

# **PM Speciation Profiles for Ocean-Going Vessel Auxiliary Boilers**

**—PM1106~1109**

September 30, 2021

California Air Resources Board  
1001 I Street  
Sacramento, California 95814

## Table of Contents

I. Introduction.....	1
II. Methodology.....	1
III. Results and Discussion .....	3
IV. Estimated Impacts of Profile Update .....	4
V. Appendix.....	7

## List of Tables

Table 1: Impacts on emissions of PM2.5 species for OGV boilers using updated profiles (2017).....	5
Table 2: Profile PM1106: Tanker boiler burning HFO (2.85% sulfur) .....	7
Table 3: Profile PM1107: Tanker boiler burning MGO (0.045% sulfur).....	8
Table 4: Profile PM1108: Non-tanker boiler burning ULSHFO (0.089% sulfur).....	8
Table 5: Profile PM1109: Non-tanker boiler burning MGO (0.038% sulfur) .....	9
Table 6: Mapping of new PM profiles to OGV boiler EICs .....	11

## List of Figures

Figure 1. Major species in OGV boiler PM profiles.....	3
--	---

## I. Introduction

In addition to main and auxiliary engines, ocean-going vessel (OGV) emissions are also generated from boilers used for supplying steam and hot water for non-propulsion purposes, such as fuel heating, space heating, and driving steam turbines on tankers that offload petroleum crude oil in ports. Marine auxiliary boilers vary in size from small boilers used on most cargo vessels primarily to heat residual fuel, to large boilers used on tanker vessels to power steam turbine discharge pumps.

To reduce particulate matter (PM), oxides of nitrogen, and sulfur oxide emissions from OGV, the California Air Resources Board (CARB) adopted the OGV Fuel Regulation, which began on July 1<sup>st</sup>, 2009. This regulation requires the use of low sulfur marine distillate fuels, either marine gas oil (MGO) or marine diesel oil (MDO), by OGVs within twenty-four nautical miles of the California coastline in main engines, auxiliary engines, and auxiliary boilers. Prior to that, most marine boilers were primarily operated on heavy fuel oil (HFO or residual oil), which is more viscous, higher in sulfur content, and other components that increase exhaust emissions; however, modern boilers can generally operate on distillate fuel as well with minor adjustments.

In CARB's inventory, the PM emissions from marine auxiliary boilers are currently mapped to profiles PM1104 (oil-fired boilers, residual oil) and PM112 (fuel consumption – distillate) depending on the type of the fuel burned in the boilers. Profile PM1104 was made based on the test of an institutional boiler unit burned with No. 6 oil during a 5-year industry and government joint program. About 54.8% of the PM mass is identified as sulfate, and there is 7.2% organic carbon (OC) and 6.5% elemental carbon (EC) in the profile [1]. Profile PM112 was developed based on the testing of a Babcock & Wilcox type H Stirling industrial boiler running on low sulfur No. 2 fuel oil [2]. In this profile, sulfate is 25% of the PM mass, the most abundant of any identified species, followed by EC (15%); however, there is no OC included in the profile. Because PM1104 and PM112 are both made for general boilers, it is necessary to develop speciation profiles for marine boilers when source testing data are available.

This work presents PM speciation profiles for OGV auxiliary boilers developed based on the studies performed by University of California, Riverside (UCR) spanning over 10 years [3-5]. The new profiles are made for tanker boilers and non-tanker boilers fueled with HFO, ultralow sulfur HFO (ULSHFO) and MGO fuels. They will replace PM1104 for boilers fueled HFO and PM112 for boilers fueled distillate fuel.

- PM1106: Tanker boiler burning HFO (2.85% sulfur)
- PM1107: Tanker boiler burning MGO (0.045% sulfur)
- PM1108: Non-tanker boiler burning ULSHFO (0.089% sulfur)
- PM1109: Non-tanker boiler burning MGO (0.038% sulfur)

## II. Methodology

The UCR researchers conducted three comprehensive source tests on marine boiler emissions [3-5] from 2007 through 2020. The test boilers varied from large auxiliary boilers

used on tanker vessels to smaller auxiliary boilers used on container vessels. The test fuels included high sulfur content HFO, ULSHFO, and MGO.

Before the Fuel Regulation was adopted by CARB, Agrawal et al. [3] investigated the emissions of a large auxiliary boiler powered by HFO with 2.85% sulfur by weight on a Suezmax tanker operating at sea in 2007. This is an ADM-707 (IHI Corporation, JP) type marine boiler, and its maximum evaporation rate was 70,000 kg/h. Emissions were measured from the boiler with all three burners operating at the maximum firing rate, which reflects conditions when the vessel is discharging crude oil from the tanker.

Modern vessels use newer auxiliary boiler designs. In 2019, the UCR team measured emissions from a large auxiliary boiler with new designs [4], and compared the emissions to their previous study [3] to quantify the change in emissions over time. The tests were performed on a 2014 crude Panamax class vessel, which is smaller than the previous Suezmax tanker vessel. The PM samples were collected from an Aalborg OL large capacity auxiliary boiler with a super heater (Alfa Laval, Sweden). The maximum evaporation rate of the boiler is 50,000 kg/h. The boiler was evaluated at the 65% of maximum capacity load, representative of normal operation for the vessel. A standard low sulfur MGO fuel with 0.045% sulfur by weight was used during the test.

Later, McCaffery et al. [5] assessed the emissions of a smaller boiler (RP-500M, KangRim Heavy Industries Company Ltd., SK) on a modern container vessel. The boiler was a vertical boiler with a pressure jet system and a maximum fuel rate heating capacity of 408 kg/h. The boiler emission measurements were made when it operated at 60% load. A standard low sulfur MGO with 0.038% sulfur and a commercially available ULSHFO with 0.089% sulfur were utilized for this study.

The PM emission measurements performed in the above UCR studies used a partial flow dilution system developed based on the ISO 8178-1 protocol. All the emissions were measured in triplicate. Samples for EC/OC were collected in parallel on pre-cleaned quartz filters and analyzed with a Thermal/Optical Carbon Aerosol Analyzer (Sunset Laboratory, Forest Grove, OR) according to the NIOSH Method 5040 reference method. Samples for sulfate were collected on Teflon filters and analyzed by utilizing an Ion Chromatography (IC). Samples for trace elements and metals were collected on Teflon filters and analyzed using X-Ray Fluorescence (XRF) [3-5].

With the emission data for EC/OC, ions, elements and metals, the following steps were carried out to develop the PM speciation profiles for marine auxiliary boiler exhausts:

- NCOM (non-carbon organic matter): a factor of 1.4 was used to convert OC to OM (organic matter) for boiler combustion [6]. NCOM is calculated by subtracting OC from OM, i.e.,

$$[\text{NCOM}] = [\text{OM}] - [\text{OC}] = 1.4 \times [\text{OC}] - [\text{OC}] = 0.4 \times [\text{OC}]$$

- 'others': this species group is created to capture the metal-bound oxygen by multiplying the five geological elements (i.e., Al, Si, Ca, Fe and Ti) by their oxygen-to-metal ratios. These ratios were based on the expected oxidation state of the metals in

the atmosphere (i.e.,  $\text{Al}_2\text{O}_3$ ,  $\text{SiO}_2$ ,  $\text{CaO}$ ,  $\text{Fe}_2\text{O}_3$  and  $\text{TiO}_2$ ). The following equation is used to calculate 'others' [7]:

$$[\text{others}] = 0.89 \times [\text{Al}] + 1.14 \times [\text{Si}] + 0.40 \times [\text{Ca}] + 0.43 \times [\text{Fe}] + 0.67 \times [\text{Ti}]$$

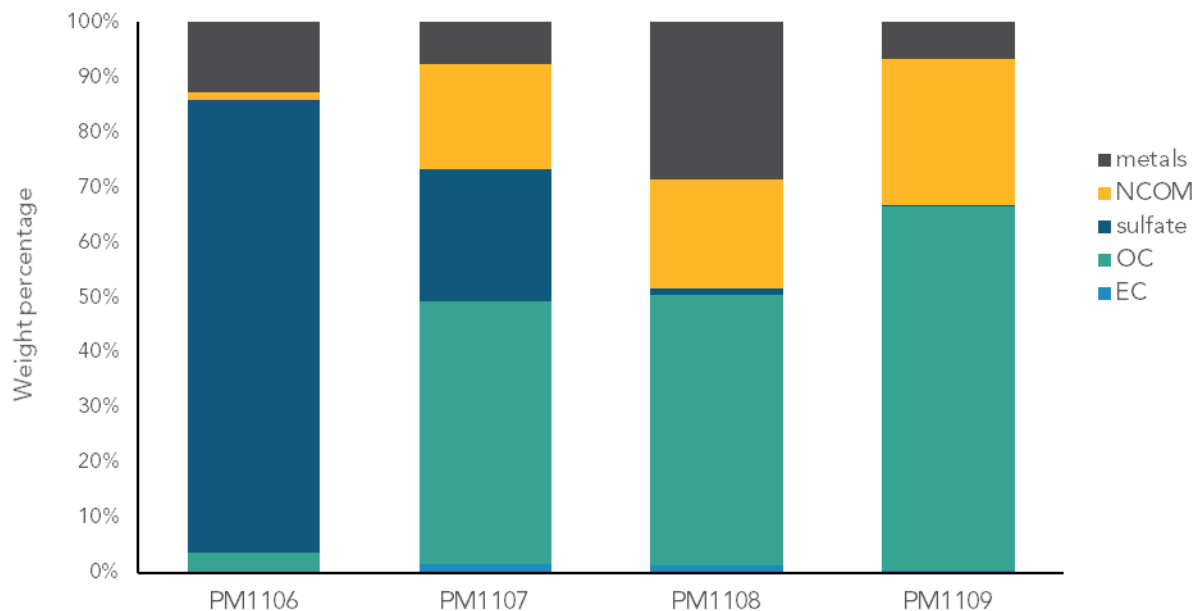
- Normalization: the emissions of all the chemical species, including EC/OC, metals, elements, ions, NCOM and 'others', are summed to get an emission total for the profile species; and then the emission of each species is divided by the total emission to determine its weight percentage in the speciation profile.

A complete CARB PM profile has two indispensable components, chemical speciation profile and size profile. For the marine auxiliary boiler profiles, the TPM (total particulate matter) to  $\text{PM}_{10}$  conversion factor is assumed to be 1.0, and the  $\text{PM}_{10}$  to  $\text{PM}_{2.5}$  conversion factor is assumed to be 0.92 [8].

### III. Results and Discussion

The details of the new profiles PM1106 to PM1109 are listed in Appendix Tables 1 to 4. Since particle-size-specific chemical composition data are not available, a homogeneous chemical composition is assumed for all PM size ranges. That is, the chemical speciation profiles of TPM,  $\text{PM}_{10}$  and  $\text{PM}_{2.5}$  are assumed to be the same. The key modeling components, such as EC, OC, and sulfate, are plotted for the four new profiles in Figure 1.

**Figure 1. Major species in OGV boiler PM profiles**



Overall, EC accounts for very little in all four OGV boiler profiles, varying from a low of 0.1% in PM1106 to a high of 1.5% in PM1107. Except for the high sulfur HFO profile (PM1106), OC

is the most abundant species in all other three low sulfur fuel profiles (PM1107, PM1108 and PM1109), ranging from 47.9% to 66.1%. Sulfate is dominant (over 82.2%) in PM1106, and is significantly lower in PM1107, PM1108 and PM1109 (23.8%, 1.2%, and 0.3%, respectively). This indicates that the reduction of the sulfur level in the fuel led to the decrease of sulfate content in the combustion PM.

In Profile PM1106 which describes the composition of the particles emitted from the big tanker boiler burning high sulfur HFO (2.85%), the content of sulfate is 82.2%, significantly higher than any other species. The total of OC and EC is only 3.7% of the PM mass.

Like PM1106, PM1107 is also made based on a tanker boiler test, but sulfur level in the test fuel is two magnitudes lower than that used in PM1106 (0.045% vs. 2.85% sulfur by weight). Figure 1 shows that compared with PM1106, PM1107 has a much lower sulfate content (82.2% vs. 23.8%) but a much higher OC content (3.6% vs 47.9%). The differences in the test fuel (high sulfur HFO vs. low sulfur MGO) and boiler technique (old vs. modern) are likely the main reasons causing the profile differences.

PM1108 and PM1109 are profiles made for smaller container boilers burning ultralow sulfur (0.089%) HFO and low sulfur (0.038%) MGO, respectively. OC is the most abundant species in both profiles, while EC and sulfate are minimal.

PM1107 and PM1109 are profiles for low sulfur MGO. However, PM1107 is for big tanker boiler (50,000kg/h) while PM1109 is for smaller container boiler (408kg/h). Figure 1 shows that sulfate contributes more in the large boiler profile (PM1107) than the small boiler profile (PM1109) but OC is the opposite, despite the sulfur levels being very close (0.045% vs. 0.038%) in their test fuels.

Tables 1-4 in the Appendix also show the PM-bounded elements and metals of the new profiles. Emissions of elements including iron, nickel, magnesium, aluminum, silicon, calcium, phosphorus, barium, and zinc are associated with both the fuel and lubrication oil compositions. The dominant metals for HFO (PM1106) and ULSHFO (PM1108) are vanadium, iron, and nickel, which can be linked to their presence in the crude oils [5].

## **IV. Estimated Impacts of Profile Update**

CARB has 74 Emission Inventory Codes (EICs) for OGV boilers including 36 EICs for residual oil and 38 EICs for distillate fuel. The newly developed profile PM1106 will replace PM1104 for the categories of OGV boiler burning HFO fuel; PM1107 and PM1109 will replace PM1112 for the categories of tanker boilers burning MGO and non-tanker boilers burning MGO, respectively. The mapping of the new OGV boiler PM profiles to their associated EICs is listed in Appendix Table 5.

Compared to the existing PM1104, the new HFO boiler profile PM1106 has much higher sulfate but lower OC and EC. Therefore, the application of PM1106 will increase sulfate emissions but reduce EC and OC emissions. Due to the implementation of the OGV Fuel Regulation, PM emissions from OGV boilers burning HFO only appear in the inventory for 2008 and previous years [9]. Thus, the impact of this profile update only applies to years before 2009.



Compared to the existing PM112, the new MGO boiler profiles PM1107 and PM1109 have much higher OC but lower EC and sulfate. Thus, the application of new profiles PM1107 and PM1109 will increase OC emissions but reduce EC and sulfate emissions. Due to the implementation of the OGV Fuel Regulation, PM emissions from OGV boilers burning distillate fuel began to appear in the 2009 inventory; therefore, the impact of this update only applies to years after 2008. The emissions for year 2017 was chosen as an example to evaluate the impacts of profile update on some of the PM<sub>2.5</sub> species for OGV boilers. Based on CEPAM: California 2019 Ozone SIP Baseline Emission Projection Planning Inventory (version 1.02) [9], the 2017 statewide annual average PM<sub>2.5</sub> emissions from OGV boilers are 0.27 tons/day, or 0.08% of the total statewide anthropogenic PM<sub>2.5</sub> emissions. Compared with the estimates using PM112, the OC emissions will increase from zero to 0.145 tons/day, and the emissions of EC and sulfate calculated by the new profiles will be reduced by 92.7% and 35.3%, respectively (Table 1).

**Table 1: Impacts on emissions of PM2.5 species for OGV boilers using updated profiles (2017)**

Statewide annual average emissions	Using current profile PM112 (tons/day)	Using new profiles PM1107/PM1109 (tons/day)	Change of Emissions (tons/day)	Percentage of Change
OC	0	0.145	0.145	N/A
EC	0.041	0.003	-0.038	-92.7%
sulfate	0.068	0.044	-0.024	-35.3%

## References:

1. Yang, W., *PM Speciation Profiles for Gas- and Oil-Fired Stationary Combustion - PM1101, PM1102, PM1103, PM1104 and PM1105*, 2015, California Air Resources Board: Sacramento, CA.
2. *California Air Resources Board Main Speciation Profiles*, 2021, California Air Resources Board, Accessed: May 20, 2021.
3. Agrawal, H., et al., *Emission Measurements from a Crude Oil Tanker at Sea*. *Environmental Science & Technology*, 2008. **42**(19): p. 7098-7103.
4. Miller, W.J., et al., *Emissions Evaluation of an Auxiliary Boiler on a Modern Panamax Tanker*, 2020, California Air Resources Board.
5. McCaffery, C., et al., *Sources of air pollutants from a Tier 2 ocean-going container vessel: Main engine, auxiliary engine, and auxiliary boiler*. *Atmospheric Environment*, 2021. **245**: p. 118023.
6. Reff, A., et al., *Emissions Inventory of PM<sub>2.5</sub> Trace Elements across the United States*. *Environmental Science & Technology*, 2009. **43**(15): p. 5790-5796.
7. Allen, P., *Developing PM Species Profiles for Emission Inventory*, 2008.
8. *Ports Emissions Inventory Guidance: Methodologies for Estimating Port-Related and Goods Movement Mobile Source Emissions*, 2020, U.S. Environmental Protection Agency.
9. *CEPAM*, 2021, California Air Resources Board, Accessed: August 2, 2021.

## V. Appendix

**Table 2: Profile PM1106: Tanker boiler burning HFO (2.85% sulfur)**

Species Name	ARB-SAROAD	TPM Weight Percentage (%)	PM <sub>10</sub> Weight Percentage (%)	PM <sub>2.5</sub> Weight Percentage (%)
elemental carbon (EC)	12116	0.1223	0.1223	0.1223
organic carbon (OC)	11102	3.5911	3.5911	3.5911
non-carbon organic matter (NCOM)	11103	1.4365	1.4365	1.4365
sulfate	12403	82.1924	82.1924	82.1924
aluminum	12101	1.9522	1.9522	1.9522
antimony	12102	0.0344	0.0344	0.0344
arsenic	12103	0.0006	0.0006	0.0006
barium	12107	0.0374	0.0374	0.0374
bismuth	12106	0.0006	0.0006	0.0006
bromine	12109	0.0008	0.0008	0.0008
cadmium	12110	0.0061	0.0061	0.0061
calcium	12111	0.0840	0.0840	0.0840
chlorine	12115	0.0076	0.0076	0.0076
chromium	12112	0.0023	0.0023	0.0023
cobalt	12113	0.0245	0.0245	0.0245
copper	12114	0.0107	0.0107	0.0107
gallium	12124	0.0222	0.0222	0.0222
germanium	12125	0.0023	0.0023	0.0023
indium	12131	0.0252	0.0252	0.0252
iron	12126	1.2531	1.2531	1.2531
lanthanum	12146	0.0550	0.0550	0.0550
lead	12128	0.0006	0.0006	0.0006
magnesium	12140	0.1528	0.1528	0.1528
manganese	12132	0.0008	0.0008	0.0008
molybdenum	12134	0.0275	0.0275	0.0275
nickel	12136	1.5251	1.5251	1.5251
palladium	12151	0.0023	0.0023	0.0023
phosphorus	12152	0.7901	0.7901	0.7901
potassium	12180	0.0023	0.0023	0.0023
rubidium	12176	0.0008	0.0008	0.0008
selenium	12154	0.0023	0.0023	0.0023
silicon	12165	0.1528	0.1528	0.1528
strontium	12168	0.0023	0.0023	0.0023
thallium	12173	0.0006	0.0006	0.0006
tin	12160	0.0191	0.0191	0.0191
titanium	12161	0.0069	0.0069	0.0069
vanadium	12164	3.8891	3.8891	3.8891

Species Name	ARB-SAROAD	TPM Weight Percentage (%)	PM <sub>10</sub> Weight Percentage (%)	PM <sub>2.5</sub> Weight Percentage (%)
yttrium	12183	0.0006	0.0006	0.0006
zinc	12167	0.0741	0.0741	0.0741
others	12999	2.4886	2.4886	2.4886
Total		100.0000	100.0000	100.0000

**Table 3: Profile PM1107: Tanker boiler burning MGO (0.045% sulfur)**

Species Name	ARB-SAROAD	TPM Weight Percentage (%)	PM <sub>10</sub> Weight Percentage (%)	PM <sub>2.5</sub> Weight Percentage (%)
elemental carbon (EC)	12116	1.5443	1.5443	1.5443
organic carbon (OC)	11102	47.8748	47.8748	47.8748
non-carbon organic matter (NCOM)	11103	19.1499	19.1499	19.1499
sulfate	12403	23.8271	23.8271	23.8271
aluminum	12101	0.1250	0.1250	0.1250
calcium	12111	0.4118	0.4118	0.4118
chlorine	12115	0.0221	0.0221	0.0221
chromium	12112	0.0588	0.0588	0.0588
copper	12114	0.0221	0.0221	0.0221
iron	12126	0.2721	0.2721	0.2721
lanthanum	12146	0.0074	0.0074	0.0074
magnesium	12140	0.0588	0.0588	0.0588
nickel	12136	0.0441	0.0441	0.0441
phosphorus	12152	0.1471	0.1471	0.1471
silicon	12165	2.2945	2.2945	2.2945
silver	12166	0.0074	0.0074	0.0074
sodium	12184	0.8089	0.8089	0.8089
tin	12160	0.0147	0.0147	0.0147
vanadium	12164	0.3162	0.3162	0.3162
yttrium	12183	0.0074	0.0074	0.0074
zinc	12167	0.1250	0.1250	0.1250
others	12999	2.8605	2.8605	2.8605
Total		100.0000	100.0000	100.0000

**Table 4: Profile PM1108: Non-tanker boiler burning ULSHFO (0.089% sulfur)**

Species Name	ARB-SAROAD	TPM Weight Percentage (%)	PM <sub>10</sub> Weight Percentage (%)	PM <sub>2.5</sub> Weight Percentage (%)
elemental carbon (EC)	12116	1.3253	1.3253	1.3253
organic carbon (OC)	11102	49.2255	49.2255	49.2255
non-carbon organic matter (NCOM)	11103	19.6902	19.6902	19.6902
sulfate	12403	1.1991	1.1991	1.1991
aluminum	12101	0.8835	0.8835	0.8835
antimony	12102	0.2524	0.2524	0.2524
barium	12107	0.7258	0.7258	0.7258

Species Name	ARB-SAROAD	TPM Weight Percentage (%)	PM <sub>10</sub> Weight Percentage (%)	PM <sub>2.5</sub> Weight Percentage (%)
bismuth	12106	0.0316	0.0316	0.0316
bromine	12109	0.0316	0.0316	0.0316
cadmium	12110	0.1893	0.1893	0.1893
calcium	12111	1.3884	1.3884	1.3884
copper	12114	0.0316	0.0316	0.0316
gadolinium	12123	0.7889	0.7889	0.7889
germanium	12125	0.0631	0.0631	0.0631
gold	12143	0.1893	0.1893	0.1893
indium	12131	0.0947	0.0947	0.0947
iron	12126	2.4928	2.4928	2.4928
lanthanum	12146	0.3155	0.3155	0.3155
lead	12128	0.0316	0.0316	0.0316
magnesium	12140	0.8204	0.8204	0.8204
molybdenum	12134	0.0631	0.0631	0.0631
nickel	12136	3.3133	3.3133	3.3133
niobium	12147	0.0631	0.0631	0.0631
palladium	12151	0.1262	0.1262	0.1262
phosphorus	12152	1.2937	1.2937	1.2937
platinum	12178	0.0631	0.0631	0.0631
rhodium	12177	0.0631	0.0631	0.0631
samarium	12190	0.5680	0.5680	0.5680
selenium	12154	0.0316	0.0316	0.0316
silicon	12165	1.2622	1.2622	1.2622
silver	12166	0.2524	0.2524	0.2524
sodium	12184	0.5049	0.5049	0.5049
strontium	12168	0.0947	0.0947	0.0947
tellurium	12117	0.0631	0.0631	0.0631
thallium	12173	0.0947	0.0947	0.0947
tin	12160	0.3471	0.3471	0.3471
uranium	12179	0.0947	0.0947	0.0947
vanadium	12164	7.8571	7.8571	7.8571
zinc	12167	0.2209	0.2209	0.2209
others	12999	3.8524	3.8524	3.8524
Total		100.0000	100.0000	100.0000

**Table 5: Profile PM1109: Non-tanker boiler burning MGO (0.038% sulfur)**

Species Name	ARB-SAROAD	TPM Weight Percentage (%)	PM <sub>10</sub> Weight Percentage (%)	PM <sub>2.5</sub> Weight Percentage (%)
elemental carbon (EC)	12116	0.3976	0.3976	0.3976
organic carbon (OC)	11102	66.0832	66.0832	66.0832
non-carbon organic matter (NCOM)	11103	26.4333	26.4333	26.4333
sulfate	12403	0.3219	0.3219	0.3219

Species Name	ARB-SAROAD	TPM Weight Percentage (%)	PM <sub>10</sub> Weight Percentage (%)	PM <sub>2.5</sub> Weight Percentage (%)
aluminum	12101	0.0379	0.0379	0.0379
antimony	12102	0.0189	0.0189	0.0189
barium	12107	0.4355	0.4355	0.4355
bromine	12109	0.0189	0.0189	0.0189
cadmium	12110	0.1515	0.1515	0.1515
calcium	12111	0.4355	0.4355	0.4355
cerium	71111	0.5681	0.5681	0.5681
chlorine	12115	0.0568	0.0568	0.0568
copper	12114	0.0568	0.0568	0.0568
gadolinium	12123	0.1894	0.1894	0.1894
gold	12143	0.0568	0.0568	0.0568
indium	12131	0.0379	0.0379	0.0379
iron	12126	0.3976	0.3976	0.3976
lanthanum	12146	0.5112	0.5112	0.5112
lead	12128	0.0379	0.0379	0.0379
magnesium	12140	0.3219	0.3219	0.3219
molybdenum	12134	0.0568	0.0568	0.0568
nickel	12136	0.0189	0.0189	0.0189
niobium	12147	0.0189	0.0189	0.0189
palladium	12151	0.0568	0.0568	0.0568
phosphorus	12152	0.2651	0.2651	0.2651
platinum	12178	0.0379	0.0379	0.0379
potassium	12180	0.0568	0.0568	0.0568
rhodium	12177	0.2272	0.2272	0.2272
rubidium	12176	0.0189	0.0189	0.0189
samarium	12190	0.4355	0.4355	0.4355
selenium	12154	0.0568	0.0568	0.0568
silicon	12165	0.3408	0.3408	0.3408
silver	12166	0.0568	0.0568	0.0568
strontium	12168	0.0568	0.0568	0.0568
tellurium	12117	0.0189	0.0189	0.0189
thallium	12173	0.0379	0.0379	0.0379
tin	12160	0.1515	0.1515	0.1515
titanium	12161	0.1325	0.1325	0.1325
uranium	12179	0.0757	0.0757	0.0757
vanadium	12164	0.3030	0.3030	0.3030
yttrium	12183	0.0379	0.0379	0.0379
zinc	12167	0.1136	0.1136	0.1136
others	12999	0.8564	0.8564	0.8564
Total		100.0000	100.0000	100.0000

**Table 6: Mapping of new PM profiles to OGV boiler EICs**

EIC	EIC Name	PM Profile No.
83383112109992	Ocean-Going Vessel – Auto Carriers – Diesel – Hoteling Boiler	PM1109
83383112109993	Ocean-Going Vessel – Auto Carriers – Diesel – Maneuvering Boiler	PM1109
83383112109994	Ocean-Going Vessel – Auto Carriers – Diesel – Anchorage Boiler	PM1109
83383112109995	Ocean-Going Vessel – Auto Carriers – Diesel – Transit Boiler	PM1109
83383312109992	Ocean-Going Vessel – Bulk Cargo Vessels – Diesel – Hoteling Boiler	PM1109
83383312109993	Ocean-Going Vessel – Bulk Cargo Vessels – Diesel – Maneuvering Boiler	PM1109
83383312109994	Ocean-Going Vessel – Bulk Cargo Vessels – Diesel – Anchorage Boiler	PM1109
83383312109995	Ocean-Going Vessel – Bulk Cargo Vessels – Diesel – Transit Boiler	PM1109
83383512109992	Ocean-Going Vessel – Container Ships – Diesel – Hoteling Boiler	PM1109
83383512109993	Ocean-Going Vessel – Container Ships – Diesel – Maneuvering Boiler	PM1109
83383512109994	Ocean-Going Vessel – Container Ships – Diesel – Anchorage Boiler	PM1109
83383512109995	Ocean-Going Vessel – Container Ships – Diesel – Transit Boiler	PM1109
83383712109992	Ocean-Going Vessel – General Cargo Vessels – Diesel – Hoteling Boiler	PM1109
83383712109993	Ocean-Going Vessel – General Cargo Vessels – Diesel – Maneuvering Boiler	PM1109
83383712109994	Ocean-Going Vessel – General Cargo Vessels – Diesel – Anchorage Boiler	PM1109
83383712109995	Ocean-Going Vessel – General Cargo Vessels – Diesel – Transit Boiler	PM1109
83383912109993	Ocean-Going Vessel – Military Vessels – Diesel – Maneuvering Boiler	PM1109
83383912109995	Ocean-Going Vessel – Military Vessels – Diesel – Transit Boiler	PM1109
83384112109992	Ocean-Going Vessel – Passenger Ships – Diesel – Hoteling Boiler	PM1109
83384112109993	Ocean-Going Vessel – Passenger Ships – Diesel – Maneuvering Boiler	PM1109
83384112109994	Ocean-Going Vessel – Passenger Ships – Diesel – Anchorage Boiler	PM1109
83384112109995	Ocean-Going Vessel – Passenger Ships – Diesel – Transit Boiler	PM1109
83384312109992	Ocean-Going Vessel – Refrigerated Cargo Vessels – Diesel – Hoteling Boiler	PM1109
83384312109993	Ocean-Going Vessel – Refrigerated Cargo Vessels – Diesel – Maneuvering Boiler	PM1109
83384312109994	Ocean-Going Vessel – Refrigerated Cargo Vessels – Diesel – Anchorage Boiler	PM1109
83384312109995	Ocean-Going Vessel – Refrigerated Cargo Vessels – Diesel – Transit Boiler	PM1109
83384512109992	Ocean-Going Vessel – Roll On/Roll Off Vessels – Diesel – Hoteling Boiler	PM1109
83384512109993	Ocean-Going Vessel – Roll On/Roll Off Vessels – Diesel – Maneuvering Boiler	PM1109
83384512109994	Ocean-Going Vessel – Roll On/Roll Off Vessels – Diesel – Anchorage Boiler	PM1109
83384512109995	Ocean-Going Vessel – Roll On/Roll Off Vessels – Diesel – Transit Boiler	PM1109

EIC	EIC Name	PM Profile No.
83384712109992	Ocean-Going Vessel – Tankers – Diesel – Hoteling Boiler	PM1107
83384712109993	Ocean-Going Vessel – Tankers – Diesel – Maneuvering Boiler	PM1107
83384712109994	Ocean-Going Vessel – Tankers – Diesel – Anchorage Boiler	PM1107
83384712109995	Ocean-Going Vessel – Tankers – Diesel – Transit Boiler	PM1107
83384912109992	Ocean-Going Vessel – Miscellaneous Vessels – Diesel – Hoteling Boiler	PM1109
83384912109993	Ocean-Going Vessel – Miscellaneous Vessels – Diesel – Maneuvering Boiler	PM1109
83384912109994	Ocean-Going Vessel – Miscellaneous Vessels – Diesel – Anchorage Boiler	PM1109
83384912109995	Ocean-Going Vessel – Miscellaneous Vessels – Diesel – Transit Boiler	PM1109
83383115009992	Ocean-Going Vessel – Auto Carriers – Residual Oil – Hoteling Boiler	PM1106
83383115009993	Ocean-Going Vessel – Auto Carriers – Residual Oil – Maneuvering Boiler	PM1106
83383115009994	Ocean-Going Vessel – Auto Carriers – Residual Oil – Anchorage Boiler	PM1106
83383115009995	Ocean-Going Vessel – Auto Carriers – Residual Oil – Transit Boiler	PM1106
83383315009992	Ocean-Going Vessel – Bulk Cargo Vessels – Residual Oil – Hoteling Boiler	PM1106
83383315009993	Ocean-Going Vessel – Bulk Cargo Vessels – Residual Oil – Maneuvering Boiler	PM1106
83383315009994	Ocean-Going Vessel – Bulk Cargo Vessels – Residual Oil – Anchorage Boiler	PM1106
83383315009995	Ocean-Going Vessel – Bulk Cargo Vessels – Residual Oil – Transit Boiler	PM1106
83383515009992	Ocean-Going Vessel – Container Ships – Residual Oil – Hoteling Boiler	PM1106
83383515009993	Ocean-Going Vessel – Container Ships – Residual Oil – Maneuvering Boiler	PM1106
83383515009994	Ocean-Going Vessel – Container Ships – Residual Oil – Anchorage Boiler	PM1106
83383515009995	Ocean-Going Vessel – Container Ships – Residual Oil – Transit Boiler	PM1106
83383715009992	Ocean-Going Vessel – General Cargo Vessels – Residual Oil – Hoteling Boiler	PM1106
83383715009993	Ocean-Going Vessel – General Cargo Vessels – Residual Oil – Maneuvering Boiler	PM1106
83383715009994	Ocean-Going Vessel – General Cargo Vessels – Residual Oil – Anchorage Boiler	PM1106
83383715009995	Ocean-Going Vessel – General Cargo Vessels – Residual Oil – Transit Boiler	PM1106
83384115009992	Ocean-Going Vessel – Passenger Ships – Residual Oil – Hoteling Boiler	PM1106
83384115009993	Ocean-Going Vessel – Passenger Ships – Residual Oil – Maneuvering Boiler	PM1106
83384115009994	Ocean-Going Vessel – Passenger Ships – Residual Oil – Anchorage Boiler	PM1106
83384115009995	Ocean-Going Vessel – Passenger Ships – Residual Oil – Transit Boiler	PM1106
83384315009992	Ocean-Going Vessel – Refrigerated Cargo Vessels – Residual Oil – Hoteling Boiler	PM1106
83384315009993	Ocean-Going Vessel – Refrigerated Cargo Vessels – Residual Oil – Maneuvering Boiler	PM1106
83384315009994	Ocean-Going Vessel – Refrigerated Cargo Vessels – Residual Oil – Anchorage Boiler	PM1106
83384315009995	Ocean-Going Vessel – Refrigerated Cargo Vessels – Residual Oil – Transit Boiler	PM1106



EIC	EIC Name	PM Profile No.
83384515009992	Ocean-Going Vessel – Roll On/Roll Off Vessels – Residual Oil – Hoteling Boiler	PM1106
83384515009993	Ocean-Going Vessel – Roll On/Roll Off Vessels – Residual Oil – Maneuvering Boiler	PM1106
83384515009994	Ocean-Going Vessel – Roll On/Roll Off Vessels – Residual Oil – Anchorage Boiler	PM1106
83384515009995	Ocean-Going Vessel – Miscellaneous Vessels – Residual Oil – Transit Boiler	PM1106
83384715009992	Ocean-Going Vessel – Tankers – Residual Oil – Hoteling Boiler	PM1106
83384715009993	Ocean-Going Vessel – Tankers – Residual Oil – Maneuvering Boiler	PM1106
83384715009994	Ocean-Going Vessel – Tankers – Residual Oil – Anchorage Boiler	PM1106
83384715009995	Ocean-Going Vessel – Tankers – Residual Oil – Transit Boiler	PM1106
83384915009992	Ocean-Going Vessel – Miscellaneous Vessels – Residual Oil – Hoteling Boiler	PM1106
83384915009993	Ocean-Going Vessel – Miscellaneous Vessels – Residual Oil – Maneuvering Boiler	PM1106
83384915009994	Ocean-Going Vessel – Miscellaneous Vessels – Residual Oil – Anchorage Boiler	PM1106
83384915009995	Ocean-Going Vessel – Miscellaneous Vessels – Residual Oil – Transit Boiler	PM1106