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EPA's National Mobile Inventory Model (NMIM), A Consolidated Emissions Modeling System for MOBILE6 and NONROAD

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ABSTRACT

This document describes EPA's National Mobile Inventory Model (NMIM) and explains how it works. NMIM is a consolidated emissions modeling system for EPA's MOBILE6 and NONROAD models. It generates county inventories using MOBILE6 and NONROAD at scales ranging from individual counties to the nation. Its primary improvements over MOBILE6 and NONROAD are 1) the inclusion of all the required county data for the nation in a single database, 2) a graphical user interface, 3) "shortcuts" for generating national inventories, 4) tools for aggregation and post-processing, 5) estimation of 33 HAPS and 17 dioxin/furan congeners, and 6) distributed processing capability to enhance performance. Previously, when national inventories have been constructed from MOBILE6 and NONROAD, the necessary input data have been widely scattered in disparate formats and have required additional specialized software to convert this data into input files for MOBILE6 and NONROAD, to run the models, to integrate the results into a final inventory, and to post-process the results into forms suitable for the national inventories. NMIM accomplishes all of these tasks in a single package. NMIM's initial version in 2003 was intended to approximate the procedures previously used for calculating nationwide emissions for EPA's National Emissions Inventory. EPA subsequently has added the capability of incorporating much more county-specific information into the database, including monthly average hourly temperature and humidity, fleet distributions, speed distributions, and diesel fractions for MOBILE6 and county-specific allocation and activity files for NONROAD.

INTRODUCTION AND OVERVIEW

This document describes EPA's National Mobile Inventory Model (NMIM) and explains how it works.[1] EPA's National Mobile Inventory Model (NMIM) is a consolidated emissions modeling system for EPA's MOBILE6 and NONROAD models. It was developed to produce, in a consistent and automated way, national, county-level mobile source emissions inventories for the National Emissions Inventory (NEI) and for EPA rule making. Previously, when national inventories have been constructed from MOBILE6 and NONROAD, the necessary input data have been widely scattered in disparate formats and have required additional specialized software to convert this data into input files for MOBILE6 and NONROAD, to run the models, to integrate the results into a final inventory, and to post-process the results into forms suitable for the national inventories. NMIM accomplishes all of these tasks in a single package.

NMIM comprises a Java framework, graphical and command line user interfaces, the MOBILE6 and NONROAD models, a national county database, and postprocessing and aggregation capabilities. NMIM's primary improvements over MOBILE6 and NONROAD are 1) the inclusion of all the required county data for the nation in a single database, 2) a graphical user interface, 3) "shortcuts" for generating national inventories, 4) tools for aggregation and post-processing, 5) estimation of 33 hazardous air pollutants (HAPS) and 17 dioxin/furan congeners by ratio to various MOBILE6 and NONROAD output parameters, and 6) distributed processing capability to enhance performance. NMIM extends MOBILE6's capabilities by

producing inventories rather than just emissions factors. NMIM provides consistency across both models and all pollutants by using a single input database for MOBILE6 and NONROAD and for criteria pollutants and HAPS.

However, NMIM is not a complete GUI front end for MOBILE6 and NONROAD, nor can it replace these models for all applications. Because it was designed primarily to generate national inventories, NMIM has features intended to speed its operation and minimize its output database size that also limit its applicability. For example, it will not produce hourly or by-model-year output from MOBILE6. In addition NMIM, like NONROAD, does not produce emissions inventories for aircraft, locomotives, and commercial marine vessels.[2]

This documentation begins with an overall explanation of how NMIM works, followed by the details of how it runs MOBILE6 and NONROAD. Next, it discusses the pollutant and source category inventories available from running NMIM. Then, it describes the NMIM County Database (NCD) and procedures for updating and improving it through the National Emission Inventory (NEI) process. Lastly, it explains how NMIM estimates various HAPS that are not direct outputs of MOBILE6 and NONROAD.

HOW NMIM WORKS

The NMIM user specifies a set of years and months, a geographic region (the whole US, any combination of whole states, or any combination of particular counties, including Puerto Rico and the Virgin Islands), a set of pollutants, and categories of on-road vehicles and non-road equipment. This collection of user requests is called a "run specification" or RunSpec, and can be saved in a file for later execution or for text editing. RunSpecs can be produced by the NMIM GUI or by using a text editor. NMIM RunSpecs can be executed from the GUI or from the command line.

Based on the RunSpec and information in the NMIM county database (NCD), NMIM writes input files for the MOBILE6 and NONROAD models. NMIM then runs these models, reads their output files, performs additional processing if necessary, and puts the inventories into an output database. Additional processing includes multiplying MOBILE6 emission factors by vehicle miles traveled (VMT) and estimating emissions of some other pollutants (see below) as ratios to pollutant inventories generated by MOBILE6 and NONROAD.

NMIM has post-processing capability that can be applied after the inventory is generated. This includes aggregation over months, roadway types, vehicle types, and equipment types. Output can go into a database table or into a tab-delimited text file. The format can be normalized (a pollutant on each line) or wide (a pollutant in each column.) NMIM can also process the output database into annual, monthly, or ozone season day (OSD) inventories and convert them into NEI Input Format Version 3 (NIF3), which is required for NEI submissions. The user's post-processing selections can be made from the GUI and saved as a text "aggregation specification" file or AgSpec, which can be reloaded into the GUI, edited from the GUI or in a

text editor, and run from the GUI or from the command line.

Temporal and Spatial Approximations for Efficient Running of National Inventories

NMIM employs two main techniques, adopted from previous NEIs, to make the production of national inventories tractable. The first is to assume that monthly time resolution is adequate for both meteorology and source activity and therefore to do twelve monthly runs instead of 365 daily runs. NMIM is designed to do only monthly runs and produces annual inventories by adding the twelve monthly inventories.

The second technique is to group similar counties, allowing NMIM to do a single MOBILE6 or NONROAD run for the entire group. The county groups are defined in the CountyMap table of the NCD. One of the counties in each group is referred to as the representing county, since it represents the others, which are called represented counties. It should be noted that county grouping is not mandatory; NMIM allows the user to employ county groups or to run all counties individually. If time is available, running individual counties is superior, since it uses the most individualized data for each county. In either case, the output contains inventories for all the individual counties in the selected geographic region.

As an example of county grouping, for some national runs that EPA has performed to date, counties were placed in the same county group for a particular year if they were in the same state and had the same fuel properties and control programs. This grouping was adapted from past NEIs. It assumed that if counties are in the same state, their temperatures are similar (California had two temperature groupings). The representing county was chosen as the one with the highest VMT, so that the temperature and relative humidity data is from a county with a significant share of mobile source activity. This scheme resulted in about 100 county groups for NONROAD and about 200 for MOBILE6 in 2002, representing the 50 states plus the District of Columbia, a total of more than 3000 counties.

EPA does not recommend or supply any particular county grouping. If they choose to employ county groups, users must tailor them to suit the purposes of their inventories. As more county-specific data becomes incorporated into the NCD, the problem of choosing county groups becomes more difficult. On the other hand, as computing power increases, it becomes easier to run every county.

NMIM Master and NMIM Worker: Distributed Processing

As a way of further improving performance, NMIM may be run in a distributed-processing mode, employing multiple computers. NMIM comprises two programs, Master and Worker. Master and Worker(s) each have a simple text configuration file which specifies the path to a shared folder through which they communicate. In standalone mode, one Master, one Worker, and the shared folder are on the same computer. In distributed mode, the Master is on one computer, multiple workers are on separate computers, and the shared folder, which they all

have access to, is on yet another computer (although it could be on the same computer as the Master or one of the Workers). Therefore, to execute NMIM in distributed mode requires only an ordinary local area network (LAN) where all the NMIM computers have access to a single shared folder.

In either mode, to execute a RunSpec requires a Master, one or more Workers, and a shared folder. When a RunSpec is executed, the Master 1) reads the RunSpec (which defines the inventory in terms of geography, time, pollutants and sources), 2) writes appropriate MOBILE6 and NONROAD input files, 3) bundles these files together with any external data files needed, and 4) posts them as "TODO" files on the shared folder. A TODO file always contains the data for a single MOBILE6 or NONROAD run for one county for one month. A Worker, seeing a TODO file on the shared folder, copies it to its local work space, executes MOBILE6 or NONROAD as appropriate, and writes the results to a "DONE" file in the shared folder. The Master, seeing the DONE file, downloads it from the shared folder to its local workspace, extracts the MOBILE6 or NONROAD output file, processes it further as necessary, and inserts it into the output database specified in the RunSpec.

HOW NMIM RUNS MOBILE6

NMIM writes a MOBILE6 input file using data obtained from the NCD and executes MOBILE6 once for each month for each county (if the user chose the Geographic Representation option "County") or once for each representing county (if the user chose the Geographic Representation option "County Group"). To produce an on-road inventory, NMIM multiplies the resulting emission factors by the VMT for each requested county, regardless of which Geographic Representation option was chosen.

The MOBILE6 input files constructed by NMIM are designed to accommodate detailed user input and to use a consistent set of commands. In order to use consistent fuels data for all pollutants, the AIR TOXICS command is always used, even if no air toxics are requested by the user. To enable the AIR TOXICS command, MOBILE6 requires that at least one of the six air toxics that it models internally be specified in its input file. To fulfill this requirement, NMIM always inserts the command to model acrolein in the MOBILE6 input file, whether the user requests it or not. However, if the user does not request acrolein, it will not appear in the output table. (Note that acrolein was an arbitrary choice; any of the six air toxics would have served the same function.) The ALTITUDE, POLLUTANTS and EVALUATION MONTH commands are always explicitly used, rather than depending on MOBILE6 default settings and always appear in the MOBILE6 input files written by NMIM. The input files always use the HOURLY TEMPERATURES command, rather than MIN/MAX TEMPERATURE command. The hourly RELATIVE HUMIDITY command is always used, rather than the ABSOLUTE HUMIDITY command. The BAROMETRIC PRES command is always used, since this value interacts with the relative humidity values. Average speed distributions are always specified using the SPEED VMT command, rather than the AVERAGE SPEED command.

Gasoline fuel parameters require the maximum amount of detail to properly model toxic emissions. The OXYGENATE command is required when modeling air toxics, and supersedes the OXYGENATED FUELS command used to model winter oxygenate programs in MOBILE6. The OXYGENATE command requires that oxygen content be expressed as volume percent instead of weight percent, as required by the OXYGENATED FUELS command. GAS AROMATIC%, GAS OLEFIN% , GAS BENZENE%, E200 and E300 must always be specified. RVP OXY WAIVER command is always set to 1 (no waiver), because Reid vapor pressure (RVP) values from the fuel surveys are assumed to already account for any RVP effect from oxygenated fuels. The FUEL RVP command is always required. The GASOLINE SULFUR command and FUEL PROGRAM command Option 4 are always used to explicitly set the sulfur content of gasoline. The same gasoline sulfur content is used for both commands and for all years in the FUEL PROGRAM command, although it would normally have different sulfur values for different years. Since each MOBILE6 run covers only a single month in a particular calendar year, NMIM sets all possible sulfur values the same to avoid programming logic to determine which of the possible years to change.

Some counties have local emission control programs. The basic information for these programs is stored in the NCD and is used to create the appropriate commands for the input file when needed. Inspection and maintenance (I/M) programs for counties are stored in external data files and accessed using the I/M DESC FILE command.

In addition to the basic required information, NMIM can also include county specific data that is normally provided to MOBILE6 using external data files. Nearly any of the valid MOBILE6 commands can be used, including commands used to model local Low Emission Vehicle (LEV) phase-in programs and local natural gas vehicle fractions. Diesel sales fractions are stored in an external file and used to create the appropriate input command.

Not all MOBILE6 commands are used by NMIM. The VMT FRACTIONS and VMT BY FACILITY commands are not needed, since these commands are only needed to create composite emission rates. NMIM converts all emission rate results from MOBILE6 to tons using the county specific VMT for each vehicle class and roadway type. Since all gasolines are explicitly defined, both the SEASON command and FUEL PROGRAM command Option 2 are never used. Options such as NO CLEAN AIR ACT can be specified as "global" NMIM inputs that affect all counties and all months.

Only weekdays are modeled by NMIM. Commands that apply to weekend variations are not used. This simplification makes sense because most weekend differences in MOBILE6 are temporal distributions, so MOBILE6's emission factors at the day level are little affected by these differences. (Parameters that can differ between weekends and weekdays are hot soak duration distribution, start distribution, starts/day, soak distribution, and trip length distribution.) The major difference between weekdays and weekends is VMT, which is provided in the NCD by month, vehicle type, and roadway type.

MOBILE6 has only 4 facility or roadway types: freeways, arterials, ramps, and locals. Ramp speed is fixed at 34.6 MPH and local speed at 12.9 MPH. Distributions of average speeds are specified separately for freeways and arterials using the SPEED VMT command. If only a single MOBILE6 scenario were run, the same distribution of average speeds would be applied to all vehicle types. Separate specification of average speed distributions for all combinations of the twelve roadway types and all twenty-eight MOBILE6 vehicle types would require running 168 MOBILE6 scenarios.

In order to avoid running so many MOBILE6 scenarios, while retaining reasonable flexibility, NMIM groups vehicle class-roadway type combinations into 18 groups, shown in Table 1. These groups are those that have been used in past NEIs, and provide flexibility in assigning average speeds while limiting the number of MOBILE6 runs necessary to generate an inventory. Since nine of these combinations use the MOBILE6 freeway facility type and nine use the arterial facility type, a total of nine MOBILE6 scenarios are needed to model the eighteen vehicle class/roadway type combinations. Average speed distributions for each of these eighteen vehicle class/roadway type combinations can be specified for each county.

Table 1. The 18 vehicle class-roadway type combinations in NMIM.

M6Vtypes*	Road Types	M6 Ftype
LDV	Rural Interstate	Freeway
LDT	Rural Interstate	Freeway
HDV	Rural Interstate	Freeway
LDV	Urban Interstate	Freeway
LDT	Urban Interstate	Freeway
HDV	Urban Interstate	Freeway
LDV	Urban Freeways & Expressways	Freeway
LDT	Urban Freeways & Expressways	Freeway
HDV	Urban Freeways & Expressways	Freeway
LDV,LDT	Rural Principal Arterial	Arterial
LDV,LDT	Rural Minor Arterial	Arterial
HDV	Rural Principal Arterial	Arterial
LDV,LDT	Rural Major Collector	Arterial
LDV,LDT	Rural Minor Collector, Rural Local	Arterial
HDV	Rural Minor Arterial	Arterial
LDV,LDT	Urban Principal Arterial, Urban Minor Arterial, Urban Collector	Arterial
HDV	Rural Major Collector, Rural Minor Collector, Rural Local	Arterial
HDV	Urban Principal Arterial, Urban Minor Arterial, Urban Collector	Arterial

* Reference MOBILE6.2 User Guide, Appendix B
LDV = MOBILE6 Vehicle Types 1 and 16.
LDT = MOBILE6 Vehicle Types 2-5.
HDV = MOBILE6 Vehicle Types 6-15.

Particulate Matter (PM)

Because MOBILE6 can model only one particle size at a time, if both PM10 and PM2.5 are desired, NMIM runs a tenth MOBILE6 scenario to obtain emission factors for the extra particle size. MOBILE6 separates exhaust particulates into SO4, organic carbon (OC), elemental carbon (EC), lead, tire wear, and brake wear. Of these, only SO4 depends on speed. If either PM10 or PM2.5 is requested, the results are obtained from the standard nine scenarios. If both PM10 and PM2.5 are requested, the nine scenarios are run for PM10. Since all SO4 is PM2.5, if both PM10 and PM2.5 are requested, the SO4 emission factor for both is taken from the nine scenarios that are sensitive to speed, and the tenth scenario is used to obtain the emission factors for all the other PM2.5 components.

Evaluation Year and Month

MOBILE6 specifies a calendar year and an evaluation month of either January or July. These two parameters determine the fleet composition for which emission factors are generated. For each month of a given inventory year, NMIM writes the MOBILE6 input file using the combination of calendar year and evaluation month shown in Table 2 below.

Table 2. The MOBILE6 calendar years and evaluation months that are used by NMIM for each month of inventory year, *Y*.

NMIM Month of Inventory Year Y	MOBILE6 calendar year	MOBILE6 evaluation month
1	Y	1
2	Y	1
3	Y	1
4	Y	7
5	Y	7
6	Y	7
7	Y	7
8	Y	7
9	Y	7
10	Y+1	1
11	Y+1	1
12	Y+1	1

The reasoning behind this scheme is that the fleet composition in October, November, and December of year Y is more like that of January of year Y+1 than it is like July of year Y. This scheme does not cause a problem with fuel properties, because NMIM always looks up the fuel properties in the NCD for the inventory year and month being modeled. Control programs in MOBILE6 are always assumed to begin on January 1, but MOBILE6 assumes that these programs have no effect on that day, since the program has had no time to get started. Hence

NMIM is not erroneously introducing next year's control programs by modeling October, November, and December as January 1 of the following year.

HOW NMIM RUNS NONROAD

NONROAD estimates monthly fuel consumption and emissions of total hydrocarbons (THC), carbon monoxide (CO), nitrogen oxides (NOX), sulfur dioxide (SO2), and particulate matter (PM). NMIM then processes the monthly results as needed to produce annual and ozone season day emissions. Additional pollutants are produced by NMIM as ratios to some of these outputs.

The NONROAD Model reads a set of text instructions, known as an "opt file" (for options). NMIM creates this file from data in the NCD. As employed in NMIM, the opt file is limited to one state and specifies month and year, fuel properties, temperature, and the counties for which to calculate emissions, which may be all or a subset of the counties in the state. NONROAD internally produces emissions for the whole state and then allocates the emissions for each SCC to the requested counties. Output is produced only for the county or counties selected in the NMIM RunSpec.

The NONROAD Model includes a group of files that specify equipment populations, emission factors, deterioration rates, activities, and allocations from the state to the county. County-specific allocation, population, seasonality, and activity files can be specified in the NCD. These files will override NONROAD's default files.

The fuel properties required by the NONROAD Model are not the same as those in the NCD. The NONROAD Model requires "Oxygen Weight %" in its opt file. The conversion from NCD fuel properties to oxygen weight percent is performed by NMIM as follows:

oxywtpct =
      etohvolume*0.3448*etohmktshare
      + mtbevolume*0.1786*mtbemktshare
      + tamevolume*0.1636*tamemktshare
      + etbevolume*0.1533*etbemktshare

These conversion factors are detailed under the OXYGENATE command in the MOBILE6 User's Guide.[3]

How NMIM converts from Total Hydrocarbons (THC) to other hydrocarbon (HC) species

THC is the NONROAD Model's native output. The other HC species that can be requested from NMIM are listed and described in Table 3 below. The conversion from THC to the other HC species differs between exhaust and evaporative emissions. For NMIM's

emissiontype classifications (exhaust, evaporative, refueling), NONROAD crankcase emissions are classified as exhaust.

NMIM uses factors in the SCC table to convert NONROAD exhaust THC to the other hydrocarbon outputs (VOC, NMHC, TOG, and NMOG). For evaporative emissions except for FuelType=CNG, no conversion is necessary (i.e., VOC = NMHC = TOG = NMOG = THC). For evaporative CNG emissions, TOG = THC, and NMOG = NMHC = VOC = 0.

POLLUTANTS FOR WHICH INVENTORIES ARE PRODUCED BY NMIM

Hydrocarbons may be expressed in one of five forms, listed in Table 3 below. The conversion factors in the SCC table are those used in the MOBILE6 and NONROAD models and depend on fuel and engine type.

Table 3. Hydrocarbon forms available from NMIM. (MOBILE6 User Guide).

Hydrocarbon Form		Includes FID HC	Includes Methane	Includes Ethane	Includes Aldehydes
Total Hydrocarbons	(THC)	Yes	Yes	Yes	Partially
Non-methane Hydrocarbons	(NMHC)	Yes	No	Yes	Partially
Volatile Organic Compounds	(VOC)	Yes	No	No	Yes
Total Organic Gases	(TOG)	Yes	Yes	Yes	Yes
Non-methane Organic Gases	(NMOG)	Yes	No	Yes	Yes

Table 4 lists all pollutants for which NMIM produces inventories. The pollutant codes are those specified by the NIF3.[4]   Numeric codes are Chemical Abstracts Service Registry Numbers[5] (CASRN) with the hyphens removed.

In Table 4, a non-blank "Ratio to" column (MB for MOBILE6, NR for NONROAD) indicates that the pollutant is calculated by NMIM, after the MOBILE6 or NONROAD model is run, by ratio to the pollutant listed in the column. A blank "Ratio to" column indicates that the pollutant is calculated inside MOBILE6 or NONROAD. The ratio depends on source type, expressed as a source classification code (SCC), and fuel characteristics. The complete list of these ratios may be found in the SCC and SCCToxics tables of the NCD. Ratio units are g/gallon, g/mile, and g/g of PM or VOC. For on-road vehicles, naphthalene is ratioed to exhaust PM and to evaporative VOC. For non-road equipment, it is ratioed to exhaust PM10 only. SOA is present to provide input to REMSAD (Regional Modeling System for Aerosols and Deposition[6]).

The "Six HAPS" category represents the first HAPS studied for mobile sources. They are selected individually in the NMIM RunSpec. The 27 "Add'l. HAPS" (additional HAPS) are selected as a group in the NMIM RunSpec. The 17 dioxin/furan congeners are also selected as a group. Pollutants in Table 4 without a category listed may be selected individually in the NMIM RunSpec. All pollutants are output separately, even if they are selected as a group.

Table 4. List of pollutants for which inventories are produced by NMIM. (See text.)

Pollutant Code	PollutantName	Category	Ratio to MB	Ratio to NR
CO	Carbon Monoxide			
HC	Hydrocarbons (choice of five forms)			
NOX	Nitrogen Oxides			
SO2	Sulfur Dioxide			
PM10-PRI	Primary PM10 (Filterables and Condensibles)			
PM25-PRI	Primary PM2.5 (Filterables and Condensibles)			PM10*
NH3	Ammonia			Gal*
75070	Acetaldehyde	Six HAPS		VOC
107028	Acrolein	Six HAPS		VOC
71432	Benzene	Six HAPS		VOC
106990	1,3-Butadiene	Six HAPS		VOC
50000	Formaldehyde	Six HAPS		VOC
1634044	MTBE	Six HAPS		VOC
100414	Ethyl Benzene	Add'l. HAPS	VOC	VOC
100425	Styrene	Add'l. HAPS	VOC	VOC
108883	Toluene	Add'l. HAPS	VOC	VOC
110543	Hexane	Add'l. HAPS	VOC	VOC
120127	Anthracene	Add'l. HAPS	PM10	PM10
123386	Propionaldehyde	Add'l. HAPS	VOC	VOC
129000	Pyrene	Add'l. HAPS	PM10	PM10
1330207	Xylene	Add'l. HAPS	VOC	VOC
16065831	Chromium (Cr3+)	Add'l. HAPS	Mile	Gal
18540299	Chromium (Cr6+)	Add'l. HAPS	Mile	Gal
191242	Benzo(g,h,i)perylene	Add'l. HAPS	PM10	PM10
193395	Indeno(1,2,3,c,d)pyrene	Add'l. HAPS	PM10	PM10
205992	Benzo(b)fluoranthene	Add'l. HAPS	PM10	PM10
206440	Fluoranthene	Add'l. HAPS	PM10	PM10
207089	Benzo(k)fluoranthene	Add'l. HAPS	PM10	PM10
208968	Acenaphthylene	Add'l. HAPS	PM10	PM10
218019	Chrysene	Add'l. HAPS	PM10	PM10
50328	Benzo(a)pyrene	Add'l. HAPS	PM10	PM10
53703	Dibenzo(a,h)anthracene	Add'l. HAPS	PM10	PM10
540841	2,2,4-Trimethylpentane	Add'l. HAPS	VOC	VOC
56553	Benz(a)anthracene	Add'l. HAPS	PM10	PM10
7439965	Manganese	Add'l. HAPS	Mile	Gal
7440020	Nickel	Add'l. HAPS	Mile	Gal
83329	Acenaphthene	Add'l. HAPS	PM10	PM10
85018	Phenanthrene	Add'l. HAPS	PM10	PM10
86737	Fluorene	Add'l. HAPS	PM10	PM10

Pollutant Code	PollutantName	Category	Ratio to MB	Ratio to NR
91203	Naphthalene	Add'l. HAPS	PMVOC	PM10
1746016	2,3,7,8-Tetrachlorodibenzo-p-Dioxin	Dioxin/furan	Mile	Gal
19408743	1,2,3,7,8,9-Hexachlorodibenzo-p-Dioxin	Dioxin/furan	Mile	Gal
3268879	Octachlorodibenzo-p-dioxin	Dioxin/furan	Mile	Gal
35822469	1,2,3,4,6,7,8-Heptachlorodibenzo-p-Dioxin	Dioxin/furan	Mile	Gal
39001020	Octachlorodibenzofuran	Dioxin/furan	Mile	Gal
39227286	1,2,3,4,7,8-Hexachlorodibenzo-p-Dioxin	Dioxin/furan	Mile	Gal
40321764	1,2,3,7,8-Pentachlorodibenzo-p-Dioxin	Dioxin/furan	Mile	Gal
51207319	2,3,7,8-Tetrachlorodibenzofuran	Dioxin/furan	Mile	Gal
55673897	1,2,3,4,7,8,9-Heptachlorodibenzofuran	Dioxin/furan	Mile	Gal
57117314	2,3,4,7,8-Pentachlorodibenzofuran	Dioxin/furan	Mile	Gal
57117416	1,2,3,7,8-Pentachlorodibenzofuran	Dioxin/furan	Mile	Gal
57117449	1,2,3,6,7,8-Hexachlorodibenzofuran	Dioxin/furan	Mile	Gal
57653857	1,2,3,6,7,8-Hexachlorodibenzo-p-Dioxin	Dioxin/furan	Mile	Gal
60851345	2,3,4,6,7,8-Hexachlorodibenzofuran	Dioxin/furan	Mile	Gal
67562394	1,2,3,4,6,7,8-Heptachlorodibenzofuran	Dioxin/furan	Mile	Gal
70648269	1,2,3,4,7,8-Hexachlorodibenzofuran	Dioxin/furan	Mile	Gal
72918219	1,2,3,7,8,9-Hexachlorodibenzofuran	Dioxin/furan	Mile	Gal
CO2	Carbon Dioxide			
SOA	Secondary Organic Aerosol		VOC*	VOC*

* Ratios for the pollutants are in the NCD SCC table. All others are in the SCCToxics table.

SOURCE CATEGORIES FOR WHICH INVENTORIES ARE PRODUCED BY NMIM

NMIM's output is always in terms of source classification codes (SCC), which are described in the SCC table. For on-road output, NMIM also distinguishes five emission types (exhaust, evaporation, refueling, brake wear, and tire wear). For non-road output, NMIM distinguishes three emission types (exhaust, evaporation, and refueling) and also reports the NONROAD power classes, which subdivide a given SCC by horsepower range.

The VMT in the BaseYearVMT table is by the 28 MOBILE6 vehicle classes. In NMIM output, however, these 28 vehicle classes are aggregated into the 12 vehicle classes that correspond to SCC codes. These 12 vehicle classes are shown in Table 5. The M6VClass table defines the correspondence between these two sets of vehicle classes, which is shown in Table 5a.

Table 5. The twelve vehicle classes that correspond to SCCs.

Class	Description	Class	Description
LDGV	Light duty gasoline vehicles	LDDT	Light duty diesel trucks
LDGT1	Light duty gasoline truck 1	2BHDDV	Class 2b heavy duty diesel vehicles
LDGT2	Light duty gasoline truck 2	LHDDV	Light heavy-duty diesel vehicles
HDGV	Heavy duty gasoline vehicles, including buses	MHDDV	Medium heavy-duty diesel vehicles
MC	Motorcycles	HHDDV	Heavy heavy-duty diesel vehicles
LDDV	Light duty diesel vehicles	BUSES	Diesel buses

Table 5a. The 28 MOBILE6 vehicle classes and the 12 vehicle classes corresponding to SCCs that are output by NMIM.

M6 #	28 M6	12 SCC	Description
1	LDGV	LDGV	Light-Duty Gasoline Vehicles (Passenger Cars)
2	LDGT1	LDGT1	Light-Duty Gasoline Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)
3	LDGT2	LDGT1	Light-Duty Gasoline Trucks 2 (0-6,000 lbs. GVWR, 3751-5750 lbs. LVW)
4	LDGT3	LDGT2	Light-Duty Gasoline Trucks 3 (6,001-8,500 lbs. GVWR, 0-5750 lbs. ALVW)
5	LDGT4	LDGT2	Light-Duty Gasoline Trucks 4 (6,001-8,500 lbs. GVWR, 5751 lbs. and greater ALVW)
6	HDGV2B	HDGV	Class 2b Heavy-Duty Gasoline Vehicles (8501-10,000 lbs. GVWR)
7	HDGV3	HDGV	Class 3 Heavy-Duty Gasoline Vehicles (10,001-14,000 lbs. GVWR)
8	HDGV4	HDGV	Class 4 Heavy-Duty Gasoline Vehicles (14,001-16,000 lbs. GVWR)
9	HDGV5	HDGV	Class 5 Heavy-Duty Gasoline Vehicles (16,001-19,500 lbs. GVWR)
10	HDGV6	HDGV	Class 6 Heavy-Duty Gasoline Vehicles (19,501-26,000 lbs. GVWR)
11	HDGV7	HDGV	Class 7 Heavy-Duty Gasoline Vehicles (26,001-33,000 lbs. GVWR)
12	HDGV8A	HDGV	Class 8a Heavy-Duty Gasoline Vehicles (33,001-60,000 lbs. GVWR)
13	HDGV8B	HDGV	Class 8b Heavy-Duty Gasoline Vehicles (>60,000 lbs. GVWR)
14	LDDV	LDDV	Light-Duty Diesel Vehicles (Passenger Cars)
15	LDDT12	LDDT	Light-Duty Diesel Trucks 1 and 2 (0-6,000 lbs. GVWR)
16	HDDV2B	2BHDDV	Class 2b Heavy-Duty Diesel Vehicles (8501-10,000 lbs. GVWR)
17	HDDV3	LHDDV	Class 3 Heavy-Duty Diesel Vehicles (10,001-14,000 lbs. GVWR)
18	HDDV4	LHDDV	Class 4 Heavy-Duty Diesel Vehicles (14,001-16,000 lbs. GVWR)
19	HDDV5	LHDDV	Class 5 Heavy-Duty Diesel Vehicles (16,001-19,500 lbs. GVWR)
20	HDDV6	MHDDV	Class 6 Heavy-Duty Diesel Vehicles (19,501-26,000 lbs. GVWR)
21	HDDV7	MHDDV	Class 7 Heavy-Duty Diesel Vehicles (26,001-33,000 lbs. GVWR)
22	HDDV8A	HHDDV	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)
23	HDDV8B	HHDDV	Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs. GVWR)
24	MC	MC	Motorcycles (Gasoline)
25	HDGB	HDGV	Gasoline Buses (School, Transit and Urban)
26	HDDBT	BUSES	Diesel Transit and Urban Buses
27	HDDBS	BUSES	Diesel School Buses
28	LDDT34	LDDT	Light-Duty Diesel Trucks 3 and 4 (6,001-8,500 lbs. GVWR)

SCC output also distinguishes twelve roadway types, listed in Table 6 below. The twelve roadway types are those used by the Federal Highway Administration's (FHWA) Highway Performance Monitoring System (HPMS).[7] These roadway types, in combination with the twelve vehicle types, result in 144 SCCs for on-road mobile sources.

Table 6. Twelve Roadway Types

Interstate: Rural	Interstate: Urban
Other Principal Arterial: Rural	Other Freeways and Expressways: Urban
Minor Arterial: Rural	Other Principal Arterial: Urban
Major Collector: Rural	Minor Arterial: Urban
Minor Collector: Rural	Collector: Urban
Local: Rural	Local: Urban

Emissions are estimated by the NONROAD Model for 214 SCCs. SCCs distinguish between equipment types, fuels (gasoline, diesel, liquified petroleum gas (LPG), and compressed natural gas (CNG)) and between two stroke and four stroke gasoline engines. In addition, NONROAD produces horsepower categories, and NMIM retains these in its output.

Within NMIM and the NONROAD Model, the non-road SCCs are grouped into 12 segments, listed in Table 7.

Table 7. NONROAD Model equipment segments.

Recreational	Lawn/Garden	Logging	Oil Field
Construction	Agriculture	Airport Support	Pleasure Craft
Industrial	Commercial	Underground Mining	Railroad

Any single SCC always falls under only one of these segments, corresponding to its most typical application, although it may be used in other segments as well. For example, skid steer loaders are in the construction segment, although they are also used in agriculture. Fuels are gasoline, diesel, LPG, and CNG. NMIM users must choose a segment and fuel; individual SCCs may not be selected. Output, however, is by individual SCC.

THE NMIM COUNTY DATABASE (NCD)

The NMIM County Database (NCD) contains all the county-specific information needed to run MOBILE6 and NONROAD. It also contains the list of pollutants and the ratios of HAPS, dioxins/furans, and some metals to various NONROAD and MOBILE6 outputs that are used to estimate inventories of these non-standard pollutants. This database is in MySQL, an open source data base management system that is available from www.mysql.com. The tables in the database are listed in Table 8.

Table 8. Tables in the NMIM County Database.

Table	Contents
BaseYearVMT	VMT by year, county, M6VClass, and HPMSRoadType.
County	For each county, Federal Information Processing System (FIPS) codes for the county and state, altitude, beginning and end of ozone season, Stage 2 information, Natural Gas Vehicle (NGV) fraction file name
CountyMap	The representing county for each county, one for NONROAD and one for MOBILE6.
CountyMonth	Defines the set of possible county-month combinations.
CountyMonthHour	Monthly average hourly temperature and humidity table used if "Use yearly weather data" is not selected or there is no data for the requested year in the CountyYearMonthHour table.
County NRFile	References to external NONROAD files pertaining to a county.
CountyVMTMonth Allocation	Mileage allocation factors for the twelve months of the year, by county.
CountyYear	Stage2 percent input to the NR model, plus external file references for MOBILE6 and NR.
CountyYearMonth	Gasoline, diesel, and natural gas fuel IDs for each county for each year and month.
CountyYearMonth Hour	Historical hourly temperature and relative humidity.
DataSource	Defines datasource identifiers used in other tables.
Diesel	Diesel sulfur content associated with each diesel ID.
EmissionType	Associates emission types (exhaust, evap, brake, tire) with EmissionTypeID used in other tables
FileType	Defines the set of valid external files and their 3-character extensions.
Gasoline	Detailed fuel properties associated with each gasoline ID.
Hour	Defines the hour identifiers.
HPMSRoadType	Defines the twelve HPMS road type identifiers.
M6VClass	Defines the 28 vehicle classes used in MOBILE6. These are the valid combinations of M6Vtype and fuel.
M6VType	Defines the fuel-independent vehicle types used in MOBILE6.
NaturalGas	Natural gas sulfur content associated with each natural gas ID.
PollutantCode	Associates NIF pollutant codes and pollutant names with PollutantCodeID used in other tables.
SCC	Associates with each SCCID an SCC code and description, and ratios for NH3, PM25, and for converting between HC forms.
SCCToxics	SCC and fuel property-dependent ratios for calculating HAPS, dioxin/furans, and metals.
State	Associates state names and abbreviations with state FIPS codes used in other tables.
VMTGrowth	The annual VMT growth rate for a M6VClass by county and year.
VMTMonth Allocation	Factors for allocating annual VMT to the 12 months, by M6VType and HPMSRoadType, used if there are no county-specific values in CountyVMTMonthAllocation.

The main emphasis in putting together the database has been on historical years, for which data are available. The best year as of this writing is 2002, since states and local organizations submitted corrected information as part of the NEI process. However, future years are of interest for rulemaking and other purposes. For future years, refinery modeling of the impacts of anticipated fuel changes, such as phase-in of low sulfur fuels, is used to develop projected fuel properties. Items such as age and speed distributions are assumed to remain unchanged from the most recent historical year, unless future estimates for such data are submitted by states. NMIM uses 20-year average temperature and humidity data from the CountyMonthHour table for future years. Data for all years from 1999 to 2050 is present in the NCD, except for VMT. Users wishing to generate a future year on-road inventory may have to provide their own VMT data and insert it into the BaseYearVMT table of the NCD. For future year non-road inventories, the necessary estimates (e.g., of population and activity) are contained in the data files associated with the NONROAD Model.

Temperature and Humidity

The NCD contains monthly average hourly temperature and humidity for historical years in the CountyYearMonthHour table. It contains 20-year averages (1981 to 2000) of monthly average hourly temperature and humidity in the CountyMonthHour table. The user can select whether to use the historical or 20-year average data. When historical data are not present in the database, the program automatically uses the 20-year average.

Because minimum and maximum temperatures occur at different hours each day, the minimum of the hourly averages will be higher than the average of the daily minima, and the maximum of the hourly averages will be lower than the average of the daily maxima. To avoid this narrowing of the daily temperature range, the monthly average of hourly temperatures is assumed to capture the daily temporal pattern and is mathematically stretched so that the low temperature equals the monthly average of the daily minima and the high temperature equals the monthly average of the daily maxima, producing a set of "adjusted monthly average hourly temperatures." The same procedure is applied to dewpoint. An adjusted monthly average hourly relative humidity is then calculated from the adjusted monthly average hourly temperatures and dewpoints. It is these adjusted hourly temperatures and relative humidities that are found in the CountyYearMonthHour table of the NCD. A similar procedure was used to generate the 20-year average temperatures and humidities in the CountyMonthHour table.

The historical and 20-year average hourly temperatures and humidities were developed by Air Improvement Resources (AIR), Inc. for EPA under contract, from data obtained from the National Climatic Data Center. County temperatures were determined by weighting nearby temperature stations by their distance from the population-based centroid of each county. For Puerto Rico and the Virgin Islands, averages were calculated using the five calendar years 1999 through 2003.

MOBILE6 uses the hourly temperatures directly from the CountyYearMonthHour table. NONROAD does not use hourly temperatures, but rather daily minimum, maximum and average temperatures. For NONROAD, NMIM selects the minimum and maximum from all 24 hourly temperatures, but calculates the average from the hourly temperatures from 6 AM to 9 PM (hourly intervals 7 to 21).

Fuel Properties

The CountyYearMonth table contains gasoline, diesel, and natural gas fuel identifiers for each county for each month of each calendar year. On-road vehicles and non-road equipment have separate fuel identifiers. The identifiers are associated with fuel properties in the Gasoline, Diesel, and NaturalGas tables.

For gasoline, the fuel properties were determined by the Eastern Research Group, Inc., (ERG) under contract to EPA using gasoline survey data.[8] The fuel properties stored in the Gasoline table are:

> o Average Reid Vapor Pressure (RVP)
> o Average sulfur content
> o Maximum sulfur content
> o Ethanol (ETOH) percent by volume of ethanol blended gasolines
> o Ethanol blend market share
> o MTBE (methyl tertiary butyl ether) percent by volume of ether blended gasolines
> o MTBE blend market share
> o ETBE (ethyl tertiary butyl ether) percent by volume of ether blended gasolines
> o ETBE blend market share
> o TAME (tertiary amyl methyl ether) percent by volume of ether blended gasolines
> o TAME blend market share
> o Aromatic content
> o Olefin content
> o Benzene content
> o E200 (vapor percentage of gasoline at 200 degrees Fahrenheit)
> o E300 (vapor percentage of gasoline at 300 degrees Fahrenheit)

The gasoline properties were derived from several surveys:

> o EPA's Reformulated Gasoline survey, 2000[9]
> o EPA's Oxygenated fuel program summary, 2001[10]
> o TRW (previously NIPER) fuel survey, 1999[11]
> o Alliance of Automobile Manufacturers of America (AAMA) survey, 1999[12]

Market share for oxygenated gasolines was obtained from the EPA Oxygenate Type Analysis Tables[13] and the Federal Highway Administration website.[14]

If the methyl tertiary butyl ether (MTBE) percent volume content was less than 0.1 percent, MTBE content was set to be zero with a zero percent market share. Similarly, if the ethanol percent volume content was less than 0.1 percent, ethanol content was set to be zero with a zero percent market share. For any area which reported non-zero values for tertiary amyl methyl ether (TAME) or ethyl tertiary butyl ether (ETBE), the entire market share was set to be MTBE, since it was not possible to distinguish the market share between these specific oxygenates.

All gasoline properties are area-wide averages, except for oxygenates, which are allowed to have market shares. Three fuels (winter, summer, and spring/fall) are determined for each county and assigned to months by season. Months representing seasons vary by location. Spring/fall gasoline properties are derived from summer and winter fuels by interpolation. Gasolines in Puerto Rico and the Virgin Islands were assumed to be similar to gasolines in Collier County, Florida. Details of how the fuel survey data were applied to individual states and counties are described in the ERG report to EPA.[15] The NCD allows counties to have different NR and on-road gasolines, but none do as of this writing, because data have not been available to make this distinction.

For diesel fuel and natural gas, the only fuel property stored is sulfur content, in the Diesel and NaturalGas tables, respectively. A sulfur content of 30 ppm for natural gas is used for all counties in all states for all years and months. Non-road and on-road diesel sulfur values tend to differ in the same county because they are subject to different regulations. In addition, there are two kinds of non-road diesel fuel: that used for pleasure craft and that used for all other non-road segments.

Vehicle Miles Traveled (VMT)

VMT is the critical activity parameter for converting MOBILE6's emission factors into inventories. Historical VMT is derived from data from the Federal Highway Administration (FHWA). Unfortunately, these data are not gathered at the spatial and temporal scales needed by NMIM, nor for the same vehicle classes required by MOBILE6. The procedures for gathering these data and processing them into the required scales and vehicle classes are described in detail in the NEI documentation.[16] States and local organizations may submit corrections to the VMT data.

Database Improvement

As part of the NEI process, States and regional and local organizations are asked to review the NCD and provide more accurate data, if available. This review includes the county data and also the external files that can be referenced by MOBILE6 or NONROAD, such as fleet distributions and equipment allocations. The development of this database improvement system promises to extend NMIM's advantages beyond convenience to include the production of better mobile source inventories. Procedures for submitting improved data for inclusion in the NCD

are contained in a technical memorandum posted with the Draft 2002 NEI.[17] This document is also useful as a comprehensive description of what county-specific data can go into the NCD. Considerable data has been received as part of the 2002 NEI process.

ESTIMATION OF HAZARDOUS AIR POLLUTANT (HAP) EMISSIONS

The hazardous air pollutants for which inventories are produced by NMIM are listed in Table 4 above. The "six HAPS" are produced internally by MOBILE6. In all other cases, as indicated in the "Pollutants" section above, HAP inventories are generated by ratios to various MOBILE6 and NONROAD outputs.

HAPS are estimated using data sources and methods developed for the 1999 NEI for HAPS, version 3,[18,19] with some modifications, described below. NMIM does not estimate HAP emissions for compressed natural gas (CNG) engines.

HAPS are estimated in NMIM using one of three approaches:

1)   Gaseous HAPS – Apply toxic to VOC ratios to VOC estimates.

2)   Poly-Aromatic Hydrocarbons (PAHs) – Apply toxic to PM10 ratios to PM10 estimates.

3)   Metals, Dioxins and Furans – For NONROAD, multiply HAP gram per gallon emission factors by county level fuel consumption estimates. For MOBILE6, multiply HAP gram per mile emission factors by county level VMT estimates.

The NCD SCCToxics table provides a complete listing of toxic ratios and emission factors for all SCCs and fuel combinations. The above approaches are described in more detail in the following sections.

Gaseous HAPS

NMIM uses the toxic to VOC ratios described in the documentation for the 1999 NEI for HAPS, version 3, and summarized in Volume 1, Appendix D, Table 1 of the documentation. Separate ratios are used for evaporative and exhaust emissions for each of the following four categories of gasoline blends:

1.   Baseline Gasoline. All cases that do not fall into categories 2-4 below. Ratios are in variables "ExhBaseGas" and "EvapBaseGas" in the SCCToxics table.

2.   WO (Winter Oxygenate) Gasoline / Ethanol or ETBE - Used where the fuel contains ethanol which is greater than or equal to 5% by volume or ETBE greater than or equal to 5% by volume. Ratios are in variables "ExhEthGas" and "EvapEthGas" in the SCCToxics table.

3.   WO (Winter Oxygenate) Gasoline / MTBE / TAME - Used where the fuel contains MTBE which is greater than or equal to 12% by volume or TAME greater than or equal to 13% by volume. Ratios are in variables "ExhMTBEGas" and "EvapMTBEGas" in the SCCToxics table.

4.   RFG/MTBE/TAME - Used where the fuel is RFG and where the fuel contains oxygenate greater than 5% by volume and where the fuel contains MTBE which is less than 12% by volume or TAME less than 13% by volume. Ratios are in variables "ExhRFGGas" and "EvapRFGGas" in the SCCToxics table.

In many cases, HAP profiles for specific non-road equipment and engine type combinations are available. However, for some equipment/engine type combinations, no speciation data are available. In such instances, default values for 2-stroke gasoline engines, 4-stroke gasoline engines, and diesel engines are used. These default values represent an average fraction for various equipment types within an engine category.

Polyaromatic Hydrocarbons (PAHs)

All PAHs emitted in exhaust are estimated as fractions of PM10, although the data used to calculate mass ratios include both gas and particle phase PAH emissions. The data used to develop the PAH fractions are described in the documentation for the 1999 NEI for HAPS. Evaporative naphthalene emissions from on-road vehicles are estimated as a fraction of VOC. NMIM does not currently estimate evaporative naphthalene emissions for non-road equipment.

Metals, Dioxins, and Furans

On-Road

NMIM estimates on-road emissions using g/mile emission factors developed for the 1999 NEI for HAPS, version 3.

Non-Road

Metals

The approach used by NMIM to estimate non-road county level metal emissions differs in a number of respects from the approach used in the 1999 NEI for HAPs, version 3. In the 1999 NEI, nationwide metal emissions for gasoline engines were obtained by applying a mass per gallon emission factor by nationwide gasoline consumption from the NONROAD model. For diesel engines, a mass per brake-horsepower hour emission factor was multiplied by nationwide energy output. The resultant nationwide emission estimates were then spatially allocated to

counties relative to the county proportion of PM10 emissions compared to the national PM10 emissions, as obtained from the NONROAD model.

In contrast, NMIM multiplies mass per gallon emission factors for both gasoline and diesel engines by county level fuel consumption in gallons to obtain a county level inventory estimate. For diesel engines, mass per brake-horsepower hour emission factors were converted to mass per gallon emission factors using the following equation:

grams per gallon =   grams per brake-horsepower hour (g/bhphr) * average fuel density
                       (lb/gallon) / fuel consumption per brake-horsepower hour (lb/bhphr)

where:

average fuel density = 7.01 lb/gal

fuel consumption per brake horsepower hour = 0.408 lb for engines less than 100 hp
                                           = 0.367 lb for engines greater than 100 hp

The fuel consumption per brake horsepower hour estimates are from the NONROAD model.[20] NMIM looks up the gram per gallon metal emission factors for gasoline and diesel engines in the SCCToxics table of the NCD.

Dioxins/furans

Mass per gallon emission factors for dioxins and furans from non-road engines were calculated by multiplying the on-road vehicle emission factors in grams per mile by fleet average fuel economy estimates. The assumed fuel economy for gasoline vehicles was 21.5 miles per gallon; for diesel vehicles it was 7 miles per gallon. Resulting gram per gallon emission factors are contained in the NCD SCCToxics table.

SUMMARY

NMIM is a consolidated modeling system for MOBILE6 and NONROAD designed to produce national inventories. A standard input configuration has been designed to provide consistency between MOBILE6 and NONROAD and between criteria pollutants and HAPS. NMIM's run specification can be constructed from its GUI or by a text editor. It can be executed from the GUI or from a command line. It is capable of standalone operation and can also take advantage of multiple computers on a LAN through a simple distributed processing scheme. Post-processing capabilities include the production of output in NIF3 format. The inclusion of a database improvement system in the NEI process promises to extend NMIM's advantages beyond convenience to the production of better mobile source inventories.

REFERENCES

1. This document is an update of a paper that was presented at the International Emission Inventory Conference (IEIC) at Clearwater, Florida in June 2004. At that conference, a training was given using source code NMIM20040512 and database County20040508. Since that time, bugs have been fixed, capabilities have been expanded, and the database has been improved.

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5. See EPA's Substance Registry System: http://www.epa.gov/srs/ and the CAS Registry website: http://www.cas.org/EO/regsys.html.

6. Information on REMSAD may be found at http://remsad.saintl.com/overview.htm.

7. Information on the Federal Highway Administration's (FHWA) Highway Performance Monitoring System (HPMS) is available at http://www.fhwa.dot.gov/policy/ohpi/hpms/.

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14. Federal Highway Administration (FHWA) website for oxygenated fuel sale percentage. Table MF-33E – Estimated Use of Gasohol and Table MF-21 – Motor-Fuel Use, 1999. Internet address: http://www.fhwa.dot.gov/ohim/hs99/mfpage.htm

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17. "Instructions to State and Local Agencies for Updating the County-Level Database from EPA's National Mobile Inventory Model: Technical Memorandum," prepared by Maureen Mullen, E.H. Pechan and Associates, Springfield, VA, for Emission Factors and Inventory Group, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711, November, 2004. It is available on the web at ftp://ftp.epa.gov/EmisInventory/draftnei2002/mobile/nmim_related/nmim_technical_memorandum_1104.pdf.

18. Documentation for the Onroad National Emissions Inventory (NEI) For Base Years 1970-2002 Prepared for: Office of Air Quality Planning and Standards Emission Factor and Inventory Group U.S. Environmental Protection Agency Research Triangle Park, NC 27711. Prepared by: E.H. Pechan & Associates, Inc., 5528-B Hempstead Way, Springfield, VA 22151, January 2004. http://www.epa.gov/ttn/chief/net/1999inventory.html#final3haps

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