PORT OF LOS ANGELES INVENTORY OF AIR EMISSIONS - 2010

THE PORT OF LOS ANGELES

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Prepared by:
STARCREST CONSULTING GROUP, LLC

THE PORT OF LOS ANGELES INVENTORY OF AIR EMISSIONS FOR CALENDAR YEAR 2010

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ACRONYMS AND ABBREVIATIONS

Act	Activity
ARRA	American Reinvestment and Recovery Act
AMP	alternative maritime power
APL	American Presidents Line
APPS	Act to Prevent Pollution from Ships
AQMP	Air Quality Management Plan
APM	A. P. Moeller
AS	actual speed
ATB	articulated tug and barge
BACT	Best Available Control Technology
BNSF	Burlington Northern Santa Fe Railroad
BSFC	brake specific fuel consumption
BTH	Business Transportation and Housing Agency
BTM	body type model (heavy-duty trucks)
BW	breakwater
CAAP	Clean Air Action Plan
Cal/EPA	California Environmental Protection Agency
CARB	California Air Resources Board
CEC	California Energy Commission
CF	control factor
CH_4	methane
CHE	cargo handling equipment
CO	carbon monoxide
CO_2	carbon dioxide
CRC	Coordinating Research Council
D	distance
CTP	Clean Truck Program
DB	dynamic braking
DF	deterioration factor
DMV	Department of Motor Vehicles
DOC	diesel oxidation catalyst
DOE	Department of Energy
DPF	diesel particulate filter
DPM	diesel particulate matter
DR	deterioration rate
DTR	Drayage Truck Registry

DWT	deadweight tonnage
E	emissions
ECA	Emission Control Area
EEIA	Energy and Environmental Analysis
EF	emission factor
EI	emissions inventory
EMD	Electromotive Division
EPA	U.S. Environmental Protection Agency
FCF	fuel correction factor
g/bhp-hr	grams per brake horsepower-hour
g/day	grams per day
g/kW-hr	grams per kilowatt-hour
g/mi	grams per mile
GHG	greenhouse gas
GM	goods movement
GMP	Goods Movement Plan
GVWR	gross vehicle weight rating
GWP	global warming potential
HC	Hydrocarbons - total
HDDV	heavy-duty diesel vehicle
HDV	heavy-duty vehicle
HFCs	hydrofluorocarbons
HFO	heavy fuel oil
hp	horsepower
hrs	hours
ICTF	Intermodal Container Transfer Facility
IFO	intermediate fuel oil
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change
ITB	integrated tug and barge
kW	kilowatt
L.A.	Los Angeles
l/cyl	liters per cylinder
LF	load factor
LLA	low load adjustment
Lloyd's	Lloyd's Register of Ships
LNG	liquefied natural gas
LPG	liquefied petroleum gas

LSI	large spark ignited (engine)
M&N	Moffatt & Nichol Engineers
MarEx	Marine Exchange of Southern California
MCR	maximum continuous rating
MDO	marine diesel oil
MGO	marine gas oil
MMGT	million gross tons
MOU	Memorandum of Understanding
mph	miles per hour
MS	maximum speed
MY	model year
N	north
NAAQS	National Ambient Air Quality Standards
nm	nautical miles
NO_x	oxides of nitrogen
N_2O	nitrous oxide
NYK	Nippon Yusen Kaisha
NRE	National Railway Equipment Co.
OBD	on-board diagnostics
OCR	optical character recognition
OGV	ocean-going vessel
PCST	Pacific Cruise Ship Terminals
PFCs	perfluorocarbons
PHL	Pacific Harbor Line
PM	particulate matter
PM_{10}	particulate matter less than 10 microns in diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter
PMSA	Pacific Merchant Shipping Association
POLB	Port of Long Beach
ppm	parts per million
PZ	precautionary zone
Reefer	refrigerated vessel
RFID	radio frequency identification
RH	relative humidity
RIA	Regulatory Impact Analysis
RO	residual oil
rpm	revolutions per minute
RSD	Regulatory Support Document

RTG	rubber tired gantry crane
S	sulfur
SCAG	Southern California Association of Governments
SCAQMD	South Coast Air Quality Management District
SF_6	sulfurhexafluoride
SFC	specific fuel consumption
SO_x	oxides of sulfur
SoCAB	South Coast Air Basin
SPBP	San Pedro Bay Ports
SSA	Stevedoring Services of America
TAP	Technology Advancement Program
TWG	Technical Working Group
TEU	twenty-foot equivalent unit
TICTF	Terminal Island Container Transfer Facility
tpd	tons per day
tpy	tons per year
UDDS	Urban Dynamometer Driving Schedule
U.S.	United States
ULSD	ultra low sulfur diesel
UNFCCC	United Nations Framework Connection on Climate Change
UP	Union Pacific Railroad
USCG	U.S Coast Guard
VBP	vessel boarding program
VDEC	verified diesel emission control system
VIN	vehicle identification number
VLCS	very large cargo ship
VMT	vehicle miles of travel
VOCs	volatile organic compounds
VSR	vessel speed reduction
VSRIP	Vessel Speed Reduction Incentive Program
VTS	vessel traffic service
W	west
ZH	zero hour
ZMR	zero mile rate

EXECUTIVE SUMMARY

The Port of Los Angeles (the Port) shares San Pedro Bay with the neighboring Port of Long Beach (POLB). Together, the San Pedro Bay Ports comprise a significant regional and national economic engine for California and the United States (U.S.), through which approximately 33% of all U.S. containerized trade flows[1]. For the first time in 4 years, throughput at the Port increased compared to prior the year and economic forecasts suggest that the demand for containerized cargo moving through the San Pedro Bay region will increase over the next two decades[2]. The ability of the San Pedro Bay Ports to accommodate the projected growth in trade will depend upon the ability of the two ports and their tenants to address adverse environmental impacts and, in particular, air quality impacts that result from such trade. In November 2006, the San Pedro Bay Ports adopted the joint San Pedro Bay Ports Clean Air Action Plan (CAAP) which was designed to reduce health risks and emissions associated with port-related operations, while allowing port development to continue. On November 22, 2010, the harbor commissioners of the two ports unanimously approved an update to the CAAP that identifies longer-term goals that build upon the commitments made in the original CAAP[3]. In order to track CAAP progress, the Port has committed to develop annual inventories of port-related sources starting with the 2005 Inventory of Air Emissions (which served as the CAAP baseline).

This study, the 2010 Inventory of Air Emissions, includes emissions estimates based on 2010 activity levels and a comparison with 2005 to 2009 emissions estimates to track CAAP progress. As in previous inventories, the following five source categories are included:

- Ocean-going vessels
- Harbor craft
- Cargo handling equipment
- Railroad locomotives
- Heavy-duty vehicles

Exhaust emissions of the following pollutants that can cause local impacts have been estimated:

- Particulate matter (PM) (10-micron, 2.5-micron)
- Diesel particulate matter (DPM)
- Oxides of nitrogen (NO_x)
- Oxides of sulfur (SO_x)
- Hydrocarbons (HC)
- Carbon monoxide (CO)

[1] North America: Container Port Traffic (1990-2010), 2010 data, American Association of Port Authorities.
[2] San Pedro Bay Container Forecast Update, The Tioga Group, Inc., July 2009.
[3] *http://www.cleanairactionplan.org/*

This study also includes emission estimates of greenhouse gases (GHGs) from port-related tenant operational sources. The following GHGs have been estimated:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)

Methodology Overview and Geographical Extent

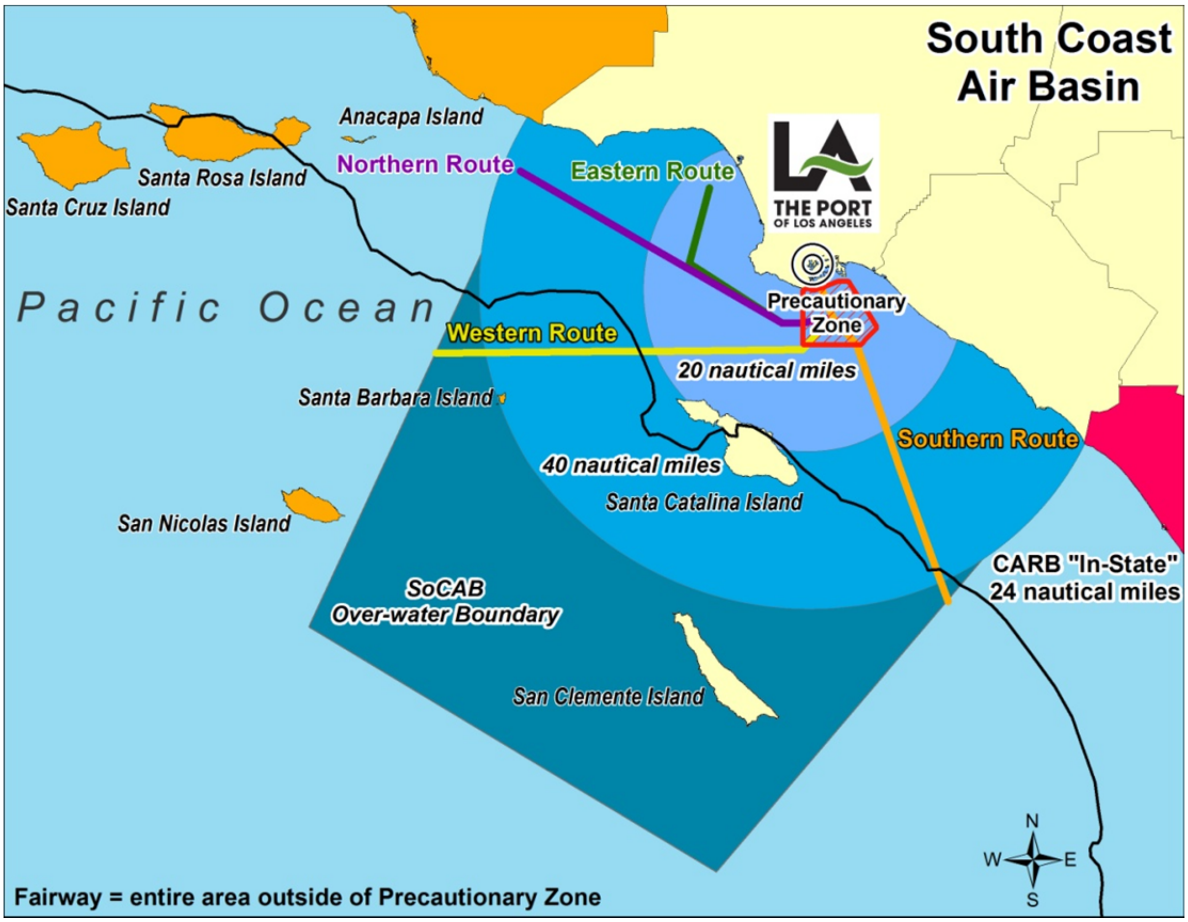
Port tenants and shipping lines play an essential role in the development of an activity-based emissions inventory (EI) by providing the most accurate activity and operational information available. Emissions estimates are developed for each of the various source categories in a manner consistent with the latest estimating methodologies agreed upon by the Port and the participating regulatory agencies. The information gathered, analyzed, and presented in this EI continues to improve the understanding of the nature and magnitude of port-related emission sources. Development of this inventory was coordinated with the U.S. Environmental Protection Agency - Region 9 (EPA), California Air Resources Board (CARB), and the South Coast Air Quality Management District (SCAQMD).

The geographical extent of the inventory is described in Section 1 and in each source category section of the report. The geographical extent of the port-related emissions did not change from previous inventories and includes emissions from all source categories within the harbor district; emissions from rail locomotives and on-road trucks transporting cargo to or from the Port up to the cargo's first point of rest within the South Coast Air Basin (SoCAB) or up to the basin boundary, whichever comes first; and emissions from commercial marine vessels within the harbor and up to the study area boundary. Figure ES.1 shows the SoCAB boundary.

Figure ES.1: South Coast Air Basin Boundary

Figure ES.2 shows the geographical extent for the ocean-going vessels and harbor craft. The over-water boundary is bounded in the north by the southern Ventura County line at the coast and in the south with the southern Orange County line at the coast.

Figure ES.2: OGV Inventory Geographical Extent



Summary of 2010 Activity

Table ES.1 lists the number of vessel calls and the container cargo throughputs for calendar years 2005 to 2010. The average number of TEUs per containership call was at its highest for this period in 2010, which means that, on average, more TEUs were handled per vessel call in 2010 than in the previous years. The TEU throughput increased by 16% from the previous year, the number of vessel calls increased by 1% and the containership calls remained the same. Compared to 2005, the number of TEU increased by 5%, containership calls decreased by 9% and the TEU/containership-call efficiency improved by 14%.

Table ES.1: TEUs and Vessel Call Comparison, %

Year	All Calls	Containership Calls	TEUs	Average TEUs/Call
2010	2,035	1,355	7,831,902	5,780
2009	2,010	1,355	6,748,995	4,981
2008	2,239	1,459	7,849,985	5,380
2007	2,527	1,573	8,355,038	5,312
2006	2,703	1,627	8,469,853	5,206
2005	2,501	1,481	7,484,625	5,054
Previous Year (2010-2009)	**1%**	**0%**	**16%**	**16%**
CAAP Progress (2010-2005)	**-19%**	**-9%**	**5%**	**14%**

In 2010, there were several significant changes that impacted 2010 port-wide emissions and resulted in lower emissions compared to previous years. Major 2010 highlights include:

- For ocean-going vessels, increased Vessel Speed Reduction (VSR) compliance which impacts all pollutants and CARB's marine fuel regulation was in effect for the entire calendar year for main and auxiliary engines and auxiliary boilers at berth and within 24 nautical miles (nm) from coast with significant PM and SO_x emission reductions.

- For heavy-duty vehicles, implementation of the Port's Clean Truck Program has resulted in significant turn-over of older trucks to newer and cleaner trucks. The second phase of the progressive ban was implemented by January 2010 and all pre-1993 trucks along with un-retrofitted 1994-2003 trucks were banned from the port. The call-weighted average age of the Port-related truck fleet is 2.2 years in 2010 compared to 6.9 years in 2009 and 11.2 years in 2005.

- For harbor craft, implementation of CARB's regulation along with funding incentives resulted in continued replacement of existing older vessels and engines with cleaner units and lower emissions.

- For the cargo handling equipment, implementation of CAAP measures and CARB's regulations along with funding incentives resulted in continued replacement of existing older equipment with cleaner units and lower emissions.

- For locomotives, the fleet-wide emission rates continued to decrease due to the continued fleet turnover and introduction of cleaner line haul and switcher locomotives.

Summary of 2010 Emission Estimates
The results for the Port of Los Angeles 2010 Inventory of Air Emissions are presented in this section. Table ES.2 summarizes the 2010 total port-related mobile source emissions of air pollutants in the South Coast Air Basin by category.

Table ES.2: 2010 Port-related Emissions by Category, short tons per year

Category	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
Ocean-going vessels	178	143	154	3,944	1,325	449	218
Harbor craft	40	36	40	950	1	364	75
Cargo handling equipment	20	19	19	804	2	594	35
Rail locomotives	30	27	30	996	7	177	54
Heavy-duty vehicles	30	27	28	1,523	4	352	71
Total	**298**	**253**	**271**	**8,216**	**1,339**	**1,936**	**452**

DB ID457

The total port-related mobile source GHG emissions in the SoCAB are summarized in Table ES.3 which presents the GHG emissions in metric tons per year (2,200 lbs/ton) instead of the short tons per year (2,000 lbs/ton) used for criteria pollutants. Throughout the report, GHG emissions are reported in metric tons per year. The CO_2 equivalent values are derived by multiplying the GHG emissions estimates for CO_2, N_2O, and CH_4 by their respective global warming potential (GWP)[4] values and then adding them together.

[4] U.S. EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009*, April 2011.

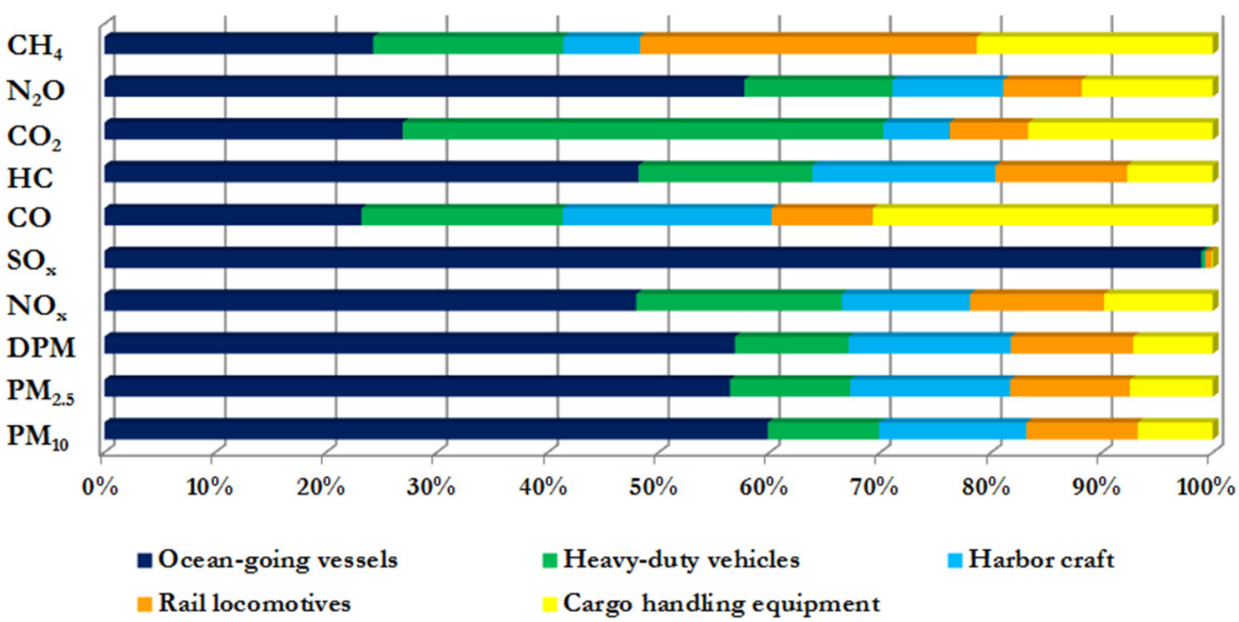
Table ES.3: 2010 Port-related GHG Emissions by Category, metric tons per year

Category	CO_2 Equivalent	CO_2	N_2O	CH_4
Ocean-going vessels	234,785	230,618	13	4
Harbor craft	51,613	50,881	2	1
Cargo handling equipment	143,463	142,555	3	3
Rail locomotives	61,594	60,988	2	5
Heavy-duty vehicles	372,509	371,505	3	3
Total	**863,964**	**856,547**	**23**	**16**

DB ID457

Figure ES.3 shows the distribution of the 2010 total port-related emissions of each pollutant from each source category. Ocean-going vessels (57%), harbor craft (15%) and rail locomotives (11%) contributed the highest percentage of DPM emissions among the port-related sources. Over 99% of the SO_x emissions were emitted from ocean-going vessels. Ocean-going vessels (48%) and HDV (19%) accounted for the majority of NO_x emissions. CHE (31%), Ocean-going vessels (23%), harbor craft (19%), and HDV (18%) accounted for the majority of CO emissions. Ocean-going vessels (48%), harbor craft (17%) and HDV (16%) accounted for the majority of hydrocarbon emissions.

Figure ES.3: 2010 Port-related Emissions by Category, %



In order to put the port-related emissions into context, the following figures and tables compare the Port's contributions to the total emissions in the South Coast Air Basin by major emission source category. The 2010 SoCAB emissions are based on 2007 AQMP Appendix III.[5]

Figure ES.4: 2010 DPM Emissions in the South Coast Air Basin, %

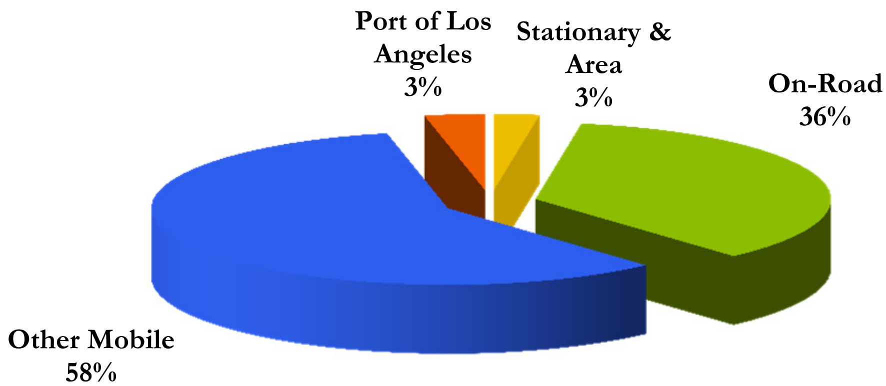
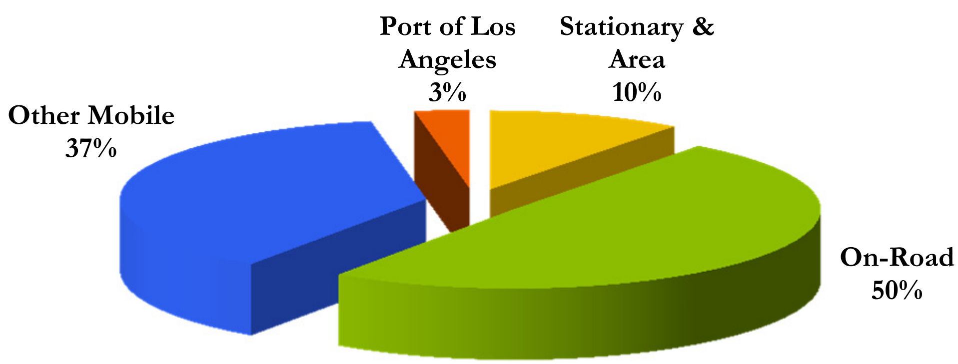


Figure ES.5: 2010 NO_x Emissions in the South Coast Air Basin, %



[5] SCAQMD, *Final 2007 AQMP Appendix III, Base & Future Year Emissions Inventories*, June 2007.

Figure ES.6: 2010 SO_x Emissions in the South Coast Air Basin, %

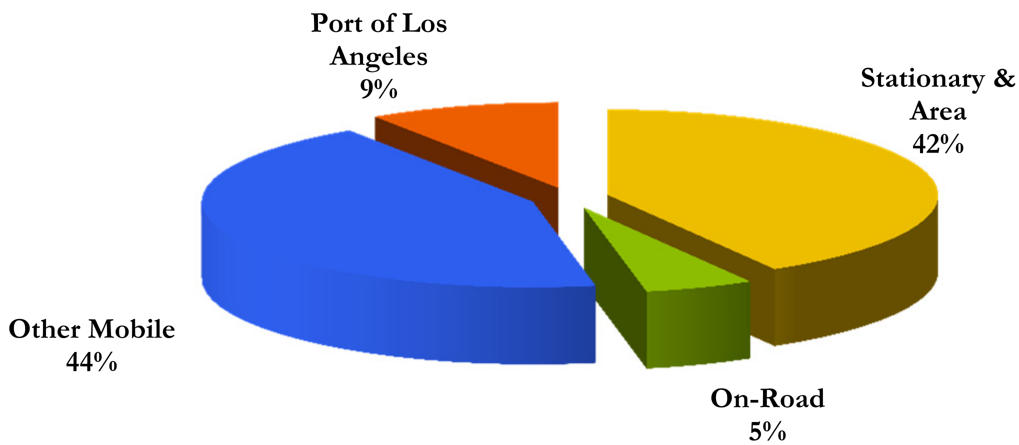


Figure ES.7 provides a comparison of the port-related mobile source emissions to the total SoCAB emissions from 2005 to 2010. As indicated, the Port's overall contribution to the SoCAB emissions has continued to decrease primarily because of the implementation of various emission reduction programs.

Figure ES.7: Port's Emissions in the South Coast Air Basin

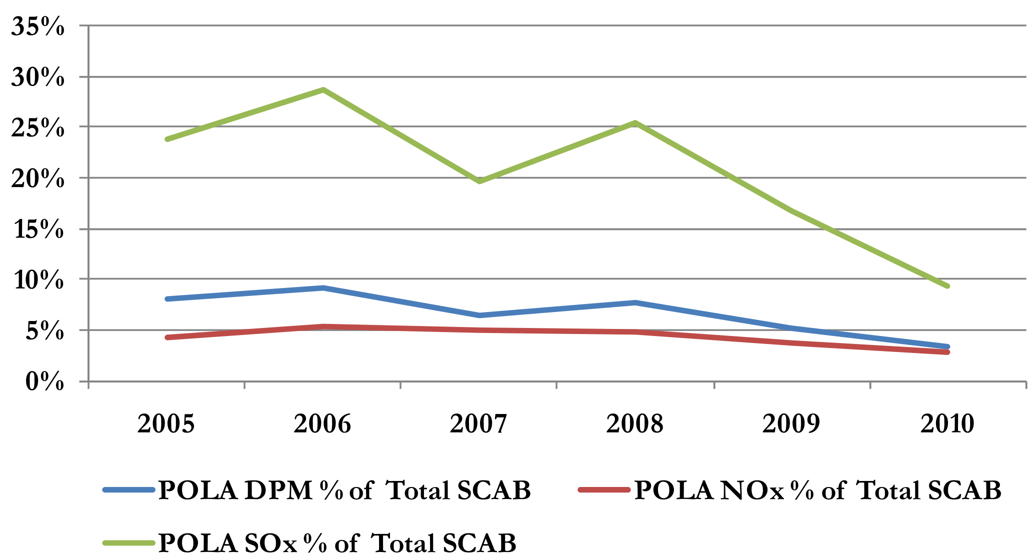


Table ES.4 presents the total net change in emissions for all source categories in 2010 as compared to previous years. The percent change is shown for the previous year (2009) and for the CAAP progress (2005). From 2009 to 2010, there was a 16% increase in throughput and emissions decreased 39% for DPM, 25% for NO_x, 45% for SO_x, 24% for CO and 19% for HC emissions. From 2005 to 2010, there was a 5% increase in throughput and emissions decreased 69% for DPM, 50% for NO_x, 75% for SO_x, 46% for CO, and 43% for HC emissions.

Table ES.4: Port-wide Emissions Comparison, tons per year and % Change

EI Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
2010	298	253	271	8,216	1,339	1,936	452
2009	486	412	442	11,023	2,444	2,555	560
2008	756	645	687	15,212	3,808	3,380	734
2007	717	619	622	16,575	3,435	3,583	796
2006	1,045	891	945	18,754	5,752	4,093	890
2005	976	832	888	16,396	5,317	3,590	791
Previous Year (2010-2009)	**-39%**	**-39%**	**-39%**	**-25%**	**-45%**	**-24%**	**-19%**
CAAP Progress (2010-2005)	**-69%**	**-70%**	**-69%**	**-50%**	**-75%**	**-46%**	**-43%**

To normalize emissions, the Port also calculated emissions on a ton per 10,000 TEU basis, which the Port refers to as emissions efficiency. Table ES.5 summarizes the annualized emissions efficiencies for all five source categories. In 2010, the overall port efficiency improved for all pollutants as compared to 2009 and 2005. A positive percentage means an increase in emission efficiency in Table ES.5 and Figure ES.8.

Table ES.5: Emissions Efficiency Comparison, tons/10,000 TEU and % Change

EI Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
2010	0.38	0.32	0.35	10.49	1.71	2.47	0.58
2009	0.72	0.61	0.66	16.33	3.62	3.79	0.83
2008	0.96	0.82	0.87	19.38	4.85	4.31	0.93
2007	0.86	0.74	0.74	19.83	4.11	4.29	0.95
2006	1.23	1.05	1.12	22.14	6.79	4.83	1.05
2005	1.30	1.11	1.19	21.91	7.10	4.80	1.06
Previous Year (2010-2009)	**47%**	**47%**	**47%**	**36%**	**53%**	**35%**	**30%**
CAAP Progress (2010-2005)	**71%**	**71%**	**71%**	**52%**	**76%**	**48%**	**45%**

Figure ES.8 compares emissions efficiency changes between 2010 and 2009 and 2010 and 2005. The purple bar represents TEU change from the previous year (a 16% increase) and the blue bar represents the TEU change when compared with 2005 (a 5% increase). The emissions efficiencies improved for all pollutants.

Figure ES.8: Emissions Efficiency Comparison, % Change

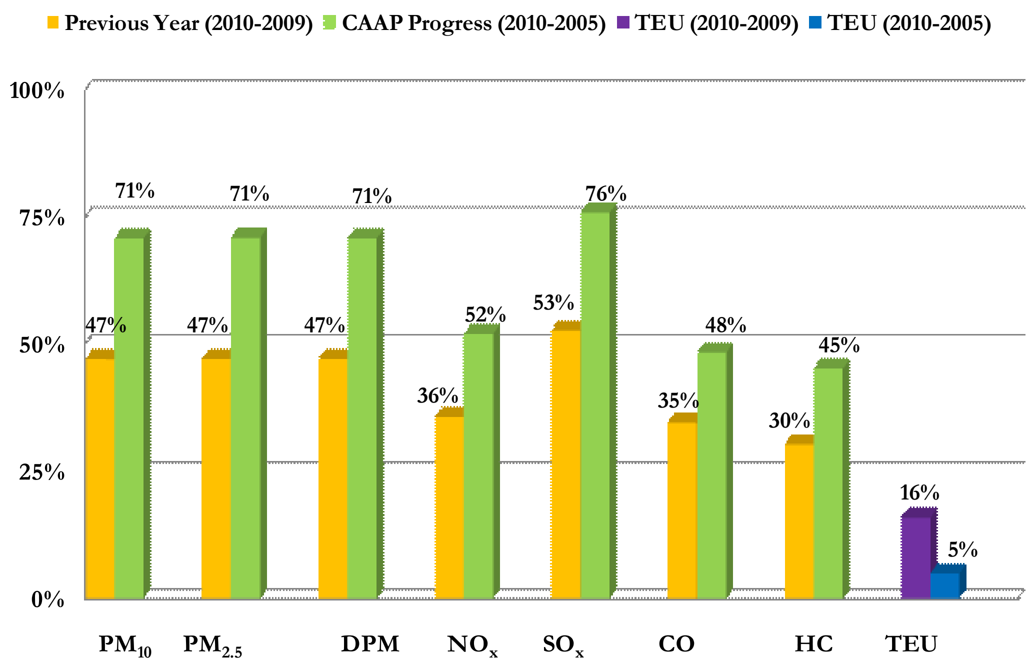


Table ES.6 compares the 2010 port-wide GHG emissions to the previous years. GHG emissions have continued to decrease over the years, mainly due to better efficiency and CAAP and regulatory measures that have GHG emission reduction co-benefits.

Table ES.6: Port-wide GHG Emissions Comparison, metric tons per year

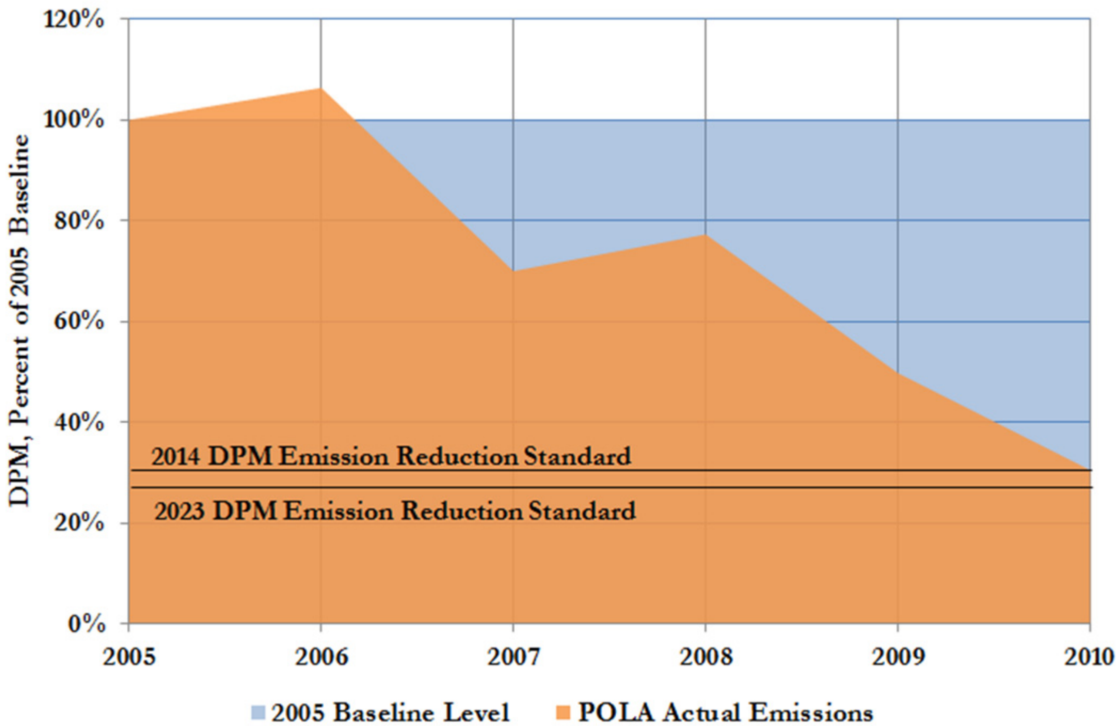
Year	CO_2 Equivalent	CO_2	N_2O	CH_4
2010	863,964	856,547	23	16
2009	909,289	901,657	23	21
2008	1,045,620	1,036,708	27	31
2007	1,116,922	1,106,740	31	32
2006	1,246,662	1,235,435	34	37
2005	1,060,727	1,050,928	29	32
Previous Year (2010-2009)	**-5%**	**-5%**	**-2%**	**-23%**
CAAP Progress (2010-2005)	**-19%**	**-18%**	**-23%**	**-48%**

CAAP Standards and Progress
One of the main purposes of the annual inventories is to provide a progress update on achieving the CAAP San Pedro Bay Standards. These standards consist of the following reduction goals, compared to 2005 published inventories

- Emission Reduction Standard:
  - By 2014, reduce emissions by 72% for DPM, 22% for NO_x, and 93% for SO_x
  - By 2023, reduce emissions by 77% for DPM, 59% for NO_x, and 93% for SO_x
- Health Risk Reduction Standard: 85% reduction by 2020

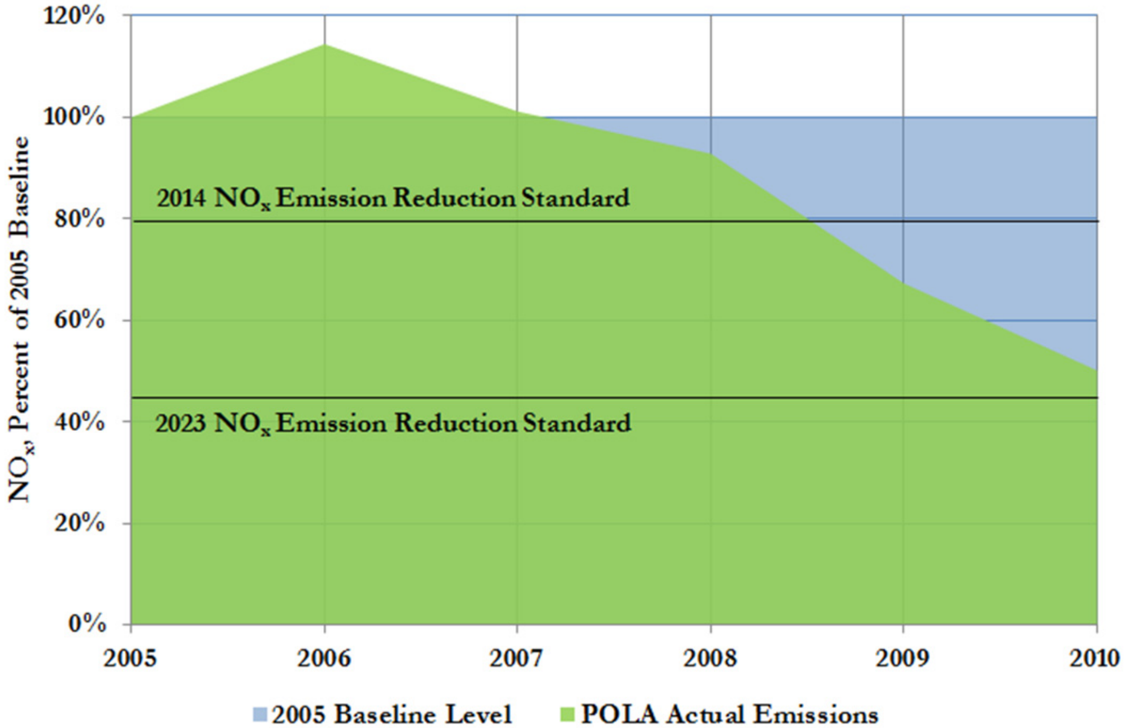
The emission reduction standards are represented as a percentage reduction of emissions from 2005 levels, and are tied to the regional SoCAB attainment dates for the federal $PM_{2.5}$ and ozone ambient air quality standards in the 2007 AQMP. This and future inventories will be used as a tool to track progress in meeting the emission reduction standards. Therefore, Figures ES.9 through ES.11 present the 2005 baseline emissions and the year to year percent change in emissions with respect to the 2005 baseline emissions as well as the draft 2014 and 2023 standards to provide a snapshot of progress to-date towards meeting those standards. In Figure ES.9, DPM emissions reductions are presented as a surrogate to $PM_{2.5}$ reductions since DPM is directly related to $PM_{2.5}$ emissions (equivalent of PM_{10} emissions from diesel-powered sources). In Figure ES.10, NO_x emissions reductions are presented since NO_x is a precursor to the ambient ozone formation and it also contributes to the formation of $PM_{2.5}$. SO_x emissions reductions are presented in Figure ES.11 because of the contribution of SO_x to $PM_{2.5}$ emissions.

Figure ES.9: DPM Reductions - Progress to Date Compared to 2005



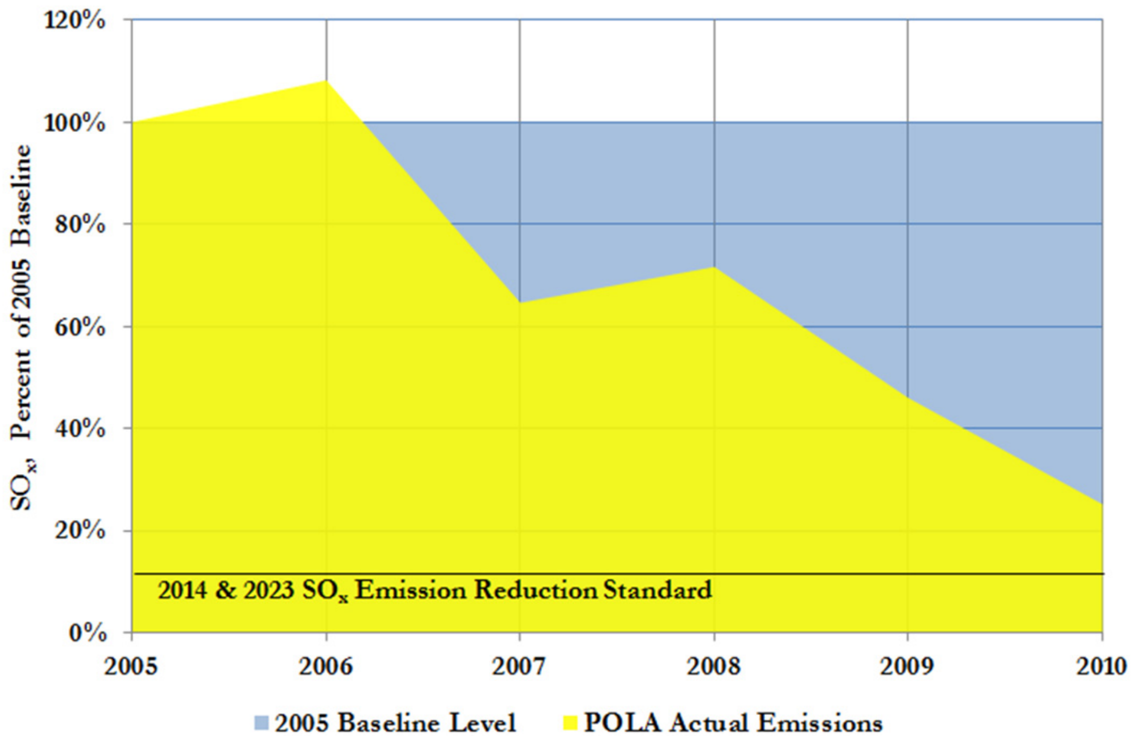
As presented above, by 2010, the Port has almost met the 2014 DPM emission reduction standards. The Port is also relatively close to meeting the 2023 DPM emission reduction standards.

Figure ES.10: NO_x Reductions - Progress to Date Compared to 2005



As presented above, the Port is exceeding the 2014 NO_x mass emission reduction standard in 2010 and is more than three quarters of the way towards meeting the 2023 standard.

Figure ES.11: SO_x Reductions - Progress to Date Compared to 2005

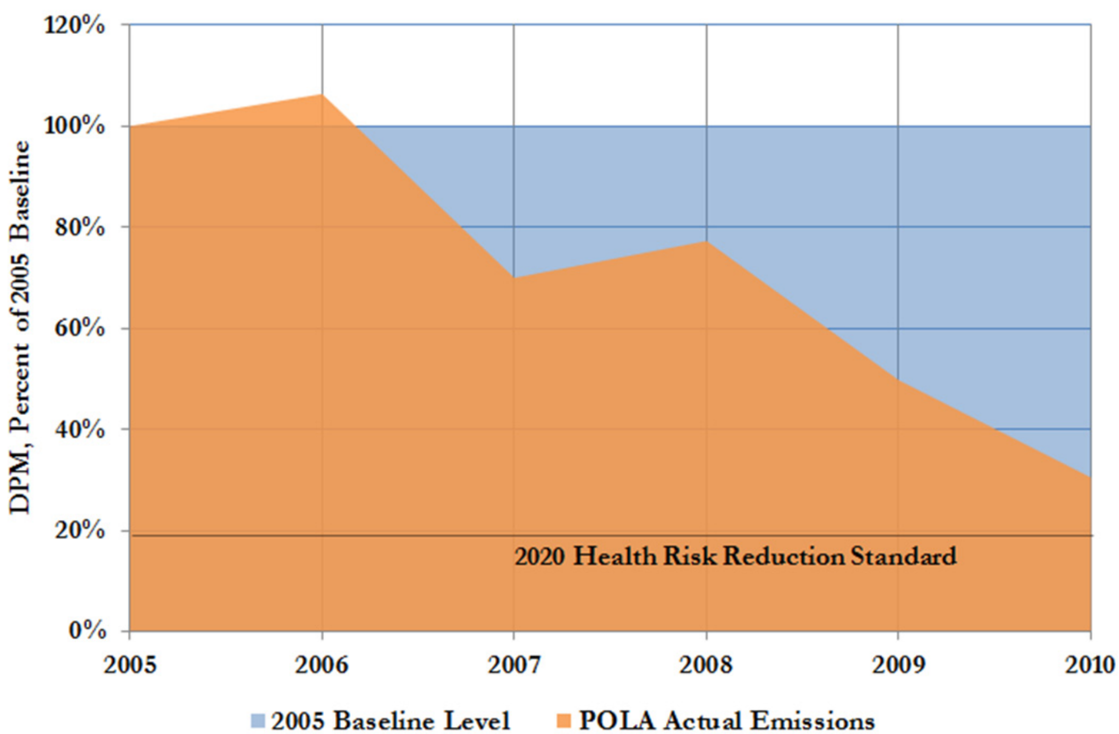


As presented above, by 2010, the Port is more than three quarters of the way towards meeting the SO_x mass emission reduction standards. The slight erosion of SO_x reductions from 2007 and 2008 was due to the injunction against the previous CARB OGV fuel rule in 2008.

Health Risk Reduction Progress
As described in the 2010 CAAP Update, the effectiveness of CAAP's control measures and applicable regulations with respect to the Health Risk Reduction Standard can be tracked by changes in mass emission reductions in DPM from the 2005 baseline. DPM is the predominant contributor to port-related health risk, and the Health Risk Reduction Standard was based on a health risk assessment study that used forecasted reductions in geographically allocated DPM emissions as the key input. Therefore, reductions in DPM mass emissions associated with CAAP measures and applicable regulations are a representative surrogate for health risk reductions. It should be noted that the use of DPM emissions as a surrogate for health risk reductions is to track relative progress. A more detailed health risk assessment will be prepared by the Port outside of this EI.

Progress to-date on health risk reduction is determined by comparing the change in DPM mass emissions to the 2005 baseline. Figure ES.12 presents the progress of achieving the standard to date.

Figure ES.12: Health Risk Reduction Benefits - Progress To Date



As shown above, by 2010 the Port is over three quarters of the way towards meeting the 2020 Health Risk Reduction Standard

SECTION 1 INTRODUCTION

The Port of Los Angeles (the Port) shares San Pedro Bay with the neighboring Port of Long Beach (POLB). Together, the San Pedro Bay Ports comprise a significant regional and national economic engine for California and the United States (U.S.), through which approximately 33% of all U.S. containerized trade flows[6]. For the first time in four years, throughput at the Port increased compared to the prior year and economic forecasts suggest that the demand for containerized cargo moving through the San Pedro Bay region will increase over the next two decades[7]. The economic benefits of the Ports are felt throughout the nation.

The ability of the San Pedro Bay Ports to accommodate the projected growth in trade will depend upon the ability of the two ports and their tenants to address adverse environmental impacts and, in particular, air quality impacts that result from such trade. In November 2006, the San Pedro Bay Ports adopted their landmark Clean Air Action Plan (CAAP), designed to reduce health risks and emissions associated with port-related operations while allowing port growth to continue. On November 22, 2010, the harbor commissioners of the two ports unanimously approved an update to the CAAP that identifies longer-term goals that build upon the commitments made in the original CAAP[8].

In order to track CAAP progress, the Port has committed to develop annual inventories of port-related sources starting with the 2005 Inventory of Air Emissions (which served as the CAAP baseline). The detailed annual activity-based inventory, with associated emissions estimates, is a critical and integral component to the success of the CAAP. Activity-based inventories based on detailed data collected on activities that occurred in a specific time period provide the most detailed inventory of air emissions for port-related sources. Activity-based inventories not only provide a greater understanding of the nature and magnitude of emissions, but also help track progress for the many emission reduction strategies that the Port, a landlord port, and its tenants have undertaken.

The Port released its first activity-based emissions inventory in 2004, documenting activity levels in the baseline year of 2001. The 2001 baseline emissions inventory evaluated emissions for all Port terminals from five source categories: ocean-going vessels, harbor craft, off-road cargo handling equipment, railroad locomotives, and on-road heavy-duty vehicles and evaluated operations at all Port terminals. The 2001 inventory provided the basis for the CAAP. In 2007, the Port released the 2005 Inventory of Air Emissions which was the first update to the baseline inventory and also the first of the annual inventories to follow. The Port has subsequently released an annual emissions inventory. These inventory reports are available on the Port's website[9].

[6] North America: Container Port Traffic (1990-2010), 2010 data, American Association of Port Authorities.
[7] San Pedro Bay Container Forecast Update, The Tioga Group, Inc., July 2009.
[8] *http://www.cleanairactionplan.org/*
[9] *http://www.portoflosangeles.org/environment/studies_reports.asp*

1.1 Scope of Study

The scope of the study is described in terms of the year of activity used as the basis of emissions estimates, the pollutants quantified, the included and excluded source categories and the geographical extent. The purpose of the 2010 Inventory of Air Emissions (2010 EI) is to develop emission estimates based on activities that occurred in calendar year 2010.

1.1.1 Pollutants

Exhaust emissions of the following pollutants have been estimated:

- Particulate matter (PM) (10-micron, 2.5-micron)
- Diesel particulate matter (DPM)
- Oxides of nitrogen (NO_x)
- Oxides of sulfur (SO_x)
- Hydrocarbons (HC)
- Carbon monoxide (CO)
- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)

Particulate matter

Particulate matter refers to tiny, discrete solid or aerosol particles in the air. Dust, dirt, soot, and smoke are considered particulate matter. Vehicle exhaust (cars, trucks, buses, among others) are the predominant source of fine particles. Fine particles are a concern because their very tiny size allows them to travel more deeply into lungs, increasing the potential for health risks.

Diesel particulate matter

Diesel particulate matter is a significant component of PM. Diesel exhaust also includes more than 40 substances that are listed as hazardous pollutants. DPM is considered a surrogate for the effects of both the PM and gaseous component of diesel exhaust. Sources of diesel emissions include diesel-powered trucks, buses, cars (on-road sources); and diesel-powered marine vessels, construction equipment and trains (off-road sources). DPM has been shown to contribute up to 80% of the carcinogenic health risk related to the portion of outdoor pollutants classified as “toxics.”

Oxides of nitrogen
Oxides of nitrogen is the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts. Most oxides of nitrogen are colorless and odorless. NO_x forms when fuel is burned at high temperatures, as in a combustion process. Oxides of nitrogen are precursors for ground level ozone formation. Ozone is formed by a reaction involving hydrocarbon and nitrogen oxides in the presence of sunlight. The primary manmade sources of NO_x are motor vehicles, electric utilities, and other sources that burn fuels.

Exposure to NO_x has been connected to a range of respiratory diseases and infections. Exposure to ozone can cause difficulty in breathing, lung damage, and reduced cardiovascular functions.

Hydrocarbons
Hydrocarbons emissions can be expressed in several ways depending upon measurement techniques and what compounds are included. In general hydrocarbons are a combination of oxygenated (such as alcohols and aldehydes) and non-oxygenated hydrocarbons (such as methane and ethane). Most hydrocarbons serve as fuels for the various sources found at ports. Some examples of hydrocarbon fuels are the components of gasoline, diesel, and natural gas. Hydrocarbon emissions are found in the engine exhaust due to incomplete fuel combustion and also due to fuel evaporation. A number of hydrocarbons are considered toxics which can cause cancer or other health problems. Hydrocarbons are precursor to ground level ozone formation which leads to smog in the atmosphere. Hydrocarbons estimated in this inventory refer to total hydrocarbons.

Carbon monoxide
Carbon monoxide is a colorless, odorless, toxic gas commonly formed when carbon-containing fuel is not burned completely. Most vehicles are the predominant source of carbon monoxide. CO combines with hemoglobin in red blood cells and decreases the oxygen-carrying capacity of the blood. CO weakens heart contractions, reducing the amount of blood pumped through the body.

Greenhouse gases
Greenhouse gases (GHG) contribute towards global warming and associated climate change. Global warming is a climate regulating phenomenon which occurs when certain gases in the atmosphere (naturally occurring or due to human activities) trap infrared radiation resulting in an increase in average global temperatures. The first far reaching effort to reduce emissions of GHG was established in the form of the Kyoto Protocol. The Kyoto Protocol is a protocol to the United Nations Framework Connection on Climate Change (UNFCCC) with the goal of reducing emissions of six GHGs. The six GHGs, also referred to as the "six Kyoto gases," are: CO_2, CH_4, N_2O, SF_6, HFCs, PFCs. Guidance to develop national GHG inventories is provided by the Intergovernmental Panel on Climate Change (IPCC), the authoritative scientific body on climate change.

CO_2, CH_4, and N_2O are emitted naturally or through human activities such as combustion of fossil fuels and deforestation. Sulfurhexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) are synthetically produced for industrial purposes. This emissions inventory report includes estimates of CO_2, CH_4 and N_2O from combustion of fuel in cargo handling equipment, harbor craft, on-road heavy-duty trucks, rail locomotives, and vessel operations associated with port operations.

Each GHG differs in its ability to absorb heat in the atmosphere. Sometimes, estimates of greenhouse gas emissions are presented in the unit of carbon dioxide equivalents, which weights each gas by its global warming potential (GWP) value. To normalize these values in a single greenhouse gas value, the GHG emissions estimates are multiplied by the following values and then added together resulting in a single greenhouse gas value (CO_2 equivalent). The values are as follows:[10]

- CO_2 – 1
- CH_4 – 21
- N_2O – 310

In this study, the greenhouse gas emissions are shown in metric tons while the criteria pollutant emissions are shown in tons.

1.1.2 Emission Sources

The scope includes the following five source categories:

- Ocean-going vessels
- Harbor craft
- Cargo handling equipment
- Railroad locomotives
- Heavy-duty vehicles

Examples of the five sources include the containerships, tankers, and cruise ships that call the Port; the assist tugs and tugboats that assist vessels in the harbor; the cranes and forklifts that may move cargo within the terminals; the railroad locomotives that haul the cargo; and the on-road diesel trucks visiting the terminals that also transport cargo. This inventory does not include stationary sources, as these are included in stationary source permitting programs administered by the South Coast Air Quality Management District (SCAQMD).

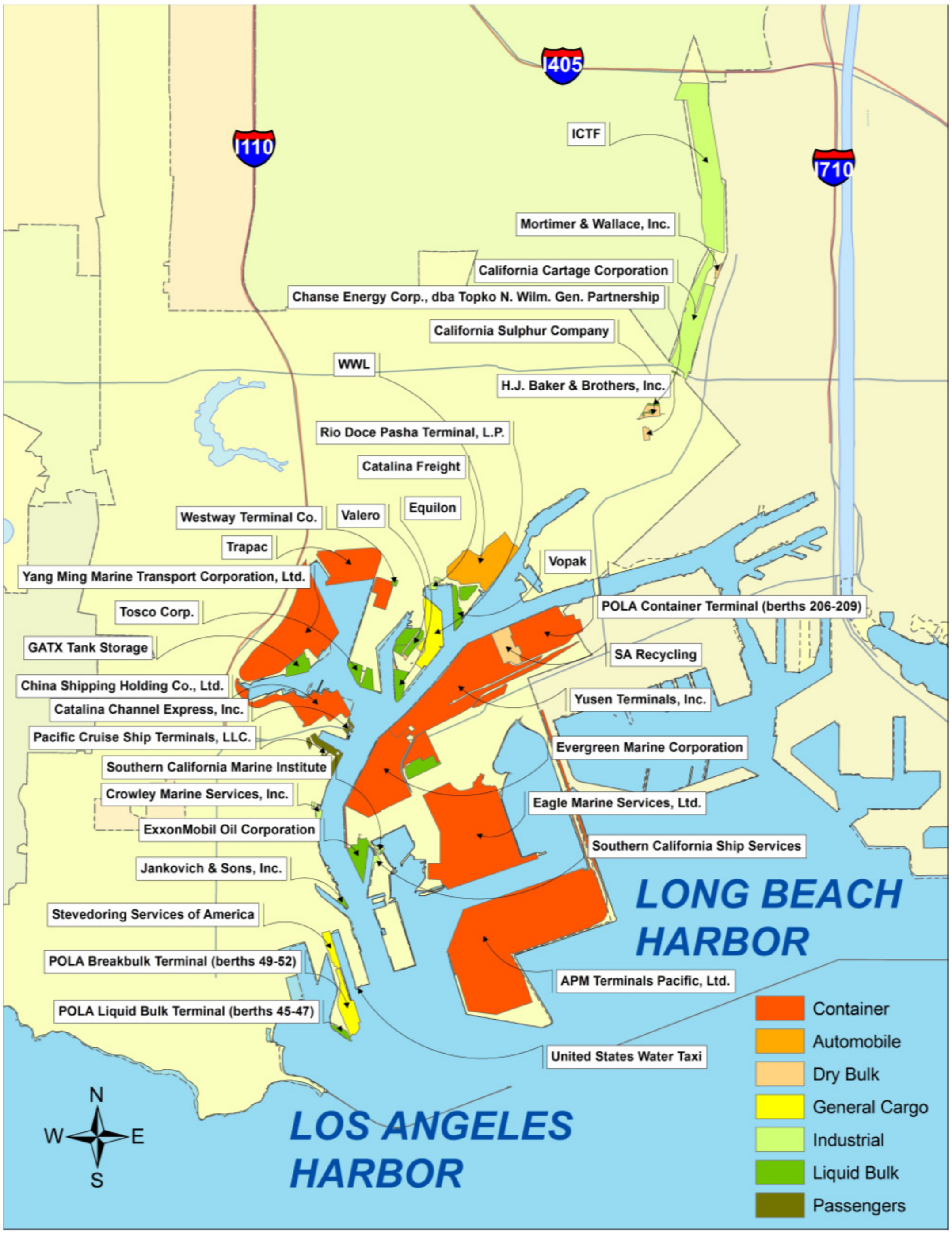
1.1.3 Geographical Extent

The study includes tenant source category emissions that occur on Port-owned land within the Port boundary/district. An overview of the geographical extent is provided below for each of the source categories.

[10] *U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009,* April 2011.

Figure 1.1 shows the land area of active Port terminals in 2010. The geographical scope for cargo handling equipment is the terminals and facilities on which they operate.

Figure 1.1: Port Boundary Area of Study



Emissions from switching and line haul railroad locomotives were estimated for on-dock rail yards, off-dock rail yards, intermodal yards, and the rail lines linking these facilities. For heavy-duty trucks related to the hauling of cargo, emissions from queuing at terminal entry gates, for travel and idling within the terminals, and for queuing at the terminal exit gates have been included. In addition to emissions that occur inside the Port facilities, emissions from locomotives and on-road trucks transporting Port cargo have been estimated for port-related activity that occurs within the SoCAB boundaries. Emissions are estimated up to first point-of-rest within the SoCAB or up to the basin boundary.

Figure 1.2 shows the SoCAB boundary for rail and HDV in relation to the location of the Port. Since both the Port and the POLB are interconnected with intermodal transportation linkages, every effort was made to only account for freight movements originating from or having a destination at the Port.

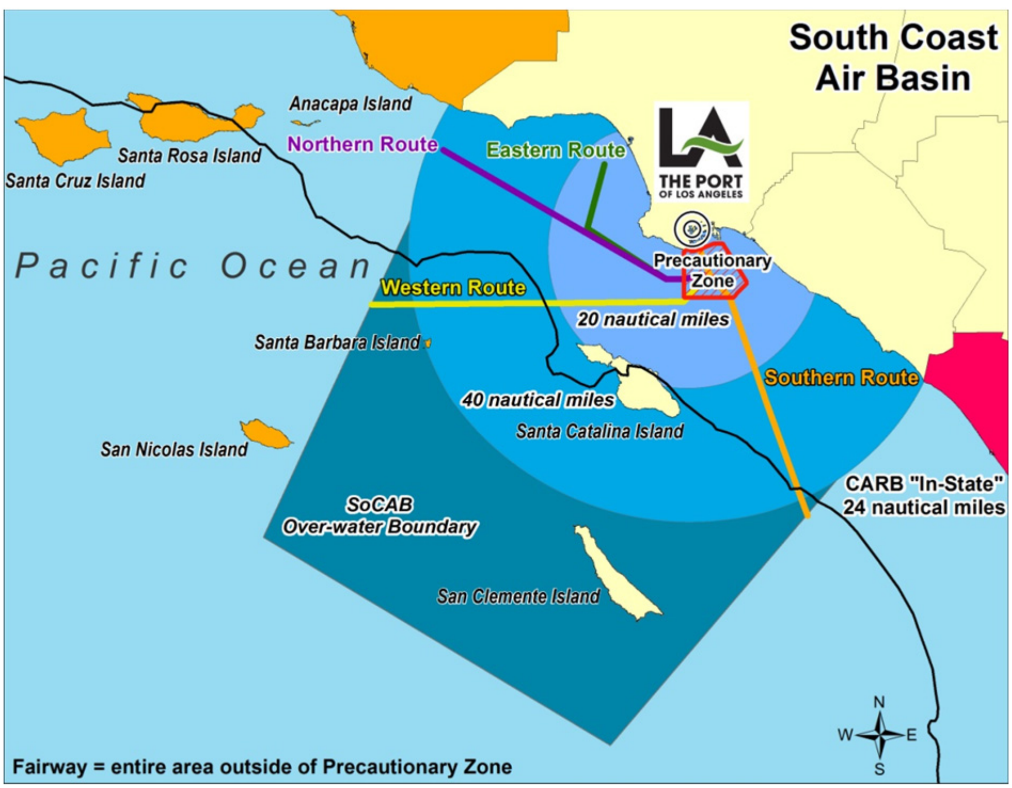
Figure 1.2: South Coast Air Basin Boundary

For marine vessels, OGVs and commercial harbor craft, the geographical extent of the Emissions Inventory (EI) is based on the same boundary that was used in previous marine vessel inventories developed for the SCAQMD and in the 2001 Baseline EI and subsequent inventories. The northern and southern boundaries are set by the South Coast county boundary which is continued over the water to the California water boundary to the west. The portion of the study area outside the Port's breakwater is four-sided, and geographically defined by the following coordinates:

- Northwest (NW) corner: 34°02'42.4" north (N) latitude by 118°56'41.2" west (W) longitude
- Southwest (SW) corner: 33°00'00.0" N latitude by 119°30'00.0" W longitude
- Southeast (SE) corner: 32°30'00.0" N latitude by 118°30'00.0" W longitude
- Northeast (NE) corner: 33°23'12.7" N latitude by 117°35'46.4" W longitude

Figure 1.3 shows the geographical extent of the study area for marine vessels (dark blue), the vessel traffic separation zone, and the main arrival and departure vessel flow. The precautionary zone (PZ) is further discussed in Section 3.2. The black line in the figure depicts the 24 nm of the California Baseline for the OGV Fuel Regulation.

Figure 1.3: OGV Inventory Geographical Extent



1.2 Methodology Comparison

In order to make a meaningful comparison between annual emission inventories, the same methodology must be used for estimating emissions for each year. If methodological changes had been implemented for a given source category in 2010 compared with a previous year, then the previous years' emissions were recalculated using the new 2010 methodology and the previous years' activity data to provide a valid basis for comparison. If there were no changes in methodology, then the emissions estimated for the prior years' inventory reports were used for the comparison.

1.3 Report Organization

This report presents the 2010 emissions and the methodologies used for each category in each of the following sections:

- Section 2 discusses regulatory and port measures
- Section 3 discusses ocean-going vessels
- Section 4 discusses harbor craft
- Section 5 discusses cargo handling equipment
- Section 6 discusses locomotives
- Section 7 discusses heavy-duty vehicles
- Section 8 discusses findings and results
- Section 9 compares 2010 emissions to previous years' emissions
- Section 10 presents a discussion of anticipated emissions improvements in 2011

SECTION 2 REGULATORY AND SAN PEDRO BAY PORTS CLEAN AIR ACTION PLAN (CAAP) MEASURES

This section discusses the regulatory initiatives and Port measures related to port activity. Almost all port-related emissions come from five diesel-fueled source categories: OGVs, HDVs, CHE, harbor craft and rail locomotives. The responsibility for the emissions control of the majority of these sources falls under the jurisdiction of local (South Coast Air Quality Management District (SCAQMD)), state (CARB) or federal (U.S. Environmental Protection Agency (EPA)) agencies. The Ports of Los Angeles and Long Beach adopted the landmark CAAP in November 2006 to curb port-related air pollution from trucks, ships, locomotives and other equipment by at least 45 percent in five years. On November 22, 2010, the harbor commissioners of the two ports unanimously approved an update to the CAAP. The 2010 CAAP Update is part of the original pledge to ensure that the CAAP is a "living document" which will be updated as needed to add new emission-control measures. The 2010 CAAP Update sets even more aggressive goals for reducing air pollution and health risks from port operations. A model for seaports around the world, the CAAP and the 2010 CAAP Update are the boldest air quality initiatives by any seaport, consisting of wide-reaching measures to significantly reduce air emissions and health risks while allowing for the development of much-needed port efficiency projects.

San Pedro Bay Standards Included in the 2010 CAAP Update
The San Pedro Bay Standards are perhaps the most significant addition to the CAAP and are a statement of the ports' commitments to significantly reduce the air quality impacts from port operations. Achievement of the standards listed below will require diligent implementation of all of the known CAAP measures and aggressive action to seek out further emissions and health risk reductions from port-related sources from strategies that will emerge over time.

Health Risk Reduction Standard
To complement the CARB's Emission Reduction Plan, the Ports of Long Beach and Los Angeles have developed the following standard for reducing overall port-related health risk impacts, relative to 2005 conditions:

- By 2020, reduce the population-weighted cancer risk of ports-related DPM emissions by 85% in highly-impacted communities located proximate to port sources and throughout the residential areas in the port region.

Emissions Reduction Standard

Consistent with the ports' commitment to meet their fair-share of mass emission reductions of air pollutants, the Ports of Long Beach and Los Angeles have developed the following standards for reducing air pollutant emissions from ports-related activities, relative to 2005 levels:

- By 2014, reduce emissions of NO_x by 22%, of sulfur oxides (SO_x) by 93%, and of DPM by 72% to support attainment of the federal fine particulate matter ($PM_{2.5}$) standards.
- By 2023, reduce emissions of NO_x by 59% to support attainment of the federal 8-hour ozone standard. The corresponding SO_x and DPM reductions in 2023 are 93% and 77%, respectively.

This section provides a list of regulatory programs and CAAP measures by each major source category that help reduce emissions from the Port.

2.1 Ocean-Going Vessels

Emissions Standard for Marine Propulsion Engines

The IMO adopted limits for NO_x in Annex VI to the International Convention for the Prevention of Pollution from Ships (MARPOL) in 1997. These NO_x limits apply to marine engines over 130 kilowatts (kW) installed on vessels built on or after 2000. The current NO_x standards vary from 17.0 grams per kilowatt-hour (g/kW-hr) (for < 130 revolutions per minute [rpm]) to 9.8 g/kW-hr (for $\geq$ 2000 rpm), depending upon the rated engine speed in rpm. The required number of countries ratified the Annex in May 2004 and it went into force for those countries in May of 2005. Engine manufacturers have been certifying engines to the Annex VI NO_x limits from 2000 because the standards were retroactive to that year, once Annex VI was ratified.

In April 2008, the Marine Environment Protection Committee of the IMO approved a recommendation for new MARPOL Annex VI sulfur limits for fuel and NO_x limits for engines. In October 2008, the IMO adopted these amendments to international requirements under MARPOL Annex VI, which place a global limit on marine fuel sulfur content of 3.5% by 2012, reduced from the current 4.5%, which will be further reduced to 0.5% sulfur by 2020, or 2025 at the latest, pending a technical review in 2018.[11] In Emissions Control Areas (ECAs), sulfur content will be limited to 1.0% in 2012, and further reduced to 0.1% sulfur in 2015 from the current 1.5% limit. In addition, new engine emission rate limits for NO_x for marine diesel engines installed on newly built ships are based on rated engine speed (n) and the year the ship is built.

11 *See:* http://www.epa.gov/otaq/regs/nonroad/marine/ci/mepc58-5noxsecretariat.pdf

The NO_x standards, in grams per kilowatt hour, are summarized as follows:

Table 2.1: NO_x Limits for Marine Engines, g/kW-hr

Tier	Date	n < 130 (g/kW-hr)	130 ≤ n < 2000 (g/kW-hr)	n ≥ 2000 (g/kW-hr)
Tier I	2000	17.0	$45 \times n^{-0.2}$	9.8
Tier II	2011	14.4	$44 \times n^{-0.23}$	7.7
Tier III	2016	3.4	$9 \times n^{-0.2}$	2.0

Finally, existing ships built between 1990 and 2000 would be subject to retrofit requirements of the Tier I NO_x standard. On July 21, 2008, President George W. Bush signed into law the Maritime Pollution Protection Act of 2008, ratifying MARPOL Annex VI by the United States, and the requirements became enforceable through the Act to Prevent Pollution from Ships (APPS) in January 2009.

On March 26, 2010, the IMO officially designated waters within 200 miles of North American coasts as an ECA. From the effective date in August 2012 until 2015, fuel used by all vessels operating in this area cannot exceed fuel sulfur content of 1.0%, which will be further reduced to 0.1% beginning in 2015. Also, starting in 2016, NO_x after-treatment requirements (Tier III standards) will become applicable in this area.

EPA's Final Regulation – Control of Emissions of Air Pollution from Locomotive and Marine Compression Ignited Engines Less than 30 Liters Per Cylinder

On March 14, 2008,[12] the EPA finalized a three-part program designed to dramatically reduce emissions from marine diesel engines with displacement less than 30 liters per cylinder. These include marine propulsion engines used on vessels and marine auxiliary engines. When fully implemented, this rule will cut PM emissions from these engines by as much as 90 percent and NO_x emissions by as much as 80 percent.

The regulations introduce two tiers of standards – Tier 3 and Tier 4 – which apply to both new and remanufactured marine diesel engines, as follows:

- *Newly-built engines:* Tier 3 standards apply to engines used in commercial, recreational, and auxiliary power applications (including those below 37 kW that were previously covered by non-road engine standards). The emissions standards for newly-built engines are phasing in, beginning in 2009. Tier 4 standards apply to engines above 600 kW (800 hp) on commercial vessels based on the application of high-efficiency catalytic after-treatment technology, phasing in beginning in 2014.

[12] *See: http://www.epa.gov/otaq/regs/nonroad/420f08004.htm#wxhaust*

- *Remanufactured engines:* The standards apply to commercial marine diesel engines above 600 kW when these engines are remanufactured and will take effect as soon as certified systems are available.

EPA's Emission Standards for Marine Diesel Engines Above 30 Liters per Cylinder (Category 3 Engines)

EPA is pursuing two parallel, related actions for establishing emission standards for Category 3 marine diesel engines: (1) EPA is a member of the U.S. delegation that participated in negotiations at the IMO with regard to amendments to Annex VI that were adopted in October 2008 including additional NO_x limits for new engines, additional sulfur content limits for marine fuel, methods to reduce PM emissions, NO_x and PM limits for existing engines, and volatile organic compounds (VOCs) limits for tankers. (2) In January 2003, EPA adopted Tier 1 standards for Category 3 marine engines, which went into effect in 2004, establishing NO_x standards based upon internationally negotiated emissions rates and readily available emissions-control technology. In December 2009, EPA finalized emission standards for Category 3 marine diesel engines installed on U.S. flagged vessels as well as marine fuel sulfur limits which are equivalent to the amendments recently adopted to MARPOL Annex VI. The final regulation establishes stricter standards for NO_x, in addition to standards for HC and CO. The final near-term Tier 2 NO_x standards for newly built engines apply beginning in 2011 and will require more efficient use of current engine technologies, including engine timing, engine cooling, and advanced computer controls. The Tier 2 standards will result in a 15 to 25 percent NO_x reduction below the current Tier 1 levels. The final long-term Tier 3 standards for newly built engines will apply beginning in 2016 in ECAs and will require the use of high efficiency emission control technology such as selective catalytic reduction to achieve NO_x reductions 80 percent below the current levels. These standards are part of EPA's coordinated strategy for addressing emissions from ocean-going vessels; this strategy also includes implementation of recent amendments to MARPOL Annex VI and designation of U.S. coasts as an ECA.

CARB's Low Sulfur Fuel for Marine Auxiliary Engines, Main Engines, and Auxiliary Boilers

On July 24, 2008, CARB adopted low sulfur fuel requirements for marine main engines, auxiliary engines, and auxiliary boilers within 24 nm of the California coastline. The regulation required the use of marine gas oil (MGO) with a sulfur content less than 1.5% by weight or marine diesel oil (MDO) with a sulfur content equal to or less than 0.5% by weight. For auxiliary engines, main engines, and boilers, the requirements started July 1, 2009. The use of MGO or MDO with a sulfur content equal to or less than 0.1 % will be required in all engines and boilers by January 1, 2012. The January 2012 start date may change to January 1, 2014 to more closely coincide with ECA Phase 2.

CARB's Regulation to Reduce Emissions from Diesel Auxiliary Engines on Ocean-Going Vessels While at Berth at a California Port[13]

On December 6, 2007, CARB adopted a regulation to reduce emissions from diesel auxiliary engines on OGVs while at-berth for container, cruise, and refrigerated cargo vessels. The regulation requires that auxiliary diesel engines on OGVs are shut down for specified percentages of fleet's visits and also the fleet's at-berth auxiliary engine power generation to be reduced by the same percentages. While the use of shore power is expected to be the primary means of compliance, as an alternative, vessel operators may employ any combination of clean emissions control technologies to achieve equivalent reductions. Specifically, by 2014, vessel operators relying on shore power are required to shut down their auxiliary engines at berth for 50 percent of the fleet's vessel visits and also reduce their onboard auxiliary engine power generation by 50 percent. The specified percentages will increase to 70 percent in 2017 and 80 percent in 2020. For vessel operators choosing the emission reduction equivalency alternative, the regulation requires a 10% reduction in OGV hotelling emissions starting in 2010, increasing in stringency to an 80% reduction by 2020.

CARB Vessel Speed Reduction Program

In order to meet the mandates of AB 32, the California Global Warming Solution Act, under CARB's Scoping Plan, implementation of VSR has been identified as one of the early action plan measures. CARB plans to evaluate the emissions benefit associated with this measure and the best approach to implement it through regulatory or volunteer/incentive-based approach. Since 2009, CARB staff has not engaged in any activity related to this measure.

CAAP Measure- SPBP-OGV1; Vessel Speed Reduction (VSR) Program

In May 2001, an MOU between the Port, the Port of Long Beach, EPA Region 9, CARB, SCAQMD, the Pacific Merchant Shipping Association (PMSA), and the Marine Exchange of Southern California was signed. This MOU called for OGVs to voluntarily reduce speed to 12 knots at a distance of 20 nm from Point Fermin. Reduction in speed demands less power from the main engine, which in turn reduces NO_x emissions and fuel usage. The term of this MOU expired in 2004; the updated measure OGV1 continues and expands the VSR program by continuing the 12 knot VSR zone between Point Fermin and the 20 nm distance, and expanding it to 40 nm from Point Fermin. There are three primary implementation approaches for this measure: 1) continuation of the voluntary program, 2) incorporation of VSR requirements in new leases, and 3) CARB's VSR strategy. Parallel to the voluntary, incentive based strategies, compliance with the VSR program to 40 nm from Point Fermin will be negotiated into new and re-negotiated lease requirements. In addition, the ports intend to work closely with CARB to facilitate a statewide VSR program and ensure that the programs are aligned.

[13] *See: http://www.arb.ca.gov/regact/2007/shorepwr07/shorepwr07.htm.*

Port of Los Angeles' Vessel Speed Reduction Incentive Program

In June 2008, the Port's Board of Harbor Commissioners adopted a Vessel Speed Reduction Incentive Program (VSRIP) which offered incentives to vessel operators complying with the reduced vessel speed of 12 knots or less within 20 nm of Point Fermin. The incentive provides vessel operators the equivalent of 15 percent of the first day of dockage per vessel visit. Vessel operators achieving 90 percent compliance in a calendar year receive the incentive for 100 percent of their vessel calls in that year. The VSRIP was expanded on September 29, 2009 to within 40 nm of Point Fermin. The expanded incentive provides vessel operators the equivalent of 25 percent of the first day of dockage per vessel visit for achieving 90 percent compliance within the 40 nm zone.

CAAP Measure- SPBP-OGV2; Reduction of At-Berth OGV Emissions

This measure requires the use of shore power to reduce hotelling emissions implemented at all container and cruise terminals and one liquid bulk terminal at the Port of Los Angeles by 2014. This measure also requires demonstration and application of alternative emissions reduction technologies for ships that are not good candidate for shore power, to be facilitated through the Technology Advancement Program (TAP)[14].

CAAP Measures- SPBP-OGV3 and 4; OGV Main & Auxiliary Engine Fuel Standards

This measure is designed to require the use of lower sulfur distillate fuels in the auxiliary and main engines and auxiliary boilers of OGVs within 40 nm of Point Fermin and while at berth. Upon lease renewal, this measure requires the use of distillate fuels that have a sulfur content of ≤0.2%. For vessel calls that are subject to these measures due to new lease agreements or renewal, the fuel switch emissions benefits will initially surpass the benefits of ARB's regulation in the region near the ports by requiring ≤0.2% sulfur MGO or MDO within 40 nm of Point Fermin. However, by January 1, 2012, CARB's regulation will surpass the CAAP measures, requiring the use of MGO or MDO with a sulfur content limit of 0.1% by weight in the main and auxiliary engines and boilers of all OGVs within 24 nm of the California coastline.

As a further backstop to the ports' programs and the CARB regulation, the IMO adopted international requirements under MARPOL Annex VI in October 2008. These enforce a global limit on marine fuel burned within 200 nm of the coastline; they limit sulfur content to 3.5% by 2012, down from the current 4.5%, which will be further reduced to 0.5% sulfur by 2020, or 2025 at the latest, pending a technical review in 2018. In Emissions Control Areas (ECAs), sulfur content will be limited to 1.0% starting in August of 2012, and further reduced to 0.1% sulfur in 2015.

[14] See *http://www.cleanairactionplan.org/programs/tap*

CAAP Measure- SPBP-OGV5 and 6; Cleaner OGV Engines and OGV Engine Emissions Reduction Technology Improvements
Measure OGV5 seeks to maximize the early introduction and preferential deployment of vessels to the San Pedro Bay Ports with cleaner/newer engines meeting the new IMO NO_x standard for ECAs. Measure OGV6 focuses on reducing DPM and NO_x from the legacy fleet through identification and deployment of effective emission reduction technologies.

CARB's Regulation Related to Ocean-going Ship Onboard Incineration
This regulation was adopted by CARB's board in 2005 and amended in 2006. As of November 2007, it prohibits all cruise ships and ocean-going vessels of 300 registered gross tons or more from conducting on-board incineration within 3 nm of the California coast. Enactment of this regulation was expected to reduce toxics air contaminants such as dioxins and toxics metals exposure to the public. It was also expected to reduce PM and hydrocarbon emissions generated during incineration.

2.2 Harbor Craft

CARB's Low Sulfur Fuel Requirement for Harbor Craft
In 2004, CARB adopted a low sulfur fuel requirement for harbor craft. Starting January 1, 2006 (in SoCAB) harbor craft are required to use on-road diesel fuel (e.g., ultra-low sulfur diesel [ULSD]), which has a sulfur content limit of 15 ppm and a lower aromatic hydrocarbon content. The use of lower sulfur and aromatic fuel has resulted in NO_x and DPM reductions. In addition, the use of low sulfur fuel will facilitate retrofitting harbor craft with emissions control devices such as diesel particulate filters (DPFs) that have the potential to reduce PM by an additional 85%.

EPA's Emission Standards for Harbor Craft Engines
On March 14, 2008, EPA finalized the latest regulation establishing new emission standards for new Category 1 and Category 2 diesel engines rated over 50 horsepower (hp) used for propulsion in most harbor craft. The new Tier 3 engine standards began phasing in starting in 2009. The more stringent Tier 4 engine standards (based on the application of high-efficiency catalytic after treatment technologies) will phase in beginning in 2014 and will apply only to commercial marine diesel engines greater than 800 hp. The regulation also includes requirements for remanufacturing commercial marine diesel engines greater than 800 hp.

CARB's Regulation to Reduce Emissions from Diesel Engines on Commercial Harbor Craft[15]

As a part of the Diesel Risk Reduction Plan and Goods Movement Plan, in November 2007, CARB adopted a regulation that reduces DPM and NO_x emissions from new and in-use commercial harbor craft operating in Regulated California Waters (i.e., internal waters, ports, and coastal waters within 24 nm of the California coastline). Under CARB's definition, commercial harbor craft include tug boats, tow boats, ferries, excursion vessels, work boats, crew boats, and fishing vessels. This regulation implements stringent emission limits from auxiliary and propulsion engines installed in commercial harbor craft. In 2010, ARB adopted amendments to the regulation which added specific in-use requirements for barges, dredges, and crew/supply vessels.

All in-use, newly purchased, or replacement engines must meet EPA's most stringent emission standards per a compliance schedule set by the CARB for in-use engines and from new engines at the time of purchase. In addition, the propulsion engines on all new ferries, with the capacity of more than 75 passengers, acquired after January 1, 2009, will be required to use control technology that represents the best available control technology in addition to an engine that meets the Tier 2 or Tier 3 EPA marine engine standards, as applicable, in effect at the time of vessel acquisition. For harbor craft with home ports in the SCAQMD, the compliance schedule is accelerated by two years (compared to statewide requirements) in order to achieve the earlier emission benefits required in SCAQMD. The in-use emission limits only apply to ferries, excursion vessels, tug boats, and tow boats. The compliance schedule for in-use engine replacement began in 2009.

CAAP Measure- SPBP-HC1- Performance Standards for Harbor Crafts

All harbor craft operating in the San Pedro Bay are required to comply with the CARB harbor craft regulation. Besides the implementation of CARB's In-Use Harbor Craft regulation and the USEPA's recently adopted Tier 3 and 4 standards, the ports are working towards a goal of repowering all harbor craft homebased in the San Pedro Bay to Tier 3 levels, within five years after the Tier 3 engines are available and use of shore power at their home port location. Ports plan to accelerate harbor craft emission reductions through emerging technologies such as the hybrid tug, new more-efficient engine configurations, alternative fuels and shore power for tugs at-berth and at the staging areas, through incentives or voluntary measures.

[15] *See: http://www.arb.ca.gov/regact/2007/chc07/isor.pd.f*

2.3 Cargo Handling Equipment

Emissions Standards for Non-Road Diesel Powered Equipment
The EPA's and CARB's Tier 1, Tier 2, Tier 3, and Tier 4 (interim Tier 4 and final) emissions standards for non-road diesel engines require compliance with progressively more stringent standards for hydrocarbon, CO, DPM, and NO_x. Tier 4 standards for non-road diesel powered equipment complement the 2007+ on-road heavy-duty engine standards which require 90 percent reductions in DPM and NO_x compared to current levels. In order to meet these standards, engine manufacturers will produce new engines with advanced emissions control technologies similar to those already in place for on-road heavy-duty diesel vehicles. These standards for new engines will be phased in starting with smaller engines in 2008 until all but the very largest diesel engines meet NO_x and PM standards in 2015. Currently, the interim Tier 4 standards include a 90% reduction in PM and a 60% reduction in NO_x.

CARB's Cargo Handling Equipment Regulation
In December of 2005 CARB adopted a regulation designed to reduce emissions from Cargo Handling Equipment (CHE) such as yard tractors and forklifts starting in 2007. The regulation calls for the replacement or retrofit of existing engines with engines that use Best Available Control Technology (BACT). Beginning January 1, 2007 the regulation requires newly purchased, leased, or rented yard tractors to be equipped with a 2007 or later on-road engine or a Final Tier 4 off-road engine. Newly purchased, leased, or rented non-yard tractors must be equipped with a certified on-road or off-road engine meeting the current model year standards in effect at the time the engine is added to the fleet. If the engine is pre-2004, then the highest level available Verified Diesel Emission Control System (VDEC) must be installed within one year. In-use yard tractors are required to meet either 2007 or later certified on-road engine standards, Final Tier 4 off-road engine standards, or install verified controls that will result in equivalent or fewer DPM and NO_x emissions than a Final Tier 4 off-road engine. In-use non-yard tractors must either install the highest level available VDEC and/or replace to an on-road or off-road engine meeting the current model year standards. For all CHE, compliance dates are phased in beginning December 31, 2007, based on the age of the engine and number of equipment in each model year group.

CAAP Measure- SPBP-CHE1- Performance Standards for CHE
This measure calls for CHE emission reductions beyond CARB's CHE regulation at the time of terminal lease renewal. As of 2007, all CHE purchases must meet the performance standards of the cleanest available NO_x alternative-fueled engine meeting 0.01 g/bhp-hr PM, available at time of purchase; or cleanest available NO_x diesel-fueled engine meeting 0.01 g/bhp-hr PM, available at time of purchase. If there are no engines available that meet 0.01 g/bhp-hr PM, then must purchase cleanest available engine (either fuel type) and install cleanest VDEC available.

In addition, as of the end of 2010, all yard tractors operating at the San Pedro Bay Ports are required to meet at a minimum the EPA 2007 on-road or Tier 4 engine standards. By the end of 2012, all pre-2007 on-road or pre Tier 4 off-road top picks, forklifts, reach stackers, rubber tired gantry cranes (RTGs), and straddle carriers <750 hp must meet, at a minimum, the EPA 2007 on-road engine standards or Tier 4 off-road engine standards. By end of 2014, all CHE with engines >750 hp must meet at a minimum the EPA Tier 4 off-road engine standards. Starting in 2007 (until equipment is replaced with Tier 4), all CHE with engines >750 hp will be equipped with the cleanest available VDEC verified by CARB.

2.4 Railroad Locomotives

EPA's Emissions Standards for New and Remanufactured Locomotives and Locomotive Engines- Latest Regulation[16]

In March 1998, EPA adopted Tier 0 (1973-2001), Tier 1 (2002-2004), and Tier 2 (2005+) emissions standards applicable to newly manufactured and remanufactured railroad locomotives and locomotive engines. These standards require compliance with progressively more stringent standards for emissions of hydrocarbon, CO, NO_x, and DPM. Although the most stringent standard, Tier 2, results in over 40% reduction in NO_x and 60% reduction in DPM compared to Tier 0, the full potential of these reductions will not be realized in the next five years because of the long life of diesel locomotive engines.

In March 2008, EPA adopted its final regulation – "Control of Emissions of Air Pollution from Locomotive and Marine Compression Ignited Engines Less than 30 Liters per Cylinder"[17] When fully implemented, this rule will cut PM emissions from these engines by as much as 90% and NO_x emissions by as much as 80%.

The regulation introduces two tiers of standards – Tier 3 and Tier 4 – which apply to new locomotives as well as standards for remanufactured locomotives, as follows:

- *Newly-Manufactured Locomotives:* The new Tier 3 emission standards will achieve 50 percent reduction in PM beyond the Tier 2 standard and will become effective in 2012. The longer term Tier 4 emission standards which are based on the application of high efficiency catalytic after-treatment technologies for NO_x and PM will become effective in 2015 and will achieve about 80 percent reduction in NO_x and PM compared to Tier 2 standards.

- *Remanufactured Locomotives:* The regulation also establishes emission standards for remanufactured Tier 0, 1, and 2 locomotives which would achieve 50 to 60 percent reduction in PM and 0 to 20 percent reductions in NO_x.

[16] *See: http://www.epa.gov/otaq/regs/nonroad/420f08004.htm.*
[17] *EPA 2008.*

EPA's Control of Emissions of Air Pollution from Nonroad Diesel Engines and Fuel
In 2012, the 15 ppm sulfur cap for locomotive and marine engine diesel fuel will go into effect. This will affect mainly interstate line-haul locomotives since there are stricter fuel regulations already in place in California for intrastate locomotives and marine diesel fuel.

CARB's Low Sulfur Fuel Requirement for Intrastate Locomotives
In 2004, CARB adopted a low sulfur fuel requirement for intrastate locomotives. Intrastate locomotives are defined as those locomotives that operate at least 90 percent of the time within the borders of the state, based on hours of operation, miles traveled, or fuel consumption. Mostly applicable to switchers, since January 1, 2006, statewide, intrastate locomotives have been required to use CARB off-road diesel fuel which has a sulfur content limit of 15 ppm sulfur and a lower aromatic content. The use of fuel with lower sulfur and aromatics results in NO_x and DPM reductions. In addition, use of low sulfur fuel facilitates retrofitting locomotives with emissions control devices such as DPFs that have potential to reduce DPM by 85%.

Statewide 1998 and 2005 Memorandum of Understanding (MOUs)
In order to accelerate the implementation of Tier 2 engines in the SoCAB, CARB, and EPA Region 9 entered into an enforceable MOU in 1998 with the two major Class 1 freight railroads operating in California. This MOU requires Union Pacific (UP) and Burlington Northern Santa Fe (BNSF) to concentrate their nation-wide introduction of Tier 2 locomotives preferentially within the SoCAB, which will achieve a 65% reduction in NO_x by 2010. In 2005, CARB entered into another MOU with UP and BNSF whereby these two railroads have agreed to phase out non-essential idling and install idling reduction devices, identify, and expeditiously repair locomotives that smoke excessively and maximize the use of 15 ppm sulfur fuel.

In addition to the 1998 and 2005 MOUs between CARB and the Class 1 rail operators described above, in June 2010, CARB's Board proposed, on voluntary basis, railyard-specific commitments with Class 1 operators to accelerate further DPM emission and risk reductions at four railyards in the South Coast Air Basin, including the Intermodal Container Transfer Facility (ICTF) located in the port area. The voluntary commitments would establish reporting and tracking mechanisms and deadlines to accelerate reductions of DPM emissions. The rail commitments would also require Class 1 operators to reduce DPM emissions by 85 percent by 2020 relative to 2005 emission levels within the fenceline of each of the four railyards. Specific strategies to achieve this level of reduction are up to the discretion of the Class 1 operators, and could include a combination of cleaning up their fleet of cargo handling equipment, drayage trucks, switcher locomotives, or line haul locomotives.

CAAP Measure- SPBP-RL1- Pacific Harbor Line (PHL) Rail Switch Engine Modernization
This measure implements the switch locomotive engine modernization and emission reduction requirements included in the operating agreements between the ports and PHL. In 2010, PHL and the ports entered into a third amendment to their operating agreements which, if PHL is successful in receiving grant funding, will result in an additional upgrade of the Tier 2 switcher locomotive fleet to meet "Tier 3-plus" standards by the end of 2011.

CAAP Measure- SPBP-RL2- Class 1 Line-haul and Switcher Fleet Modernization
The focus of this measure is to identify the emission reductions associated with the CARB Class 1 railroads MOU and the 2008 USEPA locomotive engine standards. The ultimate goal of this measure is that by 2023, all Class 1 locomotives entering the ports will meet emissions equivalent to Tier 3 locomotive standards.

CAAP Measure- SPBP-RL3- New and Redeveloped Near-Dock Rail Yards
This measure focuses on new and redeveloped near-dock rail facilities located on port properties. The goal of this measure is to incorporate the cleanest locomotive, CHE, and HDV technologies into near-dock rail operations. One of the significant goals of this measure is to achieve significant reductions in locomotive emissions through the accelerated turnover of the existing locomotive fleet to newer, lower emitting models. The ports will work with regulatory agencies (USEPA, CARB, and SCAQMD) and rail operators toward the goal of achieving a line-haul and switcher locomotive fleet with an emissions equivalent of 95% Tier 4 compliant engines operating within the ports by 2020, and statewide, as expeditiously as possible.

2.5 Heavy-Duty Vehicles

Emission Standards for New 2007+ On-Road Heavy-Duty Vehicles
In 2001, CARB adopted EPA's stringent emission standards for 2007+ HDVs, resulting in 90% reductions in emissions of NO_x and PM. This regulation required HDV engine manufacturers to meet a 0.01 g/bhp-hr PM standard starting in 2007, which is 90% lower than the 2004 PM standard of 0.1 g/bhp-hr and a phase-in of a 0.2 g/bhp-hr NO_x standard between 2007 and 2010. By 2010, all engines were required to meet the 0.2 g/bhp-hr NO_x standard, which represents a greater than 90% reduction compared to the 2004 NO_x standard of 2.4 g/bhp-hr. Between 2007 and 2010, on average, manufacturers produced HDV engines meeting the PM standard of 0.01 g/bhp-hr and a NO_x standard of 1.2 g/bhp-hr. This latter standard is referred to as the 2007 interim standard.

Heavy-Duty Vehicle On-Board Diagnostics (OBD) Requirement
In 2005, CARB adopted a comprehensive HDV On-Board Diagnostics (OBD) regulation, which ensures that the increasingly stringent HDV emissions standards being phased in are maintained during each vehicle's useful life. The OBD regulation requires manufacturers to install a system in HDVs to monitor virtually every emissions related component of the vehicle. The OBD regulation will be phased in beginning with the 2010 model years with full implementation required by 2016.

Ultra-Low Sulfur Diesel (ULSD) Fuel Requirement
In 2003, CARB adopted a regulation requiring that diesel fuel produced or offered for sale in California for use in any on-road or non-road vehicular diesel engine (with the exception of locomotive and marine diesel engines) contain no more than 15 ppm of sulfur (S) by weight, beginning June of 2006, statewide. This ULSD fuel is needed in order for retrofit technologies, such as diesel particulate filters, to work successfully.

CARB's Regulation for Reducing Emissions from On-Road Heavy-Duty Diesel Trucks Dedicated to Goods Movement at California Ports
As a part of CARB's emissions reduction plan for ports and goods movement in California, in December of 2007, CARB adopted a regulation designed to modernize the class 8 (trucks with gross vehicle weight rating greater than 33,000 pounds) drayage truck fleet in use at California's ports. This objective is to be achieved in two phases:

1. By December 31, 2009, all pre-1994 model year (MY) engines were to be retired or replaced with 1994 and newer MY engines. Furthermore, all drayage trucks with 1994 – 2003 MY engines were required to achieve an 85 percent PM emission reduction through the use of a CARB approved Level 3 VDECS.
2. By December 31, 2013, all trucks operating at California ports must comply with the 2007+ on-road heavy-duty truck engine standards.

In December 2010, CARB's Board acted on amendments that staff had proposed to the drayage truck regulation. It specifically included Class 7 drayage trucks (with gross vehicle weight rating greater than 26,000 pounds and less than 33,001 pounds) in the drayage truck regulation as follows: (a) to accelerate the filter requirement to January 1, 2012 for Class 7 drayage trucks in the South Coast Air Basin, and (b) to require Class 7 drayage trucks statewide to operate with 2007 or newer emission standard engines by January 1, 2014.

In addition, CARB expanded the definition of drayage trucks to include those non-compliant trucks that may not directly come to the ports to pick up or drop off cargo but that engage in moving cargo destined to or originated from port facilities to or from near-port facilities or rail yards. This practice, known as "dray-offs," reduces the effectiveness of the drayage truck regulation because otherwise non-compliant trucks still operate near the ports and rail yards.

CARB's On-Road Heavy-Duty Diesel Vehicles (In-Use) Regulation
In December 2008, CARB adopted a regulation that places requirements on in-use HDVs operating throughout the state. Under the regulation, existing HDVs are required to be replaced with HDVs meeting the latest NO_x and PM Best Available Control Technology (BACT), or retrofitted to meet these levels. By January 1, 2021, all MY 2007 class 8 drayage trucks are required to meet NO_x and PM BACT (i.e. 2010+ EPA engine standards). MY 2008 and MY 2009 must be replaced with 2010+ engines by January 1, 2022 and January 1, 2023 respectively.

CARB's Heavy-Duty Vehicle Greenhouse Gas Emission Reduction Regulation
In December 2008, CARB adopted a new regulation to reduce greenhouse gas emissions by improving the fuel efficiency of heavy-duty tractors that pull 53-foot or longer box-type trailers through improvements in tractor and trailer aerodynamics and the use of low rolling resistance tires. All pre-2011 MY tractors, that pull affected trailers, are required to use SmartWay verified low rolling resistance tires beginning January 1, 2012. Pre-2011 MY 53-foot or longer-type box trailers are required to be SmartWay certified or retrofitted with SmartWay verified technologies by December 31, 2012 with the exception of 2003-2008 MY refrigerated-van trailers equipped with 2003 or later transport refrigeration units which will have a compliance phase-in between 2017 and 2019. Drayage tractors and trailers that operate within a 100 mile radius of a port or intermodal rail yard are exempt from this regulation.

CAAP Measures- SPBP-HDV1- Performance Standards for On-Road Heavy-Duty Vehicles; Clean Truck Program
Per the stated goals of the CAAP, the Ports of Los Angeles and Long Beach approved the Clean Truck Program (CTP) which progressively bans older trucks from operating at the two ports. The ban is implemented in three phases as follows:

1. By 1 October 2008 – All pre-1989 trucks are banned from port services.

2. By January 1, 2010 – All 1989-1993 trucks along with un-retrofitted[18] 1994-2003 trucks are banned from port services.

3. By January 1, 2012 – All trucks that do not meet 2007and later on-road heavy duty engine standards are banned from port services.

In January 2011, harbor commissioners from the Port of Los Angeles and Long Beach adopted a resolution that included Class 7 drayage trucks and banned the "dray-off" practice under the Clean Truck Program. This aligns with CARB's recent amendments and will result in greater emissions reductions as most of the Class 7 trucks did not meet the emissions standards of the Clean Truck Program.

2.6 Greenhouse Gases

Assembly Bill 32 (AB 32), the California Global Warming Solutions Act of 2006, establishes a first-in-the-world comprehensive program requiring the CARB to develop regulatory and market mechanisms that will ultimately reduce GHG emissions to 1990 levels by the year 2020 and reduce emissions to 80 percent below 1990 levels by 2050. Mandatory caps will begin in 2012 for significant sources and ratchet down to meet the 2020 goals. In the interim, CARB will begin to measure the GHG emissions of industries determined to be significant sources of GHG emissions.

[18] CTP retrofit requirements include ARB Level 3 reduction for PM plus 25% NOx reduction.

On October 25, 2007, CARB approved several emission reduction strategies to reduce GHG emissions as "early action measures." Early action measures pertaining to goods movement activities for ships, port drayage trucks, cargo handling equipment and transport refrigeration units included:

- Green Ports (Ship Electrification)
- SmartWay Truck Efficiency
- Tire Inflation Program
- Anti-idling Enforcement
- Refrigerant Tracking, Reporting, and Recovery Program
- Low Carbon Fuel Standard

In December 2007, CARB approved the 2020 statewide GHG emission limit of 427 million metric tons of carbon dioxide equivalent (MMT CO2E). In December 2008, CARB adopted the Climate Change Scoping Plan to achieve the reductions in GHG emissions mandated in AB 32. The AB 32 Scoping Plan contains the main strategies California will use to reduce the GHGs that cause climate change. Several of these measures are targeted at goods movement, including ports, and are expected to achieve a combined 3.7 million metric tons of carbon dioxide equivalent. Proposed measures in the Scoping Plan affecting goods movement which have been fully or partially adopted as regulations include:

- T-5: Ship electrification at ports (previously adopted as regulation in December 2007)
- T-6: Goods movement efficiency measures (Port Drayage Trucks regulation adopted in December 2007 and later amended in December 2010 to include class 7 trucks that were not covered under original regulation but found to be engaging in drayage activities at the ports; other measures under development)
- T-7: Heavy-Duty Vehicle GHG Emission Reduction (adopted December 2008)

In addition, the following Scoping Plan's specific measures are planned for adoption in the next few years with potential impacts on port-related sources:[19]

- Transport Refrigeration Units Cold Storage Prohibition and Energy Efficiency
- Refrigerant Recovery from Decommissioned Refrigerated Shipping Containers
- Medium and Heavy-Duty Vehicle Hybridization
- Cargo Handling Equipment – Anti-Idling, Hybrid, Electrification
- Commercial Harbor Craft Maintenance and Design efficiency
- Goods Movement System-Wide Efficiency Improvements
- Vessel Speed Reduction
- Clean Ships

[19] *http://www.arb.ca.gov/cc/scopingplan/sp_measures_implementation_timeline.pdf*

SECTION 3 OCEAN-GOING VESSELS

This section presents emissions estimates for the ocean-going vessels source category, including source description (3.1), geographical delineation (3.2), data and information acquisition (3.3), operational profiles (3.4), emissions estimation methodology (3.5), and the emission estimates (3.6).

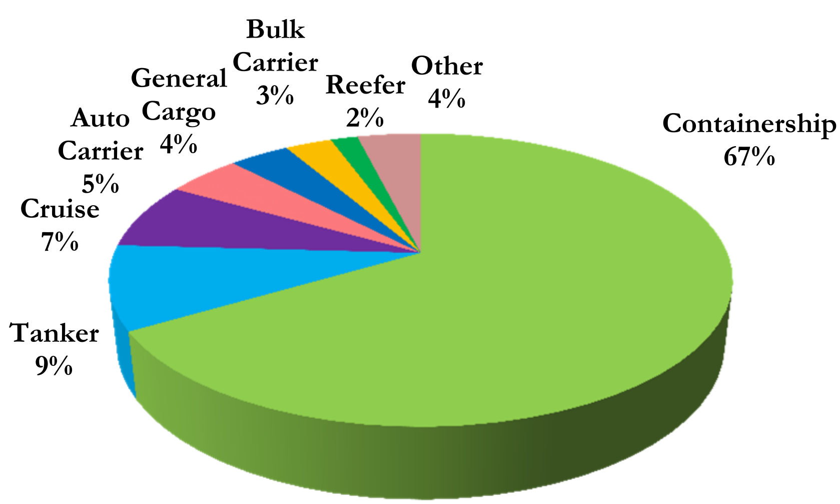
3.1 Source Description

OGVs calling at the Port in 2010 whether inbound from or outbound to the open ocean or transiting from neighboring POLB are included. OGVs calling only at POLB or bypassing both ports without physically stopping at a Port dock have not been included. Harbor craft, including tugboats, ferries, excursion vessels, work and crew boats and commercial fishing vessels are discussed in Section 4. Ocean-going vessels are categorized by the following main vessel types for purposes of this EI:

- Auto carrier
- Containership
- General cargo
- Refrigerated vessel (Reefer)
- Tanker
- Bulk carrier
- Passenger cruise vessel
- Ocean-going tugboat
- RoRo
- Miscellaneous

Based on Marine Exchange of Southern California (MarEx) data, there were 2,035 inbound vessel calls to the port in 2010. Figure 3.1 shows the percentage of calls by vessel type. Containerships (67%) made the majority of the calls; followed by tankers (9%); cruise ships (7%); auto carriers (5%); general cargo (4%); bulk carriers (3%); reefer vessels (2%); and other vessels including ocean tugs, RoRo and miscellaneous vessels (4%).

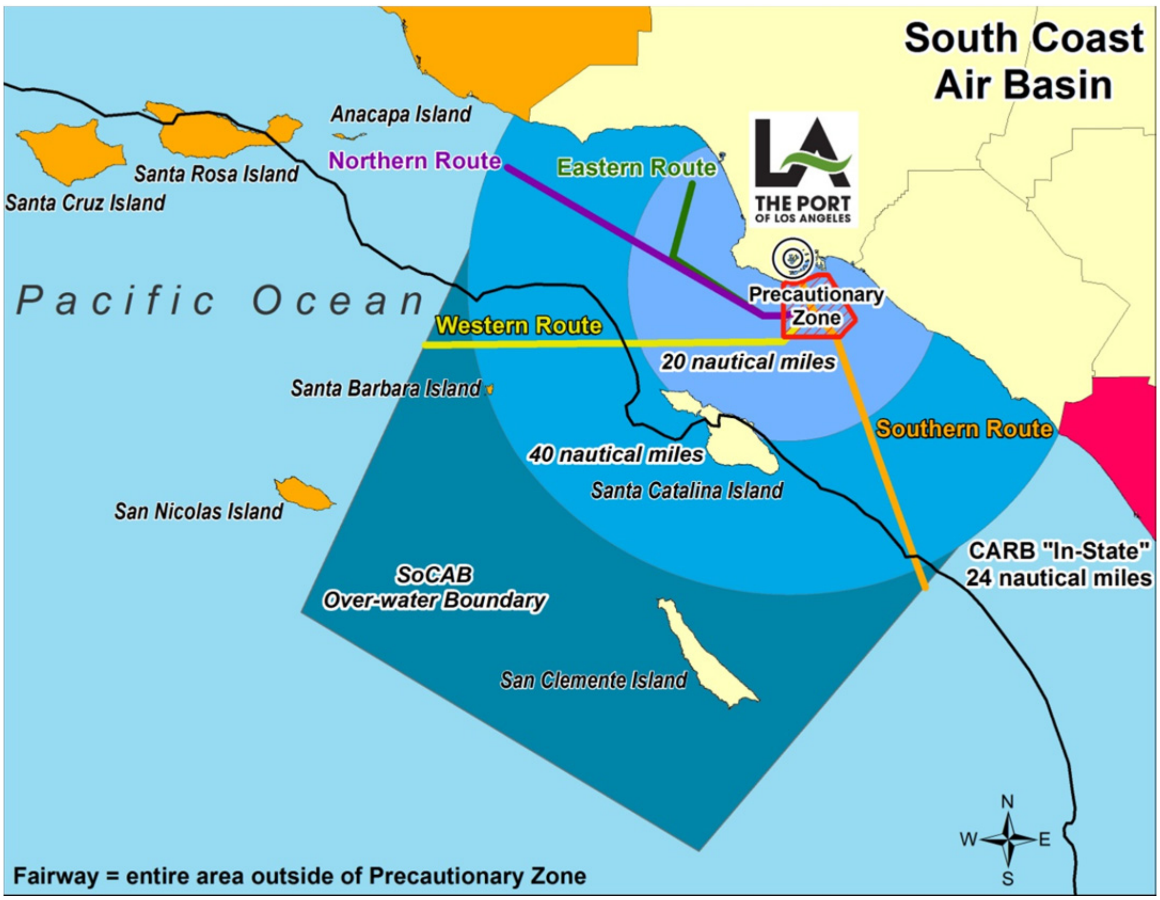
Figure 3.1: Distribution of Calls by Vessel Type



3.2 Geographical Delineation

The geographical extent of the emissions inventory for commercial marine vessels is the same as in previous EIs. Figure 3.2 shows the boundary of the study area as well as the major shipping routes and the 24 nautical mile (nm) line of the California Baseline for the CARB OGV Fuel Regulation[20], shown as black line that runs parallel to California coastline.

Figure 3.2: Geographical Extent and Major Shipping Routes



There are four primary shipping routes into the Port as designated by MarEx.[21] The North Route is typically for West Coast United States/Canada and trans-Pacific voyages, the East Route is for transits to and from El Segundo Bay, the South Route is for Central/South American and Oceania voyages, and the West Route is for Hawaiian and eastern Oceania voyages. Each route is comprised of an inbound and outbound lane which is used to separate vessel traffic arriving and departing the port. The distances for these routes from

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[20] California Air Resources Board, *Fuel Regulations for Ocean-Going Vessels*, Adopted July 24, 2008, 13 CCR 2299.2 and 17 CCR 93118.2.

[21] Marine Exchange of California of Southern California, *Vessel Tracking Service. http://www.mxsocal.org.*

the precautionary zone (PZ) to the over-water boundary and the distances of these routes from the breakwater (BW) to the PZ are listed in Table 2.2. These distances represent average distances traveled by ships for each route.

The routes are further segmented by two compliance zones based on Clean Air Action Plan emission reduction emission reduction strategies. The 20 nautical mile (nm) zone is from the PZ to an arc 20 nm in radius from Point Fermin. The 20 to 40 nm zone is from the 20 nm arc to a 40 nm from Point Fermin, as presented in Table 3.1.

Table 3.1: Route Distances, nm

Route	PZ to Boundary Distance, nm		BW to PZ Distance, nm	
	Inbound	Outbound	Inbound	Outbound
North	43.3	42.4	8.6	7.6
East	25.7	25.7	7.6	7.6
South	31.3	32.5	8.5	7.4
West	40.0	40.0	8.6	8.6

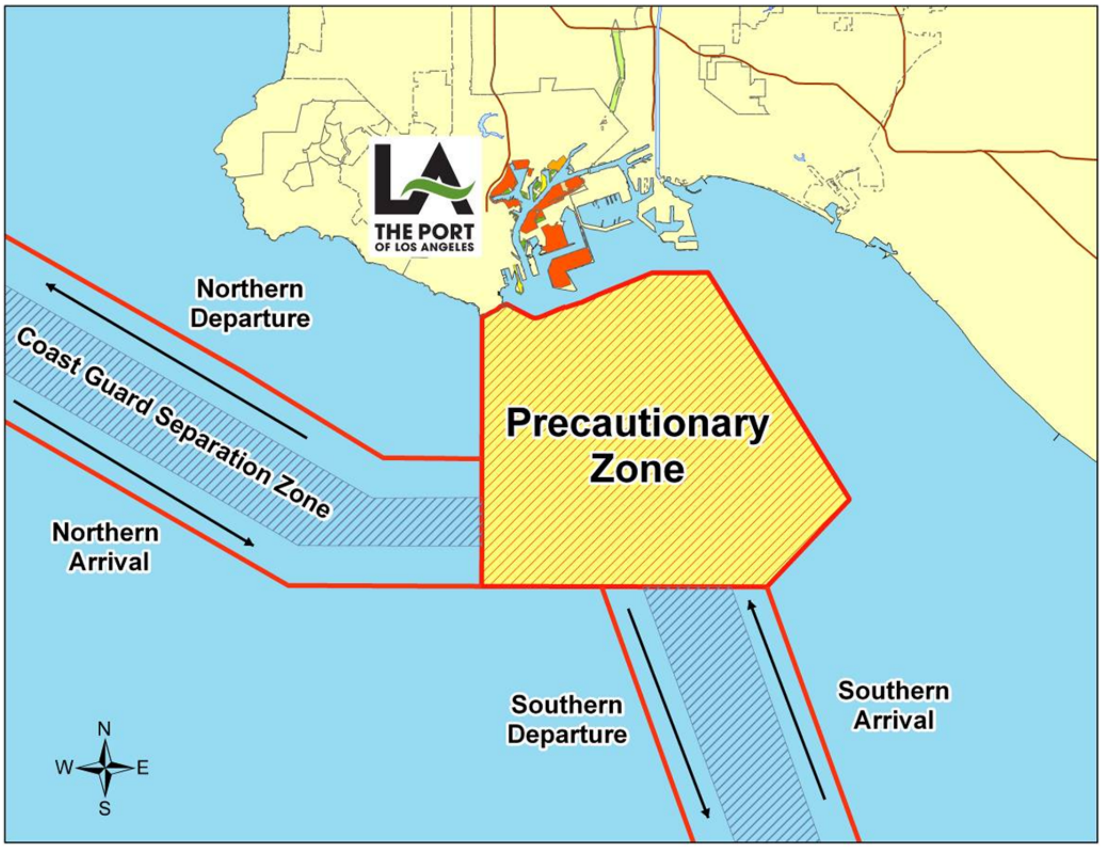
Starting on July 1, 2009 the CARB OGV Fuel Regulation requires ships to use distillate fuels instead of residual fuels when within 24 nm of the California coastline. Prior to the regulation, the North route was the predominant route for trade with Asia and points north of San Pedro Bay. Since the regulation became effective, the West route (west of the Channel Islands) has become the predominant shipping route for ships trading with Asia and points north of San Pedro Bay, presumably to avoid the CARB OGV Fuel Regulation compliance zone. This shift in route selection is highlighted Table 3.2.

Table 3.2: Route Distribution of Annual Calls

Route	Distrubution of Annual Calls		
	2008	2009	2010
North	62%	45%	10%
West	6%	23%	58%
South	31%	31%	31%
East	1%	1%	1%

Figure 3.3 shows the precautionary zone which is a designated area where ships are preparing to enter or exit a port. In this zone the Los Angeles pilots are picked up or dropped off. The harbor is located within the breakwater and is characterized by the slowest vessel speeds.

Figure 3.3: Precautionary Zone



3.3 Data and Information Acquisition

Various sources of data and operational knowledge about the Port's marine activities were used to compile the data necessary to prepare emission estimates. These sources included:

- Marine Exchange of Southern California
- VSR Program speed data
- Los Angeles Pilot Service
- Lloyd's Register of Ships
- Port Vessel Boarding Program (VBP) data
- Terminals (shore power data)
- Nautical charts and maps

3.4 Operational Profiles

Vessel activity is defined as the number of ship trips by trip type and segment. Trip segments are used for the at-sea portion of the ship trip between the open ocean and the precautionary zone. These trips are then processed so as to define time in mode and geographical segment. The purpose of this step is to estimate power demand for that mode of operation and multiply it by the amount of time spent in that particular mode, which estimates available energy expressed as power times unit of time, e.g., kilowatt-hours, (kW-hrs). A vessel-by-vessel analysis was conducted. The only need for average power or time-in-mode was for vessels that lacked data for those fields. Vessel activity was drawn from three sources:

- MarEx trip tables which define arrivals, departures, and shifts
- MarEx speed tables which define speeds for the VSR Program at 10, 15, 20, 25, 30, 35, and 40 nm
- Average transit times for harbor maneuvering

Hotelling
Hotelling time is calculated by subtracting departure time from arrival time while at berth or anchorage. Ship movements are tracked by MarEx as to:

- Arrivals (inbound trip)
- Departures (outbound trip)
- Shifts (inter-port, intra-port, and anchorage shifts)
- Total movements (sum of all the above)

Arrivals
For this study, arrivals include inbound trips from the sea to a berth and inbound trips from the sea to an anchorage. An inbound trip from the sea to an anchorage is assigned to the port if the next port of call is a berth at the port.

Departures
For this study, departures include outbound trips from a berth or anchorage to the sea.

Shifts
While many vessels make only one arrival and departure at a time, some vessels make multiple stops within a port. To assist with preparation of the marine emissions inventory, all shifts were grouped together, since they do not have an "at-sea" component as with arrivals and departures. When a vessel shifts from one berth to another or from an anchorage to a berth, the emissions associated with that shift (transit emissions from/to berth) are allocated to the "to berth" or "arriving berth."

There are three broad categories of shifts:

- Intra-port shifts – movements within a port from one berth to another.
- Inter-port shifts – movements between adjacent ports. This is a common occurrence in co-located ports such as Los Angeles and Long Beach.
- Anchorage shifts – movements between a terminal and anchorage. For example, a vessel receives a partial load, goes to anchorage, and then returns to the terminal to complete loading.

Table 3.3 presents the arrivals, departures, shifts and total movements for vessels at the Port in 2010. Arrivals and departures do not match because the activity is based on a calendar year and due to shifts. In 2010, the container-6000 subtype had a high number of shifts and thus there is a difference with the arrival and departure counts. The shifts were due to inter-port shifts where vessels called first at a Port of Long Beach berth and then shifting to a Port of Los Angeles berth. Tankers shift more than other vessel types while in port. They may shift from anchorage to berth and shift from one berth to another.

Table 3.3: Total OGV Movements for 2010

Vessel Type	Arrival	Departure	Shift	Total
Auto Carrier	94	94	23	211
Bulk	54	47	40	141
Bulk - Heavy Load	3	3	1	7
Bulk Wood Chips	2	0	1	3
Container - 1000	116	116	15	247
Container - 2000	191	192	14	397
Container - 3000	28	29	2	59
Container - 4000	302	302	21	625
Container - 5000	322	322	6	650
Container - 6000	149	192	49	390
Container - 7000	91	91	3	185
Container - 8000	145	142	5	292
Container - 9000	11	11	0	22
Cruise	148	148	0	296
General Cargo	76	67	50	193
Ocean Tugs	77	66	43	186
Miscellaneous	2	2	1	5
Reefer	34	32	52	118
RoRo	1	1	0	2
Tanker - Aframax	4	4	5	13
Tanker - Chemical	71	78	153	302
Tanker - Handyboat	58	57	69	184
Tanker - Panamax	55	56	102	213
Tanker - VLCC	1	1	0	2
Total	**2,035**	**2,053**	**655**	**4,743**

DB ID693

3.5 Emission Estimation Methodology

Emissions are estimated as a function of vessel power demand with energy expressed in kW-hrs multiplied by an emission factor, where the emission factor is expressed in terms of grams per kilowatt-hour (g/kW-hr). Emission factors and emission factor adjustments for low propulsion engine load are then applied to the various activity data.

Equations 3.1 and 3.2 report the basic equations used in estimating emissions.

$$E = Energy \times EF \times FCF \times CF \qquad \text{Equation 3.1}$$

Where:

E = Emissions from the engine(s)
Energy = Energy demand, in kW-hrs, calculated using Equation 3.2 below as the energy output of the engine (or engines) over the period of time
EF = Emission factor, expressed in terms of g/kW-hr
FCF = Fuel correction factor
CF = Control factor(s) for emission reduction technologies

The 'Energy' term of the equation is where most of the location-specific information is used. Energy is calculated using Equation 3.2:

$$Energy = Power \times LF \times Act \qquad \text{Equation 3.2}$$

Where:

Power = maximum continuous rated engine propulsion engine power or total installed power for auxiliary engines or auxiliary engine boiler load, kW
LF = load factor (unitless)
Act = activity, hours

The emissions estimation methodology section discusses methodology used for propulsion engines, found in subsections 3.5.1 to 3.5.7, auxiliary engines found in subsections 3.5.8 and 3.5.9, and auxiliary boilers found in subsection 3.5.10. Propulsion engines are also referred to as main engines. Incinerators are not included in the emissions estimates because incinerators are not used within the study area. Interviews with the vessel operators and marine industry indicate that vessels do not use their incinerators while at berth or near coastal waters

3.5.1 Propulsion Engine Maximum Continuous Rated Power

Maximum Continuous Rated Power (MCR) is defined as the manufacturer's tested engine power; for this study, it is assumed that the Lloyd's 'Power' value is the best surrogate for MCR power. The international specification is to report MCR in kilowatts, and it is related to the highest power available from a ship engine during average cargo and sea conditions.

3.5.2 Propulsion Engine Load Factor

Load factor is the ratio of an engine's power output at a given speed to the engine's MCR power. Propulsion engine load factor is estimated using the Propeller Law, which says that propulsion engine load varies with the cube of vessel speed. Therefore, propulsion engine load at a given speed is estimated by taking the cube of that speed divided by the vessel's maximum speed, as illustrated by the following equation.

$$LF = (AS / MS)^3 \qquad \text{Equation 3.3}$$

Where:

LF = load factor, percent
AS = actual speed, knots
MS = maximum speed, knots

For the purpose of estimating emissions, the load factor has been capped to 1.0 so that there are no calculated propulsion engine load factors greater than 100% (i.e., calculated load factors above 1.0 are assigned a load factor of 1.0).

3.5.3 Propulsion Engine Activity

Activity is measured in hours of operation. The transit time in PZ and the fairway, from outside the PZ to the edge of the geographical boundary, is estimated using equation 3.4 which divides the segment distance traveled by ship speed.

$$Act = D/AS \qquad \text{Equation 3.4}$$

Where:

Act = activity, hours
D = distance, nautical miles
AS = actual ship speed, knots

Actual speeds provided by MarEx (discussed in section 3.3.2) are used for estimating the fairway transit time. Vessel speeds are recorded by the Marine Exchange at 10, 15, 20, 25, 30, 35 and 40 nm. The Port's Vessel Speed Reduction Incentive Program (VSRIP) requires reduced speeds of 12 knots or slower during transiting outside the harbor and within 40 nm of the Port.

The PZ uses assigned speeds based on VBP data, as found in Table 3.4.

Table 3.4: Precautionary Zone Speed, knots

Vessel Type	Class	Speed
Auto Carrier	Fast	11.0
Bulk	Slow	9.0
Containership	Fast	11.0
Cruise	Fast	11.0
General Cargo	Slow	9.0
Miscellaneous	Slow	9.0
Ocean tug	Slow	9.0
Reefer	Slow	9.0
RoRo	Slow	9.0
Tanker	Slow	9.0

3.5.4 Propulsion Engine Emission Factors

The main engine emission factors used in this study were reported in a 2002 ENTEC study,[22] except for PM emission factors. CARB[23] provided the PM EF for slow and medium speed diesel engines. IVL 2004 study[24] was the source for the PM EF for gas turbine and steamship vessels. The greenhouse gas emission factors for CO_2, CH_4, and N_2O were also reported in the IVL 2004 study. These emissions factors are based on residual oil (RO) which is intermediate fuel oil (IFO 380) or one with similar specifications, with an average sulfur content of 2.7%.

The two predominant propulsion engine types are:

- Slow speed diesel engines, having maximum engine speeds less than 130 rpm
- Medium speed diesel engines, having maximum engine speeds over 130 rpm (and typically greater than 400 rpm).

Table 3.5 and 3.6 list the emission factors for propulsion power using residual fuel.

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22 ENTEC, *Quantification of Emissions from Ships Associated with Ship Movements between Ports in the European Community, Final Report*, July 2002. Prepared for the European Commission.(ENTEC 2002).

23 CARB, *A Critical Review of Ocean-Going Vessel Particulate Matter Emission Factors*, 9 Nov 07. See: *www.arb.ca.gov/msei/offroad/pubs/ocean_going_vessels_pm_emfac.pdf*

24 IVL, *Methodology for Calculating Emissions from Ships: Update on Emission Factors."* Prepared by IVL Swedish Environmental Research Institute for the Swedish Environmental Protection Agency.

Table 3.5: Emission Factors for OGV Propulsion Power using Residual Oil, g/kW-hr

Engine	Model Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
Slow speed diesel	≤ 1999	1.5	1.2	1.5	18.1	10.5	1.4	0.6
Medium speed diesel	≤ 1999	1.5	1.2	1.5	14.0	11.5	1.1	0.5
Slow speed diesel	2000 +	1.5	1.2	1.5	17.0	10.5	1.4	0.6
Medium speed diesel	2000 +	1.5	1.2	1.5	13.0	11.5	1.1	0.5
Gas turbine	all	0.05	0.04	0.0	6.1	16.5	0.2	0.1
Steamship	all	0.8	0.6	0.0	2.1	16.5	0.2	0.1

DB ID880

Table 3.6: GHG Emission Factors for OGV Propulsion Power using Residual Oil, g/kW-hr

Engine	Model Year	CO_2	N_2O	CH_4
Slow speed diesel	≤ 1999	620	0.031	0.012
Medium speed diesel	≤ 1999	683	0.031	0.010
Slow speed diesel	2000 +	620	0.031	0.012
Medium speed diesel	2000 +	683	0.031	0.010
Gas turbine	all	970	0.08	0.002
Steamship	all	970	0.08	0.002

DB ID880

3.5.5 Propulsion Engines Low Load Emission Factors

In general terms, diesel-cycle engines are not as efficient when operated at low loads. An EPA study[25] prepared by Energy and Environmental Analysis, Inc. (EEAI) established a formula for calculating emission factors for low engine load conditions such as those encountered during harbor maneuvering and when traveling slowly at sea, such as in the reduced speed zone. While mass emissions, pounds per hour, tend to go down as vessel speeds and engine loads decrease, the emission factors, g/kW-hr increase. This is based on observations that compression-cycle combustion engines are less efficient at low loads.

[25] USEPA, *Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data,* February 2000. Prepared by Energy and Environmental Analysis, Inc. (EEAI) for Sierra Research work assignment No. 1-10. EPA-420-R-002.

The following equations describe the low-load effect where emission rates can increase, based on a limited set of data from Lloyd's Maritime Program and the U.S. Coast Guard. The low load effect was described in a study conducted for the EPA by ENVIRON.[26] Equation 3.5 is the equation developed by EEAI to generate emission factors for the range of load factors from 2% to 20% for each pollutant:

Equation 3.5

$$y = a\,(\text{fractional load})^{-x} + b$$

Where:

y = emissions in g/kW-hr
a = coefficient
b = intercept
x = exponent (negative)
fractional load = derived by the Propeller Law (see equation 3.3)

Table 3.7 provides the variables for equation 3.5.

Table 3.7: Low-Load Emission Factor Regression Equation Variables

Pollutant	Exponent	Intercept (b)	Coefficient (a)
PM	1.5	0.2551	0.0059
NO_x	1.5	10.4496	0.1255
CO	1.0	0.1458	0.8378
HC	1.5	0.3859	0.0667

[26] USEPA, *Commercial Marine Inventory Development,* July 2002. Conducted by Environ. EPA 420-R-02-019.

Table 3.8 provides the emission factors based on Equation 3.5 and variables in Table 3.8 at 2% to 20% loads.

Table 3.8: EEAI Emission Factors, g/kW-hr

Load	PM	NO_x	CO	HC
2%	2.34	54.82	42.04	23.97
3%	1.39	34.60	28.07	13.22
4%	0.99	26.14	21.09	8.72
5%	0.78	21.67	16.90	6.35
6%	0.66	18.99	14.11	4.92
7%	0.57	17.23	12.11	3.99
8%	0.52	16.00	10.62	3.33
9%	0.47	15.10	9.45	2.86
10%	0.44	14.42	8.52	2.50
11%	0.42	13.89	7.76	2.21
12%	0.40	13.47	7.13	1.99
13%	0.38	13.13	6.59	1.81
14%	0.37	12.85	6.13	1.66
15%	0.36	12.61	5.73	1.53
16%	0.35	12.41	5.38	1.43
17%	0.34	12.24	5.07	1.34
18%	0.33	12.09	4.80	1.26
19%	0.33	11.96	4.56	1.19
20%	0.32	11.85	4.33	1.13

The low load adjustment (LLA) multipliers that are applied to the propulsion engine g/kW-hr emission factors are then determined by dividing each of the EEAI emission factors by the emission factor at 20% load using Equation 3.6. This results in positive numbers greater than one, since emissions increase as load is decreased. At 20% load, the value is exactly 1.0 since it is divided into itself.

Equation 3.6

LLA (at _% load) = y (at _% load) / y (at 20% load)

Where:

LLA = Low load adjustment multiplier
y = emission factors in g/kW-hr from equation 3.5 (See Table 3.7)

Table 3.9 lists the resulting low-load adjustment factors for diesel propulsion engines. Adjustments to N_2O and CH_4 emission factors are made on the basis of the NO_x and HC low load adjustments, respectively. The LLA is not applied at engine loads greater than 20%. For main engine loads below 20 percent, the LLA increases so as to reflect increased emissions on a g/kW-hr basis due to engine inefficiency. Low load emission factors are not applied to steamships or ships having gas turbines because the EPA study only observed a rise in emissions from diesel engines.

Table 3.9: Low Load Adjustment Multipliers for Emission Factors[27]

Load	PM	NO_x	SO_x	CO	HC	CO_2	N_2O	CH_4
2%	7.29	4.63	1.00	9.68	21.18	1.00	4.63	21.18
3%	4.33	2.92	1.00	6.46	11.68	1.00	2.92	11.68
4%	3.09	2.21	1.00	4.86	7.71	1.00	2.21	7.71
5%	2.44	1.83	1.00	3.89	5.61	1.00	1.83	5.61
6%	2.04	1.60	1.00	3.25	4.35	1.00	1.60	4.35
7%	1.79	1.45	1.00	2.79	3.52	1.00	1.45	3.52
8%	1.61	1.35	1.00	2.45	2.95	1.00	1.35	2.95
9%	1.48	1.27	1.00	2.18	2.52	1.00	1.27	2.52
10%	1.38	1.22	1.00	1.96	2.18	1.00	1.22	2.18
11%	1.30	1.17	1.00	1.79	1.96	1.00	1.17	1.96
12%	1.24	1.14	1.00	1.64	1.76	1.00	1.14	1.76
13%	1.19	1.11	1.00	1.52	1.60	1.00	1.11	1.60
14%	1.15	1.08	1.00	1.41	1.47	1.00	1.08	1.47
15%	1.11	1.06	1.00	1.32	1.36	1.00	1.06	1.36
16%	1.08	1.05	1.00	1.24	1.26	1.00	1.05	1.26
17%	1.06	1.03	1.00	1.17	1.18	1.00	1.03	1.18
18%	1.04	1.02	1.00	1.11	1.11	1.00	1.02	1.11
19%	1.02	1.01	1.00	1.05	1.05	1.00	1.01	1.05
20%	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

[27] The LLA multipliers for N_2O and CH_4 are based on NO_x and HC, respectively.

The LLA multipliers are applied to the at-sea emission factors for diesel propulsion engines only. The low load emission factor is calculated for each pollutant using Equation 3.7. In keeping with the port's emission estimating practice of assuming a minimum main engine load of 2%, the table of LLA factors does not include values for 1% load.

Equation 3.7

$$EF = Base\ EF \times LLA$$

Where:

EF = Resulting emission factor
Base EF = Emission factor for diesel propulsion engines (see Tables 3.5 and 3.6)
LLA = Low load adjustment multiplier (see Table 3.9)

3.5.6 Propulsion Engine Harbor Maneuvering Loads

Main engine loads within a harbor tend to be very light, especially on in-bound trips when the main engines are turned off for periods of time as the vessels are being maneuvered to their berths. During docking, when the ship is being positioned against the wharf, the assist tugboats do most of the work and the main engines are off. Main engine maneuvering loads are estimated using the Propeller Law, with the over-riding assumption that the lowest average engine load is 2%.

Harbor transit speeds within the breakwater were profiled from VBP information as follows:

- Inbound fast ships (auto, container, cruise ships) at 7 knots
- Inbound slow ships (any other vessel type) at 5 knots
- Outbound traffic for all vessels at 8 knots

The departure speed, and hence the departure load, is typically higher than on arrival because on departure the engine power is used to accelerate the vessel away from the berth, while on arrival the vessel usually travels slower and spends some time with the main engine off.

3.5.7 Propulsion Engine Defaults

All vessels that called the Port in 2010 were able to be matched for main engine power using the most current Lloyd's data and VBP information, except for ocean tugs. Therefore, defaults were only used for ocean tugs' main engine power.

3.5.8 Auxiliary Engine Emission Factors

The ENTEC auxiliary engine emission factors used in this study are presented in Table 3.10.

Table 3.10: Emission Factors for Auxiliary Engines using Residual Oil, g/kW-hr

Engine	MY	PM_{10}	$PM_{2.5}$	DPM	NO_X	SO_x	CO[28]	HC
Medium speed	≤ 1999	1.5	1.2	1.5	14.7	12.3	1.1	0.4
Medium speed	2000+	1.5	1.2	1.5	13.0	12.3	1.1	0.4

DB ID456

Table 3.11: GHG Emission Factors for Auxiliary Engines using Residual Oil, g/kW-hr

Engine	MY	CO_2	N_2O	CH_4
Medium speed	all	683	0.031	0.008

DB ID456

3.5.9 Auxiliary Engine Load Defaults

Lloyd's database contains limited auxiliary engine's installed power information because neither the IMO nor the classification societies require vessel owners to provide this information. Therefore, the auxiliary engine load data for each vessel follows the hierarchy described in section 3.3.5, utilizing VBP, sister ships, and Port defaults. Defaults for auxiliary engine loads were developed based on the vessel class averages of the installed auxiliary engine power, call-weighted averages by vessel class using Lloyds and VBP data for vessels calls in 2010, multiplied by load factors by vessel class by mode, which were derived from historical VBP data. Since the defaults are based on the vessels that visit the Port that year, defaults will vary slightly from year to year.

[28] IVL 2004.

Table 3.12 summarizes the auxiliary engine load defaults used for this study by vessel subtype. For diesel electric cruise ships, house load defaults are listed in Table 3.13. The auxiliary engine load defaults for the diesel electric cruise ships were obtained from VBP data and interviews with the cruise vessel industry. Diesel electric tankers did not call the port in 2010.

Table 3.12: Auxiliary Engine Load Defaults

Vessel Type	Auxiliary Engine Load Defaults (kW)			
	Sea	Maneuvering	Berth Hotelling	Anchorage Hotelling
Auto Carrier	434	1,301	723	434
Bulk	265	702	156	265
Bulk - Heavy Load	231	610	136	231
Bulk - Wood Chips	265	702	156	265
Container - 1000	459	1,091	345	459
Container - 2000	875	1,944	923	875
Container - 3000	565	1,939	485	565
Container - 4000	1,434	2,527	1,161	1,434
Container - 5000	1,115	3,983	956	1,115
Container - 6000	1,438	3,209	996	1,438
Container - 7000	1,488	3,320	1,030	1,488
Container - 8000	1,602	3,574	1,109	1,602
Container - 9000	1,498	3,341	1,037	1,498
Cruise	5,497	8,794	5,497	5,497
General Cargo	575	1,522	744	575
Ocean Tug	101	266	130	101
Miscellaneous	265	702	156	265
Reefer	484	1,453	840	484
RoRo	434	1,301	751	434
Tanker - Aframax	809	1,112	876	809
Tanker - Chemical	762	1,048	826	762
Tanker - Handyboat	504	693	546	504
Tanker - Panamax	623	856	675	623
Tanker - VLCC	1,396	1,920	1,513	1,396

Table 3.13: Diesel Electric Cruise Ship Auxiliary Engine Load Defaults

Vessel Type	Auxiliary Engine Load Defaults (kW) Passenger Count	Sea	Maneuvering	Berth Hotelling
Cruise, Diesel Electric	0-1,500	3,500	3,500	3,000
Cruise, Diesel Electric	1,500-2,000	7,000	7,000	6,500
Cruise, Diesel Electric	2,000-3,000	10,500	10,500	9,500
Cruise, Diesel Electric	3,000-3,500	11,000	11,000	10,000
Cruise, Diesel Electric	3,500-4,000	11,500	11,500	10,500
Cruise, Diesel Electric	4,000+	12,000	12,000	11,000

3.5.10 Auxiliary Boilers

In addition to the auxiliary engines that are used to generate electricity for on-board uses, most OGVs have one or more boilers used for fuel heating and for producing hot water. Boilers are typically not used during transit at sea since many vessels are equipped with an exhaust gas recovery system or "economizer" that uses heat of the main engine exhaust for heating fuel or water. Therefore, the boilers are not needed when the main engines are used while in transit. Vessel speeds for vessels calling the port have been reduced in recent years due to increased compliance with the VSR program extending to 40 nm. Because of these lower speeds, it is believed that auxiliary boilers are used during transit when the lower speeds result in the cooling of main engine exhausts, making the vessels' economizers less effective. As such, it is assumed that auxiliary boilers operate when the main engine power load is less than 20% during maneuvering and transit.

Tables 3.14 and 3.15 show the emission factors used for the auxiliary boilers based on ENTEC's report (ENTEC 2002).

Table 3.14: Emission Factors for OGV Auxiliary Boilers using Residual Oil, g/kW-hr

Engine	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
Steam boilers	0.8	0.6	0.0	2.1	16.5	0.2	0.1

DB ID880

Table 3.15: GHG Emission Factors for OGV Auxiliary Boilers using Residual Oil, g/kW-hr

Engine	CO_2	N_2O	CH_4
Steam boilers	970	0.08	0.002

DB ID880

The boiler fuel consumption data collected from vessels during the VBP was converted to equivalent kilowatts using Specific Fuel Consumption (SFC) factors found in the ENTEC report. The average SFC value for using residual fuel is 305 grams of fuel per kW-hour. Using the following equation, the average kW for auxiliary boilers was calculated.

Average kW = ((daily fuel/24) x 1,000,000)/305 Equation 3.8

Auxiliary boiler energy defaults in kilowatts used for each vessel type are presented in Table 3.16. The cruise ships and tankers, except for diesel electric tankers and cruise ships, have much higher auxiliary boiler usage rates than the other vessel types. Cruise ships have higher boiler usage due to the number of passengers and need for hot water. Tankers provide steam for steam-powered liquid pumps, inert gas in fuel tanks, and to heat fuel for pumping. Ocean tugboats do not have boilers; therefore their boiler energy default is zero. As mentioned earlier, boilers are not typically used at sea during normal transit; therefore the boiler energy default at sea is zero, if main engine load is greater than 20%. If the main engine load is less than or equal to 20%, the maneuvering boiler load defaults shown in the table are used which are similar to hotelling defaults, except for the tankers. The auxiliary boiler load defaults remained the same from the 2009 EI since there is no new VBP data for 2010 EI.

Table 3.16: Auxiliary Boiler Load Defaults

Vessel Type	Boiler Load Defaults (kW)			
	Sea	Maneuvering	Berth Hotelling	Anchorage Hotelling
Auto Carrier	0	246	246	246
Bulk	0	137	137	137
Bulk - Heavy Load	0	137	137	137
Bulk - Wood Chips	0	137	137	137
Container - 1000	0	228	228	228
Container - 2000	0	348	348	348
Container - 3000	0	497	497	497
Container - 4000	0	530	530	530
Container - 5000	0	629	629	629
Container - 6000	0	578	578	578
Container - 7000	0	497	497	497
Container - 8000	0	440	440	440
Container - 9000	0	440	440	440
Cruise	0	1,393	1,393	0
General Cargo	0	137	137	137
Ocean Tug	0	0	0	0
Miscellaneous	0	137	137	137
Reefer	0	212	212	212
RoRo	0	301	301	301
Tanker - Aframax	0	371	2,500	371
Tanker - Chemical	0	371	2,500	371
Tanker - Handyboat	0	371	2,500	371
Tanker - Panamax	0	371	2,500	371
Tanker - VLCC	0	371	2,500	371

3.5.11 Fuel Correction Factors

Fuel correction factors are used when the actual fuel used is different than the fuel used to develop the emission factors. As discussed earlier, main, auxiliary and auxiliary boiler emission factors are based on residual fuel with an average 2.7% sulfur content or marine diesel oil with an average 1.5% sulfur content. Table 3.17 lists the fuel correction factors for fuels with different sulfur content. These fuel correction factors are consistent with CARB's emission estimations methodology for ocean-going vessels.[29]

Table 3.17: Fuel Correction Factors

Actual Fuel	Sulfur Content	PM	NO_x	SO_x	CO	HC	CO_2	N_2O	CH_4
HFO	1.5%	0.82	1.00	0.56	1.00	1.00	1.00	1.00	1.00
MDO	1.5%	0.47	0.90	0.56	1.00	1.00	1.00	0.90	1.00
MDO/MGO	0.5%	0.25	0.94	0.18	1.00	1.00	1.00	0.94	1.00
MDO/MGO	0.2%	0.19	0.94	0.07	1.00	1.00	1.00	0.94	1.00
MDO/MGO	0.1%	0.17	0.94	0.04	1.00	1.00	1.00	0.94	1.00

Beginning 1 July 2009, CARB's OGV Fuel Regulation, adopted in July 2008, required vessel operators to use marine gas oil (MGO) with a sulfur content less than 1.5% by weight or marine diesel oil (MDO) with a sulfur content equal to or less than 0.5% by weight within 24 nm from California coast (and while at berth) in their diesel powered propulsion engines, auxiliary engines and auxiliary boilers. During this period, an average 0.5% sulfur fuel content is assumed for both main and auxiliary engines and auxiliary boilers. For the 2010 calendar year, 100% compliance with CARB's regulation is assumed, with the exception of the auxiliary boiler exemptions discussed below. The compliance rate and exceptions used in the EI were confirmed by CARB per discussions through the Technical Working Group (TWG).

CARB issued several Essential Modification Executive Orders exempting individual vessels from the fuel use specifications described in the OGV Fuel Regulation for vessels. Vessels that demonstrated that it is not feasible to use the specified fuels in their auxiliary boilers unless essential modifications to the vessels are made and granted the exemption are listed on CARB's website[30]. The exemptions for individual vessels are reflected in the calculated OGV emissions. For these particular vessels, if the vessel called the port in 2010, the fuel switching was not included for the boilers; therefore, the emissions were estimated for the boilers as burning residual fuel. In 2010, there were 26 exempted vessels with 49 calls total.

In 2010, there were no other fuel switching policies taken into consideration, such as port, corporate or vessel operator policies since the CARB OGV Fuel Regulation was in full effect for the whole year.

[29] See *http://www.arb.ca.gov/regact/2008/fuelogv08/fuelogv08.htm;* Appendix D, Tables II-6 to II-8.
[30] See *http://www.arb.ca.gov/ports/marinevess/ogv/ogveos.htm*

3.5.12 Control Factors for Emission Reduction Technologies

Control factors are used to take into account the emissions benefits associated with emission reduction technologies installed on vessels. One such technology for marine main engines is the fuel slide valve. This type of fuel valve leads to a better combustion process, less smoke, and lower fuel consumption, which results in reduced overall emissions for NO_x, a 30% reduction, and for PM, a 25% reduction. The newer MAN B&W engines on the 2004+ model year vessels are equipped with the fuel slide valves. Some companies are also retrofitting their vessels equipped with MAN B&W main engines with slide valves. Since information on slide valve retrofits has primarily been collected through VBP surveys, the inventory may not have captured all the vessels that have been retrofitted with slide valves. The emission reduction estimates for the slide valves are based on MAN B&W Diesel A/S emission measurements. In order to obtain the latest information on the applicability and control effectiveness of slide valves, the representative from MAN B&W in Denmark was recently contacted. Based on the recent communication with MAN B&W and preliminary information provided, for the 2010 inventory, the current emission reduction benefits, 30% for NOx and 25% for PM, are applied to 2004 and newer vessels equipped with MAN B&W engines as well as to existing engines known to be retrofitted with slide valves. The ports will continue to work with MAN B&W and the TWG to refine the emission benefits for slide valves used in new engines and as retrofits for future EIs to ensure that the latest available information is used. In 2010, slide valves were used in 31% of all vessel calls.

In addition, shore side electrical power was used for 60 vessel calls representing about 3% of all vessel calls. At-berth reduction of 95% in all pollutants for auxiliary engines emissions is assumed for ships that used shore side electrical power. This reduction estimate accounts for the time necessary to connect and disconnect the electrical power and start-up the auxiliary engines.

3.5.13 Improvements to Methodology from Previous Years

There was one change to the ocean going vessels emission calculation methodology in this inventory compared to the 2009 methodology. The last 5 nm of the departure lane of the southern route is not within the 40 nm boundary for the CARB Fuel Regulation; therefore, vessels were estimated burning the default residual oil instead of switching to a lower sulfur fuel for that 5 nm segment. Also, the previous year emissions from 2005 to 2008 were re-estimated using the 2010 transiting factors for the previous years' missing speeds. For comparison of 2010 emissions to previous years' emissions, refer to Section 9.

3.5.14 Future Improvements to Methodology

For future emission inventories, improvements to the methodology will be considered in at least three areas:

1) Engine modification technologies will be incorporated in new engines as standard practice and installed as retrofits in existing vessels. The ports will work with engine manufacturers and shipping companies, and through the TWG process, to further refine the emissions benefits associated with slide valves in new engines and in retrofits, as well as other technologies being implemented;

2) In an effort to improve the auxiliary engine loads by vessel mode, a new approach will be considered, in consultation with TWG, based on VBP reported auxiliary loads with the actual power of the engine used, by vessel class and by mode. This approach will replace using the average installed auxiliary engine power adjusted by applying load factor by vessel class and mode. Under the new approach, default loads for auxiliary engines by operating mode will be based on the average of loads for each vessel subclass recorded for vessels boarded. Load factors will no longer be multiplied by installed power for a resulting auxiliary engine load, as this is not a scalable variable by vessel owner and class and may result in inaccurate estimates of auxiliary engine load. Information from CARB surveys, if available, will also be used for filling any data gaps.

3) CARB has proposed changing the boundary for the OGV Fuel Regulation and the new boundary will be taken into consideration for the 2011 EI.

3.6 Emission Estimates

A summary of the ocean-going vessel emission estimates by vessel type for all pollutants for the year 2010 is presented in Tables 3.18 and 3.19.

Table 3.18: 2010 Ocean-Going Vessel Emissions by Vessel Type, tons per year

Vessel Type	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
Auto Carrier	3.1	2.5	2.9	83.7	20.5	8.1	3.6
Bulk	1.5	1.2	1.3	42.0	10.8	4.0	1.7
Bulk - Heavy Load	0.1	0.1	0.1	2.1	0.7	0.2	0.1
Bulk - Wood Chips	0.0	0.0	0.0	1.1	0.2	0.1	0.0
Container - 1000	2.5	2.0	2.0	69.2	20.0	7.4	3.4
Container - 2000	10.1	8.1	8.1	211.4	90.0	21.9	9.8
Container - 3000	1.8	1.5	1.6	41.5	12.8	4.7	2.3
Container - 4000	24.2	19.4	22.3	570.0	155.9	67.9	34.2
Container - 5000	32.6	26.1	29.5	696.0	209.9	87.2	45.5
Container - 6000	23.2	18.5	21.2	467.5	144.6	61.7	33.0
Container - 7000	12.3	9.9	11.4	251.0	80.6	31.4	15.7
Container - 8000	18.4	14.7	17.1	369.9	121.5	49.7	25.6
Container - 9000	1.6	1.3	1.5	33.2	9.7	3.9	2.0
Cruise	19.7	15.7	19.7	557.4	126.5	49.7	19.5
General Cargo	3.4	2.7	3.3	101.1	23.2	9.0	3.8
Ocean Tug	1.2	0.9	1.2	38.3	6.9	3.4	1.5
Miscellaneous	0.0	0.0	0.0	0.7	0.3	0.1	0.0
Reefer	1.3	1.0	1.2	43.0	8.6	3.7	1.6
RoRo	0.0	0.0	0.0	0.6	0.1	0.1	0.0
Tanker - Aframax	0.4	0.3	0.2	7.3	5.0	0.7	0.3
Tanker - Chemical	7.5	6.0	4.4	155.9	80.1	15.0	6.3
Tanker - Handyboat	4.5	3.6	2.0	75.5	62.1	6.7	2.8
Tanker - Panamax	8.9	7.1	3.1	121.2	132.9	12.2	5.2
Tanker - VLCC	0.2	0.1	0.1	4.0	1.9	0.4	0.1
Total	**178.3**	**142.7**	**154.2**	**3,943.7**	**1,324.8**	**449.0**	**218.1**

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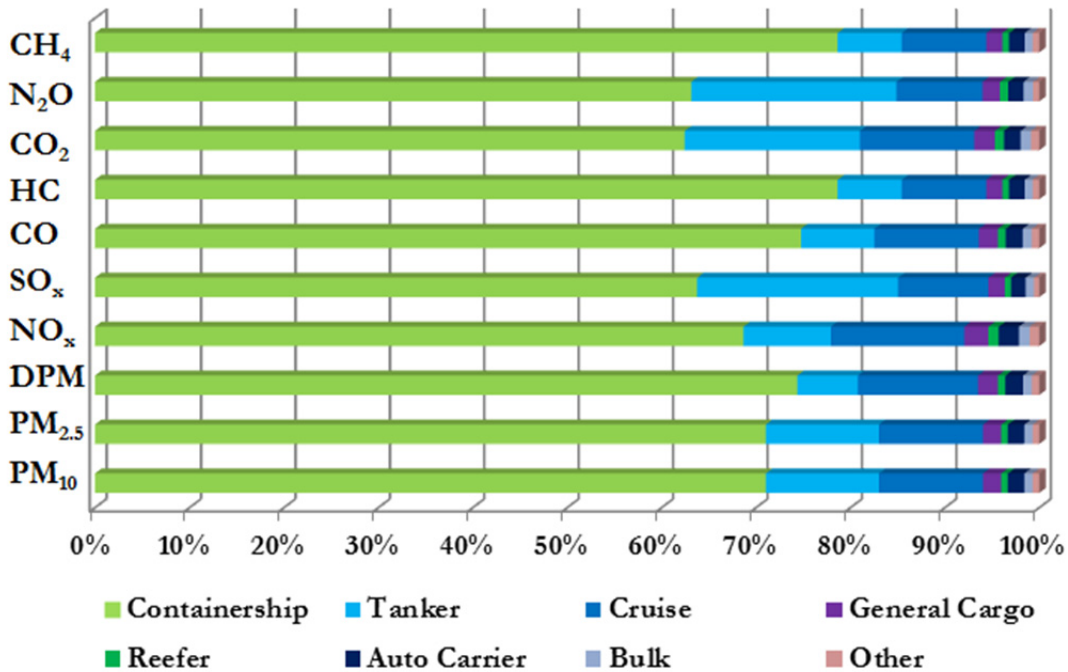
Table 3.19: Summary of 2010 Ocean-Going Vessel GHG Emissions by Vessel Type, metric tons per year

Vessel Type	CO_2 Equivalent	CO_2	N_2O	CH_4
Auto Carrier	4,134.4	4,067.2	0.2	0.1
Bulk	2,351.0	2,312.5	0.1	0.0
Bulk - Heavy Load	135.8	133.5	0.0	0.0
Bulk - Wood Chips	65.5	64.4	0.0	0.0
Container - 1000	3,996.4	3,926.6	0.2	0.1
Container - 2000	13,136.3	12,904.2	0.7	0.2
Container - 3000	2,308.4	2,265.9	0.1	0.0
Container - 4000	28,885.3	28,375.2	1.6	0.6
Container - 5000	37,576.4	36,882.4	2.2	0.8
Container - 6000	25,523.1	25,052.1	1.5	0.6
Container - 7000	13,694.8	13,449.8	0.8	0.3
Container - 8000	19,937.2	19,587.8	1.1	0.5
Container - 9000	1,664.0	1,633.6	0.1	0.0
Cruise	28,358.7	27,979.9	1.2	0.4
General Cargo	5,130.9	5,052.7	0.2	0.1
Ocean Tug	1,963.2	1,937.0	0.1	0.0
Miscellaneous	42.0	41.4	0.0	0.0
Reefer	2,209.1	2,173.5	0.1	0.0
RoRo	36.1	35.5	0.0	0.0
Tanker - Aframax	757.9	742.9	0.0	0.0
Tanker - Chemical	17,484.3	17,136.5	1.1	0.1
Tanker - Handyboat	9,803.0	9,594.7	0.7	0.1
Tanker - Panamax	15,090.3	14,778.3	1.0	0.1
Tanker - VLCC	500.7	490.2	0.0	0.0
Total	**234,784.6**	**230,617.8**	**13.2**	**4.0**

DB ID692

Figure 3.4 shows percentage of emissions by vessel type for each pollutant. Containerships contributed the highest percentage of the emissions (approximately 62 to 78%), followed by tankers (approximately 7 to 22%), cruise ships (approximately 9 to 14%), general cargo, auto carrier, reefers, and bulk vessels. The "other" category includes ocean-going tugboats and miscellaneous vessels.

Figure 3.4: 2010 Ocean-Going Vessel Emissions by Vessel Type, %



3.6.1 Emission Estimates by Engine Type

Tables 3.20 and 3.21 present summaries of emission estimates by engine type in tons per year.

Table 3.20: 2010 Ocean-Going Vessel Emissions by Engine Type, tons per year

Engine Type	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
Main Engine	90.7	72.6	89.1	1,807.5	511.3	260.1	147.1
Auxiliary Engine	65.1	52.1	65.1	1,971.3	422.7	172.3	62.6
Auxiliary Boiler	22.5	18.0	0.0	164.9	390.8	16.6	8.3
Total	**178.3**	**142.7**	**154.2**	**3,943.7**	**1,324.8**	**449.0**	**218.1**

DB ID692

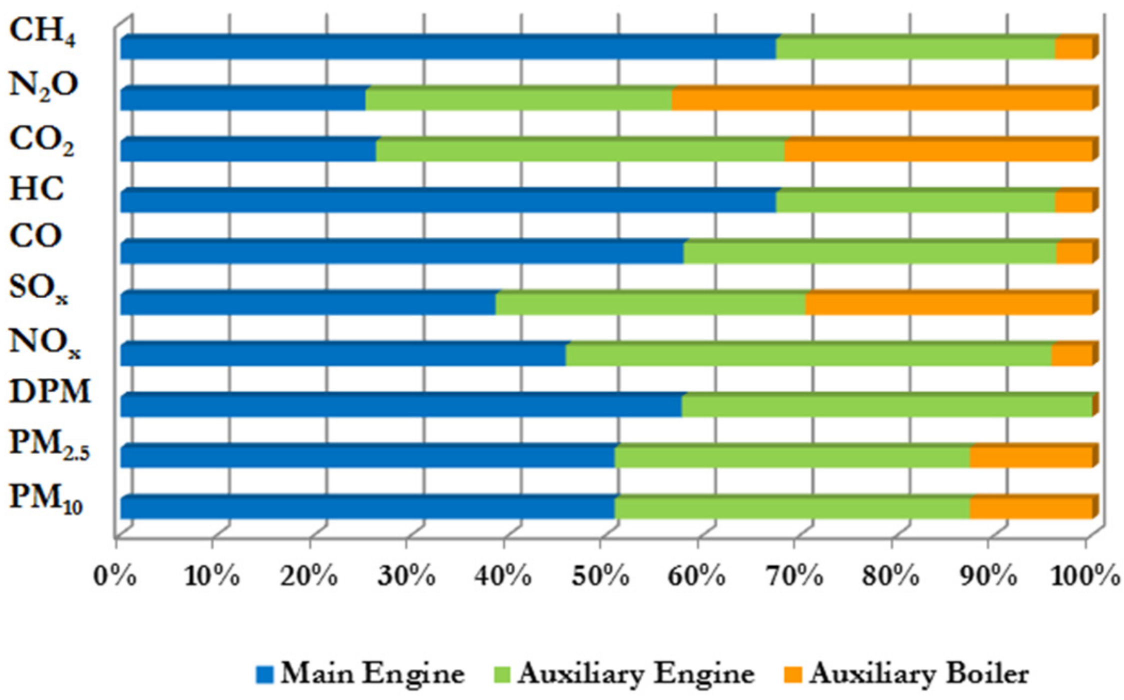
Table 3.21: 2010 Ocean-Going Vessel GHG Emissions by Engine Type, metric tons per year

Engine Type	CO_2 Equivalent	CO_2	N_2O	CH_4
Main Engine	61,725.1	60,638.0	3.3	2.7
Auxiliary Engine	98,352.6	97,042.2	4.1	1.1
Auxiliary Boiler	74,706.9	72,937.6	5.7	0.2
Total	**234,784.6**	**230,617.8**	**13.2**	**4.0**

DB ID692

Figure 3.5 shows percentages of emissions by engine type for each pollutant. The majority of OGV emissions are associated with main and auxiliary diesel engines.

Figure 3.5: 2010 Ocean-Going Vessel Emissions by Engine Type, %



3.6.2 Emission Estimates by Mode

Tables 3.22 and 3.23 present summaries of emission estimates by the various modes in tons per year. For each mode, the engine type emissions are also listed. Hotelling at terminal berth and at anchorage are listed separately. Transit and harbor maneuvering emissions include both berth and anchorage calls. Figure 3.6 shows results in percentages of emissions by mode.

Table 3.22: 2010 Ocean-Going Vessel Emissions by Mode, tons per year

Mode	Engine Type	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
Transit	Main	82.5	66.0	80.9	1,577.8	500.3	213.1	107.3
Transit	Aux	16.5	13.2	16.5	340.9	119.6	29.5	10.7
Transit	Auxiliary Boiler	2.0	1.6	0.0	11.4	36.9	1.1	0.6
Total Transit		**101.0**	**80.8**	**97.3**	**1,930.0**	**656.8**	**243.8**	**118.6**
Maneuvering	Main	8.2	6.6	8.2	229.8	11.0	47.0	39.8
Maneuvering	Aux	4.8	3.8	4.8	159.4	29.6	14.0	5.1
Maneuvering	Auxiliary Boiler	0.4	0.3	0.0	3.7	6.7	0.4	0.2
Total Maneuvering		**13.4**	**10.7**	**13.0**	**392.8**	**47.3**	**61.3**	**45.1**
Hotelling - Berth	Main	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hotelling - Berth	Aux	40.7	32.5	40.7	1,363.1	253.5	119.4	43.4
Hotelling - Berth	Auxiliary Boiler	18.6	14.9	0.0	141.0	321.6	14.2	7.1
Total Hotelling - Berth		**59.3**	**47.5**	**40.7**	**1,504.2**	**575.1**	**133.6**	**50.5**
Hotelling - Anchorage	Main	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hotelling - Anchorage	Aux	3.2	2.6	3.2	107.9	20.0	9.4	3.4
Hotelling - Anchorage	Auxiliary Boiler	1.4	1.1	0.0	8.7	25.6	0.9	0.4
Total Hotelling - Anchorage		**4.6**	**3.7**	**3.2**	**116.6**	**45.7**	**10.3**	**3.9**
Total		**178.3**	**142.7**	**154.2**	**3,943.7**	**1,324.8**	**449.0**	**218.1**

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Table 3.23: 2010 Ocean-Going Vessel Greenhouse Gas Emissions by Mode, metric tons per year

Mode	Engine Type	CO_2 Equivalent	CO_2	N_2O	CH_4
Transit	Main	58,479.3	57,527.8	2.9	1.9
Transit	Aux	16,854.0	16,627.0	0.7	0.2
Transit	Auxiliary Boiler	5,108.9	4,986.9	0.4	0.0
Total Transit		**80,442.2**	**79,141.7**	**4.0**	**2.2**
Maneuvering	Main	3,245.8	3,110.2	0.4	0.7
Maneuvering	Aux	7,968.8	7,862.9	0.3	0.1
Maneuvering	Auxiliary Boiler	1,695.7	1,655.8	0.1	0.0
Total Maneuvering		**12,910.3**	**12,628.9**	**0.9**	**0.8**
Hotelling - Berth	Main	0.0	0.0	0.0	0.0
Hotelling - Berth	Aux	68,147.2	67,241.3	2.9	0.8
Hotelling - Berth	Auxiliary Boiler	63,968.2	62,454.5	4.9	0.1
Total Hotelling - Berth		**132,115.4**	**129,695.9**	**7.7**	**0.9**
Hotelling - Anchorage	Main	0.0	0.0	0.0	0.0
Hotelling - Anchorage	Aux	5,382.5	5,311.0	0.2	0.1
Hotelling - Anchorage	Auxiliary Boiler	3,934.0	3,840.4	0.3	0.0
Total Hotelling - Anchorage		**9,316.6**	**9,151.3**	**0.5**	**0.1**
Total		**234,784.6**	**230,617.8**	**13.2**	**4.0**

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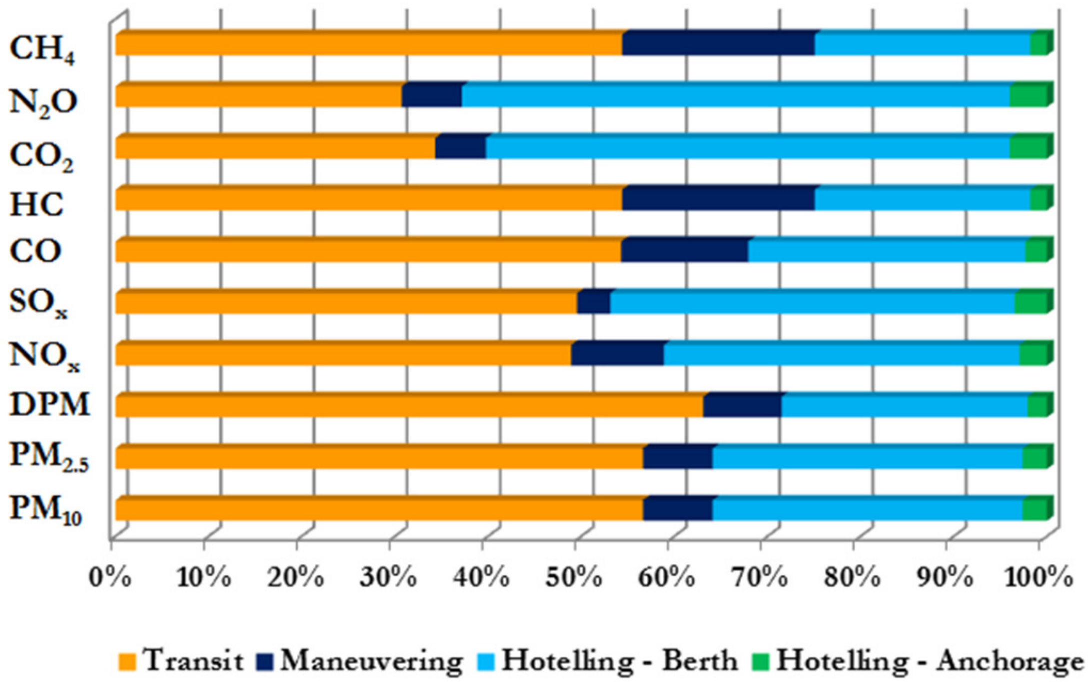
Figure 3.6: 2010 Ocean-Going Vessel Emissions by Mode, %



3.7 Facts and Findings

Table 3.24 summarizes the number of calls and total TEUs handled by the Port as well as the average TEUs/call from 2005 to 2010. The average TEU per call was at its highest in 2010 which means more TEUs were handled per vessel call. Although the TEU throughput increased by 16% from the previous year, the vessel calls only increased by 1%.

Table 3.24: TEUs and Vessel Call Comparison, 2005-2010

Year	All Calls	ontainership Calls	TEUs	Average TEUs/Call
2010	2,035	1,355	7,831,902	5,780
2009	2,010	1,355	6,748,995	4,981
2008	2,239	1,459	7,849,985	5,380
2007	2,527	1,573	8,355,038	5,312
2006	2,703	1,627	8,469,853	5,206
2005	2,501	1,481	7,484,625	5,054
Previous Year (2010-2009)	**1%**	**0%**	**16%**	**16%**
CAAP Progress (2010-2005)	**-19%**	**-9%**	**5%**	**14%**

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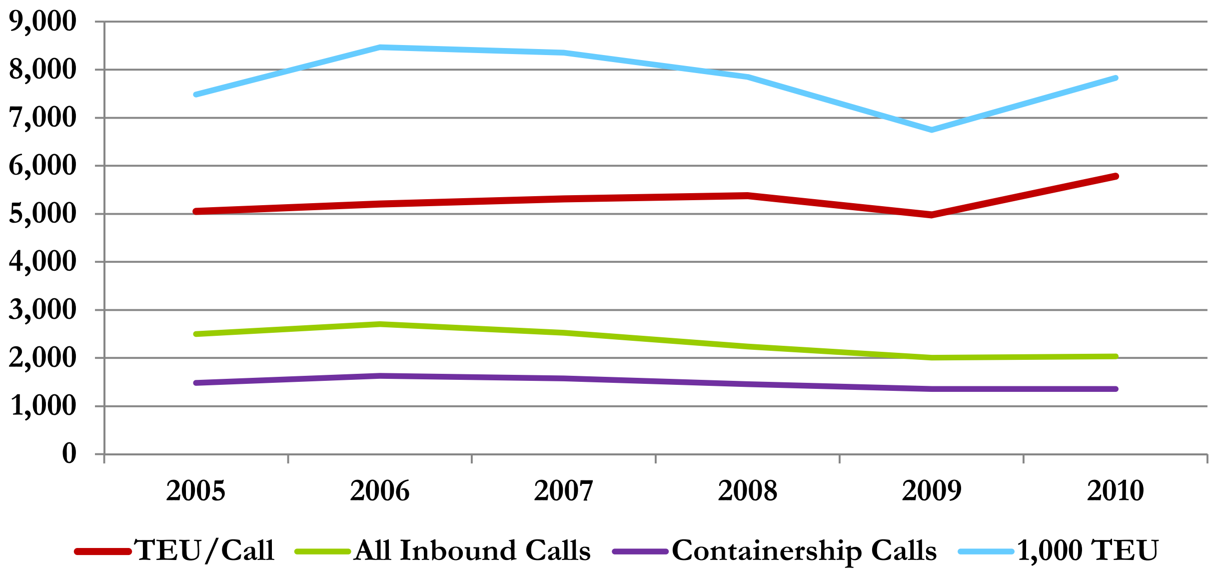
Figure 3.7 presents the trends in the total TEUs, vessel calls and TEU/call for 2005 to 2010. The TEU/container call efficiency increased in 2010 compared to 2009. In 2010, despite a 16% increase in TEUs from 2009, the container calls increased only 1%.

Figure 3.7: Vessel Call and TEU Trend



3.7.1 Flags of Convenience

Most OGVs are foreign flagged ships, whereas harbor vessels are almost exclusively domestic. Approximately 93% of the OGVs that visited the Port were registered outside the U.S. Although only 7% of the individual OGVs are registered in the U.S., they comprised 15% of all calls. This is most likely because the U.S. flagged OGVs make shorter, more frequent stops along the west coast. Figures 3.8 and 3.9 show the breakdown of the ships' registered country (i.e., flag of registry) for discrete vessels and by the number of calls, respectively. Approximately 25 "other" flags of registry are included together as "other" category.

Figure 3.8: 2010 Flag of Registry, Discrete Vessels

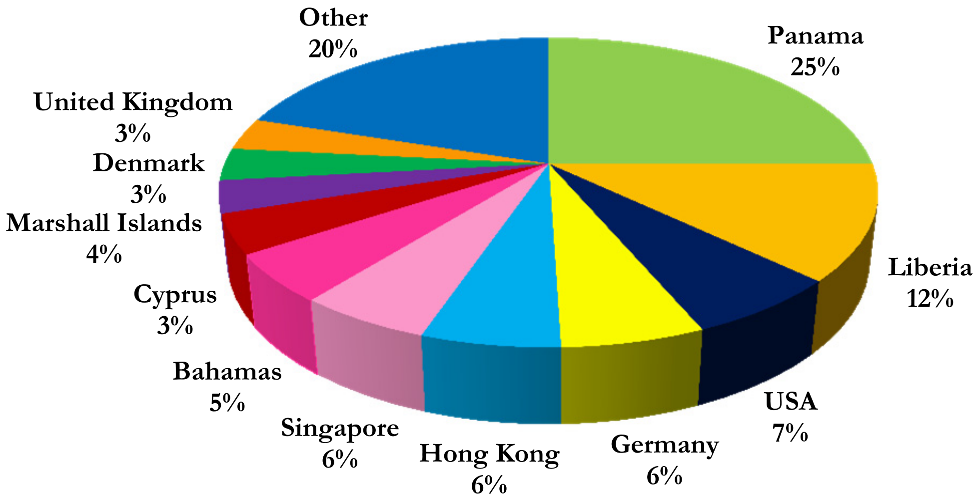
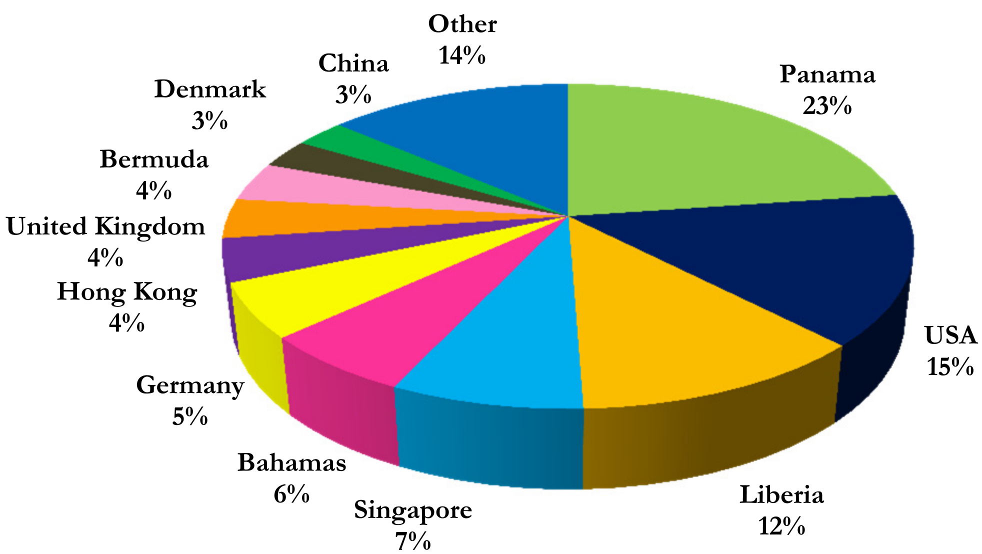


Figure 3.9: 2010 Flag of Registry, Vessel Calls



3.7.2 Next and Last Port of Call

Figures 3.10 and 3.11 summarize the next (to) port and last (from) port, respectively, for vessels that called in 2010. The other category contains about 130 ports that had less than 2% each.

Figure 3.10: 2010 Next (To) Port

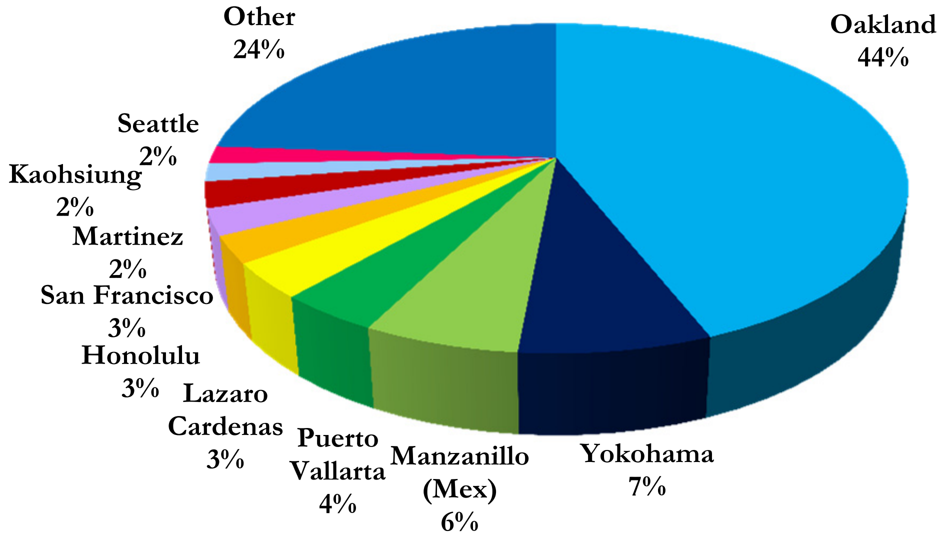
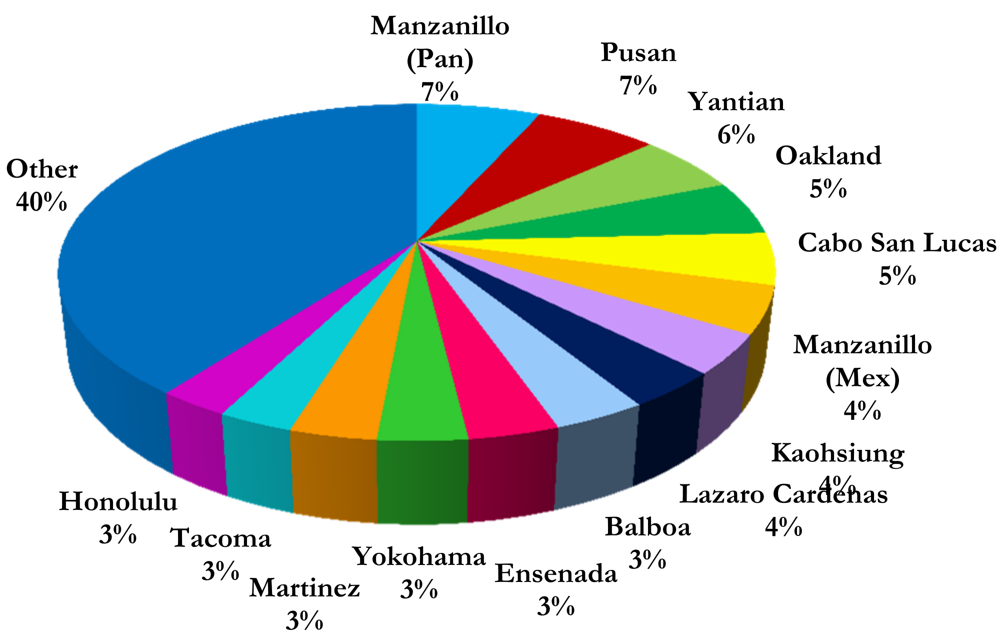


Figure 3.11: 2010 Last (From) Port



3.7.3 Vessel Characteristics

Table 3.25 summarizes the vessel and engine characteristics by vessel type. The year built, deadweight (Dwt), speed, and main engine power are based on the specific vessels that called at the Port. Due to the large number of containerships and tankers that call at the Port and their variety, the vessels were divided by vessel types. For some vessel types, there was no data available for certain characteristics and these are labeled "na".

Table 3.25: Vessel Type Characteristics for Vessels that Called the Port in 2010

Vessel Type	Year Built	Age (Years)	Average DWT (tons)	Max Speed (knots)	Main Eng (kW)	Aux Eng (kW)
Auto Carrier	2003	7	16,547	19.6	12,553	3,310
Bulk	1999	11	49,660	14.4	8,006	1,830
Bulk - Heavy Load	1990	20	11,821	14.7	7,358	1,302
Bulk - Wood Chips	2000	11	43,951	14.8	9,194	1,842
Container - 1000	2001	9	22,798	19.7	14,432	3,691
Container - 2000	1999	11	38,638	21.2	22,101	5,189
Container - 3000	1999	11	48,427	22.7	30,528	4,423
Container - 4000	2000	10	60,987	24.0	41,519	7,330
Container - 5000	2002	8	67,067	25.0	51,218	8,198
Container - 6000	2004	6	77,994	25.3	61,219	12,046
Container - 7000	2007	3	78,618	25.1	64,533	11,683
Container - 8000	2006	4	101,146	24.9	66,930	12,171
Container - 9000	2007	3	na	25.7	68,639	11,665
Cruise	1999	11	6,385	20.7	39,638	11,295
General Cargo	1997	13	41,847	16.0	10,702	2,647
Ocean Tug	1988	22	23,683	13.3	6,420	na
Miscellaneous	1997	13	na	na	4,413	na
Reefer	1990	20	11,769	19.5	9,474	3,496
RoRo	1996	14	11,285	14.7	5,296	6,740
Tanker - Aframax	2005	6	105,203	14.9	15,349	2,400
Tanker - Chemical	2004	6	34,393	14.8	8,855	2,825
Tanker - Handyboat	2001	10	44,859	14.9	8,710	2,625
Tanker - Panamax	2003	7	69,353	15.0	11,424	2,669
Tanker - VLCC	1994	16	156,382	15.5	15,445	2,689

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Figures 3.12 through Figure 3.16 show the various vessel type characteristics.

Figure 3.12: Average Age of Vessels that Called the Port in 2010, years

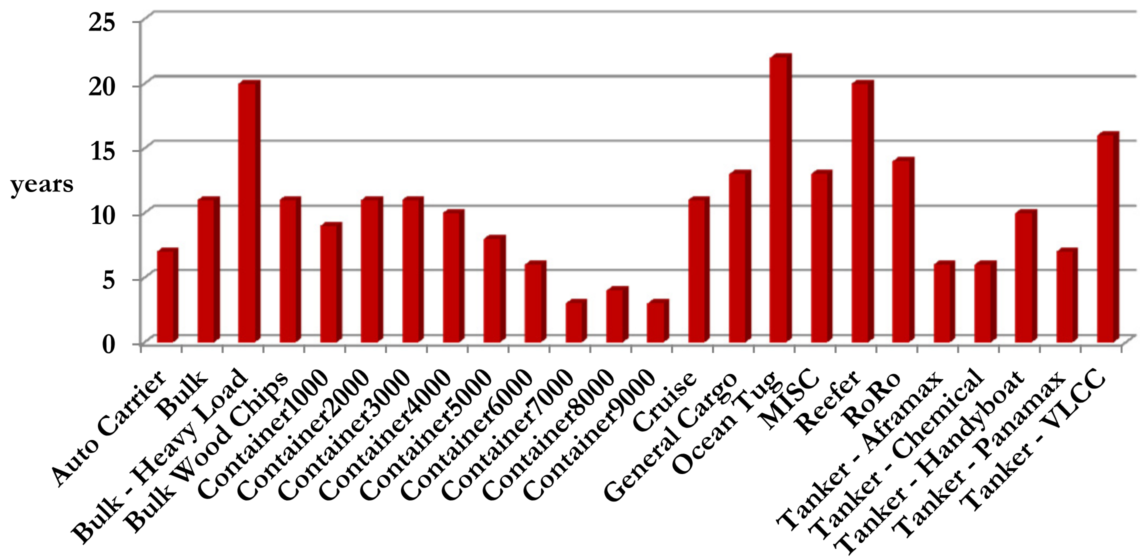


Figure 3.13: Average Maximum Rated Sea Speed of Vessels that Called the Port in 2010, knots

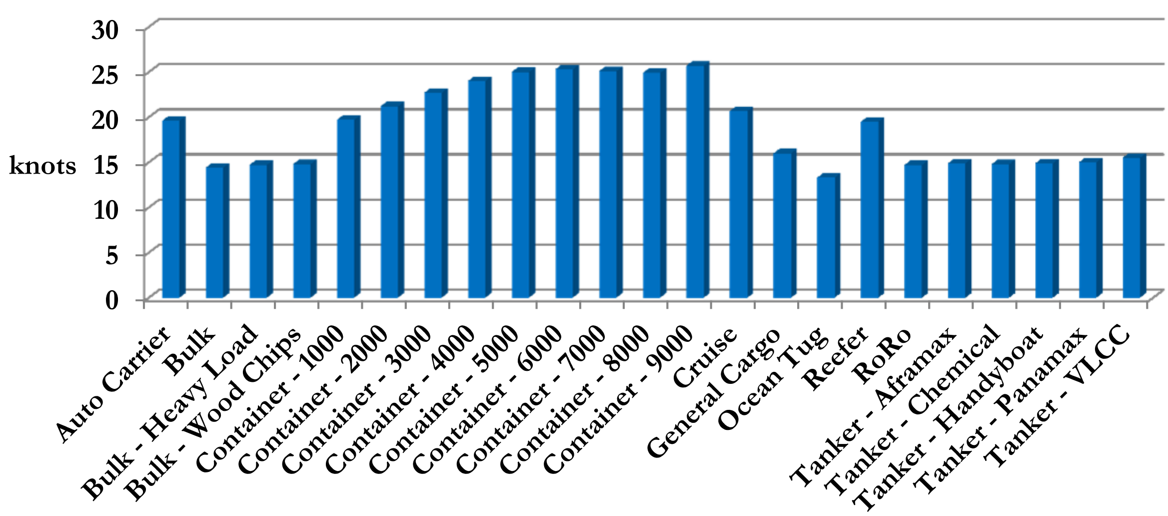


Figure 3.14: Average Deadweight of Vessels that Called the Port in 2010, tons

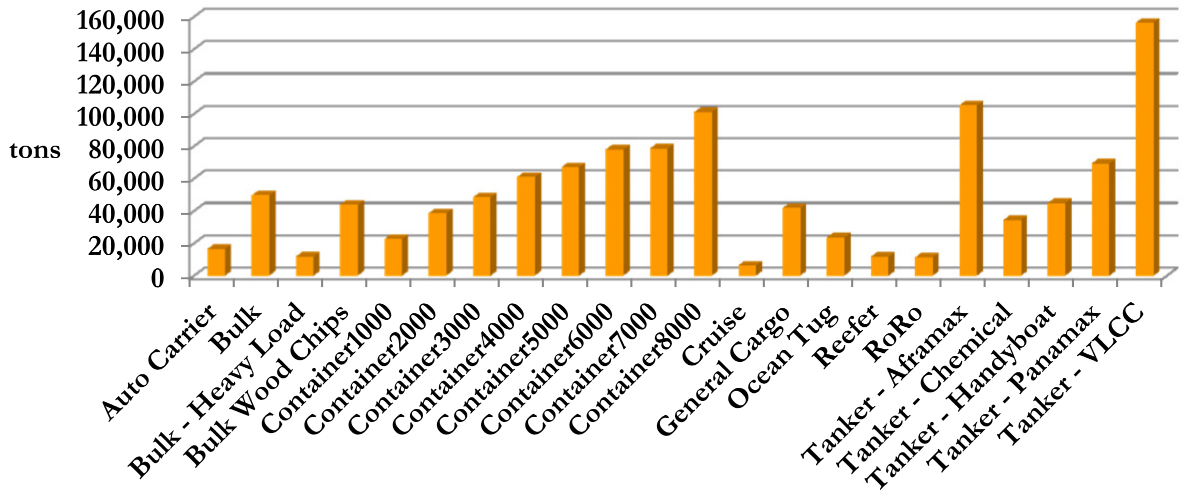


Figure 3.15: Average Main Engine Total Installed Power of Vessels that Called the Port in 2010, kilowatts

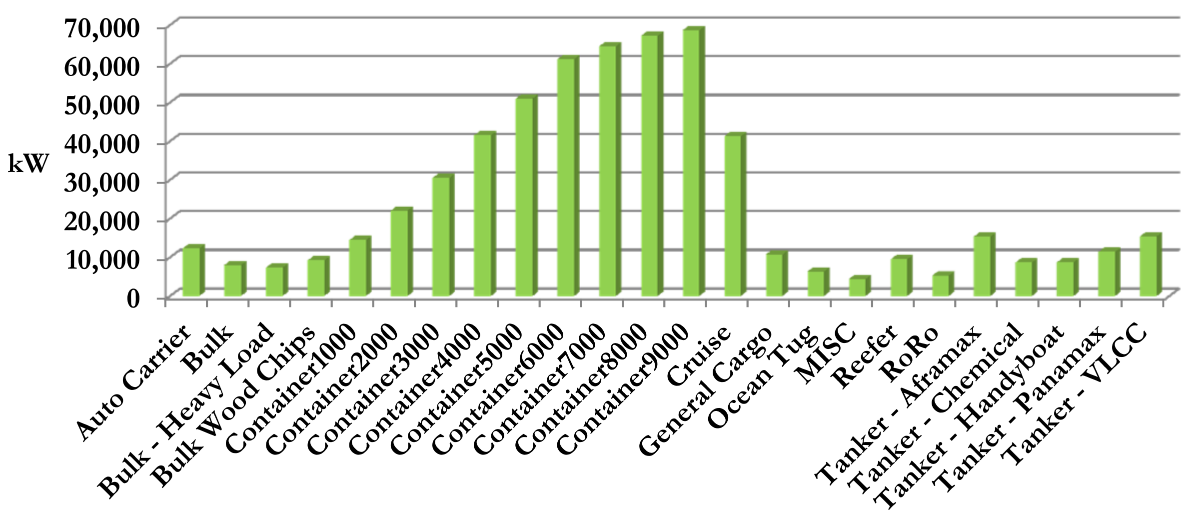
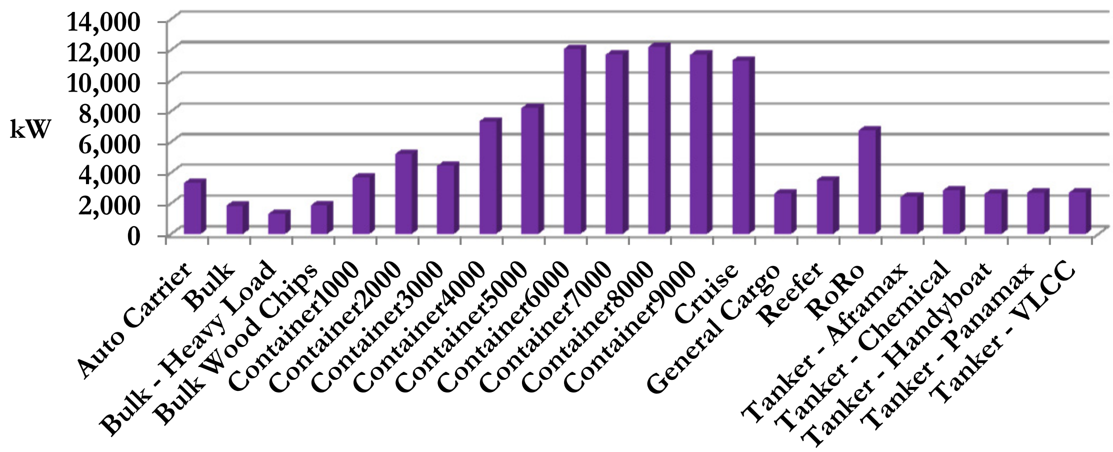


Figure 3.16: Average Auxiliary Engine Total Installed Power of Vessels that Called the Port in 2010, kilowatts



3.7.4 Hotelling Time at Berth and Anchorage

Tables 3.26 and 3.27 summarize the berth and anchorage hotelling times, respectively.

Table 3.26: Hotelling Times at Berth for Vessels that Called the Port in 2010 by Vessel Type

	Berth Hotelling Time, hours		
Vessel Type	**Min**	**Max**	**Avg**
Auto Carrier	3.0	58.8	23.3
Bulk	31.0	256.5	70.9
Bulk - Heavy Load	45.1	166.2	109.9
Bulk - Wood Chips	58.8	101.2	80.0
Container - 1000	0.7	60.2	24.1
Container - 2000	9.2	66.3	27.9
Container - 3000	3.9	85.6	48.3
Container - 4000	7.8	154.5	38.9
Container - 5000	13.5	242.6	52.9
Container - 6000	9.5	124.9	63.7
Container - 7000	27.3	103.8	80.3
Container - 8000	12.4	110.2	77.8
Container - 9000	74.7	108.6	84.1
Cruise	5.3	98.6	13.0
General Cargo	6.8	160.4	44.0
Ocean Tug	9.6	171.7	28.3
Miscellaneous	6.2	25.9	17.6
Reefer	3.1	72.4	23.4
RoRo	23.2	23.2	23.2
Tanker - Aframax	35.6	48.3	44.9
Tanker - Chemical	0.3	117.7	35.1
Tanker - Handyboat	8.9	86.2	35.5
Tanker - Panamax	12.5	120.1	51.9
Tanker - VLCC	145.3	145.3	145.3

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Table 3.27 shows the range and average of hotelling times at anchorage with the actual vessel counts for each vessel subtype that visited the anchorages.

Table 3.27: Hotelling Times at Anchorage by Vessel Type in 2010

	Anchorage Hotelling Time, hours			
Vessel Type	**Min**	**Max**	**Avg**	**Calls Count**
Auto Carrier	1.8	73.0	20.4	14
Bulk	2.9	137.7	22.3	33
Bulk - Heavy Load	12.9	12.9	12.9	1
Bulk - Wood Chips	12.8	12.8	12.8	1
Container - 1000	2.2	102.5	19.6	8
Container - 2000	0.0	18.5	6.7	8
Container - 3000	32.7	32.7	32.7	1
Container - 4000	1.9	25.2	9.7	11
Container - 5000	2.8	13.7	6.3	4
Container - 6000	2.8	5.8	3.9	3
Container - 7000	2.9	95.9	36.6	3
Container - 8000	0.8	13.9	4.9	3
Container - 9000	0.0	0.0	0.0	0
Cruise	0.0	0.0	0.0	0
General Cargo	2.1	313.7	44.1	22
Ocean Tug	1.0	91.1	21.2	6
Miscellaneous	0.0	0.0	0.0	0
Reefer	2.2	124.8	26.9	6
RoRo	0.0	0.0	0.0	0
Tanker - Aframax	6.3	17.2	10.8	4
Tanker - Chemical	1.4	430.9	34.1	58
Tanker - Handyboat	0.5	318.3	31.0	21
Tanker - Panamax	1.8	297.0	34.2	38
Tanker - VLCC	0.0	0.0	0.0	0

DB ID705

3.7.5 Frequent Callers

For purpose of this discussion, a frequent caller is a vessel that made six or more calls in one year. The vessels that made a call to a berth at the Port were included, while the vessels that only went to anchorage were not. Table 3.28 shows the percentage of repeat vessels. Container vessels, cruise ships and ocean tugs had the highest percentage of frequent callers in 2010. Tankers, reefer vessels, general cargo and bulk vessels are not frequent callers.

Table 3.28: Percentage of Frequent Callers in 2010

Vessel Type	Frequent Vessels	Total Vessels	Percent Frequent Vessels
Auto Carrier	4	45	9%
Bulk	0	46	0%
Bulk - Heavy Load	0	3	0%
Bulk Wood Chips	0	2	0%
Container - 1000	8	17	47%
Container - 2000	14	29	48%
Container - 3000	2	11	18%
Container - 4000	7	95	7%
Container - 5000	27	55	49%
Container - 6000	15	39	38%
Container - 7000	5	23	22%
Container - 8000	13	29	45%
Container - 9000	0	3	0%
Cruise	6	20	30%
General Cargo	3	42	7%
Ocean Tugs	3	9	33%
Miscellaneous	0	1	0%
Reefer	0	22	0%
RoRo	0	1	0%
Tanker - Aframax	0	4	0%
Tanker - Chemical	0	61	0%
Tanker - Handyboat	3	22	14%
Tanker - Panamax	0	42	0%
Tanker - VLCC	0	1	0%
Total	**110**	**622**	
Average			**18%**

DB ID706

SECTION 4 HARBOR CRAFT

This section presents emissions estimates for the commercial harbor craft source category, including source description (4.1), geographical delineation (4.2), data and information acquisition (4.3), operational profiles (4.4), emissions estimation methodology (4.5), and the emission estimates (4.6).

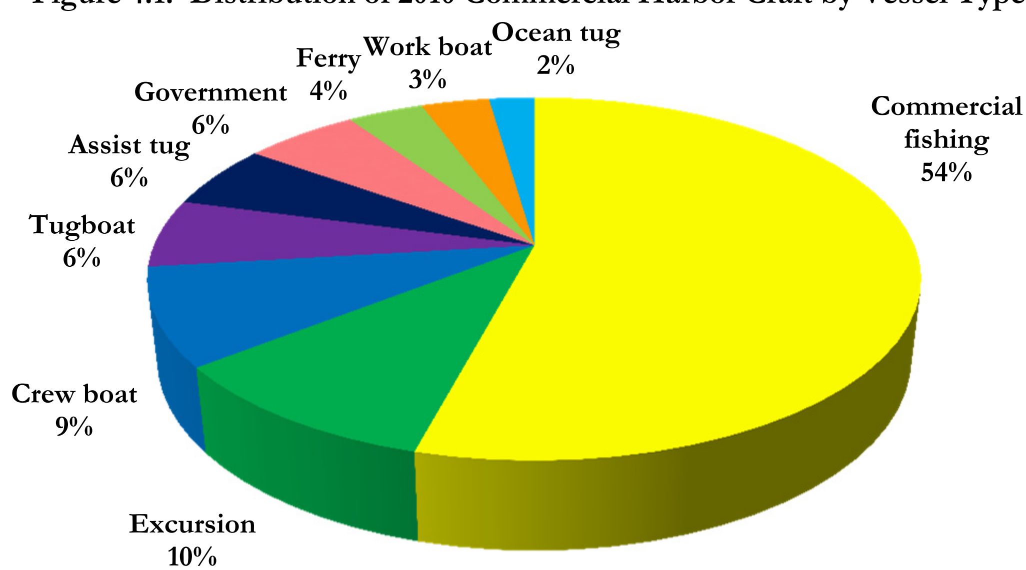
4.1 Source Description

Harbor craft are commercial vessels that spend the majority of their time within or near the Port and harbor. The harbor craft emissions inventory consists of the following vessel types:

- Assist tugboats
- Commercial fishing vessels
- Crew boats
- Ferry vessels
- Excursion vessels
- Government vessels
- Tugboats
- Ocean tugboats
- Work boats

Recreational vessels are not considered to be commercial harbor craft; therefore their emissions are not included in this inventory. Figure 4.1 presents the distribution of the 264 commercial harbor craft inventoried for the Port in 2010. Commercial fishing vessels represent 54% of the harbor craft inventoried, followed by the excursion vessels (10%), crew boats (9%), tugboats (6%), assist tugs (6%), government vessels (6%), ferries (4%), work boats (3%), and ocean tugs (2%).

Figure 4.1: Distribution of 2010 Commercial Harbor Craft by Vessel Type



Ocean tugboats included in this section are different from the integrated tug barge (ITB) and articulated tug barge (ATB) included in the ocean-going section of this report. ITB and ATB are seen as specialized single vessels and are included in the marine exchange data for ocean-going vessels. The ocean tugboats in this section are not rigidly connected to the barge and are typically not home-ported at the Port, but may make frequent calls with barges. They are different from harbor tugboats because their engine loads are higher than harbor tugboats which tend to idle more in-between jobs. Tugboats are typically home-ported in San Pedro Bay harbor and primarily operate within the harbor area, but can also operate outside the harbor based on the work assignments.

4.2 Geographical Delineation

The geographical extent of the emissions inventory for harbor craft is the boundary for the SoCAB as shown in Figure 4.2 (in dark blue). Most harbor craft operate the majority of the time within the harbor and up to 25 nm from the Port. For those harbor craft that operate outside of the harbor and travel to other ports, vessel operators were asked to provide the estimated percent of operation up to 50 nm from the Port in order to capture the emissions within the SoCAB boundary.

Figure 4.2: Geographical Extent of Harbor Craft Inventory

4.3 Data and Information Acquisition

The following sources were used to collect data for the harbor craft inventory:

- Vessel owners and/or operators
- Port Wharfingers data for commercial fishing vessels at Port-owned berths

The operating parameters of interest include the following:

- Vessel type
- Number, type and horsepower (or kilowatts) of main propulsion engine(s)
- Number, type and horsepower (or kilowatts) of auxiliary engines
- Activity hours
- Annual fuel consumption
- Qualitative information regarding how the vessels are used in service
- Main and auxiliary engine model year
- Repowered (replaced) engines
- Emission reduction strategies, if any (e.g., shore power, retrofits with after-treatment technologies)

The following companies were contacted to collect information on their fleet:

Excursion vessels:
- L.A. Harbor Sportfishing
- 22nd St. Partners, Sportfishing
- Los Angeles Harbor Cruise
- Spirit Cruises
- Fiesta Harbor Cruises
- Seahawk Sportfishing

Commercial fishing vessels:
- Berth 73 and Fish Harbor, Port-owned marinas

Ferry vessels:
- Catalina Channel Express
- Seaway Co. of Catalina

Government vessels:
- L.A. Fire Department
- L.A. Police Department
- Harbor Department
- Port of Los Angeles Pilots

Work boats:

- Pacific Tugboat Services
- Jankovich

Crew boats:

- U.S. Water Taxi
- American Marine Corp.
- Southern California Ship Services

Assist tugboats and harbor tugs:

- Crowley Marine Services
- Foss Maritime Company
- Millennium Maritime

Harbor and ocean tugs:

- Crowley Petroleum Services
- Sause Brothers Ocean Towing
- Westoil Marine Services

It should be noted that engine specific information for individual commercial fishing vessels is not readily available due to difficulty in contacting the commercial fishing vessel operators. The Port's data from the Wharfinger Department were used to identify the commercial fishing vessels that berthed at the Port-owned marinas and to determine the total number of vessels compared to prior years. The engine power and activity hours for these vessels were primarily based on CARB's commercial harbor vessel survey results, with limited information available from some vessel operators.

4.4 Operational Profiles

Commercial harbor craft companies were identified and contacted to obtain the operating parameters for their vessels.

Tables 4.1 and 4.2 summarize the main and auxiliary engine data, respectively, for each vessel type. The averages by vessel type have been used as defaults for vessels for which the model year, horsepower, or operating hour information is missing. Operational hours for the vessels that were not at the port the entire year reflect the partial time they operated at the Port during the 2010 calendar year. The engine count includes old and new engines for those vessels that were repowered during the year and provided 2010 activity hours for both old and new engines.

This emissions inventory covers harbor craft that operate in the Port of Los Angeles harbor most of the time. There are a number of companies that operate harbor craft in both the Ports of Los Angeles and Long Beach harbors. The activity hours for the vessels that are common to both ports reflect work performed during 2010 for the Port of Los Angeles harbor only.

Table 4.1: 2010 Summary of Propulsion Engine Data by Vessel Category

Propulsion Engines											
Harbor	Vessel	Engine	Model year			Horsepower			Annual Operating Hours		
Vessel Type	Count	Count	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average
Assist tug	15	33	1982	2009	2003	1,500	2,540	2,049	437	2,363	1,547
Commercial fishing	143	147	1950	2008	1984	50	615	232	200	1,500	948
Crew boat	23	55	1974	2010	2000	180	1,400	515	11	1,500	665
Excursion	27	51	1966	2004	1992	150	530	359	0	3,000	1,473
Ferry	10	22	2001	2010	2006	600	2,300	1,882	600	1,200	1,068
Government	15	26	1988	2009	2002	68	1,800	519	17	1,727	593
Ocean tug	6	12	1985	2007	2001	805	2,000	1,477	200	1,500	542
Tugboat	16	32	1981	2009	2005	200	1,500	678	0	780	376
Work boat	9	17	1969	2010	1995	137	1,000	484	0	2,000	924
Total	**264**	**395**									

DB ID423

Table 4.2: 2010 Summary of Auxiliary Engine Data by Vessel Category

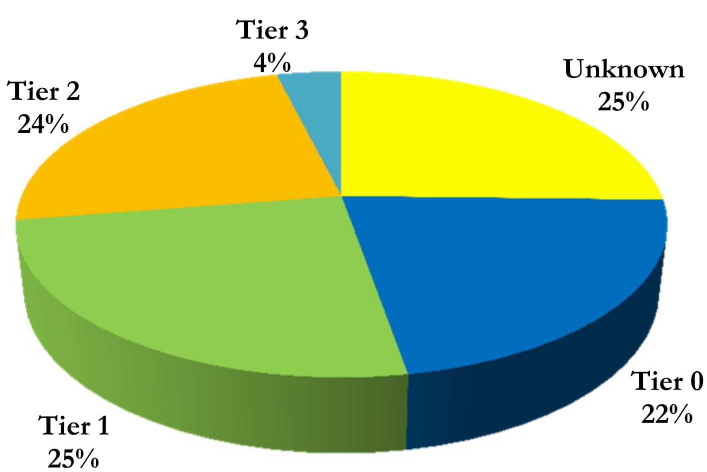
Auxiliary Engines											
Harbor	Vessel	Engine	Model year			Horsepower			Annual Operating Hours		
Vessel Type	Count	Count	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average
Assist tug	15	36	1982	2010	2003	60	425	163	53	2,729	1,603
Commercial fishing	143	19	1957	2004	1991	10	195	60	100	1,440	731
Crew boat	23	24	1965	2010	1997	11	133	51	2	2,040	620
Excursion	27	27	1966	2003	1993	7	54	39	0	3,000	1,376
Ferry	10	14	2003	2010	2006	18	120	55	300	750	686
Government	15	9	2003	2007	2004	50	400	204	20	500	156
Ocean tug	6	12	1985	2007	2001	60	150	90	200	750	417
Tugboat	16	22	1970	2009	2005	22	101	47	0	678	274
Work boat	9	13	1968	2010	1991	27	101	68	0	2,000	584
Total	**264**	**176**									

DB ID422

The harbor craft engines (propulsion and auxiliary) with known engine year and horsepower are categorized by EPA marine engine standards. Harbor craft engines for which model year and/or horsepower information is not available are classified as "unknown". Data collected from harbor craft operators does not include EPA certification standards for specific engines; therefore, it has been assumed that all small 2009 and newer engines (25 to 120 hp rating) meet Tier 3 emission standards[31]. This assumption is consistent with CARB's harbor craft emission factors which follow the same model year grouping as the EPA emissions standards for marine engines as shown below. Figure 4.3 provides the population distribution of all harbor craft propulsion and auxiliary engines inventoried for 2010. The engine Tier category assumptions for this figure, based on the certification standards, are as follows:

- Tier 0: 1999 and older model year engines
- Tier 1: Model years 2000 to 2003 for engines with less than or equal to 750 hp; model years 2000 to 2006 for engines with greater than 750 hp
- Tier 2: Model years 2004+ for engines with less than or equal to 750 hp; model years 2007+ for engines greater than 750 hp, with the exception for those that meet the Tier 3 criteria
- Tier 3: Model years 2009+ for small engines with 25 to 120 hp rating or <0.9 liter engine displacement
- "Unknown": Engines with missing model year, horsepower or both

Figure 4.3: Distribution of Harbor Craft Engines by Engine Standards, %



[31] e-CFR (Code of Federal Regulation), 40 CFR, subpart 94.8 for Tier 1 and 2 and subpart 1042.101 for Tier 3

4.5 Emissions Estimation Methodology

The emissions calculation parameters, methodologies and equations are described in this section. Emissions were estimated on a per engine basis, i.e., the main and auxiliary engines emissions were estimated individually. In order to ensure consistency, the Port's harbor craft emissions calculations methodology is primarily based on CARB's latest harbor craft emissions calculations methodology with the exceptions noted in this section.[32]

4.5.1 Emissions Calculation Equations

The basic equation used to estimate harbor craft emissions for each engine is:

$$E = Power \times Act \times LF \times EF \times FCF \qquad \text{Equation 4.1}$$

Where:

E = emissions, tons/year
Power = rated power of the engine in horsepower or kilowatts
Act = activity, hours/year
LF = load factor (ratio of average power used during normal operations as compared to maximum rated power)
EF = emission factor, grams of pollutant per unit of work (g/hp-hr or kW/hp-hr)
FCF = fuel correction factor to reflect changes in fuel properties that have occurred over time

The engine's emission factor (EF) is a function of the zero hour (ZH) emission rate, deterioration rate and cumulative hours. The deterioration rate reflects the fact that the engine's base emissions (ZH emission rates) change as the equipment is used, due to wear of various engine parts or reduced efficiency of emission control devices. The cumulative hours reflects the engine's total operating hours. The emission factor is calculated as:

$$EF = ZH + (DR \times Cumulative\ Hours) \qquad \text{Equation 4.2}$$

Where:

ZH = emission rate for a given engine size category and model year when the engine is new and there is no component malfunctioning
DR = deterioration rate (rate of change of emissions as a function of equipment age)
Cumulative hours = total number of hours the engine has been in use and calculated as annual operating hours times age of the engine

[32] Appendix B: Emissions Estimation Methodology for Commercial Harbor Craft Operating in California. See *http://www.arb.ca.gov/regact/2007chc07/chc07.htm*

The equation for the deterioration rate is:

Equation 4.3

$$DR = (DF \times ZH) / \text{cumulative hours at the end of useful life}$$

Where:

DR = deterioration rate
DF = deterioration factor, percent increase in emissions at the end of the useful life (expressed as %)
ZH = emission rate for a given engine size category and model year when the engine is new and there is no component malfunctioning
Cumulative hours at the end of useful life = annual operating hours times useful life in years

Per CARB, useful life for harbor craft is defined as the age at which 50% of the engines are retired from the fleet. All the engines are assumed to be retired at the age of twice the useful life.

4.5.2 Emission Factors, Deterioration Factors and Useful Life

Zero hour emission factors, deterioration factors, and useful life for commercial harbor craft are based on CARB's latest methodology, with the exception of greenhouse gas emission factors and the SO_x emission factor.

The SO_x emission factor is calculated using the following mass balance equation included in the CARB's methodology:

Equation 4.4

$$SO_x \text{ (gms/hp-hr)} = (\text{S content in } X/1{,}000{,}000) \times (2\ SO_2/\text{g S}) \times BSFC$$

Where:

X = S content in parts per million (ppm)
BSFC = Brake Specific Fuel Consumption (184 g/bhp-hr per CARB's methodology mentioned above)

Greenhouse gas emissions factors for harbor craft are continuously evolving as more research is conducted and reviewed, so there is some variability in emission factors recommended and used by different groups; for the 2010 EI, emissions factors for CO_2, CH_4, and N_2O are sourced from the 2004 IVL study, and are listed in Appendix B[33]. The IVL study establishes the CH_4 emission factor as 2% of the hydrocarbon emission factor.

[33] IVL, Methodology for Calculating Emissions from Ships: Update on Emission Factors, 2004, Prepared by IVL Swedish Environmental Research Institute for the Swedish Environmental Protection Agency.

Tables 4.3 and 4.4 provide the deterioration factors and useful life for harbor craft engines, respectively. In 2010, in order to be consistent with CARB methodology[34], the useful life of crew boats and workboats for auxiliary and main engines were revised to 28 years. Previously, for crew boats, 22 years was used for auxiliary and main and engines; and for work boats, 23 years was used for auxiliary engines and 17 years for main engines. CARB extended the useful life of crew and work boat engines based on their survey results which indicated that marine engines are expensive and therefore well maintained by their operators.

Table 4.3: Engine Deterioration Factors for Harbor Craft Diesel Engines

HP Range	PM	NOx	CO	HC
25-50	0.31	0.06	0.41	0.51
51-250	0.44	0.14	0.16	0.28
>251	0.67	0.21	0.25	0.44

Table 4.4: Useful Life by Vessel Type and Engine Type, years

Harbor Vessel Type	Auxiliary Engines	Main Engines
Assist tug	23	21
Commercial fishing	15	21
Crew boat	28	28
Excursion	20	20
Ferry	20	20
Government	25	19
Ocean tug	25	26
Tugboat	23	21
Work boat	28	28

[34] Page C-4 of Appendix C – Updates on the Emissions Inventory for Commercial Harbor Craft Operating in California. *http://www.arb.ca.gov/regact/2010/chc10/appc.pdf*

4.5.3 Fuel Correction Factors

Fuel correction factors are applied to adjust the emission rates for changes in fuel properties. For this inventory, fuel correction factors were used to take into account the use of ULSD used by all harbor craft. Fuel correction factors used for NO_X, HC, and PM take into account the properties of California diesel fuel which is different from EPA diesel fuel. Table 4.5 summarizes the fuel correction factors used for harbor craft. The FCF for SO_x reflects the change from diesel fuel with an average sulfur content of 350 ppm to ULSD (15 ppm). Due to the lack of any additional information, it was assumed that fuel correction factor for NO_x is also applicable to N_2O emissions and fuel correction factor for HC is also applicable to CH_4 emissions.

Table 4.5: Fuel Correction Factors for ULSD

Equipment MY	PM	NO_x	SO_x	CO	HC	CO_2	N_2O	CH_4
1995 and older	0.72	0.93	0.04	1.00	0.72	1.00	0.93	0.72
1996 and newer	0.80	0.948	0.04	1.00	0.72	1.00	0.948	0.72

DB ID446

4.5.4 Load Factors

Engine load factor is used in emissions calculations to reflect the fact that, on average, engines are not used at their maximum power rating. Table 4.6 summarizes the average engine load factors that are used in this inventory for the various harbor vessel types for their propulsion and auxiliary engines. In 2010, the crew boat and work boat load factors have been changed to 32% for auxiliary engines and 38% for propulsion engines from 43% for auxiliary engines and 45% for propulsion engines. These changes are consistent with revisions CARB made to support their regulatory amendment[35] entitled "Adoption of Proposed Amendments to the Regulations to Reduce Emissions from Diesel Engines on Commercial Harbor Craft Operated within California Waters and 24 Nautical Miles of the California Baseline." This regulation was adopted by CARB's board on June 24, 2010. Based on actual fuel consumption data from 72 auxiliary engines and 120 main engines and calculated maximum fuel consumption rate, CARB staff estimated an average load factor for auxiliary engines as 0.32 and for main engines as 0.38.

[35] *http://www.arb.ca.gov/ports/marinevess/harborcraft/documents/amendcseidoc050410.xls*

Table 4.6: Load Factors

Harbor Vessel Type	Auxiliary Engines	Main Engines
Assist tug	0.43	0.31
Commercial fishing	0.43	0.27
Crew boat	0.32	0.38
Excursion	0.43	0.42
Ferry	0.43	0.42
Government	0.43	0.51
Ocean tug	0.43	0.68
Tugboat	0.43	0.31
Work boat	0.32	0.38

DB ID426

The 31% engine load factor for assist tugboats is based on actual vessels' main engine load readings published in the Port's 2001 emissions inventory and is not consistent with the 50% engine load used in CARB's latest methodology.[36] In addition, CARB uses 43% engine load for most of the auxiliary engines as listed in Table 4.6, except for the auxiliary engines of tugboats for which CARB's load factor is 31%. The Port uses 43% engine load for most auxiliary engines, including assist tugs, except for crew boats and work boats which have been modified to reflect CARB's recently-revised auxiliary engine load for crew boats and work boats (32% from 43%, respectively).

4.5.5 Improvements to Methodology from Previous Year

As mentioned in previous subsections, in 2010, the useful life and load factors for crew boats and workboats were revised to be consistent with CARB's latest changes. For comparison of 2010 emissions to previous years' emissions, refer to Section 9.

4.5.6 Future Improvements to Methodology

Going forward, the ports will work with CARB to harmonize GHG emission factors for harbor craft. As a part of data collection enhancement, ports will strive to obtain engine emission certification for the recently purchased or repowered engines that may be available at the time of purchase or repower.

[36] CARB, *Emissions Estimation Methodology for Commercial Harbor Craft Operating in California*, Appendix B.

4.6 Emission Estimates

Tables 4.7 and 4.8 summarize the estimated 2010 harbor craft emissions by vessel type and engine type.

Table 4.7: 2010 Commercial Harbor Craft Emissions by Vessel and Engine Type, tons per year

Vessel Type	Engine Type	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
Assist Tug	Auxiliary	1.0	0.9	1.0	27.4	0.0	17.3	3.0
	Propulsion	10.2	9.4	10.2	257.9	0.2	113.1	20.5
Assist Tug Total		**11.2**	**10.3**	**11.2**	**285.3**	**0.2**	**130.5**	**23.5**
Commercial Fishing	Auxiliary	0.3	0.3	0.3	3.8	0.0	2.2	0.6
	Propulsion	5.8	5.3	5.8	134.8	0.0	35.0	9.0
Commercial Fishing Total		**6.1**	**5.6**	**6.1**	**138.6**	**0.1**	**37.2**	**9.6**
Crew boat	Auxiliary	0.2	0.2	0.2	3.2	0.0	1.6	0.4
	Propulsion	3.4	3.1	3.4	80.0	0.0	24.2	5.8
Crew boat Total		**3.6**	**3.3**	**3.6**	**83.2**	**0.0**	**25.8**	**6.2**
Excursion	Auxiliary	0.4	0.4	0.4	5.0	0.0	4.7	1.5
	Propulsion	6.6	6.0	6.6	151.5	0.1	41.0	10.0
Excursion Total		**7.0**	**6.4**	**7.0**	**156.4**	**0.1**	**45.7**	**11.5**
Ferry	Auxiliary	0.1	0.1	0.1	1.4	0.0	1.0	0.3
	Propulsion	5.4	5.0	5.4	132.1	0.1	62.9	11.2
Ferry Total		**5.5**	**5.1**	**5.5**	**133.4**	**0.1**	**63.8**	**11.5**
Government	Auxiliary	0.0	0.0	0.0	0.5	0.0	0.3	0.1
	Propulsion	1.3	1.2	1.3	28.9	0.0	11.3	2.4
Government Total		**1.3**	**1.2**	**1.3**	**29.4**	**0.0**	**11.6**	**2.5**
Ocean Tug (Line Haul)	Auxiliary	0.1	0.1	0.1	1.4	0.0	1.0	0.2
	Propulsion	2.7	2.5	2.7	63.1	0.0	22.2	4.8
Ocean Tug		**2.8**	**2.6**	**2.8**	**64.5**	**0.0**	**23.2**	**5.1**
Tugboat	Auxiliary	0.0	0.0	0.0	0.6	0.0	0.5	0.2
	Propulsion	0.6	0.6	0.6	16.7	0.0	8.8	1.5
Tugboat Total		**0.7**	**0.6**	**0.7**	**17.3**	**0.0**	**9.3**	**1.6**
Work boat	Auxiliary	0.1	0.1	0.1	1.8	0.0	0.9	0.3
	Propulsion	1.4	1.3	1.4	39.6	0.0	16.4	3.0
Work boat Total		**1.5**	**1.4**	**1.5**	**41.3**	**0.0**	**17.3**	**3.2**
Harbor craft Total		**39.6**	**36.4**	**39.6**	**949.6**	**0.6**	**364.3**	**74.7**

DB ID427

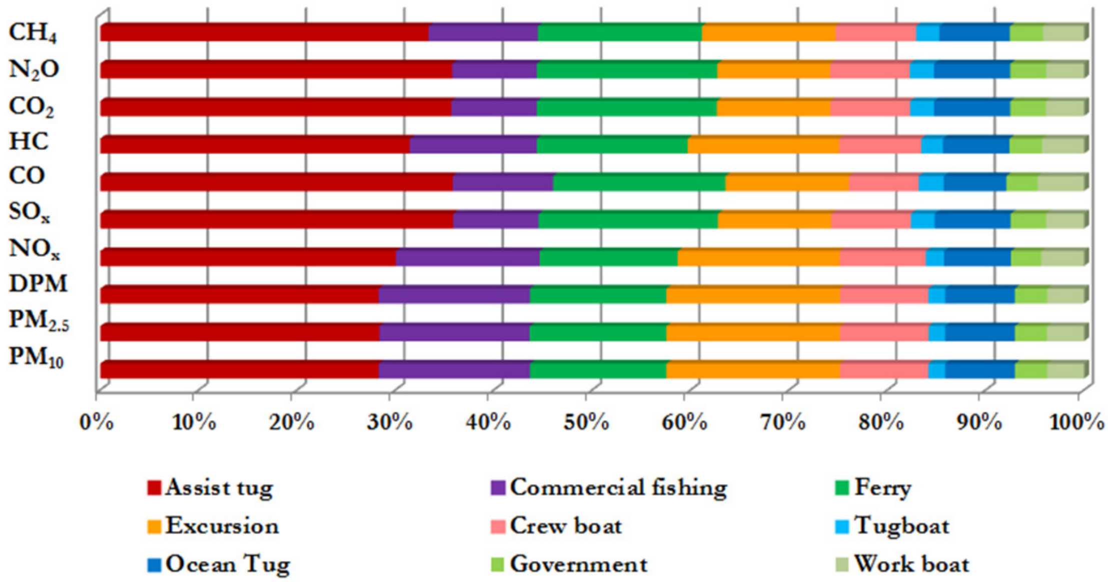
Table 4.8: 2010 Commercial Harbor Craft GHG Emissions by Vessel and Engine Type, metric tons per year

Vessel Type	Engine Type	CO_2 Equivalent	CO_2	N_2O	CH_4
Assist Tug	Auxiliary	2,041.6	2,012.4	0.1	0.1
	Propulsion	16,373.0	16,140.9	0.7	0.3
Assist Tug Total		**18,414.6**	**18,153.4**	**0.8**	**0.4**
Commercial Fishing	Auxiliary	183.6	180.9	0.0	0.0
	Propulsion	4,308.5	4,247.7	0.2	0.1
Commercial Fishing Total		**4,492.1**	**4,428.6**	**0.2**	**0.1**
Crew boat	Auxiliary	140.5	138.4	0.0	0.0
	Propulsion	4,051.4	3,994.0	0.2	0.1
Crew boat Total		**4,191.9**	**4,132.4**	**0.2**	**0.1**
Excursion	Auxiliary	325.8	320.9	0.0	0.0
	Propulsion	5,635.3	5,555.8	0.2	0.1
Excursion Total		**5,961.1**	**5,876.7**	**0.3**	**0.2**
Ferry	Auxiliary	99.1	97.6	0.0	0.0
	Propulsion	9,334.3	9,201.9	0.4	0.2
Ferry Total		**9,433.4**	**9,299.5**	**0.4**	**0.2**
Government	Auxiliary	36.0	35.4	0.0	0.0
	Propulsion	1,833.6	1,807.6	0.1	0.0
Government Total		**1,869.5**	**1,843.0**	**0.1**	**0.0**
Ocean Tug (Line Haul)	Auxiliary	108.0	106.5	0.0	0.0
	Propulsion	3,883.1	3,828.1	0.2	0.1
Ocean Tug		**3,991.2**	**3,934.5**	**0.2**	**0.1**
Tugboat	Auxiliary	50.9	50.2	0.0	0.0
	Propulsion	1,206.3	1,189.2	0.1	0.0
Tugboat Total		**1,257.2**	**1,239.4**	**0.1**	**0.0**
Work boat	Auxiliary	83.6	82.4	0.0	0.0
	Propulsion	1,918.5	1,891.3	0.1	0.0
Work boat Total		**2,002.1**	**1,973.7**	**0.1**	**0.0**
Harbor craft Total		**51,613.2**	**50,881.3**	**2.3**	**1.1**

DB ID427

Figure 4.4 shows that approximately 28-36% of the Port's harbor craft emissions are attributed to assist tugs, 9-15% to commercial fishing, 14-18% to ferries, 11-18% to excursion vessels, 7-9% to crew boats, 4% to work boats, 6-8% to ocean tugs, 2% to tugboats, and 3% to government vessels.

Figure 4.4: 2010 Harbor Craft Emissions Distribution



SECTION 5 CARGO HANDLING EQUIPMENT

This section presents emissions estimates for the cargo handling equipment (CHE) source category, including source description (5.1), geographical delineation (5.2), data and information acquisition (5.3), operational profiles (5.4), emissions estimation methodology (5.5), and the emission estimates (5.6).

5.1 Source Description

The CHE category includes equipment that moves cargo (including containers, general cargo, and bulk cargo) to and from marine vessels, railcars, and on-road trucks. The equipment typically operates at marine terminals or at rail yards and not on public roadways. This inventory includes cargo handling equipment with 25 hp or greater engines fueled by diesel, gasoline, propane, LNG, and electricity. Due to the diversity of cargo handled by the port's terminals, there is a wide range of equipment types. The majority of cargo handling equipment can be classified into one of the following equipment types:

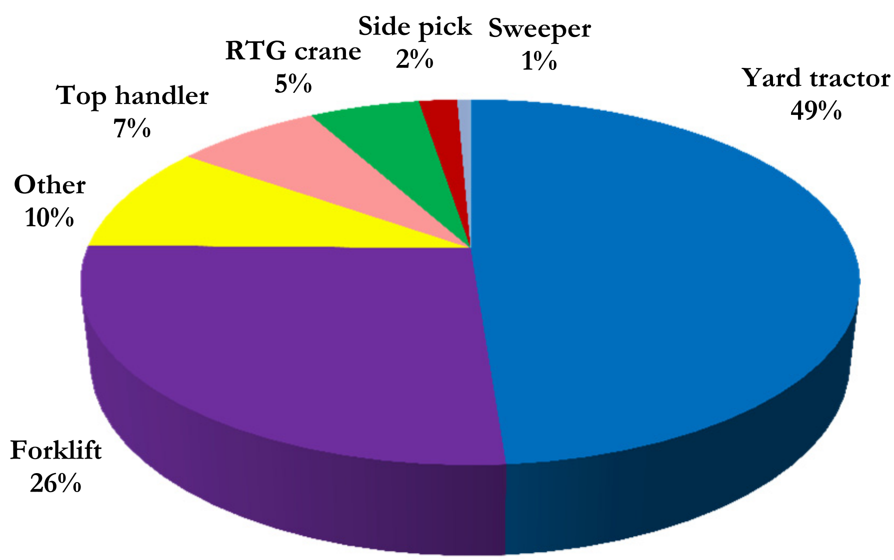
- Forklift
- Rubber tired gantry (RTG) crane
- Side pick
- Sweeper
- Top handler
- Yard tractor
- Other

The "Other" category contains the following equipment types:

- Bulldozer
- Crane
- Excavator
- Loader
- Man lift
- Miscellaneous (cone vehicles)
- Rail pusher
- Skid steer loader
- Trucks (fuel, utility, water, vacuum)

Figure 5.1 presents the population distribution of the 1,949 pieces of equipment inventoried at the Port for calendar year 2010. The 10% for other equipment includes pieces of equipment that are not typical CHE and electric equipment.

Figure 5.1: Distribution of 2010 Cargo Handling Equipment by Equipment Type



5.2 Geographical Delineation

Figure 5.2 presents the geographical delineation for container, dry bulk, break bulk, liquid bulk, auto, and cruise terminals that may operate cargo handling equipment as well as equipment from UP Intermodal Container Transfer Facility (ICTF) and smaller facilities located within Port boundaries and covered under the port's jurisdiction.

Following is the list of the terminals identified in figure 5.2, by major cargo type, included in the inventory:

Container Terminals:

- Berth 100: West Basin Container Terminal (China Shipping)
- Berths 121-131: West Basin Container Terminal (Yang Ming)
- Berths 136-139: Trans Pacific Container Terminal (Trapac)
- Berths 212-225: Yusen Container Terminal (YTI)
- Berths 226-236: Seaside Terminal (Evergreen)
- Berths 302-305: APL Terminal (Global Gateway South)
- Berths 401-406: APM Terminals (Pier 400)

Break-Bulk Terminals:

- Berths 174-181: Pasha Stevedoring Terminals
- Berths 54-55: Stevedore Services of America (SSA)
- Berths 153-155: Crescent Warehouse Company
- Berths 210-211: SA Recycling

Dry Bulk Terminals:

- California Sulfur
- LA Grain
- Berths 165-166: Rio Tinto/Borax

Liquid Terminals:

- Berths 118-119: Kinder Morgan
- Berths 187-191: Vopak
- Berths 167-169: Equillon/Shell Oil
- Berths 238-240: ExxonMobil
- Berths 148-151: ConocoPhillips
- Berths 163-164: Ultramar/Valero

Auto Terminal:

- Berths 195-199: WWL Vehicle Services Americas (formerly DAS)

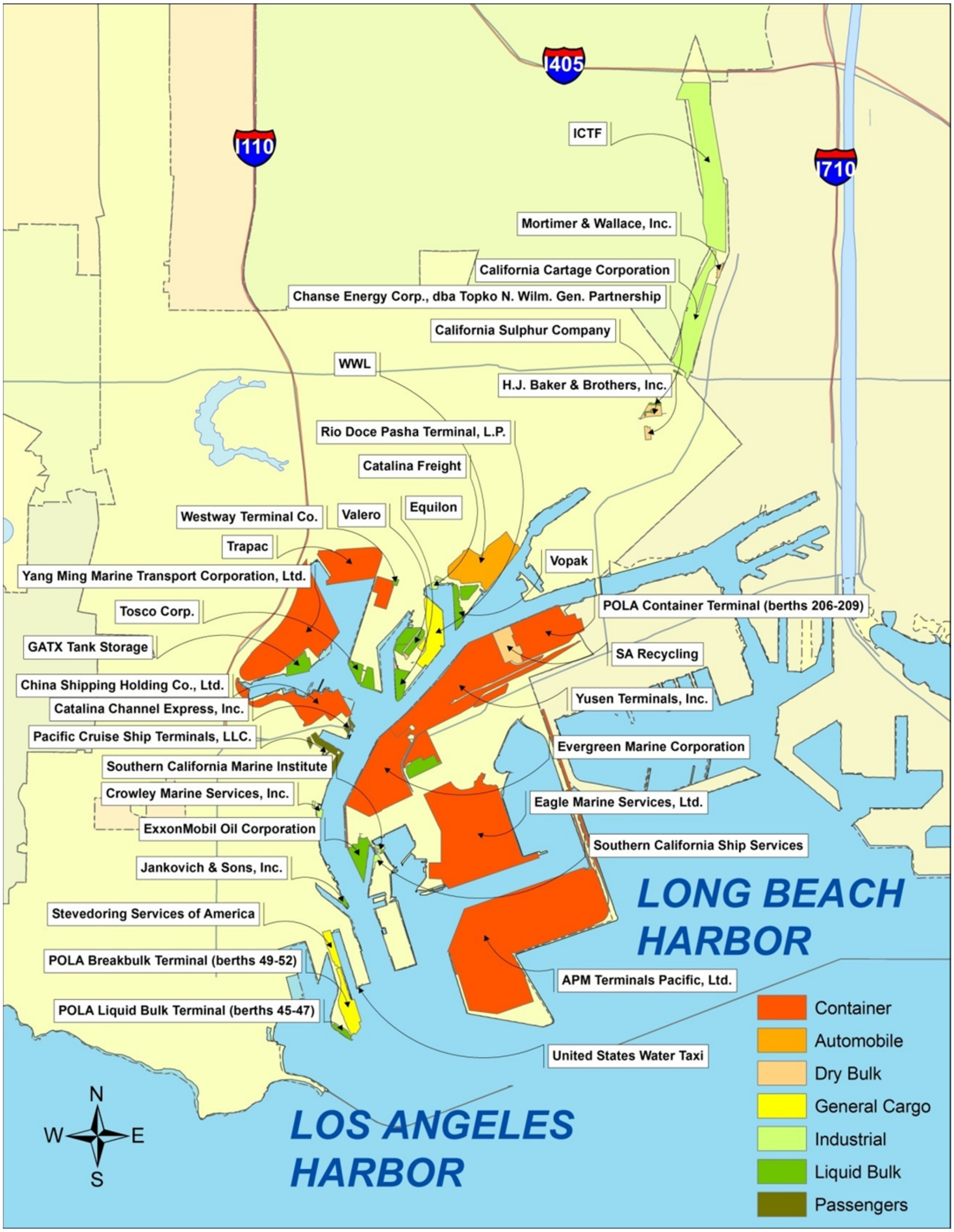
Cruise Terminal:

- Berths 91-93: Pacific Cruise Ship Terminals (PCST)

Other Facilities:

- Al Larson
- Union Pacific Intermodal Containers Transfer Facility (ICTF)
- California Cartage
- Southern California (SoCal) Ship Services
- San Pedro Forklifts
- Three Rivers Trucking
- California Multimodal

Figure 5.2: Geographical Boundaries for Cargo Handling Equipment



5.3 Data and Information Acquisition

For each terminal or facility, the maintenance and/or cargo handling equipment operating staff were contacted either in person, by e-mail or by telephone to obtain count and activity information on the equipment specific to their terminal's or facility's operation for calendar year 2010. The information requested is listed below:

- Equipment type
- Equipment identification number
- Equipment make and model
- Engine make and model
- Rated horsepower (or kilowatts)
- Equipment and engine model year
- Type of fuel used (ULSD, gasoline, propane, or other)
- Alternative fuel used
- Annual hours of operation (some terminal operators use hour meters)
- Emission control technologies installed (e.g., Diesel Oxidation Catalyst, Diesel Particulate Filter) and date installed
- On-road engine installed
- New equipment purchased
- Equipment retired or removed from service

It should be noted that not all information requested is readily available and when there are data gaps, averages are used as defaults for the data needed to estimate emissions, such as engine power, activity hours, and model year. Section 5.4 lists the averages by equipment type used for missing data. The terminal operators have started to install various emission control technologies and purchase on-road engines equipped yard tractors in order to comply with CARB's CHE regulation as further discussed in section 5.4.

5.4 Operational Profiles

Table 5.1 summarizes the cargo handling equipment data collected from the terminals and facilities for the calendar year 2010. The table includes the count of all equipment as well as the range and the average of horsepower, model year, and annual operating hours by equipment type for equipment with known operating parameters. The averages by CHE engine and fuel type were used as defaults for the missing information.

The table does not include the count or characteristics of small auxiliary engines (20 kW) for 30 RTGs because the count column is equipment count, not engine count. The main engines for these RTGs are reflected in the table; however, emissions for both main and auxiliary engines are included in the inventory. For the electric-powered equipment shown in the table, "na" denotes "not applicable" for engine size, model year and operating hours.

Table 5.1: 2010 CHE Engine Characteristics for All Terminals

Equipment	Engine Type	Count	Power (horsepower) Min	Max	Average	Model Year Min	Max	Average	Annual Activity Hours Min	Max	Average
Bulldozer	Diesel	2	165	200	183	1993	2007	2000	497	576	537
Crane	Diesel	11	130	950	279	1965	2010	1989	0	1,632	666
Pallet jack	Electric	7	na	na	na	na	na	na	na	na	na
Wharf crane	Electric	70	na	na	na	na	na	na	0	3,752	542
Excavator	Diesel	10	371	440	403	1999	2009	2005	957	3,304	1,985
Forklift	Diesel	163	45	350	149	1979	2010	2000	0	3,110	434
Forklift	Electric	10	na	na	na	na	na	na	na	na	na
Forklift	Gasoline	7	45	150	90	1991	1996	1994	257	2,250	1,111
Forklift	Propane	336	40	165	76	1985	2010	1997	0	2,576	649
Loader	Diesel	13	52	430	292	1989	2010	2002	0	4,584	1,146
Loader	Electric	4	na	na	na	na	na	na	na	na	na
Man lift	Diesel	14	48	87	75	1989	2010	2001	0	841	306
Man lift	Electric	5	na	na	na	na	na	na	na	na	na
Material handler	Diesel	1	475	475	475	2009	2009	2009	72	72	72
Miscellaneous	Diesel	7	37	268	70	2007	2008	2008	676	5,939	3,417
Rail pusher	Diesel	2	130	200	165	2000	2004	2002	8	383	196
RMG cranes	Electric	10	na	na	na	na	na	na	60	1,985	1,196
RTG crane	Diesel	107	250	685	543	1995	2009	2004	0	4,156	1,268
Side pick	Diesel	37	136	330	214	1992	2010	2003	30	3,232	1,359
Skid steer loader	Diesel	9	45	94	64	1994	2007	2003	0	1,170	368
Sweeper	Diesel	10	37	260	125	1995	2008	2002	0	814	232
Sweeper	Gasoline	2	205	205	205	2002	2005	2004	635	735	685
Sweeper	Propane	1	na	na	na	2001	2001	2001	975	975	975
Top handler	Diesel	140	250	375	294	1990	2010	2004	2	3,968	2,090
Tractor	Propane	1	101	101	101	1997	1997	1997	0	0	0
Truck	Diesel	19	97	540	354	1975	2009	2002	173	2,505	919
Yard tractor	Diesel	891	170	270	216	1995	2009	2006	0	4,528	1,939
Yard tractor	LNG	5	230	230	230	2009	2009	2009	500	500	500
Yard tractor	Propane	55	174	195	194	2000	2004	2004	0	2,540	1,585
Total count		**1,949**									

DB ID228

Table 5.2 presents the percentage of cargo handling equipment at container terminals (70%) as compared to the total Port equipment.

Table 5.2: 2010 Container Terminal CHE Compared to Total CHE

Equipment	Total Count	Container Terminal Count	Percent
Forklift	516	112	22%
RTG crane	107	97	91%
Side pick	37	34	92%
Top handler	140	137	98%
Yard tractor	951	866	91%
Sweeper	13	8	62%
Other	185	102	55%
Total	**1,949**	**1,356**	**70%**

DB ID233

The characteristics of the CHE engines at the Port's seven container terminals are summarized in Table 5.3. The auxiliary engines (20 kW) for 30 RTGs are not shown in the table but the main engines for these RTGs are included; however, emissions for both main and auxiliary engines are included in the inventory.

Table 5.3: 2010 CHE Engines Characteristics for Container Terminals

Container Terminals			Power (horsepower)			Model Year			Annual Activity Hours		
Equipment	Engine Type	Count	Min	Max	Average	Min	Max	Average	Min	Max	Average
Pallet jack	Electric	7	na	na	na	na	na	na	na	na	na
Wharf crane	Electric	70	na	na	na	na	na	na	0	3,752	542
Forklift	Diesel	60	45	330	147	1986	2010	2002	0	3,110	614
Forklift	Electric	1	na	na	na	na	na	na	na	na	na
Forklift	Propane	51	46	165	106	1985	2010	2000	0	1430	273
Man Lift	Diesel	5	80	87	86	2000	2006	2004	27	224	116
Rail pusher	Diesel	1	200	200	200	2000	2000	2000	8	8	8
RMG cranes	Electric	10	na	na	na	na	na	na	60	1,985	1,196
RTG crane	Diesel	97	250	685	543	1999	2007	2004	0	4,089	1,248
Side pick	Diesel	34	152	330	220	1996	2010	2004	30	3,232	1,448
Sweeper	Diesel	6	100	240	128	1995	2008	2002	0	343	149
Sweeper	Gasoline	2	205	205	205	2002	2005	2004	635	735	685
Top handler	Diesel	137	250	375	293	1990	2010	2004	2	3,968	2,124
Truck	Diesel	9	235	250	243	1975	2008	2000	173	1,124	692
Yard tractor	Diesel	811	170	270	218	2002	2008	2006	0	4,149	1,943
Yard tractor	Propane	55	174	195	194	2000	2004	2004	0	2,540	1,585
Total count		**1,356**									

DB ID229

Table 5.4 presents the characteristics of the CHE engines at the Port's four break-bulk terminals.

Table 5.4: 2010 CHE Engines Characteristics for Break-Bulk Terminals

Break Bulk Terminals			Power (horsepower)			Model Year			Annual Activity Hours		
Equipment	**Engine Type**	**Count**	**Min**	**Max**	**Average**	**Min**	**Max**	**Average**	**Min**	**Max**	**Average**
Bulldozer	Diesel	2	165	200	183	1993	2007	2000	497	576	537
Crane	Diesel	5	150	950	376	1965	2010	1984	0	1,632	561
Excavator	Diesel	10	371	440	403	1999	2009	2005	957	3,304	1,985
Forklift	Diesel	74	59	350	165	1979	2009	2000	0	2,292	238
Forklift	Electric	1	na	na	na	na	na	na	na	na	na
Forklift	Gasoline	3	150	150	150	1991	1991	1991	2,250	2,250	2,250
Forklift	Propane	14	40	122	110	1987	2008	1991	70	780	647
Loader	Diesel	9	52	430	330	1998	2010	2003	151	4,584	1,540
Loader	Electric	4	na	na	na	na	na	na	na	na	na
Man lift	Diesel	5	49	80	72	1999	2010	2002	77	841	565
Man lift	Electric	5	na	na	na	na	na	na	na	na	na
Material handler	Diesel	1	475	475	475	2009	2009	2009	72	72	72
Miscellaneous	Diesel	1	268	268	268	2007	2007	2007	676	676	676
Rail pusher	Diesel	1	130	130	130	2004	2004	2004	383	383	383
Side pick	Diesel	2	152	152	152	2000	2000	2000	38	124	81
Skid steer loader	Diesel	5	45	70	60	2003	2007	2006	45	1,170	643
Sweeper	Diesel	3	96	260	151	2000	2008	2003	161	814	474
Top handler	Diesel	2	250	375	313	1990	2004	1997	30	32	31
Truck	Diesel	9	210	540	482	1995	2009	2005	274	2,505	1,208
Yard tractor	Diesel	14	177	200	191	2000	2009	2005	0	315	173
Total count		**170**									

DB ID231

Table 5.5 presents the characteristics of the CHE engines at the Port's three dry bulk terminals.

Table 5.5: 2010 CHE Engines Characteristics for Dry Bulk Terminals

Dry Bulk Terminals			Power (horsepower)			Model Year			Annual Activity Hours		
Equipment	**Engine Type**	**Count**	**Min**	**Max**	**Average**	**Min**	**Max**	**Average**	**Min**	**Max**	**Average**
Forklift	Propane	1	na	na	na	na	na	na	1,000	1,000	1,000
Loader	Diesel	1	110	110	110	2009	2009	2009	1,040	1,040	1,040
Yard tractor	Diesel	4	250	250	250	1995	1995	1995	2,080	2,080	2,080
Total count		**6**									

DB ID230

There were also 53 pieces of cargo handling equipment operated at the Port's cruise, auto and liquid bulk terminals including eight forklifts at the auto terminal, four forklifts at the liquid bulk terminals, and 38 forklifts, one sweeper, one tractor and one truck at the cruise terminal.

In addition to these other terminals, there are also several other facilities within the Port boundary which were included in this inventory but did not fit into the typical terminal categories listed above. These other facilities/tenants include smaller facilities and UP's ICTF. Table 5.6 presents the characteristics of the CHE at these other facilities.

Table 5.6: 2010 CHE Engines Characteristics for Other Facilities

Other Terminals			Power (horsepower)			Model Year			Annual Activity Hours		
Equipment	**Engine Type**	**Count**	**Min**	**Max**	**Average**	**Min**	**Max**	**Average**	**Min**	**Max**	**Average**
Crane	Diesel	6	130	244	198	1987	2004	1993	600	847	754
Forklift	Diesel	15	52	155	105	1991	2005	1998	0	1,250	410
Forklift	Propane	246	43	122	70	1987	2008	1997	0	2,576	691
Loader	Diesel	3	96	310	239	1989	2006	1995	0	0	0
Man lift	Diesel	4	48	80	63	1989	2007	1997	0	631	220
Miscellaneous	Diesel	6	37	37	37	2008	2008	2008	2,257	5,939	3,874
RTG crane	Diesel	10	300	350	310	1995	2009	2000	0	4,156	1,490
Side pick	Diesel	1	136	136	136	1992	1992	1992	875	875	875
Skid steer loader	Diesel	4	54	94	69	1994	2001	1999	0	96	24
Sweeper	Diesel	1	37	37	37	1999	1999	1999	0	0	0
Top handler	Diesel	1	325	325	325	2006	2006	2006	1,463	1,463	1,463
Yard tractor	Diesel	62	173	250	186	1995	2005	2003	0	4,528	2,247
Yard tractor	LNG	5	230	230	230	2009	2009	2009	500	500	500
Total count		**364**									

DB ID232

The 2010 CHE inventory includes 302 pieces of equipment with diesel oxidation catalysts (DOCs), 40 retrofitted with level-3 verified DPFs, and 657 yard tractors and eight trucks equipped with on-road certified engines. All terminals used ULSD fuel for all the 1,436 pieces of diesel equipment. Other emissions control technologies used on port's CHE include REGEN Flywheel systems (Vycon) on 5 RTG cranes and the BlueCAT retrofit which reduces emissions for large-spark ignition (LSI) equipment. It should be noted that some of these technologies may be used in combination with one another. For example, yard tractors with on-road engines use ULSD.

Table 5.7 is a summary of the emission reduction technologies utilized in cargo handling equipment.

Table 5.7: Summary of 2010 CHE Emission Reduction Technologies

Equipment	DOC Installed	On-Road Engines	DPF Installed	Vycon Installed	ULSD Fuel	BlueCAT LSI Equip
2010						
Forklift	6	0	11	0	163	135
RTG crane	10	0	0	5	107	0
Side pick	9	0	0	0	37	0
Top handler	47	0	6	0	140	0
Yard tractor	230	657	18	0	891	0
Sweeper	0	0	0	0	10	0
Other	0	8	5	0	88	1
Total	**302**	**665**	**40**	**5**	**1,436**	**136**

DB ID234

Twenty six percent of equipment inventoried were not equipped with diesel engines but were powered by propane or gasoline engines or electric motors. Specifically, a total of 393 pieces of equipment were powered with propane engines, nine were powered with gasoline engines, five were LNG-powered, and 106 were electric-powered, as listed on Table 5.8.

Table 5.8: CHE Engine by Fuel Type

Equipment	Electric	LNG	Propane	Gasoline	Diesel	Total
2010						
Forklift	10	0	336	7	163	516
Wharf gantry crane:	70	0	0	0	0	70
RTG crane	0	0	0	0	107	107
Side pick	0	0	0	0	37	37
Top handler	0	0	0	0	140	140
Yard tractor	0	5	55	0	891	951
Sweeper	0	0	1	2	10	13
Other	26	0	1	0	88	115
Total	**106**	**5**	**393**	**9**	**1,436**	**1,949**

DB ID235

The inventory does not include smaller electric equipment that may be operating at the terminals but includes the following electric equipment:

- 70 electric wharf cranes
- 10 electric cranes
- 7 electric pallet jacks
- 10 electric forklifts
- 5 electric man lifts
- 4 material loaders

Table 5.9 summarizes the distribution of diesel cargo handling equipment equipped with off-road engines by off-road diesel engine standards[37] (Tier 0, 1, 2, 3 and 4) based on model year and horsepower range. The table shows use of on-road diesel engines on yard tractors to comply with CARB's CHE regulation. The on-road engines are generally lower in emissions than the off-road diesel of the same model year. Apart from the on-road yard tractors, there are other equipment types, such as trucks that have on-road engines that are included in the CHE inventory. As shown in Table 5.9, with the implementation of the Port's CAAP measure for CHE and CARB's In-Use CHE regulation, the CHE with cleaner on-road engines continue to represent a significant portion of all diesel-powered equipment at the Port. The Unknown Tier column shown in the table represents equipment with unknown horsepower or model year information (which provides the basis for Tier level classifications). The table does not reflect the fact that some of the engines may be cleaner than the Tier level they are certified because of use of the emissions control devices such as DOCs and DPFs.

Table 5.9: 2010 Count of Diesel Equipment by Type and Engine Standards

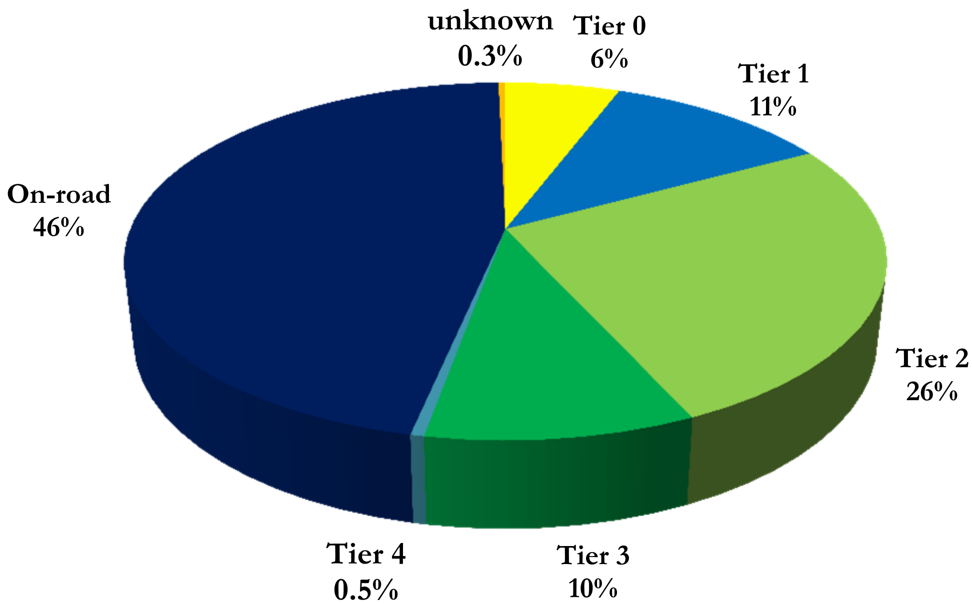
Equipment Type	Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	On-road Engine	Unknown Tier	Total Diesel
Yard tractor	8	24	195	7	0	657	0	891
Forklift	43	61	34	22	0	0	3	163
Top handler	8	25	53	54	0	0	0	140
Other	14	20	17	21	6	8	1	87
RTG crane	4	22	60	21	0	0	0	107
Side pick	4	8	13	12	0	0	0	37
Sweeper	2	3	2	2	0	0	1	10
Total	**83**	**163**	**374**	**139**	**7**	**665**	**5**	**1,436**
Percent	**6%**	**11%**	**26%**	**10%**	**0.5%**	**46%**	**0.3%**	

DB ID878

[37] U.S. EPA, Nonroad Compression-Ignition Engines- Exhaust Emission Standards, *http://www.epa.gov/otaq/standards/nonroad/nonroadci.htm*

Figure 5.3 presents the distribution of diesel equipment by off-road and on-road engine standards.

Figure 5.3: Distribution of Diesel Equipment by Engine Standards, %



5.5 Methodology

The emissions calculation methodology used to estimate the cargo handling equipment emissions is consistent with CARB's latest methodology. The basic equation used to estimate emissions for each piece of equipment is as follows.

$$E = Power \times Act \times LF \times EF \times FCF \times CF \qquad \text{Equation 5.1}$$

Where:

E = emissions, tons/year
Power = rated power of the engine in horsepower or kilowatts
Act = equipment activity, hours/year
LF = load factor (ratio of average power used during normal operations as compared to maximum rated power)
EF = emission factor, grams of pollutant per unit of work (g/hp-hr or kW/hp-hr)
FCF = fuel correction factor to reflect changes in fuel properties that have occurred over time
CF = control factor to reflect changes in emissions due to installation of emission reduction technologies not reflected in the emissions factors

The emission factor is a function of the zero-hour emission rate (ZH) by fuel type (diesel, propane or liquefied natural gas), by CHE engine type (off-road or on-road), for the CHE engine model year (in the absence of any malfunction or tampering of engine components that can change emissions), deterioration rate, and cumulative hours. The deterioration rate reflects the fact that the engine's base emissions (zero hour emission rates) change as the equipment is used, due to wear of various engine parts or reduced efficiency of emission control devices. The cumulative hours reflect the equipment's total operating hours. The emission factor is calculated as:

$$EF = ZH + (DR \times \text{Cumulative Hours}) \qquad \text{Equation 5.2}$$

Where:

ZH = emission rate for a given engine size category and model year when the engine is new and there is no component malfunctioning, expressed in g/kW-hr or g/hp-hr
DR = deterioration rate (rate of change of emissions as a function of equipment usage), expressed in g/kW-hr^2 or g/hp-hr^2
Cumulative hours = number of hours the equipment has been in use and calculated as annual operating hours times age of the equipment

The equation for the deterioration rate is:

Equation 5.3

$$DR = (DF \times ZH) / \text{cumulative hours at the end of useful life}$$

Where:

DR = deterioration rate, expressed in g/kW-hr^2 or g/hp-hr^2
DF = deterioration factor, percent increase in emissions from zero hour level at the end of the useful life (expressed as %)
ZH = emission rate for a given horsepower category and model year when the engine is new and there is no component malfunctioning, expressed in g/kW-hr or g/hp-hr
Cumulative hours at the end of useful life = annual operating hours times useful life in years

5.5.1 Emission Factors

The zero hour (ZH) emission rates for cargo handling equipment used in this inventory were provided by CARB and are consistent with the OFFROAD model. The ZH emission rates are a function of fuel type, model year, and horsepower group as defined in the OFFROAD model.

ZH emission rates vary by engine horsepower and model year to reflect the fact that depending upon the size of the engines, different engine technologies and emission standards are applicable. ZH emission factors (provided by CARB) by horsepower and engine year were used for:

- Diesel engines certified to off-road diesel engine emission standards
- Diesel engines certified to pre 2007 on-road diesel emission standards
- Gasoline and LPG engines certified to large spark ignited engine (LSI) emission standards

5.5.2 Load Factor, Useful Life, Deterioration Rates and Fuel Correction Factors

Load factor is defined as the ratio of average power used by the equipment during normal operation as compared to its maximum rated power. It accounts for the fact that engines are not used at their maximum power rating continually during normal operation. Equipment specific load factors used in 2010 are the same as those used in previous EI. Load factors for CHE are primarily based on CARB's methodology, except for RTG cranes and yard tractors which were updated based on joint studies conducted by the Ports of Los Angeles and Long Beach in consultation with CARB. Specifically, the yard tractor load factor[38] of 39% has been used since the 2006 EI report, and the 20% load factor for RTG cranes[39] has been used since the 2008 EI report.

Table 5.10 lists the useful life and load factor by equipment type.

Table 5.10: CHE Useful Life and Load Factors

Port Equipment	Useful Life	Load Factor
RTG crane	24	0.20
Crane	24	0.43
Excavator	16	0.57
Forklift	16	0.3
Top handler, side pick, reach stacker	16	0.59
Man lift, truck, other with off-road engine	16	0.51
Truck, other with on-road engine	16	0.51
Sweeper	16	0.68
Loader	16	0.55
Yard tractor with off-road engine	12	0.39
Yard tractor with on-road engine	12	0.39

DB ID459

[38] San Pedro Bay Ports Yard Tractor Load Factor Study Addendum, December 2008.
[39] Rubber Tired Gantry Crane Load Factor Study, November 2009.

Table 5.11 lists the deterioration factors for CHE by horsepower group. There are no deterioration factors for GHGs.

Table 5.11: Annual Deterioration Factors by Horsepower Group

Horsepower Group	PM	NO_x	CO	HC
0 to 50	31%	6%	41%	51%
51 to 120	44%	14%	16%	28%
121 to 175	44%	14%	16%	28%
176 to 250	44%	14%	16%	28%
250 +	67%	21%	25%	44%

DB ID445

Table 5.12 lists the fuel correction factors for ULSD fuel.[40] The base emission factors are based on the diesel fuel in use at the time the factors were developed and are adjusted by the following fuel correction factors to reflect the characteristics of ULSD. The FCF for SO_x reflects the change from diesel fuel with a sulfur content of 140 ppm to ULSD (15 ppm).

Table 5.12: Fuel Correction Factors for ULSD

Equipment MY	PM	NO_x	SO_x	CO	HC	CO_2	N_2O	CH_4
1995 and older	0.720	0.930	0.110	1	0.720	1	0.930	0.720
1996 and newer	0.800	0.948	0.110	1	0.720	1	0.948	0.720

DB ID444

Table 5.13 shows the fuel correction factors for gasoline engines. LNG and propane engines have no FCF.

Table 5.13: Fuel Correction Factors for Gasoline

Equipment MY	PM	NO_x	SO_x	CO	HC	CO_2	N_2O	CH_4
1997 and older	1	0.867	1	0.795	0.850	1	0.867	0.850
1998 and newer	1	1	1	1	1	1	1	1

[40] *http://www.arb.ca.gov/msei/offroad/techmemo/arb_offroad_fuels.pdf*

5.5.3 Control Factors

Control factors were used to reflect the change in emissions due to the use of various emissions reduction technologies. Table 5.14 shows the emission reduction percentages provided by CARB for the various technologies used on port equipment. The control factor is applied to the baseline emissions to estimate the remaining emissions and is 1 minus the emission reduction in decimal; for example, a 70% reduction has a control factor of 0.3; while a -10% increase in emissions has a control factor of 1.10.

Table 5.14: CHE Emission Reduction Percentages

Technology	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC	CO_2	N_2O	CH_4
DOC	30%	30%	30%	0%	na	70%	70%	na	0%	70%
DPF	85%	85%	85%	0%	na	0%	0%	na	0%	0%
Vycon's REGEN	25%	25%	25%	30%	15%	0%	0%	15%	30%	0%
BlueCAT	0%	0%	0%	85%	na	0%	85%	na	0%	0%

DB ID474

The emissions reductions associated with the various emissions strategies have been either verified or developed in consultation with CARB.

- DOC: Provided by CARB in a memorandum to the Port
- DPF: CARB verified technology[41]
- Vycon: CARB verified technology[42]
- Nett BlueCAT 300™: CARB verified technology for off-road large spark-ignition (LSI) equipment[43]

5.5.4 Improvements to Methodology from Previous Year

There was a change to the emission calculation methodology with regards to the 2007+ on-road emission factors. These emission factors were revised to reflect the impact of 2007+ on-road engine emission standards in comparison to off-road engine standards for the same model year.

41 *http://www.arb.ca.gov/diesel/verdev/vt/cvt.htm*
42 *http://www.arb.ca.gov/diesel/verdev/vt/cvt.htm*
43 *http://www.ar.ca.gov/msprog/offroad/orspark/verdev.htm*

CARB's original emission factors for CHE equipped with on-road engines were based on CARB's yard tractor emissions testing study[44], in which yard tractors equipped with 2004 model year on-road and off-road engines were tested on the same duty cycle. The test data showed that the difference in PM and NO_x emissions between on-road yard tractor and off-road yard tractor is similar to the differences in their respective emissions standards. The test data also showed that although the HC and CO emissions standards for 2004 on-road engines are greater than for 2004 off-road engines, the actual HC emissions for on-road engines were lower than the off-road engines and there was no significant difference in actual CO emissions between on-road and off-road engines. Therefore, CARB's on-road engine zero-hour emission factors for 2004 + model year engines were derived by applying these reduction percentages to all 2004 + off-road engine zero-hour emission factors in all horsepower groups. However, due to the larger difference in the 2007+ standards between the on-road PM and NO_x standards and the off-road PM and NO_x engine standards, the CARB-provided emission factors (derived from the 2004 model year testing) do not accurately reflect the ratio of 2007 off- and on-road engine emission standards. In addition, there is a lack of test data for MYs 2007+ on- and off-road yard tractors. Therefore, in order to estimate NO_x and PM zero-hour emission rates for on-road 2007+ model year engines, the ratios of on-road to off-road emission standards have been applied to the off-road emission factors of the corresponding model year within the horsepower group. Similar to the 2004 model year as discussed above, the ratio of on-road to off-road standards for HC and CO are greater than one (i.e., the on-road standards are higher than the off-road standards), whereas both the on-road and off-road HC and CO emissions are actually much lower than the HC and CO standards; therefore, the HC reduction of 67%, as established by the earlier emission testing, was applied to the HC emission factor, and no modification was made to the CO emission factor.

For comparison of 2010 emissions to previous years' emissions, refer to Section 9.

5.5.5 Future Improvements to Methodology

CARB is currently working on changes to their emissions inventory. Any changes CARB makes to the methodology will be reviewed and incorporated, if applicable, to next year's CHE EI.

[44] California Environmental Protection Agency Air Resources Board, Cargo Handling Equipment Yard Truck Emission Testing, September 2006.

5.6 Emission Estimates

Tables 5.15 and 5.16 provide a summary of cargo handling equipment emissions by terminal type.

Table 5.15: 2010 CHE Emissions by Terminal Type, tons per year

Terminal Type	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
Auto	0.0	0.0	0.0	0.2	0.0	1.4	0.1
Break-Bulk	2.1	2.0	2.1	68.2	0.1	42.5	4.4
Container	15.3	14.3	14.9	625.9	1.5	409.8	21.6
Cruise	0.1	0.1	0.0	7.1	0.0	14.8	1.1
Dry Bulk	0.4	0.4	0.4	8.5	0.0	4.2	0.7
Liquid	0.1	0.0	0.0	1.0	0.0	1.2	0.1
Other	2.2	2.2	2.1	93.3	0.1	119.9	7.0
Total	**20.2**	**18.9**	**19.5**	**804.2**	**1.6**	**593.7**	**35.0**

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Table 5.16: 2010 CHE GHG Emissions by Terminal Type, metric tons per year

Terminal Type	CO_2 Equivalent	CO_2	N_2O	CH_4
Auto	15.3	15.2	0.0	0.0
Break-Bulk	7,640.1	7,575.2	0.2	0.3
Container	125,452.7	124,688.3	2.3	2.8
Cruise	461.3	459.6	0.0	0.0
Dry Bulk	516.9	511.9	0.0	0.0
Liquid	58.9	58.6	0.0	0.0
Other	9,317.5	9,246.5	0.2	0.3
Total	**143,462.9**	**142,555.3**	**2.7**	**3.5**

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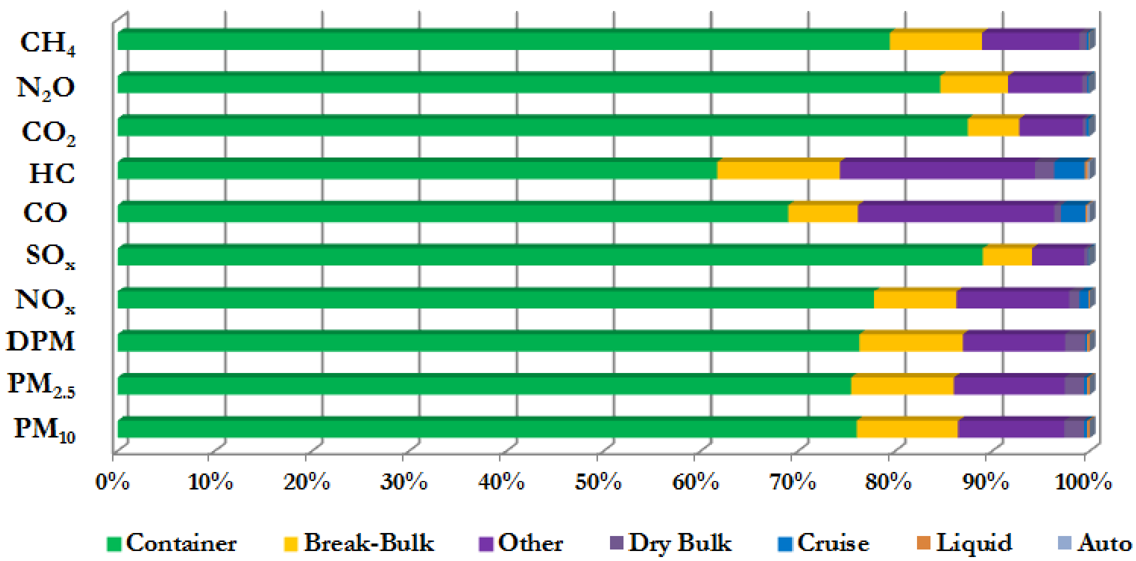
Figure 5.4 presents the percentage of CHE emissions by terminal type. Container terminals account for roughly 75% of the Port's cargo handling equipment PM emissions, 77% of the NO_x emissions, 89% of the SO_x emissions, 69% of the CO, 61% of the HC emissions, 87% of the CO_2 emissions, 84% of the N_2O emissions, and 79% of the CH_4 emissions are attributed to the container terminals. Break-bulk terminals and other terminals and facilities account for the remainder of the emissions.

Figure 5.4: 2010 CHE Emissions by Terminal Type, %



Tables 5.17 and 5.18 present the emissions by cargo handling equipment type and engine type.

Table 5.17: 2010 CHE Emissions by Equipment and Engine Type, tons per year

Port Equipment	Engine	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
Bulldozer	Diesel	0.0	0.0	0.0	0.6	0.0	0.2	0.0
Crane	Diesel	0.3	0.3	0.3	7.2	0.0	3.0	0.4
Excavator	Diesel	0.6	0.6	0.6	18.0	0.0	4.9	0.7
Forklift	Diesel	0.9	0.8	0.9	20.2	0.0	8.8	1.3
Forklift	Gasoline	0.0	0.0	0.0	5.8	0.0	16.8	1.5
Forklift	Propane	0.3	0.3	0.0	31.9	0.0	117.3	5.4
Loader	Diesel	0.6	0.5	0.6	20.4	0.0	3.7	0.9
Man Lift	Diesel	0.1	0.1	0.1	1.2	0.0	0.7	0.1
Material handler	Diesel	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Miscellaneous	Diesel	0.1	0.1	0.1	2.5	0.0	1.5	0.0
Rail Pusher	Diesel	0.0	0.0	0.0	0.1	0.0	0.1	0.0
RTG Crane	Diesel	1.9	1.8	1.9	72.7	0.1	16.6	1.9
Side pick	Diesel	0.8	0.8	0.8	31.5	0.0	6.2	0.8
Skid Steer Loader	Diesel	0.0	0.0	0.0	0.7	0.0	0.4	0.0
Sweeper	Diesel	0.1	0.1	0.1	1.1	0.0	0.5	0.1
Sweeper	Gasoline	0.0	0.0	0.0	1.2	0.0	5.3	0.2
Sweeper	Propane	0.0	0.0	0.0	0.7	0.0	2.2	0.1
Top handler	Diesel	5.9	5.5	5.9	213.5	0.3	46.1	5.4
Tractor	Propane	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Truck	Diesel	0.5	0.5	0.5	12.3	0.0	5.0	0.5
Yard tractor	Diesel	7.6	7.0	7.6	323.7	1.1	167.1	7.3
Yard tractor	LNG	0.0	0.0	0.0	0.7	0.0	0.0	0.5
Yard tractor	Propane	0.4	0.4	0.0	38.2	0.0	187.1	7.6
Total		**20.2**	**18.9**	**19.5**	**804.2**	**1.6**	**593.7**	**35.0**

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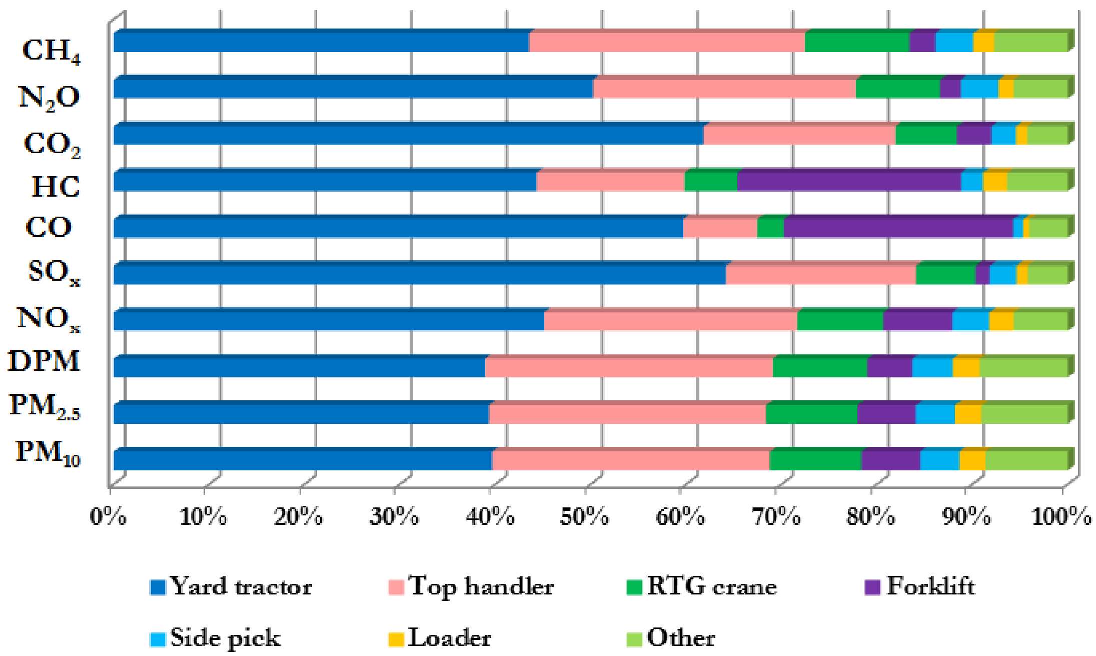
Table 5.18: 2010 CHE GHG Emissions by Equipment and Engine Type, metric tons per year

Port Equipment	Engine	CO_2 Equivalent	CO_2	N_2O	CH_4
Bulldozer	Diesel	62.4	61.7	0.0	0.0
Crane	Diesel	671.6	665.3	0.0	0.0
Excavator	Diesel	2,556.4	2,534.4	0.1	0.1
Forklift	Diesel	1,784.3	1,766.5	0.1	0.1
Forklift	Gasoline	236.0	234.0	0.0	0.0
Forklift	Propane	3,119.6	3,119.6	0.0	0.0
Loader	Diesel	1,714.6	1,699.7	0.0	0.1
Man Lift	Diesel	93.2	92.3	0.0	0.0
Material handler	Diesel	11.6	11.5	0.0	0.0
Miscellaneous	Diesel	309.5	306.1	0.0	0.0
Rail Pusher	Diesel	15.1	14.9	0.0	0.0
RTG Crane	Diesel	9,291.6	9,209.8	0.2	0.4
Side pick	Diesel	3,726.8	3,690.7	0.1	0.1
Skid Steer Loader	Diesel	68.4	67.6	0.0	0.0
Sweeper	Diesel	160.9	159.4	0.0	0.0
Sweeper	Gasoline	141.5	140.1	0.0	0.0
Sweeper	Propane	55.9	55.9	0.0	0.0
Top handler	Diesel	28,877.6	28,626.4	0.7	1.0
Tractor	Propane	0.0	0.0	0.0	0.0
Truck	Diesel	1,961.5	1,945.6	0.0	0.1
Yard tractor	Diesel	84,143.2	83,692.3	1.4	1.5
Yard tractor	LNG	0.0	0.0	0.0	0.0
Yard tractor	Propane	4,461.5	4,461.5	0.0	0.0
Total		**143,462.9**	**142,555.3**	**2.7**	**3.5**

DB ID237

Figure 5.5 presents the percentage of cargo handling equipment emissions by equipment type. Yard tractors contribute to roughly 39% of the cargo handling equipment PM emissions, 45% of the NO_x emissions, 64% of the SO_x emissions, 60% of the CO emissions, 44% of the HC emissions, 62% of the CO_2 emissions, 51% of N_2O emissions and 44% of the CH_4 emissions. Top handlers, forklifts, RTG cranes, side picks and loaders follow in emissions. "Other" equipment refers to bulldozer, crane, excavator, man lift, rail pusher, skid steer loader, sweeper, off-road truck, and miscellaneous equipment.

Figure 5.5: 2010 CHE Emissions by Equipment Type, %



SECTION 6 RAILROAD LOCOMOTIVES

This section presents emissions estimates for the railroad locomotive source category, including source description (6.1), geographical delineation (6.2), data and information acquisition (6.3), operational profiles (6.4), emissions estimation methodology (6.5), and the emission estimates (6.6).

6.1 Source Description

Railroad operations are typically described in terms of two different types of operation, line haul and switching. Line haul refers to the movement of cargo over long distances (e.g., cross-country) and occurs within the Port as the initiation or termination of a line haul trip, as cargo is either picked up for transport to destinations across the country or is dropped off for shipment overseas. Switching refers to short movements of rail cars, such as in the assembling and disassembling of trains at various locations in and around the Port, sorting of the cars of inbound cargo trains into contiguous "fragments" for subsequent delivery to terminals, and the short distance hauling of rail cargo within the Port. It is important to recognize that "outbound" rail freight is cargo that has arrived on vessels and is being shipped to locations across the U.S. (also known as eastbound cargo), whereas "inbound" rail freight is destined for shipment out of the Port by vessel (also known as westbound cargo). This is contrary to the usual port terminology of cargo off-loaded from vessels referred to as "inbound" and that loaded onto vessels as "outbound."

The Port is served by three railway companies:

- Burlington Northern Santa Fe (BNSF)
- Union Pacific (UP)
- Pacific Harbor Line (PHL)

These railroads primarily transport intermodal (containerized) freight, with lesser amounts of dry bulk, liquid bulk, and car-load (box car) freight. PHL performs most of the switching operations within the Port, while BNSF and UP provide line haul service to and from the Port and also operate switching services at their off-port locations. The two railroads that provide line haul service to the Port are termed Class 1 railroads, based on their relative size and revenues.

Locomotives used for line haul operations are typically large, powerful engines of 3,000 to 4,000 hp or more, while switch engines are smaller, typically having one or more engines totaling 1,200 to 3,000 hp. Figures 6.1 and 6.2 illustrate typical line haul and switching locomotives, respectively, in use at the Port. The locomotives used in switching service at the Port by PHL, and at the near-Port railyard operated by UP, are new, low-emitting locomotives specifically designed for switching duty.

PHL's previous fleet of older locomotives has been replaced by Tier 2 as part of an agreement among the Ports of Los Angeles and Long Beach and PHL. UP has reported that they operate similar low-emission locomotives at their local near-port railyard as part of an agreement between the railroad and CARB, but this has not been verified by the Ports.

Figure 6.1: Typical Line Haul Locomotive

Figure 6.2: PHL Switching Locomotive

6.2 Geographical Delineation

Figure 6.3 illustrates the rail track system serving both ports, and Figure 6.4 presents a broader view of the major rail routes in the Air Basin that are used to move port-related intermodal cargo. The specific activities included in this emissions inventory are movements of cargo within Port boundaries, or directly to or from Port owned properties (such as terminals and on-port rail yards). Rail movements of cargo that occur solely outside the port, such as switching at off-port rail yards, and movements that do not either initiate or end at a Port property (such as east-bound line hauls that initiate in central Los Angeles intermodal yards) are not included.

Figure 6.3: Port Area Rail Lines

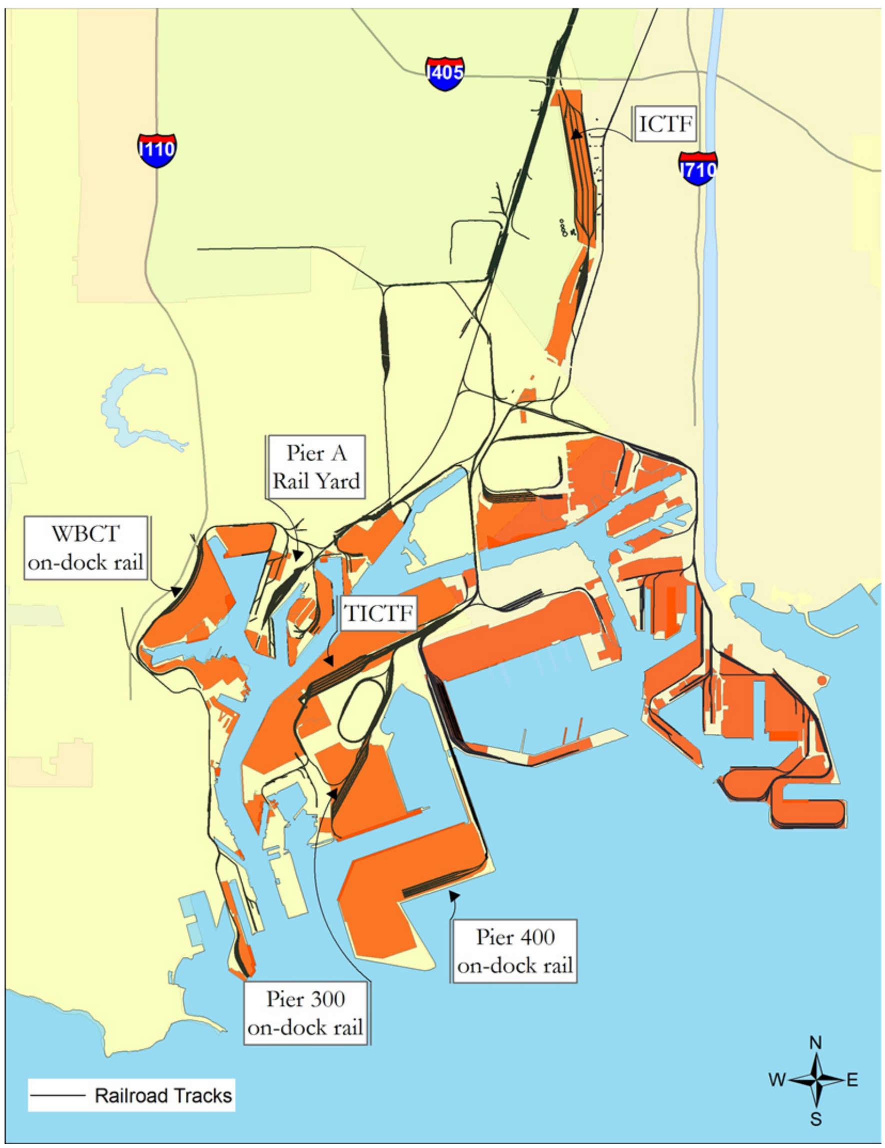


Figure 6.4: Air Basin Major Intermodal Rail Routes

6.3 Data and Information Acquisition

The locomotive section of the EI presents an estimate of emissions associated with Port-related activities of the locomotives operating within the Port and outside the Port to the boundary of the SoCAB. Information regarding these operations has been obtained from:

- Input from railroad operators
- Port cargo statistics
- Previous emissions studies

PHL provided a record of the fuel used per month in each of its locomotives. The UP railway company operating the ICTF, which is on Port property and operates as a joint powers authority of the Port and POLB, also provided information on their switch engines, including representative fuel usage. In addition, railroad personnel were interviewed for an overview of their operations in the area. In addition, certain information related to line haul locomotive fleets has been obtained from railroad companies' Internet websites and that of the Surface Transportation Board of the U.S. Department of Transportation. Additionally, terminal operators and Port departments have provided information on Port rail operations that provides an additional level of understanding of overall line haul rail operations.

Throughput information provided by the railroad companies to the ports has been used to estimate on-Port and off-Port rail activity. It should be noted that data collection is particularly difficult with respect to estimating rail emissions associated with Port activities. As a result, the rail data for locomotive operations associated with Port activities as presented in this study continues to be somewhat less refined and specific than the data for other emission source categories. The Port continues to work with the railroads to further enhance the accuracy of the port activity data on which the rail emissions inventory is based.

6.4 Operational Profiles

6.4.1 Rail System

The rail system is described below in terms of the activities that are undertaken by locomotive operators. Specifically, descriptions are provided for the assembly of outbound trains, the disassembly of inbound trains, and the performance of switching operations, as well as a detailed listing of the activities of line haul and switching operations.

Outbound Trains

The assembly of outbound trains occurs in one of three ways. Container terminals with sufficient track space build trains on-terminal in on-dock railyards, using flat cars that have either remained on site after the off-loading of inbound containers or have been brought in by one of the railroads. Alternatively, some containers are trucked (drayed) to an off-terminal transfer facility where the containers are transferred from truck chassis to railcars. A third option is for the terminal to store individual railcars (e.g., tank cars, bulk cars, container cars) or build a partial train on-terminal, to be collected later by a railroad (typically PHL) and moved to a rail yard with sufficient track space to build an entire train.

Within the Port, complete trains can be built at the terminals servicing the West Basin Container Terminal, the APL terminal, and the APM terminal. In addition, the Terminal Island Container Transfer Facility (TICTF) is shared by NYK and Evergreen as a facility to build trains. Trains are also built outside of the Port at the Watson Yard, the Dolores Yard, and the Manuel Yard, and at locations within the POLB. If containers to be transported by rail are not loaded onto railcars at the Port, they are typically drayed to off-port locations operated by the line haul railroads, as noted above.

Inbound Trains
In-bound trains carrying cargo (or empty containers) that are all destined for the same terminal are delivered directly to the terminal by the Class 1 railroads if the receiving terminal has the track space to accommodate all of the cars at one time. Trains carrying cargo that are bound for multiple terminals within one or both ports are staged by the Class 1 railroads at several locations, where they are broken up, typically by PHL, and delivered to their destination terminals. Inbound trains are also delivered to off-Port locations such as the Watson Yard, the ICTF operated by UP, the Dolores Yard, and the Manuel Yard. Of these locations, only the ICTF is included in the emission estimates presented in this emissions inventory, because of its status as a joint powers authority of the Port and the POLB.

Alameda Corridor
The Alameda Corridor is a 20-mile rail line running between the San Pedro Bay area and downtown Los Angeles that is used by intermodal and other trains servicing the San Pedro Bay Ports and other customers in the area. Running largely below grade, the Alameda Corridor provides a more direct route between downtown Los Angeles and the Port than the routes that had previously been used, shortening the travel distance and eliminating many at-grade crossings (reducing traffic congestion). Figure 6.5 illustrates the route of the Alameda Corridor and the routes it has replaced.

Figure 6.5: Alameda Corridor

Switching

Switching locomotives deliver and pick up railcars transporting containers, liquid and dry bulk materials, and general cargo to and from terminals at the Port. Switching operations take place around the clock, seven days per week, although weekend activity is generally lower than weekday or weeknight activity.

PHL is the primary switching railroad at the Port. PHL operations are organized into scheduled shifts, each shift being dispatched to do specified tasks in shift-specific areas. Other shifts move empty or laden container flat cars to and from container terminals. Much of the work involves rearranging the order of railcars in a train to organize cars bound for the same destinations (inbound or outbound) into contiguous segments of the train, and to ensure proper train dynamics. Train dynamics can include, for example, locating railcars carrying hazardous materials the appropriate minimum distance from the locomotives, and properly distributing the train's weight. Although there is a defined schedule of shifts that perform the same basic tasks, there is little consistency or predictability to the work performed during a given shift or at a particular time.

Specific Rail Activities

Locomotive activities of the Class 1 railway companies consist of:

- Delivering inbound trains (and/or empty railcars) to terminals or to the nearby rail yards, using line haul locomotives.
- Picking up trains from the terminals or nearby rail yards and transporting them to destinations across the country, using line haul locomotives.
- Breaking up inbound trains and sorting rail cars into contiguous fragments, and delivering the fragments to terminals, using PHL switch locomotives.

Locomotive switching activities consist of:

- Breaking up inbound trains and sorting railcars into contiguous fragments, and delivering the fragments to terminals.
- Delivering empty container railcars to terminals.
- Delivering railcars to non-container facilities, and removing previously delivered railcars. (For example, delivering full tank cars to a terminal that ships product and removing empties, or delivering empty tank cars to a terminal that receives product and removing full ones.)
- Rearranging full and empty railcars to facilitate loading by a terminal.

- Picking up outbound containers in less than full train configuration and transporting them to a yard for assembly into full trains – to be transported out of the Port by one of the line haul railroads.

6.4.2 Locomotives and Trains

Locomotives operate differently from other types of mobile sources with respect to how they transmit power from engine to wheels. While most mobile sources use a physical coupling such as a transmission to transfer power from the engine to the wheels, a locomotive's engine turns a generator or alternator powering an electric motor that, in turn, powers the locomotive's wheels. The physical connection of the engine, transmission, and wheels of a typical mobile source means that the engine's speed varies with the vehicle's speed through a fixed set of gear ratios, resulting in the highly transient operating conditions (particularly engine speed and load) that characterize mobile source operations. In contrast, the locomotive's engine and drive system operate more independently, such that the engine can be operated at a particular speed without respect to the speed of the locomotive itself. This allows operation under more steady-state load and speed conditions, and as a result locomotives have been designed to operate in a series of discrete throttle settings called notches, ranging from notch positions one through eight, plus an idle position.

Many locomotives also have a feature known as dynamic braking, in which the electric drive engine operates as a generator to help slow the locomotive, with the resistance-generated power being dissipated as heat. While the engine is not generating motive power under dynamic braking, it is generating power to run cooling fans, so this operating condition is somewhat different from idling. Switch engines typically do not utilize dynamic braking.

Line Haul Locomotives

Line haul locomotives are operated in the Port by BNSF and UP. Because the function of line haul locomotives is to transport freight to and from destinations across the country, there is no readily identifiable "fleet" of line haul locomotives that call on the Port other than the Class 1 railroads' nation-wide fleets.

While each railroad operates a variety of different models of locomotive, a typical BNSF line haul locomotive is the General Electric (GE) C44-9W (also known as the Dash 9), and the newer ES44 series. Among the UP locomotives calling at the Port are six-axle, Electromotive Division (EMD) SD70s as well as GE ES44 series locomotives. Line haul locomotives typically have six axles and 4,000 to 4,400 horsepower.

Both UP and BNSF are party to a Memorandum of Understanding with CARB that came into force in 2010 by which the railroads have agreed to meet specified fleet-wide average emission rates from their line haul and switching locomotives operating in the SoCAB, on a weighted average basis (i.e., the average applies to switching as well as line haul locomotives). As part of achieving these fleet average emission rates, the railroads may have diverted a higher percentage of their new, Tier 2 locomotives to the SoCAB and to the Ports, reducing their port-related emissions. However, the railroads are not due to report this information to CARB until later than the release date of this inventory, so the effects of specific fleet modifications have not been included in the emission estimates presented below.

Line haul locomotives are typically operated in groups of two to five units, with three or four units being most common, depending on the power requirements of the specific train being pulled and the horsepower capacities of available locomotives. Thus, two higher-horsepower locomotives may be able to pull a train that would take three units with lower power outputs. Locomotives operated in sets are connected such that every engine in the set can be operated in unison by an engineer in one of the locomotives.

Switching Locomotives

Most switching within the Port is conducted by PHL. Early in 2006, an agreement was concluded among PHL, the Port, and the Port of Long Beach whereby the two ports helped fund the replacement of PHL's locomotives with new locomotives meeting Tier 2 locomotive emission standards. In 2008, the last of the pre-Tier 2 locomotives were retired as the new locomotives were placed into service. PHL's fleet since 2009 has consisted of 16 Tier 2 locomotives and 6 locomotives that are powered by a set of three relatively small diesel engines and generators rather than one large engine (known as multi-engine genset switchers). These multi-genset units emit less than Tier 2 emission levels of most pollutants. The Class 1 railroads also operate switch engines in and around the Port, primarily at their switching yards outside of the Port.

Train Configuration

Container trains are the most common type of train operating at the Port. While equipment configurations vary, these trains typically consist of up to 26 or more double-stack railcars, each railcar consisting of five platforms capable of carrying up to four TEUs of containerized cargo (e.g., most platforms can carry up to two 40-foot containers). With this configuration, the capacity of a train is 520 TEUs or about 290 containers at an average ratio of 1.8 TEU/container. As a practical matter, not all platforms carry four TEUs because not all platforms are double stacked with two 40-foot containers; the current capacity or "density" is estimated to be approximately 95% (meaning, for example, a 26-car train would carry 520 TEUs x 95% = 494 TEUs).

In developing off-port line haul locomotive emission estimates, the following assumptions were made regarding the typical make-up of trains traveling the Alameda Corridor and beyond: 26 double-stack railcars, 95% density, for a capacity of 494 TEUs or 274 containers (average). These assumptions are generally consistent with information developed for the No Net Increase Task Force's evaluation of 2005 Alameda Corridor locomotive activities,[45] with adjustments for changes in train makeup over time. Average train capacity assumptions for on-port emission estimates are lower based on reported container throughput and weekly/annual train information provided by Port terminals. It has been assumed that the length and/or capacity of trains are increased or decreased in the off-port rail yards prior to or after interstate travel to or from the Port (i.e., outbound freight is consolidated into fewer, longer trains and inbound freight is broken up for delivery to terminals), so the number of trains entering and leaving the Port is higher than the number of trains traveling the Alameda Corridor.

6.5 Methodology

The following section provides a description of the methods used to estimate emissions from switching and line haul locomotives operating within the Port and in the South Coast Air Basin.

Emissions have been estimated using the information provided by the railroads and the terminals, and from published information sources such as the EPA's "Emission Factors for Locomotives"[46] and their Regulatory Support Document (RSD),[47] both published as background to EPA's locomotive rule-making processes. For on-Port switching operations, the fuel use information provided by the switching companies has been used along with EPA and manufacturer information on emission rates. Off-Port switching emissions have been estimated using 2005 fuel use data for the ICTF previously provided by UP, scaled to the increase in facility throughput between 2005 and 2010. For the limited line haul operations in the Port (arrivals and departures), emission estimates have been based on schedule and throughput information provided by the railroads and terminal operators and on EPA operational and emission factors. Off-Port line haul emissions have been estimated using cargo movement information provided by the line haul railroads, and weight and distance information first developed for the 2005 emissions inventory. A detailed explanation of emission calculation methods is presented below.

[45] Personal communication, Art Goodwin, Alameda Corridor Transportation Authority, with Starcrest Consulting Group, LLC, February 2005.
[46] EPA-420-F-09-025, Office of Transportation and Air Quality, April 2009
[47] EPA Office of Mobile Sources, *Locomotive Emission Standards Regulatory Support Document,* April 1998, revised.

Different calculation methods are required for the different types of locomotive activity because different types of information are used for different activities. However, an attempt has been made to standardize the activity measures used as the basis of calculations in order to develop consistent methodologies and results.

6.5.1 Switching Emissions

Emissions from PHL's on-port switching operations have been based on the horsepower-hours of work represented by their reported locomotive fuel use, and emission factors from the EPA documents cited above and from information published by the locomotive manufacturers. The calculations estimate horsepower-hours for each locomotive from fuel consumption in gallons per year and combine the horsepower-hour estimates with emission factors in terms of mass of emissions per horsepower-hour. Fuel usage is converted to horsepower-hours using an average value of 15.2 horsepower-hour per gallon of fuel (from EPA, 2009):

Equation 6.1

gallons/year x horsepower-hour/gallon = horsepower-hours/year

The calculation of emissions from horsepower-hours uses the following equation.

$$E = \frac{hp\text{-}hrs \times EF}{(453.59\ g/lb \times 2{,}000\ lb/ton)}$$ Equation 6.2

Where:

E = emissions, tons per year
hp-hrs = annual work, horsepower-hours per year
EF = emission factor, grams pollutant per horsepower-hour

EPA in-use emission factors for Tier 2 locomotives have been used for the 16 Tier 2 locomotives, and manufacturers' published emission rates have been used for the 6 genset switchers. The genset locomotives each operate with three diesel engines originally certified to EPA Tier 3 nonroad engine standards. Emission rates published by the locomotives' manufacturer, National Railway Equipment Co. (NRE) have been used instead of the Tier 3 nonroad standards because differences in duty cycle between nonroad and locomotive operation make the nonroad standards less appropriate.

The EPA and NRE emission factors cover particulate, NO_x, CO, and HC emissions. SO_2 emission factors have been developed to reflect the use of 15 ppm ULSD using a mass balance approach. The mass balance approach assumes that all of the sulfur (S) in the fuel is converted to SO_2 and emitted during the combustion process. While the mass balance approach calculates SO_2 specifically, it is used as a reasonable approximation of SO_x. The following example shows the calculation of the SO_x emission factor.

Equation 6.3

$$\frac{15\ g\ S}{1{,}000{,}000\ g\ fuel} \times \frac{3{,}200\ g\ fuel}{gal\ fuel} \times \frac{2\ g\ SO_2}{g\ S} \times \frac{gal\ fuel}{15.2\ hp\text{-}hr} = 0.006\ g\ SO_2/hp\text{-}hr$$

In this calculation, 15 ppm S is written as 15 lbs S per million lbs of fuel. The value of 15.2 hp-hr/gallon of fuel is the average BSFC noted in EPA's technical literature on locomotive emission factors (EPA, 2009). Two grams of SO_2 is emitted for each gram of sulfur in the fuel because the atomic weight of sulfur is 32 while the molecular weight of SO_2 is 64, meaning that the mass of SO_2 is two times that of sulfur.

Greenhouse gas emission factors from EPA references[48] have been used to estimate emissions of greenhouse gases CO_2, CH_4, and N_2O from locomotives. Additionally, all particulate emissions are assumed to be PM_{10} and DPM, and $PM_{2.5}$ emissions have been estimated as 92% of PM_{10} emissions to be consistent with CARB's $PM_{2.5}$ ratio used for offroad diesel equipment. Emission factors for the Tier 2 and genset switching locomotives, including those used for the off-port switching activity, are listed in Tables 6.1 and 6.2.

Table 6.1: Switching Emission Factors, g/hp-hr

Fuel or Locomotive Type	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
Tier 2 Locomotives	0.19	0.17	0.19	7.30	0.006	1.83	0.51
Genset Locomotives	0.05	0.05	0.05	3.37	0.006	1.51	0.04

Table 6.2: GHG Switching Emission Factors, g/hp-hr

Fuel or Locomotive Type	CO_2	N_2O	CH_4
Tier 2 Locomotives	670	0.017	0.050
Genset Locomotives	670	0.017	0.050

[48] CO_2 - Table A-39, page A-59, Annex 2 of the report entitled: *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007* April 2009; CH_4 and N_2O - Table A-92, page A-121 in Annex 3 of the same report.

The activity measure used in the switching emission estimates is total horsepower-hours of activity, derived from the locomotive-specific fuel use data provided by PHL for the on-port switching, and an estimate of off-port switching fuel use derived from information provided earlier by UP for the ICTF rail yard that is located on Port property. For the ICTF, the reported 2005 fuel usage has been multiplied by the ratio of 2010 to 2005 container throughput reported by the railroad using the assumption that switching activity varies linearly with container throughput.

PHL operates within both the Port and POLB. While some of the shifts are focused on activities in only one of the ports, other shifts may work in either or both ports depending upon the day's needs for switching services. Therefore, it is not possible to clearly designate which shifts operate solely within the Port so a method was developed for apportioning emissions between the two ports. To do this, the previous baseline emissions inventory evaluated the work shifts as to whether they are likely to work in either port exclusively or in both ports, resulting in a split of 69% of activity within the Port and 31% within the POLB, which has been maintained for the current inventory. The difference between the two ports' allocations is so great in part because PHL's main yard is within the Port, so almost all work shifts involve at least some activity within the Port.

Rail cargo from both ports is handled at the off-dock ICTF, and the complexities of the rail system are such that apportionment of activity (and emissions) between the two ports is difficult. The previous baseline emissions inventories used an allocation of 55% Port and 45% POLB – this allocation has been maintained for the current inventories because it still seems a reasonable assumption, given that the Port's overall TEU throughput represented about 56% of the two ports' combined throughput in 2010.

Regardless of apportionment, the sum of the two ports' emissions represents all of the estimated switching emissions from locomotives operated at the ICTF.

6.5.2 Line Haul Locomotive Emissions

Emissions from line haul locomotives operating in the Port have been estimated on an activity basis, i.e., estimates of the number and characteristics of locomotives that arrive and depart with cargo and/or empty containers. The information used in developing these estimates has been obtained from the Port and Port terminals.

The number of locomotive trips in the Port has been estimated by evaluating cargo movements, percentage of cargo transported by rail, and typical number of locomotives per train, using a methodology similar to that first used for the 2001 baseline emissions inventory and also used for the subsequent inventories. Emission factors for most pollutants have been taken from EPA's recent documentation (EPA-420-F-09-025, cited above) representing EPA's projected 2010 nationwide fleet of line haul locomotives, as shown in Table 6.3. The emission factors are presented in terms of grams per horsepower-hour (g/hp-hr), converted from the gram-per-gallon factors listed in the EPA documentation using the line haul BSFC of 20.8 hp-hr/gal.

The SO_x emission factor has been estimated from assumed fuel sulfur content values using a mass balance equation similar to the switching locomotives calculation. For line haul locomotives, which enter and leave California to pick up and deliver transcontinental rail cargo and typically refuel while in the SoCAB, the calculations are based on the use of 50% ULSD fuel from SoCAB refueling and 50% higher sulfur (350 ppm) fuel from out-of-state sources. Table 6.4 lists the greenhouse gas emission factors derived from the EPA reference.[49]

Table 6.3: Emission Factors for Line Haul Locomotives, g/hp-hr

	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
EF, g/bhp-hr	0.23	0.21	0.23	7.54	0.06	1.28	0.40

The same information sources for greenhouse gases has been used for line haul locomotives as for switching locomotives, described above. Table 6.4 lists the greenhouse gas emission factors.

Table 6.4: GHG Emission Factors for Line Haul Locomotives, g/hp-hr

	CO_2	N_2O	CH_4
EF, g/bhp-hr	487	0.013	0.040

On-Port Line Haul Emissions

On-port line haul locomotive activity has been estimated through an evaluation of the amount of cargo reported by the terminals to be transported by rail and their reported average or typical number of trains per week or per year. These numbers have been combined with assumptions regarding the number of locomotives, on average, that are involved with on-port line haul railroad moves, and the average duration of incoming and outgoing port trips, in the same approach taken for the previous emissions inventories. The number of trains per year, locomotives per train, and on-port hours per train have been multiplied together to calculate total locomotive hours per year. This activity information is summarized in Table 6.5. While most of the rail cargo, and the basis for these estimates, center on container traffic, the local switching railroad has reported that they prepare an average of one train per day of cargo other than containers for transport out of the San Pedro Bay Ports area. It has been assumed that a similar number of trains are inbound, and that the total number has an even split between both ports. Therefore, the number of trains

[49] CO_2 - Table A-43, page A-61, Annex 2 of the report entitled: *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009,* April 2011; CH_4 and N_2O - Table A-103, page A-129 in Annex 3 of the same report.

per year includes an average of one non-container train every other day in each direction (for an annual total of 365 additional trains for each port).

Table 6.5: On-Port Line Haul Locomotive Activity

Activity Measure	Inbound	Outbound	Totals
Number of trains/year	3,797	3,020	6,817
Number of locomotives/train	3	3	NA
Hours on Port/trip	1.0	2.5	NA
Locomotive hours/year	11,391	22,650	34,041

DB ID487

The average load factor for a typical line haul locomotive calling on the Port has been estimated by multiplying the percentage of full power in each throttle notch setting by the average percentage of line haul locomotive operating time in that setting, as summarized in Table 6.6. Both of these sets of percentages are EPA averages listed in the RSD documentation. This average load factor is probably overestimated because the throttle notch distribution is representative of nation-wide operation; including time traveling uphill when the higher notch positions are most often used. However, detailed throttle notch information has not been available to enable the development of an average on-port load factor.

Table 6.6: Estimated Average Load Factor

Notch	% of Full Power in Notch	% of Operating Time in Notch	% Full Power x % Time
DB	2.1%	12.5%	0.003
Idle	0.4%	38.0%	0.002
1	5.0%	6.5%	0.003
2	11.4%	6.5%	0.007
3	23.5%	5.2%	0.012
4	34.3%	4.4%	0.015
5	48.1%	3.8%	0.018
6	64.3%	3.9%	0.025
7	86.6%	3.0%	0.026
8	102.5%	16.2%	0.166
Average line haul locomotive load factor:			**28%**

To estimate the total number of horsepower-hours for the year, the estimated number of locomotive hours for the Port is multiplied by average locomotive horsepower and the average load factor discussed above:

Equation 6.4

34,041 locomotive hours/year x 4,000 horsepower/locomotive x 0.28

= 38.1 million horsepower-hours (rounded)

Emission estimates for on-port line haul locomotive activity have been calculated by multiplying this estimate of horsepower-hours by the emission factors listed in Tables 6.3 and 6.4 in terms of g/hp-hr.

Out-of-Port Line Haul Emissions

Line haul locomotive activity between the Port and the air basin boundary has been estimated through an evaluation of the amount of Port cargo transported by rail and of average or typical train characteristics such as number of containers and number of gross tons per train. In this way, estimates have been prepared of gross tonnage and fuel usage, similar to the methodology used for the previous Port emissions inventories.

Four components of locomotive activity have been estimated to develop the off-port emission estimates: number of trains, average weight of each train, distances traveled within the South Coast Air Basin, and amount of fuel used per ton-mile of train activity. Using the average train capacities discussed above (average 274 containers per train) and the two San Pedro Bay Ports' 2010 intermodal throughputs, the average number of port-related trains is estimated to be approximately 25 per day through the Alameda Corridor[50] including non-container trains discussed above. The gross weight (including locomotives, railcars, and freight) of a typical train is estimated to be 6,344 tons, using the assumptions in Table 6.7. The distance assumptions are 21 miles for the Alameda Corridor and 84 miles between the north end of the Alameda Corridor and the Air Basin boundary. The latter distance is a weighted average of the east and south routes taken by UP trains and the east route taken by most BNSF trains, weighted by the approximate percentage distribution of freight reported by the railroads for the 2008/2009 time period (the most recent available), as shown in Table 6.8.

[50] Overall Alameda Corridor traffic for 2010 was an average of 39 per day. This includes non-port-related traffic; See: *www.acta.org/PDF/CorridorTrainCounts.pdf.*

Gross ton-miles (in millions) have been calculated by multiplying together the number of trains, the gross weight per train, and the miles traveled, as summarized in Table 6.9. This table also shows the estimated total fuel usage, estimated by multiplying the gross tons by the average fuel consumption for the two line haul railroads. This average has been derived from information reported by the railroads to the U.S. Surface Transportation Board in an annual report known as the "R-1."[51] Among the details in this report are the total gallons of diesel fuel used in freight service and the total freight moved in thousand gross ton-miles. The total fuel reported by both railroads was divided by the total gross ton-miles to derive the average factor of 1.003 gallons of fuel per thousand gross ton-miles. The 2009 annual reports are the latest available so these reported values have been used as the basis of the 2010 fuel consumption factor. Also listed in Table 6.9 is the estimated total of out-of-port horsepower-hours, calculated by multiplying the fuel use by the fuel use conversion factor of 20.8 hp-hr/gal.

Table 6.7: Assumptions for Gross Weight of Trains

Train Component	Approximate Weight lbs	Weight tons (short)	Number per train	Weight tons (short)
Locomotive	420,000	210	4	840
Railcar (per double-stack platform)	40,000	20	130	2,600
Container		10.6	274	2,904
Total weight per train, gross tons				**6,344**

Table 6.8: Train Travel Distance Assumptions

	Miles	Approximate Percentage of Freight, 08/09	Miles x %
UP - LA east	84	15%	13
UP - LA south	91	28%	25
BNSF - LA east	82	56%	46
Weighted average distance			**84**

[51] *Class I Railroad Annual Report R-1 to the Surface Transportation Board for the Year Ending Dec. 31, 2009* (Union Pacific Railroad) and *Class I Railroad Annual Report R-1 to the Surface Transportation Board for the Year Ending Dec. 31, 2009* (BNSF Railway). Available at http://*www.stb.dot.gov/econdata.nsf/FinancialData?OpenView*

Table 6.9: Gross Ton-Mile, Fuel Use, and Horsepower-hour Estimate

	Distance miles	Trains per year	MMGT per year	MMGT-miles per year
Alameda Corridor	21	5,190	33	693
Central LA to Air Basin Boundary	84	5,190	33	2,772
Million gross ton-miles				**3,465**
Estimated gallons of fuel (millions)				**3.48**
Estimated million horsepower-hours				**72.5**

Emission estimates for out-of-port line haul locomotive activity have been calculated by multiplying this estimate of overall horsepower-hours by the emission factors in terms of g/hp-hr.

6.5.3 Improvements to Methodology from Previous Years

There were no methodology changes from the 2009 to the 2010 emissions inventories.

6.5.4 Future Improvements to Methodology

The Port expects to receive information from CARB on the Class 1 railroads' methods of complying with the MOU requiring an average of Tier 2 emissions in 2010 and later years. This information is expected to include the percentage of line haul locomotives in each tier level, the fleet mix, among locomotives arriving and departing the SoCAB; this will allow the emission estimates to reflect local conditions rather than EPA's nationwide fleet mix assumptions for the calendar year. The information may also include more specifics on the types of switching locomotives in use by the Class 1 railroads.

6.6 Emission Estimates

A summary of estimated emissions from locomotive operations related to the Port is presented below in Tables 6.10 and 6.11. These emissions include operations within the Port and Port-related emissions outside the Port out to the boundary of the South Coast Air Basin.

Table 6.10: Port-Related Locomotive Operations Estimated Emissions, tons per year

	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
Switching	2.0	1.8	2.0	78.6	0.1	20.9	5.1
Line Haul	28.0	25.5	28.0	917.3	7.3	155.7	48.7
Total	**30.0**	**27.3**	**30.0**	**995.9**	**7.4**	**176.6**	**53.8**

DB ID696

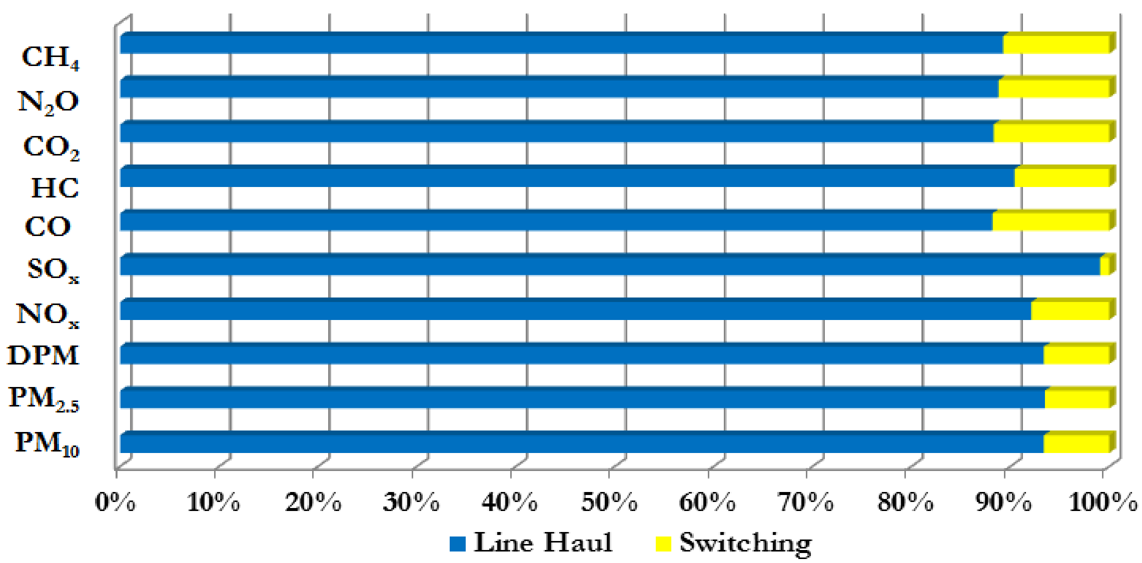
Table 6.11: GHG Port-Related Locomotive Operations Estimated Emissions, metric tons per year

	CO_2 Equivalents	CO_2	N_2O	CH_4
Switching	7,193	7,126	0.2	0.5
Line Haul	54,400	53,862	1.4	4.4
Total	**61,594**	**60,988**	**1.6**	**5.0**

DB ID696

Figure 6.6 depicts the distribution of emissions with line haul emissions accounting for roughly 87% to 99% of the total locomotive emissions.

Figure 6.6: Distribution of Locomotive Emissions by Category, %



SECTION 7 HEAVY-DUTY VEHICLES

This section presents emissions estimates for the heavy-duty vehicles source category, including source description (7.1), geographical delineation (7.2), data and information acquisition (7.3), operational profiles (7.4), emissions estimation methodology (7.5), and the emission estimates (7.6).

7.1 Source Description

Trucks are used extensively to move cargo, particularly containerized cargo, to and from the terminals that serve as the bridge between land and sea transportation. Trucks deliver cargo to local and national destinations, and they also transfer containers between terminals and off-port railcar loading facilities, an activity known as draying. In the course of their daily operations, trucks are driven onto and through the terminals, where they deliver and/or pick up cargo. They are also driven on the public roads within the Port boundaries, and on the public roads outside the Port.

This report deals primarily with diesel-fueled HDVs, as there were few gasoline-fueled or alternatively-fueled counterparts in use in 2010. Alternative fuel trucks, primarily those fueled by natural gas (LNG and CNG), made up approximately 6% of the truck fleet serving Port terminals and made approximately 7% of the terminal calls in 2009, based on fuel type information in the Port's Clean Trucks Program's Drayage Truck Registry. While these are still small percentages, the fuel type has been incorporated into the emission estimates presented in this inventory. This affects estimates of diesel particulate matter, which is not present in the exhaust of non-diesel trucks.

The most common configuration of HDV is the articulated tractor-trailer (truck and semi-trailer) having five axles, including the trailer axles. The most common type of trailer in the study area is the container trailer, built to accommodate standard-sized cargo containers. Additional trailer types include tankers, boxes, and flatbeds. A tractor traveling without an attached trailer is called a "bobtail" (no trailer load). A tractor pulling an unloaded container trailer chassis is known simply as a "chassis." These vehicles are all classified as heavy HDVs regardless of their actual weight because the classification is based on gross vehicle weight rating (GVWR), which is a rating of the vehicle's total carrying capacity. Therefore, the emission estimates do not distinguish among the different configurations.

As examples of typical HDVs, Figure 7.1 shows a typical container truck transporting a container in a terminal, and Figure 7.2 shows a bobtail.

Figure 7.1: Truck with Container

Figure 7.2: Bobtail Truck

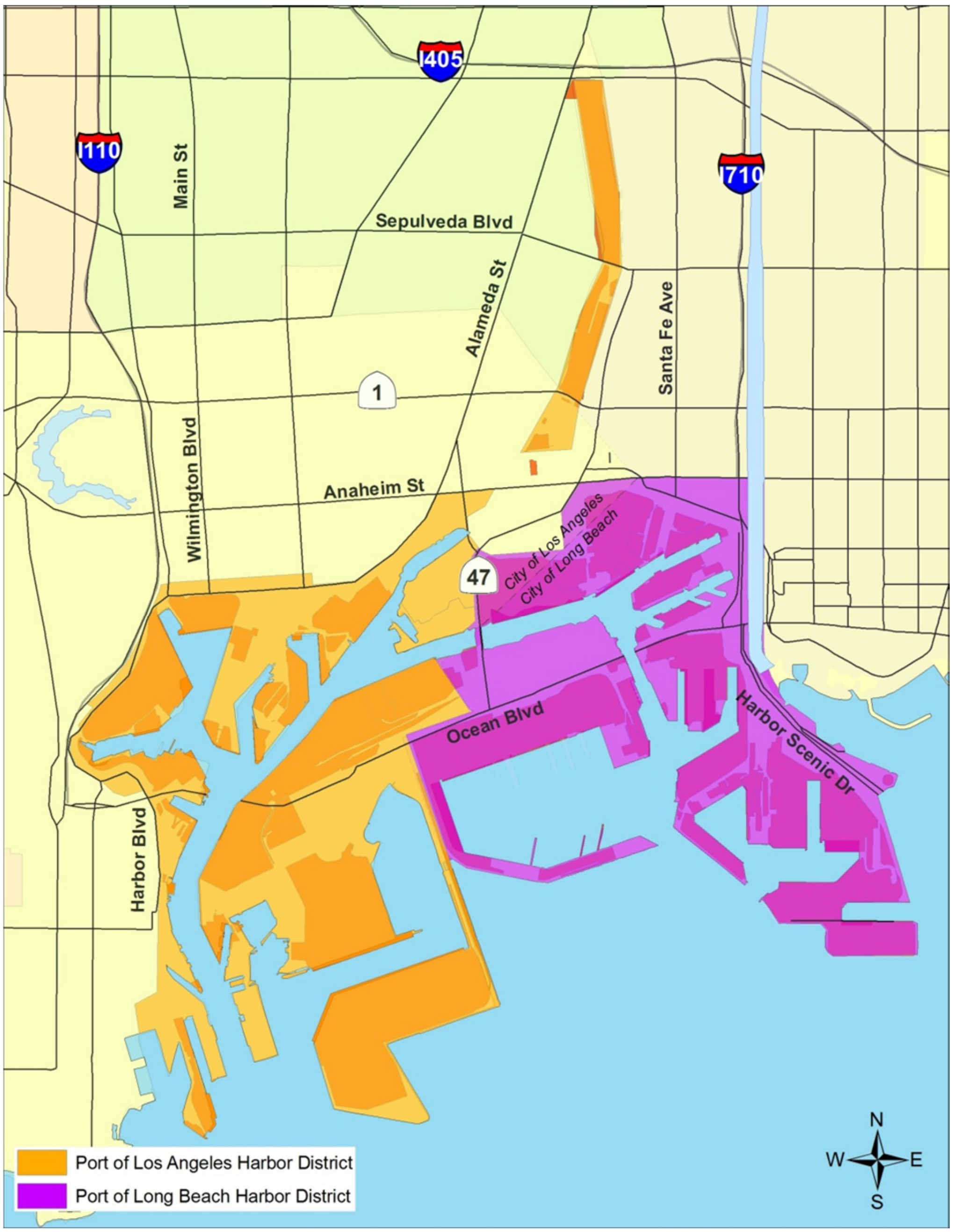
7.2 Geographical Delineation

To develop emission estimates, truck activities have been evaluated as having two components:

- On-terminal operations, which include waiting for terminal entry, transiting the terminal to drop off and/or pick up cargo, and departing the terminals.
- On-road operations, consisting of travel on public roads outside the terminals but within the SoCAB. This includes travel on public roads within the Port's boundaries.

Figure 7.3 shows the roadways in and around the Port that the HDVs use in daily operations. The figure presents the scope of a traffic study that evaluated traffic patterns in both the Port of Los Angeles and the Port of Long Beach. That traffic study and its use in developing the HDV emission estimates presented in this report are discussed in more detail in the following subsections.

Figure 7.3: Port and Near-Port Roadways



7.3 Data and Information Acquisition

Data for the HDV emission estimates came from two basic sources: terminal interviews and computer modeling of on-road HDV traffic volumes, distances, and speeds. These information sources are discussed below.

7.3.1 On-Terminal

The Port collected information regarding on-terminal truck activity during in-person and telephone interviews with terminal personnel. This information includes their gate operating schedules, on-terminal speeds, time and distance traveled on terminal while dropping off and/or picking up loads, and time spent idling at the entry and exit gates. Most terminals were able to provide estimates of these activity parameters, although few keep detailed records of information such as gate wait times and on-terminal turn-around time. However, the reported values appear to be reasonable and have been used in estimating on-terminal emissions, except as noted in the following text.

7.3.2 On-Road

The Port developed estimates of on-road truck activity inside and outside the Port. To do this, the port used trip generation and travel demand models that have been used in the previous Port emissions inventories to estimate the volumes (number of trucks) and average speeds on roadway segments between defined intersections.

The trip generation model is derived from a computer model designed to forecast truck volumes. The Port developed and validated the trip generation model using terminal gate traffic count data. The traffic study reported that the model validation confirmed that the model was able to predict truck movements to within two to ten percent of actual truck counts for all the container terminals combined, and to within 15 percent or better for the majority of individual terminals.[52] These were considered to be excellent validation results considering the variability of operating conditions and actual gate counts on any given day. The main input to the trip generation model for the current emissions inventory consists of the average daily container throughput in 2010.

[52] Meyer, Mohaddes Associates, Inc., *Ports of Long Beach/Los Angeles Transportation Study*, June 2001(MMA 2001) and Meyer, Mohaddes Associates, Inc., *Port of Los Angeles Baseline Transportation Study, (*April 2004).

The results of the trip generation model were used as input to a regional travel demand model used for transportation planning by the Southern California Association of Governments (SCAG), the federally designated Metropolitan Planning Organization for the SoCAB area. The terminal-specific truck travel information from the trip generation model, as well as the results of an origin/destination survey of approximately 3,300 Port-area truck drivers, were input to the Port-area travel demand model to predict truck travel patterns and estimate the number of trucks traveling over roadways in the region. The intent was to model Port-related trucks on their way from the Port until they make their first stop, whether for delivery of a container to a customer or to a transloading facility, or to the boundary of the South Coast Air Basin.

The travel demand model produces estimates of the number of trucks and their average speed in each direction over defined roadway segments, along with the length of each roadway segment. A brief example illustrating the data is provided in Table 7.1. The number of trucks and the distances are multiplied for each segment and summed to produce estimates of vehicle miles of travel (VMT). In addition, a VMT-weighted average speed has been calculated that takes into account how many miles were driven at each speed; these VMT and speed estimates have been used with the speed-specific EMFAC emission factors (discussed below) to estimate on-road driving emissions.

Table 7.1: On-Road HDV Activity Modeling Results – Example

Distance (miles)	Volume Dir 1 (# trucks)	Volume Dir 2 (# trucks)	Speed Dir 1 (mph)	Speed Dir 2 (mph)
0.71	4	2	50	48
0.12	19	12	33	32
0.36	1	3	35	35
0.01	4	5	40	40
0.55	1	2	62	60
1.87	1	3	62	60
0.45	12	9	47	46
0.26	12	10	26	25

7.4 Operational Profiles

The activity profiles for on-terminal and on-road truck traffic presented below have been based on the modeling data and terminal information collected as described above.

7.4.1 On-Terminal

Table 7.2 illustrates the range and average of reported characteristics of on-terminal truck activities at Port container terminals, while Table 7.3 shows the same summary data for the terminals and facilities other than container terminals. The total number of trips in each table is based on the trip generation model described above.

Table 7.2: Summary of Reported Container Terminal Operating Characteristics

	Speed (mph)	Distance (miles)	No. Trips (per year)	Gate In (hours)	Unload/ Load (hours)	Gate Out (hours)
Maximum	15	1.5	na	0.17	0.39	0.15
Minimum	10	0.9	na	0.00	0.15	0.00
Average	13	1.3	na	0.09	0.27	0.04
Total			**3,599,550**			

Table 7.3: Summary of Reported Non-Container Facility Operating Characteristics

	Speed (mph)	Distance (miles)	No. Trips (per year)	Gate In (hours)	Unload/ Load (hours)	Gate Out (hours)
Maximum	20	1.3	na	0.08	0.37	0.05
Minimum	0	0.0	na	0.00	0.00	0.00
Average	7	0.4	na	0.03	0.09	0.01
Total			**1,232,947**			

Table 7.4 provides more detail on the on-terminal operating parameters, listing total estimated miles traveled and hour of idling on-terminal and waiting at entry gates. Terminals are listed by type.

Table 7.4: Estimated VMT and Idling Hours by Terminal

Terminal Type	Total Miles Traveled	Total Hours Idling (all trips)
Container	934,875	155,813
Container	1,322,325	334,989
Container	366,255	191,267
Container	548,400	224,844
Container	1,067,850	298,998
Container	641,250	192,375
Other	188,369	27,531
Other	273,991	40,045
Other	67,600	8,320
Other	0	0
Dry Bulk	1,250	375
Break Bulk	200	300
Auto	1,463	995
Liquid	0	0
Break Bulk	26,554	5,975
Liquid	18	0
Dry Bulk	2,600	832
Break Bulk	6,250	4,000
Other	520	910
Other	60	480
Other	10,140	1,352
Other	661,877	297,845
Liquid	4,543	545
Total	**6,126,389**	**1,787,789**

7.4.2 On-Road

Figure 7.4 provides a regional map of the major area roadways. The daily traffic estimates are based on average week-day activity during an average month over these roads and on the regional network of smaller, local roads. The daily activities have been annualized for the emission estimates presented in this inventory on the basis of 300 days of terminal operation per year.

Figure 7.4: Regional Map

7.5 Methodology

This section discusses how the emission estimates have been developed based on the data collected from terminals or developed by traffic modeling. The speed-specific gram-per-mile emission rates estimated from CARB's EMFAC 2007 model were used in support of the analysis of driving emissions. However, CARB's published idle emission rates[53], rather than the modeled output, were used for gate and on-terminal idling periods because EMFAC does not directly output the information needed to calculate gram-per-hour emission rates associated with engine idling operation.

The general form of the equation for estimating the emissions inventory for a fleet of on-road vehicles is:

Equation 7.1

Emissions = Population x Basic Emission Rate x Activity x Correction Factors

Where:

Population = number of vehicles of a particular model year in the fleet
Basic Emission Rate = amount of pollutants emitted per unit of activity for vehicles of that model year
Activity = the average number of miles driven per truck, hours of idle operation
Correction Factors = adjustment to Basic Emission Rate for specific assumptions of activity and/or atmospheric conditions

53 See Table 11 in:
http://www.arb.ca.gov/msei/onroad/techmemo/revised_hhddt_emission_factors_and_speed_corr_factors.pdf;

The basic emission rate is modeled as a constant value (over time) with a "zero mile rate" (ZMR) or intercept representing the emissions of the vehicle when new or like-new (well maintained and un-tampered), plus a "deterioration rate" (DR) or slope representing the gradual increase in the emission rate over time as a function of use (the engine's cumulative mileage). For heavy-duty trucks the deterioration rate is expressed as grams per mile traveled per 10,000 accumulated miles (g/mi/10k mi).

Equation 7.2

$$\textit{Basic Emission Rate} = ZMR + (DR \times \textit{Cumulative Mileage} / 10{,}000)$$

In estimating the emissions from heavy-duty trucks, two types of activity have been considered: running emissions that occur when the engine is running with the vehicle moving at a given speed, and idle emissions that occur when the engine is running but the vehicle is at rest. Running emissions are expressed in grams per mile (g/mi), while idle emissions are expressed in grams per hour (g/hr). The emission factors (g/mi or g/hr) have been multiplied by the activity estimates, total VMT or total hours of idle operation, to derive a gram per day (g/day) or gram per year inventory (converted in this report to tons per year).

7.5.1 The EMFAC Model

The CARB has developed a computer model to calculate the fleet emissions inventories of various vehicle classes in the California fleet. EMFAC 2007, the latest official version of the model, has been approved by the EPA for use in California and this model, with noted exceptions, has been used to estimate the emissions from heavy-heavy-duty diesel trucks that called on the Port's terminals in 2010.

The EMFAC model produces ton-per-day estimates of emissions by vehicle class and model year; however, it is generally a macro-scale model that is inappropriate for directly estimating inventories at a sub-county level, such as for the fleet of trucks serving the Port. In order to calculate the inventory of emissions for Port-related heavy-duty trucks, by-model-year emission factors derived from EMFAC have been coupled with the Port-specific truck model year distribution and VMT estimates, as described below following a general description of the EMFAC model.

7.5.2 Basic Emission Rates

The basic emission rates of heavy-duty diesel trucks included in EMFAC are derived from tests of vehicles that CARB randomly selected from the in-use fleet. Because CARB has imposed progressively more stringent standards on the allowable emissions from trucks over many years, different model years of trucks have been certified to specific standards and, therefore, are assumed to emit at different rates. Table 7.5 lists the basic emission rates used by EMFAC to develop the model year-specific emission factors. The factors are applicable to the model year ranges indicated in the left-most column.

Table 7.5: Emission Factors in EMFAC 2007

Model Years	HC		CO		NO_x		PM		CO_2	
	ZMR	DR	ZMR	DR	ZMR	DR	ZMR	DR	ZMR	DR
	g/mi	g/mi/ 10k mi	g/mi	g/mi/ 10k mi	g/mi	g/mi/ 10k mi	g/mi	g/mi/ 10k mi	g/mi	g/mi/ 10k mi
Pre-87	1.20	0.027	7.71	0.176	23.0	0.019	1.73	0.028	2237	0.00
1987-90	0.94	0.032	6.06	0.209	22.7	0.026	1.88	0.025	2237	0.00
1991-93	0.62	0.021	2.64	0.090	19.6	0.039	0.78	0.014	2237	0.00
1994-97	0.46	0.024	1.95	0.103	19.3	0.046	0.51	0.011	2237	0.00
1998-02	0.47	0.024	1.99	0.103	18.9	0.053	0.56	0.010	2237	0.00
2003-06	0.30	0.011	0.87	0.031	12.5	0.052	0.35	0.005	2237	0.00
2007-09	0.26	0.008	0.74	0.022	6.84	0.047	0.035	0.001	2237	0.00
2010+	0.21	0.004	0.61	0.012	1.14	0.041	0.035	0.001	2237	0.00

CARB's "low idle" emission rates have been used in developing the emissions inventory for the Port. CARB also uses "high idle " rates in modeling HDV emissions but these are intended to "reflect activity associated with truck stops, rest areas, and distribution centers" whereas the low idle rates are "indicative of a truck in queue to either pick up or drop off a shipment."[54] The low idle emission factors are presented in Table 7.6.

Table 7.6: Idle Emission Rates (g/hr)

Model Years	HC	CO	NO_x	PM	CO_2
Pre-1987	25.9	28.4	45.7	4.76	4,640
1987-90	15.2	23.4	70.2	2.38	4,640
1991-93	12.1	21.5	78.4	1.78	4,640
1994-97	9.68	19.8	85.3	1.33	4,640
1998-02	7.26	17.8	92.1	0.92	4,640
2003-06	5.97	16.6	95.5	0.72	4,640
2007+	5.97	16.5	95.5	0.072	4,640

[54] See CARB's explanation at *http://www.arb.ca.gov/msei/onroad/latest_revisions.htm#hhddt_idle*

A more in-depth explanation of CARB's heavy-duty diesel inventory estimation methodology can be found in their document "*Revision of Heavy Heavy-Duty Diesel Truck Emission Factors and Speed Correction Factors*" 3 April 2006.[55]

Because the EMFAC model does not produce emission factors for N_2O or speed-specific emission factors for SO_x, gram-per-mile emission factors for these emissions have been developed using a mass balance approach for SO_x and a gram-per-gallon emission factor from CARB for N_2O. The following equation has been used to derive the SO_x emission factor.

Equation 7.3

$$SO_x \text{ emissions (g/mile)} = \frac{(X\text{ g S}/1{,}000{,}000\text{ g fuel}) \times (3{,}220\text{ g/gallon}) \times (2\text{ g }SO_x/\text{g S})}{(5.29\text{ miles/gallon})}$$

The emission calculations are based on 15 ppm ULSD diesel fuel. The weight of a gallon of diesel fuel is assumed to be 7.1 pounds or 3,220 grams (7.1 lbs x 453.59 g/lb). Based on the EMFAC model, the 2010 fleet average fuel economy of the heavy-heavy duty diesel fleet has been calculated to be 5.29 miles per gallon.

The N_2O emission factor has been calculated using the following equation:

Equation 7.4

$$N_2O \text{ emissions (g/mile)} = \frac{(X\text{ g }N_2O/\text{gallon})}{(5.29\text{ miles/gallon})}$$

7.5.3 Mileage Accrual Rates/Cumulative Mileage

Since no data were available to estimate the actual mileage of each truck visiting the Port, the mileage accrual rates are estimates of the miles traveled each year by vehicles of a specific age and type of vehicle. Mileage accrual rates estimated by CARB are highest for new trucks and tend to decline with increasing truck age, reflecting a decrease in the usage of trucks as they age and become less reliable. CARB, during their December 2010 board hearing[56] related to amendments to the Regulation for In-Use Off-Road Diesel Fueled Fleets (the off-road regulation) and the In-Use Heavy-Duty Diesel-Fueled Vehicles Regulation (the truck and bus regulation), established accrual rates specific to port-related trucks that are lower than the accrual rates applied to heavy-duty trucks in general, because CARB found that port-related trucks in general travel fewer miles per year than other types of trucks, such as over-the-road trucks that may travel great distances with each trip. In addition, CARB capped the deterioration rate used in the EMFAC modeling once the trucks accrue 800,000 miles.

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55 See: *http://www.arb.ca.gov/msei/supportdocs.html#onroad.*(CARB 2006)

56 *http://www.arb.ca.gov/regact/2010/truckbus10/truckbus10.htm*

The mileage accrual rates used in this analysis are shown in Table 7.7.

Table 7.7: Mileage Accrual Rates Used in EMFAC to Determine HDV Deterioration Rates

Truck Age (years)	Truck Model Year	Mileage Accrual	Cumulative Miles
1	2010	76,909	76,909
2	2009	76,908	153,817
3	2008	76,003	229,820
4	2007	80,882	310,702
5	2006	84,426	395,128
6	2005	93,859	488,987
7	2004	69,052	558,039
8	2003	57,802	615,841
9	2002	53,651	669,492
10	2001	49,792	719,284
11	2000	46,304	765,588
12	1999	34,412	800,000
13 and older	1998 and earlier	1*	800,001

*For EMFAC modeling purposes accrual for trucks 13 yrs and older is set at 1

The cumulative mileage of a vehicle is assumed to be the sum of its mileage accrual rates. That is, for a three-year-old truck, for example, the average odometer reading would be assumed to be 229,820 miles, or 76,909 + 76,908 + 76,003. In turn, the cumulative mileage is used to assess the level of deterioration to be added to the basic emission rate (see above).

In keeping with our example of a three-year-old truck in 2010 (MY 2008), the basic emission rate for NO_x would be calculated by the model as follows:

Equation 7.5

6.84 g/mi (ZMR) + [0.047 g/mi/10K miles (DR) x 229,820 miles (Cumulative Mileage)] = 7.92 g/mi

It should be noted that CARB's accrual rates and corresponding cumulative mileage by age were only used to run EMFAC and obtain exhaust emissions rates in grams per mile by model year and by speed. Emissions in tons were estimated by multiplying emission rates with VMT by speed obtained from the travel demand model mentioned in section 7.3.2.

7.5.4 Correction Factors

As noted earlier, the EMFAC model uses correction factors to adjust the basic emission rates to reflect vehicle specific activity such as speed, as well as type and quality of fuel burned, and specific ambient conditions such as temperature and relative humidity (RH).

Fuel correction factors are applied to adjust for differences between the fuel used during certification or in-use testing (before the introduction of clean diesel fuel) and the fuel used in current operation.[57] CARB diesel has a lower sulfur and aromatic hydrocarbon content compared to pre-clean diesel. According to CARB's memo cited above, entitled "*On-Road Emissions Inventory Fuel Correction Factors*," a 28 percent reduction in HC, seven percent reduction in NO_x and a 25 percent reduction in PM should be applied to the basic emission rates to reflect the benefits of CARB diesel. The model applies fuel correction factors as multiplicative modifiers to the basic emission rates. That is, a 25 percent reduction would yield a correction factor of 0.75. Table 7.8 lists the diesel fuel correction factors.

Table 7.8: CARB Diesel Fuel Correction Factors

Pollutant	Fuel Correction Factor
HC	0.72
CO	1.0
NO_x	0.93
PM	0.75

Vehicle speed is used as a surrogate for the work performed by the engine (its load), and emissions tend to increase or decrease as load increases or decreases. The basic emission rates are derived from testing vehicles over a reference cycle with a single average speed of about 20 miles per hour (the Urban Dynamometer Driving Schedule or UDDS). Speed correction factors adjust the basic emission rates for cycles or trips of differing speeds.

As running emissions are expressed in terms of grams per mile, the speed correction factors tend to be higher at the extremes of speed. At high speeds, the vehicle's engine has to work harder to overcome wind resistance and emissions tend to increase as a consequence. At low speeds, the vehicle has to overcome inertia and rolling resistance. Although emissions tend to be lower at lower speeds, as the speed approaches zero the grams/mile ratio increases. The result is a generally a "U" shaped curve describing the impact of speed on emissions.

[57] CARB, *On-Road Emissions Inventory Fuel Correction Factors*, July 2005. *www.arb.ca.gov/msei/supportdocs.htm#onroad*

The equation and coefficients used to derive the speed correction factors included in EMFAC 2007 are described in CARB documentation.[58]

Equation 7.6

$$\textbf{Speed Correction Factor} = A + (B \times Speed) + (C \times Speed^2)$$

Table 7.9 lists the speed correction factor coefficients used for HC, CO, NO_x, and PM (PM_{10}, $PM_{2.5}$, and DPM).

Table 7.9: CARB Speed Correction Factor Coefficients

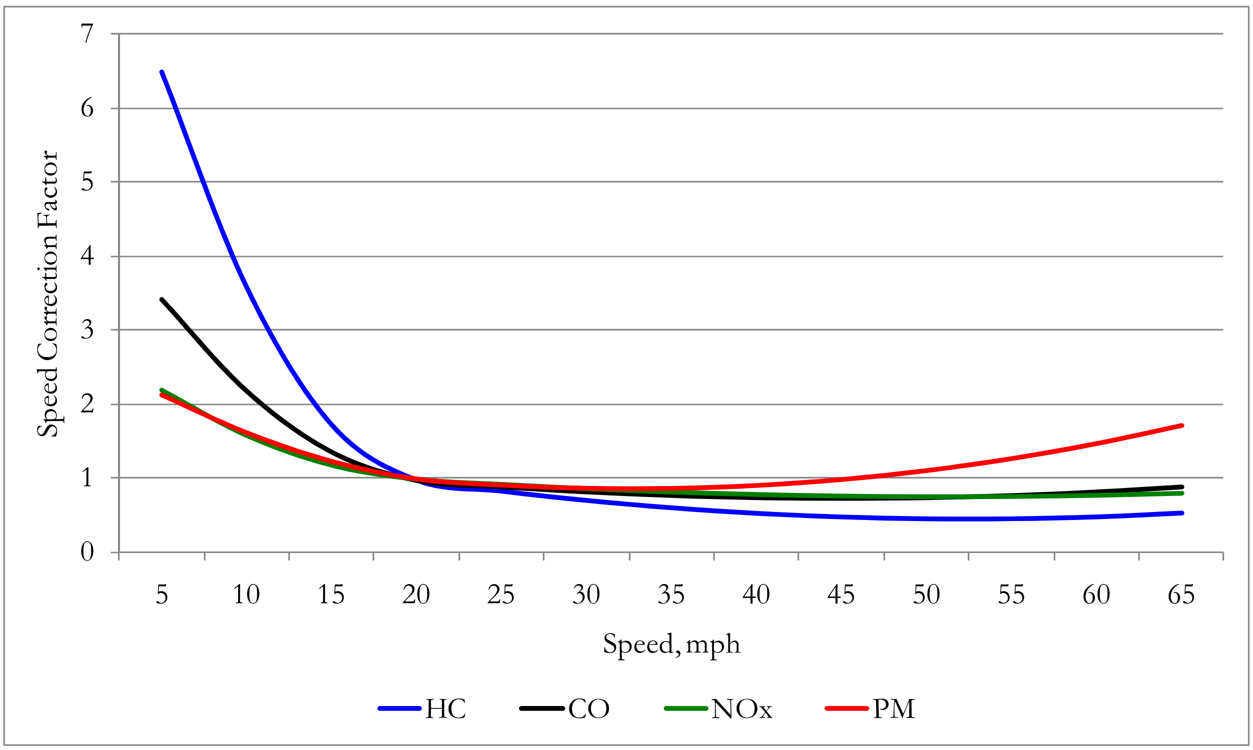
Pollutant	Model Year Group	Speed Range	A	B	C
HC	Pre-1991	5.00 - 18.8	7.1195	-0.4789	0.008159
		18.8 - 65.0	1.6373	-0.04189	0.0003884
	1991-2002	5.00 - 18.8	11.614	-0.9929	0.02278
		18.8 - 65.0	2.3019	-0.08712	0.0009773
	2003+	5.00 - 18.8	10.219	-0.8937	0.02146
		18.8 - 65.0	1.6053	-0.03799	0.0002985
CO	Pre-1991	5.00 - 65.0	1.6531	-0.04198	0.0003352
	1991-2002	5.00 - 18.8	3.0388	-0.1511	0.002267
		18.8 - 65.0	1.8753	-0.05664	0.0005141
	2003+	5.00 - 18.8	6.2796	-0.5021	0.01177
		18.8 - 65.0	1.3272	-0.02463	0.000336
NO_x	Pre-1991	5.00 - 18.8	2.2973	-0.1173	0.002571
		18.8 - 65.0	1.3969	-0.02658	0.0002725
	1991-2002	5.00 - 18.8	3.7668	-0.2862	0.007394
		18.8 - 65.0	1.0771	-0.005981	0.00009271
	2003+	5.00 - 18.8	2.7362	-0.148	0.002958
		18.8 - 65.0	1.5116	-0.03357	0.0003118
PM	Pre-1991	5.00 - 18.8	2.6039	-0.1266	0.002198
		18.8 - 65.0	1.4902	-0.03121	0.0002733
	1991-2002	5.00 - 18.8	5.7807	-0.4032	0.007918
		18.8 - 65.0	2.2766	-0.08661	0.0009948
	2003+	5.00 - 18.8	1.4086	-0.02313	0.00007449
		18.8 - 65.0	1.4881	-0.0408	0.0007894

[58] Amendment to EMFAC Modeling Change Technical Memo, *Revision of Heavy Heavy-duty Diesel Truck Emission factors and Speed Correction Factors*, 20 October 2006.

The EMFAC model uses these speed correction factors to derive the speed specific emission factors for each pollutant at 5 mile-per-hour increments for use in this analysis. The model does this by deriving the model year and pollutant specific speed correction factors and then weighting each factor by the population of trucks in each model year group. Figure 7.5 illustrates the differences in fleet weighted speed correction factors with speed, for each pollutant.

The output from the model is a table of emission estimates by model year and speed. This output is processed to develop a set of model year-weighted composite emission factors, for speeds from 5 to 65 mph, reflecting the model year distribution of the trucks calling at Port terminals over the year. The model year distribution and development of the composite emission factors are discussed in the following two subsections.

Figure 7.5: Fleet Weighted Speed Correction Factors



7.5.5 Model Year Distribution

Because vehicle emissions vary according to the vehicle's model year and age, the activity level of trucks in each model year is an important part of developing emission estimates. As a routine component of the annual emissions inventory updates, optical character recognition (OCR) license plate data have been collected from container terminal operators over the course of each year in order to determine the distribution of model years (count of vehicles and number of terminal calls by model year) of trucks calling upon the Port. Most terminals collect this information as part of their terminal operating routine, and those that do collect the information provide the records, consisting primarily of license plate numbers with date/time stamps, to the Port.

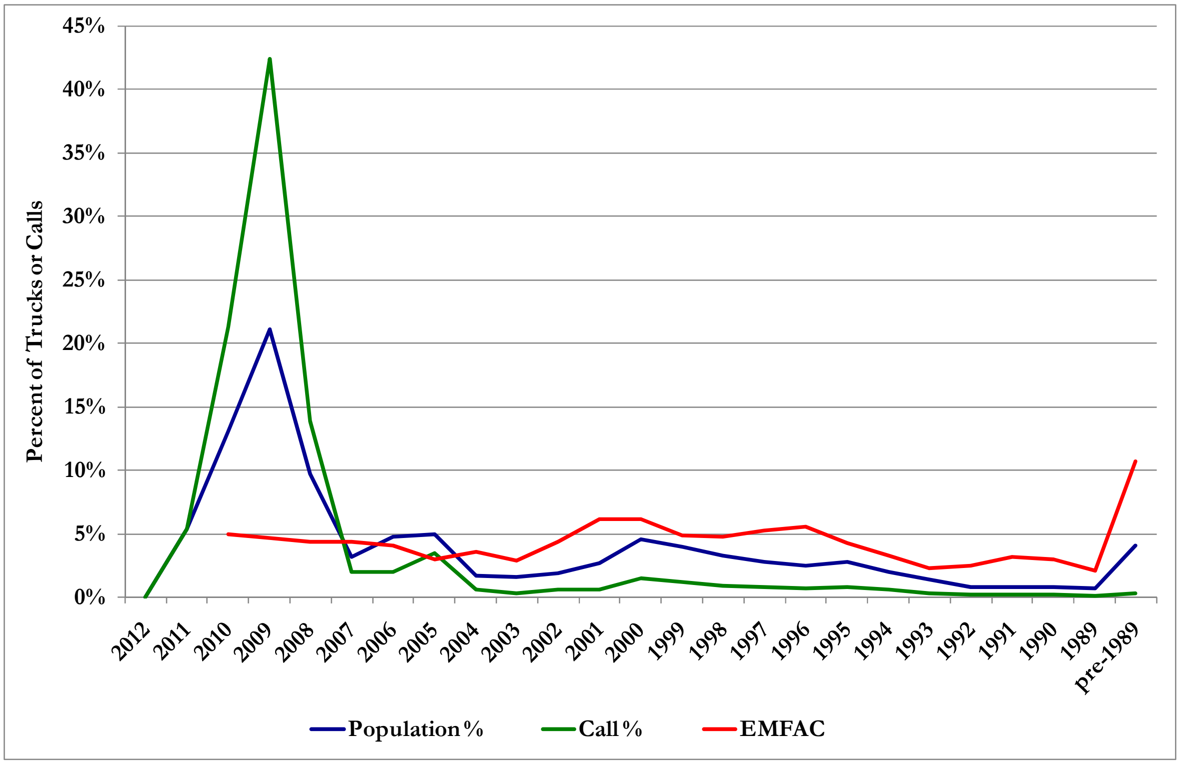
Approximately 4.37 million OCR readings were collected from nine different terminals of the Port of Los Angeles and the Port of Long Beach during the period spanning January 1 through December 31, 2010. These readings were processed to eliminate duplicate plate numbers and records that identify vehicles exiting the terminals, to minimize double counting of trips. The records were also screened to remove special characters, state suffixes (i.e., CA, NV, etc.), character strings that were obviously not license plate numbers (e.g., "NO OCR", "-----", etc.), and records that were less than six digits in length. This process left approximately 75,773 unique license plate numbers for which registration information was sought from the California Department of Motor Vehicles (DMV).

The DMV returned a total of approximately 81,909 records; many of these were "no match" returns, meaning the number that was submitted was not a valid license plate number format and/or did not match any numbers in the DMV's database. Removing these invalid records left approximately 24,031 records with vehicle identification numbers (VINs) and vehicle model year information. The matching DMV files also include a body type model (BTM) field, which was used to distinguish trucks from other types of vehicles captured by the OCR systems. Vehicles designated with a BTM of DS (diesel tractor truck), TB (tilt cab tractor), TL (tilt tandem tractor), TM (tandem axle tractor), TRAC and TRACTOR (tractors) were included in the analysis. When these were matched back to the OCR call records, a total of 15,483 unique trucks were identified, with a model year range from 1945 to a single 2012 model year truck.

The valid truck license plate numbers were then matched against the original OCR readings and further cleaned by eliminating occurrences of identical plate readings within ten minutes of each other, which are likely to be duplicate readings related to the same entry event. This matching process resulted in 3.22 million terminal calls matched to a known license plate number and truck model year. These matched calls were used to develop a call-weighted model year distribution, the percentage of terminal calls made up by each model year. The results show that the overwhelming majority of calls (over 90%) were attributable to 2005 model year and newer trucks.

The distribution of truck model years by population and by calls is presented in Figure 7.6 below, in comparison to the default distribution contained in the EMFAC model. The 2010 call-weighted average age of the Port-related fleet is 2.2 years, while the population weighted average age of the Port-related fleet was determined to be 6.2 years, newer than the EMFAC estimate of heavy-duty diesel trucks in operation within the SoCAB of 11.6 years.

Figure 7.6: Model Year Distribution of the Heavy-Duty Truck Fleet



The prominent spike at the left of the figure is composed of model year 2009 vehicles, which became the predominant model year truck over the course of 2009, a trend that continued over 2010. While the distributions shown above are of the vehicles' model years, it is known that some percentage of trucks are equipped with an engine that is a model year older – for example, a 2010 model year truck may be equipped with an engine that was built in 2009 and is certified to the 2009 emission standards rather than the 2010 standards. The EMFAC model takes this into account using information obtained by CARB during their rulemaking for the heavy-duty diesel engine software upgrade requirements (chip reflashing).[59] However, the portion of trucks fitted with a model year older engine may be more prevalent for the 2010 model year than the data gathered by CARB during the chip reflashing rulemaking may indicate.

[59] Email correspondence from Kathy Jaw, Manager, Truck and Goods Movement Analysis Section, Air Resources Board (22 July 2011) and subsequent follow-up conversation between Kathy Jaw and Archana Agrawal, Starcrest (25 July 2011).

The Port recognizes that the presence of 2009 engines in some percentage of the 2010 trucks in the fleet serving the Port may result in actual fleet emissions, particularly of NO_x, being higher than the EMFAC model results indicate because of the difference between the 2009 and 2010 NO_x standards. The effect is strengthened in the 2010 inventory because the model year distribution in 2010 was concentrated at the newer end of the model year spectrum (90% of trips were made by 2005 or newer trucks) and 2010 model year trucks made up 21% of the trips. In the years prior to the Clean Truck Program's implementation, the model year distribution was biased toward the older trucks (model years in the 1990s) so any similar effect on previous years' inventories by new model year trucks would have been insignificant. The actual difference in estimated emissions would depend on the prevalence of 2009 model year engines in the 2010 (or newer) truck population. The Port plans to investigate this prevalence during 2011 with the aim of improving the accuracy of future inventories.

7.5.6 Speed-Specific Emission Factors

The EMFAC 2007 model was run for the SoCAB for the 2010 calendar year assuming annual average atmospheric conditions, and the output option was selected to provide model year specific emission rates in tons per day by pollutant at five mile-per-hour intervals of speed (5 mph to 70 mph). The ton-per-day outputs have been converted to gram-per-mile emission rates by converting tons to grams and then dividing the resulting grams by the speed specific daily VMT that underlies the ton-per-day outputs and is also output from the model. The model year and speed specific gram-per-mile emission rates were then weighted to reflect the distribution of truck calls by model year within the fleet of trucks calling at Port terminals, using the call-weighted distribution discussed in the previous subsection. A single set of pollutant specific gram-per-hour idle emission rates has also been derived using the distribution of truck calls by model year.

Emissions of SO_x and N_2O have been estimated on an average gram-per-mile basis, based on the average fuel economy of the heavy-heavy duty diesel fleet calculated from the EMFAC output; idling emission rates have been based on an average fuel consumption rate of 0.45 gallons of diesel per hour during idling, derived from an analysis of tests performed by the Coordinating Research Council (CRC).[60] Tables 7.10 and 7.11 summarize the speed-specific emission factors developed as described above and used to estimate emissions. The units are in grams per mile, except for the idle emission factors (0 mph) which are in grams per hour.

[60] CRC, E55-59, *http://www.crcao.com/*

Table 7.10: Speed-Specific Emission Factors, grams/mile

Speed Range (mph)	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_2	CO	HC	Units
0 (Idle)	0.22	0.20	0.20	94.76	0.042	16.82	6.24	g/hr
1 - 5	0.46	0.42	0.43	16.79	0.018	6.26	2.79	g/mile
6 - 10	0.39	0.35	0.36	14.31	0.018	5.09	2.10	g/mile
11 - 15	0.27	0.24	0.25	10.41	0.018	3.28	1.07	g/mile
16 - 20	0.18	0.17	0.17	8.09	0.018	2.16	0.50	g/mile
21 - 25	0.15	0.14	0.14	7.21	0.018	1.79	0.37	g/mile
26 - 30	0.13	0.12	0.12	6.68	0.018	1.60	0.31	g/mile
31 - 35	0.12	0.11	0.11	6.25	0.018	1.46	0.26	g/mile
36 - 40	0.12	0.11	0.11	5.90	0.018	1.35	0.23	g/mile
41 - 45	0.12	0.11	0.11	5.66	0.018	1.29	0.20	g/mile
46 - 50	0.13	0.12	0.12	5.53	0.018	1.26	0.19	g/mile
51 - 55	0.15	0.14	0.14	5.49	0.018	1.28	0.18	g/mile
56 - 60	0.17	0.16	0.16	5.56	0.018	1.34	0.19	g/mile
61 - 65	0.20	0.19	0.19	5.74	0.018	1.44	0.21	g/mile
66 - 70	0.24	0.22	0.23	6.02	0.018	1.58	0.24	g/mile

Table 7.11: Speed-Specific GHG Emission Factors, grams/mile

Speed Range (mph)	CO_2	N_2O	CH_4	Units
0 (Idle)	4,640	0.037	0.183	g/hr
1 - 5	3,845	0.015	0.125	g/mile
6 - 10	3,492	0.015	0.094	g/mile
11 - 15	2,867	0.015	0.048	g/mile
16 - 20	2,353	0.015	0.022	g/mile
21 - 25	2,110	0.015	0.017	g/mile
26 - 30	1,981	0.015	0.015	g/mile
31 - 35	1,873	0.015	0.013	g/mile
36 - 40	1,788	0.015	0.011	g/mile
41 - 45	1,724	0.015	0.009	g/mile
46 - 50	1,683	0.015	0.009	g/mile
51 - 55	1,664	0.015	0.008	g/mile
56 - 60	1,666	0.015	0.008	g/mile
61 - 65	1,691	0.015	0.009	g/mile
66 - 70	1,738	0.015	0.010	g/mile

The emission factors presented above have been multiplied by the on-road and on-terminal VMT and on-terminal idling hours to develop the overall on-road and on-terminal emissions presented below in subsection 7.6, Emission Estimates.

7.5.7 Improvements to Methodology from Previous Years

The following improvements to the emissions calculation methodology were made in this inventory compared to the 2009 EI methodology. Refer to Section 9 for a comparison of 2010 emissions with previous years' emissions.

- The EMFAC modeling incorporated new mileage accrual rates developed by CARB that are specific to port-related drayage trucks. CARB developed the revised accrual rates to better reflect the actual mileage accrual of port-related drayage trucks; the effect has been a more accurate estimate of the trucks' emissions deterioration as a function of age.

- Emissions from the increasing number of LNG-fueled trucks have been factored into the 2010 emission estimates. While the EMFAC model does not yet estimate emissions from these alternatively fueled trucks, a method was developed to account for the difference in emissions of DPM (which trucks burning natural gas do not emit). While other pollutants may be emitted at different rates, the adjustment has been focused on DPM as a pollutant of particular concern. Briefly, the method assumes zero DPM is emitted from trucks that burn solely LNG, and trucks that burn a small amount of diesel along with LNG are assumed to emit DPM at 10% of their PM_{10} emission rates. An adjustment factor has been developed to convert the overall model year-composite PM_{10} emission factors (by speed range) to DPM, as a replacement for the previous practice of setting the DPM emission factors equal to the PM_{10} factors (because all PM_{10} emissions from diesel engines is classified as DPM).

7.5.8 Future Improvements to Methodology

As part of the San Pedro Bay Ports' Clean Truck Programs, the container terminals have been collecting truck entry data using radio frequency identification (RFID) technology. This data is collected and correlated with truck-specific information contained in the Drayage Truck Registry (DTR) that has also been established as part of the truck programs. The RFID/DTR data may supplement or in some ways replace the OCR/DMV data in evaluating the model year distribution of future Port-related fleets. Additionally, as stated earlier in this section, the Ports will look further into the prevalence of engine year being one year older than the truck model year

7.6 Emission Estimates

The estimates of 2010 HDV emissions are presented in this section. As discussed above, on-terminal emissions are based on terminal-specific information such as number of trucks passing through the terminal and the distance they travel on-terminal, and the Port-wide totals are the sum of the terminal-specific estimates. The on-road emissions have been estimated for Port trucks using travel demand model results to estimate how many trucks travel along defined roadways in the SoCAB on the way to their first cargo drop-off point. The on-terminal estimates include the sum of driving and idling emissions calculated separately. The on-road estimates include idling emissions as a normal part of the driving cycle. This is a valid approach because the average speeds include estimates of normal traffic idling times and the emission factors are designed to take this into account.

Emission estimates for HDV activity associated with Port terminals and other facilities are presented in the following tables. Tables 7.12 and 7.13 summarize emissions from HDVs associated with all Port terminals.

Table 7.12: Summary of HDV Emissions, tons per year

Activity Location	VMT	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
On-Terminal	6,126,389	3	2	2	268	0	60	22
On-Road	192,403,939	27	25	25	1,255	4	292	49
Total	**198,530,329**	**30**	**27**	**28**	**1,523**	**4**	**352**	**71**

Table 7.13: Summary of HDV GHG Emissions, metric tons per year

Activity Location	VMT	CO_2 Equivalent	CO_2	N_2O	CH_4
On-Terminal	6,126,389	27,421	27,357	0	1
On-Road	192,403,939	345,088	344,148	3	2
Total	**198,530,329**	**372,509**	**371,505**	**3**	**3**

Tables 7.14 and 7.15 show emissions associated with container terminal activity separately from emissions associated with other Port terminals and facilities.

Table 7.14: Summary of HDV Emissions Associated with Container Terminals, tons per year

Activity Location	VMT	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
On-Terminal	4,880,955	2	2	2	210	0	47	18
On-Road	178,335,140	25	23	24	1,164	4	270	45
Total	**183,216,095**	**27**	**25**	**26**	**1,374**	**4**	**318**	**63**

Table 7.15: Summary of HDV GHG Emissions Associated with Container Terminals, metric tons per year

Activity Location	VMT	CO_2 Equivalent	CO_2	N_2O	CH_4
On-Terminal	4,880,955	21,791	21,740	0	1
On-Road	178,335,140	319,910	319,039	3	2
Total	**183,216,095**	**341,701**	**340,779**	**3**	**2**

Tables 7.16 and 7.17 show emissions associated with other Port terminals and facilities separately.

Table 7.16: Summary of HDV Emissions Associated with Other Port Terminals, tons per year

Activity Location	VMT	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
On-Terminal	1,245,434	1	0	0	57	0	13	5
On-Road	14,068,799	2	2	2	92	0	21	4
Total	**15,314,234**	**3**	**2**	**2**	**149**	**0**	**34**	**8**

Table 7.17: Summary of HDV GHG Emissions Associated with Other Port Terminals, metric tons per year

Activity Location	VMT	CO_2 Equivalent	CO_2	N_2O	CH_4
On-Terminal	1,245,434	5,630	5,616	0	0
On-Road	14,068,799	25,178	25,110	0	0
Total	**15,314,234**	**30,808**	**30,726**	**0**	**0**

SECTION 8 SUMMARY OF 2010 EMISSION RESULTS

The emission results for the Port of Los Angeles 2010 Inventory of Air Emissions are presented in this section. Tables 8.1 and 8.2 summarize the 2010 total Port-related emissions in the South Coast Air Basin by category.

Table 8.1: 2010 Port-related Emissions by Category, tons per year

Category	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
Ocean-going vessels	178	143	154	3,944	1,325	449	218
Harbor craft	40	36	40	950	1	364	75
Cargo handling equipment	20	19	19	804	2	594	35
Rail locomotives	30	27	30	996	7	177	54
Heavy-duty vehicles	30	27	28	1,523	4	352	71
Total	**298**	**253**	**271**	**8,216**	**1,339**	**1,936**	**452**

DB ID457

The greenhouse gas emissions summarized in Table 8.2 are in metric tons per year (2,200 lbs/ton) instead of the short tons per year (2,000 lbs/ton) used throughout the report for criteria pollutants. The CO_2 equivalent values are derived by multiplying the GHG emissions estimates by their respective GWP[61] values (1 for CO_2, 310 for N_2O, 21 for CH_4) and then adding them together.

Table 8.2: 2010 Port-related GHG Emissions by Category, metric tons per year

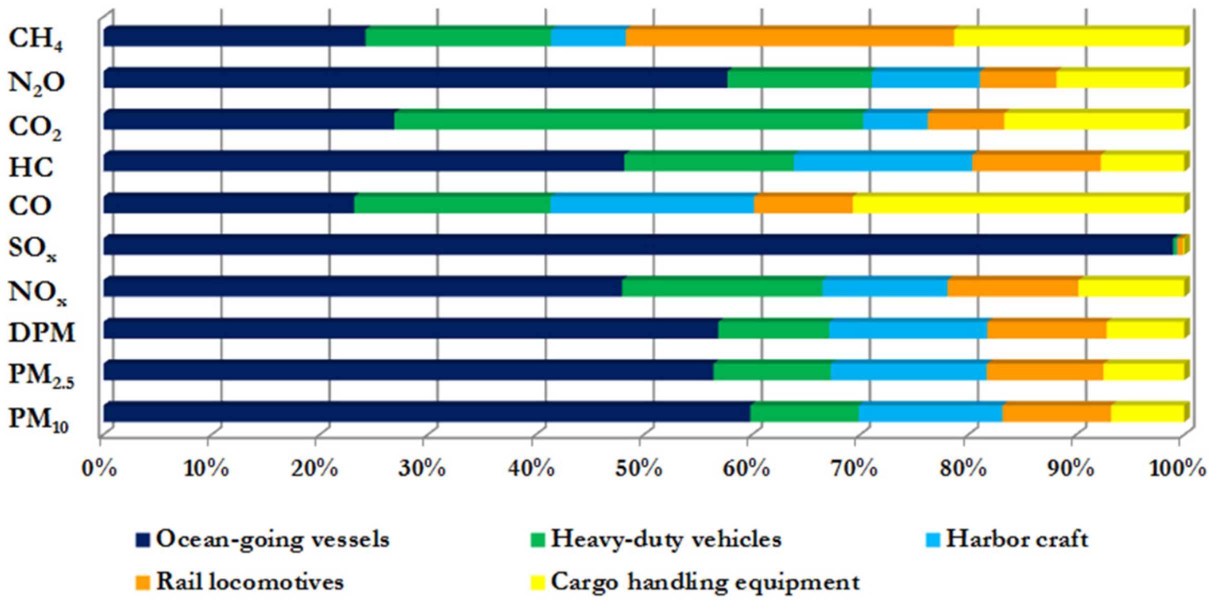
Category	CO_2 Equivalent	CO_2	N_2O	CH_4
Ocean-going vessels	234,785	230,618	13	4
Harbor craft	51,613	50,881	2	1
Cargo handling equipment	143,463	142,555	3	3
Rail locomotives	61,594	60,988	2	5
Heavy-duty vehicles	372,509	371,505	3	3
Total	**863,964**	**856,547**	**23**	**16**

DB ID457

[61] U.S. EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009*, April 2011.

Figure 8.1 shows the distribution of the 2010 total port-related emissions of each pollutant from each source category. Ocean-going vessels (57%), harbor craft (15%) and rail locomotives (11%) contributed the highest percentage of DPM emissions among the port-related sources. Approximately 99% of the SO_x emissions were emitted from ocean-going vessels. Ocean-going vessels (48%) and HDV (19%) accounted for the majority of NO_x emissions. CHE (31%), ocean-going vessels (23%), harbor craft (19%) and HDV (18%) accounted for the majority of CO emissions. Ocean-going vessels (48%), harbor craft (17%) and HDV (16%) accounted for the majority of hydrocarbon emissions.

Figure 8.1: 2010 Port-related Emissions by Category, %



Tables 8.3 through 8.5 present DPM, NO_x and SO_x emissions in the context of port-wide and air basin-wide emissions by source category and subcategory. For example, Table 8.3 shows that containerships' DPM emissions were 115 tons per year in 2010, representing 74% of the total OGV emissions (source category), 42% of the total Port-related emissions, and 1% of all emissions in the SoCAB (based on SoCAB emissions reported in the latest Air Quality Management Plan). In 2010, the OGV source category as a whole contributed 154 tons of DPM representing 57% of the Port's overall DPM emissions and 2% of SoCAB DPM emissions. The bottom of the table highlighted in grey shows that the Port's total DPM emissions constituted approximately 3% of the SoCAB DPM emissions. The other two tables similarly present NO_x and SO_x emissions.

Table 8.3: 2010 DPM Emissions by Category and Percent Contribution, tons per year and %

Category	Subcategory	DPM Emissions	Percent DPM Emissions of Total Category	Port	SoCAB AQMP
OGV	Auto carrier	2.9	2%	1%	0%
OGV	Bulk vessel	1.4	1%	1%	0%
OGV	Containership	114.7	74%	42%	1%
OGV	Cruise	19.7	13%	7%	0%
OGV	General cargo	3.3	2%	1%	0%
OGV	Ocean tugboat	1.2	1%	0%	0%
OGV	Miscellaneous	0.0	0%	0%	0%
OGV	Reefer	1.2	1%	0%	0%
OGV	RoRo	0.0	0%	0%	0%
OGV	Tanker	9.9	6%	4%	0%
OGV	**Subtotal**	**154.2**	**100%**	**57%**	**2%**
Harbor Craft	Assist tug	11.2	28%	4%	0%
Harbor Craft	Harbor tug	0.7	2%	0%	0%
Harbor Craft	Commercial fishing	6.1	15%	2%	0%
Harbor Craft	Ferry	5.5	14%	2%	0%
Harbor Craft	Ocean tugboat	2.8	7%	1%	0%
Harbor Craft	Government	1.3	3%	0%	0%
Harbor Craft	Excursion	7.0	18%	3%	0%
Harbor Craft	Crewboat	3.6	9%	1%	0%
Harbor Craft	Work boat	1.5	4%	1%	0%
Harbor Craft	**Subtotal**	**39.6**	**100%**	**15%**	**0%**
CHE	RTG crane	1.9	10%	1%	0%
CHE	Forklift	0.9	5%	0%	0%
CHE	Top handler, side pick	6.7	34%	2%	0%
CHE	Other	2.3	12%	1%	0%
CHE	Yard tractor	7.6	39%	3%	0%
CHE	**Subtotal**	**19.5**	**100%**	**7%**	**0%**
Rail	Switching	2.0	7%	1%	0%
Rail	Line haul	28.0	93%	10%	0%
Rail	**Subtotal**	**30.0**	**100%**	**11%**	**0%**
HDV	On-Terminal	2.4	9%	1%	0%
HDV	On-Road	25.5	91%	9%	0%
HDV	**Subtotal**	**27.8**	**100%**	**10%**	**0%**
Port	**Total**	**271**		**100%**	**3%**
SoCAB AQMP	**Total**	**8,200**			

Table 8.4: 2010 NO_x Emissions by Category and Percent Contribution, tons per year and %

Category	Subcategory	NO_x Emissions	Percent NO_x Emissions of Total Category	Port	SoCAB AQMP
OGV	Auto carrier	83.7	2%	1%	0%
OGV	Bulk vessel	45.2	1%	1%	0%
OGV	Containership	2,709.8	69%	33%	1%
OGV	Cruise	557.4	14%	7%	0%
OGV	General cargo	101.1	3%	1%	0%
OGV	Ocean tugboat	38.3	1%	0%	0%
OGV	Miscellaneous	0.7	0%	0%	0%
OGV	Reefer	43.0	1%	1%	0%
OGV	RoRo	0.6	0%	0%	0%
OGV	Tanker	363.9	9%	4%	0%
OGV	**Subtotal**	**3,943.7**	**100%**	**48%**	**1%**
Harbor Craft	Assist tug	285.3	30%	3%	0%
Harbor Craft	Harbor tug	17.3	2%	0%	0%
Harbor Craft	Commercial fishing	138.6	15%	2%	0%
Harbor Craft	Ferry	133.4	14%	2%	0%
Harbor Craft	Ocean tugboat	64.5	7%	1%	0%
Harbor Craft	Government	29.4	3%	0%	0%
Harbor Craft	Excursion	156.4	16%	2%	0%
Harbor Craft	Crewboat	83.2	9%	1%	0%
Harbor Craft	Work boat	41.3	4%	1%	0%
Harbor Craft	**Subtotal**	**949.6**	**100%**	**12%**	**0%**
CHE	RTG crane	72.7	9%	1%	0%
CHE	Forklift	57.9	7%	1%	0%
CHE	Top handler, side pick	244.9	30%	3%	0%
CHE	Other	66.0	8%	1%	0%
CHE	Yard tractor	362.6	45%	4%	0%
CHE	**Subtotal**	**804.2**	**100%**	**10%**	**0%**
Rail	Switching	78.6	8%	1%	0%
Rail	Line haul	917.3	92%	11%	0%
Rail	**Subtotal**	**995.9**	**100%**	**12%**	**0%**
HDV	On-Terminal	267.8	18%	3%	0%
HDV	On-Road	1,255.2	82%	15%	0%
HDV	**Subtotal**	**1,523.0**	**100%**	**19%**	**1%**
Port	**Total**	**8,216**		**100%**	**3%**
SoCAB AQMP	**Total**	**282,748**			

Table 8.5: 2010 SO_x Emissions by Category and Percent Contribution, tons per year and %

Category	Subcategory	SO_x Emissions	Percent SO_x Emissions of Total Category	Port	SoCAB AQMP
OGV	Auto carrier	20.5	2%	2%	0%
OGV	Bulk vessel	11.6	1%	1%	0%
OGV	Containership	845.0	64%	63%	6%
OGV	Cruise	126.5	10%	9%	1%
OGV	General cargo	23.2	2%	2%	0%
OGV	Ocean tugboat	6.9	1%	1%	0%
OGV	Miscellaneous	0.3	0%	0%	0%
OGV	Reefer	8.6	1%	1%	0%
OGV	RoRo	0.1	0%	0%	0%
OGV	Tanker	282.0	21%	21%	2%
OGV	**Subtotal**	**1,324.8**	**100%**	**99%**	**9%**
Harbor Craft	Assist tug	0.2	35%	0%	0%
Harbor Craft	Harbor tug	0.0	2%	0%	0%
Harbor Craft	Commercial fishing	0.1	8%	0%	0%
Harbor Craft	Ferry	0.1	18%	0%	0%
Harbor Craft	Ocean tugboat	0.0	7%	0%	0%
Harbor Craft	Government	0.0	4%	0%	0%
Harbor Craft	Excursion	0.1	11%	0%	0%
Harbor Craft	Crewboat	0.0	8%	0%	0%
Harbor Craft	Work boat	0.0	4%	0%	0%
Harbor Craft	**Subtotal**	**0.6**	**100%**	**0%**	**0%**
CHE	RTG crane	0.1	6%	0%	0%
CHE	Forklift	0.0	2%	0%	0%
CHE	Top handler, side pick	0.4	23%	0%	0%
CHE	Other	0.1	5%	0%	0%
CHE	Yard tractor	1.1	64%	0%	0%
CHE	**Subtotal**	**1.6**	**100%**	**0%**	**0%**
Rail	Switching	0.1	1%	0%	0%
Rail	Line haul	7.3	99%	1%	0%
Rail	**Subtotal**	**7.4**	**100%**	**1%**	**0%**
HDV	On-Terminal	0.1	3%	0%	0%
HDV	On-Road	4.0	97%	0%	0%
HDV	**Subtotal**	**4.1**	**100%**	**0%**	**0%**
Port	**Total**	**1,339**		**100%**	**9%**
SoCAB AQMI	**Total**	**14,311**			

In order to put the Port-related emissions into context, the following figures and tables compare the Port's contributions to the total emissions in the South Coast Air Basin by major emission source category. The 2010 SoCAB emissions are based on 2007 AQMP Appendix III.[62]

Figure 8.2: 2010 DPM Emissions in the South Coast Air Basin, %

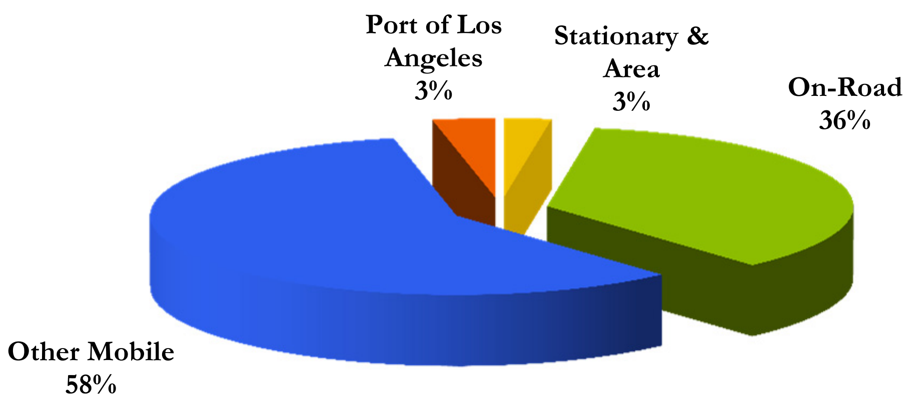
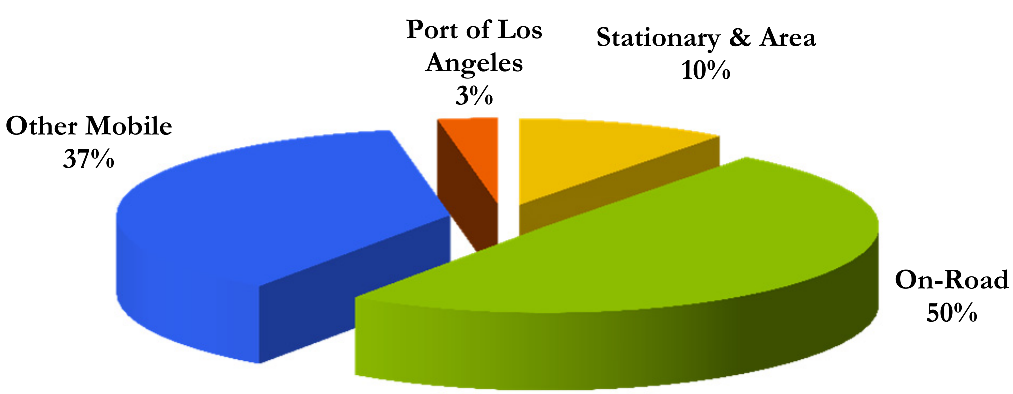


Figure 8.3: 2010 NO_x Emissions in the South Coast Air Basin, %



[62] SCAQMD, *Final 2007 AQMP Appendix III, Base & Future Year Emissions Inventories*, June 2007.

Figure 8.4: 2010 SO_x Emissions in the South Coast Air Basin, %

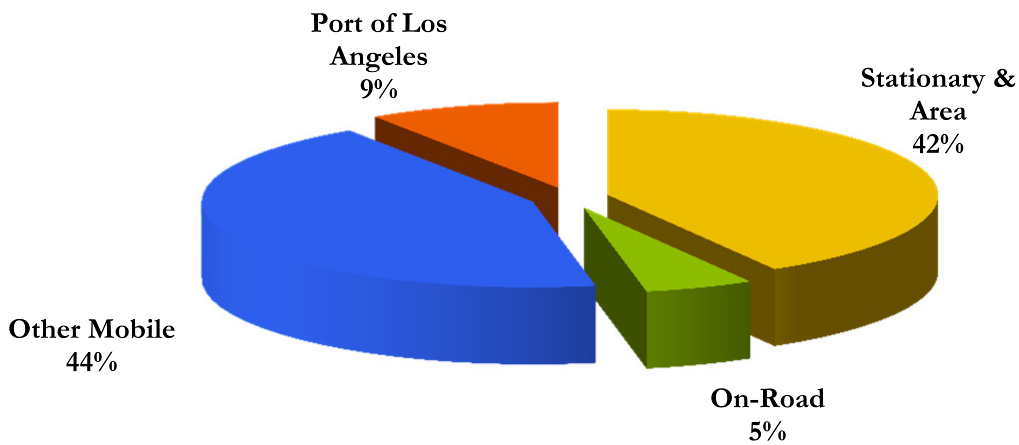
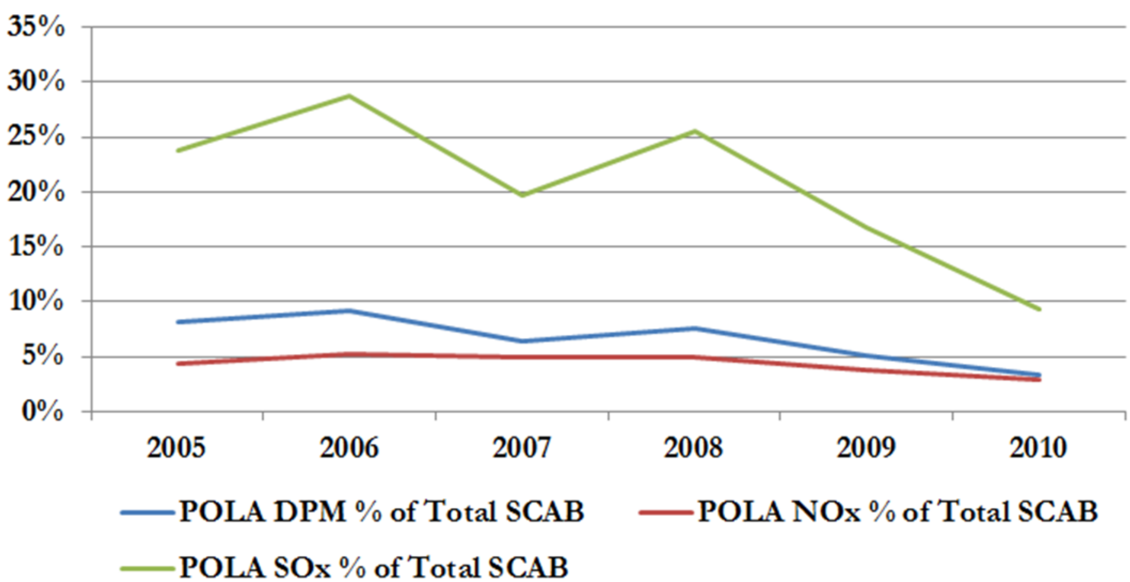


Figure 8.5 provides a comparison of the Port-related mobile source emissions to the total SoCAB emissions from 2005 to 2010. As indicated, the Port's overall contribution to the SoCAB emissions has continued to decrease because of the implementation of various emission reduction programs.

Figure 8.5: Port's Emissions in the South Coast Air Basin



SECTION 9 COMPARISON OF 2010 AND PREVIOUS YEARS' FINDINGS AND EMISSION ESTIMATES

This section compares emissions during the 2010, 2009, 2008, 2007, 2006 and 2005 calendar years, overall and for each emission source category. Emission source categories are addressed in separate subsections, containing the emissions comparisons in table and chart formats, which explain the findings and differences in emissions.

The tables and charts in this section also summarize the percent change from the previous year (2010-2009) and for the CAAP Progress (2010-2005) using the current methodology for emissions comparison. Calendar year 2005 is considered the baseline year for CAAP for which CAAP progress is tracked.

9.1 2010 Comparisons

In preparing the comparisons, the first step is to account for changes in methodology between the current year and any of the previous years. To provide a valid basis for comparison, when methodological changes have been implemented for a source category the previous years' emissions are recalculated using the new methodology and the previous years' activity data. If there have been no changes in methodology, then the emissions estimated for the prior years' inventories are used in the comparison. Because of the Port's process of continual review and improvement of the inventories, the previous years' emissions presented in this comparison may not exactly match those published in the inventory report for the prior year(s).

Methodological differences between 2010 and 2009 Inventory of Air Emissions
The methodologies used for developing the 2010 inventory changed from prior year inventories for ocean-going vessels, harbor craft, cargo handling equipment, rail and heavy-duty trucks, so the prior years' emissions have been recalculated to reflect the updated methodologies. Sections 9.1.1 through 9.1.5 present the source category comparisons across years (2005 to 2010).

Port-wide Overview of Activity and Emissions Changes
Table 9.1 presents the number of vessel calls and the container cargo throughputs for calendar years 2005 through 2010. The average number of TEUs per containership call was at its highest for this period in 2010, which means that, on average, more TEUs were handled per vessel call in 2010 than in the previous years. Despite a TEU throughput increase of 16% from the previous year, the number of vessel calls increased by 1% and the containership calls remained the same. This could be due to the transition to larger containerships (see Table 9.2). Compared to 2005, in 2010 the number of TEU increased by 5% and containership calls decreased by 9% while the TEU/containership-call efficiency improved by 14%.

Table 9.1: TEUs and Vessel Call Comparison, %

Year	All Calls	Containership Calls	TEUs	Average TEUs/Call
2010	2,035	1,355	7,831,902	5,780
2009	2,010	1,355	6,748,995	4,981
2008	2,239	1,459	7,849,985	5,380
2007	2,527	1,573	8,355,038	5,312
2006	2,703	1,627	8,469,853	5,206
2005	2,501	1,481	7,484,625	5,054
Previous Year (2010-2009)	**1%**	**0%**	**16%**	**16%**
CAAP Progress (2010-2005)	**-19%**	**-9%**	**5%**	**14%**

Table 9.2 provides a comparison of OGV containership calls from 2005 to 2010; this comparison highlights the general trend toward larger vessels.

Table 9.2: OGV Container Vessel Calls Count by Container Vessel Category

Category	2010 Arrivals	2009 Arrivals	2008 Arrivals	2007 Arrivals	2006 Arrivals	2005 Arrivals
Container - 1000	116	115	176	237	218	202
Container - 2000	191	165	96	104	149	184
Container - 3000	28	89	142	127	201	296
Container - 4000	302	295	368	537	515	398
Container - 5000	322	359	341	328	289	215
Container - 6000	149	138	199	160	181	131
Container - 7000	91	106	99	80	78	52
Container - 8000	145	78	30	4	1	0
Container - 9000	11	10	8	0	0	0

DB ID693

Table 9.3 presents the total net change in emissions from all source categories in 2010 as compared to previous years. From 2009 to 2010, there was a 16% increase in throughput while emissions of DPM decreased by 39%, NO_x decreased by 25%, SO_x decreased by 45%, CO decreased by 24%,and HC decreased by 19%. Between 2005 and 2010 there was a 5% increase in throughput while emissions of DPM decreased by 69%, NO_x decreased by 50%, SO_x decreased by 75%, CO decreased by 46%, and HC decreased by 43%.

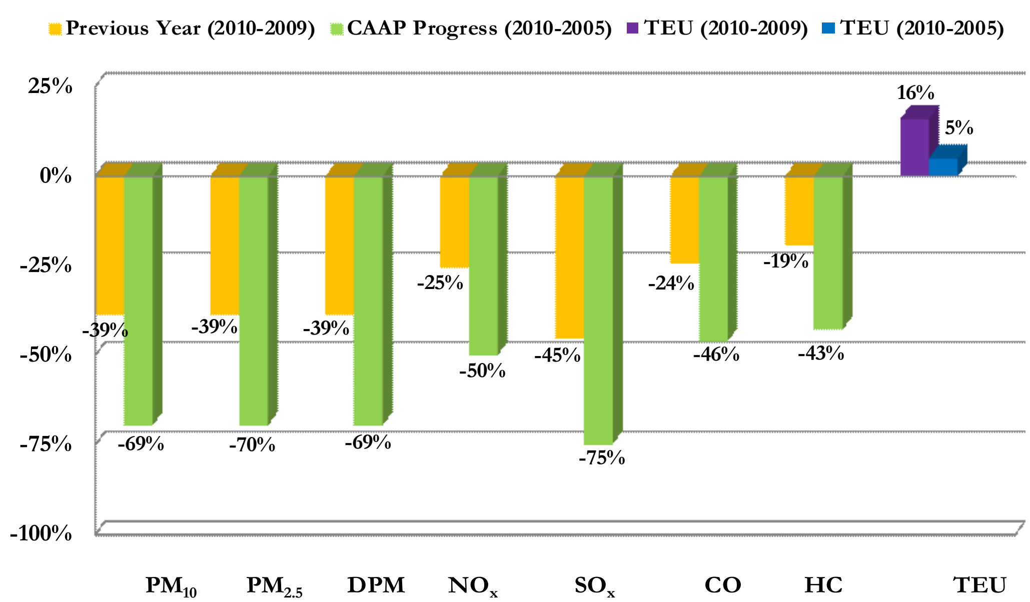
Table 9.3: Port-wide Emissions Comparison, tons per year and % Change

EI Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
2010	298	253	271	8,216	1,339	1,936	452
2009	486	412	442	11,023	2,444	2,555	560
2008	756	645	687	15,212	3,808	3,380	734
2007	717	619	622	16,575	3,435	3,583	796
2006	1,045	891	945	18,754	5,752	4,093	890
2005	976	832	888	16,396	5,317	3,590	791
Previous Year (2010-2009)	**-39%**	**-39%**	**-39%**	**-25%**	**-45%**	**-24%**	**-19%**
CAAP Progress (2010-2005)	**-69%**	**-70%**	**-69%**	**-50%**	**-75%**	**-46%**	**-43%**

DB ID457

Figure 9.1 shows the percent change in port-wide emissions since the previous year and CAAP progress since 2005.

Figure 9.1: Port-wide Emissions Comparison, % Change



Figures 9.2 through 9.4 show the emission trends for 2005 to 2010 in DPM, NO_x and SO_x emissions contributions from the ocean-going vessels, heavy-duty vehicles, harbor craft, rail locomotives, and cargo handling equipment emission source categories. As indicated, emissions from all categories have generally decreased over the years, primarily due to the implementation of the Port's emission reduction programs and the emissions reduction regulations. There are some spikes in emissions due to throughput level changes and changes in regulations and control measures.

As shown in Figure 9.2, OGVs contribute the majority of DPM emissions. DPM emissions from all categories have decreased between 2005 and 2010, except for a small increase in rail emissions in 2010. OGV and HDV emissions have significantly decreased in recent years primarily due to the port's VSR, CARB's fuel regulation and the port's Clean Truck Program.

Figure 9.2: DPM Emissions Comparison by Category, tons per year

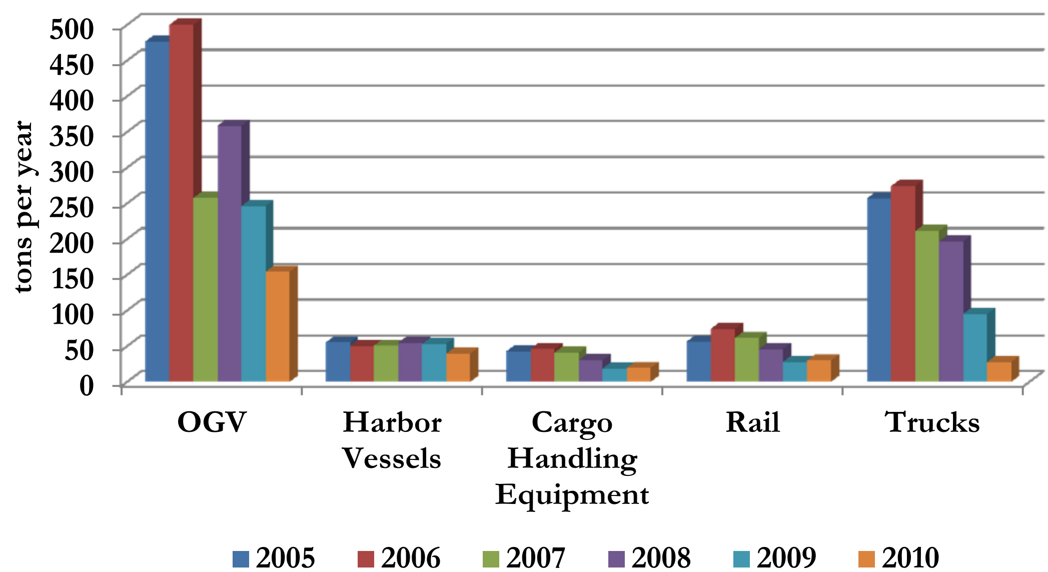


Figure 9.3 illustrates that, in 2010, emissions of NO_x from HDVs were lowered significantly due to the Clean Truck Program's second phase implementation, and OGVs currently dominate the NO_x emissions. NO_x emissions show a downward trend over the last several years, with a small increase in 2010 for CHE and rail due to increase in activity (caused by increased throughput) overtaking decrease in emissions due to emissions reduction measures implemented in past years compared with 2009.

Figure 9.3: NO_x Emissions Comparison by Category, tons per year

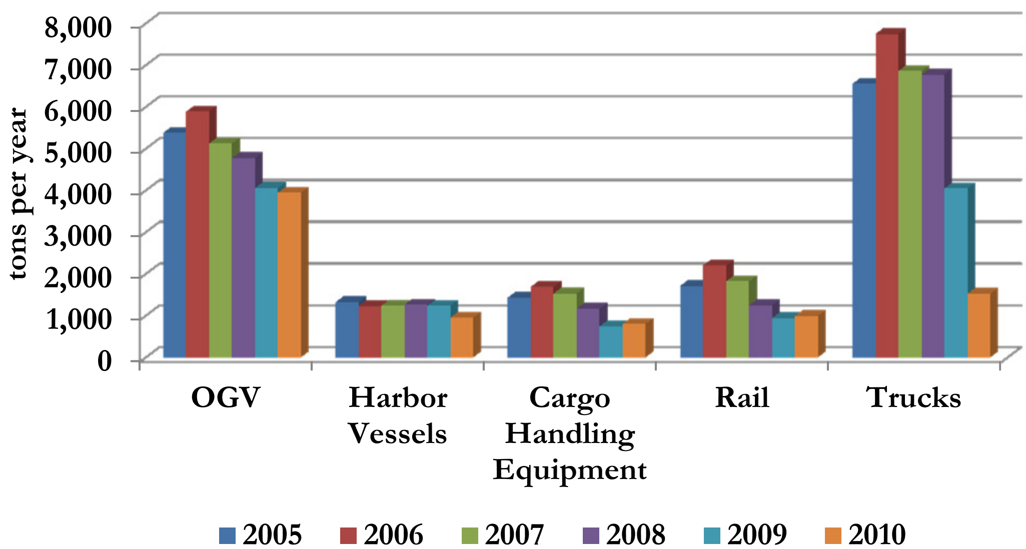


Figure 9.4 shows that OGVs are by far the largest SO_x emissions contributors at the Port. This is because SO_x emissions are produced from the sulfur in the fuel burned by engines, and OGV engines typically burn fuels with relatively high sulfur content while the other source categories use fuels that are much lower in sulfur. In 2010, the CARB fuel regulation was in place for the whole year and most OGV engines burned marine distillate fuel (with an average of approximately 0.5% sulfur). This resulted in significant reduction in OGV SO_x emissions in 2010. The other source categories, with the exception of rail, have completely switched to using ULSD with a sulfur content of 15 ppm. The rail locomotives are also fueled with ULSD when they refuel within California, but the interstate line haul locomotives are carrying a certain amount of out-of-state fuel when they enter the SoCAB, so on average their fuel sulfur content is somewhat higher than 15 ppm.

Figure 9.4: SO_x Emissions Comparison by Category, tons per year

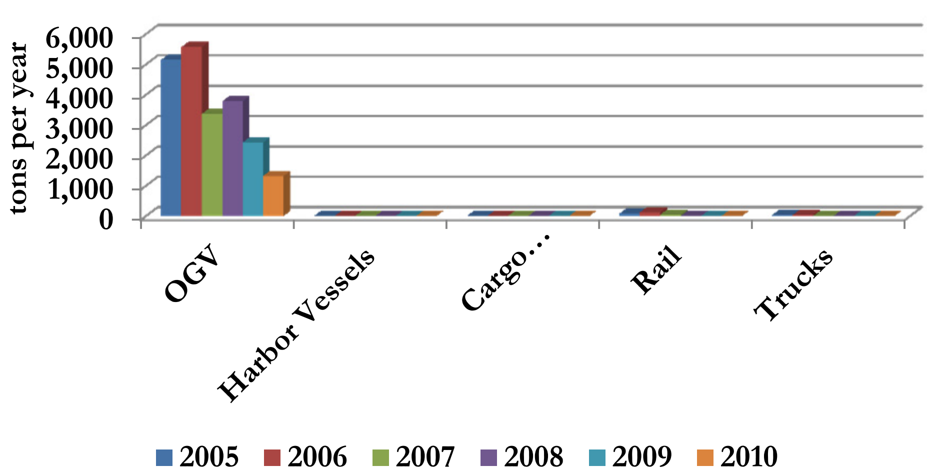


Table 9.4 compares the 2010 port-wide GHG emissions to the previous years. GHG emissions have continued to decrease over the years, mainly due to better efficiency and CAAP and regulatory measures that have GHG emission reduction co-benefits.

Table 9.4: Port-wide GHG Emissions Comparison, metric tons per year

Year	CO_2 Equivalent	CO_2	N_2O	CH_4
2010	863,964	856,547	23	16
2009	909,289	901,657	23	21
2008	1,045,620	1,036,708	27	31
2007	1,116,922	1,106,740	31	32
2006	1,246,662	1,235,435	34	37
2005	1,060,727	1,050,928	29	32
Previous Year (2010-2009)	**-5%**	**-5%**	**-2%**	**-23%**
CAAP Progress (2010-2005)	**-19%**	**-18%**	**-23%**	**-48%**

DB ID457

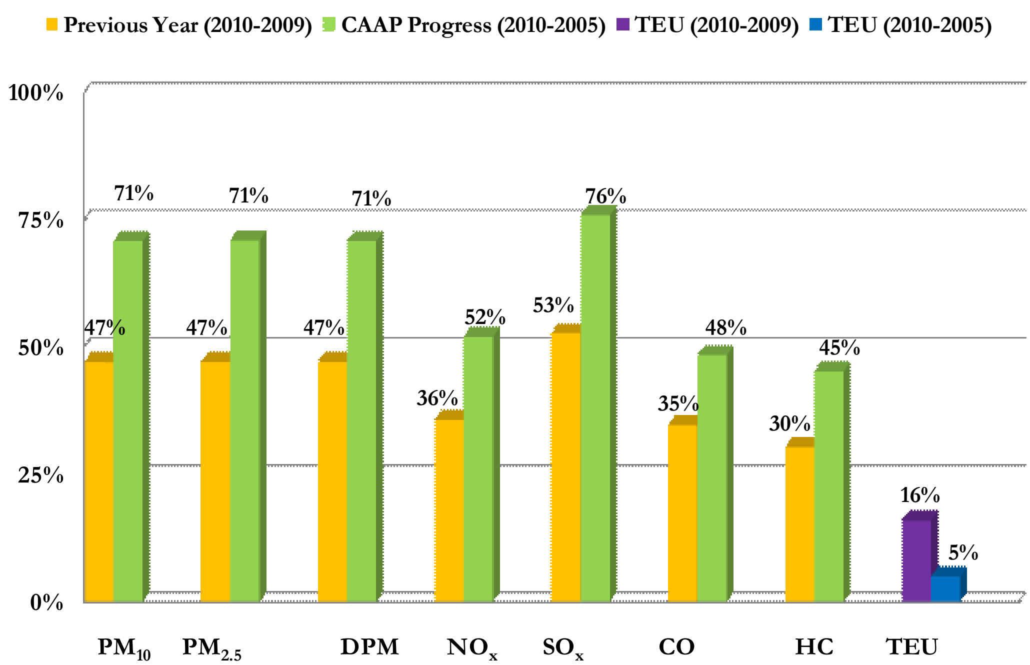
Table 9.5 and Figure 9.5 compare emissions efficiency changes between 2005 and 2010, and show that the efficiency, measured as emissions per 10,000 TEU, continues to improve over the years. A positive percent change for the emissions efficiency comparison means an improvement in efficiency.

Table 9.5: Port-wide Emissions Efficiency, tons/10,000 TEU and %

EI Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
2010	0.38	0.32	0.35	10.49	1.71	2.47	0.58
2009	0.72	0.61	0.66	16.33	3.62	3.79	0.83
2008	0.96	0.82	0.87	19.38	4.85	4.31	0.93
2007	0.86	0.74	0.74	19.83	4.11	4.29	0.95
2006	1.23	1.05	1.12	22.14	6.79	4.83	1.05
2005	1.30	1.11	1.19	21.91	7.10	4.80	1.06
Previous Year (2010-2009)	**47%**	**47%**	**47%**	**36%**	**53%**	**35%**	**30%**
CAAP Progress (2010-2005)	**71%**	**71%**	**71%**	**52%**	**76%**	**48%**	**45%**

The purple bar in Figure 9.5 represents the TEU throughput change from the previous year (a 16% increase) and the blue bar represents the TEU change when compared with 2005 (a 5% increase).

Figure 9.5: Port-wide Changes in Emissions Efficiency, % Change



9.1.1 Ocean-Going Vessels

There was one change to the ocean-going vessels emission calculation methodology in this inventory compared to the 2009 methodology. The last 5 nm of the departure lane of the southern route is not within the boundary for the CARB fuel regulation; therefore vessels were estimated burning the default residual oil instead of switching to al lower sulfur fuel for that 5 nm segment. Also, the previous year emissions from 2005 to 2008 were re-estimated using the 2010 transiting factors for the missing speeds. As of April 2008, MarEx started to measure and record actual vessel speeds beyond 20 nm to 40 nm. This data allowed for better estimation of emissions within the 20 nm to 40 nm area, and provided a basis for the development of default transiting speeds for vessels that did not have a speed indicated within the 20 nm to 40 nm zone. Due to this improvement, the previous years' vessel speeds (and emissions) from 20 nm to 40 nm have been re-estimated using the 2010 transiting factors with the previous years' activity data. This allows a more representative comparison between 2005 and 2010 emissions.

The various emission reduction strategies for ocean-going vessels are listed in Table 9.6. The table lists the percentage of calls that participated in the strategy each year from 2005 through 2010. The following emission reductions strategies are listed:

1) Slide Valve refers to the slide valve technology that is standard in newer MAN B&W main engines (most 2004 and newer vessels) and can also be retrofitted into existing engines. The percentage of calls with slide valves shown in Table 9.6 covers both new vessels and known retrofits;
2) IMO Tier I refers to calls by vessels meeting or exceeding IMO's Tier I standard (2000 and newer vessels);
3) Shore Power refers to vessel calls using shore power at berth (instead of running their diesel-powered auxiliary engines);
4) Fuel Switch for auxiliary and main engines refers to vessel calls switching to lower sulfur fuel as a result of CARB's marine fuel regulation;
5) VSR refers to the vessels reducing their transit speed to 12 knots or lower within 20 and 40 nm of the Port.

Table 9.6: OGV Emission Reduction Strategies, % of All Calls

	Percent (%) of All Calls						
Year	**Slide Valve**	**IMO Tier I**	**Shore Power**	**Fuel Switch Main Eng**	**Fuel Switch Aux Eng**	**VSR 20 nm**	**VSR 40 nm**
2010	31%	66%	3%	100%	100%	91%	63%
2009	27%	60%	3%	78%	78%	90%	48%
2008	23%	48%	2%	38%	63%	90%	42%
2007	22%	48%	3%	24%	100%	85%	na
2006	17%	46%	2%	13%	33%	73%	na
2005	11%	34%	2%	7%	27%	65%	na

DB ID882

Beginning July 1, 2009, CARB's OGV Fuel Regulation, adopted in July 2008, required vessel operators to use marine gas oil (MGO) with a sulfur content less than 1.5% by weight or marine diesel oil (MDO) with a sulfur content equal to or less than 0.5% by weight within 24 nm from the California coast (and while at berth) in their diesel powered propulsion engines, auxiliary engines and auxiliary boilers. During this period, an average 0.5% sulfur fuel content is assumed for both main and auxiliary engines and auxiliary boilers. For the 2010 calendar year, 100% compliance with CARB's regulation is assumed, with the exception of the auxiliary boiler exemptions discussed in the OGV section. In 2010, there were 26 exempted vessels with 49 total calls for the auxiliary boiler exemption.

Table 9.6 shows % of calls where the fuel was switched from residual fuel to low sulfur fuel associated with vessel operators' voluntary actions, CARB auxiliary engine fuel regulation, and the Port's Fuel Incentive Program during 2005 through 2009.

For 2010, the fuel switch compliance is for vessels that transit within the 24 nm CARB fuel regulation boundary. Prior to the regulation, the North route was the predominant route for trade with Asia and points north of San Pedro Bay. Since the regulation became effective, the West route (west of the Channel Islands) has become the predominant shipping route for ships trading with Asia and points north of San Pedro Bay, presumably to avoid the CARB OGV Fuel Regulation compliance zone. This shift in route selection, highlighted Table 9.7, impacted the SO_x and DPM emissions for 2010.

Table 9.7: Route Distribution of Annual Calls

Route	Distribution of Annual Calls		
	2008	2009	2010
North	62%	45%	10%
West	6%	23%	58%
South	31%	31%	31%
East	1%	1%	1%

Table 9.8 presents the engine activity in terms of total kW-hrs from 2005 to 2010. In 2010, the total engine activity increased by 1% compared to 2009 and decreased by 22% compared to 2005.

Table 9.8: OGV Power Comparison, kW-hr

Year	All Engines Total kW-hr	Main Eng Total kW-hr	Aux Eng Total kW-hr	Boiler Total kW-hr
2010	316,551,634	94,088,362	147,269,891	75,193,382
2009	314,062,580	100,148,756	142,221,642	71,692,182
2008	353,804,879	106,823,458	172,833,501	74,147,920
2007	411,995,744	105,556,372	202,206,121	104,233,252
2006	453,376,104	121,126,693	223,977,046	108,272,365
2005	405,789,967	117,670,182	193,719,280	94,400,504
Previous Year (2010-2009)	**1%**	**-6%**	**4%**	**5%**
CAAP Progress (2010-2005)	**-22%**	**-20%**	**-24%**	**-20%**

DB ID704

Table 9.9 compares the OGV emissions for calendar years 2005 through 2010 in tons per year and as a percent change in 2010 compared to 2009 and 2005. The emissions in previous years are different from those in previously published reports because of changes in methodologies that have been accounted for by recalculating the earlier emissions using the newer methodologies.

Table 9.9: OGV Emissions Comparison, tons per year and % Change

EI Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
2010	178	143	154	3,944	1,325	449	218
2009	289	231	246	4,055	2,431	440	211
2008	427	342	359	4,771	3,791	484	226
2007	352	281	257	5,123	3,372	520	239
2006	599	479	500	5,886	5,577	561	252
2005	563	450	477	5,378	5,156	496	222
Previous Year (2010-2009)	**-38%**	**-38%**	**-37%**	**-3%**	**-45%**	**2%**	**3%**
CAAP Progress (2010-2005)	**-68%**	**-68%**	**-68%**	**-27%**	**-74%**	**-10%**	**-2%**

DB ID692

OGV emissions of all pollutants decreased in 2010 compared to 2005 and decreases in PM, NO_x and SO_x are seen compared to 2009. The CO and HC increases as compared to 2009 are due to the increase in kW-hr activity in 2010 and the fact that fuel switching does not impact CO and HC emissions. Reductions in OGV emissions are mainly attributed to the port's VSR program (all pollutants) and CARB marine fuel regulation (PM, NO_x and SO_x) which became effective July 2009 and was enforced throughout all of 2010.

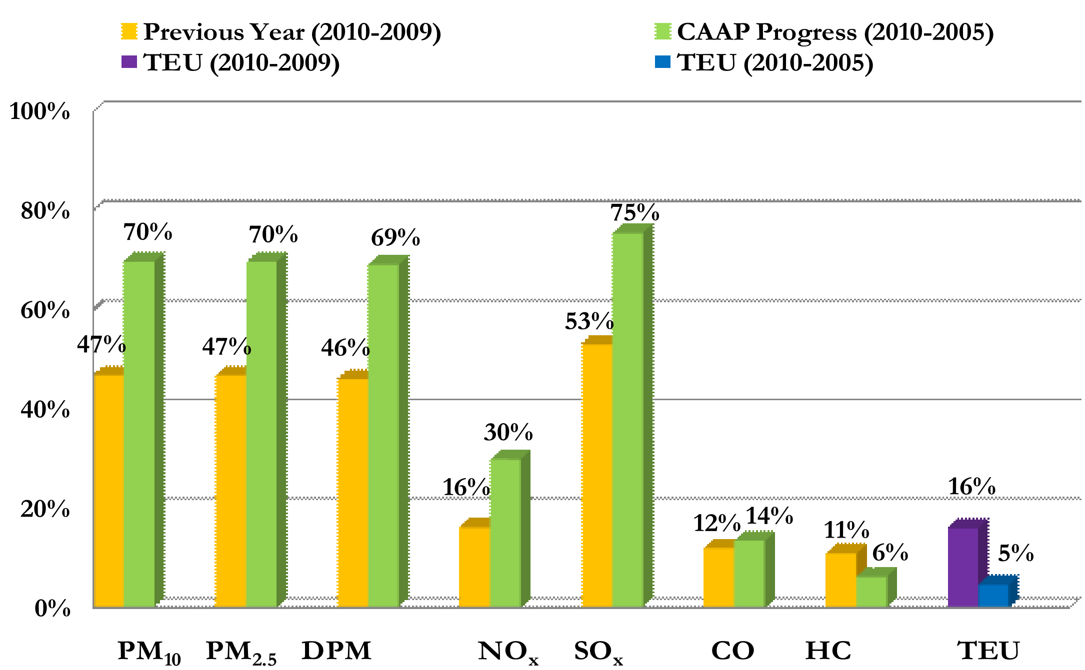
Table 9.10 and Figure 9.6 show the emissions efficiency changes between 2009 and 2010 and between 2005 and 2010. A positive percent change for the emissions efficiency comparison means an improvement in efficiency. As indicated, emissions efficiency improved for all pollutants in 2010 compared to 2009 and 2005.

Table 9.10: OGV Emissions Efficiency Comparison, tons/10,000 TEU and %

EI Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
2010	0.23	0.18	0.20	5.04	1.69	0.57	0.28
2009	0.43	0.34	0.36	6.01	3.60	0.65	0.31
2008	0.54	0.44	0.46	6.08	4.83	0.62	0.29
2007	0.42	0.34	0.31	6.13	4.04	0.62	0.29
2006	0.71	0.57	0.59	6.95	6.58	0.66	0.30
2005	0.75	0.60	0.64	7.19	6.89	0.66	0.30
Previous Year (2010-2009)	**47%**	**47%**	**46%**	**16%**	**53%**	**12%**	**11%**
CAAP Progress (2010-2005)	**70%**	**70%**	**69%**	**30%**	**75%**	**14%**	**6%**

The purple bar in Figure 9.6 represents the TEU throughput change from the previous year (a 16% increase) and the blue bar represents the TEU throughput change when compared to 2005 (a 5% increase).

Figure 9.6: OGV Emissions Efficiency Comparison, %



9.1.2 Harbor Craft

The methodology used to estimate harbor craft emissions for the 2010 Inventory of Air Emissions changed slightly from the methodology used in the 2009 inventory. The changes included modifications to load factor and useful life assumptions for crew boats and work boats in order to be consistent with CARB's latest changes.

Table 9.11 summarizes the number of harbor craft inventoried each year from 2005 through 2010. Overall, the total vessel count decreased by 5% from 2009 to 2010 and by 7% between 2005 and 2010.

Table 9.11: Harbor Craft Count Comparison

Harbor Vessel Type	2010 Count	2009 Count	2008 Count	2007 Count	2006 Count	2005 Count
Assist tug	15	18	20	16	16	16
Commercial fishing	143	148	138	140	121	156
Crew boat	23	19	21	22	19	14
Excursion	27	27	24	24	24	24
Ferry	10	10	10	9	9	9
Government	15	22	21	27	26	26
Ocean tug	6	6	7	7	7	7
Tugboat	16	20	20	23	20	19
Work boat	9	8	12	15	15	14
Total	**264**	**278**	**273**	**283**	**257**	**285**

DB ID196

Table 9.12 summarizes the percent distribution of engines based on EPA's engine standards from 2005 to 2010. As expected, the percentage of Tier 2 engines has continued to increase over the years due to the introduction of newer vessels with newer engines into the fleet and replacements of existing higher-emitting engines with cleaner engines. Also, there were a small number of small auxiliary engines that met the Tier 3 engine standard in the 2010 fleet.

Table 9.12: Harbor Craft Engine Standards Comparison by Tier

Year	Tier 0	Tier 1	Tier 2	Tier 3	Unknown
2010	22%	25%	24%	4%	25%
2009	31%	30%	16%	0%	23%
2008	36%	30%	13%	0%	22%
2007	18%	30%	5%	0%	47%
2006	17%	32%	6%	0%	45%
2005	15%	32%	4%	0%	49%

DB ID1187

For this comparison, the Tier 1, 2 and 3 categorization of engines for the Port's 2010 harbor craft inventory is based on EPA's emission standards for marine engines[63]. Tier 0 engines are unregulated engines built prior to promulgation of the EPA emission standards. The following shows the criteria used to classify engines by EPA's emission standards.

- Tier 0: 1999 and older model year engines
- Tier 1: Model years 2000 to 2003 for engines with less than or equal to 750 hp; model years 2000 to 2006 for engines with greater than 750 hp
- Tier 2: Model years 2004+ for engines with less than or equal to 750 hp; model years 2007+ for engines greater than 750 hp, with the exception for those that meet the Tier 3 criteria
- Tier 3: Model years 2009+ for small engines with 25 to 120 hp rating or <0.9 liter engine displacement
- "Unknown": Engines with missing model year, horsepower or both

The majority of engine replacements occurred prior to 2005 under the Carl Moyer Program and Port-funded projects to reduce emissions in the harbor, replacing Tier 0 engines with Tier 1 or 2 engines. In 2010, there was an increase in vessel repowers as vessel owners complied with CARB's Harbor Craft Regulation as well as availability of grant funding from EPA, CARB and the port.

[63] e-CFR (Code of Federal Regulation), 40 CFR, subpart 94.8 for Tier 1 and 2 and subpart 1042.101 for Tier 3

As shown in Table 9.13, there was a 5% decrease in vessel count between 2009 and 2010 and a 7% decrease in vessel count between 2005 and 2010. The overall activity level of harbor craft (measured as a product of the rated engine size in kW, annual operating hours and load factors) decreased by 7% in 2010 compared to the previous year and decreased by 9% compared to 2005. The activity levels changed slightly for previous years (when compared to 2009 published report) due to the use of 2010 methodology which has latest crewboat and workboat load factor taken into consideration.

Table 9.13: Harbor Craft Comparison

Year	Vessel Count	Engine Count	Total kW-hrs
2010	264	571	77,874,337
2009	278	583	83,585,992
2008	273	583	82,588,279
2007	281	597	84,906,455
2006	256	553	83,805,355
2005	255	578	85,398,148
Previous Year (2010-2009)	**-5%**	**-2%**	**-7%**
CAAP Progress (2010-2005)	**4%**	**-1%**	**-9%**

Table 9.14 shows the harbor craft activity comparison by vessel type for calendar years 2005 to 2010. While assist tugs, crew boats, and excursion vessels experienced an increase in activity from 2009 to 2010, commercial fishing, government, tugboat and work boats decreased in activity levels in 2010.

Table 9.14: Harbor Craft Activity Comparison by Type, Million kW-hrs

Vessel Type	2010	2009	2008	2007	2006	2005
Assist Tug	27.8	27.0	26.5	28.2	29.3	25.2
Commercial Fishing	6.8	11.3	12.4	12.6	11.1	14.1
Crew boat	6.3	6.0	4.4	4.5	4.0	2.4
Excursion	9.0	8.9	8.0	11.5	11.5	11.5
Ferry	14.2	14.2	14.2	13.1	13.1	13.1
Government	2.8	3.0	2.6	2.9	3.0	3.0
Ocean Tug	6.0	6.0	6.2	2.9	2.9	3.1
Tugboat	1.9	4.1	6.4	7.6	7.3	11.4
Work boat	3.0	3.2	2.0	1.6	1.6	1.6
Total	**77.9**	**83.6**	**82.6**	**84.9**	**83.8**	**85.4**

Table 9.15 shows the emissions comparisons for calendar years 2005 to 2010 for harbor craft.

Table 9.15: Harbor Craft Emission Comparison, tons per year and % Change

EI Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
2010	40	36	40	950	1	364	75
2009	54	49	54	1,238	1	380	89
2008	55	50	55	1,260	1	368	89
2007	51	47	51	1,239	1	337	82
2006	50	46	50	1,228	1	336	82
2005	55	51	55	1,320	6	365	87
Previous Year (2010-2009)	**-26%**	**-26%**	**-26%**	**-23%**	**-7%**	**-4%**	**-17%**
CAAP Progress (2010-2005)	**-28%**	**-28%**	**-28%**	**-28%**	**-91%**	**-0.2%**	**-15%**

DB ID427

In 2010, emissions of all pollutants decreased when compared to 2009 and 2005. The decrease in emissions is due to the decrease in overall harbor craft activity and to the newer engines. In 2010, there was a significant reduction in PM and NO_x emissions due to a cleaner fleet (vessel repowers and brand new vessels) and 7% decrease in activity from the 2009 activity. In 2010, there were more Tier 2 engines than in the past due to the recent vessel repowers seen in late 2009 and into 2010 and also due to new vessels bought by companies.

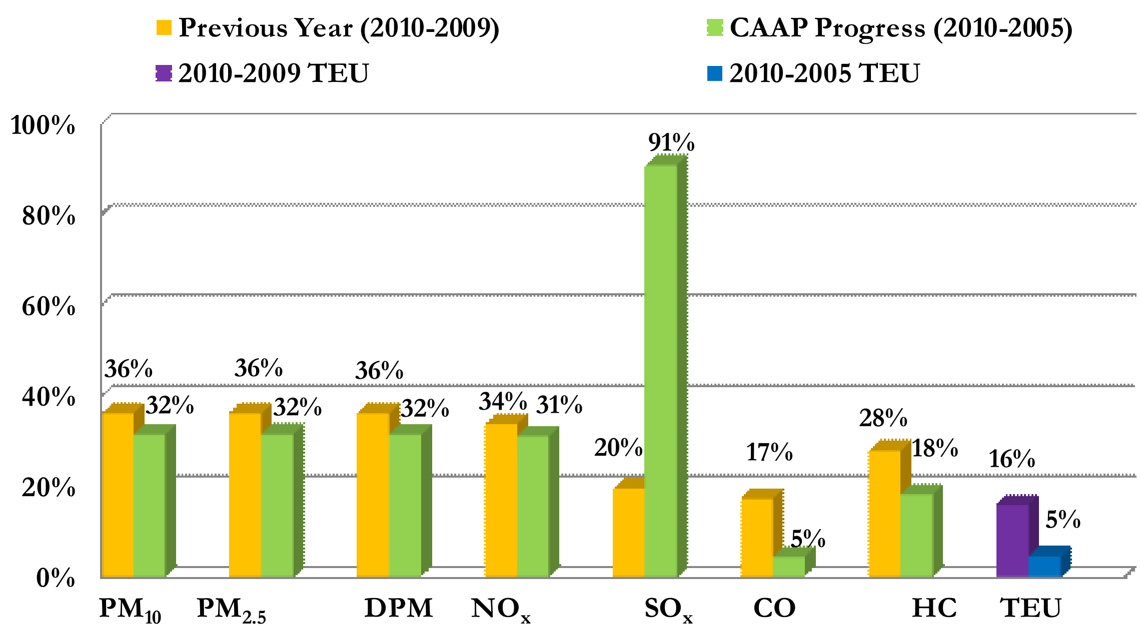
Table 9.16 shows the emissions efficiency changes from 2005 to 2010. It should be noted that total harbor craft emissions were used for this efficiency comparison although emissions from several harbor craft types (e.g., commercial fishing vessels) are not dependent on container throughput. A positive percent for the emissions efficiency comparison means an improvement in efficiency.

Table 9.16: Harbor Craft Emissions Efficiency Comparison, tons/10,000 TEU & %

EI Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
2010	0.05	0.05	0.05	1.21	0.00	0.47	0.10
2009	0.08	0.07	0.08	1.83	0.00	0.56	0.13
2008	0.07	0.06	0.07	1.60	0.00	0.47	0.11
2007	0.06	0.06	0.06	1.48	0.00	0.40	0.10
2006	0.06	0.05	0.06	1.45	0.00	0.40	0.10
2005	0.07	0.07	0.07	1.76	0.01	0.49	0.12
Previous Year (2010-2009)	**36%**	**36%**	**36%**	**34%**	**20%**	**17%**	**28%**
CAAP Progress (2010-2005)	**32%**	**32%**	**32%**	**31%**	**91%**	**5%**	**18%**

Figure 9.7 shows the harbor vessel emissions efficiency comparisons between 2010 and 2009 and between 2010 and 2005 for CAAP progress. The purple bar represents the TEU throughput change from the previous year (a 16% increase) and the blue bar represents the TEU throughput change when compared to 2005 (a 5% increase).

Figure 9.7: Harbor Craft Emissions Efficiency Comparison, %



9.1.3 Cargo Handling Equipment

The methodology used to estimate CHE emissions for the 2010 Inventory of Air Emissions changed from the methodology used in the 2009 inventory. The on-road emission factors used for 2007 and newer model year engines were revised for the 2010 inventory to reflect the impact of the 2007+ on-road engine emission standards in comparison to the off-road engine standards for the same model year. Therefore, for the emission comparisons the previous years' emissions were re-estimated using the 2010 methodology.

Table 9.17 shows there was a 3% decrease in the number of units of cargo handling equipment and a 12% increase in the overall activity level (measured as total kW-hrs, the product of the rated engine size in kW, annual operating hours and load factors) in 2010 compared to 2009. The decrease in population is attributed to the retirement of older equipment in compliance with CARB's CHE regulation and the Port's CAAP measure. The increase in activity is due to the equipment working more due to the TEU throughput increase from 2009 to 2010 and not all retired equipment got replaced. From 2005 to 2010, there was a 9% increase in population and a 7% increase in activity level.

Table 9.17: CHE Count and Activity Comparison

	Total Population	kW-hrs
2010	1,949	185,221,606
2009	2,000	165,935,481
2008	2,141	194,502,617
2007	2,014	205,495,143
2006	1,995	220,516,240
2005	1,782	173,169,439
Previous Year (2010-2009)	**-3%**	**12%**
CAAP Progress (2010-2005)	**9%**	**7%**

DB ID881

Table 9.18 summarizes the numbers of pieces of cargo handling equipment using various engine and power types, including electric, liquefied natural gas (LNG), diesel, propane, and gasoline.

Table 9.18: CHE Engine Type Matrix

Equipment	Electric	LNG	Propane	Gasoline	Diesel	Total
2010						
Forklifts	10	0	336	7	163	516
Wharf gantry cranes	70	0	0	0	0	70
RTG cranes	0	0	0	0	107	107
Side handlers	0	0	0	0	37	37
Top handlers	0	0	0	0	140	140
Yard tractors	0	5	55	0	891	951
Sweepers	0	0	1	2	10	13
Other	26	0	1	0	88	115
Total	**106**	**5**	**393**	**9**	**1,436**	**1,949**
2009						
Forklifts	3	0	342	8	185	538
Wharf gantry cranes	73	0	0	0	0	73
RTG cranes	0	0	0	0	108	108
Side handlers	0	0	0	0	40	40
Top handlers	0	0	0	0	154	154
Yard tractors	0	5	55	0	902	962
Sweepers	0	0	0	2	13	15
Other	21	0	0	0	89	110
Total	**97**	**5**	**397**	**10**	**1,491**	**2,000**
2005						
Forklifts	0	0	263	8	151	422
Wharf gantry cranes	67	0	0	0	0	67
RTG cranes	0	0	0	0	98	98
Side handlers	0	0	0	0	41	41
Top handlers	0	0	0	0	127	127
Yard tractors	0	0	53	0	848	901
Sweepers	0	0	0	3	8	11
Other	12	0	0	0	103	115
Total	**79**	**0**	**316**	**11**	**1376**	**1,782**

DB ID235

Table 9.19 summarizes the number and percentage of diesel powered CHE with various emission controls by equipment type in 2005, 2009 and 2010. The emission controls for CHE include: DOC retrofits, DPF retrofits, on-road engines (CHE equipped with on-road certified engines instead of off-road engines), LNG, use of ULSD with a maximum sulfur content of 15 ppm, and emulsified fuel. Several items to note include:

- Since some emission controls can be used in combination with others, the number of units of equipment with controls (shown in Table 9.18) cannot be added across to come up with the total equipment count (counts of equipment with controls are greater than the total equipment counts).

- With implementation of the Port's CAAP measure for CHE and CARB's CHE regulation, the relative percentage of cargo handling equipment equipped with new on-road engines increased when compared to 2005.

- Mainly due to turnover, the DOCs count have decreased since 2005 as older equipment with DOCs were replaced with newer equipment that did not require the use of DOCs.

- Emulsified fuel has not been used since 2006 due to supplier unavailability.

- ULSD has been used by all diesel equipment since 2006. For 2005, ULSD was used by some diesel equipment, but not all.

Table 9.19: CHE Diesel Equipment Emissions Control Matrix

Equipment	DOC Installed	On-Road Engines	DPF Installed	ULSD Fuel	Emulsified Fuel	Total Diesel-Powered Equipment	Powered Equipment DOC Installed	On-Road Engines	DPF Installed	ULSD Fuel	Emulsified Fuel
2010											
Forklifts	6	0	11	163	0	163	4%	0%	7%	100%	0%
RTG cranes	10	0	0	107	0	107	9%	0%	0%	100%	0%
Side handlers	9	0	0	37	0	37	24%	0%	0%	100%	0%
Top handlers	47	0	6	140	0	140	34%	0%	4%	100%	0%
Yard tractors	230	657	18	891	0	891	26%	74%	2%	100%	0%
Sweepers	0	0	0	10	0	10	0%	0%	0%	100%	0%
Other	0	8	5	88	0	88	0%	9%	6%	100%	0%
Total	**302**	**665**	**40**	**1,436**	**0**	**1,436**	**21%**	**46%**	**3%**	**100%**	**0%**
2009											
Forklifts	3	4	1	185	0	185	2%	2%	1%	100%	0%
RTG cranes	10	0	0	108	0	108	9%	0%	0%	100%	0%
Side handlers	9	0	0	40	0	40	23%	0%	0%	100%	0%
Top handlers	52	0	0	154	0	154	34%	0%	0%	100%	0%
Yard tractors	229	661	18	902	0	902	25%	73%	2%	100%	0%
Sweepers	0	1	0	13	0	13	0%	8%	0%	100%	0%
Other	0	4	0	89	0	89	0%	4%	0%	100%	0%
Total	**303**	**670**	**19**	**1,491**	**0**	**1,491**	**20%**	**45%**	**1%**	**100%**	**0%**
2005											
Forklifts	3	0	0	27	15	151	2%	0%	0%	18%	10%
RTG cranes	0	0	0	36	28	98	0%	0%	0%	37%	29%
Side handlers	14	0	0	16	10	41	34%	0%	0%	39%	24%
Top handlers	48	0	0	79	36	127	38%	0%	0%	62%	28%
Yard tractors	520	164	0	483	129	848	61%	19%	0%	57%	15%
Sweepers	0	0	0	0	0	8	0%	0%	0%	0%	0%
Other	0	1	0	65	0	103	0%	1%	0%	63%	0%
Total	**585**	**165**	**0**	**706**	**218**	**1376**	**43%**	**12%**	**0%**	**51%**	**16%**

DB ID234

Table 9.20 compares the total number of cargo handling equipment units with off-road diesel engines (meeting Tier 0, 1, 2, 3 and 4 off-road diesel engine standards) and those equipped with on-road diesel engines from 2005 to 2010. Since classification of engine standards is based on the engine's model year and horsepower, equipment with unknown horsepower or model year information are listed separately under the Unknown Tier column in this table. As indicated, over the last five years, implementation of the CAAP's CHE measure and CARB's CHE regulation have resulted in a steady increase in the prevalence of newer and cleaner equipment (i.e., primarily Tier 2 and Tier 3 with a few Tier 4) replacing the older and higher-emitting equipment (Tier 0 and Tier 1). In addition, the number of units with on-road engines, which are even cleaner than Tier 3 off-road engines, has significantly increased since 2005.

Table 9.20: CHE Diesel Engine Tier Comparison

EI Year	Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	On-road Engine	Unknown Tier	Total Diesel
2010	83	163	374	139	7	665	5	1,436
2009	114	194	381	120	6	670	6	1,491
2008	135	422	401	57	0	601	5	1,621
2007	202	578	387	36	0	293	8	1,504
2006	227	599	398	29	0	225	4	1,482
2005	256	582	360	0	0	165	13	1,376
Previous Year (2010-2009)	**-27%**	**-16%**	**-2%**	**16%**	**17%**	**-1%**	**-17%**	**-4%**
CAAP Progress (2010-2005)	**-68%**	**-72%**	**4%**	**100%**	**100%**	**303%**	**-62%**	**4%**

DB ID878

Table 9.21 shows the cargo handling equipment emissions comparisons for calendar years 2005 to 2010 in tons per year and as a percent change in 2010 compared to 2009 and 2005 (CAAP progress). As shown, in general the emissions of all pollutants have decreased over the years. Compared to 2009, the increase in 2010 DPM/PM, NO_x and SO_x emissions is due to the 16% increase in container throughput levels. The increase in DPM/PM and NO_x emissions is less than SO_x because of penetration of newer equipment with lower emissions which did not affect SO_x emissions. The decrease in CO and HC emissions is due to equipment updates due to higher quality data provided by some operators and decrease in activity of propane and gasoline equipment which are significant contributors of CO and HC emissions. The 2010 emissions compared to 2005 decreased significantly due to the implementation of the Port's CHE measure and CARB's CHE regulation resulting in the introduction of newer equipment with cleaner engines and the installation of emission controls.

Table 9.21: CHE Emissions Comparison, tons per year and %

EI Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
2010	20	19	19	804	2	594	35
2009	20	18	19	744	1	711	40
2008	31	29	30	1,165	2	739	47
2007	42	39	41	1,532	2	889	75
2006	48	44	46	1,690	2	935	87
2005	44	41	43	1,434	9	739	74
Previous Year (2010-2009)	**2%**	**3%**	**3%**	**8%**	**12%**	**-16%**	**-12%**
CAAP Progress (2010-2005)	**-54%**	**-54%**	**-55%**	**-44%**	**-82%**	**-20%**	**-53%**

DB ID237

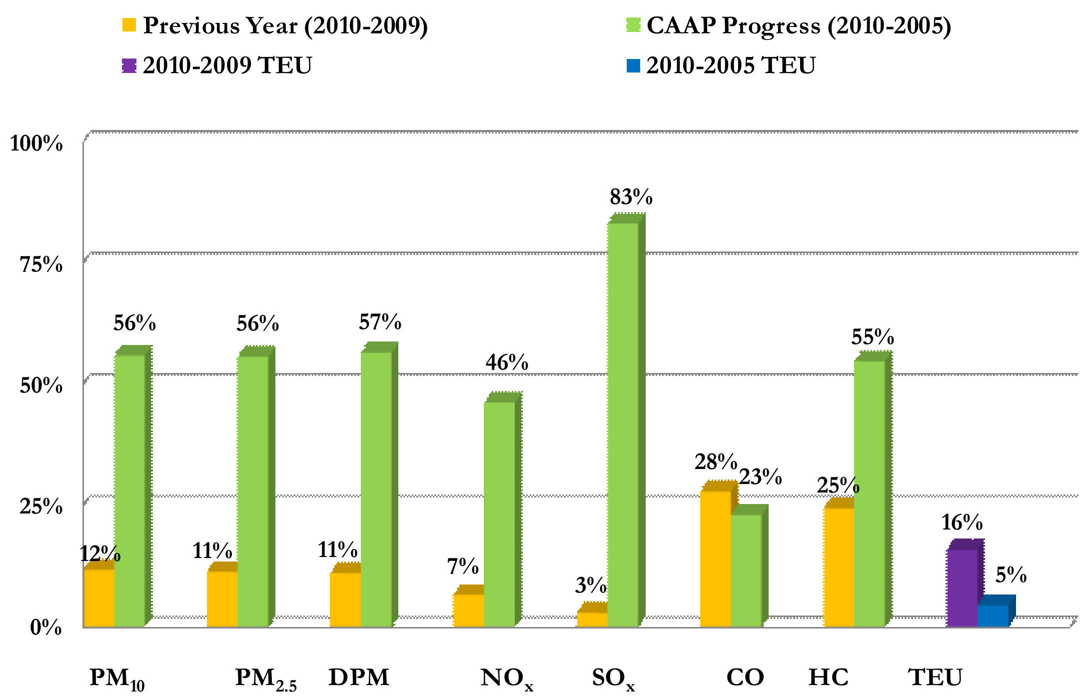
Table 9.22 shows the emissions efficiency changes over the last five years. From 2009 to 2010, there was a 16% increase in TEU throughput, and a 3% to 28% improvement in efficiency depending on pollutant. From 2005 to 2010, there was a 5% increase in TEU throughput, and a 23% to 83% improvement in emissions efficiency, depending on pollutant. A positive percentage change for the emissions efficiency comparison means an improvement in efficiency.

Table 9.22: CHE Emissions Efficiency Comparison, tons/10,000 TEU and %

EI Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
2010	0.03	0.02	0.02	1.03	0.00	0.76	0.04
2009	0.03	0.03	0.03	1.10	0.00	1.05	0.06
2008	0.04	0.04	0.04	1.48	0.00	0.94	0.06
2007	0.05	0.05	0.05	1.83	0.00	1.06	0.09
2006	0.06	0.05	0.05	2.00	0.00	1.10	0.10
2005	0.06	0.05	0.06	1.92	0.01	0.99	0.10
Previous Year (2010-2009)	**12%**	**11%**	**11%**	**7%**	**3%**	**28%**	**25%**
CAAP Progress (2010-2005)	**56%**	**56%**	**57%**	**46%**	**83%**	**23%**	**55%**

Figure 9.8 shows the CHE emissions efficiency comparisons between 2010 and 2009 and between 2010 and 2005 for the CAAP progress. The purple bar represents the TEU throughput change from the previous year (a 16% increase) and the blue bar represents the TEU throughput change when compared to 2005 (a5% increase).

Figure 9.8: CHE Emissions Efficiency Comparison, %



9.1.4 Rail Locomotives

The methodology used to estimate rail emissions in the 2010 Inventory of Air Emissions is the same as the methodology used in the 2009 inventory.

Table 9.23 shows the throughput comparisons for rail locomotives for 2005 through 2010. Compared to 2009, there was a 16% increase in total TEU throughput and an 18% increase in on-dock TEUs in 2010. The percentage of on-dock TEUs increased slightly in 2010 over 2009.

Table 9.23: TEU Throughput Comparison

Throughput	2005	2006	2007	2008	2009	2010
Total TEU Throughput	7,484,615	8,469,980	8,355,038	7,849,985	6,748,995	7,831,902
On-dock lifts	1,022,269	1,333,383	1,134,269	1,075,237	939,477	1,113,092
On-dock TEUs*	1,840,084	2,400,089	2,041,684	1,935,427	1,691,059	2,003,566
% On-Dock	25%	28%	24%	25%	25%	26%

* At an average 1.8 TEU/container

Table 9.24 shows the locomotive emissions estimate for calendar years 2005 through 2010 in tons per year and as a percentage change. The increase in emissions from rail in 2010 compared with 2009 is primarily due to increased activity in 2010. Compared to 2005, the decrease in emissions is due to rail efficiency improvements, use of cleaner fuels and turnover to cleaner locomotives.

Table 9.24: Rail Emission Comparison, tons per year and %

EI Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
2010	30	27	30	996	7	177	54
2009	28	26	28	940	7	160	51
2008	46	43	46	1,246	9	226	72
2007	61	57	61	1,821	55	268	98
2006	74	69	74	2,202	132	320	119
2005	57	53	57	1,712	98	237	89
Previous Year (2010-2009)	**7%**	**6%**	**7%**	**6%**	**11%**	**11%**	**6%**
CAAP Progress (2010-2005)	**-47%**	**-48%**	**-47%**	**-42%**	**-92%**	**-25%**	**-40%**

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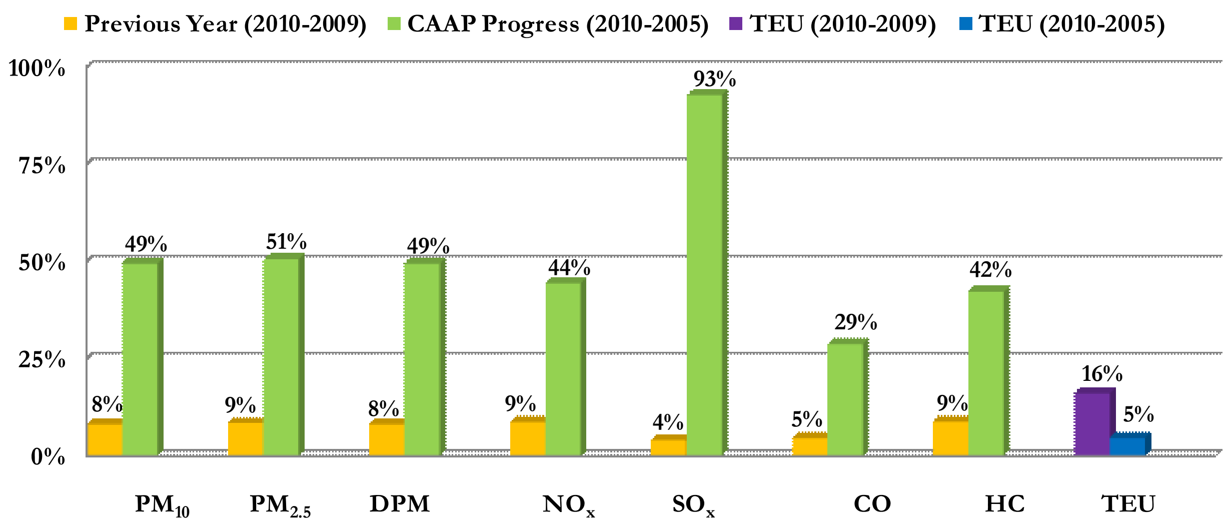
Table 9.25 and Figure 9.9 show the emissions efficiency changes from 2005 to 2010. A positive percentage for the emissions efficiency comparison means an improvement in efficiency. For both the previous year comparison (2010-2009) and the CAAP progress (2010-2005), emission efficiencies have improved for all pollutants.

Table 9.25: Rail Emissions Efficiency Comparison, tons/10,000 TEU and %

EI Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
2010	0.04	0.03	0.04	1.27	0.01	0.23	0.07
2009	0.04	0.04	0.04	1.39	0.01	0.24	0.08
2008	0.06	0.05	0.06	1.59	0.01	0.29	0.09
2007	0.07	0.07	0.07	2.18	0.07	0.32	0.12
2006	0.09	0.08	0.09	2.60	0.16	0.38	0.14
2005	0.08	0.07	0.08	2.29	0.13	0.32	0.12
Previous Year (2010-2009)	**8%**	**9%**	**8%**	**9%**	**4%**	**5%**	**9%**
CAAP Progress (2010-2005)	**49%**	**51%**	**49%**	**44%**	**93%**	**29%**	**42%**

Figure 9.9: Rail Emissions Efficiency Comparison, %



9.1.5 Heavy-Duty Vehicles

A change affecting the emissions calculation methodology for HDVs was made for this inventory, so the previous years' HDV emissions have been re-estimated in order to compare with the 2010 emissions. The EMFAC modeling incorporated new mileage accrual rates developed by CARB that are specific to port-related drayage trucks. CARB developed the revised accrual rates to better reflect the actual mileage accrual of port-related drayage trucks; the effect has been a more accurate estimate of the trucks' emissions deterioration as a function of age.

Other changes made in 2010 that do not impact the previous year emissions, but that do impact the 2010 emissions include:

- The travel demand modeling incorporated the results of a new origin/destination (O/D) survey conducted during 2010. The updated O/D information reflects changes in traffic and truck usage patterns that have occurred since the previous O/D survey was conducted in 2004. The net result of the new O/D information has been an overall 13% reduction in VMT, which is reflected in the emission estimates.

- Emissions from the increasing number of LNG-fueled trucks have been factored into the 2010 emission estimates. While the EMFAC model does not yet estimate emissions from these alternatively fueled trucks, a method was developed to account for the difference in emissions of DPM (which trucks burning natural gas do not emit). While other pollutants may be emitted at different rates, the adjustment has been focused on DPM as a pollutant of particular concern. Briefly, the method assumes zero DPM is emitted from trucks that burn solely LNG, and trucks that burn a small amount of diesel along with LNG are assumed to emit DPM at 10% of their PM_{10} emission rates. An adjustment factor has been developed to convert the overall model year-composite PM_{10} emission factors (by speed range) to DPM, as a replacement for the previous practice of setting the DPM emission factors equal to the PM_{10} factors (because all PM_{10} emissions from diesel engines is classified as DPM).

Emissions from the HDV source category have continued to improve due largely to the following factors affecting the number of truck visits, newer trucks, and average idling times.

- Reduced number of truck trips in 2010 as compared to 2006-2007 when the TEU throughput was at its highest.
- Younger fleet of trucks in 2010 due to the Port's CTP launched October 2008 which includes a progressive ban of older trucks between 2008 and 2012.
- The terminals continued to optimize their gate systems with OCR and the addition of RFID readers to identify and help check in trucks complying with the CTP ban provisions, which also helped reduce idling time.
- Since July 2005, all marine terminals at the San Pedro Bay ports offer off-peak shifts on nights and weekends. As part of the program, a Traffic Mitigation Fee is required for cargo movement through the ports during peak daytime hours.

Table 9.26 shows the continuous improvement in total port-wide idling time.

Table 9.26: HDV Idling Time Comparison, hours

EI Year	Total Idling Hours
2010	1,787,789
2009	1,830,371
2008	2,097,600
2007	2,334,568
2006	2,962,463
2005	3,017,252
Previous Year (2010-2009)	**-2%**
CAAP Progress (2010-2005)	**-41%**

Table 9.27 summarizes the average age of the port-related fleet from 2005 to 2010. The average age of the trucks visiting the Port is 6.2 years (population-weighted) and 2.2 years (call-weighted). The newer fleet is attributed to the Port's Clean Truck Program which was launched in October 2008 requiring the progressive ban of pre-2007 trucks between 2008 and 2012.

Table 9.27: Port-related Fleet Weighted Average Age

Year	Population-Weighted Average Age (years)	Call-Weighted Average Age (years)
2010	6.2	2.2
2009	10.9	6.9
2008	12.1	11.6
2007	12.2	12.4
2006	11.4	11.3
2005	11.2	11.2

Table 9.28 summarizes the HDV emissions from 2005 to 2010 and the percent change in 2010 compared to 2009 and 2005. As shown, the HDV emissions of all pollutants in 2010 have decreased significantly due to the implementation of the Clean Truck Program, reduced on-terminal idling and reduced cargo throughput compared to some of the previous years.

Table 9.28: HDV Emissions Comparison, tons per year and %

EI Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
2010	30	27	28	1,523	4	352	71
2009	95	88	95	4,046	5	865	169
2008	197	181	197	6,770	5	1,563	299
2007	211	194	211	6,859	6	1,569	302
2006	274	252	274	7,747	40	1,941	350
2005	257	237	257	6,553	48	1,753	318
Previous Year (2010-2009)	**-69%**	**-69%**	**-71%**	**-62%**	**-17%**	**-59%**	**-58%**
CAAP Progress (2010-2005)	**-88%**	**-88%**	**-89%**	**-77%**	**-91%**	**-80%**	**-78%**

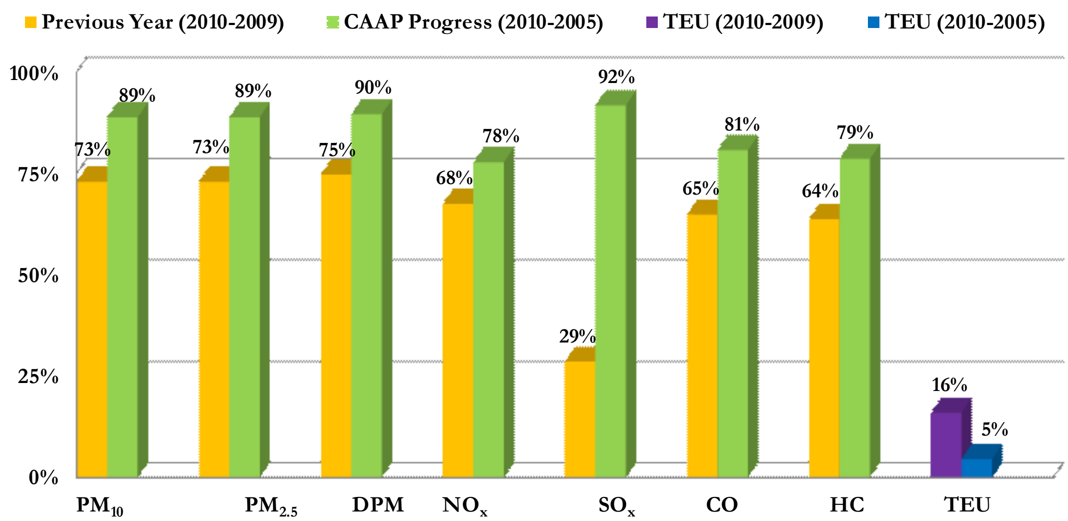
Table 9.29 and Figure 9.10 show the emissions efficiency changes. A positive percentage for the emissions efficiency comparison means an improvement in efficiency. Comparing 2010 to 2005 for CAAP progress, emission efficiency has improved for all pollutants. Comparing 2010 to 2009, emission efficiency has also improved for all pollutants.

Table 9.29: HDV Emissions Efficiency Comparison, tons/10,000 TEU and %

EI Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
2010	0.04	0.04	0.04	1.95	0.01	0.45	0.09
2009	0.14	0.13	0.14	5.99	0.01	1.28	0.25
2008	0.25	0.23	0.25	8.62	0.01	1.99	0.38
2007	0.25	0.23	0.25	8.21	0.01	1.88	0.36
2006	0.32	0.30	0.32	9.15	0.05	2.29	0.41
2005	0.34	0.32	0.34	8.75	0.06	2.34	0.42
Previous Year (2010-2009)	**73%**	**73%**	**75%**	**68%**	**29%**	**65%**	**64%**
CAAP Progress (2010-2005)	**89%**	**89%**	**90%**	**78%**	**92%**	**81%**	**79%**

The purple bar represents the TEU throughput change from the previous year (a 16% increase) and the blue bar represents the TEU change when compared to 2005 (a 5% increase).

Figure 9.10: HDV Emissions Efficiency Comparison, %



9.2 CAAP Standards and Progress

One of the main purposes of the annual inventories is to provide a progress update on achieving the CAAP's San Pedro Bay Standards. These standards consist of the following emission reduction goals, compared to the 2005 published inventories:

- Emission Reduction Standard:
  - By 2014, achieve emission reductions of 72% for DPM, 22% for NO_x, and 93% for SO_x
  - By 2023, achieve emission reductions of 77% for DPM, 59% for NO_x, and 93% for SO_x
- Health Risk Reduction Standard: 85% reduction by 2020

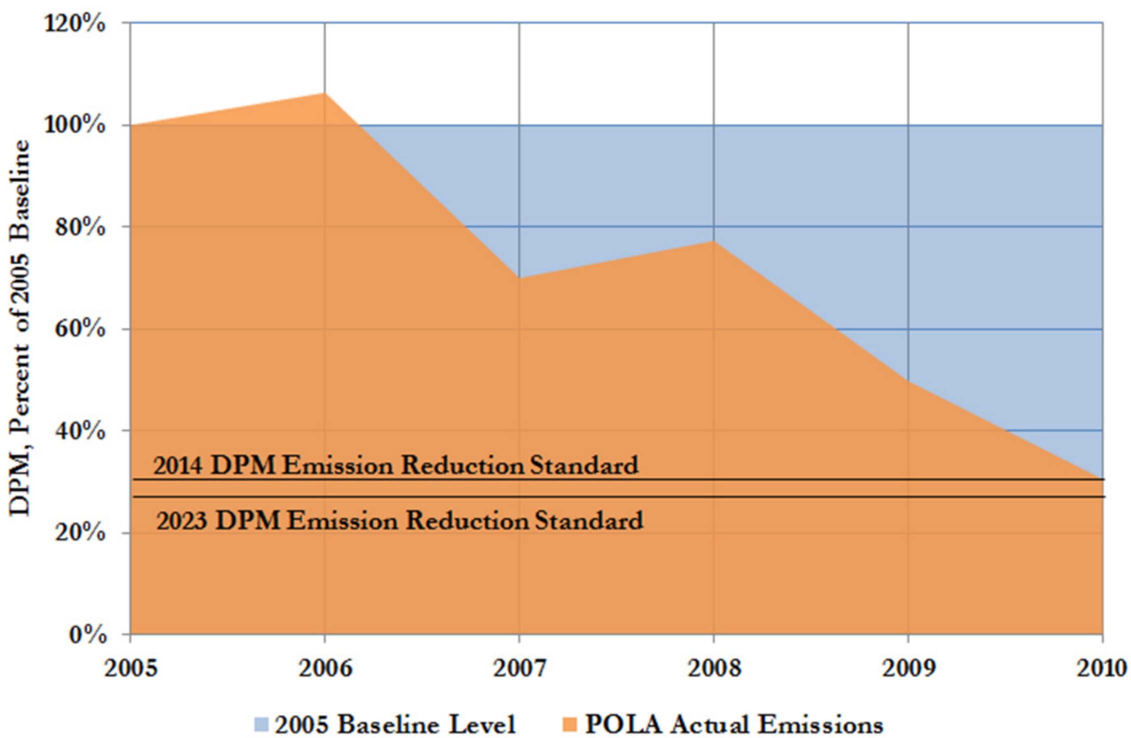
The Emission Reduction Standards are represented as a percentage reduction of emissions from 2005 levels, and are tied to the regional SoCAB attainment dates for the federal $PM_{2.5}$ and ozone ambient air quality standards in the 2007 AQMP. This and future inventories will be used as a tool to track progress in meeting the emission reduction standards. Tables 9.30 to 9.32 show the standardized estimates of emissions by source category for calendar years 2005 through 2009, using current year methodology. Figures 9.11 through 9.13 present the 2005 baseline emissions and the year to year percent change in emissions with respect to the 2005 baseline emissions as well as present the 2014 and 2023 standards to provide a snapshot of progress to-date towards meeting those standards. In Figure 9.11, DPM emissions reductions are presented as a surrogate for $PM_{2.5}$ reductions since DPM is directly related to $PM_{2.5}$ emissions (equivalent of PM_{10} emissions from diesel-powered sources). In Figure 9.12, NO_x emissions reductions are presented since NO_x is a precursor to the ambient ozone formation and it also contributes to the formation of $PM_{2.5}$. SO_x emissions reductions are presented in Figure 9.13 because of the contribution of SO_x to $PM_{2.5}$ emissions.

It is important to note that a portion of the current year's emission reductions are attributable to lower cargo throughout if compared to some of the previous year emissions such as in 2006 and 2007. As anticipated cargo volumes increase in the upcoming years, the reduction trend may not continue at the same rate experienced over the last few years. However, continued implementation of several significant emission reduction programs, such as the Port's Clean Truck Program, Vessel Speed Reduction, AMP and CARB's regulatory strategies for port-related sources, is expected to substantially mitigate the impact of resumed cargo growth.

Table 9.30: DPM Emissions by Calendar Year and Source Category, tpy

Category	2005	2006	2007	2008	2009	2010
OGV	477	500	257	359	246	154
HC	55	50	51	55	54	40
CHE	43	46	41	30	19	19
Rail	57	74	61	46	28	30
HDV	257	274	211	197	95	28
Total	**888**	**945**	**622**	**687**	**442**	**271**
% Cumulative Change		**6%**	**-30%**	**-23%**	**-50%**	**-69%**

Figure 9.11: DPM Reductions - Progress to Date Compared to 2005

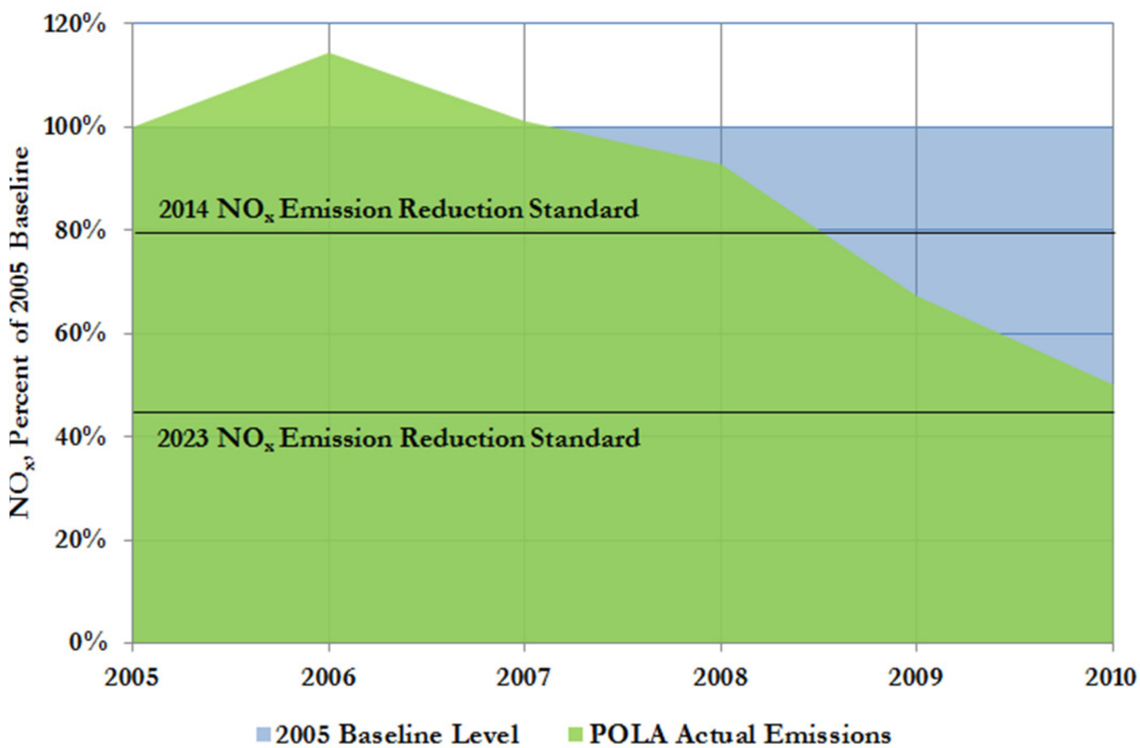


As presented above, by 2010, the Port has almost met the 2014 DPM emission reduction standards.

Table 9.31: NO_x Emissions by Calendar Year and Source Category, tpy

Category	2005	2006	2007	2008	2009	2010
OGV	5,378	5,886	5,123	4,771	4,055	3,944
HC	1,320	1,228	1,239	1,260	1,238	950
CHE	1,434	1,690	1,532	1,165	744	804
Rail	1,712	2,202	1,821	1,246	940	996
HDV	6,553	7,747	6,859	6,770	4,046	1,523
Total	**16,396**	**18,754**	**16,575**	**15,212**	**11,023**	**8,216**
% Cumulative Change		**14%**	**1%**	**-7%**	**-33%**	**-50%**

Figure 9.12: NO_x Reductions - Progress to Date Compared to 2005

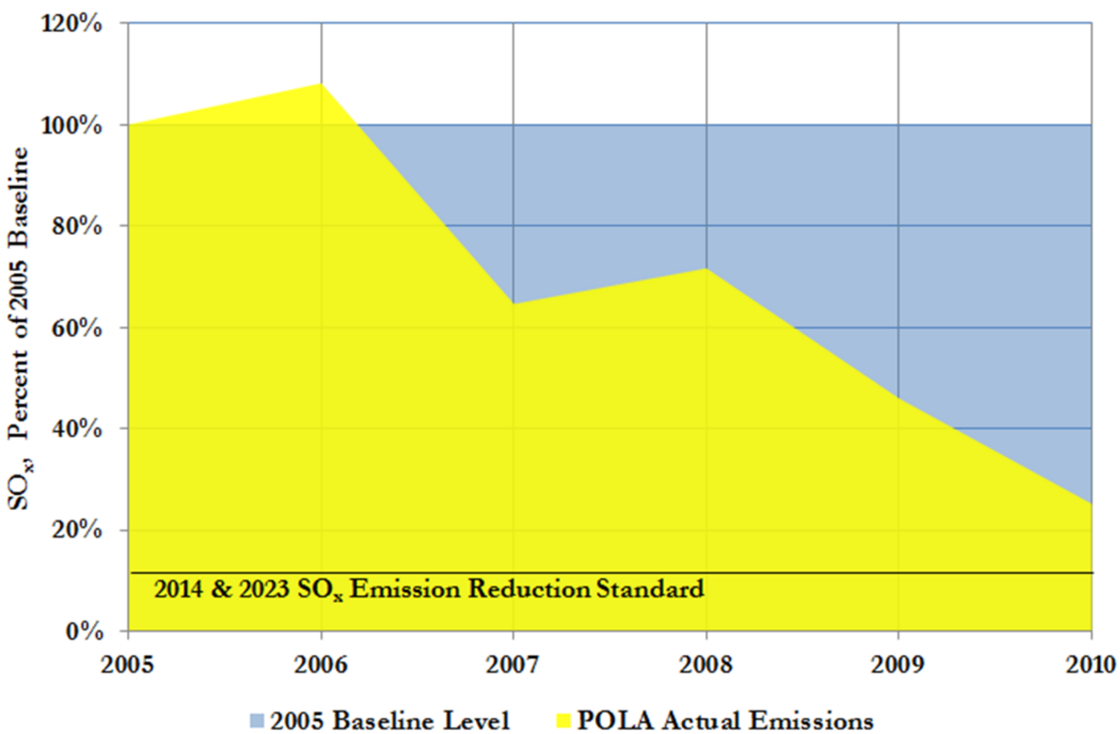


As presented above, the Port is exceeding the 2014 NO_x mass emission reduction standard in 2010 and is more than three quarters of the way towards meeting the 2023 standard.

Table 9.32: SO_x Emissions by Calendar Year and Source Category, tpy

Category	2005	2006	2007	2008	2009	2010
OGV	5,156	5,577	3,372	3,791	2,431	1,325
HC	6	1	1	1	1	1
CHE	9	2	2	2	1	2
Rail	98	132	55	9	7	7
HDV	48	40	6	5	5	4
Total	**5,317**	**5,752**	**3,435**	**3,808**	**2,444**	**1,339**
% Cumulative Change		**8%**	**-35%**	**-28%**	**-54%**	**-75%**

Figure 9.13: SO_x Reductions - Progress to Date Compared to 2005



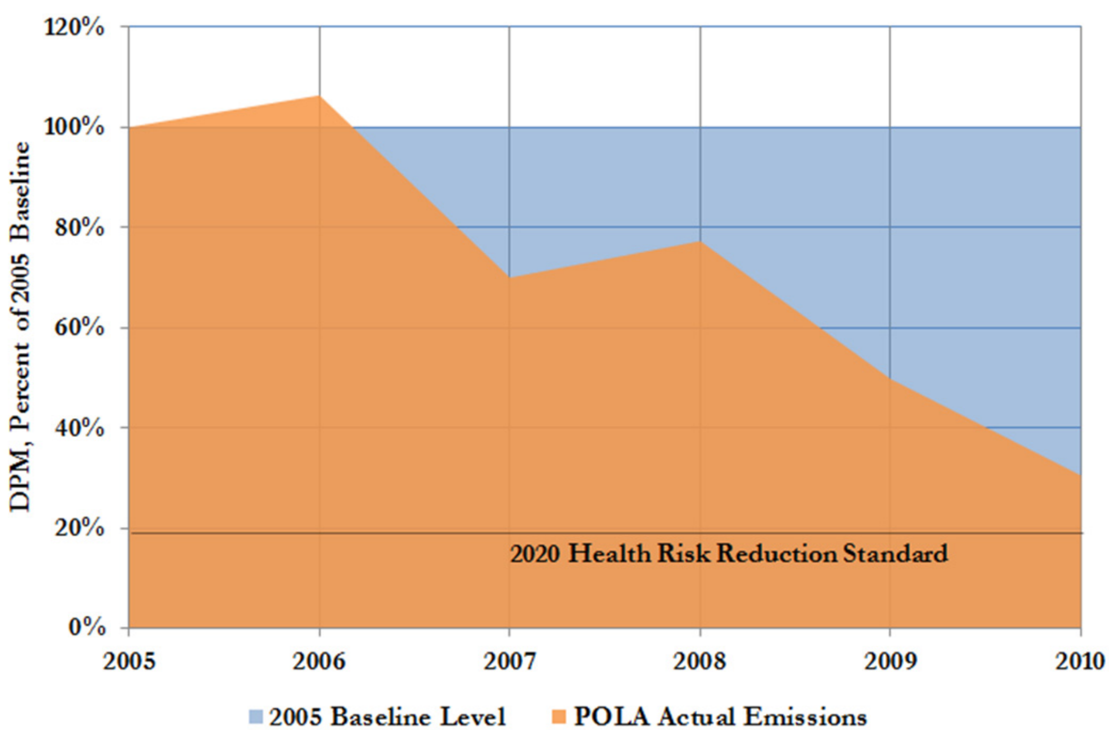
As presented above, by 2010, the Port is more than three quarters of the way towards meeting the SO_x mass emission reduction standards. The slight erosion of SO_x reductions from 2007 and 2008 was due to the injunction against the previous CARB OGV fuel rule in 2008.

Health Risk Reduction Progress

As described in Section 2 of the 2010 CAAP Update, the effectiveness of CAAP's control measures and applicable regulations with respect to the Health Risk Reduction Standard can be tracked by changes in mass emission reductions in DPM from the 2005 baseline. DPM is the predominant contributor to port-related health risk, and the Health Risk Reduction Standard was based on a health risk assessment study that used forecasted reductions in geographically allocated DPM emissions as the key input. Therefore, reductions in DPM mass emissions associated with CAAP measures and applicable regulations are a representative surrogate for health risk reductions. It should be noted that the use of DPM emissions as a surrogate for health risk reductions is to track relative progress. A more detailed health risk assessment will be prepared by the port outside of this EI.

Progress to-date on health risk reduction is determined by comparing the change in DPM mass emissions to the 2005 baseline. Figure 9.14 presents the progress of achieving the standard to date.

Figure 9.14: Health Risk Reduction Benefits - Progress To Date



As shown above, by 2010 the Port is over three quarters of the way towards meeting the 2020 Health Risk Reduction Standard.

SECTION 10 LOOKING FORWARD

10.1 Anticipated Impacts of Control Programs on Emissions in 2011

As presented in this 2010 EI report, the Port-related mobile source emissions have continued to decrease over the last several years in part due to the reduced cargo throughput (reflective of global economic conditions) as well as the implementation of the CAAP and regulatory programs affecting these sources. For 2011, the trend in TEU throughput is expected to increase as evidenced by the TEU throughput levels in the first quarter of 2011. Although the anticipated increase in throughput level in 2011 may offset some of the emissions reductions seen in 2010, the implementation of the CAAP measures and regulatory programs will continue to provide emissions benefits in 2011 and later years. The 2011 EI will reflect the Port's actual throughput level in 2011 and the net emissions benefits associated with these programs and strategies. In addition, consistent with the Port's EI development process, the latest available emission factors and methods as well as methodological improvements will be incorporated in the 2011 EI.

The following is a brief description of the anticipated impacts of control programs and measures in 2011 for each category, which will result in further reduction of emissions from these port-related sources:

OGV

In 2011, continued implementation of the CAAP measures, including the use of shore power for vessels at berth and the Port's vessel speed reduction program, will result in significant emission benefits. In addition, CARB's marine fuel regulation requiring the use of lower sulfur fuel (0.5% sulfur) in main and auxiliary engines and auxiliary boilers within 24 nm of the California coastline, which became effective on July 1, 2009 will continue in 2011. Further, the trend toward newer vessels complying with new IMO standards and incorporating emission reduction technologies is expected to continue offering additional emission benefits in 2011.

Harbor Craft

Under CARB's regulation for commercial harbor craft, in-use, newly purchased, or replacement engines in ferries, excursion vessels, tug boats and tow boats must meet EPA's most stringent emission standards per a compliance schedule set by CARB for in-use engines and from new engines at the time of purchase. For harbor craft with home ports in the SoCAB, the compliance schedule for in-use engine replacements began in 2010 with the oldest model year engines (1979 and earlier). In addition, existing older engines could be replaced with newer engines in advance of CARB's regulation for affected engines or in vessels not subject to CARB' regulation (e.g., crew boats, work boats) at company's own expense and with the help of grants.

CHE
In 2011, the continued implementation of the CAAP measure for CHE and CARB's in-use CHE regulation will result in emissions benefits due to the replacement of existing older equipment with newer and cleaner equipment powered by on-road engines or Tier 3 off-road engines.

Rail
The 1998 MOU among the Class 1 railroads (UP and BNSF), CARB, and EPA requires the accelerated introduction of cleaner locomotives in SoCAB. Specifically, the MOU requires BNSF and UP to achieve fleet-wide average emission rates meeting EPA's Tier 2 line haul emission standards for their locomotives operating in SoCAB by 2010. The averaging provisions included in the MOU, which allow the railroads to average line haul and switching emissions to achieve the Tier 2 line haul average, mean that the line haul locomotives may not average Tier 2 emission levels because of reductions achieved through the use of low-emission switching locomotives. However, additional reductions in 2011 and subsequent years are anticipated from line haul locomotives due to implementation of the MOU.

HDV
Under the Port's Clean Truck Program (CTP), following the first phase of the progressive ban of older trucks operating at the Port (banning pre-1989 trucks from port service) in October 2008, the second phase of the CTP was implemented in 2010. Specifically, as of January 1, 2010, all 1989-1993 model year trucks, as well as the non-retrofitted 1994-2003 model year trucks (i.e., not achieving CARB Level 3 PM reduction plus 25% NO_x reduction), were banned from port service. Implementation of the CTP has resulted in significant emissions reductions due to turnover of older trucks with newer. The Port will continue the efforts to increase the population of alternatively-fueled trucks serving the Port.

10.2 Future Improvements to Emissions Inventory Methodologies

In an effort to improve the annual air emissions inventories, the methodologies to estimate emissions continue to evolve with the development and discovery of new data and information. This subsection describes the proposed, but not limited to improvements to methodologies for estimating emissions in future inventories, by category.

OGV

Improvements to the methodology to estimate OGV emissions will be considered in at least two areas: 1) engine modification technologies incorporated into new engines as standard practice and installed as retrofits in existing vessels. The ports will continue to work with engine manufacturers and shipping companies, and through the TWG process, to further refine the emissions benefits associated with slide valves (new engines and retrofits) as well as other technologies being implemented; 2) in an effort to continue to improve the auxiliary engine loads by vessel mode, a new approach will be considered, in consultation with TWG, based on VBP reported auxiliary loads (actual power of the engine used), by vessel class and by mode instead of using the average installed auxiliary engine power adjusted by applying load factor by vessel class and mode. Under the proposed approach, default loads for auxiliary engines by operating mode will be based on the average of loads for each vessel subclass recorded for vessels boarded. Load Factors will no longer be used as installed power, as this is not a scalable variable by vessel owner and class, which may result in potential over/under estimates of auxiliary engine load. Information from CARB surveys, if available, will also be used for filling any data gaps; 3) the proposed CARB boundary change for the OGV Fuel Regulation will be taken into consideration.

Harbor Craft

The Port will work closely with vessel operators which provide activity data for the entire domain to separate out port-related activity, if possible. The Port will also work with CARB to harmonize GHG emission factors for harbor craft. As a part of data collection enhancement, the Port will strive to obtain engine emission certification for the recently purchased or repowered engines that may be available at the time of purchase or repower.

CHE

CARB is currently working on changes to the statewide emissions inventory for CHE. Any changes CARB makes to the methodology will be reviewed and incorporated, if applicable, to next year's CHE EI.

Rail

The Port expects to receive information from CARB on the Class 1 railroads' methods of complying with the MOU requiring an average of Tier 2 emissions in 2010 and later years. This information is expected to include the percentage of line haul locomotives in each tier level, the fleet mix, among locomotives arriving and departing the SoCAB; this will allow the emission estimates to reflect local conditions rather than EPA's nationwide fleet mix assumptions for the calendar year. The information may also include more specifics on the types of switching locomotives in use by the Class 1 railroads.

HDV

As part of the San Pedro Bay Ports' Clean Truck Programs, the container terminals have been collecting truck entry data using radio frequency identification (RFID) technology. This data is collected and correlated with truck-specific information contained in the Drayage Truck Registry (DTR) that has also been established as part of the truck programs. The RFID/DTR data may prove to supplement or replace the OCR/DMV data in evaluating the model year distribution of future Port-related fleets. The Port will also examine the use of engines one model year older than the truck model year which affect HDV emissions, particularly for 2010 model year trucks.