



Emissions reduction analysis of voluntary clean truck programs at US ports



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ARTICLE INFO

Keywords:

Port emissions
Drayage trucks
Particulate matter
Freight transportation

ABSTRACT

This paper analyzed three incentive-based, voluntary vehicle replacement programs underway at US ports using fleet baseline and program completion data and an emissions standard-based emission estimation methodology. The principal findings demonstrate that best management practices for voluntary clean truck programs can substantially reduce truck drayage emissions, although not to the level achieved through mandatory programs. Emissions reductions were found to be 1–4% as compared to potential reductions of 12–15% for particulate matter and 31–34% for nitrogen oxides.

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1. Introduction

The freight transportation system that annually moves more than 37 million Twenty-foot equivalent units (TEUs) through US ports is largely powered by heavy-duty diesel engines, whose advantages include high performance and long life. The emissions from the concentrated number of engines operating at ports, however, are a significant contributor to poor air quality in adjacent communities and to exceedances of national ambient air quality standards (NAAQS). Exposure to diesel pollutants is a recognized health threat. As such, many ports have been called upon, some under threat of legal action, to implement pollution control efforts.

Emissions inventories conducted by ports consistently highlight drayage trucks as a significant contributor to port-related pollution, accounting for 25–43% of NO_x emissions, in part because drayage trucks are typically older and more polluting than the average long haul truck. As a result, initiatives to modernize the drayage fleet have been a key element of many clean air plans at ports.

The Port of Long Beach and the Port of Los Angeles (POLA) have undertaken the most aggressive actions to reduce emissions from this sector, ultimately mandating the use of drayage trucks that meet the new 2007 emission standard. While the Southern California clean air plan was effective in reducing POLA truck emissions 80% from baseline emissions in one of the most heavily polluted areas of the country, program implementation was controversial and politically charged. In an effort to reduce emissions from port drayage trucks without regulatory action, some ports have opted to implement voluntary control efforts.

Given the adoption of emissions mitigation initiatives at ports and development of non-regulatory programs, this paper analyzed the effectiveness of emissions reduction efforts through voluntary clean truck programs in Virginia, Charleston, and Houston based on best management practices.

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Table 1
Heavy-duty highway CI engines – exhaust emission standards (modified).

Model year	NOx (g/bhp-hr)	PM (g/bhp-hr)
1985–1987	10.7	–
1988–1989	10.7	0.60
1990	6.0	0.60
1991–1993	5.0	0.25
1994–1997	5.0	0.10
1998–2003	4.0	0.10
2004–2006	2.375	0.10
2007–2009	0.2–2.375	0.01
2010	0.2	0.01

Notes: 2007–2009 was a phase-in period for the 2010 NOx standard; (–) represents no standard in place for given timeframe.

2. Methodology and data

This paper analyzed data from ongoing clean truck programs at the Port of Virginia, the Port of Charleston, and the Port of Houston Authority. These ports were selected due to their potential for high trade growth and their voluntary truck program design. The growth in throughput, attributed to rapid population growth and Panama Canal expansion in a recent report by the US Army Corps of Engineers, may lead to an increase in emissions at these ports and a greater need for pollution mitigation on the Gulf and east coasts (Institute for Water Resources, 2012). Although mandatory programs have resulted in significant emissions reductions, the success of voluntary programs has not been assessed.

To calculate emissions reductions from clean truck programs at the individual port level, we employed the US Environmental Protection Agency's (EPA) (2012) Heavy-Duty Highway Compression-Ignition Engines Exhaust Emissions Standards. EPA periodically revises emissions standards for trucks, and over the past two decades the agency has strengthened the standards dramatically, resulting in current model year trucks that are up to 60 times cleaner than many older models (Table 1). These standards are based on engine model year and not truck model year.

These standards, as well as funding requirements, local air quality needs, and emission reduction goals, have governed strategic decisions on the development of clean truck programs. A port interested in reducing NOx, for instance, might choose to optimize emissions reductions by replacing pre-1990 trucks with 2010 or newer trucks while programs designed to target PM reductions may choose to replace pre-1994 engines with 2007 or newer engines. A robust multi-pollutant strategy would emphasize retirement of pre-1990 engines coupled with the introduction of 2010-standard engines.

This paper utilized secondary data through May 2012, collected by the respective program administrators (the organization implementing the vehicle replacement program). Each program maintained a database that tracked applicants and included information such as vehicle identification number, application status, and vehicle model. Most program-reported emissions reductions calculations were driven by reporting requirements from funding agencies, which often employed their own data collection systems and methodology guidelines. For the purposes of this paper, however, a basic emission standard, conversion standard, and VMT (vehicle miles traveled) assumption of 50,000 per year were utilized to calculate combustion emissions. This did not include all emissions from operations, such as idling, due to data constraints and methodological variability in input estimations. This simplified methodology allowed for the measurement of trends in emissions rather than aggregate emissions and provided the ability to isolate the impact of vehicle replacement, as opposed to other factors that impact emissions such as idling.

The VMT assumption came from a 2009 drayage study that found average yearly VMT to be 55,336 (Harrison et al., 2009). However, the high degree of variance in VMTs and the skewed distribution of model year trucks operating at ports means that older trucks may run significantly more mileage than newer trucks and more accurate data is needed to fully understand the isolated effect of clean truck programs. From a policy perspective, the differences in business models between LMCs (licensed motor carriers) and IOOs (independent owner–operators) added to the complicated nature of the drayage industry and further demonstrated the need for clean truck programs to address market imbalances (Monaco and Grobar, 2004).

The most basic calculation used for estimating emissions is an activity-based method whereby emissions factor multiplied by activity is equal to the emissions generated:

$$\frac{g}{mi} \times mi \equiv g \quad (1)$$

where g/mi is a derived emissions coefficient given by Eq. (2), mi is a measure of activity (VMT) over a predetermined period of time (1 year), and g is the amount of emissions in grams.

The output represents the estimation for annual emissions generated by the operation of one drayage truck with engine of model year X. Although each pollutant and each model year engine have a specific emissions factor, the formula remains the same. Subtracting the emissions that the new fleet was expected to generate from the emissions that would have been generated by the old fleet, under the same circumstances, yielded the yearly emissions benefit from the vehicle replacement program. As trucks were expected to remain in service at the port for multiple years, emissions benefits calculated by

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