



Port of San Diego 2022 Maritime Air Emissions Inventory

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TABLE OF CONTENTS

Section	Page
1 EXECUTIVE SUMMARY	6
1.1 Introduction	6
1.2 Summary of 2022 Inventory	6
1.3 Emissions Trends	7
2 DISCUSSION BY EMISSION SECTOR	12
2.1 Ocean-Going Vessels	12
2.1.1 Revised 2019 Inventory	13
2.2 Harbor Craft	14
2.3 Cargo Handling Equipment	15
2.3.1 Revised 2019 Inventory	17
2.4 Freight Rail	18
2.5 Heavy-Duty Trucks	19
3 UNCERTAINTIES AND LIMITATIONS	20
4 MCAS AND FUTURE PORT STRATEGIES	20
APPENDICES	
A Inventory Methodology	
B Modeling Outputs	
C Regulatory Setting	
FIGURES	
Figure 1. Comparison of Maritime Air Emissions Inventories	8
Figure 2. NO _x Emissions Trend by Source Category	10
Figure 3. DPM Emissions Trend by Source Category	10
Figure 4. GHG Emissions Trend by Source Category	11
Figure 5. Proportion of OGV Emissions Inside and Outside of the Bay in 2022	13
Figure 6. Relative Contributions of Pollutants by Harbor Craft Type	15
Figure 7. Proportion of Cargo Handling Equipment Emissions by Terminal in 2022	17
TABLES	
Table 1. Summary of 2022 Maritime Air Emissions Inventory	7
Table 2. Summary of Maritime Air Emissions Inventories	7
Table 3. Percent Change by Inventory Year Relative to 2022 Inventory	7
Table 4. Summary of Emissions by Sector for Each Inventory Year	9
Table 5. Summary of Maritime Activity and Throughput by Year	11
Table 6. Summary of Maritime Activity and Throughput by Year at CST	11
Table 7. Summary of 2022 Ocean-Going Vessel Emissions by Vessel Type	12
Table 8. Summary of 2022 Ocean-Going Vessel Emissions by Mode	12
Table 9. Summary of 2022 Ocean-Going Vessel Emissions by Terminal	13
Table 10. Summary of Previous and Revised 2019 Ocean-Going Vessel Emissions	13
Table 11. Summary of Revised 2019 Ocean-Going Vessel Emissions by Vessel Type	13

Table 12. Summary of Revised 2019 Ocean-Going Vessel Emissions by Mode	14
Table 13. Summary of Revised 2019 Ocean-Going Vessel Emissions by Terminal	14
Table 14. Commercial Harbor Craft Emissions by Vessel Type in 2022.....	14
Table 15. Cargo Handling Equipment Emissions by Fuel and Equipment Type in 2022	16
Table 16. Summary of Cargo Handling Equipment Emissions by Terminal	16
Table 17. Summary of Previous and Revised 2019 Ocean-Going Vessel Emissions.....	17
Table 18. Summary of Revised 2019 Cargo Handling Equipment Emissions by Terminal.....	17
Table 19. Revised 2019 Cargo Handling Equipment Emissions by Fuel and Equipment Type	18
Table 20. Summary of Freight Rail Emissions by Activity Mode.....	19
Table 21. Summary of Freight Rail Emissions by Terminal	19
Table 22. Summary of Truck Emissions by Terminal	19

ACRONYMS AND ABBREVIATIONS

AIS	Automatic Identification System
AR6	IPCC Sixth Assessment Report
bhp-hr	brake horsepower-hour
BNSF	Burlington Northern Santa Fe Railway
CAP	Climate Action Plan
CARB	California Air Resources Board
CH ₄	methane
CHC	commercial harbor craft
CHE	cargo handling equipment
CO	carbon monoxide
CO ₂	carbon dioxide
CO _{2e}	carbon dioxide equivalent
CST	Cruise Ship Terminals
DPM	diesel particulate matter
EPA	U.S. Environmental Protection Agency
g	gram
g/gal	grams per gallon
g/hp-hr	grams per horsepower-hour
g/kWh	grams per kilowatt-hour
GHG	greenhouse gas
GIS	geographic information system
GT	gas turbine
GTM	gross-ton miles
GVWR	Gross Vehicle Weight Rating
GWP	global warming potential
hp	horsepower
hp-hr	horsepower-hour
I-	Interstate
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change
kW	kilowatt
kWh	kilowatt-hour
MOU	Memorandum of Understanding
MSD	medium-speed diesel
MT	metric tons
MW	megawatts
MWh	megawatt-hours
N ₂ O	nitrous oxide
NCMT	National City Marine Terminal
nm	nautical mile
NO _x	nitrogen oxides
OGV	ocean-going vessel
PM10	particulate matter 10 micrometers or less in diameter
PM2.5	particulate matter 2.5 micrometers or less in diameter
Port	Port of San Diego
ppm	parts per million
ROG	reactive organic gas
RSD	Regulatory Support Document
SB	Senate Bill

SO ₂	sulfur dioxide
SSD	slow-speed diesel
TAC	toxic air contaminant
TAMT	Tenth Avenue Marine Terminal
VMT	vehicle miles traveled
VOC	volatile organic compound
VSR	vessel speed reduction

1 EXECUTIVE SUMMARY

The Port of San Diego (Port) has prepared this maritime air emissions inventory for the purpose of identifying and quantifying the air emissions from maritime-related activities during calendar year 2022. The Port has conducted maritime air emissions inventories based on activity in calendar years 2006, 2012, 2016, and 2019. Emissions from this 2022 inventory are compared to activity and emissions in previous inventories herein.

This Executive Summary presents an overview of the results of the 2022 Maritime Air Emissions Inventory, as well as a comparison to previous maritime air emissions inventories in terms of activity and emissions over time.

In summary, emissions have decreased since 2006 because of a decrease in cargo activity as well as implementation of various regulations and new technologies that have acted to reduce emissions. However, since 2016, cargo throughput has varied year to year, but emissions are relatively flat, consistent with other West Coast ports. More discussion related to emission trends is provided below.

1.1 INTRODUCTION

The inventory includes emissions from the following Port-related source categories:

- ▶ Ocean-going vessels (OGVs)
- ▶ Commercial harbor craft (CHC)
- ▶ Cargo handling equipment (CHE)
- ▶ Freight rail
- ▶ Heavy-duty trucks

This inventory includes emissions of the following criteria pollutants:

- ▶ Particulate matter 10 micrometers or less in diameter (PM10) and 2.5 micrometers or less in diameter (PM2.5)
- ▶ Nitrogen oxides (NO_x)
- ▶ Sulfur dioxide (SO₂)
- ▶ Reactive organic gases (ROG)
- ▶ Carbon monoxide (CO)

This inventory includes emissions of the following toxic air contaminant: diesel particulate matter (DPM).

Additionally, the inventory includes emissions of the following greenhouse gases (GHGs):

- ▶ Carbon dioxide (CO₂)
- ▶ Methane (CH₄)
- ▶ Nitrous oxide (N₂O)

The emissions inventory update includes OGV, CHC, CHE, freight rail, and heavy-duty truck sources associated with activity at and related to the four marine terminals: Cruise Ship Terminals (CST; B Street Cruise Ship Terminal and Port Pavilion on Broadway Pier [Broadway Pavilion]), Tenth Avenue Marine Terminal (TAMT), and National City Marine Terminal (NCMT).

As noted above, the GHG inventory only includes the three GHG pollutants that are associated with mobile source fuel combustion. Moreover, all GHG emissions are reported as total carbon dioxide equivalent (CO₂e) values. This metric aggregates the three pollutants based on their century-long global warming potential (GWP), as determined by the Intergovernmental Panel on Climate Change's Sixth Assessment Report.¹ While all pollutant emissions are reported in short tons per year, GHG emissions are also presented in metric tons per year to be consistent with the Port's Climate Action Plan (CAP) as well as the Maritime Clean Air Strategy (MCAS).

1.2 SUMMARY OF 2022 INVENTORY

A summary of maritime emissions from all sectors in 2022 is provided in **Table 1**. Emission estimation methods are presented in Appendix A of this report. The emission estimation methodology is generally similar to those of previous maritime air emissions inventories, except for various revised methods as well as updated emission and

¹ For more information, see Table 7.15 of "Climate Change 2021: The Physical Science Basis," available at: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_FullReport_small.pdf.

load factors. These changes are discussed in Appendix A. Emission summaries from each sector are provided below.

Table 1. Summary of 2022 Maritime Air Emissions Inventory (tons)

Sector	ROG	CO	NO _x	PM10	PM2.5	DPM	SO ₂	CO _{2e} (tons)	CO _{2e} (MT)
Ocean-Going Vessels	19.6	45.5	530.0	8.8	8.1	7.3	21.4	35,598	32,294
Harbor Craft	15.8	93.1	163.4	5.1	4.9	5.1	0.2	13,939	12,645
Cargo Handling Equipment	2.9	33.7	9.1	0.2	0.2	0.2	0.02	2,390	2,168
Freight Rail	1.8	7.0	28.9	1.1	1.1	1.1	0.5	2,701	2,450
Heavy-Duty Trucks	0.5	2.1	28.3	1.5	0.6	0.2	0.2	17,165	15,572
Total Emissions	40.6	181.4	759.7	16.8	15.0	13.9	22.2	71,792	65,129

1.3 EMISSIONS TRENDS

Since 2006, the first year in which the Port quantified emissions from its maritime activities, pollutants have been reduced across all sectors. **Table 2** summarizes the results of previous maritime inventories along with the 2022 inventory, and **Table 3** summarizes the percent change for each inventory year relative to the 2022 inventory. **Figure 1** shows the trend in emissions over time for each pollutant.

Table 2. Summary of Maritime Air Emissions Inventories (tons)

Year	ROG	CO	NO _x	PM10	PM2.5	DPM	SO ₂	CO _{2e} (tons)	CO _{2e} (MT)
2022	40.6	181.4	759.7	16.8	15.0	13.9	22.2	71,792	65,129
2019 ¹	50.7	253.2	685.6	17.5	16.2	15.5	14.5	68,502	62,143
2016	58.6	260.7	652.9	17.4	16.5	15.9	17.9	74,330	67,431
2012	67.7	202.0	836.0	28.6	26.6	27.6	42.0	65,383	59,314
2006	108.7	436.0	1686.0	119.9	111.6	109.5	686.0	112,498	102,056

¹ Values for 2019 include adjustments to reflect revised OGV auxiliary engine loads, as described in Section 1.3.2, as well as revised CHE emission factors, as described in Section 3.3.

Table 3. Percent Change by Inventory Year Relative to 2022 Inventory

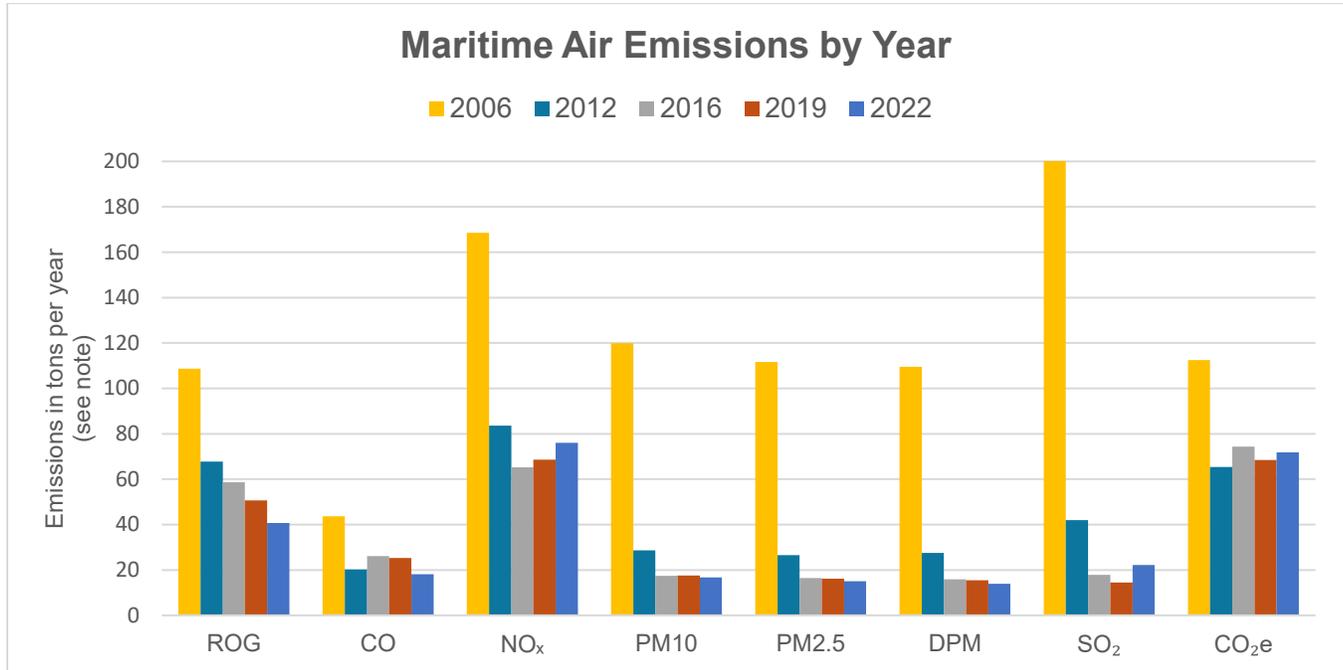
Year	ROG	CO	NO _x	PM10	PM2.5	DPM	SO ₂	CO _{2e} (tons)	CO _{2e} (MT)
2022	-	-	-	-	-	-	-	-	-
2019	-20%	-28%	+11%	-4%	-7%	-10%	+53%	+5%	+5%
2016	-31%	-30%	+16%	-4%	-9%	-13%	+24%	-3%	-3%
2012	-40%	-10%	-9%	-41%	-44%	-49%	-47%	+10%	+10%
2006	-63%	-58%	-55%	-86%	-87%	-87%	-97%	-36%	-36%

Emissions were highest in the 2006 inventory and have generally trended downward. While there has been variability between inventory years, emissions of every pollutant type have decreased substantially since 2006. Between 2006 and 2022, this includes a 55% reduction in NO_x, an 87% reduction in DPM, a 97% reduction in SO₂, and a 36% reduction in CO_{2e} emissions.

The reduction in pollutants is due to the Port's efforts to implement cleaner technologies and operations; regulations at the international, federal, state, and local levels; and varying activity levels. For instance, statewide regulations that require the use of low sulfur fuel in all marine and off-road engines as well as regulations that require the replacement or retrofit of CHC, CHE, and truck engines that operate at or near ports have led to cleaner engines and a reduction in emissions. In addition, the Port has implemented various programs to reduce emissions, including its Vessel Speed Reduction (VSR) Program, and has worked with tenants to replace their equipment with zero-emission equipment. As shown in Figure 1, since 2016, emissions have plateaued as technologies and fuels have been introduced to comply with regulations that largely went into effect in the mid-

2000's and early 2010's. Variations since 2016 appear to be a result of, in part, demonstration of new zero-emission equipment and annual changes in activity levels. This is consistent with emissions reporting from other ports in the region, such as the Port of Los Angeles.² As will be discussed, with the introduction of new regulations focused on maritime vessels, cargo handling equipment, and trucks, as well as the implementation of the Port's MCAS, emissions from maritime activity are expected to decrease following 2022 and throughout the 2020s.

Figure 1. Comparison of Maritime Air Emissions Inventories



Note: For presentation purposes, ROG, PM10, PM2.5, and DPM emissions are shown in tons per year; CO and NO_x emissions are shown in tons per year divided by 10; and CO₂e emissions are shown in tons per year divided by 1,000.

Table 4 summarizes the emissions by sector for each maritime inventory. As shown, emissions for each sector have decreased since 2006.

The trend in emissions over time is the result of changes in activity levels and the emissions profiles of the various activity types. It is important to note that activity levels are not static. The majority of cargo at the Port arrives by vessel. The number of vessel calls varies year to year, which in turn creates a cascading effect of different levels of activity for other maritime sources of emissions. Although activity levels play a significant role in the amounts of emissions generated from the maritime sector, regulations and new technologies that reduce criteria pollutant emissions have led to reductions of most emissions.

The NO_x, DPM, and GHG emissions trend charts in **Figure 2**, **Figure 3**, and **Figure 4**, respectively, show the relative proportions of emissions by source category for each year for which an emissions inventory has been prepared. The major sources of NO_x and DPM emissions are ocean-going vessels and commercial harbor craft, while the major sources of GHG emissions are ocean-going vessels, commercial harbor craft, and trucks. Notably, DPM emissions have decreased every year since 2006. Discussion of these trends is provided below.

Emissions have decreased since 2006. While the emissions for most categories vary year to year based on cargo throughput, 2022 emissions for each category are lower than they were in 2006. However, overall emissions have been relatively flat since 2016, although this varies by source type. This is consistent with reporting for other ports in the region, such as the Port of Los Angeles.² Emissions have decreased since 2006 because of various factors, including regulations implemented at the state level, programs implemented by the Port, and new technologies, all of which have acted to reduce emissions over time.

Cargo activity has decreased since 2006 but has been relatively flat since 2016. **Table 5** summarizes maritime activity by year. As shown, activity was highest in 2006 and has been relatively flat in recent years. Compared to 2019, 2022 saw marginally higher cargo tonnage and a marginally lower number of OGV calls, while

² Port of Los Angeles. 2023. *Inventory of Air Emissions 2022*. https://kentico.portoflosangeles.org/getmedia/409590b5-0e6a-4c15-8d9b-fcdb02624933/2022_Air_Emissions_Inventory.

other indicators, such as hoteling hours on auxiliary engines for OGVs, increased relative to 2019. This data demonstrates that while some of the emissions trends can be explained by changes in activity levels, a full explanation requires further review. Overall, NO_x, SO₂, and GHG emissions are higher than in previous years, which is due primarily to activity at the Port's cruise terminals.

Table 4. Summary of Emissions by Sector for Each Inventory Year (tons)

Year	ROG	CO	NO _x	PM10	PM2.5	DPM	SO ₂	CO _{2e} (tons)	CO _{2e} (MT)
OGV									
2022	20	46	530	9	8	7	21	35,598	32,294
2019	13	31	327	5	5	4	13	23,923	21,703
2016	20	32	323	8	7	6	15	24,802	22,500
2012	21	31	368	9	9	8	41	22,551	20,458
2006	31	61	726	82	76	72	681	42,963	38,975
CHC									
2022	16	93	163	5	5	5	0.2	13,939	12,645
2019	34	200	284	9	9	9	0.4	25,495	23,128
2016	29	183	235	8	8	8	0.5	28,109	25,500
2012	40	136	362	15	14	15	0.2	23,387	21,216
2006	55	150	528	24	23	24	0.2	25,116	22,785
CHE									
2022	2.9	33.7	9.1	0.2	0.2	0.20	0.02	2,390	2,168
2019	1.2	11.3	8.3	0.3	0.3	0.30	0.01	2,274	2,063
2016	4.3	26.1	13.7	0.6	0.5	0.52	1.6	2,407	2,183
2012	1.1	10.0	12.0	0.3	0.3	0.27	<0.01	1,680	1,524
2006	4.0	43.0	33.0	1.0	0.9	0.90	<0.01	4,452	4,039
Rail									
2022	1.8	7.0	28.9	1.1	1.1	1.1	0.5	2,701	2,450
2019	1.9	7.5	30.3	1.2	1.2	1.2	0.5	2,916	2,646
2016	1.9	7.5	30.3	1.2	1.2	1.2	0.5	2,916	2,646
2012	1.9	6.0	32.0	1.1	1.1	1.1	<0.1	3,192	2,896
2006	3.4	9.0	61.0	2.1	2.0	2.1	4.1	3,400	3,084
Trucks									
2022	0.5	2.1	28.3	1.5	0.6	0.2	0.2	17,165	15,572
2019	1.0	3.6	36.2	1.5	0.8	0.5	0.1	13,894	12,604
2016	3.1	12.3	51.4	0.3	0.3	0.3	0.1	16,095	14,601
2012	3.7	18.0	62.0	3.1	2.4	3.1	<0.1	14,573	13,220
2006	15.5	174.0	338.0	10.6	9.8	10.5	0.2	36,567	33,173

Cruise ship activity is increasing. Table 6 summarizes maritime activity by year at CST. Cruise ship call and passenger activity peaked in 2006 and declined significantly for several years, but activity has begun to increase. The total number of OGV hours at berth and the number of OGVs running on auxiliary engines increased in 2022 to its highest level since 2006, while the number of hours that OGVs plugged into shore power decreased slightly relative to 2019. Shore power was installed at the B Street Cruise Ship Terminal in 2010, and the construction of an additional shore power transformer and associated equipment at both the Broadway Pavilion and the B Street Cruise Ship Terminal was initiated in 2022 and completed in January 2023. The project doubled the electrical capacity of the shore power system, allowing two cruise ships to connect to shore power simultaneously. However, because of construction activities during 2022, there were multiple occasions when vessels calling at B

Street Cruise Ship Terminal were unable to plug in to shore power. Therefore, the number of shore power hours was lower in 2022 than in 2019 despite the increase in total hotel hours. This increased the total number of hours that the cruise ships ran on their auxiliary engines, which consequently increased emissions of all pollutants associated with cruise ship activity relative to previous years. With the additional infrastructure and capacity installed at CST, the number of hours cruise ships will utilize shore power is expected to increase.

Figure 2. NO_x Emissions Trend by Source Category

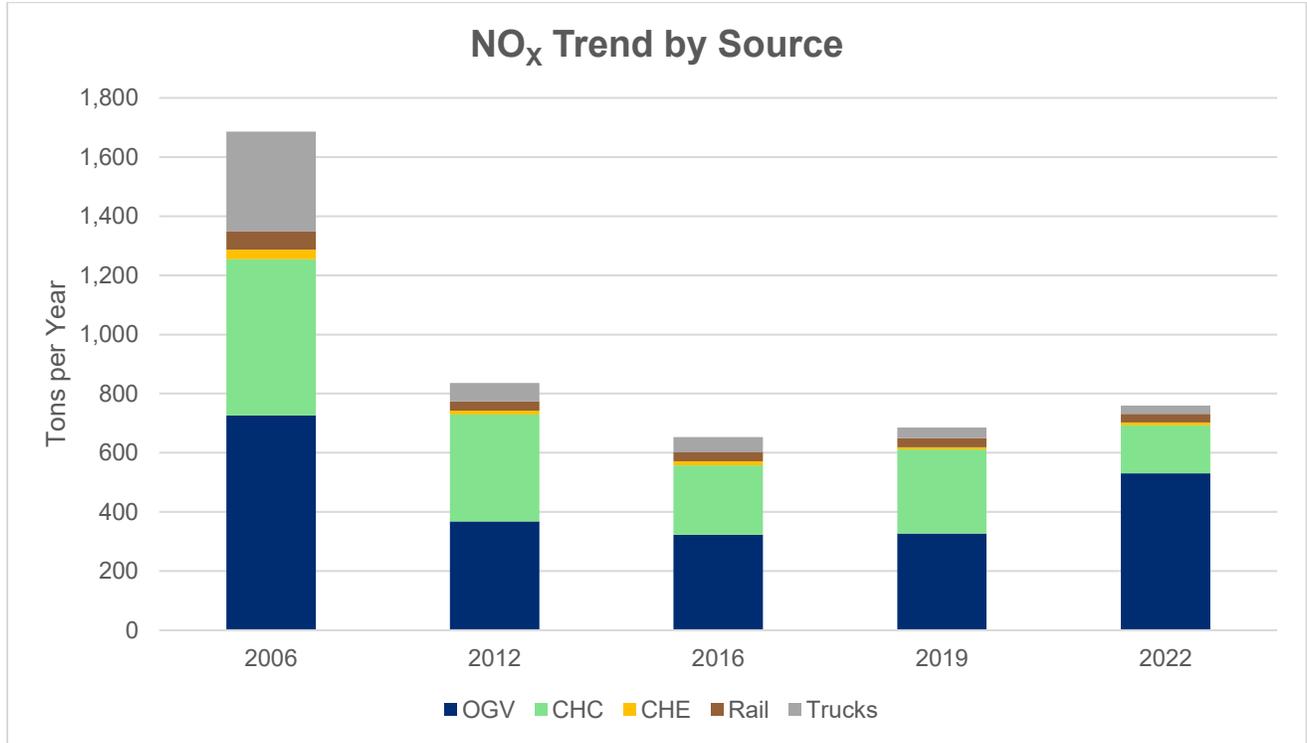


Figure 3. DPM Emissions Trend by Source Category

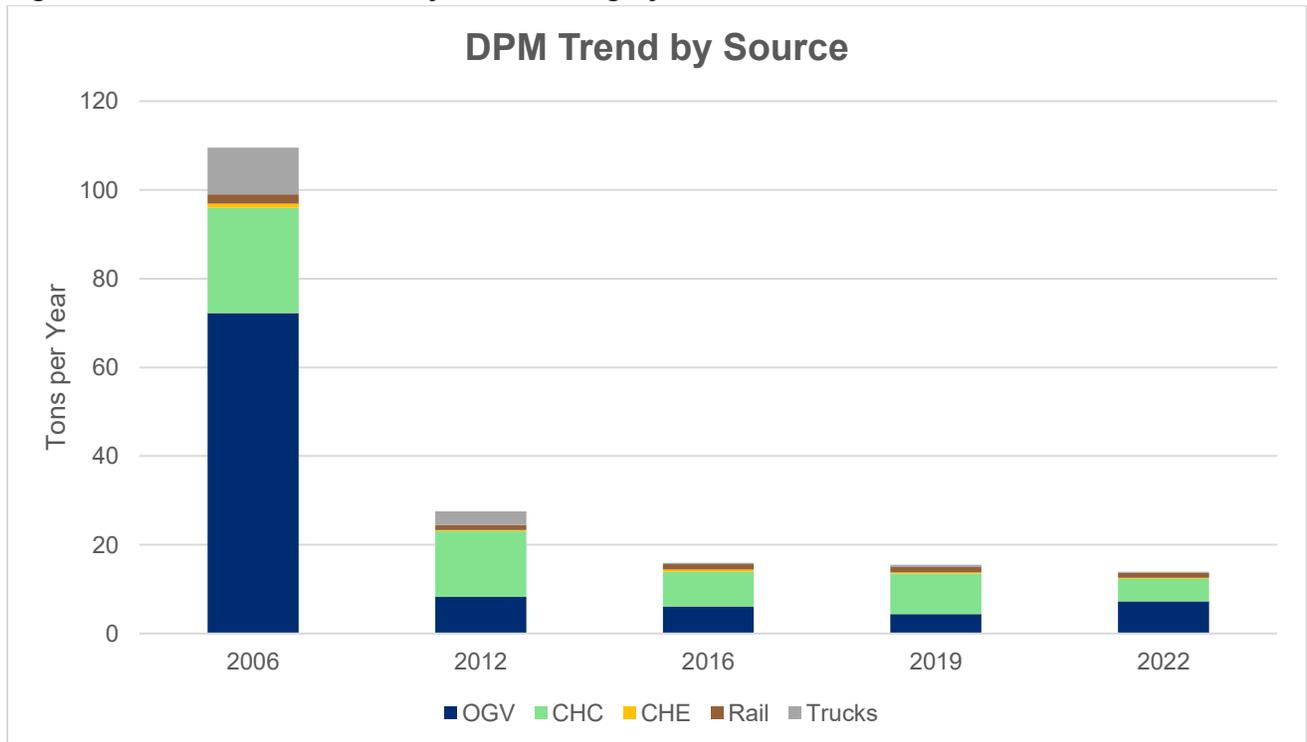


Figure 4. GHG Emissions Trend by Source Category

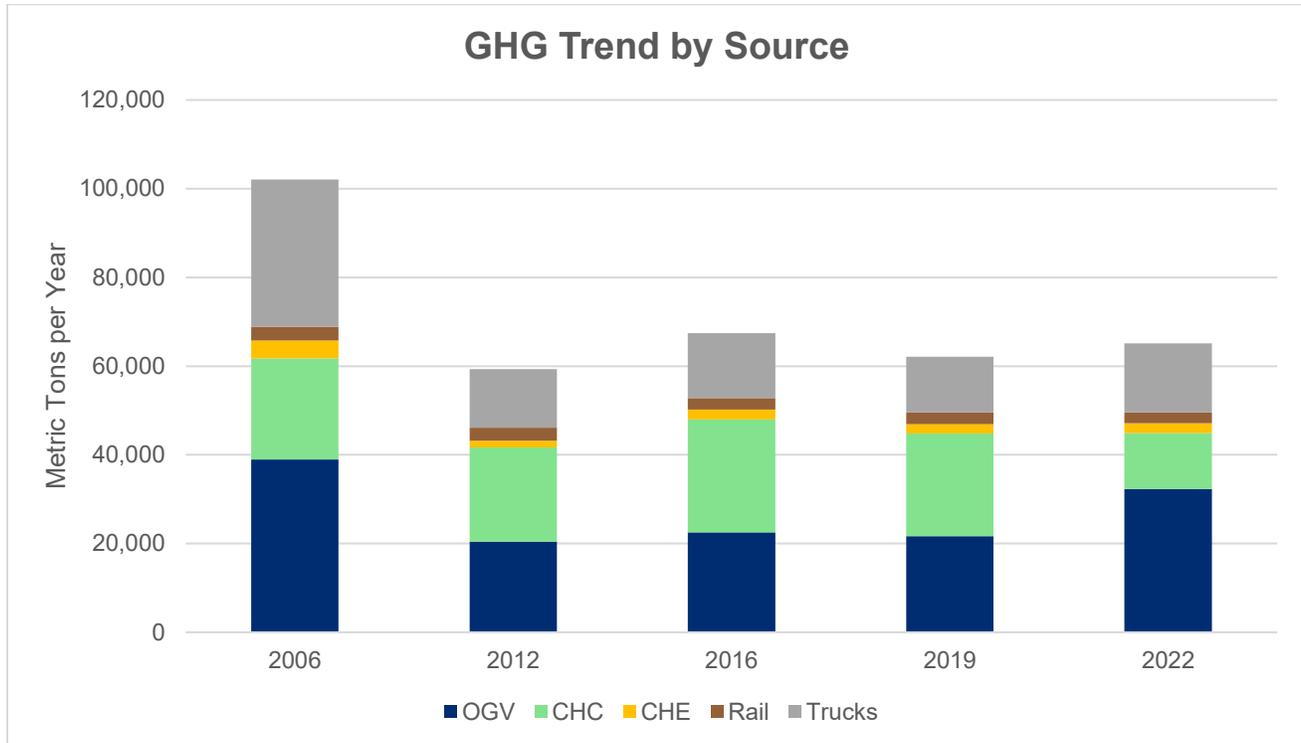


Table 5. Summary of Maritime Activity and Throughput by Year

Year	Cargo Tonnage	OGV Calls	OGV Hours At Berth		
			Total Hours at Berth	Hours on Shore Power ¹	Hours on Auxiliary Engines
2022	2,085,156	410	14,597	3,550	11,047
2019	1,981,329	424	11,128	3,391	7,736
2016	1,948,581	420	11,734	3,398	8,336
2012	1,368,346	411	10,481	120	10,361
2006	2,900,000	530	21,730	NA	21,730
Change since 2019	+5%	-3%	+31%	+5%	+43%
Change since 2006	-28%	-23%	-33%	NA	-49%

¹ Shore power infrastructure was installed at CST in 2010 and at TAMT in 2014.

Table 6. Summary of Maritime Activity and Throughput by Year at CST

Year	No. of Cruise Ship Calls	No. of Cruise Passengers	OGV Hours At Berth		
			Total Hours at Berth	Hours on Shore Power*	Hours on Auxiliary Engines
2022	126	331,425	1,692	445	1,247
2019	95	349,521	1,279	513	766
2016	74	192,700	892	264	628
2012	87	259,123	1,088	120	968
2006	167	526,886	2,204	-	2,204

2 DISCUSSION BY EMISSION SECTOR

A summary of emissions for each sector is provided in this section. Detailed methods, including emission estimation methods, formulas, and emission factor sources are presented in Appendix A to this report.

2.1 OCEAN-GOING VESSELS

The scope of the inventory includes OGVs that called at the Port's marine terminals (CST, TAMT, and NCMT) in 2022. OGVs are defined as vessels that move cargo and passengers over the open ocean and have a Category 3 propulsion engine and two or more Category 2 auxiliary engines.³ Category 1 and 2 harbor craft are discussed in Section A.2 of Appendix A. OGVs vary in speed and engine sizes based on ship type. Vessel types have been categorized by the cargo they carry. OGV types (e.g., auto carriers and bulk carriers) and location definitions (e.g., at berth and in transit within VSR zone) used in this inventory match those in previous inventories, except that travel within the 40-nautical-mile (40 nm) zone is now included to match the Port's current VSR zone.

Table 7. Summary of 2022 Ocean-Going Vessel Emissions by Vessel Type (tons)

Vessel Type	ROG	CO	NO _x	PM10	PM2.5	DPM	SO ₂	CO ₂ e (tons)	CO ₂ e (MT)
Auto Carriers	3.8	7.3	83.4	1.2	1.1	1.0	2.9	4,898	4,443
Bulk Carriers	0.6	1.5	13.9	0.3	0.3	0.2	0.8	1,280	1,161
Container Ships	0.6	1.0	11.1	0.4	0.4	0.1	1.3	2,096	1,901
General Cargo	2.1	5.3	56.5	1.0	0.9	0.8	2.4	3,976	3,607
Passenger Ships	11.8	29.3	345.9	5.6	5.2	4.9	13.3	22,137	20,082
Reefers	0.3	0.7	7.9	0.1	0.1	0.1	0.3	498	452
Roll-On/Roll-Off (RoRo)	0.4	0.6	11.4	0.1	0.1	0.1	0.4	713	647
Total Emissions	19.6	45.5	530.0	8.8	8.1	7.3	21.4	35,598	32,294

The OGV emissions inventory was updated based on 2022 conditions. Data sources used for this analysis include vessel call data from the Port, Automatic Identification System (AIS) data, and data from Lloyd's Register of Ships. A detailed description of data collection, fleet characteristics, and emission estimation methodology is described in Appendix A. Emissions were calculated based upon the California Air Resources Board's (CARB's) OGV methodology.

A summary of OGV emissions by vessel type is shown in **Table 7**, and a summary of OGV emissions by mode is shown in **Table 8**. A summary of OGV emissions by terminal is shown in **Table 9**. The relative proportions of OGV emissions that occur both inside and outside the bay are shown in **Figure 5**.

Table 8. Summary of 2022 Ocean-Going Vessel Emissions by Mode (tons)

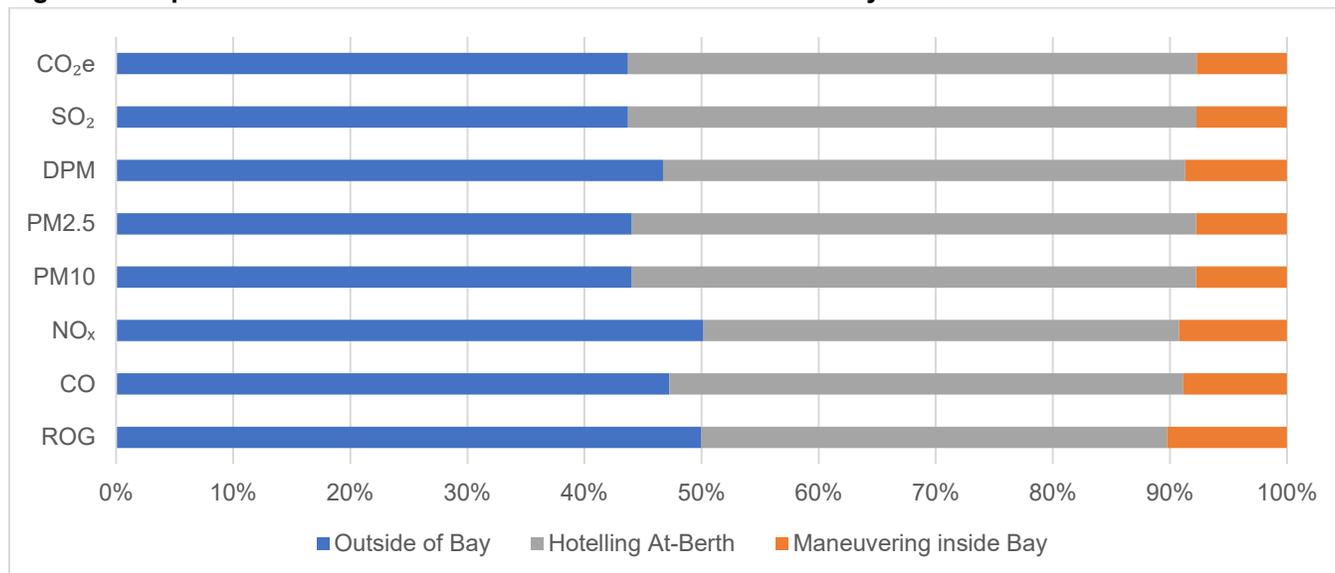
Vessel Mode	ROG	CO	NO _x	PM10	PM2.5	DPM	SO ₂	CO ₂ e (tons)	CO ₂ e (MT)
Transit Outside VSR Zone	0.1	0.1	1.6	<0.1	<0.1	<0.1	<0.1	75	68
VSR 40nm	4.3	9.5	117.5	1.7	1.6	1.5	4.1	6,785	6,155
VSR 20nm	3.7	7.6	100.0	1.2	1.1	1.2	3.0	5,058	4,588
Maneuver	2.0	4.0	48.8	0.7	0.6	0.6	1.7	2,748	2,493
Hotel	7.8	20.0	215.4	4.3	3.9	3.2	10.4	17,289	15,684
Anchor	1.7	4.2	46.7	0.9	0.8	0.7	2.2	3,643	3,305
Total Emissions	19.6	45.5	530.0	8.8	8.1	7.3	21.4	35,598	32,294

³ Category 1 engines have a gross engine power that is greater than or equal to 37 kW and a displacement that is less than 7 liters per cylinder, and they are typically associated with small harbor craft and recreational propulsion. Category 2 engines have a displacement greater than or equal to 7 and less than 30 liters per cylinder, and engines are typically used as OGV auxiliary engines, harbor craft engines, and smaller OGV propulsion engines. Category 3 engines have a displacement greater than or equal to 30 liters per cylinder, and engines are typically used for OGV propulsion.

Table 9. Summary of 2022 Ocean-Going Vessel Emissions by Terminal (tons)

Vessel Mode	ROG	CO	NO _x	PM10	PM2.5	DPM	SO ₂	CO ₂ e (tons)	CO ₂ e (MT)
TAMT	3.6	8.3	89.4	1.9	1.7	1.3	4.7	7,850	7,121
NCMT	4.2	7.9	94.7	1.3	1.2	1.1	3.4	5,612	5,091
CST	11.8	29.3	345.9	5.6	5.2	4.9	13.3	22,137	20,082
Total Emissions	19.6	45.5	530.0	8.8	8.1	7.3	21.4	35,598	32,294

Figure 5. Proportion of OGV Emissions Inside and Outside of the Bay in 2022



2.1.1 Revised 2019 Inventory

OGV emissions for 2019 were revised to reflect CARB’s updated methodology and to ensure the emission calculations for both 2022 and 2019 are based on the same methods. A summary of total previous and total revised 2019 OGV emissions is shown in **Table 10**. Summaries of revised 2019 OGV emissions by vessel type, by mode, and by terminal are shown in **Table 11**, **Table 12**, and **Table 13**, respectively.

Table 10. Summary of Previous and Revised 2019 Ocean-Going Vessel Emissions (tons)

Vessel Type	ROG	CO	NO _x	PM10	PM2.5	DPM	SO ₂	CO ₂ e (tons)	CO ₂ e (MT)
Previous 2019	17.5	33.5	378.3	7.5	6.9	6.7	15.8	25,770	23,378
Revised 2019	12.6	30.9	327.2	5.4	5.0	4.4	13.5	23,923	21,703

Table 11. Summary of Revised 2019 Ocean-Going Vessel Emissions by Vessel Type (tons)

Vessel Type	ROG	CO	NO _x	PM10	PM2.5	DPM	SO ₂	CO ₂ e (tons)	CO ₂ e (MT)
Auto Carriers	6.2	15.3	155.2	2.3	2.2	1.9	5.9	9,830	8,917
Bulk Carriers	0.3	0.9	8.3	0.2	0.2	0.1	0.4	667	605
Container Ships	0.7	1.2	17.7	0.4	0.4	0.1	1.3	2,659	2,413
General Cargo	0.8	2.2	21.4	0.4	0.4	0.3	1.0	1,601	1,452
Passenger Ships	4.6	11.1	122.8	2.1	1.9	1.9	4.9	9,051	8,211
RoRo	0.1	0.1	1.7	<0.1	<0.1	<0.1	0.1	114	104
Total Emissions	12.6	30.9	327.2	5.4	5.0	4.4	13.5	23,923	21,703

Table 12. Summary of Revised 2019 Ocean-Going Vessel Emissions by Mode (tons)

Vessel Mode	ROG	CO	NO _x	PM10	PM2.5	DPM	SO ₂	CO _{2e} (tons)	CO _{2e} (MT)
Transit Outside VSR Zone	1.0	2.9	26.4	0.3	0.3	0.3	0.7	1,215	1,102
VSR	3.7	9.1	95.6	1.1	1.0	1.1	2.8	4,670	4,237
Maneuver	2.1	4.0	51.4	0.6	0.6	0.7	1.6	2,715	2,463
Hotel	5.1	13.0	134.1	2.9	2.7	2.1	7.2	13,428	12,182
Anchor	0.8	1.9	19.7	0.5	0.4	0.3	1.1	1,895	1,719
Total Emissions	12.6	30.9	327.2	5.4	5.0	4.4	13.5	23,923	21,703

Table 13. Summary of Revised 2019 Ocean-Going Vessel Emissions by Terminal (tons)

Vessel Mode	ROG	CO	NO _x	PM10	PM2.5	DPM	SO ₂	CO _{2e} (tons)	CO _{2e} (MT)
TAMT	1.8	4.3	47.4	1.0	0.9	0.6	2.6	4,928	4,470
NCMT	6.3	15.4	157.0	2.4	2.2	1.9	6.0	9,944	9,021
CST	4.6	11.1	122.8	2.1	1.9	1.9	4.9	9,051	8,211
Total Emissions	12.6	30.9	327.2	5.4	5.0	4.4	13.5	23,923	21,703

2.2 HARBOR CRAFT

The scope of the inventory includes all commercial harbor craft (CHC) utilized by the Port and participating tenants at various locations within the bay. CHC include a variety of vessel and boat types that serve many functions within and near San Diego Bay, including crew and supply boats, charter fishing vessels, commercial fishing vessels, ferry and excursion vessels, pilot vessels, towboats or push boats, tugboats, and work boats. CHC engage in a wide variety of activities at the Port: assisting in the movement of OGVs around the harbor; moving cargo and people into and out of the port harbor area; providing fuel to OGVs; providing police, fire, pilot, and other services to harbor users; transporting crew and supplies to offshore facilities; and transporting crew and passengers to offshore fishing destinations.

Table 14. Commercial Harbor Craft Emissions by Vessel Type in 2022 (tons)

Vessel Type	Count	ROG	CO	NO _x	PM10	PM2.5	DPM	SO ₂	CO _{2e} (tons)	CO _{2e} (MT)
Assist Tugs	4	2.7	9.5	26.4	0.8	0.8	0.8	<0.1	2,749	2,493
Tugboat/Towboats	3	0.3	1.6	1.7	<0.1	<0.1	<0.1	<0.1	216	196
Ocean-Going Tugs	4	1.6	17.4	15.8	0.5	0.5	0.5	<0.1	2,454	2,226
Ferries	2	1.5	10.6	10.9	0.3	0.2	0.3	<0.1	1,373	1,246
Excursions	13	2.6	18.6	20.4	0.5	0.4	0.5	<0.1	2,440	2,213
Research Vessels	2	3.3	14.2	51.0	1.7	1.6	1.7	<0.1	1,975	1,791
Work Boats	3	0.2	2.1	0.4	<0.1	<0.1	<0.1	<0.1	49	44
Pilot Boats	1	0.1	0.6	2.1	0.1	0.1	0.1	<0.1	161	146
Sportfishing	54	2.2	13.9	18.3	0.5	0.5	0.5	<0.1	1,818	1,649
Commercial Fishing	68	1.3	4.6	16.4	0.7	0.7	0.7	<0.1	705	639
Total	154	15.8	93.1	163.4	5.1	4.9	5.1	0.2	13,939	12,645

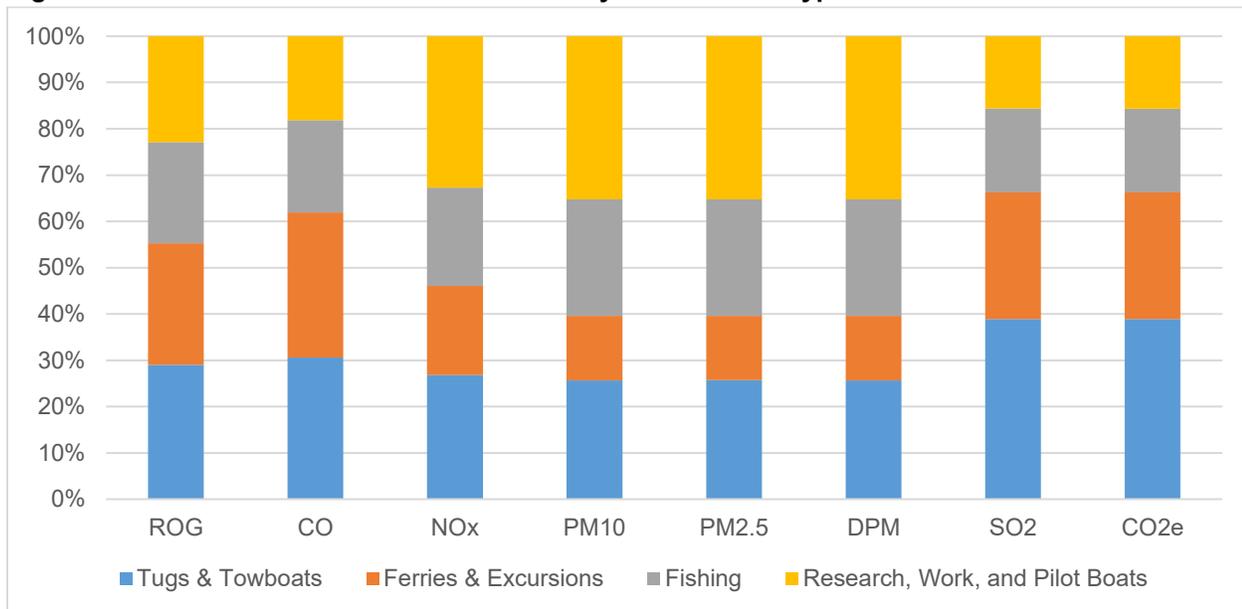
Information on the number, types, and general operating activity of CHC was obtained from equipment operators through a Port-issued survey as well as through communications with commercial fishing and sport fishing representatives. Equipment data, including engine year, horsepower, fuel type, annual operating hours, and fuel consumption, for each equipment piece were obtained from the survey results, when available. When information was missing from the survey responses, values were estimated based on category averages from CARB and

professional judgment. Detailed descriptions of data collection, fleet characteristics, and emission estimation methodology are contained in Appendix A. Emissions were calculated based upon CARB’s CHC methodology.

A summary of CHC emissions by equipment type and fuel is shown in **Table 14**. **Figure 6** shows the relative contribution of each pollutant for each vessel type. As shown, approximately 26% to 39% of the Port’s total harbor craft emissions are attributed to tugs and towboats, 14% to 31% to ferries and excursions, 18% to 25% to fishing, and 14% to 35% to research, work boats, and pilot boats, depending on the pollutant type.

Note that the research vessel category is comprised of two NOAA research vessels that dock at TAMT. Therefore, activity and associated emissions from these vessels are included in this inventory. However, it is worth noting that these vessels spend the majority of their time outside of the bay but within the 24 nm zone in which emissions are quantified for this inventory. For instance, one of the vessels spent 99% of its 3,811 hours outside of the bay, but within the inventory boundary. While these research vessels produce the largest share of NO_x and DPM emissions in the CHC category, 97% of these emissions occur outside of the bay.

Figure 6. Relative Contributions of Pollutants by Harbor Craft Type



2.3 CARGO HANDLING EQUIPMENT

The scope of the Inventory includes all CHE utilized by the Port and participating tenants at the Port’s marine terminals (CST, TAMT, and NCMT) in 2022. Types of CHE at the terminals include container handling equipment (e.g., reach stackers), yard tractors (or yard trucks and hostlers), forklifts, construction equipment (e.g., rubber-tired loaders), and general industrial equipment. The majority of equipment is electric or diesel-powered, although some equipment is powered by gasoline or propane. CHE is only used at the marine terminals and not on public roadways.

Information on the number, types, and general operating activity of CHE was obtained from equipment operators through a Port-issued survey. Equipment data, including engine year, horsepower, fuel type, annual operating hours, and fuel consumption, for each equipment piece were obtained from the survey results, when available. In cases where information was missing from the survey responses, values were estimated based on category averages from CARB and professional judgment. The detailed description of data collection, fleet characteristics, and emission estimation methodology is described in Appendix A. Emissions were calculated based upon CARB’s CHE methodology.

A summary of CHE emissions by equipment type and fuel is shown in **Table 15**. A summary of CHE emissions by terminal is shown in **Table 16**. The proportions of each terminal’s emissions by pollutant are shown in **Figure 7**. The majority of CHE emissions, aside from ROG and CO emissions, occur at TAMT, which has the largest and most active diesel-powered CHE pieces.

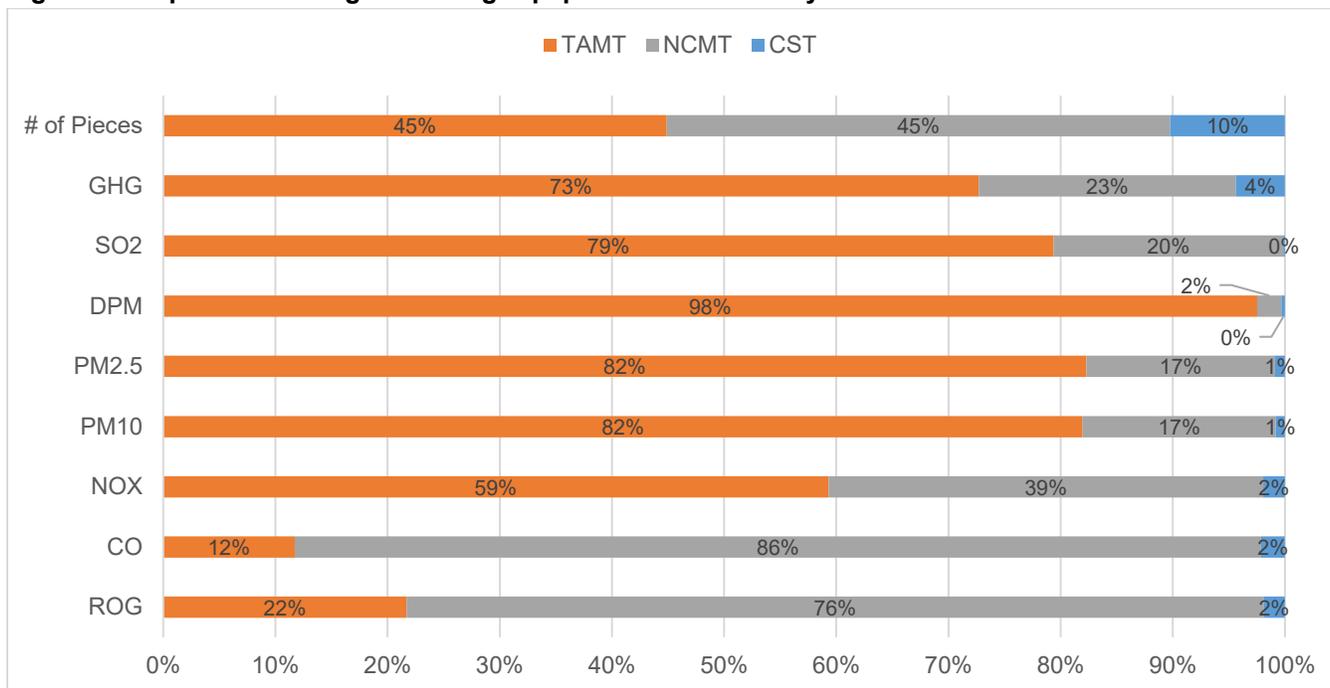
Table 15. Cargo Handling Equipment Emissions by Fuel and Equipment Type in 2022 (tons)

Fuel	Type	Count	ROG	CO	NO _x	PM10	PM2.5	DPM	SO ₂	CO ₂ e (tons)	CO ₂ e (MT)
Diesel	Compressor	1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1	1
	Crane	3	0.04	0.11	0.63	0.02	0.02	0.02	<0.01	58	53
	Forklift	21	0.04	0.49	0.55	0.01	0.01	0.01	<0.01	146	133
	Lift	1	<0.01	0.02	0.01	<0.01	<0.01	<0.01	<0.01	3	3
	Loader	1	0.01	0.05	0.09	<0.01	<0.01	<0.01	<0.01	9	8
	Other	1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Reach Stacker	7	0.06	0.3	0.63	0.03	0.03	0.03	<0.01	168	152
	Sweeper	1	<0.01	0.04	0.03	<0.01	<0.01	<0.01	<0.01	7	6
	Top Handler	2	0.03	0.3	0.33	<0.01	<0.01	<0.01	<0.01	176	159
	Vacuum truck	1	<0.01	<0.01	0.04	<0.01	<0.01	<0.01	<0.01	4	4
Yard Tractor	21	0.45	2.57	3.21	0.14	0.13	0.14	0.01	1,090	989	
Gasoline	ATV	15	1.41	16.4	0.68	0.02	0.01	<0.01	<0.01	214	194
	Cart	4	0.12	1.45	0.07	<0.01	<0.01	<0.01	<0.01	24	22
	Compressor	1	<0.01	0.46	0.01	<0.01	<0.01	<0.01	<0.01	1	1
	Loader	3	0.38	6	1.63	0.01	0.01	<0.01	<0.01	149	135
	Sweeper	1	0.18	2.3	0.37	<0.01	<0.01	<0.01	<0.01	23	21
Propane	Forklift	9	0.18	3.22	0.85	<0.01	<0.01	<0.01	<0.01	87	79
	Lift	1	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	3	3
	Sweeper	1	<0.01	0.08	0.03	<0.01	<0.01	<0.01	<0.01	7	6
Electric	Compressor	7	-	-	-	-	-	-	-	10	9
	Forklift	31	-	-	-	-	-	-	-	109	99
	Lift	21	-	-	-	-	-	-	-	6	5
	Other	12	-	-	-	-	-	-	-	2	2
	Reach Stacker	2	-	-	-	-	-	-	-	8	7
	Segway	2	-	-	-	-	-	-	-	0	0
	Yard Tractor	6	-	-	-	-	-	-	-	144	131
Total	-	176	2.92	33.81	9.17	0.24	0.22	0.20	0.02	2,450	2,222

Table 16. Summary of Cargo Handling Equipment Emissions by Terminal (tons)

Terminal	Count	ROG	CO	NO _x	PM10	PM2.5	DPM	SO ₂	CO ₂ e (tons)	CO ₂ e (MT)
TAMT	79	0.63	3.97	5.44	0.20	0.18	0.20	0.02	1,781	1,616
NCMT	79	2.23	29.13	3.56	0.04	0.04	<0.01	<0.01	561	509
CST	18	0.06	0.72	0.18	<0.01	<0.01	<0.01	<0.01	107	97
Total Emissions	176	2.92	33.81	9.17	0.24	0.22	0.20	0.02	2,450	2,222

Figure 7. Proportion of Cargo Handling Equipment Emissions by Terminal in 2022



2.3.1 Revised 2019 Inventory

CHE emissions for 2019 were revised to reflect CARB’s updated methodology for emission factors and to ensure the emission calculations for both 2022 and 2019 are based on the same methods. A summary of total previous and total revised 2019 CHE emissions is shown in **Table 17**. A summary of revised 2019 CHE emissions by terminal is shown in **Table 18**, and a summary of revised 2019 CHE emissions by fuel type and equipment type is shown in **Table 19**.

Table 17. Summary of Previous and Revised 2019 Ocean-Going Vessel Emissions (tons)

Vessel Type	ROG	CO	NO _x	PM ₁₀	PM _{2.5}	DPM	SO ₂	CO _{2e} (tons)	CO _{2e} (MT)
Previous 2019	1.03	22.64	8.41	0.15	0.13	0.13	0.02	2,439	2,213
Revised 2019	1.24	11.27	8.32	0.31	0.28	0.30	0.02	2,274	2,063

Table 18. Summary of Revised 2019 Cargo Handling Equipment Emissions by Terminal (tons)

Terminal	Count	ROG	CO	NO _x	PM ₁₀	PM _{2.5}	DPM	SO ₂	CO _{2e} (tons)	CO _{2e} (MT)
TAMT	65	0.72	3.57	6.56	0.25	0.23	0.25	0.02	1,668	1,513
NCMT	88	0.50	7.47	1.63	0.05	0.05	0.04	<0.01	502	456
CST	25	0.02	0.23	0.13	0.01	0.01	0.01	<0.01	104	94
Total Emissions	178	1.24	11.27	8.32	0.31	0.28	0.30	0.02	2,274	2,063

Table 19. Revised 2019 Cargo Handling Equipment Emissions by Fuel and Equipment Type (tons)

Fuel	Type	Count	ROG	CO	NO _x	PM10	PM2.5	DPM	SO ₂	CO ₂ e (tons)	CO ₂ e (MT)
Diesel	Crane	1	0.02	0.05	0.30	0.01	0.01	0.01	<0.01	29	26
	Forklift	26	0.07	0.69	1.01	0.05	0.04	0.05	<0.01	203	184
	Loader	1	0.01	0.05	0.09	<0.01	<0.01	<0.01	<0.01	9	8
	Reach Stacker	4	0.05	0.28	0.63	0.03	0.03	0.03	<0.01	163	148
	Top Handler	1	0.10	0.27	1.52	0.04	0.03	0.04	<0.01	136	123
	Yard Tractor	27	0.56	3.14	3.95	0.17	0.16	0.17	0.02	1,401	1,271
	Lighting	3	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Gasoline	Cart	1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<1	<1
	Compressor	1	0.02	0.96	0.03	<0.01	<0.01	<0.01	<0.01	3	3
	Forklift	1	<0.01	0.05	0.00	<0.01	<0.01	<0.01	<0.01	2	2
	Loader	3	0.02	0.34	0.12	<0.01	<0.01	<0.01	<0.01	12	11
	Sweeper	1	0.17	2.18	0.37	<0.01	<0.01	<0.01	<0.01	23	21
	ATV	18	0.22	2.52	0.17	0.01	0.01	<0.01	<0.01	90	82
Propane	Forklift	10	0.02	0.73	0.13	<0.01	<0.01	<0.01	<0.01	31	28
Electric	Cart	10	-	-	-	-	-	-	-	10	9
	Compressor	7	-	-	-	-	-	-	-	3	3
	Forklift	18	-	-	-	-	-	-	-	87	79
	Lift	21	-	-	-	-	-	-	-	1	1
	Reach Stacker	1	-	-	-	-	-	-	-	51	47
	Yard Tractor	3	-	-	-	-	-	-	-	16	15
	Other	12	-	-	-	-	-	-	-	1	1
	Segway	2	-	-	-	-	-	-	-	<1	<1
Signal Board (solar)	6	-	-	-	-	-	-	-	-	-	
Total	-	178	1.24	11.27	8.32	0.31	0.28	0.30	0.02	2,274	2,063

2.4 FREIGHT RAIL

Emissions from freight rail servicing the Port's marine cargo terminals were calculated for calendar year 2022. Rail locomotives carry freight cargo between the Port and regional destinations. Activity associated with locomotives includes activity at or near the terminals to load and unload cargo as well as regional rail activity to and from the terminals. Freight rail service at the Port is provided by the Burlington Northern Santa Fe Railway (BNSF).

Rail activity is split between regional travel (or line haul) and switching (or switch duty). Line haul refers to the movement of cargo over long distances, which either initiates from or terminates at the Port. Switching includes the assembly and disassembly of trains, the sorting of the railcars of cargo trains into contiguous "fragments" for subsequent delivery to terminals, and the short-distance hauling of fully loaded and empty railcars within terminal areas and between the BNSF yard and the terminal areas. Rail activity at TAMT is limited to some dry bulk and break bulk cargo movements, which occur a few times throughout the year. Rail activity at NCMT is more frequent and occurs daily. Freight rail emissions by activity mode (regional line haul and near-terminal switching) are shown in **Table 20**. Rail emissions by terminal are shown in **Table 21**.

Table 20. Summary of Freight Rail Emissions by Activity Mode (tons)

Fuel	ROG	CO	NO _x	PM10	PM2.5	DPM	SO ₂	CO ₂ e (tons)	CO ₂ e (MT)
Line Haul	1.21	4.77	19.74	0.78	0.75	0.78	0.34	1,847	1,676
Switching	0.56	2.21	9.13	0.36	0.35	0.36	0.15	854	774
Total Emissions	1.77	6.98	28.87	1.13	1.10	1.13	0.49	2,701	2,450

Table 21. Summary of Freight Rail Emissions by Terminal (tons)

Terminal	ROG	CO	NO _x	PM10	PM2.5	DPM	SO ₂	CO ₂ e (tons)	CO ₂ e (MT)
NCMT	1.74	6.87	28.44	1.12	1.08	1.12	0.48	2,661	2,414
TAMT	0.03	0.11	0.43	0.02	0.02	0.02	0.01	40	37
Total Emissions	1.77	6.98	28.87	1.13	1.10	1.13	0.49	2,701	2,450

2.5 HEAVY-DUTY TRUCKS

Emissions from heavy-duty trucks servicing the Port's marine cargo terminals were calculated for calendar year 2022. A summary of these emissions by marine cargo terminal is provided in **Table 22**. As described in Appendix A, truck operating modes are defined as follows:

- ▶ On-Port: truck movements and idling within a marine cargo terminal boundary as trucks move into position to pick up or drop off cargo
- ▶ Local: truck trips between the Port's marine cargo terminals and locations within San Diego County
- ▶ Regional: truck trips to and from the Port's marine cargo terminals, which originate from or end outside of San Diego County.

Note that this inventory does not account for an increasing use of biofuels in the diesel fuel blend in California. As reported in the California GHG Inventory for calendar year 2022, the biofuel blend, which includes biodiesel and renewable diesel, reached 37.7% in 2022.⁴ According to standard practice, CO₂ emissions produced by combustion of biofuels are reported separately. Methodologies to account for emission reductions due to this growing blend of biofuels have not been incorporated into this maritime inventory. As methodologies are updated, the results found in this section of the inventory may be revised.

Table 22. Summary of Truck Emissions by Terminal (tons)

Terminal	Mode	ROG	CO	NO _x	PM10	PM2.5	DPM	SO ₂	CO ₂ e (tons)	CO ₂ e (MT)
TAMT Trucks	On-Port	<0.01	0.01	0.11	0.01	<0.01	<0.01	<0.01	60	54
	Local	0.02	0.08	1.07	0.05	0.02	0.01	0.01	605	549
	Regional	0.40	1.53	19.44	0.93	0.40	0.15	0.10	10,955	9,938
NCMT Trucks	On-Port	<0.01	<0.01	0.05	<0.01	<0.01	<0.01	<0.01	36	33
	Local	0.01	0.04	0.64	0.04	0.02	0.01	<0.01	467	424
	Regional	0.10	0.41	6.96	0.43	0.19	0.08	0.05	5,042	4,574
Total Emissions		0.54	2.08	28.26	1.46	0.63	0.25	0.16	17,165	15,572

⁴ CARB. 2024. *California Greenhouse Gas Emissions from 2002 to 2022: Trends of Emissions and Other Indicators*. https://ww2.arb.ca.gov/sites/default/files/2024-09/nc-2000_2022_ghg_inventory_trends.pdf.

3 UNCERTAINTIES AND LIMITATIONS

When compiling an emissions inventory, uncertainties can arise from the modeling methods employed, the choice of emission factors, and the quality of parameters and datasets. While efforts were made to obtain the most accurate and complete data and to use the best available methods to calculate emissions in the preparation of this report, the accuracy, precision, and reliability of the total emissions presented in this report cannot be easily quantified given the following:

1. The accuracy of data provided to the Port for this inventory is difficult to estimate for some emission sources, and the precision of such data varies by emission source category and data source. Data quality can be limited by several factors, such as recordkeeping, accuracy and interpretation of datasets, and methods used to estimate activity levels.
2. The development of emission formulas and emission factors generally relies on various assumptions as well as average behavior of systems observed in experimental studies, so it is uncertain how accurately these models reflect the emission sources evaluated in this report. This inventory incorporates emission formulas and emission factors developed by regulatory agencies, utility companies, and experts in the field of air quality.
3. For some emission source categories, emission calculation methods had been updated since the release of the previous emissions inventories. In order to consistently assess emission trends, the relevant categories in the previous 2019 maritime inventory (i.e., ocean-going vessels and cargo handling equipment) were revised by incorporating these updates. However, inventories for years prior to 2019 were not re-evaluated.
4. Because of the breadth of the inventory, it is possible that the inventory is missing specific pieces of equipment, vehicles, or vessels that operated in 2022.

Despite these limitations, the Port's periodic maritime air emissions inventories are a valuable tool for understanding air quality impacts due to maritime sources, informing Port policy decisions, and tracking improvements in air quality.

4 MCAS AND FUTURE PORT STRATEGIES

In October 2021, the Port adopted the MCAS, a strategic planning document that includes short- and long-term objectives aimed at reducing air emissions due to maritime sources and their associated health impacts. Achieving such objectives entails a sustained multi-year effort that involves the participation and collaboration of multiple stakeholders, including the Port, its tenants, and other government agencies. Because the MCAS was adopted in late 2021, the 2022 maritime air emissions inventory does not reflect the early progress of MCAS objectives that will lower emissions. Many of the MCAS objectives require significant timeframes to realize emission reductions.

The list below summarizes achievements and progress of selected MCAS objectives, as of the publication date. The Port will quantify emissions benefits associated with implementation of these projects based on calendar year 2024 activities in a future inventory.

1. Cargo Handling Equipment Objective 1 has targets for the reduction of emissions due to cargo handling equipment. Since the beginning of 2023, eight pieces of zero-emission CHE have been added to the marine terminals, including two fully electric mobile harbor cranes. Not only are these cranes eliminating a major source of diesel emissions, but they also increase productivity. With a combined 400 metric tons of lift capacity, they will represent the heaviest lift capability of any crane system currently in place on the West Coast. The use of this zero-emission equipment displaces the use of diesel CHE. Through periodic emissions inventories, the operations of the CHE fleet at the terminals and the emissions reductions associated with the conversion of combustion CHE to zero-emission equipment will be assessed.
2. Harbor Craft Objective 1 calls for the Port to facilitate the implementation of the first fully electric tugboat in the United States by June 30, 2026. Crowley Maritime Corporation's electric tugboat project includes the fully electric eWolf tugboat, shoreside charging and battery storage infrastructure, and solar power generation. In August 2023, Crowley broke ground on construction of shoreside charging infrastructure for the eWolf, and in June 2024, Crowley christened the eWolf, which had arrived to San Diego in February. The eWolf has been providing tug services since July 2024. The project was made possible

through support from the Port, the San Diego County Air Pollution Control District, CARB, the U.S. Environmental Protection Agency, and the U.S. Maritime Administration.

3. Harbor Craft Objective 2A furthers the state's climate goals by supporting fuel docks' transition of diesel supply to renewable diesel. In December 2023, the first of three fuel docks began selling renewable diesel, and all three fuel docks currently have renewable diesel available for purchase. Since renewable diesel is a biogenic fuel as opposed to a fossil fuel, use of renewable diesel helps to reduce GHG emissions.
4. Harbor Craft Objective 2B seeks the installation and maintenance of shore power infrastructure for facilities receiving greater than 50 CHC visits per year by 2024. Port staff have conducted outreach with operators of harbor craft facilities in furtherance of this objective. The Port plans to install additional shore power for CHC at Fish Harbor Pier and Chesapeake Wharf, facilities primarily serving commercial fishing vessels.
5. Harbor Craft Objective 2D tasks the Port with facilitating the transition of short-run ferries to zero-emission vessels. Flagship Cruises & Events, which owns and operates two ferry vessels that transport passengers between downtown San Diego and Coronado, is planning to procure two battery-electric vessels and install 350 kW DC fast chargers onshore. In November 2024, Flagship, in partnership with the San Diego County Air Pollution Control District, was awarded a grant of \$15 million from CARB and the California Energy Commission for the implementation of this project.
6. Ocean-Going Vessels In-Transit Objective 1A pursues an enhanced Vessel Speed Reduction (VSR) Program with the goal of greater than 90% participation of vessel trips. When ocean-going vessels optimally reduce their speed near shore from cruising speeds on the open ocean, the result is lower emission rates. The Port's voluntary VSR program began in 2009 as part of the Port's 2007 Clean Air Plan. Participating cargo and cruise ships needed to travel at average speeds less than or equal to 12 knots and 15 knots, respectively, within a 20 nm zone centered on Point Loma. The original VSR program had a goal of 80% participation. In November 2021, the Port adopted an expanded VSR program with the 90% participation goal and an expanded 40 nm zone. At the time, preliminary analysis estimated annual emissions reductions, compared to 2019 emissions, of 4.3 tons DPM, 225.5 tons NO_x, and 9,791 tons CO_{2e} if 90% participation was reached within the 40 nm zone.

In 2022, VSR participation in the 20 nm zone exceeded 90%, and in the 40 nm zone, it was 67%. The Port will continue to monitor and promote VSR participation to achieve its goal of 90% participation in the 40 nm zone.

7. Ocean-Going Vessels At-Berth Objective 2A aims to expand shore power usage at the B Street Cruise Ship Terminal at CST through the installation of an additional shore power plug, which would allow for a greater number of shore-power-capable docking configurations when two cruise ships are at berth. The Port has installed two shore power systems at the B Street Cruise Ship Terminal. Construction of a new connection location to ensure greater access to shore power at the B Street Cruise Ship Terminal is complete, with commissioning expected shortly after the publication date.
8. Ocean-Going Vessels At-Berth Objective 2B targets emission reductions of OGV visits to NCMT through the installation of either shore power infrastructure or an alternative emissions control technology. Shore power installation at NCMT will occur in two phases, the first of which is nearly complete. An additional shore power system for OGVs is also planned for TAMT.

The METS-1, a barge-based capture and control system (or bonnet) for reducing emissions from at-berth OGVs, is now in operation at NCMT and was approved by CARB in May 2025 as an alternative emissions control strategy compliant with the 2020 At Berth Amendments.⁵

9. Truck Objective 1B seeks the development of a zero-emission truck program for short-haul truck routes and charging infrastructure for such trucks. In March 2024, the Board of Port Commissioners selected Skychargers LLC, to negotiate a proposed zero-emission truck stop project to be located in National City adjacent to the marine terminal. The proposed project is now undergoing an environmental review, which commenced in September 2024 at the direction of the Board. The proposed project is anticipated to provide necessary charging infrastructure for electric trucks and increase zero-emission truck trips to the Port's cargo marine terminals.

⁵ CARB Executive Orders G-25-094 and G-25-095, available at: <https://ww2.arb.ca.gov/berth-regulation-executive-orders>.

Appendix A

Inventory Methodology

This appendix provides a description of the data collection, emissions estimation methodologies, including emission factors and sources of data, for each sector included in the maritime air emissions inventory. The methodology and data collection efforts are described separately for each sector.

A.1 OCEAN-GOING VESSELS

Ocean-going vessels (OGVs) are used to transport goods and passengers to and from domestic and international ports. This section describes the activity, emissions estimation methodologies, and results for OGVs that served the Port of San Diego (Port) in 2022. OGV activity and emissions estimates take into account participation in the Port’s voluntary vessel speed reduction (VSR)¹ and shore power usage. OGV emissions herein include both tailpipe emissions associated with fuel combustion within each vessel’s engines as well as greenhouse gas (GHG) emissions associated with electricity consumption during shore power.

SOURCE DESCRIPTION

OGVs are defined as vessels that move cargo and passengers over the open ocean and have a Category 3 propulsion engine and two or more Category 2 auxiliary engines. Engine categories are defined by the U.S. Environmental Protection Agency (EPA) based upon displacement per cylinder (see **Table A-1-1**). Category 1 and 2 harbor craft are discussed in Section A.2 of this report. OGVs vary greatly in speed and engine sizes based on ship type. Vessel types have been categorized by the cargo they carry. **Table A-1-2** lists the OGV types used in this inventory.

Table A-1-1. EPA Marine Compression-Ignition Engine Categories

Category	Specification	Use
1	Gross Engine Power ≥ 37 kW Displacement < 7 liters per cylinder	Small harbor craft and recreational propulsion
2	Displacement ≥ 7 and < 30 liters per cylinder	OGV auxiliary engines, harbor craft, and smaller OGV propulsion
3	Displacement ≥ 30 liters per cylinder	OGV propulsion

Table A-1-2. EPA Marine Compression-Ignition Engine Categories

Category	Specification
Auto Carrier	Self-propelled dry-cargo vessel that carries containerized automobiles
Bulk Carrier	Self-propelled dry-cargo ship that carries loose cargo
Container Ship	Self-propelled dry-cargo vessel that carries containerized cargo
General Cargo	Self-propelled cargo vessel that carries a variety of dry cargo
Passenger Ship	Self-propelled cruise ship
Reefer	Self-propelled dry-cargo vessel that often carries perishable items.
Roll-on/Roll-off (RoRo)	Self-propelled vessel that handles cargo that is rolled on and off the ship, including ferries.

Emission sources from OGVs include propulsion engines, auxiliary engines, and auxiliary boilers. Propulsion engines are used to propel the ship and are usually either medium-speed diesel (MSD) or slow-speed diesel (SSD) engines. Less typical are vessels powered by gas turbines (GT); however, one passenger ship that visited the Port was propelled by a GT engine. In addition, the National Geographic Quest was treated as an ocean-going passenger ship even though it has a Category 1 propulsion engine. It is designated below as a high-speed

¹ A voluntary VSR program was established by the Port in 2009. The VSR zone included a zone of 20-nautical-mile radius centered on Point Loma, in which cargo vessel operators and cruise ship operators are encouraged to reduce speeds to 12 knots and 15 knots, respectively. In November 2021, the VSR zone was extended to a 40-nautical-mile radius.

diesel (HSD) engine. Passenger ships usually have electrically powered propulsion (ED), and all engine power is used to generate electricity. Auxiliary engines on non-passenger ships are used to power the ship's electrical needs and are assumed here to be Category 2 MSD engines. Auxiliary boilers are used to heat residual oil in the fuel tanks (operating outside the 200-nautical-mile North American Emission Control Area boundary). Auxiliary boilers also supply heat for engines as well as heat and hot water for crew or passenger needs. Average propulsion and auxiliary power by ship type for vessels that called in 2022 are listed in **Table A-1-3**.

DATA COLLECTION AND ACTIVITY

Data sources used for this analysis include vessel call data from the Port, Automatic Identification System (AIS) data, and Lloyd's Register data. Vessel call data obtained from the Port included various information, including vessel name, cargo type, last and next port of call, time stamps for berthing and de-berthing, time at berth, and electricity consumption (in kilowatt-hours [kWh]) for those passenger and container calls that used shore power while at berth.

The Port purchased AIS data from the Marine Exchange of Alaska to be processed for actual ship movements within the area of interest, an area bounded by the Orange County border, the U.S. contiguous zone boundary (24 nautical miles [nm] from the coast), and the international border. Data boundaries were defined as latitudes between 32.45° and 33.40° and longitudes between -116.97° and -118.17°. The AIS data included vessel position (latitude and longitude), International Maritime Organization (IMO) and Maritime Mobile Service Identity (MMSI) numbers, speed, direction, destination, and date/time for all cargo vessels over 100 tons calling at the Port. This data was used to determine operating mode. A data set was formulated by selecting AIS data at 6-minute intervals, which produced approximately 23 million records.

Only vessels that called at the Port's marine terminals were considered, corresponding to approximately 336,000 records. The remainder of the records were associated with vessels that passed by the Port and did not stop and with military vessels. Each AIS data was first assigned a ship type, as listed in Table A-1-2, and then assigned a location category. Location categories are defined in **Table A-1-4** and in **Figure A-1-1**. Data from locations in the Open Ocean, which were outside of the inventory boundaries, were not included in the analysis. Finally, each record was assigned an activity mode. Activity modes are listed in **Table A-1-5**.

Lloyd's Register data were purchased from IHS Global Limited, headquartered in Bracknell, England, and were used to define vessel characteristics (e.g., engine model year, engine sizes, and service speed). The list of vessel characteristics that were used in the inventory include:

- ▶ Vessel type
- ▶ Engine model year
- ▶ Propulsion power
- ▶ Propulsion engine type
- ▶ Auxiliary power
- ▶ Vessel service speed
- ▶ Vessel size

Lloyd's ship characteristics were matched to the AIS data based upon each vessel's unique IMO number.

Various OGVs plugged into shore power while at berth in 2022. Shore power infrastructure exists at TAMT and at CST. The Port provided shore power consumption information by vessel and by call. In 2022, a total of 109 calls utilized shore power, including 51 container vessel calls and 58 cruise ship calls, representing approximately 27% of the total vessel calls. In total, cruise ships at CST used shore power for 445 hours and consumed 3,342 megawatt-hours (MWh) of electricity, while container vessels used shore power for 3,105 hours and consumed 2,155 MWh of electricity.

Table A-1-3. Average Propulsion and Auxiliary Power by Ship Type

Ship Type	Engine Type	Calls	Average Power (kW)	
			Propulsion	Auxiliary
Auto Carrier	SSD	161	13,723	3,777
Bulk Carrier	SSD	13	6,507	1,919
Container Ship ¹	SSD	51	19,420	11,400
General Cargo	MSD	10	7,913	2,417
	SSD	23	9,011	2,245
Passenger Ships	GT-ED	3	53,911	
	HSD ²	1	2,386	858
	MSD	5	10,007	7,710
	MSD-ED	117	43,510	
Reefer	SSD	1	11,004	2,560
RoRo	SSD	25	19,040	6,000

¹ Container ships include refrigerated containerized cargo vessels that call at the Tenth Avenue Marine Terminal.

² The National Geographic Quest is treated as an ocean-going passenger ship even though it has a Category 1 propulsion engine.

Table A-1-4. Vessel Location Categories in AIS Data

Vessel Location Category	Description
At Berth	At berth at Tenth Avenue Marine Terminal, National City Marine Terminal, or Cruise Ship Terminal
In Port	Within San Diego Bay
VSR20	Outside the bay but within the 20-nautical-mile radius of Point Loma (includes anchorage time)
VSR40	Outside the bay and the 20-nautical-mile radius of Point Loma but within the 40-nautical-mile radius of Point Loma
Outside VSR	Outside the VSR zone but within the inventory boundaries
Open Ocean	Outside the inventory boundaries

Table A-1-5. OGV Activity Modes

Vessel Activity Mode	Description
Transit	Movements in the Outside VSR zone
VSR	Movements within either of the VSR zones
Maneuvering	Movements inside the Port area
Hoteling	Stopped at berth
Anchorage	Stopped within the Port area or VSR zones but not at berth

EMISSION ESTIMATION METHODOLOGY

OGV emissions are generally calculated by using energy-based emission factors together with activity profiles for each vessel. Activity is divided into distinct modes (see Table A-1-5).

OGVs have two types of engines: main engines and auxiliary engines. The main engine is a large diesel engine used primarily to propel the vessel at sea. Auxiliary engines provide power for uses other than propulsion (except for diesel-electric vessels). Additionally, most ships have auxiliary boilers to provide steam heat for a variety of uses, including fuel heating and hot water.

Propulsion engine emissions for each mode are calculated according to the general formula:

$$E = \sum Pp \times LFp \times A \times EF \times AF \times Conv$$

Where E = Emissions (grams [g])

Pp = Maximum continuous power rating for propulsion engines (kilowatts [kW])

LFp = Propulsion load factor (percent of vessel's total propulsion power)

A = Activity (hours [hr])

EF = Emission factor (grams per kilowatt-hour [g/kWh])

AF = Adjustment factor for emission factor based upon engine load

Conv = Conversion factor for grams to short tons or metric tons

Auxiliary engine emissions are calculated for each mode according to the general formula for all vessels except container ships:

$$E = \sum Pa \times LFa \times A \times EF$$

Where E = Emissions (g)

Pa = Maximum continuous power rating for auxiliary engines (kW)

LFa = Auxiliary load factor (percent of vessel's total auxiliary power)

A = Activity (hr)

EF = Emission factor (g/kWh)

Auxiliary load is the actual power used, and it is the product of auxiliary engine power (Pa) and the engine's load factor (LFa). For these vessels, auxiliary engine emissions while hoteling are calculated according to the general formula:

$$E = \sum La \times A \times EF$$

Where E = Emissions (g)

La = Auxiliary load (vessel auxiliary power)

A = Activity (hr)

EF = Emission factor (g/kWh)

Auxiliary boiler emissions are calculated for each mode using the general formula below:

$$E = \sum Lb \times A \times EF$$

Where E = Emissions (g)

Lb = Boiler load (kW)

A = Activity (hr)

EF = Emission factor (g/kWh)

The emission factor is expressed in terms of emissions per unit of energy from the engine. Emission factors are multiplied by the energy consumed while in a given mode to estimate emissions.

The propulsion load factor is based on the propeller law:

$$LF = (AS/MS)^3$$

Where LF = Load factor (percent)
 AS = Actual speed (knots)
 MS = Maximum speed (knots)

Maximum speed was calculated as 1.066 times service speed in all cases based upon the California Air Resources Board's (CARB's) methodology.² For electric drive passenger ships, all engines are used to generate electricity, and propulsion is electrically driven. Because the propulsion load factor should be applied to the propulsion engine power, the total power in electrically driven ships needs to be reduced to that commonly used for propulsion. Based upon auxiliary loads during cruise and the fact that only 80% of auxiliary power might be used for auxiliary loads in passenger ships, the total power is reduced by 16.25% before applying the propulsion load factor for electrically driven passenger ships. Auxiliary loads are calculated separately. The majority (87%) of the passenger ships that called at the Port in 2022 were electrically driven.

Emission factors vary with engine load because diesel engines are less efficient at low loads and the brake-specific fuel consumption tends to increase. Thus, while mass emissions (grams per hour) decrease with low loads, the engine power tends to decrease more quickly, thereby increasing the emission factor (grams per engine power) as load decreases. Energy and Environmental Analysis, Inc., demonstrated this effect in a study prepared for EPA in 2000.³ As such, adjustment factors were applied to propulsion engine emissions calculations. Since the 2000 EPA study, MAN-B&W, a major engine manufacturer, developed adjustment factors for their 2-stroke propulsion engines. They provided adjustment factors versus load for slide valve engines and conventional valve engines.⁴ MAN-B&W employed slide valves to meet Tier I emission standards in 2002. Thus, any MAN-B&W 2-stroke engine built since 2002 uses slide valves.⁵ For non-MAN-B&W engines, the EEA adjustment factors are used.⁶

Adjustment factors are not applied to diesel electric drive systems or auxiliary engines. For these vessels, several engines are used to generate power, and some can be shut down to allow others to operate at a more efficient setting. The purpose of these adjustment factors is to accurately calculate all emission types when an engine is operating less efficiently.

Auxiliary and boiler engine loads were taken from the latest CARB OGV methodology document from 2022.⁷ The engine loads are broken down by operating mode and ship type, while passenger ship auxiliary engine load factors are further broken down by passenger capacity of the vessel. Auxiliary and boiler loads are shown in **Table A-1-6**.

Emission factors for propulsion engines were taken from the San Pedro Bay Emissions Inventory Methodology Report. These emission factors are listed in **Table A-1-7**. Separate emissions factors were developed for the National Geographic Quest, which is an HSD. ROG emissions were calculated based on total hydrocarbons, using CARB's conversion factor of 1.26639 for diesel engines.⁸

² CARB. 2011. Initial Statement of Reasons for Proposed Rulemaking: Proposed Amendments to the Regulations "Fuel Sulfur and Other Operational Requirements for Ocean-Going Vessels Within California Waters and 24 Nautical Miles of the California Baseline," Appendix D: Emissions Estimation Methodology for Ocean-Going Vessels. <http://www.arb.ca.gov/regact/2011/ogv11/ogv11appd.pdf>.

³ Energy and Environmental Analysis, Inc. 2000. *Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data* (Publication No. EPA420-R-00-002). EPA. <https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P1009Z2K.txt>.

⁴ Starcrest Consulting Group. 2013. *MAN Slide Valve Low Load Emission Test Final Report*.

⁵ 2009. Slide Valves: Small Things That Mean a Lot. *Royal Belgian Institute of Marine Engineers Magazine*, 63(4), 166. https://www.gallois.be/ggmagazine_2009/gg_04_07_2009_166.pdf.

⁶ Starcrest Consulting Group. 2021. *San Pedro Bay Emissions Inventory Methodology Report* (Version 3a). Port of Los Angeles and Port of Long Beach. https://kentico.portoflosangeles.org/getmedia/ad5ec383-8dc6-4652-ae0d-81b6ea4c7819/SPBP_Emissions_Inventory_Methodology_v3a.

⁷ CARB. 2022. *2021 California Ocean-Going Vessels Emissions Inventory*. https://ww2.arb.ca.gov/sites/default/files/2022-03/CARB_2021_OGV_Documentation_ADA.pdf.

⁸ CARB. 2000. Public Meeting to Consider Approval of Revisions to the State's On-Road Motor Vehicle Emissions Inventory: Technical Support Document, Section 4.13: Factors for Converting THC Emission Rates TOG/ROG. <https://ww2.arb.ca.gov/sites/default/files/2023-03/emfac2000-ef.pdf>.

Table A-1-6. Auxiliary and Boiler Engine Loads

Ship Type and Size Bin ¹	Auxiliary Loads (kW)				Boiler Loads (kW)			
	Transit	Maneuver	Hotel	Anchor	Transit	Maneuver	Hotel	Anchor
Auto Carrier	583	1,325.5	954	664	91.5	183.5	308.5	300.5
Bulk Carrier	255	282.5	522.5	260.5	58	139.5	172	172
Bulk Carrier, HL	358.5	949	211	253	35	94	125	125
Container Ship - 2000	1,420	1,944	696.5	529	252.5	246	404.5	307
General Cargo	466.5	1,104	808.5	180	93	114	148	149.5
Passenger <1500	3,994	5,268	3,069	2,289	992	784	766	867
Passenger 1500-2000	7,000	9,000	5,613	3,498	1,070	1,145	976	1,951
Passenger 2000-2500	11,000	11,350	6,900	4,707	1,382	1,773	1,506	3,005
Passenger 2500-3000	9,781	8,309	6,089	5,916	596	602	431	895
Passenger 3000-3500	8,282	10,369	8,292	7,475	697	1,199	1,068	1,984
Passenger 3500-4000	9,945	11,411	10,445	10,191	401	347	868	989
Passenger >4000	12,500	14,000	12,000	9,900	335	29	503	503
Reefer	1,164	1,250.5	1,156	1,345.5	80	149.5	229	229
RoRo	283	848.5	490	283	67	148	259	251

¹ CARB categorizes auxiliary and boiler engine loads by vessel type and size bins. The size bins for container vessels correspond to the number of standard shipping containers it can carry, while the size bins for passenger ships correspond to the number of passengers they carry.

Table A-1-7. Propulsion Engine Emission Factors

Engine Type	Tier	Model Years	Propulsion Engine Emission Factors (g/kWh)								
			NO _x	DPM	PM _{2.5}	ROG	CO	SO ₂	CO ₂	CH ₄	N ₂ O
MSD	0	Pre-2000	13.2	0.19	0.17	0.53	1.10	0.40	657	0.010	0.029
	1	2000–2010	12.2	0.19	0.17	0.53	1.10	0.40	657	0.010	0.029
	2	2011–2015	10.5	0.19	0.17	0.53	1.10	0.40	657	0.010	0.029
	3	2016+	2.6	0.19	0.17	0.53	1.10	0.40	657	0.010	0.029
SSD	0	Pre-2000	17.0	0.18	0.17	0.63	1.40	0.36	593	0.012	0.029
	1	2000–2010	16.0	0.18	0.17	0.63	1.40	0.36	593	0.012	0.029
	2	2011–2015	14.4	0.18	0.17	0.63	1.40	0.36	593	0.012	0.029
	3	2016+	3.4	0.18	0.17	0.63	1.40	0.36	593	0.012	0.029
GT	All	All	5.7	-	0.01	0.11	0.20	0.59	962	0.002	0.075
HSD	2	2011–2015	7.7	0.19	0.17	0.53	1.10	0.40	657	0.010	0.029

Emission factors for auxiliary engines and boilers are shown in **Table A-1-8**. These emission factors were taken from the San Pedro Bay Ports Emissions Inventory Methodology Report. For passenger ships, the propulsion engine load factor was used for all calculations, as engines on passenger ships are Category 3 engines. Similar to propulsion engines, ROG emissions from total hydrocarbons were calculated using CARB’s conversion factor

of 1.26639 for diesel engines. Per EPA guidance, PM10 emissions from boilers are by definition not considered DPM.⁹

For the ships that used shore power (plugged into the electrical grid instead of running their auxiliary engines during hoteling) at TAMT and CST, hoteling emissions were calculated differently. Both the time during which the vessel was connected to the grid and the amount of energy (in kWh) that the ship consumed, as obtained from the Port, were used to calculate hoteling emissions from shore power electricity consumption. Normal auxiliary engine emissions were calculated for the hoteling time when the ship is not connected to the grid. In addition, electrical grid emission factors for CO_{2e} were calculated for the time the ship is connected to the grid. The power plant emission factor used for this inventory was 0 g CO_{2e}/kWh based upon guidance from Port staff.¹⁰

Table A-1-8. Auxiliary Engine and Boiler Emission Factors

Engine Type	Tier	Model Years	Auxiliary and Boiler Engine Emission Factors (g/kWh)								
			NO _x	DPM	PM2.5	ROG	CO	SO ₂	CO ₂	CH ₄	N ₂ O
Auxiliary	0	Pre-2000	13.8	0.19	0.17	0.42	1.10	0.42	696	0.008	0.029
	1	2000–2010	12.2	0.19	0.17	0.42	1.10	0.42	696	0.008	0.029
	2	2011–2015	10.5	0.19	0.17	0.42	1.10	0.42	696	0.008	0.029
	3	2016+	2.6	0.19	0.17	0.42	1.10	0.42	696	0.008	0.029
Boiler	All	All	2.0	-	0.19	0.11	0.20	0.59	922	0.002	0.075

A.2 HARBOR CRAFT

Commercial harbor craft (CHC) include a variety of vessel and boat types that serve many functions within and near San Diego Bay, including crew and supply boats, charter fishing vessels, commercial fishing vessels, ferry and excursion vessels, pilot vessels, towboats or push boats, tug boats, and work boats. This section describes the types of CHC operating at the Port and summarizes the methods used to estimate CHC emissions in 2022. The methods used herein are consistent with the methodology used by the CARB to estimate emissions for CHC operating in California.¹¹

SOURCE DESCRIPTION

CHC engage in a wide variety of activities at the Port. They assist in moving OGVs around the harbor; move cargo, crew, and passengers into and out of the harbor area; provide fuel to OGVs; provide police, fire, pilot, and other services to harbor users; transport crew and supplies to offshore facilities; and transport crew and passengers to offshore fishing destinations. Most CHC are EPA Category 1 or 2 vessels, vessels with diesel engines with displacement less than 30 liters per cylinder.¹² **Table A-2-1** lists CHC vessel types and their typical functions within the bay.¹³ This inventory does not include emissions associated with Port-owned vessels operated by various departments, including the Harbor Police Department.

⁹ EPA. 2022. *Ports Emissions Inventory Guidance: Methodologies for Estimating Port-Related and Goods Movement Mobile Source Emissions* (Publication No. EPA-420-B-22-011). <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockkey=P1014J1S.pdf>.

¹⁰ Renewable Energy Certificates were procured to offset CO_{2e} emissions from electricity at the Port's marine terminals as part of California's Low Carbon Fuel Standard program.

¹¹ CARB. 2021. Staff Report: Initial Statement of Reasons, Public Hearing to Consider the Proposed Amendments to the Commercial Harbor Craft Regulation, Appendix H: 2021 Update to the Emission Inventory for Commercial Harbor Craft: Methodology and Results. <https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2021/chc2021/apph.pdf>.

¹² Information adapted from EPA's 2016 *National Port Strategy Assessment*, available at: <https://www.epa.gov/ports-initiative/national-port-strategy-assessment-reducing-air-pollution-and-greenhouse-gases-us>.

¹³ Information adapted from reference in Footnote 9.

Table A-2-1. Commercial Harbor Craft Vessel Types

Vessel	Description
Assist Tugboats	Vessels that help OGVs maneuver in the harbor during arrivals, departures, and shifts from berth; and can also provide escort for OGVs
Towboats/Push Boats/Ocean-Going Tugboats	Self-propelled vessels that tow or push barges within and outside of the Port
Ferries and Excursion Vessels	Ferries transport passengers and property. Excursion boats provide harbor cruises and whale watching.
Research Boats	Vessels used for activities such as inspection, survey, and research
Crew and Supply Boats	Vessels that carry personnel and supplies to and from off-shore and in-harbor locations
Work Boats	Vessels used for activities such as utility services, spill/response, maritime pilot transport, mining, training, and construction
Commercial and Sport Fishing Vessels	Vessels that carry crew and/or passengers to fishing areas both within and outside 24 nautical miles from the Port

Tugboats, Towboats, Push Boats, and Assist Tugs

Tugboats, towboats, push boats, assist tugs, and ocean-going tugs are processed together. Assist tugs, tow boats, and push boats perform a variety of general work functions within the harbor, including assisting OGVs' maneuvering and hoteling in the harbor and pushing and pulling barges. Assist tugs ensure safe navigation for large cargo vessel movements upon arrival to and departure from the Port. Assist tugs have unique power levels, rudders, and other equipment designed and designated specifically to support the variety in size and maneuverability of the cargo vessels. Ocean-going tugs active at the Port primarily include tugs that pull fuel barges to and from the Ports of Los Angeles and Long Beach. There were four assist tugs, three tow or push boats, and four ocean-going tugs active at the Port in 2022.

Commercial and Sport Fishing

Commercial fishing includes those vessels harbored at one of the commercial fishing areas at Shelter Island or Tuna Harbor, which is located along the Embarcadero. Vessels in the commercial fishing fleet vary in size because they have size requirements specific to their geographic ranges and the type of catch. Sport fishing, or charter fishing, vessels are fishing boats that are commercially chartered by passengers. The list of vessels was provided by the Port. These vessels are operated by sport fishing operations based in north San Diego Bay, including Fisherman's Landing, H&M Landing, and Point Loma Sport Fishing. Similar to the commercial fishing fleet, vessels in the sport fishing fleet vary in size, depending on the destination type (e.g., half day, full day, and multiday) of the vessels. Generally, sport fishing vessel engines have greater power than those of commercial fishing vessels because of the demands of moving passengers and equipment.

Ferry and Excursion

Ferry and excursion vessels are used to move passengers for public transportation, sightseeing, whale watching, dinner cruises, and other similar events within and near the bay. Ferry and excursion services operate from the Embarcadero area along the northeastern shore of San Diego Bay within the vicinity of Broadway Pier and B Street Pier. Two companies primarily provide ferry and excursion services: Star & Crescent Boat Company (Flagship Cruises & Events) and Hornblower Cruises & Events. Passenger ferries and excursion vessels rarely travel beyond 24 nm from the Port.

Other Harbor Craft

Other harbor craft include boats that perform a variety of functions at the Port. In this analysis, these were broadly treated as crew and supply, pilot, work, and other vessels. Crew and supply boats are smaller boats that are used for carrying personnel and supplies. Work boats perform inspections, survey, and assist with construction. As an OGV approaches the bay, a San Diego pilot boat carries a bay pilot who then boards the OGV in the vicinity of the Whistle Buoy to ensure safe navigation to the berthing location.

DATA COLLECTION AND ACTIVITY

For all categories except for commercial fishing, information on the number, vessel types, location, operating radius, engine size, model year, and general operating activity of CHC was obtained from tenants through a Port-issued survey. For commercial fishing boats, AIS data were used to determine annual operating hours inside and outside the bay along with CARB default values for engine size and model year. For sport fishing boats, information on engine size, model year, and engine hours was obtained through a Port-issued survey and used to determine annual operating hours inside and outside the bay along with CARB default values for engine size and model year. Any vessel that operated less than 10 hours within the San Diego Bay area was not included.

In cases where information was missing, values were estimated based on a combination of vessel category averages from other vessels, Lloyd's Register data, web research on specific vessels, and default values from CARB models for CHC and barges/dredgers.¹⁴ Average vessel characteristics from CARB were used for commercial fishing boats. Furthermore, it was assumed that all vessels were in compliance with CARB's 2010 Commercial Harbor Craft Amendments, which set forth a compliance schedule for tugboats, towboats, push boats, ferries, excursion vessels, crew and supply vessels, barges, and dredgers based on annual hours of operation and engine model year for all in-use, newly purchased, and replacement engines that operate within Regulated California Waters (e.g., 24 nm from shore) to meet the EPA's emission standards.¹⁵ For example, a harbor craft with greater than or equal to 300 annual operating hours and a 2003 model year engine in 2017 would have needed an engine repowered or replaced to Tier 2 or higher standards by December 31, 2018.¹⁶

Table A-2-2 summarizes the activity metrics for the several types of vessels considered in this inventory, including the equipment counts as well as average main and auxiliary engine model years, annual hours within 24 nm from the coast, and total horsepower from all engines. As shown, there were 154 harbor craft vessels included in this inventory. All CHC are diesel powered except for one work boat, which is gasoline powered. Emission calculations were based on activity within the same region evaluated for OGVs, within 24 nm of the coast (see Figure A-1-1).

Note that the research vessel category is comprised of two research vessels that dock at TAMT. The main and auxiliary hours for these vessels were obtained from their operators. One of the vessels spent 99% of its 3,811 hours outside of the bay but within the inventory boundary. This amount of time is much higher than that of the same category in the 2019 inventory (114 main engine hours per vessel) and more than CARB's default (957 main engine hours per vessel).

EMISSION ESTIMATION METHODOLOGY

CHC emissions are estimated based on activity-based emission factors and activity profiles for each vessel. Emissions from diesel- and gasoline-powered CHC were estimated according to the general formula, which follows CARB's current approach for commercial harbor craft:

$$E = \sum EF * LF * HP * A * Conv$$

¹⁴ Both models are available on the CARB website at: <https://ww2.arb.ca.gov/our-work/programs/msei/road-categories/road-diesel-models-and-documentation>.

¹⁵ Commercial Harbor Craft Regulation documents are available at: <https://www.arb.ca.gov/ports/marinevess/harborcraft.htm>.

¹⁶ This compliance schedule does not apply to dredgers, barges, and crew and supply vessels, which are subject to a different compliance schedule. The compliance dates for all CHC are described in the Final Regulation Order for the 2010 Commercial Harbor Craft Amendments, which is available at: <https://www.arb.ca.gov/regact/2010/chc10/frochc931185.pdf>.

Where E = Emissions, in tons per year, for each vessel
 EF = Emission factor for each fuel type for each pollutant, in grams per brake horsepower-hour (g/bhp-hr; see subsection below)
 LF = Main and auxiliary engine load factor for harbor craft type (see subsection below)
 HP = Engine horsepower for each engine on each CHC (from Port survey)
 A = Number of annual operating hours for each engine (from Port survey and AIS data)
 Conv = Conversion factor for grams to short tons or metric tons

Emission factors are composed of zero-hour emission rates and deterioration rates. Zero-hour emission rates reflect the emissions generated per unit activity from a new engine. Over time, the rate of emissions increases because of wear on various parts of an engine. This is known as the “deterioration rate,” which changes over time. CARB assumes that at some point during the life of a piece of equipment, the engine will be rebuilt to like-new conditions. The average lifespan before an engine is rebuilt varies by the model year and fuel type. However, CARB assumes that the cumulative lifetime hours for diesel and propane equipment are capped at (limited to) 12,000 hours.¹⁷ Because gasoline engines are rarely rebuilt, CARB does not recommend a cumulative lifetime hour cap for gasoline-powered equipment. Emissions for each vessel are based on the sum of emissions from its main and, if applicable, auxiliary engines.

Emission factors were calculated according to the general formula:

$$EF = EF_{zh} * FCF \left(1 + D * \frac{A}{UL} \right)$$

Where EF = Deteriorated in-use emissions rate for each CHC for each criteria pollutant and GHG (g/bhp-hr)
 EF_{zh} = Zero-hour engine emission factor for each CHC fuel type for each criteria pollutant and GHG (g/bhp-hr; CARB CHC model)
 FCF = Fuel correction factor (as required; CARB CHC model)
 D = Horsepower and pollutant-specific engine deterioration factor (CARB CHC model)
 A = Engine age (hr)
 UL = Vessel- and engine-specific engine useful life (hr; CARB CHC model)

The zero-hour engine emission factors and deterioration rates for ROG, CO, NO_x, and particulate matter emissions from diesel engines were obtained from CARB’s CHC model. Zero-hour engine emission factors for SO₂, CH₄, and N₂O are from the San Pedro Bay Emissions Inventory Methodology Report.⁶ No deterioration was assumed for a diesel engine’s CO₂, SO₂, CH₄, and N₂O emissions, consistent with CARB.

In terms of activity, main and auxiliary engine hours are based on usage information provided by the Port or based on moving¹⁸ hours taken from the AIS data. Moving hours were assigned to the main engines. For CHC with complete AIS data, auxiliary engine hours were assigned based on the sum of moving hours and stopped hours. For other CHC with incomplete AIS data, auxiliary engine hours were based on the ratio of CARB default auxiliary engine to main engine operating hours by vessel type multiplied by main engine hours. This is because stopped hours include time at berth when vessels are connected to shore power and thus not operating auxiliary engines. For commercial fishing vessels, CARB defaults were used for vessel specifications (main engine power, auxiliary power, and model years). For sport fishing vessels, engine model years, engine size, trips per year, and average time in the bay and outside the bay for each trip were obtained from data provided by the sportfishing association. The cumulative lifetime hours were determined from the reported cumulative engine hours for each piece of equipment in the Port survey. If a survey response did not include cumulative hours, cumulative hours were estimated by multiplying the 2022 annual hours by the equipment age in years. As noted above, cumulative lifetime hours were limited to 12,000 hours for diesel-powered vessels.

Load is the average operational level of an engine in a given application expressed as a fraction of the maximum rated horsepower. Because emissions are directly proportional to engine horsepower, load factors are used to adjust the maximum rated horsepower to reflect actual operating conditions. The main engine and auxiliary

¹⁷ CARB. 2010. Staff Report: Initial Statement of Reasons for the Proposed Rulemaking, Amendments to the Regulations to Reduce Emissions from Diesel Engines on Commercial Harbor Craft Operated Within California Waters and 24 Nautical Miles of the California Baseline, Appendix C: Updates on the Emissions Inventory for Commercial Harbor Craft Operating in California. <https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2010/chc10/appc.pdf>.

¹⁸ A vessel is considered “moving” if it is traveling at a speed of 1 knot or greater.

engine load factors from CARB's CHC model are listed in **Table A-2-3**. The load factors were applied to engines of both fuel types.

Table A-2-2. Average Harbor Craft Activity by Type

Harbor Craft Type	Count	Main Engine			Auxiliary Engine		
		Model Year	Annual Hours within 24 nm	Total Rated hp	Model Year	Annual Hours within 24 nm	Total Rated hp
Assist Tug	4	2013	2,216	3,460	2014	1,548	342
Towboat	3	2015	396	484	2011	452	12
Ocean-Going Tug	4	2012	1,436	1,276	2011	1,025	133
Ferry	2	2017	5,259	724	1976	3,735	52
Excursion	13	2013	781	1,094	2015	709	349
Research Boats	2	1995	2,086	1,594	1995	2,260	1,053
Work Boats	3	2009	375	387	NA	NA	NA
Pilot Boat	1	2002	878	920	NA	NA	NA
Commercial Fishing	68	1995	100	691	1996	119	135
Charter Fishing	54	2009	131	1,985	2007	176	310
Averages	154 Total	2003	367	1,269	2002	337	231

NA = not applicable

Table A-2-3. Harbor Craft Load Factors

Vessel Type	Main Engine	Auxiliary Engine
Assist Tugs	0.163	0.338
Ocean-Going Tugs	0.334	0.370
Tow Boats	0.334	0.370
Crew and Supply	0.260	0.395
Excursion	0.268	0.403
Ferries	0.314	0.388
Work Boats	0.323	0.438
Pilot Vessels	0.333	0.322
Commercial Fishing	0.270	0.438
Sport Fishing	0.288	0.454
Others	0.333	0.322

A.3 CARGO HANDLING EQUIPMENT

Cargo handling equipment (CHE) is used to support terminal activities and move cargo onto and off of OGVs, CHC, freight rail, and heavy-duty trucks. A wide range of CHE types operate at the Port, reflecting the diversity of cargo handled at each maritime terminal, which ranges from large containers to dry bulk. This section describes the types of CHE operating at the Port and summarizes the methods used to estimate CHE emissions in 2022. The methods used herein are consistent with the methodology used by the CARB to estimate emissions for CHE operating in California.¹⁹

Table A-3-1. Cargo Handling Equipment Characteristics

Equipment	Fuel	Count	Average Horsepower	Average Engine Year	Average Annual Hours
ATV	G	15	16	2013	1,436
Cart	G	4	20	2010	535
Compressor	D	1	60	2006	43
	E	7	9	2003	1,560
	G	1	5	2003	600
Crane	D	3	711	2008	150
Forklift	D	21	168	2011	250
	E	31	105	2013	484
	P	9	91	2009	458
Lift	D	1	110	2007	100
	E	21	2	2008	1,560
	P	1	82	2012	100
Loader	D	1	125	1999	200
	G	3	138	2002	780
Other	D	1	0	2012	75
	E	12	3	2003	433
Reach Stacker	D	7	342	2013	263
	E	2	346	2016	100
Segway	E	2	2	NA	375
Sweeper	D	1	33	2017	464
	G	1	83	1998	479
	P	1	28	2017	464
Top Handler	D	2	331	2013	671
Vacuum Truck	D	1	320	2001	40
Yard Tractor	D	21	204	2012	649
	E	6	225	2020	931

Notes: D = Diesel, E = Electric, G = Gas, P = Propane, and S = Solar.

¹⁹ CARB. 2022. 2022 Cargo Handling Equipment Emissions Inventory. <https://ww2.arb.ca.gov/sites/default/files/2023-08/2022CHEInventory.pdf>.

SOURCE DESCRIPTION

Types of CHE at the terminals include container handling equipment (e.g., reach stackers), yard tractors (also known as yard trucks or hostlers), forklifts, construction equipment (e.g., rubber-tired loaders), and general industrial equipment. The majority of equipment is battery electric or diesel-powered, although some are powered by gasoline or propane. CHE is only used at the marine terminals and not on public roadways.

DATA COLLECTION AND ACTIVITY

Information on the number, types, and general operating activity of CHE was obtained from equipment operators through a Port-issued survey. A total of 176 CHE equipment pieces were reported through the surveys in 2022. The CHE was grouped by equipment type categories consistent with CARB guidance and previous Port inventories. The majority of CHE operates at TAMT (79 pieces) and NCMT (79 pieces), with the remaining equipment located at CST (18 pieces). However, most of the equipment located at NCMT (43 of the 79 pieces) and CST (15 of the 18 pieces) are electric.

Table A-3-1 summarizes the 2022 CHE inventory and average engine operating parameters by general equipment type. Engine model year, power rating, and annual operating hours for each equipment piece were obtained from the survey results, when available. Information missing from the survey responses was estimated based on category averages from CARB and professional judgment.

Table A-3-2 presents the 2022 CHE inventory by fuel type. The majority of equipment (81 pieces) is electrically powered, followed by diesel-powered equipment (60 pieces). As shown in **Table A-3-3**, the majority of these diesel-powered pieces operate at TAMT.

Table A-3-2. Cargo Handling Equipment Count by Fuel Type

Equipment Category	Diesel	Gasoline	Propane	Electric or Solar	Total by Type
ATV	0	15	0	0	15
Cart	0	4	0	0	4
Compressor	1	1	0	7	9
Crane	3	0	0	0	3
Forklift	21	0	9	31	61
Lift	1	0	1	21	23
Loader	1	3	0	0	4
Other	1	0	0	12	13
Reach Stacker	7	0	0	2	9
Segway	0	0	0	2	2
Sweeper	1	1	1	0	3
Top Handler	2	0	0	0	2
Vacuum Truck	1	0	0	0	1
Yard Tractor	21	0	0	6	27
Total by Fuel Type	60	24	11	81	176

Table A-3-3. Cargo Handling Equipment Count by Fuel Type and by Terminal

Terminal	Diesel	Gasoline	Propane	Electric or Solar	Total by Terminal
TAMT	52	1	3	23	79
NCMT	7	23	6	43	79
CST	1	0	2	15	18

EMISSION ESTIMATION METHODOLOGY

CHE emissions are estimated based on activity-based emission factors and activity profiles for each piece of equipment. Emissions from diesel, gasoline, and propane CHE were estimated according to the general formula, which follows CARB’s current approach:

$$E = \sum EF * LF * HP * A * Conv$$

- Where E = Emissions for each piece of CHE (tons/year)
- EF = Emission factor for each fuel type for each pollutant, in grams per brake horsepower-hour (g/bhp-hr; see subsection below)
- LF = Engine load factor for each general CHE type (see subsection below)
- HP = Engine horsepower for each CHE (from Port survey)
- A = Number of annual operating hours for each engine (from Port survey and CARB defaults)
- Conv = Conversion factor for grams to short tons or metric tons

Emission factors are composed of zero-hour emission rates and deterioration rates. Zero-hour emission rates reflect the emissions generated per unit activity from a new engine. Over time, the rate of emissions increases because of wear on various parts of an engine. This is known as the “deterioration rate,” which changes over time. CARB assumes that at some point during the life of a piece of equipment, the engine will be rebuilt to like-new conditions. The average lifespan before an engine is rebuilt varies by the model year and fuel type. CARB assumes that the cumulative lifetime hours for diesel and propane equipment are capped at (limited to) 12,000. Because gasoline engines are rarely rebuilt, CARB does not recommend a cumulative lifetime hour cap for gasoline-powered or propane-powered equipment.

Emission factors were calculated according to the general formula:

$$EF = \sum EF_{zh} + dr * CHrs * FCF * CF * RD$$

- Where EF = Deteriorated in-use emissions rate for each CHE for each criteria pollutant and GHG (g/bhp-hr)
- EF_{zh} = Zero-hour engine emission factor for each CHE fuel type for each criteria pollutant and GHG (g/bhp-hr; CARB CHE model)
- dr = Deterioration rate for each CHE fuel type for each criteria pollutant (CARB CHE model)
- CHrs = Cumulative lifetime hours for each CHE piece (hr)
- FCF = Fuel correction factor (as required; CARB CHE model)
- CF = Control factor for each CHE piece (based on reported controls from survey)
- RD = Reduction associated with use of renewable diesel (if applicable)

The zero-hour engine emission factors (EF_{zh}) and deterioration rates (dr) for all equipment were obtained from the San Pedro Bay Emissions Inventory Methodology Report.⁶ No deterioration was assumed for CO₂, SO₂, CH₄, and N₂O emissions, consistent with CARB guidance. The cumulative lifetime hours (CHrs) were determined from the reported cumulative engine hours for each piece of equipment from the Port survey. If a survey response did not include hours, cumulative hours were estimated by multiplying the annual hours for 2022 by the equipment age in years. As noted above, cumulative lifetime hours were limited to 12,000 hours for diesel and propane equipment.

Fuel correction factors were applied to the NO_x and particulate matter emission rates from diesel engines to account for differences in hydrocarbon and sulfur content in federal and California fuel standards. Fuel correction factors are not required for other pollutants or fuel types, consistent with CARB guidance.

Various emission control technologies have been installed on some CHE. These emission control technologies include diesel oxidation catalysts and diesel particulate filters. Emission control factors from CARB were applied to equipment that was reported to have emission controls in the Port survey. Additionally, some equipment use renewable diesel (R99). CARB guidance states that use of R99 reduces PM10, PM2.5, and DPM emissions by 30% and NO_x emissions by 10% for all engines except for Tier 4 engines equipped with a selective catalytic reduction (SCR) catalyst.²⁰ The emission reductions from R99 use in this inventory follows this guidance. No reductions for other pollutants are assumed.

Load is the average operational level of an engine in a given application expressed as a fraction of the maximum rated horsepower. Because emissions are directly proportional to engine horsepower, load factors are used to adjust the maximum rated horsepower to reflect actual operating conditions. Load factors for each of the general CHE types were obtained from CARB, except for the mobile crane, as shown in **Table A-3-4**. The load factor for the mobile crane was calculated based on the ratio of actual 2022 fuel consumption relative to the maximum fuel consumption if operating at full engine load. The load factors were applied to all fuel types.

Table A-3-4. Cargo Handling Equipment Engine Load Factors

CHE Type	Load Factor
ATV	0.72
Cart	0.58
Compressor	0.48
Crane (rented)	0.43
Crane (mobile)	0.20
Forklift	0.30
Lift	0.46
Loader	0.55
Other	0.54
Reach Stacker	0.59
Segway	0.58
Sweeper	0.68
Top Handler	0.59
Vacuum truck	0.51
Yard Tractor	0.39

²⁰ Durbin, Thomas D. et al. 2021. *Low Emission Diesel (LED) Study: Biodiesel and Renewable Diesel Emissions in Legacy and New Technology Diesel Engines*. CARB. https://ww2.arb.ca.gov/sites/default/files/2021-11/Low_Emission_Diesel_Study_Final_Report.pdf.

A.4 FREIGHT RAIL

Rail locomotives carry freight cargo between the Port and regional destinations. Activity associated with locomotives includes activity at or near the terminals to load and unload cargo as well as rail activity regionally to and from the terminals. This section describes the activity and emissions estimation methodologies.

SOURCE DESCRIPTION

Freight rail service at the Port is provided exclusively by Burlington Northern Santa Fe Railway (BNSF). Freight movements are made to and from both TAMT and NCMT along the north-south BNSF right-of-way. Commodities moved by rail include automobiles transported into and out of NCMT as well as dry bulk and break bulk cargo transported into and out of TAMT. Both TAMT and NCMT have on-site rail capabilities. There is no freight rail service to CST.

Rail activity is split between regional travel (or line haul) and switching (or switch duty). Line haul refers to the movement of cargo over long distances, which either initiates from or terminates at the Port. Switching refers to the assembly and disassembly of trains, the sorting of the cars of cargo trains into contiguous “fragments” for subsequent delivery to terminals, and the short-distance hauling of rail cargo within terminal areas as well as between the terminals and nearby railyards.

At NCMT, rail tracks used for auto train cars are on the terminal grounds, while the lumber yards are served by nearby tracks located off the terminal. In the case of automobile loading, trains arrive at NCMT, and the railcars are separated for vehicle loading and then reassembled upon departure. At TAMT, rail switching occurs when bulk cargo is delivered and switcher locomotives move cargo between the BNSF yard and loading areas within TAMT. Additionally, a smaller railcar pusher is used to move railcars within the TAMT terminal area. All switching at NCMT is performed by the line-haul locomotives.

DATA COLLECTION AND ACTIVITY

The methodologies to estimate regional line-haul (off-port) activity and on-site switching (on-port) activity differ, consistent with established protocols and available data. The methods used to estimate each are described below.

Regional Line Haul

Locomotives travel north-south between the Port and the Los Angeles metropolitan area along the BNSF right-of-way. For purposes of this inventory, locomotive emissions are estimated within the air basin boundary, located within San Diego County. Regional activity has been estimated using a methodology that is similar to those of the Port’s previous maritime air emissions inventories and inventories prepared by the Ports of Long Beach and Los Angeles. The approach includes estimating fuel consumption based on the gross weight (cargo, locomotives, and railcars) of all cargo movements, the distance that cargo traveled in the air basin, and the average fuel consumption for line-haul locomotive travel. Total fuel consumption is converted to total horsepower-hours (hp-hr) based on a fuel consumption conversion factor discussed below.

In summary, fuel consumption is calculated according to this general formula:

$$\text{gallons of diesel} = \text{tons of cargo} * \text{distance traveled} * \text{fuel efficiency}$$

Based on fuel consumption, horsepower-hours are calculated according to this general formula.

$$\text{hp-hr} = \text{gallons of diesel} * \text{hp-hr per gallon conversion factor}$$

A description of each of these variables is discussed below.

TONS OF CARGO

At NCMT, 154,407 automobiles were transported by rail within 17,450 railcars in 2022: 127,453 automobiles were moved outbound on 14,705 loaded railcars, and 26,954 automobiles were moved inbound on 2,745 loaded

railcars (total of 13,184 loaded railcars). To estimate gross-ton miles, it was assumed that the average automobile weighs 1.54 tons. Each empty railcar weighs 51.5 tons and each locomotive weighs 214 tons per BNSF’s 2022 financial information.²¹

At TAMT, during typical years, dry bulk (soda ash) is imported into the terminal by rail, stored at the terminal, and ultimately exported by vessel. However, there were no soda ash imports to TAMT in 2022 and thus no dry bulk rail activity in 2022. Break bulk includes cargo for shipbuilding and military operations. In general, break bulk cargo is imported to TAMT by BNSF via rail, where it is repositioned onto vessels or trucks for transport. Smaller movements within the terminal are typically performed by a rail pusher.

To estimate regional gross-ton miles, it was assumed that break bulk cargo weighed a total of 15,200 tons and that the cargo was transported on 108 loaded railcars. As described above, each empty railcar weighs 51.5 tons, and each locomotive weighs 214 tons.

DISTANCE TRAVELED

In terms of distance traveled, the distance for NCMT cargo is 65.7 miles (from track mile 273.1 at Tidelands Ave and 19th Street to 207.4 at the Orange County boundary), while TAMT cargo is 61.9 miles (from track mile 269.3 near the southeast edge of TAMT to 207.4 at the Orange County boundary). This leads to an estimate of 159,184,844 ton-miles from NCMT and 1,947,374 ton-miles from TAMT.

Table A-4-1. Locomotive Gross Ton-Mile Estimates, Off-Port Regional Line Haul

Direction	Item	Number	Tons/Each	Total Tons	Total Ton-Miles ^a	Total Gallons ^b	Total Hp-Hr ^c
NCMT							
Loaded	Automobiles	154,407	1.54	237,787	15,622,591	15,634	325,186
	Railcars	17,450	51.5	898,675	59,042,948	59,086	1,228,986
	Locomotives	906	214	193,884	12,738,179	12,747	265,147
	<i>Total</i>	-	-	1,330,346	87,403,718	87,467	1,819,319
Empty	Automobiles	0	1.54	0	0	0	0
	Railcars	17,450	51.5	898,675	59,042,948	59,086	1,228,986
	Locomotives	906	214	193,884	12,738,179	12,747	265,147
	<i>Total</i>	-	-	1,092,559	71,781,126	71,833	1,494,132
	Total NCMT	-	-	2,422,905	159,184,844	159,301	3,313,451
TAMT							
Loaded	Break Bulk	-	-	15,200	940,880	942	19,585
	Railcars	108	51.5	5,562	344,288	345	7,166
	Locomotives	12	214	2,568	158,959	159	3,309
	<i>Total</i>	-	-	23,330	1,444,127	1,445	30,060
Empty	Break Bulk	-	-	0	0	0	0
	Railcars	108	51.5	5,562	344,288	345	7,166
	Locomotives	12	214	2,568	158,959	159	3,309
	<i>Total</i>	-	-	8,130	503,247	504	10,475
	Total TAMT	-	-	31,460	1,947,374	1,949	40,535
Total Overall				2,454,365	161,132,218	161,249	3,353,986

^a Ton-miles estimates are based on 65.7 miles from NCMT to Orange County and 61.9 miles from TAMT to Orange County.

^b Gallons estimates are based on ton-miles x 999.3 tons-miles per gallon.

^c Horsepower-hours estimates are based on gallons x 20.8 hp-hr per gallon from EPA Regulatory Support Document and Technical Highlights.

²¹ BNSF Surface Transportation Board Reports, available at: <https://www.bnsf.com/about-bnsf/financial-information>.

FUEL CONSUMPTION

Fuel consumption is derived from information annually reported by BNSF to the U.S. Surface Transportation Board. The fuel consumption rate is calculated for this inventory based on the gross tonnage and fuel consumption provided in BNSF's 2022 financial reporting. The calculated fuel efficiency in 2022 was 1.001 gallons per thousand gross ton-miles (or 999.3 ton-miles per gallon). The 2022 fuel consumption estimate is shown in **Table A-4-1**.

GALLONS PER HORSEPOWER-HOUR CONVERSION

The fuel consumption estimate was converted to hp-hr of usable power by using a fuel consumption conversion factor of 20.8 hp-hr/gallon, which is based on EPA guidance for large line-haul Class 1 railroads.²² This multiplier is conservative: It is based on a study of locomotives manufactured in the mid-1990s, and older locomotives would be expected to produce less useful work from each gallon of fuel than newer (e.g., existing) locomotives. This conversion factor is used in other inventories, such as those of the Ports of Los Angeles and Long Beach, so it is used here for consistency. As shown in Table A-4-1, we estimate 3,313,451 hp-hr from NCMT and 40,535 hp-hr from TAMT, for a total of 3,353,986 hp-hr for line-haul activity.

On-Site Switching

Switching activity involves the loading and unloading of cargo and movements around the yard and/or terminal to position railcars. Switching activity is calculated according to this general formula:

$$\text{locomotive hp-hr} = \text{hours per train} * \text{no. of active locomotives} * \text{locomotive power rating} * \text{load factor}$$

Each variable is described below.

HOURS PER TRAIN AND NUMBER OF ACTIVE LOCOMOTIVES

Estimates of the time needed to build, spot, and load trains at both TAMT and NCMT are based on personal communication with Maritime Department staff. To determine annual activity at NCMT, it was assumed that there were 302 train-builds, based on 17,450 loaded railcars and 51.5 average railcars per train (50 railcars on weekdays and 71 railcars on Saturday). It is assumed that it takes 4.5 hours of locomotive activity for each train build.

To determine annual activity at TAMT, it was assumed that there were 12 break bulk deliveries in 2022. Each delivery was assumed to require use of a BNSF switcher to move cargo into and out of the terminal, and a rail pusher to move cargo around within the terminal.

LOCOMOTIVE POWER RATING

Freight or line-haul locomotives are the most powerful locomotives and are used to power freight train operations over long distances. Line-haul locomotives are generally equipped with 3,500 to 5,000 horsepower (hp) engines. Switch locomotives are smaller and are typically 2,000 hp or less. BNSF line-haul locomotives are equipped with 3,800 hp engines. The BNSF switcher used to move cargo into and out of TAMT is equipped with a single 3,600 hp Tier 0 engine. The railcar pusher used to move railcars around TAMT is equipped with a 300 hp Tier 3 engine.

LOAD FACTOR

A detailed description of throttle notch settings during switching activity at TAMT and NCMT is not available, so operations have been estimated based on switch-duty cycle averages from EPA's Regulatory Support Document

²² EPA. 2009. *Emission Factors for Locomotives – Technical Highlights* (Publication No. EPA-420-F-09-025). <https://nepis.epa.gov/Exe/ZyPDF.cgi/P100500B.PDF?Dockey=P100500B.PDF>.

(RSD).²³ The EPA’s RSD does not include power distribution by notch for idling, which is instead estimated based on the ratio of Dash 9 and ES44 engine fuel idling and notch 8 fuel consumption used in both the 2012 and 2016 maritime inventories. The resulting load factor is 9.0% for switcher movements. The railcar pusher load factor is based on the CARB average of 38% for railcar/track cars.

EMISSION ESTIMATION METHODOLOGY

Locomotive emissions are calculated by using activity-based emission factors together with the activity discussed above. Three sets of emissions factors were developed for BNSF line-haul locomotives, the switcher at TAMT, and the railcar pusher at TAMT.

Line-haul emission factors are based in part on BNSF’s 1998 Memorandum of Understanding (1998 MOU) with CARB and the South Coast Air Quality Management District. BNSF compliance data is submitted annually to CARB, which summarizes the work (in MWh) and NO_x emissions rating (in grams per hp-hr [g/hp-hr]).²⁴ BNSF’s compliance data are used to determine the fleet-average NO_x emission level each year, which is weighted by the work (in MWh) performed by locomotives in each engine tier. BNSF only estimates and submits its NO_x emission level consistent with the 1998 MOU. While emission factors for other pollutants are not provided, this compliance data can be used to assign other emission factors based on EPA locomotive emission factors. Emission factors for other pollutants are based on the same activity (sum of work by tier) assumed in the NO_x emissions calculation. The EPA only provides tier-specific emission factors for hydrocarbons (HC), particulate matter (PM), and CO, in addition to NO_x (which is already weighted per the 1998 MOU). Emission factor weightings for HC, PM, and CO emissions are provided in **Table A-4-2**.

Table A-4-2. Line-Haul Emission Factor Weighting

Tier	BNSF Agreement Locomotive Compliance Summary Information ¹			Other Emission Factor Weighting ²		
	Sum of work (MWh)	% Work by Tier	NO _x	PM	HC	CO
Pre-Tier 0	1,335	0.65%	13.0	0.32	0.48	1.28
Tier 0	3,792	1.84%	7.5	0.32	0.48	1.28
Tier 1	81,853	39.63%	6.2	0.32	0.47	1.28
Tier 2	63,154	30.58%	4.5	0.18	0.26	1.28
Tier 3	45,449	22.00%	4.3	0.08	0.13	1.28
Tier 4	10,968	5.31%	1.2	0.015	0.04	1.28
Total	206,554	100%	5.1	0.21	0.31	1.28

¹ Based on BNSF’s 2022 compliance data, available at: <https://ww2.arb.ca.gov/resources/documents/rail-emission-reduction-agreements>.

² Based on EPA Locomotive Exhaust Emissions Factors, available at: <https://nepis.epa.gov/Exe/ZyPDF.cgi/P100500B.PDF?Dockey=P100500B.PDF>.

These weighted tier-specific emission factors are used to estimate emission factors for other pollutants: The ROG emission factor estimate is based on a 1.053 total HC to ROG conversion factor from the EPA rulemaking. The PM emission factor is assumed to be equal to the PM10 emission factor, and the PM2.5 emission factor is assumed to be 97% of the PM10 emission factor, per EPA guidance. The DPM emission factor is assumed to equal the PM10 emission factor. SO₂ and CO₂ emission factors are based on EPA rulemaking that estimated SO₂ (assuming ultra-low sulfur diesel at 15 parts per million) and CO₂ emission rates to be 0.09 g/hp-hr (based on 1.88 grams per gallon) and 491 g/hp-hr (based on 10,217 grams per gallon), respectively. CH₄ and N₂O emission factors are taken from the EPA default emission factors of 0.038 g/hp-hr (based on 0.8 g/gallon) for CH₄ and 0.013 g/hp-hr (based on 0.26 g/gallon) for N₂O. A summary of line-haul emission factors after weighting and after the above conversions is provided in **Table A-4-3**.

²³ EPA. 1998. *Locomotive Emission Standards: Regulatory Support Document* (Publication No. EPA-420-R-98-101). <https://nepis.epa.gov/Exe/ZyPDF.cgi/P100F9QT.PDF?Dockey=P100F9QT.pdf>.

²⁴ CARB. 1998. *Memorandum of Mutual Understandings and Agreements: South Coast Locomotive Fleet Average Emissions Program*. <https://ww2.arb.ca.gov/sites/default/files/2021-02/1998MOU.pdf>.

The emissions factors for switchers are based on Tier 0 emission rates from EPA. The ROG emission factor estimate is based on a 1.053 conversion factor from EPA rulemaking. PM emissions are equal to PM10 emissions, and DPM emissions are assumed equal to PM10 emissions. PM2.5 emissions are assumed to be 97% of PM10 emissions. SO₂ and GHG emission factors are taken from EPA. Emission factors for the railcar pusher are based on Tier 3 emission rates for a 300 hp engine. A summary of weighted switcher and railcar pusher emission factors is provided in Table A-4-3.

Table A-4-3. Summary of Locomotive Emission Factors (g/hp-hr)

	ROG	CO	NO _x	PM10	PM2.5	DPM	SO ₂	CO ₂	CH ₄	N ₂ O
Line Haul	0.32	5.30	1.28	0.21	0.20	0.21	0.09	491	0.04	0.01
Switcher	1.06	12.60	1.83	0.44	0.43	0.44	0.01	671	0.03	0.01
Railcar Pusher	0.09	2.32	2.60	0.09	0.08	0.09	0.005	528	0.02	0.004

A.5 HEAVY-DUTY TRUCKS

On-road vehicles include heavy-duty trucks that are used to transport Port-related cargo between NCMT and TAMT and local and regional destinations. This section describes the activity of heavy-duty trucks and on-road vehicles that operate at the Port, including activity assumptions and methodologies that were used to develop emission estimates.

SOURCE DESCRIPTION

Heavy-duty trucks travel between NCMT and TAMT and local and regional destinations. Typical types of trucks that visit TAMT are refrigerated container trucks, dry bulk trucks, and flatbed trucks. The main type of truck that visits NCMT is auto carriers.

In order to properly account for all emissions associated with truck travel, activity for truck trips is categorized geographically:

- ▶ On-port moves, which include truck movement and idling within terminal boundaries as trucks move into position to pick up or drop off cargo
- ▶ Near-port moves, which include truck movement that occurs between terminal gates and freeway access points and between the terminal gates and local destinations or origins for trips that do not require freeway travel
- ▶ Off-port regional moves, which include truck movement on the regional freeway network between freeway access points and the cargo destination or origin

At NCMT, automobile imports arrive by vessel and are off-loaded and driven a short distance to parking areas near the terminal prior to being loaded onto trucks or rail.

DATA COLLECTION AND ACTIVITY

Information on the number of terminal truck trips and destinations by cargo type was obtained from Port staff. The emissions estimation methodology is described below,

In 2022, there were 61,478 truck visits to TAMT and 39,751 truck visits to NCMT. Truck counts are summarized in **Table A-5-1**.

Truck visit counts (one trip inbound and outbound for each gate count) and the distribution of trucks by destination were obtained from the Port and the NCMT operator, Pasha. Truck trips and vehicle miles traveled (VMT) by destination were estimated based on travel distance. At TAMT, refrigerated container and cold storage trucks primarily travel north toward Orange County along Interstate (I-) 5 or south to the National Distribution Center in National City via surface roads. A smaller portion of the refrigerated truck traffic travels north toward Riverside County along I-15 and east toward Imperial County along I-8. For dry bulk and other general cargo, trip distributions vary by cargo type. For example, all bauxite arrives to TAMT via vessel and is hauled by truck to Riverside and Imperial Counties. All trucks traveling to and from NCMT use Bay Marina Drive. A small share of

car carrier trucks travel directly from NCMT to local car dealerships located on Mile of Cars Way in National City, while the majority of trucks travel north on I-5 and I-15 for regional distribution. Additionally, a portion of auto carriers import vehicles from the Otay Mesa area to the NCMT terminal for regional distribution.

Table A-5-1. Terminal Truck Gate Counts by Type and Cargo

Terminal	Truck Type	Counts
TAMT	Containers	34,592
	Bauxite	4,793
	Sugar	5,405
	Fertilizer	471
	Car Carriers	4,056
	Break Bulk	12,143
	Other Dry Bulk	18
	Total TAMT	61,478
NCMT	Car Carriers	39,232
	Break Bulk	519
	Total NCMT	39,751

On-port distance and time duration per truck visit are taken directly from the 2012 inventory and presented in **Table A-5-2**. Near-port travel distance is based on the assumed path trucks take to access the freeway, and regional travel distance is the mileage measured from the point of freeway access to the ultimate destination.

Descriptions of the routes that trucks take between TAMT and local and regional origins and destinations are as follows:

- ▶ Trucks that move cargo between TAMT and Orange County travel on I-5 and are assumed to access I-5 and TAMT via 28th Street and Harbor Drive.
- ▶ Trucks that move cargo between TAMT and Marine Corps Air Station Miramar and Riverside County travel on I-15 and are assumed to travel between I-15 and TAMT via 32nd Street and Harbor Drive.
- ▶ Trucks that move cargo between TAMT and Imperial County travel on I-8 and are assumed to access TAMT and I-15 via 32nd Street.
- ▶ Trucks that move cargo between TAMT the National Distribution Center are assumed to travel on Harbor Drive, Tideland Avenue, and Bay Marina Drive.
- ▶ Trucks that move cargo between TAMT and bulk facilities in National City are assumed to travel on Harbor Drive and access Main Street via 32nd Street.

Descriptions of the routes that trucks take between NCMT and local and regional origins and destinations are as follows:

- ▶ All trucks that do not move cargo between NCMT and the Mile of Cars Way are assumed to travel between NCMT and regional destinations via I-5 and I-15 via Bay Marina Drive.
- ▶ Trucks that travel between NCMT and Mile of Cars Way in National City do not access the freeway but instead travel on Bay Marina Drive and Mile of Cars Way.

The distance traveled (in miles) within each travel leg was measured with geographic information systems (GIS).

Table A-5-2. Heavy-Duty Truck Activity Assumptions at TAMT and NCMT

Cargo	Activity or Direction	Round Trip Mileage
TAMT		
All	Within Terminal	0.5
Refrigerated Containers	59% to Orange County via I-5	118
	12% to Riverside County via I-15	113
	10% to Imperial County via I-8	150
	18% to National Distribution Center via Harbor Drive	10
	1% to Otay Mesa via Harbor Drive and I-905	32.8
Bauxite	64% to Riverside County via I-15	113
	36% to Imperial County via I-8	150
Cement	70% to Riverside County via I-15	113
	30% to Imperial County via I-8	150
Other Bulk	100% of sugar to Otay Mesa via Harbor Drive and I-905	32.8
	100% of fertilizer to Barrio Logan via Harbor Drive	6
NCMT		
All	Within Terminal	0.5
Vehicle Carriers	42% from Otay Mesa Port of Entry to NCMT via I-905 and Bay Marina Drive	32
	2% of truck travel to/from Otay Mesa Yard	26
	11% to Various destinations within San Diego County	50
	38% to Orange County via I-5	124
	7% to Imperial County via I-8	156
Break Bulk	100% to various destinations within San Diego County	50

EMISSION ESTIMATION METHODOLOGY

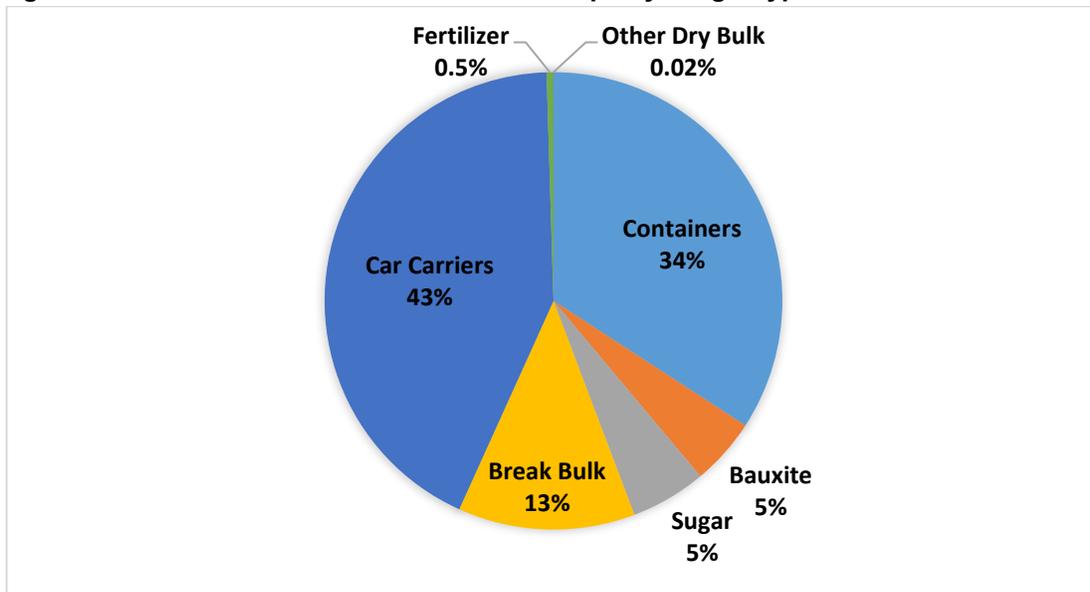
The current practice to calculate emissions from vehicles serving ports is to use activity-based emission factors and activity profiles for each vehicle type. Emissions from trucks are calculated according to the following formula:

$$E = \sum EF * T * Mi * Conv$$

- Where E = Emissions from truck activity (tons or metric tons)
- EF = Emission factor for each truck type for each pollutant (g/mile; see subsection below)
- T = Number of truck trips
- Mi = Mileage for each truck trip based on origin and destination
- Conv = Conversion factor for grams to short tons or metric tons

Emissions are estimated based on emission factors from CARB’s EMFAC2021 model multiplied by the truck trips and VMT assumptions shown in Table A-5-2. The relative contribution of truck trips by cargo type is shown in **Figure A-5-1**.

Figure A-5-1. Relative Contribution of Truck Trips by Cargo Type



Appendix B

Modeling Outputs

2022 Vessel Information

LR/IMO#	LOYDNAM	MSMI	TYPE	KEEL	MAIN_KW	DESIGN	DESIGNATIO	DISP	MAIN_ENGIN	Tier	LLAF	SPEED	Jars/TEUS/Pass	Size	T Aux Load	M Aux Load	H Aux Load	A Aux Load	T Boil Load	M Boil Load	H Boil Load	A Boil Load
9539171	ALTAIR LEADER	432817000	AUTO CARRIER	2010	14315	Mitsubishi	7UEC60LII	650.3	SSD	1	OTH	20.65	6341	> 6000 cars	583	1326	954	664	92	184	309	301
9372327	ANDROMEDA SPIRIT	372945000	AUTO CARRIER	2006	11560	Mitsubishi	8UEC50LII	382.9	SSD	0	OTH	19.90	3205	2000 - 4000 cars	583	1326	954	664	92	184	309	301
9728883	APOLLON HIGHWAY	353013000	AUTO CARRIER	2014	13000	MAN-B&W	7560MC-C8	678.6	SSD	2	BSV	20.00	7625	> 6000 cars	583	1326	954	664	92	184	309	301
9308786	ARACAZI ARROW	311942000	GENERAL CARGO	1992	8952	Sulzer	79A42	382.3	SSD	0	OTH	15.00	3688	45,000 - 90,000	467	1104	809	180	93	114	148	150
9374351	ATLANTIS FORTUNE	538807835	GENERAL CARGO	2007	7080	Mitsubishi	8UEC52LA	339.8	SSD	1	OTH	14.50	0	35,000 - 45,000	467	1104	809	180	93	114	148	150
9508419	BBC FLUI	218509000	GENERAL CARGO	2008	7000	MaK	7M43C	88.6	MSD	1	OTH	16.50	660	< 25,000	467	1104	809	180	93	114	148	150
9388883	BBC TEXAS	305063000	GENERAL CARGO	2006	5400	MaK	6M43	88.6	MSD	1	OTH	15.50	665	< 25,000	467	1104	809	180	93	114	148	150
9508471	BBC VESUVIUS	305865000	GENERAL CARGO	2008	6300	MaK	7M43C	88.6	MSD	1	OTH	16.50	660	< 25,000	467	1104	809	180	93	114	148	150
9403281	BERGAMOT ACE	319740000	AUTO CARRIER	2008	11440	MAN-B&W	8550MC	375.0	SSD	1	BSV	20.00	4216	4000 - 6000 cars	583	1326	954	664	92	184	309	301
9309617	BLUE BAIE	371716000	GENERAL CARGO	2004	7061	Mitsubishi	6UEC52LA	339.8	SSD	1	OTH	14.50	0	25,000 - 35,000	467	1104	809	180	93	114	148	150
9237357	CARNIVAL MIRACLE	354277000	PASSENGER 2500-3000	2000	62370	Wartsila	9L460	96.4	MSD-ED	1	NON	22.00	2680	2500 - 3000 Pass	9781	8309	6089	5916	596	602	411	895
9189419	CELEBRITY MILLENNIUM	249055000	PASSENGER 2000-2500	1999	71242	GE Marine	LM2500+	5.3	GT-ED	0	NON	24.00	2450	2000 - 2500 Pass	11000	11350	6900	4707	1382	1773	1506	3005
9363230	CELEBRITY SOLISTICE	249049000	PASSENGER 3000-3500	2007	67200	Wartsila	16V46	96.4	MSD-ED	1	NON	24.00	3129	3000 - 3500 Pass	8282	10369	8292	7475	697	1199	1068	1984
9308883	CEPHEUS LEADER	431323000	AUTO CARRIER	2004	15540	Mitsubishi	8UEC60LII	650.3	SSD	1	OTH	20.00	6324	> 6000 cars	583	1326	954	664	92	184	309	301
9182356	COMET ACE	351757000	AUTO CARRIER	1999	10592	Mitsubishi	8UEC52LA	392.9	SSD	0	OTH	18.90	3600	2000 - 4000 cars	583	1326	954	664	92	184	309	301
9293399	CROWN PRINCESS	310500000	PASSENGER 3500-4000	2004	67220	Wartsila	12V46	96.4	MSD-ED	1	NON	22.50	3582	3500 - 4000 Pass	9945	11411	10445	10191	401	347	868	989
9210440	CRYSTAL RAY	311039000	AUTO CARRIER	1999	15520	Sulzer	7RTA62U	649.1	SSD	0	OTH	20.50	6658	> 6000 cars	583	1326	954	664	92	184	309	301
9381249	CYGNUS LEADER	372747000	AUTO CARRIER	2006	16360	Mitsubishi	8UEC60LII	650.3	SSD	1	OTH	19.30	6501	> 6000 cars	583	1326	954	664	92	184	309	301
9565560	DALIAN HIGHWAY	357694000	AUTO CARRIER	2010	13200	MAN-B&W	7560MC-C8	678.6	SSD	1	BSV	20.00	6249	> 6000 cars	583	1326	954	664	92	184	309	301
9509595	DELTA	636015594	BULK CARRIER	2011	6480	MAN-B&W	6542MC	244.4	SSD	2	BSV	13.90	0	25,000 - 35,000	255	283	523	261	58	140	172	172
9228198	DIAMOND PRINCESS	235103359	PASSENGER 3000-3500	2002	60700	Wartsila	9L46C	96.4	MSD-ED	1	NON	23.00	3026	3000 - 3500 Pass	8282	10369	8292	7475	697	1199	1068	1984
9441506	DIGNITY ACE	311002900	AUTO CARRIER	2008	11428	MAN-B&W	7560MC-C8	678.6	SSD	2	BSV	20.50	6997	> 6000 cars	583	1326	954	664	92	184	309	301
9426350	DIONYSOS LEADER	432722000	AUTO CARRIER	2008	15544	Mitsubishi	8UEC60LII	650.3	SSD	1	OTH	20.00	6324	> 6000 cars	583	1326	954	664	92	184	309	301
9143740	DISCOVERY BAY	636022592	REEFER	1996	11004	Mitsubishi	8UEC50LII	382.9	SSD	0	OTH	19.30	242	10,000 - 20,000	1164	1251	1156	1346	80	150	229	229
9837468	DISCOVERY PRINCESS	310812000	PASSENGER 3500-4000	2015	62400	Wartsila	12V46F	96.4	MSD-ED	2	NON	22.00	3660	3500 - 4000 Pass	9945	11411	10445	10191	401	347	868	989
9126819	DISNEY WONDER	308457000	PASSENGER 2500-3000	1997	57670	Sulzer	16ZAV40S	70.4	MSD-ED	0	NON	21.50	2834	2500 - 3000 Pass	9781	8309	6089	5916	596	602	431	895
9703069	DOLE ATLANTIC	311000415	CONTAINER SHIP - 2000	2015	19420	MAN-B&W	8L70ME-C8	908.2	SSD	2	BSV	19.50	1540	1000 - 2000 TEU	1420	1944	697	529	253	246	405	307
9703071	DOLE CARIBBEAN	311000416	CONTAINER SHIP - 2000	2015	19420	MAN-B&W	8L70ME-C8	908.2	SSD	2	BSV	19.50	1540	1000 - 2000 TEU	1420	1944	697	529	253	246	405	307
9703057	DOLE PACIFIC	311000414	CONTAINER SHIP - 2000	2015	19420	MAN-B&W	8L70ME-C8	908.2	SSD	2	BSV	19.50	1540	1000 - 2000 TEU	1420	1944	697	529	253	246	405	307
9415934	DONALD	305062000	GENERAL CARGO	2004	7200	MaK	8M43	88.6	MSD	1	OTH	17.00	675	< 25,000	467	1104	809	180	93	114	148	150
9419747	DOING-A-METIS	372997000	AUTO CARRIER	2008	14280	MAN-B&W	6560MC-C8	678.6	SSD	1	BSV	20.80	6700	> 6000 cars	583	1326	954	664	92	184	309	301
9303168	DREAM BEAUTY	353642000	AUTO CARRIER	2004	11441	MAN-B&W	8550MC	375.0	SSD	1	BSV	19.40	4075	4000 - 6000 cars	583	1326	954	664	92	184	309	301
9325788	DREAM DIAMOND	372209000	AUTO CARRIER	2004	11441	MAN-B&W	8550MC	375.0	SSD	1	BSV	19.40	4075	4000 - 6000 cars	583	1326	954	664	92	184	309	301
9277486	ECCO DYNAMIC	636021765	GENERAL CARGO	2004	6620	Mitsubishi	8UEC52LA	339.8	SSD	1	OTH	14.30	0	25,000 - 35,000	467	1104	809	180	93	114	148	150
9539236	EMERALD ACE	538004697	AUTO CARRIER	2010	14315	Mitsubishi	7UEC60LII	650.3	SSD	1	OTH	20.65	6312	> 6000 cars	583	1326	954	664	92	184	309	301
9378448	EURODAM	245206000	PASSENGER 2500-3000	2007	64000	MaK	8M43C	88.6	MSD-ED	1	NON	21.90	2731	2500 - 3000 Pass	9781	8309	6089	5916	596	602	431	895
9725897	EURUS VENTURE	249832000	BULK CARRIER	2015	6050	MAN-B&W	5550MC-B9	434.7	SSD	2	BSV	14.00	0	35,000 - 45,000	255	283	523	261	58	140	172	172
9836921	GEORGIA HARMONY	354267000	BULK CARRIER	2015	6050	MAN-B&W	6546MC-B8	321.1	SSD	2	BSV	14.70	0	35,000 - 45,000	255	283	523	261	58	140	172	172
9441594	GLOVIS CARAVEL	311054300	AUTO CARRIER	2012	14280	MAN-B&W	7560MC-C8	678.6	SSD	2	BSV	20.50	6500	> 6000 cars	583	1326	954	664	92	184	309	301
9536589	GLOVIS CENTURY	411200000	AUTO CARRIER	2011	13570	MAN-B&W	6560MC-C8	678.6	SSD	2	BSV	20.50	6100	> 6000 cars	583	1326	954	664	92	184	309	301
9500991	GLOVIS CHALLENGE	441190000	AUTO CARRIER	2011	13570	MAN-B&W	6560MC-C8	678.6	SSD	2	BSV	20.50	6500	> 6000 cars	583	1326	954	664	92	184	309	301
9441582	GLOVIS CLIPPER	311054400	AUTO CARRIER	2011	14280	MAN-B&W	7560MC-C8	678.6	SSD	2	BSV	20.50	6500	> 6000 cars	583	1326	954	664	92	184	309	301
9122942	GLOVIS COMET	440269000	AUTO CARRIER	1996	14314	B&W	7560MC	648.0	SSD	1/0	BSV	20.10	6460	> 6000 cars	583	1326	954	664	92	184	309	301
9451898	GLOVIS COUGAR	441302000	AUTO CARRIER	2009	14280	MAN-B&W	6560MC-C8	678.6	SSD	1	BSV	19.50	6700	> 6000 cars	583	1326	954	664	92	184	309	301
9706994	GLOVIS CROWN	538005981	AUTO CARRIER	2014	12560	MAN-B&W	6560MC-C8	678.6	SSD	2	BSV	20.40	6600	> 6000 cars	583	1326	954	664	92	184	309	301
9736810	GLOVIS SIGMA	311000458	AUTO CARRIER	2014	12927	MAN-B&W	7560MC-C9	788.9	SSD	2	BSV	19.50	7700	> 6000 cars	583	1326	954	664	92	184	309	301
9749582	GLOVIS SIRIUS	440258000	AUTO CARRIER	2015	13070	MAN-B&W	7560MC-C8	678.6	SSD	2	BSV	20.00	7400	> 6000 cars	583	1326	954	664	92	184	309	301
9798387	GLOVIS SONIC	538007414	AUTO CARRIER	2015	13780	MAN-B&W	7560MC-C8	678.6	SSD	2	BSV	20.00	7409	> 6000 cars	583	1326	954	664	92	184	309	301
9674165	GLOVIS SPIRIT	441151000	AUTO CARRIER	2013	13070	MAN-B&W	7560MC-C8	678.6	SSD	2	BSV	20.00	7280	> 6000 cars	583	1326	954	664	92	184	309	301
9749594	GLOVIS SPRING	440260000	AUTO CARRIER	2015	13070	MAN-B&W	7560MC-C8	678.6	SSD	2	BSV	20.00	7400	> 6000 cars	583	1326	954	664				

2022 Vessel Information

LR/IMO#	LOYD/NAM	MSMI	TYPE	KEEL	MAIN_KW	DESIGN	DESIGNATIO	DISP	MAIN_ENGIN	Tier	LLAF	SPEED	Jars/TEUS/Pass	Size	T Aux Load	M Aux Load	H Aux Load	A Aux Load	T Boil Load	M Boil Load	H Boil Load	A Boil Load
9284752	LYRA LEADER	43119000	AUTO CARRIER	2004	15540	Mitsubishi	8UEC60LII	650.3	SSD	1	OTH	20.00	6324	> 6000 cars	583	1326	954	664	92	184	309	301
9614141	MAJESTIC PRINCESS	232002990	PASSENGER >4000	2010	62400	Wartsila	12V46F	96.4	MSD-ED	1	NON	22.00	4450	> 4000 Pass	12500	14000	12000	9900	335	29	503	503
9469778	MIACOLM	636021433	GENERAL CARGO	2008	8730	Wartsila	8RT4ABT	361.9	SSD	2	OTH	16.00	964	< 25,000	467	1104	809	180	93	114	148	150
9139725	MANOR	35903000	AUTO CARRIER	1999	16358	MAN	8560M-C	648.0	SSD	1/0	BSV	20.50	7194	> 6000 cars	583	1326	954	664	92	184	309	301
9619884	MARJORIE C	367641230	RORO	2011	19040	MAN-B&W	8560M-C8	678.6	SSD	1	BSV	20.00	1400	20,000 - 30,000	283	849	490	283	67	148	259	251
9209518	MERIDIAN ACE	431221000	AUTO CARRIER	1999	14123	Mitsubishi	8UEC60LS	622.0	SSD	0	OTH	19.00	6043	> 6000 cars	583	1326	954	664	92	184	309	301
9189251	MIGNON	265491000	AUTO CARRIER	1999	14710	B&W	8560M-C	648.0	SSD	1/0	BSV	20.50	7194	> 6000 cars	583	1326	954	664	92	184	309	301
9293521	MIRACULOUS ACE	431082000	AUTO CARRIER	2005	15100	Mitsubishi	8UEC60LII	650.3	SSD	1	OTH	20.50	6141	> 6000 cars	583	1326	954	664	92	184	309	301
9633185	MORNING CINDY	353647000	AUTO CARRIER	2010	13260	Mitsubishi	8UEC60LII	650.3	SSD	1	OTH	20.00	6215	> 6000 cars	583	1326	954	664	92	184	309	301
9620683	MORNING CLAIRE	373398000	AUTO CARRIER	2010	15090	MAN-B&W	7560M-C	678.6	SSD	1	BSV	20.60	6257	> 6000 cars	583	1326	954	664	92	184	309	301
9336074	MORNING COMPOSER	371659000	AUTO CARRIER	2007	14342	MAN-B&W	7560M-C	648.0	SSD	1	BSV	20.50	6500	> 6000 cars	583	1326	954	664	92	184	309	301
9336050	MORNING CONDUCTOR	372914000	AUTO CARRIER	2007	14342	MAN-B&W	7560M-C	648.0	SSD	1	BSV	20.50	6500	> 6000 cars	583	1326	954	664	92	184	309	301
9357580	MORNING MARGARETA	563077000	AUTO CARRIER	2008	14120	MAN-B&W	7560M-C	678.6	SSD	1	BSV	19.30	5195	4000 - 6000 cars	583	1326	954	664	92	184	309	301
9367580	MORNING MARGARITA	563077000	AUTO CARRIER	2008	14120	MAN-B&W	7560M-C	678.6	SSD	1	BSV	19.30	5195	4000 - 6000 cars	583	1326	954	664	92	184	309	301
9378450	NIEUW AMSTERDAM	246648000	PASSENGER 2500-3000	2008	64000	MaK	8M43C	88.6	MSD-ED	1	NON	21.90	2735	2500 - 3000 Pass	9781	8309	6089	5916	596	602	431	895
9230115	NOORDAM	246628000	PASSENGER 2500-3000	2004	75140	Sulzer	162AV40S	70.4	MSD-ED	1	NON	22.00	2596	2500 - 3000 Pass	9781	8309	6089	5916	596	602	431	895
9782649	NORD KANMON	563053200	BULK CARRIER	2015	8337	MAN-B&W	6550M-B9	434.7	SSD	2	BSV	14.50	0	45,000 - 90,000	255	283	523	261	58	140	172	172
9667588	NORDIC DALIAN	316018581	BULK CARRIER	2011	6350	Wartsila	5RT-flex50	402.5	SSD	2	OTH	14.20	0	35,000 - 45,000	255	283	523	261	58	140	172	172
9392339	NORTHERN HIGHWAY	538007592	AUTO CARRIER	2008	11000	Mitsubishi	8UEC50LII	382.9	SSD	1	OTH	19.40	3893	2000 - 4000 cars	583	1326	954	664	92	184	309	301
9304045	NORWEGIAN JEWEL	311827000	PASSENGER 3000-3500	2004	72080	MAN	12V48/60B	108.6	MSD-ED	1	NON	24.60	3000	3000 - 3500 Pass	8282	10369	8292	7475	697	1199	1068	1984
9437335	OCEAN GIANT	367535950	GENERAL CARGO	2009	9800	MAN	7L58/64CD	169.1	MSD	1	OTH	17.50	1011	< 25,000	467	1104	809	180	93	114	148	150
9419008	OCEAN GLOBE	358009118	GENERAL CARGO	2009	9800	MAN	7L58/64CD	169.1	MSD	1	OTH	17.50	1011	< 25,000	467	1104	809	180	93	114	148	150
9681833	OCEAN GLORY	367721220	GENERAL CARGO	2014	7860	MAN-B&W	6546M-8B	321.1	SSD	2	BSV	16.50	972	< 25,000	467	1104	809	180	93	114	148	150
9618121	OCEAN GRAND	367665030	GENERAL CARGO	2014	7860	MAN-B&W	6546M-8B	321.1	SSD	2	BSV	16.50	972	< 25,000	467	1104	809	180	93	114	148	150
9868869	OCEAN VICTORY	311000868	PASSENGER <1500	2019	5600	Wartsila	8L20	8.8	MSD-ED	3	NON	15.50	186	< 1500 Pass	3994	5268	3069	2289	992	784	766	867
9207388	PALMELA	351340000	AUTO CARRIER	1999	14121	Mitsubishi	8UEC60LS	622.0	SSD	0	OTH	20.00	5080	4000 - 6000 cars	583	1326	954	664	92	184	309	301
9293648	PARADISE ACE	352142000	AUTO CARRIER	2004	12170	Mitsubishi	7UEC60LII	650.3	SSD	1	OTH	20.65	6354	> 6000 cars	583	1326	954	664	92	184	309	301
9150341	PEGASUS ACE	431339000	AUTO CARRIER	1997	10592	Mitsubishi	8UEC52LS	392.9	SSD	0	OTH	19.00	3600	2000 - 4000 cars	583	1326	954	664	92	184	309	301
9597630	PETRA	538008969	GENERAL CARGO	2010	6250	Mitsubishi	6UEC415LE	292.6	SSD	1	OTH	14.20	0	25,000 - 35,000	467	1104	809	180	93	114	148	150
9210438	PLATINUM RAY	308726000	AUTO CARRIER	1999	15520	Sulzer	7RTA62U	649.1	SSD	0	OTH	20.50	6658	> 6000 cars	583	1326	954	664	92	184	309	301
9489338	POBYN	351126000	AUTO CARRIER	2008	14280	MAN-B&W	7560M-C	648.0	SSD	1	BSV	19.80	6402	> 6000 cars	583	1326	954	664	92	184	309	301
9213454	PRESTIGE ACE	355745000	AUTO CARRIER	1999	14121	Mitsubishi	8UEC60LS	622.0	SSD	0	OTH	20.00	6043	> 6000 cars	583	1326	954	664	92	184	309	301
9798985	QUEST	366945000	PASSENGER <1500	2015	2386	M.T.U.	12V4000M	4.1	MSD	2	OTH	12.00	100	< 1500 Pass	3994	5268	3069	2289	992	784	766	867
9195195	RADIANCE OF THE SEAS	311319000	PASSENGER 2000-2500	1999	57500	GE Marine	LM2500	0.0	GT-ED	0	NON	24.00	2496	2000 - 2500 Pass	11000	11350	6900	4707	1382	1773	1506	3005
9277802	RCC AMERICA	311595000	AUTO CARRIER	2003	15540	Sulzer	7RTA62U	649.1	SSD	1	BSV	20.00	6658	> 6000 cars	583	1326	954	664	92	184	309	301
9391581	RCC ASIA	311003200	AUTO CARRIER	2007	15820	MAN-B&W	7560M-C	678.6	SSD	1	OTH	20.00	6658	> 6000 cars	583	1326	954	664	92	184	309	301
9441609	RCC CLASSIC	311072300	AUTO CARRIER	2012	14280	MAN-B&W	7560M-C	678.6	SSD	2	BSV	20.50	6500	> 6000 cars	583	1326	954	664	92	184	309	301
9441611	RCC COMPASS	311072400	AUTO CARRIER	2012	15820	MAN-B&W	7560M-C	678.6	SSD	2	BSV	20.50	6500	> 6000 cars	583	1326	954	664	92	184	309	301
9391593	RCC EUROPE	311003100	AUTO CARRIER	2007	15820	MAN-B&W	7560M-C	678.6	SSD	1	BSV	20.00	6658	> 6000 cars	583	1326	954	664	92	184	309	301
9453107	RCC PASSION	311048200	AUTO CARRIER	2011	11620	MAN-B&W	7560M-C	392.7	SSD	2	BSV	19.60	3700	2000 - 4000 cars	583	1326	954	664	92	184	309	301
9361823	RCC SHANGHAI	311003600	AUTO CARRIER	2007	10460	MAN-B&W	8550M-C8	392.7	SSD	1	BSV	20.80	4900	4000 - 6000 cars	583	1326	954	664	92	184	309	301
9361835	RCC TIANJIN	311003500	AUTO CARRIER	2008	12640	MAN-B&W	8550M-C	392.7	SSD	1	BSV	20.00	4900	4000 - 6000 cars	583	1326	954	664	92	184	309	301
9156474	REGATTA	538001664	PASSENGER <1500	1998	18600	Wartsila	12V32	32.2	MSD-ED	0	NON	18.00	824	< 1500 Pass	3994	5268	3069	2289	992	784	766	867
9355214	REHA LEADER	432664000	AUTO CARRIER	2008	16360	Mitsubishi	8UEC60LII	650.3	SSD	1	OTH	20.00	6324	> 6000 cars	583	1326	954	664	92	184	309	301
9584712	ROYAL PRINCESS	310661000	PASSENGER >4000	2011	62400	Wartsila	12V46F	96.4	MSD-ED	2	NON	22.00	4450	> 4000 Pass	12500	14000	12000	9900	335	29	503	503
9378462	RUBY PRINCESS	310567000	PASSENGER 3500-4000	2006	67200	Wartsila	12V46C	96.4	MSD-ED	1	NON	22.50	3575	3500 - 4000 Pass	9945	11411	10445	10191	401	347	868	989
9160798	SAGA BEIJA FLOR	477554000	GENERAL CARGO	1997	8952	Sulzer	7RTA52	382.3	SSD	0	OTH	14.50	0	45,000 - 90,000	467	1104	809	180	93	114	148	150
9014066	SAGA CREST	477818000	GENERAL CARGO	1993	8951	Sulzer	7RTA52	382.3	SSD	0	OTH	15.00	0	45,000 - 90,000	467	1104	809	180	93	114	148	150
9343483	SAGA EXPLORER	477697600	GENERAL CARGO	2010	9510	Sulzer	7RTA52	382.3	SSD	1	OTH	14.50	769	45,000 - 90,000	467	1104	809	180	93	114	148	150
9609457	SAGA FIJI	477705070	GENERAL CARGO	2010	9474	Wartsila	45RT-flex50	402.5	SSD	1	OTH	14.50	2002	45,000 - 90,000	467	1104	809	180	93	114	148	150
9121297	SAGA HORIZON	477379000</																				

2022 Vessel AIS Data - Time, Speed, and Load Calculations

Ship	IMO	Ship Type	Calls	Per Call														
				Cruise			VSR40			VSR20			Manuever			Hotel	Anchor	Cold Iron
				Hrs	Speed	LF	Hrs	Speed	LF	Hrs	Speed	LF	Hrs	Speed	LF	Hrs	Hrs	Hrs
ALTAIR LEADER	9539171	AUTO CARRIER	1	0.211	9.76	0.09	2.205	9.68	0.08	3.620	9.24	0.07	2.259	8.09	0.05	12.429	0.00	0.00
ANDROMEDA SPIRIT	9372327	AUTO CARRIER	4	0.163	8.63	0.07	2.798	8.59	0.07	5.854	7.98	0.05	2.201	8.55	0.07	6.195	0.00	0.00
APOLLON HIGHWAY	9728083	AUTO CARRIER	1	0.172	11.00	0.14	1.850	10.90	0.13	3.564	9.16	0.08	2.049	9.25	0.08	6.493	0.00	0.00
BERGAMOT ACE	9403281	AUTO CARRIER	1	0.172	13.20	0.24	3.420	7.34	0.04	6.455	7.59	0.05	2.336	8.04	0.05	7.201	0.00	0.00
CEPHEUS LEADER	9308883	AUTO CARRIER	1	0.348	6.25	0.03	2.530	7.80	0.05	3.703	8.94	0.07	2.203	8.21	0.06	10.159	0.00	0.00
COMET ACE	9182356	AUTO CARRIER	1	0.256	9.83	0.12	6.630	3.60	0.02	5.028	10.13	0.13	2.083	8.76	0.08	6.512	0.00	0.00
CRYSTAL RAY	9210440	AUTO CARRIER	2	0.109	12.26	0.18	1.900	10.85	0.12	4.741	9.32	0.08	2.228	8.02	0.05	16.849	0.00	0.00
CYGNUS LEADER	9381249	AUTO CARRIER	2	0.198	8.72	0.08	2.272	8.75	0.08	4.589	7.79	0.05	2.231	7.99	0.06	9.222	0.00	0.00
DIGNITY ACE	9441506	AUTO CARRIER	2	0.178	10.29	0.10	4.077	5.62	0.02	4.355	9.50	0.08	2.230	8.26	0.05	9.874	0.00	0.00
DIONYSOS LEADER	9426350	AUTO CARRIER	2	0.142	6.69	0.03	1.706	8.44	0.06	4.290	8.15	0.06	2.141	8.55	0.06	9.633	0.00	0.00
DONG A METIS	9419747	AUTO CARRIER	1				0.543	15.51	0.36	3.332	9.83	0.09	2.176	8.47	0.06	10.469	0.00	0.00
DREAM BEAUTY	9303168	AUTO CARRIER	1	0.293	5.99	0.02	3.461	5.91	0.02	5.561	6.42	0.03	2.324	8.05	0.06	6.078	0.00	0.00
DREAM DIAMOND	9325788	AUTO CARRIER	1	0.072	12.80	0.24	1.842	13.15	0.26	3.891	12.11	0.20	2.287	9.75	0.10	8.848	0.00	0.00
EMERALD ACE	9539236	AUTO CARRIER	1	0.197	8.06	0.05	2.875	7.54	0.04	4.758	7.06	0.03	2.125	8.67	0.06	5.559	0.00	0.00
GLOVIS CARAVEL	9441594	AUTO CARRIER	1	0.170	13.00	0.21	1.617	13.18	0.22	3.242	10.88	0.12	2.319	7.92	0.05	7.938	0.00	0.00
GLOVIS CENTURY	9590589	AUTO CARRIER	1	0.164	16.70	0.45	1.219	15.95	0.39	2.875	12.89	0.20	1.904	9.78	0.09	9.040	0.00	0.00
GLOVIS CHALLENGE	9590591	AUTO CARRIER	1	0.000	0.00	0.00	0.492	17.70	0.53	2.859	12.72	0.20	2.355	7.72	0.04	22.155	0.00	0.00
GLOVIS CLIPPER	9441582	AUTO CARRIER	1	0.167	15.25	0.34	1.345	15.02	0.32	2.792	11.72	0.15	2.122	8.63	0.06	11.593	0.00	0.00
GLOVIS COMET	9122942	AUTO CARRIER	2	0.161	11.14	0.14	1.883	10.60	0.12	3.548	9.87	0.10	2.123	8.77	0.07	11.432	0.00	0.00
GLOVIS COUGAR	9451898	AUTO CARRIER	2	0.077	12.75	0.23	0.860	14.07	0.31	2.547	12.64	0.22	2.288	8.04	0.06	15.493	0.00	0.00
GLOVIS CROWN	9706994	AUTO CARRIER	1				11.095	3.57	0.02	2.881	11.37	0.14	2.147	8.35	0.06	10.416	0.00	0.00
GLOVIS SIGMA	9736810	AUTO CARRIER	2				0.187	11.91	0.19	2.806	9.23	0.09	2.153	8.36	0.06	13.218	0.00	0.00
GLOVIS SIRIUS	9749582	AUTO CARRIER	1							1.900	10.56	0.12	2.276	7.92	0.05	21.433	0.00	0.00
GLOVIS SONIC	9798387	AUTO CARRIER	1							2.010	11.33	0.15	2.229	8.33	0.06	10.956	0.00	0.00
GLOVIS SPIRIT	9674165	AUTO CARRIER	2				0.231	15.86	0.41	3.402	9.77	0.10	2.633	7.11	0.04	8.807	0.00	0.00
GLOVIS SPRING	9749594	AUTO CARRIER	1	0.170	10.80	0.13	2.117	11.38	0.15	4.543	11.08	0.14	2.272	8.49	0.06	7.644	0.00	0.00
GLOVIS SUMMIT	9702417	AUTO CARRIER	1				0.244	11.30	0.15	3.156	10.21	0.11	1.930	9.15	0.08	17.219	0.00	0.00
GLOVIS SUN	9749568	AUTO CARRIER	2							1.941	11.09	0.14	2.218	8.26	0.06	16.326	0.00	0.00
GLOVIS SUNLIGHT	9798416	AUTO CARRIER	2	0.042	14.10	0.29	12.218	2.04	0.02	2.916	10.02	0.10	2.448	7.52	0.04	12.809	0.00	0.00
GLOVIS SUNRISE	9702405	AUTO CARRIER	1	0.161	12.07	0.18	1.282	15.93	0.42	2.556	13.45	0.25	2.358	7.84	0.05	9.607	0.00	0.00
GLOVIS SUPREME	9674177	AUTO CARRIER	2	0.042	15.20	0.36	0.795	15.58	0.39	2.560	12.66	0.21	2.282	8.37	0.06	13.418	0.00	0.00
GOLIATH LEADER	9357315	AUTO CARRIER	1	0.222	8.21	0.05	2.686	7.62	0.04	3.983	8.34	0.06	2.182	8.48	0.06	11.486	0.00	0.00
GRAND AURORA	9279331	AUTO CARRIER	1							1.628	8.79	0.07	2.317	8.29	0.06	10.034	0.00	0.00
GRAND CHAMPION	9340570	AUTO CARRIER	1							2.107	8.91	0.08	2.181	8.26	0.06	9.653	0.00	0.00
GRAND COSMO	9303182	AUTO CARRIER	1				1.239	9.58	0.09	3.761	8.43	0.06	2.320	7.89	0.05	33.894	0.00	0.00
GRAND DAHLIA	9355238	AUTO CARRIER	1	0.033	13.50	0.26	2.377	11.15	0.15	6.181	8.37	0.06	2.129	8.65	0.07	13.541	0.00	0.00
GRAND DIAMOND	9303223	AUTO CARRIER	1	0.122	15.27	0.38	1.297	16.12	0.44	2.502	12.93	0.23	2.286	8.58	0.07	11.359	0.00	0.00
GRAND EAGLE	9267663	AUTO CARRIER	1	0.169	15.30	0.38	1.348	15.30	0.38	2.945	11.55	0.16	2.575	7.63	0.05	19.408	0.00	0.00
GRAND HERO	9339806	AUTO CARRIER	1							1.954	10.23	0.11	2.222	8.55	0.07	9.647	0.00	0.00
GRAND LEGACY	9355240	AUTO CARRIER	1	0.195	9.44	0.09	2.239	8.99	0.08	4.037	8.20	0.06	2.225	8.24	0.06	11.181	0.00	0.00
GRAND PACE	9169328	AUTO CARRIER	3				0.410	15.46	0.43	2.791	12.05	0.20	2.286	8.21	0.06	9.824	0.00	0.00
GRAND PHOENIX	9284764	AUTO CARRIER	1				0.723	11.50	0.16	3.522	9.62	0.09	2.311	7.77	0.05	10.152	0.00	0.00
GRAND RACE	9184940	AUTO CARRIER	2				0.667	14.24	0.34	3.381	12.27	0.21	2.223	8.26	0.07	9.651	0.00	0.00
GRAND VEGA	9355252	AUTO CARRIER	1				0.919	11.09	0.14	3.484	9.86	0.10	2.273	7.99	0.05	12.444	0.00	0.00
GRANDE HALIFAX	9784051	AUTO CARRIER	1	0.271	12.89	0.26	3.281	12.26	0.22	10.705	5.26	0.02	2.381	7.82	0.06	7.267	0.00	0.00
GREEN LAKE	9158288	AUTO CARRIER	2				0.692	9.16	0.09	4.085	8.79	0.08	1.697	6.15	0.03	31.962	0.00	0.00
GREEN RIDGE	9177428	AUTO CARRIER	3	0.072	11.60	0.20	5.057	5.24	0.02	3.543	7.92	0.06	2.948	6.05	0.03	72.139	0.00	0.00
HESTIA LEADER	9355226	AUTO CARRIER	2	0.193	8.93	0.07	2.145	9.35	0.08	3.905	8.93	0.07	2.263	8.25	0.06	11.162	0.00	0.00
HYPERION RAY	9690559	AUTO CARRIER	1	0.086	12.10	0.32	1.704	12.15	0.33	28.391	2.09	0.02	2.445	7.51	0.08	7.146	0.00	0.00
IRIS ACE	9515474	AUTO CARRIER	2	0.047	13.00	0.23	5.993	4.35	0.02	7.900	6.98	0.04	2.286	8.00	0.05	16.385	0.00	0.00
ISTRA ACE	9318503	AUTO CARRIER	2	1.435	2.39	0.02	13.194	2.59	0.02	4.034	10.06	0.09	2.036	8.88	0.06	7.752	0.00	0.00
IVORY ARROW	9277838	AUTO CARRIER	1	0.261	7.29	0.04	2.776	7.30	0.04	4.250	7.87	0.05	2.106	8.72	0.07	4.932	0.00	0.00
JASPER ARROW	9267912	AUTO CARRIER	1	0.114	10.60	0.12	1.988	10.44	0.11	3.528	9.00	0.07	2.077	8.87	0.07	4.392	0.00	0.00
JEAN ANNE	9233167	AUTO CARRIER	26							2.278	10.27	0.11	3.376	8.36	0.06	30.284	0.00	0.00

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				Cruise			VSR40			VSR20			Manuever			Hotel	Anchor	Cold Iron
				Hrs	Speed	LF	Hrs	Speed	LF	Hrs	Speed	LF	Hrs	Speed	LF	Hrs	Hrs	Hrs
JIUYANG FORTUNE	9088237	AUTO CARRIER	1	0.100	15.23	0.37	1.300	15.08	0.36	2.758	12.19	0.19	2.170	8.32	0.06	7.604	0.00	0.00
JUPITER SPIRIT	9509401	AUTO CARRIER	4	0.317	6.34	0.03	2.382	9.27	0.08	5.117	8.04	0.05	2.186	8.40	0.06	5.195	0.00	0.00
K.ASIAN BEAUTY	9070462	AUTO CARRIER	1				0.664	11.98	0.24	3.131	10.42	0.16	2.206	8.70	0.09	10.554	0.00	0.00
LAKE GENEVA	9713882	AUTO CARRIER	3				0.431	11.97	0.18	4.038	9.43	0.09	2.492	7.43	0.04	8.992	0.00	0.00
LAPIS ARROW	9361809	AUTO CARRIER	1	0.169	10.20	0.10	2.033	10.05	0.09	3.587	9.88	0.09	2.189	8.45	0.06	11.496	0.00	0.00
LIBERTY KING	9203291	AUTO CARRIER	1				0.550	11.30	0.17	3.728	8.28	0.07	2.214	8.55	0.07	17.290	0.00	0.00
LUNA SPIRIT	9372315	AUTO CARRIER	1	0.121	7.90	0.05	3.185	7.21	0.04	4.795	6.92	0.03	2.121	9.06	0.08	6.084	0.00	0.00
LYDDEN	9782091	AUTO CARRIER	1				0.578	8.90	0.07	4.353	7.98	0.05	2.409	7.54	0.04	6.062	0.00	0.00
LYRA LEADER	9284752	AUTO CARRIER	1	0.266	7.43	0.04	2.489	8.37	0.06	4.608	8.14	0.06	1.957	8.64	0.07	9.916	0.00	0.00
MANON	9179725	AUTO CARRIER	1	0.406	8.48	0.06	20.546	2.64	0.02	4.404	11.95	0.16	2.263	8.32	0.06	9.827	0.00	0.00
MERIDIAN ACE	9209518	AUTO CARRIER	1	0.127	8.17	0.07	2.751	7.99	0.06	4.344	8.64	0.08	2.157	8.52	0.07	6.458	0.00	0.00
MIGNON	9189251	AUTO CARRIER	1	8.130	6.79	0.03	10.791	4.57	0.02	5.160	10.34	0.11	2.478	7.54	0.04	23.394	0.00	0.00
MIRACULOUS ACE	9293521	AUTO CARRIER	1				2.014	6.92	0.03	5.989	8.60	0.06	2.125	8.61	0.06	5.610	0.00	0.00
MORNING CINDY	9633185	AUTO CARRIER	1				1.731	9.53	0.09	5.675	8.89	0.07	2.313	8.24	0.06	22.623	0.00	0.00
MORNING CLAIRE	9620683	AUTO CARRIER	1	0.428	3.94	0.02	6.291	3.95	0.02	8.281	6.23	0.02	2.186	8.57	0.06	9.707	0.00	0.00
MORNING COMPOSER	9336074	AUTO CARRIER	1				0.839	11.55	0.15	4.911	10.34	0.11	2.304	7.90	0.05	5.671	0.00	0.00
MORNING CONDUCTOR	9336050	AUTO CARRIER	1	0.221	13.20	0.22	1.881	11.51	0.15	3.627	10.02	0.10	2.336	7.87	0.05	7.002	0.00	0.00
MORNING MARGARETA	9367580	AUTO CARRIER	2	0.050	13.05	0.25	2.362	11.20	0.16	5.150	10.27	0.12	2.231	8.27	0.06	7.212	0.00	0.00
NORTHERN HIGHWAY	9392339	AUTO CARRIER	1							2.181	7.46	0.05	2.438	8.11	0.06	8.536	0.00	0.00
PALMELA	9207388	AUTO CARRIER	1	0.070	13.10	0.23	5.988	3.55	0.02	4.745	10.59	0.12	2.247	7.97	0.05	6.298	0.00	0.00
PARADISE ACE	9293648	AUTO CARRIER	1	0.075	10.24	0.10	2.013	9.79	0.09	4.003	8.66	0.06	2.213	8.09	0.05	6.474	0.00	0.00
PEGASUS ACE	9150341	AUTO CARRIER	1				1.119	12.01	0.21	4.547	10.88	0.15	2.052	8.99	0.09	5.876	0.00	0.00
PLATINUM RAY	9210438	AUTO CARRIER	1				0.131	11.99	0.16	3.003	10.35	0.11	2.159	8.33	0.06	16.058	0.00	0.00
PORGY	9409338	AUTO CARRIER	1	0.089	12.10	0.19	2.869	9.26	0.08	5.833	8.72	0.07	2.106	9.00	0.08	8.424	0.00	0.00
PRESTIGE ACE	9213454	AUTO CARRIER	2	0.132	11.21	0.14	1.831	11.11	0.14	4.349	9.15	0.08	2.219	8.13	0.06	5.405	0.00	0.00
RCC AMERICA	9277802	AUTO CARRIER	1				33.039	1.49	0.02	3.922	8.42	0.06	2.346	7.83	0.05	11.331	0.00	0.00
RCC ASIA	9391581	AUTO CARRIER	1	0.125	12.10	0.18	1.656	12.25	0.19	3.411	11.36	0.15	2.126	8.64	0.07	7.967	0.00	0.00
RCC CLASSIC	9441609	AUTO CARRIER	1	0.083	9.00	0.07	3.267	6.93	0.03	12.936	3.10	0.02	2.216	7.85	0.05	9.435	0.00	0.00
RCC COMPASS	9441611	AUTO CARRIER	1	0.122	12.66	0.19	1.700	11.77	0.16	3.206	10.48	0.11	2.378	7.59	0.04	11.058	0.00	0.00
RCC EUROPE	9391593	AUTO CARRIER	1	0.122	11.00	0.14	2.394	9.44	0.09	6.695	7.88	0.05	2.241	7.87	0.05	8.802	0.00	0.00
RCC PASSION	9453107	AUTO CARRIER	1	0.153	11.20	0.15	11.608	2.85	0.02	7.299	7.76	0.05	2.360	8.00	0.06	7.233	0.00	0.00
RCC SHANGHAI	9361823	AUTO CARRIER	2	0.118	10.99	0.12	11.847	2.81	0.02	3.383	9.81	0.09	2.295	8.01	0.05	11.575	0.00	0.00
RCC TIANJIN	9361835	AUTO CARRIER	4	0.396	3.03	0.02	4.853	3.58	0.02	3.795	9.10	0.08	2.190	8.54	0.06	9.218	0.00	0.00
RHEA LEADER	9355214	AUTO CARRIER	1	0.230	10.21	0.11	1.820	11.03	0.14	3.411	10.02	0.10	2.251	8.00	0.05	19.381	0.00	0.00
SOUTHERN HIGHWAY	9338632	AUTO CARRIER	2	0.226	8.52	0.06	2.368	8.58	0.06	4.373	8.25	0.06	2.305	7.98	0.05	6.441	0.00	0.00
TARIFA	9327748	AUTO CARRIER	1	0.077	16.84	0.46	1.277	16.84	0.46	2.881	11.88	0.16	1.976	9.35	0.08	9.268	0.00	0.00
TOMBARRA	9319753	AUTO CARRIER	1	0.083	9.40	0.09	3.133	6.56	0.03	4.433	7.97	0.06	2.407	7.75	0.05	9.039	0.00	0.00
TORINO	9398321	AUTO CARRIER	1	0.170	6.90	0.04	3.867	7.22	0.04	6.472	8.06	0.06	2.716	6.82	0.04	10.079	0.00	0.00
TRITON LEADER	9553103	AUTO CARRIER	1				0.461	10.29	0.12	4.495	7.59	0.05	2.352	7.73	0.05	10.156	0.00	0.00
UNDINE	9240160	AUTO CARRIER	1	0.170	9.15	0.07	2.997	9.67	0.09	5.623	9.17	0.07	2.417	7.61	0.04	7.874	0.00	0.00
VIKING ADVENTURE	9673018	AUTO CARRIER	1	0.000	0.00	0.00	0.000	0.00	0.00	2.562	8.80	0.14	2.086	8.77	0.14	8.595	0.00	0.00
VIKING DESTINY	9728863	AUTO CARRIER	1	0.117	12.04	0.25	1.664	11.99	0.24	3.423	13.18	0.32	2.049	9.07	0.11	17.715	0.00	0.00
VIKING DRIVE	9188817	AUTO CARRIER	3	0.085	12.20	0.24	0.546	12.47	0.25	2.178	10.67	0.16	2.219	8.32	0.07	7.377	0.00	0.00
VIKING QUEEN	9318462	AUTO CARRIER	1	0.239	10.62	0.11	2.498	15.67	0.35	3.973	14.44	0.28	2.058	9.00	0.07	19.136	0.00	0.00
DALIAN HIGHWAY	9565560	AUTO CARRIER	1	0.172	11.000	0.14	1.850	10.898	0.13	3.564	9.155	0.08	2.049	9.249	0.08	6.967	0.00	0.00
DELTA	9595395	BULK CARRIER	1							3.23	5.73	0.06	1.66	7.11	0.11	66.00	69.69	0.00
EURUS VENTURE	9725897	BULK CARRIER	1				0.40	11.89	0.50	3.46	9.90	0.29	1.83	6.44	0.08	210.98	0.00	0.00
GEORGIA HARMONY	9836921	BULK CARRIER	1							1.51	10.30	0.28	1.77	7.39	0.10	204.76	0.00	0.00
HAMBURG CITY	9863170	BULK CARRIER	1							1.78	9.27	0.24	1.69	7.44	0.12	32.76	0.00	0.00
LILA CASABLANCA	9621039	BULK CARRIER	1							4.30	5.59	0.05	1.98	6.29	0.07	174.69	14.80	0.00
LONGSHORE	9450806	BULK CARRIER	1							7.11	4.60	0.03	1.86	6.59	0.09	179.55	81.81	0.00
NORD KANMON	9782649	BULK CARRIER	1	0.15	11.05	0.36	2.03	10.13	0.28	3.96	8.70	0.18	2.04	6.28	0.07	207.95	0.00	0.00
NORDIC DALIAN	9667588	BULK CARRIER	1				0.90	8.82	0.20	11.26	3.67	0.02	2.21	5.89	0.06	31.92	0.00	0.00
SEATTLE HARMONY	9836919	BULK CARRIER	1				3.27	12.45	0.50	7.94	7.66	0.12	2.13	5.82	0.05	66.30	4.15	0.00

2022 Vessel AIS Data - Time, Speed, and Load Calculations

Ship	IMO	Ship Type	Calls	Per Call														
				Cruise			VSR40			VSR20			Manuever			Hotel	Anchor	Cold Iron
				Hrs	Speed	LF	Hrs	Speed	LF	Hrs	Speed	LF	Hrs	Speed	LF	Hrs	Hrs	Hrs
STH MONTREAL	9800635	BULK CARRIER	1	0.17	9.60	0.24	2.66	7.57	0.12	6.86	6.05	0.06	4.92	2.60	0.02	247.77	301.94	0.00
WESTERN DONCASTER	9831505	BULK CARRIER	1				0.43	11.96	0.51	3.15	10.02	0.30	1.73	6.93	0.10	166.82	0.00	0.00
UHL FELICITY	9892535	BULK CARRIER	1	0.17	15.40	0.89	1.37	15.51	0.91	3.28	10.70	0.30	1.63	7.67	0.11	86.53	72.01	0.00
UHL FREEDOM	9897121	BULK CARRIER	1							1.82	9.19	0.19	1.81	6.46	0.07	81.52	0.00	0.00
DOLE ATLANTIC	9703069	CONTAINER SHIP	17							1.57	9.52	0.10	1.53	8.03	0.06	68.97	0.00	62.45
DOLE CARIBBEAN	9703071	CONTAINER SHIP	17							1.56	9.70	0.10	1.62	7.47	0.05	65.49	0.00	59.30
DOLE PACIFIC	9703057	CONTAINER SHIP	17							1.50	9.73	0.10	1.65	7.38	0.04	67.25	0.00	60.89
ARACARI ARROW	9008706	GENERAL CARGO	1	0.17	10.39	0.27	1.95	10.39	0.27	8.19	4.83	0.03	1.88	6.47	0.07	17.07	12.60	0.00
ATLANTIS FORTUNE	9374351	GENERAL CARGO	1	0.17	12.95	0.59	1.94	12.90	0.58	5.20	10.20	0.29	2.35	5.37	0.04	26.46	0.00	0.00
BBC FUJI	9508419	GENERAL CARGO	1				0.31	12.93	0.40	3.35	9.32	0.15	1.61	7.42	0.07	51.46	0.00	0.00
BBC TEXAS	9388883	GENERAL CARGO	1				0.55	14.04	0.61	2.71	11.39	0.33	1.56	8.14	0.12	8.03	0.00	0.00
BBC VESUVIUS	9508471	GENERAL CARGO	1							1.70	9.65	0.16	1.82	6.74	0.06	11.46	0.00	0.00
BLUE BAIE	9309617	GENERAL CARGO	1							1.57	8.35	0.16	1.62	7.67	0.12	13.80	59.57	0.00
DONALD	9273791	GENERAL CARGO	1	0.17	10.21	0.18	2.06	10.21	0.18	3.30	10.67	0.20	1.57	7.76	0.08	214.10	0.00	0.00
ECO DYNAMIC	9277486	GENERAL CARGO	1							1.85	8.54	0.18	1.84	6.75	0.09	258.81	0.00	0.00
INDIANA	9186211	GENERAL CARGO	1							4.64	7.68	0.09	2.09	5.83	0.04	133.66	7.55	0.00
MALCOLM	9469778	GENERAL CARGO	1							1.66	9.48	0.17	1.61	7.64	0.09	164.95	0.00	0.00
OCEAN GIANT	9437335	GENERAL CARGO	1	0.05	16.40	0.68	1.53	16.65	0.71	3.44	14.28	0.45	1.77	6.99	0.05	171.36	0.00	0.00
OCEAN GLOBE	9419008	GENERAL CARGO	1							1.93	10.23	0.16	1.60	7.63	0.07	66.00	204.45	0.00
OCEAN GLORY	9681833	GENERAL CARGO	1							3.07	10.51	0.21	1.78	6.86	0.06	154.41	0.00	0.00
OCEAN GRAND	9681821	GENERAL CARGO	1							6.72	8.91	0.13	2.95	7.80	0.09	94.95	20.58	0.00
PETRA	9597630	GENERAL CARGO	1	0.10	12.00	0.50	2.27	10.90	0.37	6.93	7.71	0.13	1.73	7.21	0.11	19.38	76.55	0.00
SAGA CREST	9014066	GENERAL CARGO	1	0.18	12.90	0.52	2.23	11.87	0.41	6.18	8.74	0.16	1.80	6.83	0.08	112.54	51.15	0.00
SAGA EXPLORER	9343493	GENERAL CARGO	1							4.47	5.80	0.05	2.00	6.10	0.06	88.64	9.82	0.00
SAGA FUJI	9609457	GENERAL CARGO	1	0.17	11.70	0.43	1.69	11.84	0.45	3.23	10.72	0.33	2.07	5.71	0.05	120.87	0.00	0.00
SAGA HORIZON	9121297	GENERAL CARGO	1	0.28	8.45	0.15	2.10	11.22	0.34	5.45	9.80	0.23	2.01	6.19	0.06	55.06	0.00	0.00
SAGA JANDAIA	9200421	GENERAL CARGO	1				0.37	11.38	0.36	4.22	7.78	0.11	2.09	5.85	0.05	114.78	63.78	0.00
SAGA SPRAY	9014078	GENERAL CARGO	1				0.81	10.34	0.27	5.11	9.44	0.20	2.03	6.11	0.06	196.79	0.00	0.00
SAGA TUCANO	9160803	GENERAL CARGO	1				0.44	12.47	0.52	5.10	9.34	0.22	1.61	7.84	0.13	83.37	0.00	0.00
SLNC MAGOTHY	9418975	GENERAL CARGO	1	0.22	7.90	0.08	2.50	8.05	0.08	4.13	9.43	0.13	1.44	8.50	0.09	172.95	0.00	0.00
SLNC YORK	9538907	GENERAL CARGO	3	0.13	12.78	0.35	1.61	12.53	0.33	4.34	9.13	0.13	1.87	6.85	0.05	217.89	10.28	0.00
STAR HARMONIA	9103130	GENERAL CARGO	1							3.98	6.13	0.05	1.81	6.43	0.05	238.47	0.00	0.00
STAR HIDRA	9071569	GENERAL CARGO	2				0.35	12.04	0.33	4.28	9.04	0.14	1.75	7.13	0.07	230.41	0.00	0.00
STAR JAPAN	9254654	GENERAL CARGO	1				0.33	13.47	0.44	4.59	7.51	0.08	1.63	7.71	0.08	105.11	105.51	0.00
STAR KILIMANJARO	9396139	GENERAL CARGO	1							3.08	9.10	0.15	1.77	6.79	0.06	91.91	0.00	0.00
STAR MAIA	9189940	GENERAL CARGO	1							2.45	9.93	0.21	2.00	6.44	0.06	344.94	0.00	0.00
SAGA BEIJA FLOR	9160798	GENERAL CARGO	1	0.17	11.70	0.43	1.69	11.84	0.45	3.23	10.72	0.33	2.07	5.71	0.05	118.43	0.00	0.00
CARNIVAL MIRACLE	9237357	PASSENGER	1				0.00	0.00	0.00	1.77	11.30	0.11	1.48	6.59	0.02	9.59	0.00	0.000
CELEBRITY MILLENNIUM	9189419	PASSENGER	2	0.04	18.70	0.39	0.58	19.10	0.41	2.14	14.45	0.18	1.49	6.45	0.02	12.02	0.00	1.521
CELEBRITY SOLSTICE	9362530	PASSENGER	2	0.31	9.19	0.05	6.63	8.93	0.04	12.36	6.65	0.02	1.65	5.87	0.02	36.08	193.32	0.000
CROWN PRINCESS	9293399	PASSENGER	1	0.08	14.50	0.22	1.24	17.22	0.37	2.65	12.78	0.15	1.78	5.59	0.02	17.00	0.00	0.000
DIAMOND PRINCESS	9228198	PASSENGER	4							1.34	11.70	0.11	1.42	6.75	0.02	29.08	0.00	0.000
DISCOVERY PRINCESS	9837468	PASSENGER	6				0.30	14.11	0.22	2.46	11.53	0.12	1.52	6.24	0.02	12.52	0.00	0.000
DISNEY WONDER	9126819	PASSENGER	33				1.17	9.30	0.07	2.52	9.71	0.08	1.24	7.67	0.04	10.41	0.00	5.066
EURODAM	9378448	PASSENGER	2							1.45	13.08	0.18	1.54	6.23	0.02	10.33	0.00	7.635
GRAND PRINCESS	9104005	PASSENGER	1							1.55	10.27	0.08	1.56	5.84	0.02	14.21	0.00	0.000
INSIGNIA	9156462	PASSENGER	3	0.06	12.10	0.25	266.89	0.05	0.02	2.52	11.08	0.19	1.35	7.21	0.05	18.89	0.00	0.000
KONINGS DAM	9692557	PASSENGER	21	0.00	14.10	0.25	0.24	11.10	0.12	1.94	10.77	0.11	1.48	6.62	0.03	10.19	0.00	6.230
MAJESTIC PRINCESS	9614141	PASSENGER	5				0.77	10.01	0.08	3.07	10.36	0.09	1.37	6.79	0.02	13.01	0.00	11.306
NAT GEO QUEST	9798985	PASSENGER	1				0.00	0.00	0.00	2.37	10.67	0.58	1.49	8.10	0.25	16.61	0.00	5.788
NIEUW AMSTERDAM	9378450	PASSENGER	2				1.69	7.96	0.04	4.28	8.66	0.05	1.42	6.22	0.02	12.57	0.00	10.077
NOORDAM	9230115	PASSENGER	2				0.25	16.43	0.34	2.11	12.70	0.16	1.47	6.28	0.02	12.43	0.00	1.500
NORWEGIAN JEWEL	9304045	PASSENGER	5							1.21	13.09	0.12	1.51	6.64	0.02	10.36	0.00	0.000
OCEAN VICTORY	9868869	PASSENGER	2				0.18	13.68	0.57	2.77	11.15	0.31	1.83	6.14	0.05	35.14	0.00	0.000

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				Cruise			VSR40			VSR20			Manuever			Hotel	Anchor	Cold Iron
				Hrs	Speed	LF	Hrs	Speed	LF	Hrs	Speed	LF	Hrs	Speed	LF	Hrs	Hrs	Hrs
RADIANCE OF THE SEAS	9195195	PASSENGER	1	0.24	7.59	0.03	4.02	9.99	0.06	5.45	9.83	0.06	1.28	7.71	0.03	10.39	0.00	0.000
REGATTA	9156474	PASSENGER	1							2.76	10.42	0.16	1.54	6.48	0.04	11.51	0.00	0.000
ROYAL PRINCESS	9584712	PASSENGER	5	0.02	18.90	0.52	0.37	14.31	0.23	2.98	10.63	0.09	1.54	6.25	0.02	12.61	0.00	0.000
RUBY PRINCESS	9378462	PASSENGER	3							1.31	11.56	0.11	1.45	6.64	0.02	14.98	0.00	4.374
SAPPHIRE PRINCESS	9228186	PASSENGER	2							1.67	9.83	0.06	1.53	6.43	0.02	13.23	0.00	0.000
SCENIC ECLIPSE	9797371	PASSENGER	1	0.09	13.20	0.39	1.46	13.62	0.42	3.17	11.41	0.25	1.46	6.47	0.05	9.94	0.00	0.000
SEVEN SEAS EXPLORER	9703150	PASSENGER	1				1.88	10.76	0.13	2.86	9.94	0.10	0.67	7.34	0.04	17.42	0.00	0.000
SEVEN SEAS MARINER	9210139	PASSENGER	3	0.06	14.00	0.30	0.50	13.74	0.29	2.03	13.09	0.25	1.32	7.08	0.04	14.91	0.00	3.624
SILVER WIND	8903935	PASSENGER	1				0.53	8.02	0.09	3.77	8.99	0.12	1.19	8.04	0.09	12.36	0.00	0.000
STAR BREEZE	8807997	PASSENGER	3	0.09	6.24	0.05	1.07	6.28	0.05	9.62	10.32	0.22	1.48	6.68	0.06	21.53	0.00	0.000
THE WORLD	9219331	PASSENGER	1							4.24	6.57	0.03	2.18	6.81	0.04	45.53	29.02	0.000
VIKING ORION	9796250	PASSENGER	3	0.09	12.14	0.18	1.43	12.91	0.22	4.38	11.23	0.15	1.42	6.80	0.03	12.33	0.00	0.000
ZUIDERDAM	9221279	PASSENGER	8				0.30	10.11	0.08	1.86	11.23	0.11	1.54	6.22	0.02	10.91	0.00	2.408
MV DISCOVERY BAY	9143740	REEFER	1	0.19	12.44	0.22	1.41	16.77	0.54	5.58	10.00	0.11	1.56	7.42	0.05	341.14	69.97	0.000
MARJORIE C.	9619684	RORO	25	0.17	10.75	0.13	2.12	10.21	0.11	3.59	9.50	0.09	2.52	7.80	0.05	23.81	0.00	0.000

2022 Harbor Craft Activity

Vessel Type	Number	Main			Auxiliary			Hours in Bay		Hours Outside Bay		Load Factor		Useful Life		Age	
		MY	kW	No	MY	kW	No	Main	Aux	Main	Aux	Main	Aux	Main	Aux	Main	Aux
Assist	1	2009	1764	2	2017	166	2	987	557	52	29	0.163	0.338	14	16	11.55	5
Assist	1	2013	1678	2	2014	112	2	918	574	49	30	0.163	0.338	14	16	9	8
Assist	1	2021	599	2	2013	59	2	1003	2063	668	1376	0.163	0.338	14	16	1	9
Assist	1	2007	1119	2	2011	115	3	2438	735	2750	828	0.163	0.338	14	16	14	11
Towboat	1	2020	373	2	2015	9.5	1	774	800	0	0	0.334	0.37	14	16	2	7
Towboat	1	2020	373	2	2015	11	1	265	365	0	0	0.334	0.37	14	16	2	7
Towboat	1	2004	336	2	2004	7	1	149	190	0	0	0.334	0.37	14	16	14	16
Ocean Tug	1	2011	671	2	2011	30	1	520	600	126	135	0.334	0.37	14	16	11	11
Ocean Tug	1	2020	821	2	2014	121	2	1271	677	1908	1015	0.334	0.37	14	16	2	8
Ocean Tug	1	2006	1194	1	2011	92	3	320	350	960	1050	0.334	0.37	14	16	14	11
Ocean Tug	1	2012	1119	2	2009	154	3	128	55	512	218	0.334	0.37	14	16	10	13
Excursion	1	2018	149	1	0	0	0	300	292	0	0	0.268	0.403	15	14	4	14
Ferry	1	2016	298	2	1964	31	2	5575	2666	0	0	0.314	0.388	15	13	2.15	4.5
Excursion	1	2016	242	2	2016	121	2	501	531	0	0	0.268	0.403	15	14	6	6
Excursion	1	2022	372	2	2021	220	2	135	192	0	0	0.268	0.403	15	14	0	1
Excursion	1	2012	108	1	0	0	0	91	88	0	0	0.268	0.403	15	14	10	14
Excursion	1	2011	261	2	2002	38.5	2	772	479	331	205	0.268	0.403	15	14	10.88	14
Excursion	1	2013	1050	2	0	0	0	243	236	0	0	0.268	0.403	15	14	9	14
Excursion	1	1986	448	2	2020	20	2	122	240	0	0	0.268	0.403	15	14	15	2
Ferry	1	2017	242	2	1987	15	1	4944	4805	0	0	0.314	0.388	15	13	2.43	13
Excursion	1	2019	373	2	2014	121	2	3276	2232	0	0	0.268	0.403	15	14	3	5.4
Excursion	1	2011	970	2	2011	261	2	317	573	3	6	0.268	0.403	15	14	11	11
Excursion	1	2016	429	2	2017	246	2	1438	2016	76	106	0.268	0.403	15	14	6	5
Excursion	1	2013	556	2	2013	175	2	1334	1010	572	433	0.268	0.403	15	14	6.3	8.3
Excursion	1	2018	302	2	2016	63	2	414	377	4	4	0.268	0.403	15	14	4	6
Excursion	1	2014	172	2	2016	75	1	224	193	0	0	0.268	0.403	15	14	8	6
Research	1	1978	634	2	1978	230	2	38	41	3773	4089	0.323	0.438	22	28	3.15	2.91
Research	1	2011	555	2	2011	555	2	10	11	350	379	0.323	0.438	22	22	11	11
Work	1	2004	119	1				800	0	0	0	0.333		22		18	
Work	1	2011	112	1				250	0	0	0	0.333		22		11	
Work	1	2002	343	2				878	0	0	0	0.333		15		15	
Work	1	2012	317	2				75	0	0	0	0.333		22		10	
Commercial Fishing	68	1995	256	1.5	1996	75	1	33	40	67	80	0.27	0.43	31	31	25	27
Sportfishing – Overall	54	2009															
<i>Sportfishing – ½ Day Boat</i>	3	2004	280	2	2008	38	1	484	1936	669	2678	0.288	0.454	16	19	16	14
<i>Sportfishing – 1 Day Boat</i>	3	2011	290	2	2014	37	2	150	600	207	830	0.288	0.454	16	19	11	8
<i>Sportfishing – 1.5 to 4 Day Boat</i>	37	2010	355	2	2006	45	2	1118	4470	1546	6182	0.288	0.454	16	19	12	16
<i>Sportfishing – Long-Range Boat, 5-16 Days</i>	11	2007	671	2	2006	149	2	150	600	207	830	0.288	0.454	16	19	15	16

2022 Cargo Handling Equipment Activity

Terminal	Type	Quantity	Description	Original		Engine		Fuel	RD99	Annual Usage (hr)	Deterior Hours 12,000 max	Aftermarket emission control strategy installed?	Emission Control Type	Level of Control (1, 2, or 3)	Type
				MY	MY	HP	HP								
TAMT	Hostler	10	CAPACITY T5000	2007	2011	200	Diesel			1612	12000				Yard Tractor
TAMT	REACH STACKER	1	TAYLOR	2002	2010	330	Diesel			770	9240				Reach Stacker
TAMT	REACH STACKER	1	TEREX	2016	2016	315	Diesel			325	1950				Reach Stacker
TAMT	Hostler	5	ORANGE EV	2022	2022	225	Electric			1612	NA				Yard Tractor
TAMT	Forklift	1	DOOSAN	2022	2021	106	Electric			879	NA				Forklift
TAMT	Forklift	1	DOOSAN	2022	2022	106	Electric			879	NA				Forklift
TAMT	Yard Tractor	1	KALMAR 4x2	2007	2007	200	Diesel			679	10185	No			Yard Tractor
TAMT	Yard Tractor	1	KALMAR 4x2	2007	2007	200	Diesel			628	9420	No			Yard Tractor
TAMT	Yard Tractor	1	KALMAR 4x2	2007	2007	200	Diesel			553	8295	No			Yard Tractor
TAMT	Yard Tractor	1	KALMAR 4x2	2007	2007	200	Diesel			452	6780	No			Yard Tractor
TAMT	Yard Tractor	1	KALMAR 4x2	2007	2007	200	Diesel			490	7350	No			Yard Tractor
TAMT	Yard Tractor	1	KALMAR T2	2019	2019	173	Diesel			818	2454	No			Yard Tractor
TAMT	Yard Tractor	1	KALMAR T2	2019	2019	173	Diesel			1558	4674	No			Yard Tractor
TAMT	Forklift	1	CAT PD8000 3.4 MT Cap	2012	2012	63	Diesel			375	3750	No			Forklift
TAMT	Forklift	1	CAT PD8000 3.4 MT Cap	2012	2012	63	Diesel			245	2450	No			Forklift
TAMT	Forklift	1	CAT PD8000 2.9 MT Cap	2012	2012	63	Diesel			204	2040	No			Forklift
TAMT	Forklift	1	CAT PD8000 2.9 MT Cap	2012	2012	63	Diesel			293	2930	No			Forklift
TAMT	Forklift	13	MITSUBISHI HD80	2006	2006	134	Diesel			43	688	Yes	Diesel Particulate Filter (DPF)	3	Forklift
TAMT	Forklift	1	CAT P33000	2008	2008	200	Diesel			281	3934	No			Forklift
TAMT	Forklift	1	TAYLOR TX330M	2013	2013	165	Diesel			298	2682	No			Forklift
TAMT	Forklift	1	TAYLOR TX330M	2013	2013	165	Diesel			280	2520	No			Forklift
TAMT	Forklift	1	TAYLOR TXH400L	2008	2008	250	Diesel			164	2296	Yes	Diesel Particulate Filter (DPF)	3	Forklift
TAMT	Forklift	1	TAYLOR TXH400L	2008	2008	250	Diesel			235	3290	Yes	Diesel Particulate Filter (DPF)	3	Forklift
TAMT	Forklift	1	TAYLOR TXH400L	2008	2008	250	Diesel			258	3612	Yes	Diesel Particulate Filter (DPF)	3	Forklift
TAMT	Forklift	1	TAYLOR TXH400L	2008	2008	250	Diesel			291	4074	Yes	Diesel Particulate Filter (DPF)	3	Forklift
TAMT	Forklift	25	HOIST P550	2008	2008	250	Diesel			183	2562	Yes	Diesel Particulate Filter (DPF)	3	Forklift
TAMT	Forklift	1	TAYLOR XH550M	2022	2022	248	Diesel			35	35	No			Forklift
TAMT	Top Handler	1	TAYLOR TEC-9501	2005	2005	280	Diesel			402	6834	Yes	Diesel Particulate Filter (DPF)	3	Top Handler
TAMT	Top Handler	1	TAYLOR XLC976	2021	2021	382	Diesel			940	940				Top Handler
TAMT	Forklift	1	CW CB52	2008	2008	250	Diesel			102	1428	Yes	Diesel Particulate Filter (DPF)	3	Forklift
TAMT	Crane	1	Rental	2011	2011	551	Diesel			6	66				Crane
TAMT	Crane	1	Rental	2011	2011	551	Diesel			6	66				Crane
CST	Forklift	7	HYSTER	2000	2000	106	Electric			1000	NA				Forklift
CST	Forklift	7	TOYOTA	2000	2000	106	Electric			1000	NA				Forklift
TAMT	Air Compressor	1	Sullar 185	2006	2006	60	Diesel	Yes		43	688	No			Compressor
TAMT	Vac Truck	1	Ford F-650	2001	2001	320	Diesel			40	840	No			Vacuum truck
TAMT	Forklift	1	Uni Carriers Model- MAP1F2A25LV	2017	2017	106	Propane			95	475	No			Forklift
TAMT	Pump Truck	1	Ford F-350 Super Duty Cab & Chasis	2004	2004	450	Gasoline			243	4374	No			0
TAMT	Tommy Slick	1	American Work Boats	1992	2012		Diesel	Yes		75	750	No			Other
TAMT	Forklift	3	Caterpillar EC30	2004	2004	106	Electric			14	NA	No			Forklift
TAMT	Forklift	8	Caterpillar ET3000	2007	2007	106	Electric			48	NA	No			Forklift
TAMT	Reach Stacker	3	JCB	2022	2022	337	Diesel			21	21	No			Reach Stacker
TAMT	Forklift	1	HELIX CPYD30-TY5	2016	2016	149	Propane			208	1248	No			Forklift
TAMT	Forklift	1	TOYOTA 8FBE20U	2019	2019	106	Electric			100	NA	No			Forklift
TAMT	Cart	1	Clubcar	2003	2007	9	Gasoline			400	6000	No			Cart
TAMT	Front Loader	1	Rubber Tire Loader/CAT 928 G	1999	1999	125	Diesel			200	4600	No			Loader
TAMT	Reach Stacker	1	Fantuzzi	2001	2009	400	Diesel			100	1300	Yes	Diesel Particulate Filter (DPF)		Reach Stacker
TAMT	Reach Stacker	1	Fantuzzi	2001	2008	330	Diesel			100	1400	Yes	Diesel Particulate Filter (DPF)		Reach Stacker
TAMT	Reach Stacker	1	Fantuzzi	1999	2010	354.340673	Electric			100	NA				Reach Stacker
TAMT	Top Handler	1	Taylor TEC950L	1999	1999	280	Diesel			0	0	Yes	Diesel Particulate Filter (DPF)		Top Handler
TAMT	Forklift	1	TL-FL33E	2023	2023	106	Electric			400	NA				Forklift
TAMT	Reach Stacker	1	TI-RS55E	2022	2022	337	Electric			100	NA				Reach Stacker
TAMT	Forklift	1	Kalmar	2018	2018	170	Electric			400	NA				Forklift
TAMT	Forklift	1	Doosan	2020	2020	162	Diesel			400	800				Forklift
TAMT	Forklift	1	Doosan	2018	2018	140	Diesel			400	1600				Forklift
TAMT	Crane	1	Gottwald HMK300 Mobile Harbor Crane	2001	2001	1030	Diesel			437.1	9179.1	No			Crane
CST	Forklift	1	Komatsu 6000LB	2003	2003	65.7	Propane			879		No			Forklift
CST	Telescopic Reach Lift	1	JLG Skytrack 10054 Reach Lift	2007	2007	110	Diesel	Yes		100		No			Lift
CST	Telescopic Boom Lift	1	JLG Sky Track	2012	2012	82	Propane			100		No			Lift
CST	Forklift	1	DOOSAN B35X-5	2010		28.2	Electric			117					Forklift
TAMT	Sweeper/scrubber	1	Tennant T20 Scrubber	2017	2017	28	Propane			464					Sweeper
TAMT	Sweeper/scrubber	1	Tennant ATLV 4300 Litter Vacuum	2017	2017	32.8	Diesel	Yes		464					Sweeper
NCMT	UTR/Spotting Tractor	1	Terberg 4x4 Off-Road	2014	2014	225	Diesel			250	2000	Yes	Other	DEF	Yard Tractor
NCMT	UTR/Spotting Tractor	1	Terberg 4x2 Off-Road	2014	2014	225	Diesel			250	2000	Yes	Other	DEF	Yard Tractor
NCMT	UTR/Spotting Tractor	1	Ottawa 4x2 Off-Road	2015	2015	225	Diesel			250	1750				Yard Tractor
NCMT	UTR/Spotting Tractor	1	Ottawa 4x2 Off-Road	2015	2015	225	Diesel			250	1750				Yard Tractor
NCMT	UTR/Spotting Tractor	1	BYD BY Electric	2017	2017	225	Electric			250	NA				Yard Tractor
NCMT	Utility Vehicle	1	John Deere TX Gator	2012	2012	16	Gasoline			1560	12000				ATV
NCMT	Utility Vehicle	1	John Deere TX Gator	2012	2012	16	Gasoline			1560	12000				ATV
NCMT	Utility Vehicle	1	John Deere TX Gator	2012	2012	16	Gasoline			1560	12000				ATV
NCMT	Utility Vehicle	1	John Deere TX Gator	2012	2012	16	Gasoline			1560	12000				ATV
NCMT	Utility Vehicle	1	John Deere TX Gator	2013	2013	16	Gasoline			1560	12000				ATV
NCMT	Utility Vehicle	1	John Deere TX Gator	2013	2013	16	Gasoline			1560	12000				ATV
NCMT	Utility Vehicle	1	John Deere TX Gator	2013	2013	16	Gasoline			1560	12000				ATV
NCMT	Utility Vehicle	1	John Deere TX Gator	2013	2013	16	Gasoline			1560	12000				ATV

2022 Cargo Handling Equipment Activity

Terminal	Type	Quantity	Description	Original Engine		HP	Fuel	RD99	Annual Usage (hr)	Deterior Hours 12,000 max	Aftermarket emission control strategy installed?	Emission Control Type	Level of Control (1, 2, or 3)	Type
				MY	MY									
NCMT	Utility Vehicle	1	John Deere TX Gator	2015	2015	16	Gasoline		1560	10920				ATV
NCMT	Utility Vehicle	1	John Deere TX Gator	2017	2017	16	Gasoline		1560	7800				ATV
NCMT	Utility Vehicle	1	John Deere TX Gator	2017	2017	16	Gasoline		1560	7800				ATV
NCMT	Utility Vehicle	1	John Deere TX Gator	2017	2017	16	Gasoline		1560	7800				ATV
NCMT	Utility Vehicle	1	John Deere TX Gator	2017	2017	16	Gasoline		1560	7800				ATV
NCMT	2.5 Ton Forklift	1	Clark C24LPG	2011	2011	67	Propane		100	1100				Forklift
NCMT	2.5 Ton Forklift	1	Mitsubishi FG25N-LP	2013	2013	61	Propane		100	900				Forklift
NCMT	2.5 Ton Forklift	1	Mitsubishi FG25N-LP	2013	2013	61	Propane		100	900				Forklift
NCMT	10 Ton Forklift	1	Taylor TX-220S	2011	2011	160	Diesel		100	1100				Forklift
NCMT	15 Ton Forklift	1	Kalmar DCD160-9	2008	2008	160	Diesel		100	1400				Forklift
NCMT	16 Ton Forklift	1	Taylor TX370M	2011	2011	173	Diesel		80	880				Forklift
NCMT	Forklift	1	Caterpillar Model Forklift	2000	2000	106	Propane		879	12000				Forklift
NCMT	Rail Loader (yellow)	1	Rail Loader (yellow)	2002	2002	138	Gasoline		780	12000				Loader
NCMT	Rail Loader (yellow)	1	Rail Loader (yellow)	2002	2002	138	Gasoline		780	12000				Loader
NCMT	Rail Loader (yellow)	1	Rail Loader (yellow)	2002	2002	138	Gasoline		780	12000				Loader
NCMT	Hyster Forklift 18726	1	Hyster Forklift	2003	2003	103	Propane		879	12000				Forklift
NCMT	Hyster Forklift N40ZR-16.5	1	Hyster Forklift	2003	2003	103	Propane		879	12000				Forklift
NCMT	Gator	1	John Deere - Gator TS	2007	2007	13	Gasoline		780	11700				ATV
NCMT	Sweeper	1	Tennet Sweeper 800 Series	1998	1998	83	Gasoline		479	11496				Sweeper
NCMT	Gator	1	John Deere - Gator TX	2007	2007	13	Gasoline		479	7185				ATV
NCMT	Segway	1	Segway	2008	2008	2	Electric		375	NA				Segway
NCMT	Segway	1	Segway	2008	2008	2	Electric		375	NA				Segway
NCMT	Polaris Ranger	1	Polaris Ranger	2008	2008	32	Gasoline		780	10920				Cart
NCMT	ATV CLUB CAR	1	ATV CLUB CAR	2013	2013	20	Gasoline		479	4311				Cart
NCMT	ATV CLUB CAR	1	ATV CLUB CAR	2013	2013	20	Gasoline		479	4311				Cart
NCMT	2- Post lift	1	Western Hoist	2003	2003	2	Electric		1560	NA				Lift
NCMT	2- Post lift	1	Western Hoist	2003	2003	2	Electric		1560	NA				Lift
NCMT	2- Post lift	1	Western Hoist	2003	2003	2	Electric		1560	NA				Lift
NCMT	4 POST LIFT	1	ROTARY	2017	2017	2	Electric		1560	NA				Lift
NCMT	4 POST LIFT	1	ROTARY	2017	2017	2	Electric		1560	NA				Lift
NCMT	4 POST LIFT	1	ROTARY	2017	2017	2	Electric		1560	NA				Lift
NCMT	4 POST LIFT	1	ROTARY	2017	2017	2	Electric		1560	NA				Lift
NCMT	4 POST LIFT	1	ROTARY	2017	2017	2	Electric		1560	NA				Lift
NCMT	4 POST LIFT	1	ROTARY	2017	2017	2	Electric		1560	NA				Lift
NCMT	4 POST LIFT	1	ROTARY	2017	2017	2	Electric		1560	NA				Lift
NCMT	4 POST LIFT	1	ROTARY	2017	2017	2	Electric		1560	NA				Lift
NCMT	2- Post lift	1	Benwil Hoist	2003	2003	2	Electric		1560	NA				Lift
NCMT	2- Post lift	1	Benwil Hoist	2003	2003	2	Electric		1560	NA				Lift
NCMT	2- Post lift	1	Western Hoist	2003	2003	2	Electric		1560	NA				Lift
NCMT	2- Post lift	1	Western Hoist	2003	2003	2	Electric		1560	NA				Lift
NCMT	2- Post lift	1	Western Hoist	2003	2003	2	Electric		1560	NA				Lift
NCMT	2- Post lift	1	Western Hoist	2003	2003	2	Electric		1560	NA				Lift
NCMT	2- Post lift	1	Western Hoist	2003	2003	2	Electric		1560	NA				Lift
NCMT	2- Post lift	1	Western Hoist	2003	2003	2	Electric		1560	NA				Lift
NCMT	2- Post lift	1	Western Hoist	2003	2003	2	Electric		1560	NA				Lift
NCMT	2- Post lift	1	Western Hoist	2003	2003	2	Electric		1560	NA				Lift
NCMT	Car Wash Long Tunnel	1	N/A	2003	2003	6	Electric		780	NA				Other
NCMT	Car Wash Short Tunnel	1	N/A	2003	2003	4	Electric		780	NA				Other
NCMT	Compactor	1	60IID	2003	2003	5	Electric		780	NA				Other
NCMT	Compactor	1	EA30485HDS	2003	2003	5	Electric		780	NA				Other
NCMT	Portable Compressor	1	ES20	2003	2003	5	Electric		1560	NA				Compressor
NCMT	Portable Compressor	1	QX2/ES20	2003	2003	5	Electric		1560	NA				Compressor
NCMT	Portable Compressor	1	ES20	2003	2003	5	Electric		1560	NA				Compressor
NCMT	Portable Compressor	1	Predator/R420	2003	2003	5	Gasoline		600	11400				Compressor
NCMT	Atlas Air Compressor	1	KT10V12034	2003	2003	15	Electric		1560	NA				Compressor
NCMT	Atlas Air Compressor	1	KT10V12034	2003	2003	15	Electric		1560	NA				Compressor
NCMT	Atlas Air Compressor	1	GA18PA	2003	2003	15	Electric		1560	NA				Compressor
NCMT	Falcon Air Compressor	1	B-2 Falcon	2003	2003	5	Electric		1560	NA				Compressor
NCMT	Tire Balancer	1	1025S	2003	2003	2	Electric		260	NA				Other
NCMT	Tire Machine	1	10430	2003	2003	1	Electric		260	NA				Other
NCMT	Tire Balancer	1	LS8153	2003	2003	2	Electric		260	NA				Other
NCMT	Tire Machine	1	9024-E	2003	2003	1	Electric		260	NA				Other
NCMT	Tire Machine	1	IC4KOCC	2003	2003	1	Electric		260	NA				Other
NCMT	Tire Balancer	1	GSP9712	2003	2003	2	Electric		260	NA				Other
NCMT	Tire Machine	1	TC3250	2003	2003	1	Electric		260	NA				Other
NCMT	Tire Balancer	1	GSP9712	2003	2003	2	Electric		260	NA				Other

Appendix C

Regulatory Setting

Various regulations and strategies are driving the reduction of air emissions from maritime sources. **Table B-1** summarizes selected air quality regulations and strategies for maritime air emission sources that have been adopted recently and are currently active.

Table B-1. Summary of Recently Adopted Air Emissions Regulations and Strategies

Agency/Organization	Regulation or Strategy	Year of Adoption	Emission Source	Target Pollutants
CARB	At Berth Amendments	2020	Ocean-going vessels	Particulate matter (PM), DPM, NO _x , ROG, and GHG
IMO	Data Collection System for Fuel Oil Consumption of Ships (MEPC.278[70])	2016	Ocean-going vessels	GHG
IMO	Low Sulfur Fuel Requirements for Marine Engines (MEPC.280[70])	2016	Ocean-going vessels	SO _x
IMO	Carbon Intensity Indicator (MEPC.328[76])	2021	Ocean-going vessels	GHG
IMO	2023 IMO Strategy on Reduction of GHG Emissions from Ships (MEPC.377[80])	2023	Ocean-going vessels	GHG
CARB	Commercial Harbor Craft Amendments	2022	Commercial harbor craft	DPM, SO _x , NO _x , and GHG
CARB	Large Spark-Ignition Engine Fleets Amendments	2016	Off-road large spark-ignition fleets	NO _x and hydrocarbons
CARB	In-Use Off-Road Diesel-Fueled Fleets Amendments	2023	Off-road diesel fleets	DPM, NO _x , and other criteria air pollutants
CARB	Advanced Clean Trucks Regulation	2021	Medium- and heavy-duty vehicles (Class 2B-8)	PM, NO _x , and other criteria air pollutants; GHG; and toxic air contaminants
CARB	Clean Truck Check Program (Heavy-Duty Inspection/Maintenance Regulation)	2022	Heavy-duty non-gasoline vehicles (Class 4-8)	PM and NO _x
CARB	Heavy-Duty Vehicle and Engine Omnibus Low NO _x Amendments	2023	Heavy-duty vehicles (Class 4-8)	PM and NO _x
CARB	Transport Refrigeration Unit Amendments	2022	Transport refrigeration units	DPM, NO _x , and GHG
CARB	2020 Mobile Source Strategy	2021	Multiple	Criteria air pollutants, GHG, and toxic air contaminants
CARB	2022 State Strategy for the State Implementation Plan	2022	Multiple	Criteria air pollutants