Base Year: 1999 By: T. Dinh

SOURCE INVENTORY

CATEGORIES # 1194 - 1196

TUGS & TOWBOATS, DREDGE VESSELS AND OTHERS

1999 EMISSIONS

Introduction

Emissions reported in these categories are from the combustion of fuel from the engines of tugs and towboats (Category 1194), dredge vessels (Category 1195), and others (Category 1196). The tugs and towboats are considered "non-mooring"; those which assist vessels into and out of port ("mooring" tugs) are covered in Category 348 (Ships Maneuvering - Tug Boats). Dredge vessels are those which are used for bay and waterway excavation purposes. The "Others" category includes work boats, crew boats, etc.

Methodologies

The number of harbor vessels, namely tugs and towboats, dredge vessels, and others, was derived from the 1999 U.S. Army Corps of Engineers' Waterborne Transportation Lines of the United States, Volume 3 - Vessel Characteristics. This annual publication gives descriptive information regarding all U.S. registered vessels. For this study, data on homeport location, horsepower, and vessel type was extracted. For vessel type, only the tugboat category matched directly. Various assumptions were made to direct the other relevant categories to either the dredge vessel or others categories. For example, dry cargo barges were considered as dredge vessels; liquid tank barges were considered as others; offshore support vessels were assumed part of tugs and towboats. Pushboats were assumed to have been covered in Category 348.

Emission factors for the vessels (see Table 1) were found in the 1991 Booze, Allen, and Hamilton report, "Inventory of Air Pollutant Emissions from Marine Vessels", and were dependant upon horsepower and operating profiles (see Table 2). The horsepower ratings were not given in the above mentioned U.S. Army Corps of Engineers publication for dredge or "other" vessels. It was assumed the number of vessels in a particular horsepower range follows proportionally the values in the Booze, Allen, and Hamilton report. The operating profiles were "slow" at 20% power, "cruise" at 50% power, and "full" at 80% power. Operating times (hours/day and days/year) and fuel consumption used in emission calculations also came from this report (see Table 3). The fuel consumed in these vessels is assumed to be diesel with a sulfur content of 0.8%.

Emissions were calculated by multiplying the total fuel consumption for each horsepower range of a particular vessel category by the representative emission factor (which is horsepower and operation profile dependent). Summing up all the emissions of a particular vessel's horsepower ranges gives the vessel's total emissions.

Monthly Variation

Monthly variation for all three categories was assumed to vary uniformly throughout the year.

County Distribution

The county location of the home port involved in each of the three categories was used to distribute the emissions into each county.

TRENDS

History

Prior to 1999, growth was based on ship traffic as provided by the Marine Exchange.

Growth

It was assumed the growth activity for tugs and towboats, dredge vessels, and others was proportional to shipping activity. Therefore, projections to the year 2030 were based on ABAG's Projections Wholesale Trade Employment profile.

Control

Projected emissions include expected benefits from ARB's Clean Diesel Fuel Regulations (Beginning 1993) and Re-Formulated Gasoline Phase II (beginning 1996). These benefits were estimated using control factors developed by ARB. Additionally, federal EPA marine requirements finalized in 1999 on new commercial marine diesel engines will help reduce NOx and PM emissions. These requirements will affect marine vessels with new model engines beginning in 2004.

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Table 1--Emission Factors for Tugs & Towboats, Dredge, and Other Vessels

Horsepower Rating @ Operating Mode	Pollutant (lbs./Mgal)				
	PM	TOG	NOx	SOx	CO
<500 HP					
Full (80% Power)	17	21	275.1	125.6	58.5
Cruise (50% Power)	17	51.1	389.3	125.6	47.3
Slow (20% Power)	17	56.7	337.5	125.6	59
500 - 1000 HP					
Full (80% Power)	17	24	300	125.6	61
Cruise (50% Power)	17	17.1	300	125.6	80.9
Slow (20% Power)	17	16.8	167.2	125.6	62.2
1001 - 1500 HP					
Full (80% Power)	17	24	300	125.6	61
Cruise (50% Power)	17	24	300	125.6	61
Slow (20% Power)	17	24	300	125.6	61
1501 - 2000 HP					
Full (80% Power)	17	16.8	472	125.6	237.7
Cruise (50% Power)	17	24	623.1	125.6	44.6
Slow (20% Power)	17	24	371.3	125.6	122.4
>2000 HP					
Full (80% Power)	17	21.3	399.6	125.6	95.9
Cruise (50% Power)	17	16.8	391.7	125.6	78.3
Slow (20% Power)	17	22.6	419.6	125.6	59.8

Table 2--Vessel Operating Profiles

Type of Vessel	Operating Profile		
	Slow (20% Power)	Cruise (50% Power)	Full (80% Power)
Tugs & Towboats	0.30	0.50	0.20
Dredges	0.40	0.40	0.20
Other Boats	0.30	0.50	0.20

Table 3--Vessel Operating Times and Fuel Consumption at Different Horsepower Ratings

Type of Vessel/ Horsepower Range	Average Daily Operating Hrs.	Operating Days/Year	Fuel Usage (gal./hr.)
Tugs & Towboats			
0 - 499 HP	10	200	10.40
500 - 1000 HP	12	250	19.86
1001 - 1500 HP	12	250	31.68
1501 - 2000 HP	12	250	43.50
2001 + HP	8	250	10.40
Dredges			
0 - 499 HP	14	190	10.61
500 - 1000 HP	14	190	19.14
Other Boats			
500 - 1000 HP	6	220	19.86
1001 - 1500 HP	6	220	31.68
1501 + HP	4	220	43.50