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NATIONAL VEHICLE AND FUEL EMISSIONS LABORATORY
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MEMORANDUM

SUBJECT: Modifications to Heavy-Duty Diesel Emission Rates, Heavy Duty Mileage Accumulation, and Age Distributions in MOBILE5b for Tier 2/Sulfur NPRM

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TO: Docket A-97-10

This memorandum documents modifications made to MOBILE5b in order to update estimates of heavy-duty emissions. Some of these changes apply only to heavy-duty diesel (HDDV) vehicle emissions, while others apply to both HDDV and heavy-duty gasoline vehicle emissions (HDGV). Emission factors produced by this updated model were used to estimate emissions inventories for VOC and NO_x in the Tier 2 Sulfur NPRM. This memorandum only addresses changes to the MOBILE model for heavy duty emissions. Separate memoranda address changes in the PART5 model and how the resulting emission factors were used to estimate the emissions inventory. This memo documents updates to MOBILE5b in three areas for heavy duty vehicle emissions:

- basic emission rates (HDDV only)
- mileage accumulation rates (HDDV and HDGV)
- age distributions (HDDV and HDGV)

Basic Emission rates

The emission rates for heavy-duty diesel engines have changed over time. To assure that the Tier2 calculations use the most up-to-date basic emission rates, the modeling effort used updated rates developed for MOBILE6. The M6 heavy-duty BERs are given in grams/mile (g/mi) and can be found in EPA report # M6.HDE.001, entitled "Update of Heavy-Duty Emission Levels (MY 1988-2004+) for use in MOBILE6." The M6 BERs were segregated into eight heavy-duty vehicle weight classes (2b, 3, 4, 5, 6, 7, 8a, 8b) and three heavy-duty bus classes (transit, commercial, and school) while MOBILE5b input only allows for one heavy-duty BER that covers all of these classes. This document describes how the new heavy-duty diesel Basic Emission Rates (BERs) that will be used in MOBILE6 (M6) were adjusted so they would fit in the MOBILE5b input file format needed for the Tier2 modeling.

M6 BERs were weighted together to come up with a combined BER that could be used a MOBILE5b input file. This method was used for total hydrocarbons (THC) and oxides of nitrogen. Vehicle miles traveled (VMT) weighting factors were used to weight the BERs. These VMT weighting factors were segregated into 6 heavy-duty vehicle weight classes (2b, 3, 4-5, 6-7, 8a, 8b) and 2 heavy-duty bus classes (transit and school). In order to weight the M6 BERs with these VMT factors, the M6 BERs for weight classes 4 and 5 had to be averaged together, as did the BERs for weight classes 6 and 7, and heavy-duty transit buses with heavy-duty commercial buses. The VMT weighting factors were derived from 1996 vehicle counts, age distribution, and mileage accumulation rates obtained from EPA report # M6.FLT.007 entitled "Fleet Characterization Data for MOBILE6 Development and Use of Registration Distribution by Age, Average Annual Mileage Accumulation Rates by Age and Projected Vehicle Counts for Use in MOBILE6." VMT weighting factors for each weight class were calculated using the following equation:

$$\frac{\sum_{i=1}^{25} [(1996 \text{ vehicle count}) * (\text{age distribution})_i * (\text{mileage accumulation})_i]}{\text{Total Heavy - Duty Diesel VMT}}$$

Where i = age

The M6 BERs for each weight class were weighted by their corresponding VMT factor. The new weighted M6 BERs were then summed together to derive one M6-based heavy-duty diesel BER in g/mi for each year 1988-2004+.

MOBILE5b only allows for heavy-duty diesel BERs to be inputted in grams/brake horsepower-hour (g/bhp-hr) space, therefore the new M6-based heavy-duty diesel BERs had to be converted. MOBILE5 conversion factors found in AP-42 were used to convert g/mi to g/bhp-hr to obtain a new M6-based heavy-duty BER in g/bhp-hr for each year 1988-2004+. The conversion factors that were used are listed in the table below.

Pollutant	Years	Conversion Factor (bhp-hr/mi)
THC	1996-2050	2.037
NOx	1996-1997	2.039
	1998-2050	2.036

The inputs for hydrocarbon needed to be in terms of Non-Methane hydrocarbons (NMHC), therefore the MOBILE5 conversion factor (.9823) used to convert THC to NMHC found in AP-42 were used to convert the new heavy-duty THC BERs to NMHC BERs.

The resulting BERs that were calculated using the method described above and that were used in the input files for Modified MOBILE5b runs are listed in the table below.

Pollutant	Year	Heavy-Duty Diesel BERs
NMHC	1996-2030	0.316
NOx	1996-1997	5.069
	1998-2003	4.057
	2004-2030	2.029

Mileage Accumulation and Age Distribution Rates

The mileage accumulation rates and age distribution rates that are in MOBILE5b (M5b) are being updated for MOBILE6 (M6). To assure that the Tier2 calculations use the most up-to-date information available, the Tier2 modeling effort used these updated mileage accumulation rates and age distribution rates in the modified M5b runs. These rates are documented in EPA report M6.FLT.007 entitled "Fleet Characterization Data for MOBILE6: Development and Use of Registration Distribution by Age, Average Annual Mileage Accumulation Rates by Age and Projected Vehicle Counts for Use in MOBILE6." At the time the Tier2 work was done, the M6 mileage accumulation rates were split into a number of separate weight classes. M5b only allows for one set of mileage accumulation rates for gasoline and one set for diesel that cover all the weight classes, and one set of age distributions for both gasoline and diesel that covers all weight classes. This document describes how the heavy-duty diesel and gasoline mileage accumulation rates and heavy-duty age distribution rates that will be used in M6 were adjusted to fit in a M5b input file format.

Mileage Accumulation Rates

The 1996 vehicle count for the eight heavy-duty diesel weight classes and the four heavy-duty gasoline weight classes that are being used in M6 can be found in the report cited above. The following method was used for both heavy-duty diesel and for heavy-duty gasoline. We developed a weighted average with vehicle counts used to weight the mileage accumulation rates. The following mileage accumulation rates were used in the modified M5b runs.

Heavy-Duty Gasoline Mileage Accumulation Rates:

.20112 .18813 .17602 .16470 .15413 .14427 .13505 .12645 .11841 .11090
.10388 .09732 .09120 .08548 .08012 .07512 .07045 .06608 .06199 .05817
.05460 .05126 .04813 .04521 .04248

Heavy-Duty Diesel Mileage Accumulation Rates:

.62211 .56358 .51067 .46283 .41958 .38047 .34510 .31311 .28417 .25799
.23430 .21286 .19346 .17590 .16001 .14562 .13259 .12079 .11011 .10042
.09166 .08371 .07651 .06999 .06407

Age Distribution Rate

The age distributions for heavy-duty gasoline and diesel vehicles being used in M6 can be found in the report cited above. At the time this work was done there was one set of age distribution rates for heavy-duty diesel and gasoline vehicles. The age distribution rates were split into four classes (2b-3, 4-8, transit buses, school buses) for ages 1-30. Heavy-duty diesel and gasoline vehicle counts were combined. We computed a weighted average age distribution with weighting by vehicle count. M5b's input file format only allows for age distribution rates for ages 1-25, therefore the age distribution rate for age 25 is a combination of ages 25-30. The following is the set of age distribution rates that were used for both heavy-duty diesel and heavy-duty gasoline age distribution rates in the M5b input file.

Heavy-Duty Gasoline and Diesel Age Distribution:

.056 .090 .083 .077 .072 .067 .062 .058 .054 .051 .048 .045 .042 .039 .035 .032 .027 .023 .021
.019 .017 .016 .015 .013 .061