Emissions Analysis for the Statewide Truck and Bus Regulation

Cost and Inventory Workshops
July 8, 2008 – Fresno
July 11, 2008 – El Monte
July 14, 2008 - Sacramento

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Outline

- For Discussion Today
  - New Methodologies
  - New Data Sources
  - New and Updated Assumptions
  - 2008 Baseline Activity / Emissions
- Under Development
  - Growth Assumptions
  - Future Year Baseline Emissions and Benefits
  - Regional Baseline Emissions and Benefits
- Next Steps

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SIP Inventory

- Developed using EMFAC2007
- Heavy-heavy duty diesel trucks (HHDDT)
  - Gross vehicle weight rating (GVWR) >33,000 lbs
- Medium-heavy duty diesel trucks (MHDDT)
  - GVWR greater than 14,000 lbs; less than 33,000 lbs
- Basis for State Implementation Plan (SIP) adopted in September 2007
- Simplified treatment of truck fleets due to limited information
- Assumed same age and mileage accrual for all HHDDT and all MHDDT

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New Truck Analysis

- Builds on EMFAC2007
- Maintain HHDDT and MHDDT separation
- Significant improvements in activity assumptions
- Analysis of new databases and surveys of truck owners and operators allow trucking operations to be broken out by operational characteristics into inventory groups
- Assume different ages and mileage accrual schedules for each inventory group

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New Methodologies

- In-State Trucks
  - Separate HHDDT and MHDDT into sub-categories based on body type and operational characteristics
    - Single-unit trucks vs tractors
    - California plated interstate trucks
    - Owner-operators
    - Agricultural
- Out-of-State Trucks
  - Separate trucks from neighboring and non-neighboring states
  - California plated interstate trucks as a separate category
- Buses and Other Categories

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New Categories

- HHDDT (>33,000 lbs GVWR)
  - **Non-Neighboring Out-of-State Tractors***
  - **Neighboring Out-of-State Tractors***
  - **California Interstate Tractors***
  - **In-State Tractors***
  - **In-State Single Unit***
  - Public and Utility Fleets
  - Solid Waste Collection Vehicles
  - **Agricultural Trucks***
- MHDDT (14,000 – 33,000 lbs GVWR)
  - **In-State***
  - **Interstate***
  - **Agricultural***
  - Public and Utility
- Other
  - School bus
  - Other buses
  - Fuel usage for power take off

Sub-categories marked in **bold*** are split into a group of owner-operators and trucks in fleets exceeding one vehicle in size

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Calculating Emissions

$$\sum_{MY\text{-}F} = (Pop_{MY\text{-}F} \times Ac_{MY\text{-}F} \times ER_{MY\text{-}F}) = EMS_{CY}$$

Where

$Pop_{MY\text{-}F}$ =	Population of trucks for each model year within each fleet for a given calendar year;
$Ac_{MY\text{-}F}$ =	Accrual rate (miles traveled per year) per truck by model year and fleet;
$ER_{MY\text{-}F}$ =	Calculated emission rate in grams pollutant per mile driven, assuming statewide speed travel distributions in EMFAC2007 and fleet specific cumulative mileage accrual over the life of the truck, by model year and fleet;
EMS_{CY} =	Emissions calculated in tons per day for a given calendar year.

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New Data Sources

- Updated DMV Registration Data
- International Registration Plan (IRP)
- International Fuel Tax Association (IFTA)
- Vehicle and Inventory and Use Survey (VIUS)
- ARB Vehicle Surveys (on-line, agricultural, others)
- UC-Davis Out-of-State Truck Travel Surveys
- Previous ARB Regulatory Development documents and studies

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DMV Registration Data

- Provides information on in-state and CA interstate trucks
- 40 million total vehicle records, processed twice per year
- Identified population by age and body type
  - Tractor vs single-unit configurations
- Assessed population and age by fleet size and body type
  - Assess owner-operators and small fleets by body type
  - Fleets assessed by name and address combined; with adjustments for different spelling of names or same company with different address

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International Registration Plan

- Registration fee sharing program between States and Provinces
- Program for interstate trucks; informs CA-IRP and out-of-state
- 2005 Summary Report
  - Population in fleets that report mileage in California, by state of registration
- 2005, 2006 IRP data samples by fleet
  - 13 states including AL, AZ, ID, IN, NE, NJ, NV, OK, OR, TN, TX
  - Analyzed for
    - Fraction of miles accrued in California
    - Model year distribution
    - Population of trucks in fleets that enter California
  - Analyzed in two groups
    - Within neighboring states (WA, OR, NV, AZ, ID)
    - Within all other states and Canadian Provinces (non-neighboring)
- 2000-2006 California IRP Truck Database
  - Population, Model Year Distribution, Fraction of Miles Traveled in CA

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International Fuel Tax Agreement

- Fuel tax sharing program between States and Provinces
- Program for interstate trucks
- 2005 – total fuel burned and miles traveled by IFTA trucks in California
- 2006 – 75% complete data providing total fuel burned and miles traveled by IFTA trucks in California by state of registration in program
- 2007 – 100% complete data providing total fuel burned and miles traveled by IFTA trucks in California by state of registration in program

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US Census Vehicle Inventory and Use Survey

- Survey conducted every 5 years by the federal government
- Random and statistically representative
- Several thousand vehicles analyzed
- Last conducted in 2002
- Provides information on truck body types, mileage accrual, odometer, and many other factors
- Used to assess mileage accrual by age, body type
  - In-State: California specific trucks not in IRP/IFTA
  - Interstate: National trucks in IRP/IFTA programs

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ARB Vehicle Surveys

- On-Line Survey
- Vocation-specific surveys including
  - Agricultural
  - Dump Trucks
  - Others
- Used to supplement VIUS and other data
  - For population, age, mileage accrual

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UC Davis Truck Travel Surveys

- 2006 surveys
  - Designed to assess fraction of non-CA diesel fuel burned in California
  - Focus on HHDDT (>33,000 lbs GVWR)
  - Applied survey
    - Border crossings into California
    - One or two days at each site
    - Origin/Destination and other information
    - Vehicle age by state of registration
- Report finalized in 2008

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Retained Methodologies (Developed for Regulatory Actions)

- Some fleets modeled separately because regulations already apply to them
  - Public and Utility Fleets
  - Solid Waste Collection Vehicles
  - Ports and Railyard Trucks
- Regulatory documents contain assumptions based on previous research for age, accrual, etc
- We used these assumptions to develop inventory groups for each regulated category

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New and Updated Assumptions

- HHDDT
  - HHDDT Interstate Trucks
  - HHDDT In-State Trucks
  - Comparison of model year distributions
- MHDDT
- Buses/Other Categories
- “Pre-Buy”

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HHDDT Interstate Trucks (1)

- Population
  - CA Trucks: DMV IRP database provides population, age
  - Out-of-State
    - 2005 summary data to estimate population in fleets that enter CA
    - 1/12th of annual data for 13 states – collected from state reports
      - Reporting based; no seasonal bias
    - Analyzed to estimate fraction of trucks that enter California by state
      - Neighboring states ~60% enter CA in a year
      - Non-neighboring states ~40% enter CA in a year
  - Owner-operator fractions assumed same as CA-IRP; derived from CA-IRP data
- Mileage Accrual
  - Interstate truck schedule from analysis of national IRP trucks in VIUS
  - Fraction of mileage accrual in CA from analyzing IRP and IFTA data
  - Total miles traveled in CA by state from IFTA data

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HHDDT Interstate Trucks (2)

California IRP Trucks
2008 Population: 60,000; including 17,000 owner operators
2008 Average Age: 6 years; 6.7 years for owner operators
2008 Average Accrual in California: 43,000 miles
Fraction of Total Mileage in California: 57%

Neighboring States (WA, OR, ID, NV, AZ)
2008 Population: 41,000 total including 7000 owner operators
2008 Average Age: 6 years; no difference for owner operators
2008 Average Accrual in California: ~30,000 miles
Fraction of Total Mileage in California: 40%

Non-Neighboring States (All others)
2008 Population: 450,000; including 10,000 owner operators
2008 Average Age: 3 years; no difference for owner operators
2008 Average Accrual in California: ~8,000 miles/yr
Fraction of Total Mileage in California: 10%

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HHDDT In-State Trucks (1)

- Population
  - Developed from DMV Registration database
  - Processed by body type and other factors
  - Include trucks previously excluded in EMFAC
    - "Age -1"; trucks registered in CA with owner address outside of CA
  - Analyze by name and address to assess age by fleet size
- Mileage accrual
  - Analyzed CA trucks in VIUS by body type
  - Confirmed with analysis of in-state trucks in Western States
  - Developed accrual schedules for each fleet
  - Supplemented with ARB survey data
- Lifetime mileage
  - Combination accrual developed for used truck sales across inventory categories

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HHDDT In-State Trucks (2)

- Vocationally Defined Trucks
  - Agricultural Trucks
    - Assumptions developed from industry-specific surveys
  - Port and Railyard Trucks
    - Assumptions developed for regulation; based on surveys and data from Ports/Railyards (ARB, 2007)
  - Solid Waste Collection Vehicles
    - Assumptions based on surveys; population readily identifiable in DMV registration data by owner (ARB, 2003)
  - Public/Utility Vehicles
    - Assumptions developed for regulation; based on surveys; population readily identifiable in DMV registration data (ARB, 2005)

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HHDDT In-State Trucks (3)

- New assumptions for vocationally defined HHDDT

Agricultural
2008 Population: 12,000 (1,500 owner-op)
2008 Average Age: 17 years
2008 Average Accrual in California: 22,000 miles/yr
Fraction of Total Mileage in California: 100%

Port and Railyard Trucks
2008 Population: 22,000 (11,000 own-op)
2008 Average Age: 12
2008 Average Accrual in California: 43,000
Fraction of Total Mileage in California: 100%

Public/Utility
2008 Population: 15,000
2008 Average Age: 14
2008 Average Accrual in California: 8000 miles/yr
Fraction of Total Mileage in California: 100%

Solid Waste Collection
2008 Population: 12,000
2008 Average Age: 11
2008 Average Accrual in California: 16000 miles/yr
Fraction of Total Mileage in California: 100%

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HHDDT In-State Trucks (4)

- Developed two broad categories
  - Trucks that travel and operate similarly grouped together
  - Sales and use patterns between categories are different
- In-State Tractors
  - Purchased used or transferred from interstate to in-state service
  - Tractors that pull trailers
- In-State Single-Unit Trucks
  - Single-unit body types
  - Drive half as many miles on average as in-state tractors
- Populations from DMV after subtracting vocationally defined trucks by body type

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HHDDT In-State Trucks (5)

In-State Tractors

2008 Population: 63,000; including 15,000 owner operators
2008 Average Age: 10 years; 12 years for owner operators
2008 Average Accrual in California: 51,000 miles/yr
Fraction of Total Mileage in California: 100%

In-State Single-Unit Trucks

2008 Population: 43,000; including 9000 owner operators
2008 Average Age: 10.5 years; 12 years for owner operators
2008 Average Accrual in California: 25,000 miles/yr
Fraction of Total Mileage in California: 100%

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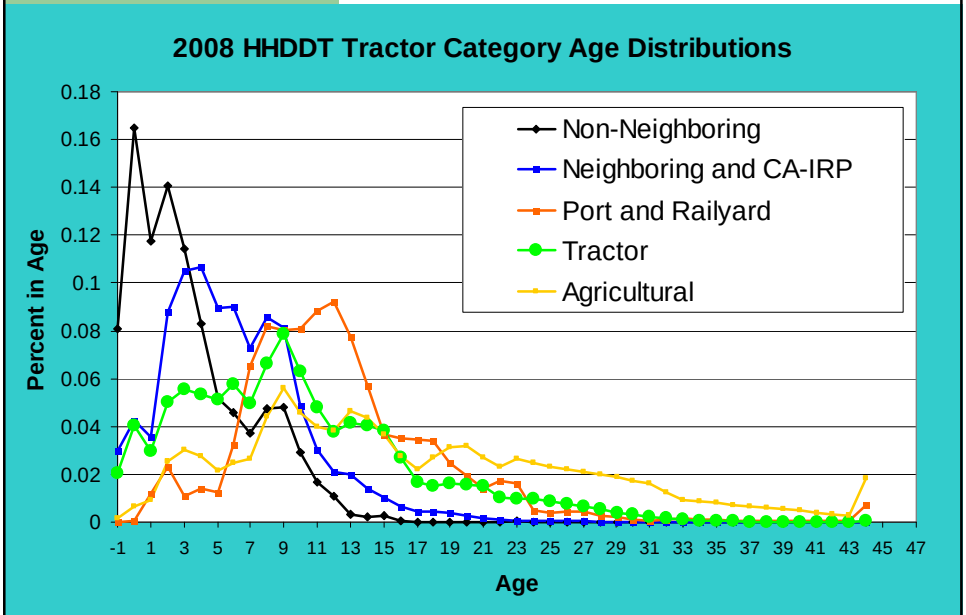

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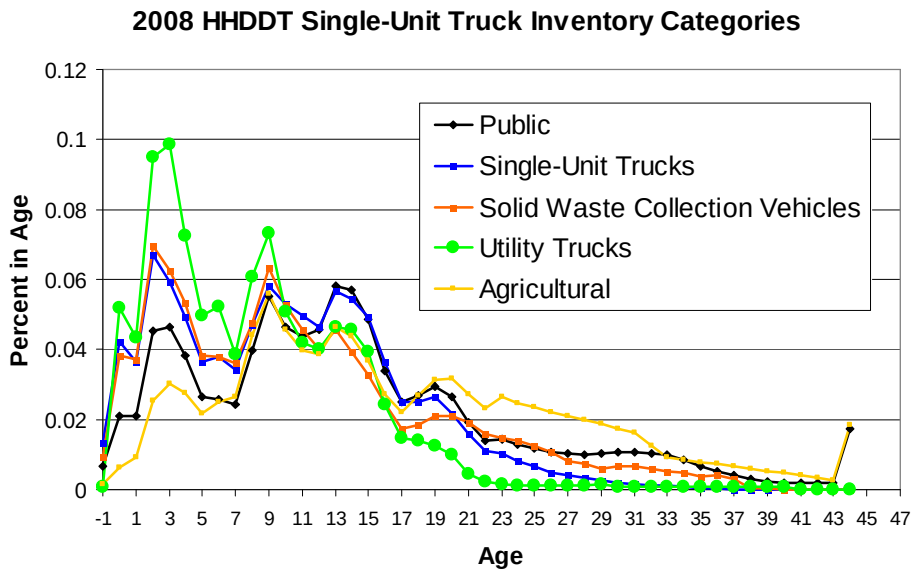

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MHDDT (1)

- Nearly all MHDDT in CA are in-state
- Population assessed from DMV registration
- Accrual rates from VIUS, CA-specific
- Some public fleet trucks assessed using surveys and regulatory documents
- Agricultural trucks assessed using industry-specific survey
- Very small interstate contribution
  - Population from CA-IRP and National IRP data
  - Accrual from VIUS

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MHDDT (2)

In-State

2008 Population: 200,000 (65,000 owner-op)
2008 Average Age: 8 (9 owner-op)
2008 Average Accrual in California: 20,000 miles/yr
Fraction of Total Mileage in California: 100%

Interstate

2008 Population: 7000 (1000 owner-op)
2008 Average Age: 4 years
2008 Average Accrual in California: 4,000 miles/yr
Fraction of Total Mileage in California: 20%

Public/Utility

2008 Population: 23,000
2008 Average Age: 11 years
2008 Average Accrual in California: 6000 miles/yr
Fraction of Total Mileage in California: 100%

Agricultural

2008 Population: 9500 (1200 owner-op)
2008 Average Age: 17
2008 Average Accrual in California: 11,000
Fraction of Total Mileage in California: 100%

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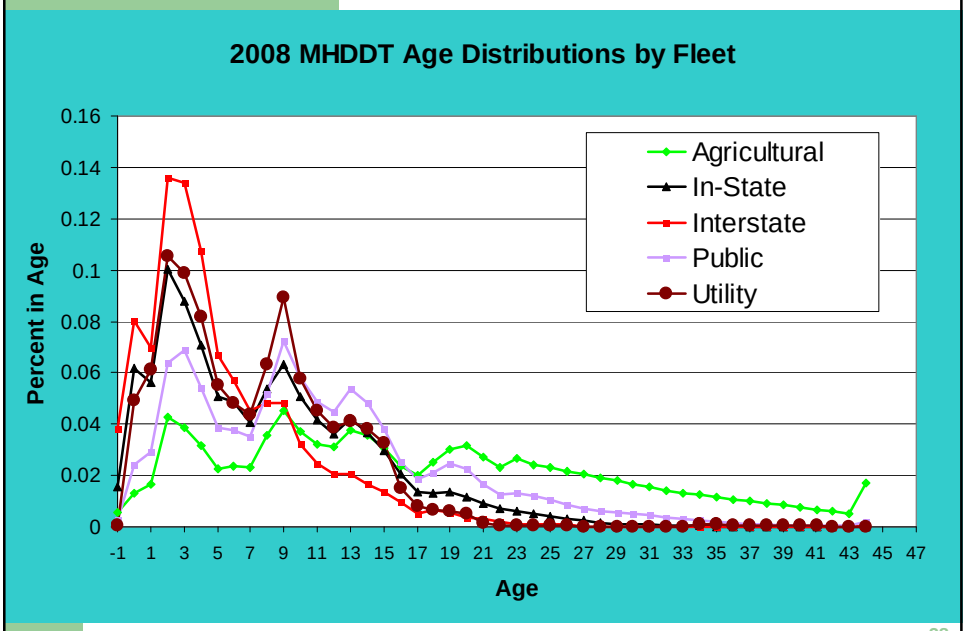

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Buses and Other Categories (1)

- School Buses
  - Population assessed using DMV and survey data
  - Accrual consistent with EMFAC2007 and previous surveys
- Other Buses
  - Approach consistent with EMFAC2007
- Power Take-Off
  - Annual fuel usage from CA Board of Equalization
  - Limited data, small category leads to simplistic approach to develop emissions estimates
  - Assume fuel consumption at average EMFAC2007 speed; estimate equivalent VMT and emissions

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Buses / Other Categories (2)

School Buses

2008 Population: 27,000
2008 Average Age: 11 years
2008 Average Accrual in California: 13,000 miles/yr
Fraction of Total Mileage in California: 100%

Other Buses

2008 Population: 11,000
2008 Average Age: 9.5 years
2008 Average Accrual in California: 18,000 miles/yr
Fraction of Total Mileage in California: 100%

Power-Take Off

2008 Annual Fuel Consumption: 29 million gallons/yr
Assumed Load: assumed equivalent to EMFAC average speed (~158 MVMT/yr)

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Summary

Fleet	2008 Annual Population	Average Age	Average Accrual	2008 Accrual in CA	VMT Pct
HH Out-of-State	491,000	3.6	10,000	12%	28%
HH CA-IRP	60,000	6	43,000	57%	15%
HH Tractor	63,000	10	51,000	100%	18%
HH Single	43,000	10.5	25,000	100%	6%
HH Port	22,000	12	43,000	100%	5%
HH Ag	12,000	17	22,000	100%	2%
HH Other	27,000	12.5	11,000	100%	2%
MH In-State	200,000	8	20,000	100%	23%
MH Interstate	9,000	5	4,000	20%	0.2%
MH Ag	9,500	17	11,000	100%	0.6%
MH Other	23,000	11	6,000	100%	0.8%

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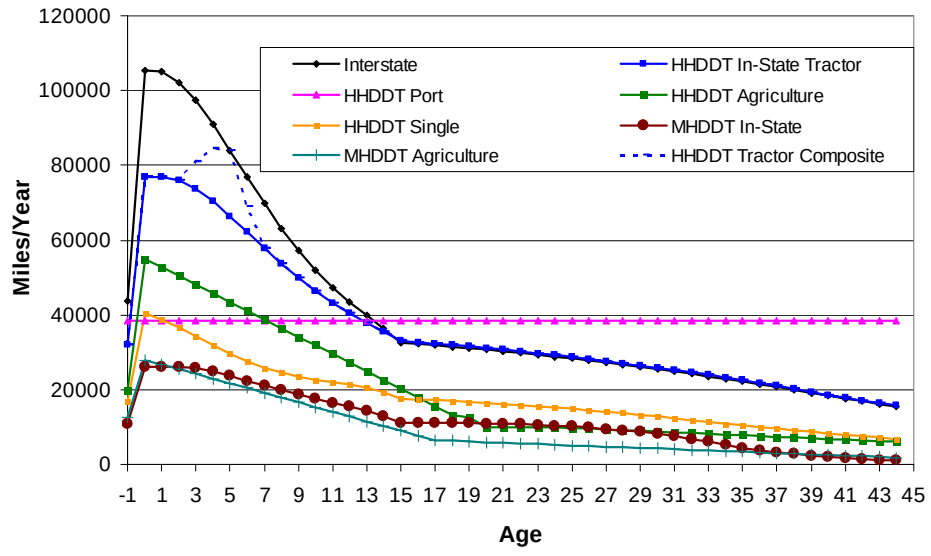
Revised Accrual Rates



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"Pre-Buy" Assumptions

- Background Information
  - Truck sales are heavily influenced by economic conditions
    - Can be modeled as a function of national transportation economy
  - Emissions standards have had a minor impact historically
    - But impact can be significant when standards generate a major technology change
  - Current economy significantly depressed 2007 truck sales
    - We believe most of these sold were 2006 engine model year trucks
- Forecasting future HHDDT sales
  - Sales will continue to be lower than historical average through 2012 due to weak economy and 2007/2010 truck standards; then rebound beginning in 2013
  - This will impact future truck age distributions and emissions
  - Even so we see no evidence that supply will not meet demand

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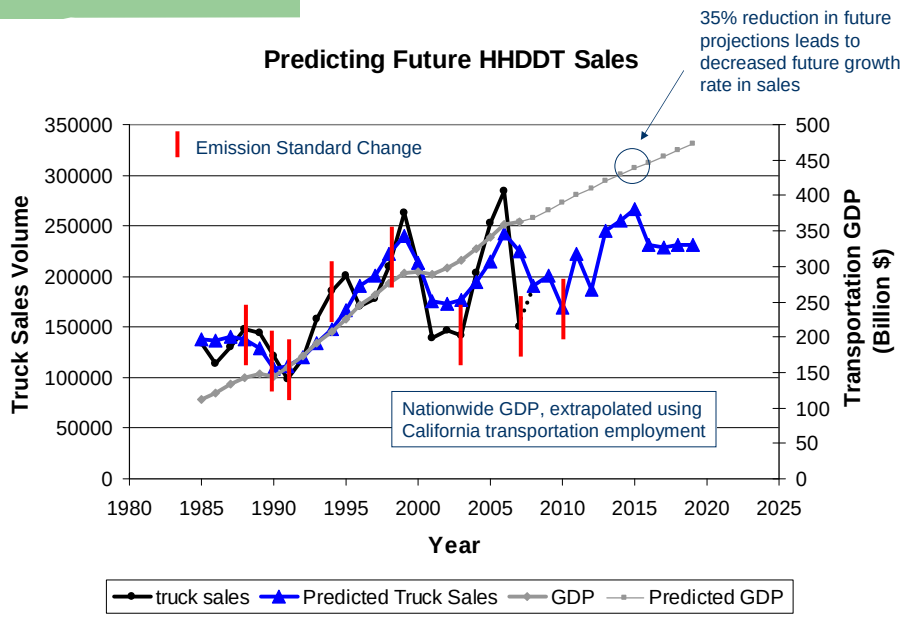

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2008 Baseline Activity / Emissions

- Apply new methodology
- Compare to EMFAC2007
  - Used as the basis for current SIPs
- Results are very different in important ways
  - Base year VMT is higher
    - Higher interstate VMT than assumed in EMFAC2007
  - Slight emissions increase
    - Even though VMT is higher than in EMFAC2007, emissions do not increase very much
    - Due to younger truck average age than in EMFAC2007
  - These trends change between calendar year based on relationships between age distribution and when emission standards apply.

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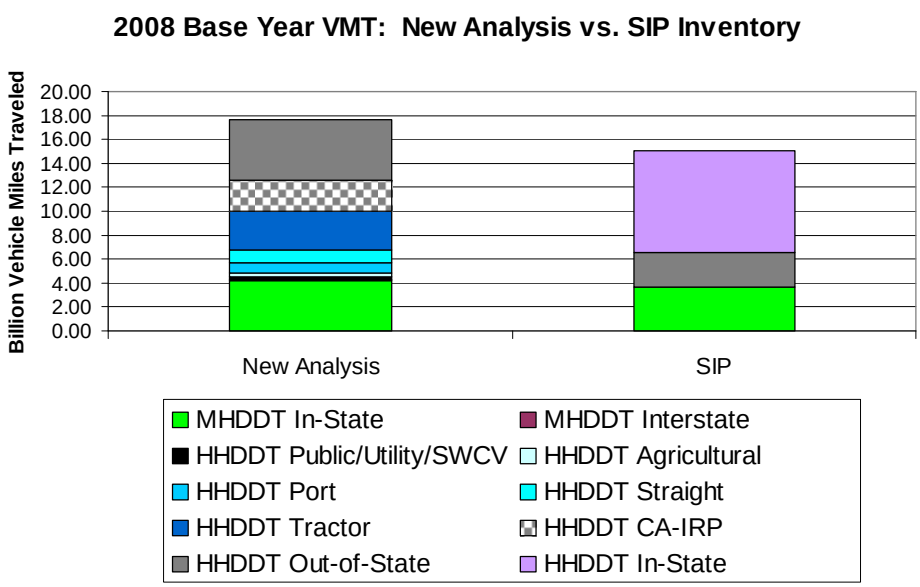

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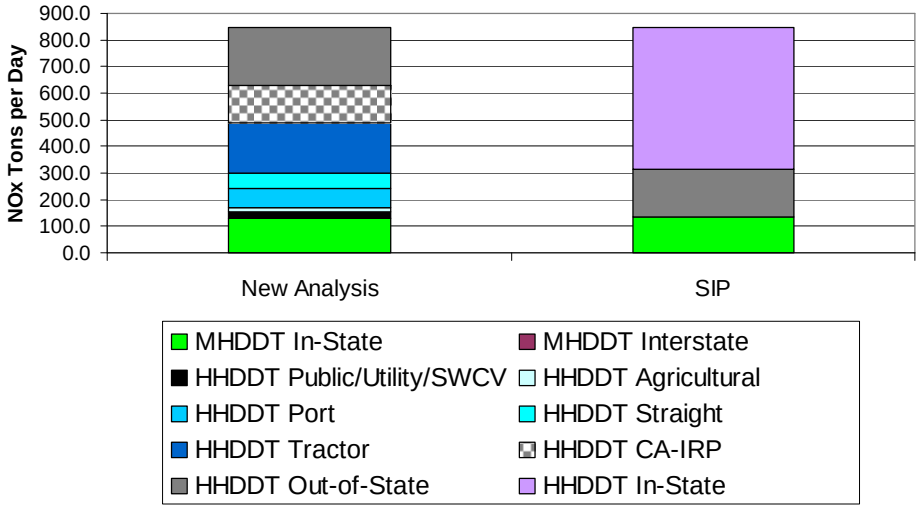
2008 NOx: New Analysis vs. SIP Inventory



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Key HHDDT Differences

	New Inventory	SIP
Population	718,000 trucks per year (551,000 interstate)	215,000 trucks/day (54,000 interstate)
Age	Multiple categories; average age range 3-17 years	Average age ~ 12 years
Accrual	20,000 miles/truck	53,000 miles/truck
VMT	13 Billion VMT; 57% interstate	11 Billion VMT; 25% interstate

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Emissions Impact

- New statewide VMT ~20% greater than the SIP inventory, but statewide NOx is only ~3% higher
- Why is increase not proportional?
  - Composite HHDDT average age is younger than previously assumed
  - Interstate trucks are younger, drive more
  - In-state trucks are roughly same age as in EMFAC; drive less

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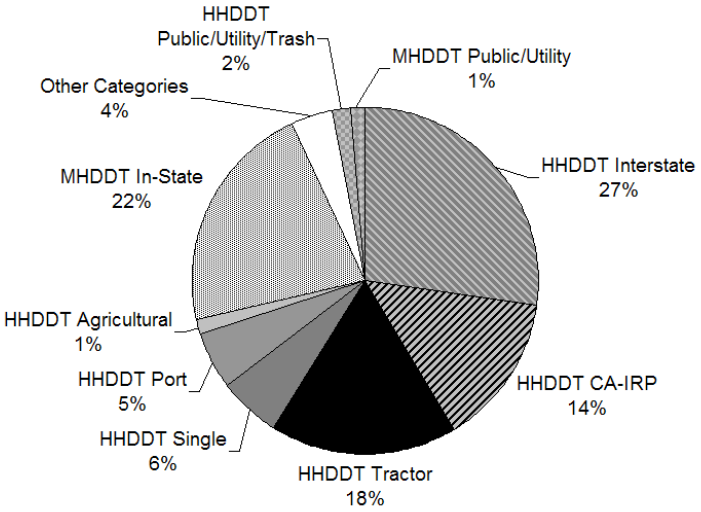
2008 VMT by Category



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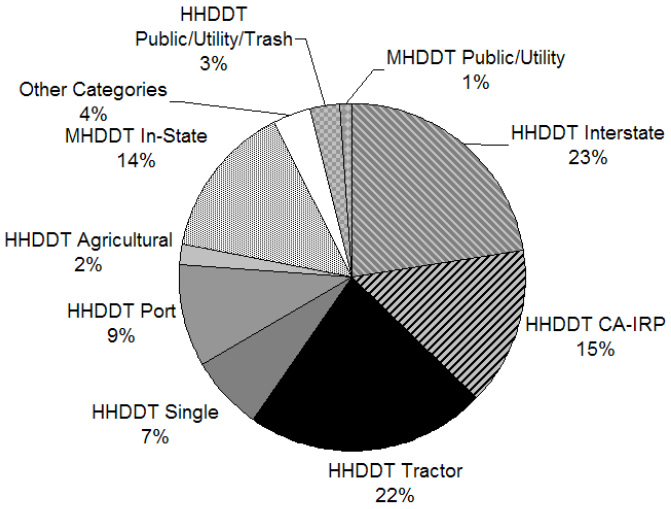
2008 NOx and PM10 Percent by Category



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Summary of Results

- More VMT than in the SIP
  - More travel in CA-IRP and out-of-state than previously assumed
- More VMT leads to little change in emissions
  - Interstate trucks much younger than previously estimates
- More than 50% of HHDDT VMT traveled by relatively young trucks that will be only marginally impacted by the proposed rule
- In-state trucks drive less, especially single-unit trucks, than previously estimated

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Review of Growth Assumptions

- Until now, assuming steady growth
  - Our growth rates agree well with general economic trends and with estimates developed by regional transit agencies
- Rapidly increasing fuel prices have impacted growth in truck VMT, but magnitude and long term trend is unclear
- We are reassessing growth rates and sensitivity to fuel prices, economic conditions, and other factors

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Under Development: Regional Estimates

- Rule is applied on a statewide basis
- SIPs are regionally focused
  - South Coast; San Joaquin Valley highest priority to assess
- Major field study in progress
  - Origin-Destination surveys
    - Designed to assess spatial allocation by inventory category
    - 6000 Origin-Destination surveys collected from 30 sites; 3000 processed
  - License plate pictures
    - Designed to assess differences between truck registration location and travel by inventory category
    - 123,000 license plates collected at 62 sites; 30,000 processed
- Once field study completed, regional emissions and benefit assessments will be finalized

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Next Steps

- Short Term
  - Complete future year baseline and benefits assessments
  - Develop inventory documentation for public review
  - Meet with interested stakeholders
  - Take comments and make changes if necessary
- Longer Term
  - Field study in process
  - Develop regional emissions estimates
  - Update EMFAC2009/2010
- Under Development
  - Working to access thousands of traffic counters to develop truck travel measurements across state
  - Developing Caltrans-ARB joint statewide freight modeling system to better understand traffic patterns, impacts on infrastructure, activity, and emissions

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