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Accounting for the Tier 2 and Heavy-Duty 2005/2007 Requirements in MOBILE6

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Accounting for the Tier 2 and Heavy-Duty 2005/2007 Requirements in MOBILE6

Final Report M6.EXH.004

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Introduction

This report details how MOBILE6 accounts for the effects of the Tier 2 vehicle and fuel program for light-duty vehicles,[1] and new standards for heavy-duty vehicles beginning as required under two recently finalized regulations known as the "Heavy-Duty 2005 rule" and the "Heavy-Duty 2007 rule".[2,3] The focus of this report is to present the methodology for implementing these requirements in MOBILE6, and contains only a brief overview of each requirement. The requirements themselves should be consulted for an in-depth treatment of the rule provisions, and for background on the terminology applied in the rules.

Tier 2

Vehicle exhaust standards

The Tier 2 vehicle program, finalized in December 1999, represents significantly more stringent tailpipe standards for HC and NOx across all light-duty vehicles and trucks. Ultimately, all light-duty vehicles and trucks will be held to the same fleet average emission standard. However, the Tier 2 program allows significant flexibility in meeting these fleet average emission requirements, including the use of interim standards and the use of multiple certification "bins" which manufacturers can use to comply with the overall Tier 2 requirement. This flexibility allows innumerable approaches which manufacturers can take to comply with Tier 2, which in turn introduces considerable complexity in addressing Tier 2 in MOBILE6. The approach for Tier 2 compliance contained in MOBILE6 reflects one set of assumptions about how manufacturers will comply with the requirement, but it is not the sole approach available.

The overall Tier 2 requirement is implemented from model years 2004 through 2009. Ultimately, all light-duty vehicles (LDVs) and trucks (LDTs) are required to meet, on average, a full-useful life NOx standard of 0.07 grams/mile by 2009. Prior to this, LDVs and trucks under 6,000 pounds (LDT1s and LDT2s) are subject to one set of fleet average NOx requirements, and trucks over 6,000 pounds (LDT3s and LDT4s) another. The fleet average NOx emission standards and phase-in schedules proposed for the vehicle component of the Tier 2/Sulfur program are shown in Table 1. In 2004, LDT2s would meet the same emission standards required under the National Low-Emitting Vehicle (NLEV) program for LDVs and LDT1s (i.e. "LDV LEV" standards). LDVs, LDT1s and LDT2s as a group would then phase in to a 0.07 full useful life (120,000 mile) gram/mile NOx standard from 2004 to 2007. LDT3s and LDT4s are treated as a separate group; in 2004, these vehicles would meet standards for MDV2s under

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[1]Federal Register Volume 65, Number 28, February 10 2000, Page 6698 "Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements"

[2]Federal Register Volume 65, Number 195, October 6, 2000, Page 59897 "Emissions Control, Air Pollution from 2004 and Later Model Year Heavy-Duty Highway Engines and Vehicles"

[3]Federal Register Volume 66, Number 12, January 18, 2001, Page 5002 "Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements"

California's Low-Emitting Vehicle (LEV I) program; as a group, LDT3s and LDT4s would then phase in to a 0.20 gram/mile NOx standard (and 0.156 gram/mile NMOG standard) from 2004 to 2007. Finally, LDT3s and LDT4s would phase in to the 0.07 gram/mile NOx and 0.09 gram/mile NMOG standards over 2008 and 2009.

Table 1 - Fleet Average Tier 2 NOx Standards and Required Phase-In Schedules

Model Year	LDV/T1/T2		LDT3/4	
	Full Useful Life NOx Fleet Average Standard (g/mi)	Required Phase-In	Full Useful Life NOx Fleet Average Standard (g/mi)	Required Phase-In
2004 (Interim)	0.30	100%	0.60	100%
2004	0.07	25%	0.20	25%
2005	0.07	50%	0.20	50%
2006	0.07	75%	0.20	75%
2007	0.07	100%	0.20	100%
2008	0.07	100%	0.07	50%
2009 and later	Fleet Average Across All Classes = 0.07 gram/mile			

Under the Tier 2 program, manufacturers may certify their vehicles in any combination of 10 certification "bins" which result in the NOx fleet average and phase-in requirements contained in Table 1 (for a full description of the Tier 2 bin structure and individual bin emission standards, consult the Tier 2 final rule). Many of these certification bins overlap with the emission certification categories in California's LEV II program: LEV, ULEV, SULEV, and ZEV.[4]

We have developed one possible phase-in schedule for inclusion in MOBILE6, based on several assumptions about how manufacturers will comply with the requirement. This phase-in schedule is shown in Attachment A. This phase-in schedule is based on the premise that manufacturers will take full advantage of the opportunity to trade off higher emissions on heavier trucks with lower emissions on LDVs and lighter trucks. Specifically, we are assuming that the bin structure will provide incentives for manufacturers to build LDV/LDT1 SULEVs under the Tier 2 program because of this ability to trade off with the heavier trucks. It is also likely that manufacturers who produce partial ZEVs (PZEVs) to comply with the ZEV requirement in California will certify these vehicles as SULEVs federally.

The default Tier 2 phase-in schedule included in MOBILE6 was developed using four

[4]California Air Resources Board, "LEV II and CAP 2000 Amendments to the California Exhaust and Evaporative Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles, and to the Evaporative Emission Requirements for Heavy-Duty Vehicles: Final Statement of Reasons", September 1999

basic principles:

1) Only LDV/LDT1s will certify in Bin 2 (SULEV) and Bin 3.

2) During phase-in years, manufacturers will comply with the lightest classes first (i.e., 100 percent of LDV/T1 will meet the 0.07 g/mi NOx requirement before any LDT2s are brought in, and the 50 percent LDT3/4 0.07 g/mi NOx requirement in 2008 will be met with LDT3s only).

3) Manufacturers will trade off LDT2 vs. LDV/T1 in 2007, resulting in a 120,000 mile NMOG average of 0.077 g/mi for LDV/LDT1/LDT in 2007 and 2008.

4) Manufacturers will trade off LDT3/4 vs. LDV/T1/T2 in 2009, so that all LDT3/4 (except the LDT3s required to be at 0.07 to meet the LDT3/4 requirement) are in Bin 8; this results in a 120,000 mile NMOG average of 0.07 g/mi across all vehicles for 2009 and later.

For MOBILE6, basic emission rates for each Tier 2 certification bin were developed based on the methodology presenting in MOBILE6 report M6.EXH.007, "Determination of NOx and HC Basic Emission Rates, OBD and I/M Effects for Tier 1 and later LDVs and LDTs". To develop a composite emission rate for Tier 2 vehicles, MOBILE6 aggregates the emission rates for each bin by the phase-in percentages presented in Attachment A, by model year and vehicle class.

The Tier 2 program does not contain a specific NMOG fleet average requirement, but NMOG emissions will be reduced under Tier 2 through the implementation of the certification "bin" structure. The fleet-average NMOG emission values under Tier 2 are driven solely by the distribution of vehicles across the certification bins. Table 2 shows the NOx and NMOG fleet averages which result when the default MOBILE6 phase-in assumptions are employed in conjunction with the projected sales splits assumed implicitly within MOBILE6.[5]

[5]MOBILE6 assumes that the share of truck sales relative to vehicles would grow to 60 percent in 2008, then level off. Within the truck classes, the splits were held constant: LDT1 = 18%, LDT2 = 57%, LDT3 = 17%, LDT4 = 8%, as derived from projected sales data for the 1999 model year.

Table 2: 120K Light-Duty NOx/NMOG Fleet Averages (g/mi)

Model Year	NOx	NMOG
2004	0.277	0.108
2005	0.214	0.106
2006	0.152	0.104
2007	0.088	0.088
2008	0.079	0.081
2009	0.070	0.070
2010	0.070	0.070

Vehicle Evaporative Standards

The Tier 2 requirement includes more stringent standards for the 2 and 3-day evaporative test procedure. California's LEV II requirement also includes evaporative emission standards. The standards for both the Tier 2 and LEV II programs are shown in Table

Table 3: Evaporative HC Standards Under Tier 2 and LEV II (grams/test over 3-day diurnal + hot soak)

Vehicle Class	Current	Tier 2	LEV II
LDV	2.0	0.95	0.5
LDT1		0.95	0.65
LDT2		0.95	0.65
LDT3/LD4		1.2	0.95

California's program requires the phase-in to the LEV II standards at 40 percent in 2004, 80 percent in 2005, and 100 percent in 2006. The Tier 2 standards are phased-in according to the same schedule required for the final NOx exhaust standards, presented in Table 1.

For MOBILE6 we are assuming that the LEV II evaporative standards will drive benefits under the Tier 2 program as well. This approach is based on our analysis of the relative stringency of the California and EPA standards as well as input from auto manufacturers, who have indicated to EPA their plans to build a single evaporative emission control system to comply with both the Federal and California evaporative requirements. The primary driver of this is that the Tier 2 evaporative program, while having slightly less stringent certification standards, includes a provision which requires manufacturers to certify the durability of their systems using the maximum allowable alcohol fuel levels; California does not require this provision. To

compensate for the increased vulnerability of system components to alcohol fuel, manufacturers will need to build a more durable system than the standard would imply using the same low permeability hoses and low loss connections planned for LEV II vehicles.

Manufacturers have provided written assurances to EPA that the alcohol fuels provision of the federal standards, and relative difficulty in "finessing" evaporative emissions between the LEV II and Tier 2 standards, will necessitate the development of a single federal system complying with the California standards. We will revisit this assumption when certification data is available on evaporative Tier 2 vehicles to determine whether this approach is still warranted.

MOBILE6 estimates evaporative emissions under the new standards by applying a percent reduction to the basic emission rates for diurnals and hot soak according to the percent reduction between the current standards and the LEV II standards. Thus, the percent reduction for LDVs is 75 percent, for LDT1s and LDT2s 67.5 percent, and for LDT3s and LDT4s 52.5 percent.

Fuel standards

Under the Tier 2 rule, gasoline producers are required to reduce fuel sulfur levels to 120 ppm in 2004, 90 ppm in 2005 and 30 ppm in 2006, on average. However, there are provisions which allow small refiners and gasoline producers in western states to achieve the 30 ppm average on a longer timetable. In addition, Averaging, Banking and Trading (ABT) provisions allow refiners who achieve early reductions in gasoline fuel sulfur levels to apply these reductions against the requirement in later years.

MOBILE6 accounts for the small refiner (termed "SBREFA"), geographic phase-in (termed "GPI") and ABT provisions contained in the Tier 2 fuel program through the development of composite by-calendar year fuel sulfur levels which estimate the effects of these provisions on a volume basis. The MOBILE6 modeling approach is based directly on the modeling assumptions developed in support of the Tier 2 rule, which developed composite fuel sulfur levels by calendar year for several fuel "categories" accounting all fuel sold in the U.S.[6] Based on the definition of Eastern U.S and Western U.S. defined by API and NPRA in their sulfur program proposed to EPA,[7] the Tier 2 modeling methodology divided the fuel produced in the 47-state region into five fuel categories, as shown in Table 4. The primary modification between the approach used in the Tier 2 rule modeling and MOBILE6 is the definition of these fuel categories; MOBILE6 developed three categories based on aggregating the five categories defined for the Tier 2 modeling. As shown in Table 4, the three MOBILE6 categories are East Conventional, RFG, and West.

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[6]"Development of Light-Duty Emission Inventory Estimates in the Final Rulemaking for Tier 2 and Sulfur Standards", Memorandum from John Koupal to Docket A-97-10, December 15, 1999.

[7]Under the API/NPRA proposal, Eastern U.S. consists of eastern Texas, Oklahoma, Mississippi, Tennessee, Missouri, Illionois, Wisconsin, and all those states (including the District of Columbia) east of these states. A detailed accounting of the API proposal is contained in the Tier 2 regulatory docket, A-97-10

Table 4 - MOBILE6 Fuel Categories

Tier 2 Fuel Category	Description	MOBILE6 Category
East Convential Gasoline (CG)	Conventional gasoline areas in the east	East CG
East SBREFA	Fuel produced by SBREFA refiners in the east	
Reformulated Gasoline (RFG)	Reformulated Gasoline areas (all in the east)	RFG
West SBREFA	Fuel produced by SBREFA refiners in the west	West
West GPI	Fuel produced by western refiners under the geographic phase-in	

The default sulfur levels contained in MOBILE6 were developed by first estimating sulfur levels for each of the five Tier 2 categories shown in Table 4, then aggregating into the three MOBILE6 categories according to weightings of fuel production across each of the categories. The first step in this analysis was to define the sulfur levels (average and cap) for each fuel category by calendar year for the baseline and control scenarios. Focusing on the projection of the average sulfur levels first, the sulfur levels in 2000 were determined from an assessment of refiner's certification records from 1998. Outside of California, gasoline sulfur levels averaged 268 ppm in 1998. EPA projects that RFG will average roughly 150 ppm beginning in 2000 in order to meet the Phase 2 RFG NOx performance specification.[8] Comments from a number of oil refiners and NPRA indicated that refiners would not reduce the sulfur of their total gasoline pool in order to meet the Phase 2 RFG NOx performance specification in 2000, but would shift sulfur from RFG to CG in the summer and vice versa in the winter. The average sulfur level of RFG in 1998 was 207 ppm. Because this level is fairly close to the 150 ppm RFG target, it is quite conceivable that refiners could perform the sulfur shift outlined in the comments to the proposed rule. Assuming that the sulfur level of summer RFG was reduced from 207 to 150 ppm, we determined that the sulfur level of CG and winter RFG would increase from its 1998 level of 295 ppm to 300 ppm. For the baseline case, sulfur levels are assumed to stay constant from calendar year 2000 onward; the baseline levels for years 2000 and later are shown in Table 5. Because the SBREFA and GPI provisions are not applicable in the baseline case, the fuel categories developed for the Tier 2 modeling methodology are directly applicable in MOBILE6.

[8] "Draft Regulatory Impact Analysis - Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements", EPA Report EPA420-D-99-001, April 1999

Table 5 - Default MOBILE6 Sulfur Levels Without Tier 2 (ppm)

Calendar Year	East Conventional		RFG		West Conventional	
	Average	Cap	Average	Cap	Average	Cap
2000 & later	300	1000	150	500	300	1000

For the "with Tier 2" case, sulfur levels in 2001-2003 were estimated from 2000 sulfur levels using the sulfur reductions which would occur from desulfurization units projected to be built and operating prior to 2004. These projections are described in Section IV.B.8. of the Final Tier 2 Regulatory Impact Analysis (RIA).[9] Based on the operation of these new units, we project that pool sulfur levels will decrease by 1, 21 and 37 ppm in 2001, 2002, and 2003. These reductions were applied uniformly to each fuel category with one exception. In 2003, a reduction of 37 ppm would have reduced RFG sulfur levels to less than 120 ppm, the corporate average standard in 2004. To avoid this, the RFG sulfur level was assumed to decrease to only 120 ppm in 2003 and the sulfur level of the remainder category of CG and RFG was decreased by 41 ppm instead of only 37 ppm. This results in a 37 ppm reduction in the non-California pool average sulfur level.

In 2004 and 2005, fuel subject to the corporate average standards, RFG and the remainder category of RFG and CG, was assumed to average at the corporate average standards, 120 and 90 ppm, respectively. The average sulfur levels of fuel certified to these standards may be below these levels due to refiners desire to maintain a safety margin between their actual sulfur levels and enforcement levels. However, the degree of this potential margin is not known and is not guaranteed by the applicable standards.

In 2004-2007, small refiners under the SBREFA program are governed by average standards which are a function of their current sulfur level. We estimated these standards for the 16 small refiners based on their sulfur certification data in 1998. In the east, the volume-weighted average of these standards was 191 ppm and in the west was 208 ppm. We assumed that these refiners would produce fuel at these sulfur levels until 2008, when the 30 ppm refinery average standard applies.

In 2004-2006, refineries covered by the geographic phase-in must meet a 150 ppm refinery average standard. We assumed that these refineries would produce fuel at this level.

For all categories of fuel, once the 30 ppm refinery average standard began to apply, we assumed that commercial gasoline in these categories would average at the standard, 30 ppm.

With respect to the maximum sulfur level possible in any fuel category, we based these

[9]"Regulatory Impact Analysis - Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements", EPA Report EPA420-R-99-023, December 1999

levels on the maximum allowable sulfur level from any individual refinery in the category. The Complex Model places a limit of 500 ppm sulfur on RFG and 1000 ppm for CG; therefore these levels were applied to RFG and CG fuel categories, respectively, from 2000-2003. Beginning in 2004, the maximum sulfur level of each fuel category was assumed to be the cap applicable to that category of fuel. Thus, these levels are simply a function of the final caps for these fuel categories. Maximum sulfur levels are used only for the calculation of sulfur "irreversibility" effects, discussed in detail in the MOBILE6 report M6.FUL.001, "Fuel Sulfur Effects on Exhaust Emissions".

Table 6 shows the sulfur levels with Tier 2 as derived by the process described above, for the disaggregated categories from Table 4. These disaggregate categories were then weighted by the fuel production weightings in Table 7, resulting in the MOBILE6 sulfur levels with Tier 2 across the three MOBILE6 fuel categories.

Table 6 - Sulfur Levels With Tier 2: Disaggregate Categories (ppm)

Year	East Conventional		East SBREFA		RFG		West SBREFA		West GPI	
	Avg	Cap	Avg	Cap	Avg	Cap	Avg	Cap	Avg	Cap
2000	300	1000	300	1000	150	500	300	1000	300	1000
2001	299	1000	299	1000	149	500	299	1000	299	1000
2002	279	1000	279	1000	129	500	279	1000	279	1000
2003	259	1000	263	1000	120	500	263	1000	263	1000
2004	120	300	191	450	120	300	208	450	150	300
2005	90	300	191	450	90	300	208	450	150	300
2006	30	80	191	450	30	80	208	450	150	300
2007	30	80	191	450	30	80	208	450	30	80
2008 & later	30	80	30	80	30	80	30	80	30	80

Table 7 - Non-RFG Category Weightings (by fuel consumption)

Tier 2 (Disaggregate) Fuel Category	Weightings	MOBILE6 Category
East CG	0.98	East CG
East SBREFA	0.02	
West SBREFA	0.16	West
West GPI	0.84	

Table 8 - Sulfur Levels With Tier 2: MOBILE6 Categories (ppm)

Year	East Conventional		RFG		West Conventional	
	Average	Cap	Average	Cap	Average	Cap
2000	300	1000	150	500	300	1000
2001	299	1000	149	500	299	1000
2002	279	1000	129	500	279	1000
2003	259	1000	120	500	263	1000
2004	121	303	120	300	160	325
2005	92	303	90	300	160	325
2006	33	87	30	80	160	325
2007	33	87	30	80	60	142
2008 & later	30	80	30	80	30	80

New Standards for Heavy-Duty Gasoline Vehicles

Methodology for Developing Basic Exhaust Emission Rates

Heavy-Duty Gas Vehicles (HDGVs) will be subject to new standards under three separate requirements. A first phase of exhaust and evaporative standards affecting all HDGVs will begin implementation in 2005, and hence are referred to as the “2005 rule"; the Tier 2 “Medium Duty Passenger Vehicle” (MDPV) standards will reduce emissions further for a subset of HDGV2bs beginning in 2008. The recently finalized Heavy-Duty 2007 rule (“2007 rule”) for diesel engines also will require emission reductions for the remainder of HDGVs beginning in 2008. These standards are shown in Table 9.

Table 9: HC/NOx 120,000 Mile Standards for HDGV (g/mi unless otherwise noted)

Class	2b			3		4-8 (g/bhp-hr)
	MDPV	Other Complete	Incomplete (g/bhp-hr)	Complete	Incomplete (g/bhp-hr)	
Pre-2005 (all g/bhp-hr)	0.9/4.00					1.7/4.0
2005 Rule	0.28/0.9	0.28/0.9	0.2/0.8	0.33/1.0	0.2/0.8	0.2/0.8
Tier 2	0.075/0.07	0.28/0.9	0.2/0.8	0.33/1.0	0.2/0.8	0.2/0.8
2007 Rule	0.075/0.07	0.195/0.2	0.14/0.2	0.23/0.4	0.14/0.2	0.14/0.2

2005 Standards

The methodology for deriving HC and NOx BERs for HDGVs under the 2005 requirements is contained in the Chapter 7 of the Regulatory Impact Analysis (RIA) for the Heavy-Duty Gas rulemaking.[10] As outlined in this document, BERs were derived by assuming a similar margin of compliance with the certification standards as for the pre-control BERs. In the RIA, separate BERs were derived for three sets of HDG classes: 2b Completes, 3 Completes, and Incomplete for all classes. Because MOBILE6 will not differentiate between Complete and Incomplete certification classes, an additional step was required for this analysis to generate a combined BER for the 2b and 3 classes. The was performed by weighting together the Complete/Incomplete emission rates according to sales figures for the 1996 model year provided by manufacturers in the Heavy-Duty Gas 2005 rule, which indicated that Completes would comprise 96 percent of HDGV2b (458,447 out of 485,046) and 15 percent of HDGV3 (38,733 out of 124,265). For the MOBILE6 analysis, the BERs for Completes/Incompletes presented in the HDG rule where therefore weighted according to 96/4 and 15/85 splits for 2bs and 3s, respectively. The resulting BERs are shown in Tables 2 and 3. Because the 2005 HDG standards for HC are expressed as NMOG, the BERs also reflect NMOG and should be handled accordingly in the model. CO standards are not reduced in 2005, so updated BERs are not required to reflect the heavy-duty rule.

Tier 2 MDPV Standards

The Tier 2 Medium-Duty Passenger Vehicle provisions require that a subset of HDG2bs used primarily as passenger vehicles (i.e. large sport utility vehicles such as the GM Suburban) meet the final Tier 2 standards (NMOG, NOx and CO) for light-duty trucks over 6,000 pounds by 2009. The specific requirement for these trucks is a full useful life standard of 0.09 g/mi NMOG and 0.07 g/mi NOx, phasing-in beginning in 2008 at 50 percent and 100 percent in 2009. In developing MOBILE6 BERs it was assumed that the subset of HDGV2bs required to meet these

[10] "Regulatory Impact Analysis: Control of Emissions of Air Pollution from Highway Heavy-Duty Engines", EPA Report EPA420-R-00-010, July 2000

standards will follow this phase-in schedule.

The effect of these standards was estimated through the 2009 and later BERs for HDG2bs. BERs for MDPVs were calculated by reducing the 2005 BERs (ZML and DR) by the ratio of the MDPV standards to the 2005 standards. The fraction of HDGV2b sales attributed to MDPVs was derived by dividing an estimate of annual sales for MDPVs of 75,000 from the Tier 2 RIA (Chapter 6)[11] by the number of HDGV2bs estimated in the heavy-duty rule (485,046), resulting in a fraction of 0.155. The overall 2009 HDGV2b BERs was then calculated by weighting together the 2005 (pre-Tier 2 BER) and the MDPV BER by a weighting split of 0.845/0.155. To model the 50 percent phase-in in 2008, the 2009 and 2005 BERs were averaged.

2007 Rule Standards

Basic emission rates corresponding to the standards under the 2007 rule were developed using the same methodology applied for the 2005 rule. Specifically, the same level of compliance was assumed in relation to the certification standard between the baseline (pre-2005), 2005 rule standards and 2007 rule standards. The emission rates were thus derived by applying the ratio of the 2005 and 2007 standards to the model year 2005 emission rates for all of the vehicles affected by the 2007 standards (including Class 2b vehicles not falling under the Tier 2 MDPV requirement).

The resulting emission rates reflecting the 2005, Tier 2 MPDV and 2007 rules are shown in Tables 10 through 13, by HDGV class 2b through 8b, and buses.

Table 10: Low Altitude NMOG Basic Emission Rates for MOBILE6 (g/mi)

NMOG ZML

Class:	2b	3	4	5	6	7	8a	8b	Bus
2005-07	0.118	0.104	0.096	0.113	0.111	0.123	0.131	0.131	0.153
2008	0.098	0.088	0.082	0.096	0.095	0.105	0.112	0.112	0.130
2009+	0.078	0.073	0.067	0.079	0.078	0.086	0.092	0.092	0.107

[11]"Regulatory Impact Analysis - Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements", EPA Report EPA420-R-99-023, December 1999

NMOG DR (per 10K miles)

Class:	2b	3	4	5	6	7	8a	8b	Bus
2005-07	0.008	0.006	0.006	0.007	0.007	0.007	0.008	0.008	0.009
2008	0.007	0.005	0.005	0.006	0.006	0.006	0.007	0.007	0.008
2009+	0.005	0.004	0.004	0.005	0.005	0.005	0.006	0.006	0.006

Table 11: Low Altitude NOx Basic Emission Rates for MOBILE6 (g/mi)

NOx ZML

Class:	2b	3	4	5	6	7	8a	8b	Bus
2005-07	0.573	0.594	0.578	0.675	0.669	0.737	0.785	0.785	0.916
2008	0.347	0.379	0.361	0.422	0.418	0.461	0.491	0.491	0.573
2009+	0.121	0.163	0.145	0.169	0.167	0.184	0.196	0.196	0.229

NOx DR (per 10K miles)

Class:	2b	3	4	5	6	7	8a	8b	Bus
2005-07	0.008	0.008	0.008	0.009	0.009	0.010	0.011	0.011	0.013
2008	0.005	0.005	0.005	0.006	0.006	0.006	0.007	0.007	0.008
2009+	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003

Table 12: High Altitude NMOG Basic Emission Rates for MOBILE6 (g/mi)

NMOG ZML

Class:	2b	3	4	5	6	7	8a	8b	Bus
2005-07	0.219	0.193	0.179	0.209	0.207	0.228	0.243	0.243	0.283
2008	0.182	0.163	0.152	0.178	0.176	0.194	0.207	0.207	0.241
2009+	0.145	0.136	0.125	0.146	0.145	0.160	0.170	0.170	0.198

NMOG DR

Class:	2b	3	4	5	6	7	8a	8b	Bus
2005-07	0.015	0.012	0.011	0.012	0.012	0.013	0.014	0.014	0.017
2008	0.013	0.009	0.009	0.010	0.010	0.011	0.012	0.012	0.014
2009+	0.009	0.007	0.008	0.008	0.008	0.009	0.010	0.010	0.012

Table 13: High Altitude NOx Basic Emission Rates for MOBILE6 (g/mi)

NOx ZML

Class:	2b	3	4	5	6	7	8a	8b	Bus
2005-07	0.469	0.486	0.473	0.552	0.547	0.603	0.642	0.642	0.749
2008	0.284	0.310	0.296	0.345	0.342	0.377	0.401	0.401	0.468
2009+	0.098	0.134	0.118	0.138	0.137	0.151	0.161	0.161	0.187

NOX DR

Class:	2b	3	4	5	6	7	8a	8b	Bus
2005-07	0.007	0.007	0.006	0.008	0.008	0.008	0.009	0.009	0.010
2008	0.004	0.004	0.004	0.005	0.005	0.005	0.006	0.006	0.006
2009+	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003

Evaporative Emission Rates for HDGV 2005/2007 Requirements

The 2005 and 2007 rules contain evaporative emission standards as well as exhaust standards. The methodology and emission rates for these requirements are contained in MOBILE6 report M6.EVP.001, “Evaluating Resting Loss and Diurnal Evaporative Emissions Using RTD Tests”, April 2001.

Heavy-Duty Diesel 2007 Rule

The heavy-duty 2007 rule requires significant reductions in PM, HC and NOx for all heavy-duty diesel engines beginning in 2007. Standards of 0.20 g/bhp-hr for NOx and 0.14 g/bhp-hr for NMHC are required on 50 percent of engines in 2007, and 100 percent in 2010. However, a 0.01 g/bhp-hr PM standard applies to 100 percent of engines in 2007, and the exhaust aftertreatment required to comply with this standard is expected to drive 100 percent compliance with the HC standard in 2007, and provide residual benefits in CO as well. These effects are modeled through the basic emission rates developed in MOBILE6.

The basic emission rates for MOBILE6 have been developed directly from those used in

the emission inventory work in support of the final rule, detailed in the Regulatory Impact Analysis of the final rule.[12] The primary modifications required for inclusion in MOBILE6 were a) the conversion of g/bhp-hour emission rates to grams/mile, using conversion factors developed for late-model heavy-duty engines and discussed in separate MOBILE6 documentation; [13] and b) the disaggregation of weight classes from those used in the regulatory support work to the MOBILE6 weight class definitions. The weight classes used in the regulatory work were simply an aggregation of the MOBILE6 classes, and the disaggregation process consisted of applying the aggregate emission rates (e.g. for the regulatory modeling class "light-heavy duty diesels") across each of the sub-classes (e.g. the MOBILE6 weight classes 2b and 3). This was therefore a trivial step but resulted in duplicate emission rates across multiple MOBILE6 classes.

The basic emission rates, in g/bhp-hr and gram/mile, are shown in Tables 14-16.

Table 14: 2007+ HDDV CO Basic Emission Rates for MOBILE6

Class	Start MY	g/bhp-hr		Correction Factor	g/mile	
		ZML	DR		ZML	DR
2b	2007	0.120	0.000	1.09	0.131	0.000
3	2007	0.120	0.000	1.25	0.150	0.000
4	2007	0.120	0.000	1.458	0.175	0.000
5	2007	0.120	0.000	1.573	0.189	0.000
6	2007	0.100	0.000	1.942	0.194	0.000
7	2007	0.100	0.000	2.409	0.241	0.000
8a	2007	0.120	0.000	2.763	0.332	0.000
8b	2007	0.120	0.000	3.031	0.364	0.000
School Bus	2007	0.100	0.000	2.989	0.299	0.000
Transit Bus	2007	0.110	0.000	4.679	0.515	0.000

[12] "Regulatory Impact Analysis - Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements", EPA Report EPA420-R-00-026, December 2000

[13] "Updated Heavy-Duty Engine Emission Conversion Factors for MOBILE6: Analysis of BSFCs and Calculation of Heavy-Duty Engine Emission Conversion Factors", EPA Report EPA420-P-98-015, May 1998

Table 15: 2007+ HDDV NMHC Basic Emission Rates for MOBILE6

Class	Start MY	g/bhp-hr		Correction Factor	g/mile	
		ZML	DR		ZML	DR
2b	2007	0.129	0.000	1.09	0.141	0.000
3	2007	0.129	0.000	1.25	0.161	0.000
4	2007	0.129	0.000	1.458	0.188	0.000
5	2007	0.129	0.000	1.573	0.203	0.000
6	2007	0.129	0.000	1.942	0.251	0.000
7	2007	0.129	0.000	2.409	0.311	0.000
8a	2007	0.129	0.000	2.763	0.356	0.000
8b	2007	0.129	0.000	3.031	0.391	0.000
School Bus	2007	0.129	0.000	2.989	0.386	0.000
Transit Bus	2007	0.080	0.000	4.679	0.374	0.000

Table 16: 2007+ HDDV NOx Basic Emission Rates for MOBILE6

Class	Start MY	g/bhp-hr		Correction Factor	g/mile	
		ZML	DR		ZML	DR
2b	2007	1.139	0.001	1.09	1.242	0.001
2b	2010	0.180	0.000	1.09	0.196	0.000
3	2007	1.139	0.001	1.25	1.424	0.001
3	2010	0.180	0.000	1.25	0.225	0.000
4	2007	1.139	0.001	1.458	1.661	0.001
4	2010	0.180	0.000	1.458	0.262	0.000
5	2007	1.139	0.001	1.573	1.792	0.002
5	2010	0.180	0.000	1.573	0.283	0.000
6	2007	1.131	0.001	1.942	2.196	0.002
6	2010	0.180	0.000	1.942	0.350	0.000
7	2007	1.131	0.001	2.409	2.725	0.002
7	2010	0.180	0.000	2.409	0.434	0.000
8a	2007	1.063	0.002	2.763	2.937	0.006
8a	2010	0.180	0.000	2.763	0.497	0.000
8b	2007	1.063	0.002	3.031	3.222	0.006
8b	2010	0.180	0.000	3.031	0.546	0.000
School Bus	2007	1.131	0.001	2.989	3.381	0.003
School Bus	2010	0.180	0.000	2.989	0.538	0.000
Transit Bus	2007	1.200	0.002	4.679	5.615	0.009
Transit Bus	2010	0.180	0.000	4.679	0.842	0.000

Attachment A - Tier 2 Phase-In Schedule

Model Year	Certification Bin									
	10	9	8	7	6	5	4	3	2	1
LDV/LDT1										
2004	0.000	0.614	0.000	0.000	0.000	0.386	0.000	0.000	0.000	0.000
2005	0.000	0.213	0.000	0.000	0.000	0.787	0.000	0.000	0.000	0.000
2006	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000
2007	0.000	0.000	0.000	0.000	0.000	0.400	0.200	0.300	0.100	0.000
2008	0.000	0.000	0.000	0.000	0.000	0.400	0.200	0.300	0.100	0.000
2009	0.000	0.000	0.000	0.000	0.000	0.100	0.100	0.550	0.250	0.000
2010	0.000	0.000	0.000	0.000	0.000	0.100	0.100	0.550	0.250	0.000
LDT2										
2004	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2005	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2006	0.000	0.663	0.000	0.000	0.000	0.337	0.000	0.000	0.000	0.000
2007	0.000	0.000	0.000	0.300	0.300	0.400	0.000	0.000	0.000	0.000
2008	0.000	0.000	0.000	0.300	0.300	0.400	0.000	0.000	0.000	0.000
2009	0.000	0.000	0.000	0.300	0.300	0.200	0.200	0.000	0.000	0.000
2010	0.000	0.000	0.000	0.300	0.300	0.200	0.200	0.000	0.000	0.000
LDT3										
2004	0.630	0.000	0.370	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2005	0.260	0.000	0.740	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2006	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2007	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2008	0.000	0.000	0.260	0.000	0.000	0.740	0.000	0.000	0.000	0.000
2009	0.000	0.000	0.260	0.000	0.000	0.740	0.000	0.000	0.000	0.000
2010	0.000	0.000	0.260	0.000	0.000	0.740	0.000	0.000	0.000	0.000
LDT4										
2004	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2005	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2006	0.780	0.000	0.220	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2007	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2008	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2009	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2010	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000