DRAFT: 2018/2019 Update to Inventory for Ocean-Going Vessels: Methodology and Results

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CALIFORNIA AIR RESOURCES BOARD

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1. Summary and Background

This report covers the 2018/2019 updates to the California Air Resources Board's (CARB) inventory for ocean-going vessels (OGV) that visit California's ports. The previous inventory was released in 2014, and the 2018/2019 inventory updates include improvements to vessel visit data, emissions factors, information on vessel compliance with CARB's At Berth Regulation[1], and growth forecasts. These updates were completed to support new regulatory development efforts, and provide data to support CARB's 2018 Health Risk Assessment (HRA) at specific California ports and marine terminal complexes (MTCs[2])[3].

OGVs included in this inventory are defined as commercial vessels greater than 400 feet in length, with a carrying capacity of 10,000 gross tons, and are propelled by a diesel marine compression ignition engine with a displacement of greater than or equal to 30 liters per cylinder. These vessels are an important part of California's trade economy, but are also a significant source of pollution in areas near ports and MTCs. Specifically, the vessel's diesel auxiliary engines and boilers produce particulate matter (PM) and oxides of nitrogen (NOx), which is a precursor to secondary PM formation, and which have a large impact in port communities and surrounding areas. This inventory update focuses on updating emissions of PM and NOx for at-berth activity in detail to support the HRA at the Ports of Los Angeles and Long Beach (Ports of LA/LB) and the Richmond Port Complex. This will not cover emissions caused by at anchorage or other modes of activity.

Major updates to methodology and data sources include:

- Updated data source for 2016 vessel visits and vessel information based on IHS-Markit data for California and South Coast Marine Exchange data for the Ports of LA/LB
- Updated growth rates based on Freight Analysis Framework (FAF)[4] for most ports and MTCs, and Mercator[5] Report for Ports of LA/LB

[1] https://www.arb.ca.gov/ports/shorepower/shorepower.htm
[2] Marine Terminal Complexes (MTCs) are CARB-defined groups of indepentend marine terminals and/or smaller ports (public and/or private) that are located in close geographical proximity to each other. MTCs represent a group of regionalized emission sources that have an impact to the surrounding community.
[3] Preliminary Health Risk Assesment - https://www.arb.ca.gov/ports/shorepower/meetings/11052018/prelimhealthanalyses.pdf
[4] The FAF growth forecast is a commodity-based forecast, forecasting total tonnage of various goods moved in or out of different regions of the state. FAF includes other modes of transportation (rail, air, trucking, etc.) but for this analysis, only water-based trade was considered.
[5] Mercator is an engineering consulting firm hired by the Ports of LA/LB.

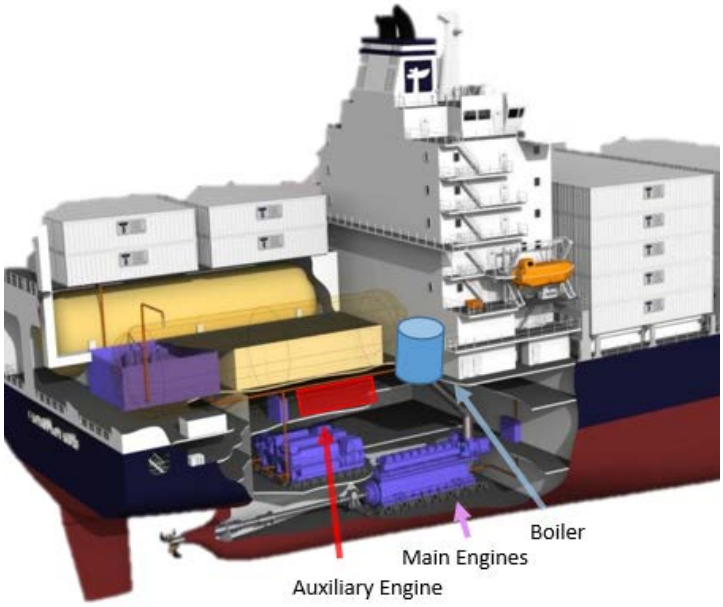
- Updated emission factor data based the approaches used by US EPA, academic institutions, and others
- Updated container vessel size forecast and freight efficiency parameters based on studies by Mercator[5] Report for Ports of LA/LB
- Delayed expected introduction of Tier 3 marine engines to 2030 or later, based on a study by Starcrest and Ports of LA/LB
- Updated data from the vessel boarding program in the Ports LA/LB

Overall, the largest impact on the emissions inventory since the 2014 OGV inventory is the reduction of PM emissions based on updated, lower emission factors.

2. Ocean-Going Vessel Background and Description

In most cases, OGVs are powered by main engines for propulsion, auxiliary engine to supply vessel power, and boilers to heat fuel, water, and provide other vessel functions (illustrated in Figure 1). The main propulsion engines are larger, consume more fuel, and produce the majority of emissions from an OGV. However, the majority of activity from these propulsion engines occurs in transit between ports, and not while the vessel is at berth. These main propulsion engines are subject to Tier standards[6] set by the International Maritime Organization (IMO) that provide emissions limits (based on the year the vessel's keel was laid), but are not covered by CARB's At Berth Regulation. The auxiliary engines and boilers, while far lower in power when compared to main engines, are often run continuously during a vessels stay at port, and are responsible for essentially all of the emissions while the vessel is at berth.

Figure 1: Example OGV Engine Illustration



This report focuses on auxiliary engines and boilers, and their associated emissions at berth. Emissions from main engines, auxiliary engines, and boilers *while not at berth* are not included in this report.

CARB and industry categorize the OGVs covered by the emissions inventory as shown in Table 1, depending on the type of goods moved by the vessel, and Table 2, dividing tanker

[6] https://www.epa.gov/regulations-emissions-vehicles-and-engines/international-standards-reduce-emissions-marine-diesel

vessels and container vessels into size bins based on their capacity. These vessel categories and size bins are useful in understanding vessel functions (i.e., the type of commodity they carry) and common characteristics (i.e., the average engine size). The only vessel type included in the inventory that does not specifically move freight is the passenger cruise category.

Table 1: Ocean-Going Vessel Categories

Vessel Type	Primary Function or Description
Auto	Transport automobiles and trucks.
Bulk Cargo	Transport dry bulk items such as mineral ore, fertilizer, wood chips, or grains.
Container	Transport a wide variety of cargo in standard-sized containers.
General Cargo	Transport non-containerized cargo such as steel, palletized goods, and heavy machinery.
Cruise	Used for passenger transport and pleasure voyages.
Reefers	Transports perishable commodities that require refrigerated transportation, mostly fruits, meat, fish, vegetables, dairy products, and other foods. Cargo may be carried in bulk holds or in refrigerated containers.
Ro-Ro	Transport large wheeled cargo such as large off-road equipment, trailers or railway carriages. Ro-Ro is an acronym for “roll on-roll off”.
Tankers	Transport liquids in bulk, including both non-edible liquids such as crude oil and chemicals, and edible liquids such as molasses and fruit juices.

Table 2 explaines how size bins are used in vessel categories where large variation in vessel and engine sizes are observed. Container vessels are sorted by size bin according to the twenty-foot equivalent units (TEUs, or containers) they can carry, with size bins for every 1,000 TEUs (after the first category which includes 0 to 1,999 TEU capacity vessels). For tankers, size bins are based on the deadweight tonnage (DWT) of tanker capacity, as shown at the bottom of Table 2.

Table 2: Container and Tanker Category by Capacity

Vessel Type	Size Bin	Min Capacity	Max Capacity	Capacity Unit
Container	1	0	1999	TEU
Container	2	2000	2999	TEU
Container	3	3000	3999	TEU
Container	4	4000	4999	TEU
Container		5000	5999	TEU
Container	6	6000	6999	TEU
Container	7	7000	7999	TEU
Container	8	8000	8999	TEU
Container	9	9000	9999	TEU
Container		10000	10999	TEU
Container	11	11000	11999	TEU
Container	12	12000	12999	TEU
Container	13	13000	13999	TEU
Container	14	14000	14999	TEU
Container		15000	15999	TEU
Container	16	16000	16999	TEU
Container	17	17000	17999	TEU
Container	18	18000	18999	TEU
Container	19	19000	19999	TEU
Container		20000	20999	TEU
Container	21	21000	21999	TEU
Container	22	22000	22999	TEU
Container	23	23000	23999	TEU
Container	24	24000	24999	TEU
Container		25000	25999	TEU
Tanker	Seawaymax	0	60000	DWT
Tanker	Panamax	60001	80000	DWT
Tanker	Aframax	80001	120000	DWT
Tanker	Suezmax	120001	200000	DWT
Tanker	VLCC	200001	315000	DWT
Tanker	ULCC	315001	520000	DWT

2.1. Ocean-Going Vessel Marine Engines and Operations

OGVs are generally powered by multiple engines, which include:

- Main engine(s) that provide thrust with displacement greater than or equal to 30 liters per cylinder
- Auxiliary engines used primarily to supply a vessel with power for various on-board functions
- Auxilary boilers used to produce steam for uses other than propulsion, such as heating of residual fuel and liquid cargo, heating of water for crew and passengers, powering steam turbine discharge pumps, freshwater generation, and space heating of cabins

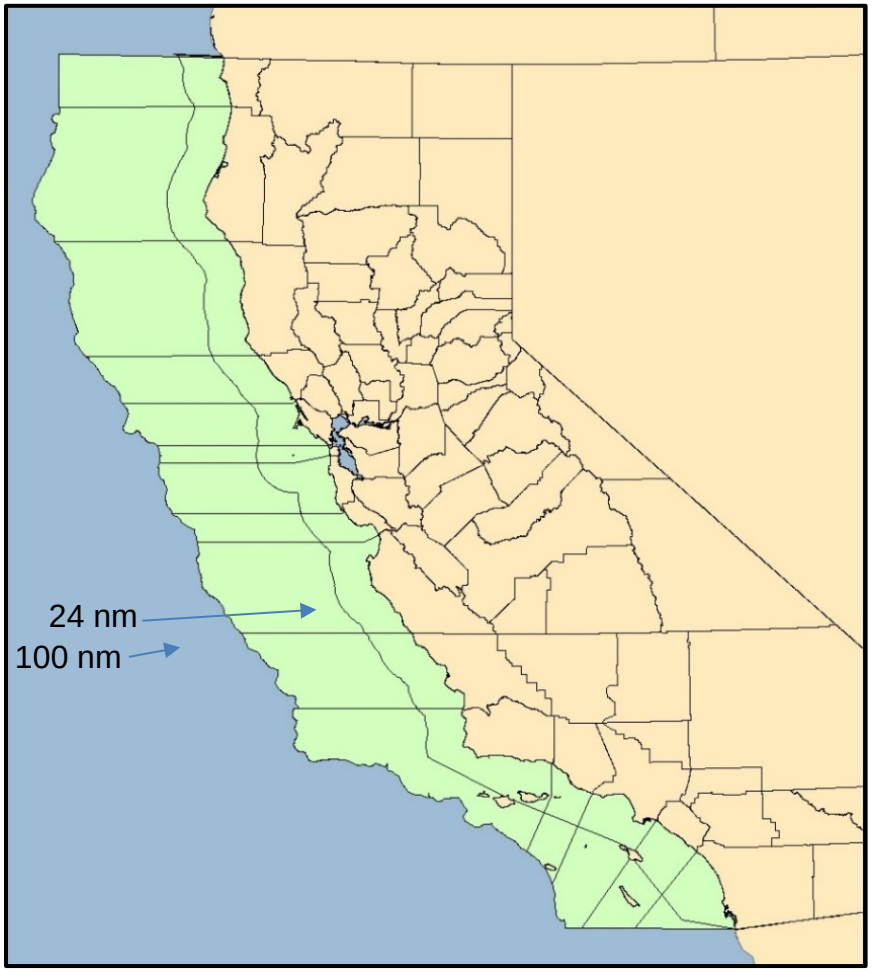
Four operating modes are used to characterize OGV activity: transiting, maneuvering, at berth, and at anchorage. Transiting is the operation of vessels on the open ocean between ports. Maneuvering is the slow speed operation while in port. At berth and at anchorage operations occur when a vessels is moored to a dock or has dropped anchor, respectively. Engine use characteristics are dependent on the operating mode.

- Transiting: Main engine (and limited auxiliary engine and auxiliary boiler use)
- Maneuvering: Main engine (and limited auxiliary engine and auxiliary boiler use)
- At Berth: Auxiliary engine and auxiliary boiler used (and main engine off)
- Anchorage: Auxiliary engine and auxiliary boiler used (and main engine off)

2.2. Geographical Areas

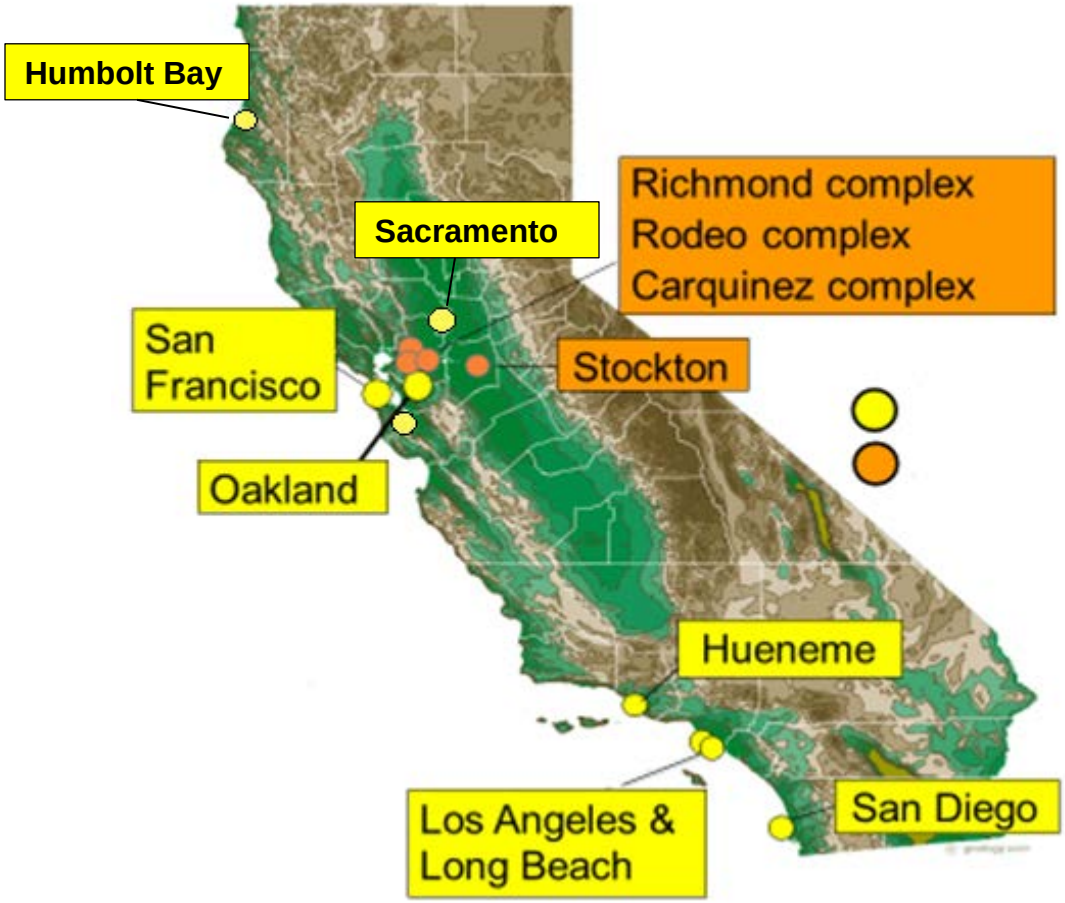
The OGV inventory covers an area within 200 nautical miles (nm) of the California coastline and divides this area into four sub-areas by their distance from shore: 0-3 nm, 3-24 nm, 24-100 nm, and 100 to 200 nm. Figure 2 shows the California territorial waters represented by the inventory which are colored green and the land mass is colored yellow. The boundaries for 24 nm and 100 nm are notated by arrows in the green territorial waters section.

Figure 2: California Territorial Waters with 24 and 100 nm Boundary



California port locations are shown below in Figure 3. While the majority of ports are in the Bay Area, the vast majority of California freight goods movement occurs at the Ports of Los Angeles and Long Beach (LA/LB), located in the South Coast Air District.

Figure 3: California Ports and MTC Locations



The MTCs listed are used for the Health Risk assesment and not in the inventory. The list of all ports used in the inventory are listed in Table 3: California Ports in Inventory

Table 3: California Ports in Inventory

Port Name
Avon
Benicia
Crockett
Eureka
Hueneme
Long Beach
Los Angeles
Martinez
Oakland
Oleum
Redwood City
Richmond
Sacramento
San Diego
San Francisco
Selby
Stockton

3. General Emissions Inventory Methodology and Sources

Broadly, the following steps describe the inventory process, with more detail included later in the report, along with the source data:

1. Vessel broadcasting data along with GIS mapping determines the number of vessel visits for each port in California (grouped by vessel type and vessel size)
2. Vessel broadcasting data also determines the average length of stay for all vessel visits (by vessel type, size and port)
3. Information on average engine effective power (based on the Starcrest Vessel Boarding Program) is combined with vessel visit and duration information
4. Future years are forecasted by applying a growth rate (specific to port, vessel type, and in some cases vessel size) and assuming an equivalent age distribution of vessel visits in the future
5. Compliance data from CARB's Enforcement Divisions is used to determine reduced engine activity time – and therefore reduced emissions – resulting from CARB's At Berth Regulation

6. Emissions are calculated for base and future years using the Equation 1:

$$\textbf{Emission per vessel engine} = \textbf{Activity} * \textbf{EP} * \textbf{EF} * \textbf{FCF} \quad \textbf{(Equation 1)}$$

Where:
Activity: Time the engine is running (hours)
EP: Effective Power: average power output for an engine (kW)
EF: Emission factor (grams/kW-hr)
FCF: Fuel correction factor (unit-less)

The following sections cover the input data, methodology used to analyze, group, or average inputs for the inventory, and forecasting methodology.

3.1. Base Year Vessel Visits and Time At Berth

The inventory updates for vessel visits and time at berth are based on:

- 2016 IHS-Markit Vessel Registry data for vessels that visited California
- 2016 IHS-Markit at berth times for California
- 2016 South Coast Marine Exchange Arrival and Departure Data

The IHS-Markit data is used for the majority of California territorial waters, and the South Coast Marine Exchange is used specifically for the Ports of LA/LB.

IHS-Markit gathers data on OGV vessel visits by use of the automatic identification system (AIS) information, which is broadcast by vessels. OGV's primarily use AIS for collision avoidance, by continuously broadcasting their location, speed, and other information to other vessels in the area. This broadcasted information provides IHS-Markit with the exact location of vessels in California waters, updated every few seconds during the vessel visit. IHS-Markit combines this location with geographic boundary mapping of berth and anchorage areas to determine when a vessel could be considered at berth (i.e. the broadcasted location data from the vessel falls inside the port boundary). IHS-Markit aggregates this second-by-second broadcasted data and supplies CARB with the vessel visit total length in hours. CARB uses this data as the basis for vessel visit count, location, and duration.

Similarly, the South Coast Marine Exchange obtains their information by monitoring the AIS broadcast around the Ports of LA/LB, as well as being the area's vessel traffic service (VTS) provider. TheVTS provides navigation assistance in areas that are heavily congested, and maintains detailed tracking, coordination, and communication with vessels on movement data. In particular, the Marine Exchange data includes not only the port, but the specific berth for each vessel stay. Additionally, the direct communication allows the Marine Exchange data a higher level of quality assurance than the statewide data provided by IHS-Markit, and so is used by CARB to determine vessel visits within the Ports of LA/LB.

The previous public release of the OGV inventory used 2006 activity data from the California State Lands Commission (CSLC), Entrances and Clearances data for the Marine Invasive Species Program[7], and data collected directly from all of the California port officials responsible for vessel docking, also known as Wharfingers. CSLC's data contained port of arrival, the previous port and next port of arrival. The Wharfinger's data included visit specific at berth and at anchorage times. However, there were a number of uncertaines with these data that led CARB to change data sources for the 2018/2019 update. For example, CSLC data is submitted by the vessel operators and the Wharfinger data is collected by individual ports. This can lead to a number of issues and errors. As such, the vessel operator's data was often subject to errors that come naturally from being transcribed by hand by many users. Also, port and vessel identification had numerous variations in abbreviations and naming systems, leading to inconsistencies. Furthermore, the level of detail, information, and quality assurance in the data had large variations depending on the port or area of the state.

Table 4 lists the updated 2016 IHS-Markit information and the 2016 South Coast Marine Exchange vessel visit counts according to port and vessel type. Note that for Long Beach and Los Angeles (Ports of LA/LB) data from South Coast Marine Exchange were used, while IHS-Markit data was used for all other ports.

[7] http://www.slc.ca.gov/Programs/MISP.html

Table 4: 2016 Vessel Visit Counts

Port	Auto	Bulk	Container	Cruise	General	Reefer	Ro-Ro	Tanker	Grand Total
Avon	-	1	-	-	-	-	-	69	70
Benicia	126	11	-	-	-	-	-	88	225
Crockett	-	14	-	-	3	-	-	-	17
Eureka	-	6	-	-	-	-	-	-	6
Hueneme	262	-	68	-	3	52	-	12	397
Long Beach	186	199	948	258	28	1	2	443	2065
Los Angeles	83	89	1291	118	47	17	24	236	1905
Martinez	-	-	-	-	-	-	-	161	161
Oakland	-	19	1711	-	-	-	1	-	1731
Oleum	-	-	-	-	-	-	-	78	78
Redwood City	-	55	-	-	-	-	-	-	55
Richmond	110	72	-	-	-	-	-	409	591
Sacramento	-	18	-	-	12	-	-	1	31
San Diego	251	6	62	73	21	-	6	16	435
San Francisco	6	58	92	79	3	-	1	70	309
Selby	-	-	-	-	-	-	-	31	31
Stockton	-	107	-	-	40	-	-	69	216
Grand Total	1024	655	4172	528	157	70	34	1683	8323

3.2. Vessel Visit Length

Vessel visit length is the duration a vessel stays at berth during a port visit, and determines activity for auxiliary engines and boilers since those are the primary emissions sources while at berth. The auxiliary engines and boilers are both assumed to be active during the full length of the vessel visit (e.g., a 10 hour vessel visit would result in 10 hours of auxiliary engine time and boiler usage time).

The information on vessel visit length is based on the same data sources used in ports visits; the Ports of LA/LB are based on data from the South Coast Marine Exchange, and all other ports are based on IHS-Markit vessel visit data.

Occasionally, a vessel's record shows abnormally long stays at berth, of up to 6 months in some cases. There were outliers seen in all categories with tankers making up the majority of abnormally long stays. Discussions with the tanker industry suggest most of these longer visits are likely repairs, vessel overhauls, or vessel storage, during which time the vessels are not likely to be constantly running the auxiliary engine or boilers. Based on these discussions with industry, CARB is using the assumption that vessel visits above 300

hours should not be included in vessel visit averages, as they do not represent time where an auxiliary engine or boiler is consistently operating.

Table 5 shows the vessel visits excluded in this adjustment, specific to tankers. The vessel visits over 300 hours comprise 1.1 percent of the visits, but 10 percent of the total tanker time at berth.

Table 5: Tanker Vessel Visits by Length of Visit

Visit Length	Tanker Visit Count	Tanker Visit Time (hours)	Tankers (Percent of Visits)	Tankers (Percent of Time)
300 to 1000 Hours	37	16,068	1%	8%
Over 1000 Hours	4	4,753	0.1%	2%

Table 5 lists the minimum, average, and maximum time at berth, in hours, according to vessel type and arrival port (averages and maximums are shown with visits over 300 hours removed). If a specific vessel type did not visit a port named in the IHS-Markit or Marine Exchange data set in 2016, the values are blank, representing no vessel visits or activity.

These vessel visit averages are applied to each vessel visit, by port, vessel type, and vessel size. For example, there were 110 vessel visits from Auto carrier vessels at the Port of Richmond, as shown in Table 3 above. The average time at berth for auto vessels in Richmond is 19 hours, as illustrated in Table 6 below. The inventory shows all 110 vessel visits at 19 hours each for a total of 2,090 hours for Auto carier vessels at berth in Richmond in the base year inventory.

Table 6: Minimum, Average, and Maximum Time At Berth (Hours)

Arrival Port	Auto			Bulk			Container			Cruise		
	Min. Activity time	Avg. Activity time	Max. Activity time	Min. Activity time	Avg. Activity time	Max. Activity time	Min. Activity time	Avg. Activity time	Max. Activity time	Min. Activity time	Avg. Activity time	Max. Activity time
Avon				1	1	1						
Benicia	1	22	74	155	278	300						
Crockett				74	225	300						
Eureka				70	130	271						
Hueneme	1	15	54				7	35	80			
Long Beach	5	14	38	10	54	237	2	62	300	8	13	17
Los Angeles	8	22	168	13	73	238	10	54	227	10	12	37
Martinez												
Oakland				60	124	200	1	24	300			
Oleum												
Redwood City				7	41	204						
Richmond	6	19	91	0	77	300						
Sacramento				1	76	300						
San Diego	6	25	270	16	56	105	1	54	300	10	13	65
San Francisco	1	29	64	0	7	27	0	7	300	1	24	300
Selby												
Stockton				20	104	300						

Continued: Table 5: Minimum, Average, and Maximum Time At Berth (Hours)

Arrival Port	General			Reefer			Ro-Ro			Tanker		
	Min. Activity time	Avg. Activity time	Max. Activity time	Min. Activity time	Avg. Activity time	Max. Activity time	Min. Activity time	Avg. Activity time	Max. Activity time	Min. Activity time	Avg. Activity time	Max. Activity time
Avon										10	53	152
Benicia										0	24	99
Crockett	200	229	277									
Eureka												
Hueneme	110	132	172	40	68.0	89				13	53	288
Long Beach	11	43	160	6	6	6	300	300	300	7	38	295
Los Angeles	6	63	160	7	34.9	94	15	34	181	7	44	294
Martinez										15	49	178
Oakland							300	300	300			
Oleum										10	49	208
Redwood City												
Richmond										0	40	252
Sacramento	88	164	282							1	1	1
San Diego	12	43	97				25	32	42	6	173	300
San Francisco	1	1	1				0	0	0	0	5	300
Selby										11	42	105
Stockton	21	104	300							18	49	175

3.3. Effective Power (EP)

Effective power for vessel auxiliary engines and auxiliary boilers are represented by the average power produced by the engines while in use, measured in Kilowatts (kW). Effective power is the combination of maximum power and the average load factor on the engines. For example, an engine that could produce 2,000 kW at maximum power that is running at 50 percent average load would have an effective power of 1,000 kW. As this report focuses on at berth emissions, only the effective power for the auxiliary engines and the boilers are included. Starcrest refers to this metric as 'effective engine load', however because CARB inventories use the term load to reflect a different engine metric (percent of total hosepower used on average), it will be referred to as effective power in this report to avoid confusion.

The effective power for auxiliary engines (Table 7) and boilers (Table 8) are based on the Starcrest's Vessel Boarding Program (VBP)[8,9]. The VBP is conducted in the Ports of LA/LB, on vessels of all types and sizes, and collects data on the effective power of each vessel type and size bin (Table 2 has a detailed description of size bins). Although collected for the Ports of LA/LB, this information represents the most detailed source on effective power of OGVs available, and therefore is used for the entire state. The values used for the state are combined from the 2016 emission inventories for the Ports of LA/LB. The effective power is a weighted average between the two inventories, based on the arrival visits of the two ports.

[8] 2016 POLA Emission Inventory, pg 15, 17 - https://kentico.portoflosangeles.org/getmedia/644d6f4c-77f7-4eb0-b05b-df4c0fea1295/2016_Air_Emissions_Inventory

[9] 2016 POLB Emission Inventory, pg 5, 7 - http://www.polb.com/civica/filebank/blobdload.asp?BlobID=14109

Table 7: Auxiliary Engine Effective Power

Vessel Type	Size Bin	Berth Hotelling (KW/hr)		
		Los Angeles	Long Beach	Weighted Average for Other Ports
Auto	-	859	1284	1159
Bulk	-	150	210	190
Bulk - Self Discharging	-	-	179	179
Container	1	429	720	709
Container	2	1035	1039	1036
Container	3	516	641	597
Container	4	1161	1136	1153
Container	5	945	1107	1007
Container	6	990	832	988
Container	7	2456	845	2326
Container	8	902	1008	951
Container	9	1037	924	973
Container	10	1450	981	1122
Container	11	1500	1500	1500
Container	12	1780	2000	1945
Container	13	982	1317	990
Container	14	1500	-	1500
Container	17	1000	1000	1000
Container	18	1000	-	1000
Cruise	-	6004	5445	5620
General	-	722	572	661
Misc	-	228	467	228
Reefer	-	890	1091	900
Ro-Ro	-	751	229	711
Tanker	Seawaymax	820	605	784
Tanker	Panamax	623	679	654
Tanker	Aframax	-	724	724
Tanker	Suezmax	-	2509	2509
Tanker	VLCC	-	1171	1171
Tanker	ULCC	-	1171	1171

The effective power for boilers effective power for all vessel types and size bins is shown in Table 8 below.

Table 8: Auxilary Boiler Effective Power

Vessel Type	Size Bin	Berth Hotelling (kW)		
		Los Angeles	Long Beach	Weighted Average for Other Ports
Auto	-	314	314	314
Bulk	-	125	125	125
Bulk - Self Discharging	-	-	132	132
Container	1	273	273	273
Container	2	361	361	361
Container	3	420	420	420
Container	4	477	477	477
Container	5	579	579	579
Container	6	615	615	615
Container	7	623	623	623
Container	8	668	668	668
Container	9	677	677	677
Container	10	581	581	581
Container	11	790	790	790
Container	12	790	790	790
Container	13	612	612	612
Container	14	612	-	612
Container	17	647	647	647
Container	18	647	-	647
Cruise	-	612	612	612
General	-	160	160	160
Misc	-	96	96	96
Reefer	-	304	304	304
Ro-Ro	-	259	259	259
Tanker	Seawaymax	2586	2586	2586
Tanker	Panamax	3421	3421	3421
Tanker	Aframax	-	5030	5030
Tanker	Suezmax	-	5843	5843
Tanker	VLCC	-	6000	6000
Tanker	ULCC	-	6000	6000

3.4. Emission Factors (EF)

Emission factors for vessels vary by pollutant, operating mode, engine type, fuel type, and fuel sulfur content. CARB uses the best available information for each emission factors, from a variety of sources. This update of the CARB OGV inventory selects emissions factor sources consistent with the US EPA and the IMO. The sources used fro CARB's analysis are listed in the begining of Appendix A.

The change that has had the largest singular impact to the inventory is a reduction to the PM emission factor for auxiliary boilers, and an increase to the NOx emission factor for auxiliary engines. As compared to previous inventories, the PM factor has been reduced by approximately 33 percent for boilers, based on the research and methodology in the EPA (2009) paper.

For auxiliary engines, the NOx emissions factors have been increased slightly based on the values used by Starcrest for the Ports of LA/LB emission inventory. The emission factors for at berth operations are provided in full detail in Appendix A.

4. Future Year Forecasts

Future year forecasts are developed by applying region or port-specific growth forecasts to the base year of the inventory. The age distribution of the vessel visits is not changed in future years, but is held constant. This methodology is known simply as a 'static age distribution model'. In most emissions inventories, CARB applies a survival curve[10] in combination with a purchasing rate to the base year inventory to forecast future age distributions, or uses a lifecycle curve to estimate future year age distributions. These methods were considered for CARB's OGV inventory but discarded for a number of reasons as described below:

(1) The general impact of a survival/turnover methodology is largely a 'smoothing' of the age distribution to reflect a more general distribution in future years. Essentially, the data contains fewer outliers and more closely resembles the survival curve used in the methodology. This method can work well to smooth out inventories based on small sample sizes with irregular results. However, the OGV inventory includes all of the visits across the state in a full year and not a small sample of such visits, which could have unrealistic outliers. Applying a survival curve would replace the real-world, non-simulated, non-adjusted distribution of visits in a given year with probably a less representative age distribution based on the assumptions of the survival curve rather than the real-world data.

(2) Applying a survival rate can also be appropriate if it can provide reasonably accurate forecasts of captive populations of equipment. OGVs however, are not captive to California and are part of a larger international fleet. Modeling the turnover of the

[10] For more information on survival rates, see additional off-road inventory documentation: https://www.arb.ca.gov/msei/msei.htm

international fleet and the subset that visits California is possible but would require a vast number of assumptions, and the end result less likely to be accurate than using the real-world age distribution from the vessel visit data.

Note that using the static age distribution methodology does not mean that future year inventories show the OGV fleet getting progressively older. Rather, the average age and age distribution stays the same in all future years.

4.1. Freight Analysis Framework

The primary source for growth forecasts is the Freight Analysis Framework (FAF) v. 4.3.1[11] (dated March 2017). This data was used for all vessel types and regions of the state outside of the Ports of LA/LB, and Port of Hueneme.

FAF is produced through a partnership between Bureau of Transportation Statistics (BTS) and Federal Highway Administration (FHWA).It collects data from a variety of sources to create a comprehensive picture of freight movement among states and major metropolitan areas by all modes of transportation. Main sources of information are the Commodity Flow Survey (CFS) and international trade data from the Census Bureau. FAF provides forecasts as estimates for tonnage and value by regions of origin and destination, commodity type, and mode.

CARB has selected the FAF growth rates for use in forecasting the OGV inventory because; (1) the methodology[12] is robust and comprehensive, and is checked against historical growth trends for accuracy, (2) covers intermodal freight movement in detail, again using historical trends to note shifts in modal choices (e.g., movement on rail versus OGV), (3) FAF is one of the few forecasting tools that covers all of the freight goods transported by OGV's represented in the inventory (except for cruise vessels), and (4) FAF is one of the few forecasting tools that covers all regions of the state.

FAF divides the state into four main regions: San Francisco, Los Angeles, San Diego, and all other California areas combined. **Table 9** maps the California Ports to their associated FAF regions. Where FAF is not used for a port, the FAF region is left blank. All three ports that are left blank are in the South Coast region.

[11] https://ops.fhwa.dot.gov/freight/freight_analysis/faf/
[12] This methodology is not described in detail in this report, but is available on FAF's website

Table 9: California Ports and FAF Regions

California Ports	FAF Regions
El Segundo	Los Angeles
Eureka	Rest of California
Hueneme	Los Angeles
Long Beach	Los Angeles
Los Angeles	Los Angeles
Avon	San Francisco
Benicia	San Francisco
Crockett	San Francisco
Martinez	San Francisco
Oakland	San Francisco
Oleum	San Francisco
Redwood City	San Francisco
Richmond	San Francisco
Sacramento	San Francisco
San Francisco	San Francisco
Selby	San Francisco
Stockton	San Francisco
San Diego	San Diego

The FAF commodities are mapped to the vessel type using the groupings shown in Table 10. The total import and export tonnage of these groups of commodities was combined to determine the expected growth for a vessel type. For example, tanker growth is based on the aggregated sum of basic chemicals, crude petroleum, fuel oils, and gasoline.

Table 10: Vessel Type Assignment for FAF Commodity Categories

Vessel Type	FAF Commodity Category	Vessel Type	FAF Commodity Category
Auto	Motorized vehicles	Container	Alcoholic beverages
Bulk cargo	Animal feed		Articles-base metal
	Building stone		Base metals
	Cereal grains		Electronics
	Coal		Furniture
	Coal-n.e.c.		Misc. mfg. prods.
	Fertilizers		Mixed freight
	Gravel		Newsprint/paper
	Logs		Paper articles
	Metallic ores		Pharmaceuticals
	Milled grain prods.		Plastics/rubber
	Natural sands		Precision instruments
	Nonmetal min. prods.		Printed prods.
	Nonmetallic minerals		Textiles/leather
General cargo	Chemical prods.		Tobacco prods.
	Live animals/fish		Waste/scrap
	Machinery		Wood prods.
Reefer	Meat/seafood	Tanker	Basic chemicals
	Other ag prods.		Crude petroleum
	Other foodstuffs		Fuel oils
Ro-Ro	Transport equip.		Gasoline

CARB does not assume any vessel practice changes or efficiency changes in the growth analysis except for the Ports of LA/LB as discussed later in the report. Therefore, if tonnage increases 35 percent over 20 years for a vessel type in a specific region, the total activity from that vessel type was modeled as increasing 35 percent over the same period. For forecasting years in-between FAF's 5 year increments, the average annual compound growth rate was used (e.g., growth from 2020 to 2021 is determined by the average annual compound growth rate from 2020 to 2025).

The totals tons by FAF region are shown in the Table 11 below. This is shown for summary purposes only. The growth rates modeled include both region and vessel type. The years shown are the product of FAF methodology and were not selected by CARB.

Table 11: Freight Analysis Framework (FAF) Freight Totals (annual tons)

FAF Region	Freight Type	2007	2015	2020	2025	2030	2035	2040
Los Angeles	Water Freight	155,767	210,078	254,189	309,253	367,723	419,347	482,672
San Francisco	Water Freight	57,085	77,410	90,673	105,944	120,562	134,535	151,964
San Diego	Water Freight	2,589	2,891	3,368	3,808	4,219	4,711	5,371
Sacramento	Water Freight	3,960	5,863	6,871	8,240	9,660	11,180	13,074
Remainder of State	Water Freight	6,689	7,921	8,297	8,571	8,327	8,326	8,613
Grand Total		226,090	304,162	363,398	435,816	510,491	578,100	661,694

The resulting growth rates from the FAF analysis are shown in Table 12 below, by region and vessel type. These growth rates are used in the OGV inventory from 2016 to 2050 for all ports and independent marine terminals except for Ports of LA/LB and Hueneme.

Table 12: Annual Growth Rates by Region and Vessel Type

Region	Vessel Type	Average Annual Growth
Los Angeles	Auto	0.028
Los Angeles	Bulk cargo	0.032
Los Angeles	Container	0.045
Los Angeles	General cargo	0.049
Los Angeles	Reefer	0.041
Los Angeles	Ro-Ro	0.049
Los Angeles	Tanker	0.015
Rest of California	Bulk cargo	0.04
Rest of California	Container	0.048
Rest of California	General cargo	0.041
San Diego	Auto	0.026
San Diego	Bulk cargo	0.003
San Diego	Container	0.038
San Diego	General cargo	0.042
San Diego	Reefer	0.048
San Diego	Ro-Ro	0.048
San Diego	Tanker	0.043
San Francisco	Auto	0.027
San Francisco	Bulk cargo	0.021
San Francisco	Container	0.046
San Francisco	General cargo	0.051
San Francisco	Reefer	0.041
San Francisco	Ro-Ro	0.048
San Francisco	Tanker	0.011

This report will focus only on forecasted data, from the base year of 2016 forward. Historical data (and not backcasting) will be used to determine emissions back to 1990 in a completed inventory (the completed inventory will be released prior to the board hearing on the potential new OGV At Berth and At Anchor Regulation).

4.2. Mercator Forecast for Ports of LA/LB

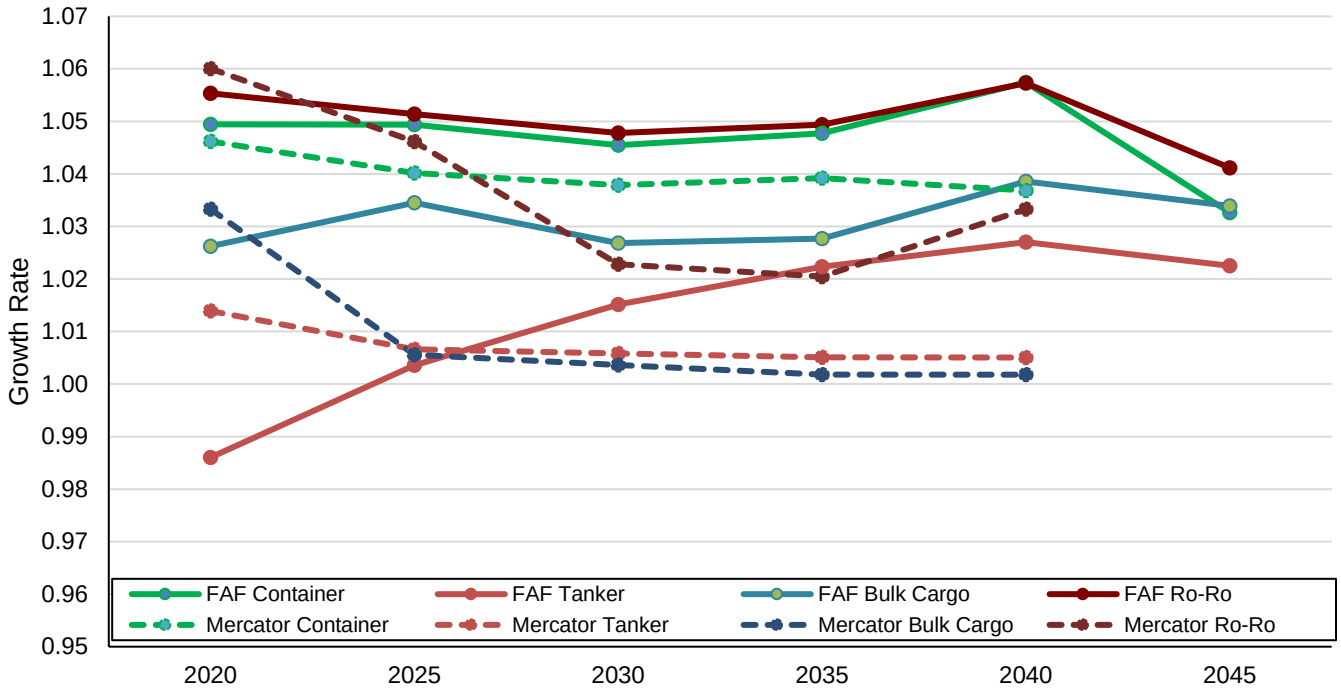
Mercator International, a consultancy group, was commissioned by the Ports of LA/LB to create a port-specific growth study of their Ports to determine future investment needed, regional transit planning, and future emissions forecasting[13]. The most recent study completed was the 2016 analysis, and focused on freight growth as well as forecasting the size of container vessels that visit the ports. CARB is using the Mercator growth rates for the Ports of LA/LB because; (1) this analysis was port specific and not regional, and (2) the forecasting accounts for berth space, port capacity, shipping lanes, and additional features not included in FAF. The Ports of LA/LB and the South Coast Area Group (SCAG) transportation planning both use the Mercator analysis, and have expressed support for its use in the CARB's OGV emissions inventory.

To determine the impact of using Mercator forecasts as opposed to FAF, CARB compared the average annual Mercator growth rates against the FAF growth for the Ports of LA/LB for 2020 to 2040, shown in Figure 4. Overall, the Mercator rates were 1 to 2 percentage points lower annually than the FAF rates, but the largest category (container vessels) was less than a half percentage point different through 2035. Ultimately, whether the FAF forecast or the Mercator forecast was used for growth, the total emissions and total energy from OGVs at the Ports of LA/LB in 2030 saw a shift of only 3 percent. Given the uncertainty inherent in all forecasting, this is not a significant difference.

In Figure 4, each type of vessel is assigned a color. The FAF forecast uses a solid line of the color, and the Mercator forecast uses a dotted line of the same color. To compare container vessels, for example, compare the solid and dotted green lines in the figure.

[13] Mercator International LLC and Oxford Economics – San Pedro Bay Long-term Unconstrained Cargo Forecast. July 2016 http://acta.org/revenue_finance/March%20%202016%20Meeting%20Item%208.pdf, pg 265

Figure 4: FAF 4.3.1 and 2016 Mercator Annual Growth Rate Comparison for Ports of LA/LB



In addition to port specific growth rates, the Mercator report also provides a forecast of the distribution of container vessel sizes. Figure 5 shows the combination of container vessel size shifts, growth rate, and capacity at the Ports of LA/LB according to the Mercator report forecasting. The increase in container vessel size over time is clearly visible. Container vessels capable of carrying over 12,000 TEUs transport only a few percent of effective TEUs in 2016, but are projected to deliver almost 60 percent of effective TEUs by 2030.

Although the growth rates continue through at least 2040, the Ports of LA/LB are projected reach capacity TEU movement before then, with limited ability to expand based on land use and port characteristics. As stated in the Port Master Plan[14], the capacity projection for the Ports is 42 million TEUs.

Both the Port Master Plan and the Mercator Forecast from 2016 applied growth rates show that the Ports of LA/LB will reach this combined capacity limit by 2035. At that point, the estimated growth rate is zero. CARB includes this capacity limit, and shows post-2035 growths as zero for the Port of LA/LB.

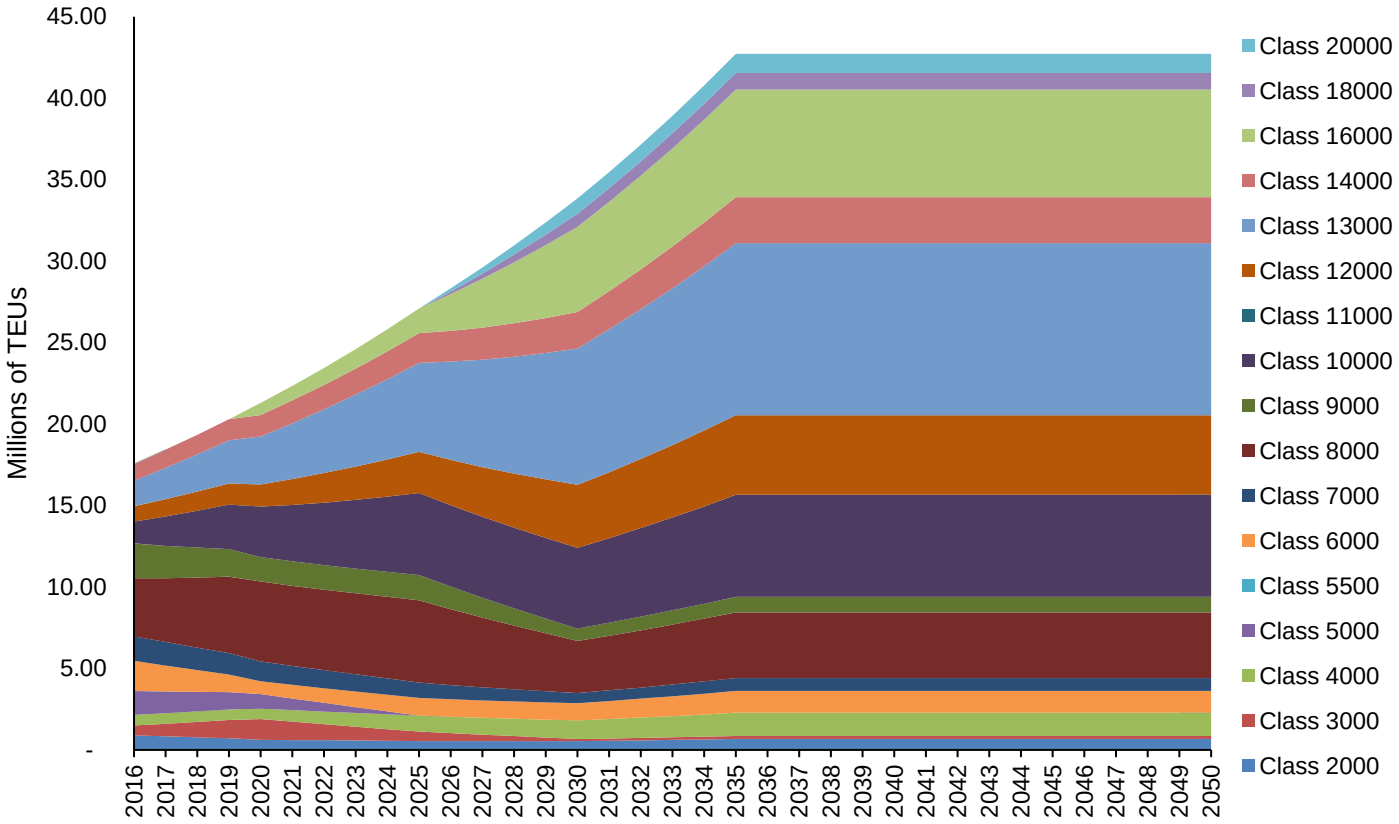
This change in container vessel sizes was included for the Ports of LA/LB as they were the only ports included in the study. Other ports may see a shift over time but could be limited

[14] https://www.portoflosangeles.org/getmedia/2f2b99a8-f0c3-4e01-9bfe-ba34de05293d/amendment-28

by berth size and channel depth, port space and capacity, and other limiting factors. Any shifts in vessel sizes for other ports will be reviewed in future inventories.

The combination of container vessel size shifts, growth rate, and capacity of Ports of LA/LB is shown in Figure 5. Note that vessel size bins are detailed in Table 2.

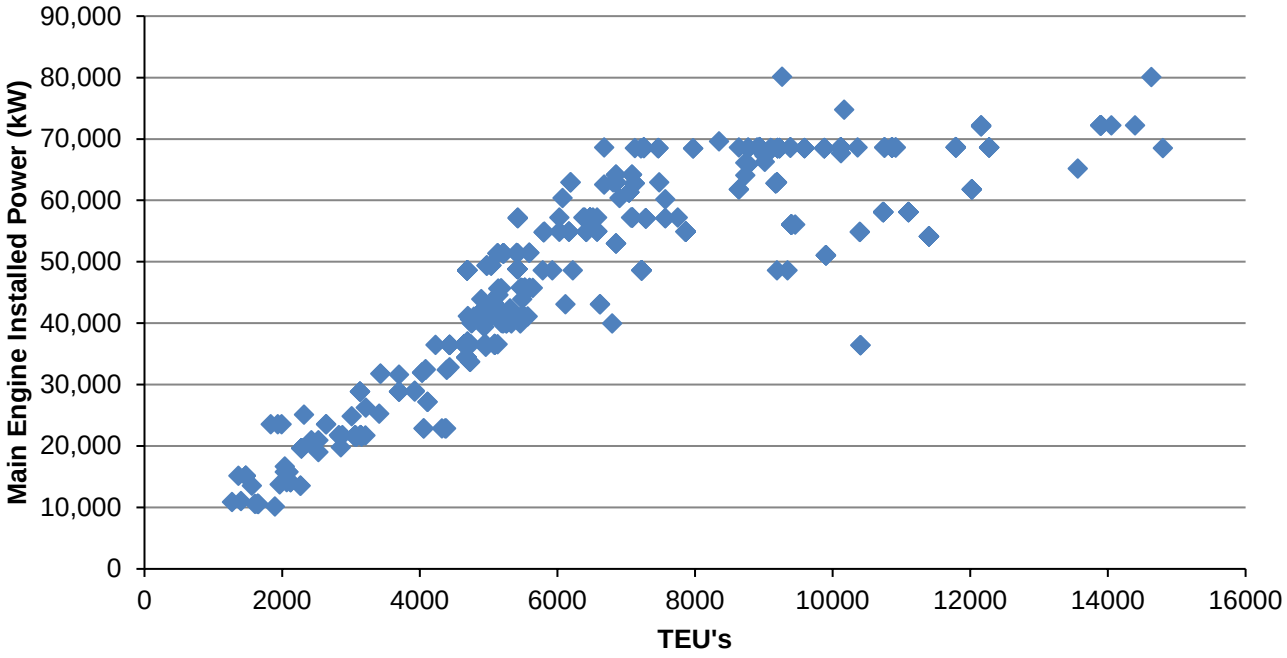
Figure 5: Capacity Growth by Container Size Forecast for Ports of LA/LB



This shift in container vessel sizes essentially increases the effiency of OGV transport in the Ports of LA/LB, as larger vessels are considerably more efficient on a per-TEU basis (on the basis of kW-hr per TEU delivered). As shown in Figure 6, although the average TEU capacity is increasing, main engine power is not increasing at the same rate, and at a certain point, the engines power levels off while capacity continues increasing. Figure 6 shows that vessels of approximately 8,000 TEU's capacity and larger have a fairly constant average engine power. Below 8,000 TEUs, the engine power to capacity relationship is fairly linear. The data is taken from the Army Corps of Engineers Entrances and Clearances database[15].

[15] Foreign waterborne transportation: Foreign cargo Inbound and Outbound Vessel Entrances and Clearances https://usace.contentdm.oclc.org/digital/collection/p16021coll2/id/2763

Figure 6: Container Vessel Main Engine to Capacity in 2014



Although this graph shows the main engine power, Table 7 and Table 8 in previous sections show that auxiliary engine power and boiler power have a non-linear relationship with vessel size as well. Larger vessels show a small increase (on average) in auxiliary engine and boiler sizes but overall are much more efficient on a per-TEU basis.

4.3. Engine Tier Availability and Introduction

Previous inventories assumed vessels would incorporate Tier 3 engines in approximately 2016, when Tier 3 engines are required in all new marine vessels. However, based on an analysis conducted by Starcrest for the Ports of LA/LB, the introduction of Tier 3 in the OGV inventory forecast has been delayed from 2030 to 2040. Currently the delay is based on a 2015 draft forecast, but there is an updated 2017 draft avalible that will be included in the inventory later in 2019. It needs to be noted that the updated information would further delay the introduction of Tier 3 marine engines for most vessel types and sizes[16].

The reason for this delay can be attributed largely to two factors, (1) the Ports of LA/LB as well as the ports in the western United States, rarely receive visits from the newest container vessels, which tend to be larger vessels that more commonly service Asian and European freight routes, and (2) the very large number of vessel builds ordered immediately prior to the Tier 3 marine standard introduction. Vessel builds that began prior

[16] San Pedro Bay Ports Clean Air Action Plan 2017: Draft – Bay Wide Ocean Going Vessel International Maritime Organization Tier Forecast 2015-2050 http://www.cleanairactionplan.org/documents/vessel-forecast-draft.pdf/

to the Tier 3 marine standards initial date may have Tier 2 marine engines installed, even if the vessel is put into service at a later date. Further details are available from Starcrest and the Ports of LA/LB[15].

The starting year for each vessel type and container size bins[17] is listed below in Table 13.

[17] Container size bins are described in Table 2

Table 13: Marine Engine Tier 3 Introduction Dates at California Ports

Vessel Type	Size Bin	Year Start
Auto	-	2037
Bulk	-	2040
Container	1	2030
Container	2	2040
Container	3	2030
Container	4	2030
Container	5	2030
Container	6	2040
Container	7	2030
Container	8	2040
Container	9	2040
Container	10	2032
Container	11	2037
Container	12	2037
Container	13	2037
Container	14	2037
Container	15	2037
Container	16	2030
Container	17	2030
Container	18	2037
Container	19	2030
Container	20	2040
Cruise	-	2026
General	-	2030
Reefer	-	2030
Ro-Ro	-	2030
Tanker	-	2030
Tanker	Seawaymax	2030
Tanker	Panamax	2030
Tanker	Aframax	2030
Tanker	Suezmax	2030
Tanker	VLCC	2030
Tanker	ULCC	2030

The net impact of this change is an increased number of Tier 2 marine engines in the inventory, well past 2040. This change increases the NOx emissions relative to earlier adoption of the Tier 3 marine standard, but is not enough to off-set the lower NOx emission factors (as shown in the emissions results section).

5. Regulations Included in the OGV Inventory

5.1. Fuels

Two regulations control the sulfur content of fuel used in California waters. One of the regulations is CARB's OGV Clean Fuel Regulation ("Fuel Sulfur and Other Operational Requirements for Ocean-Going Vessels within California Waters and 24 Nautical Miles of the California Baseline"[18]), commonly referred to as the Clean Fuel Regulation. Implementation for this regulation began in January 1, 2014, and is currently in its second and final phase of implementation. CARB's Clean Fuel Regulation requires fuel used by marine vessel operators be a distillate fuel with a sulfur content equal to or less than 0.1 percent, during operation within the 24 nm regulatory zone off the California coast. The second fuel regulation in place is the North American Emission Control Area (ECA)[19], which reduced the allowable sulfur content of marine fuels to 0.1 percent beginning January 1, 2015. This regulation requires that 0.1 percent sulfur fuel to be used within 200 nm of the United States and Canadian coasts. The sulfur content of the fuel affects SOx and PM pollutants . Appendix A contains emission factors and impacts of the Clean Fuel Regulation.

Vessels can file for a research exemption under the Clean Fuel Regulatio and use ultra-low residual fuel oil (or scrubbers) instead of diesel fuels as part of research and testing projects, but the number of vessels that utilize this research exemption are few and such exemptions for ultra-low sulfur residual fuel oil are not included in the inventory.

5.2. Shore Power and the At-Berth Regulation

In December 2007, CARB approved the "Airborne Toxic Control Measure for Auxiliary Diesel Engines Operated on Ocean-Going Vessels At-Berth in a California Port" Regulation[20,21], or the At Berth Regulation. (A brief explanation is provided in this report to explain the modeling of the regulation, but for any in-depth understanding of the regulation, readers should visit the link provided in the footnote.)

The At Berth Regulation requires container vessels, passenger vessels, and refrigerated-cargo vessels to connect to shore power for a percent of their visits or use an approved alternative to shore power, and reduce their at berth emissions across their fleet by a percentage, if the vessels are in a fleet that meet the visit threshold. Fleets must also report their total time in port and total time on shore power to CARB. Implementation for

[18]CARB OGV Fuel Regulation - https://www.arb.ca.gov/ports/marinevess/ogv.htm
[19] IMO MARPOL Annex VI Regulation 14 - http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Sulphur-oxides-(SOx)-–-Regulation-14.aspx

[20] CARB At-Berth Regulation - https://www.arb.ca.gov/regact/2007/shorepwr07/shorepwr07.htm
[21] https://www.arb.ca.gov/ports/shorepower/finalregulation.pdf

the At-Berth Regulation began in 2014 with the requirement that applicable fleets spend 50 percent of their at-berth time connected to the electric grid and not run on auxiliary engines for power, then increased to 70 percent of the fleet at-berth time in 2017. The final phase of implementation will occur in 2020, when the requirements increase to 80 percent of an applicable fleets time at-berth.

The requirements of the regulation impact each port in different ways, depending on the percent of the fleets in the port subject to the regulation based on their number of vessel visits in California ports, and the stringency of the regulation.

To forecast the At Berth Regulation's impacts, the inventory compares data from CARB enforcement team and the statewide inventory of vessels time at-berth. The following example shows a fictional port to demonstrate how the inventory calculates at-berth reductions. This is an example only, and the data in the example is not intended as a realistic evaluation of the regulation, only an example to illustrate how the regulation is applied and how inventory models the regulation.

Example (data is not based on real information): The statewide inventory shows that container vessels in a port spend 10,000 hours at-berth over the course of a year. Enforcement data informs the inventory that applicable fleets spend 6,000 hours per year at the port (meaning that only 60 percent of the total vessel at-berth hours in the port are subject to the existing regulation, due to exemptions based on number of visits per year and vessel type). Enforcement data also shows that vessels vists covered by the regulation are spending 3,000 hours on electric shore power in 2016 to meet the 50 percent shore power requirement of the regulation. To meet the regulatory requirement of 70 and 80 percent in 2017 and 2020, the regulated fleets will need to spend at least 4,200 and 4800 hours on shore power respectively. The inventory calculations are shown in Table 14.

Table 14: Existing At-Berth Regulation Requirement Levels

Calendar Year	At Berth Hours from All Vessels in Example Port	At Berth Hours of Vessels Covered by Existing ATCM	Existing At Berth ATCM Percent Time on Shorepower Requirement	Hours on Shorepower	Reduction Factor from At Berth Regulation for All Vessel Visits at Example Port
2016	10,000	6,000	50%	3,000 (6,000 hrs * 50% = 3,000 hrs)	30% (3,000 hrs / 10,000 total port hrs = 30%)
2017	10,000	6,000	70%	4,200	42%
2020	10,000	6,000	80%	4,800	48%

The reduction factors are averaged by port, vessel type, and by vessel size. Table 13 shows the percent of time on shore power (out of total time for all vessels at berth, not just

impacted fleets) and the projected time on shore power after the 2020 regulatory requirements are implemented. In some cases, fleets at certain ports met or exceeded requirements of the regulation and therefore no further increases in the shore power usage were projected.

Table 14 below shows the control factors included in the inventory based on the At-Berth Regulation. The control factor is both a reduction in power supplied by auxiliary engines as well as the percent reduction in emissions. For example, a 65 percent reduction in auxiliary engine use is assumed to achieve a 65 percent emissions reduction.

Table 15: Shore Power Control Factors for Existing At-Berth ATCM

Arrival Port	Vessel Type	Size Bin	2016 Percent Time On Shorepower	Project 2020 and Later Time on Shorepower
Hueneme	Container	1	80%	80%
Hueneme	Container	2	0%	80%
Hueneme	Reefer		0%	80%
Long Beach	Container	1	34%	65%
Long Beach	Container	2	18%	65%
Long Beach	Container	3	21%	65%
Long Beach	Container	4	58%	65%
Long Beach	Container	5	42%	65%
Long Beach	Container	6	72%	65%
Long Beach	Container	7	76%	65%
Long Beach	Container	8	71%	65%
Long Beach	Container	9	55%	65%
Long Beach	Container	10	30%	65%
Long Beach	Container	11	77%	65%
Long Beach	Container	12	95%	65%
Long Beach	Container	13	34%	65%
Long Beach	Container	14	97%	65%
Long Beach	Container	15	0%	65%
Long Beach	Container	16	0%	65%
Long Beach	Container	17	0%	65%
Long Beach	Container	18	0%	65%
Long Beach	Container	19	0%	65%
Long Beach	Container	20	0%	65%
Long Beach	Cruise		54%	64%
Los Angeles	Container	1	34%	65%
Los Angeles	Container	2	18%	65%

Arrival Port	Vessel Type	Size Bin	2016 Percent Time On Shorepower	Project 2020 and Later Time on Shorepower
Los Angeles	Container	3	21%	65%
Los Angeles	Container	4	58%	65%
Los Angeles	Container	5	42%	65%
Los Angeles	Container	6	72%	65%
Los Angeles	Container	7	76%	65%
Los Angeles	Container	8	71%	65%
Los Angeles	Container	9	55%	65%
Los Angeles	Container	10	30%	65%
Los Angeles	Container	11	77%	65%
Los Angeles	Container	12	95%	65%
Los Angeles	Container	13	34%	65%
Los Angeles	Container	14	97%	65%
Los Angeles	Container	15	0%	65%
Los Angeles	Container	16	0%	65%
Los Angeles	Container	17	0%	65%
Los Angeles	Container	18	0%	65%
Los Angeles	Container	19	0%	65%
Los Angeles	Container	20	0%	65%
Los Angeles	Cruise		54%	64%
Oakland	Container	1	9%	14%
Oakland	Container	2	1%	1%
Oakland	Container	3	40%	61%
Oakland	Container	4	46%	71%
Oakland	Container	5	33%	51%
Oakland	Container	6	53%	81%
Oakland	Container	7	77%	100%
Oakland	Container	8	46%	71%
Oakland	Container	9	67%	100%
Oakland	Container	11	63%	97%
Oakland	Container	12	85%	100%
Oakland	Container	13	19%	29%
Oakland	Container	14	8%	13%
San Diego	Container	1	83%	83%
San Diego	Container	3	83%	83%
San Diego	Cruise		28%	31%
San Francisco	Cruise		15%	24%

6. Summary of Draft Regulatory Concepts

The draft regulatory concepts for the new At Berth and At Anchor Regulation are designed to achieve additional emissions reductions of DPM, $PM_{2.5}$, NO_x, GHG (as a co-benefit of increased shore power usage) beyond those realized by the existing At-Berth Regulation; further reduce adverse health impacts to the communities surrounding ports and terminals; and increase the clarity and enforceability of regulatory requirements for vessels. The draft regulatory concepts would accomplish this by:

- Introducing emission control requirements to additional ports, MTCs, vessel visits, and vessel types that are not covered by the existing At-Berth Regulation, and
- Implementing a regulatory structure that is based on requirements applying to each individual vessel visit, with the actions of each single visit determining compliance. This represents a change in the regulatory structure from the existing At-Berth Regulation, which is an annual fleet-based regulation where compliance is based on a fleet's yearly performance.

The draft regulatory concepts would expand covered vessels to include auto carriers, roll on-roll off (Ro-Ro) vessels, crude tankers and product tankers. This requirement would include diesel-fueled auxiliary engines, as well as auxiliary engines that operate on liquefied natural gas (LNG) engines and other alternative fuels.

Regulated vessels would be required to use a CARB approved control strategy, such as shore power, a barge or land-based capture and control system, or other to-be-determined control technology, to control emissions while at berth. The draft regulatory concepts would also require boiler emissions controls for crude tankers operating boiler-powered, steam-driven pumps to off-load cargo (typically crude products). To obtain CARB approval, a control technology must be able to show that it can reduce a vessel's emissions by at least 80 percent from the default emissions of an ocean-going vessel's auxiliary engine and boiler.[22]

The draft regulatory concepts would base emission control requirements on the number of annual visits made by regulated vessel types to specific ports and terminals by setting vessel visit thresholds for ports and terminals. Ports, terminals, and vessels visiting these locations would be subject to control requirements through the draft regulatory concepts if the port or MTC receives 50 or more visits annually from container, reefer, or auto/Ro-Ro vessels, or 25 or more visits from cruise or tanker vessels. For ports and MTCs that exceed the annual port visit threshold for a specific vessel type, individual terminals at that port or MTC that receive that type of vessel would then be required to reduce emissions from vessels at berth if they receive 25 or more visits annually from container, reefer, or

[22] Default emission rates of auxiliary engines on ocean-going vessels are 13.8 g/kW-hr for NOx and 0.17 g/kW-hr for DPM. Default emission rates of tanker auxiliary boilers on ocean-going vessels are 2.0 g/kW-hr for NOx and 0.17 g/kW-hr for PM2.5. These emission rates represent a typical vessel operating on marine diesel oil with a sulfur content of 0.10 percent.

auto carriers and Ro-Ro vessels, or 5 or more visits annually from cruise or tanker vessels. These thresholds were set considering past activity and per vessel emission levels for different vessel types.

Table 16 lists ports that are subject to the existing At-Berth Regulation and ports and MTCs that would likely be subject to control requirements under the draft regulatory concepts, based on the proposed port and terminal thresholds and 2017 vessel activity information.

Table 16: Affected Ports and Marine Terminal Complexes*

Existing At-Berth Regulation	Draft Regulatory Concepts
Los Angeles	Los Angeles
Long Beach	Long Beach
Oakland	Oakland
San Francisco	San Francisco
San Diego	San Diego
Hueneme	Hueneme
	Stockton Marine Terminal Complex
	Richmond Marine Terminal Complex
	Carquinez Marine Terminal Complex
	Rodeo Marine Terminal Complex

The draft regulatory concepts would phase in from 2021 through 2031 with full implementation achieved by 2031. The proposed implementation timeline is summarized in Table 17. Vessel categories that are already regulated would have new requirements beginning in 2021 under the draft regulatory concepts. Previously unregulated vessel categories would have a later implementation date to allow for infrastructure buildout and production of capture and control systems. Specifically, emission control requirements for tankers would begin in 2025 with a 50 percent emission control requirement, which would increase to 80 percent in 2031, to allow the tanker industry to address operational issues that may arise during the initial implementation period.

Table 17: Implementation Timeline for Draft Regulatory Concepts

Vessel Category	2021	2025	2031
Container, cruise, refrigerated-cargo	• 100% of visits* • CARB-approved emission control option		
Auto/Ro-Ro (new category)		• 100% of visits* • CARB-approved emission control option	
Tankers with electrically powered pumps (new category)		• 100% of visits* • CARB-approved emission control option (intermediate control level**) for auxiliary engines	• 100% of visits* • CARB-approved emission control option for auxiliary engines
Tankers with steam powered pumps (new category)		• 100% of visits* • CARB-approved emission control option (intermediate control level**) for auxiliary engines and boilers	• 100% of visits* • CARB-approved emission control option for auxiliary engines & boilers

*Percentage of visits controlled after removing from consideration visits to low-activity ports and terminals.

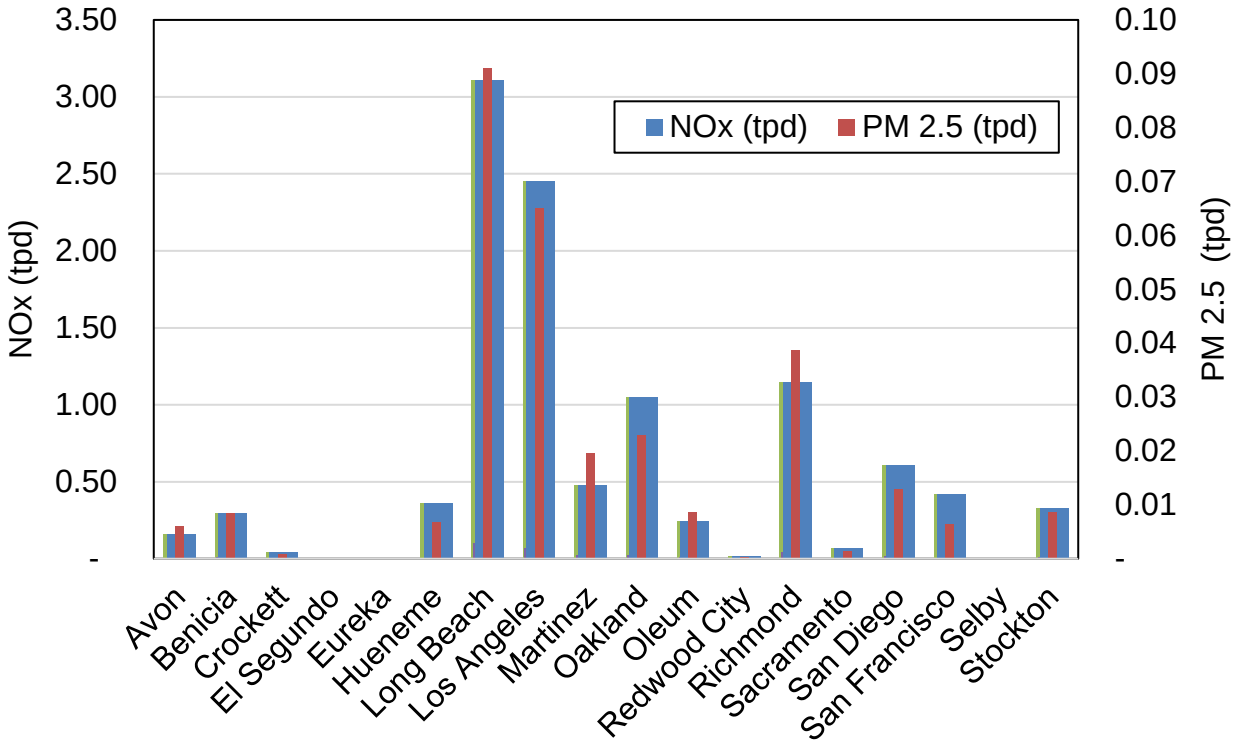
**Intermediate control level = 50% reductions from default auxiliary engine emissions rate

7. Emissions Results

The emissions results included in this section are intended to provide an overview and visualization of the emissions distribution among ports and MTCs, vessel types, as well as engine types and tiers. For a comprehensive version of the inventory output, the 2018/2019 CARB OGV Model[23] or Off-Road Inventory Online[24] (ORION) should be used[25].

The contribution to statewide at-berth criteria emissions for each port is shown below in Figure 7. In most cases the relative contribution to NOx and PM to the statewide inventory for each port are comparable in magnitude (i.e., visually this means the red and blue bars for the port are of a similar height). In some cases such as Richmond, the relative contribution to PM is higher than the contribution to NOx. This can largely be attributed to the tanker activity in the Richmond complex, and the fact that tanker boilers have a higher PM contribution than NOx. In other areas, such as San Francisco, the relative contribution to PM is lower than NOx, as the area sees very few tankers.

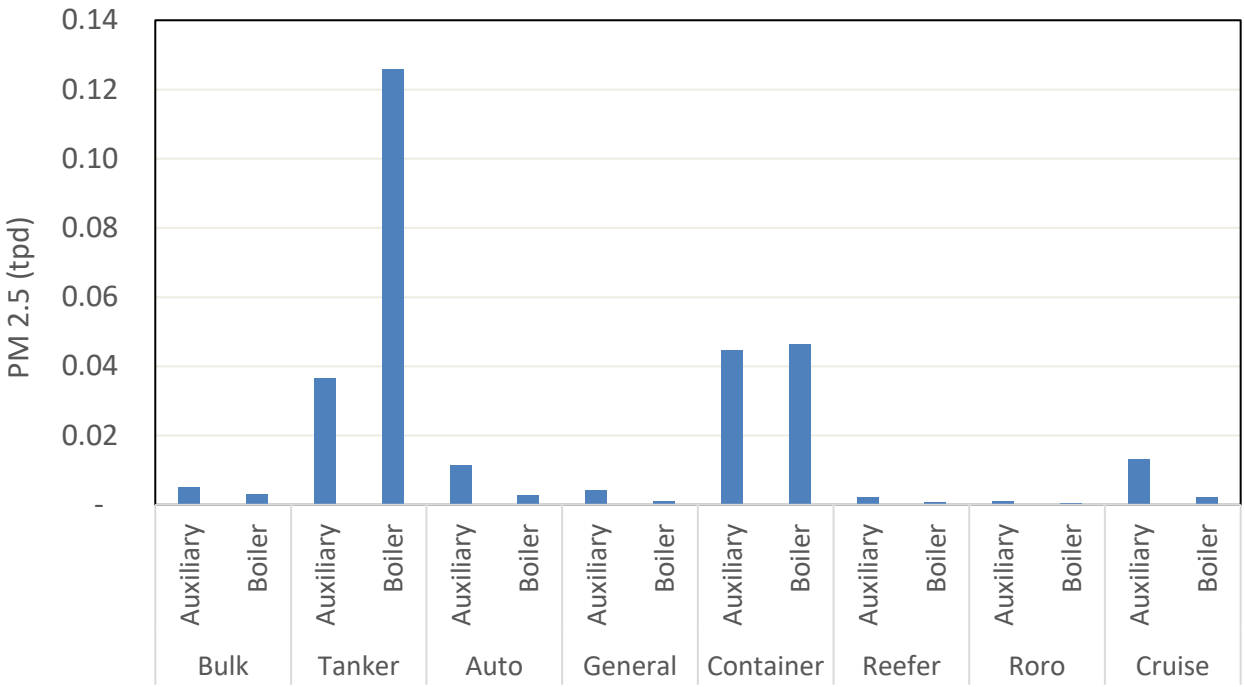
Figure 7: 2016 Statewide At-Berth NOx and PM 2.5 Emissions by Port



[23] https://www.arb.ca.gov/msei/ordiesel.htm
[24] https://www.arb.ca.gov/orion/
[25] For the draft 2018 version of this report intended for comment and review, data tables will be provided to reviewing parties with a similar level of detail. All data will be stored at the links above after further revisions.

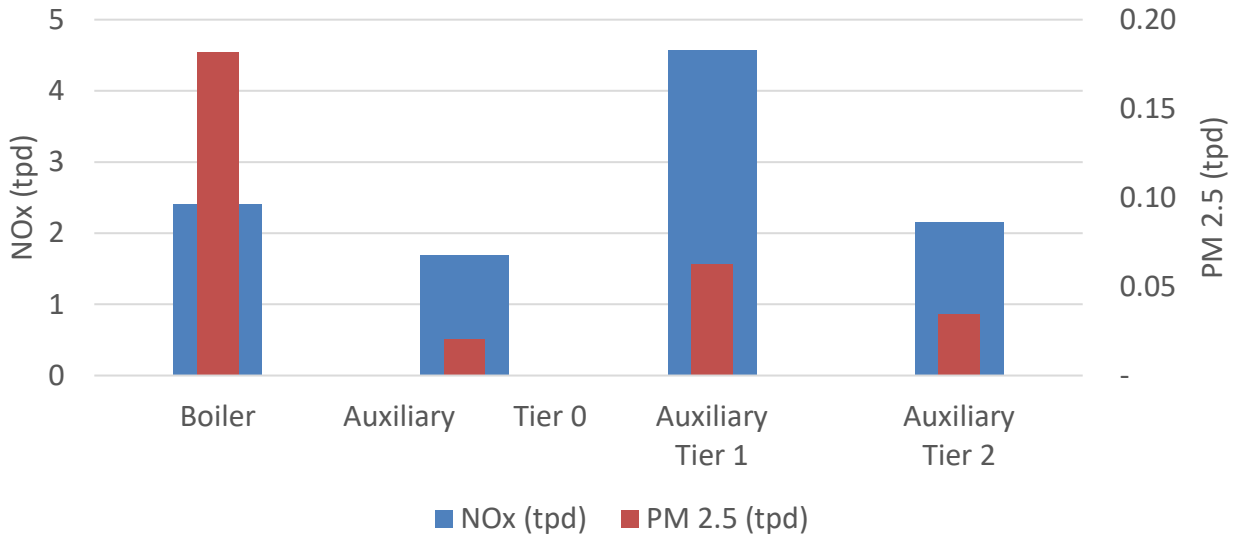
Figure 8 below shows the contribution to statewide at-berth PM emissions by each vessel type and each engine type on the vessel. Tankers and containers are by far the largest overall contributors, in particular tanker boilers.

Figure 8: 2016 Statewide At-Berth PM 2.5 Emission by Vessel and Engine Type



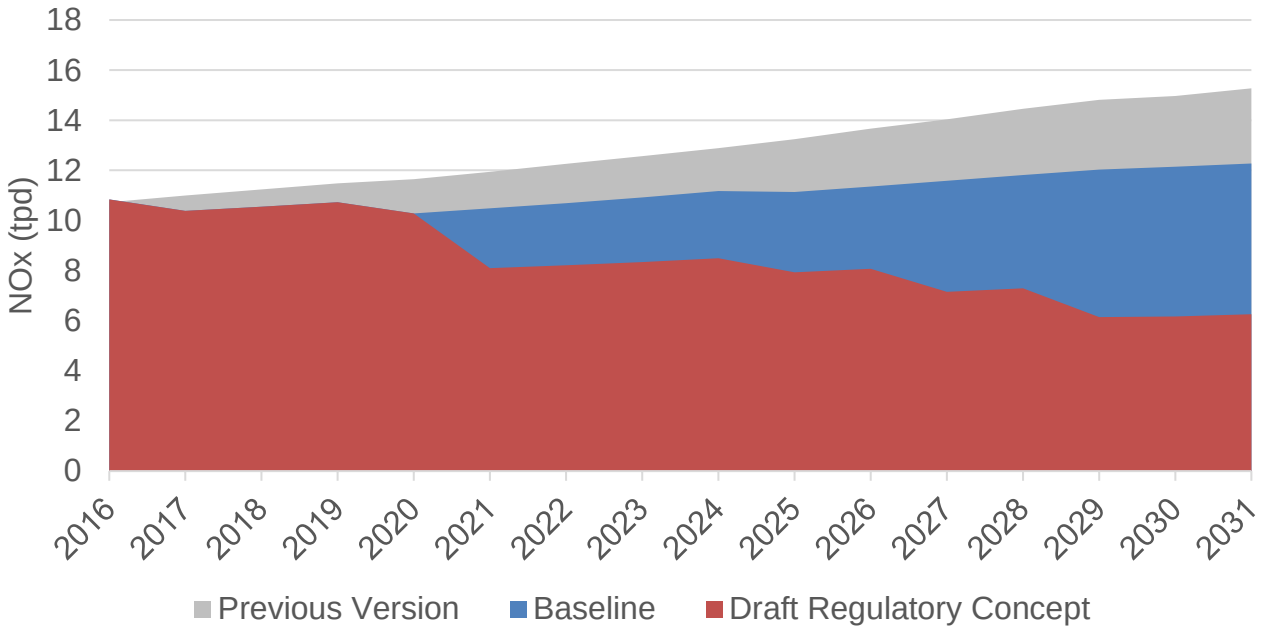
Splitting the auxiliary engines into engine tier standards and comparing against boilers shows that boilers are the largest contributor toward PM emissions, while auxiliary engines are the largest contributor towards NOx emissions. This is shown below in Figure 9.

Figure 9: 2016 Statewide At-Berth NOx and PM 2.5 by Engine Type and Tier



This emissions inventory not only reflect the updates to the baseline, but also provides scenario analysis for the draft at berth regulatory developments described. The following charts show the impact of the updates on the inventory, and the impact of the proposed regulatory changes. As shown in Figure 10, At Berth NOx emissions are lower than previous inventory estimates, and are further reduced in 2021 and 2025 by the draft regulation. Also PM emissions will be given in two units, PM 2.5 and Diesel PM (DPM). The diesel PM emissions are those produced by diesel engines, so it excludes emissions from auxillary engines.

Figure 10: Statewide At Berth NOx Emissions



Similarly, statewide PM emissions from at-berth vessels are lower than previous inventory forecasts.

Figure 11: Statewide At Berth PM 2.5 Emissions

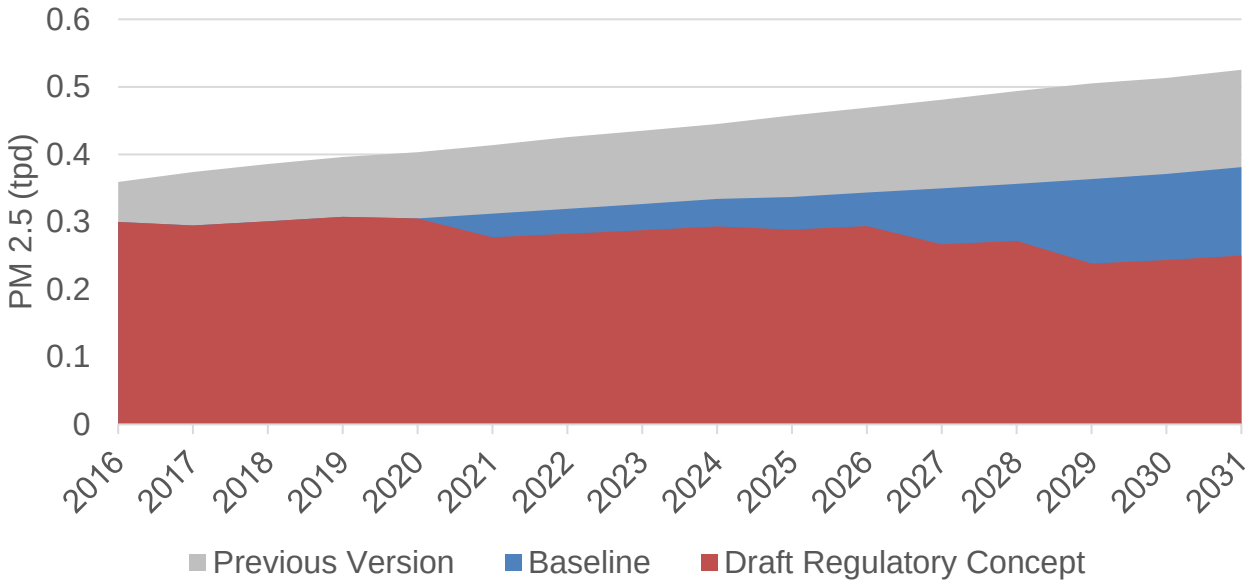


Figure 12: Statewide At Berth DPM Emissions

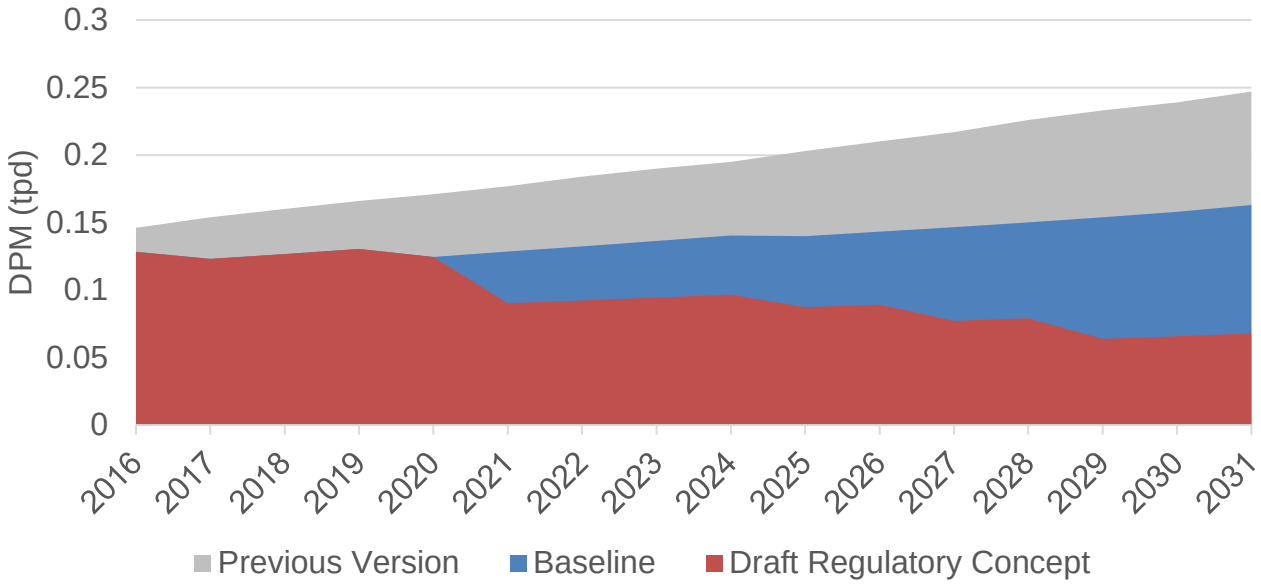


Figure 13 and Figure 14 show the NOx and PM emissions from the Ports of LA/LB, also included in the 2018 HRA, for both the baseline and the proposed At-Berth Amendments scenarios. Similarly, Figure 16 and Figure 17 show the same information for the Port of Richmond.

Table 18 shows the emissions under the existing At Berth Regulation, at a statewide level and also for the two ports in the associated HRA.

Figure 13: NOx Emissions Forecast At Ports of LA/LB

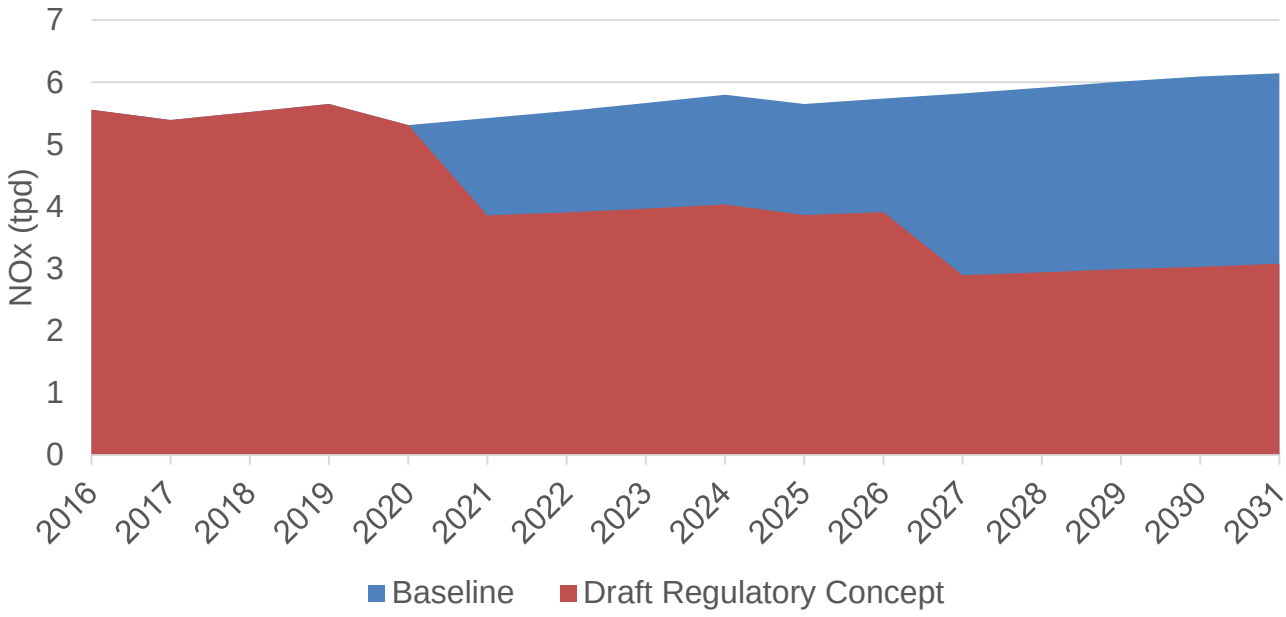


Figure 14: PM 2.5 Emission Forecast at Ports of LA/LB

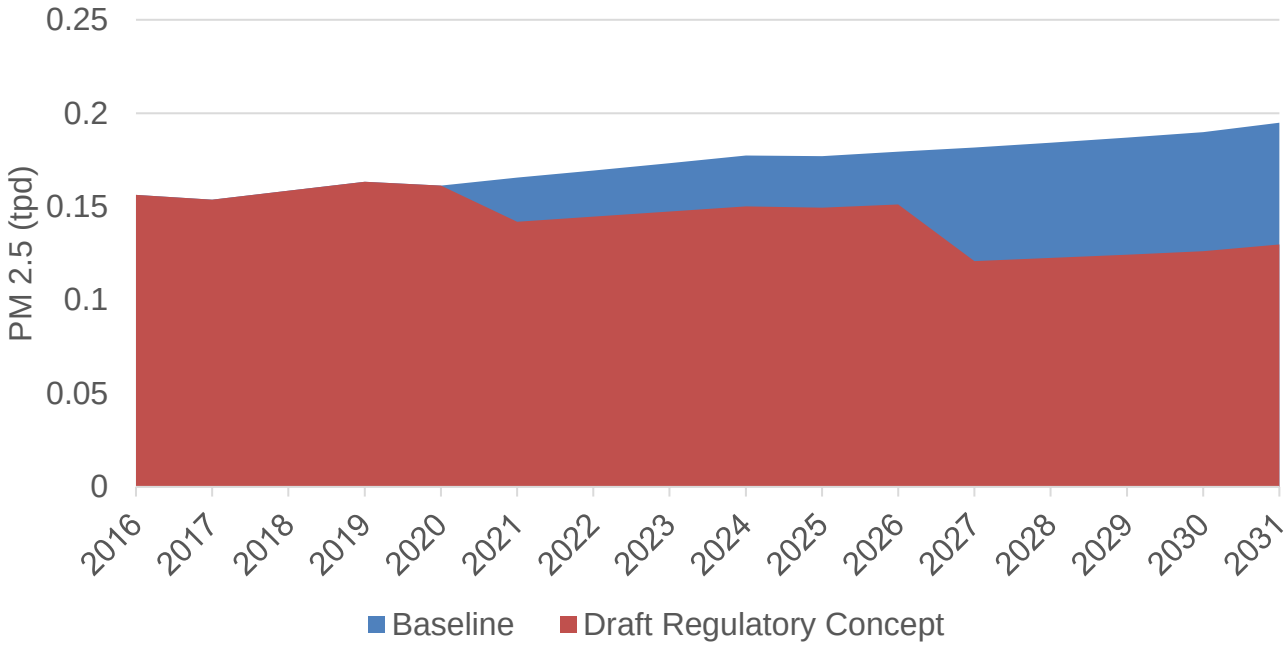


Figure 15: DPM Emission Forecast at Ports of LA/LB

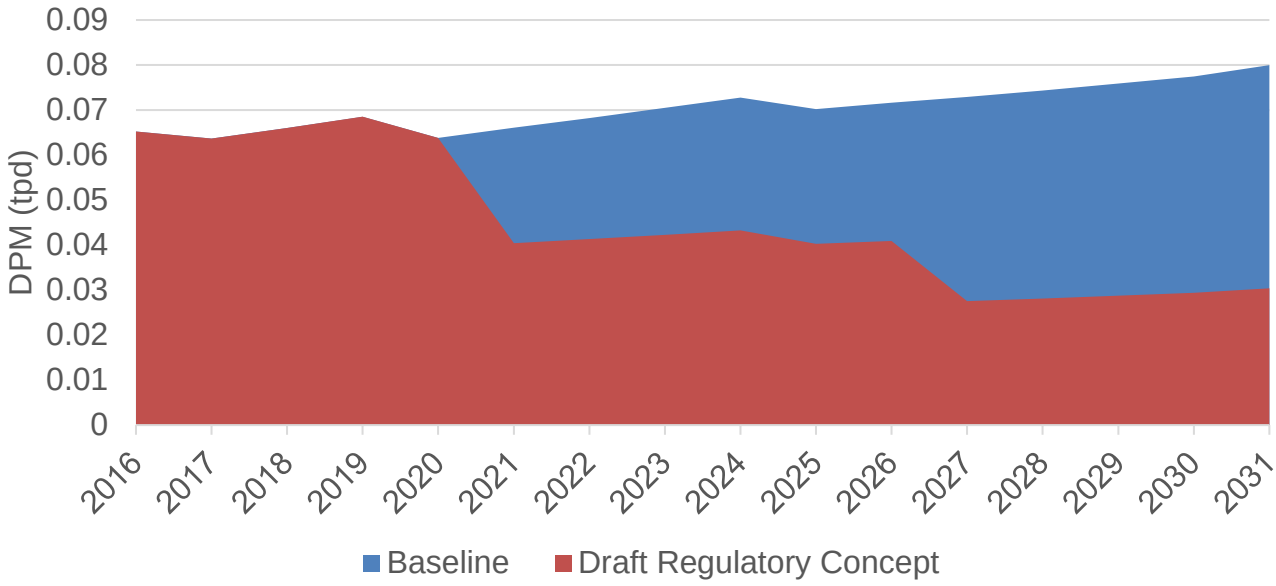


Figure 16: NOx Emission Forecast at the Port of Richmond

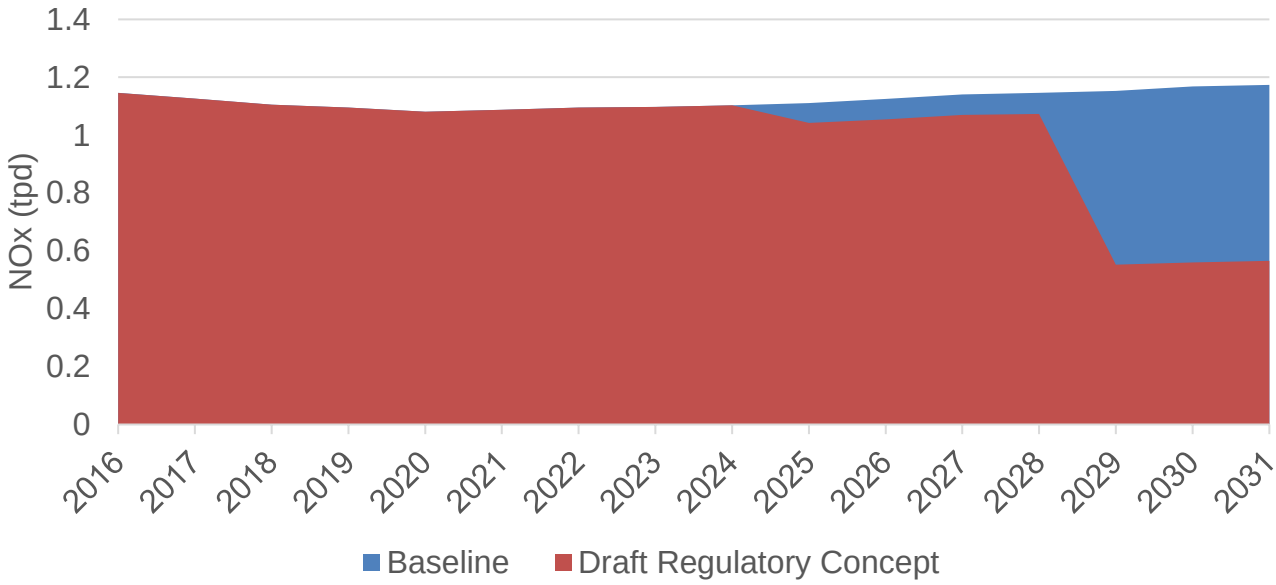


Figure 17: PM 2.5 Emission Forecast at the Port of Richmond

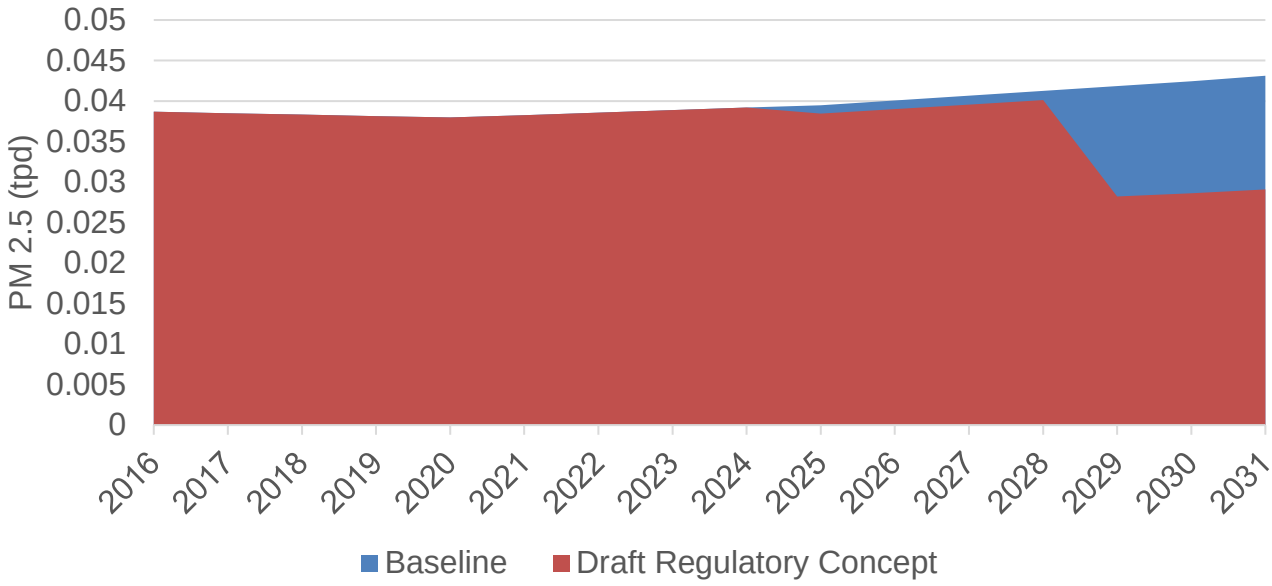


Figure 18: DPM Emission Forecast at the Port of Richmond

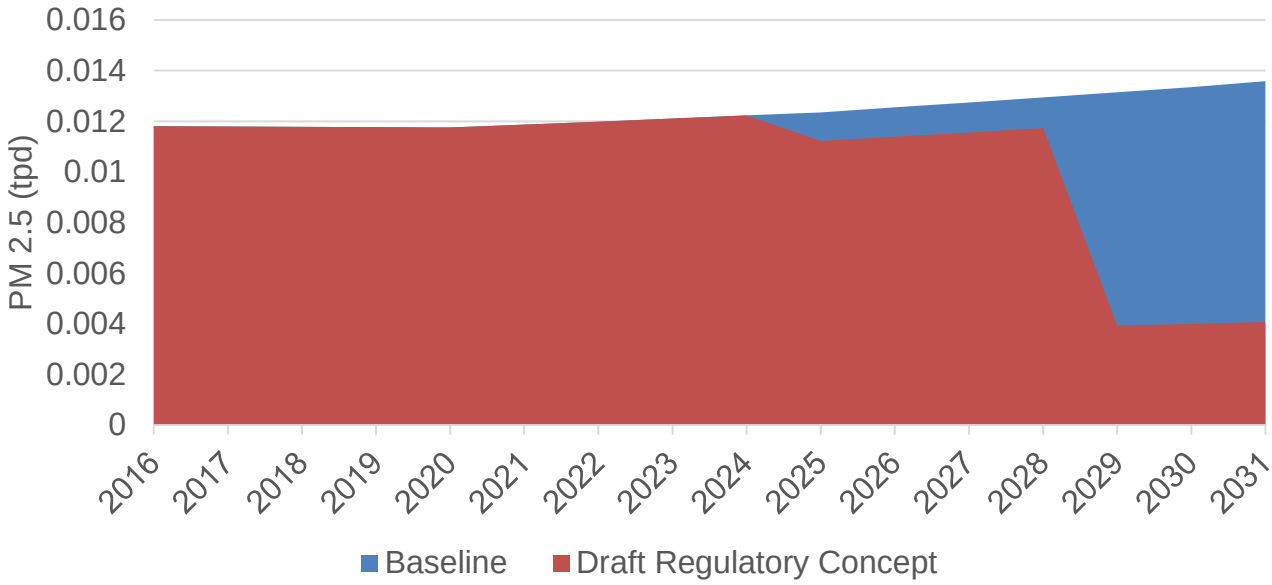


Table 18: Statewide NOx, PM10 and GHG At Berth Emissions under Existing At Berth Regulation

Calendar Year	Statewide			Bay Area			South Coast		
	NOx (tpd)	PM 2.5 (tpd)	DPM (tpd)	NOx (tpd)	PM 2.5 (tpd)	DPM (tpd)	NOx (tpd)	PM 2.5 (tpd)	DPM (tpd)
2016	10.84	0.30	0.13	3.90	0.11	0.04	5.56	0.16	0.07
2017	10.39	0.29	0.12	3.67	0.11	0.04	5.39	0.15	0.06
2018	10.55	0.30	0.13	3.68	0.11	0.04	5.52	0.16	0.07
2019	10.73	0.31	0.13	3.71	0.11	0.04	5.65	0.16	0.07
2020	10.28	0.30	0.12	3.61	0.11	0.04	5.31	0.16	0.06
2021	10.48	0.31	0.13	3.67	0.11	0.04	5.42	0.17	0.07
2022	10.69	0.32	0.13	3.74	0.12	0.04	5.53	0.17	0.07
2023	10.92	0.33	0.14	3.80	0.12	0.05	5.66	0.17	0.07
2024	11.17	0.33	0.14	3.88	0.12	0.05	5.80	0.18	0.07
2025	11.14	0.34	0.14	3.95	0.12	0.05	5.65	0.18	0.07
2026	11.36	0.34	0.14	4.04	0.13	0.05	5.74	0.18	0.07
2027	11.58	0.35	0.15	4.14	0.13	0.05	5.82	0.18	0.07
2028	11.81	0.36	0.15	4.23	0.13	0.05	5.91	0.18	0.07
2029	12.03	0.36	0.15	4.32	0.14	0.05	6.01	0.19	0.08
2030	12.15	0.37	0.16	4.42	0.14	0.05	6.09	0.19	0.08
2031	12.27	0.38	0.16	4.48	0.14	0.06	6.14	0.19	0.08
2032	12.10	0.39	0.17	4.47	0.15	0.06	6.00	0.20	0.08
2033	12.33	0.40	0.17	4.58	0.15	0.06	6.12	0.21	0.09
2034	12.25	0.41	0.18	4.59	0.15	0.06	6.02	0.21	0.09
2035	12.33	0.43	0.19	4.62	0.16	0.06	6.06	0.22	0.09
2036	12.20	0.43	0.19	4.62	0.16	0.07	5.93	0.22	0.09
2037	12.05	0.44	0.19	4.59	0.17	0.07	5.79	0.22	0.09
2038	12.01	0.45	0.20	4.67	0.17	0.07	5.67	0.22	0.09
2039	11.84	0.46	0.20	4.60	0.18	0.07	5.54	0.22	0.09
2040	11.77	0.47	0.21	4.66	0.19	0.08	5.40	0.22	0.10
2041	11.36	0.48	0.21	4.59	0.19	0.08	5.09	0.23	0.10
2042	10.76	0.49	0.22	4.41	0.19	0.08	4.74	0.23	0.10
2043	10.54	0.49	0.22	4.37	0.20	0.08	4.59	0.23	0.10
2044	10.26	0.50	0.23	4.21	0.20	0.08	4.51	0.23	0.10
2045	10.18	0.51	0.23	4.20	0.21	0.09	4.47	0.23	0.10
2046	9.87	0.52	0.24	4.19	0.21	0.09	4.20	0.23	0.10
2047	9.53	0.53	0.24	4.10	0.22	0.09	3.97	0.24	0.10
2048	9.33	0.53	0.24	4.05	0.22	0.09	3.89	0.24	0.10
2049	9.37	0.54	0.25	4.12	0.23	0.10	3.89	0.24	0.11
2050	9.31	0.55	0.25	4.13	0.23	0.10	3.82	0.24	0.11

Appendix A: Emission Factors

Emission Factors (all in g/kW*hr)

Engine type	Mode	Fuel type	Fuel S content (%)	Tier ID	CH4	N2O	NH3	ROG	CO	SOx	NOx	HC	PM 10	PM 2.5	CO2	TOG	Fuel Used
Auxiliary	At-Berth	Distillate	0.1	0	0.008	0.033	0.001	0.520	1.10	0.424	13.800	0.40	0.182	0.168	676	0.620	217
Auxiliary	At-Berth	Distillate	0.1	1	0.008	0.033	0.001	0.520	1.10	0.424	12.200	0.40	0.182	0.168	676	0.620	217
Auxiliary	At-Berth	Distillate	0.1	2	0.008	0.033	0.001	0.520	1.10	0.424	10.500	0.40	0.182	0.168	676	0.620	217
Auxiliary	At-Berth	Distillate	0.1	3	0.008	0.033	0.001	0.520	1.10	0.424	2.600	0.40	0.182	0.168	676	0.620	217
Auxiliary	At-Berth	Distillate	0.3	0	0.008	0.033	0.001	0.520	1.10	1.273	13.800	0.40	0.250	0.230	676	0.620	217
Auxiliary	At-Berth	Distillate	0.3	1	0.008	0.033	0.001	0.520	1.10	1.273	12.200	0.40	0.250	0.230	676	0.620	217
Auxiliary	At-Berth	Distillate	0.3	2	0.008	0.033	0.001	0.520	1.10	1.273	10.500	0.40	0.250	0.230	676	0.620	217
Auxiliary	At-Berth	Distillate	0.3	3	0.008	0.033	0.001	0.520	1.10	1.273	2.600	0.40	0.250	0.230	676	0.620	217
Auxiliary	At-Berth	Distillate	1	0	0.008	0.033	0.001	0.520	1.10	4.242	13.800	0.40	0.489	0.450	676	0.620	217
Auxiliary	At-Berth	Distillate	1	1	0.008	0.033	0.001	0.520	1.10	4.242	12.200	0.40	0.489	0.450	676	0.620	217
Auxiliary	At-Berth	Distillate	1	2	0.008	0.033	0.001	0.520	1.10	4.242	10.500	0.40	0.489	0.450	676	0.620	217
Auxiliary	At-Berth	Distillate	1	3	0.008	0.033	0.001	0.520	1.10	4.242	2.600	0.40	0.489	0.450	676	0.620	217
Auxiliary	At-Berth	residual	2.7	0	0.008	0.036	0.001	0.460	1.10	11.983	14.700	0.40	1.436	1.321	707	0.510	227
Auxiliary	At-Berth	residual	2.7	1	0.008	0.036	0.001	0.460	1.10	11.983	13.000	0.40	1.436	1.321	707	0.510	227
Auxiliary	At-Berth	residual	2.7	2	0.008	0.036	0.001	0.460	1.10	11.983	11.200	0.40	1.436	1.321	707	0.510	227
Auxiliary	At-Berth	residual	2.7	3	0.008	0.036	0.001	0.460	1.10	11.983	2.309	0.40	1.436	1.321	707	0.510	227
Boiler	At-Berth	Distillate	0.1	99	0.002	0.045	0.006	0.110	0.20	0.587	1.995	0.10	0.164	0.151	934	0.130	300
Boiler	At-Berth	Distillate	0.3	99	0.002	0.045	0.006	0.110	0.20	1.636	1.995	0.10	0.164	0.151	934	0.130	300
Boiler	At-Berth	Distillate	1	99	0.002	0.045	0.006	0.110	0.20	1.760	1.995	0.10	0.589	0.542	934	0.130	300
Boiler	At-Berth	residual	2.7	99	0.002	0.049	0.006	0.110	0.20	16.100	2.100	0.10	1.465	1.348	950	0.130	305

Sources:

Particulate Matter:

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ENTEC (2002). *Quantification of emissions from ships associated with ship movements between ports in the European Community*. UK: Report prepared for the European Commission; 2002. http://ec.europa.eu/environment/air/pdf/chapter2_ship_emissions.pdf [Accessed June 12 2018].

Appendix B: Emissions Results for 2016

AB	DIS	Arrival Port	Mode	Vessel Type	Size bin	Vessel Subtype	Engine type	tier ID	Fuel type	Energy Used (kWh)	NOx (tpy)	PM10 (tpy)	PM 2.5 (tpy)	DPM (tpy)	SOx (tpy)	CO2eq (tpy)
SF	BA	Avon	At Berth	Bulk		Bulk	Auxiliary	2	Distillate	190	0.002	0.000038	0.000035	0.000038	0.00009	0.1
SF	BA	Avon	At Berth	Bulk		Bulk	Boiler	-	Distillate	125	0.000	0.000023	0.000021		0.00008	0.1
SF	BA	Avon	At Berth	Tanker	Seawaymax	Crude	Auxiliary	0	Distillate	18032	0.274	0.003622	0.003332	0.003622	0.00843	13.4
SF	BA	Avon	At Berth	Tanker	Panamax	Crude	Auxiliary	1	Distillate	100716	1.354	0.020229	0.018611	0.020229	0.04710	75.0
SF	BA	Avon	At Berth	Tanker	Panamax	Crude	Auxiliary	2	Distillate	63438	0.734	0.012742	0.011723	0.012742	0.02967	47.3
SF	BA	Avon	At Berth	Tanker	Panamax	Crude	Boiler	-	Distillate	858671	1.888	0.155170	0.142756		0.55515	884.3
SF	BA	Avon	At Berth	Tanker	Seawaymax	Crude	Boiler	-	Distillate	59478	0.131	0.010748	0.009888		0.03845	61.3
SF	BA	Avon	At Berth	Tanker	Seawaymax	Product	Auxiliary	0	Distillate	105056	1.598	0.021101	0.019413	0.021101	0.04913	78.3
SF	BA	Avon	At Berth	Tanker	Panamax	Product	Auxiliary	1	Distillate	99408	1.337	0.019967	0.018369	0.019967	0.04649	74.1
SF	BA	Avon	At Berth	Tanker	Seawaymax	Product	Auxiliary	1	Distillate	1614256	21.709	0.324233	0.298294	0.324233	0.75490	1202.5
SF	BA	Avon	At Berth	Tanker	Seawaymax	Product	Auxiliary	2	Distillate	864752	10.009	0.173691	0.159795	0.173691	0.40440	644.2
SF	BA	Avon	At Berth	Tanker	Panamax	Product	Boiler	-	Distillate	519992	1.144	0.093967	0.086450		0.33618	535.5
SF	BA	Avon	At Berth	Tanker	Seawaymax	Product	Boiler	-	Distillate	8523456	18.744	1.540266	1.417043		5.51057	8777.6
SF	BA	Benicia	At Berth	auto		auto	Auxiliary	0	Distillate	905179	13.769	0.181811	0.167266	0.181811	0.42331	674.3
SF	BA	Benicia	At Berth	auto		auto	Auxiliary	1	Distillate	1714161	23.052	0.344299	0.316755	0.344299	0.80162	1276.9
SF	BA	Benicia	At Berth	auto		auto	Auxiliary	2	Distillate	576023	6.667	0.115698	0.106442	0.115698	0.26938	429.1
SF	BA	Benicia	At Berth	auto		auto	Boiler	-	Distillate	865698	1.904	0.156439	0.143924		0.55969	891.5
SF	BA	Benicia	At Berth	Bulk		Bulk	Auxiliary	1	Distillate	213560	2.872	0.042895	0.039463	0.042895	0.09987	159.1
SF	BA	Benicia	At Berth	Bulk		Bulk	Auxiliary	2	Distillate	367460	4.253	0.073807	0.067902	0.073807	0.17184	273.7
SF	BA	Benicia	At Berth	Bulk		Bulk	Boiler	-	Distillate	382250	0.841	0.069076	0.063550		0.24713	393.6
SF	BA	Benicia	At Berth	Tanker	Aframax	Crude	Auxiliary	1	Distillate	146972	1.976	0.029520	0.027159	0.029520	0.06873	109.5
SF	BA	Benicia	At Berth	Tanker	Panamax	Crude	Auxiliary	1	Distillate	221052	2.973	0.044400	0.040848	0.044400	0.10337	164.7
SF	BA	Benicia	At Berth	Tanker	Suezmax	Crude	Auxiliary	1	Distillate	1354860	18.220	0.272132	0.250361	0.272132	0.63360	1009.2
SF	BA	Benicia	At Berth	Tanker	Aframax	Crude	Auxiliary	2	Distillate	626260	7.248	0.125788	0.115725	0.125788	0.29287	466.5
SF	BA	Benicia	At Berth	Tanker	Panamax	Crude	Auxiliary	2	Distillate	18966	0.220	0.003809	0.003505	0.003809	0.00887	14.1
SF	BA	Benicia	At Berth	Tanker	Aframax	Crude	Boiler	-	Distillate	5372040	11.814	0.970776	0.893113		3.47312	5532.2
SF	BA	Benicia	At Berth	Tanker	Panamax	Crude	Boiler	-	Distillate	1255507	2.761	0.226882	0.208731		0.81171	1292.9
SF	BA	Benicia	At Berth	Tanker	Suezmax	Crude	Boiler	-	Distillate	3155220	6.939	0.570177	0.524562		2.03991	3249.3
SF	BA	Benicia	At Berth	Tanker	Panamax	Product	Auxiliary	1	Distillate	22236	0.299	0.004466	0.004109	0.004466	0.01040	16.6
SF	BA	Benicia	At Berth	Tanker	Seawaymax	Product	Auxiliary	1	Distillate	98784	1.328	0.019841	0.018254	0.019841	0.04620	73.6
SF	BA	Benicia	At Berth	Tanker	Seawaymax	Product	Auxiliary	2	Distillate	36064	0.417	0.007244	0.006664	0.007244	0.01687	26.9
SF	BA	Benicia	At Berth	Tanker	Panamax	Product	Boiler	-	Distillate	116314	0.256	0.021019	0.019337		0.07520	119.8
SF	BA	Benicia	At Berth	Tanker	Seawaymax	Product	Boiler	-	Distillate	444792	0.978	0.080378	0.073948		0.28757	458.1
SF	BA	Crockett	At Berth	Bulk		Bulk	Auxiliary	1	Distillate	353780	4.758	0.071059	0.065374	0.071059	0.16544	263.5
SF	BA	Crockett	At Berth	Bulk		Bulk	Auxiliary	2	Distillate	244910	2.835	0.049192	0.045256	0.049192	0.11453	182.4
SF	BA	Crockett	At Berth	Bulk		Bulk	Boiler	-	Distillate	393875	0.866	0.071177	0.065483		0.25465	405.6

AB	DIS	Arrival Port	Mode	Vessel Type	Size bin	Vessel Subtype	Engine type	tier ID	Fuel type	Energy Used (kWh)	NOx (tpy)	PM10 (tpy)	PM 2.5 (tpy)	DPM (tpy)	SOx (tpy)	CO2eq (tpy)
SF	BA	Crockett	At Berth	general		general	Auxiliary	1	Distillate	271671	3.653	0.054567	0.050201	0.054567	0.12705	202.4
SF	BA	Crockett	At Berth	general		general	Auxiliary	2	Distillate	183097	2.119	0.036776	0.033834	0.036776	0.08563	136.4
SF	BA	Crockett	At Berth	general		general	Boiler	-	Distillate	110080	0.242	0.019892	0.018301		0.07117	113.4
NC	NCU	Eureka	At Berth	Bulk		Bulk	Auxiliary	2	Distillate	85310	0.987	0.017135	0.015764	0.017135	0.03990	63.5
NC	NCU	Eureka	At Berth	Bulk		Bulk	Boiler	-	Distillate	56125	0.123	0.010142	0.009331		0.03629	57.8
NC	NCU	Eureka	At Berth	Bulk		Misc	Auxiliary	0	Distillate	17100	0.260	0.003435	0.003160	0.003435	0.00800	12.7
NC	NCU	Eureka	At Berth	Bulk		Misc	Auxiliary	1	Distillate	45220	0.608	0.009083	0.008356	0.009083	0.02115	33.7
NC	NCU	Eureka	At Berth	Bulk		Misc	Boiler	-	Distillate	41000	0.090	0.007409	0.006816		0.02651	42.2
SCC	Ven	Hueneme	At Berth	auto		auto	Auxiliary	0	Distillate	1262151	19.200	0.253511	0.233230	0.253511	0.59024	940.2
SCC	Ven	Hueneme	At Berth	auto		auto	Auxiliary	1	Distillate	2422310	32.575	0.486535	0.447612	0.486535	1.13279	1804.4
SCC	Ven	Hueneme	At Berth	auto		auto	Auxiliary	2	Distillate	895907	10.369	0.179948	0.165552	0.179948	0.41897	667.4
SCC	Ven	Hueneme	At Berth	auto		auto	Boiler	-	Distillate	1240928	2.729	0.224247	0.206307		0.80228	1277.9
SCC	Ven	Hueneme	At Berth	Container	1	Container	Auxiliary	1	Distillate	313662	4.218	0.063001	0.057961	0.063001	0.14668	233.6
SCC	Ven	Hueneme	At Berth	Container	2	Container	Auxiliary	1	Distillate	158508	2.132	0.031837	0.029290	0.031837	0.07413	118.1
SCC	Ven	Hueneme	At Berth	Container	2	Container	Auxiliary	2	Distillate	36260	0.420	0.007283	0.006700	0.007283	0.01696	27.0
SCC	Ven	Hueneme	At Berth	Container	1	Container	Boiler	-	Distillate	603876	1.328	0.109126	0.100396		0.39042	621.9
SCC	Ven	Hueneme	At Berth	Container	2	Container	Boiler	-	Distillate	67868	0.149	0.012264	0.011283		0.04388	69.9
SCC	Ven	Hueneme	At Berth	general		general	Auxiliary	2	Distillate	261095	3.022	0.052442	0.048247	0.052442	0.12210	194.5
SCC	Ven	Hueneme	At Berth	general		general	Boiler	-	Distillate	63200	0.139	0.011421	0.010507		0.04086	65.1
SCC	Ven	Hueneme	At Berth	Tanker	Seawaymax	Product	Auxiliary	0	Distillate	206192	3.137	0.041415	0.038102	0.041415	0.09643	153.6
SCC	Ven	Hueneme	At Berth	Tanker	Seawaymax	Product	Auxiliary	1	Distillate	259504	3.490	0.052123	0.047953	0.052123	0.12136	193.3
SCC	Ven	Hueneme	At Berth	Tanker	Seawaymax	Product	Auxiliary	2	Distillate	28224	0.327	0.005669	0.005215	0.005669	0.01320	21.0
SCC	Ven	Hueneme	At Berth	Tanker	Seawaymax	Product	Boiler	-	Distillate	1629180	3.583	0.294408	0.270855		1.05330	1677.8
SCC	Ven	Hueneme	At Berth	reefer		reefer	Auxiliary	1	Distillate	3180600	42.773	0.638842	0.587735	0.638842	1.48740	2369.3
SCC	Ven	Hueneme	At Berth	reefer		reefer	Boiler	-	Distillate	1074336	2.363	0.194142	0.178611		0.69458	1106.4
SC	SC	Long Beach	At Berth	auto		auto	Auxiliary	0	Distillate	586454	8.921	0.117793	0.108369	0.117793	0.27425	436.9
SC	SC	Long Beach	At Berth	auto		auto	Auxiliary	1	Distillate	1819630	24.470	0.365483	0.336245	0.365483	0.85095	1355.5
SC	SC	Long Beach	At Berth	auto		auto	Auxiliary	2	Distillate	667584	7.727	0.134088	0.123361	0.134088	0.31219	497.3
SC	SC	Long Beach	At Berth	auto		auto	Boiler	-	Distillate	832728	1.831	0.150482	0.138443		0.53837	857.6
SC	SC	Long Beach	At Berth	Bulk		Bulk	Auxiliary	0	Distillate	4560	0.069	0.000916	0.000843	0.000916	0.00213	3.4
SC	SC	Long Beach	At Berth	Bulk		Bulk	Auxiliary	1	Distillate	1105420	14.866	0.222030	0.204268	0.222030	0.51695	823.4
SC	SC	Long Beach	At Berth	Bulk		Bulk	Auxiliary	2	Distillate	1228113	14.214	0.246674	0.226940	0.246674	0.57433	914.8
SC	SC	Long Beach	At Berth	Bulk		Bulk	Boiler	-	Distillate	1546149	3.400	0.279403	0.257051		0.99961	1592.3
SC	SC	Long Beach	At Berth	Container	1	Container	Auxiliary	0	Distillate	687421	10.457	0.138073	0.127027	0.138073	0.32147	512.1
SC	SC	Long Beach	At Berth	Container	2	Container	Auxiliary	0	Distillate	1589989	24.186	0.319359	0.293810	0.319359	0.74356	1184.4
SC	SC	Long Beach	At Berth	Container	3	Container	Auxiliary	0	Distillate	137969	2.099	0.027712	0.025495	0.027712	0.06452	102.8
SC	SC	Long Beach	At Berth	Container	4	Container	Auxiliary	0	Distillate	47746	0.726	0.009590	0.008823	0.009590	0.02233	35.6
SC	SC	Long Beach	At Berth	Container	5	Container	Auxiliary	0	Distillate	702985	10.694	0.141199	0.129903	0.141199	0.32875	523.7

AB	DIS	Arrival Port	Mode	Vessel Type	Size bin	Vessel Subtype	Engine type	tier ID	Fuel type	Energy Used (kWh)	NOx (tpy)	PM10 (tpy)	PM 2.5 (tpy)	DPM (tpy)	SOx (tpy)	CO2eq (tpy)
SC	SC	Long Beach	At Berth	Container	1	Container	Auxiliary	1	Distillate	613853	8.255	0.123296	0.113432	0.123296	0.28707	457.3
SC	SC	Long Beach	At Berth	Container	10	Container	Auxiliary	1	Distillate	1927339	25.919	0.387118	0.356148	0.387118	0.90132	1435.7
SC	SC	Long Beach	At Berth	Container	11	Container	Auxiliary	1	Distillate	1974117	26.548	0.396513	0.364792	0.396513	0.92319	1470.5
SC	SC	Long Beach	At Berth	Container	2	Container	Auxiliary	1	Distillate	2690488	36.182	0.540401	0.497168	0.540401	1.25820	2004.2
SC	SC	Long Beach	At Berth	Container	3	Container	Auxiliary	1	Distillate	601015	8.082	0.120717	0.111060	0.120717	0.28106	447.7
SC	SC	Long Beach	At Berth	Container	4	Container	Auxiliary	1	Distillate	2025103	27.234	0.406754	0.374214	0.406754	0.94704	1508.5
SC	SC	Long Beach	At Berth	Container	5	Container	Auxiliary	1	Distillate	1547498	20.811	0.310824	0.285958	0.310824	0.72369	1152.7
SC	SC	Long Beach	At Berth	Container	6	Container	Auxiliary	1	Distillate	46640	0.627	0.009368	0.008618	0.009368	0.02181	34.7
SC	SC	Long Beach	At Berth	Container	7	Container	Auxiliary	1	Distillate	257249	3.459	0.051670	0.047536	0.051670	0.12030	191.6
SC	SC	Long Beach	At Berth	Container	8	Container	Auxiliary	1	Distillate	2851738	38.350	0.572789	0.526965	0.572789	1.33361	2124.3
SC	SC	Long Beach	At Berth	Container	9	Container	Auxiliary	1	Distillate	934634	12.569	0.187727	0.172709	0.187727	0.43708	696.2
SC	SC	Long Beach	At Berth	Container	1	Container	Auxiliary	2	Distillate	131674	1.524	0.026447	0.024332	0.026447	0.06158	98.1
SC	SC	Long Beach	At Berth	Container	10	Container	Auxiliary	2	Distillate	2680833	31.028	0.538461	0.495384	0.538461	1.25369	1997.0
SC	SC	Long Beach	At Berth	Container	11	Container	Auxiliary	2	Distillate	553213	6.403	0.111116	0.102227	0.111116	0.25871	412.1
SC	SC	Long Beach	At Berth	Container	13	Container	Auxiliary	2	Distillate	1643109	19.018	0.330028	0.303626	0.330028	0.76840	1224.0
SC	SC	Long Beach	At Berth	Container	17	Container	Auxiliary	2	Distillate	142000	1.644	0.028522	0.026240	0.028522	0.06641	105.8
SC	SC	Long Beach	At Berth	Container	2	Container	Auxiliary	2	Distillate	355219	4.111	0.071348	0.065640	0.071348	0.16612	264.6
SC	SC	Long Beach	At Berth	Container	3	Container	Auxiliary	2	Distillate	465408	5.387	0.093480	0.086002	0.093480	0.21765	346.7
SC	SC	Long Beach	At Berth	Container	4	Container	Auxiliary	2	Distillate	675677	7.820	0.135714	0.124857	0.135714	0.31598	503.3
SC	SC	Long Beach	At Berth	Container	5	Container	Auxiliary	2	Distillate	331399	3.836	0.066563	0.061238	0.066563	0.15498	246.9
SC	SC	Long Beach	At Berth	Container	8	Container	Auxiliary	2	Distillate	1848501	21.395	0.371282	0.341580	0.371282	0.86445	1377.0
SC	SC	Long Beach	At Berth	Container	9	Container	Auxiliary	2	Distillate	950108	10.997	0.190835	0.175568	0.190835	0.44432	707.7
SC	SC	Long Beach	At Berth	Container	1	Container	Boiler	-	Distillate	834834	1.836	0.150862	0.138793		0.53974	859.7
SC	SC	Long Beach	At Berth	Container	10	Container	Boiler	-	Distillate	3407565	7.494	0.615778	0.566515		2.20305	3509.2
SC	SC	Long Beach	At Berth	Container	11	Container	Boiler	-	Distillate	5904460	12.984	1.066990	0.981629		3.81734	6080.5
SC	SC	Long Beach	At Berth	Container	13	Container	Boiler	-	Distillate	1532448	3.370	0.276927	0.254773		0.99076	1578.1
SC	SC	Long Beach	At Berth	Container	17	Container	Boiler	-	Distillate	91874	0.202	0.016602	0.015274		0.05940	94.6
SC	SC	Long Beach	At Berth	Container	2	Container	Boiler	-	Distillate	1969255	4.331	0.355862	0.327393		1.27316	2028.0
SC	SC	Long Beach	At Berth	Container	3	Container	Boiler	-	Distillate	1070580	2.354	0.193464	0.177986		0.69215	1102.5
SC	SC	Long Beach	At Berth	Container	4	Container	Boiler	-	Distillate	2718423	5.978	0.491244	0.451944		1.75751	2799.5
SC	SC	Long Beach	At Berth	Container	5	Container	Boiler	-	Distillate	2566707	5.644	0.463827	0.426721		1.65942	2643.2
SC	SC	Long Beach	At Berth	Container	6	Container	Boiler	-	Distillate	105165	0.231	0.019004	0.017484		0.06799	108.3
SC	SC	Long Beach	At Berth	Container	7	Container	Boiler	-	Distillate	285334	0.627	0.051562	0.047437		0.18447	293.8
SC	SC	Long Beach	At Berth	Container	8	Container	Boiler	-	Distillate	11448184	25.176	2.068791	1.903286		7.40147	11789.6
SC	SC	Long Beach	At Berth	Container	9	Container	Boiler	-	Distillate	2886051	6.347	0.521536	0.479812		1.86589	2972.1
SC	SC	Long Beach	At Berth	Tanker	Aframax	Crude	Auxiliary	1	Distillate	2914824	39.199	0.585460	0.538623	0.585460	1.36311	2171.3
SC	SC	Long Beach	At Berth	Tanker	Panamax	Crude	Auxiliary	1	Distillate	2287038	30.756	0.459365	0.422616	0.459365	1.06953	1703.6
SC	SC	Long Beach	At Berth	Tanker	Seawaymax	Crude	Auxiliary	1	Distillate	56448	0.759	0.011338	0.010431	0.011338	0.02640	42.0

AB	DIS	Arrival Port	Mode	Vessel Type	Size bin	Vessel Subtype	Engine type	tier ID	Fuel type	Energy Used (kWh)	NOx (tpy)	PM10 (tpy)	PM 2.5 (tpy)	DPM (tpy)	SOx (tpy)	CO2eq (tpy)
SC	SC	Long Beach	At Berth	Tanker	Suezmax	Crude	Auxiliary	1	Distillate	5296499	71.228	1.063833	0.978727	1.063833	2.47690	3945.4
SC	SC	Long Beach	At Berth	Tanker	ULCC	Crude	Auxiliary	1	Distillate	392285	5.275	0.078793	0.072489	0.078793	0.18345	292.2
SC	SC	Long Beach	At Berth	Tanker	VLCC	Crude	Auxiliary	1	Distillate	721336	9.701	0.144885	0.133294	0.144885	0.33733	537.3
SC	SC	Long Beach	At Berth	Tanker	Aframax	Crude	Auxiliary	2	Distillate	1984484	22.969	0.398595	0.366708	0.398595	0.92804	1478.3
SC	SC	Long Beach	At Berth	Tanker	Panamax	Crude	Auxiliary	2	Distillate	113142	1.310	0.022725	0.020907	0.022725	0.05291	84.3
SC	SC	Long Beach	At Berth	Tanker	Suezmax	Crude	Auxiliary	2	Distillate	1405040	16.262	0.282211	0.259634	0.282211	0.65706	1046.6
SC	SC	Long Beach	At Berth	Tanker	ULCC	Crude	Auxiliary	2	Distillate	672154	7.780	0.135006	0.124206	0.135006	0.31433	500.7
SC	SC	Long Beach	At Berth	Tanker	VLCC	Crude	Auxiliary	2	Distillate	637024	7.373	0.127950	0.117714	0.127950	0.29790	474.5
SC	SC	Long Beach	At Berth	Tanker	Aframax	Crude	Boiler	-	Distillate	34038010	74.853	6.150977	5.658894		22.00621	35053.0
SC	SC	Long Beach	At Berth	Tanker	Panamax	Crude	Boiler	-	Distillate	12555070	27.610	2.268815	2.087308		8.11709	12929.5
SC	SC	Long Beach	At Berth	Tanker	Seawaymax	Crude	Boiler	-	Distillate	186192	0.409	0.033647	0.030955		0.12038	191.7
SC	SC	Long Beach	At Berth	Tanker	Suezmax	Crude	Boiler	-	Distillate	15606653	34.320	2.820264	2.594640		10.08999	16072.1
SC	SC	Long Beach	At Berth	Tanker	ULCC	Crude	Boiler	-	Distillate	5454000	11.994	0.985587	0.906739		3.52611	5616.6
SC	SC	Long Beach	At Berth	Tanker	VLCC	Crude	Boiler	-	Distillate	6960000	15.306	1.257735	1.157115		4.49977	7167.6
SC	SC	Long Beach	At Berth	Cruise		Cruise	Auxiliary	0	Distillate	7281711	110.767	1.462575	1.345569	1.462575	3.40528	5424.2
SC	SC	Long Beach	At Berth	Cruise		Cruise	Auxiliary	1	Distillate	1451676	19.522	0.291578	0.268252	0.291578	0.67887	1081.4
SC	SC	Long Beach	At Berth	Cruise		Cruise	Boiler	-	Distillate	2061828	4.534	0.372591	0.342783		1.33301	2123.3
SC	SC	Long Beach	At Berth	general		general	Auxiliary	0	Distillate	117658	1.790	0.023632	0.021742	0.023632	0.05502	87.6
SC	SC	Long Beach	At Berth	general		general	Auxiliary	1	Distillate	282247	3.796	0.056691	0.052156	0.056691	0.13199	210.2
SC	SC	Long Beach	At Berth	general		general	Auxiliary	2	Distillate	421718	4.881	0.084705	0.077928	0.084705	0.19722	314.1
SC	SC	Long Beach	At Berth	general		general	Boiler	-	Distillate	198880	0.437	0.035939	0.033064		0.12858	204.8
SC	SC	Long Beach	At Berth	Tanker	Seawaymax	Product	Auxiliary	0	Distillate	43120	0.656	0.008661	0.007968	0.008661	0.02017	32.1
SC	SC	Long Beach	At Berth	Tanker	Panamax	Product	Auxiliary	1	Distillate	504234	6.781	0.101278	0.093176	0.101278	0.23580	375.6
SC	SC	Long Beach	At Berth	Tanker	Seawaymax	Product	Auxiliary	1	Distillate	2646000	35.584	0.531465	0.488948	0.531465	1.23740	1971.0
SC	SC	Long Beach	At Berth	Tanker	Seawaymax	Product	Auxiliary	2	Distillate	813792	9.419	0.163455	0.150379	0.163455	0.38057	606.2
SC	SC	Long Beach	At Berth	Tanker	Panamax	Product	Boiler	-	Distillate	2637591	5.800	0.476637	0.438505		1.70525	2716.2
SC	SC	Long Beach	At Berth	Tanker	Seawaymax	Product	Boiler	-	Distillate	11554248	25.409	2.087958	1.920919		7.47004	11898.8
SC	SC	Long Beach	At Berth	reefer		reefer	Auxiliary	1	Distillate	5400	0.073	0.001085	0.000998	0.001085	0.00253	4.0
SC	SC	Long Beach	At Berth	reefer		reefer	Boiler	-	Distillate	1824	0.004	0.000330	0.000303		0.00118	1.9
SC	SC	Long Beach	At Berth	roro		roro	Auxiliary	0	Distillate	426600	6.489	0.085685	0.078830	0.085685	0.19950	317.8
SC	SC	Long Beach	At Berth	roro		roro	Boiler	-	Distillate	155400	0.342	0.028082	0.025836		0.10047	160.0
SC	SC	Los Angeles	At Berth	auto		auto	Auxiliary	0	Distillate	220210	3.350	0.044230	0.040692	0.044230	0.10298	164.0
SC	SC	Los Angeles	At Berth	auto		auto	Auxiliary	1	Distillate	995581	13.389	0.199968	0.183971	0.199968	0.46558	741.6
SC	SC	Los Angeles	At Berth	auto		auto	Auxiliary	2	Distillate	859978	9.954	0.172732	0.158913	0.172732	0.40217	640.6
SC	SC	Los Angeles	At Berth	auto		auto	Boiler	-	Distillate	562374	1.237	0.101626	0.093496		0.36359	579.1
SC	SC	Los Angeles	At Berth	Bulk		Bulk	Auxiliary	0	Distillate	20900	0.318	0.004198	0.003862	0.004198	0.00977	15.6
SC	SC	Los Angeles	At Berth	Bulk		Bulk	Auxiliary	1	Distillate	506920	6.817	0.101818	0.093672	0.101818	0.23706	377.6
SC	SC	Los Angeles	At Berth	Bulk		Bulk	Auxiliary	2	Distillate	756580	8.757	0.151964	0.139806	0.151964	0.35381	563.6

AB	DIS	Arrival Port	Mode	Vessel Type	Size bin	Vessel Subtype	Engine type	tier ID	Fuel type	Energy Used (kWh)	NOx (tpy)	PM10 (tpy)	PM 2.5 (tpy)	DPM (tpy)	SOx (tpy)	CO2eq (tpy)
SC	SC	Los Angeles	At Berth	Bulk		Bulk	Boiler	-	Distillate	845000	1.858	0.152699	0.140483		0.54631	870.2
SC	SC	Los Angeles	At Berth	Container	2	Container	Auxiliary	0	Distillate	3325294	50.584	0.667905	0.614473	0.667905	1.55507	2477.0
SC	SC	Los Angeles	At Berth	Container	4	Container	Auxiliary	0	Distillate	222332	3.382	0.044657	0.041084	0.044657	0.10397	165.6
SC	SC	Los Angeles	At Berth	Container	5	Container	Auxiliary	0	Distillate	1803764	27.438	0.362297	0.333313	0.362297	0.84353	1343.6
SC	SC	Los Angeles	At Berth	Container	11	Container	Auxiliary	1	Distillate	279311	3.756	0.056101	0.051613	0.056101	0.13062	208.1
SC	SC	Los Angeles	At Berth	Container	13	Container	Auxiliary	1	Distillate	546609	7.351	0.109790	0.101007	0.109790	0.25562	407.2
SC	SC	Los Angeles	At Berth	Container	14	Container	Auxiliary	1	Distillate	5675	0.076	0.001140	0.001049	0.001140	0.00265	4.2
SC	SC	Los Angeles	At Berth	Container	2	Container	Auxiliary	1	Distillate	2015742	27.108	0.404874	0.372484	0.404874	0.94266	1501.5
SC	SC	Los Angeles	At Berth	Container	3	Container	Auxiliary	1	Distillate	669054	8.997	0.134383	0.123633	0.134383	0.31288	498.4
SC	SC	Los Angeles	At Berth	Container	4	Container	Auxiliary	1	Distillate	3343180	44.959	0.671498	0.617778	0.671498	1.56343	2490.4
SC	SC	Los Angeles	At Berth	Container	5	Container	Auxiliary	1	Distillate	1829973	24.610	0.367561	0.338156	0.367561	0.85578	1363.2
SC	SC	Los Angeles	At Berth	Container	6	Container	Auxiliary	1	Distillate	2779559	37.380	0.558291	0.513628	0.558291	1.29986	2070.5
SC	SC	Los Angeles	At Berth	Container	7	Container	Auxiliary	1	Distillate	2220315	29.859	0.445963	0.410286	0.445963	1.03833	1653.9
SC	SC	Los Angeles	At Berth	Container	8	Container	Auxiliary	1	Distillate	3063192	41.194	0.615260	0.566039	0.615260	1.43250	2281.8
SC	SC	Los Angeles	At Berth	Container	9	Container	Auxiliary	1	Distillate	74718	1.005	0.015007	0.013807	0.015007	0.03494	55.7
SC	SC	Los Angeles	At Berth	Container	10	Container	Auxiliary	2	Distillate	2495406	28.882	0.501217	0.461120	0.501217	1.16697	1858.9
SC	SC	Los Angeles	At Berth	Container	11	Container	Auxiliary	2	Distillate	375684	4.348	0.075458	0.069422	0.075458	0.17569	279.9
SC	SC	Los Angeles	At Berth	Container	12	Container	Auxiliary	2	Distillate	95986	1.111	0.019279	0.017737	0.019279	0.04489	71.5
SC	SC	Los Angeles	At Berth	Container	13	Container	Auxiliary	2	Distillate	2023045	23.415	0.406341	0.373833	0.406341	0.94607	1507.0
SC	SC	Los Angeles	At Berth	Container	17	Container	Auxiliary	2	Distillate	62000	0.718	0.012453	0.011457	0.012453	0.02899	46.2
SC	SC	Los Angeles	At Berth	Container	2	Container	Auxiliary	2	Distillate	356919	4.131	0.071689	0.065954	0.071689	0.16691	265.9
SC	SC	Los Angeles	At Berth	Container	3	Container	Auxiliary	2	Distillate	163011	1.887	0.032742	0.030122	0.032742	0.07623	121.4
SC	SC	Los Angeles	At Berth	Container	4	Container	Auxiliary	2	Distillate	417656	4.834	0.083889	0.077178	0.083889	0.19532	311.1
SC	SC	Los Angeles	At Berth	Container	5	Container	Auxiliary	2	Distillate	1659323	19.205	0.333285	0.306622	0.333285	0.77598	1236.0
SC	SC	Los Angeles	At Berth	Container	6	Container	Auxiliary	2	Distillate	142919	1.654	0.028706	0.026410	0.028706	0.06684	106.5
SC	SC	Los Angeles	At Berth	Container	8	Container	Auxiliary	2	Distillate	2036094	23.566	0.408962	0.376245	0.408962	0.95218	1516.7
SC	SC	Los Angeles	At Berth	Container	9	Container	Auxiliary	2	Distillate	1512480	17.506	0.303791	0.279487	0.303791	0.70731	1126.7
SC	SC	Los Angeles	At Berth	Container	10	Container	Boiler	-	Distillate	1845256	4.058	0.333455	0.306778		1.19299	1900.3
SC	SC	Los Angeles	At Berth	Container	11	Container	Boiler	-	Distillate	1530230	3.365	0.276526	0.254404		0.98932	1575.9
SC	SC	Los Angeles	At Berth	Container	12	Container	Boiler	-	Distillate	813700	1.789	0.147043	0.135279		0.52607	838.0
SC	SC	Los Angeles	At Berth	Container	13	Container	Boiler	-	Distillate	2396592	5.270	0.433086	0.398439		1.54944	2468.1
SC	SC	Los Angeles	At Berth	Container	14	Container	Boiler	-	Distillate	68544	0.151	0.012387	0.011396		0.04431	70.6
SC	SC	Los Angeles	At Berth	Container	17	Container	Boiler	-	Distillate	40114	0.088	0.007249	0.006669		0.02593	41.3
SC	SC	Los Angeles	At Berth	Container	2	Container	Boiler	-	Distillate	2420505	5.323	0.437407	0.402414		1.56490	2492.7
SC	SC	Los Angeles	At Berth	Container	3	Container	Boiler	-	Distillate	739620	1.626	0.133656	0.122963		0.47818	761.7
SC	SC	Los Angeles	At Berth	Container	4	Container	Boiler	-	Distillate	3939543	8.663	0.711911	0.654958		2.54699	4057.0
SC	SC	Los Angeles	At Berth	Container	5	Container	Boiler	-	Distillate	5261952	11.571	0.950882	0.874811		3.40195	5418.9
SC	SC	Los Angeles	At Berth	Container	6	Container	Boiler	-	Distillate	6589725	14.491	1.190823	1.095556		4.26038	6786.2

AB	DIS	Arrival Port	Mode	Vessel Type	Size bin	Vessel Subtype	Engine type	tier ID	Fuel type	Energy Used (kWh)	NOx (tpy)	PM10 (tpy)	PM 2.5 (tpy)	DPM (tpy)	SOx (tpy)	CO2eq (tpy)
SC	SC	Los Angeles	At Berth	Container	7	Container	Boiler	-	Distillate	2462719	5.416	0.445036	0.409432		1.59219	2536.2
SC	SC	Los Angeles	At Berth	Container	8	Container	Boiler	-	Distillate	12420124	27.313	2.244429	2.064873		8.02984	12790.5
SC	SC	Los Angeles	At Berth	Container	9	Container	Boiler	-	Distillate	2430430	5.345	0.439201	0.404064		1.57132	2502.9
SC	SC	Los Angeles	At Berth	Tanker	Seawaymax	Crude	Auxiliary	0	Distillate	222656	3.387	0.044722	0.041144	0.044722	0.10412	165.9
SC	SC	Los Angeles	At Berth	Tanker	Panamax	Crude	Auxiliary	1	Distillate	2183706	29.367	0.438610	0.403521	0.438610	1.02121	1626.7
SC	SC	Los Angeles	At Berth	Tanker	Seawaymax	Crude	Auxiliary	1	Distillate	204624	2.752	0.041100	0.037812	0.041100	0.09569	152.4
SC	SC	Los Angeles	At Berth	Tanker	Panamax	Crude	Auxiliary	2	Distillate	425100	4.920	0.085384	0.078553	0.085384	0.19880	316.7
SC	SC	Los Angeles	At Berth	Tanker	Panamax	Crude	Boiler	-	Distillate	13646369	30.010	2.466023	2.268739		8.82263	14053.3
SC	SC	Los Angeles	At Berth	Tanker	Seawaymax	Crude	Boiler	-	Distillate	1409370	3.099	0.254686	0.234311		0.91118	1451.4
SC	SC	Los Angeles	At Berth	Cruise		Cruise	Auxiliary	0	Distillate	279966	4.259	0.056233	0.051734	0.056233	0.13093	208.5
SC	SC	Los Angeles	At Berth	Cruise		Cruise	Auxiliary	1	Distillate	3499576	47.063	0.702911	0.646678	0.702911	1.63657	2606.9
SC	SC	Los Angeles	At Berth	Cruise		Cruise	Boiler	-	Distillate	892296	1.962	0.161246	0.148346		0.57689	918.9
SC	SC	Los Angeles	At Berth	general		general	Auxiliary	0	Distillate	804437	12.237	0.161576	0.148650	0.161576	0.37619	599.2
SC	SC	Los Angeles	At Berth	general		general	Auxiliary	1	Distillate	590934	7.947	0.118693	0.109197	0.118693	0.27635	440.2
SC	SC	Los Angeles	At Berth	general		general	Auxiliary	2	Distillate	821623	9.510	0.165028	0.151826	0.165028	0.38423	612.0
SC	SC	Los Angeles	At Berth	general		general	Boiler	-	Distillate	536640	1.180	0.096976	0.089218		0.34695	552.6
SC	SC	Los Angeles	At Berth	Tanker	Seawaymax	Product	Auxiliary	0	Distillate	729904	11.103	0.146606	0.134877	0.146606	0.34134	543.7
SC	SC	Los Angeles	At Berth	Tanker	Panamax	Product	Auxiliary	1	Distillate	423138	5.690	0.084990	0.078191	0.084990	0.19788	315.2
SC	SC	Los Angeles	At Berth	Tanker	Seawaymax	Product	Auxiliary	1	Distillate	2954896	39.738	0.593508	0.546028	0.593508	1.38185	2201.1
SC	SC	Los Angeles	At Berth	Tanker	Seawaymax	Product	Auxiliary	2	Distillate	1996848	23.112	0.401079	0.368992	0.401079	0.93382	1487.5
SC	SC	Los Angeles	At Berth	Tanker	Panamax	Product	Boiler	-	Distillate	2213387	4.867	0.399979	0.367980		1.43100	2279.4
SC	SC	Los Angeles	At Berth	Tanker	Seawaymax	Product	Boiler	-	Distillate	18740742	41.213	3.386622	3.115689		12.11624	19299.6
SC	SC	Los Angeles	At Berth	reefer		reefer	Auxiliary	0	Distillate	918900	13.978	0.184567	0.169801	0.184567	0.42972	684.5
SC	SC	Los Angeles	At Berth	reefer		reefer	Auxiliary	1	Distillate	121500	1.634	0.024404	0.022452	0.024404	0.05682	90.5
SC	SC	Los Angeles	At Berth	reefer		reefer	Auxiliary	2	Distillate	121500	1.406	0.024404	0.022452	0.024404	0.05682	90.5
SC	SC	Los Angeles	At Berth	reefer		reefer	Boiler	-	Distillate	392464	0.863	0.070922	0.065248		0.25374	404.2
SC	SC	Los Angeles	At Berth	roro		roro	Auxiliary	2	Distillate	1070055	12.385	0.214927	0.197733	0.214927	0.50041	797.1
SC	SC	Los Angeles	At Berth	roro		roro	Boiler	-	Distillate	389795	0.857	0.070439	0.064804		0.25201	401.4
SF	BA	Martinez	At Berth	Tanker	Aframax	Crude	Auxiliary	1	Distillate	1258312	16.922	0.252739	0.232520	0.252739	0.58845	937.3
SF	BA	Martinez	At Berth	Tanker	Panamax	Crude	Auxiliary	1	Distillate	1286418	17.300	0.258385	0.237714	0.258385	0.60159	958.3
SF	BA	Martinez	At Berth	Tanker	Suezmax	Crude	Auxiliary	1	Distillate	1056289	14.205	0.212162	0.195189	0.212162	0.49397	786.8
SF	BA	Martinez	At Berth	Tanker	Aframax	Crude	Auxiliary	2	Distillate	993328	11.497	0.199516	0.183555	0.199516	0.46453	739.9
SF	BA	Martinez	At Berth	Tanker	Panamax	Crude	Auxiliary	2	Distillate	115104	1.332	0.023119	0.021270	0.023119	0.05383	85.7
SF	BA	Martinez	At Berth	Tanker	Suezmax	Crude	Auxiliary	2	Distillate	2250573	26.048	0.452041	0.415878	0.452041	1.05248	1676.5
SF	BA	Martinez	At Berth	Tanker	Aframax	Crude	Boiler	-	Distillate	15643300	34.401	2.826886	2.600733		10.11369	16109.8
SF	BA	Martinez	At Berth	Tanker	Panamax	Crude	Boiler	-	Distillate	7331203	16.122	1.324815	1.218829		4.73976	7549.8
SF	BA	Martinez	At Berth	Tanker	Suezmax	Crude	Boiler	-	Distillate	7701074	16.935	1.391654	1.280320		4.97889	7930.7
SF	BA	Martinez	At Berth	Tanker	Seawaymax	Product	Auxiliary	0	Distillate	46256	0.704	0.009291	0.008548	0.009291	0.02163	34.5

AB	DIS	Arrival Port	Mode	Vessel Type	Size bin	Vessel Subtype	Engine type	tier ID	Fuel type	Energy Used (kWh)	NOx (tpy)	PM10 (tpy)	PM 2.5 (tpy)	DPM (tpy)	SOx (tpy)	CO2eq (tpy)
SF	BA	Martinez	At Berth	Tanker	Panamax	Product	Auxiliary	1	Distillate	148458	1.996	0.029819	0.027433	0.029819	0.06943	110.6
SF	BA	Martinez	At Berth	Tanker	Seawaymax	Product	Auxiliary	1	Distillate	385728	5.187	0.077476	0.071278	0.077476	0.18039	287.3
SF	BA	Martinez	At Berth	Tanker	Seawaymax	Product	Auxiliary	2	Distillate	402976	4.664	0.080940	0.074465	0.080940	0.18845	300.2
SF	BA	Martinez	At Berth	Tanker	Panamax	Product	Boiler	-	Distillate	776567	1.708	0.140333	0.129106		0.50207	799.7
SF	BA	Martinez	At Berth	Tanker	Seawaymax	Product	Boiler	-	Distillate	2754090	6.056	0.497689	0.457874		1.78057	2836.2
SF	BA	Oakland	At Berth	Bulk		Bulk	Auxiliary	0	Distillate	55480	0.844	0.011143	0.010252	0.011143	0.02595	41.3
SF	BA	Oakland	At Berth	Bulk		Bulk	Auxiliary	1	Distillate	59850	0.805	0.012021	0.011060	0.012021	0.02799	44.6
SF	BA	Oakland	At Berth	Bulk		Bulk	Auxiliary	2	Distillate	331550	3.837	0.066594	0.061266	0.066594	0.15505	247.0
SF	BA	Oakland	At Berth	Bulk		Bulk	Boiler	-	Distillate	294000	0.647	0.053128	0.048878		0.19008	302.8
SF	BA	Oakland	At Berth	Container	1	Container	Auxiliary	0	Distillate	2384745	36.276	0.478990	0.440671	0.478990	1.11522	1776.4
SF	BA	Oakland	At Berth	Container	2	Container	Auxiliary	0	Distillate	1446712	22.007	0.290581	0.267334	0.290581	0.67655	1077.7
SF	BA	Oakland	At Berth	Container	3	Container	Auxiliary	0	Distillate	391735	5.959	0.078682	0.072388	0.078682	0.18319	291.8
SF	BA	Oakland	At Berth	Container	4	Container	Auxiliary	0	Distillate	288312	4.386	0.057909	0.053276	0.057909	0.13483	214.8
SF	BA	Oakland	At Berth	Container	5	Container	Auxiliary	0	Distillate	1037079	15.776	0.208303	0.191639	0.208303	0.48499	772.5
SF	BA	Oakland	At Berth	Container	1	Container	Auxiliary	1	Distillate	454453	6.112	0.091280	0.083977	0.091280	0.21252	338.5
SF	BA	Oakland	At Berth	Container	10	Container	Auxiliary	1	Distillate	245718	3.304	0.049354	0.045406	0.049354	0.11491	183.0
SF	BA	Oakland	At Berth	Container	11	Container	Auxiliary	1	Distillate	1172653	15.770	0.235534	0.216692	0.235534	0.54839	873.5
SF	BA	Oakland	At Berth	Container	13	Container	Auxiliary	1	Distillate	172933	2.326	0.034735	0.031956	0.034735	0.08087	128.8
SF	BA	Oakland	At Berth	Container	14	Container	Auxiliary	1	Distillate	49575	0.667	0.009957	0.009161	0.009957	0.02318	36.9
SF	BA	Oakland	At Berth	Container	2	Container	Auxiliary	1	Distillate	409389	5.505	0.082228	0.075650	0.082228	0.19145	305.0
SF	BA	Oakland	At Berth	Container	3	Container	Auxiliary	1	Distillate	391374	5.263	0.078610	0.072321	0.078610	0.18303	291.5
SF	BA	Oakland	At Berth	Container	4	Container	Auxiliary	1	Distillate	3406034	45.805	0.684122	0.629392	0.684122	1.59283	2537.2
SF	BA	Oakland	At Berth	Container	5	Container	Auxiliary	1	Distillate	1449493	19.493	0.291139	0.267848	0.291139	0.67785	1079.7
SF	BA	Oakland	At Berth	Container	6	Container	Auxiliary	1	Distillate	1311931	17.643	0.263509	0.242428	0.263509	0.61352	977.3
SF	BA	Oakland	At Berth	Container	7	Container	Auxiliary	1	Distillate	666612	8.965	0.133893	0.123182	0.133893	0.31174	496.6
SF	BA	Oakland	At Berth	Container	8	Container	Auxiliary	1	Distillate	1898096	25.526	0.381244	0.350744	0.381244	0.88764	1413.9
SF	BA	Oakland	At Berth	Container	9	Container	Auxiliary	1	Distillate	59645	0.802	0.011980	0.011022	0.011980	0.02789	44.4
SF	BA	Oakland	At Berth	Container	1	Container	Auxiliary	2	Distillate	122179	1.414	0.024540	0.022577	0.024540	0.05714	91.0
SF	BA	Oakland	At Berth	Container	10	Container	Auxiliary	2	Distillate	1455234	16.843	0.292292	0.268909	0.292292	0.68054	1084.0
SF	BA	Oakland	At Berth	Container	11	Container	Auxiliary	2	Distillate	553922	6.411	0.111259	0.102358	0.111259	0.25904	412.6
SF	BA	Oakland	At Berth	Container	12	Container	Auxiliary	2	Distillate	81885	0.948	0.016447	0.015131	0.016447	0.03829	61.0
SF	BA	Oakland	At Berth	Container	13	Container	Auxiliary	2	Distillate	1357723	15.714	0.272707	0.250890	0.272707	0.63494	1011.4
SF	BA	Oakland	At Berth	Container	17	Container	Auxiliary	2	Distillate	57000	0.660	0.011449	0.010533	0.011449	0.02666	42.5
SF	BA	Oakland	At Berth	Container	2	Container	Auxiliary	2	Distillate	84135	0.974	0.016899	0.015547	0.016899	0.03935	62.7
SF	BA	Oakland	At Berth	Container	3	Container	Auxiliary	2	Distillate	240457	2.783	0.048297	0.044433	0.048297	0.11245	179.1
SF	BA	Oakland	At Berth	Container	4	Container	Auxiliary	2	Distillate	340789	3.944	0.068449	0.062973	0.068449	0.15937	253.9
SF	BA	Oakland	At Berth	Container	5	Container	Auxiliary	2	Distillate	637428	7.378	0.128031	0.117789	0.128031	0.29809	474.8
SF	BA	Oakland	At Berth	Container	6	Container	Auxiliary	2	Distillate	175705	2.034	0.035291	0.032468	0.035291	0.08217	130.9

AB	DIS	Arrival Port	Mode	Vessel Type	Size bin	Vessel Subtype	Engine type	tier ID	Fuel type	Energy Used (kWh)	NOx (tpy)	PM10 (tpy)	PM 2.5 (tpy)	DPM (tpy)	SOx (tpy)	CO2eq (tpy)
SF	BA	Oakland	At Berth	Container	8	Container	Auxiliary	2	Distillate	1347842	15.600	0.270722	0.249064	0.270722	0.63032	1004.0
SF	BA	Oakland	At Berth	Container	9	Container	Auxiliary	2	Distillate	644165	7.456	0.129384	0.119034	0.129384	0.30124	479.8
SF	BA	Oakland	At Berth	Container	1	Container	Boiler	-	Distillate	1250613	2.750	0.225997	0.207917		0.80854	1287.9
SF	BA	Oakland	At Berth	Container	10	Container	Boiler	-	Distillate	880796	1.937	0.159168	0.146434		0.56945	907.1
SF	BA	Oakland	At Berth	Container	11	Container	Boiler	-	Distillate	2462430	5.415	0.444983	0.409384		1.59201	2535.9
SF	BA	Oakland	At Berth	Container	12	Container	Boiler	-	Distillate	218830	0.481	0.039545	0.036381		0.14148	225.4
SF	BA	Oakland	At Berth	Container	13	Container	Boiler	-	Distillate	1164636	2.561	0.210460	0.193623		0.75296	1199.4
SF	BA	Oakland	At Berth	Container	14	Container	Boiler	-	Distillate	22032	0.048	0.003981	0.003663		0.01424	22.7
SF	BA	Oakland	At Berth	Container	17	Container	Boiler	-	Distillate	36879	0.081	0.006664	0.006131		0.02384	38.0
SF	BA	Oakland	At Berth	Container	2	Container	Boiler	-	Distillate	682651	1.501	0.123361	0.113492		0.44135	703.0
SF	BA	Oakland	At Berth	Container	3	Container	Boiler	-	Distillate	1190700	2.618	0.215170	0.197956		0.76981	1226.2
SF	BA	Oakland	At Berth	Container	4	Container	Boiler	-	Distillate	3117672	6.856	0.563392	0.518320		2.01563	3210.6
SF	BA	Oakland	At Berth	Container	5	Container	Boiler	-	Distillate	2692929	5.922	0.486637	0.447705		1.74103	2773.2
SF	BA	Oakland	At Berth	Container	6	Container	Boiler	-	Distillate	1952625	4.294	0.352857	0.324628		1.26241	2010.9
SF	BA	Oakland	At Berth	Container	7	Container	Boiler	-	Distillate	781865	1.719	0.141290	0.129987		0.50549	805.2
SF	BA	Oakland	At Berth	Container	8	Container	Boiler	-	Distillate	4251820	9.350	0.768342	0.706874		2.74888	4378.6
SF	BA	Oakland	At Berth	Container	9	Container	Boiler	-	Distillate	1477891	3.250	0.267068	0.245703		0.95548	1522.0
SF	BA	Oakland	At Berth	roro		roro	Auxiliary	0	Distillate	213300	3.245	0.042843	0.039415	0.042843	0.09975	158.9
SF	BA	Oakland	At Berth	roro		roro	Boiler	-	Distillate	77700	0.171	0.014041	0.012918		0.05023	80.0
SF	BA	Oleum	At Berth	Tanker	Seawaymax	Crude	Auxiliary	0	Distillate	33712	0.513	0.006771	0.006230	0.006771	0.01577	25.1
SF	BA	Oleum	At Berth	Tanker	Aframax	Crude	Auxiliary	1	Distillate	15928	0.214	0.003199	0.002943	0.003199	0.00745	11.9
SF	BA	Oleum	At Berth	Tanker	Panamax	Crude	Auxiliary	1	Distillate	520584	7.001	0.104562	0.096197	0.104562	0.24345	387.8
SF	BA	Oleum	At Berth	Tanker	Suezmax	Crude	Auxiliary	1	Distillate	1959529	26.352	0.393583	0.362096	0.393583	0.91637	1459.7
SF	BA	Oleum	At Berth	Tanker	Aframax	Crude	Auxiliary	2	Distillate	120184	1.391	0.024140	0.022208	0.024140	0.05620	89.5
SF	BA	Oleum	At Berth	Tanker	Panamax	Crude	Auxiliary	2	Distillate	88944	1.029	0.017865	0.016436	0.017865	0.04159	66.3
SF	BA	Oleum	At Berth	Tanker	Suezmax	Crude	Auxiliary	2	Distillate	143013	1.655	0.028725	0.026427	0.028725	0.06688	106.5
SF	BA	Oleum	At Berth	Tanker	Aframax	Crude	Boiler	-	Distillate	945640	2.080	0.170886	0.157215		0.61137	973.8
SF	BA	Oleum	At Berth	Tanker	Panamax	Crude	Boiler	-	Distillate	3188372	7.012	0.576168	0.530074		2.06134	3283.5
SF	BA	Oleum	At Berth	Tanker	Seawaymax	Crude	Boiler	-	Distillate	111198	0.245	0.020094	0.018487		0.07189	114.5
SF	BA	Oleum	At Berth	Tanker	Suezmax	Crude	Boiler	-	Distillate	4896434	10.768	0.884830	0.814043		3.16564	5042.4
SF	BA	Oleum	At Berth	Tanker	Seawaymax	Product	Auxiliary	0	Distillate	26656	0.405	0.005354	0.004926	0.005354	0.01247	19.9
SF	BA	Oleum	At Berth	Tanker	Panamax	Product	Auxiliary	1	Distillate	15042	0.202	0.003021	0.002780	0.003021	0.00703	11.2
SF	BA	Oleum	At Berth	Tanker	Seawaymax	Product	Auxiliary	1	Distillate	972944	13.084	0.195422	0.179788	0.195422	0.45500	724.8
SF	BA	Oleum	At Berth	Tanker	Seawaymax	Product	Auxiliary	2	Distillate	457856	5.299	0.091963	0.084606	0.091963	0.21412	341.1
SF	BA	Oleum	At Berth	Tanker	Panamax	Product	Boiler	-	Distillate	78683	0.173	0.014219	0.013081		0.05087	81.0
SF	BA	Oleum	At Berth	Tanker	Seawaymax	Product	Boiler	-	Distillate	4807374	10.572	0.868736	0.799236		3.10806	4950.7
SF	BA	Redwood City	At Berth	Bulk		Bulk	Auxiliary	0	Distillate	81720	1.243	0.016414	0.015101	0.016414	0.03822	60.9
SF	BA	Redwood City	At Berth	Bulk		Bulk	Auxiliary	1	Distillate	115710	1.556	0.023241	0.021382	0.023241	0.05411	86.2

AB	DIS	Arrival Port	Mode	Vessel Type	Size bin	Vessel Subtype	Engine type	tier ID	Fuel type	Energy Used (kWh)	NOx (tpy)	PM10 (tpy)	PM 2.5 (tpy)	DPM (tpy)	SOx (tpy)	CO2eq (tpy)
SF	BA	Redwood City	At Berth	Bulk		Bulk	Auxiliary	2	Distillate	224882	2.603	0.045169	0.041555	0.045169	0.10517	167.5
SF	BA	Redwood City	At Berth	Bulk		Bulk	Boiler	-	Distillate	291191	0.640	0.052621	0.048411		0.18826	299.9
SF	BA	Richmond	At Berth	auto		auto	Auxiliary	0	Distillate	713944	10.860	0.143400	0.131928	0.143400	0.33387	531.8
SF	BA	Richmond	At Berth	auto		auto	Auxiliary	1	Distillate	1245925	16.755	0.250251	0.230231	0.250251	0.58266	928.1
SF	BA	Richmond	At Berth	auto		auto	Auxiliary	2	Distillate	463600	5.366	0.093117	0.085667	0.093117	0.21680	345.3
SF	BA	Richmond	At Berth	auto		auto	Boiler	-	Distillate	656574	1.444	0.118649	0.109157		0.42449	676.2
SF	BA	Richmond	At Berth	Bulk		Bulk	Auxiliary	0	Distillate	40089	0.610	0.008052	0.007408	0.008052	0.01875	29.9
SF	BA	Richmond	At Berth	Bulk		Bulk	Auxiliary	1	Distillate	376960	5.069	0.075715	0.069657	0.075715	0.17628	280.8
SF	BA	Richmond	At Berth	Bulk		Bulk	Auxiliary	2	Distillate	687501	7.957	0.138089	0.127042	0.138089	0.32151	512.1
SF	BA	Richmond	At Berth	Bulk		Bulk	Boiler	-	Distillate	734935	1.616	0.132809	0.122185		0.47515	756.9
SF	BA	Richmond	At Berth	Tanker	Seawaymax	Crude	Auxiliary	0	Distillate	455504	6.929	0.091491	0.084171	0.091491	0.21302	339.3
SF	BA	Richmond	At Berth	Tanker	Aframax	Crude	Auxiliary	1	Distillate	842736	11.333	0.169269	0.155727	0.169269	0.39410	627.8
SF	BA	Richmond	At Berth	Tanker	Panamax	Crude	Auxiliary	1	Distillate	913638	12.287	0.183510	0.168829	0.183510	0.42726	680.6
SF	BA	Richmond	At Berth	Tanker	Seawaymax	Crude	Auxiliary	1	Distillate	48608	0.654	0.009763	0.008982	0.009763	0.02273	36.2
SF	BA	Richmond	At Berth	Tanker	Suezmax	Crude	Auxiliary	1	Distillate	2002182	26.925	0.402150	0.369978	0.402150	0.93632	1491.4
SF	BA	Richmond	At Berth	Tanker	Aframax	Crude	Auxiliary	2	Distillate	203444	2.355	0.040863	0.037594	0.040863	0.09514	151.5
SF	BA	Richmond	At Berth	Tanker	Suezmax	Crude	Auxiliary	2	Distillate	3700775	42.833	0.743323	0.683857	0.743323	1.73066	2756.7
SF	BA	Richmond	At Berth	Tanker	Aframax	Crude	Boiler	-	Distillate	7268350	15.984	1.313457	1.208379		4.69912	7485.1
SF	BA	Richmond	At Berth	Tanker	Panamax	Crude	Boiler	-	Distillate	4779137	10.510	0.863633	0.794542		3.08980	4921.7
SF	BA	Richmond	At Berth	Tanker	Seawaymax	Crude	Boiler	-	Distillate	1662798	3.657	0.300483	0.276444		1.07503	1712.4
SF	BA	Richmond	At Berth	Tanker	Suezmax	Crude	Boiler	-	Distillate	13281139	29.206	2.400022	2.208018		8.58651	13677.2
SF	BA	Richmond	At Berth	Tanker	Seawaymax	Product	Auxiliary	0	Distillate	3115616	47.394	0.625790	0.575727	0.625790	1.45701	2320.9
SF	BA	Richmond	At Berth	Tanker	Panamax	Product	Auxiliary	1	Distillate	261600	3.518	0.052544	0.048340	0.052544	0.12234	194.9
SF	BA	Richmond	At Berth	Tanker	Seawaymax	Product	Auxiliary	1	Distillate	4915680	66.106	0.987343	0.908356	0.987343	2.29881	3661.7
SF	BA	Richmond	At Berth	Tanker	Seawaymax	Product	Auxiliary	2	Distillate	1467648	16.987	0.294786	0.271203	0.294786	0.68634	1093.3
SF	BA	Richmond	At Berth	Tanker	Panamax	Product	Boiler	-	Distillate	1368400	3.009	0.247282	0.227500		0.88470	1409.2
SF	BA	Richmond	At Berth	Tanker	Seawaymax	Product	Boiler	-	Distillate	31331976	68.902	5.661972	5.209010		20.25671	32266.3
SV	YS	Sacramento	At Berth	Bulk		Bulk	Auxiliary	1	Distillate	185630	2.496	0.037285	0.034302	0.037285	0.08681	138.3
SV	YS	Sacramento	At Berth	Bulk		Bulk	Auxiliary	2	Distillate	435670	5.043	0.087507	0.080506	0.087507	0.20374	324.5
SV	YS	Sacramento	At Berth	Bulk		Bulk	Boiler	-	Distillate	408750	0.899	0.073865	0.067956		0.26426	420.9
SV	YS	Sacramento	At Berth	general		general	Auxiliary	0	Distillate	238621	3.630	0.047928	0.044094	0.047928	0.11159	177.8
SV	YS	Sacramento	At Berth	general		general	Auxiliary	1	Distillate	389329	5.236	0.078199	0.071943	0.078199	0.18207	290.0
SV	YS	Sacramento	At Berth	general		general	Auxiliary	2	Distillate	673559	7.796	0.135288	0.124465	0.135288	0.31499	501.7
SV	YS	Sacramento	At Berth	general		general	Boiler	-	Distillate	315040	0.693	0.056931	0.052376		0.20368	324.4
SV	YS	Sacramento	At Berth	Tanker	Seawaymax	Product	Auxiliary	1	Distillate	784	0.011	0.000157	0.000145	0.000157	0.00037	0.6
SV	YS	Sacramento	At Berth	Tanker	Seawaymax	Product	Boiler	-	Distillate	2586	0.006	0.000467	0.000430		0.00167	2.7
SD	SD	San Diego	At Berth	auto		auto	Auxiliary	0	Distillate	1141615	17.366	0.229300	0.210956	0.229300	0.53387	850.4
SD	SD	San Diego	At Berth	auto		auto	Auxiliary	1	Distillate	4267438	57.389	0.857140	0.788569	0.857140	1.99566	3178.9

AB	DIS	Arrival Port	Mode	Vessel Type	Size bin	Vessel Subtype	Engine type	tier ID	Fuel type	Energy Used (kWh)	NOx (tpy)	PM10 (tpy)	PM 2.5 (tpy)	DPM (tpy)	SOx (tpy)	CO2eq (tpy)
SD	SD	San Diego	At Berth	auto		auto	Auxiliary	2	Distillate	1850923	21.423	0.371769	0.342027	0.371769	0.86558	1378.8
SD	SD	San Diego	At Berth	auto		auto	Boiler	-	Distillate	1966896	4.325	0.355436	0.327001		1.27164	2025.5
SD	SD	San Diego	At Berth	Bulk		Bulk	Auxiliary	1	Distillate	41230	0.554	0.008281	0.007619	0.008281	0.01928	30.7
SD	SD	San Diego	At Berth	Bulk		Bulk	Auxiliary	2	Distillate	22990	0.266	0.004618	0.004248	0.004618	0.01075	17.1
SD	SD	San Diego	At Berth	Bulk		Bulk	Boiler	-	Distillate	42250	0.093	0.007635	0.007024		0.02732	43.5
SD	SD	San Diego	At Berth	Container	1	Container	Auxiliary	0	Distillate	122614	1.865	0.024628	0.022657	0.024628	0.05734	91.3
SD	SD	San Diego	At Berth	Container	1	Container	Auxiliary	1	Distillate	27872	0.375	0.005598	0.005150	0.005598	0.01303	20.8
SD	SD	San Diego	At Berth	Container	1	Container	Auxiliary	2	Distillate	218456	2.528	0.043878	0.040368	0.043878	0.10216	162.7
SD	SD	San Diego	At Berth	Container	3	Container	Auxiliary	2	Distillate	30881	0.357	0.006203	0.005706	0.006203	0.01444	23.0
SD	SD	San Diego	At Berth	Container	1	Container	Boiler	-	Distillate	823914	1.812	0.148889	0.136978		0.53268	848.5
SD	SD	San Diego	At Berth	Container	3	Container	Boiler	-	Distillate	126000	0.277	0.022769	0.020948		0.08146	129.8
SD	SD	San Diego	At Berth	Cruise		Cruise	Auxiliary	0	Distillate	1621368	24.664	0.325661	0.299608	0.325661	0.75823	1207.8
SD	SD	San Diego	At Berth	Cruise		Cruise	Auxiliary	1	Distillate	2399461	32.268	0.481946	0.443390	0.481946	1.12210	1787.4
SD	SD	San Diego	At Berth	Cruise		Cruise	Boiler	-	Distillate	604044	1.328	0.109156	0.100424		0.39053	622.1
SD	SD	San Diego	At Berth	general		general	Auxiliary	1	Distillate	120302	1.618	0.024163	0.022230	0.024163	0.05626	89.6
SD	SD	San Diego	At Berth	general		general	Auxiliary	2	Distillate	478564	5.539	0.096122	0.088433	0.096122	0.22380	356.5
SD	SD	San Diego	At Berth	general		general	Boiler	-	Distillate	144960	0.319	0.026196	0.024100		0.09372	149.3
SD	SD	San Diego	At Berth	Tanker	Seawaymax	Product	Auxiliary	1	Distillate	192080	2.583	0.038580	0.035494	0.038580	0.08983	143.1
SD	SD	San Diego	At Berth	Tanker	Seawaymax	Product	Auxiliary	2	Distillate	2251648	26.061	0.452257	0.416076	0.452257	1.05298	1677.3
SD	SD	San Diego	At Berth	Tanker	Seawaymax	Product	Boiler	-	Distillate	8060562	17.726	1.456617	1.340086		5.21130	8300.9
SD	SD	San Diego	At Berth	roro		roro	Auxiliary	2	Distillate	134379	1.555	0.026991	0.024832	0.026991	0.06284	100.1
SD	SD	San Diego	At Berth	roro		roro	Boiler	-	Distillate	48951	0.108	0.008846	0.008138		0.03165	50.4
SF	BA	San Francisco	At Berth	auto		auto	Auxiliary	0	Distillate	1159	0.018	0.000233	0.000214	0.000233	0.00054	0.9
SF	BA	San Francisco	At Berth	auto		auto	Auxiliary	1	Distillate	127490	1.714	0.025607	0.023559	0.025607	0.05962	95.0
SF	BA	San Francisco	At Berth	auto		auto	Auxiliary	2	Distillate	74176	0.859	0.014899	0.013707	0.014899	0.03469	55.3
SF	BA	San Francisco	At Berth	auto		auto	Boiler	-	Distillate	54950	0.121	0.009930	0.009136		0.03553	56.6
SF	BA	San Francisco	At Berth	Bulk		Bulk	Auxiliary	0	Distillate	25250	0.384	0.005072	0.004666	0.005072	0.01181	18.8
SF	BA	San Francisco	At Berth	Bulk		Bulk	Auxiliary	1	Distillate	1889	0.025	0.000379	0.000349	0.000379	0.00088	1.4
SF	BA	San Francisco	At Berth	Bulk		Bulk	Auxiliary	2	Distillate	49123	0.569	0.009867	0.009077	0.009867	0.02297	36.6
SF	BA	San Francisco	At Berth	Bulk		Bulk	Boiler	-	Distillate	55981	0.123	0.010116	0.009307		0.03619	57.7
SF	BA	San Francisco	At Berth	Container	1	Container	Auxiliary	0	Distillate	709	0.011	0.000142	0.000131	0.000142	0.00033	0.5
SF	BA	San Francisco	At Berth	Container	2	Container	Auxiliary	0	Distillate	628852	9.566	0.126309	0.116204	0.126309	0.29408	468.4
SF	BA	San Francisco	At Berth	Container	3	Container	Auxiliary	0	Distillate	3582	0.054	0.000719	0.000662	0.000719	0.00168	2.7
SF	BA	San Francisco	At Berth	Container	4	Container	Auxiliary	0	Distillate	1153	0.018	0.000232	0.000213	0.000232	0.00054	0.9
SF	BA	San Francisco	At Berth	Container	5	Container	Auxiliary	0	Distillate	1007	0.015	0.000202	0.000186	0.000202	0.00047	0.8
SF	BA	San Francisco	At Berth	Container	1	Container	Auxiliary	1	Distillate	1418	0.019	0.000285	0.000262	0.000285	0.00066	1.1
SF	BA	San Francisco	At Berth	Container	11	Container	Auxiliary	1	Distillate	1500	0.020	0.000301	0.000277	0.000301	0.00070	1.1
SF	BA	San Francisco	At Berth	Container	2	Container	Auxiliary	1	Distillate	1036	0.014	0.000208	0.000191	0.000208	0.00048	0.8

AB	DIS	Arrival Port	Mode	Vessel Type	Size bin	Vessel Subtype	Engine type	tier ID	Fuel type	Energy Used (kWh)	NOx (tpy)	PM10 (tpy)	PM 2.5 (tpy)	DPM (tpy)	SOx (tpy)	CO2eq (tpy)
SF	BA	San Francisco	At Berth	Container	3	Container	Auxiliary	1	Distillate	1791	0.024	0.000360	0.000331	0.000360	0.00084	1.3
SF	BA	San Francisco	At Berth	Container	4	Container	Auxiliary	1	Distillate	16142	0.217	0.003242	0.002983	0.003242	0.00755	12.0
SF	BA	San Francisco	At Berth	Container	5	Container	Auxiliary	1	Distillate	4028	0.054	0.000809	0.000744	0.000809	0.00188	3.0
SF	BA	San Francisco	At Berth	Container	7	Container	Auxiliary	1	Distillate	4652	0.063	0.000934	0.000860	0.000934	0.00218	3.5
SF	BA	San Francisco	At Berth	Container	8	Container	Auxiliary	1	Distillate	5706	0.077	0.001146	0.001054	0.001146	0.00267	4.3
SF	BA	San Francisco	At Berth	Container	10	Container	Auxiliary	2	Distillate	4488	0.052	0.000901	0.000829	0.000901	0.00210	3.3
SF	BA	San Francisco	At Berth	Container	13	Container	Auxiliary	2	Distillate	990	0.011	0.000199	0.000183	0.000199	0.00046	0.7
SF	BA	San Francisco	At Berth	Container	3	Container	Auxiliary	2	Distillate	597	0.007	0.000120	0.000110	0.000120	0.00028	0.4
SF	BA	San Francisco	At Berth	Container	5	Container	Auxiliary	2	Distillate	3021	0.035	0.000607	0.000558	0.000607	0.00141	2.3
SF	BA	San Francisco	At Berth	Container	8	Container	Auxiliary	2	Distillate	2853	0.033	0.000573	0.000527	0.000573	0.00133	2.1
SF	BA	San Francisco	At Berth	Container	9	Container	Auxiliary	2	Distillate	1946	0.023	0.000391	0.000360	0.000391	0.00091	1.4
SF	BA	San Francisco	At Berth	Container	1	Container	Boiler	-	Distillate	819	0.002	0.000148	0.000136		0.00053	0.8
SF	BA	San Francisco	At Berth	Container	10	Container	Boiler	-	Distillate	2324	0.005	0.000420	0.000386		0.00150	2.4
SF	BA	San Francisco	At Berth	Container	11	Container	Boiler	-	Distillate	790	0.002	0.000143	0.000131		0.00051	0.8
SF	BA	San Francisco	At Berth	Container	13	Container	Boiler	-	Distillate	612	0.001	0.000111	0.000102		0.00040	0.6
SF	BA	San Francisco	At Berth	Container	2	Container	Boiler	-	Distillate	219488	0.483	0.039663	0.036490		0.14190	226.0
SF	BA	San Francisco	At Berth	Container	3	Container	Boiler	-	Distillate	4200	0.009	0.000759	0.000698		0.00272	4.3
SF	BA	San Francisco	At Berth	Container	4	Container	Boiler	-	Distillate	7155	0.016	0.001293	0.001190		0.00463	7.4
SF	BA	San Francisco	At Berth	Container	5	Container	Boiler	-	Distillate	4632	0.010	0.000837	0.000770		0.00299	4.8
SF	BA	San Francisco	At Berth	Container	7	Container	Boiler	-	Distillate	1246	0.003	0.000225	0.000207		0.00081	1.3
SF	BA	San Francisco	At Berth	Container	8	Container	Boiler	-	Distillate	6012	0.013	0.001086	0.001000		0.00389	6.2
SF	BA	San Francisco	At Berth	Container	9	Container	Boiler	-	Distillate	1354	0.003	0.000245	0.000225		0.00088	1.4
SF	BA	San Francisco	At Berth	Tanker	Seawaymax	Crude	Auxiliary	0	Distillate	784	0.012	0.000157	0.000145	0.000157	0.00037	0.6
SF	BA	San Francisco	At Berth	Tanker	Aframax	Crude	Auxiliary	1	Distillate	2896	0.039	0.000582	0.000535	0.000582	0.00135	2.2
SF	BA	San Francisco	At Berth	Tanker	Panamax	Crude	Auxiliary	1	Distillate	3270	0.044	0.000657	0.000604	0.000657	0.00153	2.4
SF	BA	San Francisco	At Berth	Tanker	Suezmax	Crude	Auxiliary	1	Distillate	12545	0.169	0.002520	0.002318	0.002520	0.00587	9.3
SF	BA	San Francisco	At Berth	Tanker	Aframax	Crude	Auxiliary	2	Distillate	2896	0.034	0.000582	0.000535	0.000582	0.00135	2.2
SF	BA	San Francisco	At Berth	Tanker	Suezmax	Crude	Auxiliary	2	Distillate	7527	0.087	0.001512	0.001391	0.001512	0.00352	5.6
SF	BA	San Francisco	At Berth	Tanker	Aframax	Crude	Boiler	-	Distillate	40240	0.088	0.007272	0.006690		0.02602	41.4
SF	BA	San Francisco	At Berth	Tanker	Panamax	Crude	Boiler	-	Distillate	17105	0.038	0.003091	0.002844		0.01106	17.6
SF	BA	San Francisco	At Berth	Tanker	Seawaymax	Crude	Boiler	-	Distillate	2586	0.006	0.000467	0.000430		0.00167	2.7
SF	BA	San Francisco	At Berth	Tanker	Suezmax	Crude	Boiler	-	Distillate	46744	0.103	0.008447	0.007771		0.03022	48.1
SF	BA	San Francisco	At Berth	Cruise		Cruise	Auxiliary	0	Distillate	2642913	40.203	0.530845	0.488377	0.530845	1.23595	1968.7
SF	BA	San Francisco	At Berth	Cruise		Cruise	Auxiliary	1	Distillate	6626433	89.113	1.330958	1.224482	1.330958	3.09884	4936.1
SF	BA	San Francisco	At Berth	Cruise		Cruise	Boiler	-	Distillate	1184832	2.606	0.214110	0.196981		0.76602	1220.2
SF	BA	San Francisco	At Berth	general		general	Auxiliary	1	Distillate	661	0.009	0.000133	0.000122	0.000133	0.00031	0.5
SF	BA	San Francisco	At Berth	general		general	Auxiliary	2	Distillate	1322	0.015	0.000266	0.000244	0.000266	0.00062	1.0
SF	BA	San Francisco	At Berth	general		general	Boiler	-	Distillate	480	0.001	0.000087	0.000080		0.00031	0.5

AB	DIS	Arrival Port	Mode	Vessel Type	Size bin	Vessel Subtype	Engine type	tier ID	Fuel type	Energy Used (kWh)	NOx (tpy)	PM10 (tpy)	PM 2.5 (tpy)	DPM (tpy)	SOx (tpy)	CO2eq (tpy)
SF	BA	San Francisco	At Berth	Tanker	Seawaymax	Product	Auxiliary	0	Distillate	3136	0.048	0.000630	0.000579	0.000630	0.00147	2.3
SF	BA	San Francisco	At Berth	Tanker	Panamax	Product	Auxiliary	1	Distillate	654	0.009	0.000131	0.000121	0.000131	0.00031	0.5
SF	BA	San Francisco	At Berth	Tanker	Seawaymax	Product	Auxiliary	1	Distillate	242256	3.258	0.048659	0.044766	0.048659	0.11329	180.5
SF	BA	San Francisco	At Berth	Tanker	Seawaymax	Product	Auxiliary	2	Distillate	6272	0.073	0.001260	0.001159	0.001260	0.00293	4.7
SF	BA	San Francisco	At Berth	Tanker	Panamax	Product	Boiler	-	Distillate	3421	0.008	0.000618	0.000569		0.00221	3.5
SF	BA	San Francisco	At Berth	Tanker	Seawaymax	Product	Boiler	-	Distillate	830106	1.825	0.150008	0.138007		0.53668	854.9
SF	BA	Selby (USA)	At Berth	Tanker	Seawaymax	Product	Auxiliary	0	Distillate	25872	0.394	0.005197	0.004781	0.005197	0.01210	19.3
SF	BA	Selby (USA)	At Berth	Tanker	Seawaymax	Product	Auxiliary	1	Distillate	836528	11.250	0.168022	0.154580	0.168022	0.39120	623.1
SF	BA	Selby (USA)	At Berth	Tanker	Seawaymax	Product	Auxiliary	2	Distillate	161504	1.869	0.032439	0.029844	0.032439	0.07553	120.3
SF	BA	Selby (USA)	At Berth	Tanker	Seawaymax	Product	Boiler	-	Distillate	3377316	7.427	0.610312	0.561486		2.18350	3478.0
SJV	SJU	Stockton	At Berth	Bulk		Bulk	Auxiliary	0	Distillate	185820	2.827	0.037323	0.034337	0.037323	0.08690	138.4
SJV	SJU	Stockton	At Berth	Bulk		Bulk	Auxiliary	1	Distillate	738530	9.932	0.148338	0.136471	0.148338	0.34537	550.1
SJV	SJU	Stockton	At Berth	Bulk		Bulk	Auxiliary	2	Distillate	1186262	13.730	0.238268	0.219206	0.238268	0.55475	883.7
SJV	SJU	Stockton	At Berth	Bulk		Bulk	Boiler	-	Distillate	1389671	3.056	0.251126	0.231036		0.89845	1431.1
SJV	SJU	Stockton	At Berth	general		general	Auxiliary	0	Distillate	320585	4.877	0.064391	0.059240	0.064391	0.14992	238.8
SJV	SJU	Stockton	At Berth	general		general	Auxiliary	1	Distillate	482530	6.489	0.096919	0.089165	0.096919	0.22565	359.4
SJV	SJU	Stockton	At Berth	general		general	Auxiliary	2	Distillate	1944001	22.500	0.390464	0.359227	0.390464	0.90911	1448.1
SJV	SJU	Stockton	At Berth	general		general	Boiler	-	Distillate	664960	1.462	0.120164	0.110551		0.42991	684.8
SJV	SJU	Stockton	At Berth	Tanker	Seawaymax	Product	Auxiliary	0	Distillate	787920	11.986	0.158258	0.145598	0.158258	0.36847	586.9
SJV	SJU	Stockton	At Berth	Tanker	Seawaymax	Product	Auxiliary	1	Distillate	1560160	20.981	0.313367	0.288298	0.313367	0.72961	1162.2
SJV	SJU	Stockton	At Berth	Tanker	Seawaymax	Product	Auxiliary	2	Distillate	285376	3.303	0.057319	0.052734	0.057319	0.13346	212.6
SJV	SJU	Stockton	At Berth	Tanker	Seawaymax	Product	Boiler	-	Distillate	8686374	19.102	1.569707	1.444129		5.61590	8945.4

Appendix C: Growth Factors

Avon

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Bulk		1.000	1.010	1.021	1.031	1.042	1.164	1.282	1.422	1.618	1.807	2.018
Tanker	Seawaymax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465
Tanker	Panamax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465

Benicia

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Auto		1.000	1.033	1.067	1.103	1.139	1.289	1.458	1.663	1.929	2.192	2.491
Bulk		1.000	1.010	1.021	1.031	1.042	1.164	1.282	1.422	1.618	1.807	2.018
Tanker	Seawaymax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465
Tanker	Panamax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465
Tanker	Aframax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465
Tanker	Suezmax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465

Crockett

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Bulk		1.000	1.010	1.021	1.031	1.042	1.164	1.282	1.422	1.618	1.807	2.018
General		1.000	1.058	1.119	1.183	1.252	1.656	2.155	2.835	3.897	4.635	5.514

El Segundo

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Tanker	Seawaymax	1.000	0.986	0.972	0.959	0.945	0.962	1.037	1.158	1.324	1.479	1.654
Tanker	Panamax	1.000	0.986	0.972	0.959	0.945	0.962	1.037	1.158	1.324	1.479	1.654

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Tanker	Aframax	1.000	0.986	0.972	0.959	0.945	0.962	1.037	1.158	1.324	1.479	1.654
Tanker	Suezmax	1.000	0.986	0.972	0.959	0.945	0.962	1.037	1.158	1.324	1.479	1.654

Eureka

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Bulk		1.000	1.034	1.070	1.106	1.144	1.420	1.677	1.995	2.543	3.108	3.798

Hueneme

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Auto		1.000	1.020	1.040	1.061	1.082	1.195	1.319	1.457	1.608	1.776	1.961
Container	1	1.000	1.020	1.040	1.061	1.082	1.195	1.319	1.457	1.608	1.776	1.961
Container	2	1.000	1.020	1.040	1.061	1.082	1.195	1.319	1.457	1.608	1.776	1.961
General		1.000	1.020	1.040	1.061	1.082	1.195	1.319	1.457	1.608	1.776	1.961
Reefer		1.000	1.020	1.040	1.061	1.082	1.195	1.319	1.457	1.608	1.776	1.961
Tanker	Seawaymax	1.000	1.020	1.040	1.061	1.082	1.195	1.319	1.457	1.608	1.776	1.961

Long Beach

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Auto		1.000	1.060	1.124	1.191	1.263	1.603	1.835	2.035	2.367	2.788	3.284
Bulk		1.000	1.033	1.068	1.103	1.140	1.204	1.229	1.242	1.253	1.265	1.276
Container	1	1.000	0.930	0.861	0.794	0.702	0.603	0.594	0.750	0.750	0.750	0.750
Container	2	1.000	0.930	0.861	0.794	0.702	0.603	0.594	0.750	0.750	0.750	0.750
Container	3	1.000	1.288	1.579	1.876	2.105	0.966	0.238	0.300	0.300	0.300	0.300
Container	4	1.000	1.001	1.005	1.010	0.983	1.521	1.746	2.204	2.204	2.204	2.204
Container	5	1.000	0.906	0.813	0.721	0.607	-	-	-	-	-	-
Container	6	1.000	0.858	0.718	0.577	0.421	0.579	0.570	0.720	0.720	0.720	0.720

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Container	7	1.000	0.960	0.921	0.884	0.819	0.634	0.416	0.525	0.525	0.525	0.525
Container	8	1.000	1.102	1.206	1.314	1.376	1.419	0.898	1.134	1.134	1.134	1.134
Container	9	1.000	0.930	0.861	0.794	0.702	0.724	0.356	0.450	0.450	0.450	0.450
Container	10	1.000	1.335	1.675	2.021	2.293	3.717	3.659	4.619	4.619	4.619	4.619
Container	11	1.000	-	-	-	-	-	-	-	-	-	-
Container	13	1.000	1.233	1.469	1.710	1.890	3.509	5.373	6.783	6.783	6.783	6.783
Container	16	-	-	-	-	1.000	2.064	7.109	8.974	8.974	8.974	8.974
Container	17	1.000	1.049	1.101	1.156	1.213	1.543	1.928	2.433	2.433	2.433	2.433
Container	18	-	-	-	-	-	-	4.960	6.262	6.262	6.262	6.262
Container	20	-	-	-	-	-	-	4.960	6.262	6.262	6.262	6.262
Cruise		1.000	1.037	1.075	1.115	1.156	1.384	1.659	1.987	2.381	2.770	3.163
General		1.000	1.046	1.094	1.145	1.198	1.467	1.771	2.143	2.574	3.084	3.696
Reefer		1.000	1.046	1.094	1.145	1.198	1.467	1.771	2.143	2.574	3.084	3.696
Ro-Ro		1.000	1.060	1.124	1.191	1.263	1.603	1.835	2.035	2.367	2.788	3.284
Tanker	Seawaymax	1.000	1.014	1.028	1.042	1.057	1.100	1.133	1.163	1.193	1.223	1.254
Tanker	Panamax	1.000	1.014	1.028	1.042	1.057	1.100	1.133	1.163	1.193	1.223	1.254
Tanker	Aframax	1.000	1.014	1.028	1.042	1.057	1.100	1.133	1.163	1.193	1.223	1.254
Tanker	Suezmax	1.000	1.014	1.028	1.042	1.057	1.100	1.133	1.163	1.193	1.223	1.254
Tanker	VLCC	1.000	1.014	1.028	1.042	1.057	1.100	1.133	1.163	1.193	1.223	1.254
Tanker	ULCC	1.000	1.014	1.028	1.042	1.057	1.100	1.133	1.163	1.193	1.223	1.254

Los Angeles

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Auto		1.000	1.060	1.124	1.191	1.263	1.603	1.835	2.035	2.367	2.788	3.284
Bulk		1.000	1.033	1.068	1.103	1.140	1.204	1.229	1.242	1.253	1.265	1.276
Container	2	1.000	0.930	0.861	0.794	0.702	0.603	0.594	0.750	0.750	0.750	0.750
Container	3	1.000	1.288	1.579	1.876	2.105	0.966	0.238	0.300	0.300	0.300	0.300
Container	4	1.000	1.001	1.005	1.010	0.983	1.521	1.746	2.204	2.204	2.204	2.204

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Container	5	1.000	0.906	0.813	0.721	0.607	-	-	-	-	-	-
Container	6	1.000	0.858	0.718	0.577	0.421	0.579	0.570	0.720	0.720	0.720	0.720
Container	7	1.000	0.960	0.921	0.884	0.819	0.634	0.416	0.525	0.525	0.525	0.525
Container	8	1.000	1.102	1.206	1.314	1.376	1.419	0.898	1.134	1.134	1.134	1.134
Container	9	1.000	0.930	0.861	0.794	0.702	0.724	0.356	0.450	0.450	0.450	0.450
Container	10	1.000	1.335	1.675	2.021	2.293	3.717	3.659	4.619	4.619	4.619	4.619
Container	11	1.000	-	-	-	-	-	-	-	-	-	-
Container	12	1.000	1.049	1.101	1.156	1.213	1.543	1.928	2.433	2.433	2.433	2.433
Container	13	1.000	1.233	1.469	1.710	1.890	3.509	5.373	6.783	6.783	6.783	6.783
Container	14	1.000	1.076	1.154	1.235	1.274	1.752	2.156	2.722	2.722	2.722	2.722
Container	16	-	-	-	-	1.000	2.064	7.109	8.974	8.974	8.974	8.974
Container	17	1.000	1.049	1.101	1.156	1.213	1.543	1.928	2.433	2.433	2.433	2.433
Container	18	-	-	-	-	-	-	4.960	6.262	6.262	6.262	6.262
Container	20	-	-	-	-	-	-	4.960	6.262	6.262	6.262	6.262
Cruise		1.000	1.037	1.075	1.115	1.156	1.384	1.659	1.987	2.381	2.770	3.163
General		1.000	1.046	1.094	1.145	1.198	1.467	1.771	2.143	2.574	3.084	3.696
Reefer		1.000	1.046	1.094	1.145	1.198	1.467	1.771	2.143	2.574	3.084	3.696
Ro-Ro		1.000	1.060	1.124	1.191	1.263	1.603	1.835	2.035	2.367	2.788	3.284
Tanker	Seawaymax	1.000	1.014	1.028	1.042	1.057	1.100	1.133	1.163	1.193	1.223	1.254
Tanker	Panamax	1.000	1.014	1.028	1.042	1.057	1.100	1.133	1.163	1.193	1.223	1.254

Martinez

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Tanker	Seawaymax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465
Tanker	Panamax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465
Tanker	Aframax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465
Tanker	Suezmax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465

Oakland

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Bulk		1.000	1.010	1.021	1.031	1.042	1.164	1.282	1.422	1.618	1.807	2.018
Container	1	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	2	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	3	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	4	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	5	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	6	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	7	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	8	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	9	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	10	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	11	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	12	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	13	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	14	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	17	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Ro-Ro		1.000	1.056	1.114	1.176	1.241	1.583	1.997	2.534	3.289	4.037	4.954

Oleum

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Tanker	Seawaymax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465
Tanker	Panamax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465
Tanker	Aframax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465
Tanker	Suezmax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465

Redwood City

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Bulk		1.000	1.010	1.021	1.031	1.042	1.164	1.282	1.422	1.618	1.807	2.018

Richmond

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Auto		1.000	1.033	1.067	1.103	1.139	1.289	1.458	1.663	1.929	2.192	2.491
Bulk		1.000	1.010	1.021	1.031	1.042	1.164	1.282	1.422	1.618	1.807	2.018
Tanker	Seawaymax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465
Tanker	Panamax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465
Tanker	Aframax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465
Tanker	Suezmax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465

Sacramento

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Bulk		1.000	1.010	1.021	1.031	1.042	1.164	1.282	1.422	1.618	1.807	2.018
General		1.000	1.058	1.119	1.183	1.252	1.656	2.155	2.835	3.897	4.635	5.514
Tanker	Seawaymax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465

San Diego

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Auto		1.000	1.032	1.065	1.099	1.134	1.269	1.418	1.597	1.827	2.084	2.377
Bulk		1.000	0.942	0.888	0.836	0.788	0.823	0.879	0.943	0.998	1.045	1.095
Container	1	1.000	1.040	1.082	1.125	1.171	1.404	1.657	1.977	2.446	2.943	3.541
Container	3	1.000	1.040	1.082	1.125	1.171	1.404	1.657	1.977	2.446	2.943	3.541
Cruise		1.000	1.037	1.075	1.115	1.156	1.384	1.659	1.987	2.381	2.770	3.163
General		1.000	1.046	1.095	1.146	1.199	1.471	1.782	2.178	2.742	3.356	4.107
Ro-Ro		1.000	1.052	1.107	1.164	1.225	1.595	2.003	2.540	3.413	4.115	4.961
Tanker	Seawaymax	1.000	1.044	1.090	1.138	1.189	1.508	1.826	2.240	2.979	3.530	4.182

San Francisco

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Auto		1.000	1.033	1.067	1.103	1.139	1.289	1.458	1.663	1.929	2.192	2.491
Bulk		1.000	1.010	1.021	1.031	1.042	1.164	1.282	1.422	1.618	1.807	2.018
Container	1	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	2	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	3	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	4	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	5	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	6	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	7	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	8	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	9	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	10	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	11	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	12	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Container	13	1.000	1.050	1.102	1.158	1.215	1.571	1.976	2.513	3.380	3.945	4.604
Cruise		1.000	1.037	1.075	1.115	1.156	1.384	1.659	1.987	2.381	2.770	3.163

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
General		1.000	1.058	1.119	1.183	1.252	1.656	2.155	2.835	3.897	4.635	5.514
Ro-Ro		1.000	1.056	1.114	1.176	1.241	1.583	1.997	2.534	3.289	4.037	4.954
Tanker	Seawaymax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465
Tanker	Panamax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465
Tanker	Aframax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465
Tanker	Suezmax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465

Selby

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Tanker	Seawaymax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465

Stockton

Vessel Type	Vessel Size	2016	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Bulk		1.000	1.010	1.021	1.031	1.042	1.164	1.282	1.422	1.618	1.807	2.018
General		1.000	1.058	1.119	1.183	1.252	1.656	2.155	2.835	3.897	4.635	5.514
Tanker	Seawaymax	1.000	0.993	0.987	0.980	0.973	1.006	1.077	1.162	1.258	1.357	1.465