



**Public Workshop To Discuss
Reducing Emissions from
Cargo Handling Equipment**

Diesel-Fueled Cargo Handling Equipment Emissions Inventory Development

August 24, 2005

California Environmental Protection Agency



Air Resources Board

Current Cargo Handling Equipment Emission Inventory

- **Cargo handling equipment emissions embedded in the ARB's OFFROAD model**
 - **No direct method to extract emissions for specific cargo handling equipment from the OFFROAD model**
 - **To support rule development, ARB staff have developed new emission estimates for cargo handling equipment**

Goals for the Cargo Handling Equipment Emission Inventory Development

- **Develop a CHE-specific element in the ARB OFFROAD model for ports and intermodal rail yards**
- **Use updated population and activity data**
- **Generate emission estimates for NO_x, PM, CO, and HC**
- **Accurately reflect adopted regulations and other programs in the baseline inventory and forecasts**

Emission Estimation Methodology

- **“Bottom up” methodology based on survey of California’s ports and intermodal rail yards**
- **Data sources:**
 - **ARB’s 2004 Cargo Handling Equipment Survey**
 - **2001 Port of Los Angeles Inventory**
 - **2002 Port of Long Beach Inventory**
- **Emissions allocated to districts based on location of ports and intermodal rail yards**

Emission Estimation Details

- Base Year is 2004
- Emission estimates are made using the estimation methodology in the ARB's OFFROAD model
- Emissions are estimated based on power use emission factors (g/bHp-hr)
- Equipment profiles (including average horsepower and average annual use) have been developed for nine equipment types

Emission Estimation Details (cont.)

- Equipment Types
 - Basic Container Handling Equipment
 - Cranes
 - Excavators
 - Forklifts
 - Other
 - Sweepers/Scrubbers
 - Tractors/Loaders/Backhoes
 - Yard Trucks

Basic Methodology for Estimating Emissions from Cargo Handling Equipment

$$E_y = S \text{ Pop}_{t, v, x} * \text{HP} * \% \text{Load}_t * \text{EF}_{v, x} * \text{Hrs}_t$$

Where:

- E = pollutant emissions (HC, CO, NOx, and PM)
- Pop = cargo handling equipment type-specific population
- HP = engine average rated brake horsepower
- % Load = average engine load
- EF = emission factor
- Hrs = average annual use
- y = inventory year
- t = equipment type (cranes, yard trucks, etc)
- v = engine age (based on model year)
- x = horsepower range of the engine

Cargo Handling Emissions Inventory Inputs

Cargo Handling Equipment Populations

Equipment Type	Statewide Numbers
Basic Container Handling Equipment	487
Cranes	321
Excavators	28
Forklifts	464
Other	55
Sweeper/Scrubber	28
Tractor/Loader/Backhoe	93
Yard Trucks	2309
Total	3785

Average Rated Horsepower

Equipment	Horsepower Ranges						
	<50	51 - 120	121 - 175	176 - 250	251 - 500	501 - 750	>750
Basic Container Handling Equip		111	164	236	310		930
Crane	43	112	150	210	412	657	966
Excavator				245	387		
Forklift	45	103	154	208	278		
Other	50	103	146	239	347		
Sweeper/Scrubber	48	106	148	180			
Tractor/Loader/Backhoe	40	88	148	203	356	750	
Yard Tractor		85	172	212	434	635	

Average Engine Load

Equipment Type	Engine Load
Basic Container Handling Equipment	0.59
Cranes	0.43
Excavators	0.57
Forklifts	0.30
Other	0.51
Sweeper/Scrubber	0.68
Tractor/Loader/Backhoe	0.55
Yard Trucks	0.45

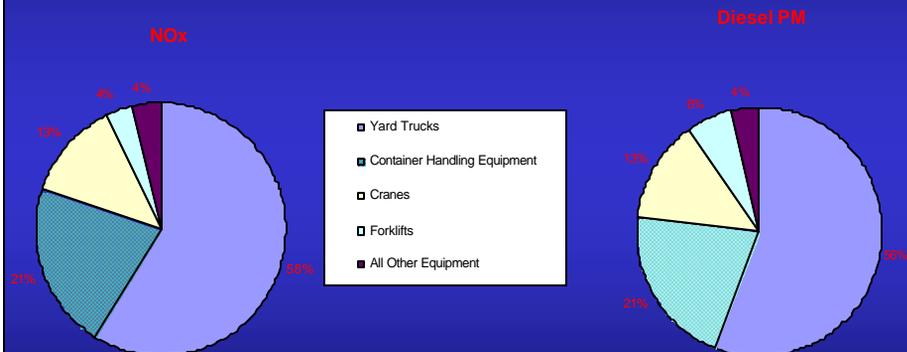
Emission Factors

- From the ARB's OFFROAD Model
- Horsepower and Model Year specific
- Not Equipment Type specific
- Zero-hour emission factors
 - Weighted to reflect population mix of on-road and off-road engines and that equipment with emission controls
- Deterioration based on an equipment-specific "useful life" in years

Average Annual Use

Equipment Type	Pre-2010 Ave. Annual Use (hrs)	Post-2010 Ave. Annual Use (hrs)
Basic Container Handling Equipment	2388	2818
Cranes	1371	1673
Excavators	2222	2333
Forklifts	1098	1274
Other	786	786
Sweeper/Scrubber	872	872
Tractor/Loader/Backhoe	755	823
Yard Trucks	2536	3043

Preliminary CHE 2004 CHE Emissions By Equipment Type



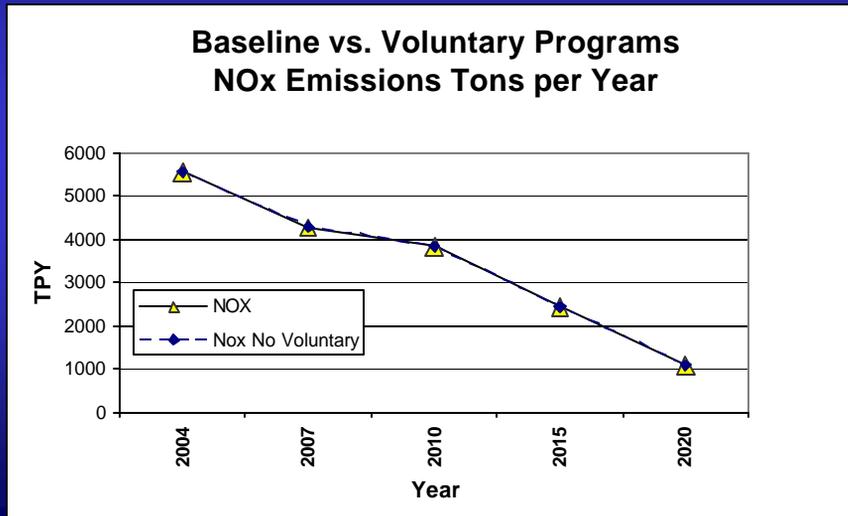
Preliminary CHE Emission Baseline NOx Emissions and Projections for 2010 and 2020

Equipment Type	Emissions (tons per day)		
	2004 (Baseline)	2010	2020
Basic Container Handling Equipment	3.24	2.81	0.85
Cranes	1.93	1.50	0.74
Excavators	0.24	0.14	0.03
Forklifts	0.54	0.32	0.11
Other	0.09	0.08	0.02
Sweeper/Scrubbers	0.04	0.03	0.01
Tractor/Loader/Backhoe	0.18	0.13	0.04
Yard Tractor	8.94	5.46	1.11
Total	15.2	10.47	2.91

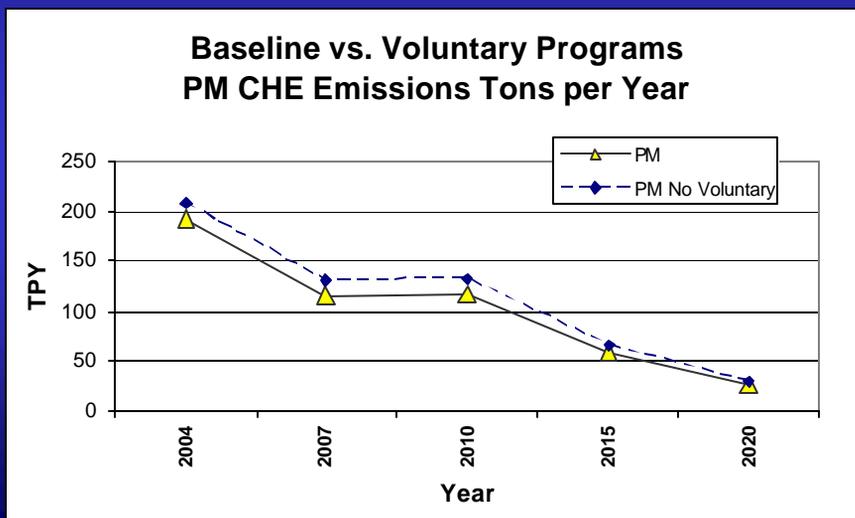
Preliminary CHE Emission Baseline Diesel PM Emissions and Projections for 2010 and 2020

Equipment Type	Emissions (tons per day)		
	2004 (Baseline)	2010	2020
Basic Container Handling Equipment	0.11	0.09	0.02
Cranes	0.07	0.05	0.02
Excavators	0.01	<0.01	<0.01
Forklifts	0.03	0.01	<0.01
Other	<0.01	<0.01	<0.01
Sweeper/Scrubbers	<0.01	<0.01	<0.01
Tractor/Loader/Backhoe	0.01	<0.01	<0.01
Yard Tractor	0.29	0.15	0.02
Total	0.52	0.30	0.06

CHE NOx Emission Trends: Baseline (2004) through 2020



CHE Diesel PM Emission Trends: Baseline (2004) through 2020



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