# An Analysis of Truck Size and Weight:
# Phase I – Safety

MULTIMODAL TRANSPORTATION
& INFRASTRUCTURE CONSORTIUM

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## *DISCLAIMER*

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## Executive Summary

Commercial motor vehicles carrying heavier loads or employing multiple trailers present significant concerns regarding the impact of their use in terms of increased accidents, accident severity and fatalities. In 2011, the most recent year for which data is available, 3,757 people were killed in crashes involving large trucks and 88,000 more were injured – absent any increase in truck size and weight.[1]

Several proposals have been made in recent years to increase limits for truck size and weight yet significant disputes exist about the safety of heavier and longer truck configurations. The Nick J. Rahall, II Appalachian Transportation Institute (RTI) performed a critical evaluation of available crash rate data, prominent safety claims and operating characteristics. Our initial findings are presented below.

## Assessment of Crash Data

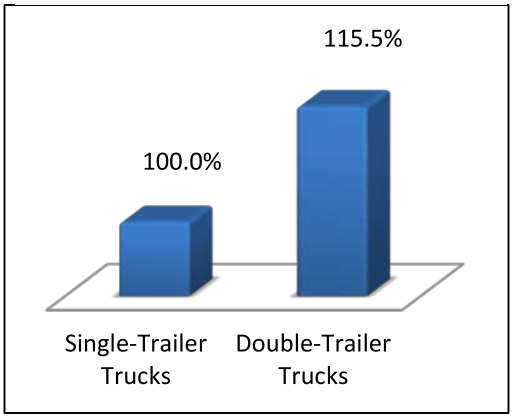
National crash rate data, though limited in several respects, show disturbingly higher crash rates for trucks that are longer or heavier than the current standard 80,000-pound, five-axle truck.

For our analysis, we used average annual fatality data from the Trucks in Fatal Accidents (TIFA) dataset for 2005-2009 and vehicle miles traveled (VMT) estimates from the Federal Highway Administration. TIFA is the most accurate and complete dataset of fatal truck crashes available. It includes reliable information on the number of trailers and axles of trucks involved in fatal accidents. It does not, however, contain the relevant length or weight information needed to calculate crash rates for specific configurations. Nevertheless, existing data shows significantly higher crash rates for multi-trailer configurations and single-trailer trucks with six or more axles relative to the rate for all singles.

[1] http://www.fmcsa.dot.gov/documents/facts-research/CMV-Facts.pdf. Retrieved May 13, 2013.

*Multi-Trailer Configurations*

**Normalized Crash Rate Comparison**




- The raw data show a 13 percent higher fatal crash rate for double-trailer configurations compared with single- trailer trucks and when the data are normalized to compare similar nation-wide operation, the gap increases. **In nation-wide operation similar to single-trailer combinations, double-trailer trucks are likely to have a fatal crash rate 15.5 percent higher than single-trailer trucks.**
- This finding is consistent with the results of the 2000 US DOT Comprehensive Truck Size and Weight Study, which found an 11 percent higher fatal crash involvement rate for multi-trailer configurations.
- The same raw data show that triple-trailer trucks have a higher fatal crash involvement rate than both doubles and singles. The average number of annual fatalities involving triples and the percentage of VMT attributable to triples are too small to yield a scientifically reliable fatal crash rate finding for triples. However, the data suggest that the finding for doubles is illustrative for longer combination vehicles generally.

*Single-Trailer Configurations with Additional Axles*

- Single-trailer combination trucks with six or more axles – presumably the heaviest trucks – have dramatically higher crash rates than five-axle singles. **An analysis of TIFA data indicates that single-trailer combination vehicles with six or more axles have a fatal crash involvement rate 867% higher than the rate for all single-trailer trucks.**
- Here, too, the relatively small population of six or more axle trucks traveling the nation's highways precludes a scientifically reliable finding. Further, we have significant concerns about the quality of underlying data, especially VMT estimates for sub-classes of vehicles. Many data collection problems exist, and the smaller the class of vehicles considered, the larger the potential sources for error.

- Even if more reliable data were to show a fatal crash rate increase even a fraction of that above, the negative implications for highway safety would be vast. It would seem unwise to allow expanded operation of six-plus-axle trucks without further serious consideration of the possible impact on fatality rates.

## Operating Characteristics

Serious safety concerns about the relative operating characteristics of heavier and longer truck configurations have been documented in both government and independent studies conducted over the past 30 years. Our review of existing research leads us to conclude that in many cases, credible new research does not exist to dispel these concerns. In some cases, new concerns have arisen in recent years. Among the concerns over the operating characteristics of heavier and longer configurations are:

- State safety inspections suggest that brake maladjustment and equipment defects continue to be widespread issues among current truck operations. Heavier loads require more braking capacity and can exacerbate braking issues.
- Heavier vehicles are likely to increase accident severity as they have more kinetic energy at any given speed. This may be exacerbated as autos become smaller and lighter to meet ever more stringent fuel efficiency standards.
- Increases in allowable vehicle weight may mean higher trailer loadings and a higher center of gravity thus increasing the risk of rollover and cause compensatory heavy vehicle operator behavior that will result in greater interference with other vehicles.
- Heavier and longer configurations can cause greater interference with other traffic (including longer acceleration times and increases in speed for trucks traveling up and down hills) that could exacerbate conflicts with other motorists.

## Non-Federal Studies

Proponents of increases in truck size or weight often cite state-specific studies or statistics from other nations to support their claim. Our analysis of prominent studies leads us to conclude that these studies have little applicability to nationwide operation of heavier or longer configurations in the US. For example, the VMT and crash exposure findings from a recent Wisconsin study are insufficient for a national analysis that would require more precise truck and rail diversion assumptions. In Idaho, the Transportation Department was unable to make a statistically significant finding about the safety of long doubles because they represent such a small percentage of truck traffic in the State, preventing the application of the Idaho study results nationally. Also, statistics from the United Kingdom showing decreased truck crash rates cannot be distinguished from a decrease in crash rates for all vehicles, have been criticized by the UK Department of Transport for significant underreporting and should not be considered applicable to US operations because of significant geographical, infrastructure and regulatory policy differences between the US and the UK.

**Illustrative Quotes from Law Enforcement Interviews**

"Maximum braking efficiency is only achieved in the lab."

"A driver would have to be on his 'A' game if he is going to control a vehicle that is 17,000 more pounds."

"We can replace bridges and roads. We cannot replace people."

## Professional Experience

Concerns over the quality of available data and the lack of substantiated claims of safety improvements led RTI to conduct interviews with law enforcement officers with expertise conducting truck safety inspections and accident investigations and to conduct a survey of truck drivers themselves.

- 20 of the 21 officers interviewed indicated flatly that heavier and longer trucks would be "more dangerous" because the additional weight and length would add new factors to an already complicated chain of events.
- Officers offered real world observations reinforcing many of the concerns about the operating characteristics of longer and heavier trucks raised in the literature.
- With specific regard to crash severity, officers often noted that larger trucks almost always increase the severity of the crash remarking that it was a simple physical equation of kinetic energy with the potential for significantly more damage.
- Similarly, surveyed truck drivers are consistent in their opinion that heavier and/or longer trucks raise significant concerns over the impacts of these configurations on safety. Full results can be seen in the charts below, but the overall conclusions are that:

- 90 percent of those surveyed believed that increased use of 97,000-pound, six-axle trucks would negatively impact highway safety, and
- 88 percent believed that greater use of longer combination vehicles would negatively impact highway safety.

**Truck Driver Views of Heavier Trucks' Safety**

| Characteristic | Positive Impact | Negative Impact | No Impact |
|---|---|---|---|
| Braking distance | 9 % | **73 %** | 18 % |
| Require additional effort to prevent rollover | 5 % | **86 %** | 9 % |
| Turning radius | 5 % | **70 %** | 25 % |
| Emergency maneuver | 0 % | **90 %** | 10 % |
| Impact on equipment | 5 % | **76 %** | 19 % |

**Truck Driver Views of Longer Combination Vehicles' Safety**

| Characteristic | Positive Impact | Negative Impact | No Impact |
|---|---|---|---|
| Braking distance | 2 % | **91 %** | 7 % |
| Require additional effort to prevent rollover | 0 % | **77 %** | 23 % |
| Turning radius | 0 % | **66 %** | 34 % |
| Emergency maneuver | 0 % | **86 %** | 14 % |
| Impact on equipment | 2 % | **81 %** | 17 % |

## Conclusion

The existing literature, research, interviews and statistics provide clear, if not conclusive, evidence. With confidence, we can say that additional axles, vehicle length and weight place pressure on the equipment, maintenance and drivers, which ultimately increases the potential for error, accident and fatality. Further, existing data suggests that heavier and longer trucks are likely to have higher fatal crash rates than the most common trucks on the road today. To better assess the safety impacts of future proposals to increase truck size or weight will require information not currently available. To that end, we make the following recommendations.

1. **Improve data collection efforts.** Data on fatal accidents by configuration and reliable VMT estimates will be required to fully answer questions about the safety of specific truck configurations. Federal agencies should work to require the collection and reporting of more specific information (including weight and configuration) for vehicles involved in fatal accidents and should significantly improve the collection of VMT data.
2. **Conduct off-road operating characteristic testing.** Industry states that technology has enhanced the operating characteristics of commercial motor vehicles yet there is no research directly comparing the operating characteristics of proposed vehicles. This analysis should be completed on a test track to avoid experiments involving the motoring public.

# An Analysis of Truck Size and Weight: Phase I – Safety

## 1. Background

The use of commercial trucking vehicles authorized to carry heavier loads or employing longer combination trailers is often promoted by industry advocates as offering significant productivity improvements. Yet, from a safety perspective, there remain hotly debated concerns regarding the impact of their use and the outcome on increased accidents, severity and, unfortunately, increased fatalities.

Considerable time has passed since the last comprehensive federal study of truck size and weight, the Comprehensive Truck Size and Weight Study completed by the US Department of Transportation in 2000. Completion of the 2000 study caused a flurry of research into nearly every issue impacted by truck sizes and weights in the 1990s. However, the lack of federal research funding for this area has meant that relatively little new research has been completed since that time. There exist gaps in the body of knowledge. The goal of this analysis is to critically evaluate the claims made by those advocating for increases in truck size or weight and to update the body of knowledge regarding the potential impacts to safety of heavier and longer trucks. The topics were selected in consultation with the Railway Supply Institute as well as Coalition Against Bigger Trucks. RTI recognizes the valuable contributions by the Railway Supply Institute, the National Troopers Coalition, the Owner Operator Independent Drivers Association, RD Mingo and Associates, and Duane Meyers of Great Lakes Crash Analysis, LLC.

> In 2010, there were 3,261 large truck fatal crashes in which 3,675 people were killed, according to FMCSA's Large Truck Crash Overview 2010.

The Rahall Appalachian Transportation Institute (RTI) is a leader in transportation and research and economic development solving transportation challenges and addressing future needs through applied multimodal research, workforce development and advanced technology. RTI is also the lead research institution in the Multimodal Transportation and Infrastructure Consortium (MTIC) funded through the Research and Innovative Technology Administration

(RITA) of the US Department of Transportation (USDOT). The Transportation Economics team at RTI provides public and private industry with information to determine the safest, most cost-effective means to move people, goods and services. Federal, state and local governments utilize the knowledge of our experienced team to make planning decisions for sustainable economic growth and development. The RTI team of researchers provides guidance for the best options in transportation as they relate to policymakers' plans for future transportation needs in West Virginia and the Appalachian region to more efficiently move people, goods and services. In an effort to serve in that role and to fill in the identified gap in research regarding the impact of larger and heavier trucks with respect to safety, RTI presents this analysis.

## 2. Organization of the Analysis

This report represents the first phase of a larger study on the impacts of heavier and larger trucks that will be divided into two main areas: safety and infrastructure. Our report relies heavily on past papers and studies given that very few new studies have been completed in recent years. Phase I, with its focus on safety included a review of pertinent past papers and prior literature as well as a discussion with industry experts and interviews conducted by R.D. Mingo and Associates, is broken down into six major elements. These include:

1. The evaluation of a consultant-completed examination regarding the presence of sufficient, reliable data to determine crash rates for various truck configurations;
2. A review of existing literature evaluating the operating characteristics of trucks heavier and longer than the current federal limits;
3. A critical evaluation of safety claims from three sources often cited by groups advocating for increases in truck size and weight;
4. An analysis of consultant-completed interviews conducted with truck enforcement officers and accident investigators; and
5. An analysis of a survey of truck drivers.

# 3. Research and Evaluation

## 3.1 Assessment of Existing Crash Data

Many previous studies have attempted to determine the safety risks of trucks of various configurations, especially trucks that are larger and heavier than the typical 80,000-lb single trailer five-axle truck that serves as the work horse of today's trucking fleet. National crash rate data, though limited in several respects, show disturbingly higher crash rates for trucks that are longer or heavier than the current standard 80,000-pound, five-axle truck.

***Previous US DOT Studies***

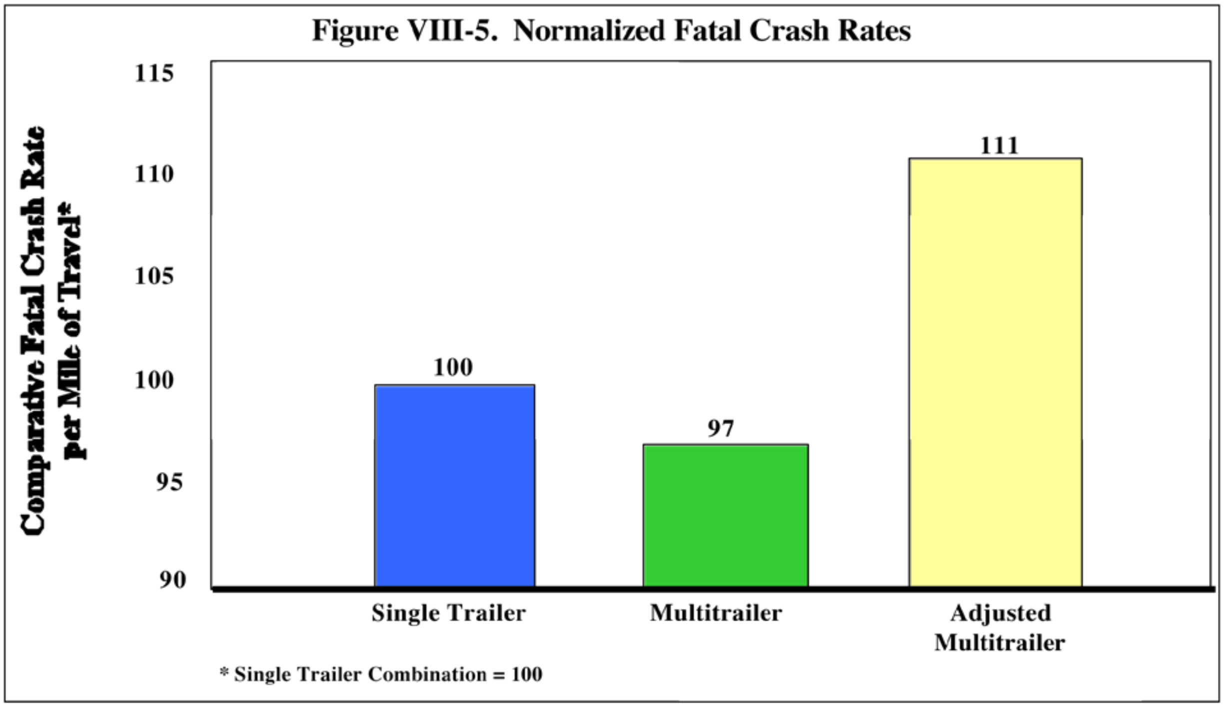
The most recent, comprehensive Federal study on truck size and weight was conducted by the US Department of Transportation in 2000. DOT documented the significant limitations with available data sources, as described below, and so did not attempt conclusions about the likely crash rates of heavy trucks with varying number or lengths of trailers or varying operating weights. However, DOT did compare the crash rates of passenger vehicles, single unit trucks, single-trailer combinations, and multi-trailer combinations.

DOT found that though raw data suggested that multi-trailer combinations had a three percent lower overall fatal crash rate than single-trailer combinations, both have significantly higher fatal crash involvement rates than personal vehicles or single unit trucks and the raw data masked important differences in the operating environments of single-trailer and multi-trailer combinations.[2] Single-trailer combinations accumulated more of their mileage on non-Interstate roads than did multi-trailer configurations and crash rates for multi-trailer combinations were consistently higher than single-trailer combinations when compared on the same non-Interstate roadway types. When fatal accident involvement rates were normalized to apply the same travel distribution pattern to both single-trailer combinations and multi-trailer combinations, the result was that, "under conditions of generally unrestricted use similar to that of single-trailer combinations, multi-trailer combinations–as they are currently designed and configured–could be expected to experience an 11 percent higher overall fatal crash rate than single-trailer

[2] Comprehensive Truck Size and Weight Study, US Department of Transportation, 2000, Vol. 3, p. VIII-3.

combinations."[3] Figure 1 below is the graphic from DOT's 2000 study that illustrates this conclusion.

**Figure 1 - Conclusion of USDOT 2000 Study**




In its 2004 Western Uniformity Scenario Analysis, US DOT came to similar conclusions. In this case, DOT was trying to determine the effects of allowing 13 Western States to harmonize LCV laws. In this analysis, DOT found that for the period 1995-1999, multi-trailer combinations in the 13 scenario States had a fatal crash involvement rate of 3.13 per 100 million vehicle miles traveled (VMT) compared with 2.88 per 100 million VMT for single-trailer combinations, an 8.7 percent higher rate. Limitations in the available data kept DOT from reaching a statistically significant conclusion, however.

"Although this represents more recent data than the previous studies, the analysis has many of the same limitations found in previous statistical safety analyses that attempt to estimate the respective safety of LCVs compared to other truck configurations. These include: (1)

[3] Comprehensive Truck Size and Weight Study, Vol. 3, p. VIII-5.

examination of past safety data may be an inaccurate predictor of future roadway safety; and (2) the analysis is unable to isolate LCVs from STAA doubles. Despite these shortcomings, the analysis demonstrates the importance of operating environment and potential trends."[4] Put another way, "The measurement problem is three-fold; fatalities are rare occurrences, there are few LCVs currently operating and there is only limited travel data collected on LCVs."[5]

Though this study focused on the question of LCV crash rates, DOT's discussion of data inadequacies extended to the broader question of crash rates for all configurations heavier or longer than the general Federal limits. "Because larger and heavier trucks are a relatively small subgroup of trucks, differentiating their crash involvement patterns from those of other truck types is problematic."[6]

***Our Approach***[7]

Previous work in analyzing accident databases has largely utilized the Trucks in Fatal Accidents (TIFA) dataset and for good reason. TIFA combines survey data compiled by the University of Michigan Transportation Institute (UMTRI) with the Fatality Analysis Report System (FARS) compiled by the National Highway Traffic Safety Administration (NHTSA) to form the most accurate and complete dataset of fatal truck crashes available. However, this dataset does not contain vehicle weight or length information. We examined updated TIFA data in a manner similar to that used by US DOT in its 2000 and 2004 studies. This allows for comparisons between multi- and single-trailer configurations like those completed by DOT, but also imposes the same limitations faced by DOT – namely that reliable analyses cannot be completed for specific vehicle configurations with specific weights and lengths.

With respect to the truck travel data required to produce normalized fatal crash rates, however, the data source utilized by USDOT in its earlier studies is no longer available in the same form. One of the best sources of information for travel by truck configuration was the

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[4] Western Scenario Uniformity Analysis, US Department of Transportation, 2004, p. VII-18.
[5] Western Scenario Uniformity Analysis, p. VII-20.
[6] Ibid, p. VII-1
[7] Roger Mingo and the staff of R.D. Mingo & Associates, serving as consultants to this project, provided significant assistance with the assessment of existing crash data for trucks of various configurations.

every-five-years Truck Inventory and Use Survey (TIUS), which in its later years was changed to the Vehicle Inventory and Use Survey (VIUS). The last VIUS was conducted for the year 2002, so the data is now stale. Furthermore, sampling methodology was changed for the last two surveys (1997 and 2002) to the extent that the Federal Highway Administration (FHWA) has concluded that it cannot rely on VIUS alone for national control totals for truck VMT, as it did with the 1987 and 1992 surveys.

In conducting its most recent highway cost allocation study, on which work was done but not completed and which was not released to the public, FHWA opted instead to use the latest weigh-in-motion (WIM) data then available as the chief source of vehicle configuration information, supplemented when necessary with VIUS survey data and with state-reported classification data. The last revision to FHWA estimates of travel by vehicle configuration occurred in 2008, using 2006 classification and WIM data and 2002 VIUS data. This estimate used data from the VM1 table published annually in the Highway Statistics Series for overall control totals for the broad classes of “single unit trucks” and “combination trucks.”

***Multi-Trailer Fatalities from TIFA***

To eliminate any bias existent in a single year of data, we examined the TIFA dataset for the five most recent years of available TIFA data. Table 1 shows the number or fatality involvements by year and broad truck type as well as the five-year total for each broad type.

**Table 1 – Fatality Involvements by Year and Truck Type**

| | 2009 | 2008 | 2007 | 2006 | 2005 | 2005-09 |
|---|---|---|---|---|---|---|
| **Single Unit** | 1,450 | 1,754 | 2,103 | 2,182 | 2,100 | 9,589 |
| **Single Trailer** | 2,238 | 2,969 | 3,578 | 3,706 | 3,694 | 15,735 |
| **Double Trailers** | 129 | 199 | 240 | 236 | 260 | 1,064 |
| **Triples** | 4 | 1 | 2 | 3 | 5 | 15 |

These fatality numbers were then converted to fatal crash involvement rates by using VMT data described above and the rate for each broad type calculated relative to the rate for single-trailer trucks. Table 2 shows this analysis.

**Table 2 - Fatality Involvement Rates (per 100 Million VMT)**

| | Fatalities (Average Annual) | VMT (Millions) | Rate | Relative to Single Trailer |
|---|---|---|---|---|
| **Single Unit** | 1,918 | 80,331 | 2.39 | 102% |
| **Single Trailer** | 3,147 | 134,557 | 2.34 | 100% |
| **Double Trailers** | 213 | 8,036 | 2.65 | 113% |
| **Triples** | 3 | 113 | 2.66 | 114% |

Note that doubles and triples both have a higher fatality involvement rate than single-trailer trucks for the five-year average. This is in contrast to the analysis for DOT’s 2000 study, which showed multi-trailer configurations exhibiting slightly lower fatality-involvement rates when operating routes were not considered. Note, too, how small are the number of fatalities and miles traveled for triples compared with those of other truck types. This indicates that doubles continue to dominate multi-trailer data, as they did in both US DOT studies, and that the small population of triples in operation precludes a scientifically reliable finding.

As noted above, US DOT found varying crash rates for the broad truck types on the various highway classes. This makes sense considering the dramatically different traffic patterns on various classes of highway and the fact that singles continue to travel much more extensively on non-Interstate roads than do multi-trailer configurations. Table 3 shows fatal crash involvement rates for each truck type on differing functional classes of highway. The last column shows the ratio of doubles to single-trailer rates. Note the differences in rates by functional class for both single- and double-trailer combinations, with the highest volume highways generally showing the lowest rate of fatalities per mile traveled.

**Table 3 - Fatality Involvement Rates per 100 Million VMT (2005-09)**

| | **Single Unit*** | **Single Trailer**** | **Double Trailer** | **Triple** | **Double Trailer to Single Trailer Ratio** |
|---|---|---|---|---|---|
| 1=Rural-Interstate | 1.430 | 1.765 | 1.994 | 3.424 | 1.13 |
| 2=Rural-Principle Arterial Other | 3.461 | 3.200 | 3.356 | 1.456 | 1.05 |
| 3=Rural-Minor Artery | 4.824 | 5.345 | 7.452 | 0.000 | 1.39 |
| 4=Rural-Major Collectors | 3.451 | 4.861 | 4.117 | 15.806 | 0.85 |
| 5=Rural-Min Collectors | 3.438 | 3.811 | 8.293 | 0.000 | 2.18 |
| 6=Rural-Local Road | 5.402 | 3.366 | 2.449 | 0.000 | 0.73 |
| 11=Urban-Interstate | 1.170 | 1.717 | 2.119 | 0.000 | 1.23 |
| 12=Urban-Freeway/Expressway | 1.415 | 1.043 | 1.064 | 0.000 | 1.02 |
| 13=Urban-other Principle Arterial | 1.739 | 1.856 | 2.117 | 9.072 | 1.14 |
| 14=Urban-Minor Artery | 1.787 | 2.285 | 3.341 | 0.000 | 1.46 |
| 15=Urban-Collector | 1.286 | 3.747 | 11.595 | 0.000 | 3.09 |
| 16=Urban-Local Street | 5.673 | 13.186 | 12.259 | 0.000 | 0.93 |
| **Total** | **2.387** | **2.406** | **2.648** | **2.665** | **1.10** |

* Single unit trucks in 2, 3, or 4+ axle configurations

**Trucks with single trailers in 3, 4, 5, or 6+ axle configurations

The 2000 USDOT Truck Size and Weight study weighted the functional class fatality ratios to take into account these differences in heavy truck traffic patterns and found that multi-trailer configurations had an 11 percent higher fatal crash involvement rate than singles. The study does not describe how the functional classes were weighted; however, Table 4 shows our attempt to derive a similar weighted result. The first column of the table shows the fatality rate ratios from Table 3, while the next three rows show alternative weighting schema – weighted by total truck fatality involvements, combination truck fatality involvements, or combination truck VMT.

**Table 4 - Weighted Rate Comparison**

| | | **Weighted by:** | | |
|---|---|---|---|---|
| | **Double Trailer to Single Trailer Ratio** | **Truck Fatalities** | **Combination Fatalities** | **Combination VMT** |
| 1=Rural-Interstate | 1.130 | 0.191 | 0.254 | 0.345 |
| 2=Rural-Principle Arterial Other | 1.049 | 0.211 | 0.236 | 0.178 |
| 3=Rural-Minor Artery | 1.394 | 0.175 | 0.165 | 0.073 |
| 4=Rural-Major Collectors | 0.847 | 0.082 | 0.069 | 0.034 |
| 5=Rural-Min Collectors | 2.176 | 0.038 | 0.025 | 0.015 |
| 6=Rural-Local Road | 0.728 | 0.027 | 0.015 | 0.011 |
| 11=Urban-Interstate | 1.234 | 0.145 | 0.172 | 0.240 |
| 12=Urban-Freeway/Expressway | 1.019 | 0.036 | 0.033 | 0.077 |
| 13=Urban-other Principle Arterial | 1.140 | 0.104 | 0.085 | 0.110 |
| 14=Urban-Minor Artery | 1.462 | 0.072 | 0.049 | 0.051 |
| 15=Urban-Collector | 3.095 | 0.051 | 0.030 | 0.017 |
| 16=Urban-Local Street | 0.930 | 0.029 | 0.017 | 0.003 |
| **Weighted Rate** | **1.101** | **1.160** | **1.150** | **1.155** |

All three weighting methods increased the ratio by approximately the same magnitude and increased the overall relative fatal crash involvement rate consistent with the weighted findings of the USDOT 2000 study. Of these three methods, the mean and median are both the same as the result generated from weighing the crash rates by combination VMT. Thus, we conclude that under similar travel patterns, double-trailer heavy trucks are likely to have a 15.5 percent higher fatal crash rate than single-trailer trucks.

***Single-Trailer Fatalities from TIFA***

Using this same data to compare the crash rate of trucks with varying numbers of axles produces dramatic results. Table 5 compares the fatality involvement rates for single-trailer combination trucks with various numbers of axles. Trucks with six or more axles have significantly higher fatal crash involvement rates than five-axle configurations or configurations with fewer axles. Relative to the overall single-trailer combination truck crash rate, single-trailer combinations with six or more axles have a fatal crash rate 867 percent higher than the overall single-trailer crash rate above.

**Table 5 – Fatality Involvement Rates for Single-Trailer Combination Vehicles**

| | Fatalities (Average Annual) | VMT (Millions) | Rate | Relative to Single Trailer |
|---|---|---|---|---|
| **3-4 Axles** | 37 | 11,852 | 0.31 | 13% |
| **5 Axles** | 2,927 | 118,143 | 2.48 | 106% |
| **6+ Axles** | 184 | 812 | 22.61 | 967% |

As Table 5 illustrates, however, trucks with six or more axles make up just 0.6 percent of overall single-trailer combination truck VMT. Given such a small sample size and the potential sources of error in VMT estimates for such a small subclass of vehicles, it is clear that this finding does not cross the threshold of statistical significance.

However, such a high relative crash rate calls into question the claims made by those advocating for heavier gross vehicle weight limits who contend that the addition of a sixth (or more) axle(s) will negate any potential differences in the safety of a heavier single-trailer combination truck. It also calls into question the findings of studies that assume a 20 percent increase in theoretical braking capacity (the equivalent of adding a "sixth axle") will result in a five percent reduction in fatal crash rates.[8] Further, that the relative crash rates of trucks with six or more axles are so much higher than that of five-axle trucks places a high burden of proof on heavier truck advocates to show that six-axle trucks will be as safe or safer than trucks in most common operation today.

***Assessment of Existing Crash Data***

In producing the findings above, significant questions arise regarding the availability and quality of truck crash/injury/fatality data as well as data about the miles of travel of truck configurations.

As noted in both USDOT's 2000 Comprehensive Truck Size and Weight Study and its 2004 Western Uniformity Scenario Analysis, larger and heavier trucks are a relatively small subgroup of all trucks, which makes differentiating the crash involvement patterns of larger and heavier configurations from other truck types very difficult. "Available crash databases are capable of ascertaining trends in overall truck safety and broad distinctions among vehicle types, but are less capable of clearly differentiating trends for smaller subsets of vehicles."[9]

For example, the TIFA dataset consistently includes reliable information on the number of cargo units and the number of axles, but it does not contain weight or vehicle length information. In fact, truck accident report forms vary among the states and typically do not include information on the weights or dimensions of vehicles involved in crashes. For example, the Missouri Uniform Accident Report (Appendix A) includes check boxes for truck tractors

[8] This assumption is relied upon by the Wisconsin Truck Size and Weight Study completed by Cambridge Systematics, Inc., in June 2009 and is based on the findings of Transportation Research Board Special Reports 225 and 227.
[9] Comprehensive Truck Size and Weight Study, Vol. 3, p. VIII-1.

with one, two, or three trailing units and whether the cargo body is an enclosed box, cargo tank, etc., but only includes check boxes for distinguishing whether the vehicle's gross vehicle weight rating (GVWR) is less than or equal to 10,000 pounds, 10,001 to 26,000 pounds, or greater than 26,000 pounds. It does not require the number of axles to be reported, the operating weight of the truck, or even whether the truck was carrying a load at the time. While it is easy to understand the challenge that would be posed by requiring accident responders to weigh the truck, particularly in cases where the accident resulted in a cargo spill, this lack of information makes truck crash data insufficient for configuration-specific determinations.

This means that fatalities can be compiled for trucks generally and for special classes of trucks, but we cannot distinguish between specific truck configurations – e.g. 97,000-pound, six-axle, single-trailer combination trucks or 111,000-pound, nine-axle, triple-trailer combination trucks. Further, even where data on the number of crashes for certain types of vehicles are known, the VMT for that vehicle often is not known, which makes it impossible to calculate crash rates for the specific configurations.

Finally, even if there was a reliable source for crash rate data for heavier or longer vehicles in operation under special circumstances like commodity-specific permits, it would not be reasonable to assume that these configurations would experience similar crash rates if they were adopted for more widespread usage. For example, the Idaho Transportation Department (ITD) recently completed a report evaluating the impacts of a 10-year pilot project during which 129,000-pound double-trailer trucks were allowed to travel on specific routes in Southern Idaho.[10] During this ten-year period, ITD noted an increase in the crash rate for trucks on pilot routes compared to non-pilot routes; further, the crash rates for trucks on the most heavily utilized pilot project routes were higher than those on other pilot routes and on non-pilot routes.[11] This suggests a correlation between the travel of these heavier, longer trucks and the increased truck crash rates. However, because ITD was unable to track pilot project trucks separately from other trucks on Idaho routes and because, "the number of trips made by the project trucks

[10] 129,000 Pound Pilot Project Report, Idaho Transportation Department, 2013.
[11] 129,000 Pound Pilot Project Report, p. 10.

represents a small portion of total truck traffic on the study routes, and an even smaller portion of the total vehicle volume on most of the routes," they were unable to make a statistically significant finding with respect to crash rates.[12] The data from this type of special operation would be even less valuable for attempting to make a finding for trucks in nationwide operation.

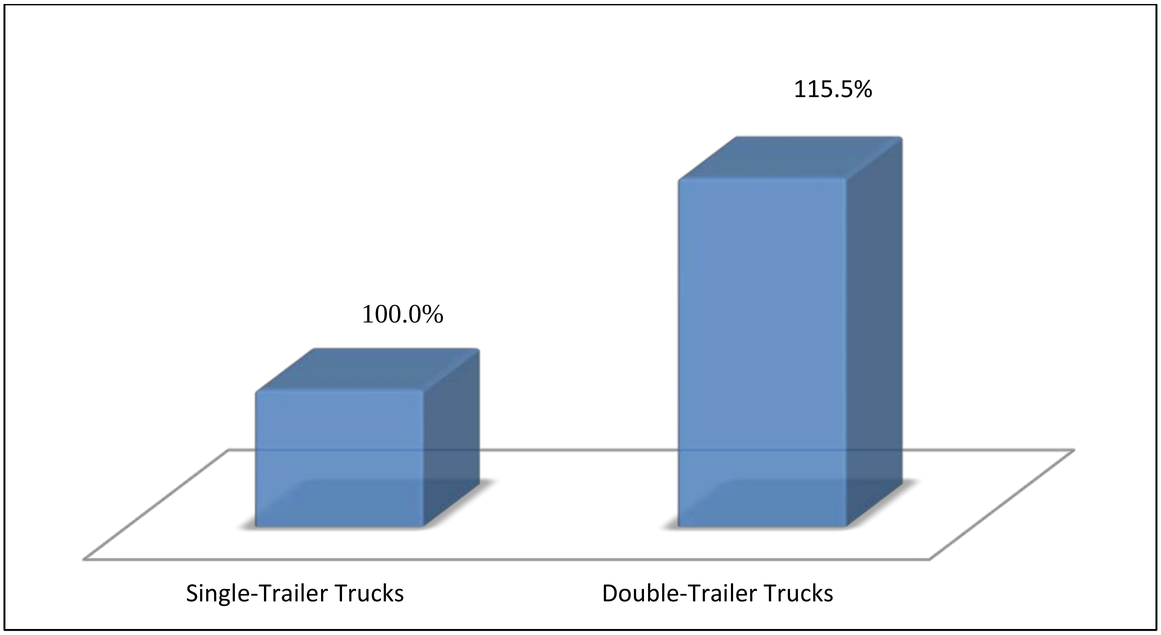
### 3.1.1 Crash Rate Conclusions

Significant problems arise when attempting to determine and compare fatal crash accident rates for truck configurations, particularly configurations heavier or longer than the general Federal limits, which are of most interest to this study and to the truck size and weight debates occurring in state capitols and in Congress. The most accurate and complete dataset of fatal truck crashes available does not contain vehicle weight or length information. One of the most reliable sources of truck VMT data has been discontinued.

However, data continues to show that under similar travel distribution patterns where single-trailer and double-trailer configurations operate in generally unrestricted use, double-trailer configurations could be expected to have a higher fatal accident involvement rate. We conclude that in situations of similar usage to that of single-trailer configurations, double-trailer trucks are likely to have a 15.5 percent higher fatal crash rate than single-trailer trucks. (Figure 2)

[12] Ibid, p. 12.

**Figure 2 – Adjusted Fatal Crash Rate Comparison**




This analysis uses more recent crash data and a different VMT source than USDOT's 2000 and 2004 studies and uses a larger data set than that considered in the 2004 study. However, it confirms the higher multi-trailer fatal crash rates presented in both studies. When taken together, it seems clear that multi-trailer configurations – particularly double-trailer trucks, which make up the bulk of the multi-trailer universe – are likely to be involved in fatal accidents more frequently than their single-trailer counterparts.

This finding is particularly important when viewed in the context of overall truck crash rates. In 2010, there were 31,000 injury crashes involving combination trucks and 43,000 persons injured in combination truck crashes.[13] Additionally, there were 2,423 fatal crashes involving combination trucks.[14] Given the conclusion above, allowing wider operation of multi-trailer trucks would likely mean that a number of crashes that currently result in injuries would result in additional fatalities – an unacceptable outcome for continued progress toward safer highways.

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[13] Large Truck and Bus Crash Facts 2010, Federal Motor Carrier Safety Administration, 2010, Table 18, p. 28.
[14] Ibid, Table 16, p. 25.

## 3.2 Evaluation of Truck Operating Characteristics[15]

Another instructive way of evaluating the safety of heavier and longer trucks is to evaluate the operating characteristics of truck configurations. This synthesis of existing research covers some of the important safety issues presented by real-world operating characteristics of trucks heavier or longer than current federal limits.

Serious safety concerns about the relative operating characteristics of heavier and longer truck configurations have been documented in both government and independent studies conducted over the past 30 years. Our review of existing research leads us to conclude that in many cases, credible new research does not exist to dispel these concerns. Longer vehicles still off-track by the same amount they have always off-tracked, and vehicles with higher centers of gravity still follow Newton's laws when they negotiate a curve.

We reviewed and examined literature from sources including but not limited to the USDOT, Transportation Research Board (TRB) papers, and the American Association of State Highway and Transportation Officials (AASHTO) studies. Among the more significant concerns regarding the operating characteristics of heavier and longer configurations are:

- Truck inspection data show that a significant number of trucks continue to be taken out of service each year following an inspection. Further, brake maladjustment and equipment defects continue to be leading causes of trucks being placed out of service. This poses a significant safety risk and sub-par equipment conditions would exacerbate any other safety risks posed by heavier and longer trucks.
- Heavier vehicles are more likely to increase accident severity as they have more kinetic energy at any given speed. This may be exacerbated as automobiles become smaller and lighter to meet ever-more-stringent fuel efficiency standards.

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[15] Roger Mingo and the staff of R.D. Mingo & Associates, serving as consultants to this project, provided a detailed evaluation of safety issues for trucks with different operating characteristics.

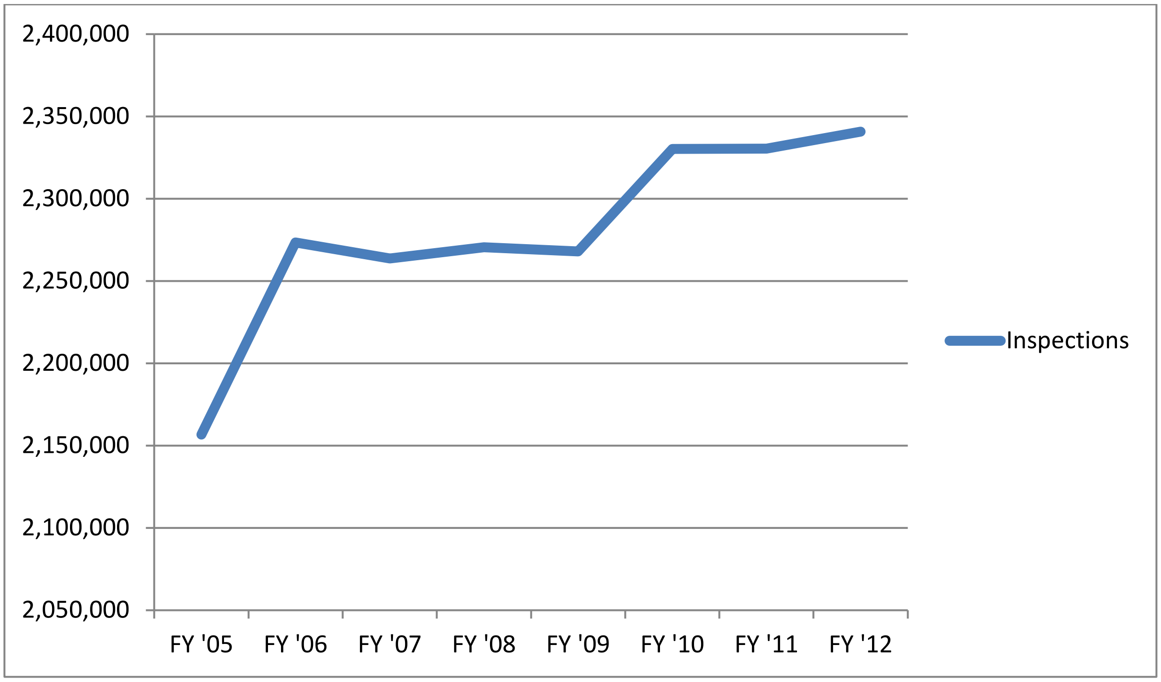
- Increases in allowable vehicle weight may mean higher trailer loadings and a higher center of gravity thus increasing the risk of rollover and causing compensatory heavy vehicle operator behavior that will result in greater interference with other vehicles.
- Heavier and longer configurations can cause greater interference with other traffic (including longer acceleration times for trucks entering traffic or traveling uphill and increases in speed for trucks traveling downhill) that could increase conflicts with other traffic.

### 3.2.1 Out of Service Violations

FMCSA sets minimum standards for commercial motor vehicles and for truck drivers, as well. Part 393 of CFR Title 49, includes standards for the parts and accessories necessary for safe operation including standards for warning lamps and signals; brake systems; glazing and window construction; fuel systems; coupling devices and towing methods; emergency equipment; miscellaneous parts and accessories like tires and horns; emergency equipment; protections against shifting and falling cargo; and frames, cab and body components, wheels, steering, and suspension systems. Section 396.3 mandates that motor carriers systematically inspect their equipment and section 396.7 makes it illegal for motor vehicles to be operated "in such a condition as to likely cause an accident or a breakdown of the vehicle."

FMCSA issues a quarterly Motor Carrier Safety Progress Report that includes information on safety outcomes like injuries and fatalities as well as program outputs, including the number of roadside truck inspections. Every year since Fiscal Year 2003, the first year for which data is available online, well over 2,000,000 roadside truck inspections have been conducted each year, as shown in Figure 3.

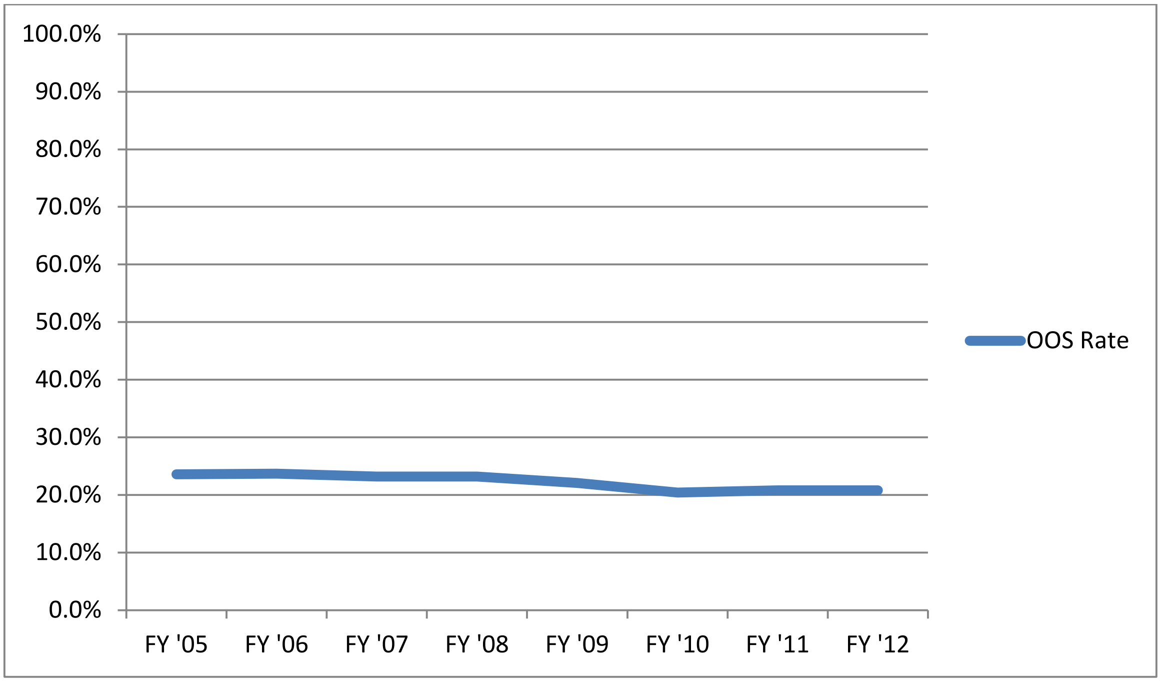
**Figure 3 – Annual Truck Inspections FY 2005 – FY 2012**




The Commercial Vehicle Safety Alliance (CVSA), a non-profit organization that brings together federal, state and provincial government agencies with private industry in North America who are dedicated to improving commercial vehicle safety, develops out-of-service criteria for commercial motor vehicles. The out-of-service criteria identify serious violations that render a commercial vehicle an imminent danger to the general public. Trucks placed out-of-service cannot operate until the items that rendered them out of service are remedied.

Since Fiscal Year 2005, FMCSA's Safety Progress Report has included the percentage of vehicles taken out of service during those inspections, which is consistently above 20%, as illustrated in Figure 4 below. This means that over 20% of trucks inspected each year have a problem that deems them an imminent danger to the general public at the time of inspection.

**Figure 4 – Truck Out of Service (OOS) Rate FY 2005 – FY 2012**




CVSA also organizes Roadcheck, the largest targeted enforcement program on commercial vehicles in the world each year. Of the commercial motor vehicles placed out of service during Roadcheck 2013, 49.6% of vehicle out-of-service violations were related to brake adjustment and other brake system violations.[16] According to CVSA's 2012 Out-of-Service Criteria publication, a vehicle or combination vehicle is out-of-service if 20 percent or more of its service brakes have a defect.[17] This means that, on the typical 18-wheeler, four of the brakes would have to be defective for the truck to be placed out-of-service. Trucks with three or fewer defective brakes would remain in service. Further, if the Roadcheck level of brake violations is representative of the overall population of trucks inspected each year, in 2012, over 241,000 trucks had brakes with defects such that the truck posed an imminent danger to the general public.

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[16] Roadcheck 2013 Results, Commercial Vehicle Safety Alliance, September 11, 2013.
[17] 2012 Out-of-Service Criteria, Commercial Vehicle Safety Alliance, p. 3, 2012.

This is significant in the discussion regarding truck size and weight. Given the likelihood that increased truck weights accelerate the consumption of braking capacity and that trucks without optimal brakes can take significantly longer to stop, these two conditions when present together could have devastating impacts on highway safety.

### 3.2.2 Safety Issues Associated with Additional Axles and Heavier or Longer Trucks

***Steering Resistance (Skidding)***

Adding any axle to a trailer, unless it is self-steering (caster mounted), decreases the steerability of the truck by requiring sideways skidding of all but one of the axles at each end of the trailer. The required degree of skidding is related to the distance between the first and last axle in each group, so a tridem axle with a total spread of eight or nine feet requires far more sideways skid than a tandem axle with a spacing of four feet. The resulting lateral force places more lateral load on the steering axle, causing it to go into a skid more easily and reducing its ability to redirect the vehicle during emergency maneuvers.[18, 19]

Increasing the spread of an axle group (to meet the bridge formula or decrease pavement damage) also increases the steering resistance. Trucks with widely spaced third axles typically become so hard to operate that they have difficulty turning on dry roads.[20]

Any factors that increase steering resistance also increase off-tracking to some degree. Off-tracking occurs when the rear wheels of a vehicle do not follow the front wheels as a truck makes a turn and can influence a significant number of truck variables. The additional tire influence in tridem-axle trailers increases off-tracking and puts greater pressure on the driver to avoid clipping cars in other lanes and avoid curbs; it also presents a dangerous environment for

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[18] Fancher, Paul S.; and Campbell, Kenneth L., Comprehensive Truck Size and Weight Study, Phase 1-- Vehicle Characteristics Affecting Safety, Working Papers 1 and 2 Combined, UMTRI for FHWA, February 1995.
[19] Billing, John R.; Nix, Fred P.; Boucher, Michel; and Raney, Bill., On the Use of Liftable Axles by Heavy Trucks, Ontario Ministry of Transportation, Downsview, Ontario, December 1990.
[20] Billing, John R.; Nix, Fred P.; Boucher, Michel; and Raney, Bill., On the Use of Liftable Axles by Heavy Trucks, Ontario Ministry of Transportation, Downsview, Ontario, December 1990.

pedestrians. Many models typically assume away lateral skid and ignore these potential impacts.[21, 22]

### *Lift Axles*

In order to improve the steerability of configurations with trailers having three axles at one or both ends, it is common to make one of the three axles a lift axle, from which the load can easily be removed in order to make turns or otherwise increase maneuverability.

Reducing the load on the lift axle increases the load on the other two axles, greatly increasing pavement damage and bridge stress. The truck operator can save fuel and tire wear by lifting the axle even when not turning, creating an incentive to lower the axle only in the vicinity of weight enforcement stations. The use of a liftable axle can also reduce a vehicle's stability in many situations.[23]

### *Uneven Loads*

Uneven loads can cause trailer swerving and loss of control. Tandem axle groupings have a rocker-arm suspension system that efficiently spreads the weight between the two axles, and allows them to transfer load among themselves on uneven pavement surfaces. This decreases the dynamic loads produced by the axles while increasing the braking efficiency and assisting in stopping distance. While tridem axles can have similar suspensions, they often do not. Sometimes, third axles are simply added adjacent to existing tandem axles on existing trailers, with no provision for making sure loads are spread equally. The 2010 Vermont pilot study, for example, cited carriers who simply added axles to take advantage of temporarily higher allowable vehicle weights with tridem axle groups.[24]

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[21] Mikulcik, E.C.; and Jensen, L.G., "Low Speed Off-tracking of Multiple-Axle Road Vehicles", Department of Mechanical Engineering, University of Calgary, Presented at SAE International Congress and Exposition; Detroit, MI, March 1990.
[22] Comprehensive Truck Size and Weight Study, Phase 1— Synthesis, Roadway Geometry and Truck Size and Weight Regulations, Working Paper 5, Battelle Team for FHWA, February 1995.
[23] Fancher, Paul S.; and Campbell, Kenneth L., Comprehensive Truck Size and Weight Study, Phase 1-- Vehicle Characteristics Affecting Safety, Working Papers 1 and 2 Combined, UMTRI for FHWA, February 1995.
[24] Vermont Pilot Program Report, Federal Highway Administration, 2012.

Analysis of weigh-in-motion (WIM) data shows that tridem axle groups in states that allow higher GVWs often have widely-varying loads among individual axles in the group, even long after any expected transition time.[25] This results in overloads on tires, bearings, and brakes.

***Braking Forces***

Theoretically, an additional axle should increase the available braking force to sufficiently compensate for the increased vehicle weight. In practice, however, brake valve balancing presents sizeable technical challenges that can limit improvements in braking efficiency with each additional axle. As discussed in several interviews with law enforcement officers, the general consensus is that braking will take longer and "larger trucks" equate to "larger accidents." Furthermore, "97,000-pound trucks can be filled with liquids which make them more dangerous than another type of weight" as drivers require "specific training to handle that vehicle" and need to react "to how liquid is moving."[26] Stopping distances on current trucks are far greater than for passenger vehicles and do not match current highway design standards.[27,28,29,30]

Antilock brakes can help solve the problem of uneven braking in sudden emergency stops and in March 1995, NHTSA issued a rule requiring antilock brakes for heavy trucks, tractors, trailers, and buses. All new truck tractors were required to have antilock brakes after March 1, 1997, and were mandatory on new air-braked trailers and single-unit trucks and buses after March 1, 1999.[31] A greater problem not helped by antilock brakes, however, results from habitual imbalance during repeated or sustained brake application. Any wheel that carries a

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[25] Mingo, Roger D., P.E., Unpublished tables derived from recent Oregon weight-in-motion (WIM) data, 2012.
[26] Transcripts of law enforcement interviews summarized in Section 3.5 of this report.
[27] Clarke, Robert M.; Radlinski, Richard W.; and Knipling, R.R., Improved Brake Systems for Commercial Motor Vehicles, Report to Congress as mandated by the Truck and Bus Safety and Regulatory Reform Act of 1988, NHTSA, April 1991.
[28] Parker, D.J.; and Hutchinson, B.G., Large Truck Braking at Signalized Intersections, Department of Civil Engineering, University of Waterloo, for Ontario Ministry of Transportation, December 1988.
[29] Comprehensive Truck Size and Weight Study, Phase 1— Synthesis, Roadway Geometry and Truck Size and Weight Regulations, Working Paper 5, Battelle Team for FHWA, February 1995.
[30] http://www.ced-aai.com/index.php/areas-of-engineering-expertise-at-ced/mold/374-heavy-truck-braking. Heavy Truck Braking On the Scene E-Newsletter, Edition 136, CED Investigative Technologies, Inc., April 13, 2011.
[31] http://www.iihs.org/research/qanda/antilock.aspx. Q&A Antilock Brakes, Insurance Institute for Highway Safety, March 2013.

disproportionate share of the load heats up disproportionately. When called upon for an emergency braking demand, the overheated wheel cannot respond. This might happen frequently when a truck is operated in rolling terrain or in congested or crowded highway conditions. Under such conditions, an additional axle provides limited reductions of stopping distances.[32,33]

As engines have become more powerful, engine braking capability has risen accordingly and truck drivers have increasingly relied upon engine brakes. Because the drive axles of a six-axle, single-trailer combination or of any multi-trailer combination carry less share of the load than the drive axles of a five-axle vehicle, trucks cannot rely upon engine braking to as great a degree. Similarly, wheels will lose traction under load more readily (starting on an uphill grade on wet pavements, for example).[34] Both situations are likely to lead to longer stopping distances.[35]

Heavier weights on existing vehicles may result in loss of braking performance. Truck brakes often have inadequate capacity with current operating weights.[36] In 2009, NHTSA amended the Federal motor vehicle safety standard on air brake systems to improve the stopping distance of truck tractors.[37] The rule required a 30 percent reduction in stopping distance compared to the 2009 required levels. For heavy truck tractors the amended standard required vehicles to stop in not more than 250 feet when loaded to their GVWR and tested at a speed of

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[32] Clarke, Robert M.; Radlinski, Richard W.; and Knipling, R.R., Improved Brake Systems for Commercial Motor Vehicles, Report to Congress as mandated by the Truck and Bus Safety and Regulatory Reform Act of 1988., NHTSA, April 1991.

[33] http://www.ced-aai.com/index.php/areas-of-engineering-expertise-at-ced/mold/374-heavy-truck-braking, Heavy Truck Braking On the Scene E-Newsletter, Edition 136, CED Investigative Technologies, Inc., April 13, 2011.

[34] Comprehensive Truck Size and Weight Study, Phase 1— Synthesis, Roadway Geometry and Truck Size and Weight Regulations, Working Paper 5, Battelle Team for FHWA, February 1995.

[35] Harwood, Douglas W.; Potts, Ingrid B.; Torbic, Darren J.; and Glauz, William D., Synthesis 3 Highway/Heavy Vehicle Interaction, Transportation Research Board, 2003.

[36] Clarke, Robert M.; Radlinski, Richard W.; and Knipling, R.R., Improved Brake Systems for Commercial Motor Vehicles, Report to Congress as mandated by the Truck and Bus Safety and Regulatory Reform Act of 1988, NHTSA, April 1991.

[37] 49 CFR Part 571.

60 MPH.[38] Allowing trucks to become even heavier could reverse the safety gains envisioned by NHTSA's stronger rule.

***Acceleration / Hill Climbing***

Heavier weights will result in many cases in lower power-to-weight ratios. As a truck's GVW increases, its acceleration capacity decreases unless horsepower or other characteristics are improved to compensate for the weight increase.[39] Lower acceleration rates and greater acceleration length makes it harder for trucks to clear specific conflict zones like intersections and railroad crossings.[40] Additionally, the weight will cause heavy combinations to climb hills and accelerate more slowly, thereby increasing interference with other vehicles and decreasing the sight distance safety margin at intersections.[41]

***Increased Accident Risk***

Higher weights on the same vehicle configuration (such as allowing more weight on existing five-axle double-trailer combinations, or operating a six-axle vehicle with a raised lift axle) cause higher accident rates.[42]

***Collision Severity***

Heavier vehicles increase accident severity because they have more kinetic energy at any given speed and because they are likely to have greater weight differentials with the vehicles with which they collide than do current trucks. Kinetic energy is the energy that an object possesses due to its motion, specifically the work needed to accelerate a body from rest to velocity. The power-to-mass ratio of heavy trucks leads to significant downhills where the

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[38] United States Department of Transportation, National Highway Traffic Safety Administration, Federal Motor Vehicle Safety Standards; Air Brake Systems, 49 CFR Part 571, Docket No. NHTSA 2009-0083.
[39] Comprehensive Truck Size and Weight Study, Phase 1— Synthesis, Roadway Geometry and Truck Size and Weight Regulations, Working Paper 5, Battelle Team for FHWA, February 1995.
[40] Harwood, Douglas W.; Potts, Ingrid B.; Torbic, Darren J.; and Glauz, William D., Synthesis 3 Highway/Heavy Vehicle Interaction, Transportation Research Board, 2003.
[41] Comprehensive Truck Size and Weight Study, Phase 1— Synthesis, Roadway Geometry and Truck Size and Weight Regulations, Working Paper 5, Battelle Team for FHWA, February 1995.
[42] Fancher, Paul S.; and Campbell, Kenneth L., Comprehensive Truck Size and Weight Study, Phase 1-- Vehicle Characteristics Affecting Safety, Working Papers 1 and 2 Combined, UMTRI for FHWA, February 1995.

vehicle accelerates without engine propulsion and significant uphills where the vehicle decelerates despite maximum engine power.[43] In the ongoing debate about truck weights and lengths, some have suggested that because truck-car collisions often result in fatality for occupants of light vehicles, an increase in truck weight would not change the outcome of a similar collision. This simplistic assumption ignores the fact that the vast majority of car-truck collisions do not kill all the auto occupants, and in these accidents, any degree of increase in accident severity increases the likelihood of serious injury or death.[44] In 2009, for example, there were 17,000 heavy truck crashes that resulted in injury other than fatality.[45]

***Rollover***

For commodities that currently "weigh out," increases in allowable vehicle weight may mean higher trailer loadings and a higher center of gravity. This will increase the risk of rollover and will cause compensatory heavy vehicle operator behavior that will result in greater interference with other vehicles.[46, 47]

Rollover in heavy trucks is described as a relatively complex concept[48] and is of major concern because it is "strongly associated with severe injury and fatalities in highway accidents."[49] Variables that contribute to truck rollovers are many and can generally be divided into "four categories – vehicle characteristics, highway features, environmental, and human factors."[50]

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43 Erik Hellstrom, Aslund, J and Nielsen, L., "Management of Kinetic and Electric Energy in Heavy Trucks", SAE International Journal of Engines, 2010.
44 Fancher, Paul S.; and Campbell, Kenneth L., Comprehensive Truck Size and Weight Study, Phase 1-- Vehicle Characteristics Affecting Safety, Working Papers 1 and 2 Combined, UMTRI for FHWA, February 1995.
45 http://www.fmcsa.dot.gov/facts-research/LTCO2010/2010LargeTruckCrashOverview.aspx. Retrieved December 7, 2012.
46 Fancher, Paul S.; and Campbell, Kenneth L., Comprehensive Truck Size and Weight Study, Phase 1-- Vehicle Characteristics Affecting Safety, Working Papers 1 and 2 Combined, UMTRI for FHWA, February 1995.
47 Billing, John R.; Nix, Fred P.; Boucher, Michel; and Raney, Bill., On the Use of Liftable Axles by Heavy Trucks, Ontario Ministry of Transportation, Downsview, Ontario, December 1990.
48 Heavy Truck Rollover Characterization (Phase-A) Final Report, National Transportation Research Center, Inc.
49 Rollover of Heavy Commercial Vehicles, UMTRI Research Review, Vol. 31, No. 4, p. 1. October-December 2000.
50 Frank Wilson and Hildebrand, Eric., "Lateral Forces on Heavy Trucks – Contributions from Wind. Transportation Group - University of New Brunswick, Paper Number 07-0444.

Duane Meyers, of Great Lakes Crash Analysis, LLC, provided simulation and analysis of rollover thresholds of tractor semi-trailers for use in this report. Using the Rec-Tec[51] software package, Mr. Meyers analyzed the rollover thresholds for trucks at 80,000 lbs. and at 97,000 lbs. in curves of varying radii. Mr. Meyers has extensive crash investigation training amounting to more than 30 years of experience and has held full Accreditation from the Commission for Traffic Accident Reconstructionists since 1993. He has held several professional certifications related to traffic control and accident investigation and has provided significant instruction and training, presentations and publications during his long career as a State Trooper and Crash Reconstruction Specialist.

The first simulation presented here analyzes the rollover thresholds for trucks at various speeds at both 80,000 pounds and 97,000 pounds. The basic measure of roll stability is the static rollover threshold, expressed as lateral acceleration in gravitational units (g).[52] Those thresholds are illustrated in Table 6 and Figure 3 as .48g for the 80,000-pound truck and .32g for the 97,000-pound truck. Translating the thresholds displayed in Figure 4 to the real world suggests that for any given radius, an 80,000-pound unit can hit a ramp safely at a higher speed than a 97,000-pound unit.

[51] http://www.rec-tec.com/

[52] C.B. Winkler and Ervin, R.D., Rollover of Heavy Commercial Vehicles, UMTRI-99-19, p. 2, August 1999.

**Table 6 – Tractor Semi-Trailer Rollover Propensity**

| Curve Radius | 80,000 lb. Unit (.48g) | 97,000 lb. Unit (.32g) |
|---|---|---|
| 100 | 27 | 22.1 |
| 200 | 38.1 | 31.2 |
| 300 | 46.7 | 38.3 |
| 400 | 54 | 44.2 |
| 500 | 60.3 | 49.4 |

**Figure 5 – Tractor Semi-Trailer Rollover Threshold**

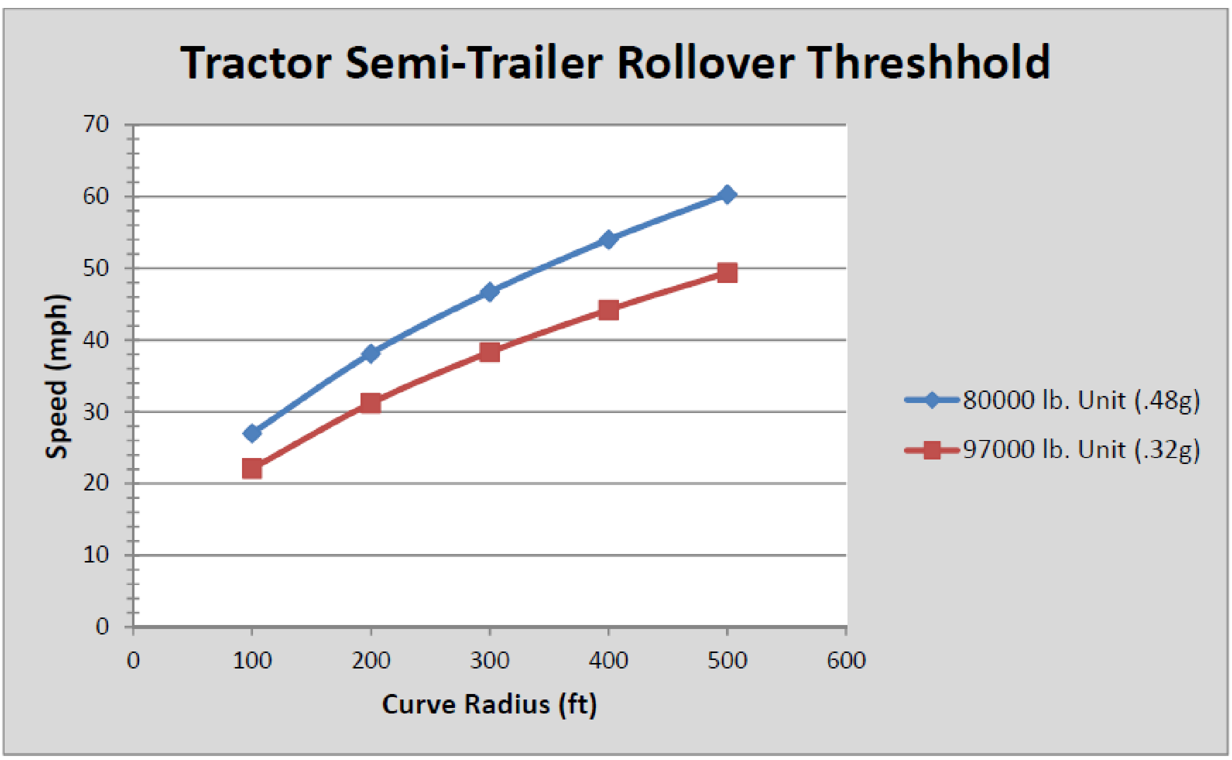
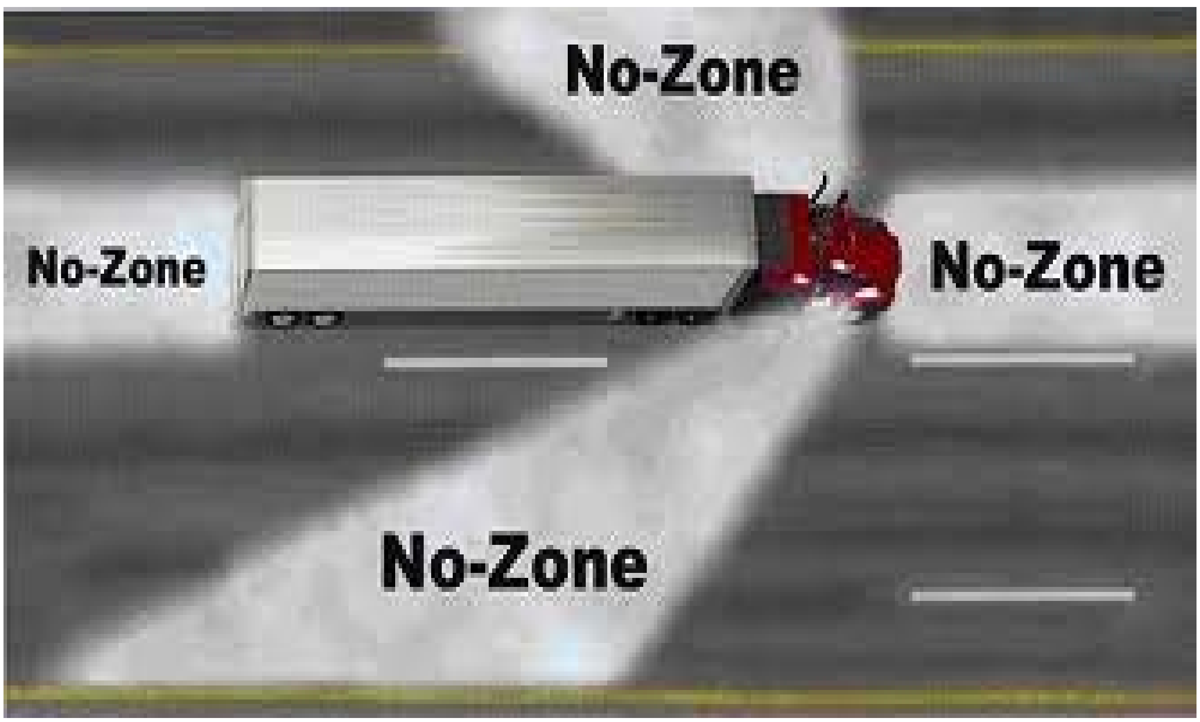



Illustration provided by Duane Meyers - Great Lakes Crash Analysis, LLC.

### *Passing*

Longer vehicles require overtaking vehicles to remain in the passing lane longer, thereby increasing passing distances. On multi-lane highways, this increases traffic interference. On two-lane roads, this increases the risks associated with passing and/or decreases the number of passing opportunities.[53] In addition, unanticipated encounters with extra length increase the likelihood of collision, as length makes it more difficult for larger trucks and other vehicles to enter a roadway. Longer trailers and multiple trailers create larger blind spots (termed the "no-zone" in recent attempts to blame light vehicles for the adverse characteristics of heavy vehicles) behind and beside the truck. This increases the risk of lane change-related collisions. Figure 4 shows the most dangerous areas and multiple blind spots of an 18-wheeler.

**Figure 6 – Typical Trailer "No-Zones"**




Source: http://www.drive-safely.net/truck-safety-training.html

[53] Sparks, Gordon A.; Neudorf, Russell D.; Robinson, John B. L.; and Good, Don., "Effect of Vehicle Length on Passing Operations", Journal of Transportation Engineering, Vol. 119, No. 3, ASCE, New York, March/April 1993.

### *Sight Distance*

Current trucks require more sight distance for intersection crossing maneuvers than required by design standards. Longer trucks would make the discrepancy even worse.[54]

### *Sway Control*

When the driver of any articulated vehicle makes a rapid steering maneuver by moving the steering wheel in one direction and then back in the opposite direction – for example to avoid a road hazard – the sideways motion is amplified as it passes through the connecting dollies and trailers. This "crack-the-whip" effect can interfere with vehicles in adjoining lanes and can increase the chance of vehicle rollover.[55]

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[54] Harwood, D.W.; Mason, J.M.; Glauz, W.D.; Kulakowski, B.T.; and Fitzpatrick, K., Truck Characteristics for Use in Highway Design and Operation, Midwest Research Institute, Kansas City, for FHWA, August 1990.

[55] Fancher, Paul S.; and Campbell, Kenneth L., Comprehensive Truck Size and Weight Study, Phase 1-- Vehicle Characteristics Affecting Safety, Working Papers 1 and 2 Combined, UMTRI for FHWA, February 1995.

## 3.3 Consideration of Prominent Safety Claims

Two sources in particular, the Wisconsin Truck Size and Weight Study and Transport Statistics Bulletin – Road Freight Statistics 2007, are frequently cited by those advocating for increases in truck size or weight to support the idea that larger/heavier trucks provide improvements in highway safety and system performance. Given the significant safety concerns historically associated with increases in truck size or weight and the conclusions above, it seems prudent to conduct a detailed review of these studies.

### 3.3.1 Wisconsin Truck Size and Weight Study

One of the most prominent recent studies of truck size and weight was completed by Cambridge Systematics for the Wisconsin Department of Transportation.[56] This study is most frequently cited to support the proposition that an increase in the gross vehicle weight of trucks would result in fewer truck-related accidents.[57] However, the Wisconsin study does not only provide much new in the way of more accurate models for estimating the impacts of truck size and weight increases, but it also contains several flawed assumptions that greatly impact its results.

***Freight Volumes***

The assumption that most impacts the outcome of the Wisconsin study is that of how increasing the payload capacity of trucks would impact freight volumes. It is commonly expected that an increase in the maximum gross weight of individual trucks would divert freight both from other truck configurations and from other freight transport modes – particularly railroads – to the heavier truck configuration. However, the Wisconsin study assumes no diversion from rail, assumes no increase in the overall amount of freight to be transported, and relies on limited and misleading sources for estimating truck-truck diversion.

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[56] Wisconsin Truck Size and Weight Study, Cambridge Systematics, Inc., June 2009.

[57] "Based on the findings of a 2009 Wisconsin DOT study, if a law like SETA had been in place in 2006, it would have prevented 90 truck-related accidents in the state that year." Truck Weight Reform & Safety, Coalition for Transportation Productivity, April 2011.

***Rail Diversion***

The Wisconsin study did not evaluate the likelihood of rail diversion. It did not engage in a market-based analysis of what impact heavier trucks would have on the transportation marketplace. Rather, the study assumed away rail diversion because the authors believed that most of the competition between truck and rail is for long-distance shipments and because in conversations with certain Wisconsin shippers, participants did not believe that truck size and weight changes would divert traffic from rail.[58] While assuming away rail diversion is convenient and simplifies the scope of the study, it ignores a fundamental part of calculating vehicles miles traveled (VMT), a key factor in examining truck traffic and crash rates.

In fact, there is significant competition between short line and regional railroads and trucks for shorter moves, including at least four non-Class I railroads in Wisconsin. A recent study concluded that short lines would stand to lose 17 percent of traffic to heavier trucks like those studied in Wisconsin hauling bulk commodities that are most frequently shipped in Wisconsin.[59] The methodology of this diversion study is consistent with that proscribed by the Wisconsin study for a diversion analysis.[60]

The Wisconsin study did conduct sensitivity analyses to "investigate how different assumptions would affect the evaluation of Scenario trucks" and found that "cost savings for pavements and bridge decks, safety, and congestion are reduced or, in some cases, eliminated, because of greater truck VMT."[61] The study does not provide the amounts of these changes, but admits that a change in freight volumes could have significant impacts on the study's conclusions. Given this finding and the fact that a decline in large truck VMT is the premise for all conclusions in the study, it is questionable for the study authors to have 'assumed away' the

[58] Wisconsin Truck Size and Weight Study, Cambridge Systematics, Inc., June 2009, p. 8-13.
[59] Estimating the Competitive Effects of Larger Trucks on Rail Freight Traffic, Dr. Carl D. Martland, 2007.
[60] "If the State wanted to develop more detailed rail diversion impacts, it would conduct market-based assessments of specific corridors or commodities...The results of such an analysis could more definitively assess the impacts on railroads, especially shortline or regional haulers." Wisconsin Truck Size and Weight Study, Cambridge Systematics, Inc., June 2009, p. 8-13.
[61] Wisconsin Truck Size and Weight Study, Cambridge Systematics, Inc., June 2009, p. 8-12.

diversion question by merely interviewing shippers with a vested interest in increasing truck weights.

***Truck Diversion***

In addition to omitting a rail diversion analysis, the Wisconsin study relies on a limited and misleading source for assumptions about the amount of freight that would shift to heavier trucks. This source is a 2008 report by the American Transportation Research Institute (ATRI), which is part of the American Trucking Associations, which has lobbied in support of heavier and longer trucks for decades.

In its report, ATRI clearly points out that it is referring to trucks that are fully loaded for weight or capacity.[62] However, this ignores the high percentage of trucks operating with empty backhauls, or only partially laden, such as Less Than Truckload (LTL) operations that often haul lower weight loads or that access terminals after dropping off one trailer. Many trucks operating at higher gross weights will operate empty or partially empty much of the time. While the percentage of partially laden trucks is based on limited data, the Federal Highway Administration estimates that up to 29 percent of heavy trucks operate completely empty. Logging trucks, for example, operate empty 40-44 percent of the time.[63] These and other assumptions made by ATRI, such as their reliance on data from highway operations, which are more efficient than rural operations, call into question the efficiencies found by ATRI and thereby the truck-truck diversion conclusions reached in the Wisconsin study.

These freight volume assumptions along with the many variations in configurations studied and allowable highways considered, lead to very large differences in the estimates of shifts among truck configurations in the Wisconsin study. For example, allowing 97,000 pounds on seven axles would result in a reduction of 4.5 million miles of travel, but allowing 98,000 pounds on six axles would result in a reduction of 11 million miles of travel according to the

[62] Energy and Emissions Impacts of Operating Higher Productivity Vehicles, American Transportation Research Institute, p. 10, 2008.
[63] FAF Freight Traffic Analysis: Chapter 3, Development of Payload Equivalency Factor, Federal Highway Administration, July 2007.

report.[64] Both of these numbers are very small when compared with overall heavy truck VMT in Wisconsin (0.07 percent and 0.18percent respectively), but result in large variations in estimated benefits. These wild variations based on such a small sample size call into serious question the productivity benefits found by Wisconsin.

***Safety***

The Wisconsin study looks at large truck crash rates and fatal crash rates, but does not attempt to look at rates for trucks of various weights. Further, it does not attempt to compare the crash rates of studied configurations with the existing standard 80,000-pound, five-axle truck.[65] In fact, the study recommends a comprehensive truck crash study to pinpoint the factors determining truck crash rates and to focus on crash rate differences between configurations.[66]

Rather, the Wisconsin study assumes that increasing a trucks' braking capacity by 20 percent (by adding a sixth axle, for example) would reduce its crash rate by five percent.[67] However, this flies in the face of the real-world experience with heavy trucks. For example, six-axle trucks often have uneven loadings, which results in overloads on tires, bearings, and brakes, decreasing the trucks braking ability. This may explain why preliminary data collected by the Commercial Vehicle Safety Alliance shows that heavier trucks have a significantly higher out-of-service violation rate than the standard 80,000-pound, five-axle trucks.[68]

The Wisconsin study relies on a series of assumptions that jeopardize the reliability of its conclusions, most notably the assumptions about freight volumes. It fails to take into consideration rail diversion and relies on overly generous estimates of truck-truck diversion. These faulty assumptions about freight volumes lead to questionable conclusions regarding the safety and accident rates of the studied configurations.

Beyond the faulty assumptions and questionable conclusions, it is also of note that the Wisconsin study treats the benefits that would accrue to private corporations – in terms of

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[64] Wisconsin Truck Size and Weight Study, Cambridge Systematics, Inc., June 2009, p. 8-6.
[65] Ibid, Chapter 5, Wisconsin Large Truck Crash Trends.
[66] Ibid, p. 6-8.
[67] Ibid, p. 7-19.
[68] For additional information on real-world truck experience, see Section 3.6 of this report.

increased productivity – as coequal with the costs of the studied configurations, which would be borne by public entities and thereby taxpayers. Given that taxpayers subsidize the operation of large trucks on US highways already and the well-documented challenges many states face with budget shortfalls and transportation project backlogs, it seems excessive that taxpayers should be asked to increase their subsidy in exchange for trucks that cannot be proven to be as safe as those on the road today and that would lead to even greater numbers of trucks on the road.

### 3.3.2 UK Road Freight Statistics

Proponents of increasing truck size and weight also frequently cite the experience of the United Kingdom as supporting the proposition that truck weight increases have led to a decrease in fatal truck accidents. The Coalition for Transportation Productivity (CTP), for example, claims that since the United Kingdom raised its GVW to 97,000 tonnes for six axles in 2001, fatal truck related accident rates have decreased by 35 percent while shipping more freight and driving fewer VMT.[69] However, no such claim or correlation can be made between the increase in weight limits and a decrease in crashes abroad or in the United States.

Each year the United Kingdom gathers data pertaining to the activities of heavy goods vehicles (HGVs), both domestically and internationally, and summarizes the activities in an annual Road Freight Statistics publication.[70] From the period of 1997 to 2007, there was a 42 percent reduction in the number of people killed or seriously injured in reported accidents involving at least one HGV and a 19 percent reduction in fatalities. Thus, the fatal accident rate for accidents involving at least one HGV fell from 1.8 accidents per 100 million kilometers to 1.3 accidents per 100 million kilometers.

However, as demonstrated by Figure 5, the accident rate for all vehicles experienced a similar decline. Over this same period, the accident rate for all vehicles fell from 52.9 accidents

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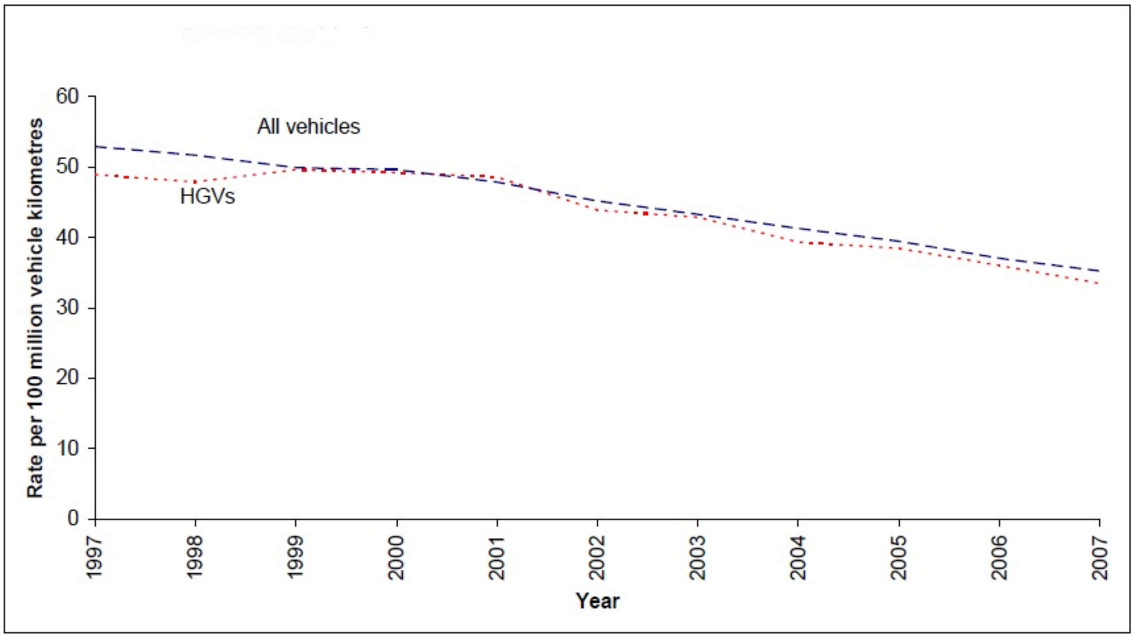
[69] http://www.transportationproductivity.org/why-raise.php. Retrieved March 26, 2013.
[70] Transportation Statistics Bulletin - Road Freight Statistics 2007, United Kingdom Department for Transport, August 2008.

per 100 million kilometers traveled to 35.2 per million vehicle kilometers traveled.[71] Given that the reduction in accident rates was not limited to accidents involving an HGV, there can be no correlation between the decrease and the increase in allowable HGV weight.

**Figure 7 - Accident rates involving at least one HGV: All severities (1997-2007)**




Other reports have addressed the decline in accidents in the United Kingdom and suggest that roads are not actually safer but that there is a misrepresentation of data. For example, Oxford University researchers found that even though UK Department of Transportation (DFT) statistics showed a 31 percent decline in fatal or serious personal injury accidents between 1996 and 2004, crash-related hospital admissions had decreased by only 1.1 percent over the same period. This led them to question whether there were reductions in fatal and serious injury accidents and whether the government would meet its targets for reductions in serious injuries. It has been

[71] Ibid, p. 149.

suggested that a reason for this discrepancy may be significant underreporting of accidents due to significantly harsher penalties for driving offenses in the UK.[72]

Also in a 2006 report prepared for the DFT, it was stated that total injuries could be as many as three times higher than reported. In 2008, the DFT did acknowledge that a considerable proportion of non-fatal accidents are not known to police. In February 2013, The Institute of Public Health in Ireland (IPH) voiced its concerns on reported statistics, stating, “one area of concern about the statistics is the under-reporting of non-fatal casualties to police and the perceived completeness of the statistics by users of the statistics” and estimated 48 percent under-reported accidents.[73]

Taken as a whole, these reports cast significant doubt on the idea that an increase in gross truck weights in the United Kingdom contributed to a decrease in heavy truck crash rates. Further, there are significant differences between the truck operating environments in the UK and the US. The differences in population, density, geography, regulatory requirements, infrastructure quality, and the like limit the ability of any possible outcome from the UK predicting similar outcomes in the US.

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[72] Are car accident rates really falling in the UK?, http://www.accidentconsult.com/RTAAccident/ArecaraccidentratesreallyfallingintheUK-810.html. Retrieved April 2, 2013

[73] Submission to UK Statistics Authority – Assessment of Reported Road Casualties Statistics, The Institute of Public Health in Ireland, February 27, 2013.

## 3.4 Law Enforcement Officer Interviews

One particularly valuable way to determine the expected safety impacts of allowing heavier and larger truck configurations is to obtain the professional experience of expert truck inspectors and law enforcement officers specializing in investigation of the causes of crashes involving large trucks. The National Troopers Coalition (NTC) helped identify law enforcement officers with significant levels of experience with commercial vehicles and/or accident investigation to assist in understanding the potential impacts of truck size and weight.

Twenty-one officers representing fifteen states participated in scheduled telephone interviews that were conducted by a consultant with R.D. Mingo and Associates. The survey included but was not limited to states as far as the west coast (California and Oregon), midwest (Iowa and Nebraska), the south (Georgia and Tennessee) and the east coast (Florida and New York). Each of the interviews was conducted using a standardized outline of topics, while allowing for the respondents to answer questions in a narrative format. As such, responses were grouped according to theme and frequency.

***Professional Background and Configuration Experience***

The officers that took part in the interviews represent a wealth of experience in both commercial vehicle enforcement and accident investigation. The 21 officers possess 449 combined years of experience and individual experience ranged from 11 to 32 years. While nearly every respondent had significant commercial vehicle experience, the range of certifications and levels of training varied predictably. Specific training included certification in hazardous materials, inspections and accident reconstruction and several of the respondents teach courses on commercial vehicle inspections. All but three respondents indicated that they had significant experience performing inspections, with two of the remaining three noting some familiarity but lacking credentials. While not every respondent provided the exact length of time for which they had been inspecting vehicles, those who did indicated that it encompassed roughly half of their overall years of experience. Many of the officers also reported considerable accident investigation and reconstruction experience, accounting for hundreds of incidents including a great number involving commercial vehicles (It should be noted here that one trooper reporting 'limited accident experience' reported responding to approximately one dozen accidents per year over 17 years).

Regarding specific configurations most respondents indicated that either in their inspection duties or in accident reconstruction that they had considerable experience with trucks with a sixth axle, oversize loads and/or double trailer combinations. Only a few troopers reported significant levels of inspection experience with triple trailers.

Despite the varied backgrounds of the officers across states, it is clear that the respondents to these interviews have significant experience in the field and a deep understanding of factors that affect the real-world operating safety of commercial vehicles.

***Consideration of Axle Weight***

The majority of the responding officers indicated experience with weight inspections and their input suggests that estimates of the percentage of trucks operating within legal weight limits varied greatly among respondents with percentages ranging from 65 to 98 percent. Nearly all officers who perform weight inspections indicated that they provide a certain amount of leeway before writing tickets, with responses varying from a few hundred to 2,000 pounds per axle dependent on the configuration of the trailer and the commodities being transported. One officer noted that many may attempt to "skirt the work" and there will be fewer inspections.

Despite the fact that most truckers obey weight limits, many of the officers noted that there are incentives in place for trucking companies to maximize the load in the hopes of getting through the inspection. Officers also mentioned their belief that truckers like to drive with a light front axle so they tend to load that axle light in order to get by troopers during inspections or elicit a warning to reload.

> One officer commented that it is often, "cheaper to pay the fine and move on."

***Likely Impacts of 97,000-pound Trucks***

Virtually all of the officers interviewed indicated that there were likely and significant impacts to the operation of trucks operating at 97,000 pounds versus those operating at 80,000 pounds. While troopers identified multiple impacts and the choice of most significant impacts varied by respondent, they were remarkably consistent in the answers provided.

*Equipment and Infrastructure*

Respondents were divided on how to quantify the impacts of increasing loads on the performance and long term maintenance needs of truck equipment. Some felt that it was obvious that greater weights would place stress on the equipment leading to a higher probability of failures, especially in older trucks and those not designed with increased capacities in mind. Other respondents suggested that the impacts, although present, may be minimal. Multiple troopers noted that smaller firms may have fewer resources to dedicate toward increased maintenance of the equipment that additional weight may impose.

The majority of respondents suggested that increased trucks weights, especially those approaching or exceeding 97,000 pounds, would have a significant impact upon infrastructure, particularly bridges and roads. Several officers suggested that increased weights would likely result in increased rutting and cracking that leads to hazard, particularly during inclement weather. The design capacities and state of the infrastructure were also cited as being inadequate for the additional weight. One officer stated that a single truck "at 80,000 pounds does as much damage to a bridge as 943 cars… so just imagine."

*Braking, Speed and Emergency Maneuvers*

All but a handful of the respondents indicated that braking distance would necessarily increase as truck weights rose and several identified braking distance as the most significant safety issue associated with increased weight. Other respondents noted that speed was an important factor, not only in a higher potential for accidents but also increasing congestion as trucks were slower up and faster down mountains and hills as weight increased.

> One trooper noted that, "[m]aximum braking efficiency is only achieved in the lab. Often, on the road, brakes are not capable of stopping the entire load, and that is where braking distance will increase."

Many of the officers suggested, that in their experience, the weight would intensify the effects of driver fatigue and place greater pressure on drivers during the application of emergency maneuvers. The effect of passenger vehicle drivers who fail to obey speed limits and drive aggressively was also recurrently mentioned. Drivers, the officers suggested, would need to be aware of how the added weight would affect stopping distance and turning radius as each would require more control.

*Load and Rollover*

One of the most significant factors identified by the officers was not simply the weight of the load, but its position on the trailer(s) and the commodities involved. Liquids, livestock and improperly balanced loads were frequently cited as dangerous and difficult to gauge because of the potential for load shifting. This load shifting was proffered as a prime contributor to the increased likelihood of rollover as it greatly affects the center of gravity of the loads themselves.

> An officer commented that a "driver would have to be on his 'A' game if he is going to control a vehicle that is 17,000 more pounds."

*Accidents*

Two main themes were identified with concern to increases in truck weight and potential accidents – accident severity and accident footprint. While officers were divided on the extent to which added weight would directly contribute to more crashes in and of itself, they were nearly uniform in noting that it would play a large factor in an already complicated chain of events.

Regarding severity explicitly, officers often noted that larger trucks almost always increase the severity of the crash reminding the interviewer that it was a simple physical equation of kinetic energy with the potential for significantly more damage. In terms of accident footprint, multiple respondents suggested that the increased amount of product associated with larger loads increases the area and time needed for cleanup and can also amplify the potential for chain reactions.

> One officer commented that it is often, "cheaper to pay the fine and move on."

Two quotes from the officers were particularly clear:

*"When you add the equivalent of six more passenger cars' weight to the vehicle to that same situation, you're going to see that many more people dying, these double fatalities are going to become triple and quad fatalities. That's why stopping distance is not the biggest issue, the biggest issue is the weight and then by extension the energy that these vehicles are creating."*

*"We can replace bridges and roads, we cannot replace people"*

### ***Likely Impacts of Longer Combination Vehicles***

Responding officers in total reported less direct experience with long double-and triple-trailer configurations, but those with experience were remarkably consistent in their comments. Fewer officers were concerned about the maintenance of the equipment or equipment failures in comparing LCVs and single trailers, but safety concerns were mentioned prominently.

#### *Equipment and Infrastructure*

The primary concern regarding long double and triple trailer trucks arose from the simple addition of length. Many officers noted that the addition of a third trailer contributed to diminished visibility for both drivers of the trucks and passenger cars, leading one trooper to describe the third trailer as an "additional vehicle on the road." Yet another officer noted that by adding the third trailer the driver will "avoid one accident, but cause another."

#### *Braking, Speed and Emergency Maneuvers*

Here the officers noted more concern with the ability of the drivers to control the equipment rather than their ability to properly maintain it. Officers cited longer acceleration times, slower hill climbs, and multiple hinge points to account for as areas of concern. Multiple officers noted that in addition to the actions of the truck drivers, longer trailers elicit more aggressive driving behavior from passenger car drivers. One officer suggested that frustrated passenger car drivers often discount the length of the trucks when making passing maneuvers, which escalates an already dangerous situation.

#### *Load and Rollover*

As with the additional weight, interviewed officers expressed concern for rollover with LCV configurations. Factors that contribute to the likelihood of a rollover included turning radius complicated by multiple hinge points, load shifting and the influence of high wind. Many of the officers indicated that the behavior of LCVs is difficult to anticipate because the mental and physical calculus to control them is affected by so many variables.

*Accidents*

Driver error, either on the part of the trucks or that of the passenger car drivers, was often cited as the primary determinant of an accident involving LCVs and what made the distinction between an ‘injury accident’ versus a ‘fatality accident.” The vast majority of the officers who provided responses indicated that more often than not, even though truck driver error was usually to blame, the simple fact of the matter is that additional trailers complicate the decision making of drivers and provide more chances for something to go wrong.

***Summary of Trooper Interviews***

The essential lesson to be drawn from the law enforcement officer interviews is that they consider there to be substantive and significant impacts from increased truck weight and/or LCV configurations. Safety, for these very experienced officers, was their primary concern. Twenty of the twenty-one officers interviewed indicated flatly that heavier and longer trucks would be “more dangerous” because adding more variables and equipment to an already difficult task makes it that much harder.

## 3.5 Truck Driver Attitudes and Opinions

Another way to shed light on the expected safety impacts of longer or heavier trucks is to rely on the professional experience of those who drive trucks. In an effort to help provide insight into the views of truck drivers themselves regarding the safety aspects of heavier and/or larger truck configurations, a web-based survey was designed and implemented in conjunction with the Owner-Operator Independent Drivers Association (OOIDA).[74] The survey was divided into two main portions, the first of which describes respondent demographics and the second gauges opinion based upon their professional experience. Seventy-five valid responses were obtained from the survey and highlights of the results are presented below. As the survey instrument was implemented online, a listing of the survey questions is attached in Appendix B.

***Driver Background and Experience***

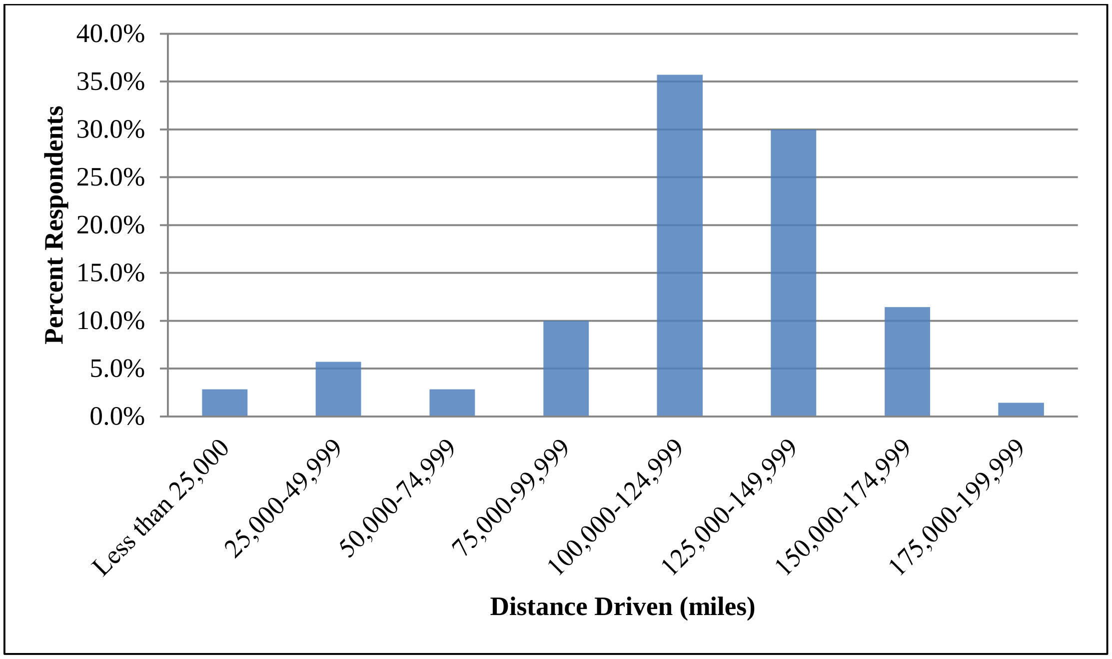
Respondents were asked a variety of questions to indicate the range of time during which they have been a truck driver, whether or not they are a driver for a carrier or an independent trucker, if they leased their own truck or drive the carrier's truck and approximately how miles were driven each year. The majority (82 percent) have been a truck driver for more than 10 years. Nearly 15 percent have been a truck driver for five to ten years while approximately two percent have been a truck driver for one to four years. The majority (70 percent) indicated being a driver for a carrier. The other 30 percent are independent truckers with their own authority.

Nearly 62 percent, the majority of respondents who drive for a carrier, are leased to the carrier with their own truck. The remaining 38 percent (approximate) drive the carrier's truck.

On average, survey respondents drive approximately 109,400 miles a year. The median distance driven of responses provided is 120,000 miles and the mode is 100,000 miles. The aggregated approximate number of miles driven each year by respondents is provided in Figure 6.

[74] http://www.ooida.com/

**Figure 8 – Approximate Distance Driven (in miles) Each Year**




Survey respondents were asked to rank their experience in five truck configurations:

- Tractor and single trailer,
- Tractor and two 28-foot trailers ("STAA Double"),
- Rocky Mountain double,
- Turnpike double, and
- Triple-trailer trucks.

Experience with each truck configuration was ranked by three experience levels:

- No experience,
- Some experience, or
- Significant experience.

The majority of individuals (approximately 96 percent) indicated significant experience with the tractor and single trailer configuration. Approximately 66 percent ranked no experience with the tractor and two 28-foot trailers configuration while 34 percent ranked either some experience or significant experience with this arrangement. For the Rocky Mountain double, turnpike double and triple-trailer truck configurations, no less than 90 percent of respondents in each case indicated that they had no experience with these setups. Table 7 provides experience ranks for each of the five configurations.

**Table 7 – Experience with Truck Configurations**

| Configuration | No Experience | Some Experience | Significant Experience |
|---|---|---|---|
| **Tractor and single trailer** | 1% | 3% | 96% |
| **Tractor and two 28' trailers** | 66% | 17% | 17% |
| **Rocky Mountain Double** | 93% | 6% | 1% |
| **Turnpike Double** | 93% | 4% | 3% |
| **Triple-trailer truck** | 90% | 7% | 3% |

When asked about experience driving trucks with a gross vehicle weight (GVW) above 80,000 pounds, nearly 40 percent of respondents reported no experience. Approximately 33 percent of those remaining indicated some experience and approximately 28 percent reported significant experience.

***Opinions Regarding Impacts from Heavier and Longer Trucks***

Obtaining the opinions of individuals (i.e. police officers, truck drivers and etc.) that are familiar with increased weight and longer vehicles is of the utmost importance as they can offer their perspectives and experiences with real world operations and the effects of things like wind, hazardous materials, the inspection of longer vehicles and such.

Those respondents who had experience with trucks weighing in excess of 80,000 pounds were asked to expound on their experiences with this configuration. Approximately 55 percent indicated their experience had been under special conditions, such as permit loads. The remaining 45 percent indicated their experience with this configuration occurred in states or on roads which allow heavier weight vehicles without permits.

Respondents with experience driving heavy weight trucks (those with a GVW in excess of 80,000 pounds) were asked to respond to six questions to determine the impact of the heavier weight on certain operating characteristics of the truck. The impacts ranked in this inquiry include:

- Positive impact
- Negative impact
- No impact.

Responses to the impact on operating characteristics of heavier weight vehicles are provided in Table 8.

**Table 8 – Impact of Heavier Weight on Truck Operating Characteristics**

| Characteristic | Positive Impact | Negative Impact | No Impact |
|---|---|---|---|
| **Braking distance** | 2% | 91% | 7% |
| **Braking ability** | 17% | 67% | 17% |
| **Additional action to prevent rollover** | 0% | 77% | 23% |
| **Turning radius** | 0% | 66% | 34% |
| **Emergency maneuver** | 0% | 86% | 14% |
| **Impact on equipment** | 2% | 81% | 17% |

Respondents were asked whether general highway safety would be positively or negatively impacted by replacing 80,000 pound, five-axle trucks with 97,000 pound, six-axle trucks. In response, nearly 90 percent indicated they felt this change would negatively impact general highway safety. The remaining individuals indicated they felt this change would positively impact general highway safety.

As with heavier weight vehicles, those respondents with experience driving longer combination vehicles (LCVs) were asked to rate the operating characteristic impacts differing between LCV and a typical semi-trailer.

Responses to the impact on operating characteristics of LCVs are provided in Table 9.

**Table 9 - Impact of Widespread Operation of LCVs on Truck Operating Characteristics**

| Characteristic | Positive Impact | Negative Impact | No Impact |
|---|---|---|---|
| **Braking distance** | 9% | 73% | 18% |
| **Additional action to prevent rollover** | 5% | 86% | 9% |
| **Turning radius** | 5% | 70% | 25% |
| **Emergency maneuver** | 0% | 90% | 10% |
| **Impact on equipment** | 5% | 76% | 19% |

Respondents to the survey with LCV experience were asked to rate whether general highway safety would be positively or negatively impacted by greater use of LCVs on roads and highways. Approximately 88 percent of respondents to this question indicated a negative impact on general highway safety, while the remaining 12 percent indicated a positive impact.

When asked what impact on the availability of truck parking might be expected with a greater use of LCVs, 87 percent of respondents indicated a negative impact. Of those remaining, approximately eight percent indicated a positive impact while six percent indicated no impact on truck parking.

***Summary of Truck Driver Opinions on Safety***

The vast majority of the responding drivers indicated that they were experienced (82 percent with more than 10 years driving experience), drove many miles per year (more than 109,000 on average) and exhibited significant concerns regarding the impacts of additional weight and LCVs. Regarding additional weight, the majority of respondents indicated experience with or negative impacts especially in the areas of equipment, braking distance and the completion of emergency maneuvers. In reference to LCVs, concerns focused the completion of emergency maneuvers and on requiring more action to prevent rollover. While it is difficult to extrapolate these 75 interviews into a statistically significant sample, the opinions presented are clear. Here, as with the law enforcement officer interviews, opinions are consistent and they raise significant concerns over the effects of heavier and longer trucks.

# 4. Conclusions

The existing literature, research, interviews and statistics provide clear, if not conclusive, evidence. With confidence, we can say that additional axles, vehicle length and weight place pressure on the equipment, maintenance and drivers, which ultimately increases the potential for error, accident and fatality. Further, existing data, though limited, suggests that heavier and longer trucks are likely to have higher fatal crash rates than the most common trucks on the road today. To better assess the safety impacts of future proposals to increase truck size or weight will require information not currently available. To that end, we make the following recommendations.

1. **Improve data collection efforts.** Data on fatal accidents by configuration and reliable VMT estimates will be required to fully answer questions about the safety of specific truck configurations. Federal agencies should work to require the collection and reporting of more specific information (including weight and configuration) for vehicles involved in fatal accidents and should significantly improve the collection of VMT data.
2. **Conduct off-road operating characteristic testing.** Industry states that technology has enhanced the operating characteristics of commercial motor vehicles yet there is no research directly comparing the operating characteristics of proposed vehicles. This analysis should be completed on a test track to avoid experiments involving the motoring public.

# Appendix A – Missouri Accident Report Form

**MISSOURI UNIFORM ACCIDENT REPORT** PAGE ____ OF ____

SPACE USED FOR BARCODE | 1 - AGENCY NAME AND ORI

LEFT THE SCENE ☐ YES ☐ NO | CLEARED ☐ YES ☐ NO | ACCIDENT CLASSIFICATION | PROPERTY DAMAGE ONLY ☐ | NUMBER INJURED | NUMBER KILLED | REPORT / CASE / INCIDENT NUMBER

NUMBER OF VEHICLES INVOLVED | ACCIDENT DATE | ACCIDENT TIME (MIL.) | TIME NOTIFIED (MIL.) | TIME ARRIVED (MIL.) | INVESTIGATION DATE

**2 - LOCATION**

COUNTY | MUNICIPALITY | BEAT / ZONE | TRP / DIST / PCT | INVESTIGATED AT SCENE ☐ YES ☐ NO

ON | DISTANCE FROM ____ FEET ____ . ____ MILES | LOCATION ☐ AFTER ☐ BEFORE ☐ AT | INTERSECTING STREET OR ROADWAY

ROADWAY DIRECTION | SPEED LIMIT | SPEED LIMIT | GEO - CODE | GPS LONGITUDE ____ LATITUDE ____ ☐ NONE

ROAD MAINTAINED BY ☐ 1. STATE ☐ 2. COUNTY ☐ 3. MUNICIPAL ☐ 4. PRIVATE PROPERTY ☐ 5. OTHER

**3 - DAMAGE TO PROPERTY OTHER THAN VEHICLES**

GIVE OWNER'S NAME AND ADDRESS, DESCRIPTION OF PROPERTY, AND DAMAGE

☐ MoDOT

**4. DRIVER 1**

DRIVER'S FULL NAME (LAST, FIRST, MI) | ADDRESS (STREET, CITY, STATE, ZIP)

DRIVER LICENSE NUMBER / ID NUMBER | STATE | TYPE OF LICENSE ☐ 1. OPERATOR CLASS ____ ☐ 2. CDL CLASS ____ ☐ 3. PERMIT ☐ 4. UNLICENSED ☐ 5. MC ONLY | MC ENDORSEMENT ☐ YES ☐ NO ☐ NA

PROOF OF INSURANCE ☐ YES ☐ NO ☐ NOT REQUIRED | INSURANCE COMPANY ☐ DRIVER ☐ VEHICLE | POLICY NUMBER ☐ NA

**VEHICLE 1**

YEAR | MAKE | MODEL | COLOR

LIC. PLATE NO. | STATE | YEAR | VIN | TOTAL NO. OF OCCUPANTS

VEHICLE OWNER NAME (LAST, FIRST, MI) / COMMERCIAL CARRIER | ADDRESS (STREET, CITY, STATE, ZIP) ☐ SAME AS DRIVER

VEHICLE DAMAGE (Circle all damaged areas) ☐ NONE | INITIAL IMPACT NO. ☐ NA | 2 3 4 5 6 7 / 1 15 16 17 8 / 14 13 12 11 10 9 REAR | 18 - Undercarriage 19 - Windshield 20 - Burned 21 - Towed Unit 22 - Cargo | TOWED FROM SCENE ☐ YES ☐ NO | TOW CO. INFORMATION

**5. DRIVER 2**

DRIVER'S FULL NAME (LAST, FIRST, MI) | ADDRESS (STREET, CITY, STATE, ZIP)

DRIVERS LICENSE NUMBER / ID NUMBER | STATE | TYPE OF LICENSE ☐ 1. OPERATOR CLASS ____ ☐ 2. CDL CLASS ____ ☐ 3. PERMIT ☐ 4. UNLICENSED ☐ 5. MC ONLY | MC ENDORSEMENT ☐ YES ☐ NO ☐ NA

PROOF OF INSURANCE ☐ YES ☐ NO ☐ NOT REQUIRED | INSURANCE COMPANY ☐ DRIVER ☐ VEHICLE | POLICY NUMBER ☐ NA

**VEHICLE 2**

YEAR | MAKE | MODEL | COLOR

LIC. PLATE NO. | STATE | YEAR | VIN | TOTAL NO. OF OCCUPANTS

VEHICLE OWNER NAME (LAST, FIRST, MI) / COMMERCIAL CARRIER | ADDRESS (STREET, CITY, STATE, ZIP) ☐ SAME AS DRIVER

VEHICLE DAMAGE (Circle all damaged areas) ☐ NONE | INITIAL IMPACT NO. ☐ NA | 2 3 4 5 6 7 / 1 15 16 17 8 / 14 13 12 11 10 9 REAR | 18 - Undercarriage 19 - Windshield 20 - Burned 21 - Towed Unit 22 - Cargo | TOWED FROM SCENE ☐ YES ☐ NO | TOW CO. INFORMATION

**6 - WITNESS** ☐ NONE IDENTIFIED

| NAME OF WITNESS | ADDRESS (STREET, CITY, STATE, ZIP) | TELEPHONE NO. |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

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REPORT # ____________ PAGE ______ OF ______

**7. COLLISION DIAGRAM** | **Direction Prior to Impact (circle one)** **V1** N E S W **V2** N E S W **V3** N E S W **V4** N E S W | Est. Speed - Fatals Only V1 V2 V3 V4

INDICATE NORTH

INDICATE ROAD NAMES

REQUIRED UNLESS DELAYED REPORT

DIAGRAM NOT TO SCALE

**8. EVIDENTIARY PHOTOS TAKEN**

☐ YES ☐ NO BY WHOM AVAILABLE FROM

**RECONSTRUCTION** - Includes Narrative, Diagram, & Photo(s)

☐ YES ☐ NO BY WHOM

ii

REPORT #________ PAGE ____ OF ____

## 9 - CODES

**SEAT LOCATION**

| FR | SR | TR |
|---|---|---|
| FC | SC | TC |
| FL | SL | TL |

- XX - Not Known
- P - Pedestrian
- B - Bicycle
- M - Motorcycle
- OE - Occupant - Enclosed Load Area
- OU - Occupant - Unenclosed Load Area
- CP - Commercial Passenger
- SV - Other (Explain in Remarks)

**INJURY**
1. Fatal
2. Disabling
3. Evident - Not Disabling
4. Probable - Not Apparent
5. None Apparent
6. Unknown

**TRANSPORTED** (Medical Treatment)
1. No
2. EMS
3. Other
4. Unknown

**EJECTION**
1. NA
2. No
3. Partially
4. Totally
5. Unknown

**AIR BAG FRONT**
1. None / NA
2. Deployed
3. Not Deployed

**AIR BAG SIDE**
1. None / NA
2. Deployed
3. Not Deployed

**SAFETY DEVICES**
1. None
2. Not Used
3. Shoulder Belt Only
4. Lap Belt Only
5. Shoulder and Lap Belt
6. Child Restraint
7. Helmet Used
8. Helmet Not Used
9. Use Unknown

## 10 - DRIVERS

| NAME / ADDRESS | DATE OF BIRTH MM-DD-YYYY | SEX | VEH. NO. | SEAT LOC. | INJ. | TRANS-PORT | EJEC-TION | AIR BAG F | AIR BAG S | SAF DEV | TELEPHONE NO. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ☐ NA DRIVER 1 - SAME ADDRESS AS ABOVE | | | 1 | | | | | | | | |
| ☐ NA DRIVER 2 - SAME ADDRESS AS ABOVE | | | 2 | | | | | | | | |

## 11 - OTHER OCCUPANTS & PEDESTRIANS (SAD = SAME AS DRIVER)

| NAME / ADDRESS | DATE OF BIRTH | SEX | VEH. NO. | SEAT LOC. | INJ. | TRANS-PORT | EJEC-TION | AIR BAG F | AIR BAG S | SAF DEV | TELEPHONE NO. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ☐ SAD | | | | | | | | | | | |
| ☐ SAD | | | | | | | | | | | |
| ☐ SAD | | | | | | | | | | | |
| ☐ SAD | | | | | | | | | | | |
| ☐ SAD | | | | | | | | | | | |
| ☐ SAD | | | | | | | | | | | |

## 12. VEHICLE BODY TYPES AUTOMOBILES / SPECIAL VEHICLES

V1 V2
- ☐ ☐ 1. Passenger Car
- ☐ ☐ 2. Station Wagon
- ☐ ☐ 3. Sport Utility Vehicle
- ☐ ☐ 4. Limousine (6-15 for hire)
- ☐ ☐ 5. Van (8 or less with driver)
- ☐ ☐ 6. Small Bus (9-15 with driver)
- ☐ ☐ 7. Bus (16 or more with driver)
- ☐ ☐ 8. School Bus (less than 16 with driver)
- ☐ ☐ 9. School Bus (16 or more with driver)
- ☐ ☐ 10. Motorcycle
- ☐ ☐ 11. ATV
- ☐ ☐ 12. Motorized Bicycle
- ☐ ☐ 13. Pedalcycle
- ☐ ☐ 14. Motor Home / Camper
- ☐ ☐ 15. Farm Implements
- ☐ ☐ 16. Construction Equipment
- ☐ ☐ 17. Other Transport Device
- ☐ ☐ 18. Unknown
- ☐ ☐ 19. Pick-up
- ☐ ☐ 20. Single-unit Truck: 2 axles, 6 tires
- ☐ ☐ 21. Single-unit Truck: 3 or more axles

(Motorcycle / ATV: ☐ ☐ 2 Wh. ☐ ☐ 3 Wh. ☐ ☐ 4 Wh. ☐ ☐ 5 Wh. or More ☐ ☐ Unknown)

- ☐ ☐ A. Vehicle Pulling Another Unit(s) 1-21 only

- ☐ ☐ 22. Truck Tractor With No Units
- ☐ ☐ 23. Truck Tractor With One Unit
- ☐ ☐ 24. Truck Tractor With Two Units
- ☐ ☐ 25. Truck Tractor With Three Units
- ☐ ☐ 26. Other Heavy Truck

GCVW Rating (not licensed weight) 19-26 only
- ☐ ☐ Less than or equal to 10,000 lbs.
- ☐ ☐ 10,001 - 26,000 lbs.
- ☐ ☐ Greater than 26,000 lbs.

## 13. EMERGENCY VEHICLE INVOLVEMENT ☐ NA

V1 V2
- ☐ ☐ 1. Police
- ☐ ☐ 2. Fire
- ☐ ☐ 3. Ambulance
- ☐ ☐ 4. Other (must check "A")
- ☐ ☐ A. Emergency Vehicle on Emergency Run

## 14. HAZARDOUS MATERIALS ☐ NA

V1 V2
- ☐ ☐ Placard Displayed
- ☐ ☐ 1. Gases in Bulk
- ☐ ☐ 2. Solids in Bulk
- ☐ ☐ 3. Liquids in Bulk
- ☐ ☐ 4. Explosives
- ☐ ☐ 5. None
- ☐ ☐ A. Hazardous Materials' Cargo Released / Spilled

## 15. ACCIDENT TYPE

- ☐ 1. On Roadway
- ☐ 2. Off Roadway

COLLISION INVOLVING
- ☐ 1. Animal
- ☐ 2. Pedalcycle
- ☐ 3. Fixed Object
- ☐ 4. Other Object
- ☐ 5. Pedestrian
- ☐ 6. Train
- ☐ 7. MV in Transport
- ☐ 8. MV on Other Roadway
- ☐ 9. Parked MV

NON-COLLISION
- ☐ 10. Overturning
- ☐ 11. Other Non-Collision

**TWO VEHICLE COLLISION**
- ☐ 60. Head On
- ☐ 61 . Rear End
- ☐ 62. Sideswipe - Meeting
- ☐ 63. Sideswipe - Passing
- ☐ 64. Angle
- ☐ 65. Backed Into
- ☐ 67. Other

## 16. TRAFFIC CONDITIONS

V1 V2
- ☐ ☐ 1. Normal
- ☐ ☐ 2. Accident Ahead
- ☐ ☐ 3. Congestion Ahead

## 17. VEHICLE ACTION / SEQUENCE OF EVENTS

1. Going Straight
2. Overtaking
3. Making Right Turn
4. Right Turn on Red
5. Making Left Turn
6. Making U Turn
7. Skidding / Sliding
8. Slowing / Stopping
9. Start in Traffic
10. Start From Parked
11. Backing
12. Stopped in Traffic
13. Parked
14. Changing Lanes
15. Avoiding
16. Crossover Median
17. Crossover Centerline
18. Crossing Road
19. Airborne
20. Ran Off Road - Right
21. Ran Off Road - Left
22. Overturn / Rollover
23. Fire / Explosion
24. Immersion
25. Jackknife
26. Cargo Loss / Shift
27. Equipment Failure
28. Separation of Units
29. Returned to Road
30. Collision Inv. Pedestrian
31. Collision Inv. Pedalcycle
32. Collision Inv. Train
33. Collision Inv. Animal (enter code - explain)
34. Collision Inv. MV in Transport
35. Collision Inv. Parked Motor Vehicle
36. Collision Inv. Fixed Object (enter code - explain)
37. Collision Inv. Other Object (explain)
38. Other - Non Collision

V1 ☐ Unknown

____ / ____ / ____ / ____ / ____ / ____ / ____

33. Animal Code ____

36. Fixed Object Code ____ / ____ / ____

V2 ☐ Unknown

____ / ____ / ____ / ____ / ____ / ____ / ____

33. Animal Code ____

36. Fixed Object Code ____ / ____ / ____

Animal, Fixed Object, and Inattention Codes explained in narrative.

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**18. PROBABLE CONTRIBUTING CIRCUMSTANCES**

V1 V2

- ☐ ☐ 1. Vehicle Defects (explain)
- ☐ ☐ 2. Traffic Control Inoperable or Missing
- ☐ ☐ 3. Improperly Stopped on Roadway
- ☐ ☐ 4. Speed - Exceeded Limit
- ☐ ☐ 5. Too Fast for Conditions
- ☐ ☐ 6. Improper Passing
- ☐ ☐ 7. Violation Signal / Sign
- ☐ ☐ 8. Wrong Side (not passing)
- ☐ ☐ 9. Following Too Close
- ☐ ☐ 10. Improper Signal
- ☐ ☐ 11. Improper Backing
- ☐ ☐ 12. Improper Turn
- ☐ ☐ 13. Improper Lane Usage / Change
- ☐ ☐ 14. Wrong Way (One-Way)
- ☐ ☐ 15. Improper Start From Park
- ☐ ☐ 16. Improperly Parked

P1 P2 V1 V2

- ☐ ☐ ☐ ☐ 17. Failed to Yield
- ☐ ☐ ☐ ☐ 18. Alcohol
- ☐ ☐ ☐ ☐ 19. Drugs
- ☐ ☐ ☐ ☐ 20. Physical Impairment (explain)
- ☐ ☐ ☐ ☐ 21. Inattention (explain)
  P1 ____ P2 ____ V1 ____ V2 ____
- ☐ ☐ ☐ ☐ 22. None

**19. PEDESTRIAN INVOLVEMENT** ☐ NA

P1 P2

- ☐ ☐ 1. At Intersection
- ☐ ☐ 2. Not At Intersection

CROSSING ROAD

- ☐ ☐ 3. With Signal
- ☐ ☐ 4. Against Signal
- ☐ ☐ 5. No Signal
- ☐ ☐ 6. Diagonally
- ☐ ☐ 7. Within Crosswalk
- ☐ ☐ 8. Within Marked Crosswalk
- ☐ ☐ 9. Behind / In Front of Parked Car
- ☐ ☐ 10. With Traffic
- ☐ ☐ 11. Against Traffic
- ☐ ☐ 12. Getting On / Off Vehicle
- ☐ ☐ 13. Standing / Lying / Sitting on Road
- ☐ ☐ 14. Pushing / Working on Vehicle
- ☐ ☐ 15. Other Working
- ☐ ☐ 16. Playing on Road
- ☐ ☐ 17. Off Roadway

**20. VISION OBSCURED**

V1 V2

- ☐ ☐ 1. Windshield
- ☐ ☐ 2. Load on Vehicle
- ☐ ☐ 3. Trees / Brush
- ☐ ☐ 4. Building
- ☐ ☐ 5. Embankment
- ☐ ☐ 6. Signboards
- ☐ ☐ 7. Hillcrest
- ☐ ☐ 8. Parked Cars
- ☐ ☐ 9. Moving Cars
- ☐ ☐ 10. Glare
- ☐ ☐ 11. Other (explain)
- ☐ ☐ 12. Not Obscured

**21. TRAFFIC CONTROL**

V1 V2

- ☐ ☐ 1. Construction Zone
- ☐ ☐ 2. Other Work Zone
- ☐ ☐ 3. School Zone
- ☐ ☐ 4. Stop Sign
- ☐ ☐ 5. Electric Signal
- ☐ ☐ 6. RR Signal / Gate
- ☐ ☐ 7. Yield Sign
- ☐ ☐ 8. Officer / Flagman
- ☐ ☐ 9. No Passing Zone
- ☐ ☐ 10. Turn Restricted
- ☐ ☐ 11. Signal on School Bus
- ☐ ☐ 12. None

**22. ROAD CHARACTER**

ALIGNMENT

- ☐ 1. Straight
- ☐ 2. Curve

PROFILE

- ☐ 1. Level
- ☐ 2. Grade
- ☐ 3. Hillcrest

**23. LIGHT CONDITION**

- ☐ 1. Daylight
- ☐ 2. Dark with Street Lights On
- ☐ 3. Dark with Street Lights Off
- ☐ 4. Dark - No Street Lights
- ☐ 5. Indeterminate (explain)

**24. WEATHER CONDITION**

- ☐ 1. Clear
- ☐ 2. Cloudy
- ☐ 3. Rain
- ☐ 4. Snow
- ☐ 5. Sleet
- ☐ 6. Freezing (temp.)
- ☐ 7. Fog / Mist
- ☐ 8. Indeterminate (explain)

**25. ROAD CONDITION**

- ☐ 1. Dry
- ☐ 2. Wet
- ☐ 3. Snow
- ☐ 4. Ice
- ☐ 5. Slush
- ☐ 6. Mud
- ☐ 7. Standing Water
- ☐ 8. Moving Water
- ☐ 9. Other (explain)

**26. ROAD SURFACE**

- ☐ 1. Concrete
- ☐ 2. Asphalt
- ☐ 3. Brick
- ☐ 4. Gravel
- ☐ 5. Dirt / Sand
- ☐ 6. Multi-Surface

**27 - COMMERCIAL MOTOR VEHICLE (Complete for each commercial vehicle involved.)**

**A. CMV CRITERIA**

Answer the following to determine if this section should be completed.

1. Does this accident involve any of the following:
   1. a person fatally injured; or
   2. a person transported for medical attention; or
   3. a vehicle towed from the scene of the accident

   ☐ NO - DO NOT COMPLETE
   ☐ YES - GO TO NUMBER 2
2. Examine each vehicle to determine if it is a commercial vehicle based on the following:
   1. a truck with GCVWR of more than 10,000 lbs. and engaged in commerce; or
   2. a bus or school bus (9 or more including driver); or
   3. a vehicle with a hazardous materials placard

   ☐ NO - DO NOT COMPLETE
   ☐ YES - COMPLETE SECTIONS B - E

**B. CARRIER ID NUMBER**

V1 ICC NO. MC __________ USDOT NO. __________

V2 ICC NO. MC __________ USDOT NO. __________

**C. HAZARDOUS MATERIAL PLACARD NUMBER** ☐ NA

V1 4-Digit Placard Number from Diamond / Box ______ Number From Bottom of Diamond ______

V2 4-Digit Placard Number from Diamond / Box ______ Number From Bottom of Diamond ______

**D. TRAFFICWAY**

- ☐ 1. Two-Way; Not Divided
- ☐ 2. Two-Way; Divided; Unprotected Median
- ☐ 3. Two-Way; Divided; Positive Median Barrier
- ☐ 4. One-Way; Not Divided

**E. CARGO BODY TYPE**

V1 V2

- ☐ ☐ 1. Enclosed Box
- ☐ ☐ 2. Cargo Tank
- ☐ ☐ 3. Flatbed
- ☐ ☐ 4. Dump
- ☐ ☐ 5. Concrete Mixer
- ☐ ☐ 6. Auto Transporter
- ☐ ☐ 7. Garbage / Refuse
- ☐ ☐ 8. Grain, Chip, Gravel
- ☐ ☐ 9. Pole Trailer
- ☐ ☐ 10. Other

**28 - NARRATIVE / STATEMENTS (If additional room is necessary, attach a separate sheet.)**

| 29. REPORTING OFFICER SIGNATURE | DSN / BADGE NO. | BEAT / ZONE | TROOP / DIST / PCT |
|---|---|---|---|
| | | | |

| REVIEWING OFFICER 1 SIGNATURE | DSN / BADGE NO. | REVIEWING OFFICER 2 SIGNATURE | DSN / BADGE NO. |
|---|---|---|---|
| | | | |

iv

# Appendix B - Truck Driver Survey Instrument

1.) How many years have you been a truck driver?
    a. Less than 1 year
    b. 1-4 years
    c. 5-10 years
    d. More than 10 years
2.) Are you a driver for a carrier or are you an independent trucker with your own authority?
3.) If you drive for a carrier, are you leased to the carrier with your own truck, or do you drive the carrier's truck?
4.) Approximately how many miles do you drive each year?
5.) How much experience do you have with the following truck configurations?
    a. Tractor and single trailer
        i. No experience
        ii. Some experience
        iii. Significant experience
    b. Tractor and two 28' trailers ("STAA Double")
        i. No experience
        ii. Some experience
        iii. Significant experience
    c. "Rocky Mountain Double"
        i. No experience
        ii. Some experience
        iii. Significant experience
    d. "Turnpike Double"
        i. No experience
        ii. Some experience
        iii. Significant experience
    e. Triple-trailer truck
        i. No experience
        ii. Some experience
        iii. Significant experience
6.) How much experience do you have driving trucks with a GVW above 80,000 pounds?
    a. No experience
    b. Some experience
    c. Significant experience
7.) If you have experience with trucks weighing over 80,000 pounds, has your experience been under special conditions (for instance, permit loads) or were you driving in a state or on roads that allows heavier weight vehicles without permits?
    a. Special conditions
    b. State allowing heavier vehicles
8.) If you have experience with trucks over 80,000 pounds, what impact did the heavier weight have on these operating characteristics of your truck?
    a. Braking distance
        i. Positive Impact (heavier truck required less braking distance)
        ii. Negative Impact (heavier truck required more braking distance)
        iii. No Impact
    b. If operating a heavier truck with a 6th axle, what impact did you feel the sixth axle had on your braking ability
        i. Positive Impact (heavier truck required less braking distance)
        ii. Negative Impact (heavier truck required more braking distance)
        iii. No Impact
    c. What about the need to take additional action to reduce the likelihood of a rollover?

i. Positive Impact (heavier truck required less effort)
ii. Negative Impact (heavier truck required more effort)
iii. No Impact

d. How was the turning radius of the truck impacted?
   i. Positive Impact (heavier truck required less turning radius)
   ii. Negative Impact (heavier truck required a larger turning radius)
   iii. No Impact
e. What about the impact on the difficulty of controlling the truck during emergency maneuvers?
   i. Positive Impact (heavier truck was easier to control/felt it would be easier to control)
   ii. Negative Impact (heavier truck was harder to control/felt it would be harder to control)
   iii. No Impact
f. Was there an impact on your tractor or trailer equipment?
   i. Positive Impact (heavier truck did less wear and tear)
   ii. Negative Impact (heavier truck did more wear and tear)
   iii. No Impact Noticed
g. Please share any personal experiences that would help us further understand your answers above.

9.) Do you feel that in general highway safety would be positively or negatively impacted by replacing 80,000-pound, five-axle trucks with 97,000-pound, six-axle trucks?

10.) If you have experience with LCVs, what differences did you notice between the LCV and a typical semi-trailer on the following truck operating characteristics?

a. Braking distance
   i. Positive Impact (LCV required less braking distance)
   ii. Negative Impact (LCV required more braking distance)
   iii. No Impact
b. What about the need to take additional action to reduce the likelihood of a rollover?
   i. Positive Impact (LCV required less effort)
   ii. Negative Impact (LCV required more effort)
   iii. No Impact
c. How was the turning radius of the truck impacted?
   i. Positive Impact (LCV required less turning radius)
   ii. Negative Impact (LCV required a larger turning radius)
   iii. No Impact
d. What about the impact on the difficulty of controlling the truck during emergency maneuvers?
   i. Positive Impact (LCV was easier to control/felt it would be easier to control)
   ii. Negative Impact (LCV was harder to control/felt it would be harder to control)
   iii. No Impact
e. Was there an impact on your tractor or trailer equipment?
   i. Positive Impact (LCV did less wear and tear)
   ii. Negative Impact (LCV did more wear and tear)
   iii. No Impact
f. Please share any personal experiences that would help us further understand your answers above.

11.) Do you feel that in general highway safety would be positively or negatively impacted by greater use of LCVs on roads and highways?

12.) What impact do you feel greater use of LCVs on our roads would have on the availability of truck parking?

a. Positive Impact
b. Negative Impact
c. No Impact

Are you interested in talking with researchers in more detail about your views on longer and heavier truckers? If so, please provide your contact information in the box below.