Texas A&M Transportation Institute

Emissions Measures for the Port of Gulfport, Mississippi

Final Report

Prepared for the Mississippi State Port Authority

April 2024

Texas A&M Transportation Institute

FINAL REPORT – DRAFT FOR REVIEW

TTI Proposal No: 2404150

Draft Report

DATE: April 25, 2024

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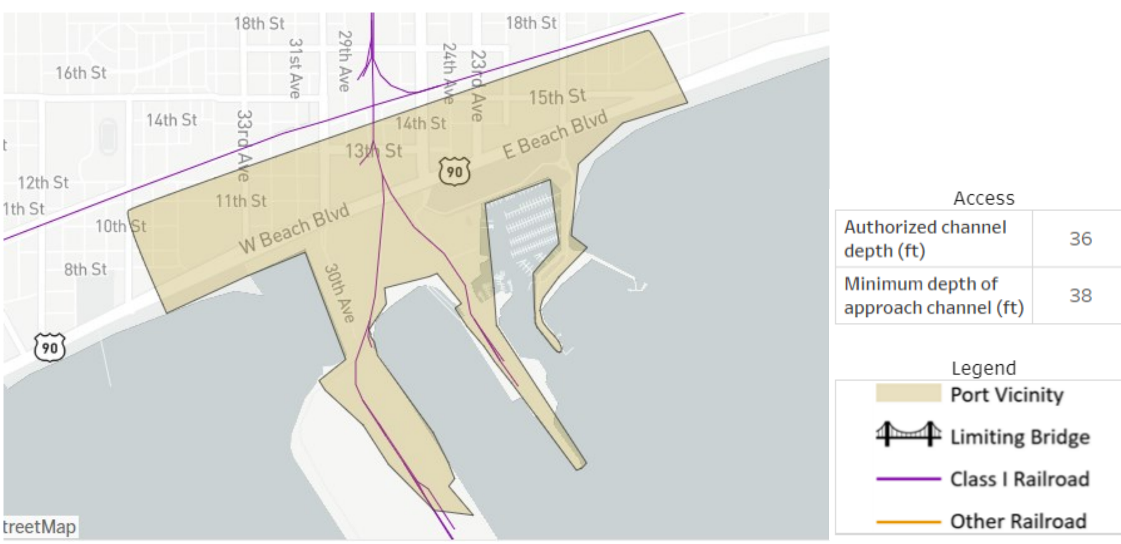
EXECUTIVE SUMMARY

For this study, the Texas A&M Transportation Institute (TTI) developed a baseline emission inventory for the Port of Gulfport, Mississippi, for the year 2022. The emissions were categorized by the major port emission sources as listed in the Environmental Protection Agency's (EPA's) *Ports Emissions Inventory Guidance* report [1], which includes ocean-going vessels (OGV), harbor crafts, recreational marine vessels, cargo handling equipment (CHE), drayage trucks, and rail (switchers and line-haul locomotives). For harbor crafts and OGVs, TTI only accounted for emissions from the harbors under the Mississippi State Port Authority's (MSPA's) jurisdictions, namely the Small Craft Harbor and the Gulfport Harbor, in the baseline emission inventory. Emissions from the Gulfport Municipal Marina, which is not under MSPA's jurisdiction, were estimated for comparison purposes.

TTI estimated emissions for criteria air pollutants (CAPs) and their precursors: nitrogen oxides (NO_x), volatile organic compounds (VOC), sulfur dioxide (SO_2), and particulate matter under 10 (PM_{10}) and 2.5 microns ($PM_{2.5}$), as well as climate-related pollutants or greenhouse gases (GHG): carbon dioxide (CO_2) and methane (CH_4).

The total emissions estimated by TTI for the Port of Gulfport domain, as shown in Figure 1, are available in Table 1. Marine sources (harbor crafts and OGVs) were the largest emission sources at the port, whereas rail was the smallest.



Source: Bureau of Transportation Statistics. Port Profile. Available at : https ://explore.dot.gov/views/PortPerformance-temp-view2/ProfileDashboard ?%3Aembed=y&%3AisGuestRedirectFromVizportal=y&Port%20ID=2083

Figure 1. Map of Port of Gulfport

Table 1. Estimated 2022 Baseline Emissions from Port of Gulfport Sources (tons/year)

Source Type	CO	NO_x	CH_4	SO_2	VOC	CO_2	PM_{10}	$PM_{2.5}$
CHE	16.60	32.81	0.17	0.02	2.82	5,456.56	3.01	2.92
Harbor Craft	6.58	42.31	0.02	0.03	1.22	2,951.97	1.01	0.98
OGV	4.65	33.94	0.04	2.67	2.22	4,193.33	1.11	1.02
On-Road/Drayage Trucks	3.73	5.09	0.06	0.00	0.39	1,119.16	0.12	0.11
Rail	1.13	5.12	0.03	0.00	0.23	434.59	0.13	0.13
Total	32.69	119.27	0.32	2.72	6.88	14,155.61	5.38	5.16

1 INTRODUCTION

The Port of Gulfport, operated by MSPA, is a commercial port in southern Mississippi, located on the northern Gulf of Mexico, just 18 miles from the open Gulf waters, approximately 12 miles east of Bay St. Louis, and five nautical miles from the Gulf Intracoastal Waterway [2]. Annually the Port of Gulfport handles more than 2 million tons of cargo and about 200,000 twenty-foot equivalent units (TEUs) [3]. According to the Bureau of Transportation Statistics (BTS) *2023 Port Performance Freight Statistics Program: Annual Report to Congress* [4], the Port of Gulfport ranks 25th nationally in terms of container ports by TEU, houses three container cranes, and houses three container terminals with on-dock rail access. The Port has 10 berths located at the West and East Piers, as well as four warehouses, two of which have direct rail access. The West Pier also has an additional Ro/Ro berth. Further inland, there is a port facility offering additional rail access and barge connections. The Port of Gulfport has facilities to handle containerized, break bulk, and bulk cargo [2].

The Port of Gulfport, which is one of the 18 commercial strategic seaports[1] in the United States, is directly accessible from U.S. Highway 49 (US 49) and is close to U.S. Highway 90 (US 90) and Interstate 10 (I-10), which makes it very accessible by truck. In terms of rail, the docks can be accessed by Class I rail provided by Canadian Pacific Kansas City [3]. Other rail connections are possible, including an announced express train with the Canadian National railway (CN) offering non-stop Port-to-Chicago service and partnerships with the CSX Transportation (CSXT) rail whose east-west track runs within a half mile of the port.

[1] Strategic seaports are ports that the state government views as vital to the national and state transportation networks, supply chains, and national defense system. A list of commercial strategic seaports is available at https://www.maritime.dot.gov/ports/national-port-readiness-network-nprn.

2 PORT-RELATED EMISSIONS INVENTORY

For this study, TTI estimated emissions for CAPs and their precursors (NO_x, VOC, SO_2, PM_{10}, and $PM_{2.5}$) as well as GHGs (CO_2 and CH_4).

2.1 CHE

CHE is equipment used to handle marine cargo and to support terminal operations. These include top handlers, side handlers, reach stackers, straddle carriers, gantry cranes, forklifts, terminal tractors, and yard trucks. Emission per unit can be calculated using the following formula [1]:

$$E = P \times LF \times A \times EF$$

Where, *E* = per unit emissions (g), *P* = rated engine power (hp), *LF* = engine load factor [1], *A* = engine operating activity (hr), *EF* = emission factor (g/hp-hr).

2.1.1 Port of Gulfport CHE Activity

TTI received a list of CHE operated at the Port of Gulfport from MSPA. The list contained information on equipment type and count, as well as aggregated model year, equipment horsepower, and average annual in-use hours. TTI assumed the CHEs were powered by diesel engines. Based on the literature review, TTI also assigned Source Classification Codes (SCC)[2] to each equipment type; these SCCs were necessary to match the equipment types with their respective emission factors (further details are discussed in Chapter 2.1.2).

For the CHEs operated by Ports America, the provided information did not include engine power. Thus, TTI assigned engine power for each CHE category based on the average engine power of the equipment type at other ports or manufacturer brochures, as shown in Table 2. These average engine powers were also applied to CHEs from other operators without a listed average.

[2] EPA utilizes SCCs to categorize various activities that produce emissions. Each SCC denotes a distinct process or function specific to a source category, which emits air pollutants. Generally, SCCs employ a hierarchical structure where the classification of emission processes becomes progressively more detailed across four levels, beginning from the left of the code and advancing from left to right. More information on SCCs are available here https://sor-scc-api.epa.gov/sccwebservices/sccsearch/.

Table 2. Port of Gulfport CHE Count, Model Year, and Activity from Ports America

Equipment	Count	Model Year Average	Average Annual In-Use Hours	Average Rated Power (hp)	SCC
Forklift (L 30,000–50,000 lb)	4	2002	812	184[a]	2270003020 (Dsl – Forklifts)
Forklift (M/S 8,000–12,000 lb)	4	2010	472	87[a]	
Forklifts (S < 8,000 lb)	11	2010	449	56[a]	Electric
Forklift (M/S 8,000–12,000 lb)	13	2010	472	87[a]	2267003020 (LPG – Forklifts)
Forklifts (S < 8,000 lb)	12	2010	449	56[a]	
Railcar mover	1	2021	990	217 (216[b], 218[c])	2270003040 (Dsl – Other General Industrial Eqp)
Reach Stacker	3	2014	216	342 (355[b], 337[c], 335[d])	2270003050 (Dsl – Other Material Handling Eqp)
Terminal Vehicles	31	2009	2,850 miles	298 (370[b], 225[c])	2270002051 (Dsl – Off-Highway Trucks)
Top Loader/Side handler	11	2013	785	299 (261[b], 278[c], 358[d])	2270002066 (Dsl – Tractors/Loaders/Backhoes)
Utility Tractor Rigs (UTR)	62	2011	700	193 (170[b], 225[c], 185[d])	2270003070 (Dsl – Terminal Tractors)

[a] Toyota. For 30,000–50,000 lb: THD4000-48, load capacity: 40,000 lb. https://www.toyotaforklift.com/content/dam/tmh/marketing/en/pdf/product-spec-brochures/2023_High%20Capacity%20IC%20Pneumatic_THD_Spec%20Sheet_Digital.pdf;
for 8,000–12,000 lb: 50-8FG45U, load capacity: 10,000 lb. https://www.constructionequipmentguide.com/charts/forklifts/toyota/8fg45u/30304529;
for < 8,000 lb: 40-8FGU20, load capacity: 4,000 lb. https://www.toyotaforklift.com/content/dam/tmh/marketing/en/pdf/product-spec-brochures/2023_Core%20IC%20Pneumatic_Spec%20Sheet_Digital.pdf#page=4.
[b] Port Houston. 2019 Goods Movement Emissions Inventory. Table 5.1. 2019 Equipment Characteristics. [5]
[c] California Air Resources Board (2022). 2022 Cargo Handling Equipment Emissions Inventory. Table 54. Average Horsepower from CARB Reporting Data. [6]
[d] Port Authority of New York and New Jersey. (2023) 2022 Multi-Facility Emissions Inventory. Table 2.8: Material Handling Equipment Characteristics. [7]

2.1.2 CHE Emissions Calculation

The emission factors for CHEs were derived from EPA's Motor Vehicle Emission Simulator (MOVES) NONROAD model. As listed in the *Ports Emissions Inventory Guidance* report [1], all CHE types are classified under either the "Industrial," "Commercial," or "Construction" MOVES-Nonroad sector.[3] The total emissions are shown in Table 3. For the emission rates for each SCC and model year, TTI selected the engine technology ID (engTechID) that yielded the largest emissions (for example, Tier 1 Diesel instead of Tier 3 Diesel). This ensures that the baseline emission inventory does

[3] For more information, review Table 6.1 of the *Ports Emissions Inventory Guidance* report [1].

not under-report any of the CHE emissions. On-terminal trucks and other terminal vehicles were the largest sources of CHE emissions at the port.

Table 3. Port of Gulfport CHE Emissions (Tons)

Equipment	Fuel	#	CO	NO_x	CH_4	SO_2	VOC	CO_2	PM_{10}	$PM_{2.5}$
Air Compressor	Diesel	2	0.005	0.013	0.000	0.000	0.001	1.609	0.001	0.001
Crane	Diesel	1	1.153	1.587	0.007	0.001	0.083	339.574	0.090	0.087
Forklift (L 30,000–50,000 lb)	Diesel	6	0.521	2.225	0.003	0.004	0.149	220.297	0.153	0.149
Forklift (M/S 8,000–12,000 lb)	Diesel	5	0.457	0.381	0.002	0.000	0.026	67.935	0.071	0.069
Forklift (M/S 8,000–12,000 lb)	Propane	13	0.941	0.173	0.005	0.000	0.023	97.305	0.011	0.011
Forklifts (S < 8,000 lb)	Diesel	4	0.038	0.087	0.001	0.000	0.011	12.741	0.006	0.006
Forklifts (S < 8,000 lb)	Propane	12	0.532	0.098	0.003	0.000	0.013	54.998	0.006	0.006
Front End Loader	Diesel	5	0.063	0.165	0.000	0.000	0.022	31.661	0.017	0.017
Generator	Diesel	811	0.343	0.903	0.006	0.000	0.085	133.050	0.041	0.040
Railcar Mover	Diesel	3	0.280	0.881	0.006	0.001	0.071	237.119	0.047	0.045
Reach Stacker	Diesel	3	0.131	0.201	0.003	0.000	0.031	41.478	0.022	0.021
Sweeper	Diesel	1	0.008	0.012	0.000	0.001	0.003	0.831	0.002	0.002
Telehandler	Diesel	1	0.006	0.006	0.000	0.000	0.001	0.641	0.001	0.001
Terminal Vehicles	Diesel	42	1.895	5.411	0.021	0.003	0.398	786.950	0.453	0.439
Top Loader/Side Handler	Diesel	12	2.189	5.816	0.014	0.002	0.764	402.669	0.568	0.551
Truck	Diesel	5	5.493	9.752	0.063	0.007	0.720	1,988.008	1.000	0.970
UTR	Diesel	62	2.544	5.101	0.037	0.004	0.421	1,039.693	0.526	0.510
Total		988	16.599	32.811	0.173	0.024	2.821	5,456.56	3.015	2.925

Note: For terminal vehicles, TTI assumed an average 15 mph operating speed. For example, if the vehicle type has an average range of travel of 2,850 miles, applying the 15 mph operating speed assumption, TTI assumed the vehicle operated for 190 hours.

2.2 OGV and Harbor Craft

For marine sources, including OGVs and harbor crafts, TTI estimated emissions using the 2022 automatic identification system (AIS) data. TTI established a 5-mile and a 10-mile emission boundary around the Port of Gulfport to capture marine source activities from the AIS data. As shown in Figure 2, TTI further divided the Port of Gulfport into three regions: Small Craft Harbor, Gulfport Harbor, and Gulfport Municipal Marina. MSPA has jurisdiction over the former two, whereas the City of Gulfport operates and maintains the Gulfport Municipal Marina. Based on conversations with MSPA, for this study, TTI only counted vessels that visited the Small Craft Harbor and the Gulfport Harbor as having called at the port, since the Gulfport Municipal Marina is primarily for recreational use rather than commercial. This port call definition filtered out vessels passing through the port area without making visits, thus resulting in a more precise calculation of Gulfport-induced emissions.

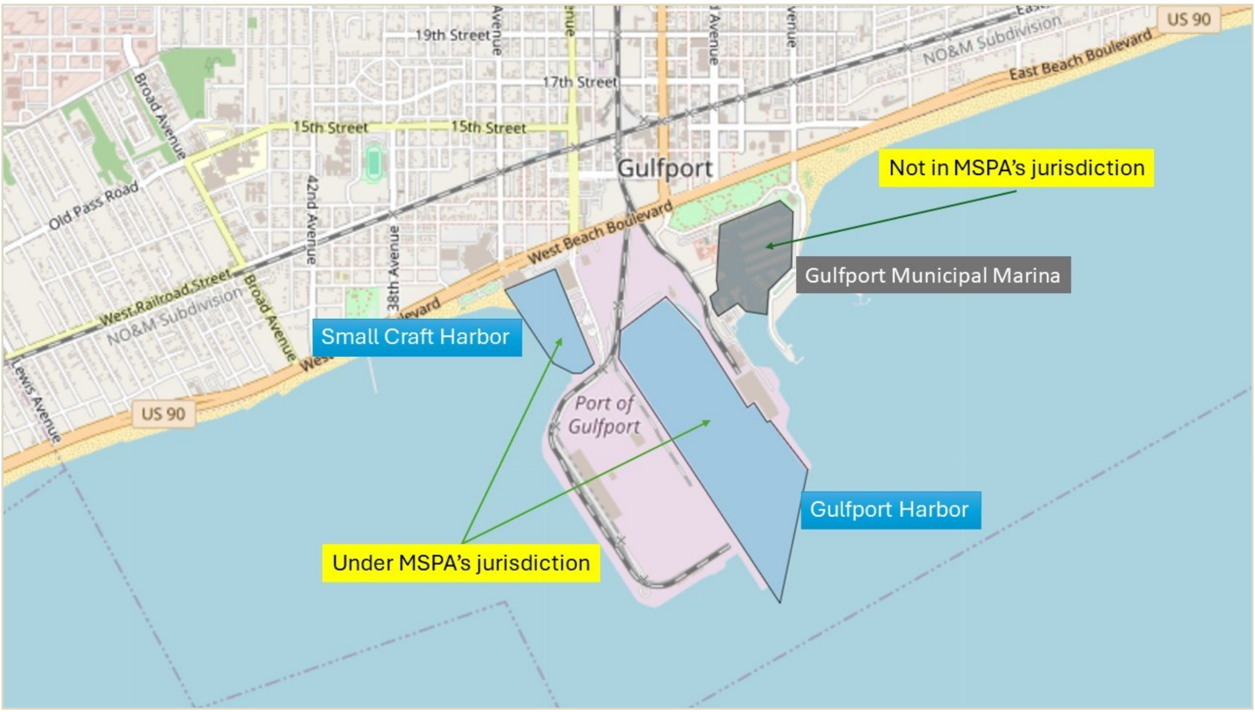


Figure 2. Marine Activity Regions at the Port of Gulfport

2.2.1 Marine Activity

Figure 3 shows the vessel distribution within the 5- and 10-mile boundaries surrounding the Port of Gulfport, as well as the three marine activity regions at the port, previously depicted in Figure 2. The vessel types shown in this table were identified based on their AIS vessel type. At 10 miles, the number of unique vessels captured was significantly higher than when the boundary was set at 5 miles; most notably, the number of unique tug-tows increased from 37 in the 5-mile boundary to 456. TTI believes this suggests a significant number of tug-tow vessels passed through the region between the 5- and 10-mile boundaries without directly visiting the Port of Gulfport. Thus, TTI concluded that the 5-mile boundary was more suitable for emissions calculation.

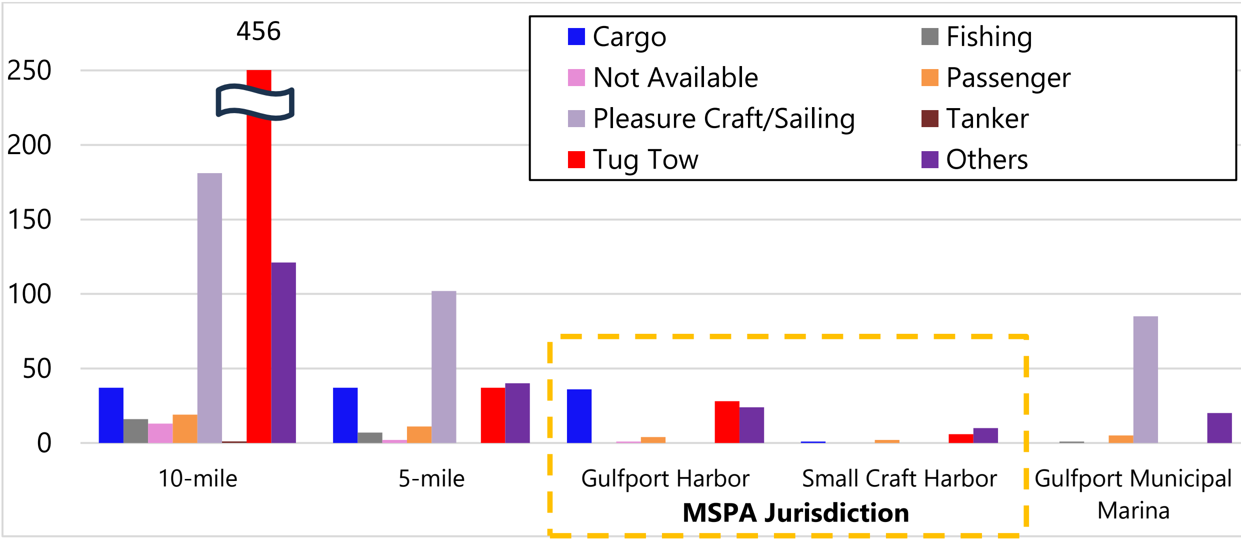


Figure 3. Number of Unique Vessels in the 5- and 10-mile Boundary and the Three Port Regions

TTI mapped and aligned the vessel type information provided in the AIS data to EPA specifications. Since this study primarily focused on vessels making port calls at the port, the AIS vessel types that had made port calls included "cargo," "passenger," "tug-tow," "others," and "not available." A survey vessel from the U.S. Army Corps of Engineers, the Damrell, was classified as "military" under the AIS categories. For this study, TTI included the Damrell as a "cargo" vessel. To align the AIS vessel types with their EPA counterparts, TTI matched the International Maritime Organization (IMO) ship identification number with the Sea-Web ship database[4], which contained their EPA vessel type information. TTI was able to match 52 of the 102 vessels that made port calls at the port to the Sea-Web ship database, including 36 of the 38 cargo ships. For unmatched vessels, which were mostly tug-tow vessels, TTI manually aligned them with their respective EPA vessel types by referencing their AIS vessel codes.

Table 4 lists the count of OGVs and harbor crafts that made port calls at the Small Craft Harbor and the Gulfport Harbor by their EPA vessel type, the total number of port calls made, and the total operating time while within the 5-mile boundary. As shown in the table, tugboats made up the largest portion of activity within the 5-mile boundary, accounting for about 62 percent of the total operating time recorded for all vessel types.

[4] More information on the Sea-Web ship database is available at https://www.spglobal.com/marketintelligence/en/mi/products/sea-web-vessel-search.html.

Table 4. Count of Vessels That Made Port Calls in 2022, the Number of Individual Port Calls, and the Total Operating Hours within the 5-mile Boundary

Vessel Category	Vessel Type	Count of Vessel	Port Calls at Small Craft Harbor	Port Calls at Gulfport Harbor	Total Operating Time (hr)
Harbor Crafts	Crew and Supply	6	8	105	660
	Dredging	2	2	38	715
	Government	2	1	10	149
	Misc. (C1/C2)	12	255	212	2,028
	Pilot	1	1	0	0
	Towboat/Pushboat	6	14	45	1,085
	Tugboat	27	92	866	19,532
	Work Boat	3	61	47	1,151
OGV	Bulk Carrier	23	15	91	1,742
	Container Ship	12	0	259	2,476
	General Cargo	4	0	34	674
	Offshore Support/Drillship	3	0	62	1,353
	Vehicle Carrier	1	0	2	14

2.2.2 Marine Emissions Calculation

The AIS database does not contain information on vessel engine tiers. TTI extracted the vessel's built year from the Sea-Web ship database for vessels with an IMO identification number matched. Based on this information, TTI assigned engine tiers according to the vessel's built year. For unmatched vessels, TTI manually assigned engine tiers based on similar ship types that called the port. Regarding engine sizes, TTI used the default OGV and harbor craft engine sizes as described in EPA's *Port Emissions Inventory Guidance* report [1], listed in Appendix A; TTI assumed that OGVs were equipped with medium-speed diesel (MSD) category 3 engines.

For OGVs, the emissions for their propulsion or primary engine, auxiliary engine, and boilers can be calculated using the following formulas [1]:

- Propulsion engine $E_p^{OGV} = P_p^{OGV} \times A \times EF_p^{OGV} \times LLAF$
- Auxiliary engine $E_a^{OGV} = P_a^{OGV} \times A \times EF_a^{OGV}$
- Boiler $E_b^{OGV} = P_b^{OGV} \times A \times EF_b^{OGV}$

For harbor crafts, the following formulas are used instead [1]:

- Propulsion engine $E_p^{HBC} = P_p^{HBC} \times A \times EF_p^{HBC} \times LF_p^{HBC}$
- Auxiliary engine $E_a^{HBC} = P_a^{HBC} \times A \times EF_a^{HBC} \times LF_a^{HBC}$

Where, $E_p, E_a,$ and E_b = vessel emissions (g) for the propulsion engines, auxiliary engines, and boilers, respectively (note that harbor crafts [shortened in the equations as HBC] do not have boilers); $P_p, P_a,$ and P_b = engine operating power (kW) for propulsion engines, auxiliary engines, and boilers, respectively; A = activity duration (hours); $EF_p, EF_a,$ and EF_b = pollutant emission factors (g/kWh) for propulsion engines, auxiliary engines, and boilers, respectively; $LLAF$ = low load adjustment factors for the OGV propulsion engine; and LF_p and LF_a = harbor craft propulsion and auxiliary engine load factors, respectively.

The total emissions within the 5-mile boundary with port calls are shown in Table 5. The emissions for vessels calling the harbors under MSPA's jurisdiction were separated from those that called the Gulfport Municipal Marina.[5] In total, emissions from OGVs were larger than those from harbor crafts for the vessels calling the harbors under MPSA's jurisdiction. Container ships and tugboats were the largest marine emission sources, accounting for more than 60 percent of the emissions of all vessel types calling the harbors within the jurisdiction of MPSA, followed by bulk carriers and general cargo ships. Lastly, vessels from the Gulfport Municipal Marina constituted a significant portion of the region's marine sources and were comparable to both MPSA harbors combined. The Municipal Marina emissions were not included in the port's baseline emissions inventory and are shown here for comparison purposes only.

[5] For the Municipal Marina, a significant proportion of the vessels that called were pleasure crafts, which have their own unique method of emissions estimation separate from OGVs and harbor crafts [1]. TTI's methodologies were not originally designed to account for pleasure crafts. Upon closer inspection, the default emission rates for pleasure crafts and the "Misc. (C1/C2)" harbor crafts were found to be comparable. Therefore, for this study, TTI categorized all pleasure crafts as "Misc. (C1/C2)" harbor crafts and assumed their engine tiers to be Tier 3. As adjustments were made to the methodology, TTI must note that the emission values for the Municipal Marina are for comparative purposes only, and TTI would caution against including them in the baseline emissions inventory.

Table 5. Port of Gulfport Marine Emissions (Tons)

Vessel Category	Vessel Type	CH_4	CO	CO_2	NOx	$PM_{2.5}$	PM_{10}	SO_2	VOC
Gulfport Harbor and Small Craft Harbor									
OGV	Bulk Carrier	0.01	0.96	955.41	4.87	0.22	0.24	0.59	0.45
	Container Ship	0.02	2.48	2,321.47	17.26	0.57	0.62	1.51	1.25
	General Cargo	0.01	0.67	575.98	5.66	0.14	0.15	0.35	0.32
	Offshore Support/ Drillship	0.00	0.53	339.02	6.12	0.08	0.09	0.21	0.20
	Vehicle Carrier	0.00	0.00	1.45	0.02	0.00	0.00	0.00	0.00
	Total	0.04	4.65	4,193.33	33.94	1.02	1.11	2.67	2.22
Harbor Craft	Crew and Supply	0.00	0.20	87.42	1.18	0.05	0.05	0.00	0.04
	Dredging	0.00	0.03	14.21	0.20	0.01	0.01	0.00	0.01
	Government	0.00	0.03	24.27	0.22	0.00	0.00	0.00	0.01
	Misc. (C1/C2)	0.00	0.98	443.01	5.83	0.22	0.22	0.00	0.18
	Pilot	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Towboat/ Pushboat	0.00	0.12	53.56	0.79	0.02	0.02	0.00	0.02
	Tugboat	0.02	5.16	2,309.83	33.81	0.68	0.70	0.02	0.96
	Work Boat	0.00	0.04	19.66	0.29	0.01	0.01	0.00	0.01
	Total	0.02	6.58	2,951.97	42.31	0.98	1.01	0.03	1.22
Gulfport Municipal Marina									
Harbor Craft	Fishing (C1/C2)	0.00	0.08	58.93	0.41	0.01	0.01	0.00	0.01
	Misc. (C1/C2)	0.01	3.85	2,845.93	19.90	0.32	0.33	0.03	0.48
	Government	0.00	1.39	1,030.78	7.21	0.12	0.12	0.01	0.18
	Harbor Ferry (C1/C2)	0.00	1.74	1,287.09	9.00	0.14	0.14	0.01	0.21
	Total	0.02	7.06	5,222.72	36.51	0.58	0.60	0.05	0.88

2.3 On-Road/Drayage Truck

Drayage trucks are heavy-duty vehicles that move cargo to and from the terminals and facilities further inland.

2.3.1 Port of Gulfport Drayage Truck Activity

The on-terminal distance was estimated by evaluating gate-to-gate distance using the Google Earth measuring tool. The distance from the port entrance to the Crowley terminal is about 0.6 miles. Additionally, based on the most common range of idling time in an Oak Ridge National Laboratory report [8], TTI assumed the average idling time per truck to be 40 minutes. Lastly, TTI assumed that a portion of the truck drivers turn off their engines while they load/unload; thus, they would need to start their vehicle after completing a loading/unloading operation. In summary, TTI assumed that:

- **Running**—The average distance traveled by all trucks within the port is 1.2 miles, which includes an average 0.6-mile journey to and from the terminals, at an average speed of 15 mph, which is the speed limit within the port. Following the example set by Port Houston [5], the road type was assumed to be urban unrestricted access (roadTypeID = 5).
- **Idling**—The average total idling time on the terminal for each truck was assumed to be 40 minutes, including queuing to enter the terminal and queuing for loading/unloading operations.
- **Starts**—Since the port does not mandate turning off engines during loading/unloading operations, based on discussions with MSPA, TTI assumed that drivers mainly idle during these operations. Thus, there are no start emissions for trucks while in the port.

Based on conversations with MSPA, TTI assumed that dump trucks circle the port without turning off their engines. Using the distance measuring tool on Google Earth, TTI estimated a round trip within the port for dump trucks to be 3 miles. In addition, MSPA conveyed that these dump trucks make a 40-mile round trip to a processing facility under MPSA jurisdiction. TTI assumed the 3-mile journey on the port was included in the 40-mile round trip; thus, the journey to and from the offsite processing facility was 37 miles total. In summary, TTI assumed that:

- **Running**—The average distance traveled by dump trucks within the port is 3 miles at an average speed of 15 mph, which is the speed limit within the port. Road type within the port was treated as urban unrestricted access (roadTypeID = 5). Additionally, the dump truck travels an additional 37-mile round trip at 35 mph. Since detailed routes were not available, TTI assumed that the road types consisted of 50 percent urban restricted access roads (roadTypeID = 4) and 50 percent urban unrestricted access roads (roadTypeID = 5).
- **Idling**—The average total idling time on the terminal for each truck was assumed to be 40 minutes, including queuing to enter the terminal and queuing for loading/unloading operations.

- **Starts**—Since the port does not mandate turning off engines during loading/unloading operations, TTI assumed the dump trucks did not turn off their engines while in the port. However, while at the processing facility, TTI assumed that drivers turned their engines off, and thus, would need to turn them on again once the unloading process is completed.

Table 6 lists the number of trucks and dump trucks that entered and left the port in 2022. This information was provided by MSPA.

Table 6. Truck and Dump Truck Entry into Port of Gulfport in 2022

Month	Truck	Dump Trucks	Total
Jan 2022	5,775	401	6,176
Feb 2022	6,277	404	6,681
Mar 2022	7,011	362	7,373
Apr 2022	6,917	353	7,270
May 2022	6,854	352	7,206
Jun 2022	6,151	380	6,531
Jul 2022	5,847	251	6,098
Aug 2022	6,636	460	7,096
Sep 2022	5,860	295	6,155
Oct 2022	6,239	313	6,552
Nov 2022	5,198	302	5,500
Dec 2022	4,228	159	4,387

2.3.2 Drayage Truck Emissions Calculation

Emission rates were estimated using the MOVES4 default values for Harrison County, MS, for the analysis year 2022. Following the example set by Port Houston [5], TTI categorized all trucks as "Combination Short-haul Trucks" (sourceTypeID = 61) and dump trucks as "Refuse Trucks" (sourceTypeID = 51). MOVES4 does not produce idling rates for either truck types; thus, idling rates for "Combination Long-haul Trucks" (sourceTypeID = 62) were used instead. The fuel type was assumed to be diesel for all trucks and dump trucks (fuelTypeID = 2). Since monthly variations in pollutants were not significant, this MOVES run was set for July and weekdays only.

The total annual emissions from trucks and dump trucks operating on-terminal, as well as dump trucks traveling from the ports to an offsite processing facility, are shown in Table 7. These values include all running, idling, and start processes (i.e., running exhaust, crankcase running exhaust, etc.). Emissions from trucks were significantly higher than those from dump trucks, accounting for more than 70 percent of the total emissions. The emissions from dump trucks at the port were very minor compared to trucks as well as dump trucks routed to the processing facility, which accounted for about a quarter of the total on-road emissions estimated.

Table 7. Port of Gulfport On-Road Emissions (Tons)

Source Type	CO	NOx	CH_4	SO_2	VOC	CO_2	PM_{10}	$PM_{2.5}$
Trucks	3.16	4.11	0.05	0.00	0.33	801.01	0.08	0.08
Dump Trucks	0.58	0.98	0.01	0.00	0.06	318.15	0.03	0.03
Total	3.73	5.09	0.06	0.00	0.39	1,119.16	0.12	0.11

2.4 Rail

Port-related rail operations are characterized by line-haul and switching activity, where the former includes the movement of cargo at the beginning or the end of a line-haul trip, and the latter involves the assembling and disassembling of trains, the sorting of rail cars, and the delivery of empty rail cars to terminals [1].

Emission per unit can be calculated using the following formula [1]:

$$E = A \times EF$$

Where, *E* = emissions (g), *A* = activity (hp-hr), and *EF* = emission factor (g/hp-hr).

According to the *Ports Emissions Inventory Guidance* report [1], locomotive activity can be calculated through several methodologies:

i. Activity based on fuel consumption:

$$A = FC \times CF$$

Where, *FC* = fuel consumption (gal) and *CF* = conversion factor (hp-hr/gal), which is 20.8 hp-hr/gal for Class I line-haul, 18.2 hp-hr/gal for Class II and III line-hauls, and 15.2 hp-hr/gal for switchers [1].

ii. Activity based on gross ton-miles—when fuel consumption (FC) is not available, it can be estimated through the gross ton-miles using the following formula:

$$FC = GTM \times FCF$$

Where, *GTM* = gross ton-miles (ton-mi) and *FCF* = fleet average fuel consumption factor (gal/ton-mi). *FCF* can be calculated by dividing the national fuel consumption (reported in the Surface Transportation Board's [STB's] R-1 report, Schedule 750, Line 4) by the national gross ton-miles (reported in STB's R-1 report, Schedule 755, Line 104) [1].

2.4.1 Rail Emission Factor

EPA's *Ports Emissions Inventory Guidance* report [1] provided the emission factors for both line-hauls and switchers. For Class II and Class III line-hauls, the Tier 0 Class I line-haul emission factors should be used. The emission factors for the other pollutant types can be calculated through brake-specific fuel consumption (BSFC), which is 154 g/hp-hr for Class I line-haul and 211 g/hp-hr for switchers [1].

- CO_2 emission factors can be calculated using the following equation:

$$EF_{CO_2} = BSFC \times CCF$$

  Where *CCF* = carbon content factor (g_{CO_2}/g_{fuel}), which is 3.19 for diesel [1].

- CH_4 emission factors can be calculated using the following equation:

$$EF_{CH_4} = BSFC \times MCF$$

  Where, *MCF* = methane content factor (g_{CH_4}/g_{fuel}), which is 0.00025 for diesel [1].

- SO_2 emission factors can be calculated using the following equation:

$$EF_{SO_2} = BSFC \times S_{act} \times FSC \times MWR$$

  Where, S_{act} = actual fuel sulfur weight (weight ratio), which is 15×10^{-6} for locomotives using ultra low sulfur diesel; *FSC* = percentage of sulfur in fuel that is converted to SO_2, which is 0.97753; and *MWR* = molecular weight ratio of SO_2 to sulfur, which is 2 [1].

2.4.2 Port of Gulfport Line-Haul and Switchers Activity

As per discussion with MSPA, Class I rail service at the port was provided by the Kansas City Southern (KCS). TTI downloaded the 2022 STB R-1 report for KCS, as shown in Table 8. Using the latest North American Rail Network (NARN) lines shapefile, which was updated by BTS on March 1, 2024, TTI identified that the total track miles within the compounds of the port, as shown in Figure 1, were about 3.5 miles.

Table 8. KCS National Locomotive and Train Characteristics from 2022 R-1 Reports

Parameter	Values
Consumption of Diesel Fuel (gal) - Freight	63,897,281
Consumption of Diesel Fuel (gal) – Work Train	288,493
Gross ton-miles (thousand)	70,645,568
Consumption of diesel fuel (gal) - Switcher	3,599,899

Next, using the NARN lines shapefile and filtering for KCS-owned and/or operated linehaul lines (including main lines [M], major industrial leads [I], and passing sidings over 4,000 feet [S]), TTI calculated that KCS miles within Mississippi account for 9.2 percent of all KCS lines.

The freight and work train (abbreviated as line-haul) national fuel usage values were then multiplied by the Mississippi KCS ratio to determine KCS line-haul fuel consumption for Mississippi. Next, TTI summed up NARN lines within the Port of Gulfport boundary, which totaled 3.5 miles.

Since there were no designated railyards on the port property as per NARN, TTI assumed that all switching activity on the minor industrial leads was performed using the same line-haul locomotives. The estimated fuel usage in the port for 2022 was 38,583 gallons.

2.4.3 Locomotive Emission Calculation

Using the default tier profiles from the 2020 National Emissions Inventory [9], as well as the activity for line-haul and switcher calculated above, TTI calculated the emissions from Port of Gulfport line-haul and switcher activity, as shown in Table 9.

Table 9. Port of Gulfport Rail Emissions (Tons)

Emission	NO_x	PM_{10}	$PM_{2.5}$	VOC	CO	CO_2	CH_4	SO_2
Class I Line-Haul (ton)	5.124	0.129	0.126	0.230	1.132	434.585	0.034	0.004
Switchers (ton)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total Emission (tons)	5.124	0.129	0.126	0.230	1.132	434.585	0.034	0.004

3 REFERENCES

[1] EPA, "Ports Emissions Inventory Guidance: Methodologies for Estimating Port-Related and Goods Movement Mobile Source Emissions," 2022.

[2] Bureau of Transportation Statistics, "Port of Gulfport. Port Performance Freight Statistics Program: Annual Report to Congress 2018," 2018. [Online]. Available: https://www.bts.gov/sites/bts.dot.gov/files/portprofiles/2018/Gulfport.pdf.

[3] Mississippi State Port Authorities at Gulfport, "Port of Gulfport, Mississippi," [Online]. Available: https://shipmspa.com/.

[4] Bureau of Transportation Statistics, "2023 Port Performance Freight Statistics Program: Annual Report to Congress," U.S. Department of Transportation, 2023.

[5] Port Houston, "2019 Goods Movement Emissions Inventory," 2021.

[6] California Air Resources Board, "2022 Cargo Handling Equipment Emissions Inventory," California Air Resources Board, 2022.

[7] Port Authority of New York and New Jersey, "2022 Multi-Facility Emissions Inventory," 2023.

[8] Oak Ridge National Laboratory, " Class-8 Heavy Truck Duty Cycle Project Final Report," 2008.

[9] EPA, "2020 National Emissions Inventory," 30 March 2023. [Online]. Available: https://www.epa.gov/air-emissions-inventories/2020-nei-supporting-data-and-summaries .

APPENDIX A: VESSEL ENGINE SIZE DEFAULTS

This appendix includes vessel engine size defaults that were obtained from EPA's *Port Emissions Inventory Guidance*. [1] Table 10 shows the default installed power (kW) for OGVs, and Table 11 shows the default engine sizes for harbor crafts.

Table 10. Average OGV Installed Power, Maximum Speed, and Maximum Draft by Ship Type

Ship Type	Subtype	Engine Category	Engine Type	Installed Propulsion Power (kW)	Max Speed (kn)	Max Draft (m)
Bulk Carrier	Small	1	MSD	3,400	16	3.1
Bulk Carrier	Small	2	MSD	3,500	14.9	5.7
Bulk Carrier	Small	2	SSD	4,400	17	7.8
Bulk Carrier	Small	3	MSD	1,700	14	6.2
Bulk Carrier	Small	3	SSD	3,300	13.3	6.9
Bulk Carrier	Handysize	2	MSD	3,500	14.6	7.8
Bulk Carrier	Handysize	2	SSD	5,100	14.9	8.6
Bulk Carrier	Handysize	2	ST	2,900	12.8	7.6
Bulk Carrier	Handysize	3	MSD	6,200	15.1	8.7
Bulk Carrier	Handysize	3	MSD-ED	22,500	21.3	9.1
Bulk Carrier	Handysize	3	SSD	6,900	15.2	9.8
Bulk Carrier	Handysize	3	ST	5,100	15.2	8.1
Bulk Carrier	Handymax	2	SSD	5,700	14.8	9.2
Bulk Carrier	Handymax	3	MSD	8,700	15.3	9.8
Bulk Carrier	Handymax	3	SSD	8,500	15.3	11.5
Bulk Carrier	Panamax	2	SSD	10,500	16	10.1
Bulk Carrier	Panamax	3	MSD	12,000	15.7	9.2
Bulk Carrier	Panamax	3	SSD	10,200	15.4	13.9
Bulk Carrier	Capesize	3	SSD	16,400	15.7	17.2
Bulk Carrier	Capesize Largest	3	SSD	17,400	16.5	18.2
Chemical Tanker	Smallest	2	MSD	2,200	11.3	5
Chemical Tanker	Smallest	3	MSD	3,000	14.4	6.2
Chemical Tanker	Small	2	MSD	2,800	15.3	7.1
Chemical Tanker	Small	3	MSD	3,700	15.1	6.9
Chemical Tanker	Small	3	SSD	3,300	14.1	7.5
Chemical Tanker	Handysize	2	MSD	3,700	13.5	7.6
Chemical Tanker	Handysize	3	MSD	5,500	15.4	8.6
Chemical Tanker	Handysize	3	SSD	5,300	15.1	9.1
Chemical Tanker	Handymax	2	MSD-ED	9,700	17.1	11.4
Chemical Tanker	Handymax	3	MSD	7,700	15.6	11.7
Chemical Tanker	Handymax	3	MSD-ED	9,000	15.4	12.2
Chemical Tanker	Handymax	3	SSD	9,000	15.6	12.3
Chemical Tanker	Handymax	3	ST	12,900	16	10.8

Ship Type	Subtype	Engine Category	Engine Type	Installed Propulsion Power (kW)	Max Speed (kn)	Max Draft (m)
Container Ship	1,000 TEU	2	MSD	2,700	16.1	5.6
Container Ship	1,000 TEU	3	MSD	7,600	18.5	7.3
Container Ship	1,000 TEU	3	SSD	13,100	20	8.8
Container Ship	2,000 TEU	3	MSD	10,600	20.9	9
Container Ship	2,000 TEU	3	SSD	15,600	21.3	9.9
Container Ship	2,000 TEU	3	ST	23,500	23.4	10.4
Container Ship	3,000 TEU	3	MSD	20,800	23.2	9.5
Container Ship	3,000 TEU	3	SSD	21,800	23	11.4
Container Ship	3,000 TEU	3	ST	22,200	22.4	11.3
Container Ship	5,000 TEU	3	SSD	37,000	25.1	12.4
Container Ship	8,000 TEU	3	SSD	55,800	26.5	13.9
Container Ship	12,000 TEU	3	SSD	61,000	25.9	14.4
Container Ship	14,500 TEU	3	SSD	65,000	25.6	15.2
Container Ship	Largest	3	SSD	49,000	25.6	14
Cruise	2,000 Ton	3	MSD	2,300	12.8	4.5
Cruise	10,000 Ton	1	MSD	3,800	14.5	3.6
Cruise	10,000 Ton	2	MSD	5,800	17.9	4.6
Cruise	10,000 Ton	3	MSD	7,100	19.1	5
Cruise	10,000 Ton	3	SSD	2,500	17	4.6
Cruise	60,000 Ton	2	MSD	14,700	20.4	6.6
Cruise	60,000 Ton	3	MSD	16,200	20.4	6.4
Cruise	60,000 Ton	3	MSD-ED	20,700	21	7
Cruise	60,000 Ton	3	SSD	23,400	20.4	7.5
Cruise	100,000 Ton	1	GT-ED	40,200	25.5	8.1
Cruise	100,000 Ton	3	GT-ED	37,900	24.3	8.2
Cruise	100,000 Ton	3	MSD	23,100	21.4	7.6
Cruise	100,000 Ton	3	MSD-ED	34,000	23.3	8
Cruise	Largest	3	GT-ED	86,000	25.5	10.3
Cruise	Largest	3	MSD	41,700	22.3	8.6
Cruise	Largest	3	MSD-ED	41,700	23.5	8.6
Cruise	Largest	3	SSD	60,000	24	9.3
Ferry/Roll-on/Passenger (C3)	2,000 Ton	1	SSD	2,200	20.2	2.2
Ferry/Roll-on/Passenger (C3)	2,000 Ton	2	SSD	2,700	15.1	3.2
Ferry/Roll-on/Passenger (C3)	2,000 Ton	3	SSD	900	15.1	3.1
Ferry/Roll-on/Passenger (C3)	Largest	1	MSD	3,900	16.9	4.7
Ferry/Roll-on/Passenger (C3)	Largest	1	MSD-ED	3,700	14.9	3.8
Ferry/Roll-on/Passenger (C3)	Largest	2	MSD	10,000	21.2	4.3

Ship Type	Subtype	Engine Category	Engine Type	Installed Propulsion Power (kW)	Max Speed (kn)	Max Draft (m)
Ferry/Roll-on/Passenger (C3)	Largest	2	MSD-ED	5,400	14.9	3.7
Ferry/Roll-on/Passenger (C3)	Largest	2	ST	1,100	10.6	2.6
Ferry/Roll-on/Passenger (C3)	Largest	3	MSD	10,800	20.9	5.1
Ferry/Roll-on/Passenger (C3)	Largest	3	MSD-ED	11,000	22.3	5.8
Ferry/Roll-on/Passenger (C3)	Largest	3	ST	6,000	14.9	5.7
Fishing (C3)	All C3 Fishing	1	MSD	700	12	3.6
Fishing (C3)	All C3 Fishing	1	SSD	1,000	12.1	3.1
Fishing (C3)	All C3 Fishing	2	MSD	2,600	13.6	5.6
Fishing (C3)	All C3 Fishing	2	SSD	2,200	13.3	4.4
Fishing (C3)	All C3 Fishing	3	MSD	3,200	13.8	5.4
Fishing (C3)	All C3 Fishing	3	SSD	4,000	18	5.7
General Cargo	5,000 DWT	1	MSD	1,500	11.5	3
General Cargo	5,000 DWT	2	MSD	1,300	12.6	4.4
General Cargo	5,000 DWT	3	MSD	1,100	12.7	4.1
General Cargo	10,000 DWT	2	MSD	2,500	13.3	6.7
General Cargo	10,000 DWT	3	MSD	3,500	13.8	7.2
General Cargo	10,000 DWT	3	SSD	3,300	16.5	6.9
General Cargo	Largest	3	MSD	14,400	18	8.3
General Cargo	Largest	3	SSD	15,900	18.4	8.4
General Cargo	Largest	3	ST	14,200	22.3	8.4
Liquified Gas Tanker	50,000 DWT	2	MSD	2,900	14.5	6.2
Liquified Gas Tanker	50,000 DWT	3	MSD	2,700	15.2	6.1
Liquified Gas Tanker	50,000 DWT	3	SSD	2,600	15.9	5.5
Liquified Gas Tanker	100,000 DWT	2	SSD	3,500	15.7	6.8
Liquified Gas Tanker	100,000 DWT	3	MSD	4,100	16	7.3
Liquified Gas Tanker	100,000 DWT	3	SSD	4,900	16.3	7.4
Liquified Gas Tanker	200,000 DWT	2	MSD	5,000	14.4	8
Liquified Gas Tanker	200,000 DWT	3	MSD	7,000	17.1	9.3
Liquified Gas Tanker	200,000 DWT	3	SSD	7,000	17.9	9.2
Liquified Gas Tanker	Largest	3	MSD	22,900	13.8	12.5
Liquified Gas Tanker	Largest	3	MSD-ED	25,600	20.1	11.9
Liquified Gas Tanker	Largest	3	SSD	12,400	17.4	11.5
Liquified Gas Tanker	Largest	3	ST	27,400	20.7	12
Miscellaneous (C3)	All C3 Misc.	1	MSD	2,200	12.7	4.2
Miscellaneous (C3)	All C3 Misc.	1	MSD-ED	3,300	13.8	5.4
Miscellaneous (C3)	All C3 Misc.	1	SSD	1,300	11.3	2.8
Miscellaneous (C3)	All C3 Misc.	2	MSD	6,300	17.4	5.2
Miscellaneous (C3)	All C3 Misc.	2	MSD-ED	6,400	15.2	5.4

Ship Type	Subtype	Engine Category	Engine Type	Installed Propulsion Power (kW)	Max Speed (kn)	Max Draft (m)
Miscellaneous (C3)	All C3 Misc.	2	SSD	3,700	14.9	4.3
Miscellaneous (C3)	All C3 Misc.	3	MSD	6,000	16.1	8
Miscellaneous (C3)	All C3 Misc.	3	MSD-ED	16,300	15.4	11.3
Miscellaneous (C3)	All C3 Misc.	3	SSD	8,900	17	9.5
Miscellaneous (C3)	All C3 Misc.	3	ST	21,200	20.4	9.8
Offshore Support/ Drillship	All Offshore Support/Drillship	1	MSD	3,100	16.2	3.6
Offshore Support/ Drillship	All Offshore Support/Drillship	1	MSD-ED	5,400	13.7	5.7
Offshore Support/ Drillship	All Offshore Support/Drillship	1	SSD	1,400	13.4	3.2
Offshore Support/ Drillship	All Offshore Support/Drillship	2	MSD	5,300	14.1	5.6
Offshore Support/ Drillship	All Offshore Support/Drillship	2	MSD-ED	13,000	13.3	9.6
Offshore Support/ Drillship	All Offshore Support/Drillship	2	SSD	4,700	13.8	4.6
Offshore Support/ Drillship	All Offshore Support/Drillship	3	MSD	9,200	14.5	6.9
Offshore Support/ Drillship	All Offshore Support/Drillship	3	MSD-ED	26,300	13.3	10.9
Offshore Support/ Drillship	All Offshore Support/Drillship	3	SSD	11,300	15.7	13.4
Oil Tanker	Handymax	3	SSD	8,700	15.5	12.1
Oil Tanker	Aframax	3	SSD	12,200	15.7	14.6
Oil Tanker	Suezmax	3	SSD	16,900	15.6	16.9
Other Tanker	All Other Tanker	1	MSD	1,600	8.7	3.2
Other Tanker	All Other Tanker	1	MSD-ED	2,300	6.4	3
Other Tanker	All Other Tanker	1	SSD	1,200	8.4	2.2
Other Tanker	All Other Tanker	2	MSD	3,300	13.6	4.5
Other Tanker	All Other Tanker	2	MSD-ED	14,000	19.1	9
Other Tanker	All Other Tanker	2	SSD	3,400	13.3	4.6
Other Tanker	All Other Tanker	3	GT	78,300	27.7	11.9
Other Tanker	All Other Tanker	3	MSD	4,700	14.4	8
Other Tanker	All Other Tanker	3	MSD-ED	20,000	16.3	18.8
Other Tanker	All Other Tanker	3	SSD	15,700	16.2	15.5
Other Tanker	All Other Tanker	3	ST	21,600	18	16.6
Reefer	All Reefer	1	MSD	1,300	10.6	0
Reefer	All Reefer	2	MSD	2,200	13.3	5.9
Reefer	All Reefer	2	SSD	2,200	12.8	5.5
Reefer	All Reefer	3	MSD	9,200	21.7	8.6
Reefer	All Reefer	3	SSD	9,800	20.4	8.6
RORO	5000 Ton	1	MSD	1,700	12.6	3.1

Ship Type	Subtype	Engine Category	Engine Type	Installed Propulsion Power (kW)	Max Speed (kn)	Max Draft (m)
RORO	5000 Ton	2	MSD	1,300	11.8	3.4
RORO	5000 Ton	2	SSD	2,400	14.9	4.5
RORO	5000 Ton	3	MSD	3,200	16.4	4.7
RORO	5000 Ton	3	SSD	2,300	16.6	4.5
RORO	Largest	1	MSD-ED	7,000	19.7	9.3
RORO	Largest	2	MSD	3,500	15.1	5.9
RORO	Largest	2	SSD	5,900	16	3.7
RORO	Largest	3	GT	45,100	26.8	10.2
RORO	Largest	3	MSD	18,500	19.6	8.2
RORO	Largest	3	MSD-ED	39,500	25.5	9
RORO	Largest	3	SSD	15,600	21.3	10
RORO	Largest	3	ST	49,400	26.1	10
Yacht (C2/C3)	C2/C3 Yacht	1	MSD	3,000	18.7	2.7
Yacht (C2/C3)	C2/C3 Yacht	2	MSD	5,400	16.8	3.7
Yacht (C2/C3)	C2/C3 Yacht	3	MSD	3,900	17	4.7
Yacht (C2/C3)	C2/C3 Yacht	3	SSD	5,000	18.4	6

Engine type: SSD = slow-speed diesel; MSD = medium-speed diesel; HSD = high-speed diesel; GT = gas turbine; ST = steam turbine; MSD-ED = electric drive MSD; DT-ED = electric drive GT; LNG = liquified natural gas.
Source: EPA (2022). *Ports Emissions Inventory Guidance: Methodologies for Estimating Port-Related and Goods Movement Mobile Source Emissions*. [1]

Table 11. Default Harbor Craft Engine Size and Annual Activities

Ship Type	Average Propulsion Engine Size (kW)	Average Installed Propulsion Power (kW)	Average Annual Propulsion Engine Hours	Average Auxiliary Engine Size (kW)	Average Installed Auxiliary Power (kW)	Average Annual Auxiliary Engine Hours
Barge				171	622	581
Crew and Supply	427	1,037	747	42	50	766
Excursion	283	513	1,038	30	24	1,268
Fishing (C1/C2)	520	909	170	224	186	139
Government	724	1,343	423	502	389	251
Harbor Ferry (C1/C2)	1,516	3,658	3,329	201	419	1,865
Misc. (C1/C2)	735	1,309	799	168	205	802
Pilot	606	1,211	1,344	14	28	137
Towboat / Pushboat	846	1,559	864	68	97	1,137
Tugboat	1,720	3,512	1,683	126	285	1,404
Work Boat	283	464	753	46	36	732

Source: EPA (2022). *Ports Emissions Inventory Guidance: Methodologies for Estimating Port-Related and Goods Movement Mobile Source Emissions*. [1]