Technical Modeling Appendix for LEV 2 / Tier 2 Comparisons

Introduction

This report explains the reasons for and the methodology that the New York State Department of Environmental Conservation (NYSDEC) used in modeling LEV 2 and Tier 2 for comparison purposes. Recently, both the U.S. Environmental Protection Agency (EPA) and the California Air Resources Board (CARB) have proposed new, more stringent versions of their vehicle emissions control programs, known as Tier 2 and LEV 2 respectively. Section 177 of the Clean Air Act allows individual states to adopt and enforce the motor vehicle emissions standards adopted by the State of California under Section 209(b) of the Clean Air Act. The NYSDEC Bureau of Air Quality Planning was tasked with quantifying the emissions benefits of both programs in order to determine which program would best protect human health.

Methodology

It was decided early on that, in order to compare the new programs to New York's current program (LEV 1), a modified version of MOBILE5B would be necessary. By using the MOBILE model, a tons per day value could be obtained for the state and each individual county, providing a much more tangible number for comparison purposes. It was acknowledged early on that the emission reductions associated with low sulfur fuel for the new programs would not be modeled. Since it is expected that vehicles from both programs will react similarly to the new fuel, this will not change the comparisons between the programs. It should be noted that the evaporative and medium duty vehicles (MDVs) reduction benefits also were not modeled for these runs.

The MOBILE model needed to be modified to accept the three new LEV 2 certification categories. Within MOBILE, the basic emission rate (BER) is based on a function of model year and age. The basic emission rate is equal to the zero mile level (ZML) emission rate plus the deterioration rate (DR). The ZML and DR emission rates are functions of pollutant standards (Tier1, LEV, etc.). The vehicle model year is used to track this. A mileage based deterioration rate is used to estimate emission increases over time. In MOBILE, mileage is a function of vehicle age. Emission rates for the National Low Emission Vehicle (NLEV) and LEV 1 programs were based on the assumption that ZMLs are proportional to the standards. Deterioration rates can be handled in two different ways: use Max I/M which makes the deterioration rate proportional to the standard, or use the "standard" I/M rate which is equivalent to a Tier 1 deterioration rate. EPA's current guidance for the Max I/M option is found in **MOBILE5 Information Sheet #6**: Effect of New National Low Emission Vehicle Standard for Light-Duty Gasoline Fueled Vehicles EPA420-F-98-027 July 1998: "In areas with I/M programs which, by the date of the evaluation (the calendar year and month in the relevant Scenario Record), will have completed one full cycle of OBD system inspections pursuant to federal or state requirements for such inspections, set the second flag of the LEV Parameter Record to be '2'." Following this guidance, NYSDEC modeled "Max I/M" for 2003 and on.

Changes to the Fortran code of MOBILE5B were confined to eight files. The first file modified was BD05.FOR to expand the LEV array to go to year 2011, allowing full implementation of the phase-in period. It was also updated to coincide with the final LEV 1 standards for LDGT1b, 2a and b (a.k.a. LDGT2, LDGT3 and LDGT4s for LEV 2 and Tier 2). BD05.FOR was also modified to contain the same LDGT percentages that MOBILE 6 will have. The post-processor accounted for future SUV growth in the vehicle fleet. The files PCTLEV.FOR, BASEQ9.I and GETLEV.FOR were modified to allow the reading of this expanded array. The file GETSC1.FOR was modified to automatically use MAX I/M from 2003 on, if the scenario record's region equals "5". This eliminates having to add an extra line for each scenario to do this. The subroutine LEVEF.FOR was used to calculate the ratio of the standards between LEV2/LEV 1, ULEV 2/ULEV 1, and SULEV/TLEV. These ratios are then used in the same way that NLEV & LEV 1 ratios were used to model those programs. TLEVs were used for the SULEV ratio because an equivalent LEV 1 standard did not exist. CONSEC.FOR was modified to recognize

when LEV 2 vehicles are being modeled (CY 2004 and later) and ask the user to input a phase-in file for the LEV 2 vehicles. The file VNAME.I was updated to display a new version name.

When running the modified Mobile5b, all modifications are transparent unless two changes are made to the input files. This allowed earlier control programs (e.g., Tier1) to be run with no changes to their respective input files. If the PROMPT flag in the Control Section of the input file is set to "5", MOBILE5B reads an alternate LEV file, which overrides the default phase-in for the California Low Emission Vehicle Program. This separate data file should contain the alternate phase-in schedule desired by the user. DECLEV2 has been modified to allow a phase-in period up to 2011 for LEV 2 or Tier 2. This phase-in file must also have a value greater than 100% ZEV vehicles in 1994 for LDGV. By having this number greater than 100%, modified Mobile5b reads the additional lines for LEV 2 or Tier 2 in the alternate file. The 1994 ZEV value for LDGV is also reset to 0%.

Phase-in Tables

The LEV 2 phase-in schedules were created using a spreadsheet to solve for the NMOG standard for each model year using the various motor vehicle certification standards, or "bins". There are four LEV 2 bins, three of which are new (LEV 2, ULEV 2, and SULEV), and the ZEV bin which is carried over from LEV 1. There are also 6 LEV 1 only bins (I-TLEV, TLEV, I-LEV, LEV, I-ULEV, and ULEV) in addition to the Tier 1 bin. In addition to the phase-in schedule created by NYSDEC, a LEV 2 phase-in schedule was obtained from the California Air Resources Board (CARB). The EPA, along with the Alliance of Automobile Manufacturers through Air Improvement Resource Inc. (AIR), each provided separate phase-ins for both LEV 2 and Tier2. The LEV 2 program is based on each vehicle class meeting an NMOG standard for each model year. This standard can be met using any combination of LEV 2 bins the manufacturer desires.

The NYSDEC proposed phase-in schedule for LEV 2 is shown in Table 1. Although there is a mandated ZEV component of the LEV 2 program, this bin is not used in NYSDEC's LEV 2 phase-in because it is New York's belief that ZEVs are not used in the same manner as gasoline powered vehicles. Therefore, ZEV's should be modeled as reduced VMT on local roads. However, the NYSDEC LEV 2 modeled emissions within this paper do not include any ZEV VMT reductions. This is believed to be a conservative approach. When solving for the NYSDEC version of LEV 2 the minimum amount of SULEVs possible were used while still allowing manufacturers to certify 5% of their passenger cars (PCs) and LDGT1s to the LEV 2 bin. The SULEV bin was not used for the heavier truck classifications because it was not necessary to meet the required NMOG standard.

The California Air Resources Board version of the phase-in table (Table 2) contains 10% ZEVs for PCs and LDGT1s along with using the LEV 2 bin for 18% of the fleet. CARB also allocates 15% SULEVs to the heavier truck classes. The EPA's version of LEV 2 (Table 3) contains 10% ZEVs starting in 2004 for PCs and LDGT1s but removes the LEV 2 bin for these vehicle classes. The AIR version of LEV 2 (Table 4) contains no ZEVs and no LEV 2 vehicles thus restricting manufacturers to the SULEV and ULEV 2 bins only for PCs and LDGT1s.

Tables 5 and 6 show NYSDEC's phase-in schedule for Tier 2. Tier 2 contains more bins than LEV 2 and the modified version of MOBILE5B. The NYSDEC Tier 2 phase-in schedule solved for the Tier 2 NOx standard using a spreadsheet that allowed the use of all the Tier 2 bins (Table 15). This spreadsheet was originally developed by EPA. The Tier 2 vehicle type averages for NMOG (Table 16) and NOx were then matched in a separate spreadsheet using bins that were available in LEV 2 (Tables 5 & 6). Because the NMOG and NOx values could not be met using the same bins, two phase-in sheets were used, one for NMOG and another for NOx, and the model was run twice. The Tier 2 phase-ins for EPA and AIR were handled in the same way and are shown in Tables 7-10. The corresponding Tier 2 bins are shown in Tables 11 & 13 for NOx and, after conversion from the 120K to 50K standard, tables 12 & 14 for NMOG.

Results

While both programs offer significant emission benefits over the current LEV 1 program, differences were revealed through the modeling. Table 17 below lists the modeling results in tons per ozone day of each pollutant. NOx emissions from the 7 different scenarios all followed a similar slope. The maximum NOx difference in each year was 7 tons in 2007, 7 tons in 2010, 10 tons in 2015 and 8 tons in 2020. In contrast, the NMOG graph showed a dispersion of slopes after 2010. The maximum NMOG difference in each year was 3 tons in 2007, 8 tons in 2010, 19 tons in 2015 and 27 tons in 2020. These graphs are shown on the next page. Tables 18 a, b, and c show the Tier 2 and LEV 2 modeling results for the New York State, EPA, and AIR phase-ins respectively. Table 18d compares the EPA's Tier 2 phase-in results against CARB's LEV 2 phase-in.

Phase-in Schedule	2007			2010			2015			2020		
	Tons per Day			Tons per Day			Tons per Day			Tons per Day		
	NOx	VOC	VOC + NOx	NOx	VOC	VOC + NOx	NOx	VOC	VOC + NOx	NOx	VOC	VOC + NOx
California LEV 2	712	483	1195	560	380	940	382	302	684	271	248	519
NYSDEC LEV 2	712	484	1196	561	382	943	385	306	691	275	253	528
EPA LEV 2	712	483	1195	561	380	941	385	302	687	276	249	525
AIR LEV 2	712	484	1196	562	382	944	386	306	692	276	253	529
EPA Tier 2	705	486	1191	555	386	941	378	316	694	279	266	545
AIR Tier 2	705	485	1190	555	385	940	376	313	689	275	263	538
NYSDEC Tier 2	705	486	1191	555	388	943	376	321	697	275	275	550

TABLE 17

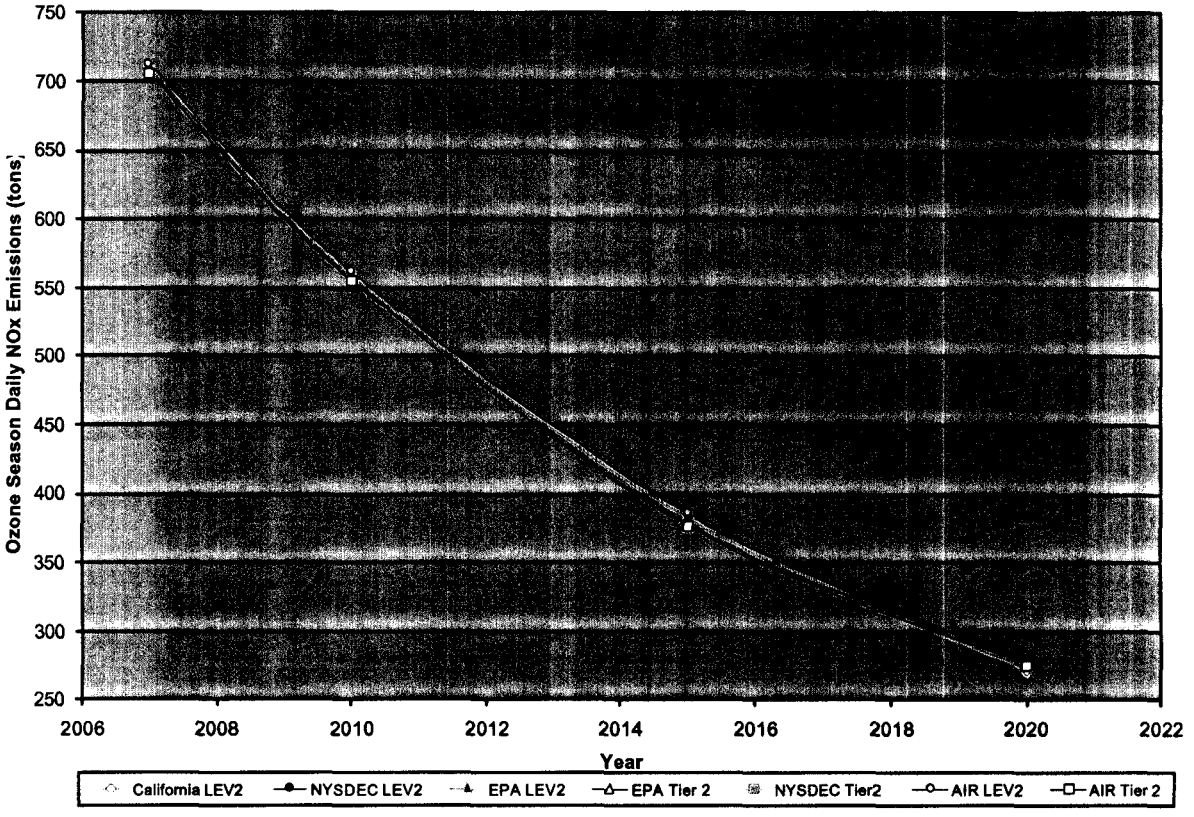
TABLE 18 a	2007		2010		2015		2020	
	Tons per Day		Tons per Day		Tons per Day		Tons per Day	
	NOx	VOC	NOx	VOC	NOx	VOC	NOx	VOC
NYSDEC Tier 2	705	486	555	388	376	321	275	275
NYSDEC LEV 2	712	484	561	382	385	306	275	253
Benefit of LEV 2	-7	2	-6	6	-9	15	0	22

TABLE 18 b	2007		2010		2015		2020	
	Tons per Day		Tons per Day		Tons per Day		Tons per Day	
	NOx	VOC	NOx	VOC	NOx	VOC	NOx	VOC
EPA Tier 2	705	486	555	386	378	316	279	266
EPA LEV 2	712	483	561	380	385	302	276	249
Benefit of LEV 2	-7	3	-6	6	-7	14	3	17

TABLE 18 c	2007		2010		2015		2020	
	Tons per Day		Tons per Day		Tons per Day		Tons per Day	
	NOx	VOC	NOx	VOC	NOx	VOC	NOx	VOC
AIR Tier 2	705	485	555	385	376	313	275	263
AIR LEV 2	712	484	562	382	386	306	276	253
Benefit of LEV 2	-7	1	-7	3	-10	7	-1	10

TABLE 18 d	2007		2010		2015		2020	
	Tons per Day		Tons per Day		Tons per Day		Tons per Day	
	NOx	VOC	NOx	VOC	NOx	VOC	NOx	VOC
EPA Tier 2	705	486	555	386	378	316	279	266
CALIFORNIA LEV 2	712	483	560	380	382	302	271	248
Benefit of LEV 2	-7	3	-5	6	-4	14	8	18

NOx Emissions from LEV 2 & Tier2



VOC Emissions from LEV 2 & Tier2