Appendix G

Emissions Inventory Methodology and Results

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List of Acronyms

ARB	Air Resources Board
BACT	Best Available Control Technology
BOE	Board of Equalization
BTS	Bureau of Transportation Statistics
CHP	California Highway Patrol
CRC	Coordinating Research Council
CY	Calendar Year
DMV	Department of Motor Vehicles
DOF	Department of Finance
DPF	Diesel Particulate Filter
DR	Deterioration Rate
ECE	Electronically Controlled Engines
EGR	Exhaust Gas Recirculation
FE	Fuel Economy
GDP	Gross Domestic Product
GVWR	Gross Vehicle Weight Rating
HH	Heavy Heavy (Duty Diesel Trucks)
HHDDT	Heavy Heavy Duty Diesel Trucks
IFTA	International Fuel Tax Agreement
IRP	International Registration Plan
LESBP	Lower Emissions School Bus Program
LA/LB	Los Angeles/Long Beach
MCPP	Motor Carrier Permit Program
MH	Medium Heavy (Duty Diesel Trucks)
MHDDT	Medium Heavy Duty Diesel Trucks
MY	Model Year
NOOS	Neighboring out-of-state
NNOOS	Non-neighboring out-of-state
PM	Particulate Matter
POAK	Port of Oakland
POLA/LB	Ports of Los Angeles and Long Beach
PTO	Power Take Off
SCR	Selective catalytic reduction
TIAX	TIAX LLC Consultants
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
VIN	Vehicle Identification Number
VIUS	Vehicle Inventory and Use Survey
VMT	Vehicle Miles Traveled
ZMR	Zero-mile rate

A. Introduction

Commercial heavy-duty diesel trucks and buses (defined as commercial diesel buses and trucks exceeding 14,000 lbs gross vehicle weight rating (GVWR)) are currently the single largest source of nitrogen oxide (NO_x) emissions in California, accounting for 30% of statewide NO_x emissions (ARB, 2008). These same trucks buses are also the largest source of diesel particulate matter (diesel PM) in California, representing about 40% of statewide diesel PM emissions.

On-road mobile source emissions in California are currently calculated using the ARB's EMFAC2007 model that was released in December of 2006 (ARB, 2006). Since the last EMFAC release, Staff members have conducted a comprehensive re-evaluation of the heavy duty diesel truck emissions inventory. In developing this new analysis, we have integrated new data and assumptions into an expanded methodology that builds upon current modeling in EMFAC2007. With this methodology, we incorporate detail for different types of trucking operations and truck configurations that are referred to as "inventory categories". Emission factors differ from those in EMFAC2007 and reflect our enhanced knowledge of trucking operations in California that has been developed through this effort. With this document we describe our approach and the results from its application. With this document we also provide emissions estimates for each category of vehicles that would be regulated under the proposed Statewide Truck and Bus Regulation.

B. Methodology

Fundamentally the EMFAC model uses a simple, vehicle population-based technique for estimating emissions for any type of on-road vehicle. We calculate emissions as the product of a population of vehicles, the number of miles traveled per vehicle, and emission rates for each vehicle per mile. Beneath this simple equation lies a series of data and assumptions about the population, miles traveled, and emission rates per vehicle model year in a given calendar year, growth and attrition estimates, deterioration rates, and other factors that affect emissions estimates.

Our revised approach for estimating commercial heavy-duty diesel truck emissions builds upon this concept by applying it separately for each category of trucks. These categories were selected by evaluating different groups of trucks that have similar travel, service, size, age or other characteristics within the category but differing between categories.

The methodology used to develop the proposed rule inventory is based on the following equation:

$$EMS_{CY} = \sum_{MY,\,C} \left(POP_{MY,\,C} \times AC_{MY,\,C} \times ER_{MY,\,C}\right)$$

where: EMS_{CY} is the emissions calculated in tons per day for a given calendar year CY.

$POP_{MY,\,C}$ is the population of trucks for model year MY within each inventory category C for a given calendar year;

$AC_{MY,\,C}$ is the accrual rate (miles traveled per year) per truck by model year MY and inventory category C in a given calendar year;

$ER_{MY,\,C}$ is the calculated emission rate, in grams pollutant per mile driven, assuming statewide speed travel distributions in EMFAC2007 and category-specific cumulative mileage accrual over the life of the truck, by model year MY and inventory category C;

With this new analysis, we developed a population and model year distribution for each vehicle category. We also estimated accrual by model year for the category and cumulative mileage accrual (odometer) by model year. Because trucks can move between categories as they age, we assessed the movement of used trucks between categories in order to develop cumulative mileage accrual estimates that reflect this movement. As a result, cumulative odometer readings by model year will not necessarily be consistent with accrual schedules for each inventory category. We developed emission rates using EMFAC2007 and statewide speed distributions, and we adjusted emission rates for modeled odometer readings by category. A more complete discussion of the data sources used is provided in the following section.

C. Data Sources

We have used many different data sources to develop input data to the methodology described above. In this section we provide a general description of each data source as well as links for further information.

1. Motor Vehicle Registration Data

The California Department of Motor Vehicles (DMV) is responsible for the process of vehicle registration in California (DMV, 2001). As part of this program, commercial trucks and buses are required to pay registration annually; however, vehicle owners have the option of registering their vehicles on a seasonal basis. Staff have an agreement with the DMV to get registration data downloads in April and October of each year. Staff process the data in order to compile a list of vehicles by vehicle class, body type, rated weight, and other parameters.

Using each vehicle's license plate configuration, which separates International Registration Plan (IRP) vehicles from non-IRP vehicles, each vehicle's rated weight, and each vehicle's body type data, we separated vehicles into different inventory categories. As such DMV registration was the primary source for vehicle population and model year by category. We also used the DMV registration data to group trucks by fleet and thus fleet size. With these data we could assess the fraction of owner-operators in each category. We did this by sorting data by owner/operator name and address before grouping trucks into trucking categories. Overall, owner-operator trucks tend to be older than other trucks within the same inventory category. These results will be discussed in detail in subsequent sections of this report describing each inventory category.

2. International Registration Plan (IRP)

The International Registration Plan is a program administered by the American Association of Motor Vehicle Administrators to transfer registration fees assessed to commercial and other vehicles that cross state boundaries, in accordance with the number of miles affected vehicles travel in each participating U.S. State or Canadian Province (IRP Inc., 2008). IRP-registered vehicles most often include commercial heavy-duty trucks and buses but can also include government vehicles and smaller vehicles. Under this program a fleet of vehicles has the option of registering their vehicles in any state where a portion of their fleet is domiciled.

IRP recordkeeping varies by state with some states maintaining electronic databases and others paper files. To facilitate data analysis, Staff obtained IRP data from states in electronic format whenever possible. Staff received in electronic format comprehensive reports representing mileage driven by California-registered IRP trucks in calendar years 2000-2006, and obtained hardcopy samples of IRP data from a number of other jurisdictions for miles driven by their IRP trucks in California.

IRP data representing California trucks were used to directly assess the population and model year distribution of these trucks, as well as the fraction of IRP-registered vehicles' mileage accrual that occurs within California. To evaluate out-of-state IRP data, we copied and analyzed one month's worth of IRP updates by fleet. This represents about 9% of all fleets operating in a given state because a similar number of fleets are required to report each month. Data were collected from four neighboring states (Arizona, Idaho, Nevada, Oregon) as well as eight non-neighboring states (Alabama, Indiana, Nebraska, New Jersey, Oklahoma, Tennessee, Texas, and Wisconsin). Of these states, Alabama, Nebraska, New Jersey, and Oklahoma each provided a model year or Vehicle Identification Number (VIN) for each truck in each fleet, allowing detailed age distributions for each of these states to be developed. Staff relied on roadside survey data to develop age distributions for other states.

All IRP data are provided at the level of a fleet rather than the level of an individual vehicle. Each fleet registered with the IRP reports the total number of power units or trucks in the fleet, the total miles traveled by that fleet, and the total miles traveled in California by that fleet. Reporting is completed annually. Many fleets reporting to IRP are large; as a result, the population of trucks reflected in that fleet's report will reflect a large number of trucks that do not enter California even though they may be authorized to do so. In addition, each state's data format is different; some states provide information such as VIN or model year for each truck in the fleet, while other states don't. Where model year data were available, staff used the information directly. Where model year data were not available but VIN data were, staff decoded the VIN to derive model year. Staff also received a summary report from DMV that provided the total population of trucks in the IRP program from each state. This report provided an estimate of the number of trucks in fleets cleared to come into California from other states.

3. Motor Carrier Permit Program (MCPP)

The California Department of Motor Vehicles and California Highway Patrol (CHP) jointly administer the Motor Carrier Permit Program (MCPP), which applies to any operator of a commercial vehicle in California exceeding 10,000 lbs GVWR or truck and trailer combinations exceeding 40 feet in length. The program generally applies to all commercial vehicle operators with an office in California. MCPP data provide information on the number of vehicles per fleet and the number of fleets operating in California; the data are separated between for-hire and private carriers. The database does not provide license plate, VIN or GVWR of trucks in each fleet.

We obtained the DMV/CHP 2005 database and used it to estimate the fraction of truck owner-operators in California. These data were compared to similar estimates derived from DMV registration data. Because the MCPP database does not provide information on individual truck size, activity, or model year, we ultimately chose to use DMV registration data to assess the fraction of total owners that are owner-operators.

4. International Fuel Tax Agreement (IFTA)

The International Fuel Tax Agreement (IFTA) is an agreement among U.S. states and Canadian provinces to simplify the reporting of fuel use taxes by interstate motor carriers. In California, IFTA is administered by the Motor Carrier Section of the Board of Equalization (BOE) (BOE, 2008). The program operates similarly to IRP in that motor carriers may choose a state for filing fuel tax returns and then each state distributes fuel taxes among other states depending on the fraction of fuel burned and miles traveled by each fleet in each jurisdiction.

Staff obtained 2005 aggregated IFTA data as well as 2006 and 2007 IFTA data summarized for each state by the California BOE. For each state, BOE provided information on the number of miles traveled and the amount of fuel burned within California by trucks from each reported state. However, data for 2006 and 2007 were incomplete with about 10% of the data in each of those years not summarized. For states with incomplete data, we extrapolated estimates using overall population data from IRP. Staff used the 2005 IFTA aggregated out-of-state records to estimate the miles traveled in California by out-of-state heavy-heavy duty trucks; Staff used the 2006 and 2007 data to develop the ratio between trucks from neighboring and non-neighboring states.

5. Vehicle Inventory and Use Survey (VIUS)

The main intent of the Vehicle Inventory and Use Survey (VIUS) is to provide data on the physical and operational characteristics of the nation's private and commercial truck population (US Census Bureau, 2002), including national and state-level estimates of the total number of trucks. Up until 2002, this survey was conducted every 5 years by the U.S. Census Bureau as part of the national census but VIUS is no longer being updated due to lack of funding. Nevertheless, VIUS provides a wealth of information on truck body types, mileage accrual, odometer, and many other factors.

We used VIUS data reported by trucks operating in California to develop mileage accrual rates and cumulative odometer by model year for interstate trucks and by model year and body type for California-based trucks.

6. ARB Vehicle Surveys

As part of this rule development, staff developed an on-line survey for truck and bus fleets in general (ARB, 2008), as well as industry-specific surveys of individual truck categories including agricultural trucks, dump trucks, and others. These surveys provided information such as truck age, miles traveled, body type, and other factors useful for inventory development.

7. Estimated Emission Rates

The EMFAC2007 model (ARB, 2006a and 2006b) was used as the starting point for developing emission rates used in this inventory. EMFAC2007 emission rates are based on analysis of chassis dynamometer testing conducted by the Coordinating Research Council (CRC) under the E55/59 testing program (CRC, 2007). Although both heavy-heavy and medium-heavy duty trucks were tested in the E55/59 study, only heavy-heavy duty truck emission rates were updated for EMFAC2007.

As part of this rule development, staff made three revisions to EMFAC emission rates. Medium-heavy duty truck emission rates were updated with new data made available through the CRC E55/59 program. Staff re-evaluated assumed penetration rates of new technologies into truck sales between 2006 and 2011, and assessed the emissions impact of these revised assumptions. Carbon dioxide emission rates were updated based upon new analysis of several different data sources. Each of these revisions is discussed further in this document. We anticipate incorporating these revised emission rates into the next EMFAC update scheduled for 2010.

8. UC Davis Out-of-State Truck Travel Surveys

In 2006 the ARB contracted with researchers at the University of California at Davis (UC-Davis) to develop and administer truck surveys at major border crossings into California from Oregon, Nevada, Arizona, and Mexico (Lutsey, 2008). For these surveys, interstate trucks were assumed to be those trucks that were registered, domiciled, and/or refueled outside California. Researchers administered 433 surveys of truck drivers at seven weigh stations near state borders with high commercial truck traffic (Lutsey, 2008). These surveys provided estimates of annual travel activity in California for each of the respondents, allowing staff to estimate the number of out-of-state trucks, their mileage, fuel usage, and fueling locations. Based on results of this study, staff examined whether estimates of interstate truck age, mileage, and fuel usage assumed in EMFAC2007 were reasonable.

Staff also used raw data from this analysis to validate estimates of model year distribution for out-of-state trucks that were developed using IRP data. In an accompanying report, UC Davis estimated the fraction of total VMT in California represented by out-of-state trucks relative to EMFAC2007. ARB did not use these estimates because, subsequent to the Lutsey (2008) report being finalized, staff received IFTA data from the BOE that provided direct mileage reports by state of registration. These issues will be described in greater detail later in this document.

D. Base Year Population and Activity by Age

In Table 1 below, we provide a list of the data sources underlying each of the truck inventory categories to be discussed in the next section including how each data source was used to help develop truck population and activity estimates.

Table 1. Data Sources Used to Develop Population and Activity Estimates

Type / Category	Population	Activity
Heavy-Heavy / Out-of-State	CA Dept. of Motor Vehicles (DMV) International Registration Plan (IRP) reports; adjusted to account only for trucks that enter California. Model-year distribution from IRP data and surveys. Category split between neighboring states (WA, OR, NV, AZ, ID) vs non-neighboring states.	Vehicle Inventory and Use Survey (2002) - Fraction of mileage accrued in California estimated using IRP data samples and International Fuel Tax Agreement Data (IFTA)
Heavy-Heavy / California-Interstate	DMV CA-IRP reports provide population by model year	VIUS for nationally registered trucks in IRP as above. CA-IRP reports fraction of mileage accrued in CA, and IFTA reports for total mileage.
Heavy-Heavy / In-State Tractor	DMV Registration data, adjusted to subtract vehicles from specific categories such as Utility, Drayage, and others.	VIUS 2002 data
Heavy-Heavy / In-State Single	DMV Registration data, adjusted to subtract specific vehicles from specific categories such as Utility, Drayage, and others.	VIUS 2002 data
Heavy-Heavy / Drayage Tractors	License plate and gate count surveys conducted at the Ports of Los Angeles, Long Beach, and Oakland.	Trip-based model developed for ARB Drayage Truck Regulation; mileage accrual assumed flat at total mileage divided by total number of trucks.
Heavy-Heavy / Agricultural Trucks	Age distribution from survey; population extrapolated from survey results; specialty trucks estimated from survey and registration data.	Accrual from survey
Heavy-Heavy / Utility Trucks	Population and age of trucks registered to public utilities in DMV database.	Surveys conducted for ARB Public Fleet Rule.

Type / Category	Population	Activity
Medium-Heavy / In-State Trucks	DMV registration data	VIUS 2002 data
Medium-Heavy / Interstate Trucks	IRP reports	VIUS 2002 data
Medium-Heavy / Agricultural Trucks	Age distribution from survey; population extrapolated from survey results; specialty trucks estimated from survey and registration data.	Accrual from survey
Medium-Heavy / Utility Trucks	DMV registration data.	Surveys conducted for ARB Public Fleet Rule.
Buses / School	California Highway Patrol Data	ARB Surveys
Buses / Other	EMFAC2007	EMFAC2007
Other / Power Take-Off	No population estimated. Total fuel usage provided by California State Board of Equalization; age distribution assumed same as in-state single-unit trucks	Fuel usage converted to equivalent mileage assuming EMFAC speed distributions and fuel economy.

One of the key assumptions in the development of this inventory is that trucks and buses that are grouped by vocation or body type have a common age distribution and accrual schedule. This assumption has been verified through analysis of the data sources described above.

Another assumption that applies to many truck inventory categories is that trucks typically move between categories as they age and accrue mileage. Staff recognized this through analysis of DMV data. For example, heavy-heavy duty diesel trucks (HHDDTs) that are used for interstate travel (e.g. by CA IRPs) are often retired from interstate travel after a few years due to increasing maintenance costs and bought for intrastate travel where reliability is less of a concern. Vehicles are driven many more miles during interstate travel than during intrastate travel. As a result, a ten year old truck that was used during its first five years for interstate travel and its last five for intrastate travel would, on average, have a higher odometer reading than a vehicle used strictly for intrastate travel during those ten years. Staff used estimated as to when vehicles would most typically be transferred between inventory categories and adjusted the odometer readings from those assumed in EMFAC2007 appropriately.

This section describes each vehicle category including the key assumptions and data analysis results that underlie the development of the inventory. For each category we show the age distribution in calendar year 2008 as well as the anticipated mileage accrual of vehicles of different age. We developed age distributions for trucks ranging between ages -1 and 44. Trucks of age -1 represent vehicles sold and operated in the calendar year prior to the model year (e.g. MY2009 trucks sold in CY2008). Model years beyond age 44 were included in the 44 age bin since the EMFAC model handles only 45 model years. We also show the distribution of trucks in each category between different fleet sizes where appropriate and the difference in the average age of vehicles between different-size fleets.

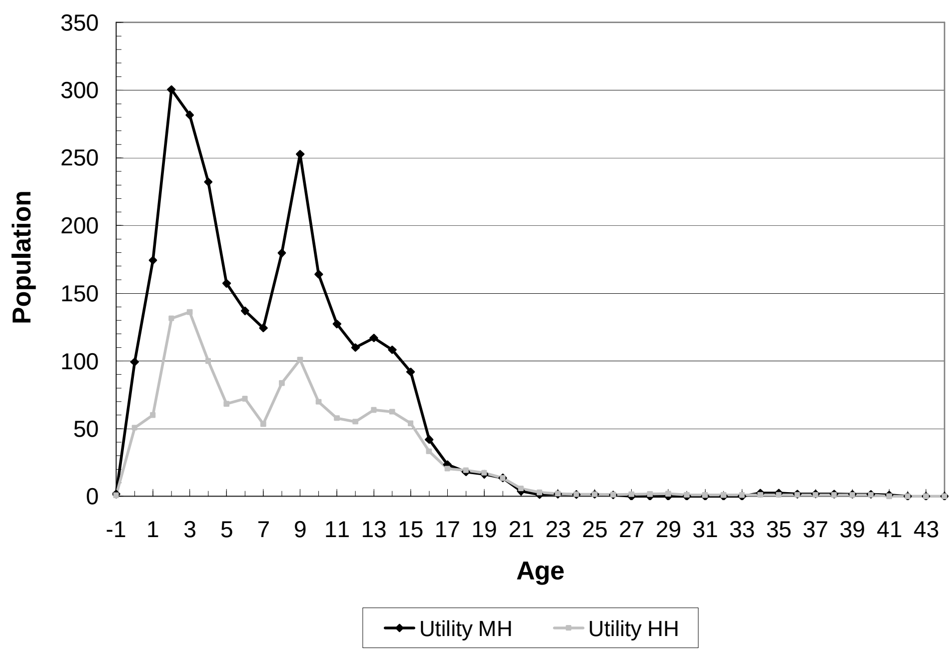
1. Utility Fleets

In October 2006, the ARB adopted a regulation designed to reduce emissions from diesel trucks that are owned or operated by private utilities that operate in California (ARB, 2006). The utility truck category as defined by the regulation includes both medium-heavy (14,000 – 33,000 lbs gross vehicle weight rating or GVWR - MHDDT) and heavy-heavy (>33,000 lbs GVWR - HHDDT) trucks but does not include refuse haulers or fire trucks and other emergency vehicles operated by public agencies. The regulation required fleet operators to reduce diesel PM emissions on a defined schedule by purchasing newer regulation-compliant engines or installing diesel particulate filters. The following methodology was used to develop a Utility Fleet emissions inventory.

a) Base Year Population and Age Distribution by Fleet Size

Staff used an identical methodology for assessing the utility truck population and model year distribution as was used in development of the utility fleet regulation (ARB, 2005). Staff developed a list of utility names and used those names to extract vehicles from DMV registration data. Those vehicles were then separated by model year and weight category (MHDDT vs HHDDT). The population-weighted average age of a vehicle in the utility fleet category was estimated at 8.2 years for HHDDT, 7.2 years for MHDDT. Figure 1 provides the distribution of the California utility truck population by age for calendar year 2008.

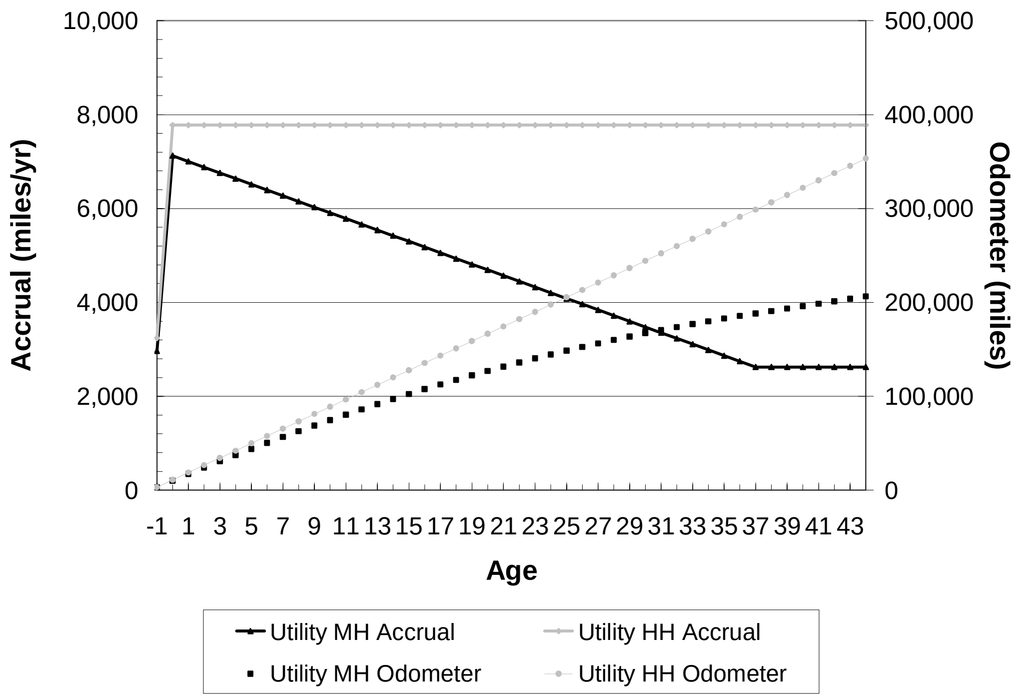
Figure 1: Utility Truck Population and Model Year Distribution (2008)



b) Base Year Accrual, Lifetime Accrual, and Mileage Thresholds

Staff used accrual rates and cumulative odometer readings that were published in the utility fleet rule staff report (ARB, 2005). These were developed by TIAX (2003); results showed that utility trucks accrue between 6,000 and 8,000 miles per year, with slightly more miles accrued per year by HHDDT. The estimated annual average mileage accrual was 7,800 miles per year for HHDDT and 6,200 miles per year for MHDDT, all of which is assumed to occur in California. The estimated average odometer reading was 122,000 miles for HHDDT and 78,000 miles for MHDDT. In Figure 2 we plot annual accrual and cumulative modeled odometer readings for utility category trucks.

Figure 2: Utility Truck Category Accrual and Modeled Odometer Readings (2008)



c) Base Year Vehicle Miles Traveled by Fleet Size and Mileage Thresholds

Utility fleet vehicles were not separated into different categories by fleet size or mileage threshold. This vehicle and emissions inventory evaluates only the fleets of privately owned utilities. The utility fleets of larger municipal agencies are not included in this assessment.

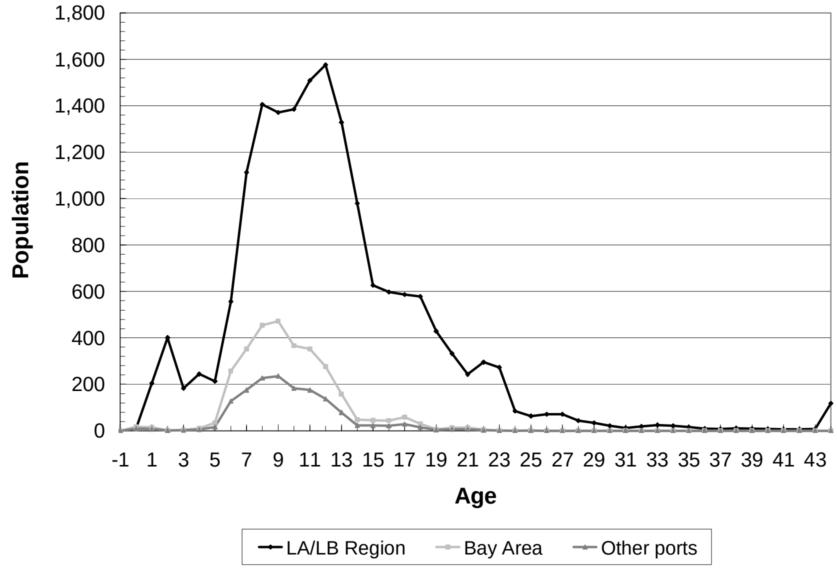
2. Drayage Trucks Serving California's Ports and Railyards

In 2007 the ARB passed a regulation requiring NO_x and diesel PM emissions reductions from drayage trucks serving California's ports and railyards (ARB, 2007a). Drayage trucks are typically older than other trucks in California and primarily serve the Ports of Los Angeles, Long Beach and Oakland along with railyards near those ports. Drayage truck travel is predominantly regional; in general, these trucks make multiple trips to and from the facilities each week. Drayage trucks are all heavy-heavy duty vehicles, exceeding 33,000 lbs GVWR. According to the regulation, by calendar year 2010 all drayage trucks must meet at a minimum model year 1994 or later emissions standards with a diesel particulate filter and by 2014 all trucks must meet 2007 truck emission standards. The following methodology was used to develop the drayage truck emissions inventory:

a) Base Year Population and Age Distribution by Fleet Size

Drayage trucks are defined by their operation rather than body type. Since DMV registration records provide information on body type but not vehicle operator, DMV registration cannot be used alone to estimate the statewide drayage truck population. The population of trucks serving the Ports of Los Angeles and Long Beach and associated railyards was derived from an analysis of one year of gate count and license plate information from approximately half of the terminals at the two Ports; these data were provided by officials from the ports. Staff compared observed license plates to DMV data to assess model year distribution; we then extrapolated results to all terminals at both Ports. A similar approach was used for the Port of Oakland and associated railyards. Regulatory documentation (ARB, 2007b) describes in more detail the methodology used to assess the population of drayage trucks. We estimated the age of drayage trucks serving other ports and railyards in California by assuming that these trucks were similar to those in the HHDDT (instate) tractor category (ARB, 2007b). The population-weighted average age of a vehicle in the drayage category was estimated at 12.4 years for trucks serving the Ports of Los Angeles and Long Beach and regional intermodal railyards and 9.7 years for drayage trucks serving Oakland and associated railyards and for trucks serving the remainder of California ports. In Figure 3 we provide drayage truck population by model year for calendar year 2008. As shown, trucks serving the Ports of Los Angeles and Long Beach are typically several years older than drayage trucks serving other California ports.

Figure 3. Drayage Truck Population and Model Year Distribution (2008)

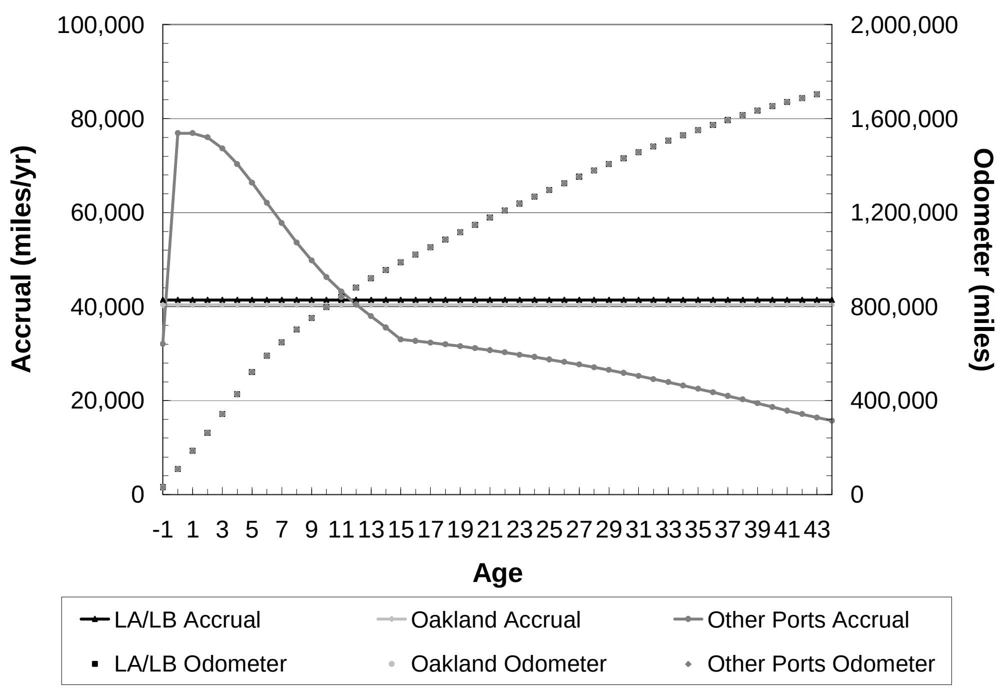


b) Base Year Accrual, Lifetime Accrual, and Mileage Thresholds

Staff used accrual rates and cumulative odometer readings published in the drayage truck rule staff report (ARB, 2007b) to estimate the vehicle miles traveled (VMT) associated with drayage trucks in each region. Staff then assumed that accrual rates were independent of age for drayage trucks and that the vehicle population increased in proportion to the overall VMT for the inventory category.

Drayage trucks serving the Ports of Los Angeles and Long Beach were estimated to drive around 41,000 miles per year. Drayage trucks serving the Port of Oakland drive, on average, around 40,000 miles per year. Drayage trucks serving other ports in California are assumed to have travel characteristics similar to in-state HHDDT tractors and therefore drive, on average, 49,000 miles per year. All drayage-related VMT are assumed to accrue in California. Odometer readings are modeled assuming that drayage trucks were purchased used from larger national fleets that drive hundreds of thousands of miles in their first several years of operation. This assumption is described in detail in the in-state tractor category. The resulting average odometer reading as estimated was 860,000 miles for LA/LB trucks and 770,000 miles for trucks serving Oakland and other ports/railyards; the apparent difference from the mileage if projected from the accrual rate and the age results from the trucks likely having been used for other purposes before being converted to drayage trucks. In Figure 4 we plot annual accrual and cumulative modeled odometer readings for drayage trucks.

Figure 4. Drayage Truck Category Accrual and Modeled Odometer Readings (2008)



c) *Base Year Vehicle Miles Traveled by Fleet Size and Mileage Thresholds*

Drayage trucks were categorized by fleet size as single truck fleets, two truck fleets, three truck fleets, and fleets of more than three trucks. No differentiation was made for drayage trucks with regard to mileage threshold, on the assumption that nearly all drayage fleets are operated in a similar manner. In Table 2, Table 3, and Table 4 we show the distribution of VMT among drayage fleets of various fleet sizes and VMT-weighted ages for trucks near the Ports of Los Angeles/Long Beach, Oakland, and all other California ports/railyards, respectively. The age distribution of drayage trucks was also assumed not to differ with regard to fleet size. With regard to the VMT-weighted average age within each category, drayage trucks near LA/LB were estimated to be older, on average, than drayage trucks near other facilities. In Table 5 we provide a summary of the VMT driven by different size drayage trucks fleets serving all California facilities.

Table 2. Distribution of VMT among POLA/LB Drayage Trucks by Fleet Size (2008)

Fleet Size	Daily VMT	Share	VMT-weighted Average Age
1 truck	1,219,969	53.7%	12.4
2 trucks	135,552	6.0%	12.4
3 trucks	152,496	6.7%	12.4
> 3 trucks	762,481	33.6%	12.4
Total	2,270,498	100.0%	

Table 3. Distribution of VMT among Port of Oakland Drayage Trucks by Fleet Size (2008)

Fleet Size	Daily VMT	Share	VMT-weighted Average Age
1 truck	210,556	53.7%	9.7
2 trucks	23,395	6.0%	9.7
3 trucks	26,319	6.7%	9.7
> 3 trucks	131,597	33.6%	9.7
Total	391,868	100.0%	

Table 4. Distribution of VMT among Drayage Trucks at Other Ports/Railyards by Fleet Size (2008)

Fleet Size	Daily VMT	Share	VMT-weighted Average Age
1 truck	127,097	53.7%	9.1
2 trucks	14,122	6.0%	9.1
3 trucks	15,887	6.7%	9.1
> 3 trucks	79,436	33.6%	9.1
Total	236,542	100.0%	

Table 5. Distribution of VMT among Drayage Trucks at all California Ports/Railyards by Fleet Size (2008)

Fleet Size	Daily VMT	Share	VMT-weighted Average Age
1 truck	1,557,622	53.7%	11.8
2 trucks	173,069	6.0%	11.8
3 trucks	194,703	6.7%	11.8
> 3 trucks	973,513	33.6%	11.8
Total	2,898,907	100.0%	

3. Trucks Serving the Agricultural Economic Sector

Agricultural trade associations, in conjunction with staff, administered a survey to farmers, ranchers, and other agricultural businesses designed to identify and characterize trucks associated with agricultural businesses. The stakeholder survey was designed primarily to capture trucks owned and operated by farms, ranches, and first processing facilities, and was similar in format to the on-line survey used to collect information on the broader truck fleet as part of this rule development (ARB, 2008). Results from the survey were used to assess the population of MHDDT and HHDDT that operate in California for agricultural purposes, either seasonally or annually. The survey was also used to assess the model year distribution and mileage accrual of these trucks, as well as the fraction that would be captured by proposed rule exemptions.

a) Base Year Population and Age Distribution by Fleet Size

To assess the model year distribution of agricultural trucks, we compiled survey results for MHDDT and HHDDT separately, and modeled the data in order to smooth trends in model year variability. Based on analysis of the survey data, the population-weighted average ages of HHDD and MHHD agricultural trucks were found to be very similar (17.3 years for HHDDTs and 17.2 years for MHDDTs).

To assess population, we compiled the survey results and extrapolated the survey sample to a statewide population using the numbers of acres farmed and other metrics collected in the survey as scaling factors. Using this methodology, Staff estimated a statewide agricultural truck population of between 40,000 and 60,000 vehicles. However, when staff compared the model year specific truck populations estimated using the extrapolated data to model year specific DMV registration data, they found that the extrapolated agricultural truck populations for certain model years exceeded the total number of trucks of that model year in the DMV database. This suggested that the directly extrapolated survey results were overestimating the agricultural truck population, at least for those model years.

In reviewing the surveys, staff found that very few were administered to farms or organizations that do not own agricultural trucks. In effect, these businesses were excluded from the survey; thus, extrapolating the population using the metrics described above would overestimate the agricultural truck population.

To correct for this overestimation, we used the DMV registration data as an upper bound of the possible number of agricultural trucks of a given model year.

Using the statewide truck population, we back-calculated an agricultural truck population assuming that the agricultural truck population, in any model year, could not exceed 80% of the total trucks registered in that model year. With this technique, we assessed a likely population of 22,150 agricultural trucks in California, of which 45% are MHDDT and 55% are HHDDT. In Figure 5 we show the California agricultural truck population and model year distribution estimated for the 2008 calendar year.

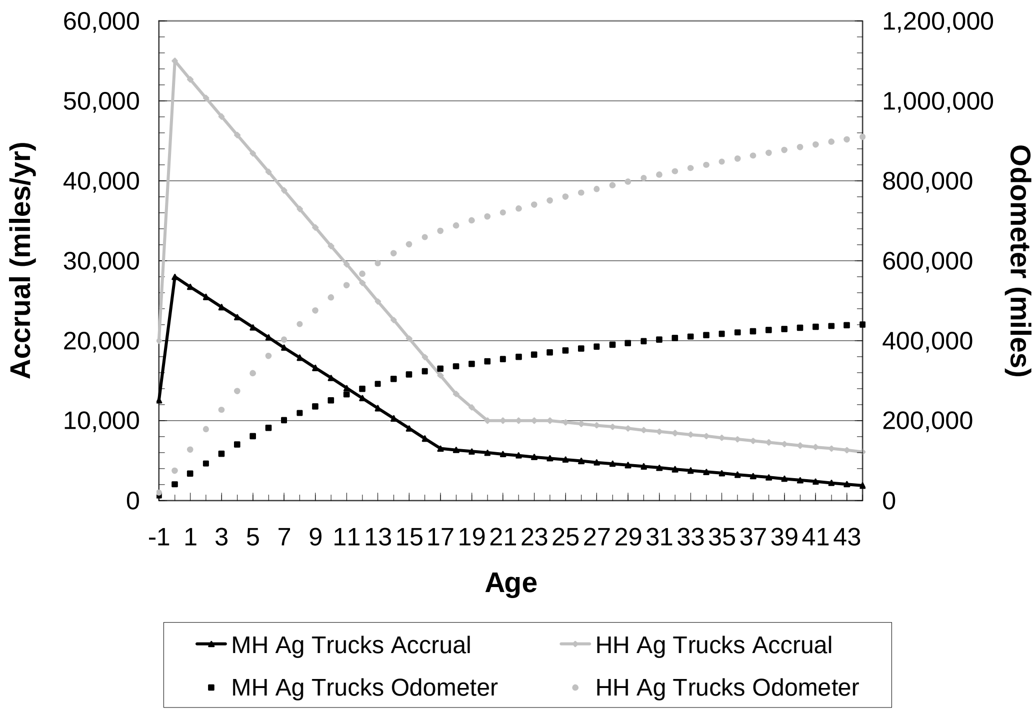
Figure 5. Agricultural Truck Population and Model Year Distribution (2008)

b) Base Year Accrual, Lifetime Accrual, and Mileage Thresholds

We analyzed survey results in order to estimate mileage accrual for agricultural trucks. Because agricultural HHDDT are assumed to be purchased used, their modeled odometer follows a composite that accounts for the mix of single-unit and combination trucks entering the category as well as the likelihood that most tractors currently in the agricultural category were previously in other categories. Because in-state tractors and single-unit trucks are driven more, on average, than agricultural trucks, the composite odometer reading is projected to be higher than the odometer reading of a truck that had been used exclusively for agriculture. These trucks then follow the agricultural truck accrual rate upon transition. Agricultural MHDDT also followed a composite rate, since in-state MHDDT were also assumed to migrate toward the agricultural category. The average odometer reading for agricultural was estimated to be approximately

601,000 miles for HHDDT and 293,000 miles for MHDDT. The average annual mileage accrual was estimated to be 23,000 miles for HHDDT agricultural trucks and 11,000 miles for MHDDT agricultural trucks. All miles are assumed to accrue in California. We present the results in Figure 6.

Figure 6. Agricultural Truck Category Mileage Accrual and Modeled Odometer (2008)



c) Base Year Vehicle Miles Traveled by Size and Mileage Thresholds

Staff did not categorize agricultural trucks by fleet size. With regard to application, both medium-heavy and heavy-heavy trucks were categorized into specialty and non-specialty vehicles. Specialty vehicles are specifically defined under the proposed regulation as water trucks used on the farm, nurse rigs, cotton module movers, or feed or mixer feed trucks owned by a cattle or calf feedlot. Using this definition, by analyzing the DMV registration data, we found that 10% of agricultural trucks or approximately 2200 agricultural trucks statewide were specialty vehicles.

Non-specialty agricultural trucks were categorized according to mileage thresholds, since the regulation is to be applied differently to vehicles driven different mileage thresholds each year. The regulation sets the low use mileage threshold for trucks in general at 10,000 miles per year. Vehicles that exceed 10,000 miles per year but do not exceed an upper mileage threshold need to turnover or retrofit their trucks prior to 2017. Agricultural trucks are below the upper mileage threshold if they fall into one of the following three categories:

- MY 1995 or earlier, and driven less than 15,000 miles/year
- MY 1996-2005, and driven less than 20,000 miles/year, or
- MY 2006 or newer, and driven less than 25,000 miles/year

These categories of agricultural truck are subject to regulatory requirements at the beginning of calendar year 2017 and are categorized as "between mileage thresholds". The third category consists of trucks that exceed the upper VMT threshold; these trucks are subject to the ARB regulation according to the standard turnover and retrofit timeline.

In Table 6 we show the distribution of daily VMT among medium-heavy agricultural trucks in California in calendar year 2008. In Table 7 we show the distribution of daily VMT among heavy-heavy agricultural trucks in California in 2008. In each table we also show the average VMT-weighted age by mileage threshold. For both heavy-heavy and medium-heavy agriculture truck weight classes, the trucks driven the fewest miles tended to be older than other vehicles.

Table 6. Distribution of VMT among Medium-Heavy Agricultural Trucks by Fleet Size (2008)

Vehicle Type	Daily VMT	Share	VMT-weighted Average Age
Non specialty, below lower threshold	46,021	13.4%	16.0
Non specialty, between thresholds	78,768	23.0%	10.3
Non specialty, above upper threshold	183,598	53.6%	9.2
Ag specialty vehicle	34,265	10.0%	10.5
Total	342,652	100.0%	

Table 7. Distribution of VMT among Heavy-Heavy Agricultural Trucks by Fleet Size (2008)

Vehicle Type	Daily VMT	Share	VMT-weighted Average Age
Non specialty, below lower threshold	82,489	9.4%	17.1
Non specialty, between thresholds	62,773	7.1%	12.5
Non specialty, above upper threshold	645,375	73.5%	10.5
Ag specialty vehicle	87,849	10.0%	11.4
Total	878,486	100.0%	

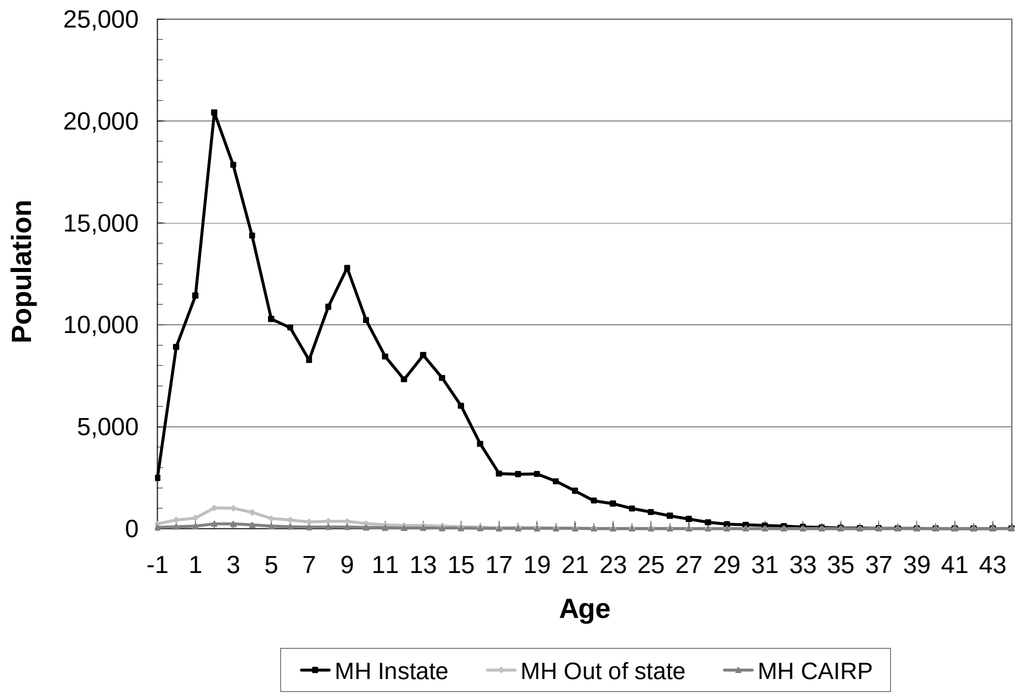
4. Medium Heavy Duty Diesel Trucks

Staff estimate that more than 200,000 MHDDT are registered in and operate in California. These trucks are primarily lighter weight delivery trucks with a GVWR between 14,000 and 33,000 lbs that travel during the work day within the area where they are registered. Most of these trucks are registered in and never leave California, although a few are California-registered and in the IRP program, and a few enter California from other states. Most MHDDTs are found in fleets of two or more although some are single-truck-fleet.

a) Base Year Population and Age Distribution by Fleet Size

Staff identified MHDDT in the DMV registration database by selecting all diesel powered vehicles with a GVWR between 14,000 and 33,000 lbs. The data were then analyzed in two ways. First, staff sorted the registration data by owner name and address to identify the number of vehicle records associated with a unique owner. This list was then used to develop the fleet size distribution, including the number of owner-operators and small fleets. Staff then used a combination of license plate and IRP registration data to estimate how many of the MHDDT are registered in California compared to other states, as well as what fraction of their travel is solely within California. Staff found that the vast majority of MHDDT that are registered in California never leave California. Also, using IRP data, staff estimated that very few out-of-state trucks fall into the MHDDT category. Since both the public and agricultural truck categories include MHDDT, we subtracted these by model year from the in-state MHDDT category to avoid double counting. We estimated the population-weighted average age of an out-of-state or IRP MHDDT at 5.4 years as compared to 8.0 years for an instate MHDDT. In Figure 9 we show the population and age distribution estimated for MHDDTs operating in California.

Figure 7. MHDDT Population and Model Year Distribution (2008)



b) Base Year Accrual, Lifetime Accrual, and Mileage Thresholds

Staff used the most recent VIUS database (calendar year 2002) to estimate annual mileage accrual and modeled odometer readings for MHDDT. We did not differentiate between in-state and interstate MHDDT with modeled odometer readings. Staff used CA IRP data to calculate the fraction of total mileage accrual that occurs in California on average. Staff estimated that CA IRP MHDDT drive 63% and out-of-state registered

MHDDT 8% of their total annual miles in California. We estimated the average odometer reading as 161,000 miles for out-of-state MHDDT and CA IRP MHDDT and 207,000 miles for instate MHDDT. We estimated the average annual mileage accrual to be 22,000 miles for out-of-state and CA IRP MHDDT and 20,000 miles for instate MHDDT. Of the 22,000 miles driven annually by out-of-state and CA IRP MHDDTs, it was assumed that out-of-state vehicles drive only 8% (1,800 miles) of their annual miles in California as compared to 64% (14,000 miles) for CA IRP vehicles. The difference in average annual accrual resulted from the different age distribution representing the population within each category. In Figure 8 we plot the annual accrual in California and cumulative modeled odometer readings for MHDDT by age and category.

Figure 8. MHDDT Accrual and Modeled Odometer (2008)

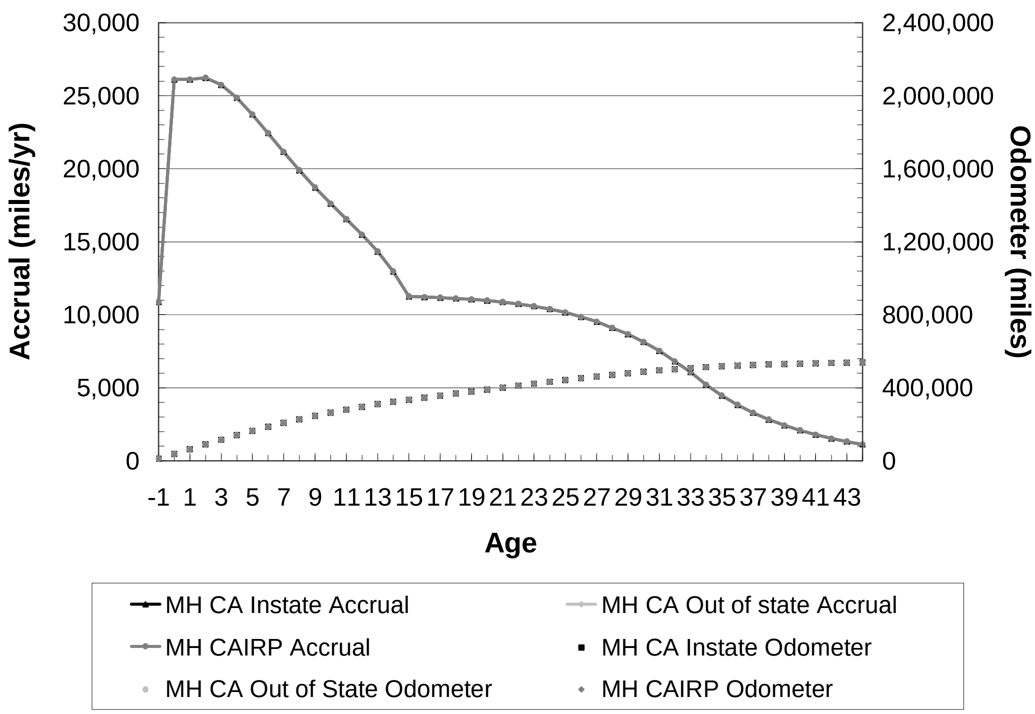
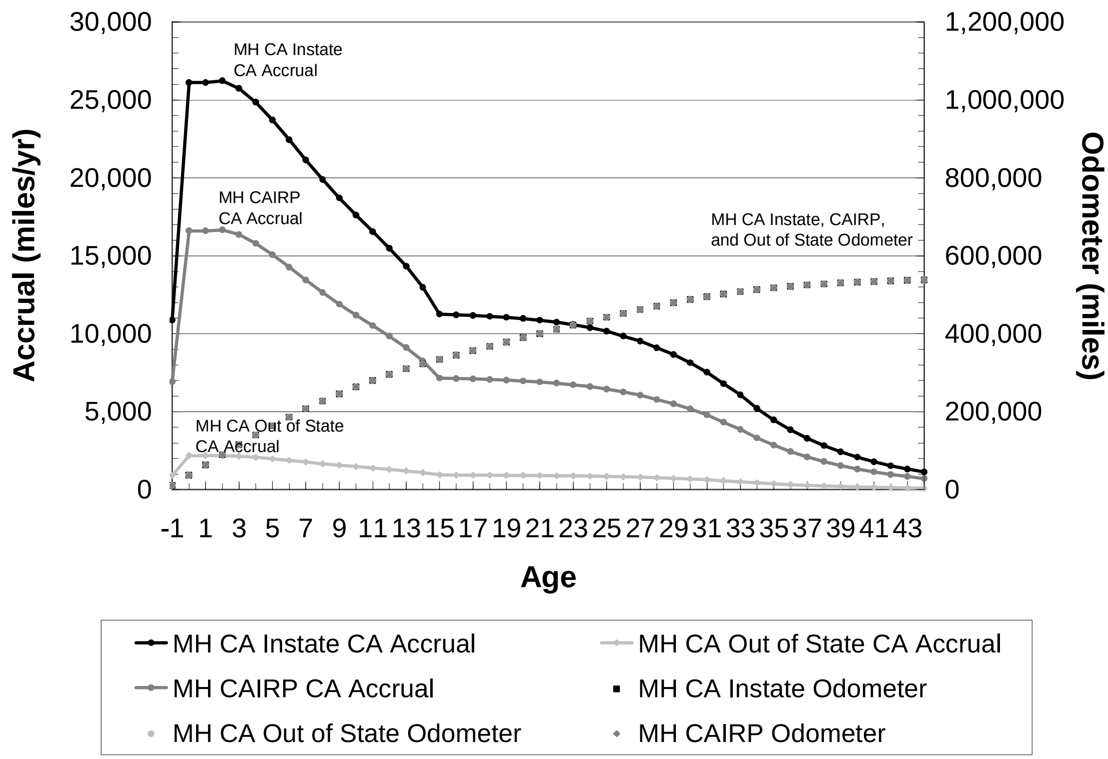


Figure 8 shows the annual mileage accrual rates to be similar for medium-heavy duty diesel CA Instate, CA Out-of-State, and CA IRP-registered trucks. However, these accrual rates are simply the total accrual rates for the vehicles in each inventory category; they do not represent the accrual rate for vehicles in each category within California. Because the share of annual travel within California varies between categories (8% for Out-of-State; 63% for CA-IRP; 100% for MHDDT Instate), the accrual rate for vehicles within California also varies for each category. We show these accrual rates in Figure 9; because California-registered MHDDT are assumed to spend 100% of their time in California, they have the highest CA accrual rate.

Figure 9. MHDDT Accrual in California and Modeled Odometer (2008)



c) Base Year Vehicle Miles Traveled by Fleet Size and Mileage Thresholds

We categorized medium-heavy duty diesel trucks by fleet size as single-truck fleets, two-truck fleets, three-truck fleets, and fleets of more than three trucks. We also categorized MHDDT based on their annual miles driven since the regulation is to be applied differently to vehicles used at differing mileage levels. The mileage threshold of significance for MHDDT from a regulatory perspective is 5,000 miles per year. In Table 8, Table 9, and Table 10 we show the distribution of daily VMT driven in California in calendar year 2008 by different size fleets of instate, CA-IRP, and out-of-state MHDDTs, respectively. Each table also shows the VMT-weighted average age of the trucks as a function of fleet size. For all categories of MHDDT, regardless of miles driven or state of registration, the smaller the fleet, the older the truck. Also, very little (less than 2%) of the total statewide MHDDT VMT is driven by vehicles in fleets driving less than 5,000 miles a year. In addition, MHDDTs driving less than 5,000 miles a year are significantly older (4 to 6 years older) than those in comparable size fleets that drive more than 5,000 miles a year.

Table 8. Distribution of VMT among Medium-Heavy Instate Vehicles by Fleet Size (2008)

	Fleet Size	Daily VMT	Share	VMT-weighted Average Age
Below 5000 miles	1 truck	80,942	0.6%	13.4
	2 trucks	25,478	0.2%	13.1
	3 trucks	15,111	0.1%	13.0
	> 3 trucks	107,142	0.8%	11.6
Above 5000 miles	1 truck	3,786,410	29.7%	7.0
	2 trucks	1,244,223	9.8%	6.8
	3 trucks	740,914	5.8%	6.9
	> 3 trucks	6,731,027	52.9%	5.7
	Total	12,731,247	100.0%	

Table 9. Distribution of VMT among Medium-Heavy CAIRP Vehicles by Fleet Size (2008)

	Fleet Size	Daily VMT	Share	VMT-weighted Average Age
Below 5000 miles	1 truck	95	0.1%	8.2
	2 trucks	61	0.1%	8.4
	3 trucks	68	0.1%	9.2
	> 3 trucks	616	0.8%	9.4
Above 5000 miles	1 truck	9,684	13.0%	4.3
	2 trucks	6,018	8.0%	4.3
	3 trucks	5,943	7.9%	4.5
	> 3 trucks	52,292	69.9%	4.7
	Total	74,777	100.0%	

Table 10. Distribution of VMT among Medium-Heavy Out-of-state Vehicles by Fleet Size (2008)

	Fleet Size	Daily VMT	Share	VMT-weighted Average Age
Below 5000 miles	1 truck	54	0.1%	8.2
	2 trucks	35	0.1%	8.4
	3 trucks	39	0.1%	9.2
	> 3 trucks	353	0.8%	9.4
Above 5000 miles	1 truck	5,552	13.0%	4.3
	2 trucks	3,450	8.0%	4.3
	3 trucks	3,407	7.9%	4.5
	> 3 trucks	29,980	69.9%	4.7
	Total	42,871	100.0%	

5. California Registered Heavy Heavy Duty Diesel Trucks

California is somewhat unique in the United States in that it has a comparatively large population of older heavy-heavy duty diesel trucks. These trucks, with an average age of 10 to 12 years, generally do not travel outside California, operating practically as a captive fleet. These California registered trucks drive fewer miles per truck than IRP trucks registered in California, both because they are older and less mechanically reliable and because they are engaged in more localized trucking services than their out-of-state registered counterparts. Consequently, California registered HHDDT are much more likely to drive in the air basin in which they are primarily based.

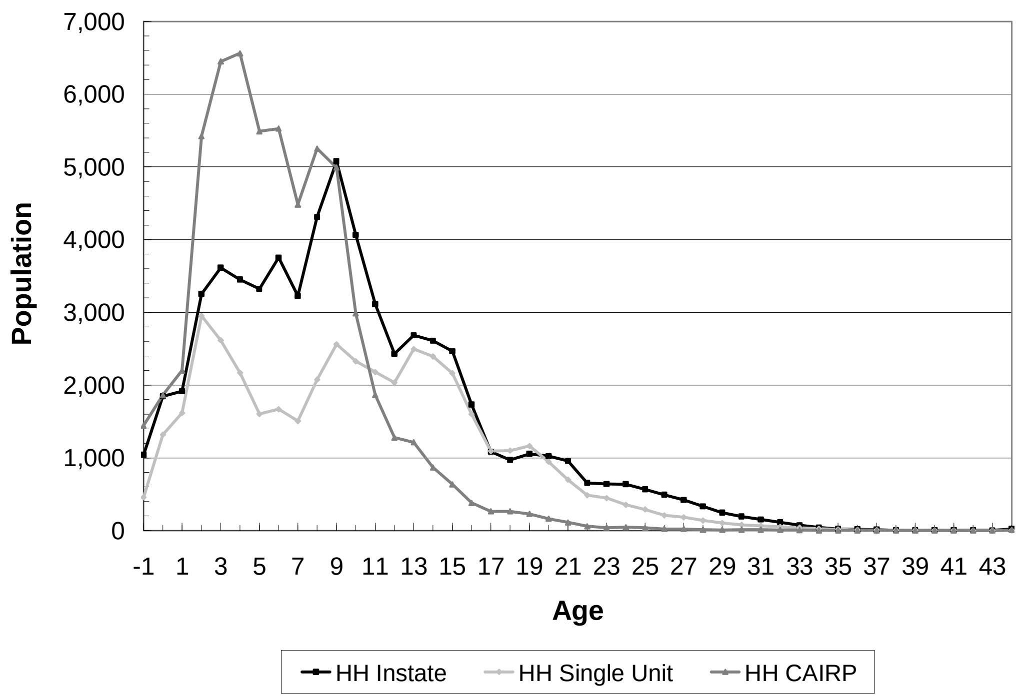
When evaluating VIUS data we realized there is a significant difference in the mileage a truck travels depending upon whether it is a single-unit truck or a combination tractor. On average, combination tractors drive more miles per year than single-unit trucks. We also found that while single-unit trucks tend to be purchased new in California and then operate in California for the life of the truck, in-state tractors tend to begin their life as interstate trucks and then transition into in-state usage as they age and accrue miles. Analysis of the VIUS data indicates interstate trucks are generally sold into the in-state fleets between 2 and 6 years of age, having accrued approximately 500,000 miles in interstate service.

a) Base Year Population and Age Distribution by Fleet Size

To develop population estimates for in-state HHDDT, staff used DMV registration data (license plate number and GVWR) to identify those HHDDT that operate solely within California (in-state). Staff then analyzed DMV and IRP data to identify only California registered IRP trucks. Next, staff used the DMV data to assess the body type of each in-state truck. We then used the DMV data to estimate the population and model year distribution of in-state single-unit trucks, in-state tractors, and California IRP trucks. We subtracted the populations of utility trucks, drayage trucks, and agricultural trucks estimated elsewhere from the in-state HHDDT category, by body type and registration, to estimate the number of in-state tractors and avoid double counting.

In Figure 10 we provide the estimated population and age distribution for in-state HHDDT categories in California in calendar year 2008. In general, vehicles traveling only in California are older than those traveling out-of-state and single unit trucks are slightly older than comparable model year tractors. As shown in Figure 10, CA IRP trucks have a population-weighted average age of 6.2 years, while in-state tractors average age 9.9 years, and single-unit trucks average 10.2 years old.

Figure 10. California-Registered In-State HHDDT Population and Model Year Distribution (2008)



b) Base Year Accrual, Lifetime Accrual, and Mileage Thresholds

Staff used VIUS to assess annual mileage accrual rates by body type for in-state HHDDT and CA-IRP trucks. This analysis indicated that California IRP trucks drive about 55% of their total miles in California. Because used trucks are sold into the in-state tractor category from interstate categories, and interstate category tractors drive more miles than in-state tractors during their early years, we developed a composite modeled odometer to represent in-state tractors. The composite odometer estimate assumes a high annual mileage in early model years when a tractor is in long-haul service and lower annual mileage once a tractor begins shorter haul service in the in-state category. For comparative purposes, a vehicle of a given model year that had been used exclusively for interstate purposes would have a higher odometer reading than a vehicle of the same age that had been used exclusively for instate purposes; a vehicle that had been used earlier in its life for interstate purposes and later for instate purposes would likely have an odometer reading between the two. The average odometer reading estimated using this approach was 723,000 miles for instate HHDDT, 338,000 miles for single-unit HHDDT, and 668,000 miles for CAIRP HHDDT. The average annual mileage accrual was estimated to be 51,000 miles for instate HHDDT, 25,000 miles for single-unit HHDDT, and 75,000 miles for CAIRP HHDDT (of which 43,000 miles are driven in California). Figure 11 provides in-state HHDDT mileage accrual and modeled odometer by model year; these data reflect the assumption of composite use. For comparative purposes, in Figure 12 we provide the composite odometer reading for instate trucks of various model years in calendar year 2008 compared with the modeled odometer reading for similar trucks used purely for in-state or interstate long-haul traffic.

Figure 11. HHDDT In-state and Interstate Fleet Accrual and Modeled Odometer (2008)

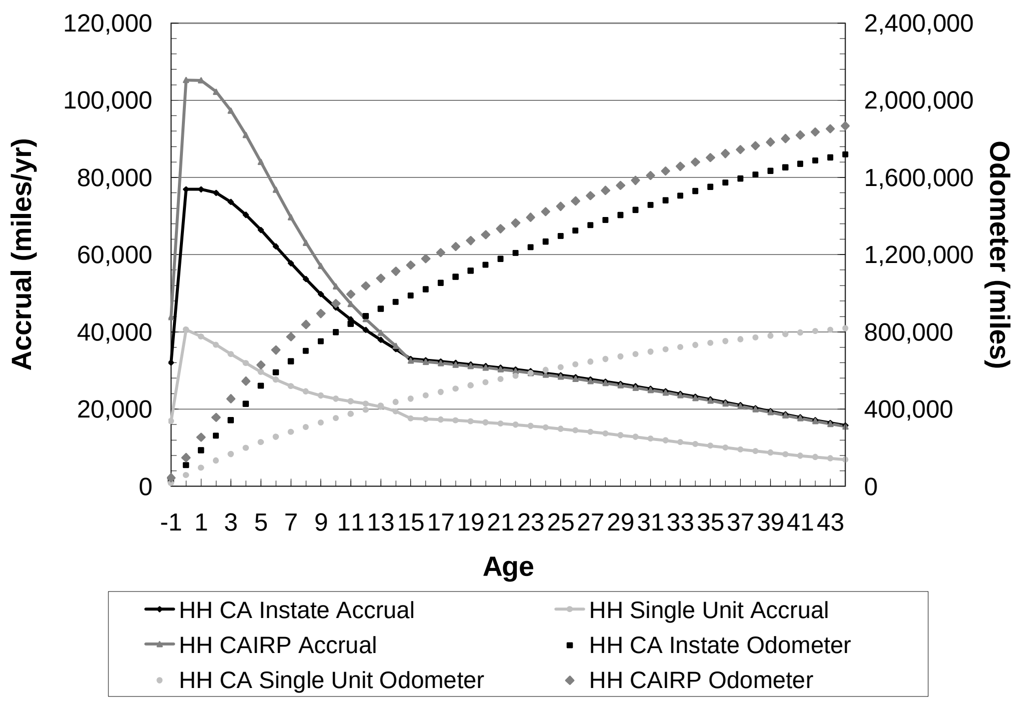
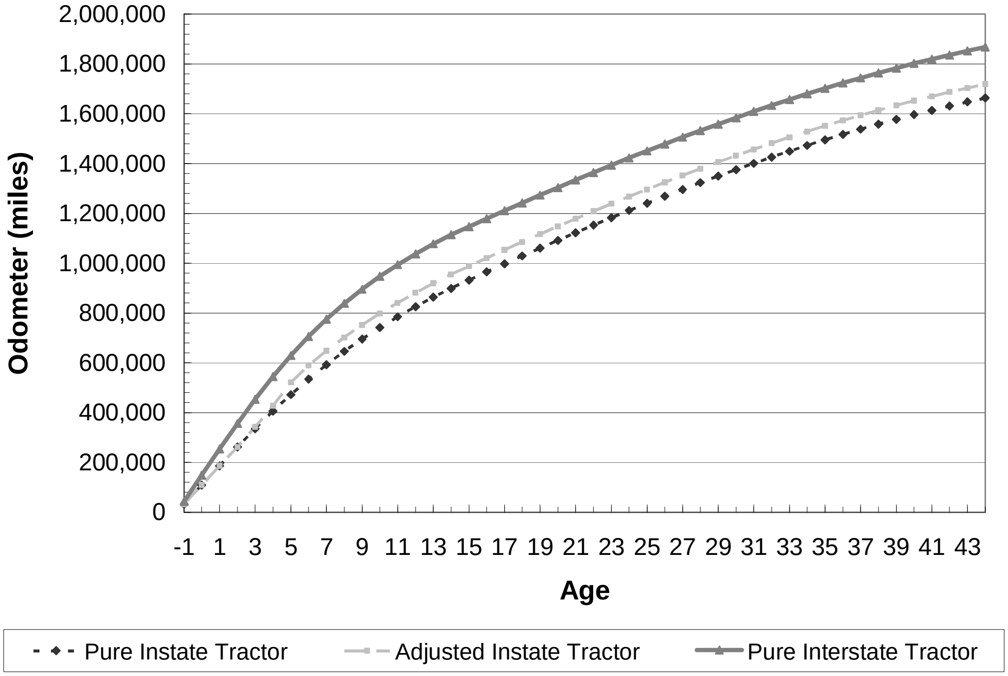


Figure 12. HHDDT In-State Tractor Modeled Odometer (2008)



c) *Base Year Vehicle Miles Traveled by Fleet Size and Mileage Thresholds*

We categorized heavy-heavy duty diesel trucks by fleet size as single-truck fleets, two-truck fleets, three-truck fleets, and fleets of more than three trucks. We also categorized the fleets by their annual VMT since the regulation is to be applied differently to trucks driven at different mileages each year. The mileage threshold of significance for HHHDT from a regulatory perspective is 7,500 miles per year. In Table 11 we show the distribution of daily VMT and the VMT-weighted average age as a function of fleet size and annual miles driven for heavy-heavy instate trucks in California in 2008. Heavy-heavy duty diesel instate trucks driving less than 7,500 miles a year are significantly older (5 years) than their counterparts driving more than 7,500 miles a year and contribute less than 2% of the total VMT driven each year by in-state HHDDTs. Regardless of miles driven, HHDDT in smaller fleets are on average older than those in larger fleets.

Table 11. Distribution of Daily VMT among California Instate Tractors Heavy-Heavy Duty Vehicles by Fleet Size (2008)

	Fleet Size	Daily VMT	Share	VMT-weighted Average Age
Below 7500 miles	1 truck	44,925	0.4%	15.2
	2 trucks	12,992	0.1%	15.4
	3 trucks	7,370	0.1%	15.3
	> 3 trucks	48,792	0.5%	13.6
Above 7500 miles	1 truck	3,031,868	29.1%	10.1
	2 trucks	902,069	8.7%	9.7
	3 trucks	529,836	5.1%	9.5
	> 3 trucks	5,835,899	56.0%	6.4
	Total	10,413,751	100.0%	

In Table 12 we show the distribution of daily VMT as a function of fleet size and mileage driven for heavy-heavy single-unit trucks operating in California in calendar year 2008. In Table 13 we show the distribution of daily VMT as a function of fleet size and mileage driven in California for heavy-heavy trucks licensed in California under the International Registration Program in California in 2008. Each table also shows the average VMT-weighted age of vehicles within the fleets of different sizes; in each case, the trucks driven fewer miles tended to be older than trucks driven more miles, and the average age of vehicles within a fleet was also estimated to decrease with the size of the fleet.

Table 12. Distribution of Daily VMT among Single-Unit Heavy-Heavy Duty Vehicles by Fleet Size (2008)

	Fleet Size	Daily VMT	Share	VMT-weighted Average Age
Below 7500 miles	1 truck	37,585	1.1%	15.6
	2 trucks	13,153	0.4%	15.5
	3 trucks	7,951	0.2%	14.8
	> 3 trucks	63,491	1.9%	13.5
Above 7500 miles	1 truck	766,081	22.5%	10.3
	2 trucks	279,769	8.2%	9.9
	3 trucks	185,491	5.4%	9.2
	> 3 trucks	2,057,340	60.3%	7.1
	Total	3,410,860	100.0%	

Table 13. Distribution of Daily VMT among California International Registration Program Vehicles in California by Fleet Size (2008)

	Fleet Size	Daily VMT	Share	VMT-weighted Average Age
Below 7500 miles	1 truck	5,804	0.1%	10.8
	2 trucks	2,096	0.0%	10.9
	3 trucks	1,223	0.0%	11.4
	> 3 trucks	9,801	0.1%	11.3
Above 7500 miles	1 truck	2,198,998	26.5%	6.0
	2 trucks	812,823	9.8%	5.8
	3 trucks	460,037	5.6%	5.7
	> 3 trucks	4,791,942	57.9%	4.6
	Total	8,282,725	100.0%	

6. Out-of-State Heavy Heavy Duty Diesel Trucks

According to the California Department of Finance, California's economy is the eighth largest in the world (DOF, 2008). Foreign trade, construction, and transportation are all major contributors to California's economy, and these economic sectors attract the services of national trucking fleets including large numbers of out-of-state heavy-heavy duty diesel trucks.

a) *Base Year Population and Age Distribution by Fleet Size*

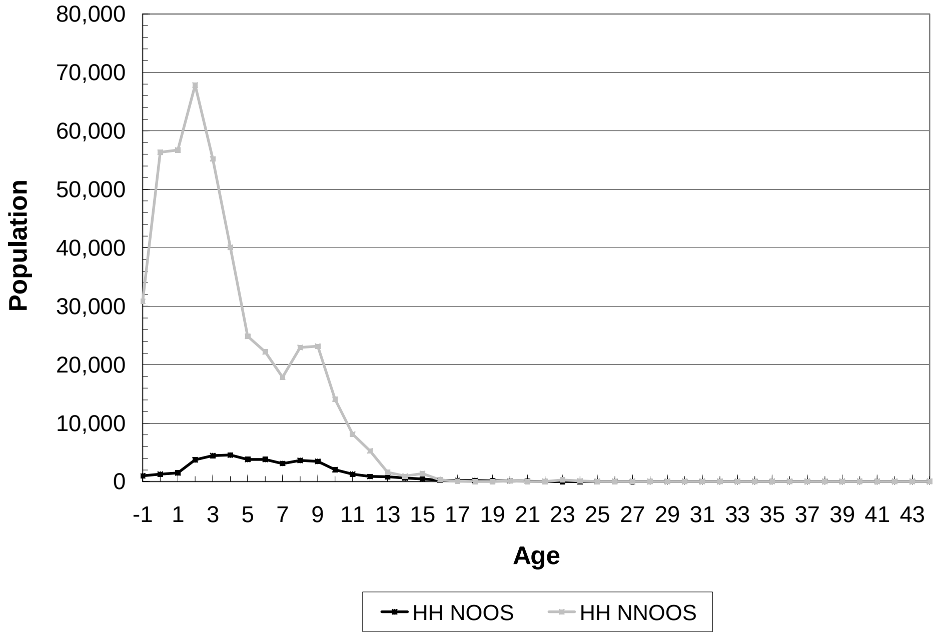
No single source of information describes out-of-state truck activity in California. To develop an inventory, staff conducted detailed research into the IRP and IFTA programs. The California DMV provided staff with a report providing the total number of out-of-state trucks, by state, that are enrolled in the IRP program and in fleets that reported any travel in California. These data suggested that more than one million trucks are in fleets that report mileage in California. However, this is likely to be an upper estimate as not all of the trucks in these fleets actually enter California. To better constrain the number of out-of-state trucks entering California, staff analyzed IRP data in greater detail, as described below.

In analyzing the age distribution of out-of-state trucks, staff divided heavy-heavy duty trucks into two groups based on their proximity to California under the assumption that trucks traveling longer distances are younger. Neighboring states were considered to include British Columbia, Washington, Oregon, Idaho, Nevada, and Arizona while non-neighboring states included all other states and Canadian provinces. Staff sampled IRP data from 12 states to obtain a statistically representative sample of data. IRP data suggested neighboring state trucks are on average 6.1 years old and have a model year distribution similar to that of California interstate trucks while non-neighboring state trucks are on average around 3.3 years old, much younger than other interstate trucks. Recent field studies supported by the ARB have confirmed this trend (Lutsey, 2008).

To better understand the population of out-of-state trucks that actually operate in California, staff developed a methodology to assess the number of trucks in a fleet likely to enter California. We evaluated all of the collected non-California registered IRP data by fleet. For each fleet we calculated the number of miles traveled in California per truck as reported in the IRP data. We then assumed an average trip length depending on the registered location of each fleet and where those trucks would most likely travel in California. In many cases the assumed trip length was longer than the calculated number of miles traveled per truck in the IRP data. In those cases, we calculated the population operating in California as the total miles traveled in California divided by the assumed trip length. For all other fleets we assumed all of the reported trucks in that fleet actually enter California. Staff then recompiled the population for trucks from neighboring states and non-neighboring states. The results suggested for fleets in states neighboring California, approximately 60% of trucks in those fleets authorized to enter California actually do so. Of fleets in states not neighboring California, approximately 40% of the trucks authorized to enter California are estimated to actually do so.

The fraction of owner-operators in the out-of-state category was based on the IRP samples collected. The population-weighted average age of HHDDT from neighboring states was estimated to be 6.2 years while HHDDT from non-neighboring states were estimated to be on average 3.6 years old. These estimates were each close to the IRP estimates. In Figure 13 we provide estimates of the out-of-state population and model year distribution of heavy-heavy duty diesel trucks operating in California in calendar year 2008.

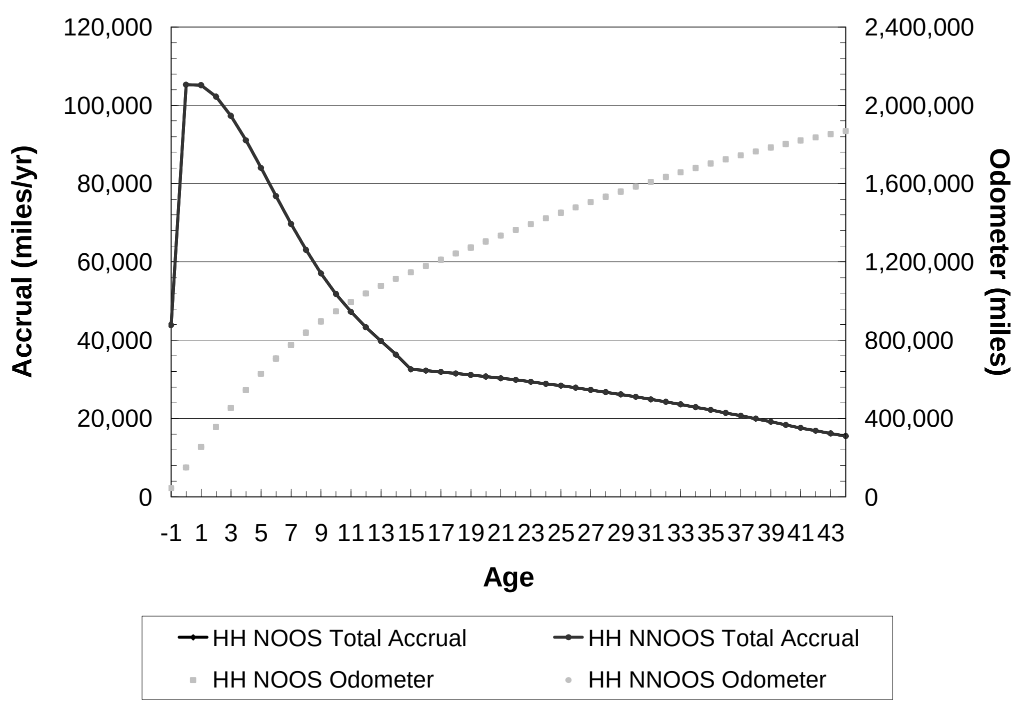
Figure 13. Out-of-State HHDDT Population and Model Year Distribution (2008)



b) Base Year Accrual, Lifetime Accrual, and Mileage Thresholds

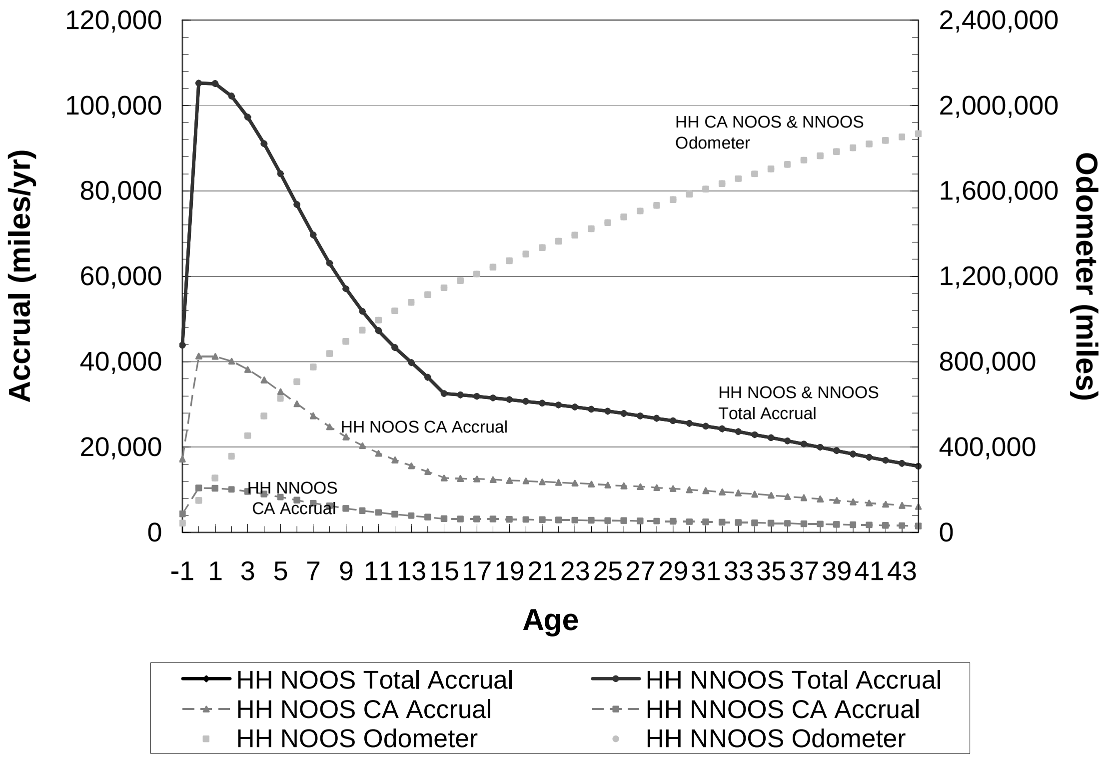
Staff used VIUS to assess accrual rates for the nationwide IRP truck category traveling in California. Staff then evaluated IRP sample data to estimate the fraction of miles accrued in California and 2005 IFTA records to quantify the total miles traveled in California by out-of-state HHDDT. Results suggested that trucks from neighboring states travel on average 40% of their total mileage in California, while trucks from non-neighboring states travel around 10% of their total mileage in California. The average odometer reading was estimated to be 668,000 miles for neighboring out-of-state HHDDT and 473,000 miles for non-neighboring out-of-state HHDDT. The average annual mileage accrual was estimated as 75,000 miles per year (30,000 miles per year in CA) for neighboring out-of-state HHDDT and 85,000 miles per year (8,400 miles per year in CA) for non-neighboring out-of-state HHDDT. In Figure 14 we provide estimates of the average annual mileage accrual and modeled odometer by model year for out-of-state heavy-heavy duty diesel trucks operating in California in calendar year 2008.

Figure 14. Out-of-State Truck Accrual and Modeled Odometer (2008)



In Figure 14, the accrual rates for HHDDT NOOS and NNOOS trucks are shown to be equal, but these rates represent the overall accrual for the trucks. Because trucks from states neighboring California drive a larger fraction of their annual miles in California than trucks from non-neighboring states, the model used for this analysis reflects different accrual rates for vehicles in each category in California. We show these in Figure 15.

Figure 15. Out-of-State Truck Accrual within California and Modeled Odometer (2008)



c) Base Year Vehicle Miles Traveled by Fleet Size and Mileage Thresholds

Staff also categorized heavy-heavy duty diesel trucks from outside California by fleet size as single truck fleets, two truck fleets, three truck fleets, and fleets of more than three trucks. We also categorized fleets based on the annual VMT of trucks, since the regulation is to be applied differently to fleets used at differing mileage levels. The mileage threshold of significance for HHDDT from a regulatory perspective is 7,500 miles per year. In Table 14 we show the distribution of daily VMT driven in California in calendar year 2008 by heavy-heavy diesel trucks of different fleet sizes registered in states neighboring California. In Table 15 we show the distribution of daily VMT driven in California in calendar year 2008 by heavy-heavy diesel trucks registered in non-neighboring states in 2008. Each table also shows the average VMT-weighted age of vehicles within each fleet size; we estimated the average age to be higher for vehicles driven fewer miles. We estimated the average age to be independent of the fleet size for vehicles registered outside California.

Table 14. Distribution of Daily California VMT among Heavy-Heavy Duty Diesel Trucks Registered in Neighboring States by Fleet Size (2008)

	Fleet Size	Daily VMT	Share	VMT-weighted Average Age
Below 7500 miles	1 truck	1,149	0.0%	11.1
	2 trucks	357	0.0%	11.1
	3 trucks	261	0.0%	11.1
	> 3 trucks	7,253	0.2%	11.1
Above 7500 miles	1 truck	501,599	12.7%	5.1
	2 trucks	155,808	3.9%	5.1
	3 trucks	113,815	2.9%	5.1
	> 3 trucks	3,167,429	80.2%	5.1
	Total	3,947,672	100.0%	

Table 15. Distribution of Daily VMT among Heavy-Heavy Duty Diesel Trucks Registered in States not Neighboring California by Fleet Size (2008)

	Fleet Size	Daily VMT	Share	VMT-weighted Average Age
Below 7500 miles	1 truck	188	0.0%	8.3
	2 trucks	58	0.0%	8.3
	3 trucks	41	0.0%	8.3
	> 3 trucks	11,610	0.1%	8.3
Above 7500 miles	1 truck	192,875	1.6%	3.1
	2 trucks	58,926	0.5%	3.1
	3 trucks	41,740	0.3%	3.1
	> 3 trucks	11,889,217	97.5%	3.1
	Total	12,194,654	100.0%	

7. Buses

The proposed regulation achieves emissions reductions for two classes of buses: school buses and other buses. School buses may be either privately- or publicly-owned, but must be used exclusively for transporting students in accordance with the definition of school buses in the California Vehicle Code. Other buses are defined as all buses identified in the DMV database that cannot be categorized as school buses and are not owned by public transit agencies. This category includes intercity buses, charter buses, and church buses. This section describes the assumptions used to develop a baseline emissions inventory for school buses and other buses.

a) Base Year Population and Age Distribution by Fleet Size

Staff used a calendar year 2005 database of school buses compiled by the CHP to estimate the population and age distribution of school buses in California in 2005 (California Highway Patrol, 2006). The age distribution of school buses in 2005 was assumed to be consistent with the age distribution of school buses between 2000 and 2004.

Staff used the survival rate of school buses in EMFAC2007 and the existing Lower Emissions School Bus Program (LESBP) to estimate the age distribution of school buses in future years. Specifically, the impact of the LESBP was modeled as though: i) all pre-1985 model year school buses will be replaced by buses that meet 2007 emission standards as of December 31, 2009, and ii) 50% of 1985 and 1986 model year school buses will be replaced with school buses that meet 2007 emission standards by December 31, 2010. In addition, the maximum age for a school bus was set at thirty years; any school bus older than thirty years was assumed to be replaced with a new bus. Any school bus that was retired due to age or attrition was assumed to be replaced in the population with a new school bus. The aggregate population of diesel school buses was assumed to remain unchanged; any increases to the total school bus population were assumed to represent new vehicles using natural gas or some other alternative fuel entering the fleet.

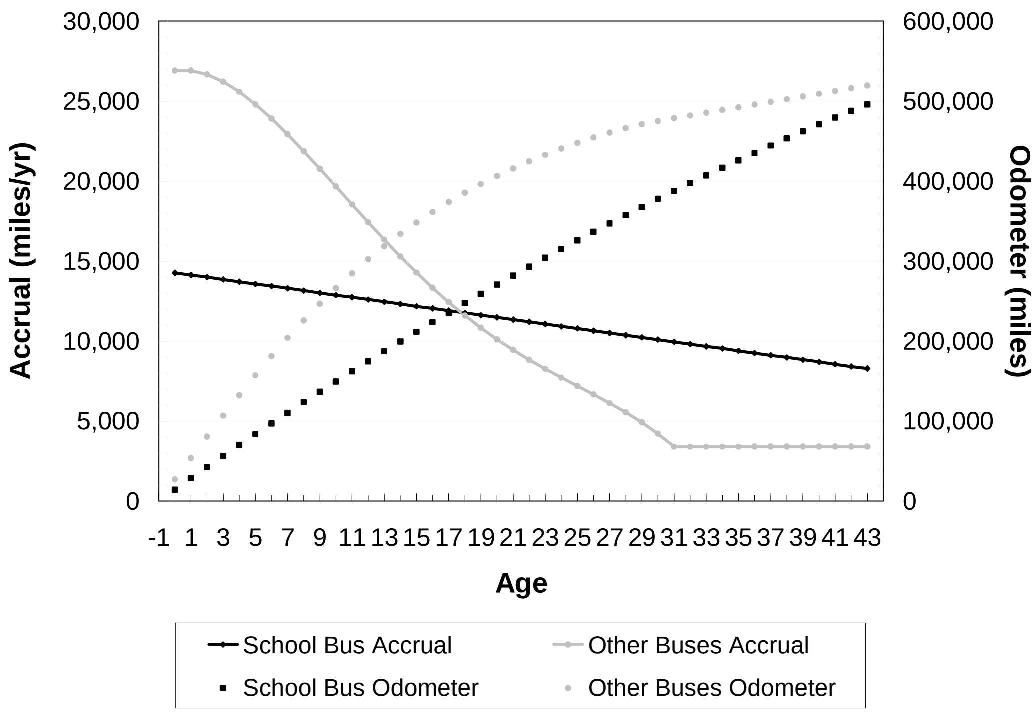
Other buses were assumed to follow the age distribution of such vehicles as modeled in EMFAC2007. The population-weighted average age was estimated to be 12.2 years for school buses and 9.6 years for other buses. We compare the age distribution of school buses and other buses operating in California as modeled for calendar year 2008 in Figure 16.

Figure 16. Bus Population and Model Year Distribution (2008)

b) Base Year Accrual, Lifetime Accrual, and Mileage Thresholds

In the absence of new information, staff used the average annual mileage accrual and odometer estimates assumed for buses in EMFAC2007 to estimate the benefits of the proposed rule. The average odometer reading was estimated to be 173,000 miles for school buses and 222,000 miles for other buses. The average annual mileage accrual was estimated to be approximately 13,000 miles for school buses and 22,000 miles for other buses. All such miles are assumed accrue in California. We show in Figure 17 the average annual mileage accrual and odometer estimates for school buses and other buses in California in calendar year 2008..

Figure 17. Bus Accrual and Modeled Odometer (2008)



c) Base Year Vehicle Miles Traveled by Fleet Size and Mileage Thresholds

Buses were not differentiated by fleet size or mileage threshold in this inventory as buses are not treated differently in the proposed regulation based on these criteria.

8. Power Take Off Operations in California

Power Take Off (PTO) operations are those that result in emissions related to activities other than travel, such as a crane lifting objects or a cement mixer processing raw materials. Emissions associated with these operations are more accurately quantified using fuel consumption than vehicle miles traveled, the usual activity metric for on-road vehicles.

a) Estimating Fuel Usage

Staff did not estimate the actual population or distribution of PTO activity. Instead we used fuel consumption data for PTO operations in California in calendar year 2005 as reported by the California Board of Equalization.

b) Converting Fuel Usage to Activity by Age

The age distribution PTO equipment was assumed to follow the same age distribution as HHDDT single-unit trucks. This distribution was given earlier in Figure 10.

Mileage accrual was not directly estimated for PTO operations since, as mentioned previously, emissions generally occur while the equipment is stationary. Staff used the fuel consumption rate in EMFAC2007 for HHDDT single-unit trucks at twenty miles-per-hour with the fuel consumption estimated by the CA Board of Equalization to back-calculate the VMT-equivalent for PTO activity in California, assuming the speed profile embedded in EMFAC2007.

E. Emission Rates

For most categories, staff have used EMFAC2007 and modeled cumulative mileage to develop category-specific emission rates. We have also updated several estimates of emission rates based upon recent data analysis. In this section we describe the methods used to estimate emission rates. In each case, a reference is provided for more detailed information as to the basis for the emission rates. The specific emission rates assumed for vehicles of each fleet will be provided in a database scheduled to be released in conjunction with the staff report..

1. Updated MHDDT Emissions

In EMFAC2007, staff did not update the emission factors for medium heavy heavy-duty trucks (MHDDT). Subsequent to the release of EMFAC2007, the CRC made emissions test data available for MHDDT available to staff through its E55/59 project final report. This proposed regulation incorporates updated MHDDT emission factors developed by staff using the latest E55/59 study results.

To revise the MHDDT emission factors for this analysis, staff merged the E55/59 data into the data set that was used to develop MHDDT emission factors for EMFAC2002. From this combined data set, staff then recalculated revised zero-mile rates (ZMR) and deterioration rates (DR) for MHDDT.

The method for deriving MHDDT ZMR and DR is the same as that used for calculating emission factors for heavy heavy-duty trucks (HHDDT); the methodology has been described in detail in an EMFAC2007 technical memo (ARB, 2006f).

In Table 16 we provide the zero-mile emission and deterioration rates for medium-heavy duty diesel trucks assumed in EMFAC2007. The deterioration rates are used to model the increase in emissions relative to the zero-mile (or new-vehicle) emission rate due to a vehicle aging and accruing miles. In Table 17 we give the updated emission rates reflecting incorporation of the latest E55/59 data, as discussed previously.

Table 16. EMFAC2007 MHDDT Zero-Mile Emission Rate (ZMR, g/mi) and Deterioration Rate (DR, g/mi/10,000 mi)

MY GROUP	HC		CO		NO_X		PM_{10}	
	ZMR	DR	ZMR	DR	ZMR	DR	ZMR	DR
Pre 1975	0.34	0.011	3.17	0.100	18.50	0.032	1.07	0.016
1975-76	0.34	0.011	3.17	0.100	18.50	0.032	1.07	0.016
1977-79	0.34	0.011	3.17	0.100	18.50	0.032	1.07	0.016
1980-83	0.34	0.011	3.17	0.100	18.50	0.032	1.07	0.016
1984-86	0.33	0.014	2.99	0.131	17.91	0.043	1.00	0.021
1987-90	0.21	0.016	1.80	0.140	15.74	0.034	0.73	0.017
1991-93	0.18	0.018	1.43	0.139	13.11	0.078	0.45	0.022
1994-97	0.11	0.017	0.78	0.121	11.55	0.048	0.27	0.018
1998	0.09	0.014	0.64	0.097	10.52	0.032	0.24	0.012
1999-02	0.09	0.014	0.64	0.097	10.52	0.032	0.24	0.012
2003	0.09	0.007	1.04	0.074	5.79	0.018	0.29	0.009
2004-06	0.09	0.006	1.04	0.074	5.48	0.017	0.29	0.009
2007-09	0.058	0.006	0.666	0.074	3.01	0.017	0.029	0.009
2010+	0.025	0.006	0.291	0.074	0.548	0.017	0.029	0.009

Table 17. Revised MHDDT Zero-Mile Emission Rate (ZMR, g/mi) and Deterioration Rate (DR, g/mi/10,000 mi)

MY GROUP	HC		CO		NO_X		PM_{10}	
	ZMR	DR	ZMR	DR	ZMR	DR	ZMR	DR
Pre 1986	0.83	0.047	2.79	0.159	15.61	0.033	0.97	0.038
1987-90	0.65	0.056	2.19	0.189	15.39	0.044	1.05	0.034
1991-93	0.29	0.025	1.12	0.095	11.51	0.053	0.57	0.026
1994-97	0.21	0.028	0.83	0.109	11.30	0.068	0.31	0.017
1998-02	0.22	0.028	0.84	0.108	11.11	0.078	0.35	0.015
2003-06	0.14	0.013	0.37	0.033	7.35	0.077	0.22	0.008
2007	0.12	0.008	0.31	0.020	4.78	0.065	0.022	0.001
2008	0.12	0.008	0.31	0.020	4.39	0.064	0.022	0.001
2009	0.12	0.008	0.31	0.020	3.78	0.062	0.022	0.001
2010	0.10	0.002	0.26	0.005	1.01	0.054	0.022	0.001
2011	0.10	0.002	0.26	0.005	0.86	0.054	0.022	0.001
2012	0.10	0.002	0.26	0.005	0.67	0.053	0.022	0.001
2013+	0.10	0.002	0.26	0.005	0.67	0.041	0.022	0.001

2. *Revised engine market information*

Staff also updated the emission factors for heavy heavy-duty diesel trucks (HHDDT) and medium heavy-duty diesel trucks (MHDDT) to reflect manufacturers' compliance with the 2007 engine standard and the anticipated compliance with the 2010 engine standard between 2006 and 2011. Staff estimated that the adjustment to 2006-2011 model year emission factors would result in lower NO_x emission rates for 2006 and 2009 model years but higher NO_x emission rates for 2007, 2008, 2010, and 2011 model years than the rates currently assumed in EMFAC2007.

The latest information available to staff indicates that at least one engine manufacturer does not plan to use selective catalyst reduction technology in their 2010-2011 model year heavy-duty diesel engines. In addition, review of the certification data shows that some engine manufacturers introduced 1.2 g/bhp-hr NO_x heavy duty engines one year earlier than required. As a result, staff decided to update the emission factors in EMFAC2007 to reflect the latest information from manufacturers and certification data.

For the earlier introduction of engines meeting 1.2 g/bhp-hr NO_x and 0.01 g/bhp-hr PM standards, the current zero-mile rates (ZMR) and deterioration rates (DR) for 2003-06 and 2007-09 model year groups were weighted by the sales fractions of 2007 standard compliant engines in 2006 model year.

For the introduction of 0.5 g/bhp-hr NOx engines in 2009 model year, staff estimated the ZMR by adjusting the current ZMR for 2006-2009 model year group (1.2 g/bhp-hr NO_x engines) but assumed that the deterioration rate for 2006-09 model year would still apply to the 0.5 g/bhp-hr NO_x engines. The assumption of unchanged DR is largely based on the fact that the engine manufacturers will achieve a 0.5 g/bhp-hr NO_x level with an integrated technology solution based on their 2006-09 model year technologies (advanced fuel system, air management, combustion and electronic controls, and enhanced cooled exhaust gas recirculation).

Staff estimated the 2005-2008 model year sales fractions of heavy and medium heavy-duty diesel engines based on the sales fraction data reported by the manufacturers and projected the 2009-2012 model year sales fractions from the information currently available. We show the ARB-estimated penetration rates for 2005 to 2012 model years in Table 18.

Table 18. ARB Estimated Penetration Rates of 2005-2012 Model Year Engines

Model Year	Certified NO_x (g/bhp-hr)				Certified PM_{10} (g/bhp-hr)	
	2.2	1.2	0.5	0.25/0.2*	0.1	0.01
Heavy Heavy-Duty Diesel						
2005	100%					
2006	99%	1%			98%	2%
2007	14%	86%			1%	99%
2008	7%	93%				100%
2009		90%	10%			100%
2010			10%	90%		100%
2011			10%	95%		100%
2012				100%		100%
Medium Heavy-Duty Diesel						
2005	100%					
2006	100%				98%	2%
2007	23%	77%				100%
2008	12%	88%				100%
2009		90%	10%			100%
2010			10%	90%		100%
2011			10%	90%		100%
2012				100%		100%

* 0.25 g/bhp-hour applies to 2010 model year only.

Using the sales fractions in Table 18, staff calculated the NO_x ZMRs and DRs of both HHDDT and MHDDT for 2006-2011 model years by weighting the ZMRs and DRs of the corresponding model year groups. Staff did not revise the PM emission factors for HHDDT and MHDDT. As can be seen in Table 18, the sales of PM filter-equipped engines in 2006 account for only about 2% for both HHDDT and MHDDT categories; thus the impact of DPF engines on the PM emission rates for the 2006 model year is negligible.

In Table 19 we show the current and revised NO_x ZMR and DR of both HHDDT and MHDDT for 2006 to 2011 model years.

Table 19. NO_x Emission Factors for 2006-2011 MY Heavy-Duty Diesel Trucks (ZMR in g/mi, DR in g/mi/10,000 mi)

Model Year	HHDDT				MHDDT			
	Current		Revised		Current		Revised	
	ZMR	DR	ZMR	DR	ZMR	DR	ZMR	DR
2006	12.54	0.0522	12.48	0.0521	7.35	0.0765	7.35	0.0765
2007	6.84	0.0465	7.66	0.0573	4.01	0.0621	4.78	0.0654
2008			7.25	0.0468			4.39	0.0638
2009			6.44	0.0464			3.78	0.0621
2010	1.14	0.0407	1.72	0.0413	0.669	0.0531	1.01	0.0540
2011			1.46	0.0413			0.859	0.0540

3. Carbon Dioxide (CO_2) Emission Rates

Reducing carbon dioxide (CO_2) emissions is a primary goal of the State of California. CO_2 emissions are generated through the combustion of fuels and in particular by combustion of fuels in trucks and buses that operate in California. CO_2 emissions are a function of engine size, load, speed, miles traveled, and many other factors. This section describes how the staff derived CO_2 emission rates to develop emissions inventories in support of the proposed regulation.

Although EMFAC2007 provides CO_2 emission rates for heavy duty diesel trucks, it assumes them to be constant regardless of model year, technology group, activity and other factors. To develop more finely resolved CO_2 emission rates for trucks, staff used fuel economy data as a surrogate for CO_2 since there is a larger database of fuel economy data available for trucks than CO_2 data. Fuel economy estimates were converted to CO_2 emission rates based on the carbon content of diesel fuel, as discussed in more detail later in this section.

In this analysis we have evaluated available data to determine how improvements in engine technology and increasingly stringent criteria pollutant emission control requirements have affected the fuel economy of HHDDT and, consequently, CO_2 emission rates. Staff has recently reviewed the following data sources to develop model year-specific fuel economy values for HHDDTs operating in California:

- Department of Energy: Calendar Year Fleet Average from 1970-2006 (United States Department of Transportation, 2007)
- CRC E55/59 study by West Virginia University: Model Year 1988-2003
- International Fuel Tax Agreement (IFTA) for trucks operating in California
- Consent Decree, in-use study by West Virginia University: Model Year 1994-2003

We chose to not use the Department of Energy (DOE) fuel economy data directly since those are national data and therefore not representative of the truck fleet or driving conditions found in California. Also, the DOE data do not provide information on how fuel economy and CO_2 emission rates vary as a result of technology. DOE data were used instead as an independent check on our technical analysis.

Our technical analysis shows differences in fuel economy between different technology groups (represented as model year groups), as shown in Table 20. This table provides the estimated HHDDT fuel economy by model year group, as well as the assumptions that are embedded in those estimates.

Table 20. Proposed Fuel Economy Values for HHDDT Operating in California

MY	MPG	Note
Pre-1988	5.20	100% Mechanically controlled engines (100% @ 5.2 mpg)
1988-1990	5.39	25% Phase-in of electronic control (75% @ 5.2 mpg and 25% @ 5.95 mpg)
1991-1993	5.58	50% Phase-in of electronic control (50% @ 5.2 mpg and 50% @ 5.95 mpg)
1994-1995	5.76	75% Phase-in of electronic control (25% @ 5.2 mpg and 75% @ 5.95 mpg)
1996	5.95	100% Phase-in of electronic control (100% @ 5.95 mpg)
1997-1998	5.95	Same Fuel Economy as MY 1996 engines
1999-2002	5.48	Post consent Decree Engines with 8% loss is Fuel Economy (Timing Retarding)
2003-2006	5.75	5% gain in Fuel Economy (Better Combustion Strategies)
2007	5.61	3% loss in Fuel Economy due to EGR + DPF (86% @5.58 mpg; 14% @5.75 mpg)
2008	5.59	3% loss in Fuel Economy due to EGR + DPF (93% @ 5.58 mpg; 7% @ 5.75 mpg)
2009	5.58	3% loss in Fuel Economy due to EGR + DPF (100% @ 5.58 mpg)
2010	5.78	4% gain in Fuel Economy due to SCR (90% @ 5.80 mpg and 10% @ 5.58 mpg)
2011	5.78	4% gain in Fuel Economy due to SCR (90% @ 5.80 mpg and 10% @ 5.58 mpg)
2012	5.80	4% gain in Fuel Economy due to SCR (100% @ 5.80 mpg)

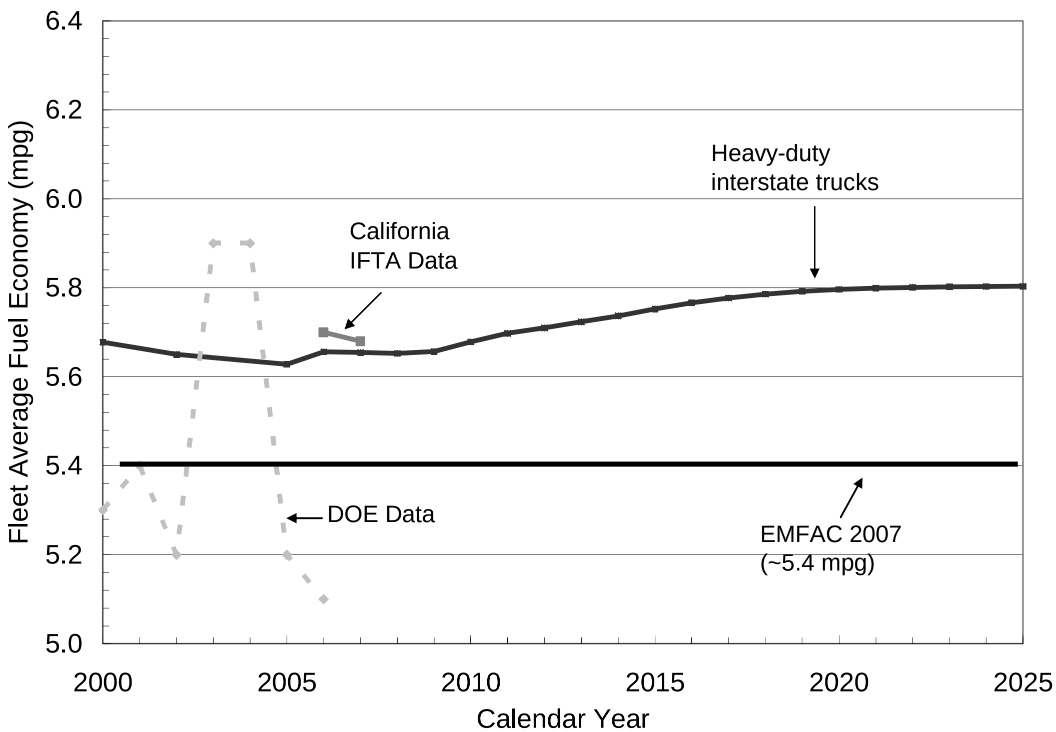
The assumptions described in Table 20 are estimated based on the following assumptions that were derived from analysis of available data:

- Mechanical vs. Electronically Controlled Engines (ECE)
    - 5.95 mpg fuel economy for electronic engines from CRC E55/59 data
    - 0.75 mpg difference in fuel economy between mechanical control and electronic control from CRC E55/59 data
    - Assume all model year mechanical control engines have same fuel economy (5.20 mpg)
    - Phase-in of Electronic Controlled Engines
        - MY 1988 to 1990: 25%
        - MY 1991 to 1993: 50%
        - MY 1994 to 1995: 75%
        - MY 1996: 100%

- Off-Cycle operation in Electronic Controlled Engines
  - MY 1993-1998
  - Higher fuel economy and higher NO_x than mechanical control engines.
  - Model year fuel economy of 5.95 mpg does not reflect chip reflash
  - Adjusted for chip reflash beginning calendar year 2002
- MY 1999-2002:
  - 8% fuel penalty
  - Post-Consent Decree engines with injection timing retarding for NO_x control
- MY 2003-2006:
  - 5% gain in fuel economy
  - Introduction of advanced combustion technologies including exhaust gas recirculation (EGR)
- MY 2007-2009:
  - Introduction of diesel particulate filter (DPF) used for PM control
  - 3% fuel penalty for meeting 2007 emissions standards
  - 86% of engines would meet 2007 emissions standards in CY 2007 (ARB, 2008a)
  - 93% of engines would meet 2007 emissions standards in CY 2008
  - 100% of engines would meet 2007 emissions standards in CY 2009
- MY 2010-2012:
  - Introduction of selective catalytic reduction (SCR) for NO_x control
  - 4% gain in fuel economy for engines equipped with (SCR)
  - 90% of engines would meet 0.2 g/bhp-hr NO_x standards in 2010 and 2011
  - 10% of engines would meet 0.5 g/bhp-hr NO_x standards with fuel economy of 5.58 mpg in 2010 and 2011
  - 100% of engines would meet 0.2 g/bhp-hr NO_x standards in 2012 (ARB, 2008c)

We applied the fuel economy estimates for each model year across each inventory category to develop a composite fuel economy by calendar year. Figure 18 compares fuel economy estimates by calendar year against values derived from DOE, IFTA, and EMFAC2007. This figure shows that HHDDT fuel economy is estimated to improve over time due initially to the introduction of electronically controlled engines and later due to the introduction of SCR-equipped engines. These results compare remarkably well with EMFAC, DOE, and IFTA data. For example, the composite fuel economy reported by all trucks operating in California in the IFTA program is 5.7 miles per gallon, which is equivalent to our estimates for interstate trucks. DOE data appear more variable across calendar years, probably due to varying sample size and representativeness in each year of reported data. Even so, DOE data are within 10% of ARB estimates, and EMFAC2007 is lower than current estimates by only 4 to 7%. In Figure 18 we show HHDDT fuel economy for interstate trucks only. In-state trucks, which are older on average than their interstate counterparts, are estimated to have slightly lower fuel economy (3% to 5%) than interstate trucks.

Figure 18. Fleet Average Fuel Economy for Trucks Operating in California



To convert fuel economy data to CO_2 emission rates, staff used the following methodology:

- estimate the fuel consumption, in gallons, for each truck category based upon the model year fuel economies and model year distribution
- multiply the estimated fuel consumption by the carbon content of diesel fuel (2,778 g carbon/gallon diesel (USEPA (2008)) to estimate the carbon emitted by each truck category
- multiply the estimate of carbon emitted by each category by the ratio between the molecular weight of CO_2 and the molecular weight of carbon (44/12) to estimate the CO_2 emissions from each category if 100% efficient
- assume 99% efficiency, multiplying the CO_2 emitted at 100% efficiency by 0.99, to estimate the final CO_2 emissions estimate for each category.

The application of this process is equivalent to applying an estimate of 22.2 lbs CO_2/gallon diesel fuel (10.08 kg CO_2/gallon diesel fuel) to the estimate of fuel consumed by vehicles in each category.

Fuel economy in MHDDT was assumed to be 33% higher than for HHDDT in the same model year, based on analysis of data described above. CO_2 emission rates for buses were taken directly from EMFAC2007.

4. Final emissions rates

Staff estimated the emission rates for each truck inventory category for two types of activity – vehicles in motion and vehicles idling. We estimated emission rates for vehicles in motion in terms of tons/day for the average vehicle; these are shown in the database provided in conjunction with this appendix. We estimated the emission rates for vehicles while idling in terms of tons/hour; these, too, are shown in the database provided with this appendix.

F. Forecasting the Baseline Inventory

In this section we describe the methods used to estimate the growth of future truck populations and truck VMT in the emissions inventory.

1. Growth

In modeling the emissions for future years, staff needed to estimate the amount of vehicular travel in future years. The emissions are in general proportional to the vehicle miles traveled. The growth rate for VMT is likely to vary between inventory categories; thus we estimated the VMT growth on a category-specific basis.

For utility trucks in this inventory, staff assumed the same growth rate (2.0%) as was assumed in the regulation adopted by the ARB for public and utility fleets (ARB, 2005).

Staff projected the population of drayage trucks to increase at 2.5% per year near the Ports of Los Angeles, Long Beach, and Oakland. We estimated the VMT associated with the drayage trucks at each of these ports/railyards to grow at a slightly faster rate. We estimated the population of drayage trucks at other California ports/railyards to increase at a rate between 1.5% and 1.6% per year, with the VMT also increasing at a slightly faster rate. We estimated future VMT using factors such as projected container traffic and projected vessel traffic that resulted from past data and survey data.

For agricultural trucks, staff assumed a negative growth rate of 0.31% statewide to reflect anticipated ongoing loss of farmland. This growth rate, which actually varies regionally, was developed in 2005 based on analysis of historical farmland acreage trends and with the assistance of agricultural stakeholders. The average annual mileage accrual of each agricultural truck was assumed to remain constant; thus the total annual VMT for agricultural trucks is assumed to decrease proportional to the truck population.

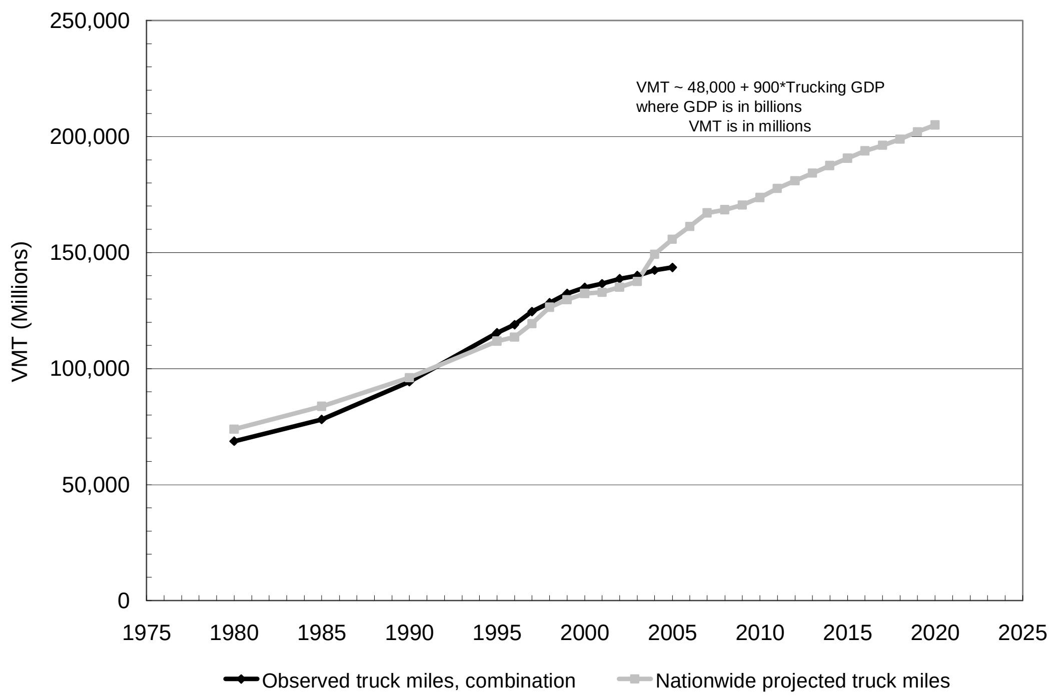
For all other truck types, we projected the VMT to grow at a rate equivalent to the overall VMT growth rate for trucks reported in EMFAC2007 which is 2.66% for heavy-heavy duty trucks and 1.62% for medium-heavy duty trucks. The annual VMT accrual of vehicles in these categories was assumed to remain constant; thus the population of the vehicles, in each category, was assumed to grow in proportion to the VMT. In Table 21 we summarize the annual growth rate estimated for VMT within each truck category.

Table 21. Annual VMT Growth Rates Projected by Category, 2008-2023

Inventory Category	VMT Growth Rate
MH Utility	2.00%
HH Utility	2.00%
HH Drayage near Oakland	5.38%
HH Drayage near LA/LB	4.93%
HH Drayage elsewhere	1.58%
MH Agriculture	-0.31%
HH Agriculture	-0.31%
MH Instate	1.62%
MH CAIRP	1.62%
MH Out of State	1.62%
HH Instate	2.66%
HH Single-unit	2.66%
HH CAIRP	2.66%
HH Non-neighboring Out-of-State	2.66%
HH Neighboring Out-of-State	2.66%
School Bus	-0.50%
Other Bus	3.65%
Power Take Off	2.64%
VMT-weighted Average	2.48%

Staff revisited VMT growth to examine the extent to which more current economic data could result in a revised VMT growth rate, different from that currently assumed in EMFAC2007. Staff regressed national VMT data from the Bureau of Transportation Statistics (BTS) against the US Gross Domestic Product (GDP) for the trucking industry nationwide, which was also released by the BTS. This relationship was then projected with a prediction of the future trucking GDP to estimate the future VMT, again on a federal level. The future nationwide trucking GDP was predicted by extending the relationship regressed earlier between the nationwide trucking GDP and the employment in the transportation sector predicted in the State of California Economic Forecast for the Sacramento Forecast Project. We show the results of this model in Figure 19.

Figure 19. The Historic and Projected Relationship between VMT and GDP on a Nationwide Level



The scale factor between nationwide VMT projected for future years and the nationwide VMT in 2007 was used with the VMT in California in 2007 to project future growth in California VMT. The resulting projections did not differ significantly from those that were estimated in the EMFAC2007 model; thus, staff decided to maintain the growth rates in EMFAC2007 as those for the overall California heavy duty truck fleet.

2. Attrition

For each vehicle category, staff assumed that, outside of regulatory impacts, the age distribution of vehicles within each inventory category would remain constant. Thus, the fraction of a vehicle class represented by vehicles of a certain age would remain constant; for example, the fraction of MY 2000 vehicles in the category in calendar year 2008 was assumed to be equivalent to the fraction of MY 2001 vehicles in the category in calendar year 2009.

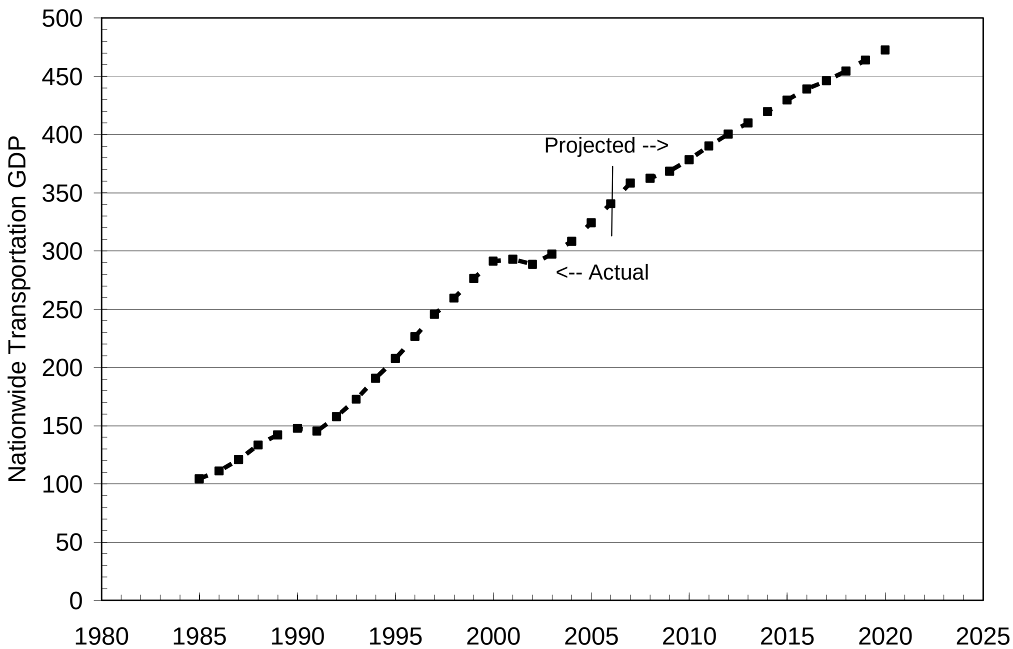
3. Pre-buy

When regulations are approved, past experience has indicated that the impact of these regulations can shift the purchase pattern of truck operators. A technology that is required in one year but not in another year may cause trucks from one year to be more expensive than, and thus preferred to, trucks of another year. A trucking firm might wish to not buy a truck with unproven technology; thus, they may delay their purchase for several years until the technology is more proven or purchase trucks with known technology in the year(s) preceding the regulation. Although our analysis has indicated that the shift in purchasing behavior related to “pre-buy” is less than that from general economic trends, we have attempted to incorporate this behavioral pattern in our assessment of model year distribution for each inventory category.

To approximate the sales of trucks in future years, and thus the impact to the age distribution of trucks, staff first estimated the historic annual nationwide truck sales as a function of the historic nationwide GDP associated with transportation activities. Staff used data regarding nationwide truck sales, as estimated by the website WardsAuto.com for 1985-2007, and GDP, as estimated for transportation services nationwide by the US Department of Commerce’s Bureau of Economic Analysis to establish the historical model of truck sales as a function of time and the nationwide transportation GDP. The approximation of this model indicated that GDP had a stronger positive correlation with truck sales than did time itself; while truck sales had a positive correlation with time itself, the correlation that also existed between GDP and time lessened the positive impact of time when truck sales were regressed against both. The strongest relationship was also found to exist between truck sales in Year y and the GDP from Year $y+1$, the time lag indicating that the trucking industry could foresee the decline in economic activity and deferred the purchase of new trucks before the decline was experienced.

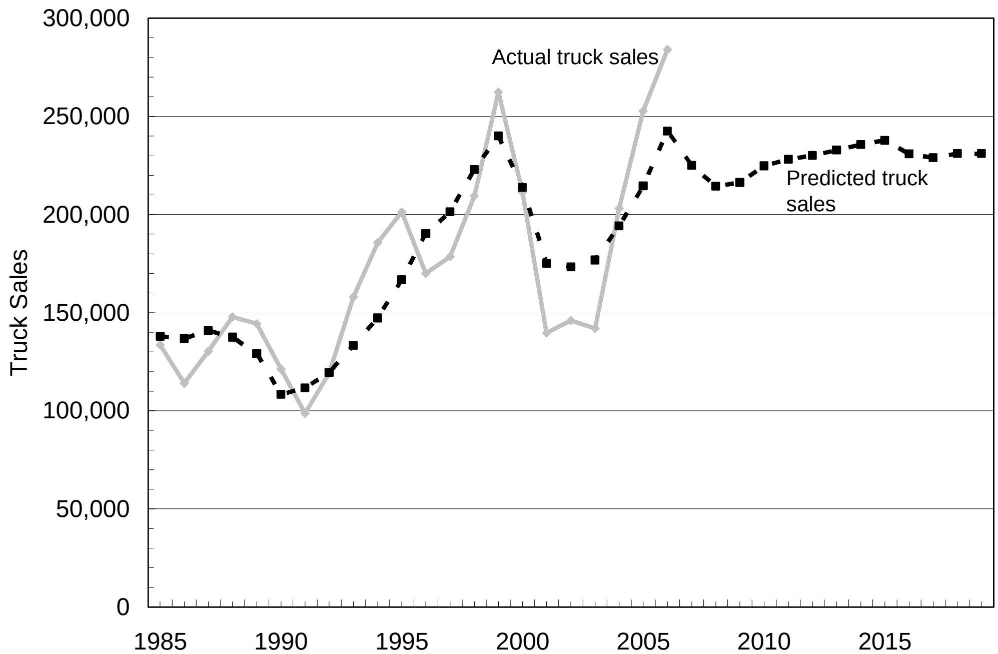
Staff then approximated the historic relationship between the historic nationwide transportation GDP and the historic California transportation employment, as estimated by a UCLA business forecast released in July 2007 (UCLA, 2007). We assumed that the growth rate for transportation employment in California was approximated by the growth rate for nationwide transportation GDP. We used this relationship with the projections to 2020 for California transportation employment from the UCLA forecast to project the nationwide transportation GDP until 2020 as shown in Figure 20.

Figure 20. Nationwide Transportation GDP Trends: Historic and as Projected from Forecast Transportation Employment



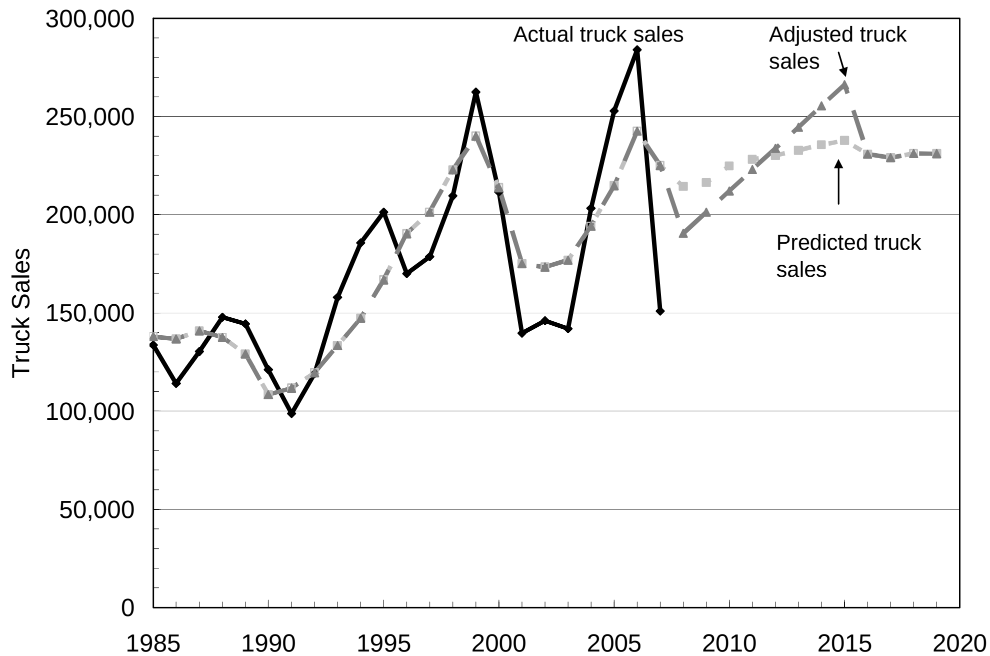
As a first step toward projecting truck sales, staff developed a regression model between nationwide transportation-related GDP and historic truck sales. We then used the estimates of the future transportation–related GDP to estimate future truck sales. In Figure 21 we compare the actual truck sales between 1985 and 2006 with the sales that would have been predicted by the model as well as the truck sales initially predicted from this model beyond 2006.

Figure 21. The Modeled Relationship between Nationwide Transportation GDP and Nationwide Truck Sales



The modeled relationship did not account for what appeared to be extremes. During periods of slow sales, the model underpredicted the decrease in sales; during periods of higher sales, the model underpredicted the increase in sales. To account for this, staff estimated a correction factor by which the 2008 truck sales were lowered. This correction factor, the adjustment made to the estimate resulting from the model, was equivalent in proportion to the difference between earlier estimates and corresponding actual results. Staff then adjusted truck sales between 2008 and 2015 by an amount appropriate to ensure that the aggregate number of trucks sold within this period remained constant. We show the resulting estimate of truck sales, the "adjusted truck sales", in Figure 22.

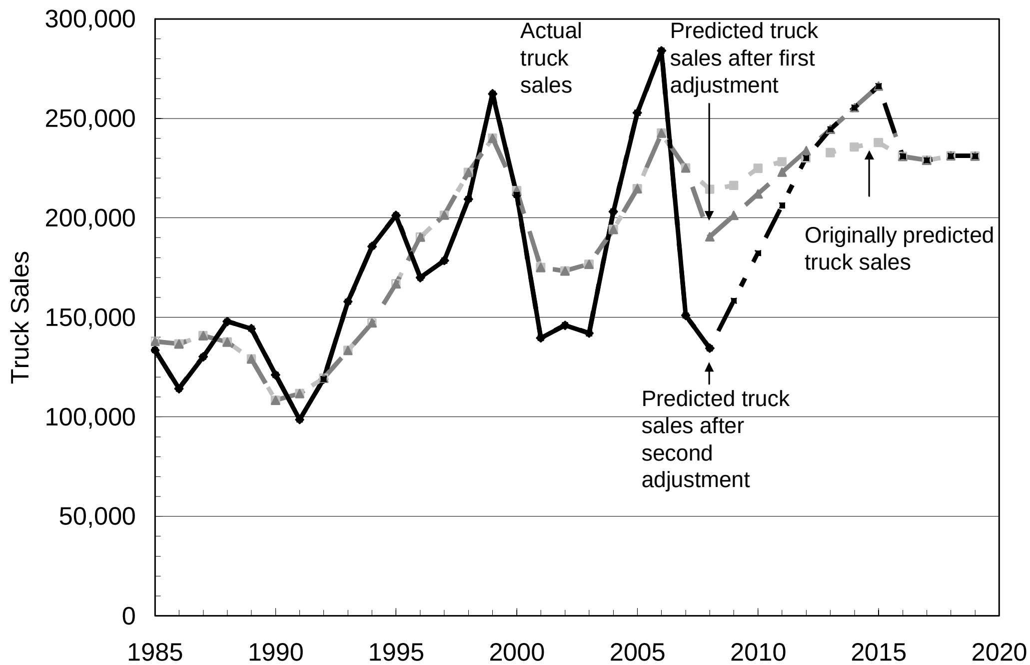
Figure 22. The Modeled Relationship between Nationwide Transportation GDP and Nationwide Truck Sales, Adjusted



Transportation employment within California was already projected to grow at a slightly slower rate after 2015; hence sales for this time period were projected to grow at a slower rate.

Finally, staff received additional data regarding truck sales to date in 2008. These sales were even lower than those projected by the adjusted model. To account for this difference, staff adjusted the model even further, decreasing the sales projected for 2008 and adjusting those in future years to account for the difference – sales in between 2008 and 2011 were adjusted downward, sales after 2011 were unchanged. We show the results of these adjustments in Figure 23.

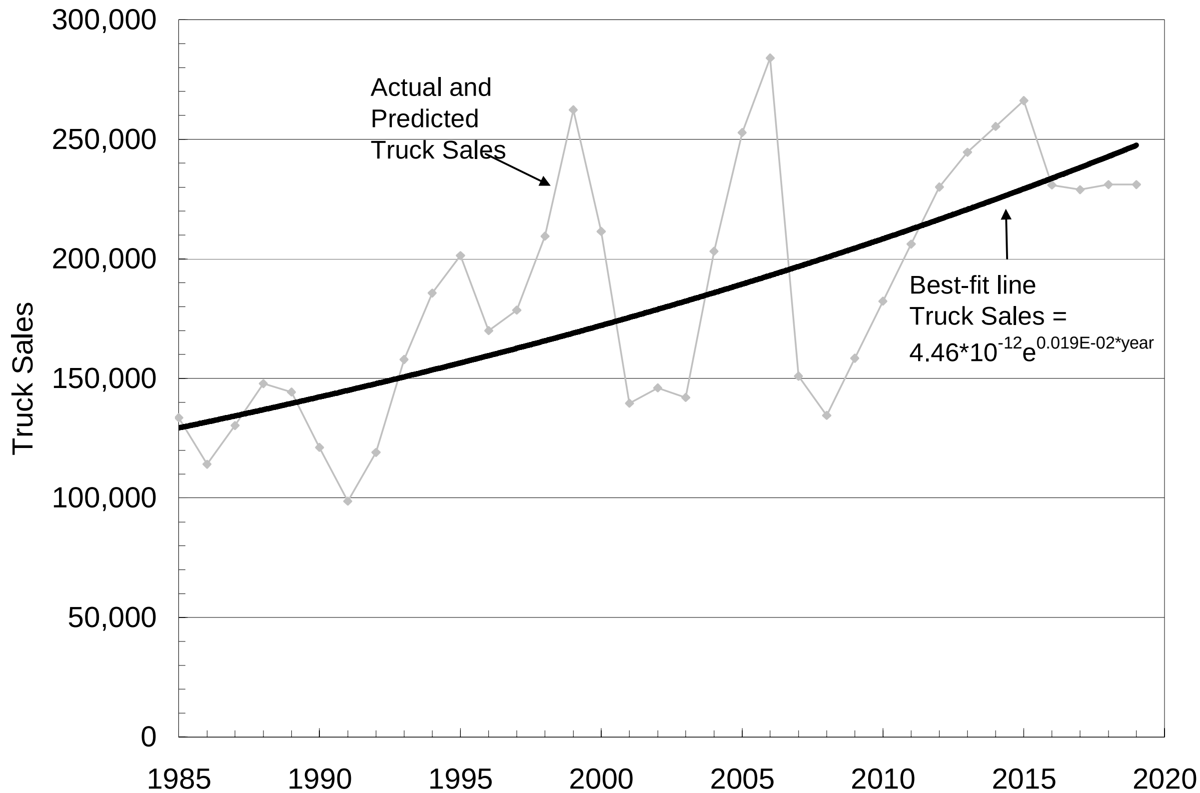
Figure 23. (Estimated) Truck Sales for Future Years



Because no data were available at the time for prediction of GDP past 2020 with the model used in this analysis, we assumed that trucks were sold in the years beyond 2020 at the same ratio as has happened historically.

Finally, to incorporate these estimates in the populations, staff calculated the ratio between sales of trucks in one model year and the expected number of sales if no factor (e.g. GDP) had caused variation. We show the actual sales and the sales predicted from the pre-buy model in Figure 24.

Figure 24. Actual and Predicted Truck Sales



The ratio between the actual/predicted truck sales and the best-fit value (the ratio assumed to be 1.0 for future years beyond 2019) was used to adjust the representation of each model year within future calendar years. (Adjusting the sales upward/downward for new trucks in a calendar year would have the same impact on the representation of trucks of that model year in later calendar years.) The representation of each model year was then scaled as appropriate to allow the cumulative representation of model years to be 100%. This adjustment was not made for the age distribution of drayage trucks, since the age distribution from the ARB drayage regulation was used.

G. Statewide Baseline Activity and Emissions

We discussed the population of each vehicle type earlier in the Base Year Population and Activity section, but we provide a summary table (Table 22) here to describe the emission sources included in this inventory.

Table 22. Population and VMT by Inventory Category

CY	Category	Population	Share of CA Population	CA Share of VMT	Share of VMT in CA
2008	HH Out-of-State	492,340	52.3%	12.1%	28.5%
2008	HH CA-IRP	60,263	6.4%	57.0%	14.6%
2008	HH Tractor	63,684	6.8%	100.0%	18.4%
2008	HH Single Unit	43,275	4.6%	100.0%	6.0%
2008	HH Drayage	21,650	2.3%	100.0%	5.1%
2008	HH Agriculture	11,998	1.3%	100.0%	1.6%
2008	HH Utility	1,357	0.1%	100.0%	0.1%
2008	MH In-State	198,525	21.1%	100.0%	22.5%
2008	MH Interstate	8,896	0.9%	18.7%	0.2%
2008	MH Agriculture	9,438	1.0%	100.0%	0.6%
2008	MH Utility	2,798	0.3%	100.0%	0.1%
2008	Buses	26,443	2.8%	100.0%	2.3%
2008	PTO				

For this table and later analyses, some categories have been combined to allow for simpler evaluation. Specifically, HH Out-of-State trucks include those trucks from neighboring states as well as non-neighboring states. HH Drayage trucks includes all drayage trucks in service in California, including those serving areas around the Ports of Los Angeles, Long Beach, Oakland, and other California ports. MH Interstate trucks include the medium-heavy trucks registered in other states as well as those registered in the CA-IRP program. Buses include those in the “school bus” and “other bus” inventory categories.

The population shown in Table 22 represents the estimated number of trucks and buses operating in California that fall under this proposed rule in calendar year 2008, including vehicles registered in-state and out-of-state. The share of California population represents the percentage of the total truck and bus population represented by each category. The California share of VMT represents the percentage of total annual VMT driven by vehicles in each category that occurs in California; this is assumed to be 100% for the majority of inventory categories but can be small for interstate categories. The share of VMT in California represents the contribution made by each inventory category to the total truck and bus VMT estimated for California.

As shown in Table 22, heavy-heavy duty diesel trucks registered outside California account for the majority of trucks traveling in California. Because these trucks do not travel exclusively in California, however, their portion of VMT in California, at 28.5%, is not as large as their representation among the population (52.3%). In addition, because trucks in this inventory category tend to be newer than trucks in other categories, their emission rates are lower and their contribution relatively less than from their in-state counterparts.

1. Base Year Age Distributions across Inventory Category

In an earlier section, we provided the age distribution of trucks within each inventory category. In Figure 25 we compare the age distributions for the different categories. (Note that trucks from non-neighboring states, because they outnumber trucks from other categories by such a large share, are plotted against the secondary axis.) From this figure one can see from the relative peaks of each age distribution that trucks from non-neighboring states tend to be newer than CA-IRP registered trucks and trucks from neighboring states, which in turn are newer than tractors registered instate. This is logical, in that the trucks traveling the farthest distances to California need to be the most reliable and therefore on average younger. In addition, the trucks representing the CA instate tractor category are frequently those transferred from the out-of-state and IRP categories in their later years. The oldest trucks represent the agriculture category and the drayage category; these trucks tend to travel, on average, the shortest distances. Staff used this age distribution when estimating emissions.

Figure 25. Comparison of Vehicle Age Distributions between Combination Tractors (2008)

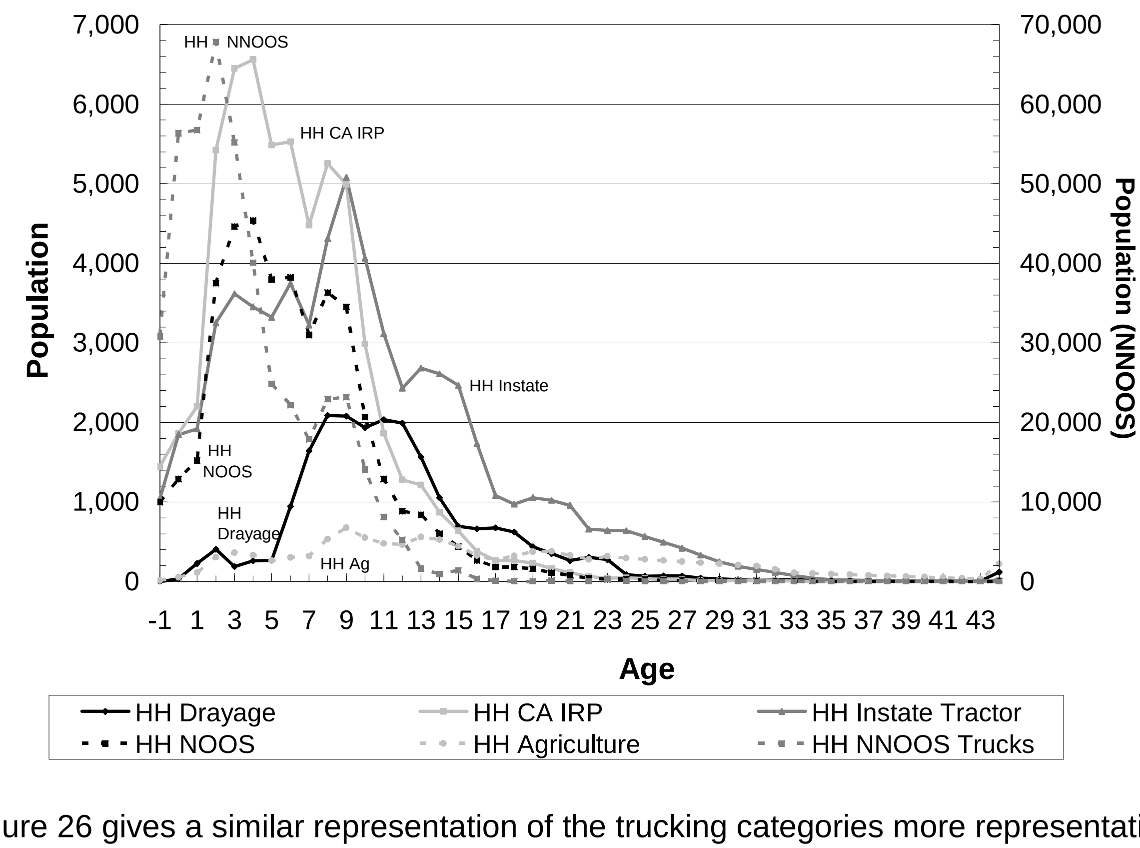
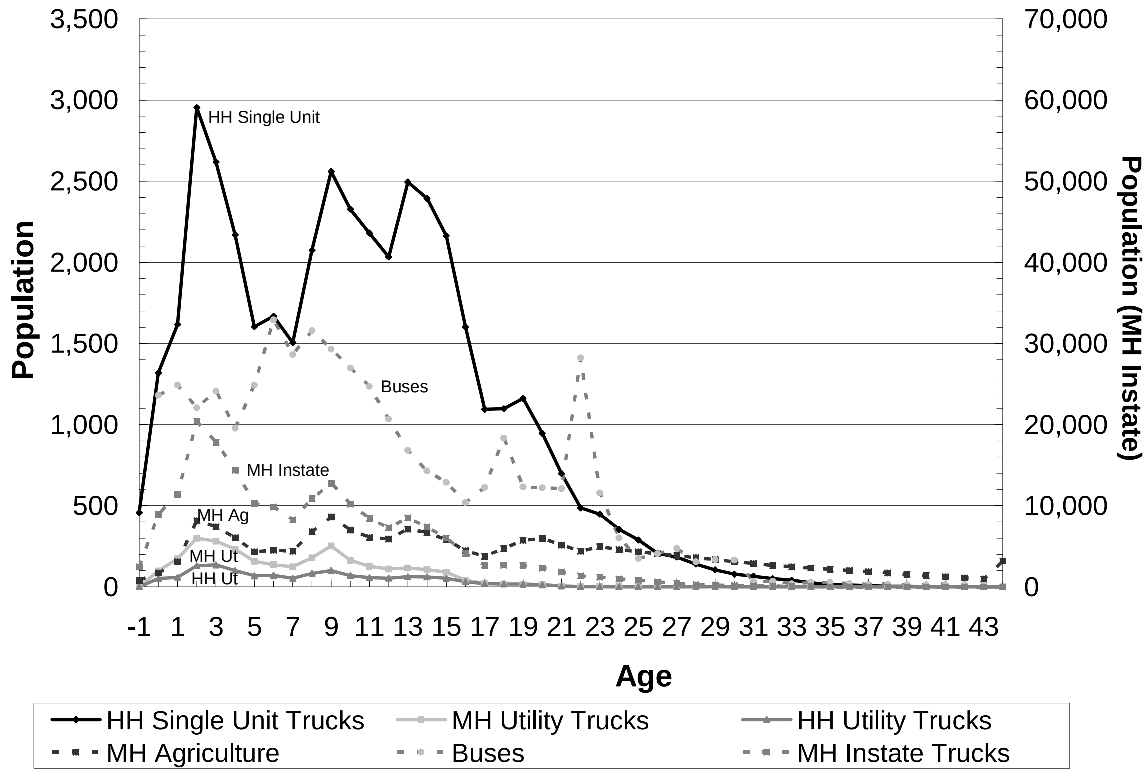


Figure 26 gives a similar representation of the trucking categories more representative of single unit trucks. (In this figure, the MHDDT Instate Trucks are plotted on the secondary axis to allow for better comparison.) As this figure shows, the age distribution for single-unit trucks does not vary so much between categories as the age distribution does for combination trucks. With regard to single-unit categories in particular, medium-heavy instate trucks are relatively newer and medium-heavy agriculture trucks relatively older.

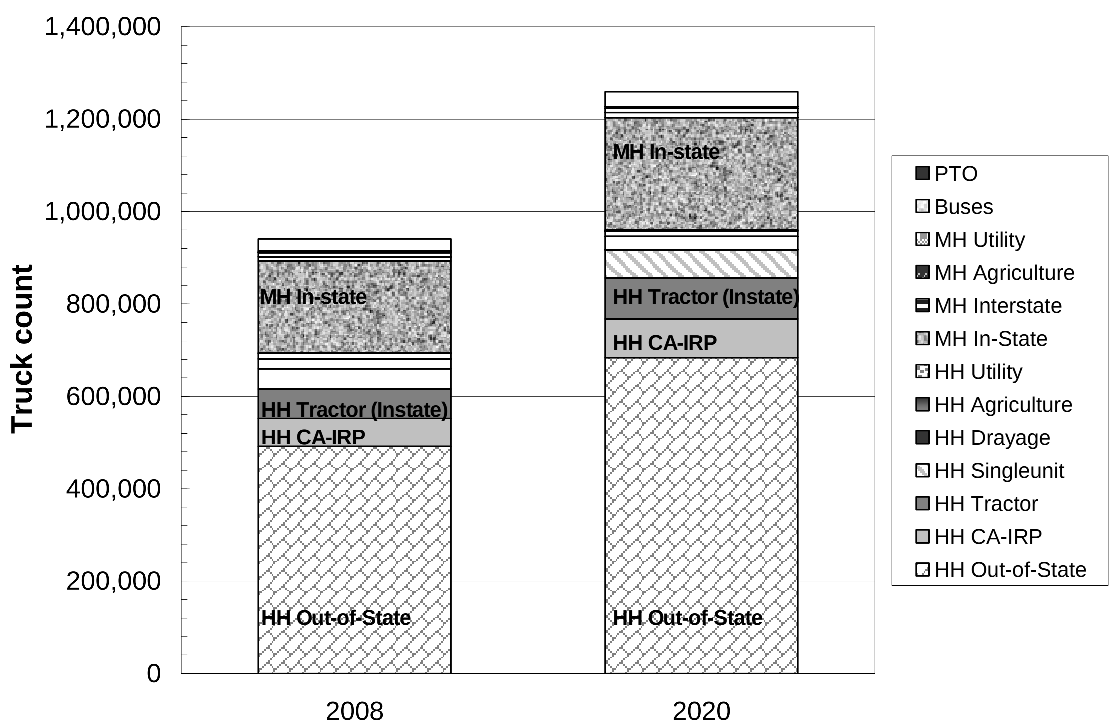
Figure 26. Comparison of Vehicle Age Distributions between Single-Unit Trucks and Buses (2008)



2. Base Year and Forecasted Population by Inventory Category

In Figure 27 we show the distribution of trucks assumed to visit California in 2008 and 2020. In both years the majority of individual trucks represent one of four categories: heavy-heavy trucks registered outside California, California-registered heavy-heavy trucks in the International Registration Program, heavy-heavy tractors registered in California, and medium-heavy trucks registered in California. In a later section we show the distribution of California VMT between the categories; for two primary reasons, the distribution of VMT differs slightly from the distribution of the unique trucks themselves. First, trucks registered outside California do not travel entirely within California. Second, trucks within differing categories typically do not exhibit the same travel patterns with regard to distance.

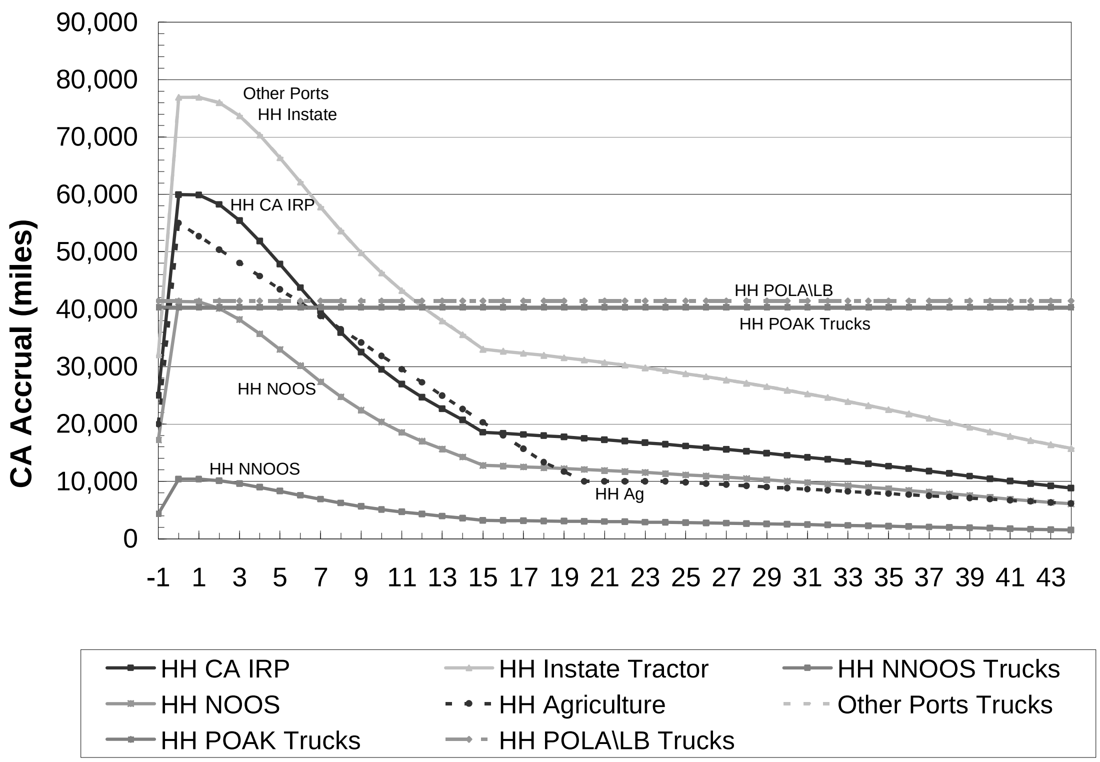
Figure 27. A Comparison of Truck Population by Category (2008 and 2020)



3. Comparing Accrual Rates by Inventory Category

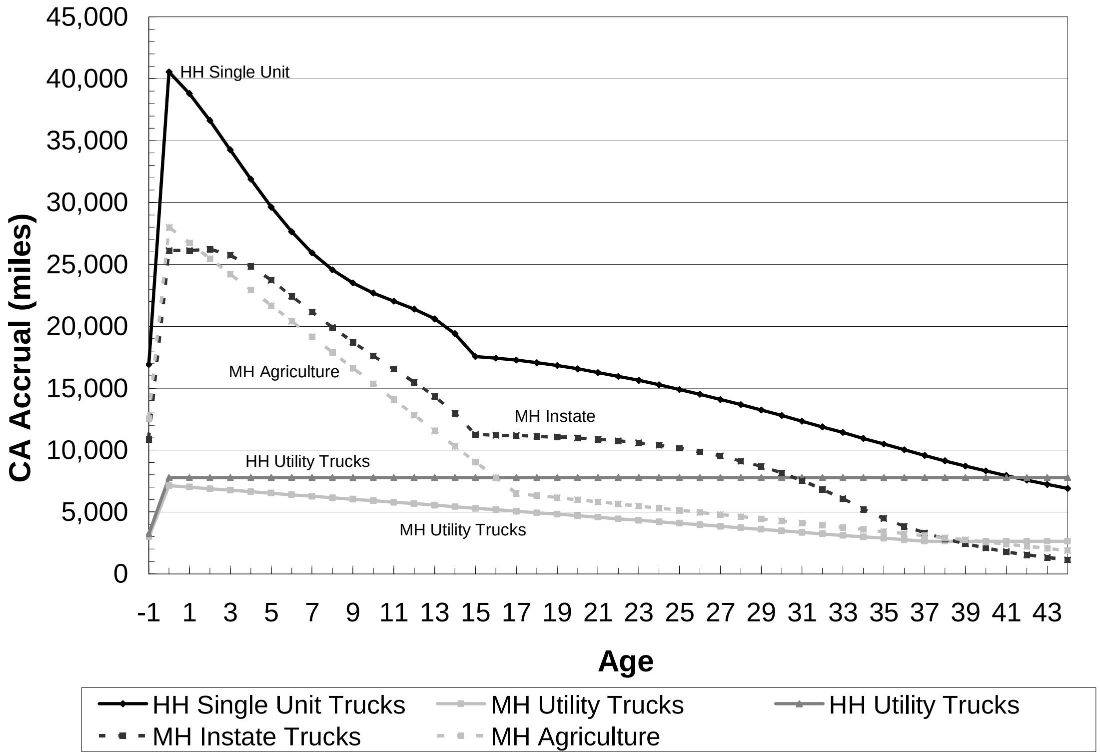
In Figure 28 we show the variation in VMT accrual rates between inventory categories in California. Note that this figure shows only the VMT estimated to be accrued within California's borders and does not include the VMT estimated to be accrued elsewhere. This is particularly relevant in the context of trucks registered in states that do not border California, of which more than 90% of the annual VMT are assumed to be accrued outside California. In the context of virtually all heavy vehicles except drayage trucks, the annual VMT for a vehicle is estimated to decrease with the age of the vehicle; drayage trucks are assumed to maintain a steady amount of usage throughout their lives.

Figure 28. Accrual Rates for Combination Trucks in California (2008)



In Figure 29 we show a similar distribution in accrual rates for single unit trucks. As shown, the average accrual rate is estimated to be highest for single unit trucks. The accrual rate is estimated to decrease with age for single unit trucks as well as medium-heavy instate trucks, buses, and medium-heavy trucks used for agriculture. The accrual rates estimated for heavy-heavy trucks from the utility category, however, start at a lower level and remain more stable throughout their lifetimes.

Figure 29. Accrual Rates for Single Unit Trucks in California (2008)



4. Base Year and Forecasted Vehicle Miles Traveled by Inventory Category

In Figure 30 and Table 23 we show the distribution of VMT driven by trucks in different categories in California between calendar years 2005 and 2025. Figure 30 shows the aggregate VMT for each year; the table lists the daily VMT for each truck category in select years. The five most significant contributors to VMT driven in California in calendar year 2008 are:

- MHDDT CA-registered instate trucks (22.5%)
- HHDDT Non-neighboring out-of-state trucks (21.5%)
- HHDDT CA-registered instate tractor (18.4%)
- HHDDT International Registration Plan, CA-IRP (14.6%)
- HHDDT Neighboring out-of-state trucks (7.0%)

Staff estimated these five categories together represent over 81% of all VMT associated with bus and truck travel in California in 2008. Though not necessarily in the same order, we project these five categories to remain the largest heavy duty truck VMT contributors in 2025, collectively accounting for over 83% of all heavy duty truck VMT driven within California's borders. (The HHDDT from states not neighboring California are projected to represent the single largest share in 2025 at 22.1%.)

Figure 30. California Vehicle Miles Traveled by Truck Category

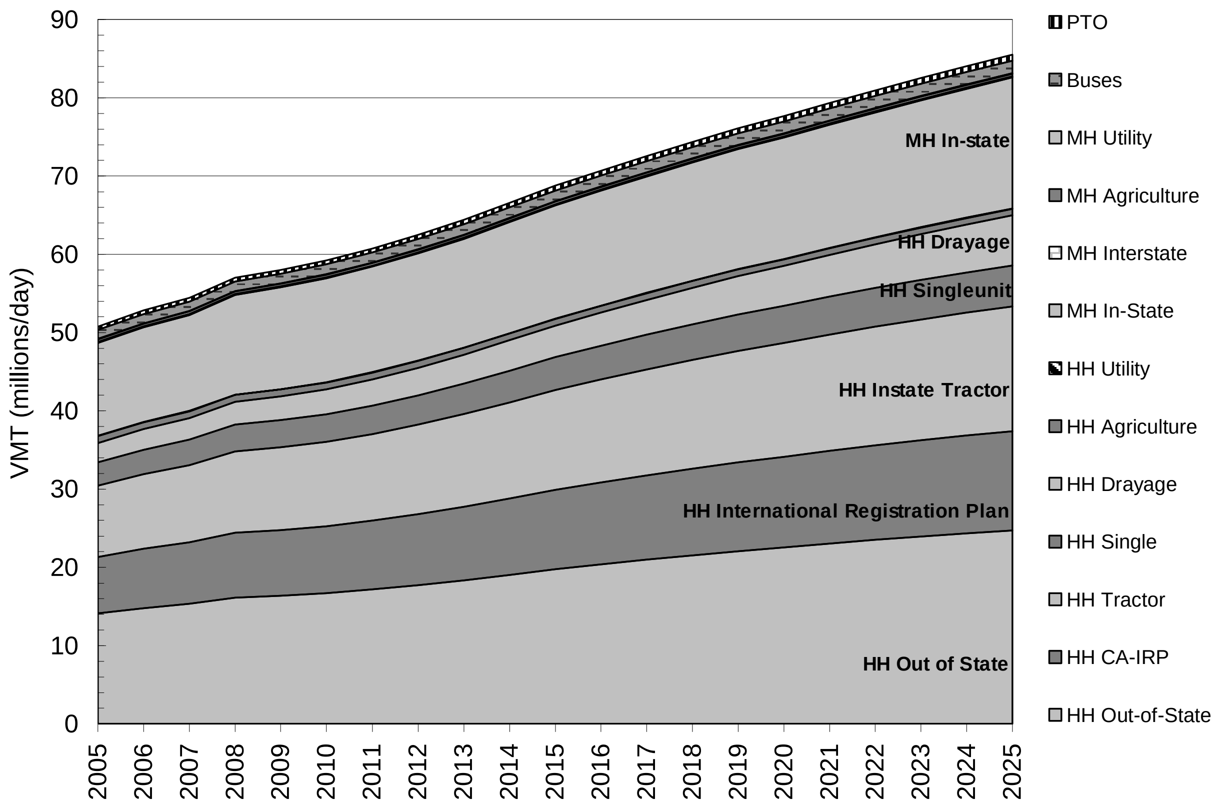


Table 23. Distribution of Estimated Daily VMT in Select Calendar Years

Inventory Category	2000	2005	2010	2015	2020	2025
HH Out-of-State	11,763,164	14,094,931	16,694,413	19,776,058	22,554,003	24,722,681
HH CA-IRP	6,035,750	7,232,194	8,566,004	10,147,215	11,572,595	12,685,357
HH Tractor	7,588,662	9,092,933	10,769,913	12,757,947	14,550,057	15,949,116
HH Single	2,485,547	2,978,247	3,527,515	4,178,664	4,765,642	5,223,882
HH Drayage	1,992,437	2,501,164	3,177,789	4,017,716	5,063,470	6,407,181
HH Agriculture	900,850	886,807	872,982	859,373	845,976	832,788
HH Utility	28,849	31,852	35,167	38,827	42,868	47,330
MH In-State	10,188,740	11,871,644	13,287,487	14,478,516	15,531,621	16,717,215
MH Interstate	94,153	109,705	122,789	133,795	143,526	154,482
MH Agriculture	351,375	345,897	340,505	335,197	329,972	324,828
MH Utility	47,746	52,716	58,203	64,260	70,949	78,333
Buses	890,204	1,125,836	1,259,711	1,371,993	1,500,120	1,617,738
PTO	358,622	429,614	509,088	601,588	685,075	751,094
Total	42,726,100	50,753,540	59,221,565	68,761,149	77,655,874	85,512,024

In Figure 31 we show the percentage of VMT associated with each category between 2005 and 2025. As the figure shows, the share of VMT represented by drayage traffic is expected to grow at the expense of other categories (e.g. MHDDT instate) due to the relatively higher growth in goods movement related truck categories.

Figure 31. Share of California Vehicle Miles Traveled by Truck Category

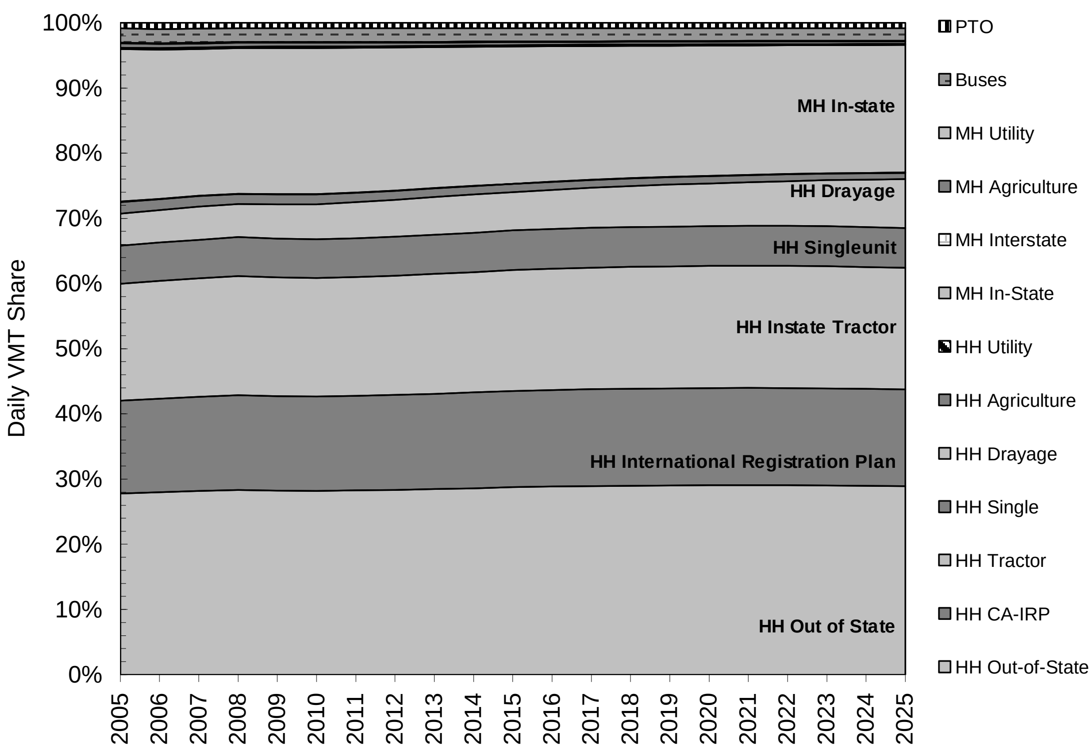


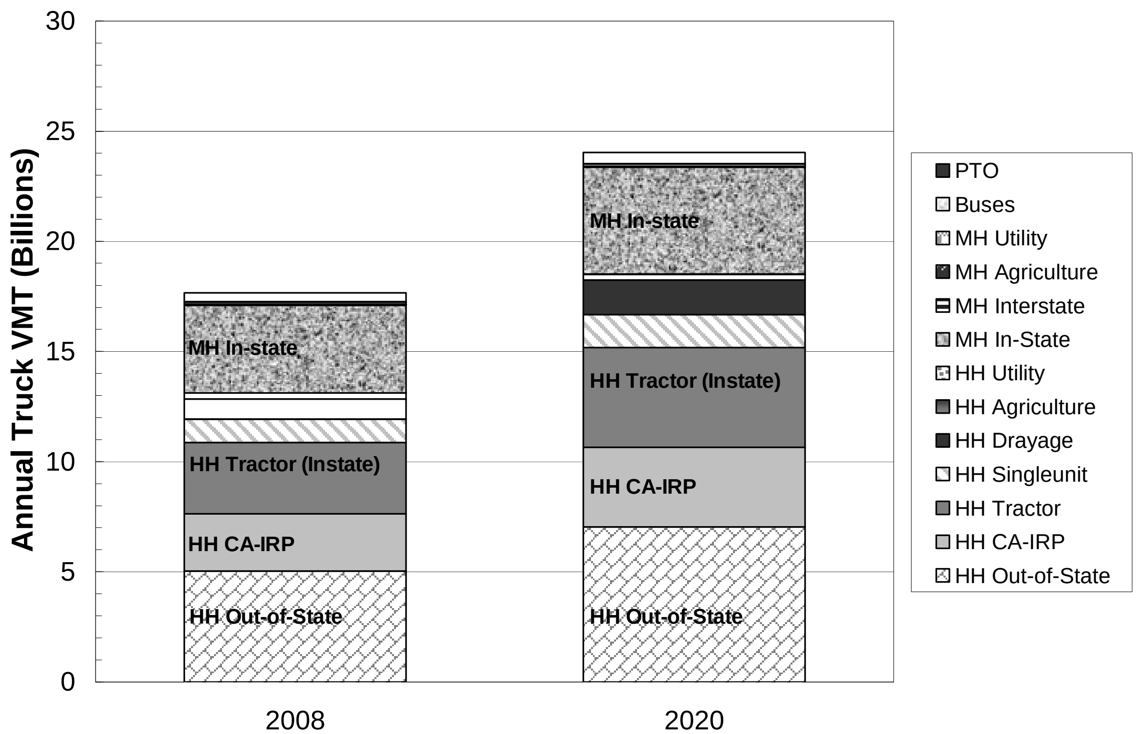
Table 24 provides the estimated population, average age, average odometer reading, and total VMT for each category of heavy duty truck in calendar year 2008.

Table 24. Assumptions made regarding truck categories in calculations.

CY	Inventory Category	Population	Average Age	Average Odometer	Total Accrual
2008	HH Out-of-State	492,340	3.8	489,526	41,666,633,775
2008	HH CA-IRP	60,263	6.2	668,314	4,535,889,834
2008	HH Tractor	63,684	9.9	722,999	3,249,093,053
2008	HH Single unit	43,275	10.3	338,253	1,064,186,055
2008	HH Drayage	21,650	11.8	839,789	904,462,366
2008	HH Agriculture	11,998	17.0	601,454	273,775,114
2008	HH Utility	1,357	8.2	74,611	10,545,996
2008	MH In-State	198,525	8.0	206,852	3,972,137,620
2008	MH Interstate	8,896	5.4	161,306	196,581,895
2008	MH Agriculture	9,438	17.3	293,027	106,907,874
2008	MH Utility	2,798	7.2	56,377	17,455,166
2008	Buses	26,443	11.2	191,829	406,667,394
2008	PTO				

In Figure 32 we show the distribution of annual truck VMT graphically. Four categories again represent the majority of truck VMT: heavy-heavy tractors registered outside California, heavy-heavy tractors registered in the International Registration Program, heavy-heavy tractors registered in California, and medium-heavy trucks registered in California.

Figure 32. A Comparison of Annual Truck VMT by Category (2008 and 2020)



5. Statewide Baseline Emissions Estimates

a) Baseline Emissions

Prior to implementation of the proposed regulation, approximately 941,000 trucks and buses were operating in California in calendar year 2008 and are estimated to contribute 859.3 tons per day NO_x, 33.1 tons per day $PM_{2.5}$, and 108,429 tons per day CO_2. We show these data in Table 25.

Table 25. Statewide Emissions (2008)

CY	Category	Truck Population	Truck CA VMT/day	NO_x (tons/day)	$PM_{2.5}$ (tons/day)	CO_2 (tons/day)
2008	All	940,667	57,009,437	859.3	33.1	108,429

b) Baseline Emissions by Inventory Category

We provide in Table 26 the baseline heavy duty truck and bus emissions inventory for the entire state of California in 2008, broken down by inventory category.

Table 26. Statewide Emissions by Inventory Category (2008)

CY	Inventory Category	Truck Population	Truck CA VMT/day	NO_x (tons/day)	$PM_{2.5}$ (tons/day)	CO_2 (tons/day)
2008	HH Out-of-State	492,340	16,142,326	221.9	8.0	32,766
2008	HH CA-IRP	60,263	8,282,725	139.6	5.2	16,783
2008	HH Tractor	63,684	10,413,751	194.1	7.9	20,897
2008	HH Single-unit	43,275	3,410,860	57.8	1.9	6,876
2008	HH Drayage	21,650	2,898,907	70.0	3.2	6,006
2008	HH Agriculture	11,998	878,486	17.3	0.7	1,788
2008	HH Utility	1,357	33,801	1	0	79
2008	MH In-State	198,525	12,731,247	125.0	4.6	19,067
2008	MH Interstate	8,896	117,648	1.0	0.0	176
2008	MH Agriculture	9,438	342,652	4.0	0.2	521
2008	MH Utility	2,798	55,942	1	0	85
2008	Buses	26,443	1,208,769	15.0	0.4	2,036
2008	PTO	0	492,322	12.2	0.8	1,349
2008	All	940,667	57,009,437	859.3	33.1	108,429

c) Baseline Emissions by Fleet Size

The baseline heavy duty truck emissions inventory for the entire state of California, broken down by inventory category, fleet size, and mileage threshold, is shown in Table 27.

Table 27. Baseline Emissions by Inventory Category and Fleet Size (2008)

Inventory Category	Fleet Size	Truck Population	Truck CA VMT/day	NO_x (tons/day)	$PM_{2.5}$ (tons/day)	CO_2 (tons/day)
HH Out of State	1 truck/above 7500 miles	12,011	694,474	10.92	0.40	1,411.3
	1 truck/below 7500 miles	432	1,337	0.04	0.00	4.2
	2 truck/above 7500 miles	3,695	214,735	3.38	0.12	436.4
	2 truck/below 7500 miles	133	414	0.01	0.00	1.3
	3 truck/above 7500 miles	2,652	155,555	2.45	0.09	316.1
	3 truck/below 7500 miles	96	301	0.01	0.00	1.0
	4+ truck/above 7500 miles	460,630	15,056,647	204.54	7.36	30,535.2
	4+ truck/below 7500 miles	12,690	18,863	0.56	0.02	60.5
HH CAIRP	1 truck/above 7500 miles	15,980	2,198,998	41.85	1.49	4,470.2
	1 truck/below 7500 miles	883	5,804	0.17	0.01	17.0
	2 truck/above 7500 miles	5,850	812,823	15.01	0.54	1,649.9
	2 truck/below 7500 miles	318	2,096	0.06	0.00	6.1
	3 truck/above 7500 miles	3,297	460,037	8.28	0.31	933.0
	3 truck/below 7500 miles	183	1,223	0.04	0.00	3.6
	4+ truck/above 7500 miles	32,273	4,791,942	73.95	2.83	9,674.7
	4+ truck/below 7500 miles	1,479	9,801	0.28	0.01	28.7
HH Tractor	1 truck/above 7500 miles	16,792	3,031,868	65.83	2.71	6,110.9
	1 truck/below 7500 miles	4,089	44,925	1.16	0.07	99.4
	2 truck/above 7500 miles	4,928	902,069	18.70	0.80	1,815.4
	2 truck/below 7500 miles	1,189	12,992	0.33	0.02	28.8

Inventory Category	Fleet Size	Truck Population	Truck CA VMT/day	NO_x (tons/day)	$PM_{2.5}$ (tons/day)	CO_2 (tons/day)
	3 truck/above 7500 miles	2,876	529,836	10.87	0.46	1,066.2
	3 truck/below 7500 miles	673	7,370	0.19	0.01	16.3
	4+ truck/above 7500 miles	28,859	5,835,899	95.82	3.82	11,652.5
	4+ truck/below 7500 miles	4,278	48,792	1.20	0.07	107.2
HH Single Unit	1 truck/above 7500 miles	7,819	766,081	14.15	0.49	1,545.2
	1 truck/below 7500 miles	3,358	37,585	0.88	0.04	82.8
	2 truck/above 7500 miles	2,826	279,769	5.01	0.18	563.7
	2 truck/below 7500 miles	1,171	13,153	0.31	0.01	29.0
	3 truck/above 7500 miles	1,857	185,491	3.26	0.11	373.0
	3 truck/below 7500 miles	703	7,951	0.18	0.01	17.4
	4+ truck/above 7500 miles	20,001	2,057,340	32.54	1.03	4,125.9
	4+ truck/below 7500 miles	5,540	63,491	1.44	0.06	138.9
HH Drayage	1 truck	11,633	1,557,622	37.64	1.69	3,227.1
	2 truck	1,293	173,069	4.18	0.19	358.6
	3 truck	1,454	194,703	4.70	0.21	403.4
	4+ truck	7,270	973,513	23.52	1.06	2,017.0
HH Agriculture	Ag non specialty higher VMT	4,098	645,375	12.41	0.49	1,301.8
	Ag non specialty lower VMT	5,258	82,489	1.89	0.10	178.5
	Ag non specialty midrange VMT	1,442	62,773	1.27	0.06	128.9
	Ag specialty vehicle	1,200	87,849	1.73	0.07	178.8
HH Utility		1,357	33,801	0.74	0.01	79.3
MH instate	1 truck/above 5000 miles	51,066	3,786,410	39.01	1.48	5,672.2
	1 truck/below 5000 miles	11,592	80,942	1.20	0.06	127.6
	2 truck/above 5000 miles	16,710	1,244,223	12.65	0.47	1,862.8
	2 truck/below 5000 miles	3,621	25,478	0.37	0.02	40.1
	3 truck/above 5000 miles	9,964	740,914	7.59	0.28	1,109.6
	3 truck/below 5000 miles	2,143	15,111	0.22	0.01	23.8
	4+ truck/above 5000 miles	88,520	6,731,027	62.45	2.24	10,063.3
	4+ truck/below 5000 miles	14,908	107,142	1.50	0.07	167.8
MH Interstate	1 truck/above 5000 miles	1,014	15,237	0.13	0.00	22.7
	1 truck/below 5000 miles	107	149	0.00	0.00	0.2
	2 truck/above 5000 miles	638	9,468	0.08	0.00	14.1
	2 truck/below 5000 miles	70	97	0.00	0.00	0.2
	3 truck/above 5000 miles	638	9,351	0.08	0.00	14.0
	3 truck/below 5000 miles	77	106	0.00	0.00	0.2
	4+ truck/above 5000 miles	5,648	82,272	0.70	0.02	122.7
	4+ truck/below 5000 miles	703	969	0.01	0.00	1.5
MH Agriculture	Ag non specialty higher VMT	1,750	183,598	2.04	0.09	277.0
	Ag non specialty lower VMT	4,799	46,021	0.66	0.04	72.6
	Ag non specialty midrange VMT	1,946	78,768	0.89	0.04	119.5
	Ag specialty vehicle	944	34,265	0.40	0.02	52.1
MH Utility		2,798	55,942	0.54	0.01	85.4
Buses		26,443	1,208,769	15.04	0.44	2,035.8
PTO			492,322	12.19	0.83	1,348.7
All		940,667	57,009,437	859.28	33.07	108,429.2

We show in Table 28 the baseline emissions inventory for the entire state of California, broken down only by fleet size and annual mileage thresholds.

Table 28. Baseline Emissions by Fleet Size and Mileage Threshold (2008)

CY	Fleet Size	Truck Population	Truck CA VMT/day	NO_x (tons/day)	$PM_{2.5}$ (tons/day)	CO_2 (tons/day)
2008	1 truck/above threshold	116,314	12,050,689	209.5	8.26	22,460
2008	1 truck/below threshold	20,462	170,742	3.4	0.17	331
2008	2 truck/above threshold	35,941	3,636,157	59.0	2.30	6,701
2008	2 truck/below threshold	6,502	54,229	1.1	0.05	105
2008	3 truck/above threshold	22,739	2,275,887	37.2	1.46	4,215
2008	3 truck/below threshold	3,876	32,062	0.6	0.03	62
2008	4+ truck/above threshold	643,202	35,528,640	493.5	18.36	68,191
2008	4+ truck/below threshold	39,598	249,058	5.0	0.22	505
2008	Ag non specialty higher VMT	5,848	828,973	14.5	0.58	1,579
2008	Ag non specialty lower VMT	10,057	128,510	2.6	0.14	251
2008	Ag non specialty midrange VMT	3,388	141,541	2.2	0.10	248
2008	Ag specialty vehicle	2,144	122,114	2.1	0.09	231
2008	Unspecified	30,597	1,790,835	28.5	1.29	3,549
2008	All	940,667	57,009,437	859.3	33.07	108,429

We show the emissions as estimated with the baseline scenario for each category of pollutant in the following figures: NO_x in Figure 33, $PM_{2.5}$ in Figure 34, and CO_2 in Figure 35. As shown, the statewide emissions for NO_x and $PM_{2.5}$ are expected to decrease in the absence of regulation, due to the natural replacement of older trucks with newer, cleaner trucks. Baseline CO_2 emissions, however, are projected to increase since improvements in fuel economy are not expected to keep pace with increased heavy duty truck VMT. ARB is proposing to improve fuel economy and reduce CO_2 emissions from heavy duty trucks in future years through other programs and technologies, including increased usage of aerodynamic fairings and tires of lower rolling resistance.

Figure 33. California Statewide NO_x emissions from Trucks, Baseline 2008 - 2023

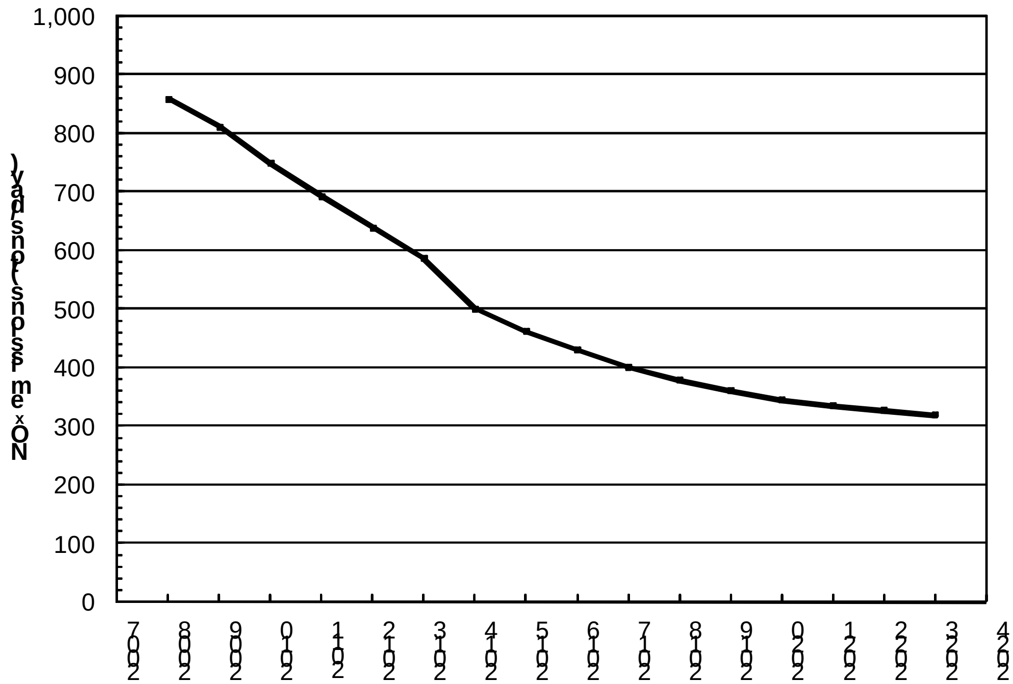


Figure 34. California Statewide $PM_{2.5}$ Emissions from Trucks, 2008-2023

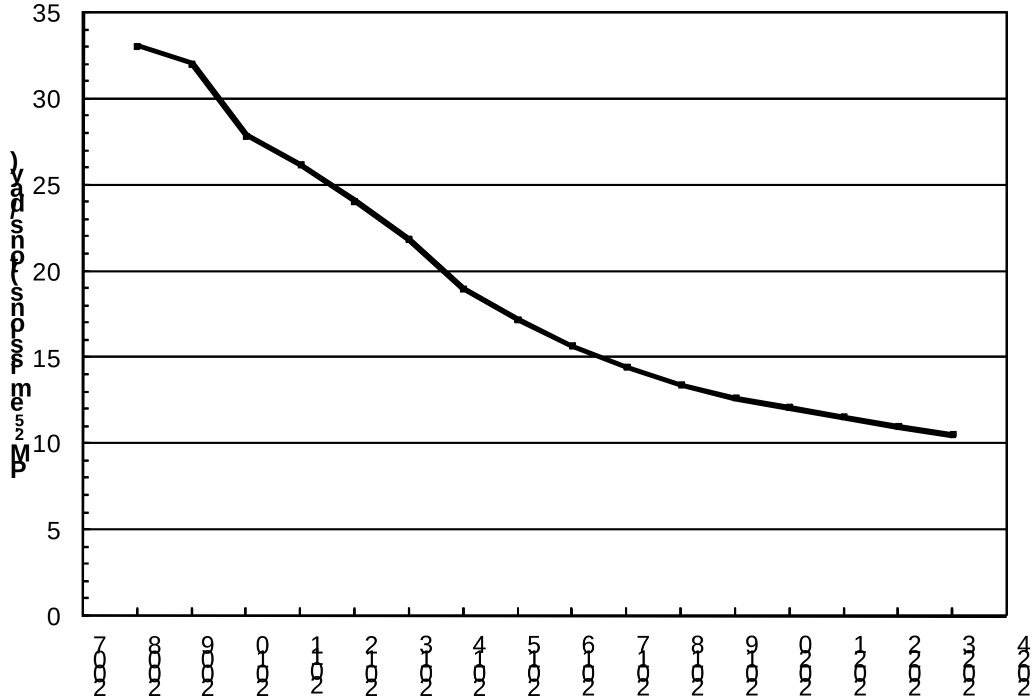
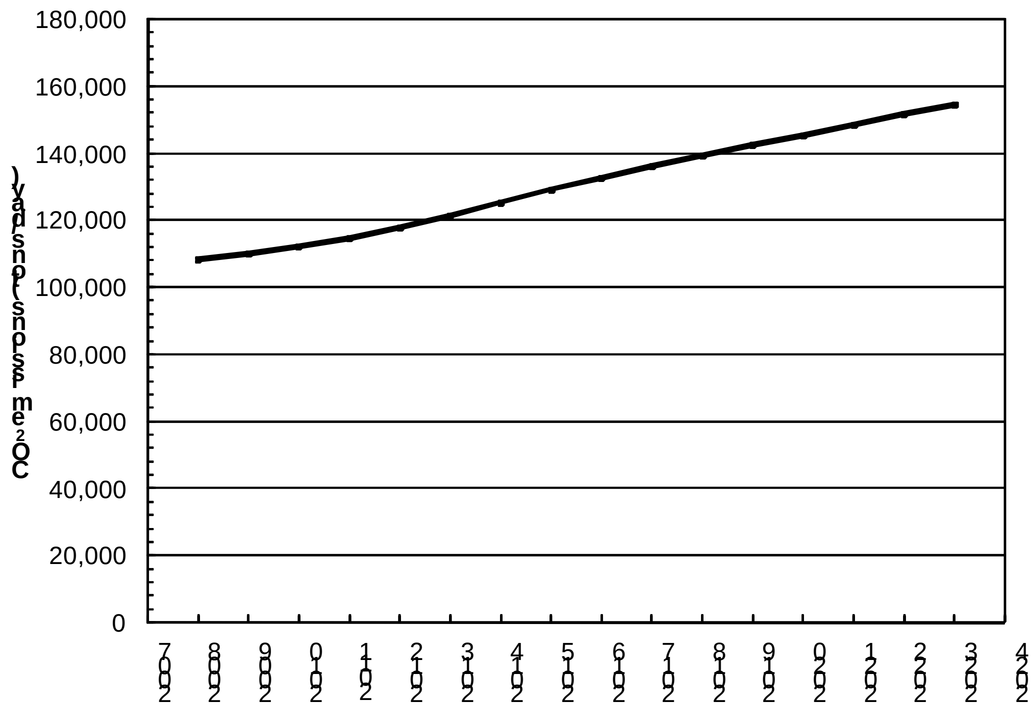


Figure 35. California Statewide CO_2 Emissions from Trucks, Baseline 2008-2023



H. Statewide Truck and Bus Regulation Benefits

The proposed Statewide Truck and Bus Regulation would initially require older vehicles to install diesel particulate filters. Several years later, the regulation would require operators to either purchase a newer compliant vehicle to replace an older non-compliant vehicle or retrofit the older non-compliant vehicle with emissions controls that would enable each vehicle to comply with regulatory emission standards. Under the proposed regulation, a fleet operator may choose among multiple compliance options on a per-pollutant and per-calendar year basis. Options include: (1) best available control technology (BACT) schedule; (2) fleet average requirements; (3) percent limit requirements; (4) low mileage thresholds with alternative compliance schedules; (5) small fleet compliance options; (6) regional compliance options; and (7) other special provisions.

To estimate the emissions benefits generated by the proposed regulation, one must understand how individual fleet operators may choose to comply with the regulation. Each operator's response may ultimately depend on the age, body type, and other characteristics of vehicles in each fleet and the relationship between vehicles in each fleet to the inventory categories. One of the ways we assess potential compliance patterns is by evaluating previous vehicle buying patterns by fleets based on survey data collected by staff. We input this information to the cost-model developed to assess capital costs under the baseline scenario and the scenario with regulation. We based the cost and economic model, described in greater detail in the *Appendix on Cost and Economic Analysis Methodology* upon survey data representing 6,700 vehicles from 688 individual company fleets.

Another way we can assess potential compliance patterns is by evaluating the base year age distribution in the inventory by category. As discussed above, the age distribution of non-neighboring out-of-state trucks suggests that trucks engaged in the longest hauls tend to be purchased new. After several years in long-haul operation, trucks tend to be sold to regional fleets, and a few years after that to local fleets. This type of purchase behavior may not be entirely true of all fleets or trucks within an inventory category, but it likely is representative of the majority. In addition to evaluating the age distribution for each inventory category, we also evaluated age distributions for each fleet size and mileage threshold group within each inventory category.

Our benefit calculations are also fundamentally based on the idea that newer vehicles drive more than older vehicles, but that the regulation will not affect the number of vehicle miles traveled within California. As a result, as new vehicles are purchased due to regulatory requirements, we redistribute VMT across age distributions by inventory category to ensure VMT is conserved, and to ensure that newer vehicles continue to be driven more than older vehicles.

1. Methodology to Assess Statewide Benefits

To calculate emission benefits, we used a methodology that separated vehicles into five groups: (a) high mileage large fleets, (b) high mileage small fleets, (c) low mileage vehicles in large or small fleets, (d) agricultural trucks, and (e) buses. For each group we developed a compliance schedule based upon our best estimate of anticipated purchase decisions. Our compliance schedules developed for each inventory category and compliance group assumed that larger, newer fleets will comply with the regulation by purchasing new or near-new vehicles and that where possible fleets will choose to avoid installing retrofits (especially on mechanically controlled engines that are more costly to control) – instead opting to purchase 2007 standard compliant trucks.

a) High Mileage Trucks in Fleets of Four or Greater

Large, high-mileage truck fleets are well-represented in the cost model. The cost model uses previous purchase behavior to predict future purchases for regulatory compliance by fleet, based on the compliance schedules available to these fleets. We assigned an inventory category to each truck in each fleet so that model results could be summarized into four general categories: in-state heavy-heavy tractors, in-state heavy-heavy single-unit trucks, medium heavy duty trucks, and heavy-heavy interstate trucks. We then compiled and analyzed model results to develop a compliance schedule for the four categories.

We show those compliance schedules in Table 29. As shown in the table, we assume large fleets will choose to replace, rather than retrofit, pre-2003 model year vehicles to meet PM BACT requirements. We do assume fleets will choose to retrofit 2003-2006 model year trucks in order to gain maximum use out of recently purchased vehicles. We also assume that, as in-state fleets purchase compliant replacement vehicles, they will purchase a vehicle that is four or five year old. This assumption is a schematic representation that some fleets will choose to purchase older compliant vehicles relatively cheaply, while other fleets will choose to purchase new or near-new vehicles. Table 29 shows that interstate fleets will replace trucks with newer trucks more frequently than in-state fleets.

Table 29. Compliance Assumptions for High-Mileage Trucks in Fleets of Four or Greater

Heavy-Heavy Duty Diesel In-state Tractors

		Turnover						
As of January 1,	**Model Year**	**Percent**	**Calendar Year**	**Percent**	**Calendar Year**	**Percent**	**Calendar Year**	**Percent with DPF (85% Control)**
2011	pre-1994	95.5%	2008	4.5%	2010	0.0%	2012	
2012	pre-1994	95.5%	2008	4.5%	2010	0.0%	2012	
2012	2003-2004							100%
2013	pre-2000	59.5%	2008	35.8%	2010	4.7%	2012	
2013	2005-2006							100%
2014	pre-2003	45.2%	2008	30.1%	2010	24.7%	2012	
2015	pre-2003	45.2%	2008	30.1%	2010	24.7%	2012	
2016	pre-2005	41.2%	2008	26.6%	2010	32.2%	2012	
2017	pre-2007	37.1%	2008	24.0%	2010	38.8%	2012	
2018	pre-2007	37.1%	2008	0.0%	2010	62.9%	2013	
2019	pre-2007	37.1%	2008	0.0%	2010	62.9%	2014	
2020	pre-2007	37.1%	2008	0.0%	2010	62.9%	2015	
2021	pre-2008	21.7%	2008	0.0%	2010	78.3%	2016	
2022	pre-2009	0.0%	2008	0.0%	2010	100.0%	2016	
2023	pre-2010	0.0%	2008	0.0%	2010	100.0%	2017	
2024	pre-2010	0.0%	2008	0.0%	2010	100.0%	2018	
2025	pre-2010	0.0%	2008	0.0%	2010	100.0%	2019	

Heavy-Heavy Duty Diesel In-State Single-Units and Power-Take Off

		Turnover						
As of January 1,	**Model Year**	**Percent**	**Calendar Year**	**Percent**	**Calendar Year**	**Percent**	**Calendar Year**	**Percent with DPF (85% Control)**
2011	pre-1994	100.0%	2008	0.0%	2010	0.0%	2012	
2012	pre-1994	100.0%	2008	0.0%	2010	0.0%	2012	
2012	2003-2004							100%
2013	pre-2000	61.1%	2008	37.0%	2010	1.9%	2012	
2013	2005-2006							100%
2014	pre-2003	47.9%	2008	37.4%	2010	14.7%	2012	
2015	pre-2003	47.9%	2008	37.4%	2010	14.7%	2012	
2016	pre-2005	44.8%	2008	33.9%	2010	21.3%	2012	
2017	pre-2007	38.5%	2008	30.5%	2010	31.0%	2012	
2018	pre-2007	38.5%	2008	0.0%	2010	61.5%	2013	
2019	pre-2007	38.5%	2008	0.0%	2010	61.5%	2014	
2020	pre-2007	38.5%	2008	0.0%	2010	61.5%	2015	
2021	pre-2008	22.6%	2008	0.0%	2010	77.4%	2016	
2022	pre-2009	0.0%	2008	0.0%	2010	100.0%	2016	
2023	pre-2010	0.0%	2008	0.0%	2010	100.0%	2017	
2024	pre-2010	0.0%	2008	0.0%	2010	100.0%	2018	
2025	pre-2010	0.0%	2008	0.0%	2010	100.0%	2019	

Medium-Heavy-Duty In-State and Interstate

		Turnover						
As of January 1,	**Model Year**	**Percent**	**Calendar Year**	**Percent**	**Calendar Year**	**Percent**	**Calendar Year**	**Percent with DPF (85% Control)**
2011	pre-1994	93.3%	2008	6.7%	2010	0.0%	2012	
2012	pre-1994	93.3%	2008	6.7%	2010	0.0%	2012	
2012	2003-2004							100%
2013	pre-2000	72.5%	2008	27.0%	2010	0.5%	2012	
2013	2005-2006							100%
2014	pre-2003	56.4%	2008	25.5%	2010	18.2%	2012	
2015	pre-2003	56.4%	2008	25.5%	2010	18.2%	2012	
2016	pre-2005	49.8%	2008	21.5%	2010	28.6%	2012	
2017	pre-2007	47.9%	2008	20.7%	2010	31.4%	2012	
2018	pre-2007	47.9%	2008	0.0%	2010	52.1%	2013	
2019	pre-2007	47.9%	2008	0.0%	2010	52.1%	2014	
2020	pre-2007	47.9%	2008	0.0%	2010	52.1%	2015	
2021	pre-2008	28.8%	2008	0.0%	2010	71.2%	2016	
2022	pre-2009	0.0%	2008	0.0%	2010	100.0%	2016	
2023	pre-2010	0.0%	2008	0.0%	2010	100.0%	2017	
2024	pre-2010	0.0%	2008	0.0%	2010	100.0%	2018	
2025	pre-2010	0.0%	2008	0.0%	2010	100.0%	2019	

Heavy-Heavy Duty Interstate Trucks

		Turnover						
As of January 1,	**Model Year**	**Percent**	**Calendar Year**	**Percent**	**Calendar Year**	**Percent**	**Calendar Year**	**Percent with DPF (85% Control)**
2011	pre-1994	85.4%	2008	14.6%	2010	0.0%	2012	
2012	pre-1994	85.4%	2008	14.6%	2010	0.0%	2012	
2012	2003-2004							100%
2013	pre-2000	48.8%	2008	42.9%	2010	8.3%	2012	
2013	2005-2006							100%
2014	pre-2003	23.0%	2008	26.8%	2010	50.2%	2012	
2015	pre-2003	23.0%	2008	26.8%	2010	50.2%	2012	
2016	pre-2005	20.4%	2008	23.8%	2010	55.8%	2012	
2017	pre-2007	19.2%	2008	22.4%	2010	58.4%	2012	
2018	pre-2007	19.2%	2008	0.0%	2010	80.8%	2013	
2019	pre-2007	19.2%	2008	0.0%	2010	80.8%	2014	
2020	pre-2007	19.2%	2008	0.0%	2010	80.8%	2015	
2021	pre-2008	10.3%	2008	0.0%	2010	89.7%	2016	
2022	pre-2009	0.0%	2008	0.0%	2010	100.0%	2016	
2023	pre-2010	0.0%	2008	0.0%	2010	100.0%	2017	
2024	pre-2010	0.0%	2008	0.0%	2010	100.0%	2018	
2025	pre-2010	0.0%	2008	0.0%	2010	100.0%	2019	

b) High Mileage Trucks in Fleets of Three or Fewer

Under the proposed regulation, small fleets are exempt from performance requirements through 2011. In 2012 a small fleet must upgrade its first truck to a maximum emission rate equivalent to a 2004 engine with a retrofit DPF. Other vehicles in small fleets must be upgraded between 2013 and 2022. Using this information, we developed the compliance schedule identified in Table 30.

Table 30. Compliance Assumptions for High Mileage Trucks in Fleets of Three or Fewer

First truck in one-, two-, or three-truck fleet

As of January 1,	Model Year	Turnover to	Percent with DPF (85% Control)
2013	pre-2003	2007	
2013	2003-2006		100%
2018	2003-2006	2011	
2021	2007	2013	
2022	2008	2014	
2023	2009	2015	

Second truck in two-truck fleet

As of January 1,	Model Year	Turnover to	Percent with DPF (85% Control)
2014	pre-2003	2009	
2014	2003-2006		100%
2016	2003-2004	2010	
2017	2005-2006	2010	
2021	2007	2013	
2022	2008	2014	
2023	2009	2015	

Second truck in three-truck fleet

As of January 1,	Model Year	Turnover to	Percent with DPF (85% Control)
2014	pre-2003	80% to 2009	
2014	pre-2003	20% to 2010	
2014	2003-2006		100%
2016	2003-2004	2010	
2017	2005-2006	2010	
2021	2007	2014	
2022	2008	2015	
2023	2009	2017	

Third truck in three-truck fleet

As of January 1,	Model Year	Turnover to	Percent with DPF (85% Control)
2014	pre-2003	80% to 2009	
2014	pre-2003	20% no turnover until 2015	
2014	2003-2006		100%
2016	2003-2004	2010	
2016	pre-2003	80% to 2009	
2016	pre-2003	20% to 2010	
2017	2005-2006	2010	
2021	2007	2015	
2022	2008	2016	
2023	2009	2017	

c) Low Mileage Trucks in Any Fleet Size

Under the proposed regulation, low mileage trucks (defined as heavy-heavy duty diesel trucks driving less than 7,500 miles/yr and medium-heavy duty diesel trucks driving less than 5,000 miles/yr) are allowed to delay compliance with turnover requirements until 2020. Using this information we applied the compliance schedule shown in Table 31.

Table 31. Compliance Assumptions for Low Mileage Trucks in Fleets of Any Size

As of January 1,	Model Year	Turnover to	Percent with DPF (85% Control)
2012	pre-2007		20%
2013	pre-2007		60%
2014	pre-2007		100%
2021	pre-2008	2010	
2022	2008	2010	
2023	2009	2010	

d) Agricultural Trucks

Under the proposed regulation, agricultural fleets are allowed the choice of opting into an alternative compliance scenario. In this scenario, high mileage non-specialty trucks in agricultural fleets, defined as pre-1996 model year trucks driven more than 15,000 miles per year, 1996-2005 model year trucks driven more than 20,000 miles per year, and 2006 and newer model year trucks driven more than 25,000 miles per year, must comply with regulatory provisions. Non-specialty trucks driving fewer miles are not required to install retrofit DPFs and are not required to meet turnover requirements until 2016 or 2022 depending on the number of miles traveled per year. In 2016, the mileage threshold is reduced to 10,000 miles per year. Trucks above that threshold which had not previously been complying with regulatory provisions are required to upgrade to a 2010 model year truck. Trucks below that threshold, and all specialty agricultural vehicles, are required to upgrade to meet 2010 model year equivalent emissions standards by the beginning of 2023. In Table 32 we provide our compliance assumptions for agricultural trucks.

Table 32. Compliance Assumptions for Agricultural Trucks

Below 10,000 miles/yr and specialty agricultural trucks

As of January 1,	Model Year	Turnover to	Percent with DPF (85% Control)
2023	pre-2010	2012	

Above 10,000 miles/yr but below first mileage threshold

As of January 1,	Model Year	Turnover to	Percent with DPF (85% Control)
2017	pre-2007	2010	
2021	2007	2012	
2022	2008	2012	
2023	2009	2012	

Above first mileage threshold (15,000-25,000 miles/yr depending on model year)

As of January 1,	Model Year	Turnover to	Percent with DPF (85% Control)
2011	pre-1994		100%
2012	2003-2004		100%
2013	2005-2006		100%
2013	1994-1999	2008	
2014	2000-2002	2009	
2015	pre-1994	2011	
2016	2003-2004	2011	
2017	2005-2006	2011	
2021	2007	2015	
2022	1994-1999	2016	
2022	2008	2016	
2023	2000-2002	2017	
2023	2009	2017	

e) Buses

Under the proposed regulation, non-school buses that are privately owned are assumed to follow BACT provisions in the proposed regulation. Due to the cost of replacing these vehicles we assume bus operators will achieve compliance with the least-cost option; this typically involves the oldest compliant vehicle available. Under the proposed regulation, school buses are required to install DPFs but are not required to meet NO_x emission standards. These requirements apply in addition to previous regulatory requirements developed under the Lower Emissions School Bus program. We provide bus compliance schedules in Table 33.

Table 33. Compliance Assumptions for Buses

School Buses

As of January 1,	Model Year	Turnover to	Percent with DPF (85% Control)
2011	2000 and after		100%
2012	1994-1999		100%
2013	1987-1993		100%
2014	pre-1987	2007	

Other Buses

As of January 1,	Model Year	Turnover to	Percent with DPF (85% Control)
2011	pre-1994		100%
2012	2003-2004		100%
2013	2005-2006		100%
2013	1994-1999	2010	
2014	2000-2002	2010	
2015	pre-1994	2010	
2016	2003-2004	2010	
2017	2005-2006	2010	
2021	2007	2010	
2022	2008	2010	
2023	2009	2010	

2. Statewide Benefits

In this section we present the statewide emissions reductions anticipated from the proposed regulation.

a) *Statewide Emissions Benefits*

In Figure 36 we show the NO_x emissions reduction estimated to result from the proposed regulation. We estimate the greatest absolute NOx emissions benefit to be achieved in calendar year 2014, with a reduction of 123.7 tons NO_x/day relative to baseline emissions. In Figure 37 we show the emissions reduction estimated to result from the regulation, in terms of $PM_{2.5}$. We anticipate the greatest emissions reduction to be achieved for $PM_{2.5}$ in 2013, with a reduction of 13.6 tons $PM_{2.5}$/day relative to baseline emissions. We estimate the CO_2 emissions benefit resulting from the regulation to be negligible, with the greatest reduction of 570.8 tons CO_2/day occurring in 2023. In some years the CO_2 emissions are estimated to slightly increase due to the decreased fuel efficiency resulting from the technologies used to reduce NO_x and $PM_{2.5}$. We show the emissions reduction estimate for CO_2 in Figure 38.

Figure 36. Statewide NO_x Emissions Estimates with Regulation

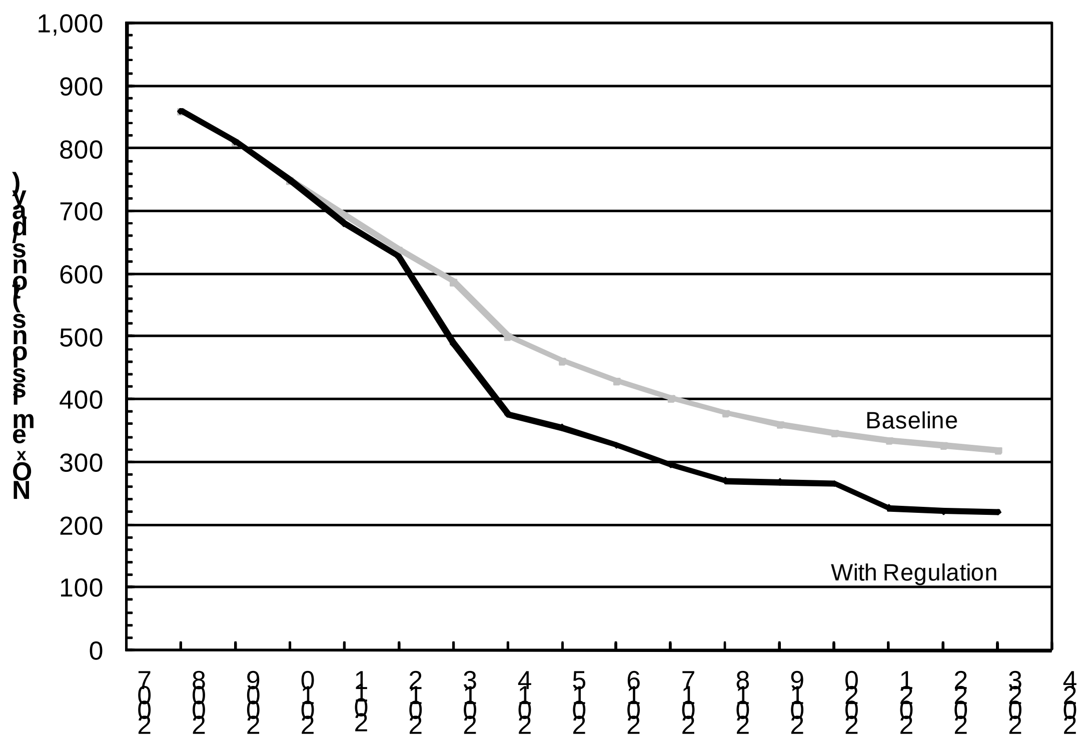


Figure 37. Statewide $PM_{2.5}$ Emissions Estimates with Regulation

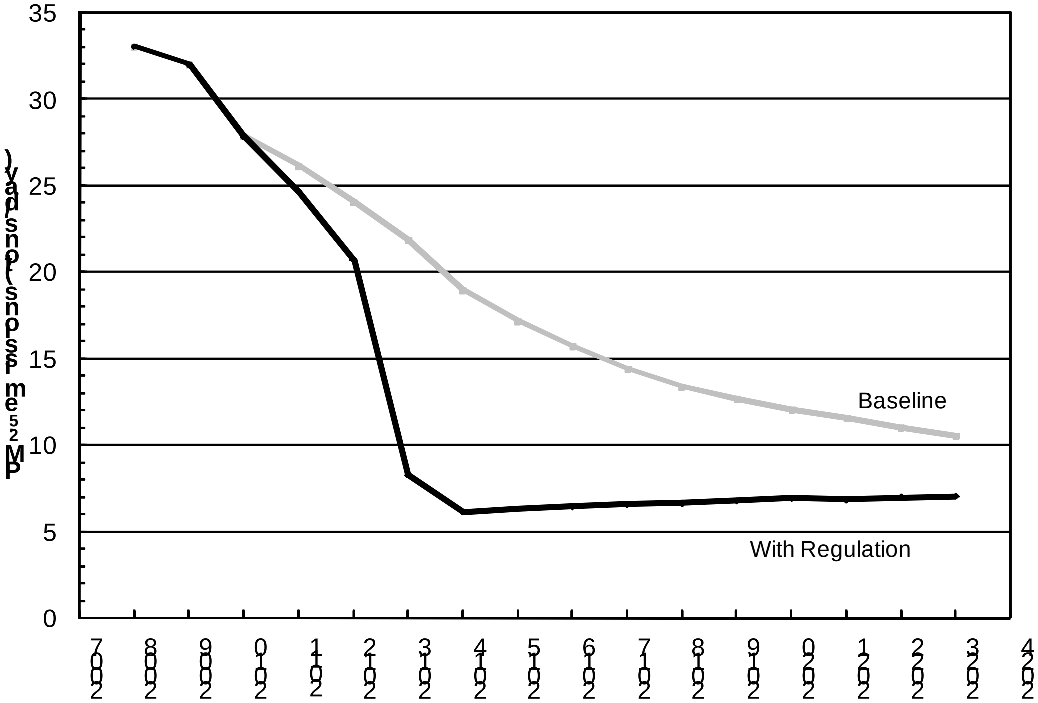
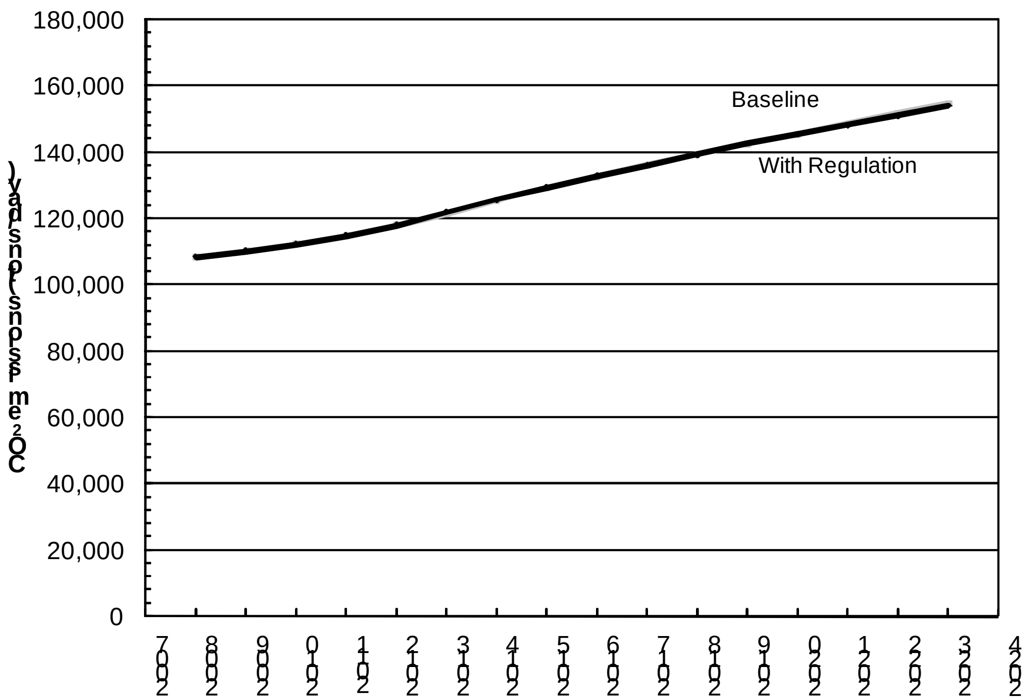


Figure 38. Statewide CO_2 Emissions Estimates with Regulation



b) Statewide Emissions Benefits by Inventory Category

In Table 34 we provide statewide NO_x reductions achieved by the proposed regulation in calendar years 2014 and 2020 for each inventory category. As the table shows, we estimate that single-unit trucks will provide the greatest percent NO_x reduction relative to their baseline, achieving 45% reductions in 2014 and 2020. (The reduction achieved by the proposed regulation with regard to drayage trucks is negligible for NO_x and other pollutants in 2014 and 2020 as a result of the ARB drayage truck regulation adopted in 2007, which will already require significant emissions reductions prior to 2014 (ARB, 2007a; ARB, 2007b); the regulation proposed herein requires further reductions after 2020). When considering all truck categories in aggregate, the largest share of the overall NO_x reduction to be achieved by the proposed rule will be provided by in-state heavy-heavy duty tractors (42% of total reductions in 2014, 45% in 2020) and medium-heavy duty diesel trucks (20%; 17%).

Table 34. California Statewide NO_x Future Emissions Reductions by Inventory Category, 2014 and 2020 (tons/day)

	2014				2020			
Inventory Category	Base[1]	Reg[2]	Reduction[3]	Share[4]	Base	Reg	Reduction	Share
HH Out-of-State	96.3	88.2	-8.4%	6.5%	62.6	59.9	-4.3%	3.4%
HH CA-IRP	74.0	64.1	-13.3%	8.0%	40.8	36.8	-9.9%	5.1%
HH Tractor	140.0	88.3	-36.9%	41.7%	92.3	56.3	-39.0%	45.2%
HH Single unit	44.9	24.5	-45.4%	16.4%	30.6	16.8	-45.2%	17.4%
HH Drayage	33.4	33.4	0.0%	0.0%	51.4	51.4	0.0%	0.0%
HH Agriculture	12.4	10.2	-17.6%	1.8%	7.5	4.6	-38.2%	3.6%
HH Utility	0.6	0.6	-1.6%	0.0%	0.5	0.5	-1.3%	0.0%
MH In-State	72.6	47.7	-34.2%	20.1%	40.2	26.3	-34.5%	17.4%
MH Interstate	0.4	0.3	-22.2%	0.1%	0.2	0.2	-19.3%	0.1%
MH Agriculture	2.7	2.5	-9.3%	0.2%	1.7	1.1	-38.7%	0.8%
MH Utility	0.3	0.3	-0.8%	0.0%	0.2	0.2	-1.4%	0.0%
Buses	11.3	9.2	-18.8%	1.7%	8.4	6.8	-19.7%	2.1%
PTO	11.4	7.1	-37.5%	3.4%	9.2	5.4	-41.8%	4.8%
All	500.2	376.5	-24.7%	100.0%	345.6	266.1	-23.0%	100.0%

[1] The emissions estimated from each category, under the baseline scenario in the absence of regulation
[2] The emissions estimated from each category, under the scenario with the proposed regulation
[3] The percent reduction estimated from each category with the proposed regulation
[4] The share of total emissions reductions (e.g. 123.7 tons/day, for all, in 2014) represented by the category

In Table 35 we provide statewide $PM_{2.5}$ reductions achieved by the proposed regulation in calendar years 2014 and 2020 for each inventory category. We predict that trucks in many categories will achieve large $PM_{2.5}$ reductions but we predict the largest reductions to come from the single-unit category as well as the in-state medium- and heavy-heavy duty tractors, in terms of reductions relative to individual category baseline emissions. When considering all truck categories in aggregate, the largest share of the overall $PM_{2.5}$ reduction to be achieved by proposed rule should be provided by in-state heavy-heavy duty tractors (38% of total reductions in 2014; 47% of total reductions in 2020) and medium-heavy duty diesel trucks (16%; 17%).

Table 35. California Statewide $PM_{2.5}$ Future Emissions Reductions by Inventory Category, 2014 and 2020 (tons/day)

	2014				2020			
Inventory Category	Base[1]	Reg[2]	Reduction[3]	Share[4]	Base	Reg	Reduction	Share
HH Out-of-State	3.7	1.7	-53.3%	15.5%	2.2	2.0	-9.0%	3.9%
HH CA-IRP	2.9	1.1	-63.8%	14.4%	1.5	1.2	-19.8%	5.8%
HH Tractor	6.1	1.3	-79.4%	37.7%	3.9	1.5	-61.2%	46.7%
HH Single Unit	1.4	0.3	-79.1%	8.5%	1.0	0.3	-66.9%	13.5%
HH Drayage	0.5	0.5	0.0%	0.0%	0.8	0.8	0.0%	0.0%
HH Agriculture	0.5	0.3	-52.6%	2.2%	0.3	0.2	-52.4%	3.3%
HH Utility	0.0	0.0	-4.7%	0.0%	0.0	0.0	-2.7%	0.0%
MH In-State	2.7	0.6	-77.1%	16.3%	1.5	0.6	-60.9%	17.3%
MH Interstate	0.0	0.0	-65.7%	0.1%	0.0	0.0	-37.2%	0.1%
MH Agriculture	0.1	0.1	-33.4%	0.3%	0.1	0.0	-52.1%	0.8%
MH Utility	0.0	0.0	-0.8%	0.0%	0.0	0.0	-0.8%	0.0%
Buses	0.4	0.1	-65.2%	1.9%	0.3	0.2	-53.2%	3.4%
PTO	0.6	0.2	-63.9%	3.1%	0.4	0.1	-74.3%	5.4%
All	19.0	6.1	-67.7%	100.0%	12.1	6.9	-42.7%	100.0%

[1] The emissions estimated from each category, under the baseline scenario in the absence of regulation
[2] The emissions estimated from each category, under the scenario with the proposed regulation
[3] The percent reduction estimated from each category with the proposed regulation
[4] The share of total emissions reductions (e.g. 12.9 tons/day, for all, in 2014) represented by the category

In Table 36 we provide statewide CO_2 reductions achieved by the proposed regulation in calendar years 2014 and 2020 for each inventory category. The overall CO_2 reduction for each category is negligible, with none exceeding 1% and some actually increasing CO_2 emissions. When considering all the categories in aggregate, the largest share of the overall CO_2 reduction in 2014 is again represented by the tractors, the heavy-heavy tractors from out-of-state as well as California, and the medium-heavy trucks from in-state. In aggregate, we anticipate a slight increase in emissions for 2014 and a slight reduction for 2020.

Table 36. California Statewide CO_2 Future Emissions Reductions by Inventory Category, 2014 and 2020 (tons/day)

	2014				2020			
Inventory Category	Base[1]	Reg[2]	Reduction[3]	Share[4]	Base	Reg	Reduction	Share
HH Out-of-State	37,997	38,058	0.2%	23.9%	44,681	44,678	0.0%	7.1%
HH CA-IRP	19,564	19,618	0.3%	20.8%	22,881	22,876	0.0%	12.4%
HH Tractor	24,309	24,363	0.2%	21.2%	28,441	28,424	-0.1%	42.2%
HH Single Unit	8,006	8,022	0.2%	6.2%	9,401	9,394	-0.1%	16.0%
HH Drayage	8,000	8,000	0.0%	0.0%	10,393	10,393	0.0%	0.0%
HH Agriculture	1,735	1,747	0.7%	4.5%	1,680	1,674	-0.4%	15.2%
HH Utility	88	88	-0.2%	-0.1%	98	98	-0.1%	0.2%
MH In-State	20,993	21,051	0.3%	22.6%	22,752	22,751	0.0%	1.9%
MH Interstate	193	194	0.2%	0.1%	210	210	0.0%	0.0%
MH Agriculture	505	507	0.4%	0.8%	489	487	-0.4%	5.1%
MH Utility	95	95	0.0%	0.0%	105	105	0.0%	0.1%
Buses	2,280	2,280	0.0%	0.0%	2,529	2,529	0.0%	-0.1%
PTO	1,589	1,589	0.0%	0.0%	1,878	1,878	0.0%	0.0%
All	125,354	125,612	0.2%	100.0%	145,537	145,496	0.0%	100.0%

[1] The emissions estimated from each category, under the baseline scenario in the absence of regulation
[2] The emissions estimated from each category, under the scenario with the proposed regulation
[3] The percent reduction estimated from each category with the proposed regulation
[4] The share of total emissions reductions (e.g. -258 tons/day, for all, in 2014) represented by the category

In Table 37 we show the distribution of all emissions reductions anticipated to result from the proposed regulation. We expect the largest reductions in NO_x and $PM_{2.5}$ will come from trucks registered in California, with heavy-heavy instate trucks providing the greatest reductions followed by medium-heavy in-state trucks and single-unit trucks. These three categories alone represent over 74% of the overall NO_x and 67% of the overall $PM_{2.5}$ emissions reductions anticipated between 2008 and 2023.

Table 37. Distribution of Total Future Emissions Reductions across Inventory Category , 2008-2023

Inventory Category	NO_x Share	$PM_{2.5}$ Share
HH Out-of-State	4.4%	10.8%
HH CA-IRP	5.8%	10.3%
HH Tractor	41.1%	40.7%
HH Single Unit	16.0%	10.4%
HH Drayage	6.0%	1.1%
HH Agriculture	2.9%	3.0%
HH Utility	0.0%	0.0%
MH In-State	17.4%	16.4%
MH Interstate	0.1%	0.1%
MH Agriculture	0.6%	0.6%
MH Utility	0.0%	0.0%
Buses	1.7%	2.7%
PTO	4.1%	4.1%
Total	100.0%	100.0%

c) Statewide Emissions Benefits by Fleet Size

In Table 38 we subdivide the statewide benefits for NO_x reductions for 2014 and 2020 by truck fleet size. As shown in the table, we expect the reductions in both 2014 and 2020 to come primarily from trucks that are driven above the respective mileage thresholds that are included for application of the regulation. When pooling the fleets together, we expect that the largest share of the overall emission reduction will come from fleets operating more than three trucks, with the second largest share coming from single-truck fleets. We expect the reduction rates, however, to be largest for fleets of 3 or fewer vehicles. In addition, we expect that nearly 45% of the NO_x emissions reductions anticipated in 2014, and more than 47% of the reductions anticipated in 2020, will come from fleets with three or fewer vehicles. These projections result largely from the fact that smaller fleets tend to have on average older trucks than do larger fleets. In Table 39 we show the future NO_x baseline emissions and reductions as a function of inventory category and fleet size.

Table 38. California Statewide NO_x Future Emissions Reductions by Fleet Size, 2014 and 2020 (tons/day)

	2014				2020			
Fleet Size	Base	Reg	Red	Share	Base	Reg	Red	Share
1 truck/above threshold	134.8	98.2	-27.2%	29.6%	98.3	73.3	-25.5%	31.5%
1 truck/below threshold	3.8	3.8	0.0%	0.0%	3.1	3.1	0.0%	0.0%
2 truck/above threshold	38.7	26.5	-31.4%	9.8%	25.5	17.6	-31.1%	10.0%
2 truck/below threshold	1.2	1.2	0.0%	0.0%	1.0	1.0	0.0%	0.0%
3 truck/above threshold	23.7	17.0	-28.6%	5.5%	16.6	11.9	-28.1%	5.9%
3 truck/below threshold	0.7	0.7	0.0%	0.0%	0.6	0.6	0.0%	0.0%
4+ truck/above threshold	253.6	194.2	-23.4%	48.0%	169.3	136.4	-19.4%	41.3%
4+ truck/below threshold	5.1	5.1	0.0%	0.0%	4.0	4.0	0.0%	0.0%
Ag non specialty higher VMT	8.9	6.4	-27.5%	2.0%	4.9	2.3	-52.1%	3.2%
Ag non specialty lower VMT	2.5	2.5	0.0%	0.0%	1.8	1.8	0.0%	0.0%
Ag non specialty midrange VMT	2.2	2.2	0.0%	0.0%	1.6	0.6	-61.0%	1.3%
Ag specialty vehicle	1.5	1.5	0.0%	0.0%	0.9	0.9	0.0%	0.0%
Unspecified	23.5	17.2	-27.1%	5.2%	18.2	12.7	-30.2%	6.9%
All	500.2	376.5	-24.7%	100.0%	345.6	266.1	-23.0%	100.0%

Table 39. California Statewide NO_x Future Emissions Reductions by Inventory Category and Fleet Size, 2014 and 2020 (tons/day)

		2014				2020			
Inventory Category	Fleet Size	Base	Reg	Red	Share	Base	Reg	Red	Share
HH Out of State	1 truck/above 7500 miles	5.45	4.93	-9.5%	0.4%	3.16	2.93	-7.3%	0.3%
	1 truck/below 7500 miles	0.04	0.04	0.0%	0.0%	0.03	0.03	0.0%	0.0%
	2 truck/above 7500 miles	1.69	1.52	-10.0%	0.1%	0.98	0.91	-7.2%	0.1%
	2 truck/below 7500 miles	0.01	0.01	0.0%	0.0%	0.01	0.01	0.0%	0.0%
	3 truck/above 7500 miles	1.23	1.11	-9.7%	0.1%	0.71	0.66	-7.3%	0.1%
	3 truck/below 7500 miles	0.01	0.01	0.0%	0.0%	0.01	0.01	0.0%	0.0%
	4+ truck/above 7500 miles	87.40	80.10	-8.3%	5.9%	57.36	55.01	-4.1%	3.0%
	4+ truck/below 7500 miles	0.47	0.47	0.0%	0.0%	0.37	0.37	0.0%	0.0%

		2014				2020			
Inventory Category	Fleet Size	Base	Reg	Red	Share	Base	Reg	Red	Share
HH CAIRP	1 truck/above 7500 miles	23.01	20.90	-9.2%	1.7%	11.77	10.84	-7.9%	1.2%
	1 truck/below 7500 miles	0.16	0.16	0.0%	0.0%	0.12	0.12	0.0%	0.0%
	2 truck/above 7500 miles	8.17	7.32	-10.4%	0.7%	4.29	3.94	-8.4%	0.5%
	2 truck/below 7500 miles	0.06	0.06	0.0%	0.0%	0.04	0.04	0.0%	0.0%
	3 truck/above 7500 miles	4.53	4.03	-11.1%	0.4%	2.42	2.18	-9.9%	0.3%
	3 truck/below 7500 miles	0.04	0.04	0.0%	0.0%	0.03	0.03	0.0%	0.0%
	4+ truck/above 7500 miles	37.72	31.32	-16.9%	5.2%	21.91	19.40	-11.4%	3.2%
	4+ truck/below 7500 miles	0.30	0.30	0.0%	0.0%	0.22	0.22	0.0%	0.0%
HH Tractor	1 truck/above 7500 miles	52.13	32.96	-36.8%	15.5%	33.68	19.74	-41.4%	17.5%
	1 truck/below 7500 miles	1.31	1.31	0.0%	0.0%	1.14	1.14	0.0%	0.0%
	2 truck/above 7500 miles	14.90	8.86	-40.5%	4.9%	9.90	5.67	-42.7%	5.3%
	2 truck/below 7500 miles	0.39	0.39	0.0%	0.0%	0.34	0.34	0.0%	0.0%
	3 truck/above 7500 miles	8.51	5.24	-38.4%	2.6%	5.65	3.22	-43.0%	3.1%
	3 truck/below 7500 miles	0.22	0.22	0.0%	0.0%	0.19	0.19	0.0%	0.0%
	4+ truck/above 7500 miles	61.24	38.05	-37.9%	18.7%	40.27	24.90	-38.2%	19.3%
	4+ truck/below 7500 miles	1.31	1.31	0.0%	0.0%	1.11	1.11	0.0%	0.0%
HH Single Unit	1 truck/above 7500 miles	12.31	6.24	-49.3%	4.9%	8.54	4.06	-52.5%	5.6%
	1 truck/below 7500 miles	1.04	1.04	0.0%	0.0%	0.90	0.90	0.0%	0.0%
	2 truck/above 7500 miles	4.28	2.08	-51.4%	1.8%	3.01	1.42	-53.0%	2.0%
	2 truck/below 7500 miles	0.36	0.36	0.0%	0.0%	0.32	0.32	0.0%	0.0%
	3 truck/above 7500 miles	2.68	1.41	-47.4%	1.0%	1.80	0.87	-51.7%	1.2%
	3 truck/below 7500 miles	0.22	0.22	0.0%	0.0%	0.18	0.18	0.0%	0.0%
	4+ truck/above 7500 miles	22.37	11.56	-48.3%	8.7%	14.54	7.72	-46.9%	8.6%
	4+ truck/below 7500 miles	1.60	1.60	0.0%	0.0%	1.31	1.31	0.0%	0.0%
HH Drayage	1 truck	17.94	17.94	0.0%	0.0%	27.62	27.62	0.0%	0.0%
	2 truck	1.99	1.99	0.0%	0.0%	3.07	3.07	0.0%	0.0%
	3 truck	2.24	2.24	0.0%	0.0%	3.45	3.45	0.0%	0.0%
	4+ truck	11.21	11.21	0.0%	0.0%	17.26	17.26	0.0%	0.0%
HH Agriculture	Ag non specialty higher VMT	7.79	5.60	-28.1%	1.8%	4.27	2.06	-51.7%	2.8%
	Ag non specialty lower VMT	1.92	1.92	0.0%	0.0%	1.38	1.38	0.0%	0.0%
	Ag non specialty midrange VMT	1.48	1.48	0.0%	0.0%	1.11	0.45	-59.3%	0.8%
	Ag specialty vehicle	1.24	1.24	0.0%	0.0%	0.75	0.75	0.0%	0.0%
HH Utility		0.60	0.59	-1.6%	0.0%	0.46	0.45	-1.3%	0.0%
MH instate	1 truck/above 5000 miles	23.96	15.18	-36.6%	7.1%	13.48	8.05	-40.3%	6.8%
	1 truck/below 5000 miles	1.20	1.20	0.0%	0.0%	0.87	0.87	0.0%	0.0%
	2 truck/above 5000 miles	7.59	4.71	-37.9%	2.3%	4.22	2.55	-39.7%	2.1%
	2 truck/below 5000 miles	0.37	0.37	0.0%	0.0%	0.26	0.26	0.0%	0.0%
	3 truck/above 5000 miles	4.52	2.90	-35.9%	1.3%	2.50	1.50	-40.0%	1.3%
	3 truck/below 5000 miles	0.22	0.22	0.0%	0.0%	0.16	0.16	0.0%	0.0%
	4+ truck/above 5000 miles	33.36	21.77	-34.7%	9.4%	17.76	12.01	-32.4%	7.2%
	4+ truck/below 5000 miles	1.39	1.39	0.0%	0.0%	0.95	0.95	0.0%	0.0%
MH Interstate	1 truck/above 5000 miles	0.05	0.05	-11.2%	0.0%	0.03	0.02	-14.4%	0.0%
	1 truck/below 5000 miles	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%
	2 truck/above 5000 miles	0.03	0.03	-17.6%	0.0%	0.02	0.01	-21.2%	0.0%
	2 truck/below 5000 miles	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%
	3 truck/above 5000 miles	0.03	0.03	-21.8%	0.0%	0.02	0.01	-23.0%	0.0%
	3 truck/below 5000 miles	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%
	4+ truck/above 5000 miles	0.31	0.23	-25.5%	0.1%	0.16	0.13	-20.6%	0.0%
	4+ truck/below 5000 miles	0.01	0.01	0.0%	0.0%	0.01	0.01	0.0%	0.0%
MH Agriculture	Ag non specialty higher VMT	1.08	0.83	-23.3%	0.2%	0.59	0.26	-55.5%	0.4%
	Ag non specialty lower VMT	0.60	0.60	0.0%	0.0%	0.44	0.44	0.0%	0.0%
	Ag non specialty midrange VMT	0.76	0.76	0.0%	0.0%	0.54	0.19	-64.4%	0.4%
	Ag specialty vehicle	0.27	0.27	0.0%	0.0%	0.17	0.17	0.0%	0.0%
MH Utility		0.32	0.32	-0.8%	0.0%	0.16	0.15	-1.4%	0.0%
Buses		11.27	9.15	-18.8%	1.7%	8.41	6.75	-19.7%	2.1%
PTO		11.35	7.10	-37.5%	3.4%	9.22	5.37	-41.8%	4.8%
All		500.23	376.48	-24.7%	100.0%	345.63	266.13	-23.0%	100.0%

In Table 40 we provide statewide $PM_{2.5}$ reductions in 2014 and 2020 by truck fleet size and mileage threshold. We expect the reductions in both 2014 and 2020 to come from trucks of all different fleet sizes, regardless of whether the trucks are driven above the respective thresholds included for application of the regulation. The only trucks not affected are agricultural trucks that are less-utilized. When considering all fleets in aggregate, the largest share of the overall reduction is again represented first by fleets operating more than three trucks, with the second largest share represented by single-truck fleets. The reduction rates, again, are greatest for fleets of 3 or fewer vehicles. We again expect that nearly 45% of the $PM_{2.5}$ emissions reductions anticipated in 2014, and more than 47% of the reductions anticipated in 2020, will come from fleets with three or fewer vehicles. These projections again result largely from the fact that smaller fleets tend to have older vehicles than do larger fleets. In Table 41 we break down the future $PM_{2.5}$ baseline emissions and reductions further as a function of inventory category and fleet size.

Table 40. California Statewide $PM_{2.5}$ Future Emissions Reductions by Fleet Size, 2014 and 2020

	2014				2020			
Fleet Size	Base	Reg	Red	Share	Base	Reg	Red	Share
1 truck/above threshold	5.0	1.3	-74.4%	29.2%	3.2	1.6	-48.7%	30.3%
1 truck/below threshold	0.1	0.0	-84.0%	1.0%	0.1	0.0	-79.1%	1.7%
2 truck/above threshold	1.5	0.4	-76.0%	8.9%	0.9	0.4	-52.6%	9.5%
2 truck/below threshold	0.0	0.0	-83.9%	0.3%	0.0	0.0	-79.2%	0.5%
3 truck/above threshold	0.9	0.3	-71.9%	5.0%	0.6	0.3	-49.9%	5.5%
3 truck/below threshold	0.0	0.0	-83.9%	0.2%	0.0	0.0	-78.9%	0.3%
4+ truck/above threshold	9.4	3.5	-63.5%	46.7%	6.0	4.0	-32.2%	37.2%
4+ truck/below threshold	0.2	0.0	-82.8%	1.2%	0.1	0.0	-75.6%	2.0%
Ag non specialty higher VMT	0.4	0.1	-81.2%	2.5%	0.2	0.1	-72.7%	3.0%
Ag non specialty lower VMT	0.1	0.1	0.0%	0.0%	0.1	0.1	0.0%	0.0%
Ag non specialty midrange VMT	0.1	0.1	0.0%	0.0%	0.1	0.0	-79.8%	1.0%
Ag specialty vehicle	0.1	0.1	0.0%	0.0%	0.0	0.0	0.0%	0.0%
Unspecified	1.0	0.4	-64.1%	5.0%	0.7	0.3	-64.0%	8.8%
All	19.0	6.1	-67.7%	100.0%	12.1	6.9	-42.7%	100.0%

Table 41. California Statewide $PM_{2.5}$ Future Emissions Reductions by Inventory Category and Fleet Size, 2014 and 2020 (tons/day)

		2014				2020			
Inventory Category	Fleet Size	Base	Reg	Red	Share	Base	Reg	Red	Share
HH Out of State	1 truck/above 7500 miles	0.21	0.08	-60.4%	1.0%	0.11	0.10	-15.7%	0.3%
	1 truck/below 7500 miles	0.00	0.00	-81.5%	0.0%	0.00	0.00	-65.3%	0.0%
	2 truck/above 7500 miles	0.07	0.03	-60.6%	0.3%	0.04	0.03	-15.8%	0.1%
	2 truck/below 7500 miles	0.00	0.00	-81.5%	0.0%	0.00	0.00	-65.4%	0.0%
	3 truck/above 7500 miles	0.05	0.02	-60.0%	0.2%	0.03	0.02	-15.8%	0.1%
	3 truck/below 7500 miles	0.00	0.00	-81.5%	0.0%	0.00	0.00	-65.4%	0.0%
	4+ truck/above 7500 miles	3.39	1.61	-52.4%	13.8%	2.04	1.87	-8.2%	3.2%
	4+ truck/below 7500 miles	0.02	0.00	-80.1%	0.1%	0.01	0.00	-55.4%	0.1%
HH CAIRP	1 truck/above 7500 miles	0.93	0.30	-67.8%	4.9%	0.42	0.35	-16.5%	1.4%
	1 truck/below 7500 miles	0.01	0.00	-81.9%	0.0%	0.00	0.00	-63.4%	0.0%
	2 truck/above 7500 miles	0.32	0.11	-66.4%	1.7%	0.16	0.13	-17.5%	0.5%
	2 truck/below 7500 miles	0.00	0.00	-81.8%	0.0%	0.00	0.00	-65.0%	0.0%
	3 truck/above 7500 miles	0.18	0.06	-66.0%	0.9%	0.09	0.07	-20.5%	0.4%
	3 truck/below 7500 miles	0.00	0.00	-82.3%	0.0%	0.00	0.00	-68.1%	0.0%
	4+ truck/above 7500 miles	1.44	0.58	-60.1%	6.8%	0.82	0.65	-21.0%	3.3%
	4+ truck/below 7500 miles	0.01	0.00	-82.0%	0.1%	0.01	0.00	-70.0%	0.1%

Inventory Category	Fleet Size	2014 Base	2014 Reg	2014 Red	2014 Share	2020 Base	2020 Reg	2020 Red	2020 Share
HH Tractor	1 truck/above 7500 miles	2.36	0.40	-82.8%	15.2%	1.45	0.51	-65.1%	18.3%
	1 truck/below 7500 miles	0.06	0.01	-84.3%	0.4%	0.05	0.01	-79.5%	0.7%
	2 truck/above 7500 miles	0.67	0.11	-82.9%	4.3%	0.43	0.15	-65.9%	5.5%
	2 truck/below 7500 miles	0.02	0.00	-84.3%	0.1%	0.01	0.00	-80.0%	0.2%
	3 truck/above 7500 miles	0.38	0.08	-79.2%	2.3%	0.25	0.09	-65.3%	3.1%
	3 truck/below 7500 miles	0.01	0.00	-84.3%	0.1%	0.01	0.00	-80.0%	0.1%
	4+ truck/above 7500 miles	2.54	0.63	-75.1%	14.9%	1.70	0.76	-55.0%	18.1%
	4+ truck/below 7500 miles	0.06	0.01	-83.5%	0.4%	0.04	0.01	-78.0%	0.7%
HH Single Unit	1 truck/above 7500 miles	0.38	0.07	-82.5%	2.5%	0.29	0.08	-71.5%	4.1%
	1 truck/below 7500 miles	0.03	0.00	-84.5%	0.2%	0.03	0.01	-81.0%	0.4%
	2 truck/above 7500 miles	0.13	0.02	-82.3%	0.9%	0.10	0.03	-71.2%	1.4%
	2 truck/below 7500 miles	0.01	0.00	-84.5%	0.1%	0.01	0.00	-81.0%	0.2%
	3 truck/above 7500 miles	0.08	0.02	-77.2%	0.5%	0.06	0.02	-68.8%	0.8%
	3 truck/below 7500 miles	0.01	0.00	-84.3%	0.0%	0.01	0.00	-80.4%	0.1%
	4+ truck/above 7500 miles	0.68	0.16	-76.0%	4.0%	0.50	0.20	-60.9%	5.9%
	4+ truck/below 7500 miles	0.05	0.01	-83.6%	0.3%	0.04	0.01	-78.7%	0.6%
HH Drayage	1 truck	0.24	0.24	0.0%	0.0%	0.43	0.43	0.0%	0.0%
	2 truck	0.03	0.03	0.0%	0.0%	0.05	0.05	0.0%	0.0%
	3 truck	0.03	0.03	0.0%	0.0%	0.05	0.05	0.0%	0.0%
	4+ truck	0.15	0.15	0.0%	0.0%	0.27	0.27	0.0%	0.0%
HH Agriculture	Ag non specialty higher VMT	0.35	0.06	-81.2%	2.2%	0.19	0.05	-71.8%	2.6%
	Ag non specialty lower VMT	0.08	0.08	0.0%	0.0%	0.06	0.06	0.0%	0.0%
	Ag non specialty midrange VMT	0.05	0.05	0.0%	0.0%	0.04	0.01	-78.2%	0.7%
	Ag specialty vehicle	0.05	0.05	0.0%	0.0%	0.03	0.03	0.0%	0.0%
HH Utility		0.00	0.00	-4.7%	0.0%	0.00	0.00	-2.7%	0.0%
MH instate	1 truck/above 5000 miles	0.91	0.19	-79.2%	5.6%	0.50	0.17	-65.3%	6.3%
	1 truck/below 5000 miles	0.05	0.01	-83.6%	0.3%	0.03	0.01	-79.3%	0.5%
	2 truck/above 5000 miles	0.29	0.06	-78.5%	1.7%	0.15	0.06	-63.7%	1.9%
	2 truck/below 5000 miles	0.01	0.00	-83.5%	0.1%	0.01	0.00	-78.7%	0.2%
	3 truck/above 5000 miles	0.17	0.04	-75.6%	1.0%	0.09	0.03	-63.1%	1.1%
	3 truck/below 5000 miles	0.01	0.00	-83.5%	0.1%	0.01	0.00	-78.5%	0.1%
	4+ truck/above 5000 miles	1.23	0.31	-74.9%	7.2%	0.63	0.29	-54.1%	6.7%
	4+ truck/below 5000 miles	0.05	0.01	-82.6%	0.3%	0.03	0.01	-76.4%	0.5%
MH Interstate	1 truck/above 5000 miles	0.00	0.00	-59.3%	0.0%	0.00	0.00	-25.5%	0.0%
	1 truck/below 5000 miles	0.00	0.00	-77.3%	0.0%	0.00	0.00	-64.4%	0.0%
	2 truck/above 5000 miles	0.00	0.00	-62.2%	0.0%	0.00	0.00	-35.7%	0.0%
	2 truck/below 5000 miles	0.00	0.00	-78.6%	0.0%	0.00	0.00	-70.3%	0.0%
	3 truck/above 5000 miles	0.00	0.00	-63.3%	0.0%	0.00	0.00	-38.8%	0.0%
	3 truck/below 5000 miles	0.00	0.00	-80.1%	0.0%	0.00	0.00	-71.0%	0.0%
	4+ truck/above 5000 miles	0.01	0.00	-66.6%	0.1%	0.01	0.00	-37.3%	0.0%
	4+ truck/below 5000 miles	0.00	0.00	-80.2%	0.0%	0.00	0.00	-69.9%	0.0%
MH Agriculture	Ag non specialty higher VMT	0.05	0.01	-80.9%	0.3%	0.03	0.01	-79.0%	0.4%
	Ag non specialty lower VMT	0.03	0.03	0.0%	0.0%	0.02	0.02	0.0%	0.0%
	Ag non specialty midrange VMT	0.03	0.03	0.0%	0.0%	0.02	0.00	-82.9%	0.4%
	Ag specialty vehicle	0.01	0.01	0.0%	0.0%	0.01	0.01	0.0%	0.0%
MH Utility		0.00	0.00	-0.8%	0.0%	0.00	0.00	-0.8%	0.0%
Buses		0.38	0.13	-65.2%	1.9%	0.33	0.15	-53.2%	3.4%
PTO		0.62	0.22	-63.9%	3.1%	0.38	0.10	-74.3%	5.4%
All		18.96	6.12	-67.7%	100.0%	12.08	6.93	-42.7%	100.0%

In Table 42 we subdivide the statewide benefits for CO_2 reductions for 2014 and 2020 by truck fleet size. We anticipate a slight increase for CO_2 emissions in 2014 and a slight decrease for emissions in 2020. As noted earlier, these proposed regulations are not directed toward the reduction of CO_2 emissions. When pooling the fleets together, the largest share of the overall reduction is represented by larger fleets and single-truck fleets in both 2014 and 2020.

Table 42. California Statewide CO_2 Future Emissions Reductions by Fleet Size, 2014 and 2020

	2014				2020			
Fleet Size	Base	Reg	Red	Share	Base	Reg	Red	Share
1 truck/above threshold	26,009	26,102	0.4%	36.4%	30,703	30,689	0.0%	33.0%
1 truck/below threshold	394	400	1.6%	2.5%	433	438	1.1%	-12.0%
2 truck/above threshold	7,650	7,681	0.4%	12.1%	8,923	8,921	0.0%	5.3%
2 truck/below threshold	125	127	1.6%	0.8%	138	140	1.1%	-3.8%
3 truck/above threshold	4,854	4,872	0.4%	6.8%	5,674	5,670	-0.1%	8.0%
3 truck/below threshold	74	75	1.6%	0.5%	82	82	1.1%	-2.2%
4+ truck/above threshold	79,365	79,449	0.1%	32.6%	92,151	92,124	0.0%	65.6%
4+ truck/below threshold	591	600	1.4%	3.2%	655	661	0.9%	-14.3%
Ag non specialty higher VMT	1,446	1,459	1.0%	5.3%	1,361	1,356	-0.4%	12.9%
Ag non specialty lower VMT	256	256	0.0%	0.0%	245	245	0.0%	0.0%
Ag non specialty midrange VMT	315	315	0.0%	0.0%	346	343	-0.9%	7.5%
Ag specialty vehicle	224	224	0.0%	0.0%	217	217	0.0%	0.0%
Unspecified	4,052	4,052	0.0%	-0.1%	4,610	4,610	0.0%	0.2%
All	125,354	125,612	0.2%	100.0%	145,537	145,496	0.0%	100.0%

Table 43. California Statewide CO_2 Future Emissions Reductions by Inventory Category and Fleet Size, 2014 and 2020 (tons/day)

		2014				2020			
Inventory Category	Fleet Size	Base	Reg	Red	Share	Base	Reg	Red	Share
HH Out of State	1 truck/above 7500 miles	1,642	1,647	0.3%	1.9%	1,925	1,924	0.0%	0.6%
	1 truck/below 7500 miles	5	5	1.0%	0.0%	5	5	0.4%	-0.1%
	2 truck/above 7500 miles	508	509	0.3%	0.6%	595	595	0.0%	0.2%
	2 truck/below 7500 miles	2	2	1.0%	0.0%	2	2	0.4%	0.0%
	3 truck/above 7500 miles	368	369	0.3%	0.4%	431	431	0.0%	0.1%
	3 truck/below 7500 miles	1	1	1.0%	0.0%	1	1	0.4%	0.0%
	4+ truck/above 7500 miles	35,407	35,460	0.2%	20.7%	41,647	41,645	0.0%	6.7%
	4+ truck/below 7500 miles	65	65	0.9%	0.2%	74	74	0.3%	-0.5%
HH CAIRP	1 truck/above 7500 miles	5,084	5,110	0.5%	9.9%	6,183	6,183	0.0%	2.3%
	1 truck/below 7500 miles	20	20	1.1%	0.1%	22	22	0.4%	-0.2%
	2 truck/above 7500 miles	1,879	1,888	0.5%	3.4%	2,283	2,282	0.0%	1.1%
	2 truck/below 7500 miles	7	7	1.1%	0.0%	8	8	0.4%	-0.1%
	3 truck/above 7500 miles	1,065	1,070	0.5%	1.9%	1,270	1,269	0.0%	0.6%
	3 truck/below 7500 miles	4	4	1.1%	0.0%	5	5	0.5%	-0.1%
	4+ truck/above 7500 miles	11,469	11,483	0.1%	5.3%	13,073	13,069	0.0%	9.2%
	4+ truck/below 7500 miles	35	35	1.1%	0.1%	37	38	0.5%	-0.5%

		2014				2020			
Inventory Category	Fleet Size	Base	Reg	Red	Share	Base	Reg	Red	Share
HH Tractor	1 truck/above 7500 miles	6,995	7,030	0.5%	13.6%	8,158	8,152	-0.1%	15.2%
	1 truck/below 7500 miles	121	123	1.7%	0.8%	136	137	1.2%	-3.9%
	2 truck/above 7500 miles	2,093	2,103	0.5%	4.0%	2,443	2,443	0.0%	0.6%
	2 truck/below 7500 miles	35	36	1.7%	0.2%	40	40	1.2%	-1.2%
	3 truck/above 7500 miles	1,232	1,238	0.4%	2.1%	1,439	1,437	-0.1%	3.3%
	3 truck/below 7500 miles	20	20	1.7%	0.1%	22	23	1.2%	-0.7%
	4+ truck/above 7500 miles	13,682	13,681	0.0%	-0.5%	16,056	16,042	-0.1%	32.5%
	4+ truck/below 7500 miles	129	131	1.5%	0.8%	148	149	1.0%	-3.7%
HH Single Unit	1 truck/above 7500 miles	1,799	1,806	0.4%	2.6%	2,103	2,100	-0.1%	7.1%
	1 truck/below 7500 miles	101	102	1.7%	0.7%	116	117	1.3%	-3.7%
	2 truck/above 7500 miles	653	656	0.4%	1.1%	762	761	-0.1%	1.6%
	2 truck/below 7500 miles	35	36	1.7%	0.2%	41	41	1.3%	-1.3%
	3 truck/above 7500 miles	435	437	0.4%	0.7%	510	509	-0.2%	2.0%
	3 truck/below 7500 miles	21	22	1.7%	0.1%	24	25	1.3%	-0.8%
	4+ truck/above 7500 miles	4,793	4,792	0.0%	-0.3%	5,652	5,646	-0.1%	16.3%
	4+ truck/below 7500 miles	169	172	1.6%	1.0%	193	195	1.1%	-5.3%
HH Drayage	1 truck	4,299	4,299	0.0%	0.0%	5,584	5,584	0.0%	0.0%
	2 truck	478	478	0.0%	0.0%	620	620	0.0%	0.0%
	3 truck	537	537	0.0%	0.0%	698	698	0.0%	0.0%
	4+ truck	2,687	2,687	0.0%	0.0%	3,490	3,490	0.0%	0.0%
HH Agriculture	Ag non specialty high VMT	1,205	1,217	1.0%	4.5%	1,141	1,136	-0.4%	10.8%
	Ag non specialty lower VMT	183	183	0.0%	0.0%	175	175	0.0%	0.0%
	Ag non specialty mid VMT	173	173	0.0%	0.0%	197	195	-0.9%	4.4%
	Ag specialty vehicle	174	174	0.0%	0.0%	168	168	0.0%	0.0%
HH Utility		88	88	-0.2%	-0.1%	98	98	-0.1%	0.2%
MH instate	1 truck/above 5000 miles	6,164	6,186	0.3%	8.3%	6,721	6,718	0.0%	7.8%
	1 truck/below 5000 miles	146	149	1.6%	0.9%	154	156	1.1%	-4.1%
	2 truck/above 5000 miles	2,024	2,032	0.4%	3.0%	2,203	2,202	0.0%	1.9%
	2 truck/below 5000 miles	46	46	1.6%	0.3%	48	49	1.1%	-1.2%
	3 truck/above 5000 miles	1,201	1,206	0.4%	1.6%	1,310	1,309	-0.1%	1.9%
	3 truck/below 5000 miles	27	27	1.6%	0.2%	29	29	1.0%	-0.7%
	4+ truck/above 5000 miles	11,193	11,211	0.2%	7.2%	12,087	12,086	0.0%	0.8%
	4+ truck/below 5000 miles	192	194	1.5%	1.1%	201	202	0.9%	-4.3%
MH Interstate	1 truck/above 5000 miles	25	25	0.3%	0.0%	28	28	0.0%	0.0%
	1 truck/below 5000 miles	0	0	0.9%	0.0%	0	0	0.4%	0.0%
	2 truck/above 5000 miles	16	16	0.3%	0.0%	17	17	0.0%	0.0%
	2 truck/below 5000 miles	0	0	1.1%	0.0%	0	0	0.6%	0.0%
	3 truck/above 5000 miles	15	15	0.3%	0.0%	17	17	0.0%	0.0%
	3 truck/below 5000 miles	0	0	1.2%	0.0%	0	0	0.6%	0.0%
	4+ truck/above 5000 miles	135	135	0.2%	0.1%	145	145	0.0%	0.0%
	4+ truck/below 5000 miles	2	2	1.2%	0.0%	2	2	0.6%	0.0%
MH Agriculture	Ag non specialty high VMT	240	242	0.9%	0.8%	221	220	-0.4%	2.1%
	Ag non specialty lower VMT	73	73	0.0%	0.0%	70	70	0.0%	0.0%
	Ag non specialty mid VMT	142	142	0.0%	0.0%	149	148	-0.8%	3.0%
	Ag specialty vehicle	50	50	0.0%	0.0%	49	49	0.0%	0.0%
MH Utility		95	95	0.0%	0.0%	105	105	0.0%	0.1%
Buses		2,280	2,280	0.0%	0.0%	2,529	2,529	0.0%	-0.1%
PTO		1,589	1,589	0.0%	0.0%	1,878	1,878	0.0%	0.0%
All		125,354	125,612	0.2%	100.0%	145,537	145,496	0.0%	100.0%

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