placed in safety research findings. This was important because it was not uncommon for prior studies to draw conflicting conclusions on the same topic.

In a 2002 study for the Montana DOT and the Western Transportation Institute to characterize commercial vehicle safety, Carson (Burke, et al, 2002), et al, gathered large truck crash data for more than 6,500 commercial vehicles that occurred in a seven year period. These crashes were matched to carrier profile information to examine crash trends. In addition the study critically reviewed almost 70 prior truck studies or publications. For example, 14 studies between 1969 and 1985 were evaluated on the topic of single trailers versus double trailers. Samples of the Carson's findings that are pertinent to this study follow:

Driver fatigue was a noted contributor to large truck crash frequency. Older, more experienced drivers were found to be safer. Use of alcohol and drugs was a contributing factor to crash rates; however, this was confined to a low portion of drivers. The safety findings for various vehicle configurations were somewhat conflicting.

There was good agreement among prior studies about vehicle weight; higher weights were associated with lower crash rates, but higher crash severities. Studies consistently showed that smaller carriers had higher fatal crash rates. Commercial vehicle crash rates and severities varied by roadway type, with rural roadways having less frequent but more severe crashes.

In 2002, Carson, et al, (2007) performed a similar study on Texas large truck crashes. Three years of Texas data, 44,000 truck crashes, were matched to carrier profile information. More than 160 research reports were reviewed. Of particular interest was the statement, "... *there is a dearth of literature linking vehicle size and weight to large truck safety levels... studies conducted over the last 60 years have not yielded definitive conclusions,*" (Morris, 2003). In general, the Texas study findings reinforced the Montana study and expanded them. Sample findings from the Texas study that are appropriate to this paper are stated in the three following paragraphs.

Fatigue contributed to increased large truck crash frequencies and severities, though this was difficult to measure and was often defined differently from study to study. Younger drivers consistently had higher crash involvement. More experienced drivers were safer, but had increased fatality risk in a crash if the driver was age 51 or older.

Consistently, higher gross vehicle weight resulted in lower crash rates but higher crash severities. However, there were few historical studies to confirm this relationship.

Smaller carriers generally had higher fatal crash rates than larger carriers, but the definition of a "small" carrier varied from study to study. Owner-operators had higher crash rates than drivers employed by a company. Local operation carriers had higher injury/fatality and overall crash rates than intercity operation carriers. Higher degrees of either horizontal or vertical roadway curvature resulted in higher crash frequencies. The effect of speed limits, either uniform or differential by vehicle type, on large truck safety levels was unconfirmed.

4. Large Truck Crash Facts

4.1 Historic Trends for Fatal Large Truck Crashes

In the U.S. large trucks are involved annually in crashes that cause approximately 5000 fatalities and more than 125,000 injuries. In 2005, 5,212 people were killed in large truck crashes, approximately 12-13% of all traffic fatalities that occurred that year (NHTSA, 2005), as illustrated for the 30-year period shown in Figure 2. This dispels a common myth – that the number of fatalities caused by large trucks is increasing rapidly. But the severity of truck crashes is high considering that large trucks account for only 3% of all registered vehicles, but 12-13% of fatal crashes. In other words, large truck crashes are four or more times more severe than crashes where large trucks are not involved.

But there is some good news. Even though truck crash fatalities are inching upward, they are still 23% lower than the distinct all-time-high in 1979. This is comprised of a 16% drop in passenger vehicle occupant deaths and a 45% drop in truck occupant fatalities (IIHS, 2007). There is more good news. The fatality rates for both passenger vehicle and large truck occupants declined over the past 25 years. There has been a 10% drop in the rate of fatal truck crashes per 100,000 trucks and a 14% drop in the VMT death rate.

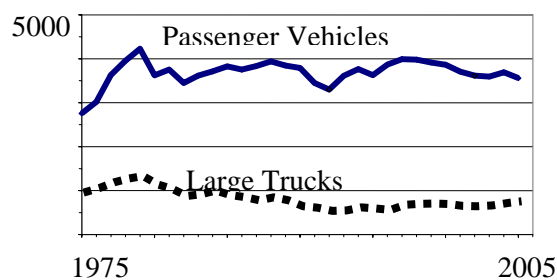


Figure 2 – Deaths in Crashes Involving Large Trucks 1975-2005 (NHTSA, 2005).

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4.2 Distribution of Fatalities

Another major concern regarding truck crash fatalities is the distribution among the crash victims. Passenger vehicle occupants are the most vulnerable in large truck crashes. In 2005, 68% of the fatalities (3,561) were the occupants of passenger vehicles involved in truck crashes (NHTSA, 2005). This is largely due to the energy associated with truck weights, which are 20 to 30 times heavier than passenger vehicles.

4.3 Types of Truck Crashes

Of the 442,000 truck crashes in 2005, the dominant type (69.9%) involved a large truck impacting another motor vehicle in motion. In about one-third of these crashes, the impact area was the front of the truck. Of fatal crashes involving large trucks, frontal impact occurred in over 60% of vehicle-to-vehicle crashes and almost half (46.8%) of all impact

scenarios (NHTSA, 2005). The second most prevalent impact point for fatal crashes was the rear of the truck (15.0%), often in the form of under-ride accidents. A relatively small portion of fatal truck crashes (3.5%) involved collisions with fixed objects, while a more significant type of crash involved collisions with non-fixed objects (10.5%). This latter category is particularly troublesome, since these crashes commonly resulted in the death of someone outside of a vehicle (8.6%).

4.4 Driver Factors in Fatal Crashes

The literature review discussed previously illuminated many driver factors (age, experience, trip length, etc.) that affect crash rates. The 2003 TIFA Factbook (Jarossi, 2007) contains additional information about driver involvement. One interesting pattern involves prior incidents of truck drivers in fatal crashes; incidences were categorized as prior accidents, license suspensions, speeding citations, and other moving violations. For all categories, 69% of truck drivers in fatal crashes had zero previous incidences, and over 87% had no more than one previous incident. Less than 4% had previously been involved in more than two crashes or received two citations or license suspensions. Only one-fourth of the involved drivers had ever been in a previous crash. Overall, prior incidences among truck drivers are much better than among automobile drivers.

4.5 Weight and Size of Trucks in Fatal Crashes

Good data are available about crash involvement for standard lengths and weights of trucks. For example, in 45% of all fatal crashes the truck length was in the range of 17.0-22.9 m. As for weight, about 9% of fatal crashes were in the range of 13,600-15,900 kg, and 11% were just below the normal legal limit at 34,000-36,300 kg. But, the literature yielded very little crash data on OS/OW commercial vehicles. What was found is listed in Table 3, which shows truck involvement in fatal crashes by truck length and weight.

Table 3 – Fatal Crash Involvement by Truck Length and Weight (Jarossi, 2007).

Length in m	%	Weight in Kg	%	
Less than 18.6	69.1	Less than 36,300	97.1	Over Legal Weight
18.6-21.3	18.5	36,300-38,600	1.2	
21.6-22.9	10.7	38,601-40,800	0.5	
23.2-24.4	0.9	40,801-43,100	0.2	
24.7-25.9	0.2	43,101-45,400	0.1	
26.2-27.4	0.2	45,401-47,600	0.4	
27.7-29.0	0.1	47,601-49,900	0.1	
29.3-30.5	0.1	49,901-52,200	0.1	
30.8 +	0.2	52,201-54,400	0.1	
		54,401-56,700	0.1	
		56,701-59,000	0.0	
		59,001-61,200	0.0	
		>= 61,201	0.1	

Unfortunately, only 2.9 % of all fatal crashes with truck involvement were listed as legally overweight. Even though they constitute a relatively small portion of the data, several conclusions may be drawn. First, exposure data is missing. We do not know the total vehicles and VkmT of OS/OW vehicles, and cannot estimate crash rates. Second, based upon

this data it appears that safety and enforcement efforts would not be efficient if directed only toward trucks near or below the 36,300 kg level. However, additional data is needed to determine whether overweight trucks have higher crash rates than trucks of lower weight or whether overweight trucks have more severe crashes than lower weight trucks. Either of these situations might warrant increased safety and enforcement counter measures.

5. Case Study – State with a Special Overweight Exemption

Kentucky legislation has allowed coal haulers to exceed normal weight limits for over 20 years. Additionally, researchers at the Kentucky Transportation Center (KTC) at the University of Kentucky (KTC) have conducted heavy commercial vehicle crash research, investigated heavy vehicle crashes, and reconstructed a number of these crashes. They have generated a number of research reports dealing specifically with legally overweight commercial vehicles, providing a wealth of information to this project.

5.1 Special Highway System Designation

The coal production industry is the crucial element of the Eastern Kentucky economy (Pigman, et al, 1995). In 1986 the Kentucky Legislature created the Extended-Weight Coal Haul Road System to allow trucks to haul larger loads to decrease coal transportation costs. Single-unit, 3-axle trucks can load to 40,800 kg, single-unit, 4-axle trucks can load 45,400 kg, and tractor-semitrailers with 5 or more axles can load 54,400 kg.

In 1992 KTC evaluated the impacts of the Coal Haul Road System. The system seemed to be successful in enhancing competitiveness and economic viability of the Kentucky coal industry. But the heavier weights of coal trucks added approximately \$9 million annually to pavement overlay costs. The evaluation also found that the overall crash rate for the extended-weight system was basically the same as the statewide rate. Injury rates were also similar. The greatest difference was the higher fatal crash rate on the extended weight system compared to the statewide rate and to the rate for a base system selected for comparison.

5.2 Truck Crash Study

In 1998 KTC initiated another truck accident study (Pigman, 1999) using a database of crashes from 1994-1997. This information was supplemented by police crash reports for 383 fatal crashes in which trucks were involved. For about two-thirds of the crashes, the primary contributing factor in truck wrecks was the action of the other driver – not the truck driver. The other driver crossed the centerline or median, or turned into the truck's path 47% of the time. In 13% of the crashes the other driver ran into the rear of a slow or stopped truck. KTC observed that in the hilly portion of Kentucky, heavy trucks drop down to crawl speed (about 24km/h) on long upgrades. There is a tendency for rear end crashes because vehicles approaching from the rear do not always recognize that the trucks are at low speed until it is too late to stop safely.

5.3 Overweight Trucks and Truck Violations

During this study KTC collected truck weight data from weigh-in-motion stations to evaluate the distribution of coal truck weights. Data was gathered from US 23 (an Extended-Weight Coal Haul road) in the southeastern portion of the state for 19,000 six-axle trucks that weighed more than 36,300 kg. The highest recorded weight was 100,000 kg, and the average was 71,700 kg. Eighty-eight percent of the vehicles exceeded the 57,100 kg weight limit for coal trucks. As a comparison, KTC obtained weights of five-axle trucks near a weigh station

on I-24. An extremely small number were over 36,300 kg, so KTC used a limited sample of 304 six-axle trucks weighing over 36,300 kg. Only 22% of them were over 45,400 kg and 5% over 54,400 kg. Both data sets are displayed in Figure 3.

Several conclusions can be drawn from the figure. First, at both sites the distribution of overweight vehicles was linear. Second, the coal truck weights far exceeded the I-24 trucks, since 88% of coal trucks but only 42% of I-24 trucks exceed the weight limit. Finally, there were many more overloaded trucks on US 23 than on I-24 (19,000 to 304).

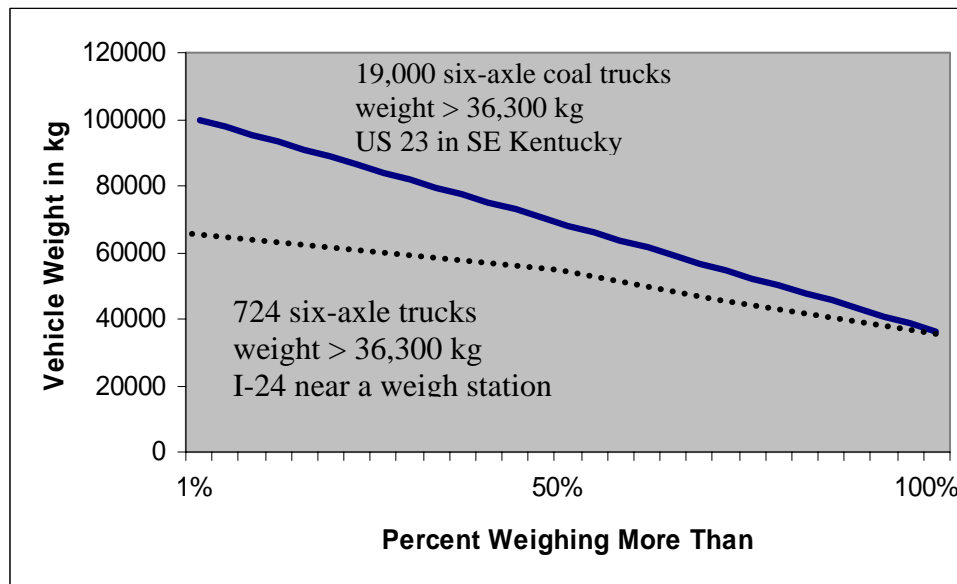


Figure 3 – Six-axle trucks weighing over 36,300 kg (Pigman, 1995).

During the 1996-97 year 2,313 citations were issued to overweight trucks; 6.1% of these cases were later dismissed (Pigman, Mar 1999). The most citations were given in three counties with weight-enforcement stations. In 1997 and 1998, 118,792 inspections were performed on trucks and or driver records. Over 17% of the trucks were taken out of service, and about 4% of the drivers were taken out of service. The four largest truck violations constituted 72% of the total. These four violations included (in order): brakes-all other, lighting, brakes out of adjustment, and tires. These four, in the same order, constituted 77% of the out-of-service violations. For drivers, the four largest violations – log book, traffic enforcement, medical certificate, and hours of service – amounted to 78% of the total. Two types of driver out-of-service violations were dominant – log book (49%) and hours of service (27%).

5.4 Other Findings

KTC researchers noted that investigation of truck crashes is difficult. Not many officers have advanced training to understand braking and stability issues. After a crash it is virtually impossible to weigh a truck and determine if it was overweight at the time of the crash, especially if it overturned and spilled the load. Few crashes have been reconstructed, due to the extensive cost for data collection and the time-consuming procedures associated with reconstruction. KTC investigations indicated that the center of gravity of the load was the key factor in maneuvering and overturning. To get 54,400 kg of coal onto a trailer, it must be piled higher than the sides of the trailer, a practice which raises the center of gravity. This

lowers the threshold for rollovers. Reconstruction of truck crashes showed a high center of gravity to be the key factor in rollover crashes.

Transportation researchers and practitioners need to know a lot more about safety relationships involving truck weight and truck speed. Even though there has been continuing and extensive discussion about the effect of extended weight loads on safety, KTC has not been able to find much evidence specifically linking truck crashes with truck weights. In other words, from looking at crash data, investigating crash sites, and reconstructing truck crashes, KTC did not see much to support excess weight as a cause of truck crashes. *While it is possible, or even probable, that excess weight is a causal factor, sufficient data does not exist to support that conclusion.*

6. Findings, Conclusions and Recommendations

6.1 Findings and Conclusions

The goal of this project was to identify safety implications of OS/OW commercial vehicles, so that the results could be used to enhance enforcement programs and to evaluate requests for permits to move large vehicles on public roads. During the study, the following conclusions were drawn:

Heavy truck growth has been rapid for the past 25 years, and it has become the dominant mode for freight shipments. Growth is expected to continue, but at a slower pace.

The literature provided good insight into truck crashes in general, including topics like driver fatigue and experience, trip length, smaller carriers and owner operators, and similar situations. In fatal crashes involving trucks, only 2.9% of the trucks were over 36,300 kg. Exposure data was lacking for calculating crash rates and other indicators. In general, the number of truck crashes diminishes with increasing gross vehicle weight, but the severity increases. This was a consistent across the literature.

There is a dearth of research regarding large truck size and weight and safety. In 2005, 5,212 fatalities occurred in large truck crashes, with about two-thirds of them occurring to passenger car occupants. Passenger car drivers are dominant cause of accidents in which large trucks are involved.

Kentucky allows overloaded coal haul trucks that can legally weigh up to 56,700 kg. A weight study found that 85% of these trucks exceeded the allowable weight, and one vehicle weighed 100,000 kg. Kentucky coal haul roads were found to have crash rates similar to other roads, but with higher fatal crash rates. Kentucky has documented the difficulty in collecting data after a large truck crashes, and the large expense of reconstructing crashes to determine crash cause.

The strongest finding of this study, both in the literature and the case study, is a general trend for decreased crashes but increased severity with increasing vehicle gross weight. There is a probable increased safety risk for speeding and excessive weight, but there is little data to support this concept.

6.2 Recommendations

The continuing growth of large trucks mandates attention and analysis, before the growth compounds congestion and safety issues. Normal crash data collection and analysis procedures have been insufficient to define the problem, and a major new effort is needed. The new effort should be national in scope, and should involve highly trained teams to investigate crashes and crash sites. The FARS program might be a model.

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