PORT OF LOS ANGELES INVENTORY OF AIR EMISSIONS - 2015

THE PORT OF LOS ANGELES

Technical Report
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July 2016

Prepared by:
STARCREST CONSULTING GROUP, LLC

INVENTORY OF AIR EMISSIONS FOR CALENDAR YEAR 2015

Prepared for:

THE PORT OF LOS ANGELES

July 2016

Prepared by:

STARCREST CONSULTING GROUP, LLC
ENVIRONMENTAL MANAGEMENT
AIR QUALITY • CLIMATE • SUSTAINABILITY

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Please note that there may be minor inconsistencies, due to rounding, associated with emission estimates, percent contribution, and other calculated numbers between the various sections, tables, and figures of this report. All estimates are calculated using more digits than presented in the various sections.

EXECUTIVE SUMMARY

The Port of Los Angeles (Port or POLA) annual activity-based emissions inventories serve as the primary tool to track the Port's efforts to reduce air emissions from maritime industry-related sources through implementation of measures identified in the San Pedro Bay Ports Clean Air Action Plan (CAAP) and regulations promulgated at the state and federal levels. Development of the annual air emissions estimates is coordinated with a technical working group (TWG) comprised of representatives from the Port, the Port of Long Beach, and the air regulatory agencies: U.S. Environmental Protection Agency (EPA), Region 9, California Air Resources Board (CARB), and the South Coast Air Quality Management District (SCAQMD).

Summary of 2015 Activity and Emission Estimates

Table ES.1 presents the number of vessel calls and the container cargo throughput for calendar years 2005, 2014 and 2015. There was a significant decrease in the number of container ship calls and a significant increase in the average number of containers per containership call over previous years, building on the trend of fewer larger ships bringing similar cargo volumes.

Table ES.1: Container Throughput and Vessel Arrival Call Comparison

Year	All Arrivals	Containership Arrivals	Containers TEUs	Average Containers per Call
2015	1,774	1,146	8,160,458	7,121
2014	1,962	1,413	8,340,066	5,902
2005	2,516	1,479	7,484,625	5,061
Previous Year (2014-2015)	**-10%**	**-19%**	**-2%**	**21%**
CAAP Progress (2005-2015)	**-29%**	**-23%**	**9%**	**41%**

Table ES.2 summarizes the 2015 total maritime industry-related mobile source emissions of air pollutants in the SoCAB by the following categories: ocean-going vessels (OGVs), harbor craft (HC), cargo handling equipment (CHE), locomotives, and heavy-duty vehicles (HDV).

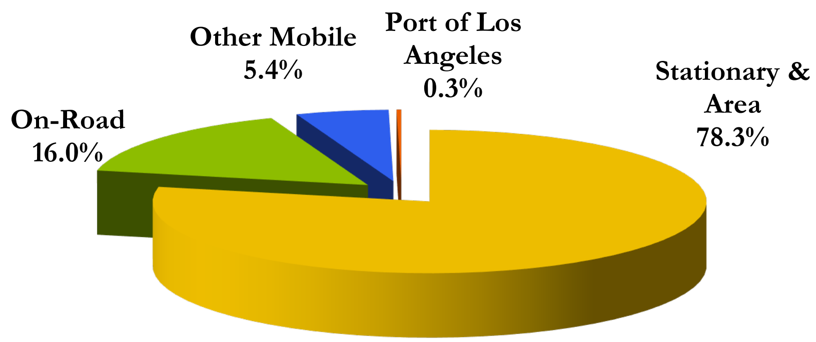
Table ES.2: 2015 Maritime Industry-related Emissions by Category

Category	PM_{10} tons	$PM_{2.5}$ tons	DPM tons	NO_x tons	SO_x tons	CO tons	HC tons	CO_2e tonnes
Ocean-going vessels	74.7	69.4	59.3	3,779.7	124.6	320.7	146.2	248,431
Harbor craft	30.5	28.1	30.5	825.5	0.7	487.4	80.9	61,013
Cargo handling equipment	9.1	8.5	7.2	557.3	1.8	760.3	84.9	170,710
Locomotives	30.2	27.5	30.2	819.0	0.8	194.3	45.8	68,432
Heavy-duty vehicles	8.3	8.0	7.7	1,895.9	4.2	134.6	36.2	381,737
Total	**152.9**	**141.4**	**134.9**	**7,877.3**	**132.1**	**1,897.3**	**394.0**	**930,324**

DB ID457

In order to put the maritime industry-related emissions into context, the following figures and tables compare the Port's contributions to the total emissions in the SoCAB by major emission source category. The 2015 SoCAB emissions are based on the 2012 AQMP Appendix III.[1] The category "Other Mobile" includes aircraft, trains, ships, commercial boats, recreational boats, off-road recreational vehicles, and off-road equipment. The on-road source category includes light duty vehicles, medium duty trucks, heavy duty trucks, motorcycles, and buses. Due to rounding, the percentages may not add up to 100% in the pie charts shown below. It should be noted that SoCAB PM_{10} and $PM_{2.5}$ emissions for on-road vehicles include brake and tire wear emissions whereas the Port's HDV emissions are presented for exhaust emissions only.

Figure ES.1: 2015 PM_{10} Emissions in the South Coast Air Basin



[1] SCAQMD, *Final 2012 AQMP Appendix III, Base & Future Year Emissions Inventories*, February 2013

Figure ES.2: 2015 $PM_{2.5}$ Emissions in the South Coast Air Basin

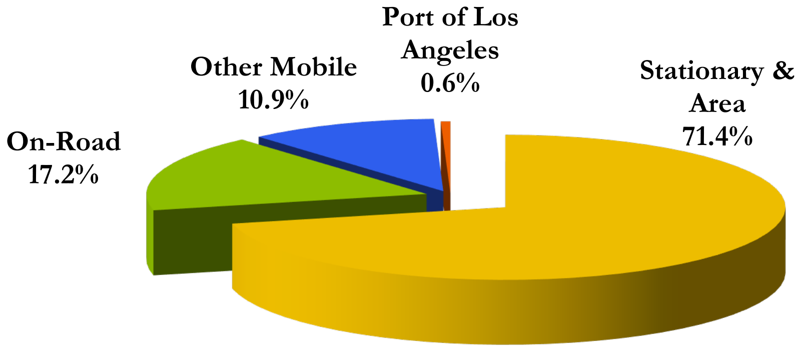


Figure ES.3: 2015 DPM Emissions in the South Coast Air Basin

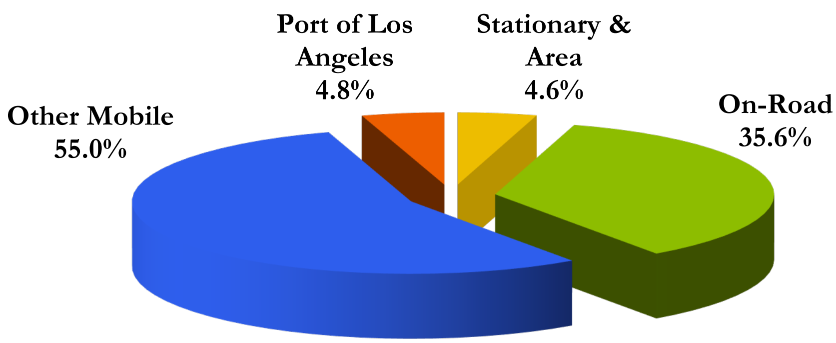


Figure ES.4: 2015 NO_x Emissions in the South Coast Air Basin

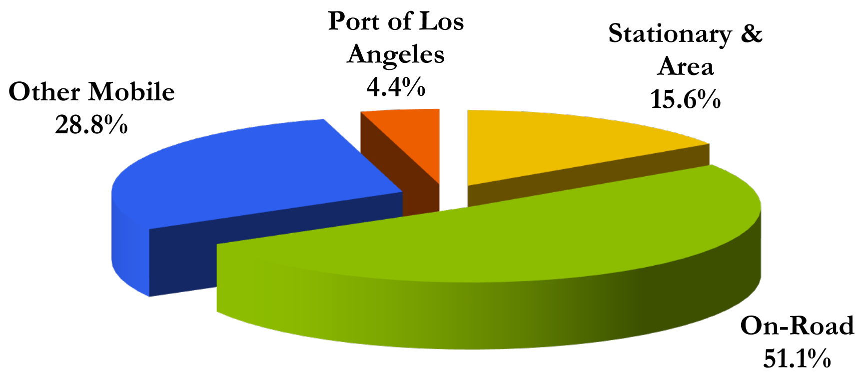


Figure ES.5: 2015 SO_x Emissions in the South Coast Air Basin

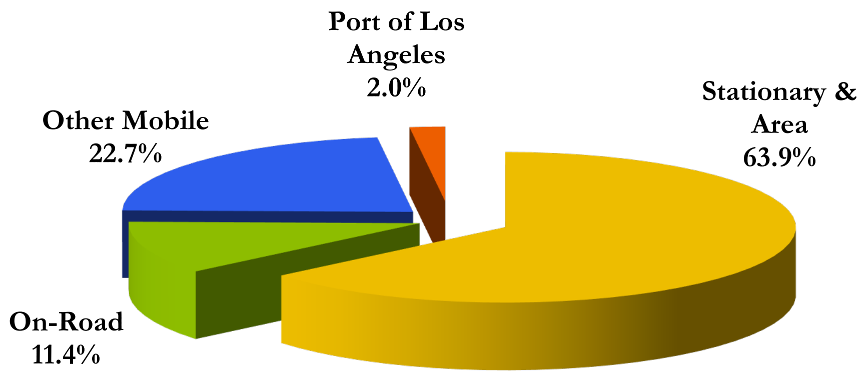


Figure ES.6 presents the decline of the maritime industry-related mobile source emissions in percentage of the total SoCAB emissions from 2005 to 2015. The Port's overall contribution to the SoCAB emissions has decreased significantly for SO_x and DPM emissions since 2005, primarily because of the implementation of various emission reduction programs by the Ports and regulatory agencies, and efficiency improvements from the maritime industry.

Figure ES.6: Port's Emission Contribution in the South Coast Air Basin

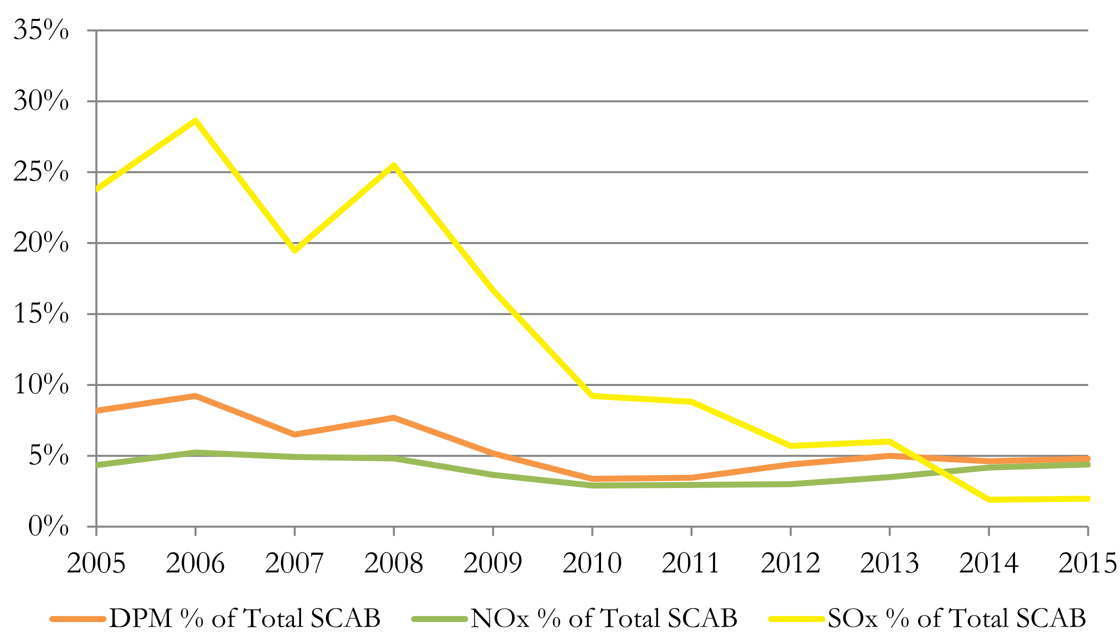


Table ES.3 presents the total net change in emissions from all source categories in 2015 as compared to the previous year and to 2005. An unusual temporary period of increased congestion that occurred in the fall 2014 and the first half of 2015 detrimentally impacted air emissions. This is clearly seen in the increase in anchorage calls by containerships, which typically do not spend time at the anchorages. In addition to the increase in anchorage calls, there was a significant increase in intra-terminal shifts in 2015. In previous years, intra-terminal shifts were not a common occurrence.

Table ES.3: Maritime Industry-related Emissions Comparison

EI Year	PM_{10} tons	$PM_{2.5}$ tons	DPM tons	NO_x tons	SO_x tons	CO tons	HC tons	CO_2e tonnes
2015	153	141	135	7,877	132	1,897	394	930,324
2014	148	137	133	7,724	128	1,906	396	869,141
2005	954	825	878	16,202	4,956	3,759	851	1,029,968
Previous Year (2014-2015)	**3%**	**4%**	**2%**	**2%**	**3%**	**0%**	**-1%**	**7%**
CAAP Progress (2005-2015)	**-84%**	**-83%**	**-85%**	**-51%**	**-97%**	**-50%**	**-54%**	**-10%**

Comparing 2015 emissions to the previous year, emissions increased slightly for PM, NO_x and SO_x, but were lower for CO and hydrocarbon emissions. Carbon dioxide emissions increased by 7% compared to 2014. The increase in emissions is primarily due to the following factors:

- Containership activities shifting to and from anchorage
- Increased containership intra-terminal shifts associated with repositioning ships to maximize berth space
- OGVs spent more time at anchorage due to a temporary period of increased congestion for the first half of 2015 and also due to larger vessels calling the Port in 2015.
- OGVs spent more time at berth due to larger vessels calling the Port in 2015 and due to the temporary period of increased congestion.
- Less fleet turnover for trucks and harbor craft in 2015.

Reductions were seen in all pollutants when comparing 2015 to 2005. Several factors contributed to lower emissions in 2015 compared to 2005. Major highlights by source category include:

- For OGV, the primary reasons for emission reductions are: fuel switching, shore power, Port's Environmental Ship Index (ESI) Incentive Program, and Vessel Speed Reduction (VSR) compliance. The CARB OGV Fuel Regulation continued to be in effect in 2015 and all engines continued to use fuel with 0.1% sulfur since 2014. The CARB Regulation, which focused on reducing emissions at berth (i.e., shore power) was also in effect in 2015 for the second year of compliance for certain vessel types.
- For harbor craft, the emissions in 2015 are lower than 2005 emissions due to the repowers that have occurred in the last few years as required by the CARB Harbor Craft Regulation. However, there were not as many repowers in 2015 as in previous years (2009-2013) due to the CARB Harbor Craft Regulation's phased compliance dates. By the end of 2013, the majority of the older pre-2000 MY engines had been repowered. The 2000 MY and newer engines will continue to be repowered at a slower pace and with fewer reductions than the older engines provided.
- For CHE, implementation of CAAP measures and CARB's Cargo Handling Equipment Regulation, along with funding incentives, resulted in replacement of older equipment with cleaner units, retrofits, and repowers that led to lower emissions.
- For locomotives, the decreases in fleet-wide emissions from line haul locomotives are due to meeting the terms of the memorandum of understanding (MOU) with CARB, and the replacement of older switching locomotives with new low-emission and ultra-low emission switchers.
- For HDV, the 2012 implementation of the final phase of the Port's Clean Truck Program (CTP) resulted in significant turnover of older trucks to newer and cleaner trucks as compared to 2005.

Table ES.4 summarizes the annualized emissions efficiencies for all five source categories. The overall emission efficiency in 2015 improved for all pollutants as compared to 2005. Compared to the previous year, there was a decrease in emissions efficiency for most pollutants. In Table ES.4, a positive percentage means an increase in emissions efficiency.

Table ES.4: Emissions Efficiency Metric Comparison, tons or tonnes/10,000 TEUs

EI Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC	CO_2e
2015	0.187	0.173	0.165	9.65	0.16	2.33	0.48	1,140
2014	0.177	0.164	0.159	9.26	0.15	2.29	0.47	1,042
2005	1.274	1.102	1.173	21.65	6.62	5.02	1.14	1,376
Previous Year (2014-2015)	**-6%**	**-5%**	**-4%**	**-4%**	**-7%**	**-2%**	**-2%**	**-9%**
CAAP Progress (2005-2015)	**85%**	**84%**	**86%**	**55%**	**98%**	**54%**	**58%**	**17%**

CAAP Standards and Progress

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

- 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 EI is used as a tool to track progress in meeting the emission reduction standards.

Figures ES.7 through ES.9 present the 2005 baseline emissions and the year to year percent change in emissions with respect to the 2005 baseline emissions. The 2014 and 2023 standards are also provided as a snapshot of progress to-date towards meeting those standards. The pink line in the figures represents percentage TEUs throughput as compared to 2005 TEU throughput. These figures provide context to the relative correlation between cargo throughput and emissions.

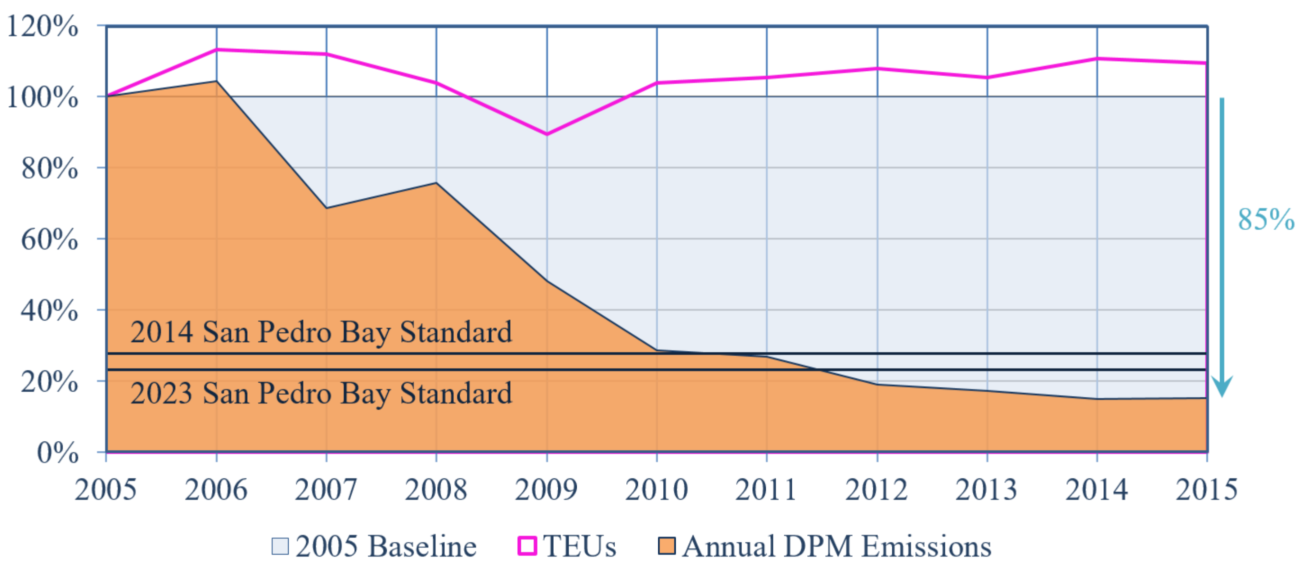
Due to the many emission reduction measures undertaken by the Port, as well as statewide and federal regulations and standards, the 2014 emission reduction standard continued to be met and exceeded in 2015 for DPM, NO_x and SO_x. Looking towards the future, the 2023 emission reduction standard has been met and exceeded for DPM and SO_x. Below is a summary of DPM, NO_x and SO_x percent reductions as compared to the 2015 emission reduction standards.

Table ES.5: Reductions as Compared to 2014 Emission Reduction Standard

Pollutant	2015 Actual Reductions	2014 Emission Reduction Standard	2023 Emission Reduction Standard
DPM	85%	72%	77%
NO_x	51%	22%	59%
SO_x	97%	93%	93%

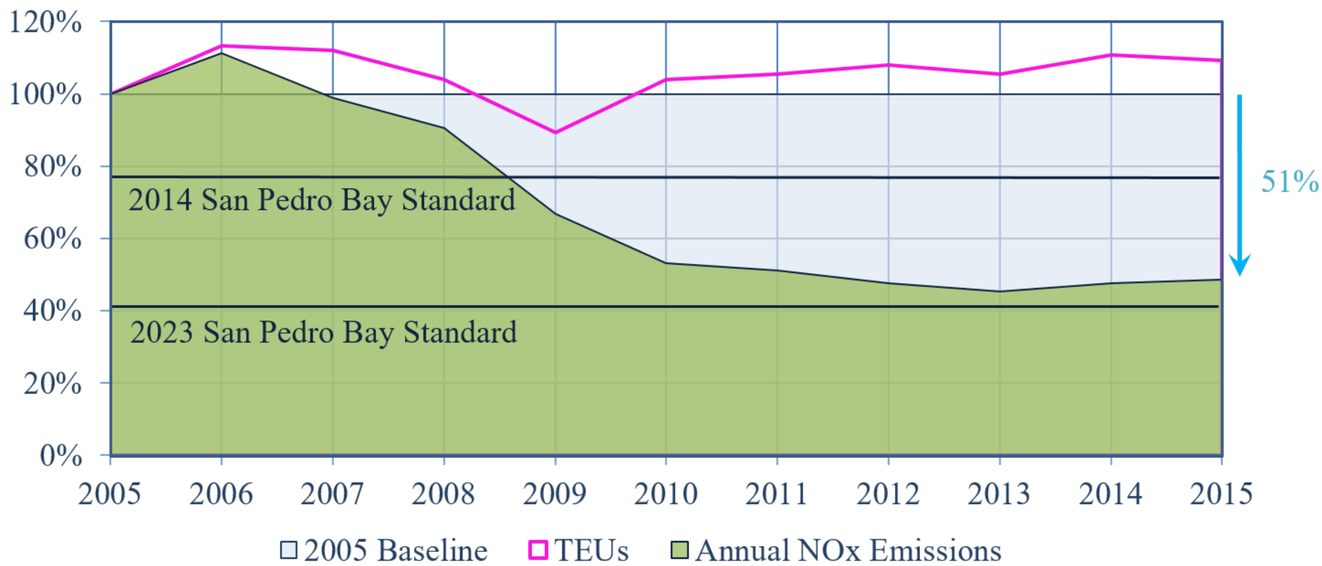
Figure ES.7 shows that the Port has surpassed the 2014 and 2023 DPM emission reduction standards with an 85% emission reduction. In 2015, 0.1% sulfur fuel for OGVs from the CARB fuel rule was implemented and there was an increase in number of ships using shore-power due to the CARB shore power rule.

Figure ES.7: DPM Reductions to Date



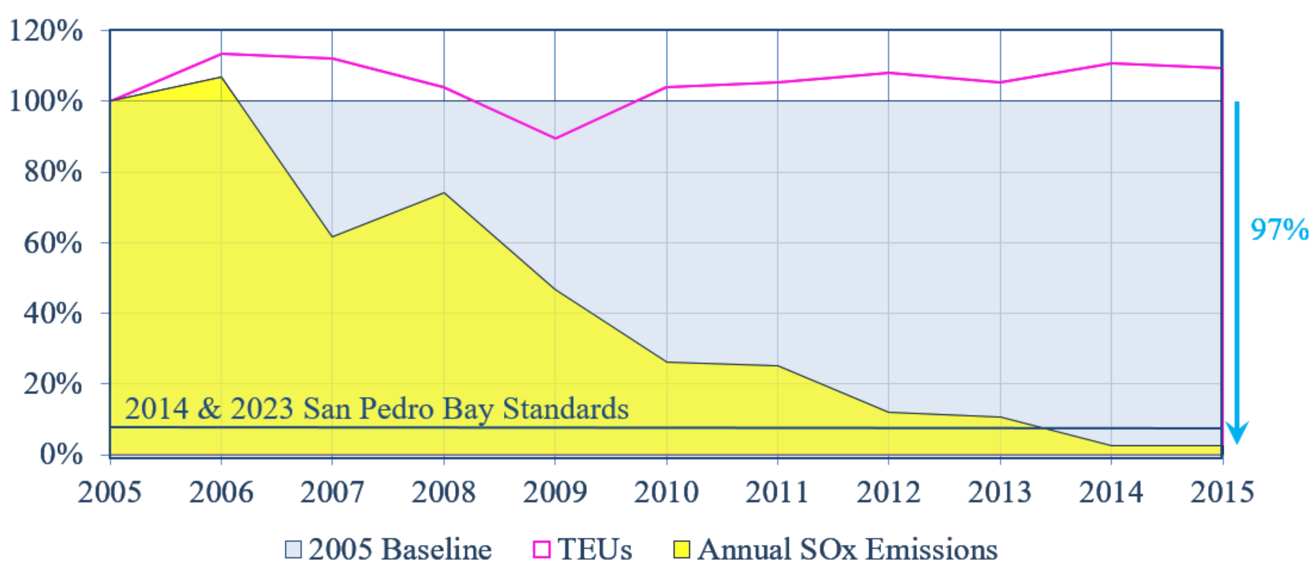
As demonstrated in Figure ES.8, the Port surpassed the 2014 NO_x mass emission reduction standard in 2015 with a 51% reduction and is close to meeting the 2023 NO_x mass emission reduction standard.

Figure ES.8: NO_x Reductions to Date



By 2015, the Port surpassed the 2014 and 2023 SO_x mass emission reduction standards with a 97% reduction. In 2015, 0.1% sulfur fuel for OGVs from the CARB fuel rule was in effect and there was an increase in number of ships using shore-power due to the CARB shore power rule.

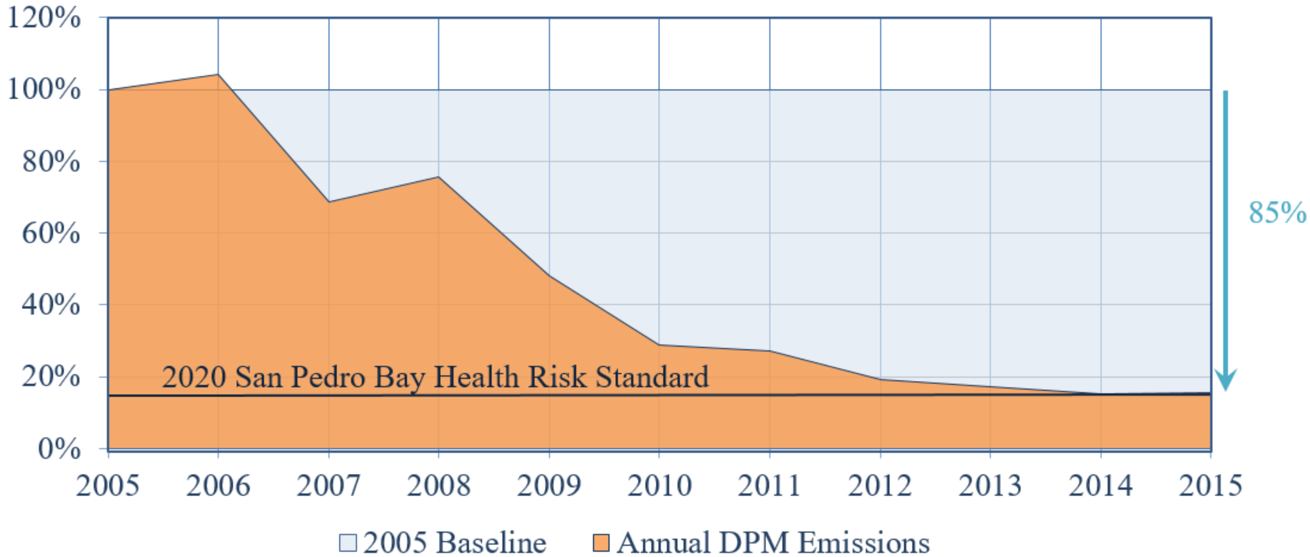
Figure ES.9: SO_x Reductions to Date



Health Risk Reduction Progress

Progress to-date on health risk reduction is determined by comparing the change in DPM mass emissions to the 2005 baseline. Figure ES.10 presents the progress of achieving the standard to date. In 2015, with an 85% reduction, the Port continues to meet the 2020 Health Risk Reduction Standard (85%).

Figure ES.10: Health Risk Reduction Benefits to Date



SECTION 1 INTRODUCTION

The Port of Los Angeles (Port or POLA) 2015 Inventory of Air Emissions study presents maritime industry-related emission estimates based on 2015 activity levels. The report includes a comparison of the estimated 2015 emissions with the 2005 baseline year and previous year emission estimates to track the Port's emission reduction progress under the San Pedro Bay Ports Clean Air Action Plan (CAAP). As in previous inventories, the following five source categories are included:

- Ocean-going vessels (OGV)
- Harbor craft
- Cargo handling equipment (CHE)
- Locomotives
- Heavy-duty vehicles (HDV)

Exhaust emissions of the following pollutants that can cause regional and local air quality 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)

This study also includes estimates of greenhouse gases (GHGs) carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) emitted from maritime industry-related tenant operational mobile sources. To normalize the three GHG values into a single number representing CO_2 equivalents (CO_2e) the GHG emission estimates are multiplied by the following values and summed.[2]

- CO_2 – 1
- CH_4 – 25
- N_2O - 298

For presentation purposes in the report, only CO_2e values are reported because they include all three GHGs in an equivalent measure to CO_2, which makes up by far the greatest mass of GHG emissions from the source categories included in this inventory. The greenhouse gas emissions are presented in metric tons (tonnes) while the criteria pollutant emissions are shown in tons.

[2] EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2013*, April 2015

Geographical Domain

The geographical extent of the inventory includes emissions from the aforementioned maritime industry-related emission sources operating within the harbor district. For commercial marine vessels, the domain lies within the harbor and up to the study area boundary comprised of an over-water area 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.

For rail locomotives and on-road trucks, the domain extends from the Port to the cargo's first point of rest within the South Coast Air Basin (SoCAB) or up to the SoCAB boundary, whichever comes first.

Figure 1.1 shows the geographical extent of this inventory, and other overlapping regulatory boundaries.

Figure 1.1: Emissions Inventory Geographical Extent

SECTION 2 REGULATORY AND CAAP MEASURES

This section summarizes the regulatory initiatives and Port measures related to port activity. Almost all maritime industry-related emissions come from five emission source categories: OGVs, harbor craft, CHE, locomotives, and HDVs. The responsibility for the control of emissions from the majority of these sources falls under the jurisdiction of local (South Coast Air Quality Management District [SCAQMD]), state (California Air Resources Board [CARB]), or federal (U.S. Environmental Protection Agency [EPA]) agencies. The Ports of Los Angeles and Long Beach (Ports) voluntarily adopted the landmark CAAP in November 2006 to curb maritime industry-related air pollution and subsequently approved an update to the CAAP (2010 CAAP Update).

San Pedro Bay Standards Included in the 2010 CAAP Update
The San Pedro Bay Standards are perhaps the most significant addition to the original CAAP and a statement of the Ports' commitments to significantly reduce the air quality impacts from port operations. Achievement and maintenance of the standards listed below requires diligent implementation of all of the known CAAP measures, additional aggressive actions to find further emissions and health risk reductions, and identification of new strategies that will emerge over time.

Health Risk Reduction Standard
To complement the CARB's Air Pollution Reduction Programs including Diesel Risk Reduction Plan, the Ports have developed the following standard for reducing overall maritime industry-related health risk impacts, relative to 2005 emissions level:

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

Emission Reduction Standard
Consistent with the Ports' commitment to meet their fair-share of mass emission reductions of air pollutants, the Ports have developed the following standards for reducing air pollutant emissions from maritime industry-related activities, relative to 2005 emission levels:

- By 2014, reduce emissions of NO_x by 22%, of SO_x by 93%, and of DPM by 72% to support attainment of the national fine particulate matter ($PM_{2.5}$) standards.
- By 2023, reduce emissions of NO_x by 59%, of SO_x by 93%, and of DPM by 77% to support attainment of the national and federal 8-hour ozone standards and national fine particulate matter ($PM_{2.5}$) standards.

Regulatory Programs by Source Category

The following section presents a list of current regulatory programs and CAAP measures by each major source category that help reduce emissions from the maritime industry in and around the Port.

Table 2.1: OGV Emission Regulations, Standards and Policies

Agency	Regulation/Standard/Policy	Targeted Pollutants	Years Effective	Impact
International Maritime Organization (IMO)	NO_x Emission Standard for Marine Engines *www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Nitrogen-oxides-%28NOx%29-%E2%80%93-Regulation-13.aspx*	NO_x	2011 – Tier 2 2016 – Tier 3 for ECA only	Auxiliary and propulsion engines over 130 kW output power on newly built vessels
IMO	Emissions Control Area, Low Sulfur Fuel Requirements for Marine Engines *www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Sulphur-oxides-%28SOx%29-%E2%80%93-Regulation-14.aspx*	DPM, PM, and SO_x	2012 ECA – 1% Sulfur 2015 ECA – 0.1% Sulfur	Significantly reduce emissions due to low sulfur content in fuel by creating Emissions Control Area (ECA)
IMO	Energy Efficiency Design Index (EEDI) for International Shipping *www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Technical-and-Operational-Measures.aspx*	CO_2 and other pollutants	2013	Increases the design efficiencies of ships relating to energy and emissions
EPA	Emission Standards for Marine Diesel Engines above 30 Liters per Cylinder (Category 3 Engines); Aligns with IMO Annex VI marine engine NO_x standards and low sulfur requirement *www.epa.gov/otaq/oceanvessels.htm#engine-fuel*	DPM, PM, NO_x, and SO_x	2011 – Tier 2 2016 – Tier 3	Auxiliary and propulsion category 3 engines on US flagged new built vessels and requires use of low sulfur fuel

Table 2.1: OGV Emission Regulations, Standards and Policies (cont'd)

Agency	Regulation/Standard/Policy	Targeted Pollutants	Years Effective	Impact
CARB	Regulation to Reduce Emissions from Diesel Auxiliary Engines on Ocean-Going Vessels While At-Berth at a California Port *www.arb.ca.gov/regact/2007/shorepwr07/shorepwr07.htm* and *www.arb.ca.gov/ports/shorepower/forms/regulatoryadvisory/regulatoryadvisory12232013.pdf*	DPM, PM, NO_x, SO_x, CO_2	2014 – 50% 2017 – 70% 2020 – 80%	Shore power (or equivalent) requirements. Vessel operators, based on fleet percentage visiting the ports.
CARB	Ocean-going Ship Onboard Incineration *www.arb.ca.gov/ports/shipincin/shipincin.htm*	DPM, PM, and HC	2007	All vessels cannot incinerate within 3 nm of the California coast
CAAP	CAAP Measure – OGV 1 Vessel Speed Reduction (VSR) Program *www.cleanairactionplan.org/strategies/ships/*	All	2008	Vessel operators within 20 nm and 40 nm of Point Fermin
CAAP	CAAP Measure – OGV 2 Reduction of At-Berth OGV Emissions *www.cleanairactionplan.org/strategies/ships/*	All	2014	Vessel operators and terminals
CAAP	CAAP Measure – OGV 5 and 6 Cleaner OGV Engines and OGV Engine Emissions Reduction Technology Improvements and Environmental Ship Index (ESI) Program *www.portoflosangeles.org/environment/ogv.asp*	DPM, PM, and NO_x	2012	Vessel operators who choose to participate in ESI and/or technology demonstrations.

Table 2.2: Harbor Craft Emission Regulations, Standards and Policies

Agency	Regulation/Standard/Policy	Targeted Pollutants	Years Effective	Impact
EPA	Emission Standards for Harbor Craft Engines *www3.epa.gov/otaq/marine.htm*	All	2009 – Tier 3 2014 – Tier 4 for 800 hp or greater	Commercial marine diesel engines with displacement less than 30 liters per cylinder
CARB	Low Sulfur Fuel Requirement for Harbor Craft *www.arb.ca.gov/regact/carblohc/carblohc.htm*	DPM, PM, NO_x, and SO_x	2006 – 15 ppm in SCAQMD area	Use of low sulfur diesel fuel in commercial harbor craft operating in SCAQMD
CARB	Regulation to Reduce Emissions from Diesel Engines on Commercial Harbor Craft *www.arb.ca.gov/regact/2010/chc10/chc10.htm*	DPM, PM, and NO_x	2009 to 2020 - schedule varies depending on engine model year	Most harbor craft with home port in SCAQMD must meet more stringent emissions limits according to a compliance schedule
CAAP	CAAP Measure – HC 1 Performance Standards for Harbor Craft *www.cleanairactionplan.org/strategies/harbor-craft*	All	Varies	Modernization of harbor craft operating at POLA upon lease renewal

Table 2.3: Cargo Handling Equipment Emission Regulations, Standards and Policies

Agency	Regulation/Standard/Policy	Targeted Pollutants	Years Effective	Impact
EPA	Emission Standards for Non-Road Diesel Powered Equipment *www.epa.gov/otaq/standards/nonroad/nonroadci.htm*	All	2008 through 2015	All non-road equipment
CARB	Cargo Handling Equipment Regulation *www.arb.ca.gov/regact/2011/cargo11/cargo11.htm*	All	2007 through 2017	All Cargo handling equipment
CARB	New Emission Standards, Test Procedures, for Large Spark Ignition (LSI) Engine Forklifts and Other Industrial Equipment *www.arb.ca.gov/regact/2008/lsi2008/lsi2008.htm*	All	2007 – first phase 2010 – second phase	Emission standards for large spark-ignition engines with 25 hp or greater
CARB	Fleet Requirements for Large Spark Ignition Engines *www.arb.ca.gov/regact/2010/offroadlsi10/lsifinalreg.pdf*	All	2009 through 2013	More stringent emissions requirements for fleets of large spark-ignition engines equipment
CAAP	CAAP Measure – CHE1 Performance Standards for CHE	All	2007 through 2014	Turnover to Tier 4 cargo handling equipment per lease renewal agreement

Table 2.4: Locomotives Emission Regulations, Standards and Policies

Agency	Regulation/Standard/Policy	Targeted Pollutants	Years Effective	Impact
EPA	Emission Standards for New and Remanufactured Locomotives and Locomotive Engines- Latest Regulation *www.epa.gov/otaq/standards/nonroad/locomotives.htm*	DPM and NO_x	2011 through 2013 – Tier 3 2015 – Tier 4	All new and remanufactured locomotive engines
EPA	Control of Emissions of Air Pollution from Nonroad Diesel Engines and Fuel *www.epa.gov/otaq/fuels/dieselfuels/regulations.htm*	SO_x and PM	2010	All locomotive engines
CARB	Low Sulfur Fuel Requirement for Intrastate Locomotives *www.arb.ca.gov/msprog/offroad/loco/loco.htm#intrastate*	SO_x, NO_x, and PM	2007	Intrastate locomotives, mainly switchers
CARB	Statewide 1998 and 2005 Memorandum of Understanding (MOUs) *www.arb.ca.gov/msprog/offroad/loco/loco.htm#intrastate*	NO_x	2010	Union Pacific and BNSF locomotives
CAAP	CAAP Measure – RL1 Pacific Harbor Line (PHL) Rail Switch Engine Modernization	PM	2010	Pacific Harbor Line switcher engines
CAAP	CAAP Measure – RL2 Class 1 Line-haul and Switcher Fleet Modernization	All	2023 – Tier 3	Class 1 locomotives at ports
CAAP	CAAP Measure – RL3 New and Redeveloped Near-Dock Rail Yards	All	2020 – Tier 4	New near-dock rail yards

Table 2.5: Heavy-Duty Vehicles Emission Regulations, Standards and Policies

Agency	Regulation/Standard/Policy	Targeted Pollutants	Years Effective	Impact
CARB/ EPA	Emission Standards for New 2007+ On-Road Heavy-Duty Vehicles *www.arb.ca.gov/msprog/onroadhd/reducstd.htm*	NO_x and PM	2007 2010	All new on-road diesel heavy-duty vehicles
CARB	Heavy-Duty Vehicle On-Board Diagnostics (OBD and OBDII) Requirement *www.arb.ca.gov/msprog/obdprog/section1971_1_clean2013.pdf*	NO_x and PM	2010 +	All new on-road heavy-duty vehicles
CARB	ULSD Fuel Requirement *www.arb.ca.gov/regact/ulsd2003/ulsd2003.htm*	All	2006 - ULSD	All on-road heavy-duty vehicles
CARB	Drayage Truck Regulation (amended in 2011 and 2014) *www.arb.ca.gov/msprog/onroad/porttruck/drayagevtruckbus.pdf*	All	Phase in started in 2009	All drayage trucks operating at California ports
CARB	Low NO_x Software Upgrade Program 2007 *www.arb.ca.gov/msprog/hdsoftware/hdsoftware.htm*	NO_x	Starting 2005	1993 to 1998 on-road heavy-duty vehicles that operate in California
CARB	Heavy-Duty Vehicle Greenhouse Gas Emission Reduction Regulation *www.arb.ca.gov/cc/hdghg/hdghg.htm*	CO_2	Phase 1 starting in 2012	Heavy-duty tractors that pull 53-foot+ trailers in California
CARB	Assembly Bill 32 requiring GHG reductions targets and Governor's Executive Order B – 30-15 *www.arb.ca.gov/cc/ab32/ab32.htm*	CO_2	GHG emissions reduction goals in 2020	All operations in California
CAAP	CAAP Measure – HDV1 Performance Standards for On-Road Heavy-Duty Vehicles; Clean Truck Program	All	Phase in started in 2008	Requires on-road heavy-duty vehicles that operate at POLA to have 2007 or newer Model Year (MY) engines by 2012

Air Quality Management Plan (AQMP)

As part of the State Implementation Plan (SIP) process, the SCAQMD Governing Board is currently developing their 2016 AQMP for ozone attainment.[3] The 2016 AQMP is being developed to demonstrate attainment of the 2008 8-hour ozone standard by 2031, and show early action measures to attain the 1997 8-hour ozone standard that needs to be met by 2023.

During 2014 and the 1st quarter of 2015, there were multiple days when the South Coast Air Basin exceeded the 24-hour $PM_{2.5}$ National Ambient Air Quality standard of 35 $\mu g/m^3$. SCAQMD staff is proposing a formal request to EPA to reclassify Basin as a Serious Non - attainment Area for 24 - hour $PM_{2.5}$. If approved, SCAQMD will develop a Serious Area 24 - hour $PM_{2.5}$ SIP as part of the 2016 AQMP.

[3] SCAQMD, *www.aqmd.gov/home/about/groups-committees/aqmp-advisory-group*

SECTION 3 OCEAN-GOING VESSELS

Source Description

Based on activity data obtained from the Marine Exchange of Southern California (MarEx), there were a total of 1,774 ocean-going vessels (OGVs, ships, or vessels) activities (arrivals not including shifts) to the Port in 2015. These vessels are grouped by the type of cargo they are designed to carry and fall into one of the following vessel categories or types:

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

From an emissions contribution perspective, the three predominant vessel types are: containerships, tankers, and cruise ships, with containerships being the most significant vessel category. Emission sources on all vessel categories include main engines (propulsion), auxiliary engines, and auxiliary boilers (boilers).

Emission Estimation Methodology and Enhancements

The methodology to estimate 2015 emissions from OGVs is the same as described in Section 3 of the Port of Los Angeles 2013 Air Emissions Inventory.[4] The 2014 Port of Los Angeles Air Emissions Inventory also included emission factor adjustments and load adjustment factors for MAN 2-stroke engines.[5] The following updates to the data and estimation methodologies for OGV in the 2015 air emissions inventory are listed below.

- Enhanced intra-terminal shift (a shift that occurs between berths within the same terminal) resolution due to increased intra-terminal shifts in 2015. The average time determined for intra-terminal shifts was used specifically for intra-terminal shifts. Prior to this year, the average maneuvering time for shifts in general, such as anchorage to terminal shift or terminal to terminal shift, was used for all shifts including intra-terminal shifts. This improvement was made due to the increased number of these activities in 2015.
- Incorporation of CARB approved emissions reduction technologies: Advance Cleanup Technologies, Inc. and Clean Air Engineering-Maritime, Inc.[6]. Emission from these technologies (mobilization, operation, and demobilization) and associated emissions reductions from ships being treated are incorporated into the inventory based on activity data and CARB reduction values.
- Containerships – updated logic for calculating anchorage hoteling auxiliary engine loads base on VBP operation data.
- 2015 shore power data as provided by POLA and terminals; data will be compared with CARB shore power data prior to the publication of the next emissions inventory.
- Diesel-electric cruise ships – turned boilers on at berth during shore power events.
- Updated tanker load and discharging activity records.
- Updated VBP operational data.
- Updated ESI fuel sulfur and engine data.
- Updated IHS Maritime Data (formerly Fairplay) vessel parameter data.

[4] POLA, *www.portoflosangeles.org/pdf/2013_Air_Emissions_Inventory_Full_Report.pdf*
[5] San Pedro Bay Ports, *www.cleanairactionplan.org/civica/filebank/blobdload.asp?BlobID=2571*
[6] CARB, *www.arb.ca.gov/ports/shorepower/shorepower.htm*

Table 3.1 presents the numbers of arrivals, departures, and shifts associated with vessels at the Port in 2015. It should be noted that there was a continued increase in the number of containership shifts from anchorage to berth, compared to 2013 and 2014. This was due to the temporary period of increased congestion in late 2014 that continued through mid-2015.

Table 3.1: 2015 Total OGV Activities

Port	Vessel Type	Arrival	Departure	Shift	Total
LA	Auto Carrier	73	72	21	166
LA	Bulk	107	103	91	301
LA	Bulk - Heavy Load	1	1	1	3
LA	Container - 1000	3	3	1	7
LA	Container - 2000	170	170	41	381
LA	Container - 3000	38	38	14	90
LA	Container - 4000	258	260	131	649
LA	Container - 5000	112	112	21	245
LA	Container - 6000	211	218	64	493
LA	Container - 7000	45	45	18	108
LA	Container - 8000	157	156	88	401
LA	Container - 9000	26	27	7	60
LA	Container - 10000	69	74	22	165
LA	Container - 11000	10	11	0	21
LA	Container - 12000	19	19	5	43
LA	Container - 13000	24	24	2	50
LA	Container - 14000	3	3	0	6
LA	Container - 18000	1	1	0	2
LA	Cruise	123	123	0	246
LA	General Cargo	57	56	54	167
LA	Ocean Tugboat (ATB/ITB)	12	12	14	38
LA	Reefer	15	17	20	52
LA	RoRo	14	14	16	44
LA	Tanker - Chemical	124	125	239	488
LA	Tanker - Handysize	25	27	49	101
LA	Tanker - Panamax	77	62	165	304
	Total	**1,774**	**1,773**	**1,084**	**4,631**

DB ID693

Geographical Domain

The geographical domain or overwater boundary for OGVs includes the berths and waterways in the Port proper and all vessel movements within the 40 nautical mile (nm) arc from Point Fermin as shown previously in Figure 1.1. The northern boundary is the Ventura County line and the southern boundary is the Orange County line. It should be noted that the overwater boundary extends further off the coast to incorporate the South Coast air quality modeling domain, although most of the vessel movements occur within the 40 nm arc.

Data and Information Acquisition

Similar to previous inventories, various sources of data and operational knowledge about the Port's marine activities are used to compile the data necessary to estimate emissions from OGV:

- Marine Exchange of Southern California
- Vessel Speed Reduction Program speed data
- Los Angeles Pilot Service
- IHS Maritime Data
- VBP data
- ESI fuel and engine data
- Port tanker load and discharge activity data
- Port and terminal shore power activity data

Operational Profiles

Tables 3.2 and 3.3 summarize the hotelling times in hours at berth and at anchorage. Hotelling time is the entire duration of time that a ship spends at berth for each visit. The average hotelling time increased significantly in 2015 from previous years due to the significant increases in container density per ship call, increasing almost 20% (as presented in Table ES.1) and delays associated with the temporary period of increased congestion from late 2014 and continued through mid-2015.

Table 3.2: 2015 Hotelling Times at Berth, hours

Vessel Type	Berth Hotelling Time		
	Min	Max	Avg
Auto Carrier	2.7	678.9	25.7
Bulk	8.4	222.8	78.1
Bulk - Heavy Load	177.5	177.5	177.5
Container - 1000	23.2	60.8	36.0
Container - 2000	5.9	220.3	37.8
Container - 3000	21.4	121.0	58.1
Container - 4000	0.0	328.1	34.5
Container - 5000	1.5	271.7	52.4
Container - 6000	1.0	398.0	56.6
Container - 7000	1.2	262.2	48.1
Container - 8000	1.0	446.7	53.4
Container - 9000	1.5	304.3	66.6
Container - 10000	2.2	432.3	67.0
Container - 11000	2.6	342.8	95.0
Container - 12000	3.2	192.3	68.2
Container - 13000	2.1	479.8	146.7
Container - 14000	8.3	121.7	60.5
Container - 18000	86.8	86.8	86.8
Cruise	0.1	40.3	9.5
General Cargo	10.3	217.9	66.5
Ocean Tugboat (ATB/ITB)	0.5	216.1	34.6
Reefer	8.8	190.5	67.7
RoRo	3.9	319.3	42.8
Tanker - Chemical	0.0	111.7	33.6
Tanker - Handysize	13.7	79.2	35.0
Tanker - Panamax	15.3	122.8	44.0

DB ID705

The increased activities at anchorage were at a peak in the first quarter of the year and then significantly decreased across the remaining quarters of 2015. The anchorage activity increase is associated with container ships which typically don't spend time at anchorage. Data from the last two quarters of 2015 show containership activity at anchorage returning to normal levels; therefore, it is anticipated that conditions for the entire year of 2016 will return to historical trend levels.

Table 3.3: 2015 Hotelling Times at Anchorage, hours

Vessel Type	Min	Max	Avg	Vessel Count
Auto Carrier	6.4	65.3	29.8	8
Bulk	5.8	432.3	81.5	67
Bulk - Heavy Load	21.7	21.7	21.7	1
Container - 1000	14.2	14.2	14.2	1
Container - 2000	0.9	118.3	28.9	14
Container - 3000	1.1	236.8	58.9	5
Container - 4000	0.5	458.2	67.8	49
Container - 5000	23.7	469.6	149.3	9
Container - 6000	6.0	499.7	129.5	30
Container - 7000	1.7	50.5	30.7	6
Container - 8000	6.4	537.1	140.5	18
Container - 9000	20.8	325.8	168.4	4
Container - 10000	11.6	488.0	189.5	10
Container - 12000	7.1	179.3	90.3	3
Container - 13000	14.7	65.1	39.9	2
General Cargo	4.9	313.7	102.3	28
Ocean Tugboat (ATB/ITB)	2.5	98.9	48.4	3
Reefer	6.1	77.9	46.6	8
Tanker - Chemical	0.3	451.1	43.2	93
Tanker - Handysize	4.8	123.9	39.1	16
Tanker - Panamax	1.7	253.3	47.4	59

DB ID705

Table 3.4 presents the auxiliary engine load defaults by vessel type, by mode, used to estimate emissions. Values in this table are based on VBP data and it should be noted that the cruise defaults are for non-diesel-electric ships.

Table 3.4: Average Auxiliary Engine Load Defaults (except for Diesel-Electric Cruise Vessels), kW

Vessel Type	Transit	Maneuvering	Berth Hotelling	Anchorage Hotelling
Auto Carrier	503	1,508	838	503
Bulk	255	675	150	255
Bulk - Heavy Load	255	675	150	255
Container - 1000	545	1,058	429	487
Container - 2000	981	2,180	1,035	1,008
Container - 3000	602	2,063	516	559
Container - 4000	1,434	2,526	1,161	1,298
Container - 5000	1,811	3,293	945	1,378
Container - 6000	1,453	2,197	990	1,222
Container - 7000	1,444	3,357	1,372	1,408
Container - 8000	1,494	2,753	902	1,198
Container - 9000	1,501	2,942	1,037	1,269
Container - 10000	2,300	2,350	1,450	1,875
Container - 11000	2,500	3,500	1,500	2,000
Container - 12000	2,500	3,500	1,500	2,000
Container - 13000	1,865	3,085	982	1,424
Container - 14000	2,500	3,500	1,500	2,000
Container - 18000	1,500	1,750	1,000	1,250
Cruise	7,058	9,718	5,353	7,058
General Cargo	516	1,439	722	516
Ocean Tug (ATB/ITB)	79	208	102	79
Reefer	513	1,540	890	513
RoRo	434	1,301	751	434
Tanker - Chemical	658	890	816	658
Tanker - Handysize	537	601	820	537
Tanker - Panamax	561	763	623	561

Table 3.5 presents the load defaults for the auxiliary boilers by vessel type and by mode.

Table 3.5: Auxiliary Boiler Load Defaults, kW

Vessel Type	Transit	Maneuvering	Berth Hotelling	Anchorage Hotelling
Auto Carrier	253	351	351	351
Bulk	132	132	132	132
Bulk - Heavy Load	132	132	132	132
Container - 1000	241	241	241	241
Container - 2000	325	325	325	325
Container - 3000	474	474	474	474
Container - 4000	492	492	492	492
Container - 5000	545	547	547	547
Container - 6000	577	573	573	573
Container - 7000	538	551	551	551
Container - 8000	650	531	531	531
Container - 9000	475	475	475	475
Container - 10000	708	708	708	708
Container - 11000	600	600	600	600
Container - 12000	600	600	600	600
Container - 13000	599	599	599	599
Container - 14000	700	700	700	700
Container - 18000	647	647	647	647
Cruise	1,482	1,482	1,482	1,482
General Cargo	137	137	137	137
Ocean Tug (ATB/ITB)	0	0	0	0
Reefer	255	255	255	255
RoRo	243	243	243	243
Tanker - Chemical	371	371	821	371
Tanker - Handysize	371	371	2,586	371
Tanker - Panamax	371	371	3,293	371
Tanker - All Diesel-Electric	0	145	220	220

Note - Auxiliary boiler load used for all tankers while being loaded at-berth is 875 kW

Emission Estimates

The following tables present the estimated OGV emissions categorized in different ways, such as by engine type, by operating mode, and by vessel type. A summary of the OGV emission estimates by vessel type for all pollutants for the year 2015 is presented in Table 3.6. The criteria pollutant emissions are in tons, while the greenhouse gas emissions are in metric tons or tonnes per year.

Table 3.6: Ocean-Going Vessel Emissions by Vessel Type

Vessel Type	PM_{10} tons	$PM_{2.5}$ tons	DPM tons	NO_x tons	SO_x tons	CO tons	HC tons	CO_2e tonnes
Auto Carrier	1.2	1.1	1.0	66.5	2.5	5.5	2.3	3,610
Bulk	2.1	2.0	1.8	107.0	4.5	9.1	3.1	6,437
Bulk - Heavy Load	0.0	0.0	0.0	1.2	0.0	0.1	0.0	67
Container - 1000	0.1	0.1	0.1	4.9	0.2	0.4	0.1	238
Container - 2000	4.5	4.2	3.4	204.5	10.3	17.5	7.3	15,322
Container - 3000	1.2	1.1	1.0	65.1	2.0	5.5	2.4	3,938
Container - 4000	10.5	9.7	9.0	563.6	13.1	51.7	25.4	31,279
Container - 5000	5.4	5.0	4.6	271.0	5.7	29.5	15.1	15,006
Container - 6000	9.3	8.5	7.0	536.2	13.0	40.4	20.8	32,966
Container - 7000	2.5	2.3	2.1	116.3	1.9	14.2	7.3	6,750
Container - 8000	7.1	6.5	5.3	386.8	10.2	30.2	15.4	25,551
Container - 9000	1.2	1.2	1.0	64.6	2.0	5.4	2.6	4,455
Container - 10000	3.5	3.2	2.2	192.3	3.4	10.9	5.2	16,064
Container - 11000	0.5	0.5	0.4	31.4	1.2	2.0	0.9	1,941
Container - 12000	1.0	0.9	0.7	59.5	2.2	3.0	1.5	3,798
Container - 13000	1.6	1.5	1.2	79.4	3.2	5.6	2.5	5,851
Container - 14000	0.1	0.1	0.1	6.9	0.2	0.3	0.1	447
Container - 18000	0.1	0.1	0.1	4.2	0.0	0.3	0.1	216
Cruise	7.0	6.6	6.9	344.7	12.2	30.3	11.7	17,753
General Cargo	2.5	2.3	2.4	125.9	3.4	11.7	4.4	7,169
Ocean Tugboat (ATB/ITB)	0.1	0.1	0.1	6.1	0.2	0.5	0.2	297
Reefer	0.7	0.7	0.6	36.3	1.5	3.0	1.2	2,058
RoRo	0.6	0.5	0.5	25.9	1.1	1.9	0.8	1,510
Tanker - Chemical	5.4	5.0	4.2	237.2	11.7	20.8	7.6	18,067
Tanker - Handysize	1.4	1.3	0.8	52.5	3.7	4.6	1.8	5,574
Tanker - Panamax	5.2	4.9	2.8	189.8	15.0	16.3	6.4	22,068
Total	**74.7**	**69.4**	**59.3**	**3,779.7**	**124.6**	**320.7**	**146.2**	**248,431**

DB ID692

Table 3.7 presents summaries of emission estimates by ship emission source in tons. The emissions for the CARB-certified capture and control system to treat emissions from auxiliary engines are rolled into the auxiliary engine emissions in the tables below.

Table 3.7: Ocean-Going Vessel Emissions by Emissions Source

Emission Source	PM_{10} tons	$PM_{2.5}$ tons	DPM tons	NO_x tons	SO_x tons	CO tons	HC tons	CO_2e tonnes
Main Engine	19.0	17.6	18.4	1,648.2	23.3	115.0	68.5	46,984
Auxiliary Engine	40.9	38.0	40.9	1,908.3	54.8	183.0	66.4	104,624.3
Auxiliary Boiler	14.8	13.7	0.0	223.2	46.5	22.6	11.3	96,824
Total	**74.7**	**69.4**	**59.3**	**3,779.7**	**124.7**	**320.7**	**146.2**	**248,431**

DB ID692

Table 3.8 presents summaries of emission estimates by mode and by emission source in tons. At-berth hotelling and at-anchorage hotelling are listed separately. Transit and harbor maneuvering emissions include both berth and anchorage calls.

Table 3.8: Ocean-Going Vessel Emissions by Mode

Mode	Emission Source	PM_{10} tons	$PM_{2.5}$ tons	DPM tons	NO_x tons	SO_x tons	CO tons	HC tons	CO_2e tonnes
Transit	Main	16.7	15.4	16.0	1,481.8	22.0	98.2	53.7	44,169
Transit	Aux	6.9	6.4	6.9	323.2	9.1	30.6	11.1	17,516
Transit	Auxiliary Boiler	0.8	0.7	0.0	11.6	2.0	1.2	0.6	5,013
Total Transit		**24.3**	**22.5**	**22.9**	**1,816.6**	**33.1**	**129.9**	**65.4**	**66,698**
Maneuvering	Main	2.4	2.2	2.3	166.4	1.3	16.9	14.8	2,814
Maneuvering	Aux	2.6	2.4	2.6	121.3	3.4	11.5	4.2	6,590
Maneuvering	Auxiliary Boiler	0.2	0.2	0.0	3.5	0.7	0.4	0.2	1,538
Total Maneuvering		**5.2**	**4.8**	**4.9**	**291.2**	**5.4**	**28.7**	**19.2**	**10,942**
Hotelling at-berth	Main	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Hotelling at-berth	Aux	19.3	17.9	19.3	904.4	26.5	86.8	31.4	49,434
Hotelling at-berth	Auxiliary Boiler	10.9	10.1	0.0	164.5	34.0	16.7	8.3	71,371
Total Hotelling at-berth		**30.2**	**28.1**	**19.3**	**1,068.9**	**60.6**	**103.4**	**39.7**	**120,805**
Hotelling at-anchorage	Main	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Hotelling at-anchorage	Aux	12.2	11.3	12.2	559.4	15.8	54.2	19.7	31,084
Hotelling at-anchorage	Auxiliary Boiler	2.9	2.7	0.0	43.6	9.7	4.4	2.2	18,902
Total Hotelling at-anchorage		**15.0**	**14.0**	**12.2**	**602.9**	**25.5**	**58.7**	**21.9**	**49,986**
Total		**74.7**	**69.4**	**59.3**	**3,779.7**	**124.6**	**320.7**	**146.2**	**248,431**

DB ID694

SECTION 4 HARBOR CRAFT

This section presents emission estimates for the commercial harbor craft source category, including source descriptions, geographical domain, data acquisition, operational profiles, emissions estimation methodology and emission estimates.

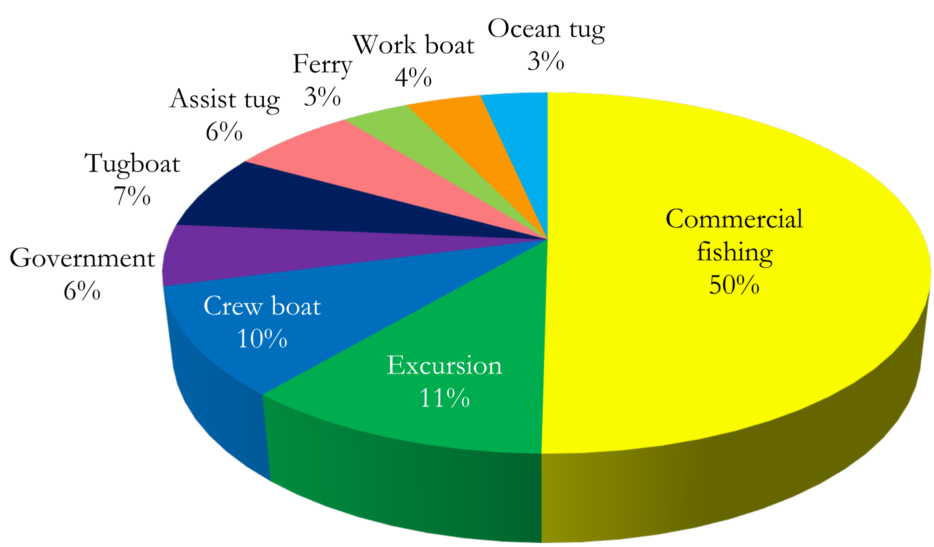
Source Description

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 tugs
- 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 237commercial harbor craft inventoried for the Port in 2015.

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



Ocean tugs included in this section are different from the integrated tug barge (ITB) and articulated tug barge (ATB) discussed 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 tugs 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 tugboats because their average engine loads are higher than tugboats, which tend to idle more 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 depending on their work assignments.

Geographical Domain

The geographical domain for harbor craft is the same as that for ocean-going vessels.

Data and Information Acquisition

Commercial harbor craft companies were contacted to obtain key operational parameters for their vessels. These include:

- Vessel type
- Engine count
- Engine horsepower (or kilowatts) for main and auxiliary engines
- Engine model year
- Operating hours in calendar year 2015
- Vessel repower information

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.

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 2015 for the Port of Los Angeles harbor only.

Table 4.1: Summary of Propulsion Engine Data by Vessel Category

Harbor Craft Type	Vessel Count	Engine Count	Model year Minimum	Model year Maximum	Model year Average	Horsepower Minimum	Horsepower Maximum	Horsepower Average	Annual Operating Hours Minimum	Annual Operating Hours Maximum	Annual Operating Hours Average
Assist tug	15	31	1980	2,014	2,007	600	2,575	2,020	59	2,256	1,408
Commercial fishing	119	125	1957	2,012	2,000	50	300	211	200	1,300	885
Crew boat	23	53	2003	2,012	2,009	180	1,450	572	50	2,012	895
Excursion	26	50	1960	2,014	2,003	150	550	363	27	2,400	1,416
Ferry	8	20	2003	2,013	2,010	2250	3,110	2,341	600	1,200	1,080
Government	13	24	1993	2,012	2,005	68	1,770	552	0	794	341
Ocean tug	8	16	1991	2,012	2,004	805	3,385	1,968	200	2,129	1,014
Tugboat	16	32	2001	2,013	2,009	235	1,500	731	46	2,034	600
Work boat	9	17	2005	2,015	2,011	135	1,000	520	23	4,592	1,219

DB ID423

Table 4.2: Summary of Auxiliary Engine Data by Vessel Category

Harbor Craft Type	Vessel Count	Engine Count	Model year Minimum	Model year Maximum	Model year Average	Horsepower Minimum	Horsepower Maximum	Horsepower Average	Annual Operating Hours Minimum	Annual Operating Hours Maximum	Annual Operating Hours Average
Assist tug	15	30	1980	2,014	2,010	107	557	208	40	3,119	1,729
Commercial fishing	119	30	1957	2,012	2,006	10	40	26	100	1,200	767
Crew boat	23	24	1980	2,012	2,007	11	107	55	2	2,243	910
Excursion	26	29	1966	2,014	2,006	7	74	39	0	4,000	1,765
Ferry	8	16	2003	2,013	2,009	18	120	69	300	750	694
Government	13	15	2002	2,012	2,004	50	1,555	522	19	871	148
Ocean tug	8	17	1991	2,013	2,005	60	253	123	200	1,680	711
Tugboat	16	26	1989	2,012	2,009	22	192	62	13	2,097	447
Work boat	9	15	1968	2,013	2,002	27	101	67	1	4,894	1,486

DB ID422

Harbor craft engines with known model year and horsepower are categorized according to their respective EPA marine engine standards (known as "tier level"). In the case where engine information gathered from harbor craft operators fails to identify the specific EPA tier level, the tier level is assigned for that engine based on engine model year and horsepower.[7] These assumptions are consistent with CARB's harbor craft emission factors, which follow the same model year grouping as EPA emissions standards for marine engines.

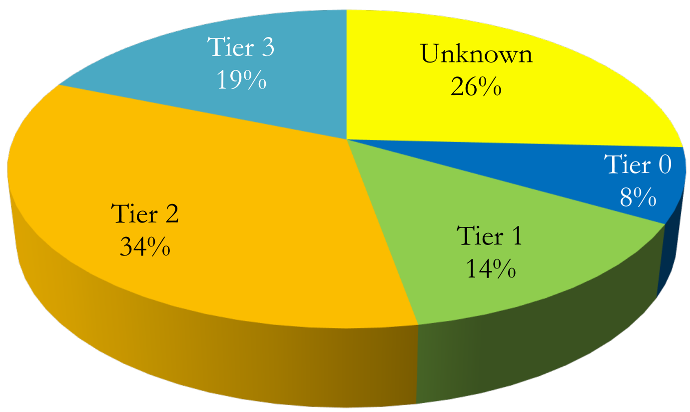
Table 4.3: Harbor Craft Marine Engine EPA Tier Levels

EPA Tier Level	Marine Engine Model Year Range	Horsepower Range
Tier 0	1999 and older	All
Tier 1	2000 to 2003	< 500 hp
Tier 1	2000 to 2006	> 500 hp
Tier 2	2004 up to Tier 3	< 500 hp
Tier 2	2007 up to Tier 3	> 500 hp
Tier 3	2009 and newer	0 to 120 hp
Tier 3	2013 and newer	> 120 to 175 hp
Tier 3	2014 and newer	> 175 to 500 hp
Tier 3	2013 and newer	> 500 to 750 hp
Tier 3	2012 to 2017	> 750 to 1,900 hp
Tier 3	2013 to 2016	> 1,900 to 3,300 hp
Tier 3	2014 to 2016	> 3,300 hp

[7] Code of Federal Regulation (CFR), *40 CFR Subpart 94.8* for Tier 1 and 2, and *40 CFR Subpart 1042.101* for Tier 3

Figure 4.2 provides the population distribution of all harbor craft propulsion and auxiliary engines operating at the Port in 2015. If model year and/or horsepower information are not available, the engines are classified as "unknown."

Figure 4.2: Distribution of Harbor Craft Engines by Engine Standards



Emissions Estimation Methodology

The emissions calculation methodology and the emission rates are same as the ones used to estimate harbor craft emissions for the Port's 2013 EI[8]. Harbor craft emissions are estimated for each engine individually, based on the engine's model year, power rating, and annual hours of operation. The Port's harbor craft emission calculation methodology is similar to the methodology used by the CARB emissions inventory for commercial harbor craft operating in California[9].

[8] POLA, *www.portoflosangeles.org/environment/studies_reports.asp*

[9] CARB, *Commercial Harbor Craft Regulatory Activities, Appendix B: Emissions Estimation Methodology for Commercial Harbor Craft Operating in California. www.arb.ca.gov/msei/chc-appendix-b-emission-estimates-ver02-27-2012.pdf*

Emission Estimates

Table 4.4 summarizes the estimated 2015 harbor craft emissions by vessel type and engine type. In order for the total emissions to be consistently displayed for each pollutant, the individual values in each table column do not, in some cases, add up to the listed total in the table. This is because there are fewer decimal places displayed (for readability) than are included in the calculated total. The criteria pollutants are listed as tons per year while the CO_2e values are listed as tonnes (metric tons) per year.

Table 4.4: Harbor Craft Emissions by Vessel and Engine Type

Harbor Craft Type	Engine Type	PM_{10} tons	$PM_{2.5}$ tons	DPM tons	NO_x tons	SO_x tons	CO tons	HC tons	CO_2e tonnes
Assist Tug	Auxiliary	0.6	0.6	0.6	22.3	0.0	19.5	3.2	2,250
	Propulsion	7.0	6.4	7.0	188.5	0.2	118.9	18.3	14,738
	Total	7.6	7.0	7.6	210.8	0.2	138.4	21.5	16,987
Commercial Fishing	Auxiliary	0.1	0.1	0.1	1.6	0.0	1.5	0.6	127
	Propulsion	2.6	2.4	2.6	56.4	0.0	19.3	4.5	3,099
	Total	2.7	2.5	2.7	58.0	0.0	20.8	5.1	3,226
Crew boat	Auxiliary	0.1	0.1	0.1	2.5	0.0	2.0	0.5	202
	Propulsion	2.1	1.9	2.1	65.5	0.1	44.1	6.7	5,614
	Total	2.2	2.0	2.2	68.0	0.1	46.1	7.3	5,817
Excursion	Auxiliary	0.2	0.2	0.2	5.0	0.0	4.2	1.6	410
	Propulsion	3.3	3.1	3.3	83.2	0.1	42.2	7.5	5,142
	Total	3.6	3.3	3.6	88.1	0.1	46.4	9.1	5,552
Ferry	Auxiliary	0.1	0.1	0.1	1.8	0.0	1.4	0.4	153
	Propulsion	4.8	4.5	4.8	132.5	0.1	87.7	13.1	10,515
	Total	4.9	4.5	4.9	134.3	0.1	89.1	13.5	10,667
Government	Auxiliary	0.1	0.1	0.1	2.0	0.0	0.8	0.2	118
	Propulsion	1.1	1.0	1.1	22.2	0.0	8.3	1.9	1,354
	Total	1.2	1.1	1.2	24.1	0.0	9.2	2.1	1,472
Ocean Tug (ATB/ITB)	Auxiliary	0.2	0.2	0.2	4.4	0.0	3.1	0.6	343
	Propulsion	6.3	5.8	6.3	178.3	0.1	88.3	15.0	11,726
	Total	6.5	6.0	6.5	182.7	0.1	91.4	15.5	12,069
Tugboat	Auxiliary	0.1	0.1	0.1	1.7	0.0	1.3	0.4	145
	Propulsion	0.7	0.6	0.7	22.6	0.0	17.7	2.4	1,989
	Total	0.8	0.7	0.8	24.3	0.0	19.0	2.8	2,134
Work boat	Auxiliary	0.1	0.1	0.1	2.5	0.0	1.9	0.6	211
	Propulsion	1.0	0.9	1.0	32.8	0.0	25.1	3.4	2,877
	Total	1.1	1.0	1.1	35.2	0.0	27.0	4.0	3,088
Total		**30.5**	**28.1**	**30.5**	**825.6**	**0.7**	**487.4**	**80.9**	**61,013**

DB ID427

SECTION 5 CARGO HANDLING EQUIPMENT

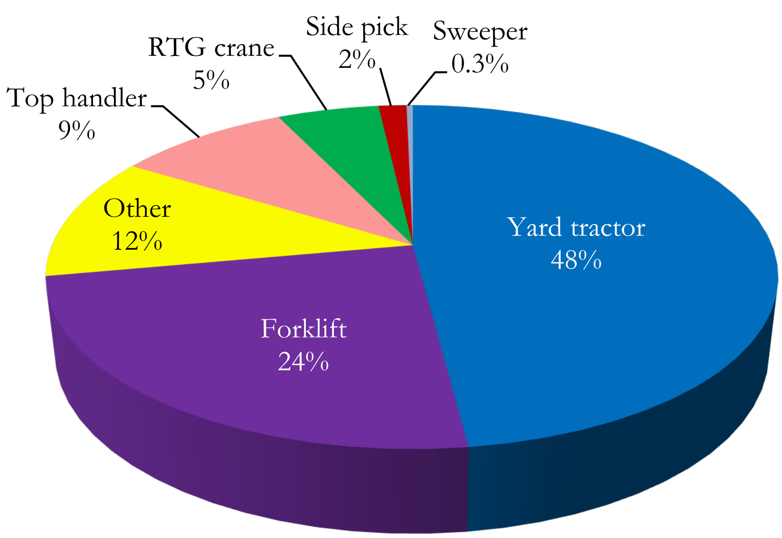
This section presents emissions estimates for the CHE source category, including source descriptions, geographical domain, data acquisition, operational profiles, emissions estimation methodology and emission estimates.

Source Description

The CHE category includes equipment that moves cargo (including cargo in containers, general cargo, and bulk cargo) to and from marine vessels, railcars, and on-road trucks. The equipment is typically operated at marine terminals or at rail yards and not on public roadways. This inventory includes cargo handling equipment fueled by diesel, gasoline, propane, liquefied natural gas (LNG), and electricity. Due to the diversity of cargo handled by the Port's terminals, there is a wide range of equipment types.

Figure 5.1 presents the population distribution of the 2,109 pieces of equipment inventoried at the Port for calendar year 2015. The 12% for other equipment includes pieces of equipment that are not typical CHE.

Figure 5.1: CHE Count Distribution by Equipment Type



Geographical Domain

The geographical domain for CHE is the terminals within the Port.

Data and Information Acquisition

The maintenance and/or CHE operating staff of each terminal were contacted in person, by e-mail, or by telephone to obtain equipment count and activity information on the CHE specific to their terminal's operation for the 2015 calendar year:

Operational Profiles

Table 5.1 summarizes the cargo handling equipment data collected from the terminals and facilities for the calendar year 2015. 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 includes the characteristics of main and small auxiliary engines (20 kW) for rubber tired gantry cranes (RTGs) in the RTG crane row. These averages are not used as defaults for either the main or auxiliary engine. Instead the separate averages for main and auxiliary engines are used for the RTG cranes. The count column is equipment count, not engine count. For the electric-powered equipment shown in the table, "na" denotes "not applicable" for engine size, model year and operating hours.

Table 5.1: CHE Engine Characteristics for All Terminals

Equipment	Type	Count	Power (hp)			Model Year			Annual Hours		
			Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Stacking Crane	Electric	19	na	na	na	na	na	na	na	na	na
Bulldozer	Diesel	3	200	310	255	2006	2007	2007	90	259	190
Crane	Diesel	8	130	950	305	1969	2010	1993	16	1,456	499
Pallet jack	Electric	7	na	na	na	na	na	na	na	na	na
Wharf crane	Electric	84	na	na	na	na	na	na	na	na	na
Excavator	Diesel	1	371	371	371	2010	2010	2010	0	0	0
Forklift	Diesel	122	56	388	178	1985	2015	2009	0	3,656	607
Forklift	Electric	10	na	na	na	na	na	na	na	na	na
Forklift	Gasoline	8	45	45	45	2010	2012	2011	0	2,267	1,015
Forklift	Propane	369	32	200	76	1987	2014	2000	0	4,057	522
Loader	Diesel	13	55	460	254	1989	2015	2006	0	4,496	1,127
Loader	Electric	3	na	na	na	na	na	na	na	na	na
Man lift	Diesel	16	48	152	77	1989	2012	2004	0	420	233
Man lift	Electric	3	na	na	na	na	na	na	na	na	na
Material handler	Diesel	12	322	475	386	2000	2011	2007	0	3,271	1,371
Miscellaneous	Diesel	7	25	268	60	2007	2013	2012	390	1,619	1,319
Miscellaneous	Electric	2	na	na	na	na	na	na	na	na	na
Rail pusher	Diesel	2	194	200	197	2000	2012	2006	0	117	59
Reach stacker	Diesel	1	250	250	250	2013	2013	2013	0	0	0
RMG cranes	Electric	10	na	na	na	na	na	na	na	na	na
RTG crane	Diesel	113	27	779	483	1998	2015	2008	0	3,794	1,571
Side pick	Diesel	31	136	250	221	1992	2015	2007	0	2,924	1,034
Skid steer loader	Diesel	8	54	94	68	1994	2012	2004	0	1,209	321
Straddle carrier	Diesel	28	425	425	425	2013	2015	2014	479	5,991	3,486
Sweeper	Diesel	5	37	260	146	1999	2008	2003	0	1,517	560
Sweeper	Gasoline	2	205	205	205	2002	2005	2004	313	2,660	1,487
Top handler	Diesel	192	250	375	322	1998	2015	2009	0	4,782	2,259
Truck	Diesel	18	185	540	344	2005	2012	2007	223	2,485	1,078
Yard tractor	Diesel	813	173	250	228	1995	2015	2010	0	3,765	1,752
Yard tractor	Gasoline	2	362	362	362	2012	2012	2012	71	184	128
Yard tractor	LNG	17	230	230	230	2009	2010	2010	284	2,470	987
Yard tractor	Propane	180	174	231	199	2000	2011	2007	0	4,997	1,855
Total Count		**2,109**									

DB ID228

Table 5.2 is a summary of the emission reduction technologies utilized in cargo handling equipment, including diesel oxidation catalysts (DOC), diesel particulate filters (DPF), and BlueCAT retrofit for large-spark ignition (LSI) engines. There is significantly less equipment with DOCs in 2015 than in earlier years because the older equipment equipped with DOCs are being phased out of the terminal fleets.

Table 5.2: Count of CHE Utilizing Emission Reduction Technologies

Equipment	DOC Installed	On-Road Engines	DPF Installed	Vycon Installed	BlueCAT LSI Equip
Forklift	0	0	40	0	198
RTG crane	6	0	13	1	0
Side pick	0	0	14	0	0
Top handler	0	0	106	0	0
Yard tractor	10	777	4	0	0
Sweeper	0	0	2	0	0
Other	0	10	22	0	0
Total	**16**	**787**	**201**	**1**	**198**

DB ID234

Table 5.3 shows the distribution of equipment by fuel type.

Table 5.3: Count of CHE Engine by Fuel Type

Equipment	Electric	LNG	Propane	Gasoline	Diesel	Total
Forklift	10	0	369	8	122	509
Wharf crane	84	0	0	0	0	84
RTG crane	0	0	0	0	113	113
Side pick	0	0	0	0	31	31
Top handler	0	0	0	0	192	192
Yard tractor	0	17	180	2	813	1,012
Sweeper	0	0	0	2	5	7
Other	44	0	0	0	117	161
Total	**138**	**17**	**549**	**12**	**1,393**	**2,109**

DB ID235

Table 5.4 summarizes the distribution of diesel cargo handling equipment by off-road diesel engine standards[10] (Tier 0, 1, 2, 3, 4i and 4) based on model year and horsepower range. The table also lists the count of each type of equipment using on-road diesel engines. The table does not reflect the fact that some of the engines may be cleaner than the Tier level they are certified to because of use of emissions control devices such as DOCs and DPFs.

The "Unknown" Tier column shown in the table represents equipment with missing horsepower or model year information necessary for Tier level classifications.

Table 5.4: Count of Diesel Equipment by Type and Engine Standards

Equipment Type	Tier 0	Tier 1	Tier 2	Tier 3	Tier 4i	Tier 4	Unknown Tier	On-road Engine	Total Diesel CHE
Yard tractor	4	1	0	0	0	31	0	777	813
Forklift	10	2	9	38	48	3	12	0	122
Top handler	0	18	34	58	34	48	0	0	192
Other	10	11	13	27	26	12	8	10	117
RTG crane	0	13	29	17	41	11	2	0	113
Side pick	2	6	4	9	0	4	6	0	31
Sweeper	0	3	0	2	0	0	0	0	5
Total	**26**	**54**	**89**	**151**	**149**	**109**	**28**	**787**	**1,393**
Percent	**2%**	**4%**	**6%**	**11%**	**11%**	**8%**	**2%**	**56%**	

DB ID878

The following table shows that the diesel equipment with higher tier levels (newer equipment) and the equipment with onroad engines are generally used more than the lower tiers, which contributes to reduce emissions due to cleaner engine standards in newer equipment.

Table 5.5: Diesel Engine Tier and Energy Consumption, kW-hrs and %

Engine Tier	Energy Consumption kW-hrs	Pecent Total
Tier 0	696,160	0.4%
Tier 1	4,282,278	2.2%
Tier 2	16,321,106	8.4%
Tier 3	29,049,512	14.9%
Tier 4i	26,985,779	13.8%
Tier 4	19,887,326	10.2%
Onroad engines	95,876,329	49.1%
Unknown	2,215,506	1.1%
Total	**195,313,995**	**100.0%**

[10] EPA, *Nonroad Compression-Ignition Engines- Exhaust Emission Standards,* June 2004

Emissions Estimation Methodology

The emissions calculation methodology used to estimate CHE emissions is consistent with CARB's latest methodology for estimating emissions from CHE[11], and is the same as described in detail in Section 5 of the Port's 2013 EI[12]. The NO_x emission rates for the newer diesel on-road engines within a certain horsepower range were updated based on discussions with CARB.

Emission Estimates

The following tables present the estimated CHE emissions by terminal type, equipment type, and engine type. In order for the total emissions to be consistently displayed for each pollutant, the individual values in each table column do not, in some cases, add up to the listed total in the tables. This is because there are fewer decimal places displayed (for readability) than are included in the calculated total.

Table 5.6 summarizes the CHE emissions by terminal type and Table 5.7 provides a more detailed summary of cargo handling equipment emissions by equipment and engine type. The criteria pollutants are listed as tons per year while the CO_2e values are listed as tonnes (metric tons) per year.

Table 5.6: CHE Emissions by Terminal Type

Terminal Type	PM_{10} tons	$PM_{2.5}$ tons	DPM tons	NO_x tons	SO_x tons	CO tons	HC tons	CO_2e tonnes
Auto	0.0	0.0	0.0	0.1	0.0	1.9	0.2	34
Break-Bulk	1.1	1.0	1.1	32.4	0.1	17.7	2.6	6,427
Container	7.4	6.9	5.6	495.7	1.7	668.6	74.0	155,651
Cruise	0.0	0.0	0.0	1.6	0.0	2.4	0.1	108
Dry Bulk	0.0	0.0	0.0	4.9	0.0	1.9	0.4	286
Liquid	0.0	0.0	0.0	0.6	0.0	1.2	0.1	73
Other	0.5	0.5	0.4	22.1	0.1	66.5	7.4	8,131
Total	**9.1**	**8.5**	**7.2**	**557.3**	**1.8**	**760.3**	**84.9**	**170,710**

DB ID237

[11] CARB, *Appendix B: Emission Estimation Methodology for Cargo Handling Equipment Operating at Ports and Intermodal Rail Yards in California. www.arb.ca.gov/regact/2011/cargo11/cargoappb.pdf,* viewed 22 July 2015
[12] POLA, *www.portoflosangeles.org/environment/studies_reports.asp*

Tables 5.7 present the emissions by cargo handling equipment type and engine type.

Table 5.7: CHE Emissions by Equipment and Engine Type

Equipment	Engine	PM_{10} tons	$PM_{2.5}$ tons	DPM tons	NO_x tons	SO_x tons	CO tons	HC tons	CO_2e tonnes
Bulldozer	Diesel	0.0	0.0	0.0	0.2	0.0	0.1	0.0	44
Crane	Diesel	0.2	0.2	0.2	5.1	0.0	1.7	0.3	463
Excavator	Diesel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Forklift	Diesel	0.2	0.2	0.2	12.5	0.0	9.3	0.9	2,328
Forklift	Gasoline	0.0	0.0	0.0	0.2	0.0	5.6	0.5	88
Forklift	Propane	0.2	0.2	0.0	14.5	0.0	70.4	3.3	2,484
Loader	Diesel	0.1	0.1	0.1	5.5	0.0	2.7	0.5	1,114
Man Lift	Diesel	0.0	0.0	0.0	0.9	0.0	0.6	0.1	87
Material handler	Diesel	0.5	0.4	0.5	11.5	0.0	4.4	1.0	2,081
Miscellaneous	Diesel	0.0	0.0	0.0	0.5	0.0	0.6	0.0	97
Rail Pusher	Diesel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7
RTG Crane	Diesel	1.4	1.3	1.4	82.0	0.2	27.7	5.6	13,940
Side pick	Diesel	0.4	0.3	0.4	12.5	0.0	5.6	1.0	2,455
Skid Steer Loader	Diesel	0.0	0.0	0.0	0.4	0.0	0.3	0.0	52
Straddle Carrier	Diesel	0.1	0.1	0.1	12.2	0.1	10.1	1.7	4,756
Sweeper	Diesel	0.1	0.1	0.1	1.4	0.0	0.7	0.1	226
Sweeper	Gasoline	0.0	0.0	0.0	4.6	0.0	19.5	1.0	307
Top handler	Diesel	1.7	1.5	1.7	203.6	0.5	100.4	19.0	47,145
Truck	Diesel	0.3	0.3	0.3	8.5	0.0	4.3	0.7	1,997
Yard tractor	Diesel	2.1	1.9	2.1	103.3	0.9	159.5	9.2	73,011
Yard tractor	Gasoline	0.0	0.0	0.0	0.0	0.0	0.2	0.0	27
Yard tractor	LNG	0.0	0.0	0.0	1.1	0.0	0.1	3.6	745
Yard tractor	Propane	1.7	1.7	0.0	76.7	0.0	336.4	36.3	17,259
Total		**9.1**	**8.5**	**7.2**	**557.3**	**1.80**	**760.3**	**84.9**	**170,710**

DB ID237

SECTION 6 LOCOMOTIVES

This section presents emission estimates for the railroad locomotives source category, including source description, geographical domain, data and information acquisition, operational profiles, the emissions estimation methodology, and the emissions estimates.

Source Description

Railroad operations are typically described in terms of two different types of operations, line haul and switching. Line haul refers to the movement of cargo by train over long distances. Line haul operations occur at or near 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., whereas "inbound" rail freight is destined for shipment out of the Port by vessel. 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." Outbound rail cargo is also referred to as eastbound and inbound rail cargo is also referred to as westbound.

The Port is served by three railway companies:

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

BNSF and UP provide line haul service to and from the Port and also operate switching services at their off-port locations, while PHL performs most of the switching operations within the Port. Locomotives used for line haul operations are typically equipped with large, powerful engines of 4,000 hp or more, while switch engines are smaller, typically having one or more engines totaling 1,200 to 3,000 hp. The locomotives used in switching service at the Port by PHL, and at the near-port railyard operated by UP, are primarily new, low-emitting locomotives specifically designed for switching duty.

Geographical Domain

The specific activities included in this emissions inventory are movements of cargo within Port boundaries, and directly to or from Port-owned properties such as terminals and on-Port rail yards, within and to the boundary of the SoCAB. The inventory does not include rail movements of cargo that occur solely outside the Port, such as off-port rail yard switching, and movements that neither begin or end at a Port property, such as east-bound line hauls that initiate in central Los Angeles intermodal yards. Please refer to Section 1 for a description of the geographical domain of the emissions inventory with regard to locomotive operations.

Data and Information Acquisition

To estimate emissions associated with maritime industry-related activities of locomotives operating within the Port and outside the Port to the boundary of the SoCAB, information has been obtained from:

- Previous emissions studies
- Port cargo statistics
- Input from railroad operators
- Published information sources
- CARB MOU line-haul fleet compliance data

The Port continues to use the most recent, locally-specific data available, including MOU compliance data reflective of actual recent line haul fleet mix characteristics in the SoCAB. Upcoming international rules on the weighing of containers during shipment, currently slated for implementation in July 2016,[13] will ultimately provide a more robust estimate of the average weight of containers shipped by rail. This will result in more accurate estimates of train weights, which form the basis of the line haul emission estimates.

Operational Profiles

The goods movement rail system in terms of the activities that are carried out by locomotive operators is the same as described in detail in Section 6 of the Port's 2013 EI report.

Emissions Estimation Methodology

The emissions calculation methodology used to estimate locomotive emissions is consistent with the methodology described in detail in Section 6 of the Port's 2013 EI.[14] Below are tables that are specific to this 2015 EI.

[13] World Shipping, *www.worldshipping.org/industry-issues/safety/cargo-weight* and *www.worldshipping.org/industry-issues/safety/SOLAS_CHAPTER_VI_Regulation_2_Paragraphs_4-6.pdf*

[14] POLA, *www.portoflosangeles.org/environment/studies_reports.asp*

Table 6.1 presents the MOU compliance information submitted by both railroads and the composite of both railroads' pre-Tier 0 through Tier 4 locomotive NO_x emissions for calendar year 2014, showing a weighted average NO_x emission factor of 5.68 g/hphr.[15] The 2014 reports were used instead of the 2015 because of the timing of the inventory data collection phase and of the posting of the compliance reports by CARB. The emission factors based on the 2015 compliance report will be used for the 2016 EI.

Table 6.1: MOU Compliance Data, MWhrs and g NO_x/hp-hr

Tier	Number of Locomotives	Energy Consumption MWhrs	% Energy Consumption by Tier Level	Weighted Average NO_x g NO_x/hp-hr	Tier Contribution Fleet Average g NO_x/hp-hr
BNSF					
Pre-Tier 0	78	220	0.1%	13	0.01
Tier 0	372	9,459	5%	7.7	0.37
Tier 1	1,128	50,382	25%	6.4	1.62
Tier 2	1,145	107,503	54%	4.6	2.48
Tier 3	576	31,832	16%	4.6	0.73
Tier 4	0	0	0%	-	-
ULEL	0	0	0%	-	-
Total BNSF	**3,299**	**199,396**	**100%**		**5.2**
UP					
Pre-Tier 0	82	624	0.3%	12.6	0.04
Tier 0	2,699	62,605	29%	7.8	2.30
Tier 1	1,805	30,671	14%	6.7	0.97
Tier 2	1,758	78,119	37%	5.1	1.87
Tier 3	636	32,040	15%	4.7	0.71
Tier 4	2	78	0.04%	1.18	0.00
ULEL	61	8,476	4%	2.63	0.10
Total UP	**7,043**	**212,613**	**100%**		**6.0**
			ULEL Credit Used		0.5
			UP Fleet Average		**5.5**
Both RRs, excluding ULELs and ULEL credits					
Pre-Tier 0	160	844	0%	12.7	0.03
Tier 0	3,071	72,063	18%	7.8	1.39
Tier 1	2,933	81,054	20%	6.5	1.31
Tier 2	2,903	185,623	46%	4.8	2.21
Tier 3	1,212	63,871	16%	4.7	0.74
Tier 4	2	78	0.02%	1.2	0.0002
Total both	**10,281**	**403,533**	**100%**		**5.68**

[15] Notes from railroads' MOU compliance submissions:
1. EPA locomotive emission standards: *www.epa.gov/oms/locomotives.htm*
2. Number of locomotives is the sum of all individual locomotives that visited or operated within the SoCAB at any time during 2014.

Emission factors (EFs) for particulate matter (PM_{10}, $PM_{2.5}$, and DPM), HC, and CO were calculated using the tier-specific emission rates for those pollutants published by EPA[16] and used to develop weighted average emission factors using the megawatt hour (MWhr) figures provided in the railroads' submissions. These results are presented in Table 6.2.

Table 6.2: Fleet MWhr and PM, HC, CO Emission Factors, g/hp-hr

Engine Tier	Energy Consumption MW-hr	% of Energy	EPA Tier-specific EFs			Fleet Composite EFs		
			PM_{10} g/hp-hr	HC g/hp-hr	CO g/hp-hr	PM_{10} g/hp-hr	HC g/hp-hr	CO g/hp-hr
Pre-Tier 0	844	0%	0.32	0.48	1.28	0.00	0.00	0.00
Tier 0	72,063	18%	0.32	0.48	1.28	0.06	0.09	0.23
Tier 1	81,054	20%	0.32	0.47	1.28	0.06	0.09	0.26
Tier 2	185,623	46%	0.18	0.26	1.28	0.08	0.12	0.59
Tier 3	63,871	16%	0.08	0.13	1.28	0.01	0.02	0.20
Totals	**403,533**	**100%**				**0.22**	**0.32**	**1.28**

Table 6.3 summarizes the emission factors for line haul locomotives, presented in units of g/hp-hr. The greenhouse gas emission factors are unchanged from the previous EI.

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

	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC	CO_2	N_2O	CH_4
EF, g/bhp-hr	0.22	0.20	0.22	5.68	0.005	1.28	0.32	494	0.013	0.040

16 EPA, Office of Transportation and Air Quality, *Emission Factors for Locomotives*, EPA-420-F-09-025, April 2009

On-Port Line Haul Emissions
The number of trains per year, locomotives per train, and on-port hours per train are multiplied together to calculate total locomotive hours per year. This activity information is summarized in Table 6.4.

Table 6.4: 2015 Estimated On-Port Line Haul Locomotive Activity

Activity Measure	Inbound	Outbound	Total
Trains per Year	3,239	3,233	6,472
Locomotives per Train	3	3	N/A
Hours on Port per Trip	1	2.5	N/A
Locomotive Hours per Year	9,717	24,250	33,967

Out-of-Port Line Haul Emissions
For out-of-port line haul estimates, the following table has updated values for the 2015 EI. Table 6.5 lists the estimated totals of travel distance, out-of-port trains per year, out-of-port million gross tons (MMGT), out-of-port MMGT-miles, gallons of fuel used, and horsepower-hours. The gross ton-miles are calculated by multiplying distance by number of trains by the average weight of a train, estimated to be 7,276 tons. Fuel consumption is calculated by multiplying gross ton-miles by the average fuel consumption factor of 0.989 gallons per thousand gross ton-miles. Overall horsepower hours are calculated by multiplying the fuel use by the fuel consumption conversion factor of 20.8 hp-hr/gal.

Table 6.5: 2015 Gross Ton-Mile, Fuel Use, and Horsepower-hour Estimate

	Distance miles	Trains per year	MMGT per year	MMGT-miles per year
Alameda Corridor	21	5,372	39	819
Central LA to Air Basin Boundary	84	5,372	39	3,276
Million gross ton-miles				**4,095**
Estimated gallons of fuel (millions)				**4.05**
Estimated million horsepower-hours				**84.2**

Emission Estimates

A summary of estimated emissions from locomotive operations related to the Port is presented below in Table 6.6. These emissions include operations within the port and maritime industry-related emissions outside the port out to the boundary of the SoCAB. The "maritime industry-related" off-port activity is associated with cargo movements having either their origin or termination at the port. Emissions resulting from the movement of cargo originating or terminating at one of the off-port rail yards are not included. The criteria pollutants are listed as tons per year while the CO_2e values are listed as tonnes (metric tons) per year.

In order for the total emissions to be consistently displayed for each pollutant, the individual values in the table entries do not, in some cases, add up to the totals listed in the table. This is because there are fewer decimal places displayed (for readability) than are included in the calculated totals.

Table 6.6: Locomotive Operations Estimated Emissions

	PM_{10} tons	$PM_{2.5}$ tons	DPM tons	NO_x tons	SO_x tons	CO tons	HC tons	CO_2e tonnes
Switching	0.5	0.5	0.5	51	0.07	21.3	2.6	7,268
Line Haul	29.7	27.0	29.7	768	0.68	173.0	43.2	61,164
Total	**30.2**	**27.5**	**30.2**	**819**	**0.75**	**194.3**	**45.8**	**68,432**

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SECTION 7 HEAVY-DUTY VEHICLES

This section presents emission estimates for the HDV source category, including source description, geographical domain, data and information acquisition, operational profiles, the emissions estimation methodology, and the emission estimates.

Source Description

Heavy-duty vehicles (specifically heavy-duty trucks) are used extensively to move cargo, particularly containerized cargo, to and from the marine terminals. Trucks deliver cargo to both local and national destinations, and they also transfer containers between terminals and off-port railcar loading facilities. The local activity is often referred to as drayage. 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.

While most of the trucks that service the Port's terminals are diesel-fueled vehicles, alternatively-fueled trucks, primarily those fueled by LNG, made approximately 7.0% of the terminal calls in 2015, according to the Port's Clean Truck Program (CTP) activity records and the Port Drayage Truck Registry (PDTR). Vehicles using fuel other than diesel fuel do not emit diesel particulate matter, so the diesel particulate emission estimates presented in this inventory have been adjusted to take the alternative-fueled trucks into account.

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 chassis, 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" while 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.

Geographical Domain

The two major geographical components of truck activities have been evaluated for this inventory:

- 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 within the SoCAB. This also includes travel on public roads within the Port boundaries and those of the adjacent POLB.

Data and Information Acquisition

The procedure to collect drayage truck related activity data is the same as described in Section 7 of the Port's 2013 EI report.

Operational Profiles

Operational profiles were developed for on-terminal truck activity using data and information collected from terminal operators. The on-road truck activity profiles were developed using trip generation and travel demand models to estimate the number of on-road vehicle miles traveled (VMT).

Table 7.1 illustrates the range and average of reported container terminal operating characteristics of on-terminal truck activities at port container terminals, while Table 7.2 shows similar summary data for the non-container terminals and facilities. The total numbers of terminal calls in 2015 were 3,550,200 associated with the port's container terminals and 1,206,820 associated with the non-container facilities. The total number of container terminal calls is based on the trip generation model on which truck travel estimates are based, while non-container terminal calls were obtained from the terminal operators. The non-container terminal number includes activity at the Port's peel-off yard that operated in 2015, totaling 20,744 terminal calls. The peel-off yard was put in place to improve terminal efficiency by allowing containers off-loaded from ships to be quickly removed from the container terminal and placed in the yard, to be picked up for further transport at a later time.

Table 7.1: Summary of Reported Container Terminal Operating Characteristics

	Speed mph	Distance miles	Gate In hours	Unload/ Load hours	Gate Out hours
Maximum	15	1.5	0.17	0.90	0.13
Minimum	10	0.9	0.08	0.38	0.00
Average	12.5	1.3	0.12	0.59	0.04

Table 7.2: Summary of Reported Non-Container Facility Operating Characteristics

	Speed mph	Distance miles	Gate In hours	Unload/ Load hours	Gate Out hours
Maximum	20	1.3	0.08	0.47	0.05
Minimum	0	0.02	0.00	0.00	0.00
Average	7.5	0.5	0.03	0.11	0.02

Table 7.3 presents further detail on the on-terminal operating parameters, listing total estimated miles traveled and hours of idling on-terminal and waiting at entry gates. Terminals are listed by type.

Table 7.3: Estimated On-Terminal VMT and Idling Hours by Terminal

Terminal Type	Total Miles Traveled	Total Hours Idling all trips
Container	1,616,427	1,153,051
Container	887,948	384,777
Container	873,897	524,338
Container	709,097	293,093
Container	434,171	230,111
Container	352,005	265,960
Auto	1,463	994.5
Break Bulk	23,101	5,198
Break Bulk	18,750	12,000
Dry Bulk	13,520	1976
Dry Bulk	1,250	375
Liquid Bulk	3,250	390
Liquid Bulk	18	0
Other	581,812	261,815
Other	273,991	40,045
Other	188,369	27,531
Other	67,600	8,320
Other	10,140	1,352
Other	2,074	9,750
Other	520	910
Other	40	320
Total	**6,059,442**	**3,222,306**

Emissions Estimation Methodology

The general emissions estimating methodology for the Port's on-road truck fleet is the same as described in section 7.0 of the Port's 2013 EI report, with the updates reported in the 2014 EI report regarding the EMFAC2014 model, which was again used to estimate emission factors. Table 7.4 summarizes the speed-specific emission factors developed from the EMFAC2014 model and used to estimate emissions.

Table 7.4: Speed-Specific Composite Exhaust Emission Factors

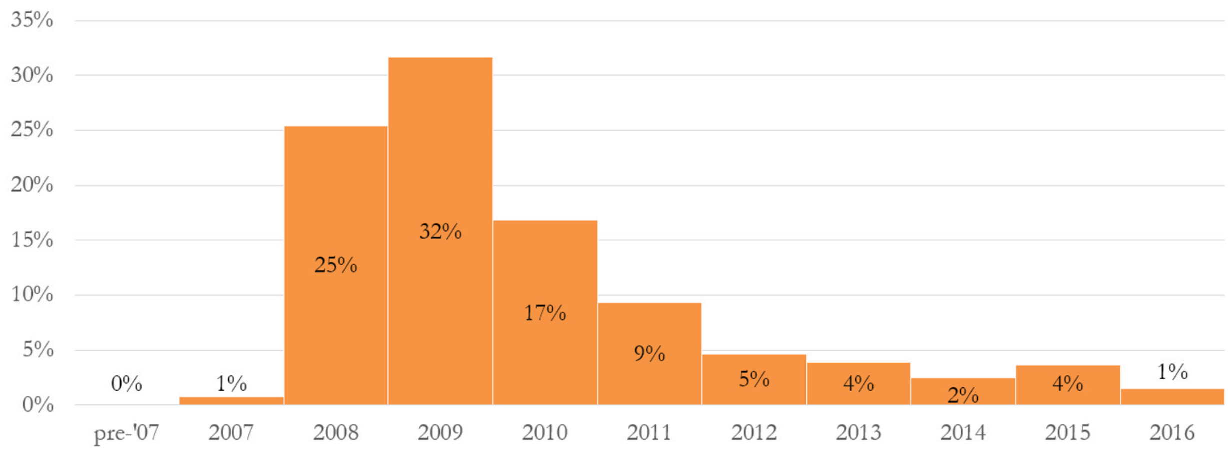
Speed (mph)	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC	CO_2	N_2O	CH_4	Units
0 (Idle)	0.0085	0.0081	0.0079	36.7915	0.0484	3.1039	1.1162	5,119	0.1647	0.0657	g/hr
5	0.0731	0.0700	0.0680	19.7725	0.0174	5.1361	1.3800	3,505	0.0624	0.0812	g/mi
10	0.0659	0.0631	0.0613	16.8087	0.0174	4.1567	1.1147	3,123	0.0624	0.0656	g/mi
15	0.0568	0.0543	0.0528	13.0560	0.0174	2.9172	0.7777	2,639	0.0624	0.0457	g/mi
20	0.0507	0.0485	0.0472	10.5826	0.0174	2.1042	0.5579	2,319	0.0624	0.0328	g/mi
25	0.0462	0.0442	0.0430	9.2869	0.0174	1.5457	0.4093	2,114	0.0624	0.0241	g/mi
30	0.0426	0.0408	0.0396	8.5455	0.0174	1.1445	0.3026	1,972	0.0624	0.0178	g/mi
35	0.0398	0.0380	0.0370	8.0025	0.0174	0.8490	0.2239	1,860	0.0624	0.0132	g/mi
40	0.0374	0.0358	0.0348	7.5816	0.0174	0.6316	0.1657	1,770	0.0624	0.0097	g/mi
45	0.0354	0.0339	0.0329	7.2405	0.0174	0.4717	0.1228	1,695	0.0624	0.0072	g/mi
50	0.0337	0.0322	0.0313	6.9583	0.0174	0.3544	0.0912	1,631	0.0624	0.0054	g/mi
55	0.0323	0.0309	0.0300	6.7232	0.0174	0.2686	0.0679	1,576	0.0624	0.0040	g/mi
60	0.0317	0.0303	0.0295	6.6221	0.0174	0.2349	0.0586	1,551	0.0624	0.0034	g/mi
65	0.0317	0.0303	0.0295	6.6485	0.0174	0.2349	0.0586	1,551	0.0624	0.0034	g/mi
70	0.0317	0.0303	0.0295	6.6688	0.0174	0.2349	0.0586	1,551	0.0624	0.0034	g/mi

Model Year Distribution

Because vehicle emissions vary according to the vehicle's model year and age, the activity level of trucks within each model year is an important part of developing emission estimates. The 2015 model year distribution for the current emissions inventory is based on call data originating from radio frequency identification (RFID) data, which tracked over 5.6 million truck calls made to the Port of Los Angeles and the Port of Long Beach in 2015, as well as model year data drawn from the PDTR. The PDTR contains model year information on all registered drayage trucks serving the Port and the fuel type used by each truck, from which an adjustment factor was developed for non-diesel fueled vehicles. The RFID data provided the number of calls made by each model year of truck.

The distribution of the truck fleet's model years by calls, which was used to develop the composite emission factors listed above, is presented in Figure 7.1. The call weighted average age of the trucks calling at San Pedro Bay port terminals in 2015 was approximately 5 years, the same as the 5-year average in 2014.

Figure 7.1: Model Year Distribution of the Heavy-Duty Truck Fleet, % calls



Emission Estimates

The estimates of 2015 HDV emissions are presented in this section. As discussed above, on-terminal emissions are based on terminal-specific information such as the 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 using travel demand model results to estimate how many miles in total the 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 idling emissions are likely to be somewhat over-estimated because the idling estimates are based on the entire time that trucks are on terminal (except for driving time), which does not account for times that trucks are turned off while on terminal. No data source has been identified that would provide a reliable estimate of the average percentage of time the trucks' engines are turned off while on terminal. The on-road estimates include idling emissions as a normal part of the driving cycle because the average speeds include estimates of normal traffic idling times, and the emission factors are designed to take this into account.

In order for the total emissions to be consistently displayed for each pollutant, the individual values in each table column do not, in some cases, add up to the listed total in the tables. This is because there are fewer decimal places displayed for readability than are included in the calculated total.

Emission estimates for HDV activity associated with port terminals and other facilities are presented in the following tables. Table 7.5 summarizes emissions from HDVs associated with all port terminals.

Table 7.5: HDV Emissions

Activity Location	VMT	PM_{10} tons	$PM_{2.5}$ tons	DPM tons	NO_x tons	SO_x tons	CO tons	HC tons	CO_2e tonnes
On-Terminal	6,059,442	0.4	0.4	0.41	229	0.3	34.1	10.1	34,037
On-Road	205,189,250	7.9	7.6	7.34	1,667	3.9	100.6	26.1	347,700
Total	**211,248,692**	**8.3**	**8.0**	**7.7**	**1,896**	**4.2**	**134.6**	**36.2**	**381,737**

Table 7.6 presents HDV emissions associated with container terminal activity separately from emissions associated with other port terminals and facilities.

Table 7.6: HDV Emissions Associated with Container Terminals

Activity Location	VMT	PM_{10} tons	$PM_{2.5}$ tons	DPM tons	NO_x tons	SO_x tons	CO tons	HC tons	CO_2e tonnes
On-Terminal	4,873,544	0.4	0.3	0.3	194	0.2	28.1	8.4	28,637
On-Road	188,178,419	7.2	6.9	6.7	1,526	3.6	92.5	24.0	318,969
Total	**193,051,964**	**7.6**	**7.3**	**7.1**	**1,720**	**3.9**	**120.5**	**32.4**	**347,606**

Table 7.7 presents emissions associated with other port terminals and facilities separately.

Table 7.7: HDV Emissions Associated with Other Port Terminals

Activity Location	VMT	PM_{10} tons	$PM_{2.5}$ tons	DPM tons	NO_x tons	SO_x tons	CO tons	HC tons	CO_2e tonnes
On-Terminal	1,185,897	0.1	0.1	0.1	35	0.0	6.0	1.7	5,399
On-Road	17,010,831	0.7	0.6	0.6	141	0.3	8.1	2.1	28,732
Total	**18,196,729**	**0.7**	**0.7**	**0.7**	**176**	**0.4**	**14.1**	**3.8**	**34,131**

SECTION 8 SUMMARY OF 2015 EMISSION RESULTS

Table 8.1 summarizes the 2015 total maritime industry-related emissions associated with the Port of Los Angeles by category. Tables 8.2 through 8.4 present DPM, NO_x and SO_x emissions in the context of port-wide and air basin-wide emissions by source category and subcategory.

Table 8.1: Emissions by Source Category

Category	PM_{10} tons	$PM_{2.5}$ tons	DPM tons	NO_x tons	SO_x tons	CO tons	HC tons	CO_2e tonnes
Ocean-going vessels	74.7	69.4	59.3	3,779.7	124.6	320.7	146.2	248,431
Harbor craft	30.5	28.1	30.5	825.5	0.7	487.4	80.9	61,013
Cargo handling equipment	9.1	8.5	7.2	557.3	1.8	760.3	84.9	170,710
Locomotives	30.2	27.5	30.2	819.0	0.8	194.3	45.8	68,432
Heavy-duty vehicles	8.3	8.0	7.7	1,895.9	4.2	134.6	36.2	381,737
Total	**152.9**	**141.4**	**134.9**	**7,877.3**	**132.1**	**1,897.3**	**394.0**	**930,324**

DB ID457

Table 8.2: DPM Emissions by Category and Percent Contribution

Category	Subcategory	DPM Emissions	Percent DPM Emissions of Total Category	Port	SoCAB AQMP
OGV	Auto carrier	1.0	2%	1%	0.0%
OGV	Bulk vessel	1.8	3%	1%	0.1%
OGV	Containership	38.1	64%	28%	1.4%
OGV	Cruise	6.9	12%	5%	0.2%
OGV	General cargo	2.4	4%	2%	0.1%
OGV	Other	0.6	1%	0%	0.0%
OGV	Reefer	0.6	1%	0%	0.0%
OGV	Tanker	7.7	13%	6%	0.3%
OGV	**Subtotal**	**59**	**100%**	**44%**	**2.1%**
Harbor Craft	Assist tug	7.6	25%	6%	0.3%
Harbor Craft	Harbor tug	0.8	2%	1%	0.0%
Harbor Craft	Commercial fishing	2.7	9%	2%	0.1%
Harbor Craft	Ferry	4.9	16%	4%	0.2%
Harbor Craft	Ocean tugboat	6.5	21%	5%	0.2%
Harbor Craft	Government	1.2	4%	1%	0.0%
Harbor Craft	Excursion	3.6	12%	3%	0.1%
Harbor Craft	Crewboat	2.2	7%	2%	0.1%
Harbor Craft	Work boat	1.1	4%	1%	0.0%
Harbor Craft	**Subtotal**	**31**	**100%**	**23%**	**1.1%**
CHE	RTG crane	1.4	20%	1%	0.1%
CHE	Forklift	0.2	3%	0%	0.0%
CHE	Top handler, side pick	2.0	28%	2%	0.1%
CHE	Other	1.3	19%	1%	0.0%
CHE	Yard tractor	2.1	30%	2%	0.1%
CHE	**Subtotal**	**7**	**100%**	**5%**	**0.3%**
Locomotives	Switching	0.5	2%	0%	0.0%
Locomotives	Line haul	29.7	98%	22%	1.1%
Locomotives	**Subtotal**	**30**	**100%**	**22%**	**1.1%**
HDV	On-Terminal	0.4	5%	0%	0.0%
HDV	On-Road	7.3	95%	5%	0.3%
HDV	**Subtotal**	**8**	**100%**	**6%**	**0.3%**
Port	**Total**	**135**		**100%**	**4.8%**
SoCAB AQMP	**Total**	**2,785**			

Table 8.3: NO_x Emissions by Category and Percent Contribution

Category	Subcategory	NO_x Emissions	Percent NO_x Emissions of Total Category	Port	SoCAB AQMP
OGV	Auto carrier	66	2%	1%	0.0%
OGV	Bulk vessel	108	3%	1%	0.1%
OGV	Containership	2,587	68%	33%	1.5%
OGV	Cruise	345	9%	4%	0.2%
OGV	General cargo	126	3%	2%	0.1%
OGV	Other	32	1%	0%	0.0%
OGV	Reefer	36	1%	0%	0.0%
OGV	Tanker	479	13%	6%	0.3%
OGV	**Subtotal**	**3,780**	**100%**	**48%**	**2.1%**
Harbor Craft	Assist tug	211	26%	2.7%	0.1%
Harbor Craft	Harbor tug	24	3%	0.3%	0.0%
Harbor Craft	Commercial fishing	58	7%	0.7%	0.0%
Harbor Craft	Ferry	134	16%	1.7%	0.1%
Harbor Craft	Ocean tugboat	183	22%	2.3%	0.1%
Harbor Craft	Government	24	3%	0.3%	0.0%
Harbor Craft	Excursion	88	11%	1.1%	0.0%
Harbor Craft	Crewboat	68	8%	0.9%	0.0%
Harbor Craft	Work boat	35	4%	0.4%	0.0%
Harbor Craft	**Subtotal**	**826**	**100%**	**10%**	**0.5%**
CHE	RTG crane	82	15%	1.0%	0.0%
CHE	Forklift	27	5%	0.3%	0.0%
CHE	Top handler, side pick	216	39%	2.7%	0.1%
CHE	Other	51	9%	0.6%	0.0%
CHE	Yard tractor	181	32%	2.3%	0.1%
CHE	**Subtotal**	**557**	**100%**	**7%**	**0.3%**
Locomotives	Switching	51	6%	0.7%	0.0%
Locomotives	Line haul	768	94%	9.7%	0.4%
Locomotives	**Subtotal**	**819**	**100%**	**10%**	**0.5%**
HDV	On-Terminal	229	12%	3%	0.1%
HDV	On-Road	1,667	88%	21%	0.9%
HDV	**Subtotal**	**1,896**	**100%**	**24%**	**1.1%**
Port	**Total**	**7,877**		**100%**	**4.4%**
SoCAB AQMP	**Total**	**178,127**			

Table 8.4: SO_x Emissions by Category and Percent Contribution

Category	Subcategory	SO_x Emissions	Percent SO_x Emissions of Total Category	Port	SoCAB AQMP
OGV	Auto carrier	2.5	2%	2%	0%
OGV	Bulk vessel	4.4	4%	3%	0%
OGV	Containership	68.7	55%	52%	1%
OGV	Cruise	12.2	10%	9%	0%
OGV	General cargo	3.4	3%	3%	0%
OGV	Other	1.3	1%	1%	0%
OGV	Reefer	1.5	1%	1%	0%
OGV	Tanker	30.4	24%	23%	0%
OGV	**Subtotal**	**124**	**100%**	**94%**	**2%**
Harbor Craft	Assist tug	0.2	28%	0%	0%
Harbor Craft	Harbor tug	0.0	3%	0%	0%
Harbor Craft	Commercial fishing	0.0	5%	0%	0%
Harbor Craft	Ferry	0.1	17%	0%	0%
Harbor Craft	Ocean tugboat	0.1	20%	0%	0%
Harbor Craft	Government	0.0	2%	0%	0%
Harbor Craft	Excursion	0.1	9%	0%	0%
Harbor Craft	Crewboat	0.1	10%	0%	0%
Harbor Craft	Work boat	0.0	5%	0%	0%
Harbor Craft	**Subtotal**	**0.7**	**100%**	**1%**	**0%**
CHE	RTG crane	0.2	9%	0%	0%
CHE	Forklift	0.0	2%	0%	0%
CHE	Top handler, side pick	0.6	31%	0%	0%
CHE	Other	0.1	7%	0%	0%
CHE	Yard tractor	0.9	51%	1%	0%
CHE	**Subtotal**	**1.8**	**100%**	**1%**	**0%**
Locomotives	Switching	0.1	9%	0%	0%
Locomotives	Line haul	0.7	91%	1%	0%
Locomotives	**Subtotal**	**0.75**	**100%**	**1%**	**0%**
HDV	On-Terminal	0.3	7%	0%	0%
HDV	On-Road	3.9	93%	3%	0%
HDV	**Subtotal**	**4.2**	**100%**	**3%**	**0%**
Port	**Total**	**132**		**100%**	**2.0%**
SoCAB AQMP	**Total**	**6,672**			

In order to put the maritime industry-related emissions into context, the following figures compare the Port's contributions to the total emissions in the South Coast Air Basin by major emission source category. The 2015 SoCAB emissions are based on the 2012 AQMP Appendix III.[17] Due to rounding, the percentages may not total 100%.

Figure 8.1: PM_{10} Emissions in the South Coast Air Basin

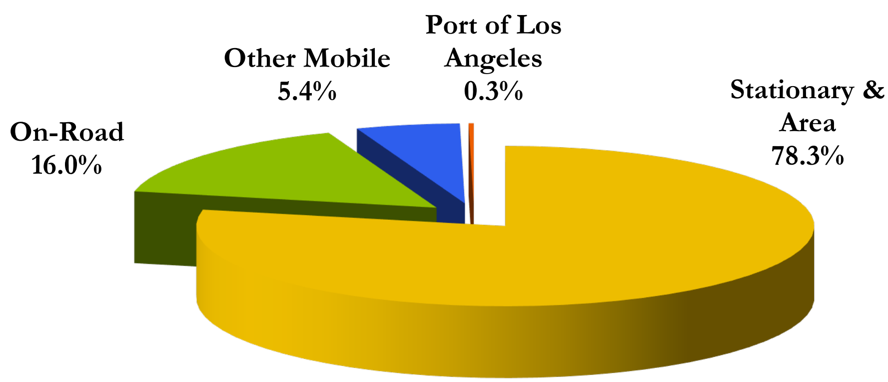
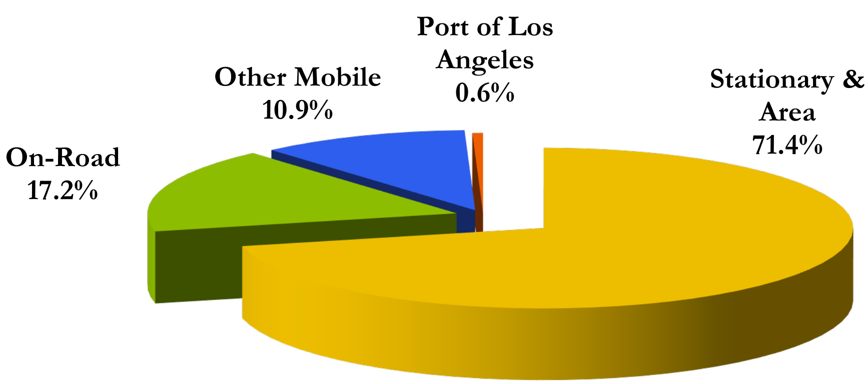


Figure 8.2: $PM_{2.5}$ Emissions in the South Coast Air Basin



[17] SCAQMD, *Final 2012 AQMP Appendix III, Base & Future Year Emissions Inventories*, February 2013

Figure 8.3: DPM Emissions in the South Coast Air Basin

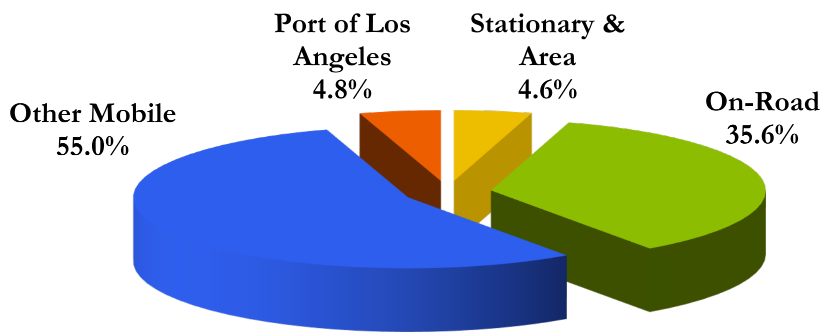


Figure 8.4: NO_x Emissions in the South Coast Air Basin

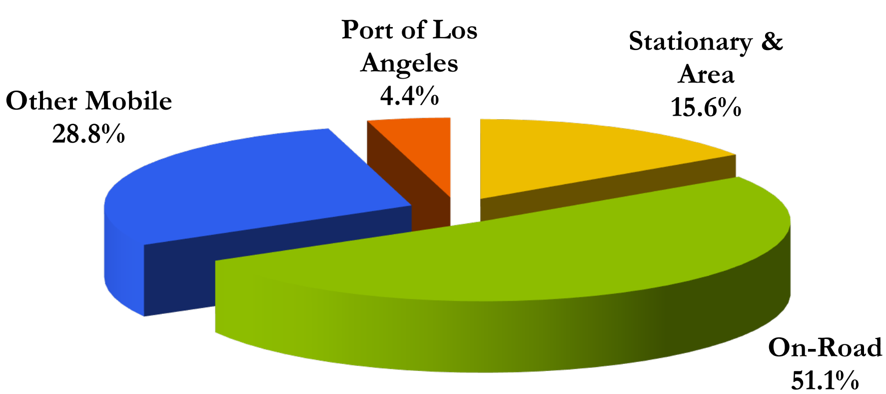


Figure 8.5: SO_x Emissions in the South Coast Air Basin

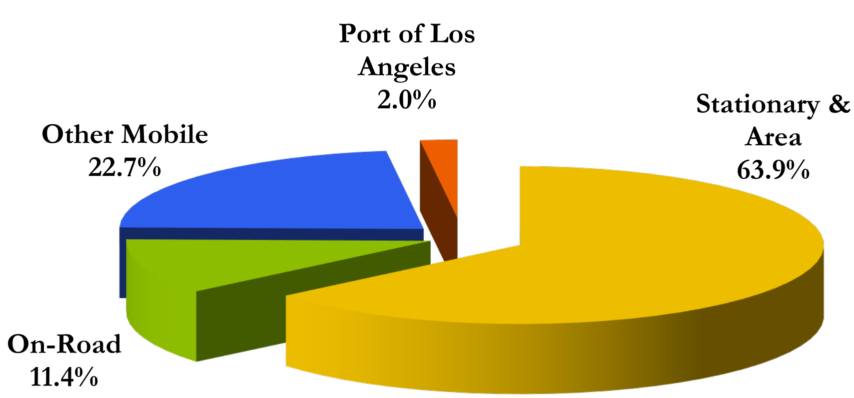
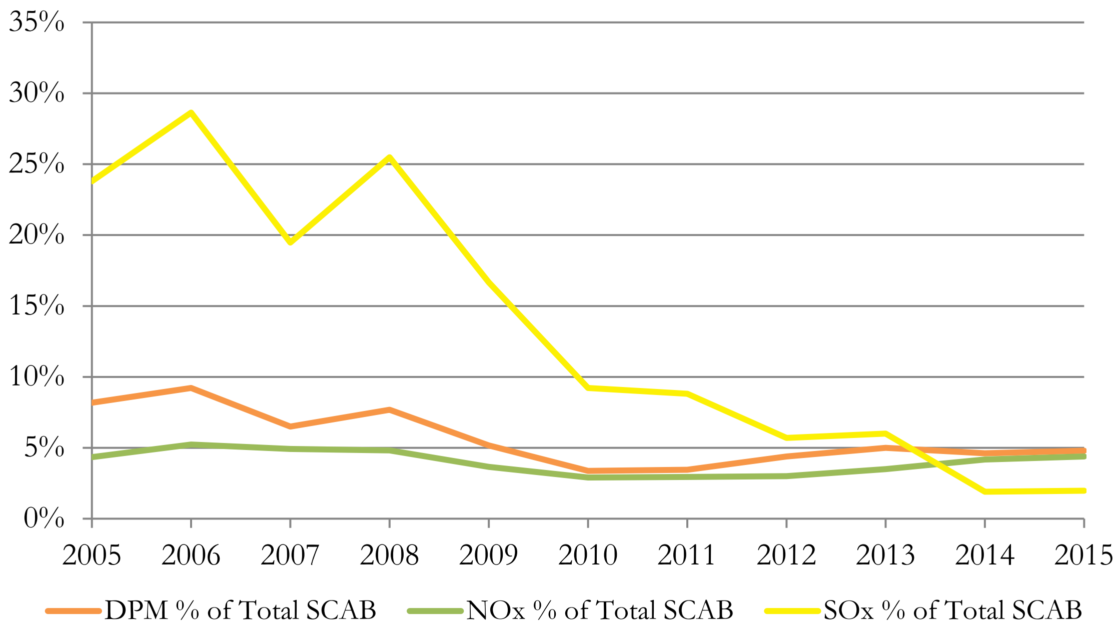


Figure 8.6 presents a comparison of the maritime industry-related mobile source emissions associated with the Port to the total SoCAB emissions from 2005 to 2015.

Figure 8.6: Emissions Contribution in the South Coast Air Basin



SECTION 9 COMPARISON OF 2015 AND PREVIOUS YEARS' FINDINGS AND EMISSION ESTIMATES

This section compares 2015 emissions to those in the previous year and in 2005, in terms of overall emissions, and for each source category. Comparisons by emission source categories are addressed in separate subsections in table and chart formats, with the explanation of the findings and differences in emissions.

The tables and charts in this section summarize the percent change from the previous year (2015 vs 2014) and for the CAAP Progress (2015 vs 2005) using 2015 methodology for emissions comparison. CAAP progress is tracked by comparing emissions each year to 2005 emissions, because 2005 is considered the baseline year for CAAP.

Table 9.1 compares emissions efficiency in 2015 as compared to 2005 and 2014. A positive percent change for the emissions efficiency comparison means an improvement in efficiency.

Table 9.1: Emissions Efficiency Metric, tons or tonnes/10,000 TEUs

EI Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC	CO_2e
2015	0.187	0.173	0.165	9.65	0.16	2.33	0.48	1,140
2014	0.177	0.164	0.159	9.26	0.15	2.29	0.47	1,042
2005	1.274	1.102	1.173	21.65	6.62	5.02	1.14	1,376
Previous Year (2014-2015)	**-6%**	**-5%**	**-4%**	**-4%**	**-7%**	**-2%**	**-2%**	**-9%**
CAAP Progress (2005-2015)	**85%**	**84%**	**86%**	**55%**	**98%**	**54%**	**58%**	**17%**

Ocean-Going Vessels

There were improvements and changes to the OGV emission calculation methodology in this inventory compared to the 2013 methodology. The improvements implemented in OGV emission calculation methodology for the current emissions inventory are discussed in Section 3 of this report.

The various emission reduction strategies implemented for ocean-going vessels are listed in Table 9.2. The table lists the percentage of calls that participated in the strategy for 2015, the previous year, and 2005. The following OGV emission reductions strategies are listed:

- Shore Power refers to vessel calls using shore power at berth, instead of running their diesel-powered auxiliary engines;
- VSR refers to the vessels reducing their transit speed to 12 knots or lower within 20 and 40 nm of the Port;
- ESI refers to the number of vessel calls using ship-specific SO_x fuel correction factors that were developed and used based on fuel quality data provided as part of the ESI program;
- Engine International Air Pollution Prevention (EIAPP) refers to the number of vessel calls using ship-specific NO_x emission factors for main and auxiliary engines, where vessel specific EIAPP Certificate data was available through the ESI program or the VBP;

Table 9.2: OGV Emission Reduction Strategies

Year	Shore Power	VSR 20 nm	VSR 40 nm	ESI	EIAPP Main Eng	EIAPP Aux Eng
2015	36%	93%	83%	56%	51%	49%
2014	35%	95%	84%	53%	56%	54%
2005	2%	65%	na	0%	5%	5%

DB ID1731

Fuel switching from heavy fuel oil (HFO) to low sulfur content fuel such as marine gas oil (MGO) or marine distillate oil (MDO) is also a major emission reduction strategy for OGV. In 2005, fuel switching was voluntary and only 7% of main engines and 27% of auxiliary engines switched fuel. In 2015, all vessels switched fuel (100%) to 0.1% sulfur content MGO to comply with Phase II of CARB's marine fuel regulation and the North American Emissions Control Area (ECA) requirements.

Table 3 summarizes the main engine tier levels for 2015, previous year and 2005. The no tier level is for vessels that do not have diesel engines, such as steamships. IMO Tier I refers to calls by vessels meeting or exceeding IMO's Tier I standard (2000 and newer vessels) and IMO Tier II refers to calls by vessels meeting or exceeding IMO's Tier II standard.

Table 9.3: OGV Main Engine Tiers

Year	IMO Tier 0	IMO Tier I	IMO Tier II	IMO Tier III	No Tier
2015	12%	67%	17%	0%	4%
2014	16%	69%	12%	0%	3%
2005	59%	37%	0%	0%	4%

DB ID1778

Table 9.4 presents the ship emissions source activity in terms of total energy consumption (expressed as kW-hrs). In 2015, the total energy consumption increased by 14% compared to the previous year and decreased by 14% compared to 2005. The increase in activity as compared to the previous year is due to the temporary period of increased congestion in the latter part of 2014 and the first half of 2015, which increased primarily containership times at berth and/or anchorage compared to historical trend.

Table 9.4: OGV Energy Consumption Comparison, kW-hr

Year	All Engines Total kW-hr	Main Eng Total kW-hr	Aux Eng Total kW-hr	Boiler Total kW-hr
2015	327,895,719	74,779,789	150,493,069	102,571,746
2014	288,689,028	79,179,115	128,182,307	81,327,606
2005	382,351,633	113,404,927	188,213,787	80,732,918
Previous Year (2014-2015)	**14%**	**-6%**	**17%**	**26%**
CAAP Progress (2005-2015)	**-14%**	**-34%**	**-20%**	**27%**

DB ID704

Table 9.5 compares the OGV emissions for calendar years 2015, the previous year and 2005. Reductions in OGV emissions as compared to 2005 are mainly attributed to increased participation in the Port's VSR program, the CARB shore power regulation, CARB marine fuel regulation, and the Port's ESI-based incentive program.

Table 9.5: OGV Emissions Comparison

EI Year	PM_{10} tons	$PM_{2.5}$ tons	DPM tons	NO_x tons	SO_x tons	CO tons	HC tons	CO_2e tonnes
2015	75	69	59	3,780	125	321	146	248,431
2014	70	65	58	3,630	121	322	154	215,066
2005	540	434	465	5,291	4,797	471	214	286,962
Previous Year (2014-2015)	**7%**	**7%**	**3%**	**4%**	**3%**	**0%**	**-5%**	**16%**
CAAP Progress (2005-2015)	**-86%**	**-84%**	**-87%**	**-29%**	**-97%**	**-32%**	**-32%**	**-13%**

DB ID692

Table 9.5 also shows that most pollutants increased in 2015, except for CO and hydrocarbon, as compared to the previous year. The key drivers for the increase in OGV emissions from previous year are listed below:

- Increased number of vessels at anchorage.
- More time at berth and anchorage due to a temporary period of increased congestion for the first half of 2015 and also due to larger vessels calling the Port in 2015.
- Increased intra-terminal shifts and shifts from anchorage in 2015.

Again, as stated in Section 3, the increased activity at the anchorages, associated with containerships which typically don't spend time at anchorage, was at a peak in the first quarter and then significantly decreased across the remaining quarters of 2015. The total estimated energy consumption by containerships at anchorage more than doubled from 2014.

Table 9.6: OGV Comparison of Energy Consumption at Anchorage by Vessel Type, kW-hours

Vessel Type	2015 kW-hrs	2014 kW-hrs	2005 kW-hrs
Auto Carrier	228,119	57,218	47,868
Bulk	2,766,143	2,029,132	1,882,649
Containership	41,596,936	18,881,533	2,535,618
Cruise	0	0	12,983
General Cargo	3,568,518	2,754,879	616,390
Ocean Tug	30,556	19,880	61,128
Miscellaneous	0	0	103,642
Reefer	333,606	39,475	223,185
RoRo	0	0	0
Tanker	16,239,555	12,117,224	5,447,467
Total	**64,763,433**	**35,899,343**	**10,930,929**

Comparing 2015 to 2014, there was a 31% increase in shifts, despite an 10% decrease in arrival calls and 2% decrease in total movements.

Table 9.7: 2014-2015 OGV Vessel Movement Comparison

Year	Arrival	Departure	Shift	Total
2015	1,774	1,773	1,084	4,631
2014	1,962	1,918	825	4,705
Change (%)	**-10%**	**-8%**	**31%**	**-2%**

DB ID693

Table 9.8 highlights once more the increased energy consumption for hotelling at anchorage and the energy consumption increase in 2015 as compared to 2014 for hotelling at berth. The increased time at berth and anchorage led to higher energy consumption.

Table 9.8: OGV Comparison of Energy Consumption by Mode, kW-hours

Mode	Hotelling at Anchorage kW-hrs	Hotelling at Berth kW-hrs	Maneuvering kW-hrs	Transit kW-hrs
2015	64,763,433	146,717,046	15,614,281	100,800,959
2014	35,899,343	126,477,095	17,032,544	109,280,046
2005	10,930,929	208,303,756	23,334,061	139,782,886
Previous Year (2014-2015)	**45%**	**14%**	**-9%**	**-8%**
CAAP Progress (2005-2015)	**83%**	**-42%**	**-49%**	**-39%**

Table 9.9 shows the emissions efficiency changes between 2014 and 2015 and between 2005 and 2015. A positive percent change for the emissions efficiency comparison means an improvement in efficiency.

Table 9.9: OGV Emissions Efficiency Metric Comparison, tons or tonnes/10,000 TEUs

EI Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC
2015	0.09	0.09	0.07	4.63	0.15	0.39	0.18
2014	0.08	0.08	0.07	4.35	0.14	0.39	0.19
2005	0.72	0.58	0.62	7.07	6.41	0.63	0.29
Previous Year (2014-2015)	**-10%**	**-9%**	**-6%**	**-6%**	**-6%**	**-2%**	**3%**
CAAP Progress (2005-2015)	**87%**	**87%**	**89%**	**38%**	**98%**	**39%**	**35%**

Harbor Craft

The methodology used to estimate harbor craft emissions for this 2015 inventory did not change from the methodology used in the previous year inventory. In 2015, better data was received for assist tugs and ferries, which was used to update the previous year's emission estimates to provide an apples to apples comparison. Thus, emissions and kw-hrs for 2014 do not exactly match the published tables in the 2014 EI report. It did not affect 2005 emissions because the engines for these vessels were not in the 2005 inventory.

Table 9.10 summarizes the number of harbor craft inventoried for 2015, the previous year and 2005. Overall, the total vessel count increased by 3% between 2014 and 2015 and decreased by 17% between 2005 and 2015.

Table 9.10: Harbor Craft Count Comparison

Harbor Vessel Type	2015	2014	2005
Assist tug	15	14	16
Commercial fishing	119	115	156
Crew boat	23	22	14
Excursion	26	26	24
Ferry	8	8	7
Government	13	14	26
Ocean tug	8	7	7
Tugboat	16	15	21
Work boat	9	8	14
Total	**237**	**229**	**285**

DB ID196

Table 9.11 summarizes the percent distribution of engines based on EPA's engine standards. As expected, the percentage of Tier 3 engines has continued to increase due to the introduction of newer vessels with newer engines into the fleet and replacements of existing higher-emitting engines with cleaner engines.

Tier 1, 2 and 3 categorization of engines for the Port's harbor craft inventory is based on EPA's emission standards for marine engines[18]. Tier 0 engines are unregulated engines built prior to the promulgation of the EPA emission standards. The percentages in the "unknown" column represent engines missing model year, horsepower, or both.

Table 9.11: Harbor Craft Engine Standards Comparison by Tier

Year	Tier 0	Tier 1	Tier 2	Tier 3	Unknown
2015	8%	14%	34%	19%	26%
2014	8%	15%	35%	15%	27%
2005	15%	33%	3%	0%	49%

DB ID1631

[18] CFR, *40 CFR Subpart 94.8* for Tier 1 and 2, and *40 CFR Subpart 1042.101* for Tier 3

Table 9.12 summarizes the overall energy consumption of harbor craft (measured as total Kw-hours; a product of the rated engine size in kW, annual operating hours and load factors), which increased by 7% in 2015 compared to the previous year and 2005.

Table 9.12: Harbor Craft Comparison

Year	Vessel Count	Engine Count	Energy Consumption kW-hrs
2015	237	570	92,289,747
2014	229	553	86,234,063
2005	285	578	86,105,024
Previous Year (2014-2015)	**3%**	**3%**	**7%**
CAAP Progress (2005-2015)	**-17%**	**-1%**	**7%**

Table 9.13 shows the harbor craft energy consumption (in million kW-hr) comparison by vessel type for calendar years 2015, the previous year, and 2005. Between 2014 and 2015, the overall increase is due to increases in activity for most vessel types, except for government vessels and ocean tugs. Compared to 2005, activity levels of commercial fishing and tugboat decreased significantly in 2015, while the other vessel type activity increased.

Table 9.13: Harbor Craft Energy Consumption Comparison by Type, million kW-hr

Vessel Type	2015	2014	2005
Assist Tug	25.7	24.1	25.2
Commercial Fishing	4.9	4.7	14.1
Crew boat	8.8	8.2	2.4
Excursion	8.4	7.9	12.4
Ferry	16.1	16.0	12.4
Government	2.2	2.5	3.0
Ocean Tug	18.3	15.5	3.1
Tugboat	3.2	2.8	11.9
Work boat	4.7	4.5	1.6
Total	**92.3**	**86.2**	**86.1**

Table 9.14 shows the emissions comparisons for calendar 2015, the previous year, and 2005 for harbor craft. In 2015, emissions for all pollutants increased slightly as compared to the previous year. The increase is mainly due to increased activity in 2015.

Table 9.14: Harbor Craft Emission Comparison

Year	PM_{10} tons	$PM_{2.5}$ tons	DPM tons	NO_x tons	SO_x tons	CO tons	HC tons	CO_2e tonnes
2015	31	28	31	826	0.7	487	81	61,013
2014	29	27	29	788	0.6	448	75	57,010
2005	55	51	55	1,318	6.3	364	87	56,925
Previous Year (2014-2015)	**4%**	**4%**	**4%**	**5%**	**7%**	**9%**	**8%**	**7%**
CAAP Progress (2005-2015)	**-45%**	**-45%**	**-45%**	**-37%**	**-89%**	**34%**	**-7%**	**7%**

DB ID427

Compared to 2005, emissions decreased except for CO. The increase in CO is more directly related to an increase in Tier 2 and Tier 3 engines that have higher CO emission rates compared to pre-Tier 2. Due to the stringency of PM and (NO_x + HC) standards of Tier 2 engines, less stringent Tier 2 CO standards were adopted which resulted in higher CO emission rates. There has been an increase in Tier 2 and Tier 3 engines due to vessel repowers and also due to new vessels bought by companies over the last few years.

Table 9.15 shows the emissions efficiency changes in 2015 from 2005 and 2014. 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 9.15: Harbor Craft Emissions Efficiency Metric Comparison, tons or tonnes/10,000 TEUs

Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC	CO_2e
2015	0.04	0.03	0.04	1.01	0.00	0.60	0.10	75
2014	0.04	0.03	0.04	0.95	0.00	0.54	0.09	68
2005	0.07	0.07	0.07	1.76	0.01	0.49	0.12	76
Previous Year (2014-2015)	**-6%**	**-6%**	**-6%**	**-7%**	**0%**	**-11%**	**-10%**	**-9%**
CAAP Progress (2005-2015)	**50%**	**50%**	**50%**	**43%**	**88%**	**-23%**	**15%**	**2%**

Cargo Handling Equipment

The methodology used to estimate CHE emissions for the 2015 inventory did not change from the methodology used in the previous year inventory, except for updating emission rates for newer diesel on-road engines.

Table 9.16 shows that while the number of units of cargo handling equipment decreased by 2%, the overall energy consumption (measured as total kW-hrs, the product of the rated engine size in kW, annual operating hours and load factors) remained the same in 2015 as compared to 2014.

From 2005 to 2015, there was an 18% increase in population and 26% increase in activity level.

Table 9.16: CHE Count and Activity Comparison

Year	Count	Energy Consumption (kW-hrs)	TEU	Activity per TEU
2015	2,109	218,673,459	8,160,458	27
2014	2,156	218,203,866	8,340,066	26
2005	1,782	173,108,402	7,484,624	23
Previous Year (2014-2015)	**-2%**	**0%**	**-2%**	**2%**
CAAP Progress (2005-2015)	**18%**	**26%**	**9%**	**16%**

DB ID881

Table 9.17 summarizes the numbers of pieces of cargo handling equipment using various engine and power types, including electric, LNG, diesel, propane, and gasoline.

Table 9.17: Count of CHE Engine Type

Equipment	Electric	LNG	Propane	Gasoline	Diesel	Total
2015						
Forklift	10	0	369	8	122	509
Wharf crane	84	0	0	0	0	84
RTG crane	0	0	0	0	113	113
Side pick	0	0	0	0	31	31
Top handler	0	0	0	0	192	192
Yard tractor	0	17	180	2	813	1,012
Sweeper	0	0	0	2	5	7
Other	44	0	0	0	117	161
Total	**138**	**17**	**549**	**12**	**1,393**	**2,109**
% Total	**6.5%**	**0.8%**	**26.0%**	**0.6%**	**66.1%**	
2014						
Forklift	10	0	403	8	121	542
Wharf crane	84	0	0	0	0	84
RTG crane	0	0	0	0	106	106
Side pick	0	0	0	0	34	34
Top handler	0	0	0	0	183	183
Yard tractor	0	17	180	2	865	1,064
Sweeper	0	0	0	2	7	9
Other	24	0	0	0	110	134
Total	**118**	**17**	**583**	**12**	**1,426**	**2,156**
% Total	**5.5%**	**0.8%**	**27.0%**	**0.6%**	**66.1%**	
2005						
Forklift	0	0	263	8	151	422
Wharf crane	67	0	0	0	0	67
RTG crane	0	0	0	0	98	98
Side pick	0	0	0	0	41	41
Top handler	0	0	0	0	127	127
Yard tractor	0	0	53	0	848	901
Sweeper	0	0	0	3	8	11
Other	12	0	0	0	103	115
Total	**79**	**0**	**316**	**11**	**1,376**	**1,782**
% Total	**4.4%**	**0.0%**	**17.7%**	**0.6%**	**77.2%**	

DB ID235

Table 9.18 summarizes the number and percentage of diesel-powered CHE with various emission controls by equipment type in 2015, the previous year and 2005. 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), use of ULSD with a maximum sulfur content of 15 ppm. 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 9.17) cannot be added across to come up with the total equipment count (counts of equipment with controls would be 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 equipment turnover, the DOC count has decreased since 2005 as older equipment with DOCs has been replaced with newer equipment that does not require the use of DOCs.
- ULSD has been used by all diesel equipment since 2006. For 2005, ULSD was used by some diesel equipment, but not all.

Table 9.18: Count of CHE Diesel Equipment Emissions Control Matrix

Equipment	DOC Installed	On-Road Engines	DPF Installed	ULSD Fuel	Total Diesel-Powered Equipment	% of Diesel Powered Equipment DOC Installed	On-Road Engines	DPF Installed	ULSD Fuel
2015									
Forklift	0	0	40	122	122	0%	0%	33%	100%
RTG crane	6	0	13	113	113	5%	0%	12%	100%
Side pick	0	0	14	31	31	0%	0%	45%	100%
Top handler	0	0	106	192	192	0%	0%	55%	100%
Yard tractor	10	777	4	813	813	1%	96%	0%	100%
Sweeper	0	0	2	5	5	0%	0%	40%	100%
Other	0	10	22	117	117	0%	9%	19%	100%
Total	**16**	**787**	**201**	**1,393**	**1,393**	**1%**	**56%**	**14%**	**100%**
2014									
Forklift	0	0	28	121	121	0%	0%	23%	100%
RTG crane	7	0	12	106	106	7%	0%	11%	100%
Side pick	0	0	16	34	34	0%	0%	47%	100%
Top handler	0	0	110	183	183	0%	0%	60%	100%
Yard tractor	92	830	4	865	865	11%	96%	0%	100%
Sweeper	0	0	2	7	7	0%	0%	29%	100%
Other	0	11	20	110	110	0%	10%	18%	100%
Total	**99**	**841**	**194**	**1,426**	**1,426**	**7%**	**59%**	**14%**	**100%**
2005									
Forklift	3	0	0	27	151	2%	0%	0%	18%
RTG crane	0	0	0	36	98	0%	0%	0%	37%
Side pick	14	0	0	16	41	34%	0%	0%	39%
Top handler	48	0	0	79	127	38%	0%	0%	62%
Yard tractor	520	164	0	483	848	61%	19%	0%	57%
Sweeper	0	0	0	0	8	0%	0%	0%	0%
Other	0	1	0	65	103	0%	1%	0%	63%
Total	**585**	**165**	**0**	**706**	**1,376**	**43%**	**12%**	**0%**	**51%**

DB ID234

Table 9.19 compares the total number of cargo handling equipment units with off-road diesel engines (meeting Tier 0, 1, 2, 3 4i, and 4 off-road diesel engine standards) and those equipped with on-road diesel engines for 2015, the previous year and 2005. Since classification of engine standards is based on the engine's model year and horsepower, equipment with missing horsepower or model year information are listed separately under the Unknown Tier column in this table.

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, Tier 3, and Tier 4) replacing the older and higher-emitting equipment (Tier 0, Tier 1, and Tier 2). 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. Note that Tier 3, 4i, and 4 engines were not available in 2005; therefore, "NA" is used for comparison of current year to 2005 for these engine categories.

Table 9.19: Count of CHE Diesel Engine Tier and On-road Engine

Year	Tier 0	Tier 1	Tier 2	Tier 3	Tier 4i	Tier 4	Unknown Tier	On-road Engine	Total Diesel
2015	26	54	89	151	149	109	28	787	1,393
2014	30	60	140	151	146	16	42	841	1,426
2005	247	577	360	0	0	0	27	165	1,376
Previous Year (2014-2015)	**-13%**	**-10%**	**-36%**	**0%**	**2%**	**581%**	**-33%**	**-6%**	**-2%**
CAAP Progress (2005-2015)	**-89%**	**-91%**	**-75%**	**NA**	**NA**	**NA**	**4%**	**377%**	**1%**

DB ID878

Table 9.20 shows the cargo handling equipment emissions comparisons for 2015, the previous year and 2005. Compared to the previous year, all emissions decreased, except SO_x and CO_2, due to significant number of Tier 0, 1, and 2 equipment turnover to Tier 4. The reductions in 2015 emissions compared to 2005 emissions are largely due to the implementation of the Port's CHE measures and CARB's CHE regulation. The efforts resulted in the introduction of newer equipment with cleaner engines and the installation of emission controls.

Table 9.20: CHE Emissions Comparison

Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC	CO_2e
	tpy	tpy	tpy	tpy	tpy	tpy	tpy	tonnes
2015	9	9	7	557	2	760	85	170,710
2014	12	11	10	677	2	821	88	170,586
2005	54	50	53	1,573	9	822	92	134,621
Previous Year (2014-2015)	**-23%**	**-22%**	**-26%**	**-18%**	**0%**	**-7%**	**-3%**	**0%**
CAAP Progress (2005-2015)	**-83%**	**-83%**	**-86%**	**-65%**	**-81%**	**-8%**	**-8%**	**27%**

DB ID237

Table 9.21 shows the emissions efficiency changes in 2015 from 2005 and 2014. A positive percentage change for the emissions efficiency comparison means an improvement in efficiency.

Table 9.21: CHE Emissions Efficiency Metric Comparison, tons or tonnes/10,000 TEUs

Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC	CO_2e
2015	0.011	0.010	0.009	0.683	0.002	0.932	0.104	209
2014	0.014	0.013	0.012	0.813	0.002	0.987	0.105	205
2005	0.072	0.066	0.071	2.102	0.013	1.099	0.123	180
Previous Year (2014-2015)	**21%**	**23%**	**25%**	**16%**	**0%**	**6%**	**1%**	**-2%**
CAAP Progress (2005-2015)	**85%**	**85%**	**87%**	**68%**	**85%**	**15%**	**15%**	**-16%**

Locomotives

The methodology used to estimate locomotive emissions in this 2015 inventory is the same as that used in the previous year inventory. Table 9.22 shows the throughput comparisons for locomotives for 2015, the previous year, and 2005.

Table 9.22: Throughput Comparison, million TEUs

Throughput	2005	2014	2015
Total	7.48	8.34	8.16
On-dock lifts	1.02	1.19	1.19
On-dock TEUs	1.84	2.15	2.14
% On-Dock	25%	26%	26%

Table 9.23 shows the locomotive emission estimates for calendar years 2015, the previous year, and 2005. Compared to 2005, the decrease in emissions are due to PHL's and UP's fleet turnover to the latest ultra-low emissions switching locomotives, the use of ULSD, and the Class 1 railroads' compliance with the MOU and introduction of newer locomotives. CO_2e emissions have been reduced since 2005 despite the increase in rail throughput through the freight movement efficiency improvements implemented by the railroads and terminals. The nominal increases in particulate emissions from 2014 to 2015 were the result of a minor increase in the PM emission factors due to line haul fleet mix variability and a slight increase in the number of trains reported by the terminals to arrive/depart the Port during 2015 compared with 2014.

Table 9.23: Locomotive Emission Comparison

Year	PM_{10} tons	$PM_{2.5}$ tons	DPM tons	NO_x tons	SO_x tons	CO tons	HC tons	CO_2e tonnes
2015	30	28	30	819	0.8	194.3	46	68,432
2014	29	26	29	819	0.7	194	45	68,317
2005	57	53	57	1,712	98.0	237	89	82,201
Previous Year (2014-2015)	**6%**	**6%**	**6%**	**0%**	**1%**	**0%**	**1%**	**0%**
CAAP Progress (2005-2015)	**-47%**	**-48%**	**-47%**	**-52%**	**-99%**	**-18%**	**-49%**	**-17%**

DB ID428

Table 9.24 shows the emissions efficiency changes in 2015 from the previous year and from 2005. A positive percentage for the emissions efficiency comparison means an improvement in efficiency. For the CAAP progress (2015 vs. 2005), emissions efficiencies have improved for all pollutants but the increase in PM emissions resulted in decreased emissions efficiency for those pollutants between 2014 and 2015. This trend should not be expected to continue as the Class 1 railroads continue to turn over their fleets to cleaner line haul locomotives and the terminals continue to work on on-dock rail efficiencies.

Table 9.24: Locomotive Emissions Efficiency Metric Comparison, tons or tonnes/10,000 TEUs

Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC	CO_2e
2015	0.04	0.03	0.04	1.00	0.00	0.24	0.06	84
2014	0.03	0.03	0.03	0.98	0.00	0.23	0.05	82
2005	0.08	0.07	0.08	2.29	0.13	0.32	0.12	110
Previous Year (2014-2015)	**-9%**	**-10%**	**-9%**	**-2%**	**0%**	**-2%**	**-4%**	**-2%**
CAAP Progress (2005-2015)	**51%**	**52%**	**51%**	**56%**	**99%**	**25%**	**53%**	**24%**

Heavy-Duty Vehicles

No major changes were made in the emission estimating methodology for 2015 compared with the 2014 emissions inventory. The EMFAC2014 model was used for 2015 as it was for the 2014 inventory, along with regional travel demand modeling based on the number of containers moved through each terminal and terminal-specific characteristics. Vehicle start emissions of NO_x have been estimated for model year 2010 and newer trucks using the methodology described in the 2014 emissions inventory report.

Table 9.25 shows the total port-wide idling time based on information provided by the terminal operators which, as noted previously, relates to time spent on terminal that may not solely be time spent idling. Total idling was similar to the previous year and has increased by 7% since 2005.

Table 9.25: HDV Idling Time Comparison, hours

Year	Total Idling Time hours
2015	3,222,306
2014	3,226,153
2005	3,017,252
Previous Year (2014-2015)	**0%**
CAAP Progress (2005-2015)	**7%**

Table 9.26 summarizes the average age of the truck fleet in 2015, the previous year and 2005. The average age of the trucks visiting the Port was 5 years in 2015, the same as in 2014. Due to a higher percentage of newer trucks making calls at the terminals the average age did not increase by a year as was seen between 2013 and 2014.

Table 9.26: Fleet Weighted Average Age, years

Year	Call-Weighted Average Age years
2015	5
2014	5
2005	11

Table 9.27 summarizes the HDV emissions for 2015, the previous year and 2005. The HDV emissions of all pollutants have decreased significantly from 2005 largely due to increasingly stringent on-road engine emission standards and the implementation of the CTP. The increase in emissions between 2014 and 2015 are due primarily to increased miles of travel reflected by the travel demand model in 2015. Despite a 2% drop in TEU throughput between 2014 and 2015, VMT increased by 7% due to changes in travel patterns in the SoCAB.

Table 9.27: HDV Emissions Comparison

Year	VMT	PM_{10} tons	$PM_{2.5}$ tons	DPM tons	NO_x tons	SO_x tons	CO tons	HC tons	CO_2e tonnes
2015	211,248,692	8.3	8.0	7.7	1,896	4	135	36	381,737
2014	197,276,199	8.0	7.6	7.3	1,811	4	121	33	358,162
2005	266,434,761	248.4	237.6	248.4	6,307	45	1,865	368	469,260
Previous Year (2014-2015)	**7%**	**5%**	**5%**	**6%**	**5%**	**6%**	**11%**	**9%**	**7%**
CAAP Progress (2005-2015)	**-21%**	**-97%**	**-97%**	**-97%**	**-70%**	**-91%**	**-93%**	**-90%**	**-19%**

As an overall measure of the changes in HDV emissions independent of changes in throughput, Table 9.28 illustrates the changes in emissions in average grams per mile (g/mi) between 2005 and 2015 and between 2014 and 2015. The units of grams per mile are used because they show the changes independent of changes in throughput or vehicle mileage, which can complicate the comparisons. The figures have been calculated by dividing overall HDV emissions by overall miles traveled, and include idling emissions as well as emissions from driving at various speeds, on-terminal and on-road. Particulate emissions have been reduced most dramatically from 2005 to 2015, followed by the other pollutants except for CO_2e, which is strongly tied to fuel consumption, which has not changed significantly since 2005. The CTP and engine emission standards are responsible for most reductions, including the particulate and NO_x decreases, while fuel sulfur standards, specifically the introduction of ultra-low sulfur diesel fuel (ULSD), are responsible for the SO_x reduction.

The increase in average g/mi emissions seen between 2013 and 2014 was reversed from 2014 to 2015 for the particulate pollutants (PM_{10}, $PM_{2.5}$, DPM) and NO_x, primarily due to an increase in the percentage of calls made by trucks of model year 2010 and newer. The 2010+ trucks made up 42% of calls in 2015 compared with 36% in 2014 and 35% in 2013.

Table 9.28: Fleet Average Emissions, g/mile

Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC	CO_2e
2015	0.0358	0.0342	0.0333	8.14	0.018	0.58	0.16	1,807
2014	0.0366	0.0350	0.0337	8.33	0.018	0.56	0.15	1,816
2005	0.8457	0.8091	0.8457	21.48	0.153	6.35	1.25	1,761
% Change (2014-2015)	**-2%**	**-2%**	**-1%**	**-2%**	**0%**	**4%**	**7%**	**0%**
% Change (2005-2015)	**-96%**	**-96%**	**-96%**	**-62%**	**-88%**	**-91%**	**-87%**	**3%**

Figure 9.1 illustrates the HDV body model year distribution changes for calendar years 2009 through 2015, showing the peak of 2009 model year trucks that largely persists in each calendar year. The slightly elevated percentages of newer, 2010+ trucks in calendar year 2015 can also be seen in the figure, especially the model year 2015 trucks.

Figure 9.1: Body Model Year Distribution, by Emissions Inventory Year

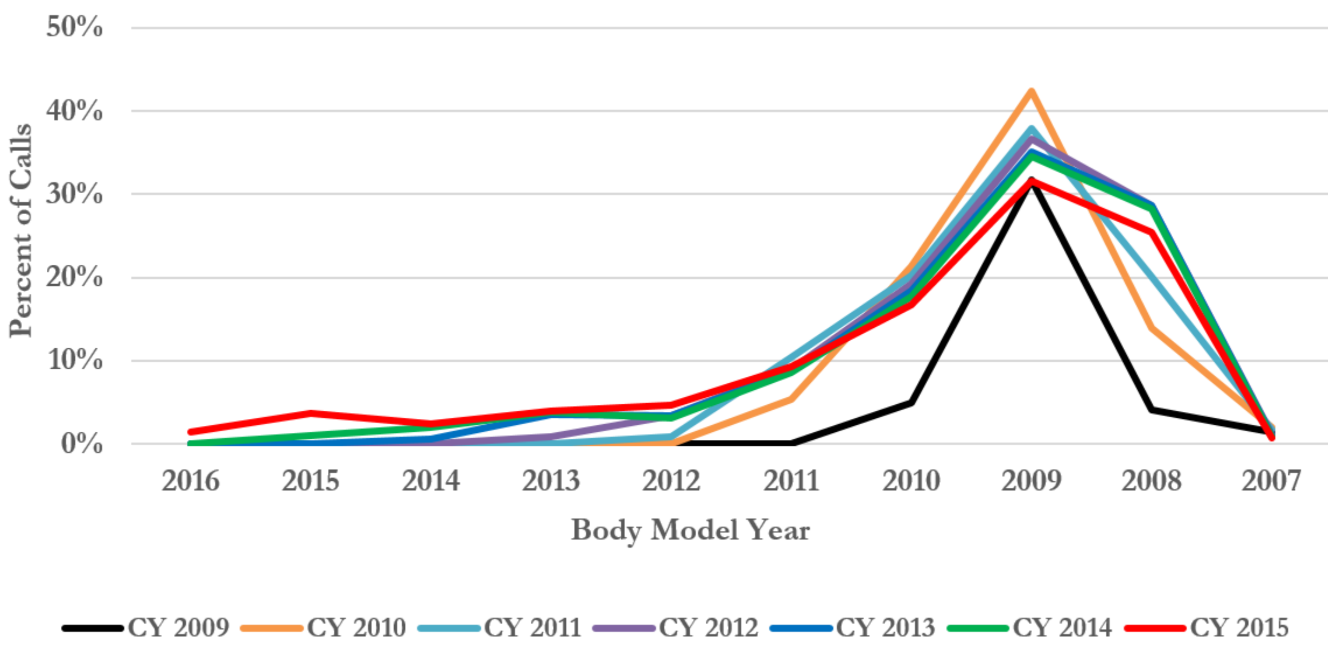


Table 9.29 shows the emissions efficiency changes for HDVs. A positive percentage for the emissions efficiency comparison means an improvement in efficiency. Comparing 2015 to 2005 for CAAP progress, HDV emissions efficiency has improved for all pollutants. Comparing 2015 to the previous year, emissions efficiency for HDVs decreased for most pollutants, consistent with the emission increases discussed above that resulted from increased VMT.

Table 9.29: HDV Emissions Efficiency Metrics Comparison, tons or tonnes/10,000 TEUs

Year	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	HC	CO_2e
2015	0.0102	0.0098	0.0095	2.323	0.005	0.17	0.04	468
2014	0.0096	0.0091	0.0088	2.171	0.005	0.14	0.04	429
2005	0.3320	0.3177	0.3320	8.432	0.060	2.49	0.49	627
Previous Year (2014-2015)	**-6%**	**-8%**	**-8%**	**-7%**	**0%**	**-21%**	**0%**	**-9%**
CAAP Progress (2005-2015)	**97%**	**97%**	**97%**	**73%**	**92%**	**93%**	**92%**	**25%**

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 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

Due to the many emission reduction measures undertaken by the Port, as well as statewide and federal regulations and standards, the 2014 emission reduction standard continued to be met and exceeded in 2015 for DPM, NO_x, and SO_x. Looking towards the future, the 2023 emission reduction standard has been met and exceeded for DPM and SO_x. Below is a summary of DPM, NO_x, and SO_x percent reductions as compared to the 2015 emission reduction standards.

Table 9.30: Reductions as Compared to 2014 Emission Reduction Standard

Pollutant	2015 Actual Reductions	2014 Emission Reduction Standard	2023 Emission Reduction Standard
DPM	85%	72%	77%
NO_x	51%	22%	59%
SO_x	97%	93%	93%

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. Tables 9.31 through 9.33 show the standardized estimates of emissions by source category for calendar years 2005 through 2015, using current year methodology.

Table 9.31: DPM Emissions by Calendar Year and Source Category, tons

Category	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Ocean-Going Vessels	465	480	243	342	233	141	136	78	77	58	59
Harbor Craft	55	51	51	55	54	40	35	30	26	29	31
Cargo Handling Equipment	53	57	51	38	24	24	23	20	13	10	7
Locomotives	57	74	61	46	28	30	30	32	29	29	30
Heavy-Duty Vehicles	248	254	196	183	85	16	12	7	6	7	8
Total	**878**	**916**	**603**	**665**	**423**	**252**	**237**	**168**	**151**	**133**	**135**
% Cumulative Change		**4%**	**-31%**	**-24%**	**-52%**	**-71%**	**-73%**	**-81%**	**-83%**	**-85%**	**-85%**

Table 9.32: NO_x Emissions by Calendar Year and Source Category, tons

Category	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Ocean-Going Vessels	5,291	5,814	5,124	4,851	4,133	4,022	3,921	3,627	3,544	3,630	3,780
Harbor Craft	1,318	1,239	1,246	1,267	1,240	944	874	770	697	788	826
Cargo Handling Equipment	1,573	1,864	1,687	1,292	804	874	829	791	676	677	557
Locomotives	1,712	2,202	1,821	1,246	940	996	1,052	877	828	819	819
Heavy-Duty Vehicles	6,307	6,906	6,127	6,006	3,687	1,791	1,615	1,661	1,580	1,811	1,896
Total	**16,202**	**18,024**	**16,004**	**14,661**	**10,804**	**8,626**	**8,291**	**7,726**	**7,325**	**7,724**	**7,877**
% Cumulative Change		**11%**	**-1%**	**-10%**	**-33%**	**-47%**	**-49%**	**-52%**	**-55%**	**-52%**	**-51%**

Table 9.33: SO_x Emissions by Calendar Year and Source Category, tons

Category	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Ocean-Going Vessels	4,797	5,114	2,991	3,651	2,302	1,290	1,236	588	524	121	125
Harbor Craft	6	1	1	1	1	1	1	1	1	1	1
Cargo Handling Equipment	9	2	2	2	1	2	2	2	1	2	2
Locomotives	98	132	55	9	7	7	6	3	1	1	1
Heavy-Duty Vehicles	45	50	5	5	4	4	4	4	4	4	4
Total	**4,956**	**5,299**	**3,054**	**3,668**	**2,315**	**1,303**	**1,247**	**597**	**531**	**128**	**132**
% Cumulative Change		**7%**	**-38%**	**-26%**	**-53%**	**-74%**	**-75%**	**-88%**	**-89%**	**-97%**	**-97%**