



# 2020 National Emissions Inventory Technical Support Document: Commercial Marine Vessels



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2020 National Emissions Inventory Technical Support Document: Commercial Marine Vessels

U.S. Environmental Protection Agency  
Office of Air Quality Planning and Standards  
Air Quality Assessment Division  
Research Triangle Park, NC

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## 11 Commercial Marine Vessels

The 2020 NEI includes emissions from commercial marine vessel (CMV) activity in the 50 states, Puerto Rico, and US Virgin Isles, out to 200 nautical miles from the US coastline.

### 11.1 Sector Descriptions and Overview

The CMV sector includes boats (excluding pleasure craft that are covered by the MOVES-Nonroad model) and ships used either directly or indirectly in the conduct of commerce or military activity. Most vessels in this category are powered by diesel engines that are either fueled with distillate or residual fuel oil blends. In previous NEIs, we assumed that Category 3 (C3) vessels primarily used residual blends while Category 1 and 2 (C1 and C2) vessels typically used distillate fuels. For the 2017 NEI, SCCs and fuel details, including emission factors, were updated. The 2020 NEI uses the same SCCs, fuel details, emission factors as the 2017 NEI.

The C3 inventory includes vessels which use C3 engines for propulsion. C3 engines are defined as having displacement above 30 liters per cylinder. The resulting inventory includes emissions from both propulsion and auxiliary engines used on these vessels, as well as those on gas and steam turbine vessels. Geographically, the inventories include port and interport emissions that occur within the area that extends 200 nautical miles (nm) from the official U.S. shoreline, which is roughly equivalent to the border of the U.S. Exclusive Economic Zone. Only some of these emissions are allocated to states based on official state boundaries that typically extend 3 to 9 miles offshore.

The C1 and C2 vessels are smaller ships that tend to operate closer to shore, and along inland and intercoastal waterways. U.S. Naval vessels are not included in this inventory, though Coast Guard vessels are included as part of the C1 and C2 vessels.

The CMV sector in the nonpoint data category does not include recreational marine vessels, which are generally less than 100 feet in length, most being less than 30 feet, and powered by either inboard or outboard. These emissions are included in those calculated by the MOVES model; they reside in the nonroad data category and EIS “Mobile - Non-Road Equipment” sectors of the 2020 NEI.

The 2020 NEI CMV SCCs are shown in Table 11-1 below. Emission factors vary by SCC.

The detailed CMV inventory files used for air quality modeling contain emissions for each hour and grid cell are developed for air quality model grids, whereas the NEI estimates are annual and are computed for over-water-only shape file codes for port estimates and county FIPS codes for underway emissions. The port shapes do not cross counties and can be readily summed to individual port or to county. Shape files and ports are posted on the [2020 NEI page](#). Shape files and ports are posted on the [2020 NEI page](#).

**Table 11-1:** New Commercial Marine Vessel SCCs and emission types in EPA estimates

SCC		SCC Level One	SCC Level Two	SCC Level Three	SCC Level Four
2280002101		Mobile Sources	Marine Vessels, Commercial	Diesel	C1C2 Port emissions: Main Engine

2280002102		Mobile Sources	Marine Vessels, Commercial	Diesel	C1C2 Port emissions: Auxiliary Engine
2280002201		Mobile Sources	Marine Vessels, Commercial	Diesel	C1C2 Underway emissions: Main Engine
2280002202		Mobile Sources	Marine Vessels, Commercial	Diesel	C1C2 Underway emissions: Auxiliary Engine
2280002103		Mobile Sources	Marine Vessels, Commercial	Diesel	C3 Port emissions: Main Engine
2280002104		Mobile Sources	Marine Vessels, Commercial	Diesel	C3 Port emissions: Auxiliary Engine
2280002203		Mobile Sources	Marine Vessels, Commercial	Diesel	C3 Underway emissions: Main Engine
2280002204		Mobile Sources	Marine Vessels, Commercial	Diesel	C3 Underway emissions: Auxiliary Engine
2280003103		Mobile Sources	Marine Vessels, Commercial	Residual	C3 Port emissions: Main Engine
2280003104		Mobile Sources	Marine Vessels, Commercial	Residual	C3 Port emissions: Auxiliary Engine
2280003203		Mobile Sources	Marine Vessels, Commercial	Residual	C3 Underway emissions: Main Engine
2280003204		Mobile Sources	Marine Vessels, Commercial	Residual	C3 Underway emissions: Auxiliary Engine

## 11.2 Sources of data

EPA’s CMV estimates are computed using detailed satellite-based **automatic identification system (AIS)** activity data from the US Coast Guard. The details of these calculation are available in the documents [“2020NEI C1C2 Documentation”](#) and [“2020 C3 Marine Emissions Tool Documentation”](#) on the [2020 Supplemental data FTP site](#).

The GHG emissions (carbon dioxide (CO<sub>2</sub>)) included in the NEI for this category utilized high-resolution Automated Identification System (AIS) data combined with ship registry data to calculate emissions for all Category 1, 2, and 3 commercial marine vessels (represented in both the AIS and ship registry datasets) operating within 200 nautical miles of the U.S. coastline. For the US GHGI, reported emissions are based on domestic fuel consumption. Emissions resulting from the combustion of fuels used for international transport activities, termed international bunker fuels under the UNFCCC, are not included in national emissions totals but are reported separately as a memo item based on the location of fuel sales. Therefore, the scope of emissions included in the NEI and the US GHGI (both at the national and state level) for CMVs are different.

Two states submitted CMV emissions to EIS (California and New Hampshire). After review, California and New Hampshire agreed to use of EPA’s AIS estimates as superior to their submittals.

### 11.3 EPA-developed estimates

Emissions are calculated for each time interval between consecutive AIS messages for each vessel and allocated to the location of the message following to the interval. Emissions are calculated according to Equation 1.

$$Emissions_{interval} = Time(hr)_{interval} \times Power(kW) \times EF(g/kWh) \times LLAF \quad (1)$$

where:

- Emissions* = mass of emissions estimated for each time interval between AIS messages for each vessel, typically calculated in grams and then converted to tons when emissions are aggregated
- Time* = length of time between AIS messages, measured in hours
- Power* = calculated in kWh for each AIS message, for each vessel, for each of the three engine groups on a vessel: propulsive (main), auxiliary, and auxiliary boiler engines
- EF* = assigned emission factors for each engine group on the vessel
- LLAF* = low load adjustment factor, a unitless factor that reflects increasing propulsive emissions during low load operations and varies according to the calculated propulsive power

Power is calculated for the propulsive (main), auxiliary, and auxiliary boiler engines for each interval and emission factor (EF) reflects the assigned emission factors for each engine, as described below. LLAF represents the low load adjustment factor, a unitless factor which reflects increasing propulsive emissions during low load operations. Time indicates the activity duration time between consecutive intervals.

#### 11.3.1 Improvements/Changes in the 2020 NEI

For 2020 CMV inventory an AIS data preprocessor was developed; this code compiles the AIS data into a format compatible for the CMV models, matching up vessel identifier codes to their characteristics in the Clackson's dataset; data gaps in the vessel characteristics were filled based on vessel types. Additionally, duration for C1C2 vessels was estimated based on last known data point, and engine operating load factors were checked to ensure they do not exceed 100% and vessel speed values that were populated using vessel type averages were checked to ensure that they were appropriate. The preprocessed data were used to estimate kw-hrs at each data point; these activity values were applied to the latest EPA emission factors.

Additionally, we updated low-load NOx emission rates for Tier-3 vessels (this was also updated in our ports inventory guidance). We also used anchorage shape files from Marine Cadastre to identify vessels at anchor for assigning operating modes.

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