Research Results

ATRI American Transportation Research Institute

Energy and Emissions Impacts of Operating Higher Productivity Vehicles Update: 2008

The Problem

According to a recent estimate, the total tonnage of primary freight shipments in the United States will increase from 15.55 billion tons in 2006 to 19.85 billion tons in 2018, an increase of nearly 28 percent over this 12-year period. Trucks' share of this tonnage is projected to rise from 69 percent in 2006 to 70 percent in 2018. With trucks continuing to dominate the overall freight transportation landscape, growth in both the number of trucks and miles driven on our nation's roadways is expected to increase over the next decade to satisfy consumer demands.

The challenge facing the U.S. transportation system is how to accommodate this growth while at the same time improving energy and environmental efficiency. Among the options for addressing this challenge include increasing the maximum operating weight and/or length of over-the-road trucks.

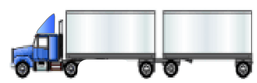
Research Goal

The American Transportation Research Institute (ATRI) and Cummins Inc. teamed to update their previous investigation of the energy and emissions impacts which can result from operating commercial vehicles at various weights and configurations[1]. The results of this analysis provide a comparative estimate of the potential energy and emissions impacts of operating different vehicle configurations at various weights.

Methodology

Six different vehicle configurations were analyzed as part of this research. These vehicle configurations were estimated to account for nearly 94 billion vehicle miles traveled (VMT) in the year 2000 and comprise more than 81 percent of the VMT accumulated by combination vehicles.

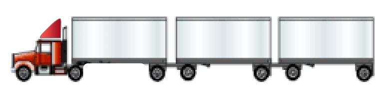
5-Axle Tractor-Semitrailer



Double

6-axle Tractor-Semitrailer

Rocky Mountain Double (RMD)



Triple Trailer Combination (TRPL)

Turnpike Double (TPD)

---

[1] American Transportation Research Institute, *Energy and Emissions Impacts of Operating Higher Productivity Vehicles*, Alexandria, VA, September 2004.

Using Cummins' sophisticated Vehicle Mission Simulation (VMS) modeling tool, each vehicle configurations was modeled over a typical route at various gross vehicle weights (GVWs) to estimate and analyze fuel consumption. Additionally, estimates of the greenhouse gas emission, CO2, as well as emissions of PM and NOx were also developed.

Using a comparative measure of the energy efficiency of each vehicle configuration, expressed as ton-miles per gallon (TM/gal), a consistent comparison was made between configurations operating over a common route at different payload weights and fuel economies. In addition to comparing trucks limited by operating weight (i.e., weight-limited), a capacity comparison was developed to assess potential impacts for trucks limited by the volume of freight carried (i.e., cube-limited).

Findings

Operating vehicles at heavier GVWs provides the opportunity to increase the amount of freight carried by each vehicle. Through the operation of the higher productivity vehicles (HPVs) analyzed in this study, for weight-limited operations, per vehicle payload weight increases ranging from 4 to 88 percent were observed with the addition of axles, trailers, and/or dollies. For cubed-limited operations, per vehicle payload weight increases ranging from 42 to 80 percent were observed through the addition of trailers and dollies.

As opposed to payload weight increases, operating vehicles at higher GVWs may require the use of larger engines which, combined with the additional weight, decreases fuel economy on a miles-per-gallon basis. Fuel economy decreases ranging from 11 to 30 percent were found for the HPVs analyzed in this study under the weight-limited scenario while decreases ranging from 10 to 22 percent were found under the cube-limited scenario.

Percentage increases in fuel efficiency, measured in ton-miles per gallon, were observed for nearly every higher productivity vehicle configuration at various weight increases under a weight-limited scenario. Increases in fuel efficiency were also observed for longer combination vehicle configurations under a cube-limited scenario.

Percentage Change in TM/gal – Weight-Limited Scenario

Configuration	Gross Vehicle Weight			
	97,000*	**100,000**	**120,000**	**140,000**
Compared to 5-axle @ 80,000 lbs GVW				
6-axle	17%	--	--	--
RMD	--	1%	25%	--
TPD	--	-10%	15%	33%
Compared to Double @ 80,000 lbs GVW				
TRPL	--	3%	31%	--

* Estimate based on straight-line extrapolation of fuel consumption data

Percentage Change in TM/gal – Cube-Limited Scenario

Configuration	Gross Vehicle Weight		
	83,175*	**84,040***	**100,370***
Compared to 5-axle @ 60,000 lbs GVW			
RMD	20%	--	--
TPD	--	--	39%
Compared to Double @ 60,000 lbs GVW			
TRPL	--	29%	--

* Estimate based on straight-line extrapolation of fuel consumption data

The estimated fuel efficiency improvements found in this study translate directly into equivalent percentage improvements in TM/lbs of CO2 emitted. As the route modeled consisted mainly of highway operations, the engines were able to operate primarily in a steady-state mode, producing emissions of PM and NOx which are fairly uniform to fuel consumption. Thus, improvements in environmental efficiency were generally observed in terms of freight transported per unit of CO2, PM and NOx emitted.

To receive a copy of this report and other ATRI studies, please visit: WWW.ATRI-ONLINE.ORG

ATRI's primary mission is to conduct and support research in the transportation field, with an emphasis on the trucking industry's essential role in the U.S. and international marketplace.