Twin 33 Foot Truck Trailers: Making U.S. Freight Transport Safer And More Efficient

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Commissioned By Americans For Modern Transportation

ACRONYMS

ATA	American Trucking Associations
ATRI	American Transportation Research Institute
CO2	Carbon Dioxide
CTSWLS	Comprehensive Truck Size & Weight Limits Study (FHWA)
DOT	Department of Transportation (Federal, unless otherwise specified)
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FMCSR	Federal Motor Carrier Safety Regulation
GHG	Greenhouse Gas
HCV	Higher Capacity Vehicle
ITF	International Transport Forum
LCV	Longer Combination Vehicle
LTL	Less-than truckload
NHTSA	National Highway Traffic Safety Administration
NOx	Nitrous Oxide
OECD	Organization for Economic Cooperation & Development
R&D	Research & Development
ROI	Return on Investment
S-53	Single-53' trailer combination-unit truck
T-28	Twin-28' trailer combination-unit truck
T-33	Twin-33' trailer combination-unit truck
TCA	Truckload Carriers Association
TL	Truckload
TPMS	Tire Pressure Monitoring System
TRB	Transportation Research Board
VMT	Vehicle Miles Traveled

Executive Summary

In 2014, Widespread Adoption of Twin 33 Trailers Would Have Resulted In:

3.1 Billion
Fewer Vehicle Miles Traveled

4,500
Fewer Annual Truck Crashes

$2.6 Billion
Dollars Saved In Shipping Costs

53.2 Million
Hours Saved Due To Less Congestion

255 Million
Fewer Gallons Of Fuel

2.9 Million
Fewer Tons Of CO_2 Emissions

Trucks and the space shuttle are opposites, but not in the way you might think. While the space shuttle seems futuristic, it runs on decades old technology. Trucks, on the other hand, seem decades-old, but are powered by cutting-edge technology. Automatic braking, electronic stability control and other advanced safety features are ensuring our highways are safer than ever before. Thanks in part to these innovations, trucks are safer than passenger vehicles – the accident rate for trucks is now one-third the rate for passenger vehicles. In fact, recent innovations such as Lane Departure Warning and Forward Collision Warning systems collectively reduce thousands of crashes a year.

To build on this success and increase safety for all motorists, we must continue reducing the number of vehicles on the road. This study examines the safety benefits of allowing higher-capacity trailers on the national road network. Increasing the efficiency of individual trailer units will decrease the number of trucks and of miles driven, resulting in less exposure to risk.

Specifically, shifting from Twin-28 foot trailers to Twin-33s will allow shippers to meet the growing demands of the American consumer while making transportation safer and more sustainable. The study builds on previous findings that Twin-33s are more stable than Twin-28s during the types of highway-speed avoidance maneuvers that might result in accidents. It chronicles the effects of today's safety technologies such as electronic stability control, lane departure, and adaptive cruise control. Twin 33s are not only more stable and less likely to roll over or jackknife, but also their widespread adoption would reduce truck miles driven by 3.1 billion, avoiding 4,500 accidents per year.

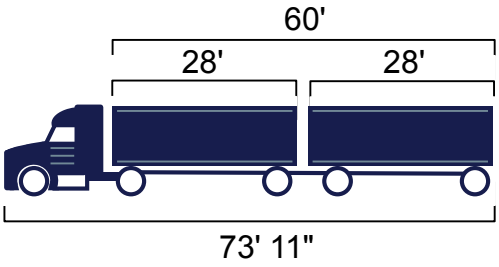
In addition to the safety benefits, this analysis finds that a shift from Twin-28 to Twin-33 foot trailers would result in better fuel efficiency and lower costs for consumers. The shift would save 255.2 million gallons of fuel, reduce carbon and nitrous oxide emissions by nearly three million tons and a billion grams respectively – all while reducing shipping costs by $2.6 billion. These emissions reductions would be equivalent to taking 551,000 cars off the roadways. Further analysis finds a Twin-33 shift would reduce congestion, decreasing total travel delay time by 53.2 million hours.

Recent decades have seen revolutionary improvements in U.S. trucking safety. Large truck fatal crash involvement rates have declined 75 percent since the 1970s. Large trucks are under-involved in fatal crashes compared to their mileage exposure. They traveled 9.2 percent of 2014 U.S. vehicle miles but were 8.3 percent of vehicles involved in fatal crashes. Truck involvement rates in injury-causing crashes are just *one-third* those of passenger cars.[1] Advanced safety technologies of proven effectiveness are rapidly penetrating the U.S. truck fleet, promising further crash reductions.

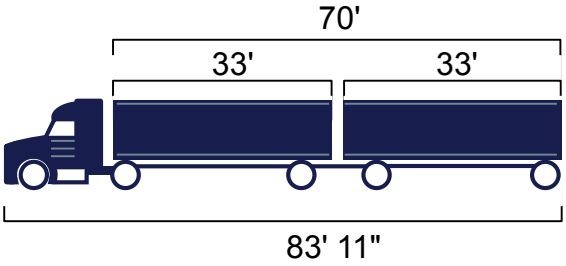
Large truck traffic carries inherent risks, though, even when trucks are driven safely. A way to reduce that risk is to deploy fewer, higher-capacity vehicles. This would mean relatively fewer truck miles driven and less exposure to risk. It would also bring better fuel efficiency, higher overall productivity, and cost savings across all links of the supply chain. The public is the ultimate beneficiary of these safety and cost-reduction benefits.

Fig 1: T-28 And T-33 Configurations

a) Twin 28 Truck Configuration



b) Twin 33 Truck Configuration



Government policy in place since 1982 restricts twin trailers used on the U.S. National Highway Network to 28' in length. The 1982 restrictions were based on the safety designs and operational uses of twin trailers at that time, 35 years ago. Tractor-trailers and their cargo are also limited to 80,000 lbs. total weight. A problem, however, is that Twin-28' trailer configurations (T-28s) usually fill up by cargo volume ("cube out") well before they reach the maximum weight limit. T-28s limit the capacity of each vehicle and necessitate more vehicles to carry the country's freight. A five-foot maximum length increase from 28' to 33' would increase each trailer's volume capacity by 18.6 percent without a maximum weight increase (Figure 1). This would greatly reduce the number of vehicles deployed and their associated risks without significant effects on infrastructure or on other sectors of freight transport. This study explains why allowing Twin-33' truck configurations (T-33s) would be beneficial to our freight system, our economy, and public safety.

> "A FIVE-FOOT MAXIMUM LENGTH INCREASE FROM 28' TO 33' WOULD INCREASE EACH TRAILER'S VOLUME CAPACITY BY 18.6 PERCENT WITHOUT A MAXIMUM WEIGHT INCREASE."

The American marketplace and transportation system have changed dramatically since 1982, and the pace of change is accelerating. Most notable has been the growth of e-commerce. Mega-sales platforms led by eBay, Amazon, Etsy, and traditional retailers selling online represent ever-increasing portions of consumer sales. E-commerce has become a staple of American life, as e-commerce sales have doubled in seven years and in less than five years will account for 10 percent of all retail sales.[2] This continuing shift in commerce requires corresponding shifts in transport strategy and equipment.

Traditional retail is supplied largely by truckload shipments of product delivered directly to retail outlets. In contrast, e-commerce generates many smaller shipments destined for end-consumers located everywhere. Cost-efficiency and timeliness of delivery favors a system of scheduled, synchronized truck trips throughout a network where each truck carries whatever variety of products has been purchased. Products are shipped to distribution hubs where they are sorted and delivered to consumers. The Less-Than-Truckload or LTL freight transport sector makes this market model possible. T-33s are designed specifically to support this rapidly expanding freight transport sector.

Over the next 30 years, America's population will increase by 70 million people, more than the combined populations of New York, Texas, and Florida. Most of the growth will occur in urban/suburban "megaregions," such as Atlanta-Charlotte, the Gulf Coast, and greater Phoenix. These megaregions already host 75 percent of America's population and employment. Reaching the growing population of consumers in these regions and across the country requires an efficient freight transport system. Trucking activity of all kinds has increased because, of all the modes, trucking is most responsive to the requirements of the cargo being shipped and customers served. Between 2004 and 2014, overall U.S. vehicle mileage increased by 2 percent while large truck mileage increased 26 percent, 13 times faster. Trucking is the fastest growing freight mode, and will carry 44 percent more freight in 2045 than in 2015.[3] Within trucking, LTL transport has been the fastest growing segment and is expected to grow by 40 percent just in the next decade. LTL growth during those years will be 66 percent higher than truckload sector growth.[4]

> **"TRUCKING IS THE FASTEST GROWING FREIGHT MODE, AND WILL CARRY 44 PERCENT MORE FREIGHT IN 2045 THAN IN 2015."**

Table 1: Efficiency And Environmental Benefits From A Twin 33 Shift

Travel Metric	T-33 Shift Reductions Modeled By U.S. DOT For 2011	T-33 Shift Reductions Extrapolated To 2014 VMT
Truck Travel	3.0 Billion Miles	3.1 Billion Miles
Fuel Use	244.7 Million Gallons	255.2 Million Gallons
CO_2 Emissions	2.7 Million Tons	2.9 Million Tons
NOx Emissions	929.8 Million Grams	969.8 Million Grams
Equivalent Cars Off Road*	528,474	551,199
Freight Transport Costs	$2.3 Billion Dollars	$2.6 Billion Dollars

*Based on 5.2 tons CO_2 per passenger vehicle per year (EPA estimate)[42]

In 2015, the U.S. Department of Transportation's (U.S. DOT) Federal Highway Administration (FHWA) published a *Comprehensive Truck Size And Weight Limits Study,* which analyzed and modeled six possible changes to truck trailer size and number.[5] One of these was to permit trucks on the National Highway Network to pull T-33s with no increase in the total truck-plus-cargo maximum weight of 80,000 lbs. The current maximum twin trailer length is 28'. This prospective policy change is referred to as the "T-33 shift."

U.S. DOT modeled numerous economic and societal benefits resulting from the T-33 shift. These benefits are documented and explained in this study. The T-33 shift increases trailer volume by 18.6 percent, which means that 15.7 percent fewer trucks and trailers could carry the same

cargo.[6] Operational cost savings would be more than 6 percent within the LTL transport niche, amounting to more than $2.5 billion in 2014 (the latest year for which normative data is available) and increasing annually.[7] Based on U.S. DOT estimates, current truck vehicle miles traveled (VMT) would be reduced by more than 3 billion, with associated reductions of more than 4,500 annual truck crashes.[8] Although twin trailer trucks are a small percentage of the overall traffic stream, permitting T-33s would reduce annual U.S. traffic delays by more than 50 million hours, with congestion-relief savings of nearly $1 billion.

Carrying the same cargo with fewer trucks and trips also reduces fuel consumption and costs. Extrapolated to 2014, DOT's estimated fuel savings would be more than 250 million gallons. Fuel use drives harmful greenhouse gas (GHG) emissions. Carbon dioxide emissions would be reduced by nearly 3 million tons, with concurrent reductions of nearly 1 billion grams of nitrous oxide. From an emissions standpoint, this is like taking 551,000 passenger vehicles off the roadways.

> "Fewer, higher-value vehicles also mean that greater safety investments can be made in each vehicle."

These economic and environmental benefits would not justify the T-33 shift unless there were substantial safety benefits. The estimate of 4,500 fewer large truck crashes based on mileage exposure reduction likely *underestimates* safety benefits substantially. Safety benefits are not just from fewer trucks, they are from better trucks. Individual T-33 trucks would be safer on highways than current T-28s because they are more dynamically stable at highway speeds. They are more stable during abrupt evasive maneuvers and less likely to roll over.

Fewer, higher-value vehicles also mean that greater safety investments can be made in each vehicle. This includes safety design enhancements to trailers, full suites of advanced crash prevention technologies in tractors, sophisticated monitoring of driver status and performance, and greater training and professional development investments in drivers. T-33s are part of a revolution in large truck safety design and operations. Today's tractors and trailers are generations removed from those in use at the time of the 1982 trailer-length restrictions. This study overviews these dramatic changes taking place in the trucking industry. Advanced technologies and management practices will ensure that, nationally, newly deployed T-33s will be among the safest trucks ever deployed.

The T-33 shift would also mean smarter deployment of drivers. Trucking has long suffered a chronic driver shortage, currently projected to be more than 100,000 drivers by next year. Many driver jobs require unpredictable schedules and weeks away from home. This leads to *churning*: frequent job changes by drivers. T-33s would alleviate the driver shortage while providing higher-quality and more stable jobs for drivers. Increasing the productivity of each vehicle increases the economic value of every delivery. These economic benefits will be shared by drivers and by everyone in the supply chain.

T-33s: What, Where, And Why

What Are T-33 Trailers?

T-33 truck configurations add five feet to each trailer but otherwise do not redesign T-28 configurations already in widespread use. The 10 feet addition to overall vehicle length does not change maximum total vehicle weight (80,000 lbs) or existing axle or bridge formula weight limits. Compared to T-28s, T-33s are 13.5 percent longer overall, but their cargo volume capacity increases by 18.6 percent. Increased capacity permits loading of two additional pallets per trailer without increasing maximum vehicle weight. Increasing capacity by 18.6 percent

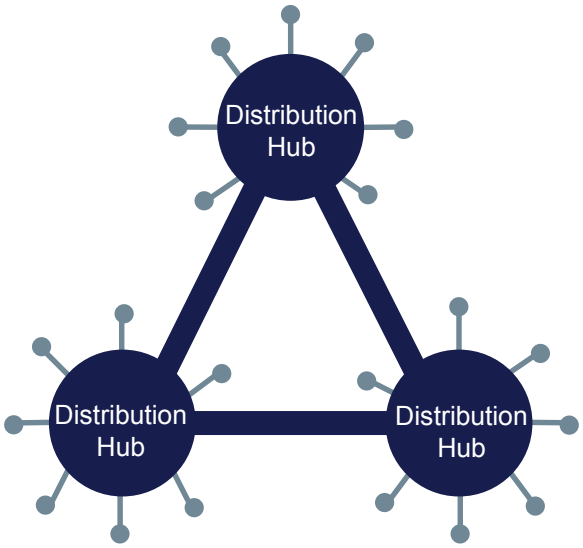
results in a 15.7 percent decrease in trucks and trips required, and reduces fuel use and emissions. Longer trailers also improve the unit's high-speed performance and stability. T-33s outperform T-28s on measures of rollover and jackknife risk.[9]

Where and How Would T-33s be Used?

When authorized by Congress, T-33s will be used mainly in hub and spoke Less-Than-Truckload (LTL) operations. These transport operations currently use mostly T-28s. They are termed "less than truckload" because their cargo packages and shipments are usually relatively small, with multiple shipments included together in the same truck. Some 85 percent of LTL freight is manufactured goods. More than 9.4 million customers are served daily by the industry in all 50 states.

Double trailers and other Higher Capacity Vehicle (HCV) configurations are more common in LTL operations because LTL cargo is usually less dense, requiring more space and volume. Double trailers also make it easier for drivers to "drop and swap" trailers, increasing the efficiency of the supply chain. "Drop and swap" reduces or eliminates the time drivers spend waiting for trailers to be loaded and unloaded—time most drivers regard as tedious, fatiguing, and unproductive. Most LTL truck trips are scheduled and regular. LTL companies have hub-and-satellite operations where drivers' regular runs are between a hub and satellite location. Companies may have multiple hubs with many regular trips between hubs. There are far fewer LTL than truckload carriers and they tend to be large fleets with closely managed transport and delivery operations. Such large fleets have the business volume, management talent, and financial resources to implement the most progressive practices in safety and efficiency. One fleet comparison found the overall LTL fleet crash rate to be 36 percent less than that for other carriers, and the at-fault crash rate to be 46 percent less.[10]

Fig 2: Schematic Of LTL Hub And Spoke Operation



LTL operations depend overwhelmingly on twin trailer trucks, currently limited to 28' per trailer maximum length. When allowed, T-33s will be used primarily in LTL operations. Single 53' trailers will continue as the workhorse for truckload operations carrying more than 97 percent of highway freight by weight.[11]

> "Single 53' trailers will continue as the workhorse for truckload operations carrying more than 97 percent of highway freight by weight."

Most truck travel across the industry is on Interstate highways and other freeways. Large trucks of all types account for about 20 percent of all traffic on rural Interstates, 8 percent on urban Interstates, and much lower percentages on other roadway types such as arterials and other approved routes.[12] In 2011, only 5.5 percent of all truck miles were traveled by twin trailer trucks of 80,000lbs or less, the truck type most affected by the suggested rule change.[13] Thus, twin

trailer trucks account for about 1 percent of all traffic on rural Interstates, 0.4 percent on urban Interstates, and even lower percentages on most other approved routes.

Twin trailer productivity and efficiency are more often limited by load volume than by weight. Most current T-28s carry dry consumer goods (e.g. cereal, snacks, paper goods, toys, electronics) or other low-density (but often high-value) cargo. Shippers typically max out T-28s with packages before they reach maximum weight — 62 percent of twin trailer trucks are loaded at 10,000 pounds or more *below* the maximum allowed weight of 80,000 pounds. For single-trailer trucks, the percentage is even higher: 73 percent.[14]

> "Only 2 percent of truck trailers or containers shipped by rail are short trailers (T-28s), and the introduction of 33' trailers would not likely change this percentage."

Heavier goods are weight-limited and would rarely be carried by T-33s. The Organization for Economic Cooperation and Development (OECD) International Transport Forum concluded that rail and existing "workhorse" trucks like S-53s were better suited to carry higher density freight "while increased truck size is best suited for freight of decreasing density."[15]

Allowing T-33s would have little impact on rail, intermodal, truckload, or local delivery operations. These industry segments serve different markets and use different equipment designed to best serve their markets. Only 2 percent of truck containers shipped by rail are short trailers (T-28s), and the introduction of 33' trailers would not likely change this percentage. The U.S. DOT's T-33 modal shift analysis found that net annual rail revenues would decline by only 0.1 percent while total transport (travel plus transport-related logistics) costs would have declined by $2.33 billion for 2011, the year modeled. The T-33 shift modeled by the U.S. DOT would reduce total comparable transport costs 6.3 percent from baseline.[16] Of the annual savings, 99.6 percent would come from trucking efficiencies with just 0.4 percent from decreased rail use.

Table 2: Traffic Delay Reduction Benefits from Twin 33 Shift

Travel Metric	T-33 Shift Reductions Modeled by U.S. DOT for 2011	T-33 Shift Reductions Extrapolated to 2014 VMT
Truck Travel	3.0 Billion Miles	3.1 Billion Miles
Traffic Delay Time	51 Million Hours	53.2 Million Hours
Traffic Delay Costs	$875 Million	$961.5 Million

Why are T-33s Safer and More Efficient?

Fewer Trucks, Fewer Trips. The U.S. DOT's Modal Shift Analysis study estimated that allowing T-33s would have reduced 2011 U.S. truck VMT by 2.95 billion miles, or 1.1 percent of *all* commercial truck VMT.[17] The increased freight capacity of individual T-33s would result in fewer trips and miles compared to the baseline case where T-28s and S-53s carried the same freight. A 1.1 percent reduction in mileage exposure may sound small, but it is large when one considers that U.S. truck VMT now approaches 300 billion miles annually. Mileage exposure is the single biggest factor driving year-to-year changes in crashes, injuries, and fatalities associated with motor vehicle travel, including truck travel. A simple but reasonable working assumption is that changes in exposure will result in proportional crash consequences. Table 3 shows several categories of U.S. DOT large truck crash statistics for 2014, the most

recent year available.[18] Table 3 also shows the crash reduction of a 1.1 percent exposure reduction based on the simple assumption of proportionality.

Economic costs of crashes include emergency services, medical costs, lost quality-of-life, lost productivity, property damage, and traffic delays. For large truck crashes occurring on urban expressways, lost time costs from *traffic delays alone* average more than $50,000 per crash and can run into the millions for major events.[19] Reducing vehicle numbers and mileage exposure reduces the likelihood of such events.

Better Enforcement. Weighing and inspecting a T-33 is essentially the same as for a T-28. In its modeling of the T-33 shift, the U.S. DOT concluded that total truck weigh station enforcement costs would be reduced by

> "The U.S. DOT concluded that total truck weigh station enforcement costs would be reduced by 1.1 percent, equal to the mileage reduction percentage. This would result in savings of $5.27 million annual enforcement costs."

1.1 percent, equal to the mileage reduction percentage. This would result in savings of $5.27 million in annual enforcement costs and permit 653,000 more trucks to be weighed for the same cost.[20,21] Thus, the safety and infrastructure protection benefits would extend beyond T-33s themselves; more could be done to ensure the safety of *other* trucks.

Additionally, motor carriers most likely to deploy T-33s are among the most compliant and safety-oriented in the industry. For example, UPS Ground Freight's vehicle and driver inspection out-of-service rates are 43 percent and 70 percent lower than the national carrier

Table 3: Large Truck 2014 Crash Statistics And Benefits Of A 1.1 Percent Reduction

Crash Statistic	2014 Large Truck Total	Estimated Annual Reductions From 1.1 Percent Exposure Reduction
Police-Reported Crashes (All Severities)	411,424	4,526
Injuries Or Fatalities	114,903	1,264
Economic Cost Of Crashes	$97.1B	$1.6B

average, respectively.[22] Many use compliance-assurance technologies such as GPS vehicle tracking to ensure route access compliance and remote monitoring of onboard vehicle diagnostic systems.

Improved High-Speed Dynamics. Lengthening twin trailers from 28' to 33' *improves* their high-speed dynamics. This makes T-33s more stable and less likely to roll over or jackknife. Increased stability is shown by computer simulations using engineering data from the vehicles such as axle weights, axle and hitch locations, suspension characteristics, tires, and payload.[23] Several significant dynamic safety performance characteristics are improved by increasing twin trailer lengths from 28' to 33' while keeping vehicle weight constant:

- *Rearward Amplification* is the increased side force or lateral acceleration acting on the rear trailer because of rapid steering in articulated vehicles. Rearward amplification increases the risk of trailer rollover. A controlled comparison shows that rearward amplification under controlled conditions is reduced by 20 percent in T-33 configurations.

- *Load Transfer Ratio* is the proportion of load on one side of a vehicle transferred

to the other side during a transient maneuver. When load transfer ratio reaches a value of one, rollover occurs. Lower values are better. Controlled simulations show an 11 percent lower load transfer ratio for T-33s compared to T-28s.

- *High-Speed Transient Offtracking* occurs when rear wheels track outside the front wheels during an avoidance maneuver. T-33s offtrack 13 percent less than T-28s during the same avoidance maneuver, making lane edge excursions and associated incidents less likely.

The above dynamic performance improvements mean that T-33s are more stable than T-28s during the types of highway-speed avoidance maneuvers that might result in rollovers or jackknifes. Other, less critical, performance measures are the same for T-33s and T-28s, or somewhat better for T-28s. Steady-state rollover threshold, the lateral acceleration needed to produce vehicle rollover, is equal for the two configurations. Braking distances are not significantly different. Offtracking during steady high-speed maneuvers (e.g., traversing a highway curve) is 7 percent higher for T-33s. Low-speed offtracking, a measure of the inboard swept path of the vehicle during turns, is 24 percent greater for T-33s, reflecting their greater length. Yet their low-speed offtracking is still comparable to that of S-53 configurations. Low-speed maneuvering of T-33s requires care and skill by drivers, but no more so than most other common configurations. Moreover, crashes relating to low-speed offtracking are likely to be property damage only, whereas crashes relating to high-speed dynamics are more likely to be serious[24].

"Lengthening twin trailers from 28' to 33' improves their high-speed dynamics."

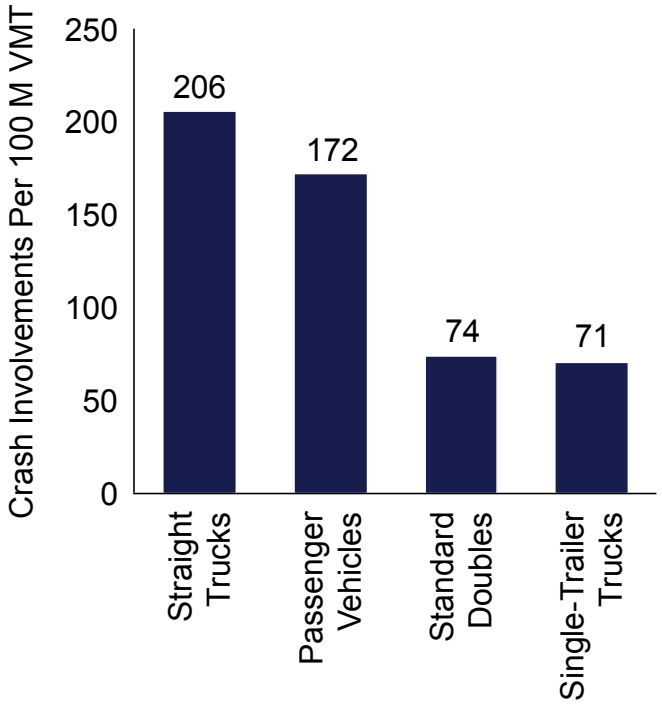
Demonstrated Safety Record. Nationally, twin trailer trucks have crash rates that are among the lowest in trucking and among all types of motor vehicles. The U.S. DOT Modal Shift Analysis estimated twin trailer VMT to be 7.3 percent of the large truck total.[25] In 2014, twin trailer trucks were involved in just 2.5 percent of large truck fatal crashes, 1.7 percent of injury crashes, and 2.2 percent of towaway crashes.[26]

There are few reliable, published statistics on the relative safety of different truck configurations. This is due primarily to inconsistent vehicle classification in crash studies and in highway mileage exposure data. Especially lacking has been comparisons among different vehicle types traveling on the same types of roadways. Perhaps the best study has been a comparative analysis performed by Alberta Infrastructure and Transportation.[27] The study compared passenger vehicle and various truck configuration crash rates over a seven-year period on Alberta's rural highway network. Crash involvement rates on the same roadway network were compared for seven types of vehicles, including standard T-28s. Total vehicle miles for all vehicle types were 416 million miles. T-28s accounted for 3.2 percent of vehicle mileage on the system, but were only 1.5 percent of vehicles involved in crashes. Figure 3 shows crash involvement rates for four vehicle categories. Twin trailer trucks and single trailer involvement rates were about the same, and both were less than one-half those of passenger vehicles and straight trucks. The huge safety advantage of higher-capacity trucks is evident when one considers that many fewer of them are needed to serve freight shippers and consumers.

The Canadian authors believe that higher-capacity trucks offer both safety and productivity benefits. They noted that these trucking operations are closely, appropriately, and intelligently controlled by carriers and enforcement officials. Part of the advantage is because these vehicles are usually driven by highly-trained drivers with years of experience and proven safety performance.

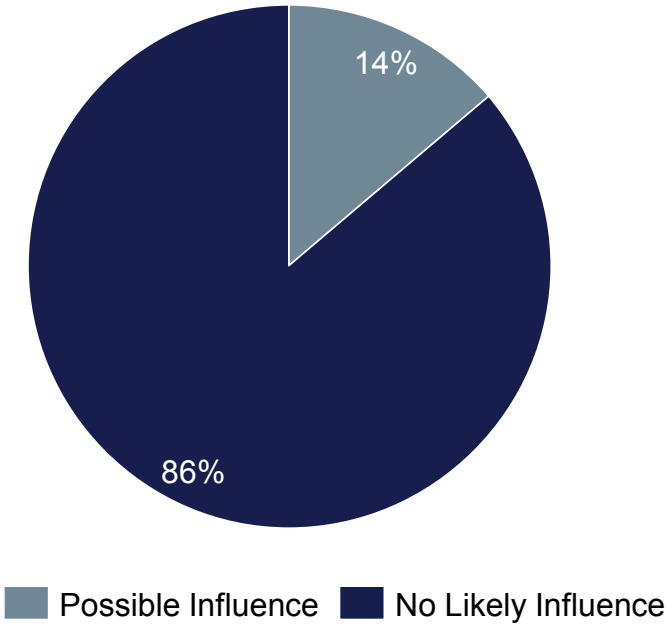
Fig 3: Alberta Crash Involvement Rates And Results From Swedish Study

Alberta Crash Involvement Rates 1995-2005



Source: Alberta Infrastructure and Transportation

Did Truck Length Influence Crash Occurrence?



Source: Chalmers University of Technology

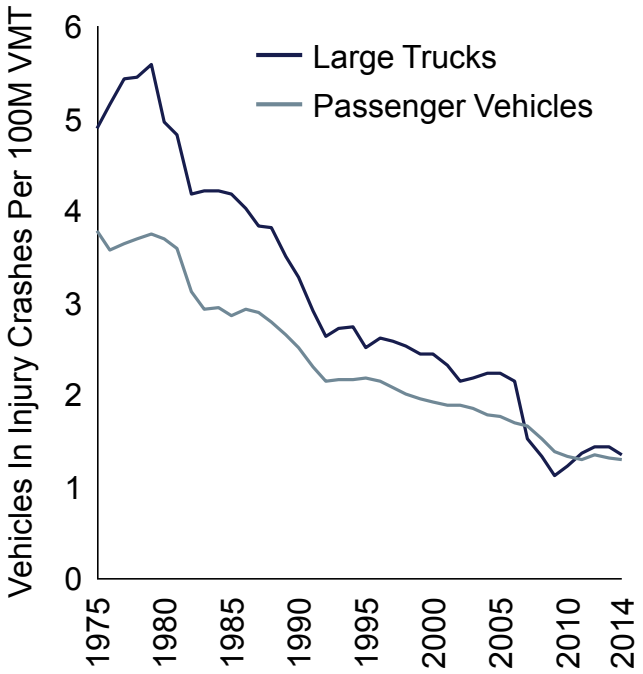
Additionally, the economic cost of crashes does not differ between configurations. In fact, it is nearly identical across truck types. Using established metrics for crash monetary cost estimation, a Texas Department of Transportation study[28] concluded that single trailer, T-28 double trailer, and LCV configurations had nearly identical crash costs per mile. All three combination-unit configurations had lower crash costs per mile than did single-unit straight trucks. The authors added that, "Of course, on a per-ton-mile or per-unit-volume basis, [higher-capacity trucks] will fare even better, since… they carry more content."

Truck Length and Risk. A 2014 university study in Sweden[29] tracked 10-year serious (fatal or severe injury) crash rates for three categories of combination-unit trucks classified by overall truck length: long, medium, and short. Sweden permits longer trucks than are found elsewhere in the EU; units may be up to 25.25M (83') in total length. The analysis found an *inverse* relationship between vehicle length and risk. Long units (all double or triple trailer) had the lowest serious crash rate at 4.4 per 100M km, followed by medium (5.6/100M km), and then short (13.7/100M km) combination-units. Two reasons were suggested for these results, which might seem counter-intuitive. As in the U.S., longer combination trucks in Europe stay mainly on major motorways, the safest roads. Also, the authors reported that companies operating the longest vehicles chose their most experienced drivers to drive them.

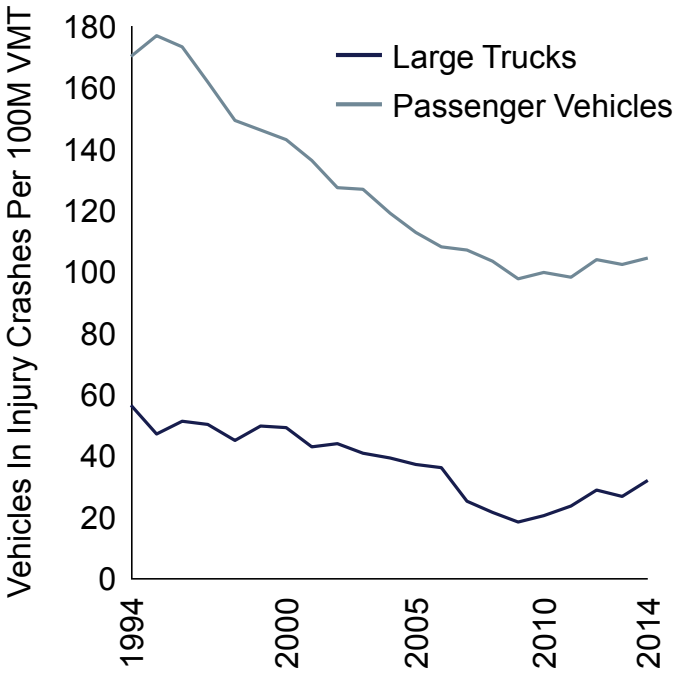
When higher-capacity trucks are in crashes, is it *because* of their size? The same university study reviewed each truck crash in-depth to determine if the truck's length played a causal role in the crash scenario. For example, truck length clearly plays a role in crashes involving a truck hit by cross-traffic at an intersection. But vehicle length is not relevant in truck frontal impacts or

Fig 4: Decline In Fatal Crash And Injury Involvement Rates

Decline In Fatal Crash Involvement Rates



Decline In Injury Crash Involvement Rates



Source: FMCSA

other scenarios where the crash would likely have occurred regardless of vehicle length. The Swedish researchers found that truck length had a likely causal influence in only 26 of 192 (14 percent) of crashes analyzed in-depth. This strongly suggests that truck crash risk is not primarily a function of vehicle size, but rather of other safety factors including driver performance, vehicle condition and equipment, and traffic conditions.

Trucking Industry Safety Achievements. The T-33 initiative comes amid a backdrop of long-term improvements to large truck safety. Technologies are revolutionizing truck safety. Large truck fatal crash involvement rate has declined by about 75 percent over the past four decades (Figure 5). Passenger vehicle rates have declined over the same period, but the truck decline has been sharper and the two rates have converged. Figure 6 shows similar declines in injury crash involvement rates since 1994, the first year for which statistics are available. Truck involvement rates in injury-causing crashes have consistently been about one-third of the passenger vehicle rate.

In 2014, large trucks traveled 9.2 percent of all U.S. vehicle miles and were 8.3 percent of vehicles involved in fatal crashes. Their percentage involvements in injury and property damage crashes were far less: 2.9 percent and 4.5 percent respectively[30]. Other evidence attests to the safe driving performance of most U.S. truck drivers. NHTSA's National Motor Vehicle Crash Causation Survey found that just 29 percent of truck-car crashes were precipitated by the truck or truck driver[31]. Truck drivers were much less likely than car drivers to be speeding, distracted, drowsy, impaired, or aggressive than were car drivers.

Leading Safety Technology. Advanced safety technologies and safety management techniques are being deployed widely in the industry. Carriers like FedEx, UPS, and YRCW are on the forefront of technology deployment, and these companies take pride in their safety achievements. Industry-wide penetration of advanced safety technologies is rapidly increasing because large trucks are the ideal platform for deployment of many advanced crash countermeasures. Supervised truck fleets permit close monitoring and objective assessments of new technologies and methods. Individual trucks travel up to ten times more miles than an average car, thus making returns on investment (ROIs) from safety and efficiency improvements far greater. Below are some of the many safety improvement devices and techniques in ever-increasing deployment in the U.S. trucking industry.

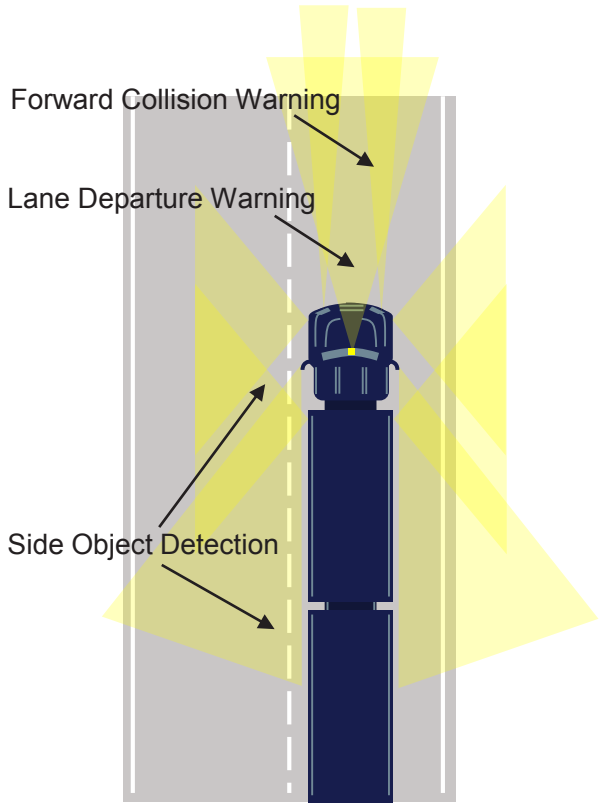
All systems listed above have demonstrated effectiveness. Separately and together they greatly reduce safety risks while also adding to transport efficiency. Among the most widely used and successful are Forward Collision Warning (FCW), Lane Departure Warning (LDW), and Side Object Detection (SOD).

Forward Collision Warning (FCW) systems use radar or other sensors to monitor forward headway and warn of rapid closing toward a vehicle or object ahead. They warn drivers in sufficient time to evoke a driver avoidance response. Some systems add Automatic Emergency Braking (AEB) to further prevent forward strikes. FCW systems principally target rear-end crashes, which have traditionally represented about 15 percent of truck crash involvements and have been the biggest source of truck crash liability claims[32]. The Insurance Institute for Highway Safety (IIHS)[33] estimates that FCW systems on all large trucks will prevent or mitigate 31,000 crashes and prevent 115 fatal crashes annually. The U.S. DOT[34] estimates five-year FCW ROIs at up to $7.22 for every dollar spent.

Table 4: Emerging Onboard Safety Technologies

Electronic Stability Control	Adaptive Cruise Control
Roll Stability Control	Intelligent Speed Adaption
Forward Collision Warning	Enhanced Rear Signaling
Lane Departure Warning	Video Mirrors
Side Object Detection Systems	Driver Safety Monitoring Systems
Electronic Logging Devices	Tire Pressure Monitoring Systems
Driver Fatigue Detection & Warning	Vehicle Component Monitoring Systems

Fig 5: Safety Technology Schematic: FCW, LDW, And SOD Systems



*Sensor field-of-view depth not to scale

Lane Departure Warning (LDW) systems warn drivers that they are beginning to drift out of their lanes. They function like an in-vehicle rumble strip, intervening to stop lane drifts due to driver inattention, drowsiness, or other impairment. Drift scenarios are most injurious to truck drivers themselves, but they can also harm the public. IIHS estimates that LDWs on all large trucks will prevent or mitigate 10,000 crashes and prevent 247 fatal crashes annually[35] while the U.S. DOT projects five-year ROIs up to $6.55 per dollar spent[36].

Lane changes are awkward for large trucks, especially when they move from left to right, since truck right-side visibility is limited. Side Object Detection (SOD) systems, which are being piloted and explored by some fleets, detect vehicles and other objects beside the truck and provide a warning if there is encroachment. IIHS projects a 40 percent reduction in truck lane change/merge crashes from this technology. An estimated 2,000 injury crashes and 79 fatal crashes will be prevented annually[37]. Side video "mirrors" can be used jointly with SOD systems to further reduce lane change risks.

Progressive carriers like those supporting the T-33 initiative also closely monitor driver safety performance. This includes traditional evaluation metrics such as driving skills and habits, vehicle care, inspection violations, moving violations, cargo loss, crashes, and incidents. Fleets also use technology to monitor driving. Continuous onboard safety monitoring records and assesses driver speeds, hard-braking, lateral accelerations (indicative of speed on curves), idling times, and fuel economy, a surrogate of safety. Fleets equip their trucks with video cameras (e.g., DriveCam®) to capture and record incidents during driving. Enlightened fleets recognize and reward drivers not just for crash-free driving but also on these leading behavioral indicators of safety and risk.

> "CO_2 EMISSIONS REDUCTIONS WOULD HAVE BEEN EQUIVALENT TO TAKING MORE THAN 551,000 PASSENGER VEHICLES OFF THE ROADS IN 2014."

Fuel Efficiency And Environmental Benefits.

Despite great progress in recent years, large trucks continue to account for a disproportionate share of fuel use and resulting air pollution. The T-33 shift would reduce truck fuel consumption and greenhouse gas (GHG) emissions. The increased freight capacity of individual T-33 trucks would result in fewer trips and miles compared to the baseline case where T-28s and S-53s carried the same freight. The U.S. DOT's Modal Shift Analysis[38] projected that the T-33 shift would have reduced 2011 U.S. large truck VMT by 2.954 billion miles, 1.1 percent of *all* truck miles. Proportional benefits would be seen in fuel use and GHG emissions. CO_2 emissions reductions would have been equivalent to taking more than 551,000 passenger vehicles off the roads in 2014. Table 3 shows these benefits as estimated for 2011 by the U.S. DOT and extrapolated to 2014 (the latest year for which data is available) based on the 4.3 percent increase in truck VMT between 2011 and 2014. Freight transport dollar savings for 2014 also reflect cost of living increases.

As seen in Table 3, efficiency benefits are substantial. Fuel savings extrapolated to 2014 would have been 255.2 million gallons. Reduced fuel consumption would have decreased truck carbon emissions by nearly three million tons and nitrous oxide emissions by nearly one billion grams. Freight transport costs would have been reduced by more than $2.5 billion. All of this could be accomplished without increasing maximum truck weights and without compromising the condition or safety of our nation's highways. The benefits would be experienced by the public through lower prices and cleaner air.

Beyond exposure-reduction savings, carriers operating T-33s are likely to embrace technologies and management practices to

further enhance efficiencies. FedEx, UPS, YRCW, and other LTL operators do many different things to reduce fuel consumption and resulting GHG emissions. This includes equipping tractors and trailers with speed limiters, electronic engine monitors, auto-shifting transmissions, tire pressure monitoring systems, and exterior fairings or other air-deflecting shields to reduce drag. Drivers are trained and monitored to ensure that they are "smooth operators." This means more gradual starts and stops, minimizing gear shifts, using cruise control, obeying speed limits, less hard braking, and less needless idling. Many carriers recognize and reward drivers who meet or exceed fuel use goals. The same smooth driving styles that reduce fuel use also reduce accident risks.

Empty miles are a target of operations optimization. Empty trips produce no revenue but add to driver costs, fuel consumption, emissions, and accident exposure. Most LTL fleets achieve empty mile percentages between 6-8 percent, versus 15-20 percent for long-haul trucking in general. National use of T-33 trucks would contribute significantly to further optimization of this systematic and efficient transport network.

Many LTL carriers have joined the U.S. Environmental Protection Agency (EPA) SmartWay Transport Partnership Program. SmartWay is a voluntary collaboration between EPA and the freight industry to increase energy efficiency and significantly reduce greenhouse gases and air pollution. The SmartWay program includes representatives from across the freight industry — shippers, carriers, even dealer service centers and truck stops.

Reduced Traffic Delay. The U.S. DOT Modal Shift Analysis estimated that the T-33 shift would have reduced U.S. traffic delay by more than 50 million vehicle-hours in 2011. The T-33 shift had the greatest traffic delay reductions of the six HCV scenarios modeled, and these benefits would be shared by all motorists. Most T-33 traffic delay reductions would be in urban areas. Associated delay cost reductions were modeled at nearly one billion dollars[39]. Table 4 shows these benefits as estimated for 2011 in the U.S. DOT Modal Shift Analysis and extrapolated to 2014 based on VMT and cost-of-living increases over the three years.

> "The T-33 shift would have reduced U.S. traffic delay by more than 50 million vehicle-hours in 2011."

LTL and other truck trip routes are often planned and standardized to minimize fuel use and traffic delays. Routing and scheduling optimization software provides more efficient routing solutions than can human dispatchers directing individual trips. Such software allows routes to be constructed considering dynamic factors including driver hours-of-service rules, pickup and delivery schedules, vehicle size constraints, vehicle-product compatibility, equipment availability, vehicle-loading dock compatibility, route restrictions, and empty mileage. Trouble-free truck trips benefit companies and also benefit the motoring public.

Reducing the Driver Shortage. Allowing T-33 trucks would reduce the national truck driver shortage while providing better jobs for drivers. Despite lagging employment opportunities for other U.S. workers, there has been a long-term and continuing shortage of qualified truck drivers to fill available jobs. The American Trucking Associations (ATA) estimates that there were 48,000 fewer qualified drivers than available driver jobs at the end of 2015.[40] Further, the ATA projects that the industry will need 890,000 new drivers through 2025 to meet the rising driver demand. Much of this demand reflects the

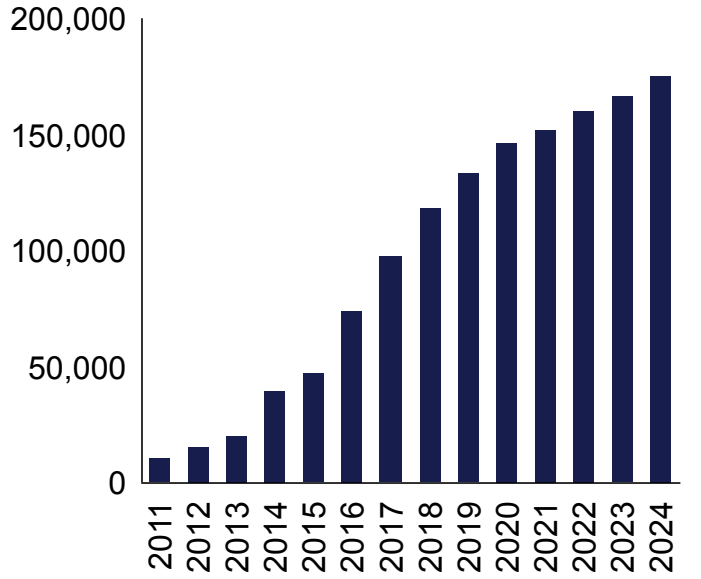
need to replace trucking's aging workforce with new drivers. Figure 6 shows annual truck driver shortages projected through 2024. The effects of the shortage are felt throughout the economy, as 69 percent of all freight tonnage is moved on highways.

Ironically, the driver shortage is often felt most acutely by the best and safest motor carriers. These carriers face a quality vs. quantity dilemma when hiring drivers. Most have strict hiring criteria based on driving history, experience, and other risk factors. Many applicants are screened and evaluated for each driver hired. In 2012, 88 percent of fleets said that most driver applicants were simply not qualified[41]. For these carriers, the costs of lowering driver standards are prohibitive because of increased crash costs and insurance premiums. More importantly, their safety cultures are committed to the highest driver performance standards.

Hauling the same freight with fewer vehicles creates both safety and driver occupational advantages. The driver shortage is alleviated, carriers can be more selective in their hiring, and an upward career path is created for drivers. Drivers of higher-capacity trucks receive greater pay, benefits, training, and recognition.

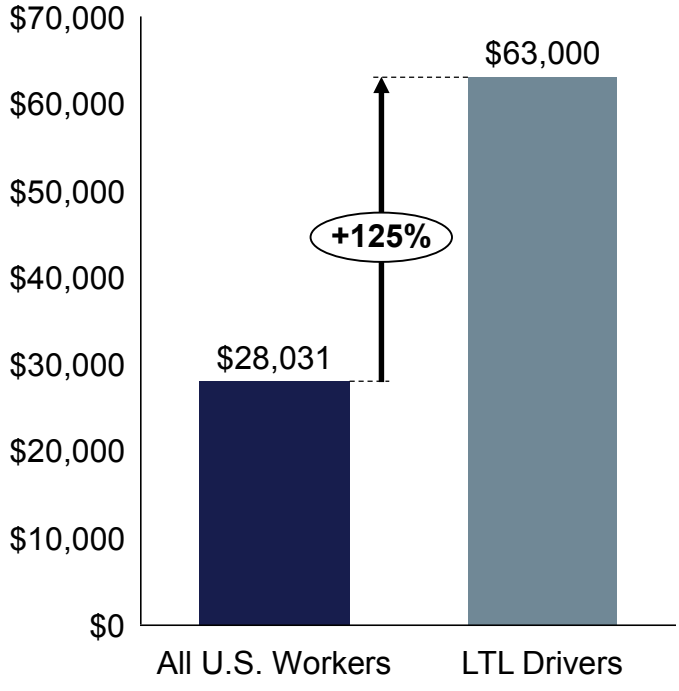
GREAT JOBS. LTL driving jobs are already among the very best in trucking. And their attractiveness will likely increase when higher-capacity trucks are allowed. Annual LTL over-the-road driver pay is nearly 40 percent higher than pay for truckload drivers running irregular national routes. It is 125 percent high than the U.S. average for all workers (Figure 7). Drivers covet LTL jobs because of their higher pay, regular routes and hours, and because most LTL drivers return home every night. Average annual LTL turnover over the past five years has been 10.2 percent versus 93.2 percent for truckload drivers. Lower turnover means longer-tenured drivers. Studies reliably show that company tenure is one of the best predictors of driver safety and quality.

Fig 6: Projections Of Annual Truck Driver Shortages Through 2024



Source: American Trucking Associations

Fig 7: 2013 Median Driver Pay



Source: American Trucking Associations, Social Security Administration

Ensuring Future Safety And Efficiency. Future legislative proposals would ensure that T-33 safety is closely monitored. Former proposals directed the Secretary of Transportation to conduct a study comparing crash data between 28' and 33' semitrailers or trailers operating in a truck tractor-semitrailer-trailer configuration. Going forward, improved transportation data collection could support continued evaluation of T-33s. This might include:

- Careful configuration classification and reporting in crashes, incidents, and violations.

- Reliable and comprehensive exposure data collection (e.g., vehicle miles).

Vision: Safe, Efficient, and Productive Transport And Delivery System

The productivity of American trucking is limited by outdated laws and policies. U.S. Federal policy on truck productivity has been frozen for 26 years, since the passage pf 1991's Intermodal Surface Transportation Efficiency Act (ISTEA). Twin-28s are an antiquated standard, first used nationwide in 1982. As a nation, we should be able to look at such government policies objectively and make rational, fact-based decisions about how they could be improved. Other advanced countries have moved forward with more progressive, efficient, and logic-based designs. Australia, New Zealand, Canada, and Mexico are among the nations which have reformed their policies to permit more productive twin trailer trucks than those allowed here. These countries have made their roads safer while increasing national economic competitiveness.

Congressional authorization of T-33s would allow the transportation industry to provide the greatest possible productivity and efficiency for shippers and the public, while *improving* its safety performance and environmental stewardship. It would save American consumers billions of dollars annually while increasing U.S. competitiveness in the world economy. Higher productivity inevitably means lower prices and greater value for consumers. As the U.S. DOT has concluded, "Increases in maximum allowable truck sizes...will predictably lead to lower truck transport costs; industry competition and regulatory pressure will translate these lower costs into lower transport rates."[42]

Allowing T-33 trucks would achieve these public economic benefits while at the same time *further improving the safety* of our transport system.

About The Author

Dr. Ron Knipling is the author of the first and only comprehensive textbook on large truck safety, Safety for the Long Haul; Large Truck Crash Risk, Causation, & Prevention. In recognition of the book, he received the International Road Transport Union (IRU) Order of Merit award, the first given to an American scientist. Dr. Knipling has more than 35 years' experience in traffic safety with emphasis on driver human factors and motor carrier safety. Specialty areas include crash data analysis, driver risk, crash causation, driver fatigue, hours-of-service, technology assessment, and carrier safety management. Dr. Knipling has held senior government, university, and consulting positions. Accomplishments include more than 300 technical reports, papers, and conference presentations. He resides near Washington, D.C., and works as a safety researcher, consultant, and trainer.

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