Appendix A: San Pedro Bay Ports Emissions Forecasting Methodology and Results

SAN PEDRO BAY PORTS
EMISSIONS FORECASTING METHODOLOGY AND RESULTS

September 2008

Prepared by:

Starcrest Consulting Group, LLC
P.O. Box 434
Poulsbo, WA 98370

TABLE OF CONTENTS

LIST OF TABLES

TABLE OF FIGURES

ACKNOWLEDGEMENTS

The Ports of Long Beach and Los Angeles and Starcrest would like to thank the following regulatory agency staff who participated in six Technical Working Group meeting held between September 2007 and March 2008 and contributed, commented, and coordinated the approach and reporting of the emissions forecasting results:

Andrew Alexis, California Air Resources Board
Nicole Dolney, California Air Resources Board
Kathy Jaw, California Air Resources Board
Todd Sax, California Air Resources Board
Chengfeng Wang, California Air Resources Board
Seungiu Yoon, California Air Resources Board
Ed Eckerle, South Coast Air Quality Management District
Zorik Pirveysian, South Coast Air Quality Management District
Roxanne Johnson, U.S. Environmental Protection Agency

Starcrest would like to thank the following Ports of Long Beach and Los Angeles staff members for assistance during the development of the emissions forecasting methodology and results:

Rick Cameron
Larry Cottrill
Tim DeMoss
Betsy Foley
Thomas Jelenic
Paul Johansen
Christopher Patton
Shashank Patil
Matt Plezia
Heather Tomley

Authors:	Archana Agrawal, Consultant, Starcrest Bruce Anderson, Principal, Starcrest Mark Carlock, Consultant, Starcrest Joseph Ray, Principal, Starcrest
Contributors:	Guiselle Aldrete, Consultant, Starcrest Rose Muller, Consultant, Starcrest
Document Preparation:	Denise Anderson, Consultant, Starcrest

EXECUTIVE SUMMARY

The Clean Air Action Plan finalized in 2006 established goals for the Ports of Los Angeles and Long Beach aimed at reducing port-related health risk through the establishment of three levels of standards. These standards include: 1) San Pedro Bay Standards, 2) Project Specific Standards, and 3) Source Specific Performance Standards.

The goals underlying the San Pedro Bay Standards include:

- The reduction of public health risk from toxic air contaminants associated with port-related mobile sources to acceptable levels.
- The reduction of criteria pollutant emission to levels that will assure that port-related sources decrease their "fair share" of regional emissions in order to facilitate the South Coast Air Basin's efforts to attain state and federal ambient air quality standards.
- The prevention of port-related violations of the state and federal ambient air quality standards at air quality monitoring stations at both ports.

Although CARB and the SCAQMD have yet to establish a "safe" level of exposure to diesel particulate matter (DPM), CARB, as part of their Goods Movement Plan established a statewide goal for reduction in DPM health risk to 85% below 2000 levels by calendar year 2020 with the near term goal of establishing measures that achieve as much reduction as possible within the first five years.

The Port's current efforts as described in this document are being undertaken in order to project what impact those regulations promulgated by the USEPA, CARB and the SCAQMD, as well as those measures enacted as part of the CAAP, will have in reducing public exposure to DPM from port-related sources in the future. The estimated reductions in mass emissions will be used to assess future risk and establish the foundation for the development of the San Pedro Bay Standard. Forecasting the levels of emissions associated with port-related sources is a complex endeavor which is heavily dependent upon anticipated changes in both activity (growth), and emissions in terms of the impact of enacted measures (control), understanding of the relationship between the two, and anticipating how these patterns might change in the future. The forecasting effort, much like the development of the underlying emissions inventories, is an ever evolving task and it is understood that the methodology utilized here will be improved upon as these complex relationships are better understood.

As with the development of the emissions inventories, a Technical Working Group (TWG) was established consisting of designated staff members from both the ports of Long Beach and Los Angeles, the US. EPA's Region 9, CARB, and the SCAQMD for the purpose of resolving those technical issues related to this effort. The TWG met several times since the inception of the project in September of 2007, and the following is the result of their combined efforts.

Table ES-1: Uncontrolled Emissions Forecast (Tons per Year)

	2005					2014					2023				
CHE	DPM	NOx	SOx	CO	HC	DPM	NOx	SOx	CO	HC	DPM	NOx	SOx	CO	HC
POLA	62	2,037	14	1,010	153	58	1,691	4	1,344	128	16	498	5	2,444	88
POLB	55	1,736	17	447	100	60	1,514	3	1,023	82	15	650	6	1,849	64
SPBP Total	**117**	**3,773**	**31**	**1,457**	**254**	**117**	**3,206**	**7**	**2,367**	**210**	**31**	**1,148**	**11**	**4,293**	**152**
HC															
POLA	38	1,259	7	297	26	40	1,144	1	321	29	42	1,066	1	341	31
POLB	30	1,004	5	237	20	34	881	1	266	23	37	867	1	280	25
SPBP Total	**68**	**2,263**	**12**	**535**	**46**	**74**	**2,025**	**2**	**587**	**52**	**79**	**1,933**	**2**	**621**	**55**
HDV															
POLA Container on terminal and on-port	65	1,075	7	471	151	41	1,177	1	394	132	18	1,018	2	301	104
POLB Container on terminal and on-port	68	1,305	9	553	201	53	1,579	2	519	174	25	1,519	3	437	151
POLA+POLB non Container	13	219	1	93	33	4	153	0	42	14	1	109	0	25	9
POLA+POLB Regional	404	9,580	76	3,267	572	418	10,190	12	2,668	559	86	3,310	17	1,309	259
SPBP Total	**551**	**12,179**	**94**	**4,385**	**957**	**516**	**13,099**	**15**	**3,623**	**879**	**130**	**5,956**	**22**	**2,072**	**523**
OGV															
POLA non-container	208	2,177	2,558	176	74	261	2,823	3,533	230	99	353	3,737	4,438	303	128
POLB non-container	244	2,921	2,957	245	106	322	3,774	3,987	316	137	386	4,567	4,645	382	166
POLA Container	344	4,029	3,051	365	173	703	7,651	6,695	737	381	899	9,443	8,488	945	484
POLB Container	393	4,005	3,544	358	167	695	7,817	6,693	743	347	879	9,768	8,312	940	439
SPBP Total	**1,189**	**13,132**	**12,110**	**1,143**	**520**	**1,981**	**22,065**	**20,909**	**2,025**	**965**	**2,517**	**27,516**	**25,883**	**2,570**	**1,218**
Rail															
POLA	58	1,784	97	244	100	83	2,558	6	601	145	88	2,724	6	639	154
POLB	43	1,314	76	183	74	72	2,142	3	534	121	91	2,730	4	678	154
SPBP Total	**101**	**3,097**	**173**	**427**	**174**	**155**	**4,701**	**9**	**1,135**	**266**	**180**	**5,455**	**11**	**1,317**	**309**
Grand SPBP Total (All 5 sources)	**2,025**	**34,444**	**12,421**	**7,946**	**1,951**	**2,843**	**45,096**	**20,942**	**9,736**	**2,372**	**2,937**	**42,008**	**25,928**	**10,873**	**2,256**

Table ES-2: Controlled Emissions (Tons per Year)

	2005					2014					2023				
CHE	DPM	NOx	SOx	CO	HC	DPM	NOx	SOx	CO	HC	DPM	NOx	SOx	CO	HC
POLA	62	2,037	14	1,010	153	18	893	4	1,335	90	8	234	5	2,295	40
POLB	55	1,736	17	447	100	13	767	3	1,008	49	10	401	6	1,829	34
SPBP Total	**117**	**3,773**	**31**	**1,457**	**254**	**31**	**1,660**	**7**	**2,343**	**139**	**18**	**635**	**11**	**4,124**	**74**
HC															
POLA	38	1,259	7	297	26	30	964	1	321	29	21	886	1	341	31
POLB	30	1,004	5	237	20	29	795	1	266	23	16	679	1	280	25
SPBP Total	**68**	**2,263**	**12**	**535**	**46**	**59**	**1,759**	**2**	**587**	**52**	**37**	**1,565**	**2**	**621**	**55**
HDV															
POLA Container on terminal and on-port	65	1,075	7	471	151	4	676	1	178	62	6	854	2	225	79
POLB Container on terminal and on-port	68	1,305	9	553	201	5	920	2	240	84	9	1,290	3	333	117
POLA+POLB non Container	13	219	1	93	33	0	114	0	25	9	0	100	0	21	7
POLA+POLB Regional	404	9,580	76	3,267	572	72	3,667	12	1,373	237	86	3,310	17	1,309	259
SPBP Total	**551**	**12,179**	**94**	**4,385**	**957**	**82**	**5,376**	**15**	**1,815**	**392**	**102**	**5,554**	**22**	**1,888**	**462**
OGV															
POLA non-container	208	2,177	2,558	176	74	44	2,417	207	202	86	50	2,824	253	239	102
POLB non-container	244	2,921	2,957	245	106	60	3,413	236	284	124	69	3,901	270	328	144
POLA Container	344	4,029	3,051	365	173	85	4,480	243	468	272	80	4,536	294	508	313
POLB Container	393	4,005	3,544	358	167	72	4,725	176	471	239	71	4,714	196	500	269
SPBP Total	**1,189**	**13,132**	**12,110**	**1,143**	**520**	**261**	**15,036**	**862**	**1,425**	**720**	**270**	**15,975**	**1,013**	**1,575**	**828**
Rail															
POLA	58	1,784	97	244	100	75	2,137	2	601	129	44	2,271	2	639	137
POLB	43	1,314	76	183	74	67	1,898	2	534	112	46	2,407	3	678	142
SPBP Total	**101**	**3,097**	**173**	**427**	**174**	**142**	**4,034**	**4**	**1,135**	**241**	**90**	**4,678**	**5**	**1,317**	**280**
Grand SPBP Total (All 5 sources)	**2,025**	**34,444**	**12,421**	**7,946**	**1,951**	**576**	**27,865**	**890**	**7,305**	**1,545**	**516**	**28,407**	**1,052**	**9,524**	**1,699**
Overall % reduction from 2005	**0%**	**0%**	**0%**	**0%**	**0%**	**72%**	**19%**	**93%**	**8%**	**21%**	**74%**	**18%**	**92%**	**-20%**	**13%**

Table ES-3: Reduction from 2005 by Source (%)

CHE	DPM	NOx	SOx	CO	HC	DPM	NOx	SOx	CO	HC	DPM	NOx	SOx	CO	HC
POLA	0%	0%	0%	0%	0%	70%	56%	72%	-32%	41%	87%	89%	63%	-127%	74%
POLB	0%	0%	0%	0%	0%	77%	56%	81%	-125%	51%	82%	77%	67%	-309%	66%
SPBP Total	**0%**	**0%**	**0%**	**0%**	**0%**	**73%**	**56%**	**77%**	**-61%**	**45%**	**84%**	**83%**	**65%**	**-183%**	**71%**
HC															
POLA	0%	0%	0%	0%	0%	21%	23%	87%	-8%	-9%	46%	30%	86%	-14%	-17%
POLB	0%	0%	0%	0%	0%	1%	21%	86%	-12%	-15%	47%	32%	85%	-18%	-23%
SPBP Total	**0%**	**0%**	**0%**	**0%**	**0%**	**13%**	**22%**	**87%**	**-10%**	**-12%**	**46%**	**31%**	**86%**	**-16%**	**-19%**
HDV															
POLA Container on terminal and on-port	0%	0%	0%	0%	0%	94%	37%	84%	62%	59%	90%	21%	74%	52%	48%
POLB Container 0n terminal and on-port	0%	0%	0%	0%	0%	92%	30%	83%	57%	58%	87%	1%	70%	40%	42%
POLA+POLB non Container	0%	0%	0%	0%	0%	97%	48%	89%	74%	73%	97%	54%	90%	77%	78%
POLA+POLB Regional	0%	0%	0%	0%	0%	82%	62%	84%	58%	59%	79%	65%	78%	60%	55%
SPBP Total	**0%**	**0%**	**0%**	**0%**	**0%**	**85%**	**56%**	**84%**	**59%**	**59%**	**81%**	**54%**	**77%**	**57%**	**52%**
OGV															
POLA non-container	0%	0%	0%	0%	0%	79%	-11%	92%	-15%	-16%	76%	-30%	90%	-36%	-38%
POLB non-container	0%	0%	0%	0%	0%	75%	-17%	92%	-16%	-16%	72%	-34%	91%	-34%	-35%
POLA Container	0%	0%	0%	0%	0%	75%	-11%	92%	-28%	-58%	77%	-13%	90%	-39%	-81%
POLB Container	0%	0%	0%	0%	0%	82%	-18%	95%	-32%	-43%	82%	-18%	94%	-40%	-61%
SPBP Total	**0%**	**0%**	**0%**	**0%**	**0%**	**78%**	**-14%**	**93%**	**-25%**	**-38%**	**77%**	**-22%**	**92%**	**-38%**	**-59%**
Rail															
POLA	0%	0%	0%	0%	0%	-30%	-20%	98%	-146%	-29%	24%	-27%	98%	-162%	-37%
POLB	0%	0%	0%	0%	0%	-55%	-44%	97%	-192%	-52%	-5%	-83%	97%	-271%	-93%
SPBP Total	0%	0%	0%	0%	0%	-41%	-30%	98%	-166%	-39%	11%	-51%	97%	-209%	-61%
Grand SPBP Total (All 5 sources)	**0%**	**0%**	**0%**	**0%**	**0%**	**72%**	**19%**	**93%**	**8%**	**21%**	**74%**	**18%**	**92%**	**-20%**	**13%**

SECTION 1.0 METHODOLOGY

Forecasts were made for two projected years, 2014 and 2023, for all port-related source categories: Ocean Going Vessels (OGV), Harbor Craft (HC), Cargo Handling Equipment (CHE), Heavy Duty Diesel Trucks (HDT), and Rail Locomotives (Rail). Forecasts were developed for two scenarios:

- First, 2005 emissions were grown using the growth scaling factors by source category. No further emission reductions were implemented for federal, state, and local regulations promulgated beyond October of 2005.
- Controlled scenario assuming all federal, state, local and port measures adopted as of July of 2008 are in effect in those forecasted years.

Assumptions of growth are consistent in both the controlled and uncontrolled scenarios.
In order to forecast emissions for the San Pedro Bay Ports the following elements were analyzed:

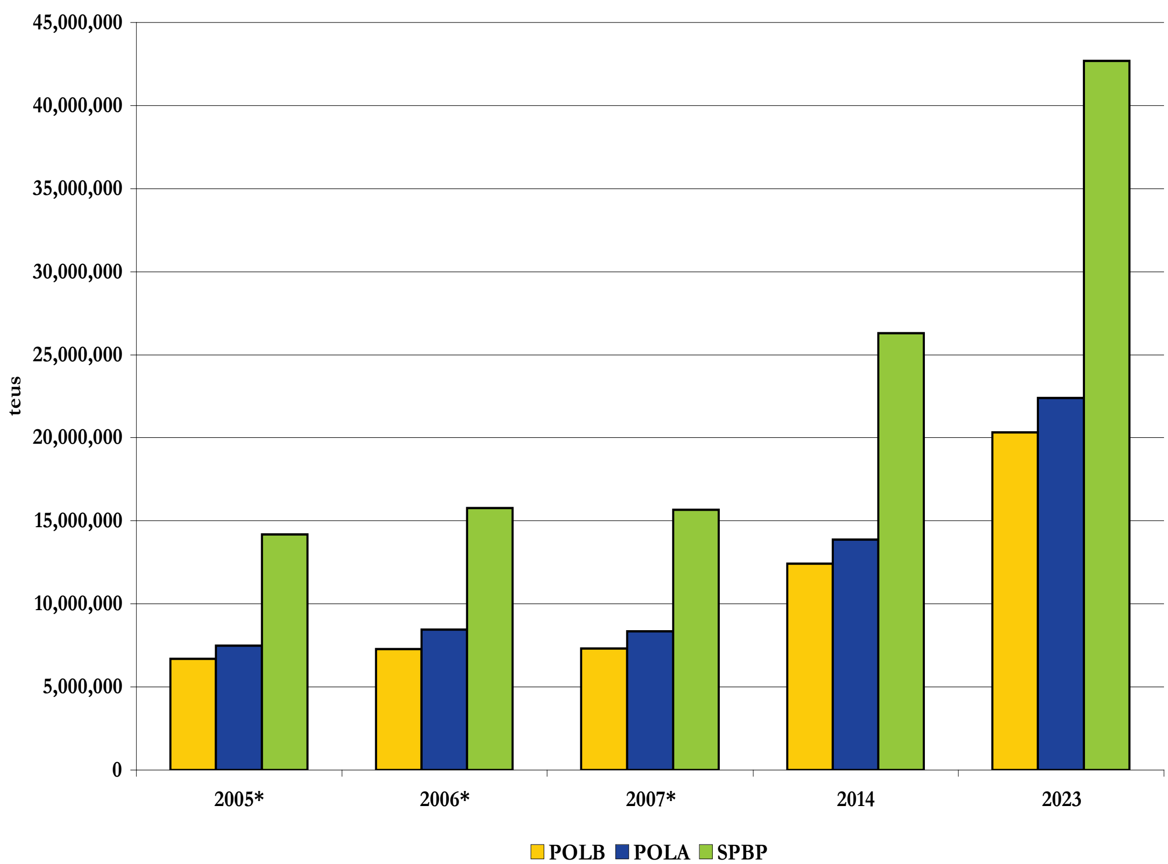
- Future activity estimates - the change or growth in cargo by type,
- Assumptions of how the activity changes affect port-related sources,
- Assumptions on future operational changes (including constraints) that would affect activity and source characteristics, and
- The potential effects of emissions reduction strategies – both through regulation and the CAAP.

Unless otherwise stated, the emission factors, models, and methods utilized in the development of these forecasts are consistent with those used in the development of the 2005 emissions inventories of both Ports.

SECTION 2.0 CARGO GROWTH ASSUMPTIONS FOR CONTAINER OGVS

Container OGV call activity for 2014 and 2023 was estimated utilizing the Mercator Report entitled, "Forecast of Container Vessel Specifications and Port Calls within San Pedro Bay" released in February of 2005. Adjustments were made to the forecasted number of calls for each Port by constraining the number of calls based on terminal capacity; something the Mercator Report neglected to take into account. The first step was to use the projected TEU throughput for both Ports from the DRAFT Global Insights 25 Year Trade Demand Forecast report which is presented below along with the actual throughput for 2005 through 2007.

Figure 2.1: Actual and Projected SPBP TEU Throughput



.* = actual not projected

Table 2.1: Port Specific and Total TEU Throughput

Year	POLB (teus)	POLA (teus)	SPBP (teus)
2005*	**6,709,725**	**7,484,615**	**14,194,340**
2006*	7,290,283	8,469,980	15,760,263
2007*	7,312,465	8,355,038	15,667,503
2014	**12,429,252**	**13,864,677**	**26,293,929**
2023	**20,314,000**	**22,384,000**	**42,698,000**

*Actual

It should be noted that container volumes from 2005 through 2007 have remained relatively flat and that the Global Insights forecasts for TEU throughput growth is currently higher than actual throughput. This is due to the rate at which goods flow in and out of the U.S., which is in turn linked to the global economy.

Based on the actual 2005 throughput and projected future TEU throughput, the Mercator scenario that best fits the forecasted growth is the "Base Case – Medium Growth and No Change to Panama Canal Dimensions" Scenario. The call distribution for the Ports was initially projected to be 108 weekly services/strings, or 5,616 annual calls in 2020, distributed by container vessel subclasses (i.e., Container 1000, Container 2000, etc.). This distribution was based on unconstrained terminal and local/regional infrastructure. This distribution was then reevaluated by Port staff and terminal constraints were taken into account on a terminal by terminal basis. The resulting annual call distribution projection for the San Pedro Bay Ports was revised from a total of 108 weekly services to 99 weekly services. The call distribution for 2005 (actual), and projections for 2014 and 2023 are provided in Table 2.2 below

Table 2.2: San Pedro Bay Ports – Container Ship Forecasting Actual and Projected Calls by Vessel Class

Container Vessel Class	Port of Long Beach			Port of Los Angeles		
	2005	**2014**	**2023**	**2005**	**2014**	**2023**
Container 1,000-1,999	203	208	52	199	0	0
Container 2,000-2,999	320	286	156	180	286	156
Container 3,000-3,999	181	182	260	285	182	260
Container 4,000-4,999	281	407	468	377	633	728
Container 5,000-5,999	170	357	416	205	267	312
Container 6,000-6,999	61	368	468	128	204	260
Container 7,000-7,999	57	166	208	49	250	312
Container 8,000-9,999	111	213	260		255	312
Container 10,000-12,000		104	260		104	260
Total	**1,384**	**2,291**	**2,548**	**1,423**	**2,181**	**2,600**

2.1 Emissions Assumptions for Container OGVs

The forecast non-controlled emissions for the container vessel fleet were developed using the 2005 EIs for each port. The average emissions per call were determined for each container class by averaging the 2005 emissions as reported in the published inventories. This analysis was performed at the vessel class and engine level to provide a ton-per-call estimate of emissions from main and auxiliary engines as well as auxiliary boilers by activity type and area (i.e., at Berth, Anchorage, Maneuvering, within the Precautionary Zone, from the Precautionary Zone to 20 nautical miles, and beyond 20 nautical miles to the overwater boundaries).

The 2005 average vessel class specific emissions by call were then multiplied by the number of calls per vessel class projected for 2014 and 2023 to derive the grown, uncontrolled emissions inventories. The by-engine and by-area distinctions were maintained within the forecast in order to facilitate the application of those control factors associated with the implementation of the CAAP and other adopted regulations.

For example:

2014 Emissions for Container 1000 vessels (main engines / PZ) =
2014 Calls for Container 1000 vessels * Average (main engine / PZ)
2005 emissions / 2005 Container 1000 calls

Table 2.3: Ton per Call 2005 Base Emission Rates (Container 1000 Vessels)

Vessel Type	Engine Type	Area / Activity	HC	CO	NOx	PM	SOx	DPM
1000	Main	PZ - 20	0.005	0.010	0.129	0.013	0.120	0.011
		Anchorage Hotelling	0.000	0.000	0.000	0.000	0.000	0.000
		Berth	0.000	0.000	0.000	0.000	0.000	0.000
		Maneuvering	0.003	0.003	0.021	0.002	0.009	0.002
		PZ	0.002	0.004	0.045	0.004	0.034	0.004
		Sea (40+)	0.012	0.028	0.349	0.034	0.288	0.030
	Aux	PZ - 20	0.000	0.001	0.010	0.001	0.008	0.001
		Anchorage Hotelling	0.001	0.002	0.022	0.002	0.017	0.002
		Berth	0.006	0.016	0.200	0.021	0.164	0.019
		Maneuvering	0.001	0.002	0.027	0.003	0.021	0.002
		PZ	0.000	0.000	0.006	0.001	0.005	0.001
		Sea (40+)	0.000	0.001	0.011	0.001	0.010	0.001
	Boiler	PZ - 20	0.000	0.000	0.000	0.000	0.000	0.000
		Anchorage Hotelling	0.000	0.000	0.004	0.002	0.032	0.000
		Berth	0.002	0.003	0.036	0.014	0.283	0.000
		Maneuvering	0.000	0.000	0.002	0.001	0.014	0.000
		PZ	0.000	0.000	0.000	0.000	0.000	0.000

Emissions data were unavailable for some of the larger capacity vessels classes given that they did not visit the San Pedro Bay Ports in 2005. In order to estimate the emissions from these vessels, regression analyses were performed assessing the power used by engine type and mode against vessel TEU capacity. It was assumed for purposes of this analysis that emissions would increase or decrease in proportion to power demand. As a result, a ***power correction factor*** was developed and applied to the emissions of the largest vessel class for which emissions data were available in order to derive an estimate of emission for those classes not included in the 2005 EI. An example of the resulting regression analysis is depicted below:

Figure 2.2: Regression Analysis Results (kWs per Vessel Capacity)

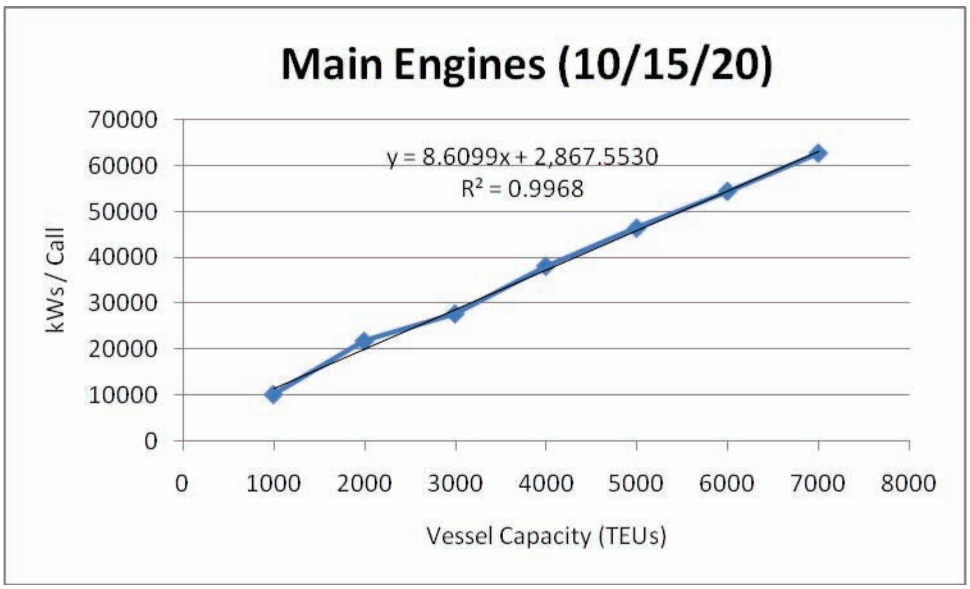


Table 2.4: Regression Analysis of Power vs. Vessel Capacity (kWs/TEU)

Engine	Activity	Equation	R^2	Engine	Activity	Equation	R^2
Main	PZ to 20	8.6099x+2867.5	0.99	Auxiliary	PZ to 20	1.938x+388.43	0.98
Main	Anchorage	N/A		Auxiliary	Anchorage	0.898x+392.47	0.95
Main	Hotelling	N/A		Auxiliary	Hotelling	1.989x+376.30	0.98
Main	Manu./PZ	8.61x+2867.55	0.99	Auxiliary	Manu./PZ	1.983x+388.43	0.98

2.2 Error Analysis

During the QA/QC process, it was discovered that emissions were being ascribed to engines during modes in which they should not be modeled as operating (i.e., emissions from main engines at berth while hotelling). Tracking down this problem led to the discovery of an error introduced into the analysis.

In order to derive the average emissions in tons per call, the basic emission rates are coupled with calls per year for each Port and vessel class. An equation was written to add the emissions from the two Ports and then divide by the combined number of calls. Although the calculation was performed correctly for the container 1,000 vessel category, the error was introduced when reproducing the equation for other vessel classes. In short, the cell references were shifted when the equation was replicated such that emissions were ascribed to the wrong activity (i.e., berth emissions per call were estimated using maneuvering emissions and maneuvering emissions were calculated using transiting emissions). This error existed for all vessel classes greater than 1,000 TEU capacity in the February 20, 2008 version of the forecasting spreadsheet yielding the overstated inventory estimates that were shared with the TWG on March 10, 2008.

The correction of the error resulted in an overall reduction in the estimate of the container OGV inventory which was in much better agreement with the initial estimates shared with the TWG in January of 2008.

2.3 Adjustment for Container Vessel Hotelling Times

As the container vessel fleet migrates toward larger capacity ships, it is anticipated that terminals will purchase additional cranes for loading and unloading cargo and make terminal densification changes that will allow the projected increased TEU throughput to be accommodated. The availability of additional cranes along with terminal operational changes should result in an overall improvement in loading and discharge rates and therefore a slight reduction in hotelling times compared to 2005 (if this does not happen, then the two Ports' forecasted TEU throughput must be reduced). Assuming a bay-wide average of approximately 1,000 moves per crane per call, the efficiency improvements in terminal operation is anticipated to result in an increase in moves per hour from an average of 28 in 2005, to 32 and 33 moves per hour in calendar years 2014 and 2023, respectively.

This increase in efficiency and the related reduction in overall hotelling times are believed to be necessary in order to accommodate the projected growth in future calls. In order to assess the impact of expected efficiencies, the Ports' projected hotelling times by vessel TEU capacity were compared to the calculated hotelling times for calendar year 2005. The actual 2005 at-berth emissions were adjusted by applying the ratio of the projected hotelling times to the calculated 2005 hotelling times. In those instances where the calculated hotelling times for 2005 exceeded actual 2005 hotelling times, no efficiency related adjustments were made.

Table 2.5: Projected Hotelling Time Efficiencies

Vessel Capacity	Average Hours POLA 2005	Average Hours POLB 2005	2014 Assumed Efficiency	2023 Assumed Efficiency
CONTAINER 1,000-1,999	36.5	23.2	0%	0%
CONTAINER 2,000-2,999	38.4	40.3	0%	0%
CONTAINER 3,000-3,999	41.6	44.7	11%	14%
CONTAINER 4,000-4,999	44.2	47.6	11%	14%
CONTAINER 5,000-5,999	73.7	72.4	11%	14%
CONTAINER 6,000-6,999	66.1	105.5	11%	14%
CONTAINER 7,000-7,999	63.5	74.0	11%	14%
CONTAINER 8,000-9,999	36.2	100.9	11%	14%
CONTAINER 10,000-12,000	N/A	N/A	0%	0%

It is important to note that it is the hotelling emissions (tons per call) rather than the times (hours per call) which are forecast. Therefore a projected hotelling efficiency of 10 percent would be reflected in the forecast by reducing the base 2005 hotelling emissions by 10 percent (2005 hotelling emissions in tons per call * 0.9). It is also important to note that the 2005 base emissions rates are calculated on average and are not Port specific.

As with vessel emissions associated with other modes of operation, the hotelling emission estimates for vessels not present in the 2005 EIs were assumed to be equivalent to those of the largest available vessel class. That is, the container 10,000-12,000 category was assumed to have the same hotelling times, and therefore emissions, as the 8,000 to 9,000 TEU capacity. As an exception, because the POLA hotelling times for this category were assumed to be uncharacteristically low (36.2 hours per call), only the POLB hotelling times (100.9 hours per call) were used for container 8,000 and larger TEU capacity vessels.

2.4 OGV Control Factor Development & Specifications

The following discussion is applicable to containerships and non-container vessels, and is common to both discussions. Emissions reductions were taken from CAAP measures, existing applicable regulatory programs, and terminal efficiencies that will have an emission reduction effect on OGVs in 2014 and 2023 are listed below:

- OGV-1: Vessel Speed Reduction
- OGV-2: Reduction of At-Berth Emissions
- OGV-3&4: Auxiliary (AUX) & Main Engine (ME) Fuel Standards
- OGV-5: ME Engine Improvements
- CARB Fuel Switch OGV Engine Low Sulfur Fuel Regulation (Main, AUX, and Boilers up to 24 nm) - July 2008
- CARB At-Berth OGV Regulation (At-Berth OGV regulation) – December 2007

2.4.1 Interaction/Hierarchy:

- OGV-1 will affect 90% of all calls in 2014 and 2023
- CARB At-Berth OGV Regulation (container, cruise, & reefer ships only) will be used in 2014 & 2023; OGV-2 will be "trumped" by the CARB rule in the out years
- CARB OGV Engine Low Sulfur Fuel Regulation applicable to main, auxiliary, and boiler engines within regulated California waters (24 nm from the coastline) will be used in 2014 & 2023. OGV3&4 will be "trumped" by the CARB rule in the out years because all of the vessels with very few exceptions are required to use either marine gas oil of marine distillate oil with sulfur limit of 0.1% by weight.
- OGV-5 will be used in 2014 & 2023 for vessels affected by a Terminal Lease Renewal (TLR)

2.4.2 CAAP Measure Implementation:

CAAP implementation methods:

OGV-1 VSR – Voluntary compliance at or >90% (Assumed 90% not lease driven)

OGV-5 is lease driven with initial implementation having fleet penetrations of 50% the 1st year, 70% 2nd year, and 90% 3rd year +. Note the year is not calendar, it's based on lease date and every 365 days after the lease has been signed. For these measures the following tables (updated from original CAAP) show the fleet penetration levels for 2014 & 2023.

Table 2.6: Port of Long Beach Fleet Penetration by Terminal

Terminal_ID	Type	OGV 2014	OGV 2023
LBA010	AUTO	90%	90%
LBB010	BREAK BULK	0%	90%
LBB030	BREAK BULK	0%	90%
LBB031	BREAK BULK	90%	90%
LBB040	BREAK BULK	0%	0%
LBB050	BREAK BULK	0%	0%
LBB060	BREAK BULK	90%	90%
LBD040	DRY BULK	0%	90%
LBC010	CONTAINER	0%	0%
LBC020	CONTAINER	90%	90%
LBC031	CONTAINER	0%	0%
LBC032	CONTAINER	0%	60%
LBC033	CONTAINER	0%	50%
LBC040	CONTAINER	90%	90%
LBC050	CONTAINER	0%	0%
LBC060	CONTAINER	90%	90%
LBB100	CRUISE	0%	0%
LBD010	DRY BULK	0%	0%
LBD020	DRY BULK	0%	0%
LBD050	DRY BULK	0%	0%
LBD070	DRY BULK	0%	0%
LBD110	DRY BULK	0%	0%
LBL020	LIQUID	90%	90%
LBL030	LIQUID	0%	0%
LBL010	LIQUID	0%	0%
LBO100	OTHER	0%	0%

Table 2.7: Port of Los Angeles Fleet Penetration by Terminal

Terminal_ID	Type	OGV 2014	OGV 2023
LAO060	AUTO	0%	0%
LAC040	BREAK BULK	90%	90%
LAO020	BREAK BULK	90%	90%
LAO120	BREAK BULK	0%	0%
LAO150	BREAK BULK	0%	90%
LAO350	BREAK BULK	90%	90%
LAC010	CONTAINER	90%	90%
LAC020	CONTAINER	90%	90%
LAC030	CONTAINER	90%	90%
LAC050	CONTAINER	90%	90%
LAC060	CONTAINER	90%	90%
LAC070	CONTAINER	0%	0%
LAC090	CONTAINER	90%	90%
LAC100	CONTAINER	90%	90%
LAO080	CRUISE	90%	90%
LAO310	DRY BULK	90%	90%
LAO130	LIQUID	57%	90%
LAO230	LIQUID	34%	67%
LAO290	LIQUID	0%	25%
LAO320	LIQUID	0%	38%
LAO330	LIQUID	90%	90%
LAO340	LIQUID	34%	67%
LAO360	LIQUID	34%	67%
LAO370	LIQUID	25%	90%
LAO400	LIQUID	90%	90%

Note: values <0.90 indicate the lease implementation is not fully engaged based on the time of year the lease is renewed and the 50%, 70, 90% implementation phase-in.

2.4.3 Control Factor Specifics:

OGV-1 Implementation:	Voluntary
Fleet penetration:	90% of all vessel classes
Applicable zones:	PZ-20, SEA (20-40)
Engine Types Affected:	Main & Auxiliary

CF Development: Ran the 2005 EI database assuming that all vessels comply with 12 knots (those vessels running <12 knots were left at their original speeds) and compared the results (which includes mains, auxiliary, and boilers) to the original 2005 EI database run on a vessel subclass to subclass basis (container 1000, container 2000, etc.) by zone (berth, anchorage, maneuvering, PZ, PZ-20, 20-EI boundary).

A Fleet Control Factor (FCF) was developed as a result of comparing the two database runs and represents the change between the two scenarios. The FCF represents the total change in ship emissions (mains/auxiliary/boilers) based on the scenario run.

Fleet Control Factor (FCF) = 100% 12 kt compliant emissions/2005 EI emissions (by subclass and zone)

Since VSR affects only PZ-20, and 20-40, all other zones have a FCF of 1.00.

Tables below show the FCF for ports of Long Beach and Los Angeles.

Table 2.8: OGV1 FCF Port of Long Beach

		PZ to 20					20 to 40 nm				
		PM	NOx	SOx	CO	HC	PM	NOx	SOx	CO	HC
LB	Auto Carrier	0.82	0.82	0.83	0.82	0.82	0.50	0.49	0.51	0.49	0.48
LB	Bulk	0.87	0.87	0.87	0.87	0.87	0.80	0.80	0.80	0.80	0.80
LB	Bulk - Heavy Load	0.94	0.93	0.94	0.93	0.93	0.89	0.86	0.91	0.86	0.87
LB	Bulk Self-Discharging	0.82	0.82	0.82	0.81	0.81	0.69	0.69	0.70	0.69	0.68
LB	Bulk Wood Chips	1.00	1.00	1.00	1.00	1.00	0.91	0.91	0.91	0.91	0.91
LB	Container1000	0.73	0.73	0.74	0.73	0.73	0.48	0.48	0.49	0.48	0.47
LB	Container2000	0.67	0.66	0.67	0.66	0.65	0.42	0.41	0.43	0.41	0.40
LB	Container3000	0.68	0.68	0.69	0.67	0.67	0.38	0.37	0.38	0.37	0.36
LB	Container4000	0.71	0.71	0.71	0.70	0.70	0.33	0.32	0.34	0.32	0.32
LB	Container5000	0.89	0.88	0.89	0.88	0.88	0.32	0.30	0.33	0.30	0.30
LB	Container6000	0.99	0.98	0.99	0.98	0.98	0.29	0.28	0.30	0.28	0.28
LB	Container7000	0.75	0.74	0.76	0.74	0.73	0.31	0.30	0.32	0.30	0.29
LB	Container8000	0.70	0.69	0.71	0.69	0.68	0.31	0.30	0.32	0.30	0.30
LB	Cruise	0.98	0.97	0.98	0.97	0.97	0.57	0.53	0.60	0.53	0.51
LB	General Cargo	0.83	0.83	0.83	0.82	0.82	0.71	0.71	0.72	0.70	0.70
LB	ITB	0.97	0.97	0.98	0.97	0.97	1.00	1.00	1.00	1.00	1.00
LB	MISC	0.78	0.81	0.76	0.82	0.82	0.74	0.81	0.71	0.83	0.82
LB	Reefer	0.78	0.77	0.79	0.77	0.76	0.52	0.51	0.53	0.51	0.50
LB	RoRo	0.77	0.77	0.77	0.75	0.75	0.49	0.50	0.44	0.49	0.48
LB	Tanker	0.84	0.83	0.83	0.83	0.83	0.80	0.79	0.80	0.79	0.79
LB	Tanker - Chemical	0.80	0.79	0.81	0.79	0.79	0.78	0.78	0.79	0.78	0.77
LB	Tanker - Crude - Aframax	0.87	0.86	0.90	0.86	0.85	0.75	0.77	0.71	0.77	0.76
LB	Tanker - Crude - Handyboat	0.92	0.92	0.92	0.92	0.92	0.75	0.75	0.76	0.75	0.74
LB	Tanker - Crude - Panamax	0.85	0.85	0.86	0.85	0.85	0.78	0.78	0.79	0.78	0.77
LB	Tanker - Crude - Suezmax	0.97	0.97	0.97	0.97	0.97	0.73	0.74	0.71	0.73	0.73
LB	Tanker - Crude - ULCC	0.94	0.94	0.94	0.94	0.94	0.72	0.72	0.73	0.72	0.71
LB	Tanker - Crude - VLCC	0.99	0.99	0.99	0.99	0.99	0.67	0.66	0.67	0.66	0.66
LB	Tanker - Oil Products	0.86	0.85	0.85	0.85	0.85	0.78	0.77	0.78	0.77	0.76

Table 2.9: OGV1 FCF Port of Los Angeles

		PZ to 20					20 to 40 nm				
		PM	NOx	SOx	CO	HC	PM	NOx	SOx	CO	HC
LA	Auto Carrier	0.71	0.70	0.71	0.70	0.70	0.51	0.50	0.52	0.50	0.50
LA	Bulk	0.86	0.86	0.86	0.86	0.86	0.79	0.79	0.79	0.79	0.79
LA	Bulk - Heavy Load	0.68	0.68	0.69	0.68	0.68	0.68	0.68	0.68	0.68	0.67
LA	Bulk Wood Chips	1.00	1.00	1.00	1.00	1.00	0.89	0.89	0.89	0.89	0.89
LA	Container1000	0.74	0.75	0.71	0.75	0.75	0.51	0.50	0.50	0.50	0.50
LA	Container2000	0.68	0.70	0.62	0.70	0.69	0.41	0.40	0.41	0.40	0.40
LA	Container3000	0.77	0.77	0.77	0.77	0.77	0.38	0.37	0.39	0.37	0.37
LA	Container4000	0.76	0.76	0.76	0.76	0.75	0.32	0.31	0.33	0.31	0.31
LA	Container5000	0.87	0.87	0.87	0.87	0.87	0.32	0.31	0.33	0.31	0.30
LA	Container6000	0.91	0.90	0.91	0.90	0.89	0.33	0.31	0.33	0.31	0.30
LA	Container7000	0.71	0.69	0.76	0.68	0.67	0.34	0.32	0.33	0.31	0.30
LA	Container8000	0.79	0.78	0.80	0.78	0.77	0.31	0.30	0.32	0.30	0.29
LA	Cruise	0.84	0.83	0.84	0.83	0.80	0.58	0.56	0.59	0.56	0.53
LA	General Cargo	0.77	0.77	0.78	0.77	0.77	0.73	0.73	0.74	0.73	0.73
LA	ITB	0.98	0.98	0.95	0.98	0.98	1.00	1.00	1.00	1.00	1.00
LA	MISC	0.92	0.93	0.93	0.93	0.92	0.68	0.65	0.60	0.66	0.66
LA	Reefer	0.78	0.76	0.78	0.76	0.76	0.53	0.52	0.54	0.52	0.51
LA	RoRo	0.79	0.79	0.79	0.79	0.78	0.43	0.42	0.43	0.42	0.42
LA	Tanker	0.83	0.83	0.83	0.83	0.83	0.76	0.76	0.76	0.76	0.76
LA	Tanker - Chemical	0.81	0.81	0.82	0.80	0.80	0.76	0.75	0.77	0.75	0.75
LA	Tanker - Crude - Aframax	0.83	0.83	0.84	0.83	0.83	0.75	0.75	0.76	0.75	0.75
LA	Tanker - Crude - Handyboat	0.91	0.91	0.91	0.91	0.90	0.80	0.79	0.80	0.79	0.79
LA	Tanker - Crude - Panamax	0.81	0.80	0.81	0.80	0.80	0.81	0.80	0.81	0.80	0.80
LA	Tanker - Oil Products	0.87	0.87	0.88	0.87	0.86	0.79	0.78	0.79	0.78	0.78

Exceptions: The Southern & Western routes have portions which lie outside of the 40 nm arc and thus a scaling factor (SF) was used to correct the emissions associated with these routes.

Applicable zone:	20-40 nm
SF all other zones:	1.00
SF Southern Route 20-40:	0.93
SF Western Route 20-40:	0.87
All other routes:	1.00

The FCF was scaled to a Scaled Fleet Control Factor (SFCF) using the following equation:

$SFCF_{(x)} = (1 – ((1 – FCF) \times SF_{(Route)}))$

$SF_{(Route)}$ was applied to the appropriate routes.

Because the FCF's assume compliance of the entire fleet with the measure, , the $SFCF_{(x)}$ for the 20 to 40 nm zone must be scaled to take into account the current ~90% compliance rate using a $SF_{(Compliance)}$ of 0.90.

For the PZ to 20 nm zone, an addition adjustment is needed given the fact that the voluntary VSR program was included in the 2005 EIs baseline at a 55% compliance rate (i.e., the FCF has an implicit 55% VSR compliance) for this zone. Therefore the $SF_{(Compliance)}$ must be adjusted to account for the inclusion of an additional 35% (55%+35% = 90%) of the remaining 45% of emissions (the portion of emissions that can be reduced by VSR) from the vessel fleet (35%/45%=78%) or $SF_{(Compliance)}$ of 0.78.

$SFCF_{(VSR)} = (1 - ((1 - SFCF_{(x)}) \times SF_{(Compliance)}))$

Where $SF_{(Compliance)}$ = Scaling factor (at 0.90 compliance) is 0.78 for PZ to 20 nm, 0.90 for 20 to 40 nm, and 1.00 for all other zones.

CARB OGV Engine Low Sulfur Fuel Regulation

Implementation:	Phase 1 - July 1, 2009 use of MGO with 1.5% S level or MDO with 0.5% S level (Exception is Auxiliary Engines where phase 1 is applicable as soon as the regulation is approved by California's Office of Administrative Law (OAL); Phase 2 – January 1, 2012 use of MGO or MDO with 0.1% S level
Fleet penetration:	100% with few exceptions
Applicable zones:	24 nm from the California coastline within regulated California waters
Engine Type:	Main, Auxiliary, and Boilers

Reference for the measures' details:
http://www.arb.ca.gov/regact/2008/fuelogv08/fuelogv08

CF Development: Ran the 2005 EI database assuming main, auxiliary and boiler engines are complying with 0.1% S MGO Fuel and compared the results to the original 2005 EI database run on a vessel subclass to subclass basis (container1000, container2000, bulk – self discharging, etc.) by zone (berth, anchorage, maneuvering, PZ, PZ-20, 20-EI boundary.

Emission reductions assumed from fuel switching are the same as utilized by CARB to support their Main, Auxiliary and Boiler engine Fuel Switch regulation adopted by its board on July 24, 2008. The reductions are shown in the tables below:

Popllutant	% Red: HFO to MGO @ 0.5% S	% Red: HFO to MGO @ 0.1% S
NOx	6%	6%
SOx	80%	96%
DPM/PM	75%	83%

Source: Table VII-2, Page VII-4
http://www.arb.ca.gov/regact/2008/fuelogv08/ISORfuelogv08.pdf

Fleet Control Factor (FCF) =
100% 0.1% S MGO compliant emissions/2005 EI emissions
(by subclass and zone - vessels that are already using MGO fuel were left as they were in the 2005 baseline run)

CARB's Low S Fuel FCF example for the Port of Long Beach:

		Berth-Hotelling					Manuevering				
Associated_Port	SubType	DPM	NOx	SOx	CO	HC	DPM	NOx	SOx	CO	HC
LB	Auto Carrier	0.37	0.91	0.04	1.00	1.00	0.36	0.90	0.04	1.00	1.00
LB	Bulk	0.35	0.90	0.04	1.00	1.00	0.35	0.90	0.04	1.00	1.00
LB	Bulk - Heavy Load	0.35	0.90	0.04	1.00	1.00	0.35	0.90	0.03	1.00	1.00
LB	Bulk Self-Discharging	0.35	0.90	0.04	1.00	1.00	0.35	0.90	0.04	1.00	1.00
LB	Bulk Wood Chips	0.35	0.90	0.03	1.00	1.00	0.35	0.90	0.03	1.00	1.00
LB	Container1000	0.41	0.92	0.04	1.00	1.00	0.39	0.92	0.04	1.00	1.00
LB	Container2000	0.36	0.90	0.04	1.00	1.00	0.36	0.90	0.04	1.00	1.00
LB	Container3000	0.35	0.90	0.04	1.00	1.00	0.35	0.90	0.04	1.00	1.00
LB	Container4000	0.38	0.91	0.04	1.00	1.00	0.36	0.90	0.04	1.00	1.00
LB	Container5000	0.35	0.90	0.03	1.00	1.00	0.35	0.90	0.03	1.00	1.00
LB	Container6000	0.38	0.91	0.04	1.00	1.00	0.37	0.91	0.04	1.00	1.00
LB	Container7000	0.35	0.90	0.04	1.00	1.00	0.35	0.90	0.03	1.00	1.00
LB	Container8000	0.35	0.90	0.03	1.00	1.00	0.35	0.90	0.04	1.00	1.00
LB	Cruise	0.88	0.98	0.05	1.00	1.00	0.35	0.90	0.03	1.00	1.00
LB	General Cargo	0.35	0.90	0.04	1.00	1.00	0.35	0.90	0.03	1.00	1.00
LB	ITB	0.82	0.99	0.20	1.00	1.00	0.79	0.98	0.18	1.00	1.00
LB	MISC	0.73	0.98	0.12	1.00	1.00	0.44	0.93	0.05	1.00	1.00
LB	Reefer	0.35	0.90	0.03	1.00	1.00	0.35	0.90	0.03	1.00	1.00
LB	RoRo	0.61	0.98	0.09	1.00	1.00	0.39	0.94	0.04	1.00	1.00
LB	Tanker	0.35	0.90	0.04	1.00	1.00	0.35	0.90	0.03	1.00	1.00
LB	Tanker - Chemical	0.35	0.90	0.03	1.00	1.00	0.35	0.90	0.03	1.00	1.00
LB	Tanker - Crude - Aframax	0.35	0.90	0.03	1.00	1.00	0.35	0.90	0.04	1.00	1.00
LB	Tanker - Crude - Handyboat	0.35	0.90	0.04	1.00	1.00	0.35	0.90	0.03	1.00	1.00
LB	Tanker - Crude - Panamax	0.35	0.90	0.04	1.00	1.00	0.35	0.90	0.03	1.00	1.00
LB	Tanker - Crude - Suezmax	0.39	0.95	0.04	1.00	1.00	0.38	0.94	0.04	1.00	1.00
LB	Tanker - Crude - ULCC	0.35	0.90	0.04	1.00	1.00	0.35	0.90	0.04	1.00	1.00
LB	Tanker - Crude - VLCC	0.35	0.90	0.04	1.00	1.00	0.35	0.90	0.04	1.00	1.00
LB	Tanker - Oil Products	0.35	0.90	0.04	1.00	1.00	0.35	0.90	0.03	1.00	1.00

CARB's Low S Fuel FCF example for the Port of Los Angeles:

		Berth-Hotelling					Manuevering				
Associated_Port	SubType	DPM	NOx	SOx	CO	HC	DPM	NOx	SOx	CO	HC
LA	Auto Carrier	0.41	0.92	0.04	1.00	1.00	0.38	0.91	0.04	1.00	1.00
LA	Bulk	0.36	0.90	0.04	1.00	1.00	0.35	0.90	0.04	1.00	1.00
LA	Bulk - Heavy Load	0.35	0.90	0.03	1.00	1.00	0.35	0.90	0.04	1.00	1.00
LA	Bulk Wood Chips	0.46	0.93	0.04	1.00	1.00	0.37	0.91	0.04	1.00	1.00
LA	Container1000	0.43	0.92	0.04	1.00	1.00	0.40	0.92	0.04	1.00	1.00
LA	Container2000	0.39	0.91	0.04	1.00	1.00	0.38	0.92	0.04	1.00	1.00
LA	Container3000	0.50	0.94	0.04	1.00	1.00	0.39	0.92	0.05	1.00	1.00
LA	Container4000	0.63	0.96	0.05	1.00	1.00	0.48	0.94	0.07	1.00	1.00
LA	Container5000	0.47	0.93	0.04	1.00	1.00	0.38	0.91	0.04	1.00	1.00
LA	Container6000	0.73	0.97	0.05	1.00	1.00	0.47	0.94	0.08	1.00	1.00
LA	Container7000	0.35	0.90	0.03	1.00	1.00	0.35	0.90	0.03	1.00	1.00
LA	Container8000	0.35	0.90	0.03	1.00	1.00	0.35	0.90	0.03	1.00	1.00
LA	Cruise	0.35	0.90	0.04	1.00	1.00	0.35	0.90	0.04	1.00	1.00
LA	General Cargo	0.35	0.90	0.03	1.00	1.00	0.35	0.90	0.03	1.00	1.00
LA	ITB	0.94	0.99	0.38	1.00	1.00	0.89	0.99	0.29	1.00	1.00
LA	MISC	0.35	0.90	0.03	1.00	1.00	0.35	0.90	0.04	1.00	1.00
LA	Reefer	0.35	0.90	0.03	1.00	1.00	0.35	0.90	0.04	1.00	1.00
LA	RoRo	0.40	0.92	0.04	1.00	1.00	0.38	0.91	0.04	1.00	1.00
LA	Tanker	0.35	0.90	0.03	1.00	1.00	0.35	0.90	0.03	1.00	1.00
LA	Tanker - Chemical	0.35	0.90	0.03	1.00	1.00	0.35	0.90	0.04	1.00	1.00
LA	Tanker - Crude - Aframax	0.35	0.90	0.03	1.00	1.00	0.35	0.90	0.03	1.00	1.00
LA	Tanker - Crude - Handyboat	0.35	0.90	0.04	1.00	1.00	0.35	0.90	0.03	1.00	1.00
LA	Tanker - Crude - Panamax	0.35	0.90	0.03	1.00	1.00	0.35	0.90	0.03	1.00	1.00
LA	Tanker - Oil Products	0.35	0.90	0.04	1.00	1.00	0.35	0.90	0.04	1.00	1.00

Scaling factor for CARB's Low S Fuel FCF is to correct for the fact that the ports OGV emissions inventory covers the area up to 40 nm from the Point Fermin whereas CARB's regulation is applicable to 24 nm from the California coastline. 7% of total emissions estimates within 40 nm from the Point Fermin are outside of 24 nm area covered by the CARB regulation. Therefore, a scaling factor ($SF_{(24\ nm\ correction)}$) of 1.07 was applied as follows:

$$SFCF_{(CARB\ Fuel)} = FCF \times SF_{(24\ nm\ correction)}$$

OGV-5 OGV Technology MAN Slide Valves

Implementation:	Lease renewals
Fleet penetration:	50% (1st Year), 70% (2nd Year), and 90% (3rd +)
Applicable zones:	All except Berth and Anchorage Applies to MAN main engines only
Engine Type:	MAN Main

Reference for the measures' details: Final 2006, "San Pedro Bay Ports Clean Air Action Plan"; Technical Report (2006 CAAP document)

CF Development: The number of MAN main engines per vessel class per call was compared to the total 2005 calls by vessel class to scale to only the MAN fleet. A FCF was developed as per the 2006 CAAP document, using an emissions reduction of 30% for NO_x and 25% for PM for MAN main engines.

OGV 5 FCF example for the Port of Long Beach provided below.

		Berth-Hotelling					Manuevering				
Associated_Port	SubType	PM	NOx	SOx	CO	HC	PM	NOx	SOx	CO	HC
LB	Auto Carrier	1.00	1.00	1.00	1.00	1.00	0.86	0.84	1.00	1.00	1.00
LB	Bulk	1.00	1.00	1.00	1.00	1.00	0.84	0.82	1.00	1.00	1.00
LB	Bulk - Heavy Load	1.00	1.00	1.00	1.00	1.00	0.85	0.83	1.00	1.00	1.00
LB	Bulk Self-Discharging	1.00	1.00	1.00	1.00	1.00	0.86	0.83	1.00	1.00	1.00
LB	Bulk Wood Chips	1.00	1.00	1.00	1.00	1.00	0.84	0.82	1.00	1.00	1.00
LB	Container1000	1.00	1.00	1.00	1.00	1.00	0.85	0.85	1.00	1.00	1.00
LB	Container2000	1.00	1.00	1.00	1.00	1.00	0.86	0.85	1.00	1.00	1.00
LB	Container3000	1.00	1.00	1.00	1.00	1.00	0.84	0.82	1.00	1.00	1.00
LB	Container4000	1.00	1.00	1.00	1.00	1.00	0.84	0.83	1.00	1.00	1.00
LB	Container5000	1.00	1.00	1.00	1.00	1.00	0.85	0.83	1.00	1.00	1.00
LB	Container6000	1.00	1.00	1.00	1.00	1.00	0.84	0.82	1.00	1.00	1.00
LB	Container7000	1.00	1.00	1.00	1.00	1.00	0.85	0.83	1.00	1.00	1.00
LB	Container8000	1.00	1.00	1.00	1.00	1.00	0.84	0.82	1.00	1.00	1.00
LB	Cruise	1.00	1.00	1.00	1.00	1.00	0.90	0.89	1.00	1.00	1.00
LB	General Cargo	1.00	1.00	1.00	1.00	1.00	0.86	0.84	1.00	1.00	1.00
LB	ITB	1.00	1.00	1.00	1.00	1.00	0.81	0.77	1.00	1.00	1.00
LB	MISC	1.00	1.00	1.00	1.00	1.00	0.84	0.82	1.00	1.00	1.00
LB	Reefer	1.00	1.00	1.00	1.00	1.00	0.88	0.87	1.00	1.00	1.00
LB	RoRo	1.00	1.00	1.00	1.00	1.00	0.87	0.86	1.00	1.00	1.00
LB	Tanker	1.00	1.00	1.00	1.00	1.00	0.86	0.85	1.00	1.00	1.00
LB	Tanker - Chemical	1.00	1.00	1.00	1.00	1.00	0.86	0.84	1.00	1.00	1.00
LB	Tanker - Crude - Aframax	1.00	1.00	1.00	1.00	1.00	0.84	0.83	1.00	1.00	1.00
LB	Tanker - Crude - Handyboat	1.00	1.00	1.00	1.00	1.00	0.85	0.83	1.00	1.00	1.00
LB	Tanker - Crude - Panamax	1.00	1.00	1.00	1.00	1.00	0.83	0.81	1.00	1.00	1.00
LB	Tanker - Crude - Suezmax	1.00	1.00	1.00	1.00	1.00	0.84	0.83	1.00	1.00	1.00
LB	Tanker - Crude - ULCC	1.00	1.00	1.00	1.00	1.00	0.82	0.79	1.00	1.00	1.00
LB	Tanker - Crude - VLCC	1.00	1.00	1.00	1.00	1.00	0.82	0.79	1.00	1.00	1.00
LB	Tanker - Oil Products	1.00	1.00	1.00	1.00	1.00	0.85	0.83	1.00	1.00	1.00

OGV 5 FCF example for the Port of Los Angeles provided below

		Berth-Hotelling					Manuevering				
Associated_Port	SubType	PM	NOx	SOx	CO	HC	PM	NOx	SOx	CO	HC
LA	Auto Carrier	1.00	1.00	1.00	1.00	1.00	0.85	0.84	1.00	1.00	1.00
LA	Bulk	1.00	1.00	1.00	1.00	1.00	0.84	0.82	1.00	1.00	1.00
LA	Bulk - Heavy Load	1.00	1.00	1.00	1.00	1.00	0.85	0.84	1.00	1.00	1.00
LA	Bulk Wood Chips	1.00	1.00	1.00	1.00	1.00	0.83	0.81	1.00	1.00	1.00
LA	Container1000	1.00	1.00	1.00	1.00	1.00	0.88	0.87	1.00	1.00	1.00
LA	Container2000	1.00	1.00	1.00	1.00	1.00	0.87	0.86	1.00	1.00	1.00
LA	Container3000	1.00	1.00	1.00	1.00	1.00	0.82	0.82	1.00	1.00	1.00
LA	Container4000	1.00	1.00	1.00	1.00	1.00	0.82	0.83	1.00	1.00	1.00
LA	Container5000	1.00	1.00	1.00	1.00	1.00	0.84	0.84	1.00	1.00	1.00
LA	Container6000	1.00	1.00	1.00	1.00	1.00	0.82	0.83	1.00	1.00	1.00
LA	Container7000	1.00	1.00	1.00	1.00	1.00	0.86	0.86	1.00	1.00	1.00
LA	Container8000	1.00	1.00	1.00	1.00	1.00	0.84	0.83	1.00	1.00	1.00
LA	Cruise	1.00	1.00	1.00	1.00	1.00	0.93	0.92	1.00	1.00	1.00
LA	General Cargo	1.00	1.00	1.00	1.00	1.00	0.86	0.84	1.00	1.00	1.00
LA	ITB	1.00	1.00	1.00	1.00	1.00	0.80	0.76	1.00	1.00	1.00
LA	MISC	1.00	1.00	1.00	1.00	1.00	0.90	0.88	1.00	1.00	1.00
LA	Reefer	1.00	1.00	1.00	1.00	1.00	0.87	0.86	1.00	1.00	1.00
LA	RoRo	1.00	1.00	1.00	1.00	1.00	0.81	0.80	1.00	1.00	1.00
LA	Tanker	1.00	1.00	1.00	1.00	1.00	0.86	0.84	1.00	1.00	1.00
LA	Tanker - Chemical	1.00	1.00	1.00	1.00	1.00	0.85	0.83	1.00	1.00	1.00
LA	Tanker - Crude - Aframax	1.00	1.00	1.00	1.00	1.00	0.82	0.80	1.00	1.00	1.00
LA	Tanker - Crude - Handyboat	1.00	1.00	1.00	1.00	1.00	0.85	0.84	1.00	1.00	1.00
LA	Tanker - Crude - Panamax	1.00	1.00	1.00	1.00	1.00	0.83	0.81	1.00	1.00	1.00
LA	Tanker - Oil Products	1.00	1.00	1.00	1.00	1.00	0.86	0.84	1.00	1.00	1.00

Scaling factors for OGV5 were developed for each vessel class for the portion of total SPBP calls by ships with MAN main engines based on calls ($SF_{(MAN)}$). The implementation rates are based on when a lease renewal is triggered (50% first year, 70% second year, and 90% third year +).

Scaling factors for OGV5 are the fleet penetration rates of the leases:

SF first year:	0.50
SF second year:	0.70
SF third year +:	0.90

$$SFCF_{(Fleet\ Penetration)} = (1 - ((1 - FCF) \times SF_{(Fleet\ Penetration)}))$$

Exceptions: The Southern & Western routes have portions which lie outside of the 40 nm arc and thus a $SF_{(Route)}$ was used to correct the emissions associated with these routes.

Applicable zone:	20-40 nm
SF all other zones:	1.00
SF Southern Route 20-40:	0.93
SF Western Route 20-40:	0.87
All other routes:	1.00

$$SFCF_{(z)} = (1 - ((1 - SFCF_{(Fleet\ Penetration)}) \times SF_{(Route)}))$$

Then the $SF_{(MAN)}$ is applied to capture only the MAN portion of the fleet. The OGV-5 correction factors shown in the tables below need to be adjusted for the portion of the fleet equipped with MAN engines.

$$SFCF_{(OGV5)} = (1 – ((1 – SFCF_{(z)}) \times SF_{(MAN)}))$$

$SF_{(MAN)}$ are shown below for both ports(note calls to Anchorage only are not included):

Associated_Port	SubType	Calls05	MAN	SF(MAN)
LB	Auto Carrier	165	49	0.30
LB	Bulk	252	142	0.56
LB	Bulk - Heavy Load	4	1	0.25
LB	Bulk Self-Discharging	21	7	0.33
LB	Bulk Wood Chips	1	0	0.00
LB	Container1000	197	89	0.45
LB	Container2000	301	257	0.85
LB	Container3000	168	144	0.86
LB	Container4000	259	203	0.78
LB	Container5000	159	78	0.49
LB	Container6000	58	53	0.91
LB	Container7000	54	1	0.02
LB	Container8000	111	102	0.92
LB	Cruise	155	0	0.00
LB	General Cargo	138	95	0.69
LB	ITB	72	0	0.00
LB	MISC	20	0	0.00
LB	Reefer	18	5	0.28
LB	RoRo	109	33	0.30
LB	Tanker	47	28	0.60
LB	Tanker - Chemical	20	7	0.35
LB	Tanker - Crude - Aframax	39	17	0.44
LB	Tanker - Crude - Handyboat	11	4	0.36
LB	Tanker - Crude - Panamax	104	71	0.68
LB	Tanker - Crude - Suezmax	92	45	0.49
LB	Tanker - Crude - ULCC	28	27	0.96
LB	Tanker - Crude - VLCC	15	2	0.13
LB	Tanker - Oil Products	51	2	0.04

Associated_Port	SubType	Calls05	MAN	SF(MAN)
LA	Auto Carrier	67	20	0.30
LA	Bulk	172	103	0.60
LA	Bulk - Heavy Load	2	0	0.00
LA	Bulk Wood Chips	3	0	0.00
LA	Container1000	204	124	0.61
LA	Container2000	184	85	0.46
LA	Container3000	295	60	0.20
LA	Container4000	398	105	0.26
LA	Container5000	216	137	0.63
LA	Container6000	131	19	0.15
LA	Container7000	52	42	0.81
LA	Container8000	0	0	0.92
LA	Cruise	272	49	0.18
LA	General Cargo	74	58	0.78
LA	ITB	60	0	0.00
LA	MISC	5	0	0.00
LA	Reefer	60	30	0.50
LA	RoRo	3	0	0.00
LA	Tanker	99	51	0.52
LA	Tanker - Chemical	47	18	0.38
LA	Tanker - Crude - Aframax	4	1	0.25
LA	Tanker - Crude - Handyboat	22	14	0.64
LA	Tanker - Crude - Panamax	10	7	0.70
LA	Tanker - Oil Products	125	5	0.04

Note: POLA Container 8000 uses POLB Container 8000 $SF_{(MAN)}$.

CARB's At-Berth OGV Regulation

Implementation:	Regulation assumed to be implemented instead of OGV-2
Fleet penetration:	>50% in 2014 for 100% grid power based option; >80% in 2023 for 100% grid power based option
Applicable zones:	Hotelling at Berth
Engine Type:	Auxiliary engines of Container, Cruise, and Reefer Vessels

Reference: Staff's Suggested Modification to the Original Proposal Presented at the December 6, 2007 Board Hearing – Appendix B posted *http://www.arb.ca.gov/regact/2007/shorepwr07/shorepwr07.htm*

CF Development: CY 2014 – Grown 2014 PM, NO_x, TOG, CO and SO_x auxiliary engine emissions were reduced by 50% as suggested in CARB's regulation under "Equivalent Emissions Reduction Option." Since 100% grid power usage was assumed to achieve the required reductions, emission reductions for TOG, CO and SO_x were assumed to be same as PM and NO_x under the regulation.

CY 2023 - Grown 2023 PM and NO_x auxiliary engine emissions were reduced by 80% as suggested in CARB's regulation under "Equivalent Emissions Reduction Option." Similar to 2014, 100% grid power usage was assumed to achieve the required reductions, emission reductions for TOG, CO and SO_x were assumed to be same as required of PM and NO_x under the regulation

Although CARB's regulation reduces auxiliary engine emissions at berth by 50% in 2014 and 80% in 2023, the overall NO_x and SO_x emissions reductions at-berth are less than 50% or 80% because of the contribution of boiler emissions at berth. At this time boiler emissions are not required to be controlled either under CARB's at-berth regulation or the CAAP, therefore the resulting FCFs will be greater than 0.50 (2014) and 0.20 (2023).

FCFs for a given Calendar Year = (Baseline auxiliary engine emissions at-berth * CF) + (Baseline boiler emissions at-berth) / (Baseline auxiliary engine emissions at-berth + Baseline boiler emissions at-berth)

CARB's regulation exempts container and reefer fleets that visit California ports less than 25 times in a calendar year and passenger fleets that visit California ports (combined) less than 5 times in a calendar year. It was not possible to determine what percent of the fleet will meet the exemption criteria. Therefore, no exemption was modeled (a scaling factor of 1.00 was used).

SF Container: 1.00

$SFCF_{(CARB\ At\text{-}Berth)} = (1 - ((1 - FCF) \times SF_{(Class)}))$

The FCFs listed in the tables below have not been adjusted for any assumed future hotelling efficiencies.

CARB's At-Berth OGV Regulation FCF for the Port of Long Beach

		Berth-Hotelling - 2014					Berth-Hotelling - 2023				
Associated_I	SubType	DPM	NOx	SOx	CO	TOG	DPM	NOx	SOx	CO	TOG
LB	Auto Carrier	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LB	Bulk	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LB	Bulk - Heavy Load	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LB	Bulk Self-Discharging	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LB	Bulk Wood Chips	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LB	Container1000	0.50	0.57	0.81	0.58	0.60	0.20	0.31	0.70	0.32	0.36
LB	Container2000	0.50	0.57	0.79	0.58	0.60	0.20	0.31	0.66	0.32	0.36
LB	Container3000	0.50	0.56	0.79	0.58	0.60	0.20	0.30	0.66	0.32	0.36
LB	Container4000	0.50	0.57	0.80	0.58	0.60	0.20	0.31	0.68	0.32	0.36
LB	Container5000	0.50	0.57	0.79	0.58	0.60	0.20	0.31	0.66	0.32	0.36
LB	Container6000	0.50	0.57	0.80	0.58	0.60	0.20	0.31	0.68	0.32	0.36
LB	Container7000	0.50	0.57	0.79	0.58	0.60	0.20	0.31	0.66	0.32	0.36
LB	Container8000	0.50	0.57	0.79	0.58	0.60	0.20	0.31	0.66	0.32	0.36
LB	Cruise	0.50	0.57	0.94	0.58	0.60	0.20	0.31	0.90	0.32	0.36
LB	General Cargo	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LB	ITB	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LB	MISC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LB	Reefer	0.50	0.56	0.79	0.58	0.60	0.20	0.30	0.66	0.32	0.36
LB	RoRo	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LB	Tanker	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LB	Tanker - Chemical	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LB	Tanker - Crude - Aframax	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LB	Tanker - Crude - Handyboat	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LB	Tanker - Crude - Panamax	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LB	Tanker - Crude - Suezmax	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LB	Tanker - Crude - ULCC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LB	Tanker - Crude - VLCC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LB	Tanker - Oil Products	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

CARB's At-Berth OGV Regulation FCF for the Port of Los Angeles

		Berth-Hotelling - 2014					Berth-Hotelling - 2023				
Associated_I	SubType	DPM	NOx	SOx	CO	TOG	DPM	NOx	SOx	CO	TOG
LA	Auto Carrier	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LA	Bulk	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LA	Bulk - Heavy Load	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LA	Bulk Wood Chips	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LA	Container1000	0.50	0.57	0.82	0.58	0.60	0.20	0.31	0.72	0.32	0.36
LA	Container2000	0.50	0.57	0.80	0.58	0.60	0.20	0.30	0.68	0.32	0.36
LA	Container3000	0.50	0.57	0.84	0.58	0.60	0.20	0.31	0.75	0.32	0.36
LA	Container4000	0.50	0.57	0.89	0.58	0.60	0.20	0.31	0.82	0.32	0.36
LA	Container5000	0.50	0.58	0.86	0.58	0.60	0.20	0.33	0.77	0.32	0.36
LA	Container6000	0.50	0.57	0.91	0.58	0.60	0.20	0.32	0.85	0.32	0.36
LA	Container7000	0.50	0.57	0.98	0.58	0.60	0.20	0.31	0.98	0.32	0.36
LA	Container8000	0.50	0.57	0.79	0.58	0.60	0.20	0.31	0.66	0.32	0.36
LA	Cruise	0.50	0.57	0.79	0.58	0.60	0.20	0.30	0.66	0.32	0.36
LA	General Cargo	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LA	ITB	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LA	MISC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LA	Reefer	0.50	0.56	0.79	0.58	0.60	0.20	0.30	0.66	0.32	0.36
LA	RoRo	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LA	Tanker	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LA	Tanker - Chemical	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LA	Tanker - Crude - Aframax	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LA	Tanker - Crude - Handyboat	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LA	Tanker - Crude - Panamax	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LA	Tanker - Oil Products	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

2.5 Sample Calculation

Container 5000 Vessels / POLB – Terminal X/ 2023 / PM

Table 2.10: 2005 Average Emissions (Tons per Call for Main, Auxiliary and Boiler)

		Area of Operation					
Vessel Type	**Pollutant**	**Berth**	**Anchorage**	**Maneuvering**	**PZ**	**PZ-20**	**20 Out**
Container 5000	PM	0.216	0.003	0.033	0.013	0.046	0.099

Grown Emissions (Tons/Year) = Calls in 2023 * 2005 Average Emissions

(Assuming 52 calls/year for container 5000 vessels @ Terminal X)

Table 2.11: Container 5000 PM Emission 2023 POLB (Tons/Year)

		Area of Operation						
Vessel Type	**Pollutant**	**Berth**	**Anchorage**	**Maneuvering**	**PZ**	**PZ-20**	**20 Out**	**Total**
Container 5000	PM	11.23	0.16	1.72	0.68	2.39	5.15	21.33

Table 2.12: Hotelling Efficiency Correction

Vessel Capacity	2005	2014	2023
CONTAINER 5000	0%	11%	14%

Emission reduction due to hotelling efficiency =
2023 PM Emissions at Berth * (1-hotelling efficiency)

Table 2.13: Container 5000 PM Emission 2023 POLB (Tons/Year) Adjusted for Hotelling

Vessel Type	Pollutant	Berth	Anchorage	Maneuvering	PZ	PZ-20	20 Out	Total
Container 5000	PM	9.66	0.16	1.72	0.68	2.39	5.15	19.76

Assuming terminal X will have a 90% Lease Implementation in 2023:

2023 Emissions=2023 emissions From Table 2.5-4 * $(SFCF_{(vsr)})$ * $(SFCF_{(CARB\ Fuel)})$ * $(SFCF_{(OGV5)})$ * $SFCF_{(CARB\ At\text{-}Berth)})$

For PM at Berth in 2023 - POLB

$(SFCF_{(vsr)})$ =	1.0
$(FCF_{(CARB\ Fuel)})$ =	0.35
$SF_{(24\ nm\ correction\ for\ fuel\ switch)}$ =	1.07
$(SFCF_{(OGV5)})$ =	1.0
$SFCF_{(CARB\ At\text{-}Berth)}$ =	0.2

PM (Berth) = 9.66 * (1.0_{vsr}) * $((0.35_{(FCF\ CARB\ Fuel)})$ * $1.07_{(24\ nm\ correction\ Factor)})$ * $(1.0_{(OGV5)})$ * $0.2_{(CARB\ at\ berth)}$ = 9.66 tons/Year * 0.075 = 0.72 tons/year

Using the equation above:

PM (Anchorage)	= 0.16 * 0.375 cf	= 0.06 tons/year
PM (Maneuvering)	= 1.72 * 0.346 cf	= 0.60 tons/year
PM (PZ)	= 0.68 * 0.334 cf	= 0.23 tons/year
PM (PZ – 20)	= 2.39 * 0.26 cf	= 0.62 tons/year
PM (20 Out)	= 5.15 * 0.14 cf	= 0.72tons/Year

Total PM for Container 5000 vessel (Terminal X 2023) = 2.95 tons/Year

Emissions Reduction = 21.33 tons/Year – 2.95 tons/year = 18.38 tons/Year
Percent Reduction = 18.38 tons/Year / 21.33 Tons/Year = 86%

2.6 Resulting Emissions

The resulting emissions estimates in tons per year are shown in the table below:

Table 2.14: Baseline and Projected Emissions in TPY for Container Vessels

	2005					2014					2023				
OGV	**DPM**	**NOx**	**SOx**	**CO**	**TOG**	**DPM**	**NOx**	**SOx**	**CO**	**TOG**	**DPM**	**NOx**	**SOx**	**CO**	**TOG**
POLA Container	344	4,029	3,051	365	173	85	4,480	227	468	272	80	4,536	275	508	313
POLB Container	393	4,005	3,544	358	167	72	4,725	164	471	239	71	4,714	183	500	269
SPBP Total	**1,189**	**13,132**	**12,110**	**1,143**	**520**	**261**	**15,036**	**805**	**1,425**	**720**	**270**	**15,975**	**947**	**1,575**	**828**

SECTION 3.0: CARGO GROWTH ASSUMPTIONS FOR NON-CONTAINER OGVS

SPBP cargo growth forecast numbers were provided by the Ports, based on the draft Global Insights report, with the exception of cruise passenger levels for both Ports, which were provided by the Marketing Department of the Port of Los Angeles (POLA). The projected growth of Port of Long Beach (POLB) cruise activity was assumed to mirror that of POLA cruise, and no change in average vessel size was projected.

Table 3.1: Non-Container Cargo Growth

Commodity		2005 (tonnes)	Forecasted Cargo 2014 (tonnes)	Forecasted Cargo 2023 (tonnes)
Dry Bulk		17,369	**26,443**	**30,141**
Liquid Bulk		23,594	**31,403**	**35,164**
General Cargo & Break Bulk		5,469	**8,597**	**11,113**
Auto		896	**1,200**	**1,560**
Reefer		476	**633**	**733**
Cruise LA	Passengers:	1,218,739	**1,406,036**	**1,727,710**

2014 and 2023 were interpolated through a straight-line method between years provided from Global Insights and the POLA 2006 Cruise Market Study. POLB cruise growth was assumed to be similar to POLA cruise growth. In addition, POLB forecast no call growth in MARAD vessel activity.

3.1 Emissions Growth Assumptions for Non-Container OGVs

Due to the large number of variables related to the possible physical and operational characteristics of future vessels and future terminal operations that could not be reasonably "locked down," it was assumed that emissions growth for non-container ships, before accounting for the effects of regulations and the CAAP, would be equal to the projected change in growth in non-container cargoes.

Uncontrolled emissions growth (estimates with no CAAP or CARB regulations applied) were based on the following scaling factors (SFs), which were calculated by dividing the projected commodity throughput in the future year by the 2005 throughput value for each category, with one exception; growth in reefer commodities are expected to shift toward containerization and away from reefer ships.

Table 3.2: Non-Container Scaling Factors

	Scaling Factors	
Ship Type	**2014**	**2023**
Auto	**1.34**	**1.74**
Cruise	**1.15**	**1.42**
Dry Bulk	**1.52**	**1.74**
General Cargo	**1.57**	**2.03**
Liquid Bulk	**1.33**	**1.49**
MARAD	**1.00**	**1.00**
Reefer	**1.00**	**1.00**

1) In container "string services" projected ship sizes can be scaled up or down to meet a constant cargo demand; however, since there are virtually no comparable services in non-container cargo transport and due to the nature of the business, it was assumed that the vessel sizes and class distributions would not change from 2005, with one exception (assumption #3).

2) POLA's Pacific Energy terminal will increase certain tanker subclass calls and introduce new tanker classes into POLA (although not new to San Pedro Bay because these classes already call at POLB). Characteristics of these new POLA classes are based on the average characteristics of their counterparts already calling at POLB. The forecasted call frequencies provided by POLA are:

Table 3.3: Projected Non-Container Vessel Calls

Vessel Type	2014	2023
Tanker - Panamax	**15**	**17**
Tanker - Aframax	**26**	**34**
Tanker - Suezmax	**57**	**74**
Tanker - VLCC	**46**	**65**
Total	**143**	**190**

The Ports will evaluate vessel size trends by vessel type with each new emissions inventory to determine if forecasting methods can be improved or enhanced.

3.2 OGV Control Factor Development & Specifications

The Control Factor Development & Specification discussed for container vessels are applicable to non-container OGVs. Please refer to sections 2.4, 2.4.1, 2.4.2 and 2.4.3.

Estimating Controlled Forecasted Non-Container OGV Emissions

Step 1. 2005 POLA/POLB emissions by vessel class/subclass and by zone (berth, anchorage, maneuvering, PZ, PZ-20, 20-boundary) [referred to as granular emissions].

POLB Summary (Excerpt Table 2.15, 2005 EI)

	2005 TONS						
Vessel Class	**PM10**	**PM2.5**	**DPM**	**NOx**	**SOx**	**CO**	**TOG**
Auto	15.9	12.7	15.0	164.6	125.2	14.0	6.4
Bulk	51.9	41.5	47.9	506.7	444.8	40.7	16.8
Cruise	45.5	36.4	44.9	624.4	265.5	54.7	24.8
General Cargo	16.7	13.4	14.4	160.0	153.8	13.0	5.6
Ocean Tugboat	10.4	8.3	10.4	98.6	81.4	7.6	3.3
Misc	4.2	3.4	3.4	55.4	31.6	4.6	1.9
Reefer	4.3	3.4	3.7	39.2	40.0	3.1	1.3
RoRo	18.5	14.8	16.9	248.3	133.0	21.0	8.9
Tanker	138.4	110.7	87.2	1,023.3	1,681.7	86.2	37.2
	305.8	**244.6**	**243.8**	**2,920.6**	**2,957.1**	**244.9**	**106.3**

POLA Summary (Excerpt Table 2.16, 2005 EI)

	2005 TONS						
Vessel Class	**PM10**	**PM2.5**	**DPM**	**NOx**	**SOx**	**CO**	**TOG**
Auto	7.1	5.7	6.6	72.9	56.8	6.2	2.8
Bulk	29.5	23.6	27.6	294.0	245.3	23.9	10.1
Cruise	115.5	92.4	112.2	1,065.2	968.1	84.5	34.5
General Cargo	11.9	9.5	9.7	110.0	117.4	8.8	3.7
Ocean Tugboat	4.3	3.4	4.3	40.0	32.9	3.1	1.4
Misc	0.6	0.5	0.5	5.7	6.7	0.4	0.2
Reefer	11.8	9.4	10.4	109.3	109.0	8.7	3.7
RoRo	0.5	0.4	0.4	4.5	3.3	0.4	0.2
Tanker	71.8	57.5	36.4	475.1	1,018.3	39.5	17.4
	253.0	**202.4**	**208.2**	**2,176.7**	**2,558.0**	**175.5**	**74.1**

For Pacific Energy, uncontrolled emissions were developed using the number of calls by vessel class for 2014 and 2023 and multiplying by the average emissions (by zone and pollutant) for similar vessel class from POLA and for the class, the POLB averages were used.

Illustration of the resolution of the "granular emissions"

terminal_type_a	Mode	vessel_type_category_abbr	Type	route	Designator	2005 TONS PM10	PM2.5	DPM	NOx	SOx	CO	TOG
BREAK BULK	Transiting	Auto Carrier	Auto	Northern Shipping Lane Outbound from LB	PZ-20	0.06	0.05	0.06	0.66	0.43	0.05	0.02
BREAK BULK	Transiting	Auto Carrier	Auto	Southern Shipping Lane Inbound to LB	PZ-20	0.03	0.03	0.03	0.36	0.22	0.03	0.02
BREAK BULK	Transiting	Auto Carrier	Auto	Southern Shipping Lane Outbound from LB	PZ-20	0.00	0.00	0.00	0.05	0.03	0.00	0.00
AUTO	Hotelling	Auto Carrier	Auto	LB shift to anc	ANC	0.02	0.02	0.02	0.15	0.22	0.01	0.00
AUTO	Hotelling	Auto Carrier	Auto	Northern Shipping Lane Inbound to LB	ANC	0.11	0.09	0.09	0.87	1.18	0.07	0.03
BREAK BULK	Hotelling	Auto Carrier	Auto	LB shift to anc	ANC	0.01	0.01	0.01	0.07	0.11	0.01	0.00
BREAK BULK	Hotelling	Auto Carrier	Auto	LB shift to anc	ANC	0.04	0.03	0.03	0.35	0.45	0.03	0.01
BREAK BULK	Hotelling	Auto Carrier	Auto	Northern Shipping Lane Inbound to LB	ANC	0.03	0.03	0.03	0.28	0.36	0.02	0.01
BREAK BULK	Hotelling	Auto Carrier	Auto	Southern Shipping Lane Inbound to LB	ANC	0.04	0.03	0.03	0.27	0.40	0.02	0.01
AUTO	Hotelling	Auto Carrier	Auto	Anc shift to LB	BERTH	0.17	0.14	0.13	1.36	1.84	0.11	0.04
AUTO	Hotelling	Auto Carrier	Auto	LB harbor shift	BERTH	0.03	0.02	0.02	0.21	0.31	0.02	0.01
AUTO	Hotelling	Auto Carrier	Auto	Northern Shipping Lane Inbound to LB	BERTH	2.14	1.71	1.68	16.99	23.15	1.35	0.51
AUTO	Hotelling	Auto Carrier	Auto	Northern Shipping Lane Outbound from LB	BERTH	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AUTO	Hotelling	Auto Carrier	Auto	Southern Shipping Lane Outbound from LB	BERTH	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AUTO	Hotelling	Auto Carrier	Auto	Western Shipping Lane Inbound to LB	BERTH	0.02	0.02	0.02	0.16	0.21	0.01	0.00
AUTO	Hotelling	Auto Carrier	Auto	Western Shipping Lane Outbound from LB	BERTH	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BREAK BULK	Hotelling	Auto Carrier	Auto	Anc shift to LB	BERTH	0.01	0.00	0.00	0.05	0.06	0.00	0.00
BREAK BULK	Hotelling	Auto Carrier	Auto	Eastern Shipping Lane Inbound to LB	BERTH	0.01	0.01	0.01	0.08	0.10	0.01	0.00
BREAK BULK	Hotelling	Auto Carrier	Auto	Northern Shipping Lane Inbound to LB	BERTH	0.31	0.25	0.25	2.47	3.38	0.20	0.07
BREAK BULK	Hotelling	Auto Carrier	Auto	Northern Shipping Lane Outbound from LB	BERTH	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BREAK BULK	Hotelling	Auto Carrier	Auto	Southern Shipping Lane Inbound to LB	BERTH	0.54	0.43	0.43	4.30	5.85	0.34	0.13
BREAK BULK	Hotelling	Auto Carrier	Auto	Southern Shipping Lane Outbound from LB	BERTH	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BREAK BULK	Hotelling	Auto Carrier	Auto	Anc shift to LB	BERTH	0.04	0.03	0.03	0.32	0.45	0.03	0.01
BREAK BULK	Hotelling	Auto Carrier	Auto	Northern Shipping Lane Inbound to LB	BERTH	0.12	0.09	0.09	0.97	1.26	0.07	0.03
BREAK BULK	Hotelling	Auto Carrier	Auto	Northern Shipping Lane Outbound from LB	BERTH	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BREAK BULK	Hotelling	Auto Carrier	Auto	Southern Shipping Lane Inbound to LB	BERTH	0.21	0.17	0.17	1.70	2.32	0.13	0.05
BREAK BULK	Hotelling	Auto Carrier	Auto	Southern Shipping Lane Outbound from LB	BERTH	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AUTO	Maneuvering	Auto Carrier	Auto	Anc shift to LB	MANU	0.03	0.03	0.03	0.28	0.21	0.03	0.02
AUTO	Maneuvering	Auto Carrier	Auto	LB harbor shift	MANU	0.00	0.00	0.00	0.01	0.01	0.00	0.00
AUTO	Maneuvering	Auto Carrier	Auto	LB shift to anc	MANU	0.01	0.00	0.01	0.05	0.04	0.01	0.00
AUTO	Maneuvering	Auto Carrier	Auto	Northern Shipping Lane Inbound to LB	MANU	0.59	0.47	0.55	5.12	3.81	0.63	0.43
AUTO	Maneuvering	Auto Carrier	Auto	Northern Shipping Lane Outbound from LB	MANU	0.40	0.32	0.37	3.53	2.63	0.43	0.28
AUTO	Maneuvering	Auto Carrier	Auto	Southern Shipping Lane Outbound from LB	MANU	0.00	0.00	0.00	0.04	0.03	0.00	0.00

Step 2. Scale up granular emissions by scaling factors to get "uncontrolled" 2014 and 2023 emissions, using cargo growth scaling factors (emissions growth assumption #1).

Ship Type	Scaling Factors 2014	2023
Auto	**1.34**	**1.74**
Cruise	**1.15**	**1.42**
Dry Bulk	**1.52**	**1.74**
General Cargo	**1.57**	**2.03**
Liquid Bulk	**1.33**	**1.49**
MARAD	**1.00**	**1.00**
Reefer	**1.00**	**1.00**

2014 Uncontrolled Emissions = 2005 Emissions x 2014 Scaling Factor
2023 Uncontrolled Emissions = 2005 Emissions x 2023 Scaling Factor

Step 3. Controlled Emissions Calculations

PM10/2.5/DPM/NO_x Calc (example for 2014, same equation for 2023 using 2023 emissions & SFCFs). All four pollutants have the same calculation but each has its own unique SFCFs for each pollutant.

Controlled Emissions = Σ Uncontrolled 2014 Emissions (by vessel type by zone) x $SFCF_{(2014\ VSR)}$ x $SFCF_{(2014\ CARB\ Fuel)}$ x $SFCF_{(2014\ OGV5)}$ x $SFCF_{(2014\ CARB\ At\text{-}Berth)}$

Where (SFCFs are by vessel type and zone),

$$SFCF_{(2014\ VSR)} = (1 - ((1 - SFCF_{(x)}) \times SF_{(Compliance)}))$$
$$SFCF_{(2014\ CARB\ Fuel\ )} = FCF \times SF_{(24\ nm\ correction)})$$
$$SFCF_{(2014\ OGV5)} = (1 - ((1 - SFCF_{(Z)}) \times SF_{(MAN)}))$$
$$SFCF_{(2014\ CARB\ At\text{-}Berth)} = (1 - ((1 - FCF) \times SF_{(Class)}))$$

SO_x Calc (example for 2014, same equation for 2023 using 2023 emissions & SFCFs)

Controlled Emissions = Σ Uncontrolled 2014 Emissions (by vessel type by zone) x $SFCF_{(2014\ VSR)}$ x $SFCF_{(2014\ CARB\ Fuel\ )}$x $SFCF_{(2014\ At\text{-}Berth\ -\ CARB)}$

Where (SFCFs are by vessel type and zone),

$$SFCF_{(2014\ VSR)} = (1 - ((1 - SFCF_{(x)}) \times SF_{(Compliance)}))$$
$$SFCF_{(2014\ CARB\ Fuel} = FCF \times SF_{(24\ nm\ correction)}$$
$$SFCF_{(2014\ CARB\ At\text{-}Berth)} = (1 - ((1 - FCF) \times SF_{(Class)}))$$

CO & TOG Calc (example for 2014, same equation for 2023 using 2023 emissions & SFCFs) Both pollutants have the same calculation but each has its own unique SFCFs for each pollutant.

Controlled Emissions = Σ Uncontrolled 2014 Emissions (by vessel type by zone) x $SFCF_{(2014\ VSR)}$ x $SFCF_{(2014\ CARB\ At\text{-}Berth)}$

Where (SFCFs are by vessel type and zone),

$$SFCF_{(VSR)} = (1 - ((1 - SFCF_{(x)}) \times SF_{(Compliance)}))$$
$$SFCF_{(2014\ CARB\ At\text{-}Berth)} = (1 - ((1 - FCF) \times SF_{(Class)}))$$

Step 4. Emissions are summed up by vessel type and Port

Port of Long Beach

	2005 TPY							2014 TPY							2023 TPY						
Vessel Class	**PM10**	**PM2.5**	**DPM**	**NOx**	**SOx**	**CO**	**HC**	**PM10**	**PM2.5**	**DPM**	**NOx**	**SOx**	**CO**	**HC**	**PM10**	**PM2.5**	**DPM**	**NOx**	**SOx**	**CO**	**HC**
Auto	15.9	12.7	15.0	164.6	125.2	14.0	6.4	3.1	2.5	2.9	166.8	6.5	14.9	6.9	4.0	3.2	3.7	213.8	8.3	19.4	9.0
Bulk	51.9	41.5	47.9	506.7	444.8	40.7	16.8	13.9	11.1	12.8	727.8	31.2	58.6	24.2	16.0	12.8	14.7	834.7	36.2	69.3	28.6
Cruise	45.5	36.4	44.9	624.4	265.5	54.7	24.8	8.6	6.9	8.4	514.7	24.8	45.0	21.3	9.1	7.3	9.1	569.3	30.6	50.4	24.5
General Cargo	16.7	13.4	14.4	160.0	153.8	13.0	5.6	4.2	3.4	3.6	213.2	10.2	17.9	7.8	5.4	4.3	4.5	268.2	12.8	22.9	9.9
Ocean Tugboat	10.4	8.3	10.4	98.6	81.4	7.6	3.3	5.9	4.7	5.9	144.9	28.0	10.2	4.4	6.7	5.3	6.7	164.0	31.7	11.6	5.0
Misc	4.2	3.4	3.4	55.4	31.6	4.6	1.9	1.6	1.3	1.2	67.0	4.7	5.2	2.1	1.8	1.5	1.4	75.0	5.5	5.8	2.4
Reefer	4.3	3.4	3.7	39.2	40.0	3.1	1.3	0.5	0.4	0.4	24.8	1.4	2.0	0.9	0.3	0.2	0.3	17.8	1.2	1.5	0.7
RoRo	18.5	14.8	16.9	248.3	133.0	21.0	8.9	4.8	3.9	4.4	270.2	13.2	21.9	9.4	5.8	4.7	5.3	320.3	14.2	26.3	11.4
Tanker	138.4	110.7	87.2	1,023.3	1,681.7	86.2	37.2	33.3	26.7	20.7	1,283.7	115.9	108.0	46.6	37.3	29.9	23.2	1,438.2	129.9	120.9	52.2
	305.8	**244.6**	**243.8**	**2,920.6**	**2,957.1**	**244.9**	**106.3**	**75.9**	**60.7**	**60.3**	**3,413.1**	**235.8**	**283.7**	**123.5**	**86.4**	**69.2**	**68.8**	**3,901.3**	**270.3**	**328.1**	**143.7**

Figure 3.1: Port of Long Beach – Non Container OGV Emissions

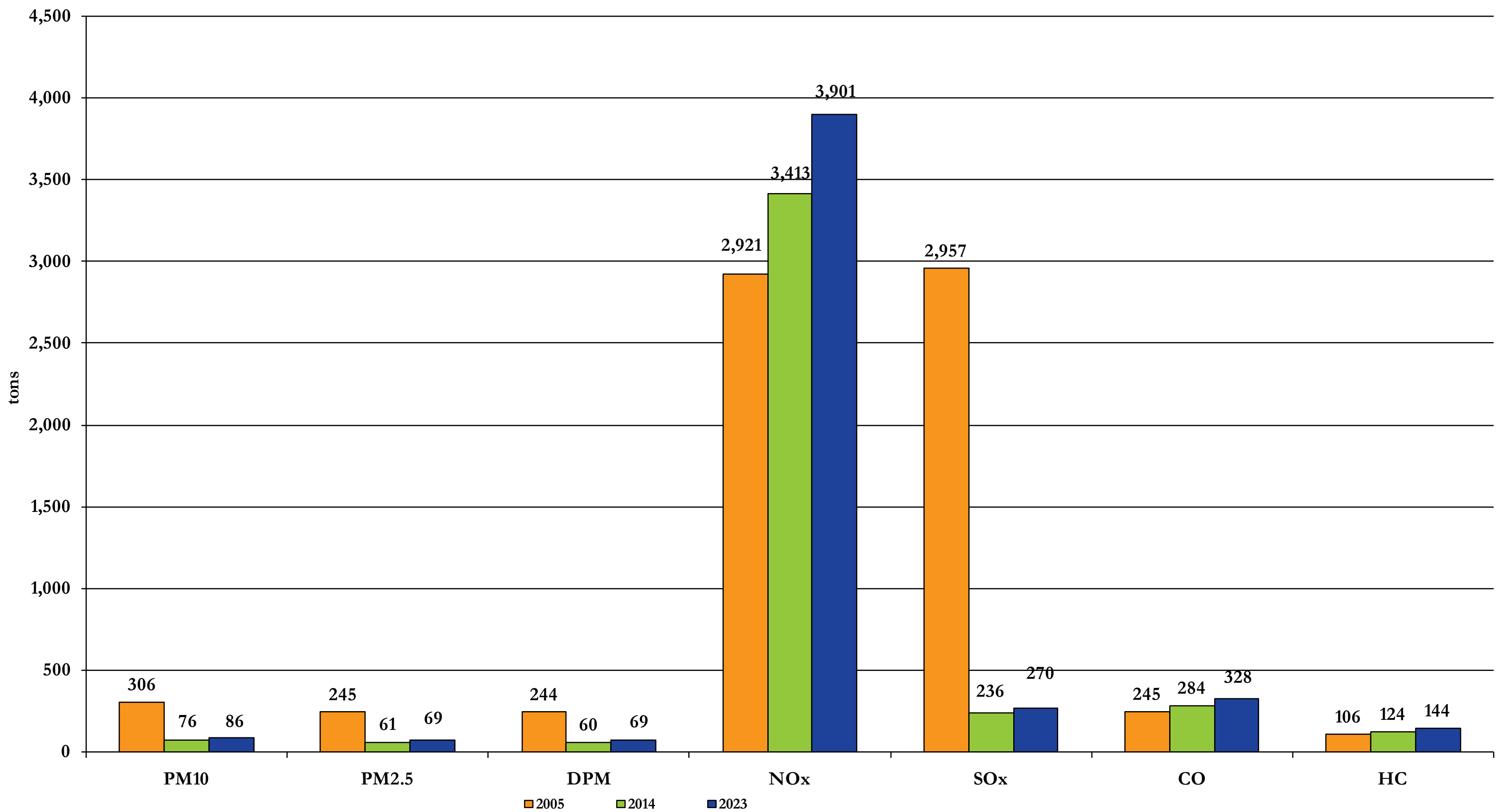
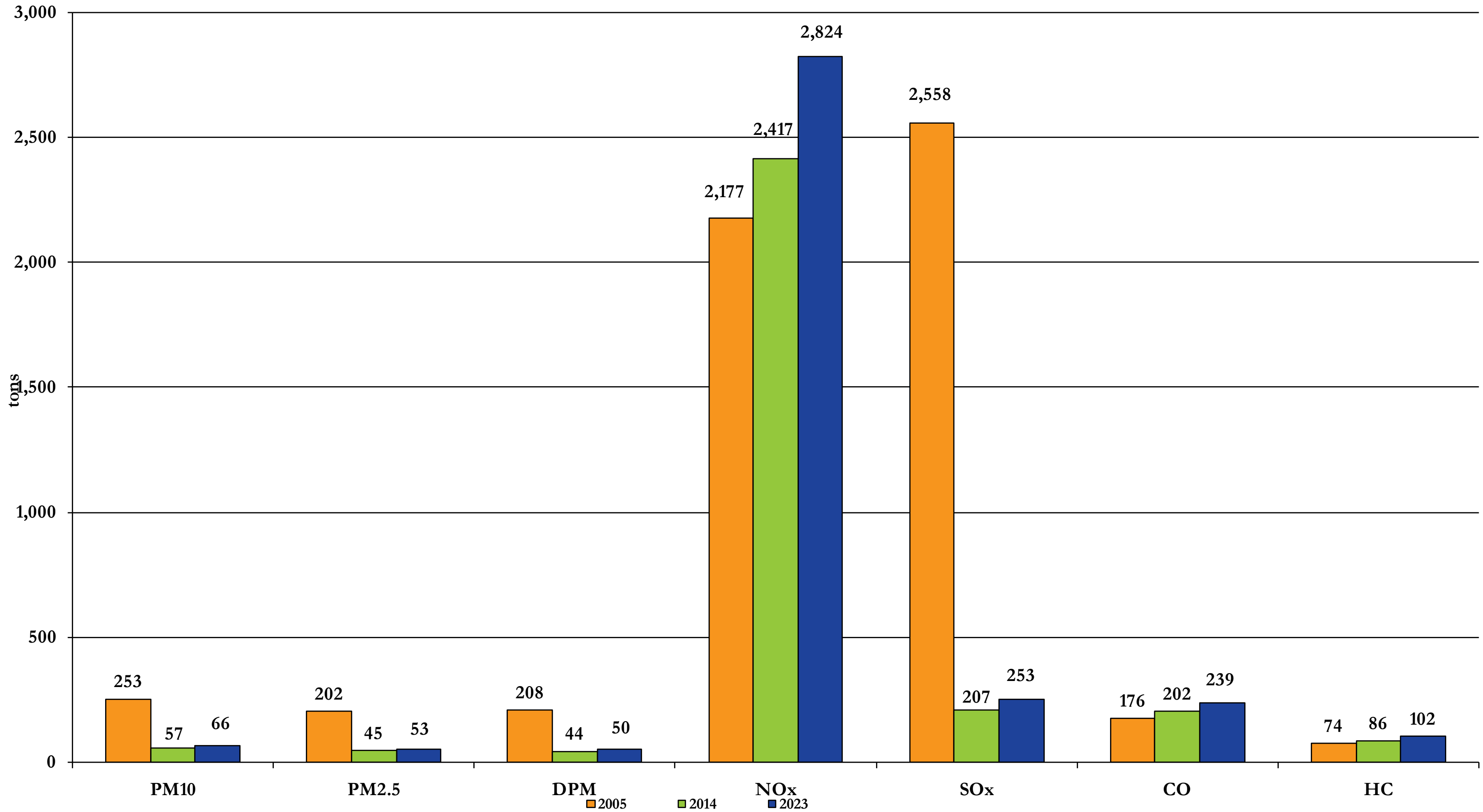


Table 3.4: Port of Los Angeles

	2005 TPY							2014 TPY							2023 TPY						
Vessel Class	**PM10**	**PM2.5**	**DPM**	**NOx**	**SOx**	**CO**	**HC**	**PM10**	**PM2.5**	**DPM**	**NOx**	**SOx**	**CO**	**HC**	**PM10**	**PM2.5**	**DPM**	**NOx**	**SOx**	**CO**	**HC**
Auto	7.1	5.7	6.6	72.9	56.8	6.2	2.8	1.5	1.2	1.4	75.7	2.8	6.5	3.0	2.0	1.6	1.8	98.3	3.7	8.4	3.9
Bulk	29.5	23.6	27.6	294.0	245.3	23.9	10.1	7.9	6.3	7.4	413.0	17.3	34.7	14.7	10.1	8.1	9.4	525.7	22.3	44.7	18.9
Cruise	115.5	92.4	112.2	1,065.2	968.1	84.5	34.5	16.8	13.5	16.4	837.5	51.7	67.9	27.6	17.7	14.2	17.5	902.5	61.1	73.8	30.6
General Cargo	11.9	9.5	9.7	110.0	117.4	8.8	3.7	3.0	2.4	2.4	141.7	6.5	12.5	5.3	3.8	3.1	3.1	183.2	8.5	16.1	6.9
Ocean Tugboat	4.3	3.4	4.3	40.0	32.9	3.1	1.4	2.7	2.2	2.7	58.8	18.2	4.1	1.8	3.1	2.4	3.1	65.8	19.9	4.6	2.0
Misc	0.6	0.5	0.5	5.7	6.7	0.4	0.2	0.2	0.1	0.1	7.2	0.4	0.6	0.2	0.2	0.1	0.2	8.5	0.4	0.7	0.3
Reefer	11.8	9.4	10.4	109.3	109.0	8.7	3.7	1.3	1.0	1.1	67.4	3.6	5.8	2.6	0.9	0.7	0.8	51.7	3.3	4.6	2.2
RoRo	0.5	0.4	0.4	4.5	3.3	0.4	0.2	0.1	0.1	0.1	4.6	0.2	0.4	0.2	0.1	0.1	0.1	5.9	0.2	0.5	0.3
Tanker	71.8	57.5	36.4	475.1	1,018.3	39.5	17.4	23.2	18.6	12.6	811.5	106.8	69.7	30.5	28.1	22.5	14.5	981.8	133.3	85.4	37.4
	253.0	**202.4**	**208.2**	**2,176.7**	**2,558.0**	**175.5**	**74.1**	**56.7**	**45.4**	**44.2**	**2,417.4**	**207.5**	**202.1**	**86.0**	**66.0**	**52.8**	**50.3**	**2,823.5**	**252.7**	**238.8**	**102.4**

Figure 3.2: Port of Los Angeles – Non Container OGV Emissions



SAMPLE CALCULATIONS NON-CONTAINER OGVS

STEP 1: 2005 BASELINE EMISSIONS

2005 Emissions by terminal, terminal type, mode, route, zone, vessel subclass and pollutant

Example: 2005 POLB Cruise, Southern Shipping Lane Inbound to LB (Note: Segment = Zone)

Port	I Mode	Class	Growth	Route	Segment	PM10 (tons)	PM2.5 (tons)	DPM (tons)	NOx (tons)	SOx (tons)	CO (tons)	TOG (tons)
LB	Hotelling	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	Berth-Hotelling	7.3	5.9	6.8	163.0	8.7	14.2	5.2
LB	Hotelling	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	Anchorage	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LB	Maneuvering	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	Maneuvering	1.0	0.8	1.0	22.6	1.0	2.7	1.8
LB	Transiting	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	PZ	1.7	1.3	1.7	23.7	10.6	2.3	1.0
LB	Transiting	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	20 Out	2.1	1.7	2.1	20.4	13.5	2.1	1.3
LB	Transiting	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	Sea (40 out)	12.1	9.7	12.1	137.7	87.2	10.9	4.6

STEP 2: SCALE UNCONTROLLED EMISSIONS TO 2014 & 2023

2014	Cruise LB	growth Scaling Factor (SF)	1.15
2023	Cruise LB	SF	1.42

2014 Grown Emissions - Uncontrolled

Port	Mode	Class	Growth	Route	Segment	PM10 (tons)	PM2.5 (tons)	DPM (tons)	NOx (tons)	SOx (tons)	CO (tons)	TOG (tons)
LB	Hotelling	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	Berth-Hotelling	8.4	6.7	7.8	187.5	10.0	16.4	6.0
LB	Hotelling	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	Anchorage	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LB	Maneuvering	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	Maneuvering	1.2	0.9	1.1	26.0	1.1	3.1	2.1
LB	Transiting	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	PZ	1.9	1.5	1.9	27.3	12.1	2.6	1.2
LB	Transiting	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	20 Out	2.5	2.0	2.5	23.5	15.6	2.4	1.5
LB	Transiting	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	Sea (40 out)	13.9	11.1	13.9	158.4	100.3	12.5	5.3

2023 Grown Emissions - Uncontrolled

Port	Mode	Class	Growth	Route	Segment	PM10 (tons)	PM2.5 (tons)	DPM (tons)	NOx (tons)	SOx (tons)	CO (tons)	TOG (tons)
LB	Hotelling	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	Berth-Hotelling	10.4	8.3	9.6	231.5	12.4	20.2	7.4
LB	Hotelling	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	Anchorage	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LB	Maneuvering	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	Maneuvering	1.5	1.2	1.4	32.2	1.4	3.9	2.5
LB	Transiting	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	PZ	2.4	1.9	2.4	33.7	15.0	3.3	1.5
LB	Transiting	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	20 Out	3.0	2.4	3.0	29.0	19.2	3.0	1.9
LB	Transiting	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	Sea (40 out)	17.2	13.8	17.2	195.6	123.8	15.5	6.5

STEP 3: CONTROLLED EMISSIONS CALCULATIONS

First Develop the SFCFs for each applicable control measure/regulation.

OGV-1

Applicable Compliance: $SF_{(Compliance)} = 90\%$

Zones: PZ to 20, Sea (20 to 40+); All other zones $SFCF_{(VSR)}$ = 1.00

Exceptions: $SF_{(x)}$ for Southern route (Sea zone) = 0.93

FCF:

PZ to 20					Sea (20 to 40+)				
PM	NOx	SOx	CO	TOG	PM	NOx	SOx	CO	TOG
0.98	0.97	0.98	0.97	0.97	0.57	0.53	0.60	0.53	0.51

Develop - $SFCF_{(x)}$ to take into account exception (distance of Southern Route outside the 40 nm arc) for Sea zone

$$SFCF_{(x)} = (1 – ((1 – FCF) \text{ x } SF_{(Route)}))$$

PZ to 20

PM $SFCF_{(x)}$ = (1 – ((1 – 0.98) x 1.00)) = 0.98
NOx SFCF(x) = (1 – ((1 – 0.97) x 1.00)) = 0.97
SOx SFCF(x) = (1 – ((1 – 0.98) x 1.00)) = 0.98
CO SFCF(x) = (1 – ((1 – 0.97) x 1.00)) = 0.97
TOG SFCF(x) = (1 – ((1 – 0.97) x 1.00)) = 0.97

Sea (20 – 40+)

PM $SFCF_{(x)}$ = (1 – ((1 – 0.57) x 0.93)) = 0.60
NOx SFCF(x) = (1 – ((1 – 0.53) x 0.93)) = 0.56
SOx SFCF(x) = (1 – ((1 – 0.60) x 0.93)) = 0.63
CO SFCF(x) = (1 – ((1 – 0.53) x 0.93)) = 0.56
TOG SFCF(x) = (1 – ((1 – 0.51) x 0.93)) = 0.54

Develop - $SFCF_{(VSR)}$ which is scaled to 90% compliance (Same for 2014 & 2023)

$$SFCF_{(VSR)} = (1 – ((1 – SFCF_{(x)}) \text{ x } SF_{(Compliance)}))$$

PZ to 20

PM SFCF(VSR) = (1 – ((1 – 0.98) x 0.78)) = 0.984
NOx SFCF(VSR) = (1 – ((1 – 0.97) x 0.78)) = 0.977
SOx SFCF(VSR) = (1 – ((1 – 0.98) x 0.78)) = 0.984
CO SFCF(VSR) = (1 – ((1 – 0.97) x 0.78)) = 0.977
TOG SFCF(VSR) = (1 – ((1 – 0.97) x 0.78)) = 0.977

Sea (20 – 40+)

PM SFCF(VSR) = (1 – ((1 – 0.60) x 0.90)) = 0.64
NOx SFCF(VSR) = (1 – ((1 – 0.56) x 0.90)) = 0.61
SOx SFCF(VSR) = (1 – ((1 – 0.63) x 0.90)) = 0.67
CO SFCF(VSR) = (1 – ((1 – 0.56) x 0.90)) = 0.61
TOG SFCF(VSR) = (1 – ((1 – 0.54) x 0.90)) = 0.59

CARB's Fuel Reg Applicable
Compliance: $SF_{(Compliance)}$ = 100%
Zones: All
Exceptions: $SF_{(24\ nm\ corection)}$ = 1.07

FCF for 2014 and 2023 below:

Zone	PM CARB Fuel Switch	NOx CARB Fuel Switch	SOx CARB Fuel Switch	CO CARB Fuel Switch	TOG CARB Fuel Switch
Berth-Hotelling	0.88	0.98	0.05	1.00	1.00
Maneuvering	0.35	0.9	0.03	1.00	1.00
PZ	0.35	0.9	0.04	1.00	1.00
PZ to 20	0.35	0.9	0.04	1.00	1.00
Sea (20-40 out)	0.35	0.9	0.04	1.00	1.00

Develop - $SFCF_{(CARB\ Fuel)}$ to take into account exception (24 nm correction – CARB fuel applicability) for all zones

$SFCF_{(CARB\ Fuel)}$ = (1 – ((1 – FCF) x $SF_{(24\ nm\ correction)}$)) where $SF_{(24\ nm\ correction)}$ = 1.07

$SFCF_{(CARB\ Fuel)}$ for 2014 and 2023

Zone	PM CARB Fuel Switch	NOx CARB Fuel Switch	SOx CARB Fuel Switch	CO CARB Fuel Switch	TOG CARB Fuel Switch
Berth-Hotelling	0.94	1.00	0.05	1.00	1.00
Maneuvering	0.37	0.96	0.03	1.00	1.00
PZ	0.37	0.96	0.04	1.00	1.00
PZ to 20	0.37	0.96	0.04	1.00	1.00
Sea (20-40 out)	0.37	0.96	0.04	1.00	1.00

OGV-5 Main & Auxiliary Engine Emissions Improvements - Not Applicable because the cruise terminal doesn't lease from POLB

CARB's At-Berth OGV Reg Applicable
Penetration: Assumes that 100% of the calls will be applicable
Zones: Berth-Hotelling only
Exceptions: $SF_{(Class)}$ for = 1.00
FCFs:

CARB At-Berth-2014

Zone	DPM CARB At-Berth	NOx CARB At-Berth	SOx CARB At-Berth	CO CARB At-Berth	TOG CARB At-Berth
Berth-Hotelling	0.5	0.57	0.94	0.58	0.6

CARB At-Berth-2023

Zone	DPM CARB At-Berth	NOx CARB At-Berth	SOx CARB At-Berth	CO CARB At-Berth	TOG CARB At-Berth
Berth-Hote	0.2	0.31	0.9	0.32	0.36

Develop for each pollutant (different in 2014 & 2023)

$SFCF_{(At\text{-}Berth\ -\ CARB)} = (1 – ((1 – FCF) \times SF_{(Class)}))$

Example: 2023 PM

$SFCF_{(At\text{-}Berth\ -\ CARB)} = (1 – ((1 – 0.2) \times 1.00 = 0.2$

SFCFs (At-Berth):

CARB At-Berth-2014						CARB At-Berth-2023					
Zone	DPM CARB At-Berth	NOx CARB At-Berth	SOx CARB At-Berth	CO CARB At-Berth	TOG CARB At-Berth	Zone	DPM CARB At-Berth	NOx CARB At-Berth	SOx CARB At-Berth	CO CARB At-Berth	TOG CARB At-Berth
Berth-Hotelling	0.5	0.57	0.94	0.58	0.6	Berth-Hote	0.2	0.31	0.9	0.32	0.36

Next, string SFCFs together by zone and pollutant.

$SFCF_{(2014)} = SFCF_{(2014\ VSR)} \times SFCF_{(2014\ CARB\ Fuel)} \times SFCF_{(2014\ OGV5)} \times SFCF_{(2014\ CARB\ At\text{-}Berth)}$

$SFCF_{(2023)} = SFCF_{(2023\ VSR)} \times SFCF_{(2023\ CARB\ Fuel)} \times SFCF_{(2023\ OGV5)} \times SFCF_{(2023\ CARB\ At\text{-}Berth)}$

Example calc: PM $SFCF_{(2014)}$ Sea (20 to 40+)

$SFCF_{(2014)} = 0.64 \times 0.37 \times 1.00 \times 1.00 = 0.24$

Full list of 2014 and 2023 SFCFs:

Zone	PM SFCF (2014)	NOx SFCF (2014)	SOx SFCF (2014)	CO SFCF (2014)	TOG SFCF (2014)
Berth-Hotelling	0.47	0.57	0.05	0.58	0.6
Maneuvering	0.37	0.96	0.03	1.00	1.00
PZ	0.37	0.96	0.04	1.00	1.00
PZ to 20	0.36	0.94	0.04	0.98	0.98
Sea (20-40 out)	0.24	0.59	0.03	0.61	0.59

Zone	PM SFCF (2023)	NOx SFCF (2023)	SOx SFCF (2023)	CO SFCF (2023)	TOG SFCF (2023)
Berth-Hotelling	0.19	0.31	0.05	0.32	0.36
Maneuvering	0.37	0.96	0.03	1.00	1.00
PZ	0.37	0.96	0.04	1.00	1.00
PZ to 20	0.36	0.94	0.04	0.98	0.98
Sea (20-40 out)	0.24	0.59	0.03	0.61	0.59

Finally, multiply Grown Emissions – Uncontrolled by appropriate $SFCF_{(2014)}$ & $SFCF_{(2023)}$

Example calc: 2023 NOx Sea (20 to 40+)

2023 Grown NO_x Emissions – Controlled (Sea) = 195.6 x 0.59 = 115.4 tons

Port ID	Mode	Class	Growth	Route	Segment	2014 Grown Emissions - Controlled DPM (tons)	NOx (tons)	SOx (tons)	CO (tons)	TOG (tons)
LB	Hotelling	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	Berth-Hotelling	3.7	106.9	0.5	9.5	3.6
LB	Maneuvering	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	Maneuvering	0.4	25.0	0.0	3.1	2.1
LB	Transiting	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	PZ	0.7	26.2	0.5	2.6	1.2
LB	Transiting	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	PZ to 20	0.9	22.1	0.6	2.3	1.5
LB	Transiting	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	Sea (20-40)	3.3	93.5	3.0	7.7	3.1

Port ID	Mode	Class	Growth	Route	Segment	2023 Grown Emissions - Controlled DPM (tons)	NOx (tons)	SOx (tons)	CO (tons)	TOG (tons)
LB	Hotelling	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	Berth-Hotelling	1.8	71.8	0.6	6.5	2.7
LB	Maneuvering	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	Maneuvering	0.5	30.9	0.0	3.9	2.5
LB	Transiting	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	PZ	0.9	32.3	0.6	3.3	1.5
LB	Transiting	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	PZ to 20	1.1	27.3	0.8	2.9	1.9
LB	Transiting	Cruise	Cruise LB	Southern Shipping Lane Inbound to LB	Sea (20-40)	4.1	115.4	3.7	9.4	3.8

SECTION 4.0 HARBOR CRAFT BASELINE: 2005 EMISSIONS INVENTORY

All baseline assumptions were consistent with those included in the published 2005 emissions inventories prepared for the Ports of Los Angeles and Long Beach. These assumptions include the harbor craft population, age distribution, and assumptions of activity as shown in the following tables.

Table 4.1: 2005 Port of Long Beach Harbor Craft Vessel Characteristics Summary

	Propulsion Engines			Auxiliary Engines		
Vessel Type	Average MY	Average HP	Average Hrs/yr	Average MY	Average HP	Average Hrs/yr
Assist Tug	1997	2,050	1,400	1997	130	1,390
Crew Boat	1993	400	700	1992	36	542
Excursion	na	665	1,137	na	108	2,488
Ferry	2001	1,773	1,200	na	49	857
Government	na	575	3,665	na	650	665
Tugboat, harbor	1994	1,025	824	1996	77	858
Line Haul Tug	1990	1,990	293	1990	152	293
Work Boat	na	350	125	na	18	54

Table 4.2: 2005 Port of Los Angeles Harbor Craft Vessel Characteristics Summary

	Propulsion Engines					
Vessel Type	Average MY	Average HP	Average Hrs/yr	Average MY	Average HP	Average Hrs/yr
Assist Tug	1997	2,050	1,509	1997	131	1,519
Commercial Fishing	na	239	179	na	74	55
Crew boat	1985	347	750	1991	154	713
Excursion	1995	351	2,150	1997	39	2,264
Ferry	2001	1,833	1,115	1998	56	750
Government	1996	445	450	na	212	158
Tugboat, harbor	1994	1,067	1,027	1996	84	1,064
Line Haul Tug	1988	1,530	260	1988	93	260
Work boat	na	380	309	na	30	546

Table 4.3: 2005 San Pedro Bay Ports Harbor Craft Load Factors

Harbor Vessel Type	Engine LF
Assist Tug	0.31
Commercial Fishing	0.27
Crewboat	0.45
Excursion	0.76
Ferry	0.76
Government	0.51
Tugboat, harbor	0.68
Line Haul Tug	0.68
Workboat	0.45
Auxiliary engines	0.43

Consistent with the 2005 EIs, no emissions deterioration was assumed. Tier 0, 1 and 2 emission factors are shown in the tables below.

Since the publication of 2005 EIs, CARB has revised their harbor craft emissions calculation methodology which includes a change in zero hour emission factors and load factors and addition of emission deterioration factors. In order to be consistent with 2005 EIs, these changes are not included in the emission forecasting calculations.

Emission factors for the forecast years for Tier 0, 1 and 2 engines were those used in the 2005 EIs. Emissions from Tier 3 engines were assumed to be equivalent to the Tier 3 standards (i.e., no deterioration) as shown in the table following the 2005 emission factor tables. Please note that U.S. EPA's standards are by displacement, category 1 and category 2 types and broad horsepower range. In order to match the proposed standards to horsepower ranges that were used for the ports' 2005 emissions inventories for harbor crafts, CARB staff (Mr. Todd Sterling) assistance was sought. CARB provided a cross reference table of engine displacement and various horsepower categories.

Since there are no direct Tier 2 and Tier 3 standards for hydrocarbons (the standards are "NO_x plus HC") and the pre-Tier 2 CO emission factors are lower than the Tier 2 standards, we assumed that there would be no change in the HC and CO emissions factors from the 2005 emission factors to avoid an artificial increase in forecast emissions of those pollutants.

Since no deterioration rate was assumed in the 2005 EI methodology, Tier 3 standards as shown in the summary table were treated as the emission rates.

Table 4.4: 2005 Harbor Craft Emission Factors

Lower Bound kilowatts	NOX	CO	HC	PM	SO2
			Tier 0 Engines g/kW-hr		
37	11.0	2.00	0.27	0.90	0.15
75	10.0	1.70	0.27	0.40	0.15
130	10.0	1.50	0.27	0.40	0.15
225	10.0	1.50	0.27	0.30	0.15
450	10.0	1.50	0.27	0.30	0.15
560	10.0	1.50	0.27	0.30	0.15
1,000	13.0	2.50	0.27	0.30	0.15
Category 2 engines	13.20	1.10	0.50	0.72	0.15
			Tier 1 Engines g/kW-hr		
Lower Bound kilowatts	**NOX**	**CO**	**HC**	**PM**	**SO2**
37	9.8	2.00	0.27	0.90	0.15
75	9.8	1.70	0.27	0.40	0.15
130	9.8	1.50	0.27	0.40	0.15
225	9.8	1.50	0.27	0.30	0.15
450	9.8	1.50	0.27	0.30	0.15
560	9.8	1.50	0.27	0.30	0.15
1,000	9.8	2.50	0.27	0.30	0.15
Category 2 engines	9.8	1.10	0.50	0.72	0.15
			Tier 2 Engines g/kW-hr		
Lower Bound kilowatts	**NOX**	**CO**	**HC**	**PM**	**SO2**
37	6.8	5.00	0.27	0.40	0.15
75	6.8	5.00	0.27	0.30	0.15
130	6.8	5.00	0.27	0.30	0.15
225	6.8	5.00	0.27	0.30	0.15
450	6.8	5.00	0.27	0.30	0.15
560	6.8	5.00	0.27	0.30	0.15
1,000	6.8	5.00	0.27	0.30	0.15
Category 2 engines	9.8	5.00	0.50	0.72	0.15

Table 4.5: 2005 Harbor Craft Emission Factor Sources

Engine Standard	EPA Eng. Cat.	Model Year Range	Source of Emission Factor
Tier 0	Cat 1	1999 and older	1999 EPA RIA
Tier 0	Cat 2	1999 and older	2002 Entec
Tier 1	Cat 1	2000 to 2003	1999 EPA RIA, IMO NOX
Tier 1	Cat 2	2000 to 2003	2002 Entec, IMO NOX
Tier 2	Cat 1	2004 and newer	1999 EPA RIA
Tier 2	Cat 2	2004 and newer	2002 Entec, 1999 EPA RIA

Table 4.6: EPA Tier 3 Harbor Craft Emission Standards

Engine Category	Displacement per cylinder	CARB HP Range	NOx+HC gm/hp-hr	PM gm/hp-hr	NOx* gm/hp-hr	Effective Model Year
Cat 1	disp <0.9	25-120 hp	4	0.1	3.80	2012
	0.9<=disp<1.2	120-175 hp	4	0.09	3.80	2013
	1.2<=disp<2.5	175-500 hp	4.2	0.08	4.00	2014
	1.2<=disp<2.5	175-500 hp	4.2	0.07	4.00	2018
	2.5<=disp<3.5	500-750 hp	4.2	0.08	4.00	2013
	3.5<=disp<7.0	750-1900 hp	4.3	0.08	4.10	2012
Cat 2	7<=disp<15	1900-3300 hp	4.6	0.1	4.23	2013
	15<=disp<20	3300-5000 hp	6.5	0.2	6.13	2014
	20<=disp<25	3300-5000 hp	7.3	0.2	6.93	2014
	25<=disp<30	3300-5000 hp	8.2	0.2	7.83	2014

* This estimate of NO_x emission factor is derived by subtracting Tier 1/2 HC values from the Tier 3 NO_x+HC value.
Note: All Category 2 engines operated at the Port of Los Angeles and Long Beach are <3,300 HP
Source: Tables 3 and 5 http://www.arb.ca.gov/regact/2007/chc07/appa.pdf

4.1 Activity Growth Assumptions

For future years, the activity of assist tugs and pilot boats was scaled using the projected growth in OGV calls which are consistent with OGV emissions forecast described in Section 2 of this document. Activity of all other harbor craft categories were assumed to remain constant at the 2005 EI level with the exception of fishing vessels which were assumed to decline by 6% per year between 2005 and 2009[1]. (No changes in utilization efficiency were assumed.) The table below illustrates the projected OGV calls on which the assist tug and pilot boat activity growth estimates have been made.

Table 4.7: OGV Call Growth Projections

OGV Calls	2005	2014	2023
POLA Container Calls	1,423	2,181	2,600
POLA Non-Container Calls	918	1,414	1,751
POLA Total Calls	2,341	3,595	4,351
POLA Growth Factors		**1.54**	**1.86**
POLB Container Calls	1,384	2,291	2,548
POLB Non-Container Calls	1,782	2,508	3,077
POLB Total Calls	3,166	4,799	5,625
POLB Growth Factors		**1.52**	**1.78**

4.2 Regulatory Penetration of Fleet

For purposes of this analysis, it was assumed that all tugs are home-ported and therefore subject to CARB's regulations per compliance dates as shown in the table below. Vessel types affected by CARB's regulation are assist tugs, excursion vessels, ferries, ocean tugs and tug boats.

2014 - Although the Port's Clean Air Action Plan calls for the accelerated turnover of the harbor craft vessel fleet to use lower emitting engines, at this time there is no CAAP action-forcing mechanism available. Therefore, it was assumed that the average fleet age in 2014 and 2023 will be similar to what it was in 2005 and that CARB's regulation adopted in November 2007 would dictate the implementation schedule in 2014. Refer to the table below entitled "Harbor Craft Replacement Schedule to Tier 2 or Tier 3 in 2014."

2023 – Similar to 2014, average fleet was assumed for all vessels except for those vessels where CARB's regulation was applicable. Almost 80% of the Harbor Crafts operating in San Pedro Bay Ports and subject to CARB's regulation are assumed to be Tier 3 in 2023.

[1] Reference for fishing vessel decline - page B-19; http://www.arb.ca.gov/regact/2007/chc07/appb.pdf

Table 4.8: CARB Regulation Compliance Dates for Vessels with Home Ports in the SCAQMD

Engine MY	Total Annual hours	Compliance year-End of
<=1979	>= 300	2009
1980-1985	>=300	2010
1986-1990	>= 300	2011
1991-1995	>= 300	2012
1996-2000	>= 300	2013
2001	>= 300	2014
2002	>= 300	2015
2003	>= 300	2016
2004	>= 300	2017
2005	>= 300	2018
2006	>= 300	2019
2007	>= 300	2020

Table 4.9: Harbor Craft Replacement Schedule to Tier 2 or Tier 3 in 2014

Cat 1		Cat 2	
Tier 2 HP Range	Tier 3 HP Range	Tier 2 HP Range	Tier 3 HP Range
All	None	All	None
All	None	All	None
All	None	All	None
>120 and <=750	<=120 and >750	All	None
175 to 500	<=175 and >500	None	All
	All	None	All
None	None	None	None
None	None	None	None
None	None	None	None
None	None	None	None
None	None	None	None
None	None	None	None

4.3 Forecast Emission Estimates

Emissions calculated as in the example for all engines in the inventory were summed for each forecast year to arrive at the emissions as presented in the following tables.

Table 4.10: Harbor Craft Emissions Forecast - Port of Long Beach

	CY 2005					CY 2014 with CARB's Regulation					CY 2023 with CARB's Regulation				
Category	**HC tpy**	**CO tpy**	**NOX tpy**	**DPM tpy**	**SOx tpy**	**HC tpy**	**CO tpy**	**NOX tpy**	**DPM tpy**	**SOx tpy with ULSD**	**HC tpy**	**CO tpy**	**NOX tpy**	**DPM tpy**	**SOx tpy with ULSD**
Assist Tugs															
Auxilliary	0.40	4.18	18.09	0.63	0.11	0.60	6.31	18.72	0.62	0.02	0.70	7.40	18.07	0.40	0.02
Propulsion	5.33	50.17	275.55	9.26	1.37	8.05	75.75	283.24	13.03	0.24	9.43	88.80	243.18	5.59	0.28
Commercial Fishing															
Auxilliary	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propulsion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Crew Boat															
Auxilliary	0.01	0.11	0.38	0.02	0.00	0.01	0.11	0.36	0.02	0.00	0.01	0.11	0.36	0.02	0.00
Propulsion	0.31	3.23	14.01	0.40	0.09	0.31	3.23	11.89	0.37	0.01	0.31	3.23	10.58	0.22	0.01
Excursion															
Auxilliary	0.06	0.77	3.09	0.19	0.02	0.06	0.77	1.85	0.07	0.00	0.06	0.77	1.47	0.03	0.00
Propulsion	1.01	9.52	46.72	1.17	0.28	1.01	9.52	31.77	1.12	0.03	1.01	9.52	25.78	0.49	0.03
Ferry															
Auxilliary	0.04	0.36	1.77	0.10	0.01	0.04	0.36	1.13	0.04	0.00	0.04	0.36	0.93	0.02	0.00
Propulsion	4.96	92.75	207.07	5.76	1.39	4.96	92.75	147.91	4.04	0.16	4.96	92.75	132.70	2.38	0.16
Government															
Auxilliary	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propulsion	1.58	12.20	75.62	1.82	0.05	1.58	12.20	51.42	1.76	0.05	1.58	12.20	42.09	0.76	0.05
Ocean Tug															
Auxilliary	0.07	0.63	3.46	0.13	0.02	0.07	0.63	2.02	0.05	0.00	0.07	0.63	1.93	0.05	0.00
Propulsion	1.42	12.67	87.94	2.82	0.40	1.42	12.67	46.02	1.53	0.05	1.42	12.67	45.58	1.48	0.05
Tug Boat															
Auxilliary	0.16	1.61	7.39	0.39	0.04	0.16	1.61	4.85	0.18	0.01	0.16	1.61	3.90	0.09	0.01
Propulsion	4.64	47.15	250.57	6.59	1.30	4.64	47.15	182.13	5.92	0.15	4.64	47.15	141.28	4.06	0.15
Workboat															
Auxilliary	0.00	0.01	0.04	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.01	0.02	0.00	0.00
Propulsion	0.06	0.47	2.90	0.08	0.02	0.06	0.47	1.99	0.07	0.00	0.06	0.47	1.60	0.03	0.00
Pilot Boat															
Auxilliary	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propulsion	0.20	1.56	9.56	0.22	0.06	0.30	2.35	9.91	0.34	0.01	0.36	2.76	9.34	0.16	0.01
TOTAL	**20**	**237**	**1004**	**30**	**5.2**	**23**	**266**	**795**	**29**	**0.7**	**25**	**280**	**679**	**16**	**0.8**
% Reduction from Baseline [1]						15%	12%	-21%	-1%	-86%	23%	18%	-32%	-47%	-85%
negative % indicates decrease in emissions															
TOTAL SPBP	**46**	**535**	**2263**	**68**	**12.2**	**52**	**587**	**1759**	**59**	**2.0**	**55**	**621**	**1565**	**37**	**2.1**
% Reduction from Baseline [1]						12%	10%	-22%	-12%	-84%	19%	16%	-31%	-46%	-83%

Table 4.11: Harbor Craft Emissions Forecast - Port of Los Angeles

	CY 2005 (Baseline)					CY 2014 with CARB's Regulation					CY 2023 with CARB's Regulation				
Category	HC tpy	CO tpy	NOX tpy	DPM tpy	SOx tpy	HC tpy	CO tpy	NOX tpy	DPM tpy	SOx tpy with ULSD	HC tpy	CO tpy	NOX tpy	DPM tpy	SOx tpy with ULSD
Assist Tugs															
Auxilliary	0.42	4.43	19.42	0.68	0.12	0.64	6.69	20.01	0.52	0.02	0.78	8.11	21.09	0.44	0.03
Propulsion	5.47	53.67	283.79	9.02	1.40	8.25	81.04	282.42	12.44	0.24	10.00	98.22	266.90	6.85	0.30
Commercial Fishing															
Auxilliary	0.53	7.40	24.05	1.35	0.15	0.41	5.77	15.99	0.72	0.01	0.41	5.77	14.09	0.62	0.01
Propulsion	2.49	22.11	116.23	3.61	0.70	1.94	17.25	83.92	0.72	0.08	1.94	17.25	60.59	0.58	0.08
Crew Boat															
Auxilliary	0.09	0.74	4.28	0.15	0.03	0.09	0.74	3.67	0.02	0.02	0.09	0.74	3.67	0.02	0.02
Propulsion	0.53	6.02	23.45	0.71	0.15	0.53	6.02	19.69	0.25	0.09	0.53	6.02	18.58	0.13	0.09
Dredge Operation															
Auxilliary	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propulsion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Excursion															
Auxilliary	0.18	1.88	8.87	0.63	0.05	0.18	1.88	4.85	0.14	0.01	0.18	1.88	4.53	0.10	0.01
Propulsion	4.48	37.66	208.76	5.42	1.24	4.48	37.66	145.80	3.62	0.36	4.48	37.66	134.57	2.37	0.36
Ferry															
Auxilliary	0.03	0.34	1.67	0.10	0.01	0.03	0.34	1.03	0.03	0.00	0.03	0.34	0.96	0.03	0.00
Propulsion	5.03	101.90	200.42	5.82	1.41	5.03	101.90	146.37	3.64	0.16	5.03	101.90	135.07	2.41	0.16
Government															
Auxilliary	0.02	0.14	0.81	0.03	0.00	0.02	0.16	0.93	0.01	0.00	0.02	0.17	0.98	0.02	0.00
Propulsion	0.63	5.41	29.60	0.72	0.04	0.72	6.24	27.75	0.64	0.02	0.78	6.76	23.26	0.55	0.02
Ocean Tug															
Auxilliary	0.03	0.25	1.33	0.06	0.01	0.03	0.25	0.81	0.03	0.00	0.03	0.25	0.79	0.02	0.00
Propulsion	0.65	6.29	39.42	1.13	0.19	0.65	6.29	20.08	0.60	0.02	0.65	6.29	19.68	0.56	0.02
Tug Boat															
Auxilliary	0.17	1.71	7.85	0.43	0.05	0.17	1.71	4.95	0.15	0.01	0.17	1.71	4.45	0.10	0.01
Propulsion	4.98	44.36	270.51	8.01	1.40	4.98	44.36	171.81	6.53	0.17	4.98	44.36	165.40	5.83	0.17
Workboat															
Auxilliary	0.03	0.31	1.41	0.10	0.01	0.03	0.31	0.75	0.02	0.00	0.03	0.31	0.76	0.02	0.00
Propulsion	0.37	2.84	17.36	0.43	0.10	0.37	2.84	12.70	0.25	0.01	0.37	2.84	10.70	0.26	0.01
TOTAL	**26**	**297**	**1,259**	**38**	**7.1**	**29**	**321**	**964**	**30**	**1.2**	**31**	**341**	**886**	**21**	**1.3**
% Reduction from Baseline [1]						9%	8%	-23%	-21%	-83%	17%	14%	-30%	-46%	-82%
negative % indicates increase in emissions															
TOTAL SPBP	**46**	**535**	**2263**	**68**	**12.2**	**52**	**587**	**1759**	**59**	**2.0**	**55**	**621**	**1565**	**37**	**2.1**
% Reduction from Baseline [1]						12%	10%	-22%	-12%	-84%	19%	16%	-31%	-46%	-83%

SECTION 5.0 CHE BASELINE: 2005 EMISSIONS INVENTORY

The cargo handling equipment forecasts for the Ports of Long Beach and Los Angeles are based upon the data underlying the published 2005 emissions inventories for each port. The population, average age, horsepower and annual hours of usage estimates are the same as those included in Tables 4.3, 4.4, 4.5 and 4.6 of 2005 Emissions Inventory reports published by both ports. The complete reports can be obtained from the following Internet sources:
http://www.portoflosangeles.org/environment_studies.htm
http://www.polb.com/environment/air_quality/documents.asp

Table 5.1: POLA 2005 Emissions in tpy by Equipment Type

Equipment Type	Count	Avg. Model Year	PM10	PM2.5	DPM	NO_x	SO_x	CO	TOG
RTG cranes, cranes	100	1994	5.2	4.8	5.2	141.9	0.8	43.3	11.5
Excavator	12	1996	1.6	1.5	1.6	55.1	0.0	12.1	4.0
Forklift	422	1995	2.9	2.7	2.5	127.0	0.3	279.4	40.5
Top Handler, Side Pick	166	1999	8.3	7.7	8.3	287.6	2.1	60.1	16.5
Other Equipment	61	1992	5.8	5.3	5.8	106.4	0.2	39.7	12.0
Sweeper	11	2000	0.1	0.1	0.1	4.6	0.0	6.9	0.6
Loader	16	1993	1.2	1.1	1.2	38.7	0.1	8.1	2.8
Yard Tractor	901	2001	37.7	34.6	36.8	1,275.2	10.5	560.5	78
Total	**1,689**	**1999**	**62.8**	**57.8**	**61.5**	**2,036.6**	**14.0**	**1,010.1**	**166.1**

Table 5.2: POLB 2005 Emissions in tpy by Equipment Type

Equipment Type	Count	Avg. Model Year	PM10	PM2.5	DPM	NO_x	SO_x	CO	TOG
RTG Crane, Crane	95	1995	10.3	9.5	10.3	356.4	3.0	84.8	27.0
Forklift	294	1993	2.1	1.9	2.0	59.8	0.3	70.3	11.9
Top Handler, Side Pick	156	2000	5.8	5.3	5.8	252.8	2.5	27.7	7.0
Aerial Lift, Truck, Other	39	1995	0.2	0.2	0.2	4.6	0.0	1.3	0.4
Sweeper	14	1996	0.2	0.2	0.2	4.7	0.0	2.9	0.6
Loader	16	1991	2.6	2.4	2.5	58.8	0.3	30.3	6.9
Yard Tractor	641	2001	34.5	31.7	34.5	999.1	10.8	229.7	46.5
Total	**1,255**	**1998**	**55.6**	**51.1**	**55.5**	**1,736.3**	**17.0**	**446.9**	**100.4**

In order to simplify the forecast, the equipment type specific averages for model year/ age, horsepower and annual hours of usage for each terminal at the ports of Long Beach and Los Angeles were utilized rather than performing a separate analysis for each individual piece of equipment.

5.1 Activity and Equipment Population Growth

The forecast was accomplished by performing separate analyses of growth and control. These analyses were performed at the terminal specific level, and separate estimates of growth were developed for containerized and non-containerized cargo.

For container terminal CHE, the Global Insight forecast growth in TEU throughput as described in the document entitled "SPBP Emissions Forecasting Methodology" (26 Oct 07) was applied to the cargo handling equipment population of each container terminal.

Estimates of growth were developed for non-container terminal CHE based upon the forecast growth in cargo tonnage provided in the Global Insight report. Separate estimate were developed for liquid-bulk, dry-bulk, break–bulk, autos, refrigerated and general cargo. Growth in cruise ship calls were provided by the Port of Los Angeles and applied to cruise ships' activity for both ports.

The population and activity of terminals that did not exist during 2005 but that are expected to come on line during the forecast period were estimated based on the average characteristics of the type of terminal (e.g., container, break bulk, liquid) in operation in 2005. The terminals that were added are:

POLA

- Berth 206-209 – Container Terminal
- Pacific Energy – Liquid-Bulk Terminal

POLB

- Pier S – Container Terminal

The various growth factors used in the forecast are depicted in the graph and table below.

Figure 5.1.: Growth Factors for CHE by Terminal Type

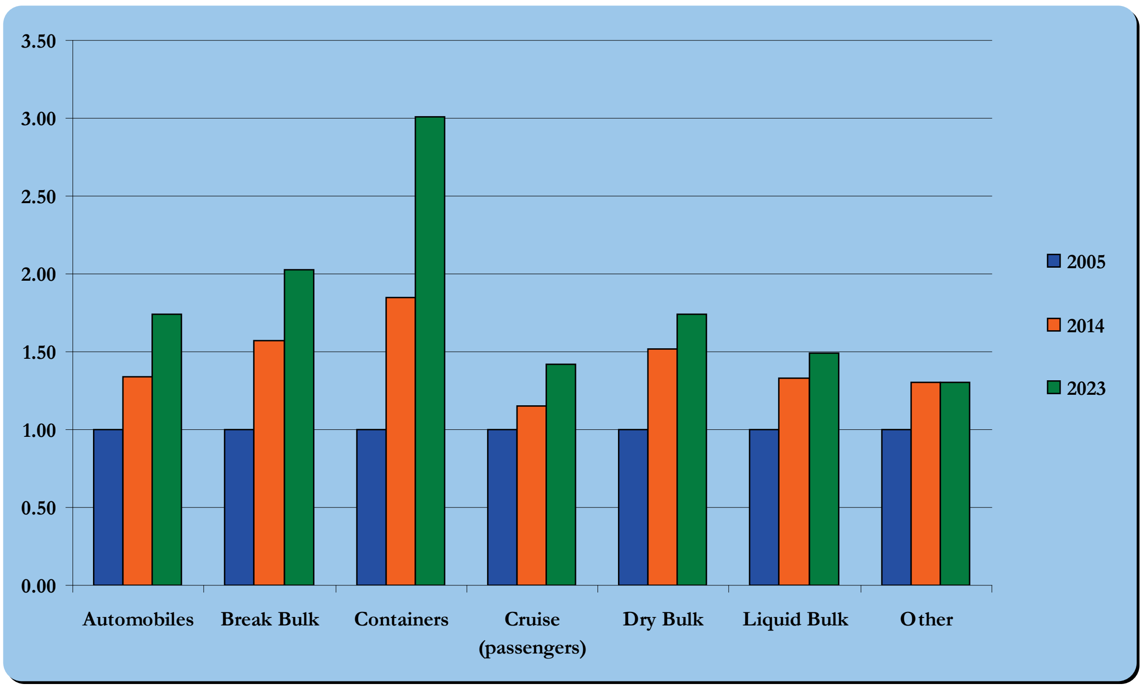


Table 5.3: Growth Factors for CHE by Terminal Type

Cargo Type	2014	2023
Automobiles	1.34	1.74
Break Bulk	1.57	2.03
Containers	1.85	3.01
Cruise (passengers)	1.15	1.42
Dry Bulk	1.52	1.74
Liquid Bulk	1.33	1.49
Other	1.30	1.30

In scaling the 2005 population according to growth in cargo, no terminal operational efficiencies were assumed regarding future CHE usage.

5.2 Emission Factors

The emission factors, assumptions of deterioration, load, useful life and fuel correction factors used in this analysis were consistent with those agreed upon by the technical working group and included in the 2005 emissions inventories. The only exception was the 2007+ model year, on-road zero hour emission factors needed to forecast yard tractor emissions. The 2007+ on-road NO_x and PM zero-hour emission rates provided by CARB for the 2005 EIs were adjusted for the more stringent USEPA 2007+ on-road diesel vehicle standards by multiplying the 2004 on-road emissions factors by the ratio of the standards applicable in 2004 versus 2007 to 2009 and 2010. An example of this adjustment is provided below:

2010+ MY (175 HP) PM in gm/hp-hr = 2004 on-road EF for 175 HP * 2010 on-road PM standard / 2004 on-road PM standard

2004+ On-Road emissions factors used for the analysis are shown in the table below:

Table 5.4: On-Road Emission Factors Utilized for Yard Tractors Equipped with On-Road Engines

Hp	Model Year	HC in gm/hp-hr	CO in gms/hp-hr	NO_x in gms/hp-hr	PM in gms/hp-hr
175	2004	0.07	2.70	2.08	0.13
175	2005	0.05	2.70	1.95	0.11
175	2006	0.05	2.70	1.95	0.11
175	2007	0.03	2.70	1.17	0.01
175	2008	0.03	2.70	1.17	0.01
175	2009	0.03	2.70	1.17	0.01
175	2010+	0.03	2.70	0.20	0.01
250	2004	0.05	0.92	2.02	0.08
250	2005	0.04	0.92	1.93	0.08
250	2006	0.04	0.92	1.93	0.08
250	2007	0.03	0.92	1.16	0.01
250	2008	0.03	0.92	1.16	0.01
250	2009	0.03	0.92	1.16	0.01
250	2010+	0.03	0.92	0.19	0.01

Emission factors for the off-road engines including Tier 4 engines are the same as provided by CARB for 2005 EIs. Emission benefits associated with the use of clean diesel fuel were assumed to lower the emissions of the CHE fleet consistent with the assumptions put forth by CARB. Reference: Table 7, "Off-Road Exhaust Emissions Inventory Fuel Correction Factors", dated July 25, 2005 posted at: http://www.arb.ca.gov/msei/supportdocs.htm#offroad

For LPG equipment, CARB provided a modified emissions factor file reflecting lower emission rates due to the "Large Spark-Ignited Off-Road Engine Regulation" adopted in 2006. More details can be found at: http://www.arb.ca.gov/regact/lore2006/lore2006.htm

5.3 Future Fleet Modeling

First the 2005 CHE population was grown to 2014 and 2023 according to the terminal specific growth factors described above. Initially, the average age of the equipment by terminal as determined by the 2005 data was retained. Second, the model year replacement or emission controls were applied to the grown CHE population according to which program requirements, those of the CAAP or those regulations adopted by the CARB, are more stringent. In making this evaluation, the CHE fleet was subdivided into the following groups:

5.3.1 2014 Equipment Groups

1) Yard Tractors regardless of the lease renewal status – The average age at both ports for off-road yard tractors in CY 2005 is five years (MY 2000) and for on-road yard tractors (15% of all yard tractors in San Pedro Bay Ports) is 0 year (MY 2005). Since CARB's regulation requires all of the pre-2003 yard tractor replacement to 2007+ on-road by end of CY 2008 and on-road yard tractors replacement by end of 2014, and since CAAP requires complete turnover to 2007+ on-road engines by CY 2010, if a terminal's lease is up for renewal before or by 2014, we used a simple rule which captures, on average, the CARB as well as CAAP's requirement. For each terminal, if the average age as determined from 2005 EI data was less than or equal to 7 years (which equates to MY 2007 + in 2014), it was retained and assumed that all yard tractors will be equipped with on-road engines. If the average age as determined from 2005 EI data was greater than 7 years (which equates to MY pre-2007 in 2017), all yard tractors were assumed to be 2007 equipped with on-road engines.
2) Non-Yard Tractors <= 750 HP in which the lease will be up for renewal regardless of fuel type – CAAP requirements were applied resulting in a Tier 4 CHE fleet
3) Non-Yard Tractors <=750 HP powered by diesel in terminals in which the lease will not be up for renewal – CARB's in-use CHE regulation was applied resulting in emissions controls applied to pre- Tier 4 equipment
4) Non-Yard Tractors >750 HP in terminals in which the lease will be up for renewal, regardless of fuel type – CAAP requirement was applied resulting in Tier 4 CHE
5) Non-Yard Tractors >750 HP powered by diesel in terminals in which the lease will not be up for renewal, regardless of fuel type – CARB's in-use CHE regulation was applied resulting in emissions controls applied to pre-Tier 4 equipment

Reference for CAAP requirement for CHE – section 5.3 of Final 2006, "San Pedro Bay Ports Clean Air Action Plan", Technical Report

Reference for CARB's in-use CHE regulation, Attachment 2 posted May 17, 2006 and Appendix D - http://www.arb.ca.gov/regact/cargo2005/cargo2005.htm

For non-yard tractors if CARB's in-use CHE regulation was applicable, all diesel powered Rubber-Tired Gantry Cranes and Forklifts were assumed to be retrofitted with level 3 VDEC systems resulting in an 85%; reduction in PM; all other diesel powered equipment were assumed to be retrofitted with level 1 VDEC system resulting in a 25% reduction in PM.

5.3.2 2023 Equipment Groups

1) All yard tractors regardless of lease status, fuel type or horsepower were assumed to be 2007+ on-road with average age same as in 2005
2) All Non-Yard Tractors regardless of lease status, fuel type or horsepower were assumed to be Tier 4 with the same average age as in 2005 if it was less than 9 years, otherwise they were assumed to be MY 2015.

Calculation Steps:
For CYs 2014 and 2023, assume the same average HP, usage and load factors by equipment by terminal as in 2005. (Also discussed above under Baseline description)

Grow the 2005 population by equipment type by terminal to 2014 and 2023 by applying terminal type appropriate growth factors (as shown in the graph and table above).

Depending upon the equipment type (Yard Tractor or non-Yard Tractor), average age of the equipment in 2005, lease schedule and CARB's in-use CHE regulation or CAAP requirement, determine the average MY of the equipment by terminal in 2014 and 2023.

Calculate emissions using 2005 EI methodology and terminal-specific equipment characteristics and based on projected average MY.

An example of one terminal scenario out of several used in developing the forecast is provided below for diesel yard tractor equipment:

2005 Baseline data
Terminal X – Container Terminal – Lease Renewal in 2010
5 diesel powered Off-Road Yard Tractors with average MY 2001 (4 years old), equipped with DOC,
Average HP 240
Average annual usage 1,600 hours
Projected growth in TEU between 2005 and 2010 is 130%

2014 Yard Tractor Data for Terminal X

The average age in 2005 was 4 years. It is assumed that turnover results in this average age continuing through 2014, which means the average model year in 2014 will be MY 2010, which complies with both the CAAP and the CARB regulation. This is a reasonable assumption because the terminal was maintaining this turnover in 2005 in the absence of any regulatory requirement, so it's reasonable to assume the terminal will continue to turn over its equipment at the same rate. This assumption means that any equipment purchased to comply with the CARB requirement to replace off-road MY 2001 and older with VDEC Yard Tractor by December 2009 will most likely have been replaced by 2014.

Other terminal fleet characteristics:

Population = 2005 population * growth factor = 5 * 1.30 = 7 (rounded)
Usage = 1,600 hours per year
Average HP = 240
PM ZH for on-road 2010 engine = 0.01 gm/hp-hr (from the table above)
DF = 0.67 for 250 hp per 2005 methodology
LF = 0.65
FCF = 0.800
Useful life = 12 years

Emissions in tons per year in 2014 =

ZH * (1+(DF*age/useful life))*annual hrs*HP*LF*FCF/(453.59*2000) =
0.015 tons per year

5.4 Forecast Emission Estimates

The resulting forecast emission estimates are listed in the tables below.

Table 5.5: POLA 2014 Emissions in tpy by Equipment Type

Equipment Type	Count	MYR	DPM	NO_x	CO	TOG	SO_x
RTG cranes, cranes	163	2008	1.1	88.9	40.2	5.2	0.2
Excavator	19	2005	1.0	47.5	11.8	1.5	0.1
Forklift	642	2006	1.6	169.8	353.5	40.6	0.1
Top Handler, Side Pick	299	2010	5.0	191.8	99.8	10.7	0.5
Other Equipment	100	2002	4.9	115.4	49.9	12.1	0.1
Sweeper	19	2011	0.1	3.6	1.9	0.2	0.0
Loader	25	2002	0.8	36.2	8.0	1.8	0.0
Yard Tractor	1588	2010	3.7	239.9	770.2	18.0	2.8
Total	**2,855**	2009	**18.2**	**893.0**	**1,335.3**	**89.9**	**3.9**
% Change from 2005	**69%**		**-70%**	**-56%**	**32%**	**-41%**	**-72%**

Negative % indicates decrease

Table 5.6: POLB 2014 Emissions in tpy by Equipment Type

Equipment Type	Count	MYR	DPM	NO_x	CO	TOG	SO_x
RTG Crane, Crane	176	2010	1.5	268.9	103.2	12.0	0.6
Forklift	457	2007	2.2	80.1	96.8	9.9	0.1
Top Handler, Side Pick	307	2011	3.9	178.0	103.4	8.4	0.5
Aerial Lift, Truck, Other	61	2008	0.4	15.0	17.1	1.1	0.0
Sweeper	26	2007	0.1	3.6	7.4	0.2	0.0
Loader	26	2001	1.8	56.2	16.5	5.2	0.0
Yard Tractor	1,130	2010	3.1	165.5	663.2	12.2	2.1
Total	**2,183**	**2009**	**12.8**	**767.3**	**1,007.5**	**49.1**	**3.3**
% Change from 2005	**74%**		**-77%**	**-56%**	**125%**	**-51%**	**-80%**

Negative % indicates decrease

Table 5.7: POLA 2023 Emissions in tpy by Equipment Type

Equipment Type	Count	MYR	DPM	NO_x	CO	TOG	SO_x
RTG cranes, cranes	242	2016	1.1	11.4	41.4	2.4	0.2
Excavator	25	2017	0.2	4.0	14.5	0.9	0.1
Forklift	830	2016	0.2	40.7	755.3	12.5	0.1
Top Handler, Side Pick	465	2016	0.8	20.8	81.2	4.6	0.4
Other Equipment	139	2017	0.3	6.8	22.5	1.1	0.1
Sweeper	30	2017	0.0	0.9	2.4	0.1	0.0
Loader	31	2015	0.1	1.4	5.5	0.3	0.0
Yard Tractor	2395	2020	5.6	147.9	1,371.9	18.2	4.1
Total	**4,157**	2018	**8.2**	**233.9**	**2,294.8**	**40.1**	**5.2**
% Change from 2005	**146%**		**-87%**	**-89%**	**127%**	**-74%**	**-63%**

Negative % indicates decrease

Table 5.8: POLB 2023 Emissions in tpy by Equipment Type

Equipment Type	Count	MYR	DPM	NO_x	CO	TOG	SO_x
RTG Crane, Crane	292	2017	2.6	222.8	176.3	10.3	1.0
Forklift	630	2016	0.3	21.6	235.8	3.1	0.2
Top Handler, Side Pick	518	2019	1.5	42.0	179.5	8.7	0.8
Aerial Lift, Truck, Other	77	2016	0.1	2.4	20.7	0.5	0.0
Sweeper	32	2017	0.0	1.3	5.0	0.1	0.0
Loader	31	2016	0.1	2.6	9.5	0.6	0.1
Yard Tractor	1,914	2019	5.6	108.1	1,202.1	10.7	3.5
Total	**3,494**	**2018**	**10.1**	**400.8**	**1,828.9**	**34.2**	**5.7**
% Change from 2005	**178%**		**-82%**	**-77%**	**309%**	**-66%**	**-67%**

Negative % indicates decrease

Table 5.9: POLA 2005 Emissions in tpy by Terminal Type – Yard Tractors

Terminal Type	Count	MYR	DPM	NO_x	CO	TOG
Automobile	0	0	0.00	0.00	0.00	0.00
Break Bulk	21	1993	0.33	8.13	2.24	0.70
Container	800	2001	31.47	1,133.51	481.21	69.54
Cruise	0	0	0.00	0.00	0.00	0.00
Dry Bulk	22	1999	1.83	35.11	13.79	3.91
Liquid Bulk	0	0	0.00	0.00	0.00	0.00
Other	58	2005	3.15	98.46	63.26	3.92
Total	901	2001	36.77	1,275.20	560.51	78.07

Table 5.10: POLA 2005 Emissions in tpy by Terminal Type – Non-Yard Tractor CHE

Terminal Type	Count	MYR	DPM	NO_x	CO	TOG
Automobile	7	1996	0.00	0.22	1.79	0.12
Break Bulk	241	1993	10.59	267.81	170.95	35.09
Container	311	1998	11.43	392.02	105.06	25.57
Cruise	33	1992	0.31	8.33	13.48	2.32
Dry Bulk	130	1997	0.21	38.38	119.75	17.06
Liquid Bulk	7	1995	0.04	1.91	4.16	0.63
Other	59	1996	2.12	52.73	34.68	7.14
Total	788	1996	24.70	761.40	449.86	87.91

Table 5.11: POLB 2005 Emissions in tpy by Terminal Type – Yard Tractors

Terminal Type	Count	MYR	DPM	NO_x	CO	TOG
Automobile	0	0	0.00	0.00	0.00	0.00
Break Bulk	6	1998	0.04	1.26	0.80	0.05
Container	635	2001	34.47	997.83	228.85	46.43
Cruise	0	0	0.00	0.00	0.00	0.00
Dry Bulk	0	0	0.00	0.00	0.00	0.00
Liquid Bulk	0	0	0.00	0.00	0.00	0.00
Other	0	0	0.00	0.00	0.00	0.00
Total	641	2001	34.51	999.09	229.65	46.48

Table 5.12: POLB 2005 Emissions in tpy by Terminal Type – Non-Yard Tractor CHE

Terminal Type	Count	MYR	DPM	NO_x	CO	TOG
Automobile	11	1995	0.04	2.41	4.29	0.63
Break Bulk	207	1992	3.89	91.86	33.62	7.70
Container	307	1997	16.36	606.02	116.77	35.14
Cruise	16	1989	0.13	8.11	19.39	3.03
Dry Bulk	63	1998	0.42	26.93	41.77	7.09
Liquid Bulk	12	1991	0.08	6.15	2.37	0.43
Other	0	0	0.00	0.00	0.00	0.00
Total	616	1995	20.93	741.49	218.21	54.02

Table 5.13: POLA 2014 Emissions in tpy by Terminal Type – Yard Tractors

Terminal Type	Count	MYR	DPM	NO_x	CO	TOG
Automobile	0	0	0.00	0.00	0.00	0.00
Break Bulk	33	2008	0.01	1.87	2.40	0.06
Container	1447	2010	3.28	224.11	670.10	16.75
Cruise	0	0	0.00	0.00	0.00	0.00
Dry Bulk	33	2008	0.07	8.29	15.88	0.28
Liquid Bulk	0	0	0.00	0.00	0.00	0.00
Other	75	2014	0.30	5.61	81.86	0.94
Total	1588	2010	3.66	239.87	770.24	18.04

Table 5.14: POLA 2014 Emissions in tpy by Terminal Type – Non-Yard Tractor CHE

Terminal Type	Count	MYR	DPM	NO_x	CO	TOG
Automobile	9	2005	0.01	0.38	4.23	0.13
Break Bulk	384	2004	7.61	304.59	298.42	35.11
Container	563	2010	5.54	281.55	165.47	16.53
Cruise	38	2001	0.47	14.59	33.74	5.80
Dry Bulk	199	2006	0.13	14.46	25.77	9.53
Liquid Bulk	10	2005	0.06	2.36	6.40	0.53
Other	64	2005	0.71	35.23	31.01	4.26
Total	1267	2007	14.54	653.17	565.05	71.89

Table 5.15: POLB 2014 Emissions in tpy by Terminal Type – Yard Tractors

Terminal Type	Count	MYR	DPM	NO_x	CO	TOG
Automobile	0	0	0.00	0.00	0.00	0.00
Break Bulk	10	2008	0.01	0.12	1.59	0.02
Container	1120	2010	3.08	165.37	661.58	12.21
Cruise	0	0	0.00	0.00	0.00	0.00
Dry Bulk	0	0	0.00	0.00	0.00	0.00
Liquid Bulk	0	0	0.00	0.00	0.00	0.00
Other	0	0	0.00	0.00	0.00	0.00
Total	1130	2010	3.08	165.49	663.18	12.23

Table 5.16: POLB 2014 Emissions in tpy by Terminal Type – Non-Yard Tractor CHE

Terminal Type	Count	MYR	DPM	NO_x	CO	TOG
Automobile	14	2012	0.00	0.35	2.02	0.03
Break Bulk	326	2007	3.35	116.93	57.10	8.43
Container	576	2010	5.98	457.71	219.52	22.28
Cruise	18	1999	0.12	8.14	24.65	2.49
Dry Bulk	104	2008	0.28	17.42	39.81	3.54
Liquid Bulk	15	2001	0.04	1.25	1.26	0.12
Other	0	0	0.00	0.00	0.00	0.00
Total	1053	2009	9.77	601.80	344.35	36.90

Table 5.17: POLA 2023 Emissions in tpy by Terminal Type – Yard Tractors

Terminal Type	Count	MYR	DPM	NO_x	CO	TOG
Automobile	0	0	0.00	0.00	0.00	0.00
Break Bulk	42	2014	0.02	0.99	3.22	0.05
Container	2240	2020	5.16	139.64	1268.32	17.39
Cruise	0	0	0.00	0.00	0.00	0.00
Dry Bulk	38	2016	0.09	1.62	18.50	0.19
Liquid Bulk	0	0	0.00	0.00	0.00	0.00
Other	75	2023	0.30	5.61	81.86	0.52
Total	2395	2020	5.57	147.85	1371.91	18.17

Table 5.18: POLA 2023 Emissions in tpy by Terminal Type – Non-Yard Tractor CHE

Terminal Type	Count	MYR	DPM	NO_x	CO	TOG
Automobile	12	2015	0.00	0.16	5.04	0.10
Break Bulk	502	2016	0.67	32.86	300.04	9.96
Container	899	2016	1.92	37.96	177.25	7.68
Cruise	50	2015	0.01	2.40	43.16	0.43
Dry Bulk	225	2016	0.03	9.15	360.36	3.20
Liquid Bulk	10	2015	0.00	0.47	8.08	0.08
Other	64	2017	0.04	3.02	28.95	0.50
Total	1762	2016	2.67	86.01	922.88	21.95

Table 5.19: POLB 2023 Emissions in tpy by Terminal Type – Yard Tractors

Terminal Type	Count	MYR	DPM	NO_x	CO	TOG
Automobile	0	0	0.00	0.00	0.00	0.00
Break Bulk	13	2016	0.01	0.16	2.39	0.02
Container	1901	2019	5.57	107.97	1199.71	10.69
Cruise	0	0	0.00	0.00	0.00	0.00
Dry Bulk	0	0	0.00	0.00	0.00	0.00
Liquid Bulk	0	0	0.00	0.00	0.00	0.00
Other	0	0	0.00	0.00	0.00	0.00
Total	1914	2019	5.58	108.13	1202.10	10.71

Table 5.20: POLB 2023 Emissions in tpy by Terminal Type – Non-Yard Tractor CHE

Terminal Type	Count	MYR	DPM	NO_x	CO	TOG
Automobile	18	2015	0.00	0.26	7.67	0.07
Break Bulk	422	2016	0.34	19.21	61.16	2.19
Container	991	2018	4.14	267.34	385.24	19.46
Cruise	22	2015	0.00	0.71	24.82	0.23
Dry Bulk	112	2018	0.04	4.94	146.11	1.46
Liquid Bulk	15	2015	0.00	0.23	1.79	0.03
Other	0	0	0.00	0.00	0.00	0.00
Total	1580	2017	4.53	292.68	626.79	23.45

SECTION 6.0 HDV EMISSIONS FORECASTING METHODOLOGY

The basis of the forecast is the TEU throughput projection developed by the ports and summarized in Table 6.1 of the forecasting methodology document (and summarized in Table 6.1 and Figure 6.1 below).

The methodology is consistent with the previous port emissions inventories, consisting of 3 components:

- On-terminal
- On-port on-road
- Regional (off-port) on-road

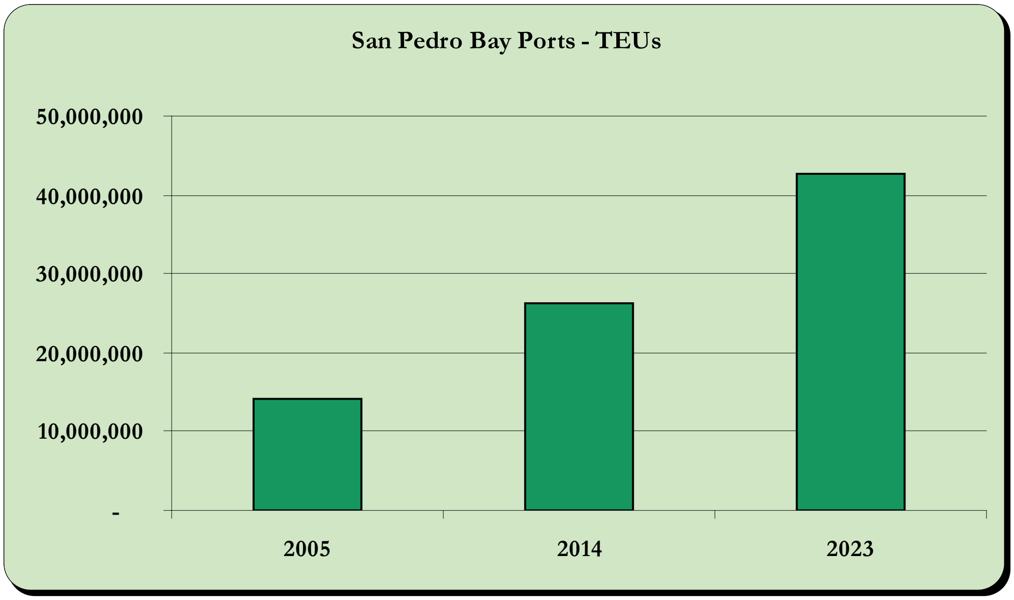
One important difference between the ports' EIs and these emission forecasts is how the on-port on-road activity and emissions are reported. Since each port's inventory stands alone, the on-port activity for each port is confined to trucks associated with that port (POLA-related truck trips on POLA roads, and POLB-related truck trips on POLB roads). The portion of a POLB-related truck trip that takes place on roads within POLA is reported in the POLB EI as a regional, off-port emission, as is the portion of a POLA-related truck trip that takes place on POLB roads. However, since these forecasts are being spatially allocated to support risk assessment modeling, the activity and emissions of trucks associated with both ports are reported for each port - that is, POLA emissions include POLB-related truck trips as well as POLA-related truck trips, and vice versa. For this reason the emissions reported as baseline (2005) emissions in this summary are not the same as those presented in the two ports' 2005 EIs.

Table 6.1: San Pedro Bay Ports Container Throughput Projection

Year	TEUs	Containers*
2005	14,194,340	7,885,745
2014	26,293,929	14,607,738
2023	42,698,000	23,721,111

*Estimated as TEU/1.8

Figure 6.1: San Pedro Bay Ports TEU Projection



6.1 Ports Truck Population Distribution by Model Year - Used to Calculate Composite Fleet Emission Factors

The baseline ports truck population distribution by model year is the same as determined by the OCR data records collected for CY 2005 and published in section 5.1.1 of San Pedro Bay Ports Clean Air Action Plan, Final 2006, as shown in the table below. Growth factors for 2014 and 2023 were based on projected on-terminal truck trips described above. Growth in CYs 2014 and 2023 with respect to CY 2005 is 43% and 125% respectively. Survival rates by age were obtained from EMFAC2007.

First, the baseline (CY 2005) population was grown to future years based on the growth factors. Second, survival rates by age were applied to calculate the remaining population. Third, the difference between the current year's and previous year's population was distributed according to the baseline distribution.

Ban and Retrofit requirements (from the Ports' Clean Truck Program tariff schedule) were applied in CYs 2008, 2010 and 2012. The trucks assumed to replace the banned population were distributed within the MYs allowed within the calendar year of concern.

Table 6.2: Model Year Distribution Assumptions

CY 2005		CY 2014		CY 2023	
Model Year	Population Fraction	Model Year	Population Fraction	Model Year	Population Fraction
2006	0.28%	2015	0.28%	2024	0.28%
2005	1.23%	2014	0.93%	2023	0.52%
2004	0.33%	2013	3.04%	2022	0.53%
2003	0.80%	2012	8.73%	2021	0.65%
2002	0.58%	2011	3.84%	2020	0.70%
2001	2.00%	2010	9.32%	2019	1.06%
2000	4.97%	2009	9.22%	2018	2.06%
1999	6.85%	2008	23.64%	2017	3.35%
1998	7.85%	2007	41.00%	2016	4.69%
1997	8.64%	2006	0.00%	2015	6.01%
1996	9.85%	2005	0.00%	2014	7.39%
1995	10.22%	2004	0.00%	2013	9.04%
1994	9.17%	2003	0.00%	2012	10.86%
1993	7.20%	2002	0.00%	2011	10.08%
1992	4.06%	2001	0.00%	2010	10.35%
1991	4.06%	2000	0.00%	2009	9.46%
1990	4.07%	1999	0.00%	2008	10.75%
1989	4.02%	1998	0.00%	2007	12.21%
1988	3.04%	1997	0.00%	2006	0.00%
1987	2.22%	1996	0.00%	2005	0.00%
1986	1.59%	1995	0.00%	2004	0.00%
1985	2.27%	1994	0.00%	2003	0.00%
1984	1.98%	1993	0.00%	2002	0.00%
1983	0.50%	1992	0.00%	2001	0.00%
1982	0.33%	1991	0.00%	2000	0.00%
1981	0.34%	1990	0.00%	1999	0.00%
1980	0.35%	1989	0.00%	1998	0.00%
1979	0.35%	1988	0.00%	1997	0.00%
1978	0.16%	1987	0.00%	1996	0.00%
1977	0.12%	1986	0.00%	1995	0.00%
1976	0.09%	1985	0.00%	1994	0.00%
1975	0.02%	1984	0.00%	1993	0.00%
1974	0.11%	1983	0.00%	1992	0.00%
1973	0.11%	1982	0.00%	1991	0.00%
1972	0.05%	1981	0.00%	1990	0.00%
1971	0.03%	1980	0.00%	1989	0.00%
1970	0.06%	1979	0.00%	1988	0.00%
1969	0.04%	1978	0.00%	1987	0.00%
1968	0.03%	1977	0.00%	1986	0.00%
1967	0.03%	1976	0.00%	1985	0.00%
1966	0.03%	1975	0.00%	1984	0.00%

6.2 Fleet Average Emission Factor Development

The EMFAC model was used to estimate fleet average emission factors based on fleet turnover rates dictated by the San Pedro Bay Ports' Clean Trucks Program tariff schedule.

Table 6.3: Speed-Corrected Fleet Average Emission Rates, g/mile

Speed, mph	5	10	15	20	25	30	35	40
NOx								
2005	54.2	44.6	30.6	23.9	22.7	22.2	21.8	21.6
2014	18.7	15.8	11.8	9.2	8.0	7.2	6.6	6.0
2023	12.3	10.3	7.6	5.9	5.1	4.6	4.3	3.9
PM								
2005	5.1	4.2	2.8	1.9	1.5	1.3	1.1	1.0
2014	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2023	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
HC								
2005	18.7	14.4	7.7	3.6	2.5	2.0	1.7	1.4
2014	4.9	3.5	1.8	0.8	0.7	0.6	0.5	0.4
2023	3.6	2.6	1.3	0.6	0.5	0.4	0.4	0.3
CO								
2005	30.2	26.9	21.2	16.5	13.6	11.4	9.5	8.0
2014	9.6	7.2	4.1	2.5	2.1	2.0	2.0	2.0
2023	7.0	5.3	3.0	1.8	1.5	1.5	1.5	1.4

(continued below)

Table 6.3: Speed-Corrected Fleet Average Emission Rates, g/mile (cont'd)

Speed, mph	45	50	55	60	65	70	Idle (g/hr)
NOx							
2005	21.6	21.7	22.0	22.5	23.2	24.2	80.6
2014	5.6	5.4	5.3	5.3	5.5	5.9	95.5
2023	3.6	3.5	3.4	3.4	3.5	3.8	95.5
PM							
2005	0.9	0.9	0.9	1.0	1.2	1.4	1.7
2014	0.1	0.1	0.1	0.1	0.2	0.2	0.1
2023	0.1	0.1	0.1	0.1	0.2	0.2	0.1
HC							
2005	1.3	1.2	1.3	1.5	1.8	2.2	11.5
2014	0.4	0.3	0.3	0.3	0.3	0.3	6.0
2023	0.3	0.3	0.2	0.2	0.2	0.2	6.0
CO							
2005	6.8	5.9	5.4	5.2	5.4	5.8	20.7
2014	2.0	2.0	2.1	2.3	2.4	2.7	16.6
2023	1.4	1.5	1.5	1.7	1.8	2.0	16.6

Figure 6.2: Speed-Corrected Fleet Average NO_x Emission Rates, g/mile

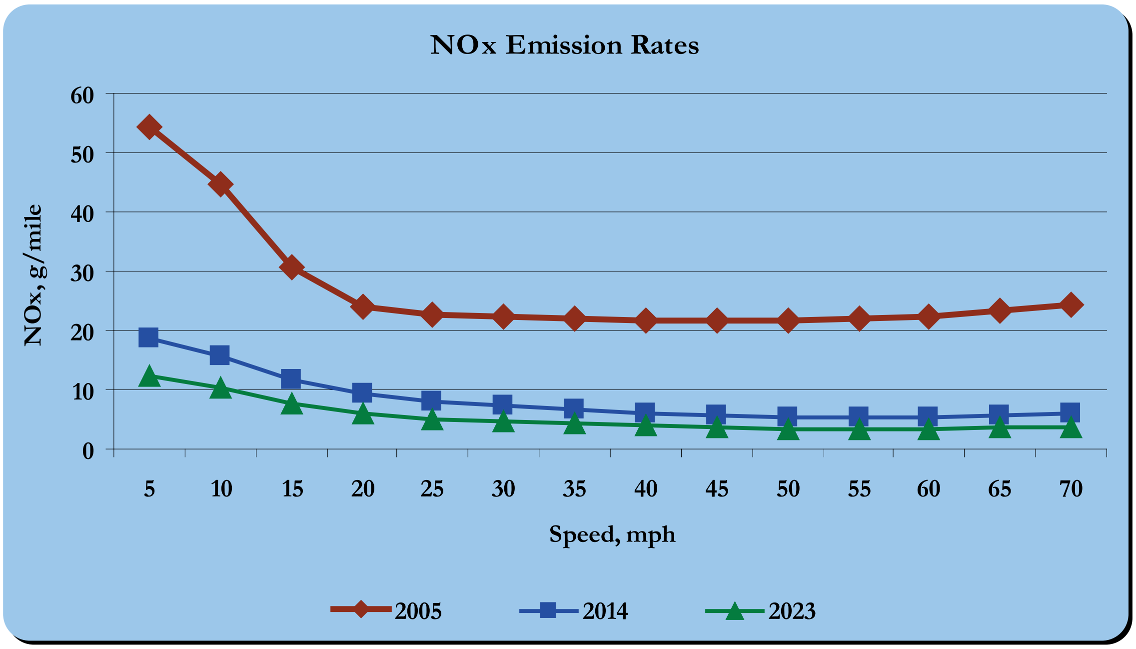
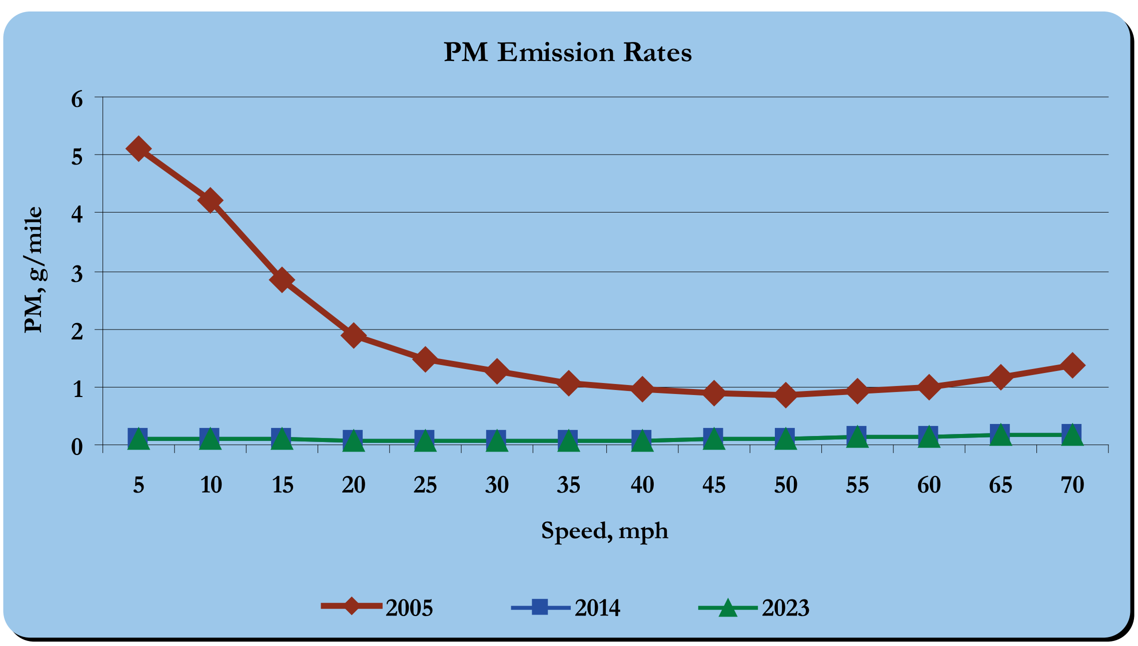


Figure 6.3: Speed-Corrected Fleet Average PM Emission Rates, g/mile



6.3 On-terminal Activity Forecasting Methodology

On-terminal activity relates to the operation of trucks as they arrive at, operate within, and depart from a terminal or other facility.

The number of truck trips for each terminal for forecast years 2014 and 2023 are from QuickTrip runs using the throughputs summarized above, and truck/rail mode split assumptions developed for each year. The terminal characteristics assumed for on-terminal speed, distance, and idling times are the 2006 characteristics which will be used to develop 2006 emission estimates - these were used in preference to the 2005 values because 2006 is believed to better reflect the effects of PierPass implementation on idling and other terminal operations. No additional information was available to adjust these values for 2014 or 2023 such as terminal efficiency improvements) so the 2006 characteristics were used unmodified for the later years.

As with the port emissions inventory methodology, the calculations are based on the number of truck trips through the terminals multiplied by either the average idling time per visit (for the idling time calculation) or the average distance traveled on-terminal during each visit. These values are terminal-specific and were obtained from the individual terminals. Total VMT and idling times were calculated for each port by summing the totals for each terminal.

Examples: 0.5 hours idling per truck visit x 1,000,000 truck visits per year = 500,000 hours idling per year
1.0 mile on-terminal per truck visit x 1,000,000 truck visits per year = 1,000,000 vehicle miles per year

The QuickTrip model provides activity numbers (number of truck visits) for container terminals. Activity related to non-container terminals has been separately projected by the Ports not to grow substantially between 2005 and 2014, with a 12% increase between 2014 and 2023.

Several facilities are located on POLA property away from the area typically considered to be within the ports. Most of these facilities are related to container transportation, such as dispatch and warehouse facilities, and one is an off-dock rail yard operated by Union Pacific - the Intermodal Container Transfer Facility (ICTF). Activity forecasting for these facilities was based on different assumptions than those used for the non-container terminals because their activity is related to container activity. Therefore, their activity growth was scaled with overall container throughput growth, with the exception that the ICTF was held at its current capacity of 1,250,000 containers per year.

The following tables and charts illustrate the forecast truck trips and VMT for the two ports' container terminals and for the other terminals (including the ICTF) for the 2005 baseline year and the forecast years 2014 and 2023.

Table 6.4: San Pedro Bay Ports On-Terminal Truck Trips

	2005	2014	2023
PoLA Container Terminals	4,179,330	6,090,289	9,565,977
PoLB Container Terminals	3,967,832	5,628,843	9,939,841
Other Terminals and ICTF	2,068,283	2,081,153	2,188,751
	10,215,445	13,800,285	21,694,569

Figure 6.4: San Pedro Bay Ports On-Terminal Truck Trips

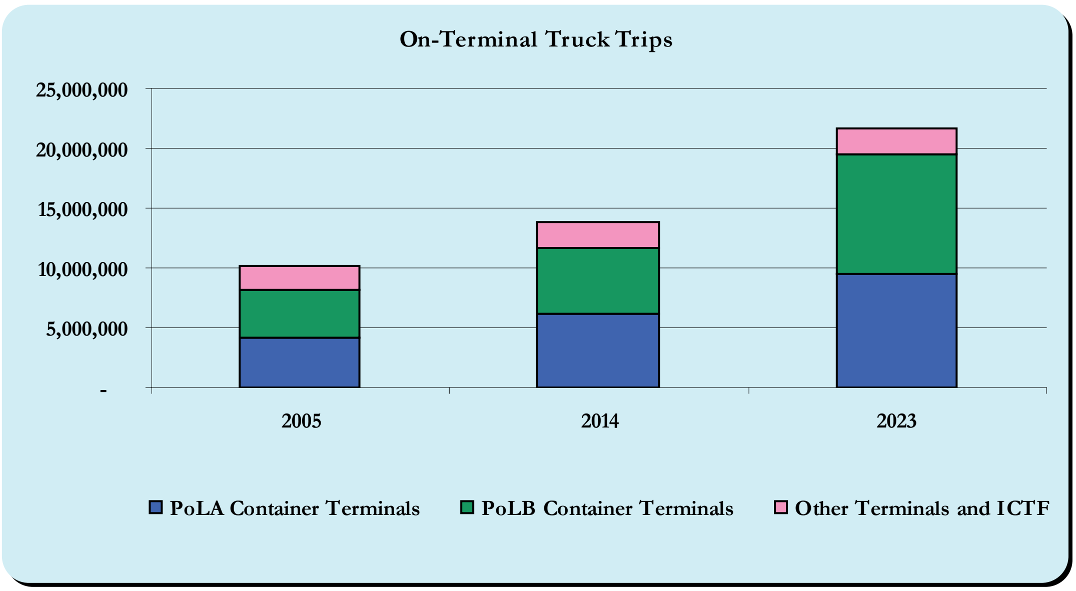
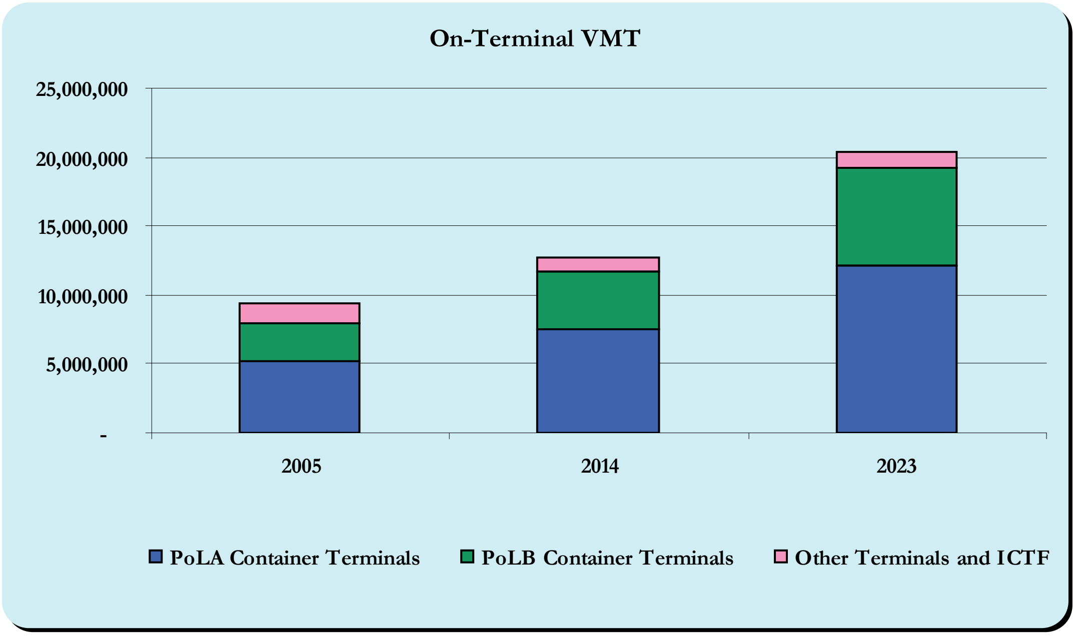


Table 6.5: San Pedro Bay Ports On-Terminal VMT

	2005	2014	2023
PoLA Container Terminals	5,188,764	7,521,509	12,105,673
PoLB Container Terminals	2,768,198	4,113,594	7,142,948
Other Terminals and ICTF	1,472,353	1,065,763	1,081,206
Total	9,429,315	12,700,866	20,329,828

Figure 6.5: San Pedro Bay Ports On-Terminal VMT



6.4 On-Port and Regional Activity Forecasting Methodology

The composite emission factors used in the heavy-duty diesel truck forecast are from the current version of CARB's EMFAC model (EMFAC 2007 Version 2.3 November 1, 2006). The model was run for calendar years 2014 and 2023 for the South Coast Air Basin under "Summer" conditions in model-year-specific five-mile-per-hour speed increments. The emissions for each speed increment and model year, in tons per day, were divided by the EMFAC model's internal VMT assumptions for that speed and year to calculate a model-year-specific gram-per-mile emission rate (with the appropriate conversion of tons to grams). The published low idle emission rates from the EMFAC 2007 documentation were used for the on-terminal estimates rather than the model output because the idle emission rates as a function of time are not readily retrievable from the output.

The model year specific emission rates were then weighted according to the calendar year specific population distribution which conforms to CARB and CAAP fleet requirements to derive a single set of composite emission rates by pollutant and speed.

The on-port and regional activity estimates were provided for the forecast years by Iteris from their travel demand model - examples of the on-port and regional modeling outputs are provided below.

Table 6.6: Example of On-Port Model Output

(this would be associated with a specific terminal's trucks over one of the four daily time periods)

Roadway Segment	From	To	Direction	Speed (MPH)	Direction	Bobtails	Chassis	Containers	Distance (Miles)	Speed (MPH)
Anaheim St	Anaheim Way	9th St	East Bound	35	Westbound	3	-	-	0.36	35
Anaheim St	9th St	Jackson	East Bound	35	Westbound	2	-	-	0.26	35
Anaheim St	Santa Fe	Canal	East Bound	35	Westbound	2	-	-	0.19	35
Anaheim St	Canal	Caspian	East Bound	35	Westbound	2	-	-	0.19	35
Anaheim St	Harbor Ave	I-710 SB ramp	East Bound	33	Westbound	2	-	-	0.05	33
New Dock St	Henry Ford	SR-47 Off Ramp	East Bound	15	Westbound	3	-	-	0.23	15
New Dock St	SR-47 Off Ramp	SR-47 On Ramp	East Bound	15	Westbound	3	-	-	0.11	15

The on-port activity files estimate the traffic volumes and speeds for approximately 350 roadway segments on the ports of Los Angeles and Long Beach for truck traffic associated with each terminal. Volumes and speeds are reported for each segment for each terminal in each direction. Separate volume estimates are made for bobtail, chassis and container trucks. The activity estimates are made for four daily periods: AM, mid-day, PM and night.

The vehicle miles traveled on each roadway segment are estimated by summing the number of trucks in each category and multiplying the total by the length of the roadway segment. The total VMT is calculated by summing all of the roadway segment VMTs.

Example:

Bobtails	Chassis	Containers	Miles
10	12	200	0.25

Segment volume = 222 trucks (bobtails + chassis + containers)
Segment VMT = 56 VMT (trucks * miles)

Although the speed traveled on each roadway segment is reported as a model output, the aggregate speed for each terminal's trucks and each time period was estimated by weighting each roadway segment's speed by the percentage of the VMT assumed to occur on that roadway. Once the average speed and overall VMT are estimated, the corresponding emission rate is used to derive the tons of emissions per time period associated with each terminal's activity. A lookup function is used to choose the speed-specific emission factor based on the next-lower speed. For example, the average speed of 33 mph in the table above would return the emission factor for 30 mph. The 35 mph speeds would return the emission factor for 35 mph.

Speed	NOx, g/mile	
25	7.98	
30	7.20	valid between 30 mph and 35 mph (less than 35)
35	6.59	valid between 35 mph and 40 mph (less than 40)
40	6.03	

Calculation:

Tons per period = Total VMT * Composite Emission Factor (at average speed) / 453.59 g/lb * 2,000 lbs/ton
Tons per period = 7,500 VMT * 7.20 g/mile / 453.59 g/lb * 2000 lbs/ton = 0.06 tons per period.

The emissions for each period and each terminal are summed to arrive at the ton-per-day total.

6.5 Regional (Off-port)

The emissions associated with regional (off-port) travel are calculated in a manner similar to that of the on-port estimate. The output of the travel demand model for regional travel consists of some 92,000 segments for each of the four daily periods (AM, Mid-day, PM and night). The distance of each segment is reported as a model output and the traveled speed is estimated using distance and time fields in the data file and the following equation:

Roadway Segment Speed = Distance (miles)/ time (mins)/60 (mins/hr) = Miles/Hour

As with the on-port emissions estimate, the roadway segment VMT was calculated by summing the number of trucks in each classification (bobtail, chassis and container) and multiplying the total by the length of the corresponding segment. The total VMT was derived by summing the VMT of all roadway segments and the average speed is estimated by weighting the individual roadway segment speeds by the fraction of the overall VMT on that roadway segment. The emissions in tons per time period were derived by applying the composite emission factor that corresponds to the VMT weighted speed to the overall VMT.

Calculation:

Regional emissions per period =
VMT per period * Composite Emission Factor (at average speed) / 453.59 g/lb*2000 lbs/ton

The emissions estimated for the four periods were added together to derive the daily emissions.

6.6 Forecast Emissions

The emissions forecast for 2014 and 2023 using the methods described above are summarized in the following two tables. After these summary tables, additional tables and charts present the information developed from the container throughput forecasts and mode split assumptions discussed above. The tables and charts show the projected numbers of containers to be moved by truck either to local destinations or to off-dock rail yards (i.e., all container throughputs other than containers to be shipped via on-dock rail).

Table 6.7: 2005 Estimated Emissions

2005	Annual Gate Moves	Total Hours Idling	Total Miles	HC tpy Running	HC tpy Idle	HC tpy Total	CO tpy Running	CO tpy Idle	CO tpy Total	NOx tpy Running	NOx tpy Idle	NOx tpy Total	PM tpy Running	PM tpy Idle	PM tpy Total	SOx tpy Running	SOx tpy Idle	SOx tpy Total
On-Terminal Emissions																		
Container																		
Port of Los Angeles	4,179,330	2,292,414	5,188,764	59	29	**88**	134	52	**186**	206	204	**410**	19.33	9.87	**29**	0.93	2.18	**3.11**
Port of Long Beach	3,967,832	3,759,192	2,768,198	53	48	**101**	89	86	**175**	158	334	**492**	14.78	5.27	**20**	0.5	3.57	**4.07**
Non-Container																		
POLA + POLB	2,068,283	819,918	1,472,353	13	10	**23**	33	19	**52**	53	73	**126**	4.57	2.80	**7**	0.26	0.78	**1.04**
Subtotal	10,215,445	6,871,524	9,429,315			**213**			**414**			**1,027**			**57**	1.69	6.53	**8.22**
On-Port On-Road Emissions																		
Container																		
Port of Los Angeles			24,270,410	62		**62**	284		**284**	665		**665**	36.05		**36**	4.36	0	**4.36**
Port of Long Beach			27,987,817	99		**99**	378		**378**	813		**813**	48.27		**48**	5.03	0	**5.03**
Non-Container																		
POLA + POLB			2,367,307	10		**10**	41		**41**	93		**93**	5.24		**5**	0.43	0	**0.43**
Subtotal			54,625,534			**172**			**704**			**1,571**			**90**	9.82	0	**9.82**
Regional Emisions																		
POLA + POLB			425,346,508	572		**572**	3,267		**3,267**	9,580		**9,580**	404.35		**404**	76.45	0	**76.45**
TOTAL	10,215,445	6,871,524	489,401,357	870	87	**957**	4,228	157	**4,385**	11,568	611	**12,179**	533	18	**551**	87.96	6.53	**94.49**

Table 6.8: 2014 Forecast Emissions

2014	Annual Gate Moves	Total Hours Idling	Total Miles	HC tpy Running	HC tpy Idle	HC tpy Total	CO tpy Running	CO tpy Idle	CO tpy Total	NOx tpy Running	NOx tpy Idle	NOx tpy Total	PM tpy Running	PM tpy Idle	PM tpy Total	SOx tpy Running	SOx tpy Idle	SOx tpy Total
On-Terminal Emissions																		
Container																		
Port of Los Angeles	6,090,289	2,830,365	7,521,509	21	19	**40**	46	52	**98**	113	298	**411**	0.78	0.22	**1**	0.15	0.31	**0.46**
Port of Long Beach	5,628,843	4,001,841	4,113,594	20	26	**47**	41	73	**114**	81	421	**502**	0.47	0.32	**1**	0.08	0.44	**0.52**
Non-Container																		
POLA + POLB	2,081,153	786,739	1,065,763	2	5	**7**	5	14	**20**	14	83	**97**	0.10	0.06	**0**	0.02	0.09	**0.11**
Subtotal	13,800,285	7,618,944	12,700,866			**94**			**231**			**1,010**			**2**	0.25	0.84	**1.09**
On-Port On-Road Emissions																		
Container																		
Port of Los Angeles			34,357,077	22		**22**	80		**80**	265		**265**	3.11		**3**	0.71	0	**0.71**
Port of Long Beach			51,399,096	37		**37**	126		**126**	417		**417**	4.60		**5**	1.06	0	**1.06**
Non-Container																		
POLA + POLB			2,367,307	1		**2**	5		**5**	17		**17**	0.21		**0**	0.05	0	**0.05**
Subtotal			88,123,480			**61**			**211**			**699**			**8**	1.82	0	**1.82**
Regional Emisions																		
POLA + POLB			601,170,480	237		**237**	1,373		**1,373**	3,667		**3,667**	71.97		**72**	12.37	0	**12.37**
TOTAL	13,800,285	7,618,944	701,994,826	342	50	**392**	1,676	139	**1,815**	4,574	802	**5,376**	81	1	**82**	14.44	0.84	**15.28**

Table 6.9: 2023 Forecast Emissions

2023	Annual Gate Moves	Total Hours Idling	Total Miles	HC tpy Running	HC tpy Idle	HC tpy Total	CO tpy Running	CO tpy Idle	CO tpy Total	NOx tpy Running	NOx tpy Idle	NOx tpy Total	PM tpy Running	PM tpy Idle	PM tpy Total	SOx tpy Running	SOx tpy Idle	SOx tpy Total
On-Terminal Emissions																		
Container																		
Port of Los Angeles	9,565,977	4,566,527	12,105,673	25	30	**55**	53	84	**137**	117	481	**597**	1.27	0.36	**2**	0.25	0.5	**0.75**
Port of Long Beach	9,939,841	7,229,621	7,142,948	27	48	**74**	53	132	**185**	94	761	**855**	0.86	0.57	**1**	0.15	0.79	**0.94**
Non-Container																		
POLA + POLB	2,188,751	753,735	1,081,206	1	5	**6**	3	14	**17**	9	79	**88**	0.10	0.06	**0**	0.02	0.08	**0.1**
Subtotal	21,694,569	12,549,883	20,329,828			**135**			**339**			**1,540**			**3**	0.42	1.37	**1.79**
On-Port On-Road Emissions																		
Container																		
Port of Los Angeles			55,981,788	24		**24**	88		**88**	256		**256**	4.69		**5**	1.17	0	**1.17**
Port of Long Beach			87,117,614	43		**43**	147		**147**	436		**436**	7.54		**8**	1.83	0	**1.83**
Non-Container																		
POLA + POLB			2,579,817	1		**1**	4		**4**	12		**12**	0.23		**0**	0.05	0	**0.05**
Subtotal			145,679,219			**68**			**239**			**704**			**12**	3.05	0	**3.05**
Regional Emisions																		
POLA + POLB			806,350,493	259		**259**	1,309		**1,309**	3,310		**3,310**	86.45		**86**	16.91	0	**16.91**
TOTAL	21,694,569	12,549,883	972,359,539	379	83	**462**	1,658	230	**1,888**	4,233	1,321	**5,554**	101	1	**102**	20.38	1.37	**21.75**

Table 6.10: Port of Long Beach Container Moves by Truck

Container Moves by Truck	2005	2014	2023
Local destinations	2,516,539	4,434,220	7,247,157
Off-dock rail yards	726,376	819,606	1,803,912
Total	**3,242,914**	**5,253,825**	**9,051,069**

Table 6.11: Port of Los Angeles Container Moves by Truck

Container Moves by Truck	2005	2014	2023
Local destinations	2,600,931	4,946,317	7,985,643
Off-dock rail yards	645,659	699,969	2,135,021
Total	**3,246,590**	**5,646,286**	**10,120,664**

Table 6.12: San Pedro Bay Ports Container Moves by Truck

Container Moves by Truck	2005	2014	2023
Local destinations	5,117,470	9,380,537	15,232,800
Off-dock rail yards	1,372,035	1,519,574	3,938,933
Total	**6,489,505**	**10,900,111**	**19,171,733**

Figure 6.6: Port of Long Beach Container Moves by Truck

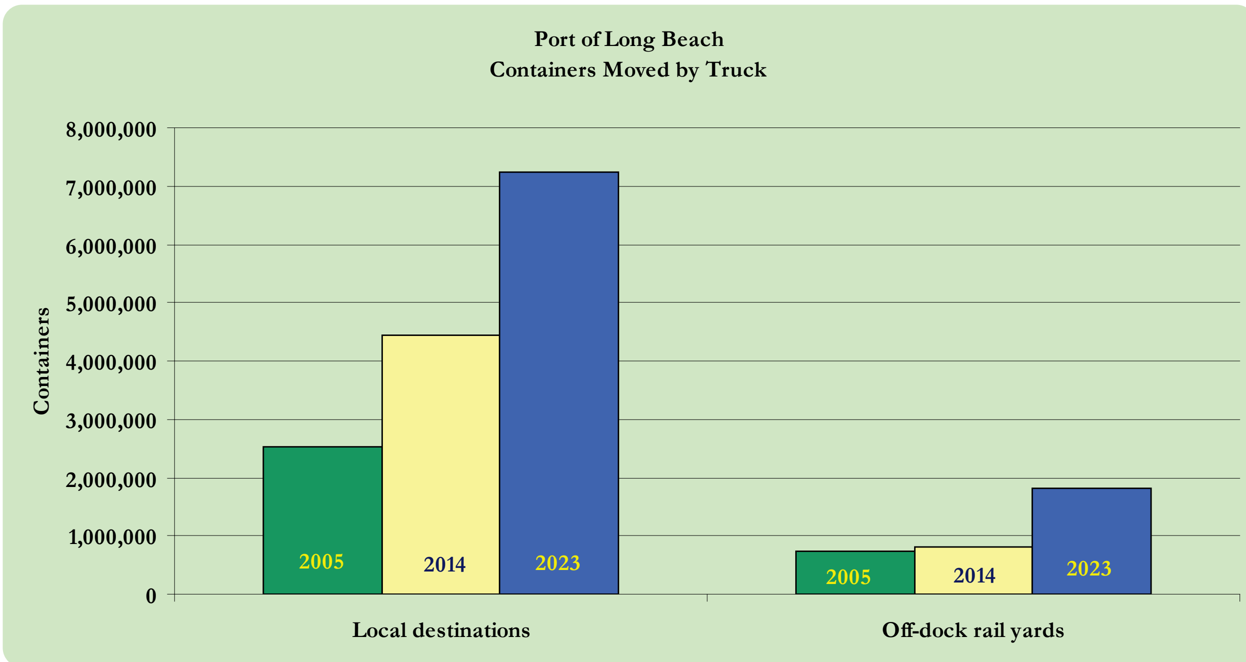


Figure 6.7: Port of Los Angeles Container Moves by Truck

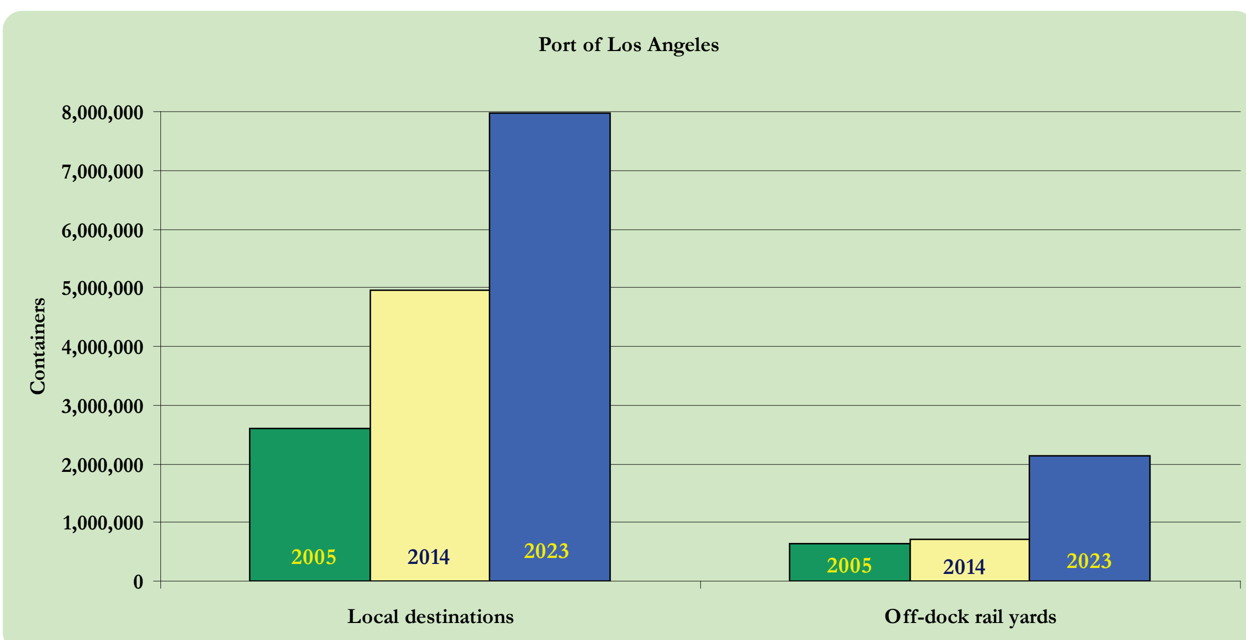
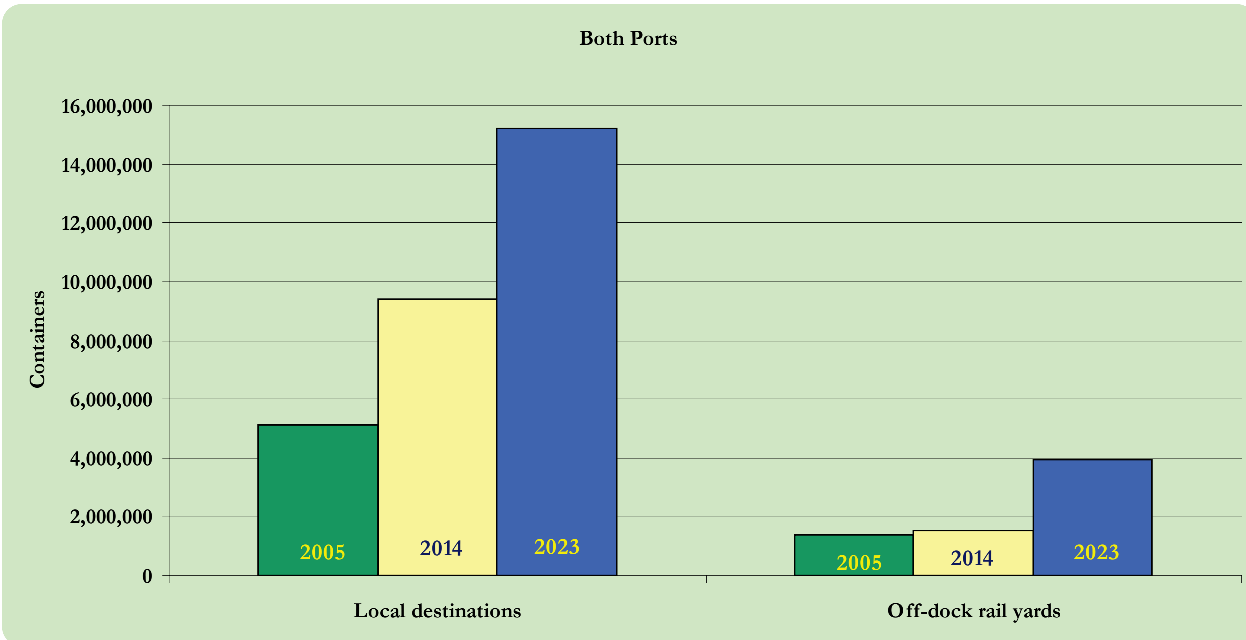


Figure 6.8: San Pedro Bay Ports Container Moves by Truck



SECTION 7.0 RAIL EMISSIONS FORECASTING METHODOLOGY

The rail emission forecasts for the Ports of Long Beach and Los Angeles are based upon the emission estimates developed for the published 2005 emissions inventories for each port and on cargo throughput increases forecast for the ports. The increases were used to develop growth factors that were multiplied by the 2005 emission estimates to develop "uncontrolled" emission estimates for 2014 and 2023. These uncontrolled estimates were adjusted to account for the effect of a cleaner locomotive fleet in the forecast years than in 2005.

Table 7.1: POLA 2005 Emissions in tpy

	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	TOG
On-port switching	6.3	5.8	6.3	296.1	1.6	30.8	16.7
On-port line haul	16.2	14.9	16.2	464.6	31.1	67.4	25.9
Off-port switching	1.8	1.7	1.8	71.1	0.4	7.5	4.4
Off-port line haul	33.1	30.5	33.1	951.6	63.7	138.2	53.1
Total	57.5	52.9	57.5	1,783.5	96.8	243.9	100.2

Table 7.2: POLB 2005 Emissions in tpy

	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	TOG
On-port switching	2.9	2.6	2.9	134.4	0.5	13.9	7.6
On-port line haul	11.5	10.6	11.5	331.4	22.2	48.1	18.5
Off-port switching	1.5	1.4	1.5	58.2	0.3	6.1	3.6
Off-port line haul	27.5	25.3	27.5	789.7	52.8	114.6	44.1
Total	43.4	39.9	43.4	1,313.6	75.9	182.8	73.8

7.1 Activity Growth Assumptions

Assumptions about the growth in rail activity were drawn from port-wide TEU throughput growth assumptions (previously distributed) and from truck/rail mode splits developed by the ports and used in the QuickTrip terminal throughput model.

Total annual containers x on-dock mode split (%) = on-dock rail containers.

Example:

7,494,420 containers multiplied by 25% on-dock rail = 1,848,134 containers by on-dock rail

The estimated numbers of containers moved by rail from on-dock rail yards and from the near-port rail yard on POLA property (ICTF) are presented in the following tables. Because the splits between each port to the ICTF versus the other off-port rail yards is not known, the ICTF throughput was divided equally between each port for each year. The summary information for both ports is depicted graphically in the figure following the tables.

Table 7.3: Port of Long Beach Container Moves by Rail

Container Moves by Rail	2005	2014	2023
On-dock rail	493,013	1,464,689	1,929,472
Off-dock rail (ICTF)	300,375	389,000	389,000
Total	**793,388**	**1,853,689**	**2,318,472**

Table 7.4: Port of Los Angeles Container Moves by Rail

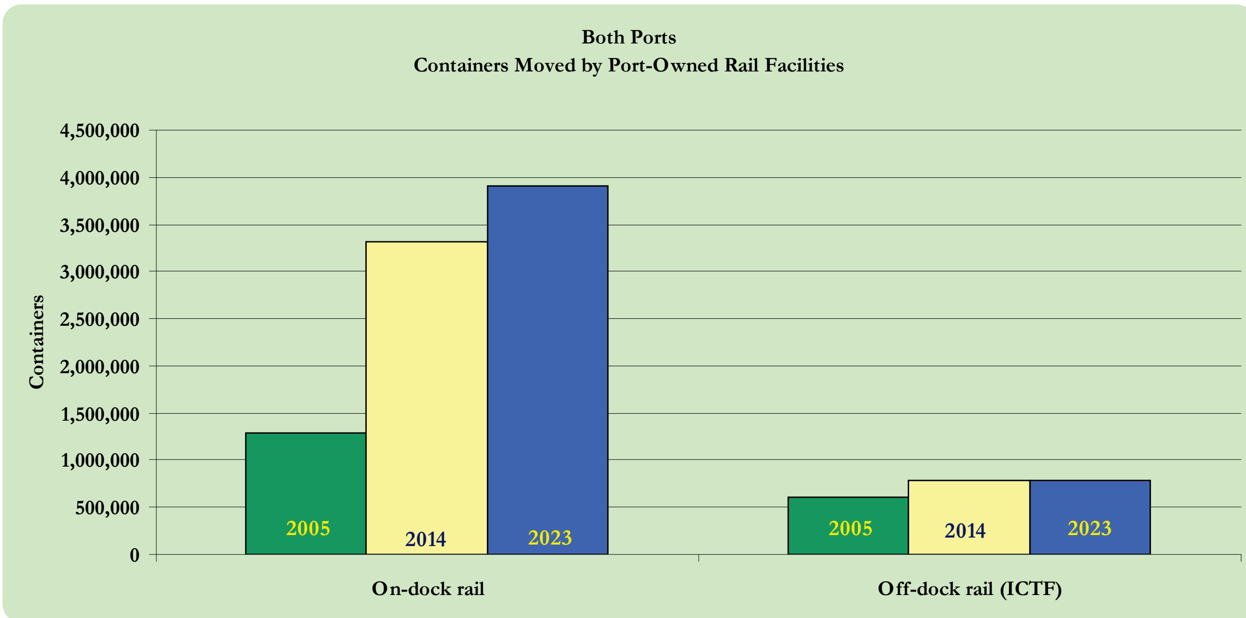
Container Moves by Rail	2005	2014	2023
On-dock rail	792,123	1,848,134	1,978,795
Off-dock rail (ICTF)	300,375	389,000	389,000
Total	**1,092,498**	**2,237,134**	**2,367,795**

Table 7.5: San Pedro Bay Ports Container Moves by Rail

Container Moves by Rail	2005	2014	2023
On-dock rail	1,285,136	3,312,823	3,908,267
Off-dock rail (ICTF)	600,750	778,000	778,000
Total	**1,885,886**	**4,090,823**	**4,686,267**

It has been noted that the total ICTF throughput ascribed to 2005 in Table 7.5 is lower than the value used in developing the 2005 emission estimates. This is because the number used for the 2005 estimates inadvertently included containers moved by the same railroad but at other (non-port) locations.

Figure 7.1: San Pedro Bay Ports Container Moves by Rail



The projected changes in rail activity between 2005 and 2014 and between 2005 and 2023 were used to develop growth factors applied to 2005 emission estimates.

2014 # of containers / 2005 # of containers = 2005 to 2014 growth factor

Example:

3,312,823 containers in 2014 / 1,285,136 containers in 2005 = 2.58 growth factor for 2005 to 2014

Growth factors were developed for two categories of rail activity – on-dock rail and off-dock rail (limited to the off-dock rail yard located on POLA property). The on-dock rail growth will affect the activity growth of on-port line haul and switching, and will be a component of off-port line haul activity, because the trains that originate or terminate on-port travel off-port through the air basin;. The off-dock rail growth will affect off-port (ICTF) switching and will also be a component of off-port line haul activity growth. The off-port switching growth was estimated by comparing the actual 2005 ICTF throughput with its current capacity, which it is expected to reach before the 2014 forecast year. This assumes that increases in off-dock rail beyond the current capacity of the ICTF will be allocated to existing or future off-port rail yards, and the transportation between the ports and these off-port locations is reflected in the on-road truck activity projections.

Table 7.6: Container Related Growth Factors Relative to 2005

Port / Rail Component	2005	'05 - '14	'05 - '23
POLA On-Port Line Haul & Switching	1.00	2.33	2.50
POLB On-Port Line Haul & Switching	1.00	2.97	3.91
Off-Port Switching	1.00	1.30	1.30
POLA On-Dock & ICTF	1.00	2.05	2.17
POLB On-Dock & ICTF	1.00	2.34	2.92

Most of the growth associated with port rail activity will be related to container throughput, and the growth discussed above is based on anticipated container traffic. However, non-container freight is also a component of Port rail operations, so the container-related growth factors were adjusted to account for the non-container component. This was done according to the ratio of container to non-container trains in 2005 and the projected changes in non-container freight tonnages that were used to forecast changes in non-container OGV traffic. Specifically, the forecasts for liquid and dry bulk, general cargo, break bulk, and automobiles were used to develop non-container rail growth projections.

The 2005 line haul railroad emission estimates were based on a rail volume equivalent to approximately 32 trains per day. The port switching railroad PHL has reported that they assembled on average one non-container train per day. If one outbound and one inbound non-container train per day are assumed, then the non-container traffic was equal to approximately 6% of the container traffic in 2005 (2 / 32 = 0.06). This relationship will not continue into the future, however, because container throughput is anticipated to increase at a greater rate than non-container throughput. To take this into account, the differences between container growth and non-container growth in 2014 and 2023 were applied to the 6% difference in 2005 to produce an estimate of the fraction that non-container traffic will be of container traffic in 2014 and 2023. The table below illustrates the results of this process for the periods 2005 to 2014 and 2005 to 2023. For example, the '05-to-'14 non-container growth divided by the '05-to-'14 container growth is 0.55, meaning the non-container growth will be approximately half that of container growth. Multiplying this fraction by the 6% non-container/container ratio in 2005 projects that non-container traffic will be approximately 3% of container traffic in 2014. The same ratio is obtained for 2023.

Table 7.7: Adjustment for Non-Container Fraction of Container Activity Increases

Growth Measure	05 - '14	05 - '23
Non-container growth	1.43	1.65
On-dock rail growth	2.58	3.04
Non-container growth relative to containers	0.55	0.54
Percentage relative to 6% in '05	3%	3%

The 3% result was used to adjust the projected container-based growth factors to take into account the different projected growth rates of container and non-container activity. This was done in three ways for different components of Port rail activity. For on-port line haul activity, the 3% was added to the growth factor to account for the additional activity represented by the non-container activity over the projected container activity, because the 2005 activity data was based on containers and did not include the non-container component. For on-port switching, however, because the activity estimates underlying the 2005 emission estimates included non-container as well as container activity (i.e., were based on all of PHL's switching activity), the 3% was subtracted from the growth factors since the growth in combined container and non-container activity will not be as great as container activity alone. The third growth factor to be adjusted was the off-port rail activity factor. The off-port rail activity includes both on-dock rail (once it leaves the port) and off-dock (ICTF) container traffic. The ICTF portion of off-port rail will not be affected by the differential growth rates between container and non-container activity because only containers are handled at that facility, so the 3% non-container adjustment was reduced to account for the on-port/off-port split to approximately 2%. The final growth factors representing container and non-container growth are presented in the following table.

Table 7.8: Container and Non-Container Related Growth Factors Relative to 2005

Port / Rail Component	2005	'05 - '14	'05 - '23
POLA On-Port Switching	1.00	2.30	2.47
POLB On-Port Switching	1.00	2.94	3.88
POLA On-Port Line Haul	1.00	2.36	2.53
POLB On-Port-Line Haul	1.00	3.00	3.94
Off-Port Switching	1.00	1.30	1.30
POLA Off-port line haul	1.00	2.08	2.20
POLB Off-port line haul	1.00	2.37	2.95

The growth factors listed above were multiplied by the 2005 emission estimates to develop "uncontrolled" emission estimates for 2014 and 2023, as listed below. These estimates include only the effects of growth and do not include the effects of any emission reduction programs."

Table 7.9: 2014 Emission Estimates Adjusted for Activity Changes

		PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	TOG
On-port switching	POLA	14.6	13.4	14.6	680.3	3.6	70.7	38.3
	POLB	8.4	7.8	8.4	394.6	1.5	41.0	22.2
	Total	23.0	21.2	23.0	1,074.8	5.1	111.6	60.5
On-port line haul	POLA	38.2	35.2	38.2	1,097.8	73.5	159.4	61.3
	POLB	34.7	31.9	34.7	995.2	66.6	144.5	55.6
	Total	72.9	67.1	72.9	2,093.0	140.1	303.9	116.9
Off-port switching	POLA	2.3	2.2	2.3	92.4	0.5	9.7	5.7
	POLB	1.9	1.8	1.9	75.6	0.4	8.0	4.7
	Total	4.3	3.9	4.3	168.1	1.0	17.7	10.4
Off-port line haul	POLA	68.9	63.3	68.9	1,976.8	132.3	287.0	110.4
	POLB	65.1	59.9	65.1	1,868.4	125.0	271.2	104.3
	Total	133.9	123.2	133.9	3,845.2	257.3	558.2	214.7

Table 7.10: 2023 Emission Estimates Adjusted for Activity Changes

		PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	TOG
On-port switching	POLA	15.7	14.4	15.7	730.9	3.9	76.0	41.2
	POLB	11.1	10.3	11.1	521.0	1.9	54.1	29.3
	Total	26.8	24.7	26.8	1,251.9	5.9	130.0	70.5
On-port line haul	POLA	41.0	37.7	41.0	1,176.3	78.7	170.8	65.7
	POLB	45.5	41.9	45.5	1,306.4	87.4	189.7	73.0
	Total	86.5	79.6	86.5	2,482.7	166.1	360.4	138.6
Off-port switching	POLA	2.3	2.2	2.3	92.4	0.5	9.7	5.7
	POLB	1.9	1.8	1.9	75.6	0.4	8.0	4.7
	Total	4.3	3.9	4.3	168.1	1.0	17.7	10.4
Off-port line haul	POLA	72.8	67.0	72.8	2,090.5	139.9	303.5	116.7
	POLB	81.0	74.6	81.0	2,326.8	155.7	337.8	129.9
	Total	153.9	141.5	153.9	4,417.4	295.6	641.3	246.7

7.2 Emission Factors

The growth adjusted uncontrolled emissions were adjusted to account for the effect of a cleaner locomotive fleet in the forecast years than in 2005. This was done by developing control factors based on the difference between the emission factors used for the 2005 emission estimates and the anticipated emissions from the fleets in operation in the forecast years. The following section addresses the 2005 and future emission factors.

7.2.1 Line Haul Locomotives (2005)

Emission factors in g/hp-hr from EPA's Regulatory Support Document, 2005 line haul fleet average emission factors from http://www.epa.gov/oms/locomotv.htm, spreadsheet: locorsd.wk3, tab H (this file has been converted to Microsoft® Excel® format and will be distributed with this write-up).

NO_x, g/hp-hr	PM, g/hp-hr		NO_x, g/hp-hr	PM, g/hp-hr
8.817	0.307	shown in 2005 EI reports as:	8.82	0.31

Converted to grams/gallon using BSFC of 20.8 hp-hr/gal from EPA420-F-97-051 Locomotive Rule Technical Highlights, Dec. 1997, page 2 (copy attached).

NO_x, g/gal	PM, g/gal
183.7	6.4

For the 2005 EI emission estimates, these g/gal factors were multiplied by fuel use estimates to derive emission estimates.

7.2.2 Switching Locomotives (2005)

Off-Port (ICTF)

Emission factors in g/gal from EPA420-F-97-051 Locomotive Rule Technical Highlights, Dec. 1997, Table 3 – representing baseline in-use emission rates – chosen because the railroad did not provide fleet-specific information.

NO_x, g/gal	PM, g/gal
362	9.2

For the 2005 EI emission estimates, these g/gal factors were multiplied by fuel use estimates to derive emission estimates.

On-Port (PHL)
Developed lb/hr emission rates from EPA's notch-specific g/hp-hr switch engine emission rates (from locorsd.wk3 cited above, tab E) and PHL throttle notch frequency data. The process is documented in 2005 EIs, pages 163 – 169 in Port of Long Beach EI and pages 174 – 180 in Port of LA EI, and also in the 2002 Port of Long Beach EI and 2001 Port of LA EI summary is provided below:

Started with average g/hp-hr by notch from EPA switching locomotive rates (from locorsd.wk3, tab E):

Table 7.11: Horsepower-Based Emission Factors from RSD, g/hp-hr

Notch	PM g/bhp-hr	NO_x g/bhp-hr
DB	1.05	40.20
Idle	2.26	77.70
1	0.29	16.63
2	0.37	12.26
3	0.34	13.09
4	0.26	14.27
5	0.24	15.10
6	0.29	15.88
7	0.25	16.37
8	0.29	16.15

Converted these to hourly notch-specific rates using estimate of the average in-use notch-specific horsepower of PHL fleet.(The notch-specific horsepower was estimated by comparing the average rated horsepower of PHL locomotives with the average rated power of the switching locomotives EPA included in their data, and the average power-in-notch reported by EPA – see below.)

Equation: lb/hr = g/hp-hr * hp /453.6 g/lb

Table 7.12: Hourly Notch-Specific Emission Rates, lb/hr

Notch	Power in Notch, bhp	PM g/bhp-hr	PM lb/hr	NO_x g/bhp-hr	NO_x lb/hr
DB	81	1.05	0.19	40.20	7.18
Idle	17	2.26	0.08	77.70	2.91
1	101	0.29	0.06	16.63	3.70
2	304	0.37	0.25	12.26	8.22
3	596	0.34	0.44	13.09	17.20
4	900	0.26	0.51	14.27	28.32
5	1,229	0.24	0.64	15.10	40.92
6	1,554	0.29	0.98	15.88	54.40
7	1,923	0.25	1.08	16.37	69.41
8	2,258	0.29	1.42	16.15	80.38

Then the notch-specific emission rates were combined with the PHL-specific throttle notch data to estimate the weighted average lb/hr emission rates.
Equation: lb/hr = $\sum$ wt'd avg % time in mode * lb/hr

Table 7.13: Weighted Average Emission Rates, lb/hr

Notch	wt'd avg % time in mode	PM lb/hr	PM % x lb/hr	NO_x lb/hr	NO_x % x lb/hr
DB	0.0%	0.19	0.00	7.18	0.00
Idle	67.4%	0.08	0.05	2.91	1.96
1	5.9%	0.06	0.004	3.70	0.22
2	7.7%	0.25	0.02	8.22	0.63
3	6.7%	0.44	0.03	17.20	1.16
4	5.3%	0.51	0.03	28.32	1.49
5	3.0%	0.64	0.02	40.92	1.24
6	2.0%	0.98	0.02	54.40	1.11
7	0.9%	1.08	0.01	69.41	0.64
8	1.1%	1.42	0.02	80.38	0.88
Sum			**0.20**		**9.33**

These lb/hr factors were multiplied by annual PHL activity estimates (based on their switching schedule history) to derive emission estimates.

The average in-use notch-specific horsepower of the PHL fleet was estimated by comparing the average percent of full power in each notch of the locomotives in EPA's switch locomotive dataset with the average power rating of the PHL fleet.

EPA/RSD average rated hp: 1,750; PHL average rated hp: 2,144

Equations: % of avg. rated hp = RSD power in notch / RSD avg rated hp
Avg in-use power = % of average rated hp * PHL avg. rated hp

Table 7.14: Average In-Use Horsepower

Notch	RSD Power in Notch, bhp	% of Avg. Rated bhp	Avg. in-use Power, bhp
DB	67	3.8%	81
Idle	14	0.8%	17
1	83	4.7%	101
2	249	14.2%	304
3	487	27.8%	596
4	735	42.0%	900
5	1,002	57.3%	1,229
6	1,268	72.5%	1,554
7	1,570	89.7%	1,923
8	1,843	105.3%	2,258

7.3 Tier 2 Emission Factors (for forecast years)

7.3.1 Line Haul Locomotives

Tier 2 emission standards of 5.5 g/hp-hr for NO_x, 0.20 g/hp-hr for PM from Table 4-9 of EPA's Regulatory Support Document (April 1998) were used as future case emission factors based on the 1998 MOU between the Class 1 railroads and the California air Resources Board which requires Tier 2 average emission rates by 2010. However, since not all locomotives will necessarily be Tier 2 locomotives, the use of the lower in-use emission rates (also listed in Table 4-9 of the document) is not appropriate.

7.3.2 Switching Locomotives

Off-Port

The same Tier 2 emission standards have been used for off-port switching locomotives as for line haul because they are also covered under the MOU and will be part of the Tier 2 (5.5 g NO_x/hp-hr) averaging process.

On-Port

Tier 2 in-use emission rates for the switching duty cycle from Table 4-9 of EPA's Regulatory Support Document April 1998: NO_x – 7.3 g/hp-hr, PM – 0.19 g/hp-hr. These are the appropriate factors because the ports' MOU with the on-port switching railroad requires Tier 2 or better switching locomotives.

An additional measure that was factored into the emission control factors is the implementation of idling shut-down devices on switching and on-port line haul operations. The amount of reduction, 9% reduction of PM and 8% reduction of NO_x, was estimated as part of the work of the No Net Increase Task Force. The reduction was not applied to off-port line haul emissions since once the trains leave the port they will be less likely to spend as much time idling.

The following example illustrates the control factor calculation for PM emissions from line haul locomotives with 2005 emissions of 0.31 g/hp-hr and 2014 (Tier 2 standard) emissions of 0.20 g/hp-hr.

% rdx = (0.31 – 0.20) / 0.31 = 0.35 or 35% reduction without idle limiters (off-port)
Corresponding control factor is 1 – 0.35 = 0.65

% rdx = (0.31 – (0.20 * (1 - 0.9))) / 0.31 = 0.41, or 41% reduction with idle limiters (on-port)
Corresponding control factor is 1 – 0.41 = 0.59

The following tables detail the percent reductions and control factors for on- and off-port line haul and on-and off-port switching emissions.

Table 7.15: Line Haul Emission Reductions, 2005 to 2014

Line Haul	PM_{10}	NO_x	SO_x	CO	TOG
2005 EF, g/bhp-hr	0.31	8.82	0.59	1.28	0.49
Tier 2 standard, g/hp-hr	0.20	5.50	0.0046	1.50	0.30
% Rdx (off-port)	35%	38%	99%	-17%	39%
% Rdx with idle rdx (on-port)	41%	43%	99%	-17%	39%
Control factors (off-port)	0.65	0.62	0.01	1.17	0.61
Control factors (on-port)	0.59	0.57	0.01	1.17	0.61

Table 7.16: On-Port Switching Emission Reductions, 2005 to Tier 2

On-Port Switching	PM_{10}	NO_x	SO_x	CO	TOG
2005 EF, g/bhp-hr	0.38	17.63	0.09	1.83	0.87
Tier 2 in-use, g/hp-hr	0.19	7.30	0.0046	1.83	0.51
% Rdx	50%	59%	95%	0%	41%
% Rdx with idle rdx	54%	62%	95%	0%	41%
Control factors	0.46	0.38	0.05	1.00	0.59

Table 7.17: Off-Port Switching Emission Reductions, 2005 to Tier 2

Off-Port Switching	PM_{10}	NO_x	SO_x	CO	TOG
2005 EF, g/bhp-hr	0.44	17.40	0.09	1.83	1.01
Tier 2 line haul standard, g/hp-hr	0.20	5.50	0.0046	1.50	0.30
% Rdx	55%	68%	95%	18%	70%
% Rdx with idle rdx	59%	71%	95%	18%	70%
Control factors	0.41	0.29	0.05	0.82	0.30

7.3.3 Tier 3, Tier 4, and Rebuilds

Recently promulgated regulations will require that locomotive engines undergoing rebuild will be retrofit to meet lower emission standards than when they were new. The net effect of the requirements will be that, after rebuild, the locomotives will emit 50% less particulate matter than before. New Tier 3 locomotives manufactured in 2012 and later will also achieve 50% reduction in particulate matter. It is anticipated that, by 2023, all locomotives will have been either rebuilt to emit 50% of what they emitted before the rebuild or will have been replaced by Tier 3 locomotives, which will have half the particulate matter emissions of Tier 2 engines. As a result, the line haul emission forecast for 2023 has been reduced by an additional 50% to account for the effect of the new regulation. Although new Tier 4 locomotives (2015 and later) will provide additional reductions by 2023, if deployed, these reductions are not quantified at this time because of uncertainties in terms of the potential penetration level of Tier 4 locomotives serving the ports by 2023, the upcoming Tier 2 MOU requirements, and the long useful life of locomotives.

7.4 Forecast Emission Estimates

The 2005 emission estimates adjusted for activity changes presented above were further adjusted for locomotive emission reductions using the control factors immediately above. The ton-per-year value for each pollutant and activity category was multiplied by the corresponding control factor to arrive at the forecast emission estimate for the year and pollutant, as presented in the following tables.

Table 7.18: 2014 Port of Los Angeles Emission Estimates Adjusted For Activity and Controls

Activity Category	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	TOG
On-port switching	6.7	6.2	6.7	258.5	0.2	70.7	22.6
On-port line haul	22.6	20.8	22.6	625.7	0.7	186.5	37.4
Off-port switching	1.0	0.9	1.0	26.8	0.0	8.0	1.7
Off-port line haul	44.8	41.2	44.8	1,225.6	1.3	335.8	67.3
Total	75.0	69.0	75.0	2,136.7	2.3	600.9	129.1

Table 7.19: 2014 Port of Long Beach Emission Estimates Adjusted For Activity and Controls

Activity Category	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	TOG
On-port switching	3.9	3.6	3.9	149.9	0.1	41.0	13.1
On-port line haul	20.5	18.8	20.5	567.3	0.7	169.0	33.9
Off-port switching	0.8	0.7	0.8	21.9	0.0	6.5	1.4
Off-port line haul	42.3	38.9	42.3	1,158.4	1.3	317.4	63.6
Total	67.4	62.0	67.4	1,897.6	2.0	533.9	112.1

Table 7.20: 2023 Port of Los Angeles Emission Estimates Adjusted For Activity and Controls

Activity Category	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	TOG
On-port switching	7.2	6.6	7.2	277.7	0.2	76.0	24.3
On-port line haul	12.1	11.1	12.1	670.5	0.8	199.8	40.1
Off-port switching	1.0	0.9	1.0	26.8	0.0	8.0	1.7
Off-port line haul	23.7	21.8	23.7	1,296.1	1.4	355.1	71.2
Total	43.9	40.4	43.9	2,271.1	2.4	638.8	137.3

Table 7.21: 2023 Port of Long Beach Emission Estimates Adjusted For Activity and Controls

Activity Category	PM_{10}	$PM_{2.5}$	DPM	NO_x	SO_x	CO	TOG
On-port switching	5.1	4.7	5.1	198.0	0.1	54.1	17.3
On-port line haul	13.4	12.3	13.4	744.7	0.9	221.9	44.5
Off-port switching	0.8	0.7	0.8	21.9	0.0	6.5	1.4
Off-port line haul	26.3	24.2	26.3	1,442.6	1.6	395.2	79.3
Total	45.7	42.0	45.7	2,407.2	2.6	677.7	142.5

8.0 ADDENDUM - 2020 FORECAST EMISSION ESTIMATES (UPDATE AS OF AUGUST 2009)

The 2014 and 2023 controlled emissions discussed above became basis for San Pedro Bay Emissions Reduction Standards as outlined in "2009 Update San Pedro Bay Ports Clean Air Action Plan Technical Report". To compliment the CARB's Emission Reduction Plan, the ports of Long Beach and Los Angeles conducted further analysis for calendar year 2020. This analysis was done to assess both ports emissions reduction progress against CARB's Health Risk Reduction goal of 85% reduction in DPM emissions reduction relative to 2005 conditions.

Using the same methodology and emissions control regulation and CAAP control measures the following table shows 2020 controlled DPM emissions for the ports of Long Beach and Los Angeles.

As stated above, the growth factors and emissions control factors for 2020 are same as used for 2014 and 2023 with the following exceptions:

OGV5
Actual terminal lease renewal schedule for CY 2020 was used which is slightly different than for CY 2023.

HDV
The actual age distribution with Clean Truck Program implemented in 2020 was developed to estimate 2020 emissions estimates.

Locomotives
In 2020, it was assumed that line haul locomotives operating at the ports will be consisted of engines meeting 10% Tier 2 and 90% Tier 3 standards. For the 2023 emissions modeling, all line haul locomotives operating at the ports were assumed to be meeting on average Tier 3 standards.

Following table presents the DPM results of 2020 analysis:

Table 8.1: Controlled DPM Emissions Forecast (Tons Per Year)

	2005	**2020**
CHE	**DPM**	**DPM**
POLA	62	7
POLB	55	9
SPBP Total	**117**	**16**
HC		
POLA	38	20
POLB	30	15
SPBP Total	**68**	**36**
HDV		
POLA Container on terminal and on-port	65	8
POLB Container on terminal and on-port	68	10
POLA+POLB non Container	13	0
POLA+POLB Regional	404	102
SPBP Total	**551**	**120**
OGV		
POLA	552	120
POLB	637	136
SPBP Total	**1,189**	**256**
Rail		
POLA	58	46
POLB	43	46
SPBP Total	**101**	**92**
Grand SPBP Total (All 5 sources)	**2,025**	**520**
Overall % reduction from 2005	0%	74%