

PM Speciation Profiles for On-Road Gasoline-Powered Vehicle Exhaust: Start and Running

—PM4006 and PM4007

April 25, 2023

California Air Resources Board
1001 I Street
Sacramento, California 95814

Table of Contents

| | | |
|------|--|---|
| I. | Introduction..... | 1 |
| II. | Methodology..... | 1 |
| A. | General information of VSP-19 | 1 |
| B. | Sample collection and analytical methods | 2 |
| C. | Profile development | 2 |
| III. | Results and Discussion | 3 |
| IV. | Estimated Impacts of Profile Update | 4 |
| V. | Appendix..... | 6 |

List of Tables

| | |
|--|----|
| Table 1: Impacts on emissions of PM _{2.5} species for on-road gasoline vehicles using updated profiles PM4006 and PM4007 (2020) | 4 |
| Table 2. Profile PM4006: On-road gasoline vehicle start exhaust (E10) | 6 |
| Table 3. Profile PM4007: On-road gasoline vehicle hot stabilized running exhaust (E10)..... | 7 |
| Table 4. Mapping of PM4006 to on-road gasoline vehicle start categories | 8 |
| Table 5. Mapping of PM4007 to on-road gasoline vehicle running and idle categories | 11 |

List of Figures

| | |
|--|---|
| Figure 1. Major species in PM4006 (start) and PM4007 (hot stabilized running)..... | 3 |
|--|---|

I. Introduction

PM4001 is the particulate matter (PM) speciation profile currently used for exhaust emissions from on-road gasoline-powered vehicles with catalytic converters [1]. This profile was developed in 2011 based on test data from various studies including the Kansas City PM Characterization Study [2], CRC E-24-2 [3], and Gasoline/Diesel PM Split Study [4]. PM4001 is assigned to all three types of combustion emissions for gasoline-powered vehicles equipped with catalytic converters used in CARB's inventory: start, hot stabilized running and idling.

The California Air Resources Board (CARB) has been conducting the Light-Duty Vehicle Surveillance Program (VSP) since the 1970s. The program procures and tests vehicles from the current in-use fleet for exhaust and evaporative emissions to support California's on-road mobile emissions inventory.

The PM speciation profiles generated based on the test data obtained from the 19th VSP (VSP-19) conducted between 2013 and 2014 at the Hagen-Smit Laboratory (HSL) in El Monte, California, are presented in this work. This is the first time that PM samples were collected and analyzed in this program. The tested vehicles used E10 (10% vol ethanol) fuel in this program. The newly developed PM speciation profiles will be used to replace the current profile PM4001 for the categories of gasoline vehicles using E10 fuel for 2010 and subsequent years in California. The new profiles are for start and hot stabilized running emissions, respectively:

- PM4006: On-road gasoline-powered vehicle start exhaust (E10)
- PM4007: On-road gasoline-powered vehicle running exhaust (E10)

II. Methodology

A. General information of VSP-19

The VSP-19 was conducted by CARB staff to measure criteria pollutant emissions for in-use California light-duty vehicles after the transition from E6 (6% vol ethanol) to E10 fuel in 2013 and 2014. A total of 225 light-duty vehicles were randomly selected from the DMV data representing households within a 50-mile radius from the CARB's laboratory facilities in El Monte, CA. All selected vehicles are catalyst-equipped, and they reflected the differences in vehicle technology and standards used in the motor vehicle emissions in the EMFAC model. A subset of 38 vehicles, including personal cars and light-duty trucks, with model year ranging from 1990 to 2011, were selected for the detailed chemical characterization.

All the vehicles are tested on a three-bag Unified Cycle (UC), which included a cold start (Phase 1), hot stabilized running (Phase 2), and a hot start (Phase 3). In the test fleet, 23 vehicles were fueled with commercial summer-grade E10 gasoline, 14 used winter-grade E10 gasoline, and one ran on E85 (85% vol ethanol) fuel. It should be noted that since this work focuses on E10 gasoline, test data of the vehicle burning E85 fuel was not included in the profile development.

B. Sample collection and analytical methods

Filters were used to collect the PM gravimetric mass and PM speciation samples. Three collocated sampling sets were deployed to collect samples from Phase 1 (Bag 1), Phase 2 (Bag 2) and Phase 3 (Bag 3), respectively. Each sampling set consisted of a Teflon filter, a quartz-fiber filter, and another Teflon filter (T-Q-T set). A total of 9 filters for all 3 phases were collected for each vehicle tested over the modal UC driving cycle.

The first Teflon filter was used to collect samples for determining PM mass emissions (MLD SOP145) and analyzing water soluble ions (ammonium, chloride, nitrate, and sulfate) using Ion Chromatography (MLD SOP142 v.2.0); the pre-baked quartz-fiber filter was used to collect samples for the determination of organic carbon (OC) and elemental carbon (EC) (MLD SOP139 v.1.1), and the second Teflon filter in the sampling set was used to collect samples for the elemental analysis (MLD SOP156 v.1.0) using Energy Disperse X-ray Fluorescent (ED-XRF).

C. Profile development

PM speciation profiles for start and hot stabilized running were developed using the bag-specific PM emission data obtained from the three-bag UC driving cycle. To assure the validity of the individual species measurements, only the analytical measurements above the detection limit were used for the profile development. The emissions for start are calculated based on the difference in emissions measured from Bag 1 (cold start) and Bag 3 (hot start), which have the same speed versus time profile. The running emissions are defined as emissions from the vehicle when the engine is warm and the operating catalyst temperature is reached, and they are measured from Bag 2 of the UC cycle.

As mentioned previously, there were 37 vehicles running on E10 in the VSP-19 speciation tests. However, to ensure the validity of the test data and representativeness of the profile, two more vehicles were excluded from the profile development in this work. Suspiciously high emissions were detected in the sampling filters of one test vehicle. Because the emissions were particularly high for those species used as additives in lubricating oil, such as Ca, Zn, and P, it is possible that the samples might contain contaminants from leaking engine oil. Another test vehicle only had measurements for Bag 1 and Bag 2, with emissions missing for many species. The exclusion of this vehicle from the profile development is due to the incomplete test data. Therefore, the speciation measurements of 35 vehicles were used for making start and running profiles following the steps below.

The emission rates of each species are used for the profile development. The composite emission rates were calculated from the individual phase-specific and vehicle-specific emissions. For combustion sources, organic matter (OM) can be estimated as 1.4 times the OC [5]. The non-carbon organic matter (NCOM) is calculated by subtracting OC from OM. Thus, the NCOM is obtained as 0.4 times the OC. The metal-bound oxygen is named as 'others' and it is calculated 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., Al_2O_3 , SiO_2 , CaO , Fe_2O_3 and TiO_2). The following equation is used to calculate 'others' [6]:

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

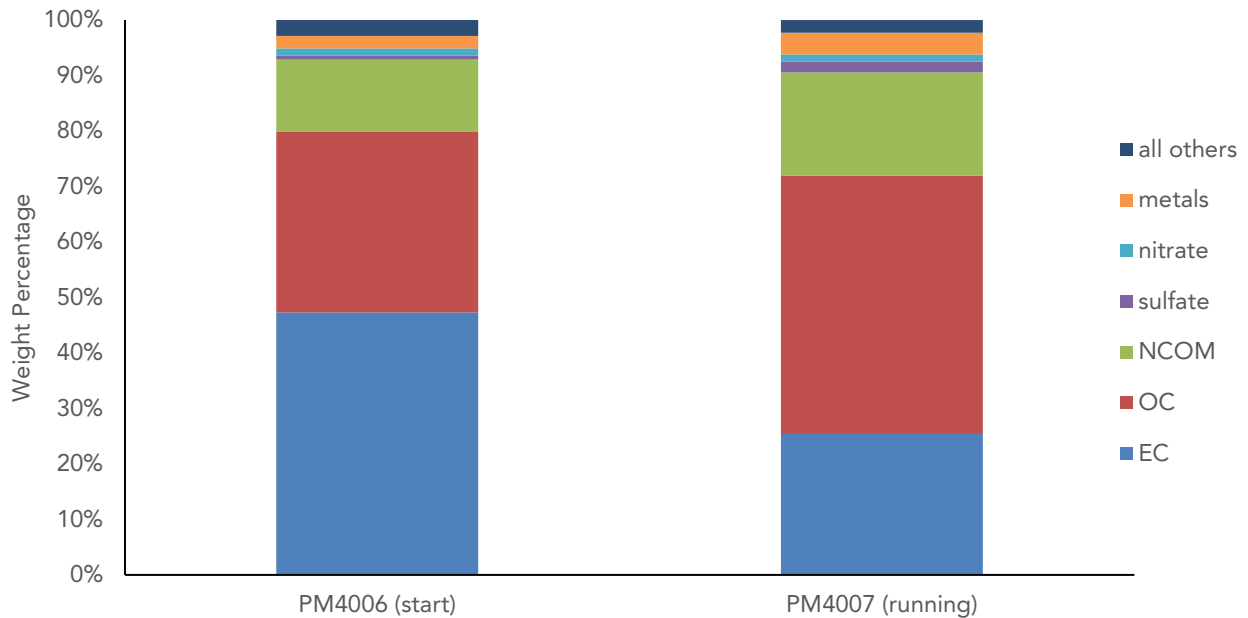
Then the emissions of all the chemical species, including EC, OC, elements, ions, NCOM and 'others', are summed up to get a total emission rate. The emission rate of each species is divided by the total emission rate to determine its weight percentage in the speciation profile.

III. Results and Discussion

Details of the new PM profiles PM4006 (start) and PM4007 (hot stabilized running) are listed in Appendix Table 2 and Table 3. Due to the lack of particle size data, the size distributions of the current profile PM4001 is applied to the new profiles, i.e., PM₁₀/TPM (total particulate matter) is 0.894 and PM_{2.5}/TPM is 0.822 [1].

The key PM modeling components, such as EC, OC, sulfate, and nitrate are plotted for the new profiles in Figure 1. PM4006 shows that EC dominates the composition of start exhaust and almost half of the particles from start emissions is EC (47.3%). This is due to the incomplete fuel combustion before the engine gets warm and the operating catalyst temperature is reached. In PM4006, OC is less than one third (32.5%) of the PM mass. In contrast, PM4007 shows that OC is the most abundant species (46.6%) in the running exhaust particles, followed by EC which is about 25.4% of the PM mass. Sulfate, nitrate, and metals account for small fractions in both start and running exhausts. Compared to PM4006, PM4007 has higher sulfate (2.0% vs. 0.8%) and metals (3.9% vs. 2.2%) fractions in the profile.

Figure 1. Major species in PM4006 (start) and PM4007 (hot stabilized running)



IV. Estimated Impacts of Profile Update

The Emission Inventory Codes (EICs) of combustion emissions from on-road gasoline vehicles with catalytic converter are summarized in the Appendix Table 4 and Table 5. The new profile PM4006 will be assigned to the start categories (Table 4) to replace the current PM4001; the new profile PM4007 will be assigned to hot stabilized running categories and idle categories (Table 5) to replace the current PM4001.

Compared to PM4001, the new start profile PM4006 has higher EC but lower OC fractions; the new running profile PM4007 has similar EC but higher OC fractions. However, the sulfate fractions in both new profiles are much lower than in PM4001. Using the emissions of year 2020 as an example, the statewide annual average PM_{2.5} emissions for on-road gasoline vehicles with catalytic converter combustion are 1.8 tons/day based on CEPAM: California 2022 Ozone SIP Baseline Emission Projection Planning Inventory (version 1.01) [7], which is about 0.5% of the statewide total anthropogenic PM_{2.5} emissions and 6.4% of the on-road motor vehicle PM_{2.5} emissions.

Applying the new specific profiles to their associated categories, the overall calculated EC emissions are 0.51 tons/day, which is 13.3% higher than the estimated value calculated using the current PM4001 for year 2020 (Table 1). The increase of EC is mainly due to the higher EC emissions from the start categories. With the new profiles, the total OC emissions from these combustion categories are 0.80 tons/day, which is 11.1% more than the current estimation. The OC fraction is lower in PM4006 than in PM4001, but it is higher in PM4007 than in PM4001. The overall weighted OC emissions are still increased using the new profiles. With the new profiles, the sulfate emissions decrease from 0.08 to 0.03 tons/day (Table 1).

Table 1: Impacts on emissions of PM_{2.5} species for on-road gasoline vehicles using updated profiles PM4006 and PM4007 (2020)

| Statewide annual average emissions | Using current profile PM4001 (tons/day) | Using new profiles PM4006 and PM4007 (tons/day) | Change of emissions (tons/day) | Percentage of change |
|------------------------------------|---|---|--------------------------------|----------------------|
| EC | 0.45 | 0.51 | +0.06 | +13.3% |
| OC | 0.72 | 0.80 | +0.08 | +11.1% |
| sulfate | 0.08 | 0.03 | - 0.05 | -62.5% |

References:

1. *California Air Resources Board Main Speciation Profiles*. 2023, California Air Resources Board.
2. Kishan, S., et al., *Kansas City PM Characterization Study*. 2008, U.S. Environmental Protection Agency: Washington DC.
3. Norbeck, J.M., T.D. Durbin, and T.J. Truex, *Measurement of Primary Particulate Matter Emissions from Light-Duty Motor Vehicles*. 1998, Coordinating Research Council, Inc.
4. Fujita, E.M., et al., *Gasoline/Diesel PM Split Study: Source and Ambient Sampling, Chemical Analysis, and Apportionment Phase*. 2005, National Renewable Energy Laboratory: Golden, CO.
5. Brown, S.G., et al., *Variations in the OM/OC ratio of urban organic aerosol next to a major roadway*. *Journal of the Air & Waste Management Association*, 2013. **63**(12): p. 1422-1433.
6. Allen, P., *Developing PM Species Profiles for Emission Inventory*. 2008.
7. *California Emissions Projection Analysis Model (CEPAM)*. 2023, California Air Resources Board.

V. Appendix

Table 2. Profile PM4006: On-road gasoline vehicle start exhaust (E10)

| Species Name | CARB-SAROAD | TPM Weight Percentage (%) | PM ₁₀ Weight Percentage (%) | PM _{2.5} Weight Percentage (%) |
|----------------------------------|-------------|---------------------------|--|---|
| elemental carbon (EC) | 12116 | 47.3102 | 47.3102 | 47.3102 |
| organic carbon (OC) | 11102 | 32.5339 | 32.5339 | 32.5339 |
| non-carbon organic matter (NCOM) | 11103 | 13.0136 | 13.0136 | 13.0136 |
| sulfate | 12403 | 0.7746 | 0.7746 | 0.7746 |
| nitrate | 12306 | 1.2857 | 1.2857 | 1.2857 |
| calcium | 12111 | 0.8214 | 0.8214 | 0.8214 |
| chloride | 12203 | 0.5128 | 0.5128 | 0.5128 |
| iodine | 12141 | 0.2909 | 0.2909 | 0.2909 |
| iron | 12126 | 0.0333 | 0.0333 | 0.0333 |
| molybdenum | 12134 | 0.1077 | 0.1077 | 0.1077 |
| nickel | 12136 | 0.0079 | 0.0079 | 0.0079 |
| palladium | 12151 | 0.1488 | 0.1488 | 0.1488 |
| phosphorus | 12152 | 0.4152 | 0.4152 | 0.4152 |
| platinum | 12178 | 0.0274 | 0.0274 | 0.0274 |
| potassium | 12180 | 0.1637 | 0.1637 | 0.1637 |
| rubidium | 12176 | 0.0239 | 0.0239 | 0.0239 |
| scandium | 12104 | 0.0817 | 0.0817 | 0.0817 |
| strontium | 12168 | 0.0279 | 0.0279 | 0.0279 |
| tellurium | 12117 | 0.1618 | 0.1618 | 0.1618 |
| thallium | 12173 | 0.0838 | 0.0838 | 0.0838 |
| tin | 12160 | 0.0480 | 0.0480 | 0.0480 |
| titanium | 12161 | 0.0643 | 0.0643 | 0.0643 |
| yttrium | 12183 | 0.0114 | 0.0114 | 0.0114 |
| zinc | 12167 | 0.3946 | 0.3946 | 0.3946 |
| zirconium | 12185 | 0.0236 | 0.0236 | 0.0236 |
| others | 12999 | 1.6319 | 1.6319 | 1.6319 |
| Total | | 100.0000 | 100.0000 | 100.0000 |

Table 3. Profile PM4007: On-road gasoline vehicle hot stabilized running exhaust (E10)

| Species Name | CARB-SAROAD | TPM Weight Percentage (%) | PM ₁₀ Weight Percentage (%) | PM _{2.5} Weight Percentage (%) |
|----------------------------------|-------------|---------------------------|--|---|
| elemental carbon (EC) | 12116 | 25.3723 | 25.3723 | 25.3723 |
| organic carbon (OC) | 11102 | 46.5636 | 46.5636 | 46.5636 |
| non-carbon organic matter (NCOM) | 11103 | 18.6254 | 18.6254 | 18.6254 |
| ammonium | 12301 | 0.1394 | 0.1394 | 0.1394 |
| sulfate | 12403 | 1.9923 | 1.9923 | 1.9923 |
| nitrate | 12306 | 1.2139 | 1.2139 | 1.2139 |
| cadmium | 12110 | 0.0412 | 0.0412 | 0.0412 |
| calcium | 12111 | 2.1948 | 2.1948 | 2.1948 |
| cesium | 12118 | 0.0558 | 0.0558 | 0.0558 |
| chloride | 12203 | 0.2382 | 0.2382 | 0.2382 |
| chromium | 12112 | 0.0204 | 0.0204 | 0.0204 |
| iodine | 12141 | 0.2242 | 0.2242 | 0.2242 |
| iron | 12126 | 0.4874 | 0.4874 | 0.4874 |
| manganese | 12132 | 0.0133 | 0.0133 | 0.0133 |
| molybdenum | 12134 | 0.1446 | 0.1446 | 0.1446 |
| nickel | 12136 | 0.0236 | 0.0236 | 0.0236 |
| phosphorus | 12152 | 0.5986 | 0.5986 | 0.5986 |
| potassium | 12180 | 0.0288 | 0.0288 | 0.0288 |
| rubidium | 12176 | 0.0103 | 0.0103 | 0.0103 |
| tellurium | 12117 | 0.0474 | 0.0474 | 0.0474 |
| thallium | 12173 | 0.0045 | 0.0045 | 0.0045 |
| tin | 12160 | 0.0174 | 0.0174 | 0.0174 |
| titanium | 12161 | 0.0109 | 0.0109 | 0.0109 |
| zinc | 12167 | 0.8051 | 0.8051 | 0.8051 |
| zirconium | 12185 | 0.0315 | 0.0315 | 0.0315 |
| others | 12999 | 1.0951 | 1.0951 | 1.0951 |
| Total | | 100.0000 | 100.0000 | 100.0000 |

Table 4. Mapping of PM4006 to on-road gasoline vehicle start categories

| EIC | EIC Name |
|----------------|---|
| 71073011000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light Duty Passenger (LDA) - Catalyst Cold Start - Gasoline (Unspecified) - Sub-Category Unspecified |
| 72073011000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light and Medium Duty Trucks - Catalyst Cold Start - Gasoline (Unspecified) - Sub-Category Unspecified |
| 71073113100000 | Light Duty Passenger (LDA) - Catalyst Starts - Plug-In Hybrid Electric Vehicle (PHEV) - Sub-Category Unspecified |
| 71073211000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light Duty Passenger (LDA) - Catalyst Hot Start - Gasoline (Unspecified) - Sub-Category Unspecified |
| 72073211000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light and Medium Duty Trucks - Catalyst Hot Start - Gasoline (Unspecified) - Sub-Category Unspecified |
| 71073111000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light Duty Passenger (LDA) - Catalyst Start - Gasoline (Unspecified) - Sub-Category Unspecified |
| 72273111000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light Duty Trucks - 1 (LDT1) - Catalyst Start - Gasoline (Unspecified) - Sub-Category Unspecified |
| 72273113100000 | Light Duty Trucks - 1 (LDT1) - Catalyst Starts - Plug-In Hybrid Electric Vehicle (PHEV) - Sub-Category Unspecified |
| 72373111000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light Duty Trucks - 2 (LDT2) - Catalyst Start - Gasoline (Unspecified) - Sub-Category Unspecified |
| 72373113100000 | Light Duty Trucks - 2 (LDT2) - Catalyst Starts - Plug-In Hybrid Electric Vehicle (PHEV) - Sub-Category Unspecified |
| 72473111000000 | Gasoline Vehicle Equipped with Catalytic Converter - Medium Duty Trucks (MDV) - Catalyst Start - Gasoline (Unspecified) - Sub-Category Unspecified |
| 72473113100000 | Medium Heavy Duty Trucks (MHDT) - Catalyst Starts - Plug-In Hybrid Electric Vehicle (PHEV) - Sub-Category Unspecified |
| 72573111000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light Heavy Duty Trucks - 1 (LHDT1) - Catalyst Start - Gasoline (Unspecified) - Sub-Category Unspecified |
| 72673111000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light Heavy Duty Trucks - 2 (LHDT2) - Catalyst Start - Gasoline (Unspecified) - Sub-Category Unspecified |

| EIC | EIC Name |
|----------------|---|
| 72773111007066 | Gasoline Vehicle Equipped with Catalytic Converter - Medium Heavy Duty Trucks (MHDT) - Catalyst Start - Gasoline (Unspecified) - T6TS |
| 72873111007080 | Gasoline Vehicle Equipped with Catalytic Converter - Heavy Heavy Duty Trucks (HHDT) - Catalyst Start - Gasoline (Unspecified) - T7IS |
| 73273111000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light Heavy Duty Gas Trucks - 1 (LHDT1) - Catalyst Start - Gasoline (Unspecified) - Sub-Category Unspecified |
| 73373111000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light Heavy Duty Gas Trucks - 2 (LHDT2) - Catalyst Start - Gasoline (Unspecified) - Sub-Category Unspecified |
| 73473111000000 | Gasoline Vehicle Equipped with Catalytic Converter - Medium Heavy Duty Gas Trucks (MHDV) - Catalyst Start - Gasoline (Unspecified) - Sub-Category Unspecified |
| 73673111000000 | Gasoline Vehicle Equipped with Catalytic Converter - Heavy Heavy Duty Gas Trucks (HHDV) - Catalyst Start - Gasoline (Unspecified) - Sub-Category Unspecified |
| 75073111000000 | Gasoline Vehicle Equipped with Catalytic Converter - Motorcycles (MCY) - Catalyst Start - Gasoline (Unspecified) - Sub-Category Unspecified |
| 76273111000000 | Gasoline Vehicle Equipped with Catalytic Converter - Heavy Duty Gas Urban Buses (UB) - Catalyst Start - Gasoline (Unspecified) - Sub-Category Unspecified |
| 77073111000000 | Gasoline Vehicle Equipped with Catalytic Converter - School Buses (SB) - Catalyst Start - Gasoline (Unspecified) - Sub-Category Unspecified |
| 77173111000000 | Gasoline Vehicle Equipped with Catalytic Converter - School Buses - Gas (SBG) - Catalyst Start - Gasoline (Unspecified) - Sub-Category Unspecified |
| 77573111007200 | Gasoline Vehicle Equipped with Catalytic Converter - Buses - Catalyst Start - Gasoline (Unspecified) - Other Bus (OB) |
| 77573111007203 | Gasoline Vehicle Equipped with Catalytic Converter - Buses - Catalyst Start - Gasoline (Unspecified) - School Buses (SB) |
| 77573111007204 | Gasoline Vehicle Equipped with Catalytic Converter - Buses - Catalyst Start - Gasoline (Unspecified) - Heavy Duty Urban Buses (UB) |
| 77673111000000 | Gasoline Vehicle Equipped with Catalytic Converter - Other Buses (OB) - Catalyst Start - Gasoline (Unspecified) - Sub-Category Unspecified |
| 77773111000000 | Gasoline Vehicle Equipped with Catalytic Converter - Other Buses - Gas (OBG) - Catalyst Start - Gasoline (Unspecified) - Sub-Category Unspecified |

| EIC | EIC Name |
|---------------|--|
| 7807311100000 | Gasoline Vehicle Equipped with Catalytic Converter - Motor Homes (MH) - Catalyst Start - Gasoline (Unspecified) - Sub-Category Unspecified |

Table 5. Mapping of PM4007 to on-road gasoline vehicle running and idle categories

| EIC | EIC Name |
|----------------|--|
| 71073411000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light Duty Passenger (LDA) - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 71073413100000 | Light Duty Passenger (LDA) - Catalyst Hot Stabilized Exhaust - Plug-In Hybrid Electric Vehicle (PHEV) - Sub-Category Unspecified |
| 72073411000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light and Medium Duty Trucks - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 72273411000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light Duty Trucks - 1 (LDT1) - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 72273413100000 | Light Duty Trucks - 1 (LDT1) - Catalyst Hot Stabilized Exhaust - Plug-In Hybrid Electric Vehicle (PHEV) - Sub-Category Unspecified |
| 72373411000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light Duty Trucks - 2 (LDT2) - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 72373413100000 | Light Duty Trucks - 2 (LDT2) - Catalyst Hot Stabilized Exhaust - Plug-In Hybrid Electric Vehicle (PHEV) - Sub-Category Unspecified |
| 72473411000000 | Gasoline Vehicle Equipped with Catalytic Converter - Medium Duty Trucks (MDV) - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 72473413100000 | Medium Heavy Duty Trucks (MHDT) - Catalyst Hot Stabilized Exhaust - Plug-In Hybrid Electric Vehicle (PHEV) - Sub-Category Unspecified |
| 72573411000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light Heavy Duty Trucks - 1 (LHDT1) - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 72673411000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light Heavy Duty Trucks - 2 (LHDT2) - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 72773411007066 | Gasoline Vehicle Equipped with Catalytic Converter - Medium Heavy Duty Trucks (MHDT) - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - T6TS |
| 72873411007080 | Gasoline Vehicle Equipped with Catalytic Converter - Heavy Heavy Duty Trucks (HHDT) - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - T7IS |
| 73073411000000 | Gasoline Vehicle Equipped with Catalytic Converter - Heavy Duty Gas Trucks (All) - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 73273411000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light Heavy Duty Gas Trucks - 1 (LHDV1) - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |

| EIC | EIC Name |
|----------------|--|
| 73373411000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light Heavy Duty Gas Trucks - 2 (LHDV2) - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 73473411000000 | Gasoline Vehicle Equipped with Catalytic Converter - Medium Heavy Duty Gas Trucks (MHDV) - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 73673411000000 | Gasoline Vehicle Equipped with Catalytic Converter - Heavy Heavy Duty Gas Trucks (HHDV) - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 75073411000000 | Gasoline Vehicle Equipped with Catalytic Converter - Motorcycles (MCY) - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 76273411000000 | Gasoline Vehicle Equipped with Catalytic Converter - Heavy Duty Gas Urban Buses (UB) - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 77073411000000 | Gasoline Vehicle Equipped with Catalytic Converter - School Buses (SB) - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 77173411000000 | Gasoline Vehicle Equipped with Catalytic Converter - School Buses - Gas (SBG) - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 77573411007200 | Gasoline Vehicle Equipped with Catalytic Converter - Buses - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Other Bus (OB) |
| 77573411007203 | Gasoline Vehicle Equipped with Catalytic Converter - Buses - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - School Buses (SB) |
| 77573411007204 | Gasoline Vehicle Equipped with Catalytic Converter - Buses - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Heavy Duty Urban Buses (UB) |
| 77673411000000 | Gasoline Vehicle Equipped with Catalytic Converter - Other Buses (OB) - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 77773411000000 | Gasoline Vehicle Equipped with Catalytic Converter - Other Buses - Gas (OBG) - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 78073411000000 | Gasoline Vehicle Equipped with Catalytic Converter - Motor Homes (MH) - Catalyst Hot Stabilized Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 72573511000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light Heavy Duty Trucks - 1 (LHDT1) - Catalyst Idle Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 72673511000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light Heavy Duty Trucks - 2 (LHDT2) - Catalyst Idle Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 72773511007066 | Gasoline Vehicle Equipped with Catalytic Converter - Medium Heavy Duty Trucks (MHDT) - Catalyst Idle Exhaust - Gasoline (Unspecified) - T6TS |

| EIC | EIC Name |
|----------------|--|
| 73273511000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light Heavy Duty Gas Trucks - 1 (LHDV1) - Catalyst Idle Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 73373511000000 | Gasoline Vehicle Equipped with Catalytic Converter - Light Heavy Duty Gas Trucks - 2 (LHDV2) - Catalyst Idle Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 73473511000000 | Gasoline Vehicle Equipped with Catalytic Converter - Medium Heavy Duty Gas Trucks (MHDV) - Catalyst Idle Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 73673511000000 | Gasoline Vehicle Equipped with Catalytic Converter - Heavy Heavy Duty Gas Trucks (HHDV) - Catalyst Idle Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 77073511000000 | Gasoline Vehicle Equipped with Catalytic Converter - School Buses (SB) - Catalyst Idle Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 77173511000000 | Gasoline Vehicle Equipped with Catalytic Converter - School Buses - Gas (SBG) - Catalyst Idle Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 77573511007200 | Gasoline Vehicle Equipped with Catalytic Converter - Buses - Catalyst Idle Exhaust - Gasoline (Unspecified) - Other Bus (OB) |
| 77573511007203 | Gasoline Vehicle Equipped with Catalytic Converter - Buses - Catalyst Idle Exhaust - Gasoline (Unspecified) - School Buses (SB) |
| 77673511000000 | Gasoline Vehicle Equipped with Catalytic Converter - Other Buses (OB) - Catalyst Idle Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |
| 77773511000000 | Gasoline Vehicle Equipped with Catalytic Converter - Other Buses - Gas (OBG) - Catalyst Idle Exhaust - Gasoline (Unspecified) - Sub-Category Unspecified |