National Scale Modeling of Air Toxics for the Mobile Source Air Toxics Rule; Technical Support Document

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16. ABSTRACT

The purpose of the work described in this technical document was to project emissions for mobile source hazardous air pollutants (HAPs) to 2007, 2010, 2015, 2020, and 2030 from the 1999 National Emissions Inventory Version 3 (NEI), conduct air quality and exposure modeling, and estimate cancer and non-cancer risk for select future years. Air quality modeling utilized the Assessment System for Population Exposure Nationwide (ASPEN) model. Exposure modeling utilized the Hazardous Air Pollutant Exposure Model, Version 5 (HAPEM5). Modeling was done for reference cases, which included programs currently planned and in place, as well as control scenarios that evaluated potential impacts of additional control programs. This work was done to support regulatory needs related to the 2006 proposed mobile source air toxics rule. Intermediate year inventories for 2002 through 2010, inclusive, were also developed to support other program needs in the Office of Air and Radiation.

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Research Triangle Park, North Carolina

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List of Acronyms

AEO	Annual Energy Outlook
ASPEN	Assessment System for Population Exposure Nationwide
BEA	Bureau of Economic Analysis
CAS	Chemical Abstract Service
EGAS	Economic Growth Analysis System
EMS-HAP	The Emissions Modeling System for Hazardous Air Pollutants
EPA	United States Environmental Protection Agency
HAP	Hazardous Air Pollutant
HAPEM5	Hazardous Air Pollutant Exposure Model, Version 5
HI	non-cancer Hazard Index for a target organ system
HQ	non-cancer Hazard Quotient for an individual HAP
MACT	Maximum Available Control Technology standards for HAP, established under Section 112 of the Clean Air Act
MSAT	Mobile Source Air Toxics
NATA	National Air Toxics Assessment
NEI	EPA's National Emission Inventory
NMIM	National Mobile Inventory Model
OAQPS	EPA's Office of Air Quality Planning and Standards
OTAQ	EPA's Office of Transportation and Air Quality
REMI	Regional Economic Model, Inc.
SAROAD	Air pollution chemical species classification system used in EPA's initial data base for "Storage and Retrieval of Aerometric Data"
SCC	Source Classification Code
SIC	Standard Industrial Classification code used for Federal economic statistics
TAF	Terminal Area Forecast
URE	Unit risk estimate for cancer risk

List of files referenced in document

File	Description	Section
onroad_0923.xls	Excel workbook of onroad emissions by vehicle type for state and national level	3.3.2
onroad_pivot.xls	Excel workbook containing pivot table of onroad emissions by vehicle type for state and national	3.3.2
nonroad_0923.xls	Excel workbook of nonroad emissions by engine, equipment, and engine/equipement type for state and national level	3.3.3
nonroad_pivot.xls	Excel workbook containing pivot table of nonroad emissions by engine, equipment, and engine/equipment type for state and national level	3.3.3
mwi.sas	SAS® program to substitute 2002 MWI point emissions in the 1999 point inventory	4.3
concentrations.xls	Excel workbook of national and state mean concentrations and concentration distribution for ASPEN results	6.3
ASPEN_medians.ppt	PowerPoint file containing national maps of county median total ASPEN concentrations	6.3
hapem_concentrations.xls	Excel workbook of national and state mean concentrations and concentration distribution for HAPEM results	7.2
HAPEM_medians.ppt	PowerPoint file containing national maps of county median total HAPEM concentrations	7.2
hapem_risks.xls	Excel workbook of national and state mean risks and risk distribution for HAPEM based results	8.1
risk_030305.ppt	PowerPoint file containing national maps of county median total HAPEM based risks	8.1
hapem_hq.xls	Excel workbook of national and state mean HQ and HI and HQ and HI distribution for HAPEM based results	8.2
hq_030305.ppt	PowerPoint file containing national maps of county median total HAPEM based HQ and respiratory HI	8.2
pop_stats_risk.xls	Excel workbook of population statistics using both 2000 and projected populations for cancer risk	8.3
pop_stats_hi_respiratory.xls	Excel workbook of population statistics using both 2000 and projected populations for respiratory HI	8.3
cty_cntr99.sas7bdat	SAS® dataset of county centroids	9
background_test.xls	Excel workbook containing national and county mean concentrations using 1999 background and scaled backgrounds	9
background_acetaldehyde_0111.ppt	PowerPoint file containing county maps of concentrations using 1999 and scaled backgrounds for acetaldehyde.	9
background_butadiene_0111.ppt	PowerPoint file containing county maps of concentrations using 1999 and scaled backgrounds for 1,3-butadiene.	9
background_test_0111.ppt	PowerPoint file containing county maps of concentrations using 1999 and scaled backgrounds for benzene.	9
background_formaldehyde_0111.ppt	Powerpoint file containing county maps of concentrations using 1999 and scaled backgrounds for formaldehyde.	9
background_xylenes_0111.ppt	PowerPoint file containing county maps of concentrations using 1999 and scaled backgrounds for xylenes.	9
benzene_gas_scc.xls	Excel workbook containing benzene gasoline distribution reference and controlled emissions by SCC	10.1
onroad_controls.xls	Excel workbook of controlled onroad emissions by vehicle type for state and national level	10.2
onroad_controls_pivot.xls	Excel workbook containing pivot table of controlled onroad emissions by vehicle type for state and national	10.2

List of files referenced in document

File	Description	Section
nonroad_ controls.xls	Excel workbook of controlled nonroad emissions by engine, equipment, and engine/equipment type for state and national level	10.3
nonroad_pivot_ controls.xls	Excel workbook containing pivot table of controlled onroad emissions by engine, equipment, and engine/equipment type for state and national level	10.3
aspen_conc_controls.xls	Excel workbook of national and state mean controlled concentrations and concentration distribution for ASPEN results	10.5
ASPEN_median_cntrl.ppt	PowerPoint file containing national maps of county median total ASPEN controlled concentrations	10.5
hapem_concentrations_cntrl.xls	Excel workbook of national and state mean concentrations and concentration distribution for HAPEM controlled results	10.6
HAPEM_median_cntrl.ppt	PowerPoint file containing national maps of county median total HAPEM controlled concentrations	10.6
hapem_risks_control.xls	Excel workbook of national and state mean risks and risk distribution for controlled HAPEM based results	10.7.1
risk_cntrll.ppt	PowerPoint file containing national maps of county median total controlled HAPEM based risks	10.7.1
hapem_hq_control.xls	Excel workbook of national and state mean HQ and HI and HQ and HI distribution for controlled HAPEM based results	10.7.2
hq_cntrll.ppt	PowerPoint file containing national maps of county median total controlled HAPEM based HQ and respiratory HI	10.7.2
pop_stats_risk_cntrl.xls	Excel workbook of population statistics using both 2000 and projected populations for controlled cancer risk	10.7.3
pop_stats_hi_resp_cntrl.xls	Excel workbook of population statistics using both 2000 and projected populations for controlled respiratory HI	10.7.3
onroad.sas	SAS® program to project 1999 onroad emissions to future years	App. B
loco_marine.sas	SAS® program to create locomotive and CMV projection factor files	App. C
marine_locomotive_growth.sas	SAS® program to project 1999 locomotive and CMV emissions to future years.	App. C
nonroad.sas	SAS® program to project nonroad emissions (excluding aircraft, locomotives, and CMV) to future years	App. C
cancer_risk.sas	SAS® program to calculate risk estimates from HAPEM results	App. D
noncancer.sas	SAS® program to calculate non-cancer estimates from HAPEM results	App. D
project_stationary_benz.sas	SAS® program to apply controls to projected benzene gasoline distribution emissions	App. E
control_onroad.sas	SAS® program to apply controls to projected onroad emissions	App. F
calc_factors.sas	SAS® program to calculate exhaust and evaporative factors for use in controlling projected nonroad emissions	App. G
control_nonroad.sas	SAS® program to control projected nonroad emissions	App. G

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1. Purpose of Work

The purpose of the work described in this technical document was to project emissions for mobile source hazardous air pollutants (HAPs) to 2007, 2010, 2015, 2020, and 2030 from the 1999 National Emissions Inventory Version 3 (NEI) (U. S. EPA, 2004a), conduct air quality and exposure modeling, and estimate cancer and non-cancer risk for select future years. Air quality modeling utilized the Assessment System for Population Exposure Nationwide (ASPEN) model (U. S. EPA, 2000). Exposure modeling utilized the Hazardous Air Pollutant Exposure Model, Version 5 (HAPEM5) (U.S. EPA, 2005d). Cancer risk and non-cancer risk were estimated for 2015, 2020, and 2030. Modeling was done for reference cases, which included programs currently planned and in place, as well as control scenarios that evaluated potential impacts of additional control programs. This work was done to support regulatory needs related to the 2006 proposed mobile source air toxics rule. Intermediate year inventories for 2002 through 2010, inclusive, were also developed to support other program needs in the Office of Air and Radiation.

The pollutants modeled in this study, in support of the mobile source air toxics rule, are shown in Table 1. They are referenced in the document as MSAT HAPs. These pollutants are all included in the NEI and are on EPA's list of hazardous pollutants in Section 112 of the Clean Air Act. They are also emitted by mobile sources. In this assessment, projected inventories were developed for both the mobile and stationary emission sources in the 1999 NEI. There are additional hazardous air pollutants in the 1999 NEI with a mobile source emissions estimate that are not included in Table 1. Some of these were pollutants found only in data submitted by individual States. Others were generated by EPA through the use of speciation factors obtained from a non-mobile source process (e.g., commercial marine vessels, residual oil). More information on the 1999 NEI development can be found at www.epa.gov/ttn/chief/.

Emission projection methods for other HAPs (non-MSAT HAPs) are also discussed in several places in this document. These projections were done to support other OAR program needs.

After inventory projection, these pollutants were modeled in ASPEN and HAPEM5, following the same general methods used in the 1999 National Air Toxics Assessment (www.epa.gov/ttn/nata99).

The remainder of this document describes the methodology used for the inventory projections and subsequent air quality modeling. Section 2 describes the 1999 base HAP and precursor inventories, Section 3 describes the development of the projected mobile inventories and refueling projection factors. Section 4 describes the development of the projected stationary inventories. Sections 5, 6, and 7 describe the emissions processing, air quality modeling and exposure modeling. Section 8 describes the calculation of cancer risk and non-cancer risk (hazard quotients and hazard indices). Section 9 describes the methodology to adjust future year background concentrations based on projected emissions, and Section 10 describes the methodology to develop future year inventories that incorporate the benzene control scenario. Appendices also follow describing the calculations in more detail, and providing sample calculations and additional supporting data.

Table 1. Pollutants of interest in MSAT study. CAS numbers in italics are in the stationary inventories only; otherwise they are in mobile and stationary inventories.

HAP	CAS or pollutant code in 1999 NEI	SAROAD(s)
Organic gaseous HAPs (excluding those assessed as POM group)		
1,3-Butadiene	106990	43218
2,2,4-Trimethylpentane	540841	43250
Acetaldehyde	75070	43503
Acrolein	107028	43505
Benzene	71432	45201
Ethyl Benzene	100414	45203
Formaldehyde	50000	43502
Hexane	110543	43231
Methyl tert-butyl ether (MTBE)	1634044	43376
Naphthalene	91203	46701, 46702
Propionaldehyde	123386	43504
Styrene	100425	45220
Toluene	108883	45202
Xylenes	106423, 108383, 1330207, 95476	45102
Metal HAPs		
Chromium III	*10060125, 12018018, 1308389,* 136, *16065831, 21679312,* 7440473	59992, 59993
Chromium VI	*10294403, 10588019, 11103869, 11115745, 1308130, 1333820, 13530659,* 136, *13765190, 14307358, 18454121, 18540299,* 7440473, *7738945, 7758976, 7775113, 7778509, 7789006, 7789062*	69992, 69993
Manganese	*10101505, 1313139, 1317346, 1317357,* 198, 7439965, *7722647, 7783166, 7785877*	80196, 80396
Nickel	*10101970, 12054487, 13138459, 1313991, 1314063, 13462889, 13463393, 13770893,* 226, *373024,* 7440020, *7718549, 7786814, NY059280*	80216, 80316
HAPs grouped as POM		
Acenaphthene	83329	72002
Acenaphthylene	208968	72002
Anthracene	120127	72002
Benzo(g,h,i)perylene	191242	72002
Fluoranthene	206440	72002
Fluorene	86737	72002
Phenanthrene	85018	72002
Pyrene	129000	72002
Benzo(a)pyrene	50328	75002
Dibenzo(a,h)anthracene	53703	75002
Benz(a)anthracene	56553	76002
Benzo(b)fluoranthene	205992	76002
Benzo(k)fluoranthene	207089	76002
Indeno(1,2,3,c,d)-pyrene	193395	76002
Chrysene	218019	77002
Description of POM groups by SAROAD		
72002: POM, Group 2: no URE data 75002: POM, Group 5: 5.0E-4 < URE ≤ 5.0E-3 76002: POM, Group 6: 5.0E-5 < URE ≤ 5.0E-4 77002: POM, Group 7: 5.0E-6 < URE ≤ 5.0E-5		

The following notes apply to Table 1:

- Although designated as SAROAD code in the EMS-HAP User's Guide (U.S. EPA, 2004b) and ASPEN User's Guide (U.S. EPA, 2000), the SAROAD code value in Table 1 is not the actual SAROAD code for the HAP. Rather, it is a 5-digit code used by ASPEN and EMS-HAP to represent the specific pollutant or pollutant group that is modeled in ASPEN.

- For HAPs with two SAROAD codes, the lower numbered code represents the fine particle mode and the other number represents the coarse particle mode. For naphthalene, the lower numbered code represents the gas mode while the higher number represents the fine particle mode. For chromium III and chromium VI, CAS numbers 136 and 7440473 are used for both HAPs. These two CAS numbers represent non-speciated chromium. During emissions processing, the non-speciated chromium is speciated to chromium III and chromium VI. For mobile sources, eighteen percent of the chromium was assumed to be hexavalent, based on combustion data from stationary combustion turbines that burn diesel fuel (Taylor, 2003).

- The NEI contains additional POM pollutants including unspeciated POM groups such as 7-PAH or other specific POM that are not on the MSAT list but are emitted from stationary sources and were thus modeled as a POM group. These other POM pollutants, with CAS in parentheses, are listed below along with the POM group that they fall in.

    - POM group 71002: total PAH (234), POM (246), 16-PAH – 7-PAH (75040)[1], 16-PAH (40), Benz(a)Anthracene/Chrysene (103)
    - POM group 72002: Benzo(e)pyrene (192972), Perylene (198550), 2-Methylnaphthalene (91576), Benzofluoranthenes (56832736), 2-Chloronaphthalene (91587), Methylanthracene (26914181), Methylchrysene (248), 12-Methylbenz(a)Anthracene (2422799), 1-Methylpyrene (2381217), 1-Methylphenanthrene (832699), Methylbenzopyrenes (247), 9-Methylbenz(a)Anthracene (779022), Benzo(a)fluoranthene (203338), Benzo(g,h,i)Fluoranthene (203123), Benzo(c)phenanthrene (195197)
    - POM group 73002: 7,12-Dimethylbenz(a)anthracene (57976)
    - POM group 74002: Dibenzo(a,i)pyrene (189559), D(a,h)pyrene (189640), 3-Methylcholanthrene (56495)
    - POM group 75002: D(a,e)pyrene (192654), 5-Methylchrysene (3697243)
    - POM group 76002: B(j)fluoranthene (205823), D(a,j)acridine (224420), Benzo(b+k)fluoranthene (102)
    - POM group 78002: 7-PAH (75)

[1] See Table 2 for explanation of CAS 75040.

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2. 1999 base inventories

2.1 1999 HAP inventories

The inventories used in development of the future mobile and stationary inventories are from the 1999 National Emissions Inventory (NEI) Version 3 (http://www.epa.gov/ttn/chief/net/1999inventory.html); this is the inventory used for the 1999 NATA. The HAP emissions are provided for the following four inventory sectors: point, non-point, onroad mobile, and nonroad mobile. Point and non-point inventories contain the stationary source emissions, and onroad and nonroad contain the mobile emissions. For details about each inventory see http://www.epa.gov/ttn/chief/net/1999inventory.html.

For the 1999 NATA, emissions, concentrations and risks are also summarized by emission source sector: major, area & other, onroad and nonroad. The inventory sectors onroad and nonroad map directly to the corresponding NATA source sectors. The stationary sources (point and non-point) map as follows: point sources contain both major and area sources; non-point sources contain area and area & other sources.

Before processing the inventories for the 1999 NATA and/or the future year projections, some changes (or fixes) were made to the inventories before processing in EMS-HAP. Table 2 lists these changes.

Table 2. Changes made to the 1999 NEI HAP inventories prior to processing for 1999 NATA or projections.

Inventory	Change	Reason (NATA or projections)
Point	Changed stack diameter for siteid 4200300899 to 0.67 ft	Both
	Corrected emissions from pounds to tons for siteid 31109-0217 for methylene chloride	Both
	Convert stack parameters from English units to metric units	Both
	Removed dashes from SCC code and convert all lowercase characters in SCC code to uppercase. Also if SCC is 0, 00000000, "NONE", or "N/A" make SCC blank	Both
	If SIC code is "NONE" or "XXXX" make SIC blank	Both
	If Maximum Achievable Control Technology (MACT) code is "NONE" make MACT blank	Both
	For sources defaulted to county centroids (DEFAULT_LOC_FLAG='CNTYCENT') make the location coordinates equal to missing so that EMS-HAP will default location to tracts.	Both
	If MACT code = 723 then MACT = 0723	Projections
	If MACT code = 724 then MACT = 0724	Projections
	Remove mercury emissions	Projections
	Remove all emissions for Puerto Rico and Virgin Islands since we conducted the MSAT analysis for the 50 states	Projections
	Replace 1999 MACT 1801 emissions with 2002 draft 1801 emissions	Projections
Non-point	Remove all emissions for Puerto Rico and Virgin Islands since we conducted the MSAT analysis for the 50 states.	Projections
	Change MACT 1801 emissions to 0 for projections.	Projections
	Remove mercury emissions (note onroad and nonroad inventories contain no mercury)	Projections
	For FIPS/SCC/ combinations where there were both 16-PAH emissions (CAS=40) and 7-PAH emissions (CAS=75) and the 16-PAH emissions are larger than the 7-PAH emissions, subtract the 7-PAH emissions from the 16-PAH emissions and assign the CAS 75040 to the emissions. For the FIPS/SCC combinations being changed delete the 16-PAH emissions but retain the 7-PAH emissions. For FIPS/SCC combinations that have both 16-PAH and 7-PAH, but 7-PAH emissions are larger than 16-PAH emissions, make no changes. Also make no changes where there are 7-PAH emissions but no 16-PAH and vice versa.	Both
Onroad	Remove all emissions for Puerto Rico and Virgin Islands since we conducted the MSAT analysis for the 50 states	Projections
	Change Chromium III and Chromium VI CAS numbers to the unspeciated Chromium CAS (7440473). Once making the change, sum up the chromium emissions by FIPS/SCC. The chromium was summed so that EMS-HAP would use an 82/18 chromium III/chromium VI split. Before the summation, the chromium III/chromium VI split was not 82/18% as desired.	Both

Table 2. Continued.

Inventory	**Change**	**Reason (NATA or projections)**
Nonroad	Remove all emissions for Puerto Rico and Virgin Islands since we conducted the MSAT analysis for the 50 states	Projections
	For FIPS/SCC/ combinations where there were both 16-PAH emissions (CAS=40) and 7-PAH emissions (CAS=75) and the 16-PAH emissions are larger than the 7-PAH emissions, subtract the 7-PAH emissions from the 16-PAH emissions and assign the CAS 75040 to the emissions. For the FIPS/SCC combinations being changed delete the 16-PAH emissions but retain the 7-PAH emissions. For FIPS/SCC combinations that have both 16-PAH and 7-PAH, but 7-PAH emissions are larger than 16-PAH emissions, make no changes. Also make no changes where there are 7-PAH emissions but no 16-PAH and vice versa.	Both
	Change Chromium III and Chromium VI CAS numbers to the unspeciated Chromium CAS (7440473). Once making the change, sum up the chromium emissions by FIPS/SCC. The chromium was summed so that EMS-HAP would use an 82/18 chromium III/chromium VI split. Before the summation, the chromium III/chromium VI split was not 82/18% as desired.	Both
	Corrected FIPS for aircraft emissions in a few counties in which we found the underlying NEI geographic data to be erroneous. Section C.2.1 of the EMS-HAP V3 User's Guide provides details, in particular, see Table C-4.	Both

Table 3 lists the inventory emissions for each of the MSAT HAPs prior to EMS-HAP processing.

Table 3. Emissions (tons) for MSAT HAPs in the 1999 NEI inventories. Totals include Puerto Rico and the Virgin Islands.

HAP	Inventory				Total
	Point	Non-point	Onroad	Nonroad	
1,3-butadiene	2,068	22,133	23,785	9,923	57,909
2,2,4-Trimethylpentane	7,211	7,076	167,576	94,546	276,409
Acetaldehyde	12,141	26,474	30,068	24,099	92,782
Acrolein	959	21,083	4,013	3,183	29,238
Benzene	12,529	98,961	171,644	67,642	350,776
Ethyl Benzene	12,026	27,805	70,075	44,137	154,043
Formaldehyde	35,571	121,738	81,081	57,520	295,910
Hexane	46,698	94,755	65,898	30,063	237,414
MTBE	4,398	13,915	82,777	24,338	125,428
Naphthalene	2,652	11,433	4,008	1,257	19,350
Propionaldehyde	1,964	3,480	4,231	4,833	14,508
Styrene	40,713	9,673	13,266	4,319	67,971
Toluene	93,912	231,196	460,240	211,095	996,443
Xylenes	62,588	181,248	269,500	198,748	712,084
Chromium (total)	846	47	21	22	936
Manganese	2,844	356	16	6	3,222
Nickel	1,304	176	16	34	1,530
Acenaphthene	40	310	26	26	402
Acenaphthylene	1	1,745	139	66	1,951
Anthracene	38	333	32	15	418
Benzo(g,h,i)perylene	2	284	9	10	305
Fluoranthene	232	524	33	30	819
Fluorene	60	254	55	51	420
Phenanthrene	175	1,085	91	101	1,452
Pyrene	399	617	46	35	1097
Benzo(a)pyrene	16	1,074	5	3	1,098
Dibenzo(a,h)anthracene	1	7	0.001	0.07	8.071
Benz(a)anthracene	109	434	8	5	556
Benzo(b)fluoranthene	5	86	5	3	99
Benzo(k)fluoranthene	2	144	5	2	153
Indeno(1,2,3,c,d)-pyrene	0.4	178	3	3	184.4
Chrysene	30	388	4	3	425
7-PAH*	66	40	0	1	107
16-PAH*	13	320	0	1	334
16-PAH – 7-PAH*	0	132	0	0	132
Total PAH*	55	977	0	0	1032
Total POM*	3,315	644	0	0	3,959

*Some portion of these could be MSAT HAPs but are not sufficiently speciated in the inventory to determine what portion is MSAT POM HAP

One change made to modeled concentrations for NATA (and this effort) after EMS-HAP and ASPEN was to the POM group 75002 concentrations for Oregon for area & other sources. The area & other emissions for benzo(a)pyrene were incorrect in the 1999 NEI for Oregon. In order to alleviate the problem, the national median area & other concentration (excluding Oregon) was substituted for Oregon's area & other tract level concentrations.

2.2 1999 Precursor inventories

In order to calculate secondary concentrations for acetaldehyde, acrolein, formaldehyde, and propionaldehyde after ASPEN simulations for the primary concentrations, the emissions for the precursors also had to be processed through EMS-HAP and subsequently ASPEN for later secondary contribution calculations. For those precursors that are not HAPs themselves (non-HAP precursors) a separate precursor inventory was used. The precursor inventory used was the same as that used for the 1999 NATA and is Version 2 of the NEI for VOC. Precursor emissions were obtained by speciating VOC emissions from Version 2 of the NEI. The speciation profiles are the same as those used for the 1996 NATA (see Section D.1.2 in EMS-HAP Version 2 User's Guide, [U.S. EPA, 2002]). All point sources in the precursor inventory were treated as major sources. Table 4 lists the non-HAP precursors for the four secondary HAPs being modeled in this study.

Table 4. Non-HAP precursors for the MSAT secondary HAPs with source sector emissions for 1999. Totals include Puerto Rico and the Virgin Islands.

Precursor	Precursor for	Inventory				Total
		Point	Non-point	Onroad	Nonroad	
1-Butene	Formaldehyde,	5,337	24,245	41,481	12,503	83,566
1-2,3-Dimethyl butene	Formaldehyde	110	3,004	1,902	0	5,016
1-2-Ethyl butene	Formaldehyde	0.0005	0	0	255	255.0005
1-2-Methyl butene	Formaldehyde	104	4,750	30,647	11,898	47,399
1-3-Methyl butene	Formaldehyde	81	7,527	4,625	2,947	15,180
2-Butene	Acetaldehyde	2,170	7,503	42,270	7,521	59,464
2-2-Methyl butene	Acetaldehyde	78	4,750	89,651	19,722	114,201
1-Decene	Formaldehyde	762	0	0	166	928
Ethanol	Acetaldehyde	43,907	201,811	22,820	330	268,868
Ethene	Formaldehyde	24,481	349,992	411,045	165,071	950,589
1-Heptene	Formaldehyde	602	177	1,524	1,805	4,108
2-Heptene	Acetaldehyde	579	177	2,822	2,196	5,774
1-Hexene	Formaldehyde	1,248	1,332	15,498	6,507	24,585
2-Hexene	Acetaldehyde	94	1,332	13,399	10,077	24,902
3-Hexene	Propionaldehyde	516	1,332	5,370	4,370	11,588
Isoprene	Formaldehyde	316	401	6,280	5,289	12,286
1-Nonene	Formaldehyde	56	301	35,806	7,082	43,245
2-Nonene	Acetaldehyde	2	0	0	82	84
1-Octene	Formaldehyde	37	0.3	1,961	1,828	3,826.3
2-Octene	Acetaldehyde	18	0.3	1,961	837	2,816.3
1-Pentene	Formaldehyde	2,693	18,199	32,313	8,959	62,164
1-2,4,4-Trimethyl	Formaldehyde	27	0	21,064	0	21,091
1-2-Methyl pentene	Formaldehyde	124	1,784	37,937	4,780	44,625
1-3-Methyl pentene	Formaldehyde	87	1,782	55,197	4,127	61,193
1-4-Methyl pentene	Formaldehyde	96	1,782	6,072	2,275	10,225
2-Pentene	Acetaldehyde, Propionaldehyde	2,699	4,550	70,835	22,234	100,318
2-3-Methyl pentene	Acetaldehyde	66	1,782	14,328	10,916	27,092
2-4-Methyl pentene	Acetaldehyde	132	1,782	37,937	8,950	48,801
Propene	Acetaldehyde, Formaldehyde	15,705	64,853	171,468	66,043	318,069
2-Methyl propene	Formaldehyde	602	8,896	93,943	19,171	122,612

3. Development of Future Year Mobile and Mobile-Related Emissions

3.1 Locomotive and commercial marine vessels

Emissions from locomotive and commercial marine vessels were projected similarly; using ratios computed from previously projected, multi-year, national-level, criteria pollutant emission data. Because these previously projected emissions account for both activity growth and reductions due to control programs, the term “projection factor” is used rather than “growth factor” to describe the factor used to multiply base year emissions to obtain future year emissions. Table 5 shows the eight locomotive SCC codes in the 1999 NEI.

Table 5. Locomotive SCC codes in the 1999 NEI nonroad inventory.

SCC	Description
2285000000	Mobile Sources, Railroad Equipment, All Fuels, Total
2285002000	Mobile Sources, Railroad Equipment, Diesel, Total
2285002005	Mobile Sources, Railroad Equipment, Diesel, Line Haul Locomotives
2285002006	Mobile Sources, Railroad Equipment, Diesel, Line Haul Locomotives: Class I operations
2285002007	Mobile Sources, Railroad Equipment, Diesel, Line Haul Locomotives: Class II/III operations
2285002008	Mobile Sources, Railroad Equipment, Diesel, Line Haul Locomotives: Passenger Trains (Amtrak)
2285002009	Mobile Sources, Railroad Equipment, Diesel, Line Haul Locomotives: Commuter lines
2285002010	Mobile Sources, Railroad Equipment, Diesel, Yard Locomotives

Projection factors for the locomotive emissions, which account for both growth and reductions due to control programs, were developed from the VOC and PM10 projected emissions shown in Table 6. These were derived as part of the EPA’s 2004 Clean Air Nonroad Diesel Rule (U.S. EPA, 2004d).

Table 6. Locomotive 50-State annual emissions trends (tons per year) and future year ratios

Year	VOC emissions	VOC ratio (future year/1999)	PM10 emissions	PM10 ratio (future year/1999)
1999	34,579	1.0000	20,869	1.0000
2007	32,646	0.9441	17,657	0.8461
2010	31,559	0.9127	15,109	0.7240
2015	31,072	0.8986	14,461	0.6929
2020	30,170	0.8725	13,652	0.6542
2030	28,622	0.8277	12,061	0.5779

In that they were computed using 50-state total emission sums, the projection factors were national level. In addition, they were applied to each pollutant across all SCC codes. That is, all locomotive SCC codes with pollutants deemed VOC received the same projection factor. The pollutants associated with locomotive emissions are shown in Table 7 with their assigned projection factor for locomotives.

Table 7. Locomotive HAPs. HAPs not in bold are not emphasized in the MSAT study but are projected.

HAP	Growth factor basis	HAP	Growth factor basis
1,3-Butadiene	VOC ratios	**Hexane**	VOC ratios
2,2,4-Trimethylpentane	VOC ratios	Lead	Metals (projection factors = 1.0)
Acetaldehyde	VOC ratios	**Manganese**	Metals (growth factors = 1.0)
Acrolein	VOC ratios	Methanol	VOC ratios
Antimony	Metals (projection factors = 1.0)	Methyl ethyl ketone	VOC ratios
Benzene	VOC ratios	**Naphthalene**	PM ratios
Beryllium	Metals (projection factors = 1.0)	**Nickel**	Metals (projection factors = 1.0)
Cadmium	Metals (projection factors = 1.0)	**POM (excluding Naphthalene)**	PM ratios
Chlorine	VOC ratios	Phosphorus	PM ratios
Chromium	Metals (projection factors = 1.0)	**Propionaldehyde**	VOC ratios
Cobalt	Metals (projection factors = 1.0)	Selenium	Metals (projection factors = 1.0)
Cumene	VOC ratios	**Styrene**	VOC ratios
Ethyl benzene	VOC ratios	**Toluene**	VOC ratios
Formaldehyde	**VOC ratios**	**Xylene**	VOC ratios

Metals were set to no growth (projection factor = 1.0, metals remain at 1999 levels) because little activity change is expected in locomotives in the future. This is because metal emissions were most likely the result of impurities in fuel and engine oil, and from engine wear, and it is not known how these emissions would be impacted by controls, if it all. Several of the metals were estimated using emission factor (EF) x Activity, and several were estimated as fractions of PM emissions.

Projection factors for commercial marine vessels (CMV) were computed similarly to locomotive projection factors, using 50-state emission summaries for various future years that were developed as part of the EPA's 2004 Clean Air Nonroad Diesel Rule (U.S. EPA, 2004d). These emissions summaries are shown in Table 8.

One difference, however, is that the projection factors for CMV were specific to both SCC (diesel, residual, or no fuel information) and pollutant specific (VOC or PM). The SCC dependence on the projection factor was based on whether the SCC was related to diesel emissions or residual emissions. There were three SCC codes used to assign the basis of the projection factor for the SCC. Within the SCC, the projection factor used was dependent on whether the HAP was VOC or PM. Table 8 lists the projection factors computed from the 50-state total emission summaries commercial marine vessels.

Projection factors computed for the SCC codes in Table 8 were assigned to the five SCC codes corresponding to the commercial marine vessels in the 1999 NEI. Each HAP within the SCC category was then assigned the projection factor for VOC or PM. Table 9 lists the SCC codes and HAPs associated with the commercial marine vessel emissions in the 1999 NEI.

Table 8. Commercial marine vessel 50-State annual emissions trends (tons per year) and future year ratios used as projection factors

SCC	Description	Year	VOC emissions	VOC ratio (year/ 1999)	PM10 emissions	PM10 ratio (year/ 1999)
2280000000	Mobile Sources, Marine Vessels, Commercial, All Fuels, Total, All Vessel Types	1999	32,133	1.0000	39,012	1.0000
		2007	35,951	1.1188	43,247	1.1086
		2010	36,990	1.1511	43,717	1.1206
		2015	39,543	1.2306	47,456	1.2165
		2020	43,395	1.3505	53,496	1.3713
		2030	55,083	1.7142	72,489	1.8581
2280002000	Mobile Sources, Marine Vessels, Commercial, Diesel, Total, All Vessel Types	1999	23,403	1.0000	19,927	1.0000
		2007	24,530	1.0482	19,133	0.9601
		2010	24,568	1.0498	17,721	0.8893
		2015	24,695	1.0552	16,900	0.8481
		2020	25,268	1.0797	16,795	0.8428
		2030	27,546	1.7700	18,258	1.9162
228003000	Mobile Sources, Marine Vessels, Commercial, Residual, Total, All Vessel Types	1999	8,730	1.0000	19,085	1.0000
		2007	11,421	1.3083	24,115	1.2635
		2010	12,421	1.4229	25,996	1.3621
		2015	14,848	1.7009	30,556	1.6011
		2020	18,127	2.0765	36,701	1.9230
		2030	27,537	3.1544	54,231	2.8416

Table 9. Commercial marine vessel SCC codes, HAPs, and basis of projection factors. HAPs in bold are emphasized in the MSAT study.

SCC	Description	VOC and PM HAPs	Projection factor basis
2280000000	Mobile Sources, Marine Vessels, Commercial, All Fuels, Total, All Vessel Types	**1,3-Butadiene, 2,2,4-Trimethylpentane, Acetaldehyde, Benzene,** Chlorine, Cumene, **Ethyl Benzene, Formaldehyde, Hexane,** Methanol, Methyl Ethyl Ketone, **Propionaldehyde, Styrene, Toluene, Xylenes**	VOC ratios for 2280000000 (all fuels)
		Antimony, Cadmium, **Chromium,** Cobalt, Lead, **Manganese, Naphthalene, Nickel,** Phosphorus, **POM,** Selenium	PM ratios for 2280000000 (all fuels)
2280002100	Mobile Sources, Marine Vessels, Commercial, Diesel, Diesel- port emissions	**1,3-Butadiene, 2,2,4-Trimethylpentane, Acetaldehyde, Acrolein, Benzene,** Chlorine, Cumene, **Ethyl Benzene, Formaldehyde, Hexane,** Methanol, Methyl Ethyl Ketone, **Propionaldehyde, Styrene, Toluene, Xylenes**	VOC ratios for 2280002000 (diesel)
		Antimony, Cadmium, **Chromium,** Cobalt, Lead, **Manganese, Naphthalene, Nickel,** Phosphorus, **POM,** Selenium	PM ratios for 2280002000 (diesel)
2280002200	Mobile Sources, Marine Vessels, Commercial, Diesel, Diesel- underway emissions	**2,2,4-Trimethylpentane, Acetaldehyde, Acrolein, Benzene, Ethyl Benzene, Formaldehyde, Hexane, Propionaldehyde, Styrene, Toluene, Xylenes**	VOC ratios for 2280002000 (diesel)
		Chromium, Lead, Manganese, Naphthalene, Nickel, POM	PM ratios for 2280002000 (diesel)
2280003100	Mobile Sources, Marine Vessels, Commercial, Residual, Residual - port emissions	**2,2,4-Trimethylpentane, Acetaldehyde, Acrolein, Benzene,** Chlorobenzene, **Ethyl Benzene, Formaldehyde, Hexane, Propionaldehyde, Styrene, Toluene, Xylenes**	VOC ratios for 2280003000 (residual)
		Beryllium, Cadmium, **Chromium,** Lead, **Manganese, Naphthalene, Nickel, POM,** Selenium	PM ratios for 2280003000 (residual)
2280003200	Mobile Sources, Marine Vessels, Commercial, Residual, Residual -underway emissions	**2,2,4-Trimethylpentane, Acetaldehyde, Acrolein, Benzene, Ethyl Benzene, Formaldehyde, Hexane, Propionaldehyde, Styrene, Toluene, Xylenes**	VOC ratios for 2280003000 (residual)
		Beryllium, Cadmium, **Chromium,** Lead, **Manganese, Naphthalene, Nickel, POM,** Selenium	PM ratios for 2280003000 (residual)

As can be seen from Tables 7 and 9, there were other HAPs being projected other than those of interest for the MSAT study. As mentioned previously, these were HAPs found only in data submitted by States or in surrogate profiles for vessels running on residual fuel. These HAPs were not removed from the inventories for MSAT because these HAPs would need to be projected for other projections work; by not removing pollutants there were fewer datasets to manage.

Appendix C (C.1.1) describes the steps involved in the development of the projection factor files used for the locomotives and commercial marine vessels emission projections and (C.1.2) the steps taken to apply the factors and produce projected emissions.

Tables 10 and 11 present the nationwide 1999 and projected emissions for locomotives and commercial marine vessels, respectively. "All HAPs" refer to the sum of MSAT and non-MSAT HAPs.

Table 10. National locomotive emissions (rounded) by SCC for selected HAPs and across all HAPs.

SCC	HAP	Emissions (tons/yr)					
		1999	2007	2010	2015	2020	2030
2285000000	Acrolein	24	23	22	22	21	20
	All HAPs	151	143	138	136	132	125
2285002000	Acetaldehyde	1	1	1	1	1	1
	Acrolein	0.3	0.3	0.3	0.3	0.3	0.3
	Formaldehyde	2	2	2	2	2	1
	All HAPs	5	5	5	5	5	4
2285002005	1,3-Butadiene	5	4	4	4	4	4
	Acetaldehyde	174	165	159	157	152	144
	Benzene	47	45	43	43	41	39
	Formaldehyde	349	330	319	314	305	289
	Naphthalene	2	2	2	1	1	1
	All HAPs	717	677	654	644	625	593
2285002006	1,3-Butadiene	90	85	82	81	78	74
	Acetaldehyde	519	490	474	466	453	429
	Acrolein	87	83	80	79	76	72
	Benzene	71	67	65	64	62	59
	Formaldehyde	1,196	1,129	1,091	1,074	1,043	990
	Naphthalene	48	40	35	33	31	28
	All HAPs	2,709	2,550	2,458	2,419	2,347	2,223
2285002007	1,3-Butadiene	6	6	5	5	5	5
	Acetaldehyde	35	33	32	31	30	29
	Acrolein	6	6	6	6	5	5
	Benzene	5	5	4	4	4	4
	Formaldehyde	80	75	73	72	70	66
	Naphthalene	3	3	2	2	2	2
	All HAPs	184	173	167	164	160	151
2285002008	1,3-Butadiene	2	2	2	2	2	2
	Acetaldehyde	11	11	10	10	10	9
	Acrolein	2	2	2	2	2	2
	Benzene	2	1	1	1	1	1
	Formaldehyde	26	24	24	23	23	21
	Naphthalene	1	1	1	1	1	1
	All HAPs	59	55	53	53	51	48
2285002009	1,3-Butadiene	2	2	2	2	1	1
	Acetaldehyde	10	9	9	9	8	8
	Acrolein	1	1	1	1	1	1
	Benzene	1	1	1	1	1	1
	Formaldehyde	22	21	20	20	20	19
	Naphthalene	1	1	1	1	1	1
	All HAPs	49	46	45	44	43	40
2285002010	1,3-Butadiene	8	7	7	7	7	6
	Acetaldehyde	66	62	60	59	57	54
	Acrolein	7	6	6	6	6	5
	Benzene	12	12	11	11	11	10
	Formaldehyde	143	135	131	129	125	118
	Naphthalene	5	5	4	4	3	3
	All HAPs	371	350	337	332	322	305
Total Locomotive	1,3-Butadiene	111	105	102	100	97	92
	Acetaldehyde	815	770	744	732	711	675
	Acrolein	128	121	117	115	112	106
	Benzene	139	131	127	125	121	115
	Formaldehyde	1,817	1,716	1,659	1,634	1,586	1,505
	Naphthalene	60	51	44	42	39	35
	All HAPs	4,246	4,000	3,858	3,796	3,684	3,491

Table 11. National commercial marine vessel emissions (rounded) by SCC for selected HAPs and across all HAPs.

SCC	HAP	Emissions (tons/yr)					
		1999	2007	2010	2015	2020	2030
2280000000	1,3-Butadiene	0.1	0.2	0.2	0.2	0.2	0.2
	Acetaldehyde	5	6	6	6	7	9
	Benzene	1	2	2	2	2	2
	Formaldehyde	10	12	12	13	14	18
	Naphthalene	0.1	0.1	0.1	0.1	0.1	0.1
	All HAPs	21	24	25	26	29	37
2280002100	1,3-Butadiene	6	6	6	6	6	7
	Acetaldehyde	1,478	1,549	1,551	1,559	1,595	1,739
	Acrolein	54	56	56	57	58	63
	Benzene	404	424	424	427	437	476
	Formaldehyde	2,973	3,116	3,121	3,136	3,210	3,499
	Naphthalene	33	31	29	28	27	30
	All HAPs	5,478	5,736	5,740	5,766	5,898	6,430
2280002200	Acetaldehyde	459	481	482	485	496	540
	Acrolein	22	23	23	23	23	25
	Benzene	126	132	132	133	136	148
	Formaldehyde	925	969	971	976	998	1,088
	Naphthalene	11	10	10	9	9	10
	All HAPs	1,694	1,774	1,776	1,785	1,826	1,990
2280003100	Acetaldehyde	300	392	426	510	622	945
	Acrolein	17	23	24	29	36	54
	Benzene	80	104	113	135	165	251
	Formaldehyde	561	733	798	954	1,164	1,768
	Naphthalene	16	20	22	26	31	46
	All HAPs	1,126	1,467	1,594	1,901	2,316	3,506
2280003200	Acetaldehyde	122	160	174	208	254	386
	Acrolein	6	8	8	10	12	18
	Benzene	33	44	48	57	69	105
	Formaldehyde	247	323	351	420	513	779
	Naphthalene	6	7	8	9	11	16
	All HAPs	466	607	660	787	959	1,451
Total CMV	1,3-Butadiene	6	6	6	6	6	7
	Acetaldehyde	2364	2588	2639	2768	2974	3619
	Acrolein	98	109	112	118	129	161
	Benzene	644	705	719	753	809	982
	Formaldehyde	4715	5153	5252	5499	5899	7152
	Naphthalene	65	69	68	72	79	102
	All HAPs	8,786	9,609	9,795	10,266	11,028	13,414

3.2 Aircraft and Aviation gasoline

Aircraft emissions were projected by using growth factors based on activity growth. These growth factors were also used to project aviation gasoline source categories that are inventoried in the NEI as stationary sources. Note that the projection of airport support equipment source categories did not use this approach; they were projected using the National Mobile Inventory Model (NMIM) as described in Section 3.3.3.

Aircraft growth factors were developed using data on itinerant (landing and take-off) operations from the Terminal Area Forecast System (TAF) (FAA, 2004), http://www.apo.data.faa.gov/. These data were accessed from the website in February 2004.

The TAF model provides itinerant activity for commercial aircraft, general aviation, air taxis, and military aircraft. The four categories map directly to inventory categories for aircraft emissions. We used the growth factors for general aviation for aviation gasoline emissions since most aircraft gasoline is used with general aviation aircraft. Although the TAF model provides activity at individual airports, the TAF data were summed to create growth factors at the national level. This was done to smooth out the large-scale year-to-year changes in individual airport itinerant data that were questionable. The same approach was used in the modeling for the Clean Air Interstate (CAIR) rule (EPA, 2005b). Table 12 provides the nationally aggregated TAF intinerant data for 2002-2010, inclusive, 2015 and 2020. Note that the "all operations" data is simply the sum of commercial aircraft, air taxi, general aviation, and military operations.

Table 12. TAF landing and take-off data for 2002 through 2020, 2015, and 2020.

Year	Commercial	Air Taxi	General Aviation	Military	All Operations
1999	14,769,055	14,177,496	44,413,777	3,977,646	77,337,974
2000	15,239,632	14,474,434	45,075,619	4,023,672	78,813,357
2001	14,806,610	14,559,287	44,199,554	4,145,459	77,710,910
2002	13,823,811	13,976,494	44,096,192	4,168,042	76,064,539
2003	12,877,845	15,192,330	42,946,739	4,141,986	75,158,900
2004	13,144,840	15,812,801	43,302,577	4,148,717	76,408,935
2005	13,587,336	16,177,234	43,672,459	4,155,567	77,592,596
2006	13,931,296	16,478,077	44,041,238	4,155,999	78,606,610
2007	14,244,149	16,754,880	44,409,867	4,156,432	79,565,328
2008	14,559,169	17,022,228	44,778,567	4,156,864	80,516,828
2009	14,875,408	17,292,401	45,147,517	4,157,297	81,472,623
2010	15,199,253	17,566,653	45,516,733	4,157,730	82,440,369
2011	15,516,407	17,839,971	45,886,238	4,158,162	83,400,778
2012	15,837,083	18,113,540	46,255,950	4,158,595	84,365,168
2013	16,167,397	18,388,892	46,626,125	4,159,028	85,341,442
2014	16,503,853	18,666,510	46,996,330	4,159,460	86,326,153
2015	16,844,216	18,943,304	47366,817	4,159,893	87,314,230
2020	18,584,876	20,347,985	49,223,017	4,162,058	92,317,936

Growth factors were computed for 2002-2010, inclusive, 2015 and 2020 by dividing each year's TAF data by the TAF data for 1999. The TAF data did not cover 2030; growth factor for 2030 was calculated by using the same rate of growth between 2015 and 2020 and extrapolating to 2030 using Equation 1:

$$GF_{2030} = GF_{2020} + ((2030 - 2020) \times (GF_{2020} - GF_{2015}) \div (2020 - 2015)) \qquad (1)$$

where GF is the growth factor for the respective years.

The growth factors for the MSAT study years are shown in Table 13. The growth factor assignments for each of the airport related SCC codes are shown in Table 14.

Table 13. Aircraft growth factors for MSAT study years.

Aviation type	**Growth Factors**				
	2007	**2010**	**2015**	**2020**	**2030**
Commercial	0.9645	1.0291	1.1405	1.2584	1.4941
Air Taxi	1.1818	1.2391	1.3362	1.4352	1.6334
General	0.9999	1.0248	1.0665	1.1083	1.1919
Military	1.0449	1.0453	1.0458	1.0464	1.0475
All operations	1.0288	1.0660	1.1290	1.1937	1.3231

Table 14. Airport related SCC codes and assigned growth factor basis.

SCC	Description	Growth factor basis
2265008000	Airport Support Equipment, Total, Off-highway 4-stroke	No factor. Projected emissions in NMIM (see 3.3.3)
2265008005	Airport Support Equipment, Off-highway 4-stroke	No factor. Projected emissions in NMIM (see 3.3.3)
2267008000	Airport Ground Support Equipment, All, LPG	No factor. Projected emissions in NMIM (see 3.3.3)
2267008005	Airport Ground Support Equipment, LPG	No factor. Projected emissions in NMIM (see 3.3.3)
2268008000	Airport Ground Support Equipment, CNG, All	No factor. Projected emissions in NMIM (see 3.3.3)
2270008000	Airport Service Equipment, Total, Off-highway Diesel	No factor. Projected emissions in NMIM (see 3.3.3)
2270008005	Airport Service Equipment, Airport Support Equipment, Off-highway Diesel	No factor. Projected emissions in NMIM (see 3.3.3)
2275000000	All Aircraft Types and Operations	Growth factor for All operations
2275060000	Air Taxi, Total	Growth factor for Air Taxi
2275020000	Commercial Aircraft, Total	Growth factor for Commercial Aviation
2275070000	Aircraft Auxiliary Power Units, Total	Growth factor for Commercial Aviation
2275050000	General Aircraft, Total	Growth factor for General Aviation
2275900000	Aircraft Refueling: All Fuels, All Processes	Growth factor for General Aviation
2501080000#	Aviation Gasoline Distribution: Stage 1 & II	Growth factor for General Aviation
2501080050#	Aviation Gasoline Storage -Stage I	Growth factor for General Aviation
2501080100#	Aviation Gasoline Storage -Stage II	Growth factor for General Aviation
2275001000	Military Aircraft, Total	Growth factor for Military Aviation

Stationary sources in the non-point inventory. All others are nonroad sources.

Growth factor files were created for each year, 2002-2010 inclusive, 2015, 2020, and 2030, using the SCC growth factor file format for EMS-HAP Version 3.0 described in Appendix B of the EMS-HAP Version 3.0 User's Guide (U.S. EPA, 2004b). For this format, each SCC was assigned a code describing its growth method, basically the "growth factor basis" column in Table 14. The format of the file is shown in Figure 1. The naming convention of the aircraft and aviation gasoline growth factor files is gf99scca_XX.txt where XX is the two-digit year for 2002 through 2010 inclusive, 2015, 2020, and 2030.

```
1999 Base Year EGAS SCC Growth Factors for 2010, Created 12APRIL04  BEGIN SCC-REMI XREF on line 3.
GROWTH FACTORS BEGIN ON LINE 18.
2265008000 N/A projected emissions will be supplied with NMIM
2265008005 N/A projected emissions will be supplied with NMIM
2267008000 N/A projected emissions will be supplied with NMIM
2267008005 N/A projected emissions will be supplied with NMIM
2268008000 N/A projected emissions will be supplied with NMIM
2270008000 N/A projected emissions will be supplied with NMIM
2270008005 N/A projected emissions will be supplied with NMIM
2275000000 TAF for ALL OPERATIONS (p_tot)
2275060000 TAF for Air Taxi
2275020000 TAF for Commercial Aviation
2275070000 TAF for Commercial Aviation
2275050000 TAF for General Aviation
2275900000 TAF for General Aviation
2501080000 TAF for General Aviation
2501080050 TAF for General Aviation
2501080100 TAF for General Aviation
2275001000 TAF for Military Aviation
00 000   1.0000  N/A projected emissions will be supplied with NMIM
00 000   1.0660 TAF for ALL OPERATIONS (p_tot)
00 000   1.2391 TAF for Air Taxi
00 000   1.0291 TAF for Commercial Aviation
00 000   1.0248 TAF for General Aviation
00 000   1.0453 TAF for Military Aviation
```

Figure 1. Format of the aircraft growth factor file. 2010 growth factors shown as example.

EMS-HAP V3 was used to apply the growth factors to the aircraft and aviation gasoline sources.

Aircraft emissions were projected by first subsetting the nonroad airport-related emissions to exclude the airport support equipment emissions, which were projected using NMIM future emissions data as described in Section 3.3.3. The subsetting of the data was done on the temporally allocated 1999 NEI emissions for NATA (National Air Toxics Assessment). These emissions had previously been processed through the appropriate EMS-HAP programs, COPAX, PtDataProc, PtModelProc, and PtTemporal for the 1999 NATA (see EMS-HAP User's Guide for details, (U.S. EPA, 2004b)). After the subsetting was completed, the emissions were processed through the EMS-HAP program PtGrowCntl for 2002 through 2010, 2015, 2020, and 2030, using the TAF-derived growth factors described above.

Aviation gasoline emissions (SCCs shown in Table 14 with # footnotes) that had been processed through the appropriate EMS-HAP programs for the 1999 NATA, were projected using the EMS-HAP program PtGrowCntl for 2002 through 2010, 2015 and 2020, using the TAF-derived growth factors described above. Aviation gasoline emissions were projected to 2030 but it was decided to use 2020 projected emissions for 2030 for all stationary sources because of uncertainty in the 2030 projection and growth factors.

A flowchart of the projection processing is shown in Figure 2.

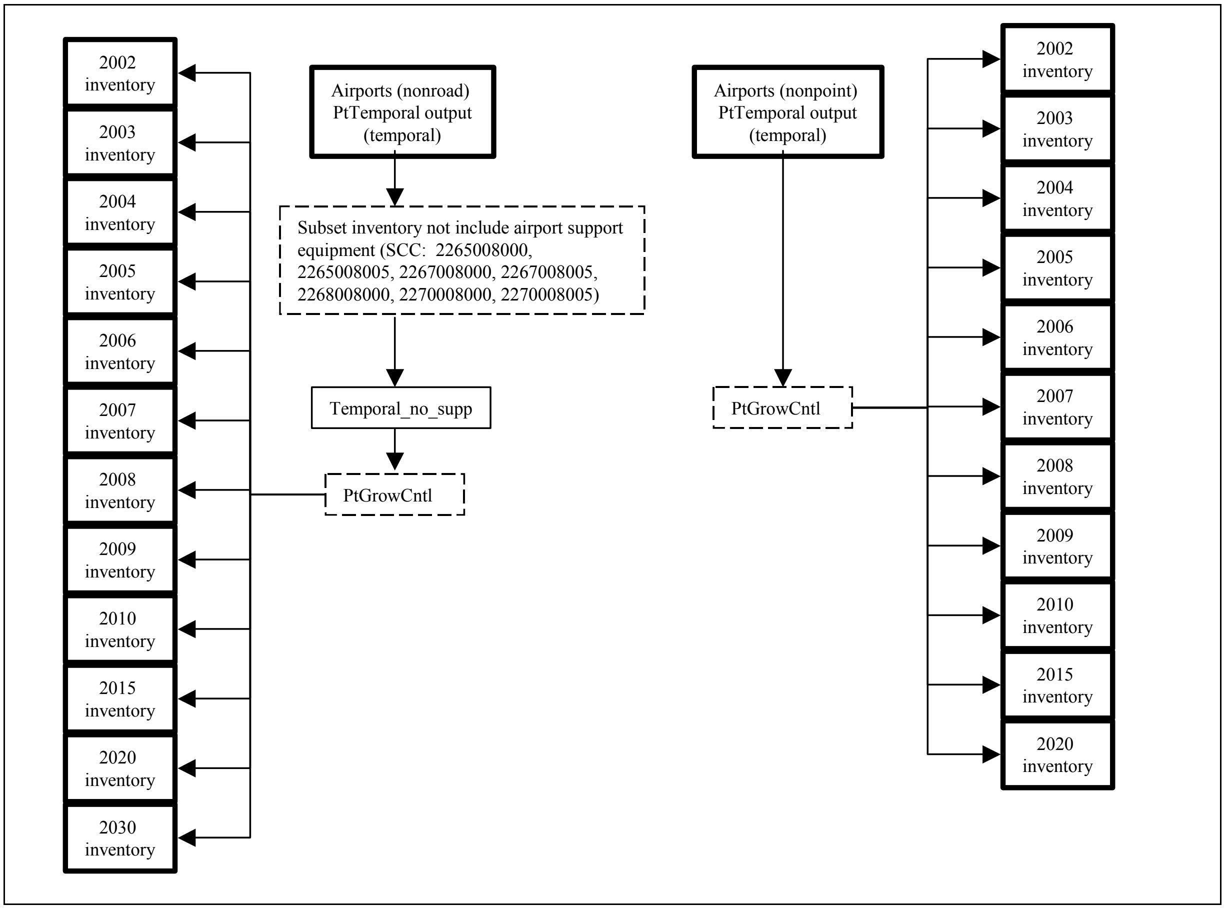

Figure 2. Flowchart of aircraft and aviation gasoline emissions projections.

Projected airport related emissions (excluding airport support equipment) by SCC are shown in Table 15.

Table 15. Airport related emissions (excluding airport support equipment) for selected HAPs and all HAPs by SCC. Non-point SCC emissions for 2030 are set equal to 2020.

SCC	HAP	Emissions (tons/yr)					
		1999	2007	2010	2015	2020	2030
2275000000	1,3-Butadiene	6	6	6	6	7	7
	Acetaldehyde	12	12	13	14	14	16
	Acrolein	6	6	6	6	7	7
	Benzene	10	10	10	11	12	13
	Formaldehyde	40	41	43	45	48	53
	Naphthalene	1	1	1	1	2	2
	All HAPs	116	119	123	131	138	153
2275001000	1,3-Butadiene	193	202	202	202	202	202
	Acetaldehyde	506	529	529	529	530	530
	Acrolein	247	258	258	258	258	258
	Benzene	213	223	223	223	223	223
	Formaldehyde	1,635	1,708	1,709	1,710	1,711	1,712
	Naphthalene	62	64	64	64	64	64
	All HAPs	3,171	3,313	3,315	3,316	3,318	3,322
2275020000	1,3-Butadiene	525	506	540	599	661	784
	Acetaldehyde	1,357	1,309	1,397	1,548	1,708	2028
	Acrolein	662	638	681	754	832	988
	Benzene	574	554	591	655	722	858
	Formaldehyde	4,383	4,227	4,510	4,998	5,515	6548
	Naphthalene	164	158	169	187	206	245
	All HAPs	8,455	8,155	8,701	9,643	10,640	12,633
2275050000	1,3-Butadiene	60	60	61	64	66	71
	Acetaldehyde	85	85	87	91	95	102
	Acrolein	33	33	34	35	36	39
	Benzene	186	186	191	199	206	222
	Formaldehyde	285	285	293	304	316	340
	Naphthalene	109	109	111	116	120	129
	All HAPs	2,053	2,053	2,104	2,190	2,275	2,447
2275060000	1,3-Butadiene	40	47	49	53	57	65
	Acetaldehyde	58	68	72	77	83	94
	Acrolein	22	26	27	29	31	35
	Benzene	119	141	147	159	171	194
	Formaldehyde	206	243	255	275	296	336
	Benzene	121	143	150	162	174	198
	All HAPs	1,077	1,272	1,334	1,439	1,545	1,758
2501080000	Benzene	0.04	0.04	0.04	0.04	0.05	0.05
	Naphthalene	0.01	0.01	0.01	0.01	0.01	0.01
	All HAPs	1	1	1	1	1	1
2501080050	Benzene	287	287	294	306	318	318
	Naphthalene	16	16	16	17	18	18
	All HAPs	1,676	1,676	1,718	1,788	1,858	1,858
2501080100	Benzene	20	20	20	21	22	22
	Naphthalene	1	1	1	1	1	1
	All HAPs	117	117	119	124	129	129
Total	1,3-Butadiene	824	821	859	924	993	1,131
	Acetaldehyde	2,019	2,004	2,098	2,259	2,430	2,770
	Acrolein	968	960	1,005	1,083	1,165	1,329
	Benzene	1,409	1,420	1,477	1,574	1,674	1,850
	Formaldehyde	6,549	6,505	6,809	7,333	7,885	8,990
	Naphthalene	473	492	513	548	585	657
	All HAPs	16,666	16,706	17,415	18,632	19,904	22,301

3.3 Projection of onroad and nonroad categories using NMIM

3.3.1 Description of NMIM

For all mobile source categories except commercial marine vessels, locomotives, and aircraft (Sections 3.1 and 3.2), EPA's Office of Transportation and Air Quality's (OTAQ) new emissions inventory modeling system for highway and nonroad sources, the National Mobile Inventory Model (NMIM) (Michaels et al. 2005; Cook et al. 2004) was used to generate emission data for projections. NMIM develops county level inventories using MOBILE6.2, NONROAD, and model inputs stored in data files. The version of NMIM used in this assessment includes NONROAD2004, which was also used in the recent Clean Air Nonroad Diesel Rule (U.S. EPA, 2004d). More details on the inputs and data files used in the modeling can be found in Appendix A. In addition to criteria pollutants, NMIM can currently produce 13 gaseous hydrocarbons, 16 polycyclic aromatic hydrocarbons, 4 metal compounds and 17 dioxin and furan congeners, for any calendar year 1999 through 2050.

Future year MOBILE6.2 and NONROAD inputs include future year vehicle miles traveled (VMT) and fuel parameters, and future year equipment populations. Future year VMT for years 2010, 2020 and 2030 were developed at the county-level using data from the Energy Information Administration's National Energy Modeling System (NEMS) Transportation Model and Regional Economic Models Inc. population growth (Mullen and Neumann, 2004). VMT for intermediate years were interpolated, using 1999 as the base year. This same approach and projected VMT were used for the CAIR rule. Projection year fuel parameters were developed using results of several refinery modeling analyses conducted to assess impacts of fuel control programs on fuel properties (MathPro, 1998; 1999a, 1999b). The projection year fuel parameters were calculated by applying adjustment factors to the base year parameters (Eastern Research Group, 2003). In addition, NMIM uses monthly rather than seasonal fuel parameters, and parameters for spring and fall months were estimated by interpolating from summer and winter data. Documentation of the fuel parameters used in NMIM was compiled in 2003 (Eastern Research Group, 2003) and then subsequently, a number of changes were made, based on comments from States. These changes are documented in the change log for NMIM, dated May 14, 2004. This change log is included in the docket for this rule (EPA-HQ-OAR-2005-0036), along with the original documentation. In general, multiplicative adjustment factors were used to calculate future year gasoline parameters (i.e., future year parameter = base year parameter x adjustment factor). However, additive adjustment factors were used to calculate future year parameters for E200, E300, and oxygenate market shares (i.e., future year parameter = base year parameter + adjustment factor). The database used for this assessment assumes no Federal ban on MTBE, but does include State bans. Also, it did not include the renewable fuels mandate in the recent Energy Policy Act.

3.3.2 Onroad projections using NMIM

The 1999 NEI, which contains some State reported data for California and Texas, served as the base year inventory for the emission projections. In order to preserve the State reported data, it was decided to compute projection factors from NMIM output for 1999 and each future year of interest.

Equation 2 shows the computation of the projection factor

$$PF_{20XX} = \frac{E_{NMIM,20XX}}{E_{NMIM,1999}} \quad (2)$$

where PF_{20XX} is the projection factor for 2007, 2010, 2015, 2020, or 2030, E_{20XX} is the emissions for the corresponding year and E_{1999} is the 1999 emissions.

Under this approach, the projection factor is computed at the detailed inventory level, for each FIPS/SCC/CAS combination where 1999 emissions are nonzero. The FIPS represents the specific state and county of the emission; the SCC is the source category code and the CAS is the particular HAP emitted.

Before calculating the projection factors, the NMIM emissions for each year had to be summed by FIPS/SCC/CAS to remove the emissions type from the NMIM SCC. This was because the NMIM onroad emissions SCCs were broken out by exhaust and evaporative (non refueling) emissions for several of the HAPs. The NEI emissions were not broken out into exhaust and evaporative emissions. Once 1999 and future years' NMIM results were summed by FIPS/SCC/CAS for each year, then the projection factors were calculated using Equation 2.

The projection factors were then applied to the same FIPS/SCC/CAS combinations in the 1999 NEI. Only combinations in the 1999 NEI were kept. However, before the projection factors could be applied, the NMIM output needed to be processed because for some situations, the NMIM FIPS/SCC/CAS combinations did not match the NEI FIPS/SCC/CAS combinations. The bullets below describe the necessary processing. More details on the programming steps and example calculations are provided in Appendix B (B.1).

- Since the NEI contained the CAS for chromium, 7440473, the NMIM chromium III and chromium VI emissions were summed for each FIPS/SCC to give a total chromium number. New projection factors were calculated for the summed chromium and the CAS 7440473 was assigned to each record. This was done for all FIPS/SCC combinations with chromium III or chromium VI in NMIM.

- For xylenes, manganese, and nickel, NMIM results and projection factors were assigned to the CAS associated with total xylenes (1330207) and elemental manganese (7439965) and nickel (7440020). The 1999 NEI used CAS numbers 106423, 108383, and 95476 for p-xylene, m-xylene, and o-xylene respectively. In addition to 7439965 and 7440020 for manganese and nickel, the NEI also reported emissions using 198 as a manganese CAS number and 226 as a nickel CAS number. NMIM xylenes, manganese, and nickel observations were copied to observations with the same FIPS/SCC and emissions but replacing the CAS numbers with one of the other xylenes, manganese, or nickel CAS numbers while still retaining the original NMIM emissions.

- The 1999 NEI contained emissions for SCC codes 2230070YYY where YYY is the 3-digit road type descriptor (110, 130, 150, 170, 190, 210, 230, 250, 270, 290, 310, and 330). These SCC codes were for heavy duty diesel vehicles (HDDV). In NMIM, there were no SCC codes with 2230070 as the first seven numbers. NMIM contained emissions for SCC codes beginning with 2230071, 2230072, 2230073, 2230074, and 2230075. In order to calculate a projection factor for SCC codes beginning with 2330070 in the NEI, the emissions for 2230071YYY, 2230072YYY, 2230073YYY, 2230074YYY, and 2230075YYY were summed together for each road type YYY (as described above) for each FIPS/CAS across the HDDV SCC emissions. The summed emissions were assigned to an SCC code 223007XYYY where YYY is the road type. Table 16 shows the NMIM SCC codes used to create each of the 223007XYYY SCC emissions. Emissions were assigned to an SCC code 223007X instead of 2230070 for ease of visual QA of the emissions, given the quantity of data being processed for the onroad emissions. Once the 223007XYYY emissions were created from the NMIM results (for 1999 and future years), a projection factor was calculated using Equation 2. In this case, $E_{NMIM,20XX}$ represents the sum of the 5 HDDV types by road type for each FIPS/CAS for a future year and $E_{NMIM,1999}$ represents the sum of the 5 HDDV types by road type for each FIPS/CAS for 1999. For example, for SCC 2230070130 for benzene in Autauga County, AL for 2007 the projection factor used would be:

$$PF_{2230070130,2007} = \frac{E_{2230071130,2007} + E_{2230072130,2007} + E_{2230073130,2007} + E_{2230074130,2007} + E_{2230075130,2007}}{E_{2230071130,1999} + E_{2230072130,1999} + E_{2230073130,1999} + E_{2230074130,1999} + E_{2230075130,1999}} \quad (3)$$

  where E represents the benzene emissions. For examples of the calculations see Table B-2 in Appendix B.

- After preliminary processing, it was found that three counties in California, had data for motorcycle SCC codes, 2201080YYY, (where YYY is the road type as described in the above HDDV discussion) in the 1999 NEI which were not in NMIM and thus had no FIPS/SCC/CAS projection factor. These counties were Alpine County (06003), Modoc County (06049), and Sierra County (06091). The SCC codes are shown in Table 17. To project the 1999 NEI emissions in these counties, the future year onroad emissions were summed across all SCC codes for each FIPS/CAS, resulting in a county-HAP specific emissions number. The same was done for 1999. To calculate a county level HAP-specific projection factor the summed future year emissions were divided by the summed 1999 emissions. The county level HAP specific projection factors were then applied to the 1999 NEI motorcycle emissions for the appropriate HAPs.

Table 16. HDDV SCC codes used to calculate HDDV emissions for NEI projections.

HDDV type (First 7 characters of SCC code)	Road types (last 3 digits of SCC code)	SCC in NEI which projections are applied
2230071, 2230072, 2230073, 2230074, 2230075	110 (Rural Interstate)	2230070110
2230071, 2230072, 2230073, 2230074, 2230075	130 (Other Principal Arterial)	2230070130
2230071, 2230072, 2230073, 2230074, 2230075	150 (Rural Minor Arterial)	2230070150
2230071, 2230072, 2230073, 2230074, 2230075	170 (Rural Major Collector)	2230070170
2230071, 2230072, 2230073, 2230074, 2230075	190 (Rural Minor Collector)	2230070190
2230071, 2230072, 2230073, 2230074, 2230075	210 (Rural Local)	2230070210
2230071, 2230072, 2230073, 2230074, 2230075	230 (Urban Interstate)	2230070230
2230071, 2230072, 2230073, 2230074, 2230075	250 (Urban Other Freeways and Expressways)	2230070250
2230071, 2230072, 2230073, 2230074, 2230075	270 (Urban Other Principal Arterial)	2230070270
2230071, 2230072, 2230073, 2230074, 2230075	290 (Urban Minor Arterial)	2230070290
2230071, 2230072, 2230073, 2230074, 2230075	310 (Urban Collector)	2230070310
2230071, 2230072, 2230073, 2230074, 2230075	330 (Urban Local)	2230070330
HDDV descriptions: 2230070: HDDV 2230071: HDDV Class 2B 2230072: HDDV Class 3, 4, and 5 2230073: HDDV Class 6 and 7 2230074: HDDV Class 8A and 8B 2230075: HDDV Buses (School and Transit)		

Table 17. Motorcycle (MC) SCC codes not in NMIM output for Alpine, Modoc, and Sierra Counties California.

SCC	Description
2201080110	Mobile Sources, Highway Vehicles - Gasoline, Motorcycles (MC), Rural Interstate: Total
2201080130	Mobile Sources, Highway Vehicles - Gasoline, Motorcycles (MC), Rural Other Principal Arterial: Total
2201080150	Mobile Sources, Highway Vehicles - Gasoline, Motorcycles (MC), Rural Minor Arterial: Total
2201080170	Mobile Sources, Highway Vehicles - Gasoline, Motorcycles (MC), Rural Major Collector: Total
2201080190	Mobile Sources, Highway Vehicles - Gasoline, Motorcycles (MC), Rural Minor Collector: Total
2201080210	Mobile Sources, Highway Vehicles - Gasoline, Motorcycles (MC), Rural Local: Total
2201080330	Mobile Sources, Highway Vehicles - Gasoline, Motorcycles (MC), Urban Local: Total

A summary of national-level onroad projected emissions is provided in Table 18. Summary emissions were calculated nationwide by vehicle type. The vehicle types summarized are: 1) heavy duty gasoline vehicles (HDGV), 2) heavy duty diesel vehicles (HDDV), 3) light duty diesel trucks (LDDT), 4) light duty diesel vehicles (LDDV), 5) light duty gasoline trucks 1 (LDGT1), 6) light duty gasoline trucks 2 (LDGT2), 7) light duty gasoline vehicles (LDGV) and 8) motorcycles (MC).

More detailed summaries of onroad projected emissions can be found in the MSAT rule docket: EPA-HQ-OAR-2005-0036. The State and HAP specific summaries can be found in onroad_0923.xls and as a pivot table in onroad_pivot.xls

Table 18. National summary of projected onroad emissions by vehicle type for 1999, 2007, 2010, 2015, 2020, and 2030 across all HAPs and for 1,3-butadiene, acetaldehyde, acrolein, benzene, formaldehyde, and naphthalene.

Vehicle Type	HAP	Emissions (tons/yr)					
		1999	2007	2010	2015	2020	2030
HDDV	1,3-Butadiene	1,431	995	877	760	755	859
	Acetaldehyde	7,568	5,310	4,682	4,071	4,049	4,633
	Acrolein	807	561	494	429	425	483
	Benzene	2,674	1,872	1,650	1,434	1,426	1,629
	Formaldehyde	19,887	13,921	12,272	10,663	10,601	12,109
	Naphthalene	172	98	67	33	20	16
	All HAPs	38,534	26,923	23,707	20,570	20,435	23,336
HDGV	1,3-Butadiene	1,507	483	260	130	103	84
	Acetaldehyde	1,569	722	465	297	245	209
	Acrolein	714	177	79	25	18	12
	Benzene	7,967	4,041	2,970	2,152	1,760	1,539
	Formaldehyde	6,648	2,242	1,309	741	599	498
	Naphthalene	752	540	388	241	189	170
	All HAPs	80,227	35,096	24,838	17,342	13,666	12,023
LDDT	1,3-Butadiene	64	38	31	29	26	23
	Acetaldehyde	200	120	96	84	73	57
	Acrolein	24	14	12	11	10	9
	Benzene	167	100	82	74	67	57
	Formaldehyde	495	297	283	211	186	148
	Naphthalene	6	3	2	1	1	1
	All HAPs	1,279	766	617	552	491	402
LDDV	1,3-Butadiene	44	6	3	1	1	1
	Acetaldehyde	164	24	10	6	4	4
	Acrolein	16	2	1	1	0.4	0.4
	Benzene	120	17	7	4	3	3
	Formaldehyde	391	56	24	14	9	9
	Naphthalene	7	1	0.3	0.2	0. 1	0.1
	All HAPs	977	139	60	34	23	22
LDGT1	1,3-Butadiene	5,132	3,218	2,801	2,307	2,291	2,447
	Acetaldehyde	5,766	3,947	3,265	2,714	2,682	2,899
	Acrolein	661	434	368	306	302	326
	Benzene	42,433	30,773	27,498	23,835	23,346	24,856
	Formaldehyde	14,907	8,540	6,787	5,572	5,516	5,975
	Naphthalene	766	612	4,164	702	774	906
	All HAPs	342,839	239,534	208,636	177,486	170,855	179,122
LDGT2	1,3-Butadiene	3,483	1,919	1,735	1,524	1,503	1,486
	Acetaldehyde	3,433	2,411	2,023	1,789	1,726	1,710
	Acrolein	357	255	222	198	191	188
	Benzene	20,638	17,701	16,805	15,694	14,897	14,505
	Formaldehyde	9,809	5,264	4,164	3,628	3,513	3,509
	Naphthalene	491	260	268	274	281	316
	All HAPs	186,078	139,447	126,396	114,204	105,843	102,085

Table 18. Continued.

Vehicle Type	HAP	Emissions (tons/yr)					
		1999	2007	2010	2015	2020	2030
LDGV	1,3-Butadiene	11,743	3,983	2,855	1,895	1,500	1,614
	Acetaldehyde	11,057	4,311	3,155	2,123	1,690	1,831
	Acrolein	1,396	511	374	251	199	215
	Benzene	955,951	40,478	29,722	19,835	15,643	16,895
	Formaldehyde	27,957	9,239	6,811	4,628	3,705	4,028
	Naphthalene	1,757	950	831	726	678	807
	All HAPs	778,772	317,021	232,547	153,050	118,762	128,305
MC	1,3-Butadiene	220	234	244	266	288	350
	Acetaldehyde	171	204	214	233	253	309
	Acrolein	18	19	20	22	24	29
	Benzene	764	784	817	892	967	1177
	Formaldehyde	582	609	635	693	751	912
	Naphthalene	26	27	28	30	33	40
	All HAPs	8,826	8,691	9,035	9,854	10,673	12,957
Total Onroad	1,3-Butadiene	23,623	10,876	8,807	6,913	6,468	6,864
	Acetaldehyde	29,928	17,049	13,909	11,317	10,721	11,651
	Acrolein	3,993	1,974	1,570	1,242	1,170	1,263
	Benzene	170,355	95,766	79,550	63,920	58,109	60,660
	Formaldehyde	80,677	40,168	32,240	26,150	24,879	27,188
	Naphthalene	3,978	2,490	2,229	2,007	1,976	2,255
	All HAPs	1,437,532	767,617	625,836	493,092	440,748	458,252

HDDV: Heavy Duty Diesel Vehicles; HDGV: Heavy Duty Gasoline Vehicles
LDDT: Light Duty Diesel Trucks; LDDV: Light Duty Diesel Vehicles
LDGT1: Light Duty Gasoline Trucks 1; LDGT2: Light Duty Gasoline Trucks 2
LDGV: Light Duty Gasoline Vehicles; MC: Motorcycles

Once the onroad inventory had been projected, emissions for intermediate years not included in assessments done for the MSAT rule, 2002 through 2006, inclusive, 2008, and 2009 were interpolated from the MSAT projections and 1999 base emissions for each FIPS/SCC/CAS. For years between 1999 and 2007, the following formula was used to interpolate the projection factors for non-MSAT years:

$$PF_{20XX} = 1 + \left((20XX - 1999) \times \left(PF_{2007} - 1 \right) \big/ (2007 - 1999) \right) \quad (4)$$

where PF_{20XX} is the interpolated projection factor for 2002 through 2006, 20XX is the year 2002 through 2006, PF_{2007} is the projection factor for 2007 calculated from Equation 2 and 1 is the projection factor for 1999 (base year, no growth PF=1).

For 2008 and 2009, 2010 replaces 2007, and 2007 replaces 1999.

$$PF_{20XX} = 1 + \left((20XX - 2007) \times \left(PF_{2010} - PF_{2007} \right) \big/ (2010 - 2007) \right) \quad (5)$$

3.3.3 Nonroad projections using NMIM (excluding aircraft, locomotives, and commercial marine vessels)

The projection of the portion of the nonroad inventory that is developed using the NONROAD model followed a similar methodology as for the onroad. Projection factors (FIPS/SCC/CAS specific) were developed using the 1999 and future year NMIM runs using equation (2) above, and were applied to nonroad categories in the 1999 NEI. Similar to onroad, some processing took place, as described by the bullets below, to create FIPS/SCC/CAS projection factors to map to the 1999 NEI.

- The same processing was done for the nonroad as for onroad to create summed chromium, xylenes, manganese, and nickel projection factors. See first two bullets of Section 3.3.2.
- NMIM SCC emissions were summed to a "Total" or aggregated category (first 7 digits of SCC followed by 3 zeros) for each FIPS/HAP/SCC since numerous emission records in the 1999 NEI contained these aggregated categories and thus needed NMIM-based projection ratios. See Table 19 for a list.
- NMIM pleasure craft emissions, SCC codes beginning with 2282, were summed to provide a projection factor for the SCC code 2282000000 for each FIPS/CAS.
- For remaining FIPS/SCC/CAS combinations that did not match the NMIM emissions, county-level HAP specific projection factors were created based on engine/fuel type by summing emissions for 1999 NMIM and future year NMIM for each FIPS/CAS/engine/fuel type. These were applied to all SCC codes with the relevant engine/fuel type by HAP and by county. The engine fuel types were 2-stroke gasoline, 4-stroke gasoline, diesel, LPG, CNG, and miscellaneous.
- For CNG and LPG emissions in California and Texas (SCC codes beginning with 226800, 226801, and 226700) from the 1999 NEI without an NMIM based FIPS/SCC/CAS specific projection factor, used the VOC or PM county level ratios for CNG and LPG as fuel types for the HAPs in the inventory. Particulate HAPs received the PM ratios, and gaseous HAPs received the VOC ratios.

Appendix C provides the steps used to develop the projected emissions and contains sample calculations.

Table 19. SCC codes in the 1999 NEI inventory and not in the NMIM inventory.

SCC	Description	SCC	Description
2260001000	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Recreational Equipment, Total	2265008000	Airport Support Equipment, Total, Off-highway 4-stroke
2260002000	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Construction and Mining Equipment, Total	2265010000	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Industrial Equipment, All
2260003000	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Industrial Equipment, Total	2267001000	Mobile Sources, LPG, Recreational Equipment, All
2260004000	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Lawn and Garden Equipment, All	2267002000	Mobile Sources, LPG, Construction and Mining Equipment, All
2260005000	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Agricultural Equipment, Total	2267003000	Mobile Sources, LPG, Industrial Equipment, All
2260006000	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Commercial Equipment, Total	2267004000	Mobile Sources, LPG, Lawn and Garden Equipment, All
2260007000	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Logging Equipment, Total	2267005000	Mobile Sources, LPG, Agricultural Equipment, All
2265001000	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Recreational Equipment, Total	2267006000	Mobile Sources, LPG, Commercial Equipment, All
2265001020	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Recreational Equipment, Snowmobiles	2267008000	Airport Ground Support Equipment, All, LPG
2265002000	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Construction and Mining Equipment, Total	2268002000	Mobile Sources, CNG, Construction and Mining Equipment, All
2265003000	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Industrial Equipment, Total	2268003000	Mobile Sources, CNG, Industrial Equipment, All
2265004000	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Lawn and Garden Equipment, All	2268005000	Mobile Sources, CNG, Agricultural Equipment, All
2265005000	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Agricultural Equipment, Total	2268006000	Mobile Sources, CNG, Commercial Equipment, All
2265006000	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Commercial Equipment, Total	2268008000	Airport Ground Support Equipment, CNG, All
2265007000	Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Logging Equipment, Total	2268010000	Mobile Sources, CNG, Industrial Equipment, All
2270001000	Mobile Sources, Off-highway Vehicle Diesel, Recreational Equipment, Total	2270009000	Mobile Sources, Off-highway Vehicle Diesel, Underground Mining Equipment, All
2270002000	Mobile Sources, Off-highway Vehicle Diesel, Construction and Mining Equipment, Total	2270010000	Mobile Sources, Off-highway Vehicle Diesel, Industrial Equipment, All
2270003000	Mobile Sources, Off-highway Vehicle Diesel, Industrial Equipment, Total	2282000000	Mobile Sources, Pleasure Craft, All Fuels, Total, All Vessel Types
2270004000	Mobile Sources, Off-highway Vehicle Diesel, Lawn and Garden Equipment, All	2282005000	Mobile Sources, Pleasure Craft, Gasoline 2-Stroke, Total
2270005000	Mobile Sources, Off-highway Vehicle Diesel, Agricultural Equipment, Total	2282010000	Mobile Sources, Pleasure Craft, Gasoline 4-Stroke, Total
2270006000	Mobile Sources, Off-highway Vehicle Diesel, Commercial Equipment, Total	2282020000	Mobile Sources, Pleasure Craft, Diesel, Total
2270007000	Mobile Sources, Off-highway Vehicle Diesel, Logging Equipment, Total	2270008000	Airport Service Equipment, Total, Off-highway Diesel

In addition to the MSAT HAPs, there were several other HAPs in the 1999 NEI nonroad inventory. These HAPs were also projected for other projections work and the processing is described in Appendix C.

Summaries of national-level nonroad projected emissions for the MSAT HAPS by engine, equipment, and engine/equipment type are provided in Tables 20, 21 and 22, respectively. Engine types include 4-stroke gasoline, 2-stroke gasoline, diesel, aircraft, CNG (natural gas), LPG (liquid propane), miscellaneous, and residual fuel. Equipment types projected include agriculture, aircraft, airport support, commercial, commercial marine vessel, construction, industrial, lawn & garden, logging, pleasure craft, railroad, recreation, and underground mining. Engine and equipment type definitions were based on the NMIM definitions found in the NMIM tables. These tables include the nonroad categories (locomotives, commercial marine and aircraft) that did not utilize NMIM for projections; these were discussed in Sections 3.1 and 3.2.

More detailed summaries of nonroad projected emissions can be found in the MSAT rule docket: EPA-HQ-OAR-2005-0036. The State and HAP specific summaries, including non-MSAT HAPs, can be found in nonroad_0923.xls and nonroad_pivot.xls.

Table 20. National engine emissions for selected HAPs and total MSAT HAPs for 1999, 2007, 2010, 2015, 2020, and 2030.

Engine type	HAP	Emissions (tons/yr)					
		1999	2007	2010	2015	2020	2030
2-stroke gas	1,3-Butadiene	3,182	2,513	2,240	1,847	1,604	1,595
	Acetaldehyde	2,560	1,974	1,755	1,467	1,293	1,296
	Acrolein	559	472	426	344	292	291
	Benzene	29,998	25,165	22,545	18,582	16,287	16,457
	Formaldehyde	6,701	5,235	4,728	3,928	3,415	3,414
	Naphthalene	82	72	69	71	74	80
	MSAT HAPs	501,265	437,667	395,319	318,999	270,889	270,706
4-stroke gas	1,3-Butadiene	5,157	4,148	3,330	3,224	3,379	3,805
	Acetaldehyde	2,968	2,848	2,309	2,196	2,265	2,511
	Acrolein	458	367	300	289	300	334
	Benzene	28,713	23,717	19,531	19,165	20,153	22,705
	Formaldehyde	8,759	7,043	5,736	5,495	5,688	6,326
	Naphthalene	487	493	470	497	531	597
	MSAT HAPs	171,323	139,306	115,264	113,151	118,789	133,591
Aircraft	1,3-Butadiene	824	821	859	924	993	1131
	Acetaldehyde	2,019	2,004	2,098	2,259	2,430	2,770
	Acrolein	968	960	1,005	1,083	1,165	1,329
	Benzene	1,102	1,114	1,163	1,247	1,335	1,511
	Formaldehyde	6,549	6,505	6,809	7,333	7,885	8,990
	Naphthalene	456	475	496	530	566	638
	MSAT HAPs	14,276	14,315	14,965	16,081	17,256	19,603
CNG	1,3-Butadiene	8	2	1	1	1	1
	Acetaldehyde	5	2	1	0.5	0.4	0.3
	Acrolein	1	0.2	0.1	0.1	0.1	0.05
	Benzene	64	20	11	6	5	4
	Formaldehyde	38	17	10	5	4	3
	MSAT HAPs	373	115	61	33	28	24
Diesel	1,3-Butadiene	526	404	359	299	259	231
	Acetaldehyde	15,472	11,926	10,604	8,766	7,633	7,059
	Acrolein	1,048	801	709	583	504	459
	Benzene	5,190	3,930	3,467	2,812	2,410	2,199
	Formaldehyde	33,311	25,598	22,729	18,739	16,274	15,000
	Naphthalene	207	168	149	125	105	87
	MSAT HAPs	67,113	51,410	45,569	37,457	32,414	29,718
LPG	1,3-Butadiene	22	17	9	3	2	2
	Acetaldehyde	12	9	5	2	1	1
	Acrolein	2	1	1	0.3	0.2	0.2
	Benzene	174	134	72	23	16	15
	Formaldehyde	45	34	19	6	4	4
	MSAT HAPs	957	697	376	121	83	77
Miscellaneous	1,3-Butadiene	1	0.4	0.4	0.4	0.4	0.4
	Acetaldehyde	22	19	19	18	18	20
	Acrolein	24	23	22	22	21	20
	Benzene	6	5	4	4	4	4
	Formaldehyde	44	37	34	32	32	36
	Naphthalene	0.3	0.3	0.3	0.3	0.3	0.3
	MSAT HAPs	238	215	205	200	196	196

Table 20. Continued.

Engine type	HAP	Emissions (tons/yr)					
		1999	2007	2010	2015	2020	2030
Residual Oil	Acetaldehyde	422	552	600	717	876	1330
	Acrolein	23	30	33	39	47	72
	Benzene	113	148	161	192	235	356
	Formaldehyde	807	1,056	1,149	1,373	1,677	2,547
	Naphthalene	22	28	30	35	42	62
	MSAT HAPs	1,591	2,074	2,253	2,687	3,274	4,956

Table 21. National equipment emissions for selected HAPs and all MSAT HAPs for 1999, 2007, 2010, 2015, 2020, and 2030.

Equipment type	HAP	Emissions (tons/yr)					
		1999	2007	2010	2015	2020	2030
Agriculture	1,3-Butadiene	243	176	148	120	101	85
	Acetaldehyde	4,493	3,058	2,581	1,966	1,542	1,260
	Acrolein	285	194	164	125	98	81
	Benzene	2,203	1,569	1,323	1,058	877	744
	Formaldehyde	9,816	6,671	5,630	4,288	3,363	2,749
	Naphthalene	49	36	32	26	21	15
	MSAT HAPs	23,098	15,954	13,476	10,546	8,530	7,129
Aircraft	1,3-Butadiene	824	821	859	924	993	1131
	Acetaldehyde	2,019	2,004	2,098	2,259	2,430	2,770
	Acrolein	968	960	1,005	1,083	1,165	1,329
	Benzene	1,102	1,114	1,163	1,247	1,335	1,511
	Formaldehyde	6,549	6,505	6,809	7,333	7,885	8,990
	Naphthalene	456	475	496	530	566	638
	MSAT HAPs	14,276	14,315	14,965	16,081	17,256	19,603
Airport Support	1,3-Butadiene	7	5	3	3	3	3
	Acetaldehyde	63	49	42	33	29	30
	Acrolein	6	4	4	3	3	3
	Benzene	44	33	26	21	20	22
	Formaldehyde	139	105	90	71	63	65
	Naphthalene	1	1	1	1	1	1
	MSAT HAPs	421	311	251	206	191	205
Commercial	1,3-Butadiene	1,140	892	683	738	813	972
	Acetaldehyde	1,400	1,270	1,071	975	920	906
	Acrolein	156	127	105	99	98	102
	Benzene	6,809	5,323	4,206	4,529	4964	5,906
	Formaldehyde	3,418	2,907	2,435	2,236	2131	2,128
	Naphthalene	98	106	98	108	119	142
	MSAT HAPs	46,990	33,732	27,281	29,004	31,451	36,981
Commercial Marine Vessel	1,3-Butadiene	6	6	6	6	6	7
	Acetaldehyde	2,364	2,588	2,639	2,768	2,974	3,619
	Acrolein	98	109	112	118	129	161
	Benzene	644	705	719	753	809	982
	Formaldehyde	4,715	5,153	5,252	5,499	5,899	7,152
	Naphthalene	65	69	68	72	79	102
	MSAT HAPs	8,736	9,557	9,742	10,213	10,973	13,354
Construction	1,3-Butadiene	407	259	214	182	165	156
	Acetaldehyde	5,723	4,138	3,578	2,745	2,210	1,883
	Acrolein	392	280	241	186	151	130
	Benzene	3,601	2,310	1,957	1,639	1,450	1,348
	Formaldehyde	12,417	8,958	7,742	5,937	4,779	4,074
	Naphthalene	61	46	42	32	23	16
	MSAT HAPs	39,675	25,138	21,702	17,937	15,609	14,303

Table 21. Continued.

Equipment type	HAP	Emissions (tons/yr)					
		1999	2007	2010	2015	2020	2030
Industrial	1,3-Butadiene	302	143	88	50	39	33
	Acetaldehyde	1,350	857	676	459	389	381
	Acrolein	119	71	55	38	33	34
	Benzene	1,976	986	633	368	291	258
	Formaldehyde	3,046	1,790	1,404	963	832	837
	Naphthalene	30	18	15	9	6	4
	MSAT HAPs	14,559	7,456	5,114	3,157	2,573	2,382
Lawn/Garden	1,3-Butadiene	3,423	2,445	1,933	1,887	2,030	2,342
	Acetaldehyde	2,478	1,920	1,548	1,480	1,546	1,748
	Acrolein	388	252	207	201	212	241
	Benzene	20,451	14,729	12,112	12,039	12,960	14,941
	Formaldehyde	6,867	4,727	3,830	3,678	3,856	4,371
	Naphthalene	261	245	224	232	251	289
	MSAT HAPs	196,257	115,652	99,485	101,535	109,328	125,823
Logging	1,3-Butadiene	44	29	29	29	31	36
	Acetaldehyde	176	102	85	62	55	55
	Acrolein	16	9	8	7	7	8
	Benzene	267	185	180	177	187	221
	Formaldehyde	432	248	214	167	155	163
	Naphthalene	4	4	4	4	4	5
	MSAT HAPs	3,816	2,325	2,339	2,394	2,562	3,054
Pleasure Craft	1,3-Butadiene	2071	1423	1201	1018	928	895
	Acetaldehyde	1703	1179	1002	854	782	757
	Acrolein	316	212	179	152	139	134
	Benzene	20304	14177	13113	10507	9787	9598
	Formaldehyde	4136	2848	2447	2105	1932	1879
	Naphthalene	112	103	100	101	104	110
	MSAT HAPs	258,190	172,930	144,245	122,057	111,936	108,260
Railroad	1,3-Butadiene	114	107	104	102	99	94
	Acetaldehyde	853	805	776	758	731	686
	Acrolein	131	124	120	117	113	107
	Benzene	162	150	144	140	134	125
	Formaldehyde	1,901	1,793	1,730	1,690	1,629	1,529
	Naphthalene	61	51	44	42	40	35
	MSAT HAPs	4,416	4,143	3,984	3,896	3,758	3,531
Recreational	1,3-Butadiene	1,136	1,600	1,530	1,238	1,029	1,009
	Acetaldehyde	820	1,330	1,264	1,041	886	870
	Acrolein	206	312	295	228	180	176
	Benzene	7,781	12,938	12,365	9,544	7,622	7,587
	Formaldehyde	2,731	3,743	3,562	2,890	2,404	2,333
	Naphthalene	56	81	90	101	105	109
	MSAT HAPs	146,526	244,129	231,291	171,593	128,661	124,142

Table 21. Continued.

Equipment type	HAP	Emissions (tons/yr)					
		1999	2007	2010	2015	2020	2030
Underground Mining	1,3-Butadiene	1	1	1	1	1	1
	Acetaldehyde	39	34	31	25	22	23
	Acrolein	2	2	2	1	1	1
	Benzene	15	13	12	10	9	9
	Formaldehyde	87	77	68	55	50	51
	Naphthalene	0.2	0.2	0.2	0.1	0.1	0.1
	MSAT HAPs	176	155	138	112	100	104

Table 22. National engine/equipment emissions for MSAT HAPs

Engine Type	Equipment Type	Emissions (ton/yr)					
		1999	2007	2010	2015	2020	2030
2-stroke gas	Agriculture	358	81	79	85	91	102
2-stroke gas	Commercial	8,758	2,330	2,487	2,769	3,072	3,698
2-stroke gas	Construction	9,852	4,001	3,774	3,825	3,877	3,980
2-stroke gas	Industrial	127	17	14	8	4	0.002
2-stroke gas	Lawn/Garden	107,470	45,085	43,643	47,298	51,110	58,731
2-stroke gas	Logging	2,753	1,629	1,736	1,882	2,051	2,483
2-stroke gas	Pleasure Craft	241,175	158,105	129,809	108,270	98,520	94,557
2-stroke gas	Recreational	130,772	226,419	213,777	154,861	112,163	107,154
4-stroke gas	Agriculture	3,186	2,620	2,210	1,967	1,803	1,621
4-stroke gas	Airport Support	162	116	81	74	77	88
4-stroke gas	Commercial	34,652	28,153	21,883	23,931	26,534	31,956
4-stroke gas	Construction	5,327	3,366	2,537	2,374	2,350	2,384
4-stroke gas	Industrial	8,571	3,695	2,251	1,269	920	669
4-stroke gas	Lawn/Garden	86,647	68,917	54,462	53,090	57,199	66,074
4-stroke gas	Logging	418	340	319	331	366	444
4-stroke gas	Pleasure Craft	16,724	14,515	14,131	13,491	13,129	13,407
4-stroke gas	Railroad	51	33	28	29	30	33
4-stroke gas	Recreational	15,595	17,551	17,361	16,595	16,383	16,915
Aircraft	Aircraft	14,276	14,315	14,965	16,081	17,256	19,603
CNG	Agriculture	10	3	1	1	1	1
CNG	Airport Support	0.21	0.11	0.07	0.03	0.03	0.02
CNG	Commercial	55	20	11	6	5	4
CNG	Construction	.04	0.02	0.01	0.005	0.004	0.003
CNG	Industrial	307	93	48	27	23	20
Diesel	Agriculture	19,553	13,249	11,184	8,493	6,636	5,405
Diesel	Airport Support	257	193	169	131	114	117
Diesel	Commercial	3,485	3,201	2,884	2,292	1,836	1,320
Diesel	Commercial Marine Vessel	7,125	7,460	7,466	7,500	7,672	8,363
Diesel	Construction	24,479	17,758	15,384	11,735	9,381	7,939
Diesel	Industrial	4,671	3,009	2,455	1,742	1,550	1,622
Diesel	Lawn/Garden	2,127	1,640	1,374	1,145	1,018	1,017
Diesel	Logging	645	356	284	181	145	127
Diesel	Pleasure Craft	225	262	262	257	250	260
Diesel	Railroad	4,213	3,967	3,818	3,732	3,596	3,373
Diesel	Recreational	159	159	153	136	115	72
Diesel	Underground Mining	176	155	138	112	100	104
LPG	Agriculture	0.24	0.19	0.12	0.05	0.04	0.02
LPG	Airport Support	2	2	1	0.31	0.21	0.19
LPG	Commercial	39	29	16	5	4	3
LPG	Construction	18	13	7	2	2	1
LPG	Industrial	883	642	346	111	76	71
LPG	Lawn/Garden	14	10	5	2	1	1
LPG	Railroad	0.04	0.03	0.02	0.02	0.02	0.02
LPG	Recreational	1	0.40	0.22	0.08	0.05	0.05
Miscellaneous	Commercial Marine Vessel	20	23	23	25	27	35
Miscellaneous	Pleasure Craft	66	49	44	39	36	36
Miscellaneous	Railroad	151	143	138	136	132	125
Residual	Commercial Marine Vessel	1,591	2,074	2,253	2,687	3,274	4,956
Total nonroad		**757,136**	**645,797**	**574,012**	**488,730**	**442,928**	**458,871**

3.3.4 Projection of onroad refueling emissions

Onroad refueling emissions are inventoried as stationary sources, although the emissions are related to mobile sources, and can be estimated using NMIM. As such, the onroad refueling emissions were projected using ratios developed from 1999, 2007, 2010, 2015, 2020, and 2030 refueling emissions developed from NMIM (Michaels et. al, 2005). More details on the NMIM refueling runs can be found in Appendix A. The ratios, used as projection factors, were calculated by dividing the future year NMIM onroad refueling emissions (2007 and beyond) by 1999 NMIM onroad refueling emissions in each county. These factors were then assigned to the onroad refueling SCC codes in the 1999 point and non-point inventory shown in Table 23. A map of the county-level 2015 growth factors is shown as an example in Figure 3. As with the aviation refueling emissions, the 2020 projected emissions were used for 2030 as well because of uncertainty in other stationary source projection information for 2030. The onroad refueling projection factors were included in the SCC growth factor files described in Section 4.1.3, and the onroad refueling emissions were projected at the same time as the other stationary sources as described in Section 4.3. Results are presented here however, since the projection factors were derived from NMIM.

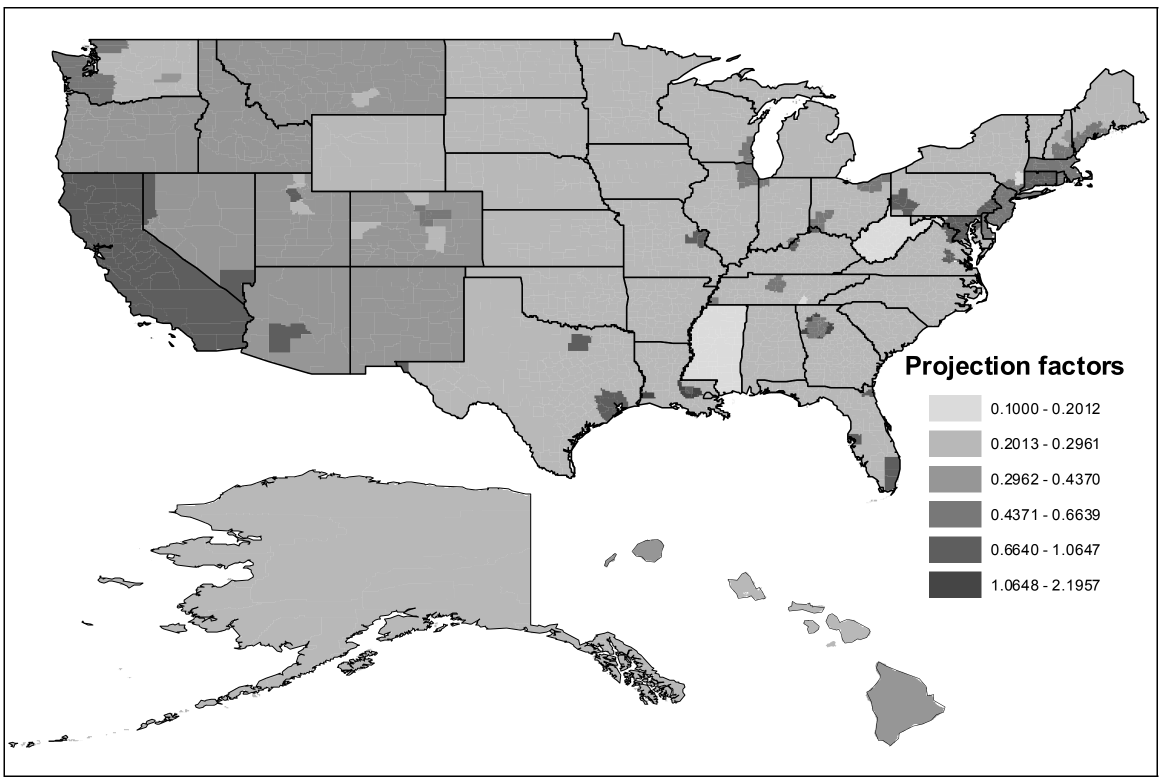

Figure 3. 2015 county level refueling projection factors.

Table 23. Onroad refueling SCC codes.

SCC	Description
2501060000	Storage and Transport, Petroleum and Petroleum Product Storage, Gasoline Service Stations, Total: All Gasoline/All Processes
2501060100	Storage and Transport, Petroleum and Petroleum Product Storage, Gasoline Service Stations, Stage 2: Total
2501060101	Storage and Transport, Petroleum and Petroleum Product Storage, Gasoline Service Stations, Stage 2: Displacement Loss/Uncontrolled
2501060102	Storage and Transport, Petroleum and Petroleum Product Storage, Gasoline Service Stations, Stage 2: Displacement Loss/Controlled
2501060103	Storage and Transport, Petroleum and Petroleum Product Storage, Gasoline Service Stations, Stage 2: Spillage
40600401	Petroleum and Solvent Evaporation, Transportation and Marketing of Petroleum Products, Filling Vehicle Gas Tanks - Stage II, Vapor Loss w/o Controls
40600402	Petroleum and Solvent Evaporation, Transportation and Marketing of Petroleum Products, Filling Vehicle Gas Tanks - Stage II, Liquid Spill Loss w/o Controls
40600403	Petroleum and Solvent Evaporation, Transportation and Marketing of Petroleum Products, Filling Vehicle Gas Tanks - Stage II, Vapor Loss w/o Controls
40600499	Petroleum and Solvent Evaporation, Transportation and Marketing of Petroleum Products, Filling Vehicle Gas Tanks - Stage II, Not Classified
40600601	Petroleum and Solvent Evaporation, Transportation and Marketing of Petroleum Products, Consumer (Corporate) Fleet Refueling - Stage II, Vapor Loss w/o Controls
40600602	Petroleum and Solvent Evaporation, Transportation and Marketing of Petroleum Products, Consumer (Corporate) Fleet Refueling - Stage II, Liquid Spill Loss w/o Controls
40600603	Petroleum and Solvent Evaporation, Transportation and Marketing of Petroleum Products, Consumer (Corporate) Fleet Refueling - Stage II, Vapor Loss w/controls

A national summary of onroad refueling emissions by SCC is shown in Table 24.

Table 24. Onroad refueling emissions by SCC for 1999, 2007, 2010, 2015 and 2020.

SCC	HAP	Emissions (tons)				
		1999	2007	2010	2015	2020
2501060000	1,3-Butadiene	3	2	2	1	1
	Benzene	93	65	54	46	45
	Naphthalene	3	2	2	2	2
	All HAPs	1,329	905	747	633	629
2501060100	Benzene	993	08	452	322	291
	Naphthalene	151	94	73	57	54
	All HAPs	10,882	6,775	5,146	3,821	3,544
2501060101	Benzene	223	140	105	75	67
	Naphthalene	7	4	3	2	2
	All HAPs	1,336	839	625	445	401
2501060102	Benzene	21	17	16	16	17
	All HAPs	1,171	998	940	942	1,017
2501060103	Benzene	138	112	103	102	109
	Naphthalene	24	19	18	18	19
	All HAPs	4,672	3,838	3,585	3,565	3,825
40600401	Benzene	84	109	119	142	164
	Naphthalene	0.001	0.002	0.003	0.003	0.003
	All HAPs	111	144	156	185	214
40600402	Benzene	6	8	8	10	12
	All HAPs	9	11	12	14	16
40600403	Benzene	8	10	11	13	14
	Naphthalene	0.2	0.2	0.3	0.3	0.3
	All HAPs	215	281	295	342	386
40600499	Benzene	0.01	0.01	0.01	0.01	0.01
	Naphthalene	0.002	0.002	0.002	0.002	0.002
	All HAPs	0.23	0.30	0.31	0.33	0.36
40600601	Benzene	0.004	0.004	0.004	0.005	0.005
	All HAPs	0.021	0.021	0.022	0.025	0.028
40600602	Benzene	0.001	0.001	0.001	0.002	0.002
	All HAPs	0.006	0.006	0.007	0.007	0.008
40600603	Benzene	0.1	0.1	0.2	0.2	0.2
	All HAPs	0.36	0.46	0.52	0.61	0.70

3.4 Projection of HAP Precursor Emissions from Mobile Sources

In order to calculate secondary concentrations for acetaldehyde, acrolein, formaldehyde, and propionaldehyde after ASPEN simulations for the primary concentrations for those HAPs, the emissions for the precursors also had to be projected to 2015, 2020, and 2030 (see Table 4 for non-HAP precursors). The total number of precursors is thirty-four. The precursor inventory used was the same as that used for the 1999 NATA and was derived from Version 2 of the NEI for VOC. In addition to the non-HAP precursors listed in Table 4 there are four HAPs that are precursors as well: 1,3-butadiene, acetaldehyde, MTBE, and methanol. The first three were HAPs already in the projected nonroad, aircraft, and locomotive/commercial marine inventories. Methanol (a HAP, but not an MSAT HAP) was projected as described in Appendix C. The precursors which themselves are HAPs were projected separately from the other non-HAP precursors and were appended to the remaining non-HAP precursors' inventories prior to processing through EMS-HAP. Following is the methodology used to project the mobile non-HAP precursors for locomotive and commercial marine vessels, aircraft, onroad, and remaining nonroad sources.

3.4.1 Locomotive and Commercial Marine Vessel Precursor Emissions

Locomotive and commercial marine vessel precursor emissions were projected in the same way as the HAP locomotive and commercial marine vessel emissions. For locomotives, the VOC ratios shown in Table 6 were applied to each precursor. For commercial marine vessels, the VOC ratios (Table 8) were applied to the same SCC codes shown in Table 9. In addition to the SCC codes in Table 9, there were two other SCC codes in the precursor inventory, 2280001000 (commercial marine vessels, coal) and 2283002000 (military marine vessels, diesel). The coal fueled marine vessel emissions were projected using the VOC ratio for all vessel types (VOC factors for 2280000000). The military marine vessel emissions were projected using the VOC ratios for diesel (VOC factors for 2280002000).

After the precursor emissions were assigned ratios and projected to 2015, 2020, and 2030, the locomotive and commercial marine 1,3-butadiene, acetaldehyde, MTBE, and methanol air toxics emissions from the projections were appended to the projected precursor locomotive and commercial marine inventory.

3.4.2 Aircraft Precursor Emissions

Aircraft precursor emissions were projected using the same methodology and growth factors as discussed in Section 3.2. The temporally allocated nonroad airport precursor emissions output from PtTemporal for 1999 NATA were subset to: 1) include only the pollutants shown in Table 4, other than the precursors that were MSAT HAPs (1,3-Butadiene, acetaldehyde, MTBE, and methanol); and 2) exclude airport support equipment SCC codes. They were then projected for 2015, 2020, and 2030 using PtGrowCntl.

Non-point airport-related precursor emissions (i.e., aviation gasoline) were not projected. This is because these are stationary source emissions and it was decided to use the 1999 NATA precursor secondary concentrations for all future year stationary precursor concentrations, except for acrolein, which utilizes 1,3-butadiene as the sole precursor. Since acrolein's precursor is an MSAT HAP, its secondary formation could be reasonably calculated with some confidence. There were several reasons for not projecting the other stationary precursors: projection data were not readily available for the stationary precursors as they were for the mobile precursors and the approach for estimating secondary concentrations is approximate and generally shows secondary concentrations from stationary sources to be a small portion of the total concentration as discussed in Section 5.5.

3.4.3 Onroad Precursor Emissions

Onroad emissions for the precursors were projected using the ratio of VOC emissions for each FIPS/SCC of 2015, 2020, or 2030 to 1999 NMIM results, in a similar fashion to that done for the MSAT HAPs. The precursor inventory's SCC codes were classified as either exhaust or evaporative emissions, i.e., HDDV emissions for rural interstates were divided into exhaust and evaporative emissions. The NMIM results also were divided by exhaust or evaporative emissions. It was decided to calculate VOC projection ratios for exhaust and evaporation separately for each FIPS/SCC.

As with the onroad processing for MSAT HAPs, the heavy-duty diesel vehicle emissions in NMIM were summed to create a total HDDV emission number for each FIPS/road type/exhaust or evaporative emission type. New ratios were calculated and were applied to SCC codes beginning with 2230070 for each FIPS/CAS in the 1999 NEI precursor inventory for the same road type and exhaust/evaporation emission type. Table 25 lists the HDDV SCC codes in the precursor inventory.

3.4.4 Nonroad Precursor Emissions (excluding aircraft, locomotives, and commercial marine vessels)

The precursors from nonroad emission categories covered by the NONROAD model were processed using a similar methodology as the emissions for HAPs. However, instead of HAP specific projection ratios, we used VOC ratios from NMIM.

Table 25. HDDV SCC codes used to calculate HDDV emissions in the precursor inventory.

HDDV type (First 7 characters of SCC code)	Road types (last 3 digits of SCC code)	SCC in precursor inventory which projections are applied
2230071, 2230072, 2230073, 2230074, 2230075	11X (Rural Interstate, Exhaust) 11V (Rural Interstate, Evaporation)	223007011X 223007011V
2230071, 2230072, 2230073, 2230074, 2230075	13X (Other Principal Arterial, Exhaust) 13V (Other Principal Arterial, Evaporation)	223007013X 223007013V
2230071, 2230072, 2230073, 2230074, 2230075	15X (Rural Minor Arterial, Exhaust) 15V (Rural Minor Arterial, Evaporation)	223007015X 223007015V
2230071, 2230072, 2230073, 2230074, 2230075	17X (Rural Major Collector, Exhaust) 17V (Rural Major Collector, Evaporation)	223007017X 223007017V
2230071, 2230072, 2230073, 2230074, 2230075	19X (Rural Minor Collector, Exhaust) 19V (Rural Minor Collector, Evaporation)	223007019X 223007019V
2230071, 2230072, 2230073, 2230074, 2230075	21X (Rural Local, Exhaust) 21V (Rural Local, Evaporation)	223007021X 223007021V
2230071, 2230072, 2230073, 2230074, 2230075	23X (Urban Interstate, Exhaust) 23V (Urban Interstate, Evaporation)	223007023X 223007023V
2230071, 2230072, 2230073, 2230074, 2230075	25X (Urban Other Freeways and Expressways, Exhaust) 25V (Urban Other Freeways and Expressways, Evaporation)	223007025X 223007025V
2230071, 2230072, 2230073, 2230074, 2230075	27X (Urban Other Principal Arterial, Exhaust) 27V (Urban Other Principal Arterial, Evaporation)	223007027X 223007027V
2230071, 2230072, 2230073, 2230074, 2230075	29X (Urban Minor Arterial, Exhaust) 29V (Urban Minor Arterial, Evaporation)	223007029X 223007029V
2230071, 2230072, 2230073, 2230074, 2230075	31X (Urban Collector, Exhaust) 31V (Urban Collector, Evaporation)	223007031X 223007031V
2230071, 2230072, 2230073, 2230074, 2230075	33X (Urban Local, Exhaust) 33V (Urban Local, Evaporation)	223007033X 223007033V

4. Development of Future Year Stationary Source Emissions

This section describes the methodology used to develop growth factors, reduction factors, and other inventory changes used to project the stationary (point and non-point inventories) to various future years, including 2015 and 2020, which are the MSAT years of interest. As previously noted, 1999 stationary source emissions were not projected to 2030 because of uncertainty in 2030 projection information; 2020 stationary emissions were used for both 2020 and 2030.

The general approach was to develop growth and reduction factors, and apply them using EMS-HAP Version 3.0. For one category (medical waste incineration), however, a draft 2002 emission inventory was used to represent emissions for all future years (Section 4.3).

4.1 Growth factors

Three sets of growth factors (GFs) were developed for input into EMS-HAP for use in growing stationary source emissions: Maximum Achievable Control Technology (MACT)-based GFs, Standard Industrial Classification (SIC)-based GFs and SCC-based GFs. Depending upon the particular code (i.e., MACT, SCC, SIC), the GFs were national, state-level or county level.

EMS-HAP uses the most specific level of data (county) available within a particular GF file. Thus, if a SIC-based GF file contained state and county GFs for the same SIC, and if the county in the GF file matched the county in the inventory, EMS-HAP would apply the county SIC-based GF. Also, in EMS-HAP, if an inventory record matches to GFs in multiple files, the MACT-based GF overrides the SIC-based GF, which overrides the SCC-based one.

For stationary sources, growth factors were developed using three sources of information:

- Regional Economic Model, Inc. (REMI) Policy Insight® model, version 5.5 (REMI, 2004; Fan et al., 2000),
- Regional and National fuel-use forecast data from the U.S. Department of Energy, Annual Energy Outlook for the years 2004, 2001 and 2002 (Energy Information Administration, 2005), and
- Rule development leads or economists who had obtained economic information in the process of rule development.

The first two sources of information were also used in projecting criteria pollutant emissions for the Clean Air Interstate Rule (U.S. EPA, 2005b). Earlier versions of REMI and AEO were used to develop the EGAS 4.0, which provides growth factors from 1996 up to 2020 (E.H. Pechan and Associates, 2001).

4.1.1 MACT based growth factors

The MACT-based growth factors used in the projections are shown in Tables 26 (national level growth factors) and Table 27 (state level growth factors for utility boilers, coal, which is

MACT=1808-1). Most growth factors were based on data from rule development project leads. Some leads estimated that particular categories were not expected to experience any growth, and were assigned growth factors of 1.0. Some leads provided a per year rate, which resulted in a formula of raising a percent growth to a power, where the power was the number of years between the future year and 1999. In one case, for primary aluminum production (MACT=0201), year-specific growth factors based on a 1996 base year were provided; we determined the 1999 base year growth factors as the ratio of the future year's growth factor and 1999 growth factor from the 1996 base year information (Table 26). All MACT-based growth factors in the files were national level growth factors with the exception of 1808-1 (coal burning utility boilers). These growth factors were developed at the state level, using Integrated Planning Model (IPM) run results from the IAQR proposal (http://www.epa.gov/airmarkets/epa-ipm/iaqr.html) (U. S. EPA, 2004c). The IPM data were available for 2010 and 2015; thus growth factors for 1808-1 for other years were computed using interpolation, with 2020 being set equal to 2015. For years prior to 2010 the interpolation formula was:

$$GF_X = 1 + ((X - 1999) \times (GF_{2010} - 1) / (2010 - 1999)) \quad (6)$$

where X is 2015 or 2020.

Table 26. National level MACT growth factors for 2015 and 2020.

MACT	Description	Methodology*	Equation	Growth Factors 2015	Growth Factors 2020
0101-2	Rocket Engine Test Firing	no growth	GF = 1	1.0000	1.0000
0105	Stationary RICE	5% growth per year	$GF=1.05^{(year-1999)}$	2.1829	2.7860
0108	Stationary Combustion Turbines	0.8% growth per year	$GF=1.008^{(year-1999)}$	1.1360	1.1821
0201	Primary Aluminum Production	Future year's 1996 based growth factor divided by 1999 growth factor based on 1996	$GF=GF_{1996}/(1999\ GF_{1996})$ 1999 $GF_{1996} = 0.832$ 2015 $GF_{1996} = 1.025$ 2020 $GF_{1996} = 1.11$	1.2320	1.3341
0302	Coke Ovens: Charging, Top Side, and Door Leaks	4% decline per year	$GF=0.96^{(year-1999)}$	0.5204	0.4243
0303	Coke Ovens: Pushing, Quenching, & Battery Stacks	4% decline per year	$GF=0.96^{(year-1999)}$	0.5204	0.4243
0409	Mineral Wool Production	no growth	GF = 1	1.0000	1.0000
0412	Wool Fiberglass Manufacturing	no growth	GF = 1	1.0000	1.0000
0415	Clay Ceramics Manufacturing	no growth	GF = 1	1.0000	1.0000
0705	Magnetic Tapes (Surface Coating)	no growth	GF = 1	1.0000	1.0000
0707	Metal Can (Surface Coating)	no growth	GF = 1	1.0000	1.0000
0802	Municipal Landfills	no growth	GF = 1	1.0000	1.0000
1001	Acrylic/Modacrylic Fibers Production	no growth before 2007, 1% growth after 2007	GF=1 before 2007 $GF=1.01^{(year-2007)}$	1.0829	1.1381
1101	Manufacture of Nutritional Yeast	growth factors based on 2020 GF=1.14	$1.006258947^{(year-1999)}$	1.1045	1.1400
1609	Commercial Sterilization Facilities	0.5% growth per year	$1.005^{(year-1999)}$	1.0831	1.1104
1614	Halogenated Solvent Cleaners	no growth	GF = 1	1.0000	1.0000
1621	Paint Stripping Operations	decline by 40% from 1999 to 2010 Keep same growth factor as 2010 for all future years thereafter.	$GF=0.954623^{(year-1999)}$ GF=0.6 for 2010 and beyond	0.6	0.6
1631	Rubber Tire Production	increase by 2% per year from 1999 to 2020.	$1.02^{(year-1999)}$	1.3728	1.5157
1643	Dry Cleaning: Perchloroethylene	no growth	GF = 1	1.0000	1.0000
1801	Medical Waste Incinerators	no growth; future set to 2002 emissions. See Section 4.3	GF = 1	1.0000	1.0000
1802	Municipal Waste Combustors	no growth	GF = 1	1.0000	1.0000
1808-2	Utility Boilers: Natural Gas	no growth	GF = 1	1.0000	1.0000
1808-3	Utility Boilers: Oil	no growth	GF = 1	1.0000	1.0000

* growth factor methodologies provided by project leads

Table 27. Utility Boilers: Coal (MACT=1808-1) state level growth factors for 2015 and 2020.

State FIPS	State	Growth Factor	State FIPS	State	Growth Factor	State FIPS	State	Growth Factor
01	Alabama	1.0124	21	Kentucky	1.0061	38	North Dakota	0.8446
02	Alaska	1.0291	22	Louisiana	0.7512	39	Ohio	1.1332
04	Arizona	0.8722	23	Maine	0.8222	40	Oklahoma	0.9677
05	Arkansas	1.0505	24	Maryland	0.8925	41	Oregon	0.9657
06	California	1.1607	25	Massachusetts	0.6548	42	Pennsylvania	1.1294
08	Colorado	0.9969	26	Michigan	1.0635	44	Rhode Island	1.0000
09	Connecticut	2.9294	27	Minnesota	1.0894	45	South Carolina	1.1315
10	Delaware	1.1898	28	Mississippi	1.1299	46	South Dakota	0.9049
11	District of Columbia	1.0000	29	Missouri	1.1095	47	Tennessee	1.0324
12	Florida	0.9407	30	Montana	0.9568	48	Texas	0.8056
13	Georgia	1.1779	31	Nebraska	1.1353	49	Utah	0.8566
15	Hawaii	1.0291	32	Nevada	1.1310	50	Vermont	1.0000
16	Idaho	1.0000	33	New Hampshire	0.9262	51	Virginia	0.9378
17	Illinois	1.1783	34	New Jersey	1.3554	53	Washington	1.0034
18	Indiana	1.0211	35	New Mexico	0.9538	54	West Virginia	1.0764
19	Iowa	0.9547	36	New York	1.1976	55	Wisconsin	1.2966
20	Kansas	1.1285	37	North Carolina	1.1753	56	Wyoming	0.8366

In Table 27, Alaska and Hawaii were set equal to the average 48 state growth factor.

Note, MACT codes in the NEI that are not listed in Tables 26 and 27 were not assigned a MACT-based growth factor. Instead growth for sources with those MACT codes were grown using the SIC or SCC based growth factors, described in the next sections.

The actual MACT-based growth factors files containing the data described above are provided with the EMS-HAP version 3.0 projection-related ancillary files, at http://www.epa.gov/ttn/chief/emch/projection/emshap30.html and also in the MSAT rule docket (EPA-HQ-OAR-2005-0036).

4.1.2 SIC based growth factors

State-specific SIC-based growth factors, for specific standard industrial codes (SIC) were developed using the Regional Economic Model, Inc. (REMI) Policy Insight® model, version 5.5 (being used in the development of the Economic Growth Analysis System (EGAS), version 5.0, (U.S. EPA, 2005c)). The REMI model forecasts economic activity by region and for individual sectors of the economy. By making assumptions about which economic indicators can represent emissions growth, growth factors can be developed for projecting emission inventories. A review of these growth factors for the development of the Clean Air Interstate Rule (U.S. EPA, 2005b) projected inventories, led to changes to about thirty SIC-based growth factors where they were unrealistic or highly uncertain (U.S. EPA 2005b). They were replaced with data (national-level) from industry forecasts, bureau of labor statistics (BLS) projections and Bureau of Economic Analysis (BEA) historical growth from 1986 – 2002 (U. S. EPA, 2005b). These SIC codes are shown in Table 28. Also SIC 1041 (Mining of gold ores) was set to no growth (GF=1.0). Growth factors for 3322 (Malleable iron foundries) and 3324 (Steel investment foundries) were set equal to the growth factors for SIC 3321.

Table 28. SIC codes changed due to unrealistic growth factors.

SIC	Description
1311	Oil And Gas Extraction, Crude Petroleum And Natural Gas, Crude petroleum and natural gas
1321	Oil And Gas Extraction, Natural Gas Liquids, Natural gas liquids
2821	Chemicals And Allied Products, Plastics Materials and Synthetics, Plastics materials and resins
2822	Chemicals And Allied Products, Plastics Materials and Synthetics, Synthetic rubber
2823	Chemicals And Allied Products, Plastics Materials and Synthetics, Cellulosic manmade fibers
2851	Chemicals And Allied Products, Paints and Allied Products, Paints and allied products
2873	Chemicals And Allied Products, Agricultural Chemicals, Nitrogenous fertilizers
2874	Chemicals And Allied Products, Agricultural Chemicals, Phosphatic fertilizers
2895	Chemicals And Allied Products, Miscellaneous Chemical Products, Carbon black
3011	Rubber And Misc. Plastics Products, Tires and Inner Tubes, Tires and inner tubes
3211	Stone, Clay, And Glass Products, Flat Glass, Flat glass
3221	Stone, Clay, And Glass Products, Glass and Glassware, Pressed Or Blown, Glass containers
3229	Stone, Clay, And Glass Products, Glass and Glassware, Pressed Or Blown, Pressed and blown glass, nec
3241	Stone, Clay, And Glass Products, Cement, Hydraulic, Cement, hydraulic
3321	Primary Metal Industries, Iron and Steel Foundries, Gray and ductile iron foundries
3325	Primary Metal Industries, Iron and Steel Foundries, Steel foundries, nec
3331	Primary Metal Industries, Primary Nonferrous Metals, Primary copper
3334	Primary Metal Industries, Primary Nonferrous Metals, Primary aluminum
3339	Primary Metal Industries, Primary Nonferrous Metals, Primary nonferrous metals, nec
3411	Fabricated Metal Products, Metal Cans and Shipping Containers, Metal cans
3441	Fabricated Metal Products, Fabricated Structural Metal Products, Fabricated structural metal
3471	Fabricated Metal Products, Metal Services, Nec, Plating and polishing
3479	Fabricated Metal Products, Metal Services, Nec, Metal coating and allied services
3497	Fabricated Metal Products, Misc. Fabricated Metal Products, Metal foil & leaf
3499	Fabricated Metal Products, Misc. Fabricated Metal Products, Fabricated metal products, nec
3711	Transportation Equipment, Motor Vehicles and Equipment, Motor vehicles and car bodies
3713	Transportation Equipment, Motor Vehicles and Equipment, Truck and bus bodies
3714	Transportation Equipment, Motor Vehicles and Equipment, Motor vehicle parts and accessories
3715	Transportation Equipment, Motor Vehicles and Equipment, Truck trailers

The actual SIC-based growth factors files containing the data described above are provided with the EMS-HAP version 3.0 projection-related ancillary files, at http://www.epa.gov/ttn/chief/emch/projection/emshap30.html and in the MSAT rule docket (EPA-HQ-OAR-2005-0036).

4.1.3 SCC based growth factors

SCC based growth factors for stationary sources were derived from four sources: 1) REMI model, 2) Energy Information Administration's National Energy Modeling System (Energy Information Administration, 2005), and 3) NMIM derived onroad refueling future-to-1999 emission ratios. The REMI model is discussed in Section 4.1.2 and the onroad refueling factors are discussed in Section 2.3; and 4) aviation gasoline emissions (discussed in Section 3.2). The National Energy Modeling system was used to calculate growth factors for emission sources related to energy use such as residential heating. The data are provided at a division level, with the country divided into nine divisions, for some sectors (e.g., residential fuel use), and at the national level for more detailed industrial sectors (e.g., paper). Growth factors were developed at the most detailed geographic scale (e.g., developed State-level growth factors from the division information) and sectors available. The AEO data were then mapped to SCC codes (Bollman, 2004).

In addition to the three sources of data above, emissions for fires (wild and prescribed) were assumed to remain flat, i.e. no.

For all SCC codes, with the exception of the onroad refueling SCC codes, growth factors were at national or state level. The refueling factors were at county level.

In the growth factor files that are input into EMS-HAP, instead of listing growth factors by SCC, each SCC is assigned a growth indicator group. These groups consist of related SCC codes that shared common growth factors. For example, for the onroad refueling SCC codes, instead of listing the growth factor for each of the 12 SCC codes by FIPS, the onroad refueling SCC codes are assigned the growth indicator group "NMIM Refueling" and the growth factors cross-referenced by growth indicator group instead of SCC. This cuts down on the number of records in the SCC-based growth factor files. Example records showing the SCC based growth factor file format are shown in Figure 1 in Section 3.2.

The actual SCC-based growth factors files containing the data described above are provided with the EMS-HAP version 3.0 projection-related ancillary files, at http://www.epa.gov/ttn/chief/emch/projection/emshap30.html and in the MSAT rule docket (EPA-HQ-OAR-2005-0036).

4.2 Reduction factors

Not only does EMS-HAP allow the user to specify the growth factors for emissions sources, EMS-HAP also allows for reduction of emissions. Reduction factors were applied to the grown stationary source emissions to account for regulatory impacts and plant closures.

The percent reductions were primarily based on estimates of national average reductions for specific HAPs or for groups of HAPs from a source category or subcategory as a result of regulatory efforts. These efforts are primarily the MACT and Section 129 standards, mandated in Title III of the 1990 Clean Air Act Amendments. Percent reductions were determined by, as well as information on applicability and compliance dates, whether they apply to "major" only or both "major" and "area" sources. With regards to applicability it was necessary to gather information for the various rules from rule preambles, fact sheets and through the project leads (questionnaire and phone calls). A major source is defined as any stationary source or group of stationary sources located within a contiguous area and under common control that has the potential to emit, considering controls, in the aggregate, 10 tons per year or more of any hazardous air pollutant or 25 tons per year or more of any combination of hazardous air pollutants; the status of a point source as "major" is indicated in the NEI by the field called "FACILITY CATEGORY". For some rules, percent reductions were provided for specific HAPs or groups of HAPs (e.g., all metals, or all volatiles) rather than a single number for all HAPs in the categories. Information was also received on plant closures for several categories such as coke ovens and municipal waste combustors. For the "utility boilers coal" category, it was assumed that the acid gases (hydrochloric acid, hydrogen fluoride and chlorine) would be reduced by the same amount as SO_2 due to co-benefits of potential controls. State-level SO_2 reductions were calculated using SO_2 projected emissions from the Integrated Planning Model (IPM) runs done for proposed CAIR (U. S. EPA, 2004c) and applied these reductions to the acid gas emissions. At the time of the projections, the IPM runs for the final CAIR rule were not available.

Emission reductions were applied in EMS-HAP by MACT code; some were HAP and MACT specific, some were SCC and MACT specific. Site specific reductions such as plant closures or estimations of reductions expected from particular facilities in the source category, were applied by the EMS-HAP site id; process specific, site specific reductions used the SCC as well.

A list of the source categories to which reductions were applied in EMS-HAP, either to facilities in the category or the entire category, is presented in Table 29. Note that this does not include the impacts of all of the rules, only those for which HAP emission reductions were able to be estimated and for which the compliance date was later than 1999, or for which information on closures was obtained. In addition, if the inventory did not have emissions for which the rule was expected to impact, then that was also left out of the table. It also does not include reductions from MWI, as discussed in the next section.

The actual reduction information for these source categories is provided with the EMS-HAP version 3.0 projection-related ancillary files, at http://www.epa.gov/ttn/chief/emch/projection/emshap30.html along with more detailed descriptions and summaries of the data. The reduction information and detailed summaries and descriptions can also be found in the MSAT rule docket (EPA-HQ-OAR-2005-0036).

Table 29. Summary of Categories for which reductions were applied in EMS-HAP.

Category	Category
Amino/Phenolic Resins Production: POLYMERS & RESINS III Ammonium Sulfate - Caprolactam By-Product Plants: THE MON Asphalt roofing and Processing Boat Manufacturing Brick and Structural Clay Products Manufacturing Carbon Black Production Carbonyl Sulfide (COS) Production Cellulose products manufacturing Commercial/Industrial Solid Waste Incineration (CISWI)Coke Ovens: Charging, Topside and Door Leaks Coke Ovens: Pushing, Quenching, & Battery Stacks Cyanide Chemicals Manufacturing Ethylene Processes Flexible Polyurethane Foam Production Friction Products Manufacturing Hazardous Waste Incineration and its subcategories: Commercial Haz. Waste Incinerators, On-Site Haz. Waste Incinerators, Cement Kilns, Lightweight Aggregate Kilns Industrial/Commercial/ Institutional Boilers & Process Heaters Industrial/Commercial/ Institutional Boilers & Process Heaters (Coal) Integrated Iron & Steel Manufacturing Iron Foundries Leather Tanning & Finishing Operations Lime Manufacturing Manufacturing of Nutritional Yeast Mineral Wool Production Municipal Solid Waste Landfills Miscellaneous Organic Chemical Products & Processes Miscellaneous Coatings Manufacturing Municipal Waste Combustors Primary Aluminum Production Primary Copper Smelting Primary Magnesium Refining Secondary Aluminum Production Stationary Reciprocating Internal Combustion Engines Natural Gas Transmission & Storage Off-Site Waste and Recovery Operations Oil & Natural Gas Production	Organic Liquids Distribution (Non-Gasoline) Pesticide Active Ingredient Production Petroleum Refineries - Catalytic Cracking, Catalytic Reforming, & Sulfur Plant Units (10 yr) Petroleum Refineries - Other Sources Not Distinctly Listed (4yr) Pharmaceuticals Production Reinforced Plastic Composites Production Phosphate Fertilizers Production& Phosphoric Acid Manufacturing Plywood and Composite Wood Products Polyether Polyols Production Portland Cement Manufacturing Pulp & Paper Production – Combustion & Noncombustion. Refractories Products Manufacturing Rubber Tire Production Secondary Aluminum Production Secondary Lead Smelting Site Remediation Solvent Extraction for Vegetable Oil Production Stationary Reciprocating Internal Combustion Engines Surface coating related categories: • Auto & Light Duty Truck • Wood Building Products • Large Appliances • Metal Can • Metal Coil • Metal Furniture • Miscellaneous Metal Parts • Paper & Other Webs • Plastic Parts & Products • Fabric Coating Dying and Printing • Printing/Publishing Steel Pickling - HCL Process Taconite Iron Ore Processing Viscose Process Manufacturing Wet-Formed Fiberglass Mat Production Wool Fiberglass Manufacturing Utility Boilers: Coal

4.3 Application of growth and reductions to project stationary source emissions

For stationary sources, EMS-HAP was used to project the emissions, including onroad refueling, with the lone exception of Medical Waste Incinerator (MWI, MACT=1801) emissions which utilized draft 2002 MWI emissions as advised by the MWI project lead. For this category, it was expected that emissions would remain at 2002 levels into the future.

For point sources, the PtTemporal output from the 1999 NATA EMS-HAP run was adjusted (via a program called mwi.sas, which is available in the docket for this rule [EPA-HQ-OAR-2005-0036] to change the 1999 medical waste incineration (MWI) emissions to 2002 emissions (U.S. EPA, 2005a). The adjusted emissions then processed through PtGrowCntl, using the growth and reduction factors described in Sections 3.3.5, 4.1 and 4.2, to project the inventory to 2002 through 2010 inclusive, 2015, and 2020.

The substitution of the 2002 MWI emissions for the 1999 emissions resulted in a change from 727 tons to 31.5 tons.

Note that the aviation gasoline point sources were run separately through EMS-HAP, using the aircraft growth factors as described in Section 3.2.

For the non-point inventory, the EMS-HAP program CountyProc was run using the growth and reduction factors described in Sections 3.3.4, 4.1 and 4.2, to project the inventory to 2002 through 2010 inclusive, 2015, and 2020. For all non-point projection years except for 2015 and 2020, ASPEN ready files for the non-point inventory were not needed so the GCFLAG variable in CountyProc was set to 0, creating projected emissions without the other ASPEN-specific steps. This was done to decrease run time.

There were no 2002 MWI emissions in the non-point inventory, so 1999 MWI non-point emissions were removed. The amount of emissions removed was 220 tons.

Summaries of major and area & other emissions for 1999, 2007, 2010, 2015, and 2020 for selected MSAT HAPs and the sum across all MSAT HAPs are shown in Table 30. For all MSAT HAPs, major source emissions initially decrease from 1999 to 2007 but then increase with time to 2020. Area & other source emissions increase with all years.

Table 30. 1999 and projected stationary emissions for selected HAPs and total MSAT HAPs.

HAP	Year									
	1999		2007		2010		2015		2020	
	Major	Area & other	Major	Area & other	Major	Area & other	Major	Area & other	Major	Area & other
1,3-butadiene	1,982	22,164	1,731	22,819	1,805	22,961	2,011	23,068	2,247	23,212
Acetaldehyde	11,578	26,990	9,299	28,277	9,225	28,715	10,695	29,419	12,111	30,142
Acrolein	899	21,097	763	21,808	731	21,896	819	21,990	904	22,088
Benzene	9,820	101,362	7,671	108,123	7,877	109,628	8,696	111,634	9,634	114,161
Formaldehyde	30,611	126,365	30,857	131,649	30,970	133,283	35,367	136,008	40,657	139,095
Naphthalene	2,245	11,831	1,850	13,162	1,919	13,570	2,146	14,314	2,398	15,137
ALL MSAT HAPs*	290,498	925,042	230,800	1,020,953	242,641	1,067,558	277,173	1,143,706	313,831	1,225,530

* POM groups 2, 5, 6, and 7 may include emissions of HAPs that are not MSAT HAPs but part of those POM groups in the stationary inventories. Non MSAT HAPs may be included due to processing in EMS-HAP when POM HAPs are grouped into POM groups.

Figure 4 shows the comparison of stationary and mobile emissions, nationwide, after all projections for 1999, 2007, 2010, 2015, 2020, and 2030. With all source groups considered, it can be seen that total MSAT HAP emissions were projected to decrease with time from 1999 to 2030 with a slight increase between 2020 and 2030, due to mobile sources. It can also be seen that non-gasoline mobile emissions are a very small part of the total emissions for all years.

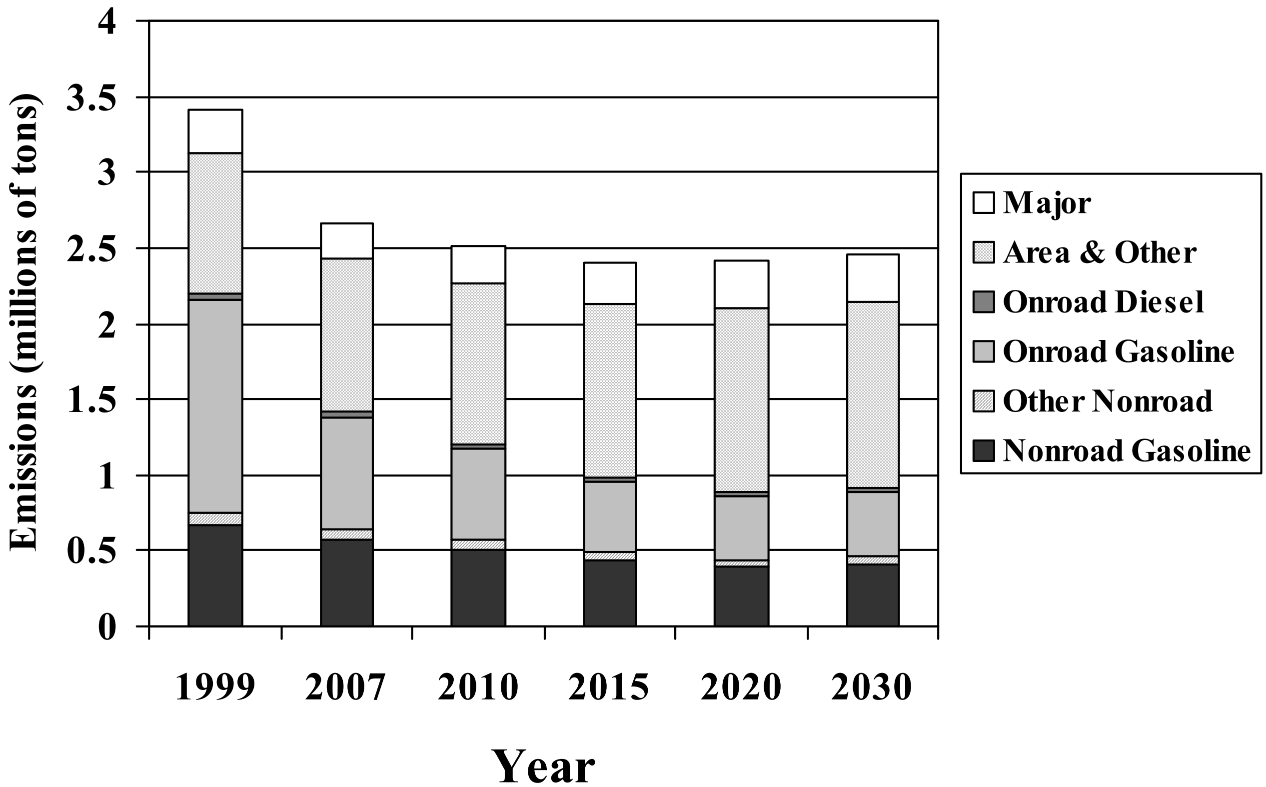

Figure 4. Annual emissions by source sector at the national level.

5. EMS-HAP Processing for HAPs

Prior to conducting air quality modeling using the ASPEN model, the emissions were processed in the Emissions Modeling System for Hazardous Air Pollutants (EMS-HAP) Version 3 (U.S. EPA, 2004b). EMS-HAP creates the emissions input files that are used by ASPEN to calculate the air quality concentrations. Following are brief descriptions of the EMS-HAP processing. The reader is referred to the EMS-HAP User's Guide (U.S. EPA, 2004b) for more details.

5.1 Point sources

Point sources (including major and area sources) are processed through four EMS-HAP programs to create ASPEN ready files: PtDataProc, PtModelProc, PtTemporal, and PtFinal_ASPEN. A fifth point source program, PtGrowCntl is used to apply growth factors and reduction information to a base year inventory to develop future year emissions inventories. This program is run between PtTemporal and PtFinal_ASPEN.

For the MSAT study, the point inventory had already been processed through PtDataProc, PtModelProc and PtTemporal for the 1999 National Air Toxics Assessment (NATA). Geographic locations and stack parameters' quality assurance was done in PtDataProc. See Ch. 3, EMS-HAP User's Guide for details.

In PtModelProc, the individual POM HAPs were grouped into eight POM groups, based on cancer risk (See Section C.4.2 in Appendix C of the EMS-HAP User's Guide for POM groupings). Also in PtModelProc, the metals (chromium, nickel, and manganese) were split into fine and coarse particle emissions. Also, unspeciated chromium was speciated into chromium III and chromium VI based on MACT codes. For naphthalene, emissions were split into gaseous and particle mode. For descriptions of these two processes see Ch. 4, EMS-HAP User's Guide. Urban/rural dispersion parameters, vent type, and building parameters are also assigned in PtModelProc.

PtTemporal allocated the annual emissions to eight 3-hour time blocks based on the category of the emissions. PtTemporal output was adjusted to change the 1999 medical waste incineration (MWI) emissions to 2002 emissions (see Section 4.3) which were used as the projected MWI emissions for all future years.

As discussed in 4.3, PtGrowCntl was run to project the inventory to 2002 through 2010 inclusive, 2015, and 2020. For 2015 and 2020, the PtGrowCntl output was subset to MSAT HAPs and then processed through PtFinal_ASPEN to create ASPEN ready emissions files (including reactivity/particle size information) for the point inventory. EMS-HAP also allows for grouping of the emissions so that the contribution of different source groups can be quantified when calculating concentrations in ASPEN. As for the 1999 NATA, the point sources were binned into two groups, major (group=0) and area & other sources (group=1). Source groupings for stationary and mobile sources can be seen in Table 31.

5.2 Non-point sources

For the 1999 NATA, the non-point emissions inventory was first processed through the EMS-HAP COPAX program to separate the airport related emissions from other non-point emissions (see Table 14 for airport related SCC codes). COPAX allocated the airport related emissions to point source locations at the airports (See Ch. 2 in the EMS-HAP User's Guide). The airport related emissions were then processed through the same programs as the point source inventory. The growth factors used for PtGrowCntl are documented in Section 2.2.

For the remaining non-point inventory, after removing the MWI (MACT=1801) emissions, the emissions were projected to 2002 through 2010 inclusive, 2015, and 2020 using the EMS-HAP program CountyProc. This program also spatially allocated county level emissions to census tracts, temporally allocated emissions to 3-hour time blocks, assigned urban/rural dispersion parameters, assigned reactivity classes/particle size information for ASPEN, and grouped certain pollutants together such as the POM groups, and metals (See Ch. 9 of EMS-HAP User's Guide).

For 2015 and 2020, not all HAPs were needed for ASPEN files. Therefore, the 1999 inventory was subset to MSAT HAPs and all POM HAPs only and CountyProc run again to project emissions, this time with the GCFLAG set to 1, resulting in projected ASPEN-ready emissions. With GCFLAG=1, ASPEN ready files are created with the projected emissions.

For both the non-point airport related emissions and remaining non-point sources, the emissions were grouped into area & other sources (group=1).

5.3 Onroad sources

The emission inventories for 2015, 2020, and 2030 were projected outside of EMS-HAP using the methodology in Section 2.4.2. Therefore, EMS-HAP was only used to create the ASPEN ready files. For the onroad inventory, the CountyProc program was used to create the ASPEN ready files. As with the non-point inventory, CountyProc spatially allocated county level emissions to census tracts, temporally allocated emissions to 3-hour time blocks, assigned urban/rural dispersion parameters, assigned reactivity classes/particle size information for ASPEN, and grouped certain pollutants together such as the POM groups, and metals (See Ch. 9 of EMS-HAP User's Guide for details). Onroad emissions were grouped into two onroad groups: onroad gasoline emissions (group=2) and onroad diesel emissions (group=4). SCC codes beginning with 2201 were assigned to group 2 and SCC codes beginning with 2230 were assigned to group 4.

5.4 Nonroad sources

5.4.1 Aircraft sources

Aircraft emissions had been previously extracted from the 1999 inventory for NATA using COPAX in order to be modeled in ASPEN as point sources. The projected aircraft emissions were processed in PtFinal_ASPEN to create ASPEN ready files. Aircraft emissions, SCC codes beginning with 2275, were grouped into non-gasoline nonroad emissions (group=3).

5.4.2 Airport Support Equipment

The projected nonroad inventories discussed in Section 3.3.3 contained emissions related to airport support equipment. Therefore, the projected nonroad inventories were processed through COPAX to separate the airport related emissions from the remaining nonroad emissions. See Table 14 for airport support equipment SCC codes (those denoted as being projected in NMIM). After the COPAX program, the airport support equipment emissions were processed through the point source programs PtDataProc, PtmodelProc, PtTemporal, and PtFinal_ASPEN. Note that unlike the non-point airport emissions and aircraft emissions, the airport support equipment emissions were not processed through the PtGrowCntl program since emissions had already been projected outside of EMS-HAP.

5.4.3 Remaining nonroad sources

The remaining nonroad emissions were processed through CountyProc in a similar fashion to the onroad emissions.

Both airport support equipment emissions and remaining nonroad emissions were binned into two groups, non-gasoline nonroad emissions (group=3) and nonroad gasoline (group=5) (Table 31). SCC codes beginning with 2267, 2268, 2270, 2280, and 2285 were assigned to group 3 and SCC codes beginning with 2260, 2265, and 2282 were assigned to group 5. The exceptions to this were SCC codes 22882020000, 2282020005, and 2282020010, which are diesel pleasure craft emissions. These codes were assigned to group 5 by mistake and should have been assigned to group 3. This mistake was found after EMS-HAP and ASPEN modeling. It was determined however, that these emissions were small when compared to the nonroad emissions and changes were not made, and EMS-HAP and ASPEN were not rerun.

Table 31. ASPEN emission groups for MSAT for future years[2]

Group	Source Sector	Description	Inventories[#]
0	Major sources	Any stationary source or group of stationary sources located within a contiguous area and under common control that emits or has the potential to emit considering controls, in the aggregate, 10 tons per year or more of any hazardous air pollutant or 25 tons per year or more of any combination of hazardous air pollutants	Point
1	Area & other sources	Any stationary source of hazardous air pollutants that is not a major source. Does not include motor vehicles or nonroad vehicles.	Point, and non-point
2	Onroad gasoline sources	Onroad vehicles burning gasoline	Onroad
3	Non-gasoline nonroad sources	Nonroad vehicles burning fuels other than gasoline such as diesel, natural gas, aviation fuel, LP gas, residual oils, and miscellaneous fuel sources.	Nonroad
4	Onroad diesel sources	Onroad vehicles burning diesel	Onroad
5	Nonroad gasoline sources	Nonroad vehicles burning gasoline	Nonroad

[#]Non-point and nonroad include airport related emissions.

5.5 EMS-HAP for precursors

EMS-HAP was run for 2015, 2020, and 2030 for the precursor emissions from the mobile inventory only (i.e. not stationary sources) with the exception of 1,3 butadiene, which is both a HAP and a precursor to acrolein, and was thus projected and run for both stationary and mobile sources. Mobile EMS-HAP processing followed the same steps as described in Sections 5.3 and 5.4

Secondary concentrations for stationary sources for all HAPs other than acrolein were taken as secondary concentrations from the 1999 NATA for all years. Stationary precursors were not projected due to the small contribution of stationary secondary contributions to the total concentrations for acetaldehyde and formaldehyde. An analysis of the secondary contributions of the 1999 precursor concentrations for acetaldehyde and formaldehyde revealed that stationary secondary contributions were small when compared to the total concentrations (secondary and background included). Figure 5 shows box and whisker plots for acetaldehyde and formaldehyde for ratios of tract level stationary secondary concentrations to total concentrations (white boxes) and ratios of tract level mobile secondary concentrations to total concentrations (gray boxes) for 1999. The ratios for the stationary secondary contributions are much less than the mobile ratios, since acetaldehyde and formaldehyde are mobile dominant. Note that even though propionaldehyde is an MSAT HAP, it has no cancer or non-cancer risks associated with it and was not included in the analysis of the secondary concentrations.

[2] 1999 NATA source groups were: 0=major, 1=area & other, 2=all onroad mobile, and 3=all nonroad mobile.

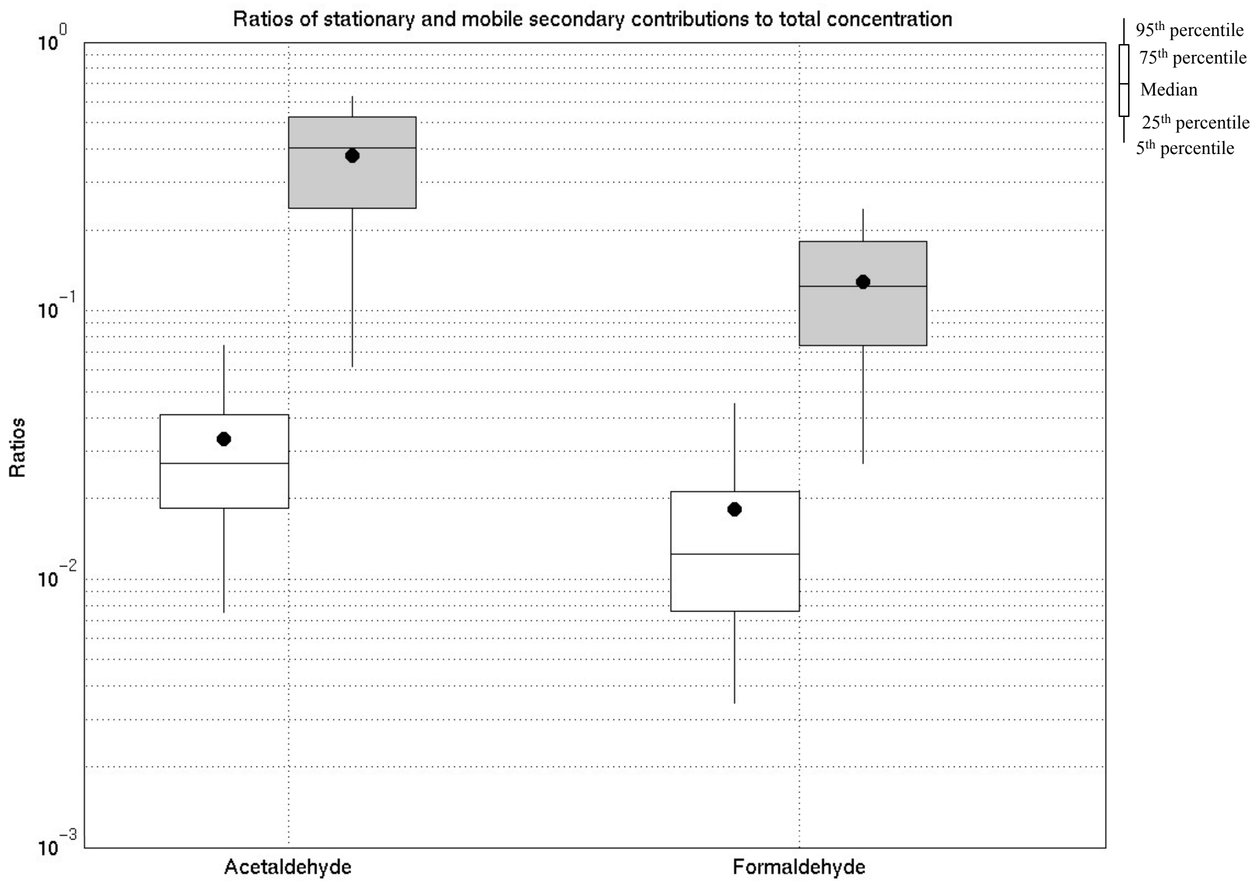

Figure 5. Box and whisker plots of ratios of stationary secondary contributions to total concentrations (white boxes) and ratios of mobile secondary contributions to total concentrations (gray boxes) for 1999 acetaldehyde and formaldehyde concentrations. Dots represent the national mean ratios.

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6. ASPEN Processing

6.1 MSAT HAPs

Once the emissions were processed, they were input into ASPEN (U.S. EPA, 2000) to calculate ambient air quality concentrations. In addition to the emissions, ASPEN needs meteorological parameters, and census tract centroid locations for concentration calculations. For the MSAT years, 2015, 2020, and 2030, the 1999 meteorology and year 2000 census tract locations were used as for the 1999 NATA.

In EMS-HAP, emissions are divided into nine files, one for each HAP reactivity class, 1-9, as defined for ASPEN (Reactivity classes 6 and 8 are not used for HAPs) based on decay rates or particulate sizes (See ASPEN User's Guide [U.S. EPA, 2000] for details). For example, the emissions file for reactivity class 1 would contain the emissions information (location, emissions, stack parameters, etc.) for all of the HAPs processed through EMS-HAP with reactivity class 1. The reactivity classes for each MSAT HAP are listed in Table 32.

ASPEN runs were set up such that the stationary and mobile concentrations were calculated in two separate runs, one for stationary and one for mobile. Table 33 shows how the separate sets of emission files (one file for each reactivity class) are provided to ASPEN.

ASPEN is composed of two modules, ASPENA and ASPENB. ASPENA calculates concentrations at receptors arranged in rings around an emission source up to 50 km away. ASPENB then reads the ASPENA output and interpolates the concentrations to census tract centroids. ASPEN is run for each reactivity class for mobile sources and for each reactivity class for stationary sources. The output from ASPEN is a binary file for each SAROAD code in the emissions input file (see Table 1 for MSAT HAPs' SAROAD codes). Figures 6 and 7 graphically show the input/output for each reactivity class for stationary and mobile sources respectively, including which HAPS are in each reactivity class.

Once ASPEN has been run, the programs AVGDAT and EXTRAVG were used to convert the binary output from ASPEN to ASCII text. Concentrations are annual average concentrations for each source sector and are at the census tract level. For details of the two programs see the ASPEN User's Guide (U.S. EPA, 2000).

6.2 Precursors

Precursor emissions were processed through ASPEN in the same manner as for the HAPs but in a separate model run. Reactivity classes for precursors are also shown in Table 32 with input/output files shown in Figure 8 for mobile sources. As discussed in Section 5.5, the 1999 stationary secondary concentrations were used for 2015 and 2020 secondary concentrations, excluding acrolein whose precursor emissions were projected to 2030 for both stationary and mobile sources.

Table 32. Reactivity classes for MSAT HAPs and precursors.

Pollutant	SAROAD	Reactivity	Pollutant	SAROAD	Reactivity
1,3-Butadiene	43218	7	Propionaldehyde, primary	43505	5
2,2,4-Trimethylpentane	43250	1	Styrene	45220	7
Acetaldehyde, primary	43503	5	Toluene	45202	4
Acrolein, primary	43505	5	Xylenes	45102	5
Benzene	45201	1	POM 1	71002	2
Chromium III, fine	59992	2	POM 2	72002	2
Chromium III, coarse	59993	3	POM 3	73002	2
Chromium VI, fine	69992	2	POM 4	74002	2
Chromium VI, coarse	69993	3	POM 5	75002	2
Ethyl Benzene	45203	4	POM 6	76002	2
Formaldehyde, primary	43502	5	POM 7	77002	2
Hexane	43231	9	POM 8	78002	2
Manganese, fine	80196	2	Acetaldehyde precursors, reactive	80100	7
Manganese, coarse	80396	3	Formaldehyde precursors, reactive	80180	6
MTBE	43376	1	Propionaldehyde precursors, reactive	80234	7
Naphthalene, gas	46701	5	Acetaldehyde precursors, inert	80301	1
Naphthalene, fine PM	46702	2	Acrolein precursor, inert	80302	1
Nickel, fine	80216	2	Formaldehyde precursors, inert	80303	1
Nickel, coarse	80316	3	Propionaldehyde precursors, inert	80305	1

POM 1: POM, Group 1: Unspeciated
POM 2: POM, Group 2: no URE data
POM 3: POM, Group 3: 5.0E-2 < URE <= 5.0E-1
POM 4: POM, Group 4: 5.0E-3 < URE <= 5.0E-2
POM 5: POM, Group 5: 5.0E-4 < URE <= 5.0E-3
POM 6: POM, Group 6: 5.0E-5 < URE <= 5.0E-4
POM 7: POM, Group 7: 5.0E-6 < URE <= 5.0E-5
POM 8: POM, Group 8: Unspeciated (7-PAH only)

REACTIVITY CLASSES:
1 non reactive
2 fine particulate (2.5 microns and less)
3 coarse particulate (2.5 to 10 microns)
4 medium low reactivity
5 medium reactivity
6 medium high reactivity
7 very high reactivity
8 high reactivity
9 low reactivity

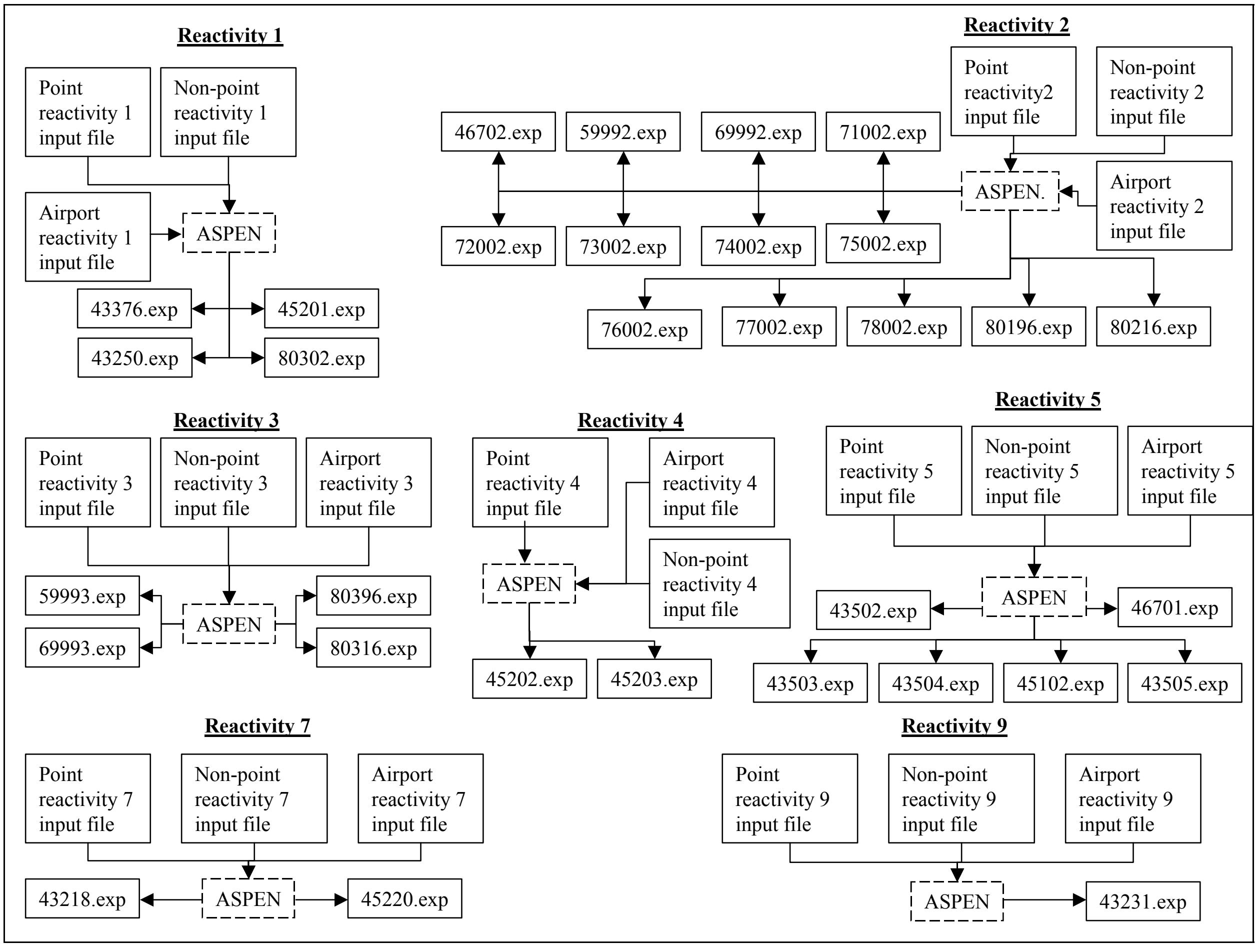

Figure 6. Stationary source emission input files and ASPEN output files for each reactivity class for MSAT HAPs.

Table 33. Description of emissions files for the stationary and mobile divisions used for ASPEN simulations.

Division	Emissions type
Stationary	point sources (major and area & other)
	non-point airport emissions (i.e., aviation gasoline categories) assigned to point sources by COPAX
	non-point emissions (excluding non-point airport emissions)
Mobile	Aircraft emissions assigned to point sources by COPAX
	Airport support equipment emissions assigned to point sources by COPAX.
	Onroad mobile sources
	Nonroad mobile sources (excluding aircraft and airport support equipment)

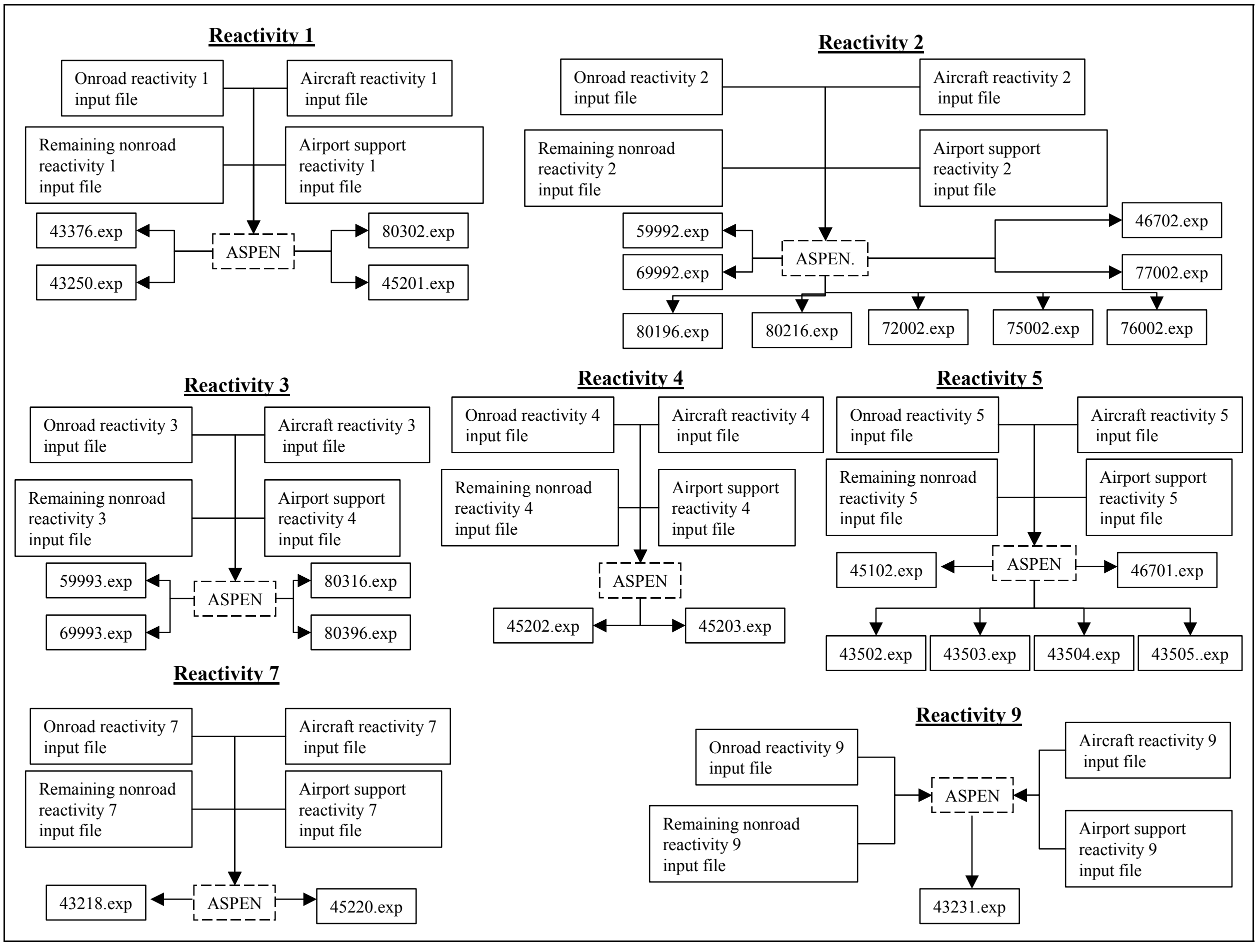

Figure 7. Mobile source emission input files and ASPEN output files for each reactivity class for MSAT HAPs.

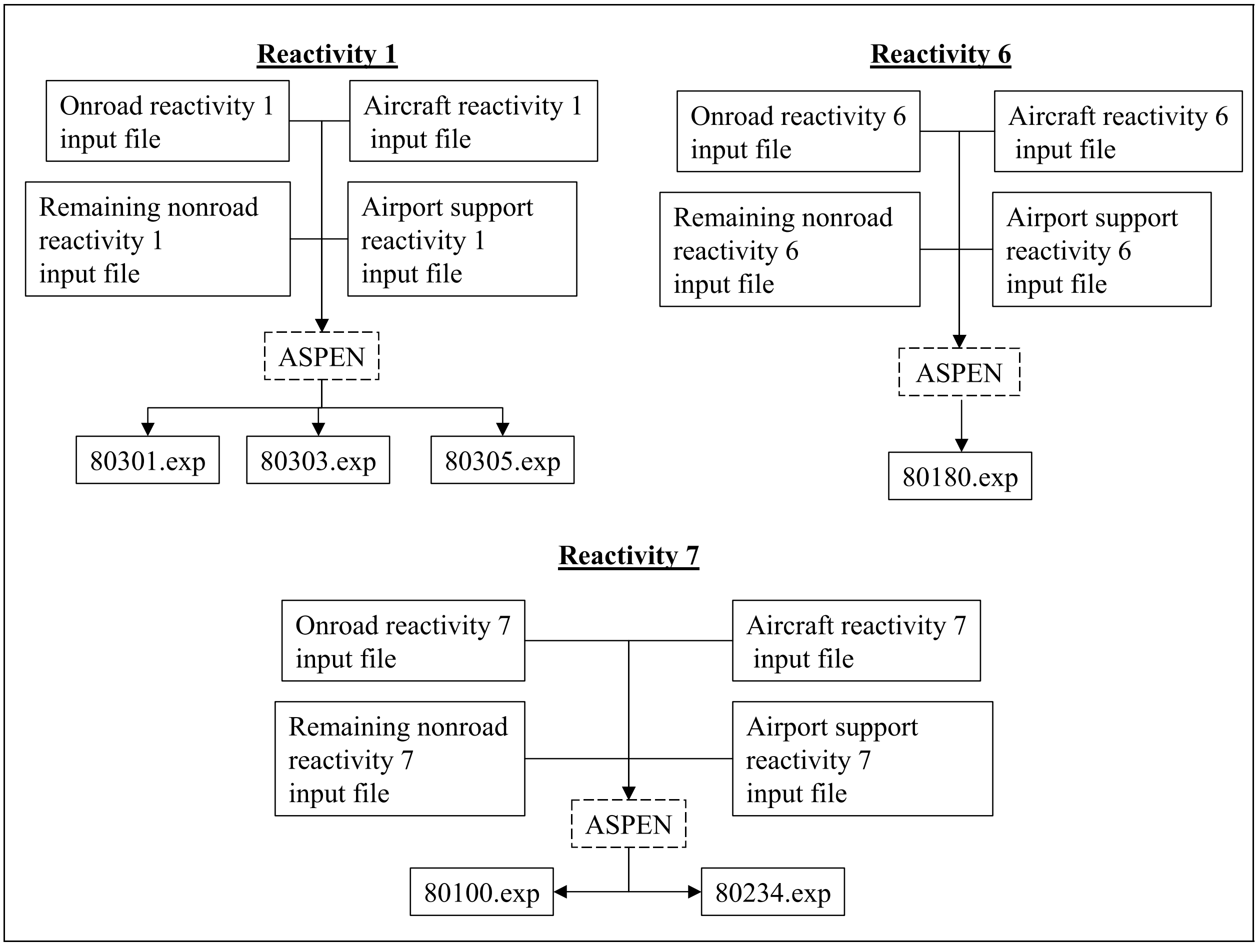

Figure 8. Mobile source emission input files and ASPEN output files for each reactivity class for MSAT precursors.

6.3 Post-processing of ASPEN concentrations

ASPEN output concentrations were calculated for each SAROAD associated with the MSAT HAPs (see Table 1 for SAROADs). Post-processing of the ASPEN concentrations for each year included the following:

- Adjusting the SAROAD 75002 (POM Group 5) area & other concentrations in Oregon as described in Section 2.1.
- Merging the stationary and mobile concentrations together at tract level. For 2030, 2020 stationary concentrations were used.
- Summing the fine and coarse metal concentrations (i.e., fine and coarse nickel) at census tract level for each source sector.

- Summing the particle and gas modes of naphthalene at census tract level for each source category.

- Adding secondary concentrations for each source category using the appropriate precursor concentrations for acetaldehyde, acrolein, formaldehyde, and propionaldehyde at the census tract level. Total concentrations were calculated by adding the primary concentrations (SAROADS in Table 1) and secondary concentrations. Secondary concentrations are computing by subtracting the reactive component of the precursor from the inert component of the precursor, and multiplying by a factor (if needed). The following equations show how the ASPEN-modeled[3] concentrations for each of the HAPs with secondary components were calculated:

$$X_{acetaldehyde} = X_{43503} + X_{80301} - X_{80100} \quad (7)$$

$$X_{acrolein} = X_{43503} + 1.04(X_{80301} - X_{80100}) \quad (8)$$

$$X_{formaldehyde} = X_{43502} + X_{80303} - X_{80180} \quad (9)$$

$$X_{propionaldehyde} = X_{43504} + X_{80305} - X_{80234} \quad (10)$$

Where:
$X_{acetaldehyde}$ = Acetaldehyde concentrations with secondary contributions included.
X_{43503} = Primary acetaldehyde concentrations due to directly emitted acetaldehyde.
X_{80301} = Inert precursor concentrations for acetaldehyde (reactivity class 1).
X_{80100} = Reactive precursor concentrations for acetaldehyde (reactivity class 7).

$X_{acrolein}$ = Acrolein concentrations with secondary contributions included.
X_{43505} = Primary acrolein concentrations due to directly emitted acrolein.
X_{80302} = Inert precursor concentrations for acrolein (reactivity class 1)- note that 1,3 butadiene is the sole precursor for acrolein and that 80302 represents 1,3 butadiene, inert.
X_{43218} = Reactive precursor concentrations for acrolein (reactivity class 7))- note that 1,3 butadiene is the sole precursor for acrolein and that SAROAD=43218 represents 1,3 butadiene.

$X_{formaldehyde}$ = Formaldehyde concentrations with secondary contributions included.
X_{43502} = Primary formaldehyde concentrations due to directly emitted formaldehyde.
X_{80303} = Inert precursor concentrations for formaldehyde (reactivity class 1).
X_{80180} = Reactive precursor concentrations for formaldehyde (reactivity class 6).

$X_{propionaldehyde}$ = Propionaldehyde concentrations with secondary contributions included.

[3] These equations provide the ASPEN-modeled concentrations prior to the addition of the background concentration, discussed in the next bullet.

X_{43504} = Primary propionaldehyde concentrations due to directly emitted propionaldehyde.
X_{80305} = Inert precursor concentrations for propionaldehyde (reactivity class 1).
X_{80234} = Reactive precursor concentrations for propionaldehyde (reactivity class 6).

- Adding county level background concentrations to total concentrations (all sources) for HAPs with background. The MSAT HAPs with nonzero background are: 1,3-butadiene, acetaldehyde, benzene, formaldehyde, and xylenes. Each of the three model years used 1999 background. For details about the 1999 background see http://www.epa.gov/ttn/atw/nata1999/background.html or Batelle (2003). Because it would be expected that background levels would likely change in the future due to emissions changes, a sensitivity analysis was done to evaluate the potential impact of changing the constant background assumption. This analysis is detailed in Section 9.

After post-processing of the concentrations, summary statistics for the concentrations for each year, including 1999 were calculated. They included:

- Average concentrations for major, area & other, onroad gasoline, onroad diesel, nonroad gasoline, remaining nonroad, background, and total at the county, state, state urban/rural, state RFG/non-RFG, national, national urban/rural, and national RFG/non-RFG levels.

- Distributions (5^{th}, 10^{th}, 25^{th}, 50^{th}, 75^{th}, 90^{th}, and 95^{th} percentiles) for total concentrations at the county, state, state urban/rural, state RFG/non-RFG levels.

- Maps of county median concentrations for 1,3-butadiene, acetaldehyde, acrolein, benzene, formaldehyde, and naphthalene were generated for 1999, 2015, 2020, and 2030.

National level average concentrations for 1999, 2015, 2020, and 2030 are shown in Table 34 and county maps for the same years for benzene are in Figures 9 through 12.

The complete summaries and maps described above are in concentrations.xls and ASPEN_medians.ppt respectively in the MSAT rule docket EPA-HQ-OAR-2005-0036. Note that in Table 34 and in concentrations.xls, the national average background concentration differs from the national average background concentration for NATA even though the same county level background concentrations were used for all years. This is because Puerto Rico and the Virgin Islands were not included in the 2015, 2020, and 2030 analyses but were included in the NATA analysis.

Table 34. National average background, stationary, and mobile ASPEN concentrations ($\mu g\ m^{-3}$) for each MSAT HAP for 2015, 2020, and 2030.

HAP	Back-ground	2015		2020		2030	
		Stationary	Mobile	Stationary	Mobile	Stationary	Mobile
1,3-Butadiene	5.11×10^{-2}	2.27×10^{-2}	2.44×10^{-2}	2.28×10^{-2}	2.38×10^{-2}	2.28×10^{-2}	2.63×10^{-2}
2,2,4-Trimethylpentane	0	4.19×10^{-2}	2.86×10^{-1}	4.44×10^{-2}	2.59×10^{-1}	4.44×10^{-2}	2.75×10^{-1}
Acetaldehyde	5.17×10^{-1}	8.67×10^{-2}	3.62×10^{-1}	8.93×10^{-2}	3.29×10^{-1}	8.93×10^{-2}	3.50×10^{-1}
Acrolein	0	2.97×10^{-2}	3.41×10^{-2}	2.93×10^{-2}	3.37×10^{-2}	2.93×10^{-2}	3.74×10^{-2}
Benzene	3.94×10^{-1}	2.04×10^{-1}	3.16×10^{-1}	2.13×10^{-1}	2.95×10^{-1}	2.13×10^{-1}	3.18×10^{-1}
Chromium III	0	1.66×10^{-3}	2.11×10^{-4}	1.86×10^{-3}	2.30×10^{-4}	1.87×10^{-3}	2.73×10^{-4}
Chromium VI	0	4.08×10^{-4}	4.64×10^{-5}	4.61×10^{-4}	5.05×10^{-5}	4.61×10^{-4}	6.00×10^{-5}
Ethyl Benzene	0	1.24×10^{-1}	1.33×10^{-1}	1.37×10^{-1}	1.23×10^{-1}	1.37×10^{-1}	1.32×10^{-1}
Formaldehyde	7.62×10^{-1}	1.48×10^{-1}	3.13×10^{-1}	1.60×10^{-1}	3.03×10^{-1}	1.60×10^{-1}	3.31×10^{-1}
Hexane	0	5.91×10^{-1}	1.35×10^{-1}	6.38×10^{-1}	1.18×10^{-1}	6.38×10^{-1}	1.23×10^{-1}
MTBE	0	7.04×10^{-2}	1.26×10^{-1}	7.41×10^{-2}	1.05×10^{-1}	7.41×10^{-2}	1.05×10^{-1}
Manganese	0	6.14×10^{-3}	1.85×10^{-4}	6.80×10^{-3}	2.08×10^{-4}	6.80×10^{-3}	2.61×10^{-4}
Naphthalene	0	6.15×10^{-2}	1.24×10^{-2}	6.57×10^{-2}	1.26×10^{-2}	6.57×10^{-2}	1.46×10^{-2}
Nickel	0	2.50×10^{-3}	2.50×10^{-4}	2.74×10^{-3}	2.71×10^{-4}	2.74×10^{-3}	3.19×10^{-4}
POM*	0	2.25×10^{-2}	1.47×10^{-3}	2.34×10^{-2}	1.50×10^{-3}	2.34×10^{-2}	1.71×10^{-3}
Propionaldehyde	0	3.32×10^{-2}	9.20×10^{-2}	3.39×10^{-2}	8.21×10^{-2}	3.39×10^{-2}	8.62×10^{-2}
Styrene	0	4.90×10^{-2}	1.23×10^{-2}	5.53×10^{-2}	1.19×10^{-2}	5.53×10^{-2}	1.29×10^{-2}
Toluene	0	1.19	7.24×10^{-1}	1.31	6.63×10^{-1}	1.31	7.07×10^{-1}
Xylenes	1.70×10^{-1}	8.62×10^{-1}	5.22×10^{-1}	9.52×10^{-1}	4.87×10^{-1}	9.52×10^{-1}	5.24×10^{-1}

*POM is the sum of all POM groups.

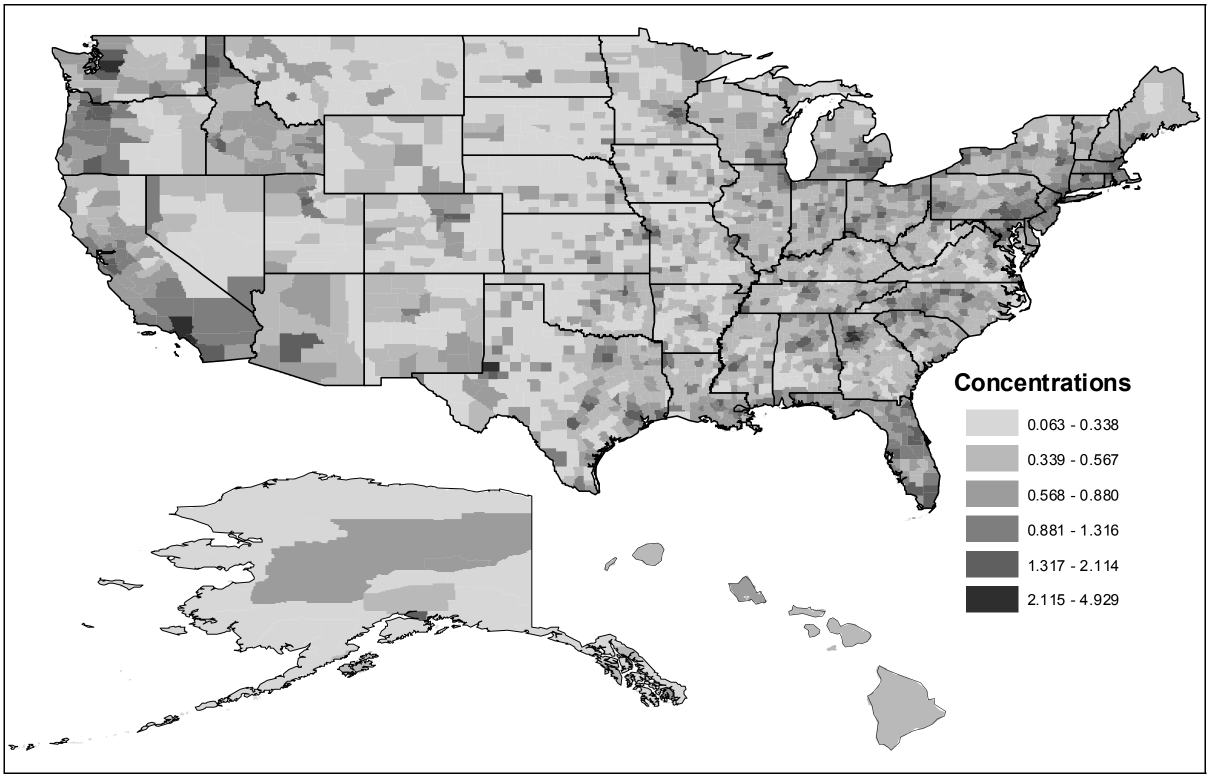

Figure 9. 1999 County level median total (all sources and background) concentrations ($\mu g\ m^{-3}$) for benzene.

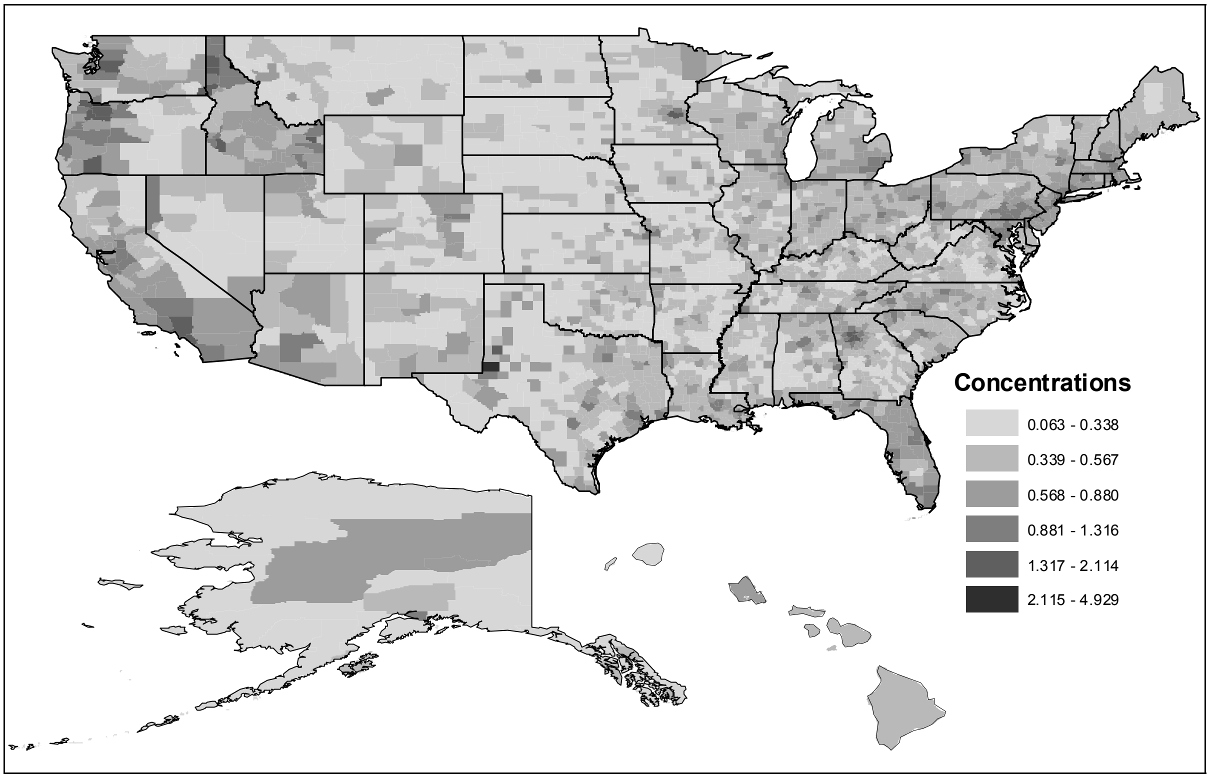

Figure 10. 2015 County level median total (all sources and background) concentrations (μg m^{-3}) for benzene.

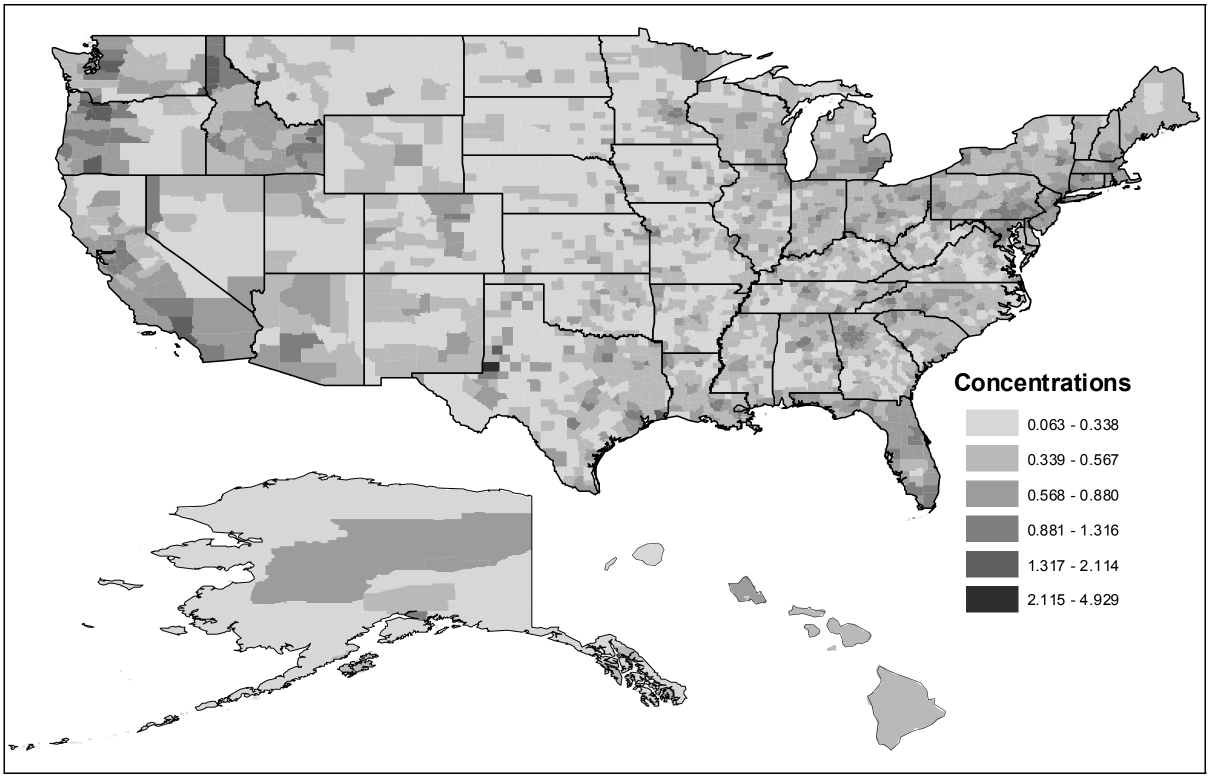

Figure 11. 2020 County level median total (all sources and background) concentrations (μg m^{-3}) for benzene.

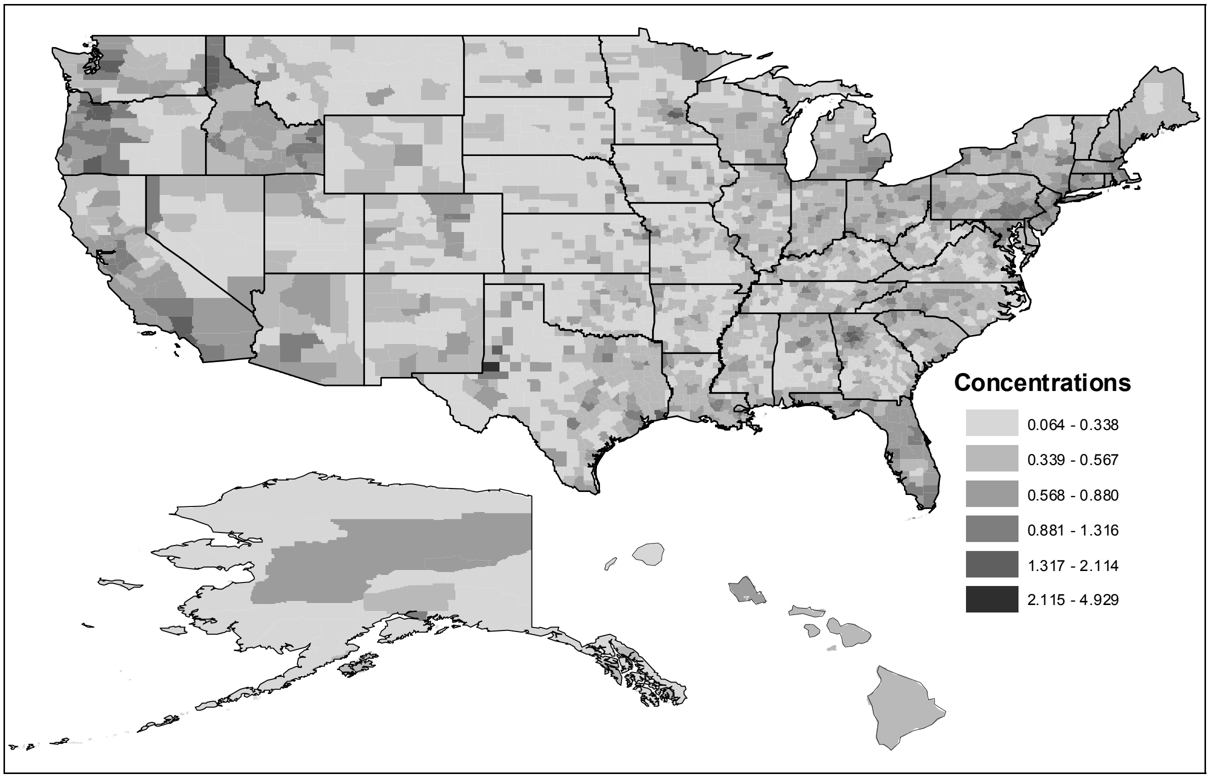

Figure 12. 2030 County level median total (all sources and background) concentrations ($\mu g\ m^{-3}$) for benzene.

ASPEN results were also processed for input to HAPEM5. ASPEN outputs annual average tract-level concentrations for eight 3-hour time blocks. The concentrations were extracted from the binary ASPEN output, .exp files, using the AVGDAT program and written to an ASCII text file. The concentrations were then processed in a similar fashion as for the annual average concentrations: stationary and mobile concentrations merged together, fine and coarse components of the metals added together, gas and particulate phases of naphthalene added together and secondary concentrations added to the secondary HAPs. Once these steps were done there were eight 3-hour concentrations for major, area & other, onroad gasoline, onroad diesel, nonroad gasoline and, nonroad other. Background was also added for each tract.

Normally HAPEM input files, also called air quality files, contain major, area & other, onroad, nonroad, and background concentrations, as done for the 1999 NATA. For MSAT, the onroad and nonroad concentrations were broken into two categories each, resulting in a total of seven concentration categories. In order to avoid recoding the FORTRAN programs of HAPEM, the HAPEM input files were split into two different files, called "run1" and "run2." Run1 files contained major, area & other, onroad gasoline, nonroad gasoline and background. Run2 files contained placeholders (values of zero concentration) for major, area & other and background. The onroad diesel and nonroad other concentrations were added to the run2 files. Figures 13 and 14 show sample records for the run1 and run2 HAPEM input files.

```
Annual average concentrations in ug/m3 by time blocks
Pollutant species: Benzene
Source category: ALL

    FIPS   Tract   Conc_block1   Conc_block2   Conc_block3   Conc_block4   Conc_block5
Conc_block6   Conc_block7   Conc_block8   Conc_block1   Conc_block2   Conc_block3
Conc_block4   Conc_block5   Conc_block6   Conc_block7   Conc_block8   Conc_block1
Conc_block2   Conc_block3   Conc_block4   Conc_block5   Conc_block6   Conc_block7
Conc_block8   Conc_block1   Conc_block2   Conc_block3   Conc_block4   Conc_block5
Conc_block6   Conc_block7   Conc_block8   Bconc_block8
   01001  020100  1.014290E-02  7.904850E-03  2.722090E-03  1.851860E-03  2.127090E-03
4.262630E-03  1.014880E-02  1.014940E-02  6.959740E-02  1.451020E-01  1.125670E-01
7.934730E-02  8.579260E-02  1.807510E-01  2.245080E-01  6.572720E-02  9.880010E-02
7.547470E-02  8.572060E-02  6.858460E-02  8.586170E-02  2.021050E-01  2.630900E-01
1.726230E-01  7.336690E-03  6.009230E-03  3.060390E-02  3.728000E-02  4.081490E-02
8.620350E-02  4.950200E-02  7.228590E-03  3.212943E-01
   01001  020200  1.926930E-02  1.436350E-02  4.269420E-03  3.102840E-03  3.331600E-03
6.697180E-03  1.928040E-02  1.928210E-02  1.090870E-01  2.961870E-01  4.099370E-01
3.081070E-01  3.301660E-01  5.106280E-01  4.794080E-01  1.037620E-01  1.762320E-01
1.409060E-01  2.053260E-01  1.727360E-01  2.178950E-01  4.099920E-01  4.509380E-01
3.009450E-01  7.639370E-03  6.252210E-03  1.075850E-01  1.475200E-01  1.605220E-01
2.436150E-01  9.773740E-02  7.526810E-03  3.212943E-01
```

Figure 13. Sample records of the Run1 2015 HAPEM input air quality file con45201_run1.txt for benzene. Note that each set of concentrations for a tract is one record. More records appear due to of "wrapping" of text in word processor.

```
Annual average concentrations in ug/m3 by time blocks
Pollutant species: Benzene
Source category: ALL

    FIPS   Tract   Conc_block1   Conc_block2   Conc_block3   Conc_block4   Conc_block5
Conc_block6   Conc_block7   Conc_block8   Conc_block1   Conc_block2   Conc_block3
Conc_block4   Conc_block5   Conc_block6   Conc_block7   Conc_block8   Conc_block1
Conc_block2   Conc_block3   Conc_block4   Conc_block5   Conc_block6   Conc_block7
Conc_block8   Conc_block1   Conc_block2   Conc_block3   Conc_block4   Conc_block5
Conc_block6   Conc_block7   Conc_block8   Bconc_block8
   01001  020100  0.000000E+00  0.000000E+00  0.000000E+00  0.000000E+00  0.000000E+00
0.000000E+00  0.000000E+00  0.000000E+00  0.000000E+00  0.000000E+00  0.000000E+00
0.000000E+00  0.000000E+00  0.000000E+00  0.000000E+00  0.000000E+00  5.437490E-04
7.163460E-04  2.433580E-03  2.331080E-03  2.200300E-03  5.139870E-03  2.213920E-03
9.321060E-04  3.162220E-04  2.568330E-04  1.723930E-03  1.608990E-03  1.761980E-03
3.808400E-03  3.525590E-03  1.210110E-03  0.000000E+00
   01001  020200  0.000000E+00  0.000000E+00  0.000000E+00  0.000000E+00  0.000000E+00
0.000000E+00  0.000000E+00  0.000000E+00  0.000000E+00  0.000000E+00  0.000000E+00
0.000000E+00  0.000000E+00  0.000000E+00  0.000000E+00  0.000000E+00  9.786940E-04
1.364310E-03  6.234640E-03  6.259710E-03  5.902090E-03  1.110560E-02  3.984490E-03
1.677710E-03  4.114270E-04  3.463900E-04  4.707650E-03  4.879280E-03  5.317610E-03
8.468020E-03  5.789880E-03  1.999970E-03  0.000000E+00
```

Figure 14. Sample records of the Run2 2015 HAPEM input air quality file con45201_run2.txt for benzene.

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7. HAPEM5 Model and Post-Processing

7.1 HAPEM model

The HAPEM5 (U.S. EPA, 2005d) model was originally compiled to run on a DOS PC, one pollutant (HAP) at a time. In early 2004, HAPEM5 was compiled on a Linux cluster in order to run the model for multiple pollutants simultaneously (using multiple computer processors), thereby reducing the overall time required to run HAPEM5 for a long list of pollutants. The post-processing FORTRAN code that converts HAPEM5 output into the input for the risk calculations was also compiled for Linux.

The HAPEM model consists of 5 modules, to be run in order: 1) DURAV5, 2) INDEXPOP5, 3) COMMUTE5, 4) AIRQUAL5 and 5) HAPEM5. The first three modules only need to be run once for the whole domain, while the last two modules must be run for each HAP (generally distinguished by SAROAD code). Refer to the HAPEM5 User's Guide for more detailed information about the model and formats of input and output files (U.S. EPA, 2005e).

For NATA (and thus 1999 results), as noted in Section 6.3, the emissions source categories were major, area & other, onroad, nonroad and background. However, as discussed previously in 5.3, for the future year MSAT analyses described here, the onroad and nonroad mobile source categories were split into two categories each (highway gasoline, highway diesel, nonroad gasoline and remaining nonroad), making the total number of non-background source categories equal to six. Because HAPEM is limited to a maximum of five source categories per run, the runs for each projection year were split into two runs per HAP. In other words, there were two runs (2) for each year (3) and for each HAP (26), a grand total of 156 individual HAPEM runs. The first run for each HAP for each year ("run1") included ASPEN-derived air quality input data for the major, area & other, highway gasoline, and nonroad gasoline groups and background, while "run2" only included highway diesel and remaining nonroad (no background). The output for the two onroad groups were added together after post-processing and prior to the risk calculations, as were the two nonroad groups.

The HAPEM5 runs for MSAT used 2000 census data, 1990 commuting data adjusted to reflect the 2000 census tract designations, and activity pattern data from the Consolidated Human Activity Database (CHAD) (Glen et al. 1997). HAPEM5 output for the first three modules from a previous set of HAPEM5 runs done for the 1999 NATA were included, so only the HAP-specific modules (AIRQUAL5 and HAPEM5) were run for MSAT.

The input files were the same for all pollutants, except for:

- a) the HAP-specific parameter file used for the AIRQUAL5 and HAPEM5 modules (p2_MSAT_XXXXX_YYYY_runZ.txt, where XXXXX is the 5-digit pollutant SAROAD code or text identifier, YYYY is the 4-digit projection year and Z is the run number "1" or "2"),
- b) the ASPEN-derived air quality (AQ) concentration file (conXXXXX_runZ.txt, for each pollutant, located in the appropriate year- and run-specific run directories), and

- c) the microenvironmental factors file used (gas, particulate or mixed).

There are three microenvironments factor files provided with the HAPEM5 model: gas, particulate and mixed. The factor file used for each HAP is determined from a HAP factors lookup file also provided with the model. The factor file is listed in each HAP-specific parameter file (p2 files) for the AIRQUAL5 and HAPEM5 modules.

The final output files generated by HAPEM5 are in the form of XXXXX.YY.dat, where XXXXX is the 5-digit SAROAD (for gaseous HAPs excluding secondary HAPs) or text HAP identifier (for metals or secondary HAPs) and YY is the 2-digit state FIPS code. There are 53 output files for each SAROAD (HAP), one for each state FIPS code. This includes Puerto Rico and Virgin Islands even though those areas were not projected. Puerto Rico and the Virgin Islands are included because HAPEM5 was run as set up for the 1999 NATA. Given that there would be many files to edit (because of the number of HAPs and years) to exclude Puerto Rico and the Virgin Islands, and that runtimes would not be significantly decreased if they were excluded, they remained in the setup files for AIRQUAL and ignored after post-processing.

The raw HAPEM5 output had to be post-processed prior to making the risk calculations. The post-processing code we used basically takes the exposure concentrations for each demographic group (10 demographic groups, 5 age groups x 2 genders) and builds a lifetime exposure (about 70 years) for an individual at that tract for each HAP. At each tract and demographic group, there are 30 replicates. For the total exposure (all sources), for each tract and demographic group, the median exposure is used to adjust the mean exposure at each tract for the difference source categories (major, area & other, etc.) by dividing the mean source category exposure concentration for the tract by the median total concentration. This operation causes stationary exposure concentrations for 2020 and 2030 to differ even though the same input concentrations were used. The mobile concentrations between the two years changed, causing the total concentrations to change, changing the median total concentrations at the tract level. This in turn, changed the adjusted stationary source exposure concentrations. The final output file is in the form XXXX_SAROAD_runY.HAPEM5-TRACT.txt where XXXX is 2015, 2020, or 2030, SAROAD is the SAROAD or HAP name, and Y is 1 or 2 for run1 or run2. Sample records of post-processed HAPEM5 output for 2015 Benzene run1 and run2 are shown in Figures 15 and 16 respectively.

01001	020100	5.592E-03	1.027E-01	1.715E-01	3.346E-02	5.653E-01	2.521E-01
01001	020200	1.002E-02	2.417E-01	2.838E-01	7.260E-02	8.586E-01	2.505E-01
01001	020300	1.158E-02	1.763E-01	2.403E-01	5.643E-02	7.346E-01	2.500E-01
01001	020400	1.597E-02	1.413E-01	2.582E-01	4.394E-02	7.132E-01	2.538E-01
01001	020500	1.446E-02	1.044E-01	2.155E-01	3.762E-02	6.250E-01	2.531E-01
01001	020600	4.544E-02	8.300E-02	2.014E-01	3.387E-02	6.139E-01	2.502E-01
01001	020700	2.747E-02	7.944E-02	1.601E-01	3.409E-02	5.496E-01	2.485E-01
01001	020800	3.978E-03	5.112E-02	9.521E-02	2.191E-02	4.208E-01	2.486E-01
01001	020900	1.757E-03	4.429E-02	6.416E-02	1.158E-02	3.648E-01	2.430E-01
01001	021000	1.300E-03	4.273E-02	5.122E-02	1.045E-02	3.525E-01	2.468E-01
01001	021100	3.073E-03	4.065E-02	6.345E-02	1.440E-02	3.736E-01	2.520E-01
01003	010100	3.347E-03	3.120E-02	4.427E-02	1.870E-02	3.471E-01	2.496E-01
01003	010200	1.019E-02	5.030E-02	6.172E-02	2.341E-02	3.949E-01	2.493E-01
01003	010300	9.414E-03	4.720E-02	6.464E-02	3.340E-02	4.035E-01	2.488E-01
01003	010400	4.961E-03	7.028E-02	6.688E-02	2.827E-02	4.210E-01	2.506E-01
01003	010500	5.667E-03	1.279E-01	7.744E-02	4.564E-02	5.071E-01	2.504E-01
01003	010600	6.178E-03	1.192E-01	7.016E-02	4.180E-02	4.884E-01	2.511E-01
01003	010701	1.852E-02	4.337E-02	8.418E-02	5.977E-02	4.595E-01	2.537E-01
01003	010703	9.308E-03	4.769E-02	9.990E-02	5.949E-02	4.656E-01	2.492E-01

Figure 15. Sample records showing HAPEM5 output for Benzene Run1. Filename is 2015_45201_run1.HAPEM5-TRACT.txt. Variables are FIPS, tract id, major, area & other, onroad gasoline, nonroad gasoline, total and background concentrations.

01001	020100	0.000E+00	0.000E+00	2.836E-03	1.629E-03	4.465E-03	0.000E+00
01001	020200	0.000E+00	0.000E+00	5.176E-03	3.097E-03	8.273E-03	0.000E+00
01001	020300	0.000E+00	0.000E+00	4.209E-03	2.422E-03	6.631E-03	0.000E+00
01001	020400	0.000E+00	0.000E+00	4.552E-03	1.975E-03	6.527E-03	0.000E+00
01001	020500	0.000E+00	0.000E+00	3.569E-03	1.984E-03	5.554E-03	0.000E+00
01001	020600	0.000E+00	0.000E+00	3.553E-03	1.895E-03	5.448E-03	0.000E+00
01001	020700	0.000E+00	0.000E+00	2.575E-03	1.941E-03	4.516E-03	0.000E+00
01001	020800	0.000E+00	0.000E+00	1.513E-03	1.089E-03	2.602E-03	0.000E+00
01001	020900	0.000E+00	0.000E+00	9.994E-04	6.306E-04	1.630E-03	0.000E+00
01001	021000	0.000E+00	0.000E+00	7.444E-04	4.991E-04	1.243E-03	0.000E+00
01001	021100	0.000E+00	0.000E+00	1.016E-03	7.317E-04	1.748E-03	0.000E+00
01003	010100	0.000E+00	0.000E+00	3.194E-04	7.389E-04	1.058E-03	0.000E+00
01003	010200	0.000E+00	0.000E+00	6.738E-04	1.490E-03	2.164E-03	0.000E+00
01003	010300	0.000E+00	0.000E+00	8.175E-04	2.639E-03	3.456E-03	0.000E+00
01003	010400	0.000E+00	0.000E+00	6.943E-04	2.991E-03	3.685E-03	0.000E+00
01003	010500	0.000E+00	0.000E+00	1.069E-03	2.462E-03	3.531E-03	0.000E+00
01003	010600	0.000E+00	0.000E+00	8.959E-04	2.692E-03	3.588E-03	0.000E+00
01003	010701	0.000E+00	0.000E+00	1.063E-03	7.130E-03	8.193E-03	0.000E+00
01003	010703	0.000E+00	0.000E+00	1.256E-03	9.177E-03	1.043E-02	0.000E+00

Figure 16. Sample records showing HAPEM5 output for Benzene Run2. Filename is 2015_45201_run2.HAPEM5-TRACT.txt. Variables are FIPS, tract id, major, area and other, onroad diesel, nonroad other, total and background concentrations.

7.2 Summaries of annual HAPEM5 output

After post-processing of the HAPEM5 concentrations, summary statistics for the concentrations for each year, including 1999 were calculated as done for ASPEN results. The statistics included:

- Average concentrations for major, area & other, onroad gasoline, onroad diesel, nonroad gasoline, remaining nonroad, background, and total at the county, state, state urban/rural, state RFG/non-RFG, national, national urban/rural, and national RFG/non-RFG levels.

- Distributions (5^{th}, 10^{th}, 25^{th}, 50^{th}, 75^{th}, 90^{th}, and 95^{th} percentiles) for total concentrations at the county, state, state urban/rural, state RFG/non-RFG levels.

- Maps of county median concentrations for 1,3-butadiene, acetaldehyde, acrolein, benzene, formaldehyde, and naphthalene were generated for 1999, 2015, 2020, and 2030.

Table 35 lists national average HAPEM concentrations for each MSAT HAP for stationary and mobile sources for each year. Figure 17 shows the county median total concentration for Benzene for 2015.

The summaries and maps described above can be found in the MSAT rule docket: EPA-HQ-OAR-2005-0036 in the excel file hapem_concentrations.xls. County median maps are also in the docket; the file name is: HAPEM_medians.ppt.

Table 35. National average stationary and mobile HAPEM concentrations (μg m^{-3}) for 2015, 2020, and 2030 by HAP.

HAP	2015			2020			2030		
	Stationary	Mobile	Background	Stationary	Mobile	Background	Stationary	Mobile	Background
1,3-Butadiene	1.91×10^{-2}	2.77×10^{-2}	3.90×10^{-2}	1.92×10^{-2}	2.68×10^{-2}	3.90×10^{-2}	1.92×10^{-2}	2.94×10^{-2}	3.90×10^{-2}
2,2,4-Trimethylpentane	3.61×10^{-2}	3.16×10^{-1}	0	3.83×10^{-2}	2.86×10^{-1}	0	3.83×10^{-2}	3.03×10^{-1}	0
Acetaldehyde	7.40×10^{-2}	3.84×10^{-1}	4.00×10^{-1}	7.62×10^{-2}	3.47×10^{-1}	4.00×10^{-1}	7.62×10^{-2}	3.67×10^{-1}	4.00×10^{-1}
Acrolein	2.53×10^{-2}	3.40×10^{-2}	0	2.50×10^{-2}	3.33×10^{-2}	0	2.50×10^{-2}	3.68×10^{-2}	0
Benzene	1.78×10^{-1}	3.54×10^{-1}	3.01×10^{-1}	1.86×10^{-1}	3.29×10^{-1}	3.01×10^{-1}	1.86×10^{-1}	3.53×10^{-1}	3.01×10^{-1}
Chromium III	6.68×10^{-4}	1.21×10^{-4}	0	7.51×10^{-4}	1.33×10^{-4}	0	7.51×10^{-4}	1.60×10^{-4}	0
Chromium VI	1.687×10^{-4}	2.70×10^{-5}	0	1.90×10^{-4}	2.96×10^{-5}	0	1.90×10^{-4}	3.57×10^{-5}	0
Ethyl Benzene	1.08×10^{-1}	1.44×10^{-1}	0	1.19×10^{-1}	1.32×10^{-1}	0	1.19×10^{-1}	1.41×10^{-1}	0
Formaldehyde	1.27×10^{-1}	3.25×10^{-1}	5.91×10^{-1}	1.38×10^{-1}	3.12×10^{-1}	5.91×10^{-1}	1.38×10^{-1}	3.40×10^{-1}	5.91×10^{-1}
Hexane	5.12×10^{-1}	1.50×10^{-1}	0	5.53×10^{-1}	1.30×10^{-1}	0	5.53×10^{-1}	1.36×10^{-1}	0
MTBE	5.95×10^{-2}	1.40×10^{-1}	0	6.27×10^{-2}	1.14×10^{-1}	0	6.27×10^{-2}	1.14×10^{-1}	0
Manganese	2.48×10^{-3}	1.23×10^{-4}	0	2.74×10^{-3}	1.39×10^{-4}	0	2.74×10^{-3}	1.74×10^{-4}	0
Naphthalene	5.25×10^{-2}	1.34×10^{-2}	0	5.61×10^{-2}	1.36×10^{-2}	0	5.61×10^{-2}	1.57×10^{-2}	0
Nickel	1.03×10^{-3}	1.35×10^{-4}	0	1.12×10^{-3}	1.48×10^{-4}	0	1.12×10^{-3}	1.77×10^{-4}	0
POM	1.40×10^{-2}	1.12×10^{-3}	0	1.46×10^{-2}	1.14×10^{-3}	0	1.46×10^{-2}	1.31×10^{-3}	0
Propionaldehyde	2.80×10^{-2}	9.68×10^{-2}	0	2.86×10^{-2}	8.58×10^{-2}	0	2.86×10^{-2}	8.98×10^{-2}	0
Styrene	4.09×10^{-2}	1.36×10^{-2}	0	4.61×10^{-2}	1.30×10^{-2}	0	4.61×10^{-2}	1.42×10^{-2}	0
Toluene	1.03	8.06×10^{-1}	0	1.14	7.35×10^{-1}	0	1.14	7.83×10^{-1}	0
Xylenes	7.52×10^{-1}	5.61×10^{-1}	1.28×10^{-1}	8.31×10^{-1}	5.20×10^{-1}	1.27×10^{-1}	8.31×10^{-1}	5.59×10^{-1}	1.27×10^{-1}

Note that even though the 2020 and 2030 stationary concentrations input into HAPEM were identical, the output stationary concentrations for the two years were not exactly the same. This is due to the post-processing of the raw HAPEM output. The average tract-level source category concentrations are adjusted by dividing by the tract-level median total concentration. Between 2020 and 2030, the mobile concentrations change, therefore changing the total concentrations. Therefore, the stationary HAPEM output concentrations change, even though the ASPEN concentrations are no different between the two years.

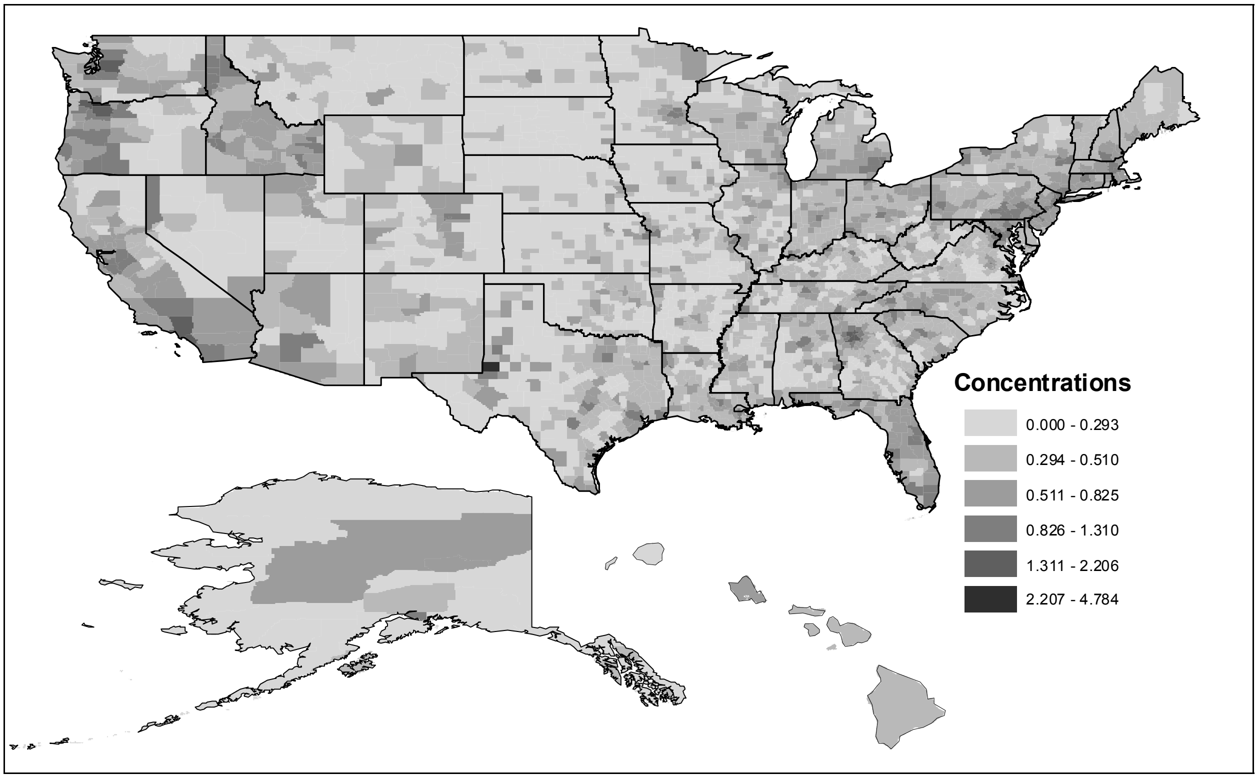

Figure 17. 2015 HAPEM county median total concentrations (all sources) for benzene.

8. Cancer and non-cancer risk calculations

Once HAPEM runs were completed, cancer and non-cancer risks were calculated for each of the MSAT HAPs. Table 36 lists the MSAT HAPS with their respective unit risk estimates (URE) for cancer calculations and non-cancer reference concentrations (Rfc) for non-cancer calculations, resulting from long term (chronic) inhalation exposure to these HAPS. Also listed are the HAPs appropriate carcinogenic class and target organ system(s) for non-cancer effects.

Table 36. MSAT HAPs carcinogenic class, URE, non-cancer target organ systems, and Rfc. N/A denotes HAP is neither a cancer or non-cancer HAP

HAP	Carcinogen Class	URE	Organ systems	Rfc
1,3-Butadiene	A	$3.0x10^{-5}$	Reproductive	$2.0x10^{-3}$
2,2,4-Trimethylpentane	N/A	N/A	N/A	N/A
Acetaldehyde	B2	$2.2x10^{-6}$	Respiratory	$9.0x10^{-3}$
Acrolein		N/A	Respiratory	$2.0x10^{-5}$
Benzene	A	$7.8x10^{-6}$	Immune	$3.0x10^{-2}$
Chromium III	N/A	N/A	N/A	N/A
Chromium VI	A	$1.2x10^{-2}$	Respiratory	$1.0x10^{-4}$
Ethyl Benzene		N/A	Developmental	1.0
Formaldehyde	B	$5.5x10^{-9}$	Respiratory	$9.8x10^{-3}$
Hexane		N/A	Respiratory, Neurological	$2.0x10^{-1}$
Manganese		N/A	Neurological	$5.0x10^{-5}$
MTBE		N/A	Liver, Kidney, Ocular	3.0
Naphthalene	C	$3.4x10^{-5}$	Respiratory	$3.0x10^{-3}$
Nickel	A	$1.6x10^{-4}$	Respiratory, Immune	$6.5x10^{-5}$
Propionaldehyde	N/A	N/A	N/A	N/A
POM1	B2	$5.5x10^{-5}$		N/A
POM2	B2	$5.5x10^{-5}$		N/A
POM3	B2	$1.0x10^{-1}$		N/A
POM4	B2	$1.0x10^{-2}$		N/A
POM5	B2	$1.0x10^{-3}$		N/A
POM6	B2	$1.0x10^{-4}$		N/A
POM7	B2	$1.0x10^{-5}$		N/A
POM8	B2	$2.0x10^{-4}$		N/A
Styrene		N/A	Neurological	1.0
Toluene		N/A	Respiratory, Neurological	$4.0x10^{-1}$
Xylenes		N/A	Neurological	$1.0x10^{-1}$

URE and Rfc estimates were obtained from hazard and dose-response information that EPA's Office of Air Quality Planning and Standards posts on the internet ("OAQPS Toxicity Values") at the following link: www.epa.gov/ttn/fera. This information is updated as new data become available; the version of the table used for this paper is the same as used for the 1999 NATA (U. S. EPA, 2005d).

Prior to computing risks, the HAPEM results from run1 and run2 were combined into a single data set containing the major, area & other, onroad gasoline, onroad diesel, nonroad gasoline, nonroad other, background, and total (all sources) exposure concentrations for each census tract. For each modeling year, each HAP was contained in its own dataset.

In that the 1999 NATA approach involved the use of ACCESS to store exposure results and compute risks, and the MSAT approach involved the use of a series of SAS® programs, quality assurance was performed on the SAS® programs to ensure the same results were obtained as would have been under the ACCESS approach.

8.1 Cancer risk calculations

To calculate cancer risks and summary statistics for 1999, 2015, 2020, and 2030, the HAPEM concentrations for each HAP were multiplied by the corresponding URE for the HAP. This was done for each source sector (and background) in each census tract to produce tract-level, source sector level cancer risks. Appendix D (D.1) provides the programming steps.

After calculating the risks, the tract level risks for each HAP, risk for each carcinogen class, and risk across all HAPs were summarized at the same levels as done for the ASPEN and HAPEM5 outputs. Once statistics were calculated for each year and level (county, state, etc.) they were merged together. Maps of county median risk were generated for several HAPs and total risk. The total risk map for 2015 is shown in Figure 18. Table 37 lists national and stationary and mobile risks for the cancer risk HAPs, carcinogen class, and total risk across all HAPs.

More detailed summaries can be found in the MSAT rule docket: EPA-HQ-OAR-2005-0036 in the excel file named hapem_risks.xls. County median risk maps are also in the docket; the file name is: risk_030305.ppt.

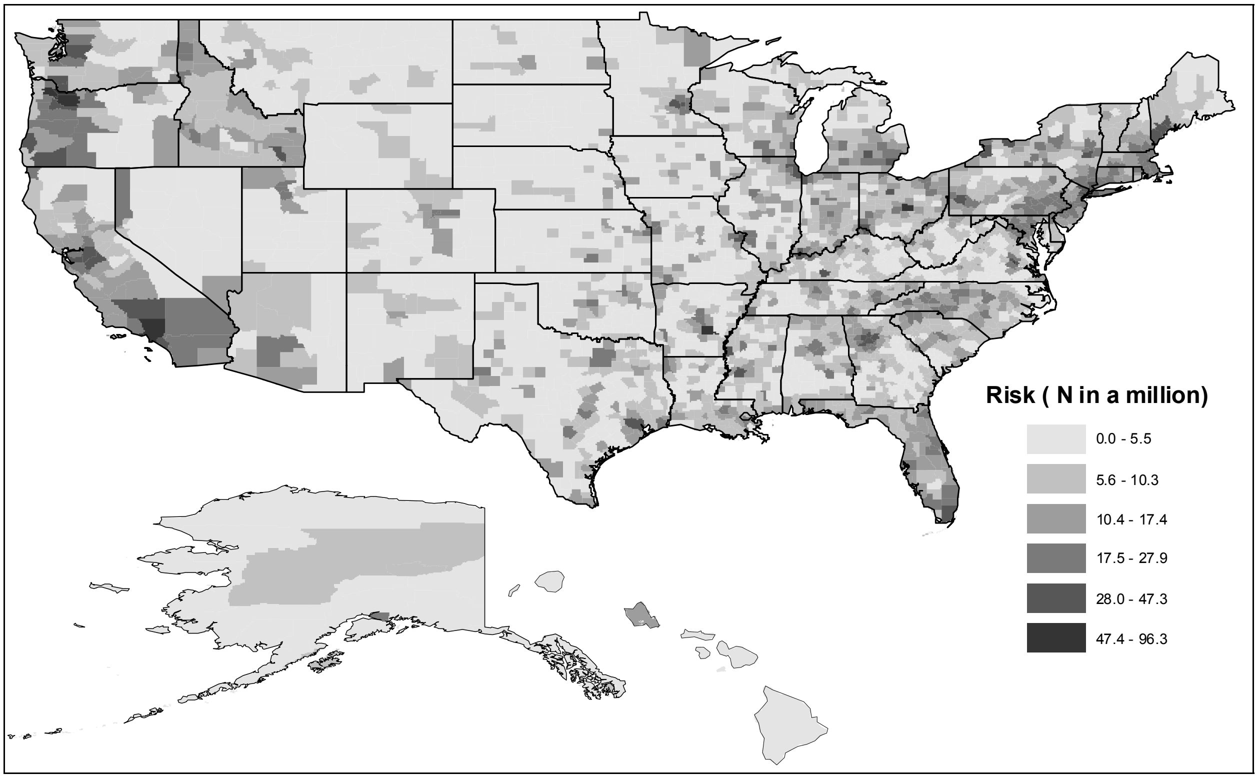

Figure 18. County median total inhalation cancer risks for all MSAT HAPs for 2015. Risk is characterized as N in a million.

Table 37. National average inhalation cancer risks for stationary and mobile sources for MSAT HAPs, each carcinogenic class and total risk (all MSAT HAPs).

HAP	Carcinogen Class	2015		2020		2030	
		stationary	mobile	stationary	mobile	stationary	mobile
1,3-Butadiene	A	5.73×10^{-7}	8.30×10^{-7}	5.76×10^{-7}	8.03×10^{-7}	5.76×10^{-7}	8.82×10^{-7}
Benzene	A	1.38×10^{-6}	2.76×10^{-6}	1.45×10^{-6}	2.57×10^{-6}	1.45×10^{-6}	2.75×10^{-6}
Chromium VI	A	2.01×10^{-6}	3.24×10^{-7}	2.28×10^{-6}	3.56×10^{-7}	2.28×10^{-6}	4.29×10^{-7}
Nickel	A	1.64×10^{-7}	2.17×10^{-8}	1.80×10^{-7}	2.37×10^{-8}	1.80×10^{-7}	2.83×10^{-8}
Class A	**A**	$\mathbf{4.14\times10^{-6}}$	$\mathbf{3.94\times10^{-6}}$	$\mathbf{4.48\times10^{-6}}$	$\mathbf{3.75\times10^{-6}}$	$\mathbf{4.48\times10^{-6}}$	$\mathbf{4.09\times10^{-6}}$
Formaldehyde	B1	7.01×10^{-10}	1.79×10^{-9}	7.57×10^{-10}	1.73×10^{-9}	7.57×10^{-10}	1.87×10^{-9}
Class B1	**B1**	$\mathbf{7.01\times10^{-10}}$	$\mathbf{1.79\times10^{-9}}$	$\mathbf{7.57\times10^{-10}}$	$\mathbf{1.73\times10^{-9}}$	$\mathbf{7.57\times10^{-10}}$	$\mathbf{1.87\times10^{-9}}$
Acetaldehyde	B2	1.63×10^{-7}	8.45×10^{-7}	1.68×10^{-7}	7.64×10^{-7}	1.68×10^{-7}	8.08×10^{-7}
POM	B2	1.31×10^{-6}	7.29×10^{-8}	1.36×10^{-6}	7.44×10^{-8}	1.36×10^{-6}	8.51×10^{-8}
Class B2	**B2**	$\mathbf{1.47\times10^{-6}}$	$\mathbf{9.18\times10^{-7}}$	$\mathbf{1.53\times10^{-6}}$	$\mathbf{8.38\times10^{-7}}$	$\mathbf{1.53\times10^{-6}}$	$\mathbf{8.931\times10^{-7}}$
Naphthalene	C	1.79×10^{-6}	4.57×10^{-7}	1.91×10^{-6}	4.63×10^{-7}	1.91×10^{-6}	6.35×10^{-7}
Class C	**C**	$\mathbf{1.79\times10^{-6}}$	$\mathbf{4.57\times10^{-7}}$	$\mathbf{1.91\times10^{-6}}$	$\mathbf{4.63\times10^{-7}}$	$\mathbf{1.91\times10^{-6}}$	$\mathbf{6.35\times10^{-7}}$
Total Risk	**All**	$\mathbf{7.39\times10^{-6}}$	$\mathbf{5.31\times10^{-6}}$	$\mathbf{7.92\times10^{-6}}$	$\mathbf{5.05\times10^{-6}}$	$\mathbf{7.92\times10^{-6}}$	$\mathbf{5.52\times10^{-6}}$

8.2 Non-cancer risk calculations

Tract level non-cancer hazard quotients (HQ) for each HAP were calculated by dividing, for each HAP and each source sector, the exposure concentration by the Rfc. A hazard index was computed for each organ system by summing the HQs over all HAPs that share the same target organ system.   Appendix D (D.2) describes the programming steps.

The tract level HQ and HI estimates for each HAP and organ system respectively, were summarized at the same levels as done for the ASPEN and HAPEM5 outputs. Once statistics were calculated for each year and level (county, state, etc.) they were merged together. Maps of county median HQ for several HAPs and respiratory HI were generated. The respiratory system HI map for 2015 is shown in Figure 19. Table 38 lists national and stationary and mobile HI for the non-cancer HAPs, and the organ systems affected by the MSAT HAPs.

More detailed summaries can be found in the MSAT rule docket: EPA-HQ-OAR-2005-0036 in the excel file named hapem_hq.xls. County median non-cancer risk maps are also in the docket; the file name is hq_030305.ppt.

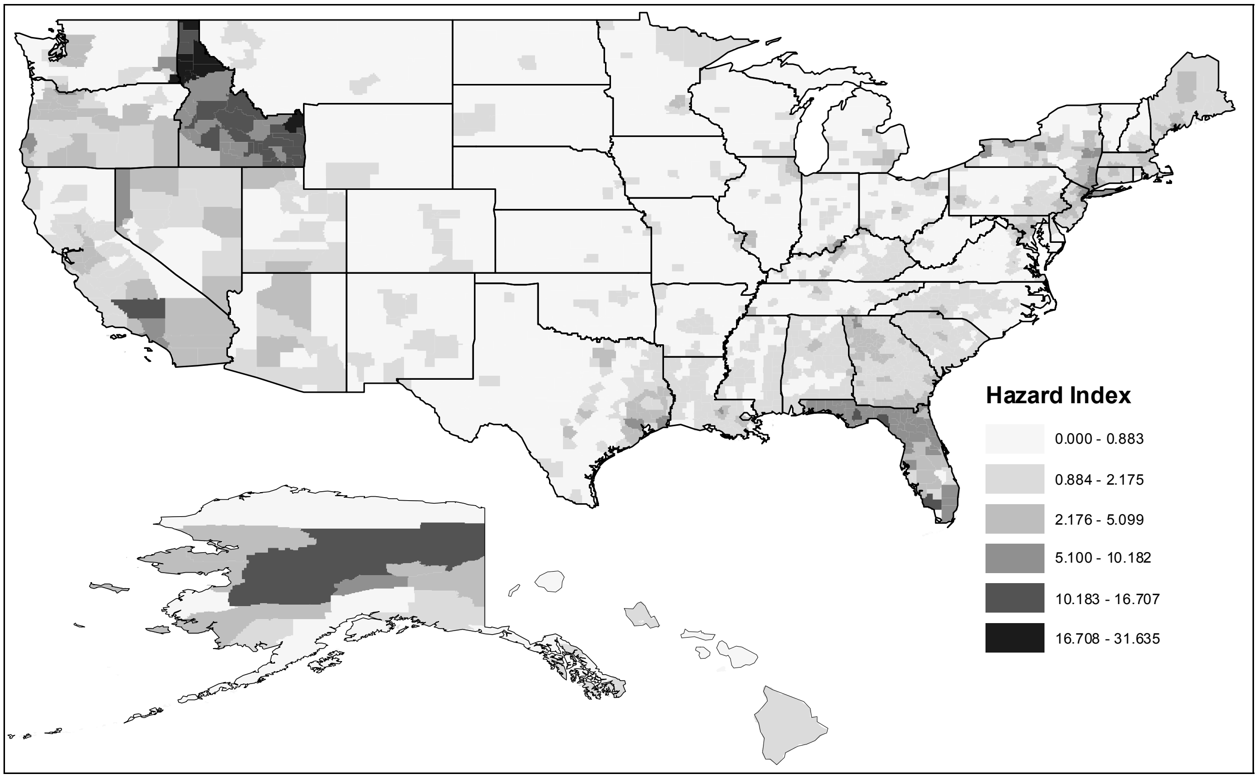

Figure 19. County median total (all sources) non-cancer hazard index for MSAT HAPs affecting the respiratory system.

Table 38. National average non-cancer hazard quotient (HQ) for MSAT HAPs and hazard index (HI) for organ systems for stationary and mobile sources.

HAP	2015		2020		2030	
	stationary	mobile	stationary	mobile	stationary	mobile
1,3-Butadiene	9.55×10^{-3}	1.38×10^{-2}	9.60×10^{-3}	1.39×10^{-2}	9.60×10^{-3}	1.47×10^{-2}
Acetaldehyde	8.22×10^{-3}	4.27×10^{-2}	8.47×10^{-3}	3.86×10^{-2}	8.47×10^{-3}	4.08×10^{-2}
Acrolein	1.27	1.70	1.25	1.67	1.25	1.84
Benzene	5.92×10^{-3}	1.18×10^{-2}	6.19×10^{-3}	1.10×10^{-2}	6.19×10^{-3}	1.18×10^{-2}
Chromium VI	1.68×10^{-3}	2.70×10^{-4}	1.90×10^{-3}	2.97×10^{-4}	1.90×10^{-3}	3.57×10^{-4}
Ethyl Benzene	1.08×10^{-4}	1.44×10^{-4}	1.19×10^{-4}	1.32×10^{-4}	1.19×10^{-4}	1.41×10^{-4}
Formaldehyde	1.30×10^{-2}	3.32×10^{-2}	1.40×10^{-2}	3.19×10^{-2}	1.40×10^{-2}	3.47×10^{-2}
Hexane	2.56×10^{-3}	7.52×10^{-4}	2.77×10^{-3}	6.51×10^{-4}	2.77×10^{-3}	6.80×10^{-4}
MTBE	1.98×10^{-5}	4.67×10^{-5}	2.09×10^{-5}	3.82×10^{-5}	2.09×10^{-5}	3.80×10^{-5}
Manganese	4.95×10^{-2}	2.46×10^{-3}	5.48×10^{-2}	2.77×10^{-3}	5.48×10^{-2}	3.47×10^{-3}
Naphthalene	1.75×10^{-2}	4.48×10^{-3}	1.87×10^{-2}	4.54×10^{-3}	1.87×10^{-2}	5.24×10^{-3}
Nickel	1.58×10^{-2}	2.08×10^{-3}	1.73×10^{-2}	2.28×10^{-3}	1.73×10^{-2}	2.72×10^{-3}
Styrene	4.09×10^{-5}	1.36×10^{-5}	4.61×10^{-5}	1.30×10^{-5}	4.61×10^{-5}	1.42×10^{-5}
Toluene	2.58×10^{-3}	2.01×10^{-3}	2.84×10^{-3}	1.84×10^{-3}	2.84×10^{-3}	1.96×10^{-3}
Xylenes	7.52×10^{-3}	5.61×10^{-3}	8.31×10^{-3}	5.20×10^{-3}	8.31×10^{-3}	5.59×10^{-3}
Organ Systems	**2015**		**2020**		**2030**	
	stationary	**mobile**	**stationary**	**mobile**	**stationary**	**mobile**
Developmental	1.08×10^{-4}	1.44×10^{-4}	1.19×10^{-4}	1.32×10^{-4}	1.19×10^{-4}	1.41×10^{-4}
Immunological	2.17×10^{-2}	1.39×10^{-2}	2.35×10^{-2}	1.32×10^{-2}	2.35×10^{-2}	1.45×10^{-2}
Kidney	1.98×10^{-5}	4.67×10^{-5}	2.09×10^{-5}	3.82×10^{-5}	2.09×10^{-5}	3.80×10^{-5}
Liver	1.98×10^{-5}	4.67×10^{-5}	2.09×10^{-5}	3.82×10^{-5}	2.09×10^{-5}	3.80×10^{-5}
Neurological	6.22×10^{-2}	1.09×10^{-2}	6.87×10^{-2}	1.05×10^{-2}	6.87×10^{-2}	1.17×10^{-2}
Ocular	1.98×10^{-5}	4.67×10^{-5}	2.09×10^{-5}	3.82×10^{-5}	2.09×10^{-5}	3.80×10^{-5}
Reproductive	9.55×10^{-3}	1.38×10^{-2}	9.60×10^{-3}	1.39×10^{-2}	9.60×10^{-3}	1.47×10^{-2}
Respiratory	1.33	1.79	1.31	1.75	1.31	1.93

8.3 Cancer and non-cancer risk population statistics using 2000 and projected population

Tract level population and risks were used to develop population statistics for base and future years. We used the same county-level projected population data as is used in BenMAP (Abt, 2005) for 2015, 2020, and 2030, which originated from Woods and Poole (www.woodsandpoole.com). The projected population data was for the contiguous 48 states, not Alaska and Hawaii. Therefore, the statistics were for the contiguous 48 state region.

Also, populations statistics were calculated using 2000 census population for all years' future year risks. Following is the methodology used for the population statistic calculations.

8.3.1 Allocation of future county level populations to tract level

As previously noted, the projected populations for 2015, 2020, and 2030 were at the county level. Since the calculated risks and non-cancer HQ or HI estimates were at tract level, the county level future year populations were allocated to the tracts using the 2000 census based tract-level to county-level population ratio (this is also spatial surrogate code 100 [population] used by EMS-HAP Version 3.0). Each tract's ratio was applied to the county's projected population to calculate a future year's tract population. For example, for Wake County, NC (FIPS=37183), the 2000 county population was 627,846. The 2000 population of tract 050100 was 1,847, resulting in a ratio of 0.003. The projected 2015 population of Wake County was 867,680.75. Applying the 2000 population ratio to the 2015 county population resulted in a projected tract population of 2,552.55. This was done for each tract in the 48 contiguous U.S. states.

8.3.2 Population statistic calculations for cancer risk

Once the 2015, 2020, and 2030 populations had been allocated to tract level, the populations were then merged by FIPS and tract with the tract level total risk (across all MSAT HAPs) estimates. Next, for each year and source sector, population totals were calculated based on three risk benchmark values: $1\text{x}10^{-4}$, $1\text{x}10^{-5}$, and $1\text{x}10^{-6}$.

For example, for major source total risk for 2015, each tract level major risk was checked to see how it compared to the three values listed above. The following formulas show the checks and the population calculations:

If tract major source total risk $\geq 10^{-4}$ then

$$major\_4 = major\_4 + pop_{tract} \tag{11}$$

If tract major source total risk $\geq 10^{-5}$ then

$$major\_5 = major\_5 + pop_{tract} \tag{12}$$

If tract major source total risk $\geq 10^{-6}$ then

$$major\_6 = major\_6 + pop_{tract} \tag{13}$$

If tract major source total risk $< 10^{-6}$ then

$$major\_7 = major\_7 + pop_{tract} \tag{14}$$

where major_4, major_5, major_6, and major_7 are the running totals and pop_{tract} is the tract population for 2015. Note, initially, before any checks of the tracts, major_4, major_5, major_6, and major_7 are initialized to zero.

From the logic, a tract's 2015 population was added to each major_4, major_5, and major_6. For example if the major source risk was 1.1 then the tract's population was added to major_4, major_5, and major_6. After all tracts in the contiguous 48 states had been checked, each running total represented a national population affected by each of the three risk classes listed. These populations were then binned so that they became mutually exclusive, i.e., no overlap, and were plotted on charts or summarized. The following formulas were used to bin the populations:

For population affected by risk $\geq 10^{-5}$ but $< 10^{-4}$

$$major\_5a = major\_5 - major\_4 \tag{15}$$

For population affected by risk ≥ 10^{-6} but < 10^{-5}

$$major\_6a = major\_6 - major\_5 \qquad (16)$$

where major_5a is the population affected by risk ≥ 10^{-5} but < 10^{-4} and major_6a is the population affected by risk ≥ 10^{-6} but < 10^{-5}. Note that major_4 and major_7 do not need to be modified.

The steps described in this section were performed for each source sector, major, area & other, onroad gasoline, onroad diesel, total onroad, nonroad gasoline, non-gasoline nonroad, total nonroad, background, and total risk (all source sectors). Table 39 shows the results for onroad nonroad for 1999, 2015, 2020, and 2030. Note that Alaska and Hawaii populations are not included.

Table 39. Population risk classes for mobile total risk for 2015, 2020, and 2030 using projected populations for each year.

Source Category	Population Class	Populations			
		Year			
		1999	2015	2020	2030
Onroad	Risk ≥ 10^{-4}	208,150	0	0	0
	10^{-5} ≤ Risk <10^{-4}	112,848,474	19,596,469	16,703,891	21,839,016
	10^{-6} ≤ Risk <10^{-5}	145,060,999	241,185,986	249,373,492	269,464,226
	Risk <10^{-6}	21,465,809	56,122,217	63,615,359	64,592,322
	Total Population	**279,583,432**	**316,904,672**	**329,692,742**	**355,895,564**
Nonroad	Risk ≥ 10^{-4}	22,272	23,710	25,123	27,986
	10^{-5} ≤ Risk <10^{-4}	2,630,188	1,365,537	1,584,116	2,215,401
	10^{-6} ≤ Risk <10^{-5}	180,439,149	150,013,784	159,142,708	18,553,8098
	Risk <10^{-6}	96,491,823	165,501,640	168,940,795	168,114,078
	Total Population	**279,583,432**	**316,904,672**	**329,692,742**	**355,895,564**

8.3.3 Population statistic calculations for non-cancer respiratory hazard index

A similar procedure was used for the respiratory system hazard index. The threshold HI values used for binning purposes were 10, 1, and 0.1. As described above, each respiratory HI for each source sector and year were compared against these values and a running total kept for three populations. For example for 2015 for major source HI values, the following conditions and equations are used:

If tract major source respiratory HI ≥ 10 then

$$major\_10 = major\_10 + pop_{tract} \qquad (17)$$

If tract major source respiratory HI ≥ 1 then

$$major\_1 = major\_1 + pop_{tract} \qquad (18)$$

If tract major source respiratory HI ≥ 0.1 then

$$major\_01 = major\_01 + pop_{tract} \quad (19)$$

If tract major source respiratory HI < 0.1 then

$$major\_0 = major\_0 + pop_{tract} \quad (20)$$

where major_10, major_1, major_01, and major_0 are the running totals and pop_{tract} is the tract population for 2015. Note, initially the four running totals are set to zero before any checks.

As with the risk calculations, from the logic, a tract's 2015 population can be added to each major_10, major_1, and major_01. For example if the major source respiratory HI was 11 then the tract's population would be added to major_10, major_1, and major_01. After all tracts in the contiguous 48 states have been checked, each running total represented a national population affected by each of the three HI classes listed. These populations were then binned so that they become mutually exclusive, i.e., no overlap. The following formulas were used to bin the populations:

For population affected by HI ≥ 1 but < 10

$$major\_1a = major\_1 - major\_10 \quad (21)$$

For population affected by HI ≥ 0.1 but < 1

$$major\_01a = major\_01 - major\_1 \quad (22)$$

where major_1a is the population affected by HI ≥ 1 but < 10 and major_01a is the population affected by HI ≥ 0.1 but < 1. Major_10 and major_0 were not modified.

The steps described in this section were performed for each source sector, major, area & other, onroad gasoline, onroad diesel, total onroad, nonroad gasoline, non-gasoline nonroad, total nonroad, background, and total HI (all source sectors). Table 40 shows the results for onroad nonroad for 1999, 2015, 2020, and 2030. Note that Alaska and Hawaii populations are not included.

Table 40. Population respiratory HI classes for mobile sources for 2015, 2020, and 2030 using projected populations for each year.

Source Category	Population Class	Populations Year 1999	2015	2020	2030
Onroad	HI ≥ 10	17,567,623	37,998	16,297	30,134
	1 ≤ HI < 10	200,171,904	114,954,321	105,041,326	121,633,149
	0.1 ≤ HI <1	58,288,431	184,163,448	204,853,751	214,512,775
	HI < 0.1	3,555,474	17,748,905	19,781,369	19,719,506
	Total Population	**279,583,432**	**316,904,672**	**329,692,742**	**355,895,564**
Nonroad	HI ≥ 10	1,116,086	1,280,756	1,449,660	1,989,107
	1 ≤ HI < 10	85,670,356	65,585,394	70,546,734	85,032,069
	0.1 ≤ HI <1	161,073,537	189,650,787	192,548,911	202,958,366
	HI < 0.1	31,723,453	60,387,735	65,147,437	65,916,022
	Total Population	**279,583,432**	**316,904,672**	**329,692,742**	**355,895,564**

8.3.4 Population statistic calculations using 2000 population for all years

A similar program as described above was used to calculate populations using the 2000 census population for all years. Basically the 2015, 2020, and 2030 projected populations were replaced with the year 2000 population. Population statistics calculated using 2000 population for all years allowed the differences in risks or HI to be evaluated separately from changes in population.

Detailed summaries of population statistics for 2000 and projected year populations can be found in the MSAT rule docket: EPA-HQ-OAR-2005-0036 in the excel files pop_stats_risks.xls and pop_stats_hi_respiratory.xls, for cancer and non-cancer respiratory risks, respectively.

9. Background concentration sensitivity analysis

For the air quality modeling, background concentrations that were added to the ASPEN-modeled concentrations for subsequent HAPEM modeling (Section 7) and risk calculations (Section 8) were assumed to remain the same across the modeled future years, 2015, 2020, and 2030. The values used were the same background values used for the 1999 NATA background concentrations. The background concentrations were at the county level so for a given HAP with a background value, all tracts in a county received the same background. Details about the development of the 1999 background concentrations can be found in Batelle (2003).

Because background concentrations added are assumed to account for medium-to-long range transport of emissions, it is expected that they would decrease or increase as emissions increased or decreased. A sensitivity analysis to determine the potential magnitude of such background concentration changes was made for 1,3-butadiene, acetaldehyde, benzene, formaldehyde, and xylenes for the following years: 2015, 2020, and 2030. The sensitivity analysis included adjusting the 1999 background concentrations using the change in emissions between 1999 and these future years. Following is the methodology and results of the analysis.

For each county in the U.S. (excluding Puerto Rico and Virgin Islands), the emissions from all sources in the county were summed together for each year, 1999, 2015, 2020 and 2030. Next, the emissions for that county and the surrounding counties whose county centroids (supplied from the EMS-HAP ancillary file cty_cntr99.sas7bdat, found in the MSAT rule docket EPA-HQ-OAR-2005-0036) were within 300 km of the county were summed together for each year, resulting in emission totals for 1999, 2015, 2020, and 2030. These summed emissions were assigned to the county being analyzed. After summation, for each year, 2015, 2020, and 2030, the emissions were divided by the 1999 emissions to create a scaling factor to multiply with the 1999 background concentration.

As an example, consider Wake County, NC (FIPS=37183). Figure 20 shows the 209 counties (including Wake County) whose centroids are within 300 km of Wake County’s centroid. These counties cover most of North Carolina with some in Virginia and South Carolina. The total benzene emissions for 1999, 2015, 2020, and 2030 can be seen in Table 41. The ratio to apply to the 1999 background was calculated by dividing the future year's emissions (2015, 2020, or 2030) by the 1999 emissions. This ratio was then applied to the 1999 background, and the new scaled background was added to the total model concentrations at each tract. Table 41 also shows the scaled backgrounds used for 2015, 2020, and 2030 for benzene.

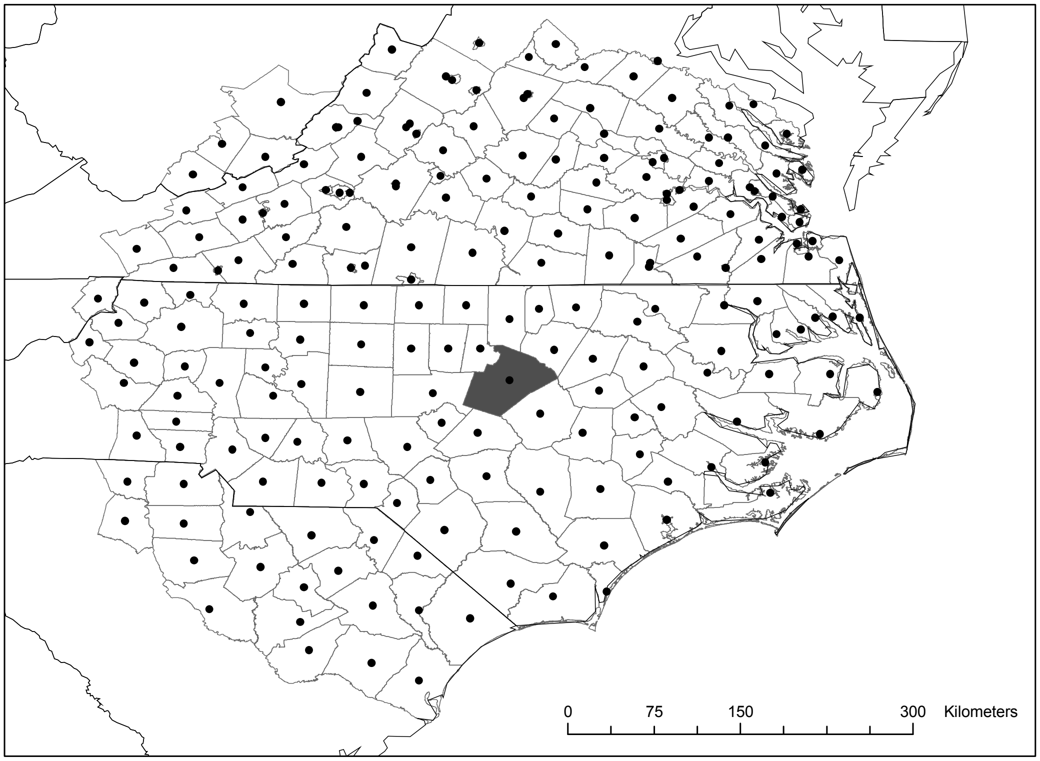

Figure 20. Counties within 300 km of the centroid of Wake County, North Carolina (county in gray). Dots represent county centroids.

Table 41. Total benzene emissions of counties within 300 km of Wake County, NC for 1999, 2015, 2020 and 2030, 1999 background benzene concentration for Wake County, and scaled background concentrations for Wake County for 2015, 2020, and 2030.

Year	Emissions (tons)	Emissions Ratios (Future year/1999)	Background Concentration (μg m^{-3}) (1999 background × Ratio)
1999	15,692.404	1	0.403794
2015	9,364.748	0.59677	0.242117
2020	9,225.224	0.58788	0.238277
2030	9,552.035	0.608704	0.246566

Table 42 shows national average background concentrations for 1999 and future years. Table 43 shows total concentrations (all sources plus background) using both the 1999 background for each year and using the scaled background for each year for the five HAPs studied in the analysis. The analysis showed how much the scaling affected background concentrations but also showed how little background changed between 2015, 2020, and 2030. This can be seen both for one county in Table 41 and for the whole country in Table 42. In Figure 21, the changes for the benzene background between the four years can be seen. The 1999 background concentrations are generally higher than 2015, 2020, and 2030. One outcome of the analysis was a change in spatial variability of background for xylenes. For 1999, the entire country received the same background for xylenes (0.17 μg m^{-3}). Scaling background by emissions created a spatial variability of xylenes background (Figure 22).

Detailed summaries of scaled background concentrations for the five HAPs summaries can be found in the MSAT rule docket: EPA-HQ-OAR-2005-0036 in the excel file named background_test.xls with maps for the HAPs in background_acetaldehyde_0111.ppt, background_butadiene_0111.ppt, background_test_0111.ppt (for benzene), background_formaldehyde_0111.ppt, and background_xylenes_0111.ppt.

Table 42. National average 1999 background and scaled backgrounds for 1,3-butadiene, acetaldehyde, benzene, formaldehyde, and xylenes.

HAP	Background concentrations (μg m^{-3})			
	1999	2015	2020	2030
1,3-Butadiene	5.12×10^{-2}	2.86×10^{-2}	2.83×10^{-2}	2.95×10^{-2}
Acetaldehyde	5.17×10^{-1}	3.29×10^{-1}	3.28×10^{-1}	3.36×10^{-1}
Benzene	3.94×10^{-1}	2.38×10^{-1}	2.32×10^{-1}	2.40×10^{-1}
Formaldehyde	7.62×10^{-1}	4.96×10^{-1}	5.05×10^{-1}	5.21×10^{-1}
Xylenes	1.70×10^{-1}	1.15×10^{-1}	1.17×10^{-1}	1.20×10^{-1}

Table 43. National average total concentrations (all sources and background) for 2015, 2020, and 2030 using both the 1999 background and the scaled backgrounds.

HAP	Total concentrations (μg m^{-3}) using 1999 background			Total concentrations (μg m^{-3}) using scaled background concentrations		
	2015	2020	2030	2015	2020	2030
1,3-Butadiene	9.81×10^{-2}	9.77×10^{-2}	1.00×10^{-1}	7.58×10^{-2}	7.50×10^{-2}	7.86×10^{-2}
Acetaldehyde	9.66×10^{-1}	9.36×10^{-1}	9.56×10^{-1}	7.77×10^{-1}	7.47×10^{-1}	7.78×10^{-1}
Benzene	9.13×10^{-1}	9.02×10^{-1}	9.24×10^{-1}	7.57×10^{-1}	7.40×10^{-1}	7.71×10^{-1}
Formaldehyde	1.22	1.22	1.25	9.57×10^{-1}	9.68×10^{-1}	1.01
Xylenes	1.55	1.61	1.65	1.50	1.56	1.60

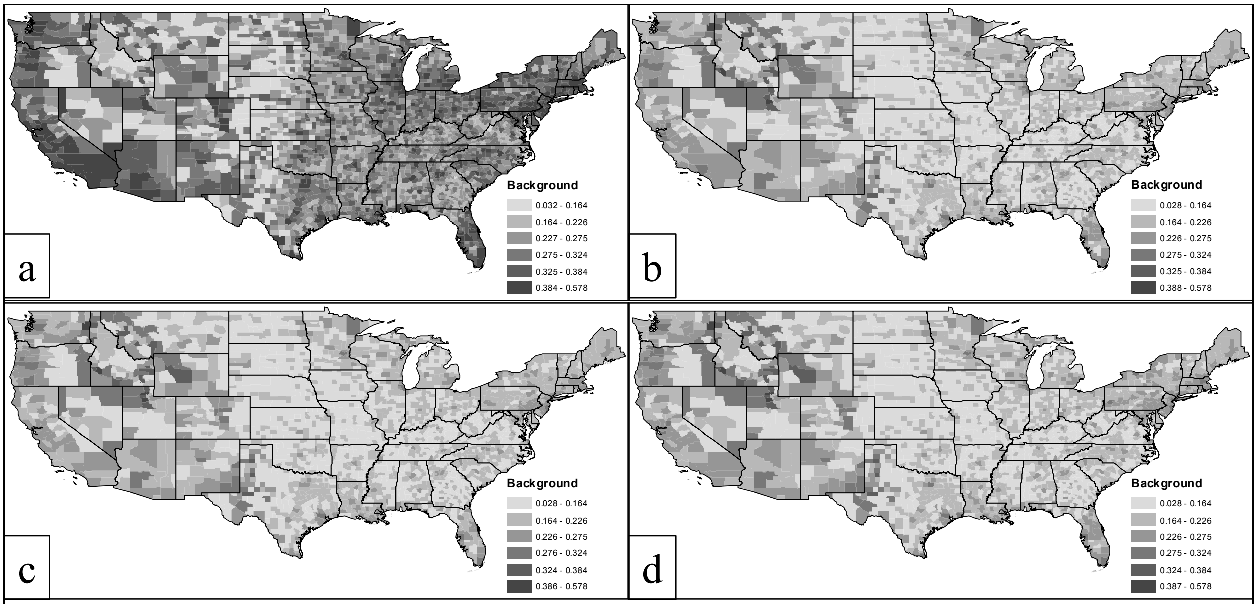

Figure 21. Benzene background concentrations (µg m^{-3}) for a) 1999 background, b) 2015 scaled background c) 2020 scaled background and d) 2030 scaled background.

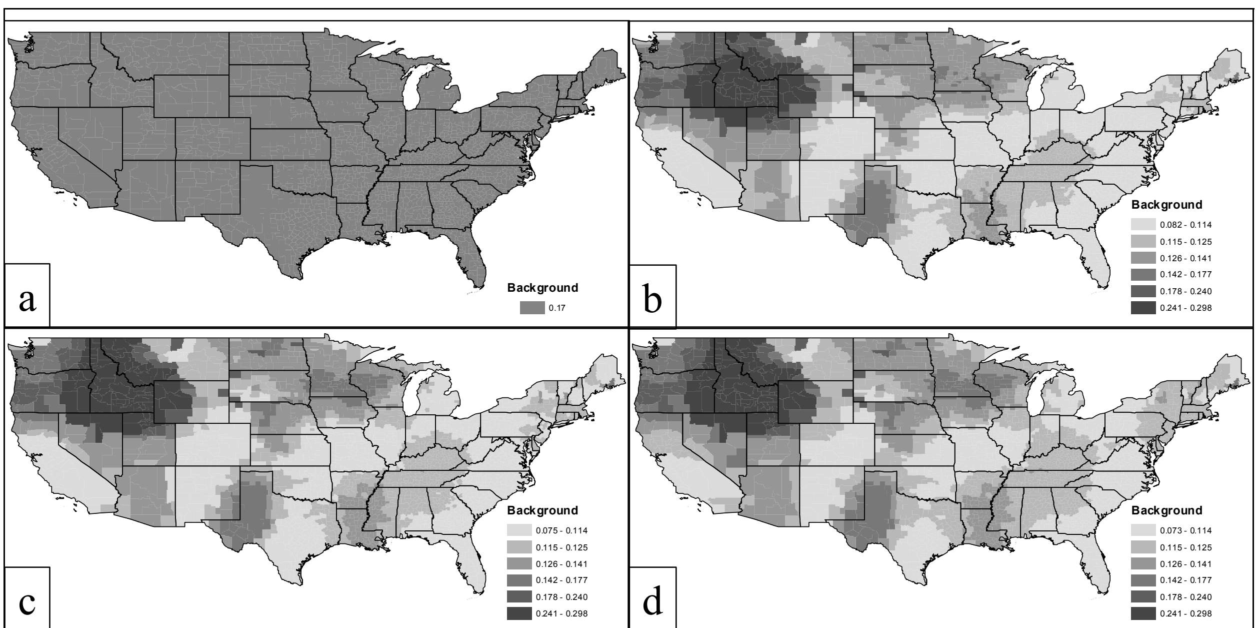

Figure 22. Xylenes background concentrations (µg m^{-3}) for a) 1999 background, b) 2015 scaled background c) 2020 scaled background and d) 2030 scaled background.

While background scaling did not change background concentrations much between 2015, 2020, and 2030, concentrations did differ between the three future years and 1999. Scaling the background using the projected emissions can add a spatial variation to background concentration.

10. Benzene Control Scenario

This section details the methodology used to develop the controlled inventories for 2015, 2020 and 2030 for benzene, formaldehyde, acetaldehyde, acrolein, and 1,3-butadiene as part of the benzene control scenario. Controls were applied to gasoline marketing and distribution emissions, onroad gasoline refueling emissions, onroad gasoline emissions, and nonroad gasoline emissions.

10.1 Stationary gasoline distribution and vehicle gasoline refueling inventory

For the stationary inventories, controls were applied to benzene emissions only for gasoline marketing and distribution and onroad gasoline refueling for 2015 and 2020. For 2030, these emissions (along with all other stationary source emissions for the reference case) were set equal to 2020 emissions. Table 44 lists the gasoline distribution SCC codes contained in the reference case inventories, for which controlled emissions were estimated. Onroad gasoline refueling SCC codes can be found in Table 23.

Gasoline marketing and distribution emissions were estimated for the control scenario by applying a county specific control ratio based on the change in average fuel benzene level for the control and reference case. Average fuel benzene level for the control case was determined from refinery modeling done for the rule. As part of the refinery modeling, average fuel properties for each Petroleum Administration for Defense District (PADD) under the new standards were estimated. Average fuel benzene levels for conventional gasoline (CG) and reformulated gasoline (RFG) in each PADD before and after implementation of the proposed standards were used to develop multiplicative factors. These multiplicative factors were used as control ratios for estimating the controlled gasoline marketing and distribution emissions. They were also applied to the reference case fuel benzene levels for each county in the NMIM database to use for generating the NMIM controlled case emissions, which were used to develop control inventories for the other categories discussed in this section.

The multiplicative factors (control ratios for gasoline marketing and distribution emissions) are shown in Table 45. Although California is part of PADD5, it was treated separately since California has its own reformulated gasoline program. PADD regions are shown in Figure 23.

To apply the control ratios to the gasoline marketing and distribution SCCs, it was necessary to distinguish between the counties in each PADD using RFG versus CG. Figure 24 shows which counties are RFG counties.

Onroad gasoline refueling emissions were estimated for the control scenario by calculating a county specific ratio of control to reference case NMIM refueling emissions for benzene for 2015, 2020 and 2030. NMIM was rerun for refueling emissions for the control case with revised gasoline input parameters as described in 10.2.

Appendix E describes the steps used to develop the controlled benzene emissions for gasoline marketing and distribution and onroad gasoline refueling. Sample calculations are also provided.

Table 44. Benzene gasoline marketing and distribution SCC codes to be controlled.

SCC	Description	SCC	Description
2501000000	Storage and Transport; Petroleum and Petroleum Product Storage; All Storage Types: Breathing Loss; Total: All Products	2501050120	Storage and Transport; Petroleum and Petroleum Product Storage; Bulk Stations/Terminals: Breathing Loss; Gasoline
2501060050	Storage and Transport; Petroleum and Petroleum Product Storage; Gasoline Service Stations; Stage 1: Total	2501060051	Storage and Transport; Petroleum and Petroleum Product Storage; Gasoline Service Stations; Stage 1: Submerged Filling
2501060052	Storage and Transport; Petroleum and Petroleum Product Storage; Gasoline Service Stations; Stage 1: Splash Filling	2501060053	Storage and Transport; Petroleum and Petroleum Product Storage; Gasoline Service Stations; Stage 1: Balanced Submerged Filling
2501060200	Storage and Transport; Petroleum and Petroleum Product Storage; Gasoline Service Stations; Underground Tank: Total	2501060201	Storage and Transport; Petroleum and Petroleum Product Storage; Gasoline Service Stations; Underground Tank: Breathing and Emptying
2501080000	Aviation Gasoline Distribution: Stage 1 & II	2501080050	Aviation Gasoline Storage -Stage I
2501080100	Aviation Gasoline Storage -Stage II	2501995120	Storage and Transport; Petroleum and Petroleum Product Storage; All Storage Types: Working Loss; Gasoline
2505000000	Storage and Transport; Petroleum and Petroleum Product Transport; All Transport Types; Total: All Products	2505000120	Storage and Transport; Petroleum and Petroleum Product Transport; All Transport Types; Gasoline
2505010000	Storage and Transport; Petroleum and Petroleum Product Transport; Rail Tank Car; Total: All Products	2505020000	Storage and Transport; Petroleum and Petroleum Product Transport; Marine Vessel; Total: All Products
2505020120	Storage and Transport; Petroleum and Petroleum Product Transport; Marine Vessel; Gasoline	2505020121	Marine Vessel Operations - Barge Handling of Gasoline
2505030120	Storage and Transport; Petroleum and Petroleum Product Transport; Truck; Gasoline	40400101	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13: Breathing Loss (67000 Bbl Capacity) - Fixed Roof Tank
40400102	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 10: Breathing Loss (67000 Bbl Capacity) - Fixed Roof Tank	40400103	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 7: Breathing Loss (67000 Bbl. Capacity) - Fixed Roof Tank
40400104	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13: Breathing Loss (250000 Bbl Capacity)-Fixed Roof Tank	40400105	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 10: Breathing Loss (250000 Bbl Capacity)-Fixed Roof Tank
40400106	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 7: Breathing Loss (250000 Bbl Capacity) - Fixed Roof Tank	40400107	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13: Working Loss (Diam. Independent) - Fixed Roof Tank
40400108	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 10: Working Loss (Diameter Independent) - Fixed Roof Tank	40400109	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 7: Working Loss (Diameter Independent) - Fixed Roof Tank

Table 44. Continued.

SCC	Description	SCC	Description
40400110	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13: Standing Loss (67000 Bbl Capacity)-Floating Roof Tank	40400111	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 10: Standing Loss (67000 Bbl Capacity)-Floating Roof Tank
40400112	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 7: Standing Loss (67000 Bbl Capacity)- Floating Roof Tank	40400113	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13: Standing Loss (250000 Bbl Cap.) - Floating Roof Tank
40400114	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 10: Standing Loss (250000 Bbl Cap.) - Floating Roof Tank	40400115	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 7: Standing Loss (250000 Bbl Cap.) - Floating Roof Tank
40400116	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13/10/7: Withdrawal Loss (67000 Bbl Cap.) - Float Rf Tnk	40400117	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13/10/7: Withdrawal Loss (250000 Bbl Cap.) - Float Rf Tnk
40400118	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13: Filling Loss (10500 Bbl Cap.) - Variable Vapor Space	40400119	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 10: Filling Loss (10500 Bbl Cap.) - Variable Vapor Space
40400120	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 7: Filling Loss (10500 Bbl Cap.) - Variable Vapor Space	40400131	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13: Standing Loss - Ext. Floating Roof w/ Primary Seal
40400132	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 10: Standing Loss - Ext. Floating Roof w/ Primary Seal	40400141	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13: Standing Loss - Ext. Floating Roof w/ Secondary Seal
40400142	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 10: Standing Loss - Ext. Floating Roof w/ Secondary Seal	40400143	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 7: Standing Loss - Ext. Floating Roof w/ Secondary Seal
40400148	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13/10/7: Withdrawal Loss - Ext. Float Roof (Pri/Sec Seal)	40400150	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Miscellaneous Losses/Leaks: Loading Racks
40400151	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Valves, Flanges, and Pumps	40400152	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Vapor Collection Losses
40400153	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Vapor Control Unit Losses	40400154	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Tank Truck Vapor Leaks
40400161	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13: Standing Loss - Int. Floating Roof w/ Primary Seal	40400162	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 10: Standing Loss - Int. Floating Roof w/ Primary Seal

Table 44. Continued.

SCC	Description	SCC	Description
40400163	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 7: Standing Loss - Internal Floating Roof w/ Primary Seal	40400171	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13: Standing Loss - Int. Floating Roof w/ Secondary Seal
40400172	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 10: Standing Loss - Int. Floating Roof w/ Secondary Seal	40400173	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 7: Standing Loss - Int. Floating Roof w/ Secondary Seal
40400178	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13/10/7: Withdrawal Loss - Int. Float Roof (Pri/Sec Seal)	40400201	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 13: Breathing Loss (67000 Bbl Capacity) - Fixed Roof Tank
40400202	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 10: Breathing Loss (67000 Bbl Capacity) - Fixed Roof Tank	40400203	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 7: Breathing Loss (67000 Bbl. Capacity) - Fixed Roof Tank
40400204	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 13: Working Loss (67000 Bbl. Capacity) - Fixed Roof Tank	40400205	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 10: Working Loss (67000 Bbl. Capacity) - Fixed Roof Tank
40400206	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 7: Working Loss (67000 Bbl. Capacity) - Fixed Roof Tank	40400207	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 13: Standing Loss (67000 Bbl Cap.) - Floating Roof Tank
40400208	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 10: Standing Loss (67000 Bbl Cap.) - Floating Roof Tank	40400209	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 7: Standing Loss (67000 Bbl Cap.) - Floating Roof Tank
40400210	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 13/10/7: Withdrawal Loss (67000 Bbl Cap.) - Float Rf Tnk	40400212	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 10: Filling Loss (10500 Bbl Cap.) - Variable Vapor Space
40400213	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 7: Filling Loss (10500 Bbl Cap.) - Variable Vapor Space	40400231	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 13: Standing Loss - Ext. Floating Roof w/ Primary Seal
40400241	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 13: Standing Loss - Ext. Floating Roof w/ Secondary Seal	40400242	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 10: Standing Loss - Ext. Floating Roof w/ Secondary Seal
40400250	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Loading Racks	40400251	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Valves, Flanges, and Pumps
40400252	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Miscellaneous Losses/Leaks: Vapor Collection Losses	40400253	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Miscellaneous Losses/Leaks: Vapor Control Unit Losses

Table 44. Continued.

SCC	Description	SCC	Description
40400254	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Tank Truck Vapor Losses	40400261	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 13: Standing Loss - Int. Floating Roof w/ Primary Seal
40400262	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 10: Standing Loss - Int. Floating Roof w/ Primary Seal	40400263	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 7: Standing Loss - Internal Floating Roof w/ Primary Seal
40400278	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 10/13/7: Withdrawal Loss - Int. Float Roof (Pri/Sec Seal)	40400401	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Petroleum Products - Underground Tanks; Gasoline RVP 13: Breathing Loss
40400402	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Petroleum Products - Underground Tanks; Gasoline RVP 13: Working Loss	40400403	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Petroleum Products - Underground Tanks; Gasoline RVP 10: Breathing Loss
40400404	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Petroleum Products - Underground Tanks; Gasoline RVP 10: Working Loss	40400405	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Petroleum Products - Underground Tanks; Gasoline RVP 7: Breathing Loss
40400406	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Petroleum Products - Underground Tanks; Gasoline RVP 7: Working Loss	40400497	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Petroleum Products - Underground Tanks; Specify Liquid: Breathing Loss
40400498	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Petroleum Products - Underground Tanks; Specify Liquid: Working Loss	406001	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Tank Cars and Trucks
40600101	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Tank Cars and Trucks; Gasoline: Splash Loading **	40600126	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Tank Cars and Trucks; Gasoline: Submerged Loading **
40600131	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Tank Cars and Trucks; Gasoline: Submerged Loading (Normal Service)	40600136	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Tank Cars and Trucks; Gasoline: Splash Loading (Normal Service)
40600141	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Tank Cars and Trucks; Gasoline: Submerged Loading (Balanced Service)	40600144	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Tank Cars and Trucks; Gasoline: Splash Loading (Balanced Service)
40600147	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Tank Cars and Trucks; Gasoline: Submerged Loading (Clean Tanks)	40600162	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Tank Cars and Trucks; Gasoline: Loaded with Fuel (Transit Losses)
40600163	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Tank Cars and Trucks; Gasoline: Return with Vapor (Transit Losses)	406002	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels

Table 44. Continued.

SCC	Description	SCC	Description
40600231	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Gasoline: Ship Loading - Cleaned and Vapor Free Tanks	40600232	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Gasoline: Ocean Barges Loading
40600233	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Gasoline: Barge Loading - Cleaned and Vapor Free Tanks	40600234	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Gasoline: Ship Loading - Ballasted Tank
40600236	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Gasoline: Ship Loading - Uncleaned Tanks	40600237	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Gasoline: Ocean Barges Loading - Uncleaned Tanks
40600238	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Gasoline: Barges Loading - Uncleaned Tanks	40600239	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Gasoline: Tanker Ship - Ballasted Tank Condition
40600240	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Gasoline: Barge Loading - Average Tank Condition	40600241	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Gasoline: Tanker Ship - Ballasting
40600242	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Gasoline: Transit Loss	40600301	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Gasoline Retail Operations - Stage I; Splash Filling
40600302	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Gasoline Retail Operations - Stage I; Submerged Filling w/o Controls	40600305	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Gasoline Retail Operations - Stage I; Unloading **
40600306	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Gasoline Retail Operations - Stage I; Balanced Submerged Filling	40600307	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Gasoline Retail Operations - Stage I; Underground Tank Breathing and Emptying
40600399	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Gasoline Retail Operations - Stage I; Not Classified **	40600706	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Consumer (Corporate) Fleet Refueling - Stage I; Balanced Submerged Filling
40600707	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Consumer (Corporate) Fleet Refueling - Stage I; Underground Tank Breathing and Emptying	40688801	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Fugitive Emissions; Specify in Comments Field
40688802	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Fugitive Emissions; Specify in Comments Field		

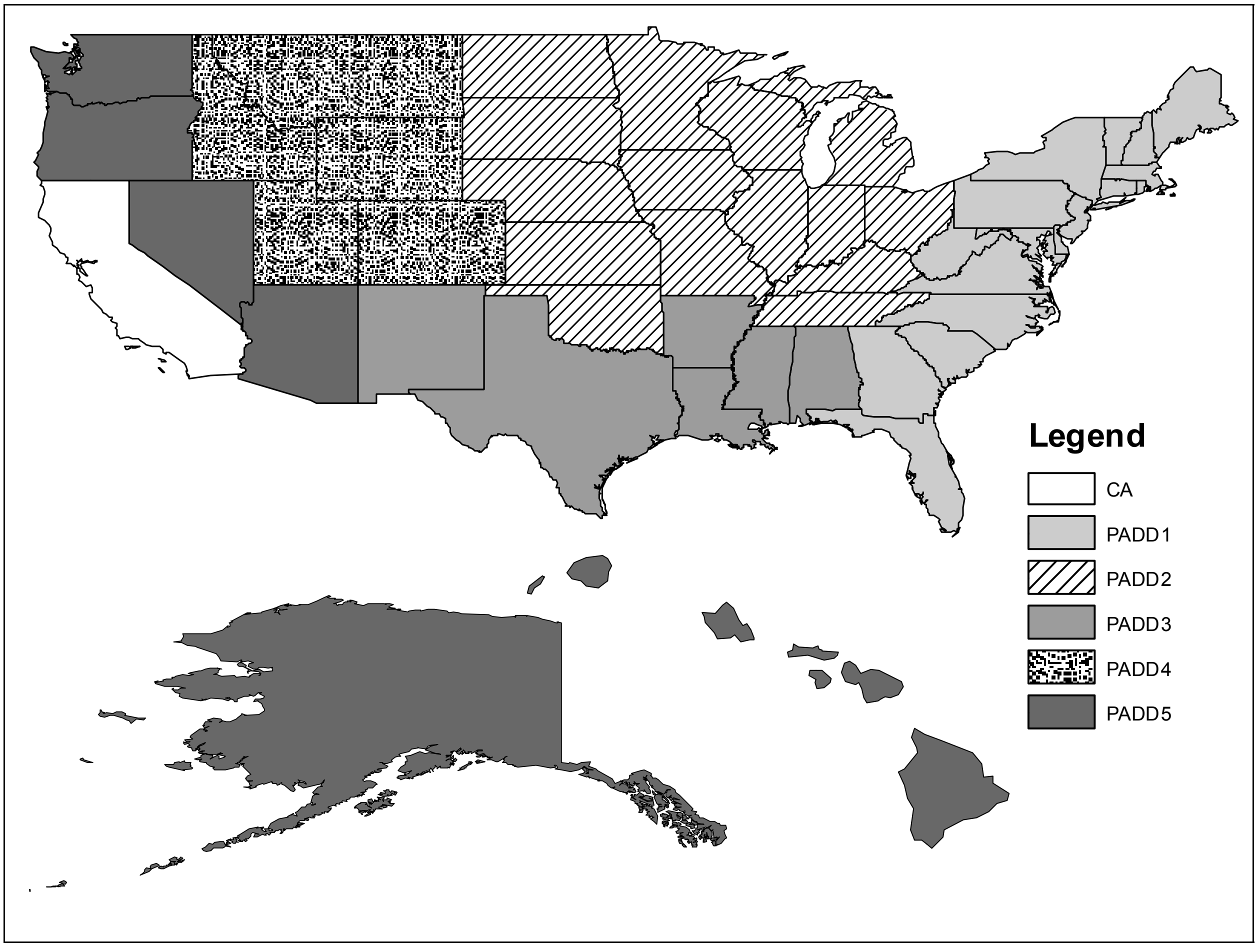

Figure 23. PADD regions for the U.S.

Figure 24. RFG counties (dark gray) for the U.S.

Table 45. Change in Average Fuel Benzene Level (Volume Percent) by PADD with Implementation of Proposed Fuel Benzene Standard (CG – Conventional Gasoline; RFG – Reformulated Gasoline).

	Gasoline Type	Region					
		PADD 1	PADD 2	PADD 3	PADD 4	PADD 5	Calif.
Reference Case	CG	0.91 %	1.26%	0.95%	1.47%	1.42%	0.62%
	RFG	0.59%	0.80%	0.57%	1.05%	0.65%	0.62%
Control Case	CG	0.55%	0.68%	0.54%	0.93%	0.85%	0.61%
	RFG	0.54%	0.71%	0.55%	0.62%	0.60%	0.61%
Multiplicative Factor	CG	0.60	0.54	0.57	0.63	0.60	0.98
	RFG	0.92	0.89	0.96	0.59	0.92	0.98

Table 46 shows the reference (no controls) and controlled stationary benzene emissions after applying the controls to 2015 and 2020 emissions by SCC. Detailed summaries can be found in benzene_gas_scc.xls in the MSAT rule docket EPA-HQ-OAR-2005-0036

Table 46. Benzene stationary emissions (tons) before and after applying controls to reference case gasoline marketing and distribution emissions (non refueling gasoline) and vehicle refueling emissions. Also shown are the percent differences (control-reference). 1999 NEI emissions are shown for comparison.

Emissions type	SCC codes	1999	2015			2020		
			Reference	Control	% Diff.	Reference	Cont rol	% Diff.
All storage types and all products: total breathing loss	2501000000	8	12	7	-40	14	8	-10
Bulk stations/terminals: gasoline breathing loss: gasoline	2501050120	1,535	1,579	952	-40	1,593	960	-40
Stage 1 Filling	2501060050, 2501060051, 2501060052, 2501060053	1,785	1,826	1,176	-36	1,835	1,182	-36
Underground Tanks: Gasoline Service	2501060200, 2501060201	86	88	62	-25	88	62	-30
Aviation gasoline distribution	2501080050, 2501080000, 2501080100	307	327	226	-31	340	236	-31
Transport	2501995120, 2505000000, 2505000120, 2505010000, 2505020000, 2505020120, 2505020121, 2505030120	915	1,110	908	-18	1,198	983	-18
Bulk terminals	40400101, 40400102, 40400103, 40400104, 40400105, 40400106, 40400107, 40400108, 40400109, 40400110, 40400111, 40400112, 40400113, 40400114, 40400115, 40400116, 40400117, 40400118, 40400119, 40400120, 40400131, 40400132, 40400141, 40400142, 40400143, 40400148, 40400150, 40400151, 40400152, 40400153, 40400154, 40400161, 40400162, 40400163, 40400171, 40400172, 40400173, 40400178	69	107	71	-33	120	80	-33
Bulk plants	40400201, 40400202, 40400203, 40400204, 40400205, 40400206, 40400207, 40400208, 40400209, 40400210, 40400212, 40400213, 40400231, 40400241, 40400242, 40400250, 40400251, 40400252, 40400253, 40400254, 40400261, 40400262, 40400263, 40400278,	40	61	41	-32	68	46	-32
Underground tanks	40400401, 40400402, 40400403, 40400404, 40400405, 40400406, 40400497, 40400498	3	4	3	-23	5	4	-23

Table 46. Continued.

Emissions type	SCC codes	1999	2015			2020		
			Reference	Control	% Diff.	Reference	Control	% Diff.
Tank cars and trucks	406001, 40600101, 40600126, 40600131, 40600136, 40600141, 40600144, 40600147, 40600162, 40600163	149	192	127	-34	217	143	-34
Marine vessels	406002, 40600231, 40600232, 40600233, 40600234, 40600236, 40600237, 40600238, 40600239, 40600240, 40600241, 40600242	17	24	17	-30	27	19	-30
Stage 1 Evaporation Retail	40600301, 40600302, 40600305, 40600306, 40600307, 40600399	22	35	22	-37	40	25	-37
Stage 1 Evaporation Fleet	40600706, 40600707, 40688801, 40688802	35	54	49	-10	61	55	-9
Total non refueling gasoline		**4,970**	**5,419**	**3,663**	**-32**	**5,606**	**3,804**	**-32**
Vehicle refueling		**1,566**	**724**	**459**	**-37**	**720**	**459**	**-36**
Other stationary sources		**104,645**	**114,186**	**114,186**	**0**	**117,470**	**117,470**	**0**
Total		**111,181**	**120,329**	**118,308**	**-2**	**123,796**	**121,732**	**-2**

10.2 Highway gasoline vehicle inventory

To develop the highway vehicle inventories, NMIM was rerun for the controlled case, using revised gasoline fuel parameter inputs for fuel benzene and aromatics levels. The revised fuel benzene inputs were described in Section 10.1 (see Table 45). The refinery modeling also indicated that the reduction in fuel benzene levels would result in small decreases in aromatics levels as well. Thus, aromatics levels were adjusted using the additive factors calculated as follows:

$$\text{Additive Factor} = 0.7*(\text{Benzene}_{\text{control}} - \text{Benzene}_{\text{reference}}) \quad (23)$$

A pollutant, county and SCC specific projection factor was computed from the controlled and reference case NMIM- based emissions as follows:

$$PF_{20XX} = \frac{E_{NMIMcontrol,20XX}}{E_{NMIMreference,20XX}} \quad (24)$$

This factor was then applied to the reference case inventories for 2015, 2020 and 2030, at the county and SCC and pollutant level, for the 1,3-butadiene, benzene, acetaldehyde, acrolein, and formaldehyde.

Details on the computation of the projection factor and the application to the reference case inventories are provided in Appendix F. Sample calculations are also provided. Summaries are shown in Table 47. The complete summaries can be found in onroad_controls.xls or onroad_controls_pivot.xls in the MSAT rule docket, EPA-HQ-OAR-2005-0036.

Table 47. National MSAT reference and controlled emissions (nearest ton) for gasoline powered vehicles by HAP for 2015, 2020, and 2030.

Vehicle	HAP	2015 emissions		2020 emissions		2030 emissions	
		Base	Controlled	Base	Controlled	Base	Controlled
HDGV	1,3-Butadiene	130	130	103	103	84	84
	Acetaldehyde	297	297	245	245	209	209
	Acrolein	25	25	18	18	12	12
	Benzene	2,152	1,890	1,760	1,557	1,539	1,359
	Formaldehyde	741	741	599	599	498	498
LDGT1	1,3-Butadiene	2,307	2,312	2,291	2,297	2,447	2,453
	Acetaldehyde	2,714	2,721	2,682	2,690	2,899	2,907
	Acrolein	306	306	302	302	326	326
	Benzene	23,835	21,060	23,346	20,700	24,856	22,116
	Formaldehyde	5,572	5,591	5,516	5,534	5,975	5,994
LDGT2	1,3-Butadiene	1,524	1,528	1,503	1,506	1,486	1,489
	Acetaldehyde	1,789	1,793	1,726	1,730	1,710	1,714
	Acrolein	198	198	191	191	188	188
	Benzene	15,694	13,940	14,897	13,329	14,505	13,060
	Formaldehyde	3,628	3,639	3,513	3,524	3,509	3,519
LDGV	1,3-Butadiene	1,895	1,899	1,500	1,503	1,614	1,618
	Acetaldehyde	2,123	2,130	1,690	1,695	1,831	1,837
	Acrolein	251	251	199	199	215	215
	Benzene	19,835	17,424	15,643	13,794	16,895	14,914
	Formaldehyde	4,628	4,643	3,705	3,717	4,028	4,041
MC	1,3-Butadiene	266	266	288	288	350	350
	Acetaldehyde	233	233	253	253	309	309
	Acrolein	22	22	24	24	29	29
	Benzene	892	770	967	835	1,177	1,017
	Formaldehyde	693	693	751	751	912	912

HDGV: Heavy Duty Gasoline Vehicles
LDGT1: Light Duty Gasoline Trucks 1
LDGT2: Light Duty Gasoline Trucks 2
LDGV: Light Duty Gasoline Vehicles
MC: Motorcycles

10.3 Nonroad gasoline inventory

The approach used to compute controlled inventories for 2015, 2020 and 2030 for all nonroad gasoline source categories (excluding planes, trains and ships) was to use projection factors based on NMIM results for the controlled case and reference case, and apply them to the reference inventories.

Exhaust and evaporative projection factors for each year, 2015, 2020, and 2030 were obtained from the NMIM light duty gasoline vehicle reference and control case inventories. We assumed that changes in county level exhaust emissions of nonroad gasoline equipment were proportional to changes in highway light duty gasoline vehicle exhaust emissions, and changes in county level evaporative emissions of nonroad gasoline equipment were proportional to changes in highway light duty gasoline vehicle evaporative (refueling and non-refueling) emissions:

$$PF\ nonroad\ exhaust_{20XX} = \frac{E_{LDGVexhaust\ NMIM\ Control\ 20XX}}{E_{LDGVExhaust\ NMIM\ Reference\ 20XX}} \tag{25}$$

$$PF\ nonroad\ evap_{20XX} = \frac{E_{LDGVevap\ NMIMControl20XX}}{E_{LDGVEvap\ NMIMReference20XX}} \tag{26}$$

The steps taken to compute the projection factors, along with example calculations, are shown in Appendix G.

Once the projection factors were developed, the reference case nonroad emissions were projected using the factors. For benzene, the reference MSAT emissions were broken out by exhaust and evaporative emissions in NMIM, with each type being multiplied by the appropriate projection factor, exhaust or evaporative. For the other HAPs, the exhaust projection factor was applied to the reference MSAT emissions, with no exhaust or evaporative breakout of the emissions because those HAPs did not have an evaporative component.

Appendix G describes the steps taken to develop of the controlled nonroad gasoline emissions. Example calculations are also provided.

Table 48 summarizes the 2-stroke and 4-stroke emissions for the reference and controlled case inventories for 2015, 2020, and 2030. Complete nonroad summaries, including emissions not affected by the controls for the five HAPs are in nonroad_controls.xls and nonroad_pivot_controls.xls in the MSAT rule docket EPA-HQ-OAR-2005-0036.

Table 48. 2015, 2020, and 2030 reference and controlled emissions for the five HAPS for nonroad gasoline categories.

Engine	HAP	2015 emissions		2020 emissions		2030 emissions	
		Reference	Controlled	Reference	Controlled	Reference	Controlled
2-stroke	1,3-Butadiene	1,847	1,852	1,604	1,608	1,595	1,599
	Acetaldehyde	1,467	1,471	1,293	1,297	1,296	1,300
	Acrolein	344	344	292	292	291	291
	Benzene	18,582	16,295	16,287	14,198	16,457	14,311
	Formaldehyde	3,928	3,942	3,415	3,427	3,414	3,426
	5 HAP total	26,168	23,904	22,890	20,821	23,054	20,927
4-stroke	1,3-Butadiene	3,224	3,231	3,379	3,386	3,805	3,814
	Acetaldehyde	2,196	2,201	2,265	2,271	2,511	2,517
	Acrolein	289	289	300	300	334	334
	Benzene	19,165	16,852	20,153	17,820	22,705	20,089
	Formaldehyde	5,495	5,510	5,688	5,704	6,326	6,344
	5 HAP total	30,368	28,183	31,784	29,480	35,682	33,098

10.4 EMS-HAP Processing

EMS-HAP processing for stationary sources followed that as described in Section 5.1 for point sources and 5.2 for non-point sources. For onroad emissions, processing followed that as described in Section 5.3, while the nonroad processing followed that as described in Section 5.4.2 for airport support equipment and Section 5.4.3 for remaining nonroad emissions. Aircraft emissions were unaffected, and EMS-HAP was not rerun. Note that the point, non-point, onroad, airport support equipment, and remaining nonroad emissions (no aircraft) contained only the five HAPS being emphasized. The aircraft emissions files input into ASPEN contained other HAPs.

10.5 ASPEN Processing and Post-Processing

ASPEN processing followed that as described in Section 6.1. For the stationary sources, only benzene was modeled for the controlled case, as that was the only HAP affected by the benzene control scenario as described in Section 10.1. For the mobile sources, 1,3-butadiene, benzene, acetaldehyde, acrolein, and formaldehyde were modeled.

ASPEN post-processing followed that as described in Section 6.3, using the same "run1" and "run2" file organization as described in that section. For the creation of the HAPEM input files, only the run1 file was affected since it contains the stationary, onroad gasoline, and nonroad gasoline concentrations. The run2 files contain the onroad diesel and non-gasoline nonroad concentrations and zeros for major, area & other, and background. The non-gasoline mobile concentrations were unaffected by the controls on the emissions; thus, the run2 files did not need to be rerun through HAPEM.

Table 49 presents the national average 1999 and projected reference and controlled stationary source concentrations for benzene.

Table 49. National average 1999 and future year reference and controlled benzene stationary concentrations.

Year	Concentration Type	Benzene Concentrations (µg m^{-3})	
		Major	Area & other
1999	Base	2.24×10^{-2}	1.63×10^{-1}
2015	Reference	1.60×10^{-2}	1.88×10^{-1}
	Controlled	1.58×10^{-2}	1.81×10^{-1}
2020	Reference	1.75×10^{-2}	1.95×10^{-1}
	Controlled	1.73×10^{-2}	1.88×10^{-1}

Tables 50 and 51 present the national average reference and controlled concentrations for onroad gasoline and nonroad gasoline, respectively.

Table 50. National average reference and controlled onroad gasoline concentrations for the five HAPs for 2015, 2020, and 2030.

HAP	Onroad Gasoline Concentrations (µg m^{-3})					
	2015		2020		2030	
	Reference	Controlled	Reference	Controlled	Reference	Controlled
1,3-Butadiene	1.33×10^{-2}	1.33×10^{-2}	1.22×10^{-2}	1.22×10^{-2}	1.31×10^{-2}	1.31×10^{-2}
Acetaldehyde	2.38×10^{-1}	2.38×10^{-1}	2.05×10^{-1}	2.05×10^{-1}	2.13×10^{-1}	2.13×10^{-1}
Acrolein	1.44×10^{-2}	1.44×10^{-2}	1.31×10^{-2}	1.31×10^{-2}	1.41×10^{-2}	1.41×10^{-2}
Benzene	2.21×10^{-1}	2.00×10^{-1}	1.98×10^{-1}	1.80×10^{-1}	2.09×10^{-1}	1.91×10^{-1}
Formaldehyde	1.12×10^{-1}	1.12×10^{-1}	1.01×10^{-1}	1.01×10^{-1}	1.08×10^{-1}	1.08×10^{-1}

Table 51. National average reference and controlled nonroad gasoline concentrations for the five HAPs for 2015, 2020, and 2030.

HAP	Nonroad Gasoline Concentrations (µg m^{-3})					
	2015		2020		2030	
	Reference	Controlled	Reference	Controlled	Reference	Controlled
1,3-Butadiene	7.44×10^{-3}	7.45×10^{-3}	7.87×10^{-3}	7.88×10^{-3}	9.01×10^{-3}	9.02×10^{-3}
Acetaldehyde	4.89×10^{-2}	4.89×10^{-2}	4.97×10^{-2}	4.97×10^{-2}	5.53×10^{-2}	5.54×10^{-2}
Acrolein	5.37×10^{-3}	5.37×10^{-3}	5.53×10^{-3}	5.53×10^{-3}	6.18×10^{-3}	6.19×10^{-3}
Benzene	7.40×10^{-2}	6.76×10^{-2}	7.68×10^{-2}	7.00×10^{-2}	8.67×10^{-2}	7.91×10^{-2}
Formaldehyde	5.31×10^{-2}	5.31×10^{-2}	5.55×10^{-2}	5.56×10^{-2}	6.29×10^{-2}	6.30×10^{-2}

More detailed summaries can be found in the MSAT rule docket EPA-HQ-OAR-2005-0036 in the excel file named aspen_conc_control.xls. County median concentration maps are also in the docket; the file name is: ASPEN_median_cntrl.ppt.

10.6 HAPEM Processing and Post-Processing

HAPEM runs were made for 2015, 2020, and 2030 for the five HAPs modeled in the control case. Only the run1 file was needed, since it contained the stationary and the mobile gasoline ASPEN concentrations and background concentrations. Run2 files contained zeros for stationary and background and the non-gasoline nonroad concentrations and onroad diesel concentrations.

After the HAPEM runs, summaries were calculated for the five HAPs. Due to the adjustment to exposure concentrations in HAPEM (documented in Section 7) by the median total concentration at each tract, the stationary source concentrations of 1,3-butadiene, acetaldehyde, acrolein, and formaldehyde stationary concentrations were different from the reference case, even though the stationary input concentrations into HAPEM were unchanged. This is because they were contained in the run1 file along with the onroad and nonroad gasoline concentrations, which did change. Since the control case does not impact the stationary source contribution for these HAPs, we replaced the HAPEM control case concentrations for these four HAPs with the reference case concentrations. This was not done for benzene, since stationary concentrations were expected to change resulting from the changes to the stationary benzene gasoline inventory described in Section 10.1.

Table 52 presents the national average 1999 and projected reference and controlled stationary source concentrations for benzene.

Table 52. National average 1999 and future reference and controlled benzene HAPEM stationary concentrations.

Year	Concentration Type	Benzene Concentrations (μg m^{-3})	
		Major	Area & other
1999	Base	$1.88x10^{-2}$	$1.42x10^{-1}$
2015	Reference	$1.35x10^{-2}$	$1.64x10^{-1}$
	Controlled	$1.34x10^{-2}$	$1.58x10^{-1}$
2020	Reference	$1.48x10^{-2}$	$1.71x10^{-1}$
	Controlled	$1.47x10^{-2}$	$1.65x10^{-1}$

Tables 53 and 54 present the national average reference and controlled concentrations for the five modeled HAPs for onroad gasoline and nonroad gasoline, respectively.

More detailed summaries can be found in the MSAT rule docket EPA-HQ-OAR-2005-0036. in the excel file named hapem_concentrations_cntrl.xls. County median concentration maps are also in the docket; the file name is: HAPEM_median_cntrl.ppt.

Table 53. National average reference and controlled HAPEM onroad gasoline concentrations for the five HAPs for 2015, 2020, and 2030.

HAP	Onroad Gasoline Concentrations (μg m^{-3})					
	2015		2020		2030	
	Reference	**Controlled**	Reference	**Controlled**	Reference	**Controlled**
1,3-Butadiene	$1.68x10^{-2}$	$1.68x10^{-2}$	$1.54x10^{-2}$	$1.54x10^{-2}$	$1.65x10^{-2}$	$1.65x10^{-2}$
Acetaldehyde	$2.73x10^{-1}$	$2.73x10^{-1}$	$2.35x10^{-1}$	$2.35x10^{-1}$	$2.44x10^{-1}$	$2.44x10^{-1}$
Acrolein	$1.65x10^{-2}$	$1.66x10^{-2}$	$1.51x10^{-2}$	$1.51x10^{-2}$	$1.61x10^{-2}$	$1.62x10^{-2}$
Benzene	$2.66x10^{-1}$	$2.41x10^{-1}$	$2.38x10^{-1}$	$2.17x10^{-1}$	$2.51x10^{-1}$	$2.30x10^{-1}$
Formaldehyde	$1.40x10^{-1}$	$1.40x10^{-1}$	$1.26x10^{-1}$	$1.27x10^{-1}$	$1.35x10^{-1}$	$1.35x10^{-1}$

Table 54. National average reference and controlled HAPEM nonroad gasoline concentrations for the five HAPs for 2015, 2020, and 2030.

HAP	Nonroad Gasoline Concentrations (μg m^{-3})					
	2015		2020		2030	
	Reference	**Controlled**	Reference	**Controlled**	Reference	**Controlled**
1,3-Butadiene	$7.28x10^{-3}$	$7.29x10^{-3}$	$7.73x10^{-3}$	$7.75x10^{-3}$	$8.88x10^{-3}$	$8.89x10^{-3}$
Acetaldehyde	$4.26x10^{-2}$	$4.26x10^{-2}$	$4.35x10^{-2}$	$4.36x10^{-2}$	$4.86x10^{-2}$	$4.86x10^{-2}$
Acrolein	$4.67x10^{-3}$	$4.68x10^{-3}$	$4.82x10^{-3}$	$4.82x10^{-3}$	$5.40x10^{-3}$	$5.40x10^{-3}$
Benzene	$6.86x10^{-2}$	$6.28x10^{-2}$	$7.15x10^{-2}$	$6.54x10^{-2}$	$8.11x10^{-2}$	$7.42x10^{-2}$
Formaldehyde	$4.73x10^{-2}$	$4.74x10^{-2}$	$4.96x10^{-2}$	$4.96x10^{-2}$	$5.63x10^{-2}$	$5.63x10^{-2}$

10.7 Cancer and Non-cancer Calculations

The cancer and non-cancer risk calculations followed the same general methodology as discussed in Section 8 with some minor differences in that HAP specific calculations were made for only the five HAPs being modeled. When calculating total risk or organ specific non-cancer estimates, MSAT results for the other MSAT HAPs were used. Following are the results of the calculations.

10.7.1 Cancer

Cancer risk estimates for 1,3-butadiene, acetaldehyde, benzene, and formaldehyde were calculated based on the controlled HAPEM results. Total risks (across all MSAT HAPs) and risks by carcinogen classes were also recalculated using the newly calculated risks for the four above HAPs and the other carcinogenic MSAT HAPs reference case MSAT risks.

Table 55 lists the stationary risks for benzene, MSAT HAPs in carcinogen class A (benzene's carcinogen class), and total risk from MSAT HAPs. Table 56 lists the onroad gasoline risks for 1,3-butadiene, acetaldehyde, benzene, formaldehyde and MSAT HAPs in carcinogenic classes A, B, B2 and total MSAT HAP risk. Table 57 lists the nonroad gasoline risks for the same HAPs, carcinogen classes, and total risk.

More detailed summaries can be found in the MSAT rule docket EPA-HQ-OAR-2005-0036 in the excel file named hapem_risks_control.xls. County median risk maps are also in the docket; the file name is: risk_cntrll.ppt.

Table 55. National average risks from stationary sources for 1999 and future year reference and controlled benzene, carcinogen class A, and total (all MSAT HAPs).

Year	Risk Type	Stationary Risks					
		Benzene		Carcinogen Class A		Total Risk (All HAPs)	
		Major	Area & other	Major	Area & other	Major	Area & other
1999	Base	1.47E-07	1.11E-06	7.71E-07	2.70E-06	1.14E-06	5.19E-06
2015	Reference	1.05E-07	1.28E-06	8.85E-07	3.25E-06	1.20E-06	6.19E-06
	Controlled	1.04E-07	1.23E-06	8.85E-07	3.20E-06	1.20E-06	6.15E-06
2020	Reference	1.15E-07	1.33E-06	9.98E-07	3.49E-06	1.34E-06	6.57E-06
	Controlled	1.14E-07	1.28E-06	9.97E-07	3.44E-06	1.34E-06	6.53E-06

Table 56. Reference and controlled HAPEM onroad gasoline risks for 2015, 2020, and 2030 for individual HAPs and carcinogen classes A, B1, and B2 and total risk (all MSAT HAPs, including HAPs not controlled).

HAP	Onroad Gasoline Risks					
	2015		2020		2030	
	Reference	Controlled	Reference	Controlled	Reference	Controlled
1,3-Butadiene	$5.04x10^{-7}$	$5.05x10^{-7}$	$4.62x10^{-7}$	$4.63x10^{-7}$	$4.94x10^{-7}$	$4.94x10^{-7}$
Acetaldehyde	$6.00x10^{-7}$	$6.00x10^{-7}$	$5.18x10^{-7}$	$5.18x10^{-7}$	$5.38x10^{-7}$	$5.38x10^{-7}$
Benzene	$2.07x10^{-6}$	$1.88x10^{-6}$	$1.86x10^{-6}$	$1.69x10^{-6}$	$1.96x10^{-6}$	$1.79x10^{-6}$
Formaldehyde	$7.71x10^{-10}$	$7.72x10^{-10}$	$6.96x10^{-10}$	$6.96x10^{-10}$	$7.42x10^{-10}$	$7.43x10^{-10}$
Class A MSAT	$2.84x10^{-6}$	$2.64x10^{-6}$	$2.61x10^{-6}$	$2.44x10^{-6}$	$2.81x10^{-6}$	$2.64x10^{-6}$
Class B1 MSAT	$7.71x10^{-10}$	$7.72x10^{-10}$	$6.96x10^{-10}$	$6.96x10^{-10}$	$7.42x10^{-10}$	$7.43x10^{-10}$
Class B2 MSAT	$6.38x10^{-7}$	$6.38x10^{-7}$	$5.57x10^{-7}$	$5.58x10^{-7}$	$5.84x10^{-7}$	$5.85x10^{-7}$
Total MSAT Risk	$3.79x10^{-6}$	$3.60x10^{-6}$	$3.48x10^{-6}$	$3.32x10^{-6}$	$3.76x10^{-6}$	$3.60x10^{-6}$

Table 57. Reference and controlled HAPEM nonroad gasoline risks for 2015, 2020, and 2030 for individual HAPs and carcinogen classes A, B1, and B2 and total risk (all MSAT HAPs, including HAPs not controlled).

HAP	Nonroad Gasoline Risks					
	2015		2020		2030	
	Reference	Controlled	Reference	Controlled	Reference	Controlled
1,3-Butadiene	$2.18x10^{-7}$	$2.19x10^{-7}$	$2.32x10^{-7}$	$2.32x10^{-7}$	$2.66x10^{-7}$	$2.67x10^{-7}$
Acetaldehyde	$9.38x10^{-8}$	$9.38x10^{-8}$	$9.58x10^{-8}$	$9.58x10^{-8}$	$1.07x10^{-7}$	$1.07x10^{-7}$
Benzene	$5.35x10^{-7}$	$4.90x10^{-7}$	$5.58x10^{-7}$	$5.10x10^{-7}$	$6.32x10^{-7}$	$5.78x10^{-7}$
Formaldehyde	$2.60x10^{-10}$	$2.60x10^{-10}$	$2.73x10^{-10}$	$2.73x10^{-10}$	$3.10x10^{-10}$	$3.10x10^{-10}$
Class A MSAT	$7.63x10^{-7}$	$7.18x10^{-7}$	$8.00x10^{-7}$	$7.52x10^{-7}$	$9.10x10^{-7}$	$8.56x10^{-7}$
Class B1 MSAT	$2.60x10^{-10}$	$2.60x10^{-10}$	$2.73x10^{-10}$	$2.73x10^{-10}$	$3.10x10^{-10}$	$3.10x10^{-10}$
Class B2 MSAT	$1.11x10^{-7}$	$1.11x10^{-7}$	$1.14x10^{-7}$	$1.15x10^{-7}$	$1.28x10^{-7}$	$1.28x10^{-7}$
Total MSAT Risk	$9.23x10^{-7}$	$8.78x10^{-7}$	$9.67x10^{-7}$	$9.19x10^{-7}$	$1.10x10^{-6}$	$1.04x10^{-6}$

10.7.2 Non-cancer

Non-cancer hazard quotient estimates for 1,3-butadiene, acetaldehyde, acrolein, benzene, and formaldehyde were calculated based on the controlled HAPEM results. Hazard indices by organ system (across all MSAT HAPs) were also recalculated using the newly calculated risks for the five above HAPs and the other non-cancer MSAT HAPs reference case risks.

Table 58 lists the stationary HQ for benzene and stationary HI for the immune system. Table 59 lists the onroad gasoline HQ for 1,3-butadiene, acetaldehyde, benzene, formaldehyde and HI for immune, reproductive and respiratory systems. Table 60 lists the nonroad gasoline HQ for 1,3-butadiene, acetaldehyde, benzene, formaldehyde and HI for immune, reproductive and respiratory systems.

More detailed summaries can be found in the MSAT rule docket EPA-HQ-OAR-2005-0036 in the excel file named: hapem_hq_control.xls. County median HQ or HI maps are also in the docket; the file name is: hq_cntrll.ppt.

Table 58. 1999 and future year reference and controlled stationary benzene hazard quotients and immune system hazard indices for MSAT HAPs for 2015 and 2020.

Year	Non-cancer estimate type	Stationary			
		Benzene		Immune System	
		Major	Area & other	Major	Area & other
1999	Base	$6.27x10^{-4}$	$4.72x10^{-3}$	$5.42x10^{-3}$	$1.39x10^{-2}$
2015	Reference	$4.49x10^{-4}$	$5.47x10^{-3}$	$5.95x10^{-3}$	$1.57x10^{-2}$
	Controlled	$4.46x10^{-4}$	$5.27x10^{-3}$	$5.95x10^{-3}$	$1.55x10^{-2}$
2020	Reference	$4.93x10^{-4}$	$5.70x10^{-3}$	$6.48x10^{-3}$	$1.70x10^{-2}$
	Controlled	$4.89x10^{-4}$	$5.49x10^{-3}$	$6.47x10^{-3}$	$1.68x10^{-2}$

Table 59. Reference and controlled HAPEM onroad gasoline HQ for controlled HAPs and HI for immune, reproductive, and respiratory systems (including MSAT HAPs not controlled) for 2015, 2020, and 2030.

HAP	Onroad Gasoline					
	2015		2020		2030	
	Reference	Controlled	Reference	Controlled	Reference	Controlled
1,3-Butadiene	$8.40x10^{-3}$	$8.42x10^{-3}$	$7.70x10^{-3}$	$7.71x10^{-3}$	$8.23x10^{-3}$	$8.24x10^{-3}$
Acetaldehyde	$3.03x10^{-2}$	$3.03x10^{-2}$	$2.61x10^{-2}$	$2.62x10^{-2}$	$2.72x10^{-2}$	$2.72x10^{-2}$
Acrolein	$8.27x10^{-1}$	$8.27x10^{-1}$	$7.54x10^{-1}$	$7.54x10^{-1}$	$8.07x10^{-1}$	$8.08x10^{-1}$
Benzene	$8.87x10^{-3}$	$8.05x10^{-3}$	$7.94x10^{-3}$	$7.24x10^{-3}$	$8.37x10^{-3}$	$7.65x10^{-3}$
Formaldehyde	$1.43x10^{-2}$	$1.43x10^{-2}$	$1.29x10^{-2}$	$1.29x10^{-2}$	$1.38x10^{-2}$	$1.38x10^{-2}$
Immune System	$1.01x10^{-2}$	$9.29x10^{-3}$	$9.34x10^{-3}$	$8.63x10^{-3}$	$1.01x10^{-2}$	$9.40x10^{-3}$
Reproductive System	$8.40x10^{-3}$	$8.42x10^{-3}$	$7.70x10^{-3}$	$7.71x10^{-3}$	$8.23x10^{-3}$	$8.24x10^{-3}$
Respiratory System	$8.78x10^{-1}$	$8.79x10^{-1}$	$8.00x10^{-1}$	$8.00x10^{-1}$	$8.56x10^{-1}$	$8.57x10^{-1}$

Table 60. Reference and controlled HAPEM nonroad gasoline HQ for controlled MSAT HAPs and HI for immune, reproductive, and respiratory systems (from MSAT HAPs including those HAPs not controlled) for 2015, 2020, and 2030.

HAP	Nonroad Gasoline					
	2015		2020		2030	
	Reference	Controlled	Reference	Controlled	Reference	Controlled
1,3-Butadiene	$3.64x10^{-3}$	$3.64x10^{-3}$	$3.87x10^{-3}$	$3.87x10^{-3}$	$4.44x10^{-3}$	$4.44x10^{-3}$
Acetaldehyde	$4.74x10^{-3}$	$4.74x10^{-3}$	$4.84x10^{-3}$	$4.84x10^{-3}$	$5.40x10^{-3}$	$5.40x10^{-3}$
Acrolein	$2.34x10^{-1}$	$2.34x10^{-1}$	$2.41x10^{-1}$	$2.41x10^{-1}$	$2.70x10^{-1}$	$2.70x10^{-1}$
Benzene	$2.29x10^{-3}$	$2.09x10^{-3}$	$2.38x10^{-3}$	$2.18x10^{-3}$	$2.70x10^{-3}$	$2.47x10^{-3}$
Formaldehyde	$4.83x10^{-3}$	$4.83x10^{-3}$	$5.06x10^{-3}$	$5.06x10^{-3}$	$5.74x10^{-3}$	$5.74x10^{-3}$
Immune System	$2.34x10^{-3}$	$2.15x10^{-3}$	$2.44x10^{-3}$	$2.24x10^{-3}$	$2.77x10^{-3}$	$2.54x10^{-3}$
Reproductive System	$3.64x10^{-3}$	$3.64x10^{-3}$	$3.87x10^{-3}$	$3.87x10^{-3}$	$4.44x10^{-3}$	$4.44x10^{-3}$
Respiratory System	$2.44x10^{-1}$	$2.44x10^{-1}$	$2.52x10^{-1}$	$2.52x10^{-1}$	$2.82x10^{-1}$	$2.82x10^{-1}$

10.7.3 Population statistics

Population statistics were calculated for total risk across MSAT HAPs and respiratory HI across MSAT HAPs as documented in Section 8.3. Table 61 lists the total risk populations for 1999, and for the future years 2015, 2020, and 2030 for reference and control cases. Differences between reference and control case are also shown. Table 62 lists the respiratory HI populations for 1999, and for the future years 2015, 2020, and 2030 for reference and control cases as well as the differences. Major and area & other statistics are not shown for the HI statistics because benzene is the only stationary source HAP impacted by the controls and is not a respiratory HAP. Full summaries can be found in pop_stats_risk_cntrl.xls and pop_stats_hi_resp_cntrl.xls for cancer and non-cancer respectively in the MSAT rule docket EPA-HQ-OAR-2005-0036.

Table 61. Population risk classes for stationary and mobile total risk for 2015, 2020, and 2030 for reference and controlled risks from MSAT HAPs using projected populations for each year. The total category includes background contributions.

Source Category	Population Class	Populations						
		Year						
		1999	2015		2020		2030	
		Base	Reference	Controlled	Reference	Controlled	Reference	Controlled
Major	Risk ≥ 10^{-4}	168,437	192,100	192,100	254,904	254,904	276,017	276,017
	10^{-5} ≤ Risk <10^{-4}	3,537,717	4,244,119	4,244,119	5,215,260	5,215,260	5,560,051	556,873
	10^{-6} ≤ Risk <10^{-5}	52,027,786	52,174,340	52,019,015	57,544,083	57,423,740	61,320,162	61,217,659
	Risk <10^{-6}	223,849,492	260,294,114	260,449,439	266,678,495	266,798,839	288,739,334	288,845,016
	Total Population	**279,583,432**	**316,904,672**	**316,904,672**	**329,692,742**	**329,692,742**	**355,895,564**	**355,895,564**
Area & Other	Risk ≥ 10^{-4}	433,665	636,991	636,991	739,981	739,981	779012	779,012
	10^{-5} ≤ Risk <10^{-4}	28,874,198	39,345,554	39,086,924	4,417,331	43,749,847	46500156	46,107,408
	10^{-6} ≤ Risk <10^{-5}	210,220,920	245,736,898	245,293,550	254,558,606	254,305,389	276158456	275,864,333
	Risk <10^{-6}	40,054,649	31,185,230	31,887,208	30,276,824	30,987,525	32457940	33,144,812
	Total Population	**279,583,432**	**316,904,672**	**316,904,672**	**329,692,742**	**329,692,742**	**355,895,564**	**355,895,564**
Onroad	Risk ≥ 10^{-4}	208,150	0	0	0	0	0	0
	10^{-5} ≤ Risk <10^{-4}	112,848,474	19,596,469	17,860,243	16,703,891	15,240,789	21,839,016	20,411,989
	10^{-6} ≤ Risk <10^{-5}	145,060,999	241,185,986	238,194,479	249,373,492	245,938,812	269,464,226	265,725,873
	Risk <10^{-6}	21,465,809	56,122,217	60,849,950	63,615,359	68,513,141	64,592,322	69,757,702
	Total Population	**279,583,432**	**316,904,672**	**316,904,672**	**329,692,742**	**329,692,742**	**355,895,564**	**355,895,564**
Nonroad	Risk ≥ 10^{-4}	22,272	23,710	23,710	25,123	25,123	27,986	27,986
	10^{-5} ≤ Risk <10^{-4}	2,630,188	1,365,537	1,335,534	1,584,116	1,548,720	2,215,401	2,129,598
	10^{-6} ≤ Risk <10^{-5}	180,439,149	150,013,784	143,285,777	159,142,708	151,982,761	18,553,8098	177,885,571
	Risk <10^{-6}	96,491,823	165,501,640	172,259,651	168,940,795	176,136,139	168,114,078	175,852,409
	Total Population	**279,583,432**	**316,904,672**	**316,904,672**	**329,692,742**	**329,692,742**	**355,895,564**	**355,895,564**
Total	Risk ≥ 10^{-4}	2,035,482	1,303,148	1,253,210	1,547,121	1,489,062	1,654,725	1,620,506
	10^{-5} ≤ Risk <10^{-4}	211,743,744	210,880,893	207,704,745	219,257,053	216,237,537	239,434,529	235,991,736
	10^{-6} ≤ Risk <10^{-5}	64,760,978	104,720,624	107,946,710	108,888,561	111,966,135	114,806,302	118,283,314
	Risk <10^{-6}	10,243,228	7	7	7	7	9	9
	Total Population	**279,583,432**	**316,904,672**	**316,904,672**	**329,692,742**	**329,692,742**	**355,895,564**	**355,895,564**

Table 62. Population HI classes for mobile and total respiratory HI for 2015, 2020, and 2030 for reference and controlled risks using projected populations for each year. The total category includes background contributions.

Source Category	Population Class	Populations						
		Year						
		1999	2015		2020		2030	
		Base	Reference	Controlled	Reference	Controlled	Reference	Controlled
Onroad	HI ≥ 10	17,567,623	37,998	0	16,297	0	30,134	0
	1 ≤ HI < 10	200,171,904	114,954,321	17,860,243	105,041,326	15,240,789	121,633,149	20,411,989
	0.1 ≤ HI <1	58,288,431	184,163,448	238,194,479	204,853,751	245,938,812	214,512,775	265,725,873
	HI < 0.1	3,555,474	17,748,905	60,849,950	19,781,369	68,513,141	19,719,506	69,757,702
	Total Population	**279,583,432**	**316,904,672**	**316,904,672**	**329,692,742**	**329,692,742**	**355,895,564**	**355,895,564**
Nonroad	HI ≥ 10	1,116,086	1,280,756	23,710	1,449,660	25,123	1,989,107	27,986
	1 ≤ HI < 10	85,670,356	65,585,394	1,335,534	70,546,734	1,548,720	85,032,069	2,129,598
	0.1 ≤ HI <1	161,073,537	189,650,787	143,285,777	192,548,911	151,982,761	202,958,366	177,885,571
	HI < 0.1	31,723,453	60,387,735	172,259,651	65,147,437	176,136,139	65,916,022	175,852,409
	Total Population	**279,583,432**	**316,904,672**	**316,904,672**	**329,692,742**	**329,692,742**	**355,895,564**	**355,895,564**
Total	HI ≥ 10	44,450,141	19,252,802	19,267,037	19,134,918	19,134,918	21,967,871	21,972,418
	1 ≤ HI < 10	208,040,954	223,718,621	223,762,189	230,402,091	230,458,518	251,444,395	251,536,613
	0.1 ≤ HI <1	26,972,148	73,579,914	73,522,111	79,779,745	79,723,317	82,112,984	82,016,219
	HI < 0.1	120,189	353,336	353,336	375,989	375,989	370,314	370,314
	Total Population	**279,583,432**	**316,904,672**	**316,904,672**	**329,692,742**	**329,692,742**	**355,895,564**	**355,895,564**

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Appendix A: Documentation of NMIM Runs Used to Develop Inventories for MSAT Rule Air Quality Modeling

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Office of Transportation and Air Quality

Mobile source hazardous air pollutants (HAP) inventories at a county-level resolution were produced for the Mobile Sources Air Toxics (MSAT) rule analysis by running the National Mobile Inventory Model (NMIM) for all 50 States and the District of Columbia. Simulations were made for calendar years 1999, 2007, 2010, 2015, 2020 and 2030. The same temperature and humidity inputs were used for all calendar years; the determination of these values is explained in more detail below. Although monthly inputs were used in the model, results were provided (summed up) to an annual temporal resolution for all calendar years. Resulting inventories were used to develop future year to 1999 inventory ratios, which were then applied to the final 1999 National Emissions Inventory (NEI). Thus, the emission trends for projection years were consistent with the 1999 NEI, the inventory used in the 1999 NATA assessment. The onroad sources were run separately, with and without refueling emissions for all inventory years. This allowed the refueling runs to be used to develop future year to 1999 inventory ratios that could be applied for refueling emissions which are contained in the 1999 NEI as non-point sources.

Modeling air toxics requires specific fuel parameter inputs, as discussed in NMIM documentation. The sources of the fuel parameter inputs used in this modeling, and the methods used to develop the fuel parameter database are described in the technical document, "Draft National Mobile Inventory Model (NMIM) Base and Future Year County Database Documentation and Quality Assurance Procedures," prepared by Eastern Research Group for U. S. EPA, Office of Transportation and Air Quality, 15 April, 2003. However, the gasoline parameters as delivered from the contractor do not address the phase out of gasoline containing MTBE in California, Arizona, New York and Connecticut properly. The difference is important when calculating HAPs. Thus, a new set of gasoline parameters was derived for areas in these States using reformulated gasoline with MTBE, for summer and winter in 2004, 2005 and 2006. An interpolated set of parameters was derived from the summer/winter values for use in spring/fall months. The 2006 gasoline parameters were used for all 2007 and later calendar years as well. More information on these revisions can be found in the change log for the NMIM database. Both the technical document and change log described above can be found in the docket for the rulemaking.

Three versions of the NMIM code and two versions of the NMIM County database were used to generate onroad and nonroad inventories. The three code versions represent fixes to minor problems in the computer code and added features that do not affect the output results. The three NMIM code versions are equivalent in terms of the emission results they produce.

Two versions of the NMIM County database were used. The May 14, 2004, database is identical to the April 12, 2004, version of the database, but includes the 1999 National Emission Inventory (NEI) list of counties with Stage 2 refueling programs for estimating the effects of local control programs on refueling emissions. Stage 2 refueling programs only affect onroad inventories for refueling emissions. The Stage 2 used counties are listed in Appendix E-2 County Level Allocation Values Used for Allocation Schemes 18, 22 and 27 (Stage 2 Control) in the report, "Documentation for the Final 1999 Nonpoint Area Source National Emission Inventory for

Hazardous Air Pollutants (Version 3)," August 26, 2003. This document is available on the EPA web site at: http://www.epa.gov/ttn/chief/net/1999inventory.html

Multiple runs were necessary for the refueling runs due to computer problems during the runs that resulted in incomplete results. The additional runs (labeled "a" and "b" in the table below) were needed to fill in for the missing data in the original runs. The entire nationwide run was not redone to save running time.

All onroad results are based on runs of the MOBILE6.2.03 version of MOBILE6. All nonroad results are based on runs of the NR2003a version of the NONROAD model.

Output databases have been named to be the same as the run identification, except for recreational marine, which goes in the same database as the other nonroad output. All run results aggregate by emission type and power class.

Every run has associated with it a RunSpec and a batch file with the run name and extensions “nrs” (for NMIM RunSpec) and “bat,” respectively. RunSpecs and batch files have been archived along with copies of the output results from the simulations.

Table A-1 describes the specific version of the NMIM code and the version of the input parameter database used for the analysis. The codes following the table are useful in understanding the names used in the table.

Table A-1. Run summary for MSAT mobile source inventories.

Run ID	***Output Database***	***Description***
MSATOH1999c24d13	MSATOH1999c24d13	Onroad HAPS 1999
MSATOH2007c24d13	MSATOH2007c24d13	Onroad HAPS 2007
OH2010c22d11	OH2010c22d11	Onroad HAPS 2010
MSATOH2015c24d13	MSATOH2015c24d13	Onroad HAPS 2015
MSATOH2020c24d13	MSATOH2020c24d13	Onroad HAPS 2020
MSATOH2030c24d13	MSATOH2030c24d13	Onroad HAPS 2030
NH1999c22d11	NH1999c22d11	Nonroad HAPS 1999
NH2007c22d11	NH2007c22d11	Nonroad HAPS 2007
NH2010c22d11	NH2010c22d11	Nonroad HAPS 2010
NH2015c22d11	NH2015c22d11	Nonroad HAPS 2015
NH2020c22d11	NH2020c22d11	Nonroad HAPS 2020
NH2030c22d11	NH2030c22d11	Nonroad HAPS 2030
RH1999c22d11	NH1999c22d11	Recreational Marine HAPS 1999
RH2007c22d11	NH2007c22d11	Recreational Marine HAPS 2007
RH2010c22d11	NH2010c22d11	Recreational Marine HAPS 2010
RH2015c22d11	NH2015c22d11	Recreational Marine HAPS 2015
RH2020c22d11	NH2020c22d11	Recreational Marine HAPS 2020
RH2030c22d11	NH2030c22d11	Recreational Marine HAPS 2030
MSATOR1999c24rd13	MSATOR1999c24rd13	Onroad Refueling 1999
MSATOR1999c24rd13a	MSATOR1999c24rd13	Onroad Refueling 1999
MSATOR2001c24rd13	MSATOR2001c24rd13	Onroad Refueling 2001
MSATOR2001c24rd13a	MSATOR2001c24rd13	Onroad Refueling 2001
MSATOR2007c24rd13	MSATOR2007c24rd13	Onroad Refueling 2007
MSATOR2010c24rd13	MSATOR2010c24rd13	Onroad Refueling 2010
MSATOR2015c24rd13	MSATOR2015c24rd13	Onroad Refueling 2015
MSATOR2015c24rd13a	MSATOR2015c24rd13	Onroad Refueling 2015
MSATOR2015c24rd13b	MSATOR2015c24rd13	Onroad Refueling 2015
MSATOR2020c24rd13	MSATOR2020c24rd13	Onroad Refueling 2020
MSATOR2030c24rd13	MSATOR2030c24rd13	Onroad Refueling 2030

NMIM Code Version:
c22 = NMIMSource20040415
c24 = NMIMSource20040512
c24r = NMIMSource20040512 altered for refueling emissions only output.

NMIM County Database Version:
d11 = County20040412
d13 = County20040514

Run codes:
NH = Nonroad except diesel recreational marine HAPS
RH = Diesel recreational marine HAPS
OH = Onroad HAPS
OR = Onroad Refueling

Methodology Used to Compute By-County, By-Month, By-Hour Temperature and Relative Humidity Tables

Both onroad and nonroad emission inventories are affected by changes in temperature. In addition, onroad estimates for NOx from gasoline fueled vehicles are affected by humidity. A detailed analysis of climate data was done to produce an estimate for the average hourly temperatures and humidity (over an approximately 20 year period) to use for each county in the nation. The results of this analysis are found in the NMIM County database. Below is a brief discussion of how the county specific average hourly temperatures were determined for each month.

1) Hourly temperature and dew point data, as well as location (latitude and longitude), for all 1st Order weather stations across the United States were obtained from the National Climatic Data Center (NCDC). (Note: Automated weather stations began being installed in 1996. Data from these 2nd order stations were used for the more recent, shorter analysis periods.)

2) For each station, an inventory was made as to the number of hours with joint temperature and dew point data. In order to be included in the 1981-2000 analysis, each station had to have at least 50% data recovery for each hour of each month, and at least 75% data recovery over the entire 20 years. (This cutoff was raised to 75% for the 5-year analysis, and to 90% for one-year analyses). (Note: Climatological averages are usually based on a 30-year period. The 20-year period of 1981-2000 was selected due to hourly data availability constraints. Prior to 1981, limited computer technology forced the NCDC to only store observations for every 3rd hour. Attempts to interpolate the 3-hour data showed biases and errors (for example dew point exceeding temperature.)

3) For each station passing the data availability filter, the average temperature and dew point for each hour of each month over the 20-year period was computed. (Note: Relative humidity data should never be averaged. Since it depends on the associated temperature and dew point, relative humidity is not a conservative property of the atmosphere.)

4) Population centroids (latitude and longitude) for each county were obtained from the 2000 United States Census. Population, rather than geographic, centroids were used to provide the best estimate where the county's VMT would occur. (Note: This selection proved particularly important for those counties near mountainous or desert areas.)

5) From each county's centroid, the distance and direction to each weather station was calculated. The shortest distance was computed using the standard great circle navigation method and the constant course direction was computed using the standard rhumb line method.

6) Based on the computed directions, the stations were assigned to an octant, as follows: Octant 1: 0°<Dir≤45°, Octant 2: 45°<Dir≤90°, Octant 3: 90°<Dir≤135°, Octant 4: 135°<Dir≤180°, Octant 5: 180°<Dir≤225°, Octant 6: 225°<Dir≤270°, Octant 7: 270°<Dir≤315°, Octant 8: 315°<Dir≤360°.

7) For each octant, the stations were sorted by distance. The station closest to the centroid for each octant was chosen for further processing. If the closest station was more than 200 miles away, that octant is ignored. (Such situations occurred near the oceans and the along the Canadian and Mexican borders.)

8) To remove the effects of differing time zones between counties and stations, the temperature and dew point data from each octant station were synchronized to the same local hour. Thus, noon EST is matched up with noon CST, with noon MST with noon PST, etc.

9) The octant (8 or less) temperature and dew point values were merged together using inverse distance-squared weighting.

10) The corresponding relative humidity was then computed from the weighted temperature and dew point values. (Note: In keeping with standard meteorological practices, the relative humidity was always computed with respect to water, even if the temperature was below freezing.)

11) The above process was repeated for each hour, for each month, and for each county centroid. As a final check, the results from different times and months were plotted on maps and contoured.

Appendix B: Steps and Example calculations of onroad projections

B.1 Onroad HAPs (Section 3.3.2)

The following steps summarizes the SAS® program, onroad.sas (found in the MSAT rule docket EPA-HQ-OAR-2005-0036) used to project the onroad inventory with sample calculations for 2015 for Autauga County, AL and Modoc County, CA. A detailed flow chart is shown in Figure B-1.

1. Read the 1999 NEI onroad inventory and retained only the MSAT HAPs listed in Table 1, Section 1. It was found that all HAPs in the onroad NEI were MSAT HAPs. Also, NMIM emissions were initially provided by FIPS/SCC/CAS where SCC categories were broken out by evaporative and exhaust components. For each FIPS/SCC/CAS, the exhaust and evaporative components were summed together to give one emission number.

   Table B-1. Partial listing of emissions after merger of 1999 NEI emissions after merger with MSAT CAS numbers. CAS 71432 is benzene, 1330207 is xylenes, 7440473 is chromium, and CAS 226 and 7440020 are nickel.

FIPS	SCC	CAS	emis
01001	2201001130	226	0.00007
01001	2201001130	71432	1.15235
01001	2201001130	7440473	0.0001
01001	2201080130	71432	0.009925
01001	2230070130	226	5E-6
01001	2230070130	71432	0.02079
06049	2201001130	71432	1.075615
06049	2201001130	7440020	0.000225
06049	2201001130	7440473	0.00032
06049	2201080130	71432	0.015485

2. Read in NMIM emissions and summed heavy-duty diesel vehicle emissions to create a total HDDV emission number for each FIPS/CAS/ road type where road type is represented by the last 3 characters of SCC code and calculate new projection factors based on the summed emissions for 1999 NMIM and future year NMIM results. These factors were applied to SCC codes beginning with 2230070 for each FIPS/CAS in the 1999 NEI in step 13. These SCC codes are shown in Table 16 (Section 3.3.2). Output dataset was named hddv_nmim. The temporary SCC code in the NMIM output was 223007XYYY where YYY is road type.

Table B-2. Partial listing of Autauga County emissions after creating total HDDV SCC from NMIM results. Emis99 are the 1999 NMIM emissions, emis15 are 2015 emissions, and ratio_15 is the ratio of 2015 emissions to the 1999 emissions.

FIPS	SCC	CAS	emis99	emis15	ratio_15
01001	223007X130	71432	0.0009132375	0.000441322	0.4832499782
01001	223007X130	7440020	7.8660057E-7	9.3792589E-7	1.1923788539
01001	223007X130	71432	0.0006728924	0.0004738843	0.7042497321
01001	223007X130	7440020	4.798758E-7	7.5895458E-7	1.5815645908
01001	223007X130	71432	0.0029419617	0.0017220468	0.5853396615
01001	223007X130	7440020	1.1361038E-6	1.7165236E-6	1.510886278
01001	223007X130	71432	0.0155974124	0.0072218833	0.4630180423
01001	223007X130	7440020	4.0112847E-6	5.4976188E-6	1.3705381898
01001	223007X130	71432	0.0006618121	0.0004315654	0.6520966767
01001	223007X130	7440020	1.7606117E-7	3.0090454E-7	1.7090908974

Table B-3. Partial listing of Autuaga County HDDV emissions after summing by FIPS/SCC/CAS with recalculated ratio.

FIPS	SCC	CAS	emis99	emis15	ratio_15
01001	223007X130	71432	0.020787316	0.0102907019	0.4950471688
01001	223007X130	7440020	6.589926E-6	9.2119274E-6	1.3978802578

3. Recombined step 2 output with the original NMIM dataset.

Table B-4. Partial listing of emissions after concatenating HDDV emissions with original NMIM emissions.

FIPS	SCC	CAS	emis99	emis15	ratio
01001	223007X130	71432	0.020787316	0.0102907019	0.4950471688
01001	223007X130	7440020	6.589926E-6	9.2119274E-6	1.3978802578
01001	2201001130	16065831	0.0000593097	0.0000494437	0.8336535061
01001	2201001130	18540299	0.0000395398	0.0000329625	0.8336535004
01001	2201001130	71432	1.1247759168	0.2370964659	0.2107944012
01001	2201001130	7440020	0.0000718905	0.0000599318	0.8336535267
01001	2201080130	16065831	5.9322425E-7	6.6164804E-7	1.1153422083
01001	2201080130	18540299	3.9548283E-7	4.410987E-7	1.1153422209
01001	2201080130	71432	0.00979517	0.0104629781	1.0681772804
01001	2201080130	7440020	7.1905967E-7	8.0199761E-7	1.1153422226
06049	2201001130	16065831	0.0000394923	0.0000369164	0.9347752652
06049	2201001130	18540299	0.0000263282	0.0000246109	0.9347752577
06049	2201001130	71432	0.506942138	0.136686063	0.2696285292
06049	2201001130	7440020	0.0000478695	0.0000447472	0.9347752469

4. The NMIM Chromium III and Chromium VI emissions were summed for each FIPS/SCC to give a total Chromium number. New projection factors were calculated for the summed chromium and the CAS 7440473 was assigned to each record. This was done for all FIPS/SCC combinations with Chromium III or Chromium VI.

Table B-5. Partial listing of NMIM chromium emissions (Section 3.4.2, step 4).

FIPS	SCC	CAS	emis99	emis15	ratio
01001	2201001130	16065831	0.0000593097	0.0000494437	0.8336535061
01001	2201001130	18540299	0.0000395398	0.0000329625	0.8336535004
01001	2201080130	16065831	5.9322425E-7	6.6164804E-7	1.1153422083
01001	2201080130	18540299	3.9548283E-7	4.410987E-7	1.1153422209
06049	2201001130	16065831	0.0000394923	0.0000369164	0.9347752652
06049	2201001130	18540299	0.0000263282	0.0000246109	0.9347752577

Table B-6. Partial listing of NMIM chromium after summing by FIPS/SCC, assigning a CAS, and calculating a ratio.

FIPS	SCC	CAS	emis99	emis15	ratio
01001	2201001130	7440473	0.0000988494	0.0000824062	0.8336535038
01001	2201080130	7440473	9.8870708E-7	1.1027467E-6	1.1153422134
06049	2201001130	7440473	0.0000658205	0.0000615274	0.9347752622

5. Combined the chromium data with the original NMIM data.

Table B-7. Partial listing of NMIM emissions after concatenating with chromium emissions.

FIPS	SCC	CAS	emis99	emis15	ratio
01001	223007X130	71432	0.020787316	0.0102907019	0.4950471688
01001	223007X130	7440020	6.589926E-6	9.2119274E-6	1.3978802578
01001	2201001130	16065831	0.0000593097	0.0000494437	0.8336535061
01001	2201001130	18540299	0.0000395398	0.0000329625	0.8336535004
01001	2201001130	71432	1.1247759168	0.2370964659	0.2107944012
01001	2201001130	7440020	0.0000718905	0.0000599318	0.8336535267
01001	2201080130	16065831	5.9322425E-7	6.6164804E-7	1.1153422083
01001	2201080130	18540299	3.9548283E-7	4.410987E-7	1.1153422209
01001	2201080130	71432	0.00979517	0.0104629781	1.0681772804
01001	2201080130	7440020	7.1905967E-7	8.0199761E-7	1.1153422226
06049	2201001130	16065831	0.0000394923	0.0000369164	0.9347752652
06049	2201001130	18540299	0.0000263282	0.0000246109	0.9347752577
06049	2201001130	71432	0.506942138	0.136686063	0.2696285292
06049	2201001130	7440020	0.0000478695	0.0000447472	0.9347752469
01001	2201001130	7440473	0.0000988494	0.0000824062	0.8336535038
01001	2201080130	7440473	9.8870708E-7	1.1027467E-6	1.1153422134
06049	2201001130	7440473	0.0000658205	0.0000615274	0.9347752622

6. Extracted the NMIM xylenes, manganese, and nickel observations from the NMIM results in preparation for work described in step 7.

Table B-8. Partial list of emissions for nickel.

FIPS	SCC	CAS	emis99	emis15	ratio
01001	223007X130	7440020	6.589926E-6	9.2119274E-6	1.3978802578
01001	2201001130	7440020	0.0000718905	0.0000599318	0.8336535267
01001	2201080130	7440020	7.1905967E-7	8.0199761E-7	1.1153422226
06049	2201001130	7440020	0.0000478695	0.0000447472	0.9347752469

7. Copied the xylenes, manganese, and nickel observations to new observations with new CAS numbers.

Table B-9. Partial list of nickel emissions after copying observations to duplicate records and assigning CAS number to 226.

FIPS	SCC	CAS	emis99	emis15	ratio
01001	223007X130	226	6.589926E-6	9.2119274E-6	1.3978802578
01001	2201001130	226	0.0000718905	0.0000599318	0.8336535267
01001	2201080130	226	7.1905967E-7	8.0199761E-7	1.1153422226
06049	2201001130	226	0.0000478695	0.0000447472	0.9347752469

8. Appended output from step 7 to output from step 5.

Table B-10. Partial list of emissions after concatening duplicate nickel records with original data and sorted by FIPS/SCC/CAS.

FIPS	SCC	CAS	emis99	emis15	ratio
01001	2201001130	16065831	0.0000593097	0.0000494437	0.8336535061
01001	2201001130	18540299	0.0000395398	0.0000329625	0.8336535004
01001	2201001130	226	0.0000718905	0.0000599318	0.8336535267
01001	2201001130	71432	1.1247759168	0.2370964659	0.2107944012
01001	2201001130	7440020	0.0000718905	0.0000599318	0.8336535267
01001	2201001130	7440473	0.0000988494	0.0000824062	0.8336535038
01001	2201080130	16065831	5.9322425E-7	6.6164804E-7	1.1153422083
01001	2201080130	18540299	3.9548283E-7	4.410987E-7	1.1153422209
01001	2201080130	226	7.1905967E-7	8.0199761E-7	1.1153422226
01001	2201080130	71432	0.00979517	0.0104629781	1.0681772804
01001	2201080130	7440020	7.1905967E-7	8.0199761E-7	1.1153422226
01001	2201080130	7440473	9.8870708E-7	1.1027467E-6	1.1153422134
01001	223007X130	226	6.589926E-6	9.2119274E-6	1.3978802578
01001	223007X130	71432	0.020787316	0.0102907019	0.4950471688
01001	223007X130	7440020	6.589926E-6	9.2119274E-6	1.3978802578
06049	2201001130	16065831	0.0000394923	0.0000369164	0.9347752652
06049	2201001130	18540299	0.0000263282	0.0000246109	0.9347752577
06049	2201001130	226	0.0000478695	0.0000447472	0.9347752469
06049	2201001130	71432	0.506942138	0.136686063	0.2696285292
06049	2201001130	7440020	0.0000478695	0.0000447472	0.9347752469
06049	2201001130	7440473	0.0000658205	0.0000615274	0.9347752622

9. After making changes to NMIM for total chromium, xylenes, manganese, and nickel, the NEI and NMIM data were merged by FIPS/SCC/CAS keeping all records from the NEI inventory. Keep all NEI observations and output data to merged1.

Table B-11. Merged NEI and NMIM emissions by FIPS/SCC/CAS. Emis_nei is the 1999 NEI emissions variable.

FIPS	SCC	CAS	emis	emis99	emis15	ratio
01001	2201001130	226	0.00007	0.0000718905	0.0000599318	0.8336535267
01001	2201001130	71432	1.15235	1.1247759168	0.2370964659	0.2107944012
01001	2201001130	7440473	0.0001	0.0000988494	0.0000824062	0.8336535038
01001	2201080130	71432	0.009925	0.00979517	0.0104629781	1.0681772804
01001	2230070130	226	5E-6	.	.	.
01001	2230070130	71432	0.02079	.	.	.
06049	2201001130	71432	1.075615	0.506942138	0.136686063	0.2696285292
06049	2201001130	7440020	0.000225	0.0000478695	0.0000447472	0.9347752469
06049	2201001130	7440473	0.00032	0.0000658205	0.0000615274	0.9347752622
06049	2201080130	71432	0.015485	.	.	.

10. Calculated the projection factors for motorcycles by first summing across all SCC codes for each FIPS/CAS for the future year and 1999 and dividing the future year summed emissions by the 1999 summed emissions.

Table B-12. County emissions for benzene for Modoc County. Emissions total includes SCC emissions not shown in tables.

FIPS	CAS	emis99	emis15	ratio1
06049	71432	4.0984894367	2.560901195	0.6248402575

11. Merged output from step 10 to output from step 9 for the observations without a projection factor. Did not do this for the HDDV emissions (1999 NEI SCC beginning with 2230070).

Table B-13. Merged NEI and NMIM emissions with Modoc County benzene county ratio reset to county ratio (ratio1).

FIPS	SCC	CAS	emis	emis99	emis15	ratio	ratio1
01001	2201001130	226	0.00007	0.0000718905	0.0000599318	0.8336535267	
01001	2201001130	71432	1.15235	1.1247759168	0.2370964659	0.2107944012	
01001	2201001130	7440473	0.0001	0.0000988494	0.0000824062	0.8336535038	
01001	2201080130	71432	0.009925	0.00979517	0.0104629781	1.0681772804	
01001	2230070130	226	5E-6	.	.	.	
01001	2230070130	71432	0.02079	.	.	.	
06049	2201001130	71432	1.075615	0.506942138	0.136686063	0.2696285292	
06049	2201001130	7440020	0.000225	0.0000478695	0.0000447472	0.9347752469	
06049	2201001130	7440473	0.00032	0.0000658205	0.0000615274	0.9347752622	
06049	2201080130	71432	0.015485	.	.	0.6248402575	0.6248402575

12. Subset HDDV emissions, 223007XYYY from the NMIM data.

Table B-14. Subsetted HDDV emissions. Ratio has been renamed ratio_07 and SCC to SCC1.

FIPS	SCC1	CAS	emis99	emis15	ratio_07
01001	223007X130	226	6.589926E-6	9.2119274E-6	1.3978802578
01001	223007X130	71432	0.020787316	0.0102907019	0.4950471688
01001	223007X130	7440020	6.589926E-6	9.2119274E-6	1.3978802578

13. Merged the subsetted HDDV emissions by FIPS, CAS, and where the NEI SCC began with 2230070 and the NMIM derived SCC began with 223007X.

Table B-15. Merged NEI and NMIM emissions merged with HDDV data by FIPS/CAS where SCC=SCC1. SCC1, ratio1, emis99 and emis15 not shown. For HDDV SCC emissions, ratio has been set equal to ratio_07

FIPS	SCC	CAS	emis_nei	ratio	ratio_07
01001	2201001130	226	0.00007	0.8336535267	
01001	2201001130	71432	1.15235	0.2107944012	
01001	2201001130	7440473	0.0001	0.8336535038	
01001	2201080130	71432	0.009925	1.0681772804	
01001	2230070130	226	5E-6	1.3978802578	1.3978802578
01001	2230070130	71432	0.02079	0.4950471688	0.4950471688
06049	2201001130	71432	1.075615	0.2696285292	
06049	2201001130	7440020	0.000225	0.9347752469	
06049	2201001130	7440473	0.00032	0.9347752622	
06049	2201080130	71432	0.015485	0.6248402575	0.6248402575

14. Output to a permanent dataset.

Table B-16. Output to permanent dataset and create 2015 projected emissions by multiplying the ratio by emis_nei, creating a new variable called emis.

FIPS	SCC	CAS	emis	ratio	emis_nei
01001	2201001130	226	0.0000583557	0.8336535267	0.00007
01001	2201001130	71432	0.2429089282	0.2107944012	1.15235
01001	2201001130	7440473	0.0000833654	0.8336535038	0.0001
01001	2201080130	71432	0.0106016595	1.0681772804	0.009925
01001	2230070130	226	6.9894013E-6	1.3978802578	5E-6
01001	2230070130	71432	0.0102920306	0.4950471688	0.02079
06049	2201001130	71432	0.2900164904	0.2696285292	1.075615
06049	2201001130	7440020	0.0002103244	0.9347752469	0.000225
06049	2201001130	7440473	0.0002991281	0.9347752622	0.00032
06049	2201080130	71432	0.0096926381	0.6248402575	0.015485

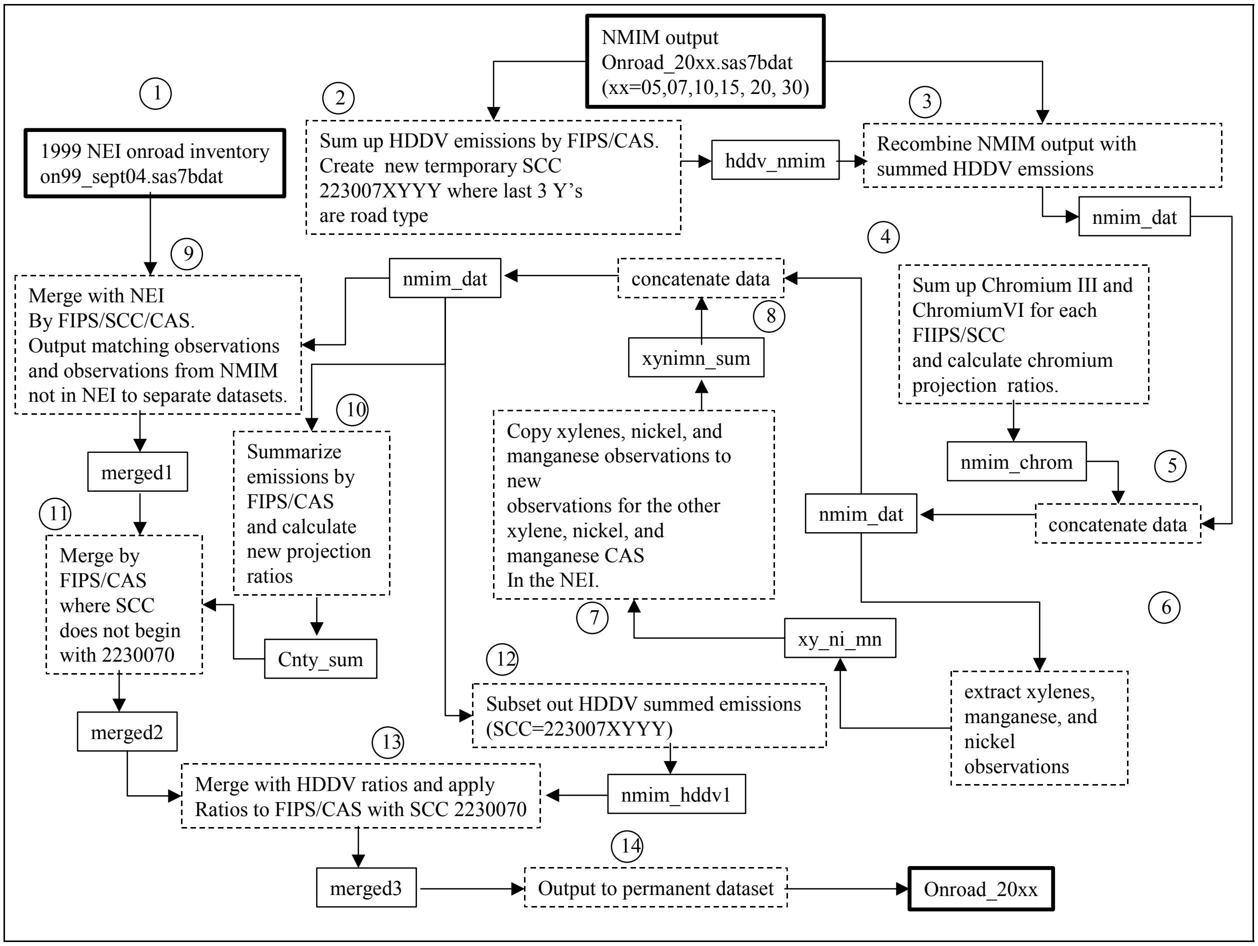

Figure B-1. Projection of the 1999 NEI onroad inventory to 2007, 2010, 2015, 2020, and 2030.

B.2 Onroad Precursor Emissions (see 3.4.3)

Following are the steps used to project the onroad precursor emissions:

1. Read in the precursor HAP table used for EMS-HAP and subset the data to the acetaldehyde, acrolein, formaldehyde, and propionaldehyde precursors, with the exception of 1,3-butadiene, acetaldehyde, and MTBE.

2. The precursor onroad inventory was subset to the acetaldehyde, acrolein, formaldehyde, and propionaldehyde precursors by merging with the output of step 1 by CAS. Also created a variable called CAS1 that is set to a value of "VOC". This was to be used for merging with the NMIM inventory.

3. The NMIM data was split into non-HDDV emissions and HDDV emissions. Summed up the heavy-duty diesel vehicle emissions in NMIM to create a total HDDV emission number for each FIPS/ HDDV road type (last 3 characters of SCC code) and exhaust or evaporative type. Created a new SCC, by replacing the seventh digit of the SCC with a zero. Output dataset for HDDV emissions was hddv and for non-HDDV emissions, voc. For both datasets created a new variable, CAS1 which was set to "VOC".

4. Summed up the HDDV emissions with the new SCC by FIPS. Calculated new projection factors for each FIPS/SCC using Equation 2 (Section 3.3.2). These factors would be applied to SCC codes beginning with 2230070YY# for each FIPS/CAS in the 1999 precursor inventory. These SCC codes are shown in Table 25.

5. Concatenated the HDDV and non-HDDV data with projection factors.

6. Merged step 5 output with the 1999 precursor inventory by FIPS/SCC/CAS1. Output all observations for 1999 precursor inventory. Some 1999 observations did not have a matching observation by FIPS/SCC/CAS1 in the NMIM data.

7. Extracted the emissions where the SCC code did not contain X or V, i.e. the total SCC emissions (exhaust + evaporative).

8. To provide projection factors for the non-matching data, summed all the emissions in each county across all SCC codes and calculated a new projection factor using Equation 2.

9. Merged the output from step 7 with the output from step 6 by FIPS.

10. Applied the projection factors to each FIPS/SCC/CAS.

11. Extracted the onroad emissions for 1,3-butadiene, acetaldehyde, and MTBE from the MSAT onroad inventory.

12. Appended output from step 10 to output from step 9.

13. If emissions were 1,3-butadiene, acetaldehyde, or MTBE, set the emis variable (emissions variable for EMS-HAP) equal to the appropriate year emissions (emis_xx where xx is 15, 20, or 30). Otherwise, projected the emissions from 1999 by multiplying the 1999 emissions by the projection factor.

The flowchart of the projection processing is shown in Figure B-2.

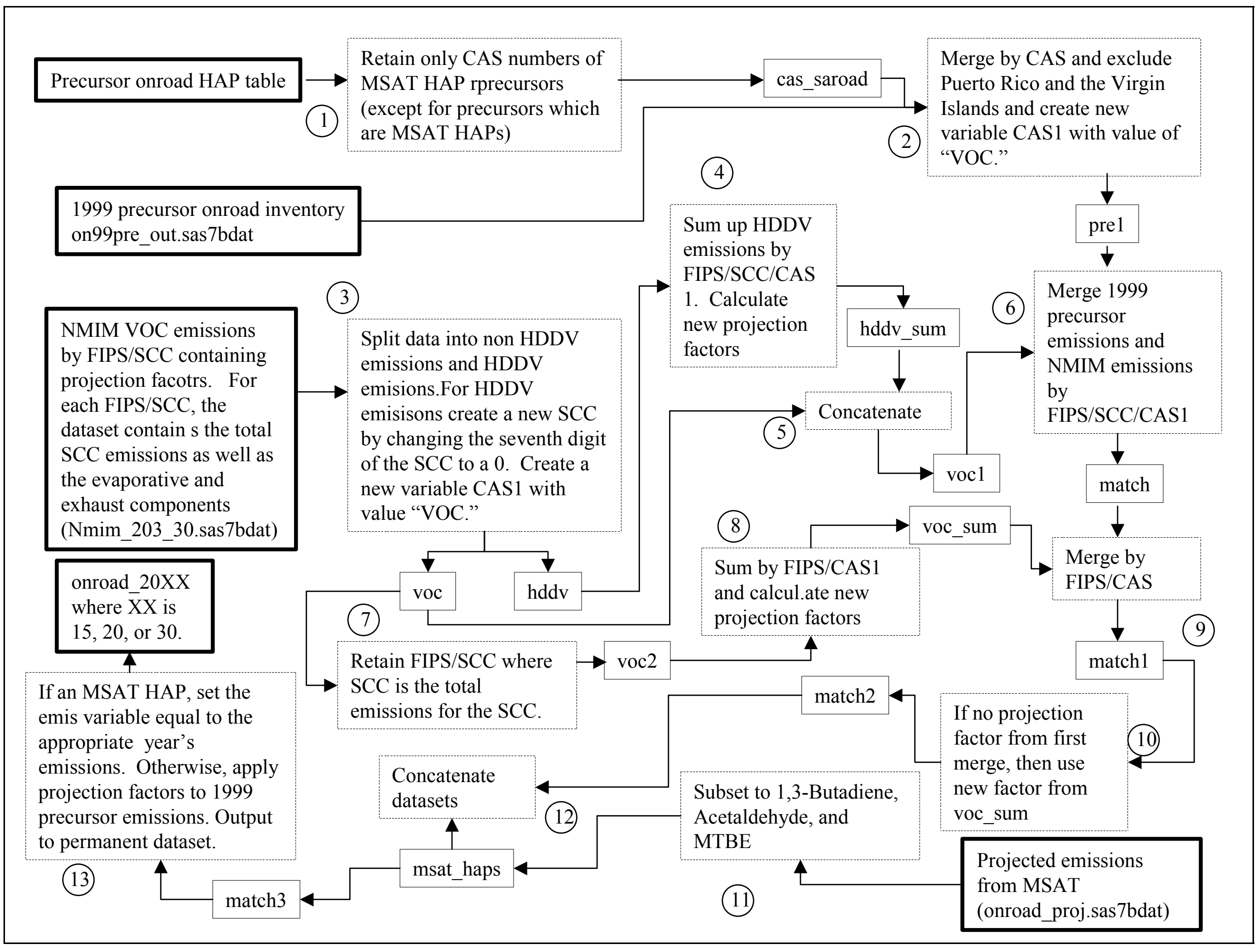

Figure B-2. Precursor onroad inventory projection processing.

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Appendix C: Example calculations of nonroad projections

C.1 Locomotive and commercial marine vessel emissions

C.1.1 Development of Projection Factor Files for locomotives and commercial marine vessels emission projections

The development of the projection factor files included the following steps performed in a SAS® program called loco_marine.sas which can be found in the docket for the MSAT rule (EPA-HQ-OAR-2005-0036):

1. Read the 1999 NEI nonroad inventory, nonroad_fixed_airports.sas7bdat (found in the MSAT rule docket EPA-HQ-OAR-2005-0036), and extracted the HAP emissions by CAS for the locomotive and commercial marine vessel SCC codes. Emissions were summed by CAS and SCC. HAP names were then assigned by CAS numbers. Emissions were then summed by HAP name and SCC. This was done because some HAPs such as Chromium III or Chromium VI were composed of several CAS numbers. This step was done as a matter of convenience for the user. The summations were done for the entire U.S. excluding Puerto Rico and the Virgin Islands.

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2. The resulting emissions from step 1 were transferred to a PC where they were imported into an Excel spreadsheet where the projection factors for the various years were added to the emissions based on the criteria in Tables 4 and 6. The spreadsheet name is loco_marine.xls

3. The Excel spreadsheet was then imported into SAS® where SAROAD codes were added based on the HAP name in the SAS® program loco_marine.sas. For HAPs with two SAROAD codes, i.e. the metals and naphthalene, both SAROAD codes were assigned and the projection factors were associated with each SAROAD.

4. Output the SAROAD/SCC/projection factors to text files, locomotive_gf.txt for locomotives and marine_cv.txt for commercial marine vessels. The files contained the growth factors for all MSAT years.

Figures C-1 and C-2 show sample records of the projection factor files for locomotive and commercial marine vessels.

2285000000	43231	0.9962	0.9441	0.9127	0.8986	0.8725	0.8277
2285000000	43504	0.9962	0.9441	0.9127	0.8986	0.8725	0.8277
2285000000	59992	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2285000000	59993	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Figure C-1. Sample records of the locomotive_gf.txt file. Variables are in the following order: SCC, SAROAD, 2001 projection factor, 2007 projection factor, 2010 projection factor, 2015 projection factor, 2020 projection factor, and 2030 projection factor. Note that the 2001 projection factor is not used.

2280000000	43218	1.0352	1.1188	1.1511	1.2306	1.3505	1.7142
2280000000	43231	1.0352	1.1188	1.1511	1.2306	1.3505	1.7142
2280000000	59992	1.0181	1.0743	1.1036	1.1541	1.2070	1.3202
2280000000	59993	1.0181	1.0743	1.1036	1.1541	1.2070	1.3202

Figure C-2. As for Figure 1, except for the commercial marine vessel projection factor file, marine_cv.txt.

C.1.2. Projection of the 1999 locomotive and commercial marine vessel emissions

Projection of the 1999 locomotive and commercial marine vessel emissions was performed in marine_locomotive_growth.sas (found in the MSAT rule docket EPA-HQ-OAR-2005-0036) and included the following steps. The methodology of the program is shown in Figure C-3 as a flowchart with example calculations shown with each step:

1. Combined the commercial marine vessels and locomotive SAROAD/SCC/projection factor data into one file.

Table C-1. Partial listing of locomotive and commercial marine vessel growth factors by SAROAD after reading in growth factor files, concatenating, and sorting. Benzene and unspeciated chromium growth factors are shown.

SCC	SAROAD	gf99_01	gf99_07	gf99_10	gf99_15	gf99_20	gf99_30
2280000000	45201	1.0352	1.1188	1.1511	1.2306	1.3505	1.7142
2280000000	80141	1.0181	1.0743	1.1036	1.1541	1.207	1.3202
2280000000	80341	1.0181	1.0743	1.1036	1.1541	1.207	1.3202
2280002200	45201	1.0196	1.0482	1.0498	1.0552	1.0797	1.177
2280002200	80141	1.0181	1.0743	1.1036	1.1541	1.207	1.3202
2280002200	80341	1.0181	1.0743	1.1036	1.1541	1.207	1.3202
2285002005	45201	0.9962	0.9441	0.9127	0.8986	0.8725	0.8277
2285002005	80141	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2285002005	80341	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2285002010	45201	0.9962	0.9441	0.9127	0.8986	0.8725	0.8277
2285002010	80141	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2285002010	80341	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

2. Read in the text file, haptabl_nonroadGEN_toxwt.txt to get the CAS/SAROAD cross reference for nonroad HAPs. The data was sorted to eliminate duplicate CAS numbers. For metals, this usually meant the CAS became associated with the fine particle SAROAD or the lowest numbered SAROAD for the metal.

   Table C-2. CAS/SAROAD cross reference for benzene and unspeciated chromium after sorting by CAS/SAROAD.

CAS	SAROAD
136	80141
136	80341
71432	45201
7440473	80141
7440473	80341

3. Merged the output from steps 1 and 2 together so that now the projection factors were associated with CAS and SCC codes instead of SAROAD and SCC codes. Metals were associated with the fine SAROAD codes usually but duplicate records were put into the projection factor text files for the coarse SAROAD codes as a precaution.

   Table C-3. Partial listing merged CAS/SAROAD cross-reference with growth factors after sorting by SCC/CAS, eliminating duplicate CAS observations.

SCC	SAROAD	gf99_01	gf99_07	gf99_10	gf99_15	gf99_20	gf99_30	CAS
2280000000	80141	1.0181	1.0743	1.1036	1.1541	1.207	1.3202	136
2280000000	45201	1.0352	1.1188	1.1511	1.2306	1.3505	1.7142	71432
2280000000	80141	1.0181	1.0743	1.1036	1.1541	1.207	1.3202	7440473
2280002200	80141	1.0181	1.0743	1.1036	1.1541	1.207	1.3202	136
2280002200	45201	1.0196	1.0482	1.0498	1.0552	1.0797	1.177	71432
2280002200	80141	1.0181	1.0743	1.1036	1.1541	1.207	1.3202	7440473
2285002005	80141	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	136
2285002005	45201	0.9962	0.9441	0.9127	0.8986	0.8725	0.8277	71432
2285002005	80141	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	7440473
2285002010	80141	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	136
2285002010	45201	0.9962	0.9441	0.9127	0.8986	0.8725	0.8277	71432
2285002010	80141	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	7440473

4. Summed the locomotive and commercial marine vessel emissions from the 1999 NEI nonroad inventory for QA purposes.

   Total locomotive and commercial marine vessels before processing among all HAPs is 13,085.96 tons

5. Merged the nonroad emissions with the projection factors by CAS/SCC across all FIPS, retaining only the locomotive and commercial marine vessel HAP and SCC emissions. Summed the 1999 emissions again to check against the emissions total from step 4. These emissions should be the same.

Table C-4. Partial listing of merged emissions for Los Angeles County, CA (FIPS=06037) after merging nonroad inventory with growth factors.

SCC	FIPS	CAS	emis	gf99_01	gf99_07	gf99_10	gf99_15	gf99_20	gf99_30
2280000000	06037	71432	0.764	1.0352	1.1188	1.1511	1.2306	1.3505	1.7142
2280002200	06037	71432	0.0100924896	1.0196	1.0482	1.0498	1.0552	1.0797	1.177
2280002200	06037	7440473	2.1818725E-6	1.0181	1.0743	1.1036	1.1541	1.207	1.3202
2285002005	06037	71432	5.956	0.9962	0.9441	0.9127	0.8986	0.8725	0.8277
2285002005	06037	7440473	0.001143	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2285002010	06037	71432	1.336	0.9962	0.9441	0.9127	0.8986	0.8725	0.8277
2285002010	06037	7440473	0.0002790113	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Summed emissions of 1999 emissions after merger is 13,085.96.

6. Projected the 1999 emissions to future years at the FIPS/SCC/CAS level by multiplying each future year's growth factor by the 1999 emissions.

7. Output to a SAS® dataset for later use with the other nonroad emissions for projection to future years.

Table C-5. Partial listing of projected emissions (steps 6 and 7). 1999 base emissions and growth factors not shown.

SCC	FIPS	CAS	emis_01	emis_07	emis_10	emis_15	emis_20	emis_30
2280000000	06037	71432	0.7908928	0.8547632	0.8794404	0.9401784	1.031782	1.3096488
2280002200	06037	71432	0.0102903024	0.0105789476	0.0105950955	0.010649595	0.010896861	0.0118788602
2280002200	06037	7440473	2.2213644E-6	2.3439856E-6	2.4079145E-6	2.518099E-6	2.6335201E-6	2.8805081E-6
2285002005	06037	71432	5.9333672	5.6230596	5.4360412	5.3520616	5.19661	4.9297812
2285002005	06037	7440473	0.001143	0.001143	0.001143	0.001143	0.001143	0.001143
2285002010	06037	71432	1.3309232	1.2613176	1.2193672	1.2005296	1.16566	1.1058072
2285002010	06037	7440473	0.0002790113	0.0002790113	0.0002790113	0.0002790113	0.0002790113	0.0002790113

8. Output first two records of projected dataset to manually QA calculations.

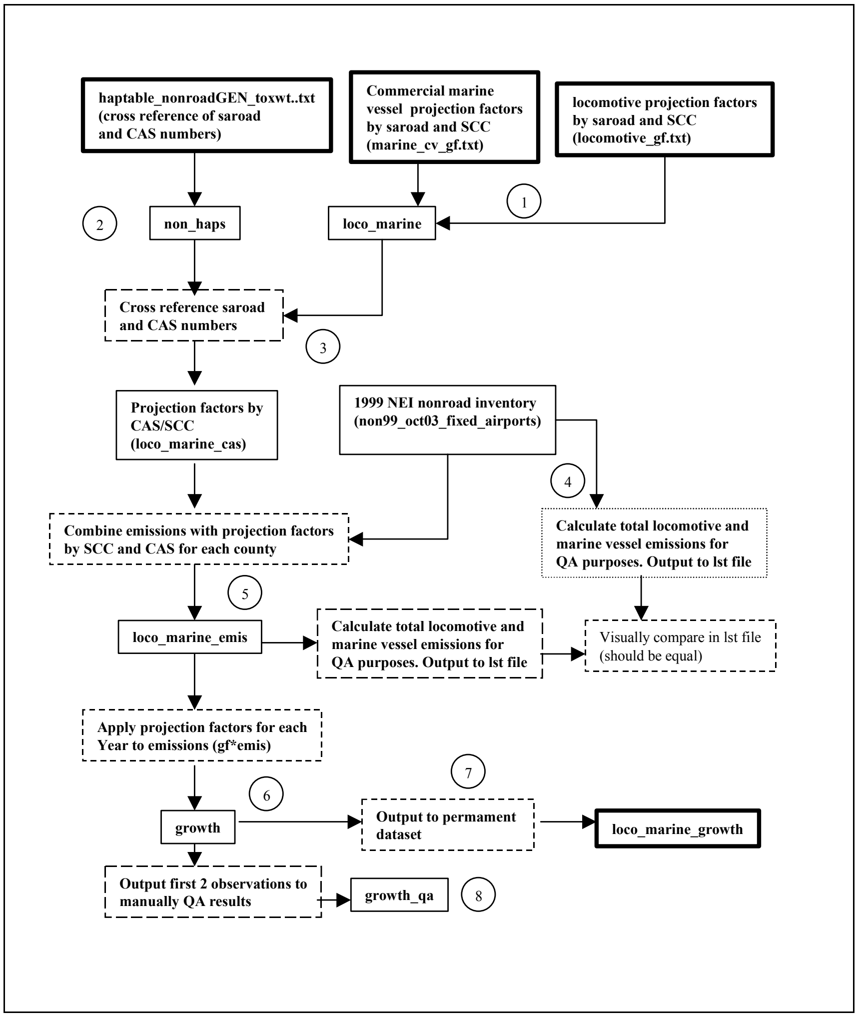

Figure C-3. Projection of 1999 locomotive and commercial marine vessel emissions to 2002, 2007, 2010, 2015, 2020, and 2030. Data is represented by solid boxes with processes or steps denoted by dashed boxes. Input and final output data denoted by heavy solid boxes. Steps outlined in text are shown as circled numbers. Unless otherwise denoted, data represents SAS® datasets.

C.2 Remaining nonroad emissions (excluding aircraft, locomotives, and commercial marine vessels)

The following summarizes the steps used in the SAS® program nonroad.sas (found in the MSAT rule docket EPA-HQ-OAR-2005-0036) with example calculations for Alameda County, CA (FIPS=06001). A detailed flow chart is shown in Figure C-4.

1. The 1999 NEI nonroad inventory was subsetted to the MSAT HAPs, excluding aircraft, marine commercial vessels, and locomotive emissions. These were projected separately from the other nonroad emissions as documented in Section 3.1.

   Table C-6. Partial listing of 1999 NEI nonroad emissions for Alameda County after subsetting inventory to MSAT HAPs and excluding aircraft, locomotive, and commercial marine vessel SCC emissions. SCC descriptions are listed for informational purposes. Emis_nei is the emissions variable and polldesc is the pollutant description.

FIPS	SCC	CAS	emis_nei	polldesc	SCC description
06001	2260001010	1330207	14.317113886	Xylenes (mixture of o, m, and p isomers)	Mobile Sources,Off-highway Vehicle Gasoline, 2-Stroke,Recreational Equipment,Motorcycles: Off-road
06001	2260001010	71432	2.3263908964	Benzene	
06001	2260001010	7440473	0.0000122711	Chromium	
06001	2260002000	108383	0.30705	m-Xylene	Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke,Construction and Mining Equipment, Total
06001	2260002000	71432	0.23736	Benzene	
06001	2260002000	7440473	0.00015	Chromium	
06001	2260002000	95476	0.10695	o-Xylene	
06001	2265008000	108383	0.6141	m-Xylene	Airport Support Equipment, Total, Off-highway 4-stroke
06001	2265008000	71432	0.47472	Benzene	
06001	2265008000	7440473	0.00015	Chromium	
06001	2265008000	95476	0.2139	o-Xylene	
06001	2268003000	108383	0.01102	m-Xylene	Mobile Sources,CNG,Industrial Equipment, All
06001	2268003000	71432	0.12122	Benzene	
06001	2268003000	7440473	0.0013	Chromium	
06001	2268003000	95476	0.01102	o-Xylene	
06001	2282000000	106423	0.0015	p-Xylene	Mobile Sources, Pleasure Craft, All Fuels, Total, All Vessel Types
06001	2282000000	108383	0.00915	m-Xylene	
06001	2282000000	71432	0.03	Benzene	
06001	2282000000	7440473	2E-6	Chromium	
06001	2282000000	95476	0.0051	o-Xylene	

2. NMIM SCC emissions were summed to a "Total" category for each SCC category (first 7 digits of SCC followed by 3 zeros) for each FIPS/HAP/SCC. These SCC codes were found in a separate SAS® program missing_scc.sas (found in the MSAT rule docket EPA-HQ-OAR-2005-0036) that was run before any nonroad processing. See Table 19 for list.

Table C-7. Partial listing of NMIM 1999 and 2015 emissions for Alameda County after summing SCC emissions to total SCC category for each HAP.

FIPS	SCC	CAS	emis99	emis15
06001	2260002000	1330207	14.632461572	5.9177500529
06001	2260002000	16065831	9.9206348E-6	7.218985E-6
06001	2260002000	18540299	5.1106299E-6	3.718871E-6
06001	2260002000	71432	3.3503477212	1.3761635963

3. NMIM pleasure craft emissions, first four SCC digits 2282, were summed and assigned SCC 2282000000 for each FIPS/SCC.

Table C-8. Partial listing of NMIM 1999 and 2015 emissions for Alameda County after summing pleasure craft emissions into one SCC for each HAP (Section 3.4.3, step 3).

FIPS	SCC	CAS	emis99	emis15
06001	2282000000	1330207	45.980996386	18.529284389
06001	2282000000	16065831	0.0000759904	0.0000757439
06001	2282000000	18540299	0.0000391466	0.0000390196
06001	2282000000	71432	9.8014022292	3.6067584954

4. Concatenated the total SCC emissions from step 2 and pleasure craft emissions from step 3.

Table C-9. Partial listing of NMIM emissions and 2015 to 1999 ratios for Alameda County after concatenating the total SCC emissions and the total pleasure craft emissions. Ratio_15 has been renamed ratio.

FIPS	SCC	CAS	emis99	emis15	ratio
06001	2260002000	1330207	14.632461572	5.9177500529	0.4044261469
06001	2260002000	16065831	9.9206348E-6	7.218985E-6	0.7276737009
06001	2260002000	18540299	5.1106299E-6	3.718871E-6	0.727673714
06001	2260002000	71432	3.3503477212	1.3761635963	0.4107524683
06001	2282000000	1330207	45.980996386	18.529284389	0.4029770089
06001	2282000000	16065831	0.0000759904	0.0000757439	0.9967563592
06001	2282000000	18540299	0.0000391466	0.0000390196	0.9967563665
06001	2282000000	71432	9.8014022292	3.6067584954	0.3679839283

5. Concatenated the data from step 4 with the original NMIM inventory.

Table C-10. Partial listing of NMIM emissions after concatenating the total SCC and pleasure craft emissions with the original NMIM emissions.

FIPS	SCC	CAS	emis99	emis15	ratio
06001	2260002000	1330207	14.632461572	5.9177500529	0.4044261469
06001	2260002000	16065831	9.9206348E-6	7.218985E-6	0.7276737009
06001	2260002000	18540299	5.1106299E-6	3.718871E-6	0.727673714
06001	2260002000	71432	3.3503477212	1.3761635963	0.4107524683
06001	2282000000	1330207	45.980996386	18.529284389	0.4029770089
06001	2282000000	16065831	0.0000759904	0.0000757439	0.9967563592
06001	2282000000	18540299	0.0000391466	0.0000390196	0.9967563665
06001	2282000000	71432	9.8014022292	3.6067584954	0.3679839283
06001	2260001010	1330207	9.711512804	14.214579582	1.4636833487
06001	2260001010	16065831	5.1118629E-6	0.0000109192	2.1360424041
06001	2260001010	18540299	2.6333838E-6	5.6250196E-6	2.1360424142
06001	2260001010	71432	1.5561215132	2.2015727758	1.4147820444

6. Extracted chromium III and chromium VI emissions from the output of step 5.

Table C-11. Partial listing of extracted chromium emissions.

FIPS	SCC	CAS	emis99	emis15	ratio
06001	2260001010	16065831	5.1118629E-6	0.0000109192	2.1360424041
06001	2260001010	18540299	2.6333838E-6	5.6250196E-6	2.1360424142
06001	2260002000	16065831	9.9206348E-6	7.218985E-6	0.7276737009
06001	2260002000	18540299	5.1106299E-6	3.718871E-6	0.727673714
06001	2282000000	16065831	0.0000759904	0.0000757439	0.9967563592
06001	2282000000	18540299	0.0000391466	0.0000390196	0.9967563665

7. As with the onroad summed up NMIM chromium III and chromium VI emissions to create total chromium. For the NEI nonroad inventory, chromium was reported with either CAS 136 or CAS 7440473[4]. To make sure all FIPS/SCC/CAS combinations are covered, the summed chromium III and chromium VI emissions were assigned to both Chromium CAS numbers. Therefore temporarily, chromium emissions were double counted while processing the NMIM output.

[4] In the 1999 NEI nonroad inventory (just like in the onroad inventory), chromium was speciated as chromium III and chromium VI. The emissions were summed and re-speciated by EMS-HAP to use a speciation factor of 18% of total chromium is chromium VI.

Table C-12. Partial listing of chromium emissions after summing by FIPS/SCC and assigning unspeciated chromium CAS numbers and calculating a new ratio.

FIPS	SCC	CAS	emis99	emis15	ratio
06001	2260001010	136	7.7452467E-6	0.0000165442	2.1360424076
06001	2260001010	7440473	7.7452467E-6	0.0000165442	2.1360424076
06001	2260002000	136	0.0000150313	0.0000109379	0.7276737054
06001	2260002000	7440473	0.0000150313	0.0000109379	0.7276737054
06001	2282000000	136	0.000115137	0.0001147635	0.9967563617
06001	2282000000	7440473	0.000115137	0.0001147635	0.9967563617

8. Concatenated step 7 output with step 5 output.

Table C-13. Partial listing of NMIM emissions after concatenating chromium emissions with NMIM data.

FIPS	SCC	CAS	emis99	emis15	ratio
06001	2260002000	1330207	14.632461572	5.9177500529	0.4044261469
06001	2260002000	16065831	9.9206348E-6	7.218985E-6	0.7276737009
06001	2260002000	18540299	5.1106299E-6	3.718871E-6	0.727673714
06001	2260002000	71432	3.3503477212	1.3761635963	0.4107524683
06001	2282000000	1330207	45.980996386	18.529284389	0.4029770089
06001	2282000000	16065831	0.0000759904	0.0000757439	0.9967563592
06001	2282000000	18540299	0.0000391466	0.0000390196	0.9967563665
06001	2282000000	71432	9.8014022292	3.6067584954	0.3679839283
06001	2260001010	1330207	9.711512804	14.214579582	1.4636833487
06001	2260001010	16065831	5.1118629E-6	0.0000109192	2.1360424041
06001	2260001010	18540299	2.6333838E-6	5.6250196E-6	2.1360424142
06001	2260001010	71432	1.5561215132	2.2015727758	1.4147820444
06001	2260001010	136	7.7452467E-6	0.0000165442	2.1360424076
06001	2260001010	7440473	7.7452467E-6	0.0000165442	2.1360424076
06001	2260002000	136	0.0000150313	0.0000109379	0.7276737054
06001	2260002000	7440473	0.0000150313	0.0000109379	0.7276737054
06001	2282000000	136	0.000115137	0.0001147635	0.9967563617
06001	2282000000	7440473	0.000115137	0.0001147635	0.9967563617

9. Extracted xylenes, nickel, and manganese observations from step 8 output.

Table C-14. Extracted xylenes emissions.

FIPS	SCC	CAS	emis99	emis15	ratio
06001	2260002000	1330207	14.632461572	5.9177500529	0.4044261469
06001	2282000000	1330207	45.980996386	18.529284389	0.4029770089
06001	2600010210	1330207	9.711512804	14.214579582	1.4636833487

10. As with the onroad processing, copied the NMIM xylenes, nickel, and manganese NMIM observations to duplicate observations with the other xylenes, nickel, and manganese CAS numbers.

Table C-15. Xylenes emissions after copying records to duplicate records and changing CAS numbers to 106423, 108383, and 95476.

FIPS	SCC	CAS	emis99	emis15	ratio
06001	2260002000	106423	14.632461572	5.9177500529	0.4044261469
06001	2260002000	108383	14.632461572	5.9177500529	0.4044261469
06001	2260002000	95476	14.632461572	5.9177500529	0.4044261469
06001	2282000000	106423	45.980996386	18.529284389	0.4029770089
06001	2282000000	108383	45.980996386	18.529284389	0.4029770089
06001	2282000000	95476	45.980996386	18.529284389	0.4029770089
06001	2600010210	106423	9.711512804	14.214579582	1.4636833487
06001	2600010210	108383	9.711512804	14.214579582	1.4636833487
06001	2600010210	95476	9.711512804	14.214579582	1.4636833487

11. Concatenated step 10 output with step 8 output.

Table C-16. Concatenated NMIM emissions and duplicate xylenes emissions.

FIPS	SCC	CAS	emis99	emis15	ratio
06001	2260002000	1330207	14.632461572	5.9177500529	0.4044261469
06001	2260002000	16065831	9.9206348E-6	7.218985E-6	0.7276737009
06001	2260002000	18540299	5.1106299E-6	3.718871E-6	0.727673714
06001	2260002000	71432	3.3503477212	1.3761635963	0.4107524683
06001	2282000000	1330207	45.980996386	18.529284389	0.4029770089
06001	2282000000	16065831	0.0000759904	0.0000757439	0.9967563592
06001	2282000000	18540299	0.0000391466	0.0000390196	0.9967563665
06001	2282000000	71432	9.8014022292	3.6067584954	0.3679839283
06001	2260001010	1330207	9.711512804	14.214579582	1.4636833487
06001	2260001010	16065831	5.1118629E-6	0.0000109192	2.1360424041
06001	2260001010	18540299	2.6333838E-6	5.6250196E-6	2.1360424142
06001	2260001010	71432	1.5561215132	2.2015727758	1.4147820444
06001	2260001010	136	7.7452467E-6	0.0000165442	2.1360424076
06001	2260001010	7440473	7.7452467E-6	0.0000165442	2.1360424076
06001	2260002000	136	0.0000150313	0.0000109379	0.7276737054
06001	2260002000	7440473	0.0000150313	0.0000109379	0.7276737054
06001	2282000000	136	0.000115137	0.0001147635	0.9967563617
06001	2282000000	7440473	0.000115137	0.0001147635	0.9967563617
06001	2260002000	106423	14.632461572	5.9177500529	0.4044261469
06001	2260002000	108383	14.632461572	5.9177500529	0.4044261469
06001	2260002000	95476	14.632461572	5.9177500529	0.4044261469
06001	2282000000	106423	45.980996386	18.529284389	0.4029770089
06001	2282000000	108383	45.980996386	18.529284389	0.4029770089
06001	2282000000	95476	45.980996386	18.529284389	0.4029770089
06001	2600010210	106423	9.711512804	14.214579582	1.4636833487
06001	2600010210	108383	9.711512804	14.214579582	1.4636833487
06001	2600010210	95476	9.711512804	14.214579582	1.4636833487

12. Merged the NEI and NMIM output, nei_dat and nmim_dat, by FIPS/SCC/CAS, retaining all NEI observations. Split the data into a dataset that matched (called okay), i.e. has a projection factor, and into dataset that did not matched (called need_ratio), i.e. no projection factors.

Table C-17. Partial listing of merged NEI and NMIM emissions, with all NEI emissions retained.

FIPS	SCC	CAS	emis_nei	emis99	emis15	ratio
06001	2260001010	1330207	14.317113886	9.711512804	14.214579582	1.4636833487
06001	2260001010	71432	2.3263908964	1.5561215132	2.2015727758	1.4147820444
06001	2260001010	7440473	0.0000122711	7.7452467E-6	0.0000165442	2.1360424076
06001	2260002000	108383	0.30705	14.632461572	5.9177500529	0.4044261469
06001	2260002000	71432	0.23736	3.3503477212	1.3761635963	0.4107524683
06001	2260002000	7440473	0.00015	0.0000150313	0.0000109379	0.7276737054
06001	2260002000	95476	0.10695	14.632461572	5.9177500529	0.4044261469
06001	2265008000	108383	0.6141	.	.	.
06001	2265008000	71432	0.47472	.	.	.
06001	2265008000	7440473	0.00015	.	.	.
06001	2265008000	95476	0.2139	.	.	.
06001	2268003000	108383	0.01102	.	.	.
06001	2268003000	71432	0.12122	.	.	.
06001	2268003000	7440473	0.0013	.	.	.
06001	2268003000	95476	0.01102	.	.	.
06001	2282000000	106423	0.0015	45.980996386	18.529284389	0.4029770089
06001	2282000000	108383	0.00915	45.980996386	18.529284389	0.4029770089
06001	2282000000	71432	0.03	9.8014022292	3.6067584954	0.3679839283
06001	2282000000	7440473	2E-6	0.000115137	0.0001147635	0.9967563617
06001	2282000000	95476	0.0051	45.980996386	18.529284389	0.4029770089

Table C-18. Listing of emissions still needing a ratio with six digit SCC, scc6.

FIPS	scc6	SCC	CAS	emis_nei	emis99	emis15	ratio
06001	226500	2265008000	108383	0.6141	.	.	.
06001	226500	2265008000	71432	0.47472	.	.	.
06001	226500	2265008000	7440473	0.00015	.	.	.
06001	226500	2265008000	95476	0.2139	.	.	.
06001	226800	2268003000	108383	0.01102	.	.	.
06001	226800	2268003000	71432	0.12122	.	.	.
06001	226800	2268003000	7440473	0.0013	.	.	.
06001	226800	2268003000	95476	0.01102	.	.	.

Table C-19. Listing of emissions assigned a ratio with projected emissions, emis.

FIPS	SCC	CAS	emis_nei	emis99	emis15	ratio	emis
06001	2260001010	1330207	14.317113886	9.711512804	14.214579582	1.4636833487	20.955721197
06001	2260001010	71432	2.3263908964	1.5561215132	2.2015727758	1.4147820444	3.2913360685
06001	2260001010	7440473	0.0000122711	7.7452467E-6	0.0000165442	2.1360424076	0.0000262116
06001	2260002000	108383	0.30705	14.632461572	5.9177500529	0.4044261469	0.1241790484
06001	2260002000	71432	0.23736	3.3503477212	1.3761635963	0.4107524683	0.0974962059
06001	2260002000	7440473	0.00015	0.0000150313	0.0000109379	0.7276737054	0.0001091511
06001	2260002000	95476	0.10695	14.632461572	5.9177500529	0.4044261469	0.0432533764
06001	2282000000	106423	0.0015	45.980996386	18.529284389	0.4029770089	0.0006044655
06001	2282000000	108383	0.00915	45.980996386	18.529284389	0.4029770089	0.0036872396
06001	2282000000	71432	0.03	9.8014022292	3.6067584954	0.3679839283	0.0110395178
06001	2282000000	7440473	2E-6	0.000115137	0.0001147635	0.9967563617	1.9935127E-6
06001	2282000000	95476	0.0051	45.980996386	18.529284389	0.4029770089	0.0020551827

13. For remaining FIPS/SCC/CAS combinations in the 1999 NEI that did not match the NMIM results, created county-level HAP specific projection factors based on engine/fuel type by summing emissions for 1999 NMIM and future year NMIM for each FIPS/CAS/engine/fuel type. These were applied to all SCC codes with the relevant engine/fuel type by HAP and by county. The engine fuel types were 2-stroke gasoline, 4-stroke gasoline, diesel, LPG, CNG, and miscellaneous.

Table C-20. Partial listing of Alameda County emissions for SCC6 of 226500.

FIPS	scc6	SCC	CAS	emis99	emis15	ratio
06001	226500	2265008000	108383	428.80604172	253.71038624	0.5916670046
06001	226500	2265008000	71432	324.73697506	197.05535819	0.6068152792
06001	226500	2265008000	7440473	0.0056123247	0.0066134549	1.1783806775
06001	226500	2265008000	95476	428.80604172	253.71038624	0.5916670046

14. Merged the output from step 13, cnty_sum, with the need_ratio dataset from step 12. Separated data into two datasets, observations with a projection factor (fill_data2) and those without a projection factor (need_data2).

Table C-21. Alameda County emissions where a ratio was applied from cnty_sums and applied to NEI emissions to calculate emis variable.

FIPS	scc6	SCC	CAS	emis_nei	emis99	emis15	ratio	emis
06001	226500	2265008000	108383	0.6141	.	.	0.5916670046	0.3633427075
06001	226500	2265008000	71432	0.47472	.	.	0.6068152792	0.2880673493
06001	226500	2265008000	7440473	0.00015	.	.	1.1783806775	0.0001767571
06001	226500	2265008000	95476	0.2139	.	.	0.5916670046	0.1265575723

Table C-22. Alameda County emissions still needing a ratio with a CAS1 variable assigned.

FIPS	scc6	SCC	CAS	CAS1	emis_nei	emis99	emis15	ratio
06001	226800	2268003000	108383	VOC	0.01102	.	.	.
06001	226800	2268003000	71432	VOC	0.12122	.	.	.
06001	226800	2268003000	7440473	PM10-PRI	0.0013	.	.	.
06001	226800	2268003000	95476	VOC	0.01102	.	.	.

15. Even after the above step, there remained CNG and LPG emissions for California and Texas (SCC codes beginning with 226800, 226801, and 226700) from the 1999 NEI without an NMIM based projection factor. Per discussion with Madeleine Strum and Rich Cook, the VOC or PM county level ratios for CNG and LPG as fuel types were calculated and used for the HAPs in the inventory. Particulate HAPs received the PM ratios and gaseous HAPs received the VOC ratios. Calculated county level projection factors by summing VOC or PM emissions across all SCC codes that used CNG and LPG as fuel types for 1999 NMIM and future year NMIM output and dividing the future year summed emissions by the 1999 summed emissions for each county.

Table C-23. Summed VOC and PM10-PRI NMIM emissions for Alameda County by six digit SCC code emissions with ratio.

FIPS	scc6	CAS1	emis99	emis15	ratio_15
06001	226800	PM10-PRI	0.6706211131	1.0020067495	1.4941473358
06001	226800	VOC	2.2227693134	0.3633906096	0.1634855257

16. Merged the projection factors from step 15 (ca_tx_sum) with the need_data2 output from step 14 and apply factors. Output dataset was fill_data3.

Table C-24. Projected emissions for Alameda County using the county sums for LPG and CNG .

FIPS	scc6	SCC	CAS	CAS1	emis_nei	emis	ratio
06001	226800	2268003000	108383	VOC	0.01102	0.0018016105	0.1634855257
06001	226800	2268003000	71432	VOC	0.12122	0.0198177154	0.1634855257
06001	226800	2268003000	7440473	PM10-PRI	0.0013	0.0019423915	1.4941473358.
06001	226800	2268003000	95476	VOC	0.01102	0.0018016105	0.1634855257

17. Concatenated datasets okay, fill_data2, and fill_data3. Output was merged2.

18. Appended the locomotive and commercial marine vessel projected emissions to step 17 output and output data to permanent dataset, nonroad_20xx where xx is 07, 10, 15, 20, or 30.

Table C-25. Projected nonroad emissions with appended locomotive and commercial marine vessels after sorting by FIPS/SCC/CAS (steps 17 and 18).

FIPS	SCC	CAS	emis_nei	ratio	emis
06001	2260001010	1330207	14.317113886	1.4636833487	20.955721197
06001	2260001010	71432	2.3263908964	1.4147820444	3.2913360685
06001	2260001010	7440473	0.0000122711	2.1360424076	0.0000262116
06001	2260002000	108383	0.30705	0.4044261469	0.1241790484
06001	2260002000	71432	0.23736	0.4107524683	0.0974962059
06001	2260002000	7440473	0.00015	0.7276737054	0.0001091511
06001	2260002000	95476	0.10695	0.4044261469	0.0432533764
06001	2265008000	108383	0.6141	0.5916670046	0.3633427075
06001	2265008000	71432	0.47472	0.6068152792	0.2880673493
06001	2265008000	7440473	0.00015	1.1783806775	0.0001767571
06001	2265008000	95476	0.2139	0.5916670046	0.1265575723
06001	2268003000	108383	0.01102	0.1634855257	0.0018016105
06001	2268003000	71432	0.12122	0.1634855257	0.0198177154
06001	2268003000	7440473	0.0013	1.4941473358.	0.0019423915
06001	2268003000	95476	0.01102	0.1634855257	0.0018016105
06001	2280000000	106423	0.0045	1.2306	0.0055377
06001	2280000000	108383	0.02745	1.2306	0.03377997
06001	2280000000	71432	0.09	1.2306	0.110754
06001	2280000000	95476	0.0153	1.2306	0.01882818
06001	2282000000	106423	0.0015	0.4029770089	0.0006044655
06001	2282000000	108383	0.00915	0.4029770089	0.0036872396
06001	2282000000	71432	0.03	0.3679839283	0.0110395178
06001	2282000000	7440473	2E-6	0.9967563617	1.9935127E-6
06001	2282000000	95476	0.0051	0.4029770089	0.0020551827
06001	2285000000	106423	0.038	0.8986	0.0341468
06001	2285000000	108383	0.2318	0.8986	0.20829548
06001	2285000000	71432	0.76	0.8986	0.682936
06001	2285000000	7440473	0.000192	1.0000	0.000192
06001	2285000000	95476	0.1292	0.8986	0.11609912

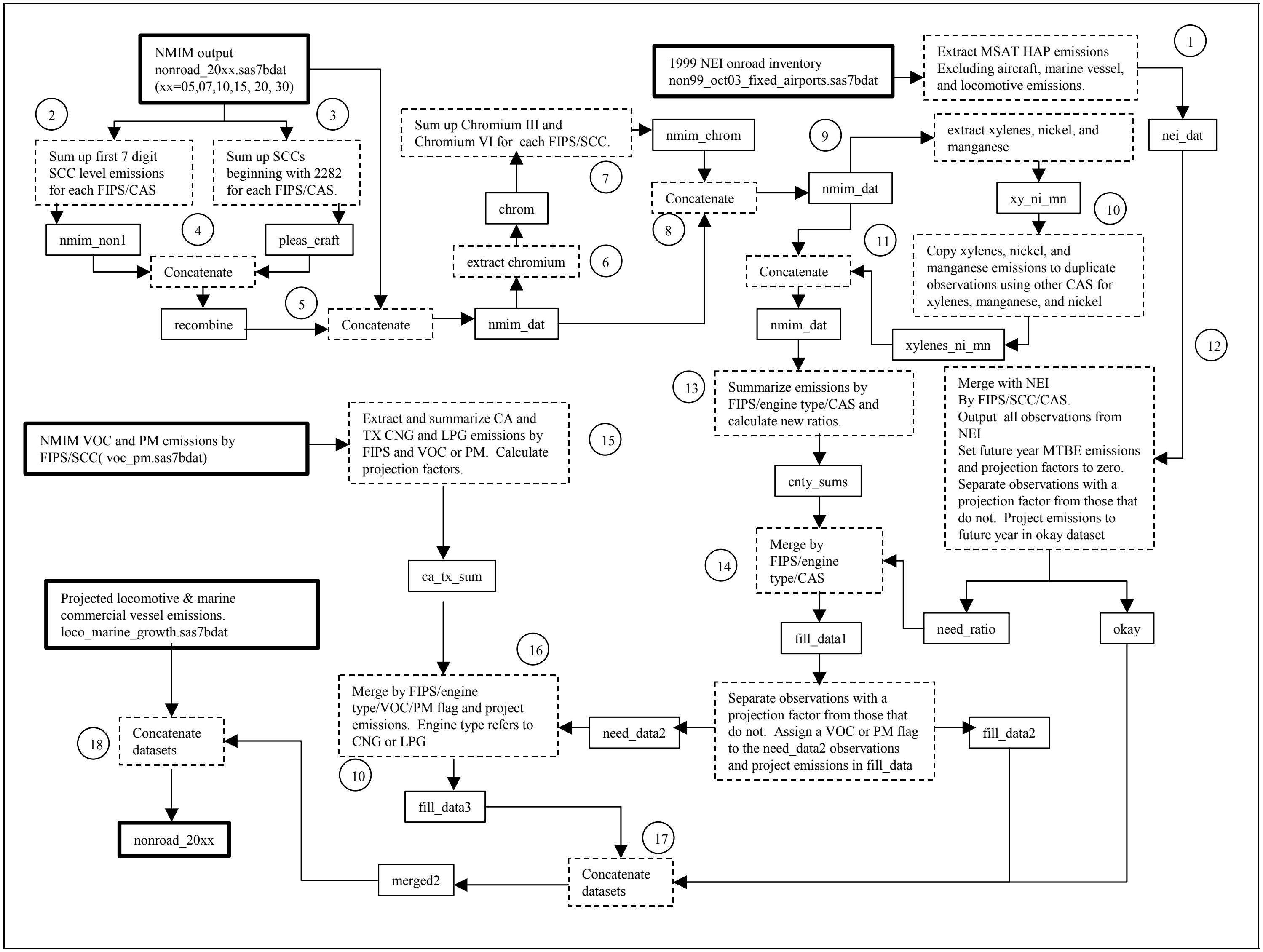

Figure C-4. Flowchart of nonroad projections. Box types as for Figure C-3.

C.3 Nonroad Precursor Emissions

The following contains the steps used for projecting precursors from nonroad emission categories covered by the NONROAD model .

1. Subset 1999 precursor nonroad inventory to the precursors for acetaldehyde, acrolein, formaldehyde, and propionaldehyde using the precursor HAP table from EMS-HAP to get the CAS numbers associated with the appropriate precursors.

2. Excluded locomotive, commercial marine vessel, and aircraft emissions. Also subset data to exclude Puerto Rico and the Virgin Islands. Create a variable called CAS1 with value "VOC."

3. Summed NMIM VOC SCC emissions to a "Total" category for each SCC category (first 7 digits of SCC) for each FIPS/ SCC.

4. Summed up NMIM VOC pleasure craft emissions, first four SCC digits 2282, and assigned SCC 2282000000 for each FIPS/SCC.

5. Combined output from steps 3 and 4 with original NMIM output and calculated new projection factors for the total SCC codes and pleasure craft emissions.

6. Merged the 1999 precursor inventory and NMIM output, by FIPS/SCC/CAS1, retaining all NEI observations.

7. For remaining non-matching FIPS/SCC/CAS combinations, created a county level HAP specific projection factor based on engine/fuel type by summing emissions for 1999 and future year NMIM VOC for each FIPS and calculate a county level projection factor. These were then assigned to all FIPS/SCC codes for each pollutants based on engine type. The engine fuel types were: 2-stroke gasoline, 4-stroke gasoline, diesel, LPG, CNG, residual, and miscellaneous.

8. Merged the output from step 6,with output from step 7.

9. Appended output from step 8 to the matched data from step 6 and applied projection factors to create 2015, 2020, and 2030 emissions.

10. Extracted precursor locomotive and commercial marine vessel emissions from the precursor locomotive and commercial marine vessel projected inventory.

11. Appended output from step 10 to step 9 output.

12. Extracted 1,3-butadiene, acetaldehyde, MTBE, and methanol nonroad emissions (excluding aircraft) from the interpolated nonroad inventory (see Appendix B) that contains MSAT and non-MSAT HAPs.

13. Appended output from step 12 to output from step 11.

14. Split data into separate datasets for 2015, 2020, and 2030.

The flowchart of the processing is shown in Figure C-5.

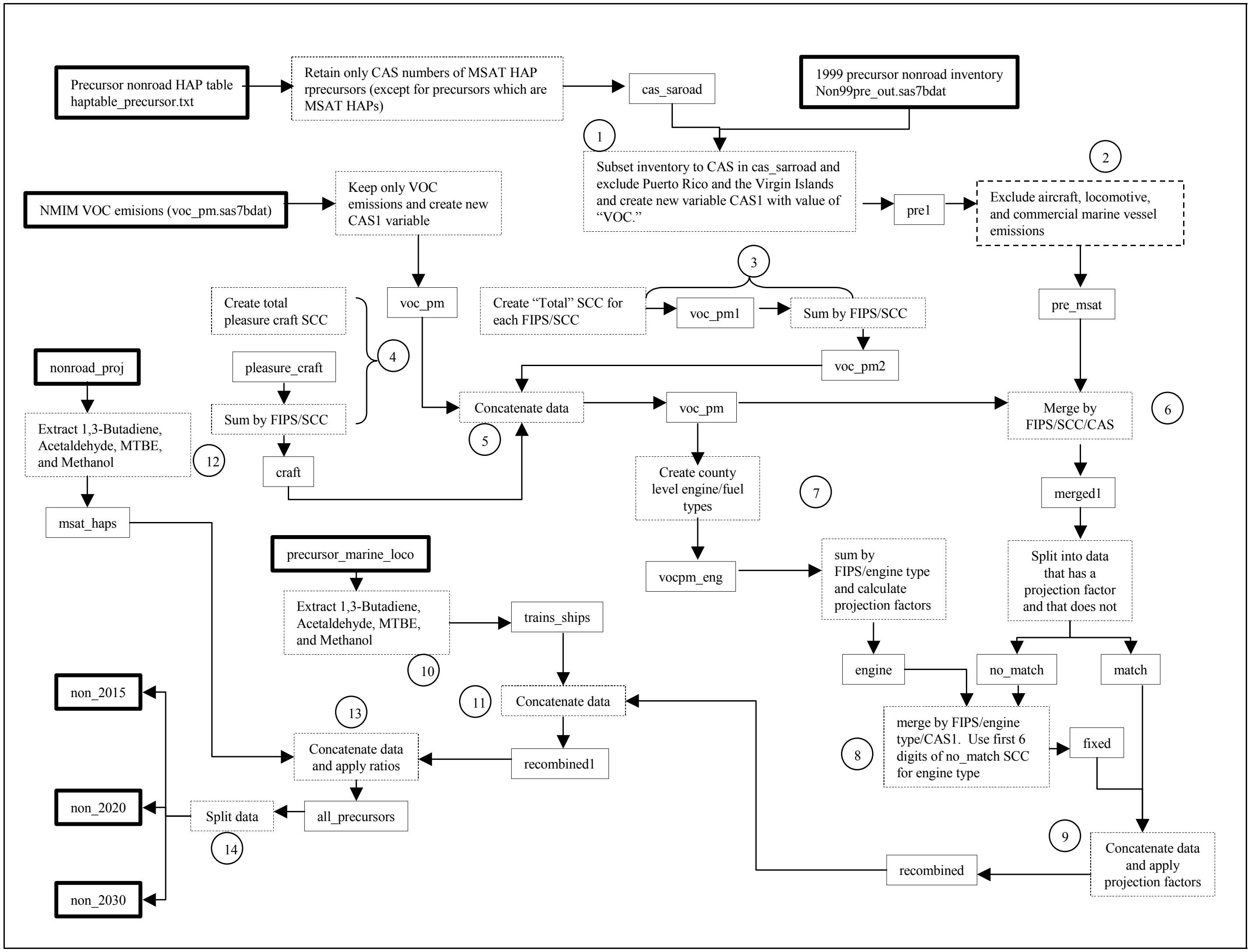

Figure C-5. Nonroad projection processing for precursors.

C.4 Non-MSAT HAPs non-road processing

The remaining nonroad inventory contained HAPs not covered by the NMIM results. These included Antimony, Beryllium, Cadmium, Chlorine, Cobalt, Cumene, Lead, Methanol, Methyl Ethyl Ketone, Phenol, Phosphorus, and Selenium. In order to project these HAPs for the GPRA project, NMIM VOC and PM emissions would be used to calculate the projection factors instead of the actual HAP emissions as done for the MSAT HAPs. The metals, Antimony, Beryllium, Cadmium, Cobalt, Lead, and Selenium would use the PM emissions for projection and all the other HAPs would use the VOC emissions.

The processing of the nonroad inventory for non MSAT HAPs followed a very similar procedure as the nonroad processing for MSAT HAPs:

1. Subset 1999 NEI nonroad inventory to the non MSAT HAPs, excluding aircraft, marine commercial vessels, and locomotive emissions. These were projected separately from the other nonroad emissions as documented in Section 3.1. Assign a variable, CAS1 denoting whether the HAP is to use VOC or PM projection factors. CAS1 = VOC for HAPs using VOC and CAS1 = PM for HAPs using PM factors.

2. Assigned a CAS1 flag to the NMIM output to be used for merger with the NEI data. CAS1=CAS.

3. Summed NMIM SCC emissions to a "Total" category for each SCC category (first 7 digits of SCC) for each FIPS/CAS1/SCC.

4. Summed up NMIM pleasure craft emissions by FIPS/CAS1, first four SCC digits 2282, and assign SCC 2282000000 to these emissions. Combine these emissions and the emissions from step 3 to the original NMIM output.

5. Merged the NEI and NMIM output, by FIPS/SCC/CAS1, retaining all NEI observations. Split the data into a dataset that matched i.e. has a projection factor, and into dataset that did not matched, i.e. no projection factors.

6. For remaining non-matching FIPS/CAS/HAP combinations, created a county level VOC or PM specific projection factor based on engine/fuel type by summing emissions for 1999 and future year NMIM for each FIPS/HAP where HAP is VOC and PM and calculate a county level projection factor. These were then assigned to all SCC codes for each CAS based on the CAS1 value. The engine fuel types were: 2-stroke gasoline, 4-stroke gasoline, diesel, LPG, CNG, and miscellaneous.

7. Merged the output from step 6, cnty_sum, with the nonmatched dataset from step 5. Separate data into two datasets, observations with a projection factor (fill_data2) and those without a projection factor (need_data2).

8. Concatenated output datasets from step 7 and the matched dataset from step 5.

9. Appended the non-MSAT locomotive and commercial marine vessel emissions and aircraft projected emissions to the output from step 8.

10. Projected the emissions to non-MSAT years using Equations 3 and 4.

After projecting the non-MSAT emissions, the MSAT HAPs were appended to the non-MSAT projections. This included the locomotive and commercial marine vessel emissions. Also MSAT projected aircraft emissions were appended to the data. MSAT HAPs were then projected to non-MSAT years using Equations 3 and 4.

Appendix D: Risk Calculations

D.1 Cancer risk calculation methodology

The following steps detail the cancer risk calculations in cancer_risk.sas (found in the MSAT rule docket EPA-HQ-OAR-2005-0036).

1. Read in a sorted a SAS® dataset of census tracts and retained FIPS, state name, county name, tract ID, and tract population.

2. Read in the URE and carcinogenic class for each MSAT HAP from the SAS® dataset msat_haps_tox_factors.sas7bdat (found in the MSAT rule docket EPA-HQ-OAR-2005-0036), keeping only HAPs where the URE is nonzero and nonmissing. The dataset, msat_haps_tox_factors.sas7bdat was created from the ACCESS table, 0Toxicity in Master.mdb from Roy Smith.

3. From the output of step 2, created a list of HAPs by SAROAD to be read in by a SAS® macro for further processing, beginning with step 4.

4. Read in the tract level HAPEM5 output.

5. Merged the output from step 4 with the URE data from step 2 using PROC SQL.

6. Merged the tract population data from step 1 with the output from step 5.

7. For each source sector in each tract, multiplied the tract level source sector concentration by the URE.

8. Output the tract level risk estimates to a permanent dataset for the HAP.

9. After computing risk estimates for each HAP, appended the HAP risk estimates to a master dataset containing risk estimates for all HAPs.

Steps 5 through 9 were executed in the SAS® macro calc_risk.

10. Repeated steps 4 through 9 for each HAP in the MACRO calc_risk.

11. Sorted the master dataset by carcinogen class and FIPS/tract and summed the source category risks within carcinogen classes for each FIPS and tract. For example, for each tract, summed the risks for 1,3-butadiene, benzene, and nickel for Class A carcinogens.

12. From the output of step 11, output permanent datasets for each carcinogen class.

13. Sorted the master dataset by FIPS/TRACT and calculate a total risk (across all HAPs) for each source sector at the tract level.

14. Output the total risk estimates to a permanent dataset.

15. Calculated national risk distributions (percentiles and median) for each source category for each carcinogen class across all census tracts.

16. Calculated a national risk distribution for each source category across all tracts and carcinogen class, i.e. total risk.

17. Concatenated outputs from step 15 and step 16.

18. Output to a permanent dataset.

All 18 steps are done in the SAS® MACRO main for each modeling year and 1999 where the argument for the macro is the year and the flowchart of the program is shown in Figure D-1.

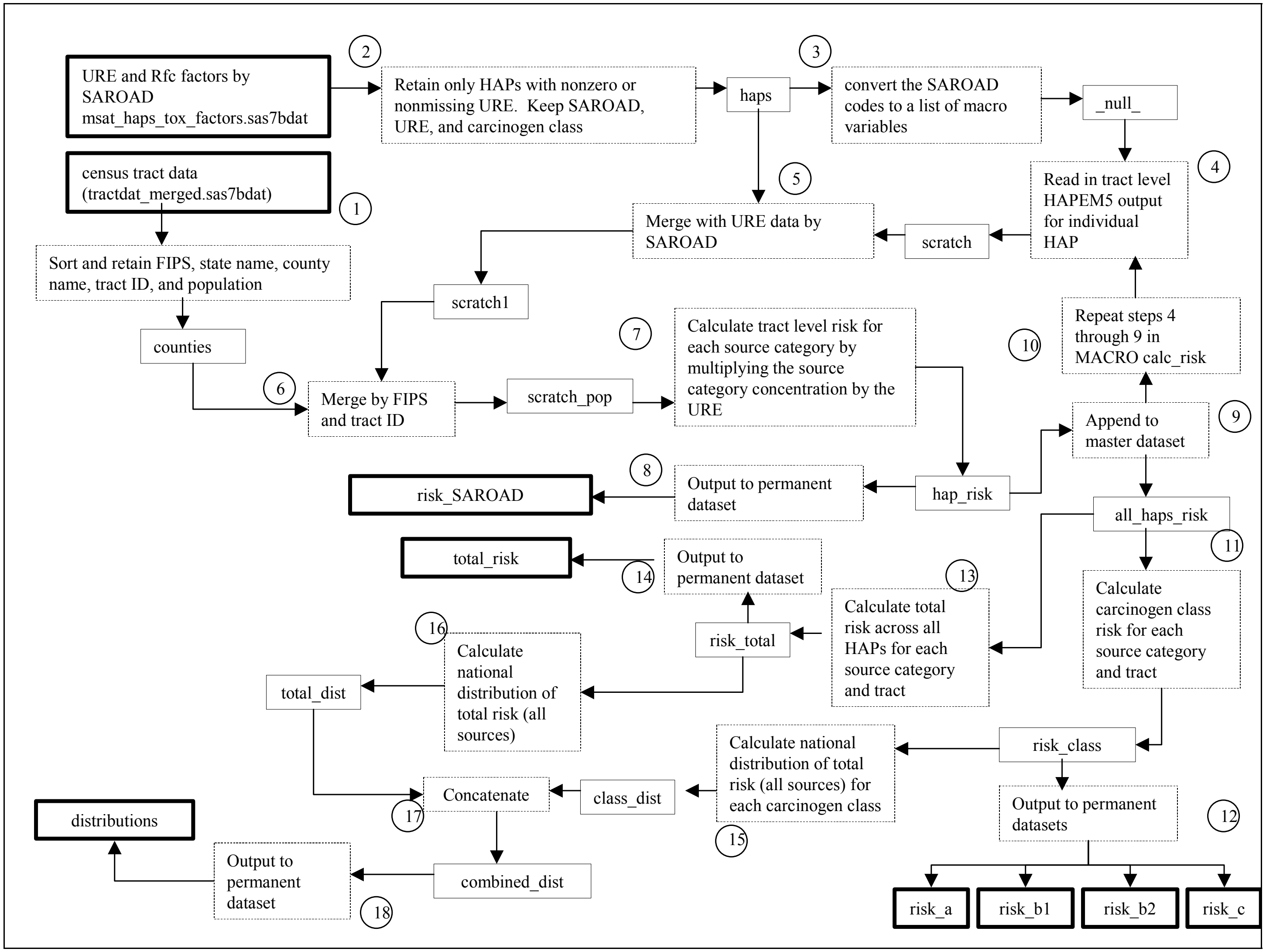

Figure D-1. Flowchart of the cancer risk calculations in cancer.sas.

D.2 Non-cancer Risk Calculation methodology

The following steps were used to calculate hazard quotients and hazard indices and summary statistics for 1999, 2015, 2020, and 2030 in the program noncancer.sas (found in the MSAT rule docket EPA-HQ-OAR-2005-0036):

1. Read in and sorted a SAS® dataset of census tracts retain FIPS, state name, county name, tract ID, and tract population.

2. Read in the Rfc and target organ system(s) for each MSAT HAP from the SAS® dataset msat_haps_tox_factors.sas7bdat, keeping only HAPs where the Rfc was non-zero and non-missing.

3. From the output of step 1, created a list of HAPs by SAROAD to be read in by a SAS® macro for further processing, beginning with step 4.

4. The tract level HAPEM5 output was read into a dataset.

5. Merged the output from step 4 with the Rfc data from step 2 using PROC SQL.

6. Merged the tract population data from step 1 with the output from step 5.

7. For each source category, multiplied the tract level source category concentrations by 0.001 and then divided by the Rfc to calculate the HAP's hazard quotient (HQ).

8. Output the tract level HQ estimates to a permanent dataset for the HAP.

9. Appended the HAP HQ estimates to a master dataset.

   Steps 4 through 9 were executed in the SAS® MACRO calc_hq.

10. Repeated steps 4 through 9 for each HAP in the MACRO calc_hq.

11. After performing steps 4 through 9 for each HAP, the master dataset was separated into multiple datasets, one for each target organ system. If a HAP affected more than one organ system, such as hexane, its HQ estimates would go to both the datasets for respiratory and neurological organ systems.

12. Sorted each organ system dataset by FIPS/tract and calculated a hazard index (HI) for the organ system by summing the individual HQ estimates at the FIPS/tract level. This was done for each source category (major, area, onroad gasoline, etc.).

13. Output each organ system's HI tract level estimates to a permanent dataset.

14. Calculated a national distribution of HI estimates for each source category for the organ systems across all census tracts.

15. Output distribution to dataset named for organ system.

16. Repeat steps 12 through 15 in the MACRO stats.

17. Once the HI and distributions had been calculated for each organ system, concatenated all the datasets into one dataset.

18. Sorted step 17 output by organ system and output to a permanent dataset.

All 18 steps were done for each modeling year and 1999 in the SAS® macro main with the macro's argument as the year and the processing is shown in Figure D-2.

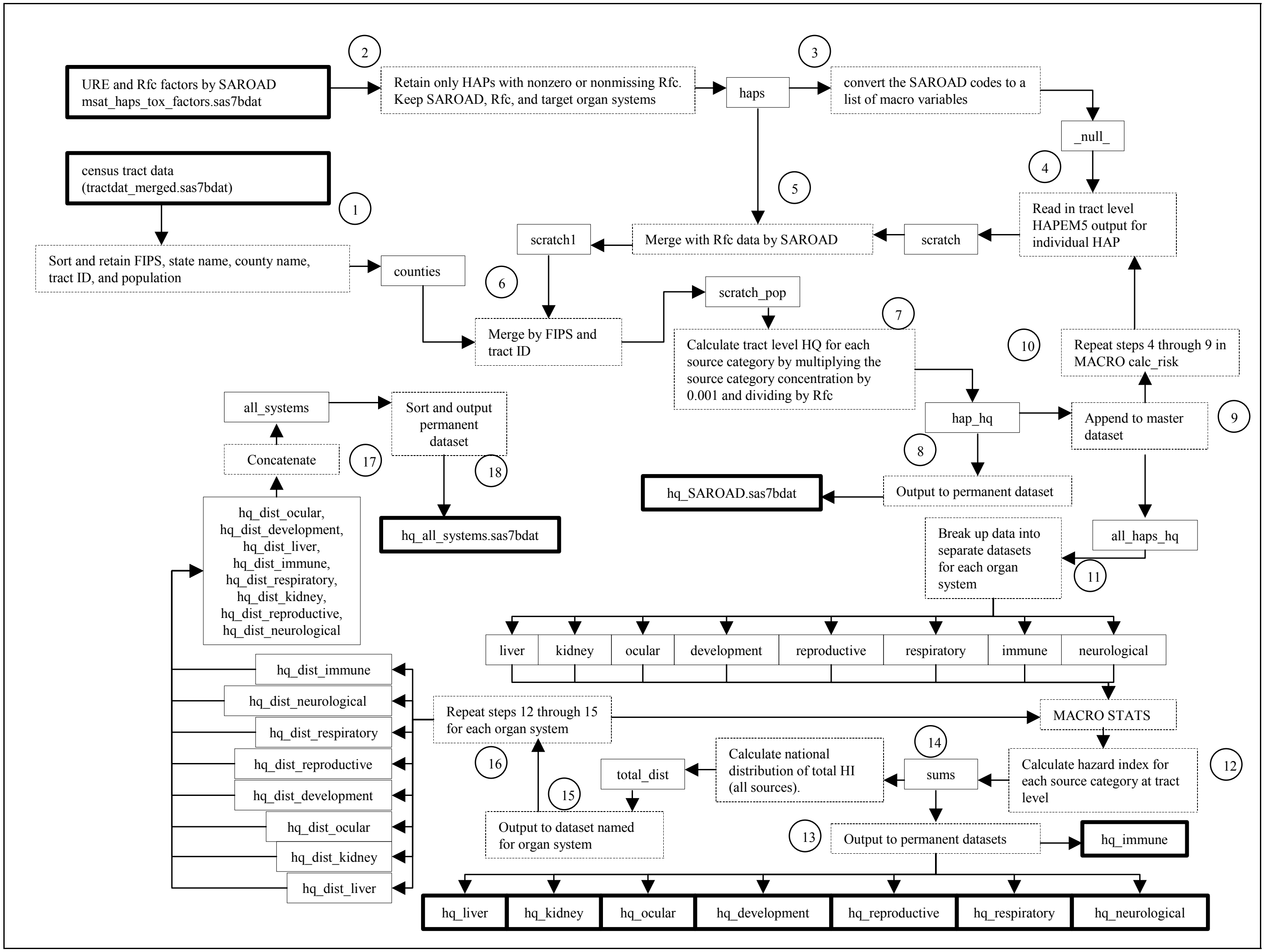

Figure D-2. Flowchart of the HQ and HI calculations in noncancer.sas.

Appendix E: Control of stationary refueling and gasoline marketing emissions

Steps used in project_stationary_benz.sas (found in the MSAT rule docket EPA-HQ-OAR-2005-0036) to develop the controlled gasoline inventories for benzene are listed below with example calculations for 2015 for Imperial County, CA (FIPS=06025) and Denver County, CO (FIPS=08031).

1. Read the comma delimited county level refueling emissions for benzene and VOC and convert the integer state and county FIPS codes to character and combining into one code for the state/county. Retain records for benzene only.

Perform step 1 for 2015 control emissions, 2015 base emissions, 2020 control emissions, and 2020 base emissions, resulting in step 1 being executed four times.

2. Once the 2015 and 2020 control and base cases have been read into SAS®, merged the emissions by FIPS/CAS so that the control and base for both years are in one dataset.

Table E-1. Partial listing of 2015 and 2020 base and controlled refueling emissions after merger (Steps 1 and 2).

FIPS	CAS	refuel_15_base	refuel_15_control	refuel_20_base	refuel_20_control
06025	71432	0.123459112	0.0740812439	0.1337206137	0.0802398396
08031	71432	1.0662192751	0.6716807497	1.1037468356	0.695301335

3. Calculated 2015 projection factor by dividing the 2015 control refueling emissions by the 2015 base refueling emissions and calculated 2020 projection factor by dividing the 2020 control refueling emissions by the 2020 base refueling emissions.

Table E-2. Partial listing of refueling projection factors after dividing control emissions by base emissions.

FIPS	CAS	pf15_refuel	pf20_refuel
06025	71432	0.6000467907	0.6000558732
08031	71432	0.6299649288	0.6299463904

4. Read in a text file containing the FIPS codes for the 3,141 counties in the U.S. with their RFG status. Create a flag denoting the county as CG or RFG, rfg_status. If a county is an RFG county, rfg_status='RFG', otherwise rfg_status='CG.'

Table E-3. Rfg status of Imperial and Denver counties. RFG=reformulated gasoline, CG=conventional gasoline.

FIPS	rfg_status
06025	RFG
08031	CG

5. Sorted a SAS® dataset of all 66,300 tracts by FIPS, eliminating double values of FIPS and Puerto Rico and the Virgin Islands. Retain the FIPS and 2 letter state abbreviation.

6. Assign the PADD region to the counties based on 2-letter state abbreviation.

Table E-4. Partial listing of counties after assign PADD region (Steps 5 and 6).

Region	FIPS	state
CA	06025	CA
PADD4	08031	CO

7. Sorted the output of step 4, the rfg status data, by FIPS.

Table E-5. Rfg status of Imperial and Denver counties after sorting.

FIPS	rfg_status
06025	RFG
08031	CG

8. Merged the rfg status data (step 4 output) with the PADD/county data (output of step 5) and the refueling projection factors (step 3 output) by FIPS, retaining matching observations.

Table E-6. Partial listing of counties after merging counties with rfg status and refueling projection factors.

Region	FIPS	state	rfg_status	CAS	pf15_refuel	pf20_refuel
CA	06025	CA	RFG	71432	0.6000467907	0.6000558732
PADD4	08031	CO	CG	71432	0.6299649288	0.6299463904

9. Create a dataset containing PADD region identifiers and emissions to develop projection factors for the gasoline marketing and distribution emissions (excluding refueling).

10. Calculate the projection factors for the PADD regions output from step 9.

Table E-7. PADD regions and percentages (Steps 9 and 10).

Region	rfg_status	start	end	pf
PADD1	CG	0.91	0.55	0.6043956044
	RFG	0.59	0.54	0.9152542373
PADD2	CG	1.26	0.68	0.5396825397
	RFG	0.80	0.71	0.8875
PADD3	CG	0.95	0.54	0.5684210526
	RFG	0.57	0.55	0.9649122807
PADD4	CG	1.47	0.93	0.6326530612
	RFG	1.05	0.62	0.5904761905
PADD5	CG	1.42	0.85	0.5985915493
	RFG	0.65	0.60	0.9230769231
CA	CG	0.62	0.61	0.9838709677
	RFG	0.62	0.61	0.9838709677

11. Merged the output of step 8 with the step 10 output by FIPS using PROC SQL so that each county was assigned a PADD region and projection factor for gasoline marketing and distribution.

Table E-8. Refueling projection factors and gasoline marketing projection factors after merging the county dataset with the PADD regions dataset.

Region	FIPS	state	rfg_status	CAS	pf15_refuel	pf20_refuel	pf
CA	06025	CA	RFG	71432	0.6000467907	0.6000558732	0.9838709677
PADD4	08031	CO	CG	71432	0.6299649288	0.6299463904	0.6326530612

12. Read in a text file of SCC codes pertaining to gasoline marketing and distribution. Created a variable called gas_flag and gave it a value of 1 to help identify these codes in the inventory later.

Table E-9. Partial listing of gasoline marketing and distribution SCC codes with flag indicating them as marketing/distribution SCC codes. SCC descriptions added for reference only.

SCC	gas_flag	Description
2501000000	1	Storage and Transport; Petroleum and Petroleum Product Storage; All Storage Types: Breathing Loss; Total: All Products
2501050120	1	Storage and Transport; Petroleum and Petroleum Product Storage; All Storage Types: Breathing Loss; Total: All Products
2501060050	1	Storage and Transport; Petroleum and Petroleum Product Storage; Gasoline Service Stations; Stage 1: Total
2501060051	1	Storage and Transport; Petroleum and Petroleum Product Storage; Gasoline Service Stations; Stage 1: Submerged Filling
2501060052	1	Storage and Transport; Petroleum and Petroleum Product Storage; Gasoline Service Stations; Stage 1: Splash Filling

Steps 13 through 20 are performed in the MACRO point for the following cases: 2015 point inventory, 2015 non-point airport inventory, 2020 point inventory, and 2020 non-point airport inventory.

13. From the projected point or airport inventory for 2015 or 2020, pull the benzene emissions, based on SAROAD code = 45201, from the inventory. Calculate a variable, gcemis which is the average of the eight temporally allocated emissions, for QA purposes.

Table E-10. Partial listing of benzene point source emissions with key variables.

FIPS	site_id	emrelpid	src_type	SCC	temis1	temis2	temis3	temis4	temis5	temis6	temis7	temis8
06025	06025-13151144	111-11-1	AREA	40688801	0.00033	0.00033	0.00033	0.00033	0.00033	0.00033	0.00033	0.00033
06025	06025-13151177	3081-308-1	AREA	40600403	0.01006	0.01006	0.01006	0.01006	0.01006	0.01006	0.01006	0.01006
06025	06025-13151115	2M-3-2	AREA	10300601	0.02940	0.02940	0.02940	0.02940	0.02940	0.02940	0.02940	0.02940
08031	08031-1194	001-001-01	AREA	40400401	0.01398	0.01398	0.01398	0.01398	0.01398	0.01398	0.01398	0.01398
08031	08031-1713	001-001-03	AREA	40600401	0.07731	0.07731	0.07731	0.07731	0.07731	0.07731	0.07731	0.07731
08031	08031-13388	69583-55912-69185	AREA	10100601	0.00253	0.00252	0.00254	0.00255	0.00267	0.00254	0.00255	0.00253

14. Using PROC SQL, merge the benzene emissions from step 13 with the SCC list created in step 12 by SCC, retaining all observations and data from the benzene inventory and the gas_flag variable. Emissions that are not gasoline marketing/distribution will have a missing value for the gas_flag and emissions that are gasoline marketing/distribution will have a value of 1 for the gas_flag.

Table E-11. Partial listing of benzene point sources after merging with gasoline marketing/distribution SCC list.

FIPS	site_id	emrelpid	src_type	SCC	temis1	temis2	temis3	temis4	temis5	temis6	temis7	temis8	gas_flag
06025	06025-13151144	111-11-1	AREA	40688801	0.00033	0.00033	0.00033	0.00033	0.00033	0.00033	0.00033	0.00033	1
06025	06025-13151177	3081-308-1	AREA	40600403	0.01006	0.01006	0.01006	0.01006	0.01006	0.01006	0.01006	0.01006	.
06025	06025-13151115	2M-3-2	AREA	10300601	0.02940	0.02940	0.02940	0.02940	0.02940	0.02940	0.02940	0.02940	.
08031	08031-1194	001-001-01	AREA	40400401	0.01398	0.01398	0.01398	0.01398	0.01398	0.01398	0.01398	0.01398	1
08031	08031-1713	001-001-03	AREA	40600401	0.07731	0.07731	0.07731	0.07731	0.07731	0.07731	0.07731	0.07731	.
08031	08031-13388	69583-55912-69185	AREA	10100601	0.00253	0.00252	0.00254	0.00255	0.00267	0.00254	0.00255	0.00253	.

15. Split the benzene inventory into two datasets: gasoline and others. Output observations to the gasoline dataset if they have a value of 1 for the gas_flag OR they are a vehicle refueling SCC (shown in Table 23). Otherwise output to the others dataset. The others dataset contains non-gasoline marketing/distribution or vehicle refueling emissions.

Table E-12. Partial listing of gasoline related emissions after splitting gasoline related emissions and non-gasoline related emissions.

FIPS	site_id	emrelpid	src_type	SCC	temis1	temis2	temis3	temis4	temis5	temis6	temis7	temis8	gas_flag
06025	06025-13151144	111-11-1	AREA	40688801	0.00033	0.00033	0.00033	0.00033	0.00033	0.00033	0.00033	0.00033	1
06025	06025-13151177	3081-308-1	AREA	40600403	0.01006	0.01006	0.01006	0.01006	0.01006	0.01006	0.01006	0.01006	.
08031	08031-1194	001-001-01	AREA	40400401	0.01398	0.01398	0.01398	0.01398	0.01398	0.01398	0.01398	0.01398	1
08031	08031-1713	001-001-03	AREA	40600401	0.07731	0.07731	0.07731	0.07731	0.07731	0.07731	0.07731	0.07731	.

Table E-13. Partial listing of non-gasoline related emissions after splitting gasoline related emissions and non-gasoline related emissions.

FIPS	site_id	emrelpid	src_type	SCC	temis1	temis2	temis3	temis4	temis5	temis6	temis7	temis8	gas_flag
06025	06025-13151115	2M-3-2	AREA	10300601	0.02940	0.02940	0.02940	0.02940	0.02940	0.02940	0.02940	0.02940	.
08031	08031-13388	69583-55912-69185	AREA	10100601	0.00253	0.00252	0.00254	0.00255	0.00267	0.00254	0.00255	0.00253	.

16. Using PROC SQL, merge the gasoline dataset from step 15 with the projection factor data from step 11 by FIPS.

Table E-14. Partial listing of gasoline related emissions with projection factors. Note not all variables shown because of space.

FIPS	site_id	SCC	temis1	temis2	temis3	temis4	temis5	temis6	temis7	temis8	gas_flag	pf	pf15_refuel
06025	06025-13151144	40688801	0.00033	0.00033	0.00033	0.00033	0.00033	0.00033	0.00033	0.00033	1	0.98387	0.60005
06025	06025-13151177	40600403	0.01006	0.01006	0.01006	0.01006	0.01006	0.01006	0.01006	0.01006	.	0.98387	0.60005
08031	08031-1194	40400401	0.01398	0.01398	0.01398	0.01398	0.01398	0.01398	0.01398	0.01398	1	0.63265	0.62996
08031	08031-1713	40600401	0.07731	0.07731	0.07731	0.07731	0.07731	0.07731	0.07731	0.07731	.	0.63265	0.62996

17. Apply the projection factors to each of the eight temporally allocated projected emissions. If a gasoline marketing/distribution SCC emission (gas_flag=1), apply the projection factor based on the PADD data from step 10. Otherwise, multiply each of the temporally allocated projected emissions by the appropriate year's projection factor for vehicle refueling.

Table E-15. Partial listing of gasoline related emissions after applying appropriate projection factors to emissions. Emissions with gas_flag=1 use the pf number while the others use the pf15_refuel number.

FIPS	site_id	SCC	temis1	temis2	temis3	temis4	temis5	temis6	temis7	temis8	gas_flag	pf	pf15_refuel
06025	06025-13151144	40688801	0.00033	0.00033	0.00033	0.00033	0.00033	0.00033	0.00033	0.00033	1	0.98387	0.60005
06025	06025-13151177	40600403	0.00604	0.00604	0.00604	0.00604	0.00604	0.00604	0.00604	0.00604	.	0.98387	0.60005
08031	08031-1194	40400401	0.00885	0.00885	0.00885	0.00885	0.00885	0.00885	0.00885	0.00885	1	0.63265	0.62996
08031	08031-1713	40600401	0.04870	0.04870	0.04870	0.04870	0.04870	0.04870	0.04870	0.04870	.	0.63265	0.62996

18. Concatenate the output of step 17 with the others dataset created in step 15. Note the projected and controlled emissions from step 17 have the same variable name as the projected only emissions from the dataset others. This is to keep consistency for PtFinal_ASPEN.

19. Sort the concatenated data from step 18 by FIPS site id emrelpid SAROAD MACT SIC and SCC and output to a permanent dataset.

Table E-16. Partial listing of point emissions after concatenating controlled emissions with the non-gasoline emissions, sorting, and output to a permanent dataset (Steps 18 and 19).

FIPS	site_id	emrelpid	src_type	SCC	temis1	temis2	temis3	temis4	temis5	temis6	temis7	temis8
06025	06025-13151115	2M-3-2	AREA	10300601	0.02940	0.02940	0.02940	0.02940	0.02940	0.02940	0.02940	0.02940
06025	06025-13151144	111-11-1	AREA	40688801	0.00033	0.00033	0.00033	0.00033	0.00033	0.00033	0.00033	0.00033
06025	06025-13151177	3081-308-1	AREA	40600403	0.00604	0.00604	0.00604	0.00604	0.00604	0.00604	0.00604	0.00604
08031	08031-1194	001-001-01	AREA	40400401	0.00885	0.00885	0.00885	0.00885	0.00885	0.00885	0.00885	0.00885
08031	08031-13388	69583-55912-69185	AREA	10100601	0.00253	0.00252	0.00254	0.00255	0.00267	0.00254	0.00255	0.00253
08031	08031-1713	001-001-03	AREA	40600401	0.04870	0.04870	0.04870	0.04870	0.04870	0.04870	0.04870	0.04870

20. Sort the 1999 non-point COPAX output for non-airport emissions by SCC to get the surrogate codes used in EMS-HAP. Sort only where the CAS = 71432 (benzene). This data is needed to merge with the controlled non-point emissions for EMS-HAP input.

Table E-17. Partial listing of non-point SCC codes and surrogate codes. SCC and surrogate descriptions added for informational purposes only.

SCC	spatsurr	SCC description	Surrogate description
2102004000	505	Stationary Source Fuel Combustion; Industrial; Distillate Oil; Total: Boilers and IC Engines	Industrial land
2501050120	650	Storage and Transport; Petroleum and Petroleum Product Storage; Bulk Stations/Terminals: Breathing Loss; Gasoline	Refineries and tank farms
2501060102	600	Storage and Transport; Petroleum and Petroleum Product Storage; Gasoline Service Stations; Stage 2: Displacement Loss/Controlled	Gas stations

Steps 21-28 are performed in the MACRO nonpoint for the following cases: 2015 non-point (excluding airport emissions) and 2020 non-point (excluding airport emissions).

21. Extract the benzene emissions from the projected non-point inventory and assign the benzene CAS number to the observations.

Table E-18. Partial listing of benzene non-point emissions with key variables.

FIPS	CAS	SCC	emisgc
06025	71432	2102004000	1.3460706
06025	71432	2501050120	0.08181288
06025	71432	2501060102	0.067603788

22. Using PROC SQL, merge the benzene emissions from step 22 with the gasoline marketing/distribution SCC list from step 12, retaining all observations and data from the benzene inventory and the gas_flag variable. Emissions that are not gasoline marketing/distribution will have a missing value for the gas_flag and emissions that are gasoline marketing/distribution will have a value of 1 for the gas_flag.

Table E-19. Partial listing of benzene emissions after merging with the gasoline marketing/distribution SCC list.

FIPS	CAS	SCC	emisgc	gas_flag
06025	71432	2102004000	1.3460706	.
06025	71432	2501050120	0.08181288	1
06025	71432	2501060102	0.067603788	.

23. Split the benzene inventory into two datasets: gasoline and others. Output observations to the gasoline dataset if they have a value of 1 for the gas_flag OR they are a vehicle refueling SCC (shown in Table X). Otherwise output to the others dataset. The others dataset contains non-gasoline marketing/distribution or vehicle refueling emissions.

Table E-20. Partial listing of benzene gasoline related emissions after splitting gasoline and non-gasoline emissions.

FIPS	CAS	SCC	emisgc	gas_flag
06025	71432	2501050120	0.08181288	1
06025	71432	2501060102	0.067603788	.

Table E-21. Partial listing of benzene non-gasoline related emissions after splitting gasoline and non-gasoline emissions.

FIPS	CAS	SCC	emisgc	gas_flag
06025	71432	2102004000	1.3460706	.

24. Using PROC SQL, merge the gasoline dataset from step 24 with the projection factor data from step 11 by FIPS.

Table E-22. Partial listing of benzene gasoline emissions after merging with projection factors.

FIPS	CAS	SCC	emisgc	gas_flag	pf	pf15_refuel
06025	71432	2501050120	0.08181288	1	0.98387096777	0.6000467907
06025	71432	2501060102	0.067603788	.	0.98387096777	0.6000467907

25. Apply the projection factors to the annual projected emissions. If a gasoline marketing/distribution SCC emission (gas_flag=1), apply the projection factor based on the PADD data from step 10. Otherwise, multiply the annual projected emissions by the appropriate year's projection factor for vehicle refueling.

Table E-23. Partial listing of benzene gasoline related emissions after applying appropriate projection factors. If gas_flag =1 apply pf, otherwise apply pf15_refuel to emissions.

FIPS	CAS	SCC	emisgc	gas_flag	pf	pf15_refuel
06025	71432	2501050120	0.0804933174	1	0.98387096777	0.6000467907
06025	71432	2501060102	0.040565436	.	0.98387096777	0.6000467907

26. Concatenate the output of step 26 with the others dataset created in step 24.

Table E-24. Partial listing of benzene emissions after concatenating controlled emissions with non-gasoline emissions.

FIPS	CAS	SCC	emisgc
06025	71432	2501050120	0.0804933174
06025	71432	2501060102	0.040565436
06025	71432	2102004000	1.3460706

27. Using PROC SQL, merge the emissions with the SCC/surrogate cross reference created in step 21 by SCC. This is to assign surrogate codes to the emissions, which is needed for CountyProc for non-point sources.

Table E-25. Partial listing of benzene emissions after merging the emissions with the spatial surrogate codes.

FIPS	CAS	SCC	emisgc	spatsurr
06025	71432	2501050120	0.0804933174	650
06025	71432	2501060102	0.040565436	600
06025	71432	2102004000	1.3460706	505

28. Sort step 27 output by FIPS MACT SIC SCC and CAS and output to permanent dataset.

Table E-26. Partial listing of benzene emissions after sorting by FIPS/SCC/CAS and renaming the emissions variable emisgc to emis and output to permanent dataset.

FIPS	CAS	SCC	emis	spatsurr
06025	71432	2102004000	1.3460706	505
06025	71432	2501050120	0.0804933174	650
06025	71432	2501060102	0.040565436	600

Figure E-1 shows the first 19 steps of the program and Figure E-2 shows the non-point steps.

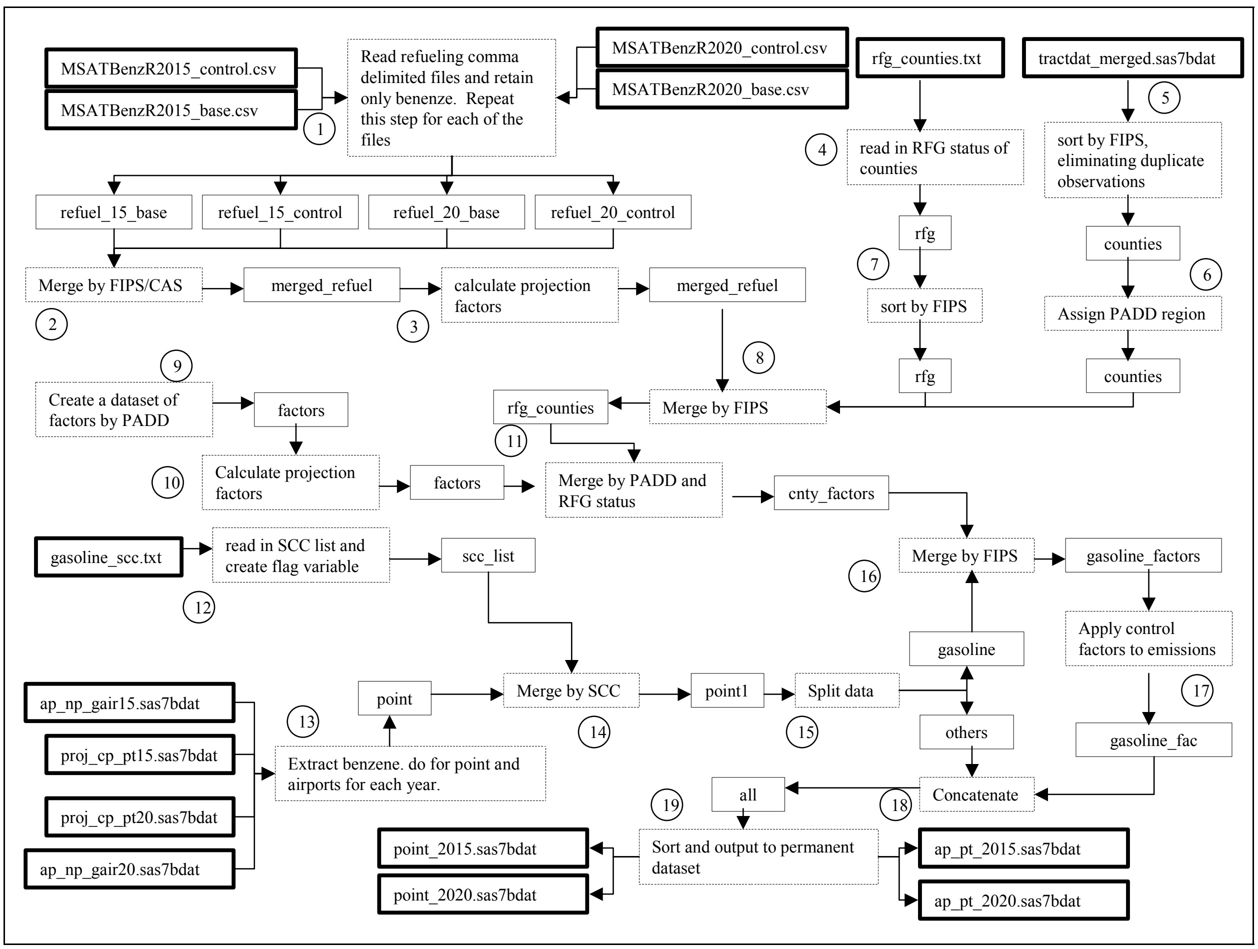

Figure E-1. Steps in point gasoline inventory control program.

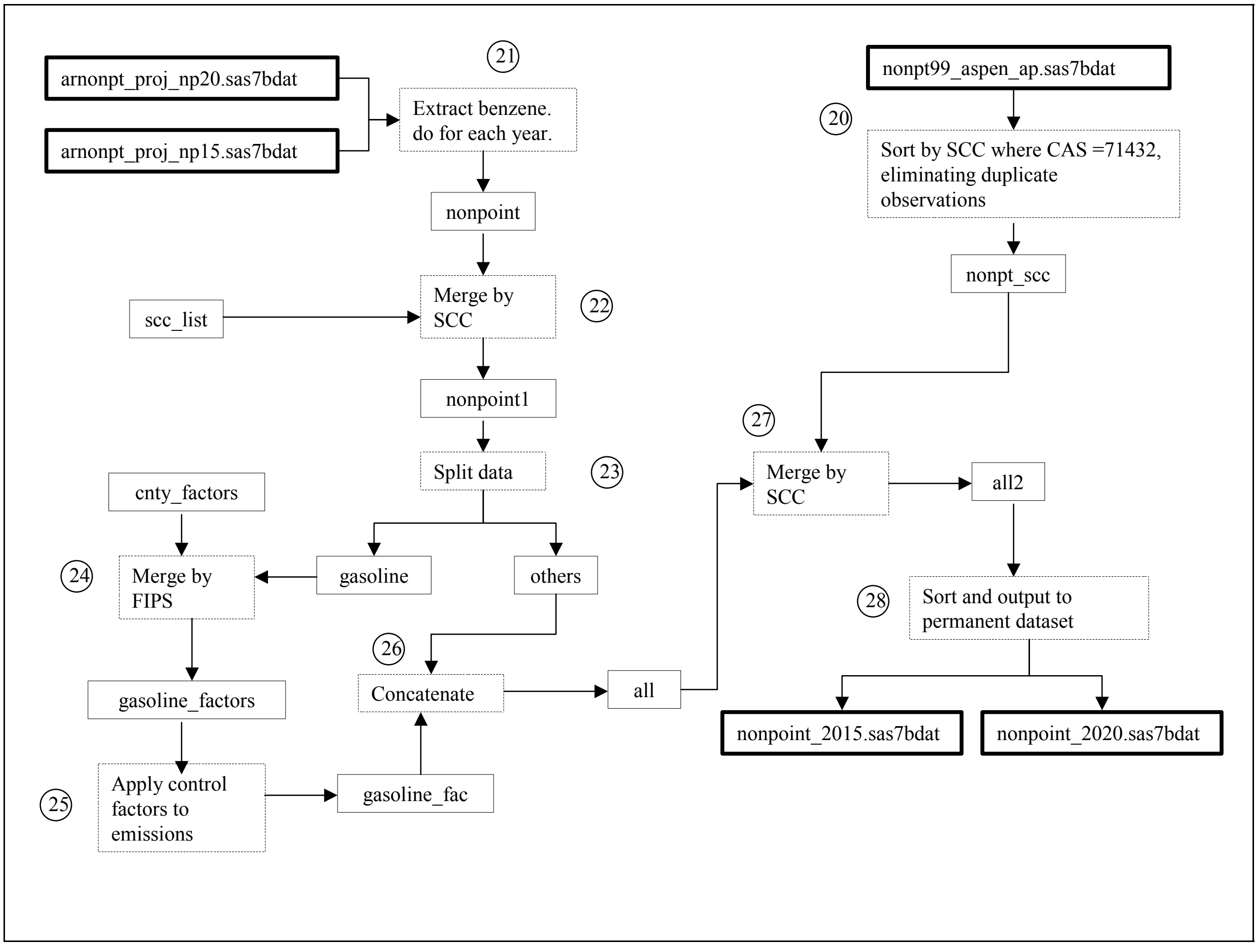

Figure E-2. Non-point steps of the stationary gasoline controls program.

Appendix F: Control of onroad gasoline emissions

Following are the steps and examples for Alpine County, CA (FIPS=06003) for benzene for the year 2015 in applying controls to the onroad gasoline emissions. Example calculations are also shown below. Controls are done in the SAS® program control_onroad.sas (found in the MSAT rule docket EPA-HQ-OAR-2005-0036). All steps take place within the SAS® MACRO control where the argument for control is the four digit year. **Steps 1 and 2 are performed in the SAS® MACRO control where the argument for control is the four digit year**.

1. Read in the projected MSAT emissions (output from onroad.sas in Section 3.3.2) and subset the emissions to the five HAPs.

   Table F-1. Partial listing of 2015 projected benzene emissions for Alpine County. Note that SCC descriptions are listed here for information purposes only. The variables emis, ratio, and emis_nei are the 2015 projected emissions, the projection factor for 2015, and the 1999 NEI emissions respectively.

FIPS	SCC	SCC description	CAS	emis	ratio	emis_nei
06003	2201001130	Mobile Sources, Highway Vehicles - Gasoline, Light Duty Gasoline Vehicles (LDGV), Rural Other Principal Arterial: Total	71432	0.0578743127	0.269621769	0.21465
06003	2201001150	Mobile Sources, Highway Vehicles - Gasoline, Light Duty Gasoline Vehicles (LDGV), Rural Minor Arterial: Total	71432	0.0330683928	0.2681076114	0.12334
06003	2201001170	Mobile Sources, Highway Vehicles - Gasoline, Light Duty Gasoline Vehicles (LDGV), Rural Major Collector: Total	71432	0.0323135532	0.2666134753	0.1212
06003	2201080130	Mobile Sources, Highway Vehicles - Gasoline, Motorcycles (MC),Rural Other Principal Arterial: Total	71432	0.0041931539	0.6348454049	0.006605
06003	2201080150	Mobile Sources, Highway Vehicles - Gasoline, Motorcycles (MC),Rural Minor Arterial: Total	71432	0.0024060641	0.6348454049	0.00379
06003	2230001130	Mobile Sources, Highway Vehicles - Diesel, Light Duty Diesel Vehicles (LDDV),Rural Other Principal Arterial: Total	71432	0.0011643267	0.377415447	0.003085
06003	2230001150	Mobile Sources, Highway Vehicles - Diesel, Light Duty Diesel Vehicles (LDDV), Rural Minor Arterial: Total	71432	0.0006597704	0.3706575353	0.00178

2. Split the output from step 1 into two datasets, gasoline and diesel. Gasoline contained gasoline emissions and diesel contained diesel emissions. The first four characters of the SCC code were used to determine if the observation being read was gasoline or diesel. If the first four characters were 2201 then the observation was gasoline, otherwise it was diesel.

   Table F-2. Partial listing of Alpine County gasoline emissions after splitting the gasoline and diesel emissions. The variables ratio and emis_nei have been dropped. SCC description has also been dropped.

FIPS	SCC	CAS	emis
06003	2201001130	71432	0.0578743127
06003	2201001150	71432	0.0330683928
06003	2201001170	71432	0.0323135532
06003	2201080130	71432	0.0041931539
06003	2201080150	71432	0.0024060641

   Table F-3. Partial listing of Alpine County diesel emissions after splitting the gasoline and diesel emissions. The variables ratio and emis_nei have been dropped. SCC description has also been dropped.

FIPS	SCC	CAS	emis
06003	2230001130	71432	0.0011643267
06003	2230001150	71432	0.0006597704

3. Create a dataset of motorcycle SCC codes to be used later.

   Table F-4. Dataset of motorcycle SCC codes. SCC description added for information purposes.

SCC	Description
2201080110	Mobile Sources, Highway Vehicles - Gasoline, Motorcycles (MC), Rural Interstate: Total
2201080130	Mobile Sources, Highway Vehicles - Gasoline, Motorcycles (MC), Rural Other Principal Arterial: Total
2201080150	Mobile Sources, Highway Vehicles - Gasoline, Motorcycles (MC), Rural Minor Arterial: Total
2201080170	Mobile Sources, Highway Vehicles - Gasoline, Motorcycles (MC), Rural Major Collector: Total
2201080190	Mobile Sources, Highway Vehicles - Gasoline, Motorcycles (MC), Rural Minor Collector: Total
2201080210	Mobile Sources, Highway Vehicles - Gasoline, Motorcycles (MC), Rural Local: Total
2201080230	Mobile Sources, Highway Vehicles - Gasoline, Motorcycles (MC), Urban Interstate: Total
2201080330	Mobile Sources, Highway Vehicles - Gasoline, Motorcycles (MC), Urban Local: Total

Steps 4 through 18 are performed in the SAS® MACRO read_nmim.

4. Read in the NMIM emissions for MSAT and subset to the five HAPs and gasoline emissions only. The first four digits of the SCC code were used to determine if the emissions were gasoline as in step 2 above.

5. Sorted output from step 4 by FIPS, SCC, and CAS.

Table F-5. Partial listing of Alpine County base MSAT NMIM onroad gasoline emissions for benzene after sorting. (Steps 4 and 5). The variable nmim_msat is the NMIM emissions.

FIPS	SCC	CAS	nmim_msat
06003	2201001130	71432	0.0223670533
06003	2201001150	71432	0.0129730606
06003	2201001170	71432	0.0128725145

6. Read the NMIM control emissions comma delimited file and subset to the five HAPs and gasoline emissions. Create FIPS variable from the integer state and county FIPS variables.

7. Sorted the output from step 6 by FIPS, SCC, and CAS.

Table F-6. Partial listing of the control NMIM output after sorting (Steps 6 and 7). Note that each SCC is listed twice, one entry for exhaust emissions and the other for evaporative emissions. Emissions type, exhaust or evaporative, was not retained.

FIPS	SCC	CAS	emis
06003	2201001130	71432	0.019649687
06003	2201001130	71432	0.0009109781
06003	2201001150	71432	0.0113615684
06003	2201001150	71432	0.0005509424
06003	2201001170	71432	0.0112324624
06003	2201001170	71432	0.0005728415
06003	2201080130	71432	0
06003	2201080130	71432	0
06003	2201080150	71432	0
06003	2201080150	71432	0

8. Summed the output from step 7 by FIPS, SCC, and CAS. This was done because the emissions were broken down by evaporative and exhaust types.

Table F-7. Partial listing of the control NMIM emissions after summing exhaust and evaporative components.

FIPS	SCC	CAS	nmim_cntrl
06003	2201001130	71432	0.0205606651
06003	2201001150	71432	0.0119125108
06003	2201001170	71432	0.0118053039
06003	2201080130	71432	0
06003	2201080150	71432	0

9. Merged the output of step 8 with the output of step 4 by FIPS, SCC, and CAS. Output datasets were merged, no_msat, and no_cntrl. The dataset merged contained matching observations, no_msat contained observations from step 8 output ? are you sure ? I thought no_msat had no step 8 (controlled NMIM) emissions, but did have the reference NMIM emissions? that were not in the original MSAT NMIM emissions, and no_cntrl contained observations where there were original MSAT emissions but no matching observations in the step 8 output (this dataset was always empty). The dataset no_msat contained observations where the control emissions were 0.

Table F-8. Partial listing of merged base MSAT NMIM data and control NMIM data with matching observations (merged).

FIPS	SCC	CAS	nmim_cntrl	nmim_msat
06003	2201001130	71432	0.0205606651	0.0223670533
06003	2201001150	71432	0.0119125108	0.0129730606
06003	2201001170	71432	0.0118053039	0.0128725145

Table F-9. Partial listing of emissions where there were no base MSAT NMIM observations but there were control NMIM emissions (no_msat). The control emissions are zero in this dataset.

FIPS	SCC	CAS	nmim_cntrl	nmim_msat
06003	2201080130	71432	0	.
06003	2201080150	71432	0	.

10. Created a dataset from no_msat where the control emissions were nonzero as a second check. This dataset was always empty.

11. Subset the output from step 8 to the three California counties (Modoc, Sierra, and Alpine) that did not have NMIM motorcycle emissions. Note, there are observations for these in the NMIM data for both the MSAT and control runs, but they are zero for all years.

12. Sorted the output of step 11 by FIPS and CAS.

Table F-9. Partial listing of emissions after subsetting to California and sorting by CAS (Steps 11 and 12).

FIPS	SCC	CAS	nmim_cntrl	nmim_msat
06003	2201001130	71432	0.0205606651	0.0223670533
06003	2201001150	71432	0.0119125108	0.0129730606
06003	2201001170	71432	0.0118053039	0.0128725145

13. Summed the output of step 12 by FIPS and CAS to get county level HAP emissions.

Table F-10. Summed emissions for Alpine County.

FIPS	CAS	nmim_cntrl	nmim_msat
06003	71432	0.3708404994	0.403293093

14. Merged the output of step 13 with the motorcycle SCC data from step 13. This would basically expand the output of step 13 8 times.

Table F-11. Partial listing of emissions after merging county emissions with motorcycle SCC codes.

FIPS	CAS	nmim_cntrl	nmim_msat	SCC
06003	71432	0.3708404994	0.403293093	2201080110
06003	71432	0.3708404994	0.403293093	2201080130
06003	71432	0.3708404994	0.403293093	2201080150
06003	71432	0.3708404994	0.403293093	2201080170
06003	71432	0.3708404994	0.403293093	2201080190
06003	71432	0.3708404994	0.403293093	2201080210
06003	71432	0.3708404994	0.403293093	2201080230
06003	71432	0.3708404994	0.403293093	2201080330

15. Concatenated the output of step 9 and step 14.

16. Sorted the output of step 15 by FIPS, SCC, and CAS.

Table F-12. Partial listing of concatenated data shown in Table F-8 and F-11 after sorting (Steps 15 and 16).

FIPS	SCC	CAS	nmim_cntrl	nmim_msat
06003	2201001130	71432	0.0205606651	0.0223670533
06003	2201001150	71432	0.0119125108	0.0129730606
06003	2201001170	71432	0.0118053039	0.0128725145
06003	2201080110	71432	0.3708404994	0.403293093
06003	2201080130	71432	0.3708404994	0.403293093
06003	2201080150	71432	0.3708404994	0.403293093
06003	2201080170	71432	0.3708404994	0.403293093
06003	2201080190	71432	0.3708404994	0.403293093
06003	2201080210	71432	0.3708404994	0.403293093
06003	2201080230	71432	0.3708404994	0.403293093
06003	2201080330	71432	0.3708404994	0.403293093

17. Created a projection or control factor by dividing the control NMIM emissions by the MSAT NMIM emissions for each FIPS, SCC, and CAS.

Table F-13. Partial listing of emissions and projection factors.

FIPS	SCC	CAS	nmim_cntrl	nmim_msat	pf
06003	2201001130	71432	0.0205606651	0.0223670533	0.9192388834
06003	2201001150	71432	0.0119125108	0.0129730606	0.9182498384
06003	2201001170	71432	0.0118053039	0.0128725145	0.9170938514
06003	2201080110	71432	0.3708404994	0.403293093	0.9195309959
06003	2201080130	71432	0.3708404994	0.403293093	0.9195309959
06003	2201080150	71432	0.3708404994	0.403293093	0.9195309959
06003	2201080170	71432	0.3708404994	0.403293093	0.9195309959
06003	2201080190	71432	0.3708404994	0.403293093	0.9195309959
06003	2201080210	71432	0.3708404994	0.403293093	0.9195309959
06003	2201080230	71432	0.3708404994	0.403293093	0.9195309959
06003	2201080330	71432	0.3708404994	0.403293093	0.9195309959

18. Created a dataset of the first five observations of step 17 output for QA purposes to visually check calculations.

19. Merged the gasoline dataset from step 2 with the output of step 17 by FIPS, SCC, and CAS. Two datasets were created, merged_gas, containing matching observations and no_nmim, which contained observations from gasoline but not in step 17 output. This dataset was empty.

Table F-14. Partial listing of emissions after merging the projected emissions shown in Table F-1 with the factors shown in Table F-13.

FIPS	SCC	CAS	emis	nmim_cntrl	nmim_msat	pf
06003	2201001130	71432	0.0578743127	0.0205606651	0.0223670533	0.9192388834
06003	2201001150	71432	0.0330683928	0.0119125108	0.0129730606	0.9182498384
06003	2201001170	71432	0.0323135532	0.0118053039	0.0128725145	0.9170938514
06003	2201080130	71432	0.0041931539	0.3708404994	0.403293093	0.9195309959
06003	2201080150	71432	0.0024060641	0.3708404994	0.403293093	0.9195309959

20. Applied the factors calculated in step 17 to the projected MSAT emissions. Created a variable emis_msat, which was the original MSAT projected emissions.

Table F-15. Partial listing of emissions after applying factor to projected 2015 emissions. Note nmim_cntrl and nmim_msat not shown but are in dataset.

FIPS	SCC	CAS	emis	pf	emis_msat
06003	2201001130	71432	0.0532003187	0.9192388834	0.0578743127
06003	2201001150	71432	0.0303650464	0.9182498384	0.0330683928
06003	2201001170	71432	0.0296345609	0.9170938514	0.0323135532
06003	2201080130	71432	0.003855735	0.9195309959	0.0041931539
06003	2201080150	71432	0.0022124505	0.9195309959	0.0024060641

21. Concatenated step 20 output with the diesel data from step 2.

22. For the diesel emissions, set the variable emis_msat equal to the diesel emissions for QA purposes.

23. Sorted the step 22 output by FIPS, SCC, and CAS to a permanent dataset with the year in the dataset name.

Table F-16. Partial listing of emissions after concatenating controlled emissions with diesel emissions and set the variable emis_msat for diesel equal to the emis variable for diesel, sorting and creating a permanent dataset (Steps 21 through 23).

FIPS	SCC	CAS	emis	pf	emis_msat
06003	2201001130	71432	0.0532003187	0.9192388834	0.0578743127
06003	2201001150	71432	0.0303650464	0.9182498384	0.0330683928
06003	2201001170	71432	0.0296345609	0.9170938514	0.0323135532
06003	2201080130	71432	0.003855735	0.9195309959	0.0041931539
06003	2201080150	71432	0.0022124505	0.9195309959	0.0024060641
06003	2230001130	71432	0.0011643267	.	0.0011643267
06003	2230001150	71432	0.0006597704	.	0.0006597704

24. Created a dataset of the first five observations of step 23 output to visually check calculations.

Figure F-1 shows the steps of the program.

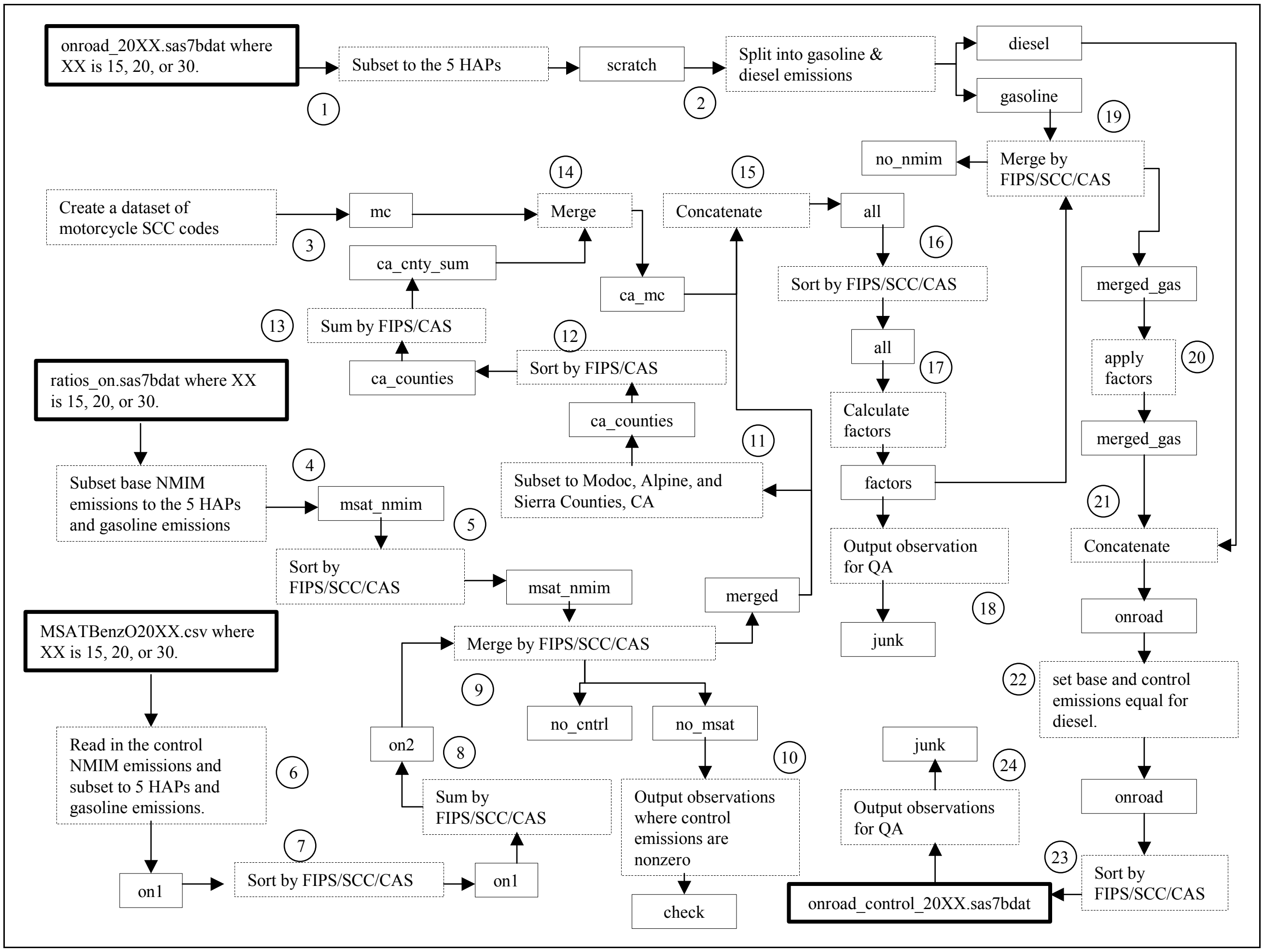

Figure F-1. Steps in the onroad gasoline controls program.

Appendix G: Development of controlled nonroad inventory

G.1. Calculation of exhaust and evaporative fractions

Following are the steps taken in the SAS® program calc_factors.sas (found in the MSAT rule docket EPA-HQ-OAR-2005-0036) to develop the exhaust and evaporative fractions for use in developing the controlled nonroad inventory. Example calculations for Autauga County, AL are shown.

1. Read in the base onroad NMIM emissions comma delimited file and subset emissions to the five HAPs (by CAS) and LDGV emissions (first seven characters of SCC code = 2201001). Emissions were by emtype (exhaust or evaporative).

2. Sorted by FIPS/CAS/emtype.

Table G-1. Partial listing of NMIM base LDGV emissions after sorting by FIPS, CAS, and emtype. (Steps 1 and 2). Emtype is exh for exhaust and eva is for evaporative.

FIPS	SCC	CAS	emtype	emis
01001	2201001110	106990	Exh	0.1329114838
01001	2201001130	106990	Exh	0.0224262833
01001	2201001150	106990	Exh	0.0274003661
01001	2201001110	107028	Exh	0.0149620306
01001	2201001130	107028	Exh	0.0025289852
01001	2201001150	107028	Exh	0.0030914513
01001	2201001110	50000	Exh	0.2919313181
01001	2201001130	50000	Exh	0.0491281133
01001	2201001150	50000	Exh	0.0599782676
01001	2201001110	71432	Eva	0.1188655905
01001	2201001130	71432	Eva	0.0226015763
01001	2201001150	71432	Eva	0.0290840303
01001	2201001110	71432	Exh	1.2735248953
01001	2201001130	71432	Exh	0.2144948896
01001	2201001150	71432	Exh	0.2619329412
01001	2201001110	75070	Exh	0.1059866981
01001	2201001130	75070	Exh	0.0178493559
01001	2201001150	75070	Exh	0.0217964613

3. Summarized emissions by FIPS/CAS/type to give county level LDGV emissions for each CAS.

Table G-2. Total base LDGV emissions by CAS and emtype for Autauga County. Note that total emissions include emissions not shown in Table G-1.

FIPS	CAS	emtype	emis
01001	106990	Exh	0.3896782826
01001	107028	Exh	0.0442493623
01001	50000	Exh	0.8536461103
01001	71432	Eva	0.4343823954
01001	71432	Exh	3.7298372318
01001	75070	Exh	0.3102395715

4. Transposed the output of step 3 by FIPS/CAS so that the exhaust and evaporative emissions were on the same row.

5. Created a dataset called ldgv_base and renamed the exhaust and evaporative emissions to exhaust_base and ldgv_evap_base respectively.

Table G-3. Autauga County reference LDGV emissions after transposing the data by FIPS and CAS and renaming the exhaust and evaporative emissions (Steps 4 and 5).

FIPS	CAS	exhaust_base	ldgv_evap_base
01001	106990	0.3896782826	.
01001	107028	0.0442493623	.
01001	50000	0.8536461103	.
01001	71432	3.7298372318	0.4343823954
01001	75070	0.3102395715	.

6. Repeated steps 1 through 5 for the control case with output file called ldgv_control and emissions called exhaust_control and ldgv_evap_control.

Table G-4. Partial listing of NMIM control LDGV emissions after sorting by FIPS, CAS, and emtype. (Steps 1 and 2). Emtype is exh for exhaust and eva is for evaporative.

FIPS	SCC	CAS	emtype	emis
01001	2201001110	106990	Exh	0.1332807094
01001	2201001130	106990	Exh	0.0224884795
01001	2201001150	106990	Exh	0.0274765282
01001	2201001110	107028	Exh	0.0149620306
01001	2201001130	107028	Exh	0.0025289852
01001	2201001150	107028	Exh	0.0030914513
01001	2201001110	50000	Exh	0.2930203266
01001	2201001130	50000	Exh	0.0493116695
01001	2201001150	50000	Exh	0.0602024053
01001	2201001110	71432	Eva	0.071318306
01001	2201001130	71432	Eva	0.0135608203
01001	2201001150	71432	Eva	0.0174501906
01001	2201001110	71432	Exh	1.1610455513
01001	2201001130	71432	Exh	0.1955535179
01001	2201001150	71432	Exh	0.2388030291
01001	2201001110	75070	Exh	0.1063300385
01001	2201001130	75070	Exh	0.0179073763
01001	2201001150	75070	Exh	0.0218667063

Table G-5. Total control LDGV emissions by CAS and emtype for Autauga County. Note that total emissions include emissions not shown in Table G-4.

FIPS	CAS	emtype	emis
01001	106990	Exh	0.390761545
01001	107028	Exh	0.0442493623
01001	50000	Exh	0.8568307054
01001	71432	Eva	0.2606270021
01001	71432	Exh	3.4006572287
01001	75070	Exh	0.3112453358

Table G-6. Autauga County control LDGV emissions after transposing the data by FIPS and CAS and renaming the exhaust and evaporative emissions (Steps 4 and 5).

FIPS	CAS	exhaust_control	ldgv_evap_control
01001	106990	0.390761545	.
01001	107028	0.0442493623	.
01001	50000	0.8568307054	.
01001	71432	3.4006572287	0.2606270021
01001	75070	0.3112453358	.

Steps 1 through 5 are performed in the SAS® MACRO read_ldgv.

7. Read the county level refueling emissions for benzene and VOC from comma delimited file and output to dataset called refuel_base with emissions called refuel_base. Create 5 character FIPS variable and retain only benzene emissions.

Table G-7. Autauga County base refueling emissions for 2015.

FIPS	CAS	refuel_base
01001	71432	0.1618722891

8. Repeated step 7 for the control case, with output file called refuel_control and emissions called refuel_control.

Table G-8. Autauga County control refueling emissions for 2015.

FIPS	CAS	refuel_control
01001	71432	0.0971250232

Step 7 is performed in the SAS® MACRO refuel.

9. Merged the ldgv_base and ldgv_control datasets by FIPS/CAS.

Table G-9. Autauga County LDGV emissions after merging base and control emissions by FIPS and CAS.

FIPS	CAS	exhaust_base	ldgv_evap_base	exhaust_control	ldgv_evap_control
01001	106990	0.3896782826	.	0.390761545	.
01001	107028	0.0442493623	.	0.0442493623	.
01001	50000	0.8536461103	.	0.8568307054	.
01001	71432	3.7298372318	0.4343823954	3.4006572287	0.2606270021
01001	75070	0.3102395715	.	0.3112453358	.

10. Merged refuel_base and refuel_control by FIPS/CAS.

Table G-10. Autauga County refueling emissions after merging base and control emissions by FIPS and CAS.

FIPS	CAS	refuel_control	refuel_base
01001	71432	0.0971250232	0.1618722891

11. Merged output of step 10 and step 11 by FIPS/CAS using PROC SQL retaining all observations from step 10 output.

Table G-11. Autauga County LDGV and refueling emissions after merging the two datasets together by FIPS and CAS, retaining all LDGV emissions.

FIPS	CAS	exhaust_base	ldgv_evap_base	exhaust_control	ldgv_evap_control	refuel_control	refuel_base
01001	106990	0.3896782826	.	0.390761545	.	.	.
01001	107028	0.0442493623	.	0.0442493623	.	.	.
01001	50000	0.8536461103	.	0.8568307054	.	.	.
01001	71432	3.7298372318	0.4343823954	3.4006572287	0.2606270021	0.0971250232	0.1618722891
01001	75070	0.3102395715	.	0.3112453358	.	.	.

12. Calculated projection factors for exhaust type for all HAPs by dividing exhaust_control by exhaust base. For benzene calculated projection factors for evaporation type by dividing the sum of ldgv_evap_control and refuel_control by the sum of ldgv_evap_base and refuel_base.

Table G-12. Autauga County emissions with projection factors. Projection factors rounded for visual purposes

FIPS	CAS	exhaust_base	ldgv_evap_base	exhaust_control	ldgv_evap_control	refuel_control	refuel_base	pf_exh	pf_evap
01001	106990	0.3896782826	.	0.390761545	.	.	.	1.00278	.
01001	107028	0.0442493623	.	0.0442493623	.	.	.	1	.
01001	50000	0.8536461103	.	0.8568307054	.	.	.	1.00373	.
01001	71432	3.7298372318	0.4343823954	3.4006572287	0.2606270021	0.0971250232	0.1618722891	0.91174	0.59999
01001	75070	0.3102395715	.	0.3112453358	.	.	.	1.00324	.

13. Sorted the output of step 12 by FIPS and CAS and output to a permanent dataset, retaining the FIPS, CAS, exhaust projection factor and evaporative projection factor.

Table G-13. Autauga County projection factors after sorting and outputting to a permanent dataset.

FIPS	CAS	pf_exh	pf_evap
01001	106990	1.00278	.
01001	107028	1	.
01001	50000	1.00373	.
01001	71432	0.91174	0.59999
01001	75070	1.00324	.

Figure G-1 shows the steps of the projection factor development program.

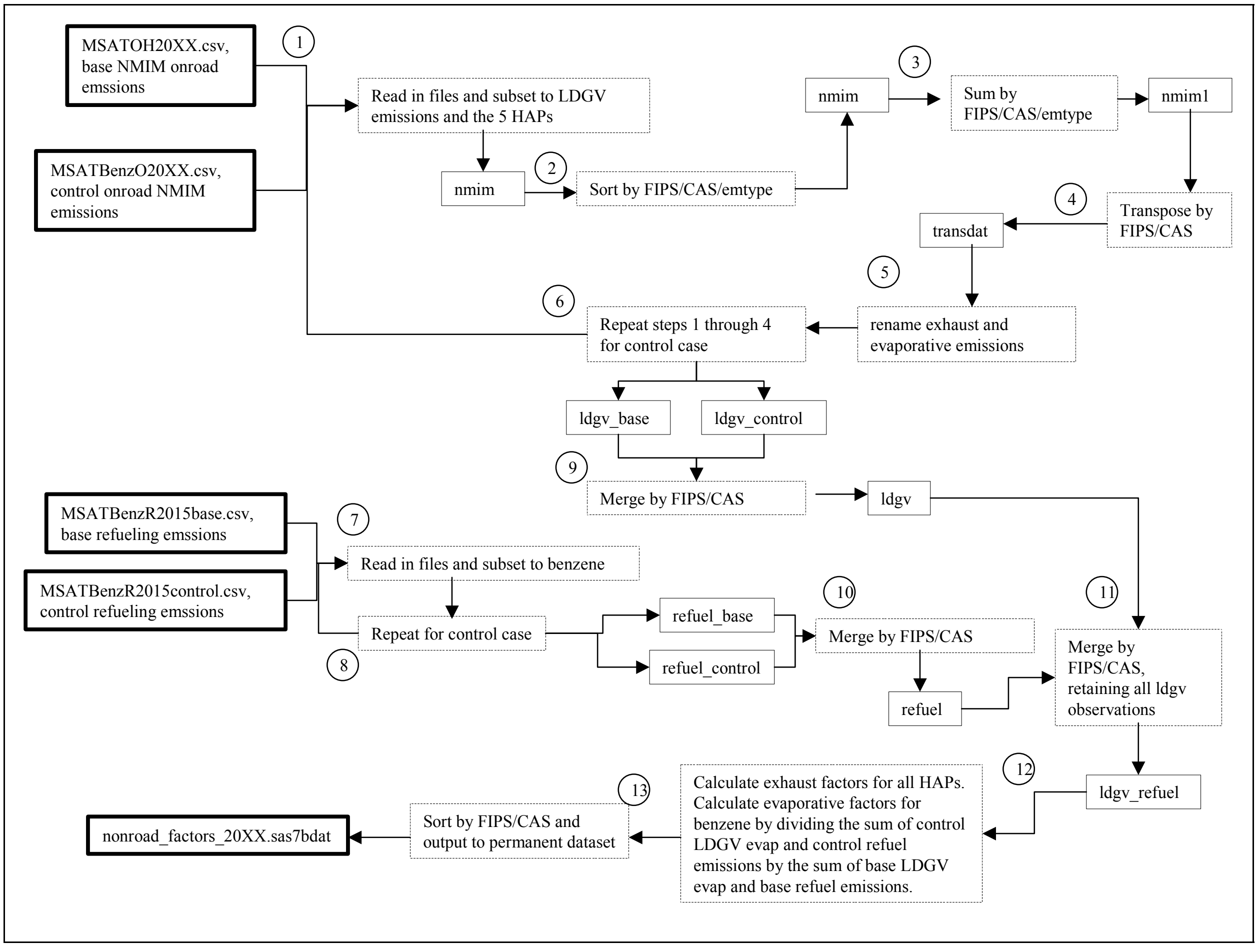

Figure G-1. Steps of the nonroad projection factor development program.

G.2 Development of controlled nonroad inventories

The following describes the steps taken to apply the projection factors to the nonroad controlled inventory in the program control_nonroad.sas (found in the MSAT rules docket EPA-HQ-OAR-2005-0036) with examples from California and Texas.

1. Read in the SCC/ASPEN source group cross reference text file and retain only the nonroad group SCC codes. Corrected the airport support equipment group to nonroad gasoline and corrected pleasure craft SCC codes to other nonroad.

   Table G-14. Partial listing of SCC codes with bins after correcting airport support equipment and pleasure craft bins.

SCC	grp
2260000000	5
2265008000	5
2265008005	5
2282000000	3
2282020000	3
2282020005	3
2282020010	3

2. Read in the NMIM base nonroad exhaust and evaporative emissions for benzene and VOC. Retained only benzene.

3. Sorted step 2 output by FIPS/SCC/CAS/emtype where emtype is exh for exhaust and eva for evaporative emissions.

Table G-15. Partial listing of NMIM base nonroad exhaust and evaporative emissions for benzene after sorting by FIPS, SCC, and CAS (Steps 2 and 3).

FIPS	SCC	CAS	emtype	emis
06001	2260001010	71432	Eva	0.027924
06001	2260001010	71432	Exh	2.173649
06001	2260001030	71432	Eva	0.0332
06001	2260001030	71432	Exh	1.412159
06001	2260002006	71432	Eva	0.003535
06001	2260002006	71432	Exh	0.36573
06001	2265001010	71432	Eva	0.0106649406
06001	2265001010	71432	Exh	0.1943388665
06001	2265007015	71432	Eva	0
06001	2265007015	71432	Exh	0
06021	2260001010	71432	Eva	0
06021	2260001010	71432	Exh	0
06021	2260001030	71432	Eva	0
06021	2260001030	71432	Exh	0
06021	2260002006	71432	Eva	2.81E-05
06021	2260002006	71432	Exh	0.002958
06021	2265001050	71432	Eva	0.0012738279
06021	2265001050	71432	Exh	0.0632532043
06021	2265007015	71432	Eva	0
06021	2265007015	71432	Exh	0
48001	2260001010	71432	Eva	0
48001	2260001010	71432	Exh	0
48001	2260001030	71432	Eva	0
48001	2260001030	71432	Exh	0
48001	2260002006	71432	Eva	0.00016
48001	2260002006	71432	Exh	0.006782
48001	2265007015	71432	Eva	2.63E-05
48001	2265007015	71432	Exh	0.000281

4. Transposed step 3 output by FIPS/SCC/CAS so that the exhaust and evaporative emissions are now on the same observation or row instead of multiple rows.

Table G-16. Partial listing of NMIM base emissions after transposing by FIPS, SCC, and CAS.

FIPS	SCC	CAS	Eva	Exh
06001	2260001010	71432	0.027924	2.173649
06001	2260001030	71432	0.0332	1.412159
06001	2260002006	71432	0.003535	0.36573
06001	2265001010	71432	0.0106649406	0.1943388665
06001	2265007015	71432	0	0
06021	2260001010	71432	0	0
06021	2260001030	71432	0	0
06021	2260002006	71432	2.81E-05	0.002958
06021	2265001050	71432	0.0012738279	0.0632532043
06021	2265007015	71432	0	0
48001	2260001010	71432	0	0
48001	2260001030	71432	0	0
48001	2260002006	71432	0.00016	0.006782
48001	2265007015	71432	2.63E-05	0.000281

5. From step 4 output, created a new value for the SCC codes but changing the last three characters to 000 to create "Total" level SCC codes. Output to new dataset.

6. Sorted step 5 output by FIPS/SCC/CAS.

Table G-17. Partial listing of NMIM base emissions after changing last three characters of SCC codes to 000 and sorting by FIPS, SCC, and CAS (Steps 5 and 6).

FIPS	SCC	CAS	Eva	Exh
06001	2260001000	71432	0.027924	2.173649
06001	2260001000	71432	0.0332	1.412159
06001	2260002000	71432	0.003535	0.36573
06001	2265001000	71432	0.0106649406	0.1943388665
06001	2265007000	71432	0	0
06021	2260001000	71432	0	0
06021	2260001000	71432	0	0
06021	2260002000	71432	2.81E-05	0.002958
06021	2265001000	71432	0.0012738279	0.0632532043
06021	2265007000	71432	0	0
48001	2260001000	71432	0	0
48001	2260001000	71432	0	0
48001	2260002000	71432	0.00016	0.006782
48001	2265007000	71432	2.63E-05	0.000281

7. Summed the exhaust and evaporative emissions by FIPS/SCC/CAS of the step 6 output. This created "Total" level SCC emissions for exhaust and evaporative components.

Table G-18. Partial listing of NMIM base emissions after summing "Total" level SCC codes by FIPS and CAS. Note emissions include SCC codes not listed in Table G-17.

FIPS	SCC	CAS	Exh	Eva
06001	2260001000	71432	3.6161273849	0.065301121
06001	2260002000	71432	1.3666668567	0.0094967323
06001	2265001000	71432	2.1453478962	0.1289871176
06001	2265007000	71432	0	0
06021	2260001000	71432	0	0
06021	2260002000	71432	0.0110537204	0.000076092
06021	2265001000	71432	0.0632532043	0.0012738279
06021	2265007000	71432	0	0
48001	2260001000	71432	0	0
48001	2260002000	71432	0.0253426696	0.000416299
48001	2265007000	71432	0.015208714	0.008868335

8. Created a dataset of snow mobile emissions (SCC 265001020) for California from step 7 output by changing the SCC code 2265001000 to 2265001020. This was done because counties in California had snow mobile emissions but they were not in the NMIM output.

Table G-19. Partial listing of NMIM base emissions after changing SCC code 2265001000 to 2265001020 for California.

FIPS	SCC	CAS	Exh	Eva
06001	2265001020	71432	2.1453478962	0.1289871176
06001	2265001020	71432	0.0632532043	0.0012738279

9. Created a dataset by concatenating step 4, step 7, and step 8 output.

10. Created macro variables for the exhaust and evaporative emissions for SCC 2265001000 for FIPS 06021.

11. For FIPS 06021 and SCC = 2265001030 set the exhaust and evaporative emissions equal to the exhaust and evaporative emission macro variables created in step 10.

Table G-20. Partial listing of NMIM base emissions after concatenating base NMIM output, total SCC emissions, and snow mobile emissions and after substituting 2265001000 emissions in FIPS 06021 (Steps 9, 10, and 11).

FIPS	SCC	CAS	Eva	Exh
06001	2260001010	71432	0.027924	2.173649
06001	2260001030	71432	0.0332	1.412159
06001	2260002006	71432	0.003535	0.36573
06001	2265001010	71432	0.0106649406	0.1943388665
06001	2265007015	71432	0	0
06021	2260001010	71432	0	0
06021	2260002006	71432	2.81E-05	0.002958
06021	2265001050	71432	0.0012738279	0.0632532043
06021	2265007015	71432	0	0
48001	2260001010	71432	0	0
48001	2260001030	71432	0	0
48001	2260002006	71432	0.00016	0.006782
48001	2265007015	71432	2.63E-05	0.000281
06001	2260001000	71432	0.065301121	3.6161273849
06001	2260002000	71432	0.0094967323	1.3666668567
06001	2265001000	71432	0.1289871176	2.1453478962
06001	2265007000	71432	0	0
06021	2260001000	71432	0	0
06021	2260002000	71432	0.000076092	0.0110537204
06021	2265001000	71432	0.0012738279	0.0632532043
06021	2265001030	71432	0.0012738279	0.0632532043
06021	2265007000	71432	0	0
48001	2260001000	71432	0	0
48001	2260002000	71432	0.000416299	0.0253426696
48001	2265007000	71432	0.008868335	0.015208714
06001	2265001020	71432	0.1289871176	2.1453478962
06001	2265001020	71432	0.0012738279	0.0632532043

12. Created a dataset for California and Texas with the engine designation for 2 and 4 stroke emissions based on the first six characters of the SCC code. This was only done with SCC codes where the last three characters were not 000 (total level) to avoid double counts of emissions.

13. Sorted step 12 output by FIPS/CAS/eng where eng = 2 for 2-stroke gasoline and eng=4 for 4-stroke gasoline emissions.

Table G-22. Partial listing of NMIM base emissions after adding engine type variable and sorting by engine type (Steps 12 and 13).

FIPS	SCC	CAS	Eva	Exh	eng
06001	2260001010	71432	0.027924	2.173649	2
06001	2260001030	71432	0.0332	1.412159	2
06001	2260002006	71432	0.003535	0.36573	2
06001	2265001010	71432	0.0106649406	0.1943388665	4
06001	2265001020	71432	0.1289871176	2.1453478962	4
06001	2265007015	71432	0	0	4
06021	2260001010	71432	0	0	2
06021	2260002006	71432	2.81E-05	0.002958	2
06001	2265001020	71432	0.0012738279	0.0632532043	4
06021	2260001030	71432	0.0012738279	0.0632532043	4
06021	2265001050	71432	0.0012738279	0.0632532043	4
06021	2265007015	71432	0	0	4
48001	2260001010	71432	0	0	2
48001	2260001030	71432	0	0	2
48001	2260002006	71432	0.00016	0.006782	2
48001	2265007015	71432	2.63E-05	0.000281	4

14. Summed the exhaust and summed the evaporative emissions for by FIPS/CAS/eng.

Table G-23. Partial listing of emissions after summing by FIPS, CAS, and engine type. (Section.

FIPS	CAS	eng	exh1	eva1
06001	71432	2	20.824142764	3.1043091582
06001	71432	4	93.924771216	6.8976984165
06021	71432	2	0.0570237128	0.0113984838
06021	71432	4	0.9153963121	0.0600273041
48001	71432	2	0.1681255378	0.0664583016
48001	71432	4	1.4996708652	0.2811232142

15. Merged the step 14 output and step 9 output by FIPS and CAS and where the first six digits of the SCC were 226501 or 226500 and eng=4 or where the first six digits of the SCC code were 226000 and eng=2. Retain all observations of the step 9 dataset and the FIPS/CAS/eng emissions from step 14.

Table G-24. Partial listing of emissions after merging with the engine emissions by FIPS, CAS, and engine type.

FIPS	SCC	CAS	Eva	Exh	eng	exh1	eva1
06001	2260001000	71432	0.065301121	3.6161273849	2	20.824142764	3.1043091582
06001	2260001010	71432	0.027924	2.173649	2	20.824142764	3.1043091582
06001	2260001030	71432	0.0332	1.412159	2	20.824142764	3.1043091582
06001	2260002000	71432	0.0094967323	1.3666668567	2	20.824142764	3.1043091582
06001	2260002006	71432	0.003535	0.36573	2	20.824142764	3.1043091582
06001	2265001000	71432	0.1289871176	2.1453478962	4	93.924771216	6.8976984165
06001	2265001010	71432	0.0106649406	0.1943388665	4	93.924771216	6.8976984165
06001	2265001020	71432	0.1289871176	2.1453478962	4	93.924771216	6.8976984165
06001	2265007000	71432	0	0	4	93.924771216	6.8976984165
06001	2265007015	71432	0	0	4	93.924771216	6.8976984165
06021	2260001000	71432	0	0	2	0.0570237128	0.0113984838
06021	2260001010	71432	0	0	2	0.0570237128	0.0113984838
06021	2260002000	71432	0.000076092	0.0110537204	2	0.0570237128	0.0113984838
06021	2260002006	71432	2.81E-05	0.002958	2	0.0570237128	0.0113984838
06021	2265001000	71432	0.0012738279	0.0632532043	4	0.9153963121	0.0600273041
06001	2265001020	71432	0.0012738279	0.0632532043	4	0.9153963121	0.0600273041
06021	2265001030	71432	0.0012738279	0.0632532043	4	0.9153963121	0.0600273041
06021	2265001050	71432	0.0012738279	0.0632532043	4	0.9153963121	0.0600273041
06021	2265007000	71432	0	0	4	0.9153963121	0.0600273041
06021	2265007015	71432	0	0	4	0.9153963121	0.0600273041
48001	2260001000	71432	0	0	2	0.1681255378	0.0664583016
48001	2260001010	71432	0	0	2	0.1681255378	0.0664583016
48001	2260001030	71432	0	0	2	0.1681255378	0.0664583016
48001	2260002000	71432	0.000416299	0.0253426696	2	0.1681255378	0.0664583016
48001	2260002006	71432	0.00016	0.006782	2	0.1681255378	0.0664583016
48001	2265007000	71432	0.008868335	0.015208714	4	1.4996708652	0.2811232142
48001	2265007015	71432	2.63E-05	0.000281	4	1.4996708652	0.2811232142

16. Corrected the exhaust and evaporative emissions for SCC codes where the eng variable was 2 or 4 and the exhaust and evaporative emissions were 0 and the emissions were California or Texas. They were replaced with exhaust and evaporative emissions for the eng type as calculated in step 14. This was done because the MSAT emissions for several SCC codes were not zero in 1999 but were not available in 2015 NMIM output for base MSAT. The same was true with the exhaust and evaporative emissions. Therefore county level engine emissions for exhaust and evaporative emissions were calculated to be used for the fraction calculations in step 17.

Table G-25. Emissions after correcting zero exhaust and evaporative emissions with engine type exhaust and evaporative emissions.

flag	FIPS	SCC	CAS	Eva	Exh	eng	exh1	eva1
	06001	2260001000	71432	0.065301121	3.6161273849	2	20.824142764	3.1043091582
	06001	2260001010	71432	0.027924	2.173649	2	20.824142764	3.1043091582
	06001	2260001030	71432	0.0332	1.412159	2	20.824142764	3.1043091582
	06001	2260002000	71432	0.0094967323	1.3666668567	2	20.824142764	3.1043091582
	06001	2260002006	71432	0.003535	0.36573	2	20.824142764	3.1043091582
	06001	2265001000	71432	0.1289871176	2.1453478962	4	93.924771216	6.8976984165
	06001	2265001010	71432	0.0106649406	0.1943388665	4	93.924771216	6.8976984165
	06001	2265001020	71432	0.1289871176	2.1453478962	4	93.924771216	6.8976984165
C	06001	2265007000	71432	6.8976984165	93.924771216	4	93.924771216	6.8976984165
C	06001	2265007015	71432	6.8976984165	93.924771216	4	93.924771216	6.8976984165
C	06021	2260001000	71432	0.0113984838	0.0570237128	2	0.0570237128	0.0113984838
C	06021	2260001010	71432	0.0113984838	0.0570237128	2	0.0570237128	0.0113984838
	06021	2260002000	71432	0.000076092	0.0110537204	2	0.0570237128	0.0113984838
	06021	2260002006	71432	2.81E-05	0.002958	2	0.0570237128	0.0113984838
	06021	2265001000	71432	0.0012738279	0.0632532043	4	0.9153963121	0.0600273041
	06001	2265001020	71432	0.0012738279	0.0632532043	4	0.9153963121	0.0600273041
	06021	2265001030	71432	0.0012738279	0.0632532043	4	0.9153963121	0.0600273041
	06021	2265001050	71432	0.0012738279	0.0632532043	4	0.9153963121	0.0600273041
C	06021	2265007000	71432	0.0600273041	0.9153963121	4	0.9153963121	0.0600273041
C	06021	2265007015	71432	0.0600273041	0.9153963121	4	0.9153963121	0.0600273041
C	48001	2260001000	71432	0.1681255378	0.0664583016	2	0.1681255378	0.0664583016
C	48001	2260001010	71432	0.1681255378	0.0664583016	2	0.1681255378	0.0664583016
C	48001	2260001030	71432	0.1681255378	0.0664583016	2	0.1681255378	0.0664583016
	48001	2260002000	71432	0.000416299	0.0253426696	2	0.1681255378	0.0664583016
	48001	2260002006	71432	0.00016	0.006782	2	0.1681255378	0.0664583016
	48001	2265007000	71432	0.008868335	0.015208714	4	1.4996708652	0.2811232142
	48001	2265007015	71432	2.63E-05	0.000281	4	1.4996708652	0.2811232142

17. Calculated exhaust emission fractions by dividing the exhaust emissions by the sum of the exhaust and evaporative emissions for each FIPS/SCC/CAS from step 16 output. Calculate the evaporative emissions fractions by dividing the evaporative emissions by the sum of the exhaust and evaporative emissions for each FIPS/SCC/CAS. Do this only where both are not zero. One of them could be zero but not both. If both were zero, then set the fractions equal to 0.

18. Sort step 17 output by FIPS/SCC/CAS.

Table G-26. Partial listing of emissions after calculating projection factors and sorting by FIPS, SCC, and CAS (Steps 17 and 18).

flag	FIPS	SCC	CAS	Eva	Exh	eng	exh_frac	eva_frac
	06001	2260001000	71432	0.065301121	3.6161273849	2	0.9822620157107	0.01773798428934
	06001	2260001010	71432	0.027924	2.173649	2	0.987316341543	0.012683658457
	06001	2260001030	71432	0.0332	1.412159	2	0.977029928205	0.0229700718
	06001	2260002000	71432	0.0094967323	1.3666668567	2	0.9930991254413	0.006900874558744
	06001	2260002006	71432	0.003535	0.36573	2	0.99042692917	0.00957307083
	06001	2265001000	71432	0.1289871176	2.1453478962	4	0.9432857882338	0.05671421176623
	06001	2265001010	71432	0.0106649406	0.1943388665	4	0.9479768656452	0.05202313435476
	06001	2265001020	71432	0.1289871176	2.1453478962	4	0.9432857882338	0.05671421176623
C	06001	2265007000	71432	6.8976984165	93.924771216	4	0.931585702655	0.06841429734505
C	06001	2265007015	71432	6.8976984165	93.924771216	4	0.931585702655	0.06841429734505
C	06021	2260001000	71432	0.0113984838	0.0570237128	2	0.833409560546	0.166590439454
C	06021	2260001010	71432	0.0113984838	0.0570237128	2	0.833409560546	0.166590439454
	06021	2260002000	71432	0.000076092	0.0110537204	2	0.9931632270819	0.006836772918113
	06021	2260002006	71432	2.81E-05	0.002958	2	0.990589732427	0.00941027
	06021	2265001000	71432	0.0012738279	0.0632532043	4	0.9802590037606	0.0197409962394
	06001	2265001020	71432	0.0012738279	0.0632532043	4	0.9802590037606	0.0197409962394
	06021	2265001030	71432	0.0012738279	0.0632532043	4	0.9802590037606	0.0197409962394
	06021	2265001050	71432	0.0012738279	0.0632532043	4	0.9802590037606	0.0197409962394
C	06021	2265007000	71432	0.0600273041	0.9153963121	4	0.9384602719239	0.06153972807615
C	06021	2265007015	71432	0.0600273041	0.9153963121	4	0.9384602719239	0.06153972807615
C	48001	2260001000	71432	0.0664583016	0.1681255378	2	0.7166970164271	0.2833029835729
C	48001	2260001010	71432	0.0664583016	0.1681255378	2	0.7166970164271	0.2833029835729
C	48001	2260001030	71432	0.0664583016	0.1681255378	2	0.7166970164271	0.2833029835729
	48001	2260002000	71432	0.000416299	0.0253426696	2	0.9838386774539	0.01616132254612
	48001	2260002006	71432	0.00016	0.006782	2	0.976951887064	0.02304811294
	48001	2265007000	71432	0.008868335	0.015208714	4	0.6316685238295	0.3683314761705
	48001	2265007015	71432	2.63E-05	0.000281	4	0.914415880247	0.08558412

Steps 2 through 18 were performed in the SAS® MACRO exhaust_evap.

19. Read the projected MSAT emissions (output from Section 3.3.3) and subset to 1,3-butadiene, acetaldehyde, acrolein, benzene, and formaldehyde based on CAS.

Table G-27. Partial listing of reference MSAT emissions after subsetting to the five HAPs.

FIPS	SCC	CAS	emis
06001	2260001010	106990	0.219016
06001	2260001010	107028	0.065565
06001	2260001010	50000	0.438031
06001	2260001010	71432	3.291336
06001	2260001010	75070	0.131409
06001	2260001030	106990	0.095558
06001	2260001030	107028	0.028607
06001	2260001030	50000	0.191117
06001	2260001030	71432	1.454391
06001	2260001030	75070	0.057335
06001	2260002000	106990	0.022212
06001	2260002000	107028	0.004665

Table 27. Continued.

FIPS	SCC	CAS	emis
06001	2260002000	50000	0.090633
06001	2260002000	71432	0.097496
06001	2260002000	75070	0.041693
06001	2265001010	106990	0.039095
06001	2265001010	107028	0.002868
06001	2265001010	50000	0.067717
06001	2265001010	71432	0.187604
06001	2265001010	75070	0.034401
06001	2270005045	107028	0.000112
06021	2260002006	106990	0.00028
06021	2260002006	107028	3.84E-05
06021	2260002006	50000	0.000398
06021	2260002006	71432	0.003259
06021	2260002006	75070	0.000457
06021	2265001020	106990	0.319786
06021	2265001020	107028	0.066658
06021	2265001020	50000	1.220082
06021	2265001020	71432	1.522297
06021	2265001020	75070	0.608339
06021	2270005045	107028	0.001556
48001	2260001000	106990	0.032812
48001	2260001000	107028	0.006512
48001	2260001000	50000	0.058605
48001	2260001000	71432	0.70733
48001	2260001000	75070	0.035782
48001	2260002000	106990	0.001097
48001	2260002000	107028	0.000219
48001	2260002000	50000	0.001857
48001	2260002000	71432	0.018899
48001	2260002000	75070	0.001217
48001	2265001000	106990	0.034624
48001	2265001000	107028	0.003068
48001	2265001000	50000	0.075164
48001	2265001000	71432	0.397382
48001	2265001000	75070	0.017972
48001	2265007015	106990	5.26E-05
48001	2265007015	107028	3.86E-06
48001	2265007015	50000	6.47E-05
48001	2265007015	71432	0.000304
48001	2265007015	75070	2.26E-05
48001	2270001000	106990	0.000114
48001	2270001000	107028	0.000843
48001	2270001000	50000	0.010962
48001	2270001000	71432	0.00152
48001	2270001000	75070	0.005444

20. Merged the output of step 19 with step 1 output using PROC SQL by SCC, retaining all observations from the step 19 output and the ASPEN source group from step 1 output.

21. Based on the source group, output source group=5 emissions to a gasoline dataset and all other emissions to a non-gasoline dataset for later use.

Table G-28. MSAT gasoline emissions after merging with SCC/bin cross reference and separate gasoline emissions and non-gasoline emissions (Section 10.3.2, steps 20 and 21).

FIPS	SCC	CAS	emis	grp
06001	2260001010	106990	0.219016	5
06001	2260001010	107028	0.065565	5
06001	2260001010	50000	0.438031	5
06001	2260001010	71432	3.291336	5
06001	2260001010	75070	0.131409	5
06001	2260001030	106990	0.095558	5
06001	2260001030	107028	0.028607	5
06001	2260001030	50000	0.191117	5
06001	2260001030	71432	1.454391	5
06001	2260001030	75070	0.057335	5
06001	2260002000	106990	0.022212	5
06001	2260002000	107028	0.004665	5
06001	2260002000	50000	0.090633	5
06001	2260002000	71432	0.097496	5
06001	2260002000	75070	0.041693	5
06001	2265001010	106990	0.039095	5
06001	2265001010	107028	0.002868	5
06001	2265001010	50000	0.067717	5
06001	2265001010	71432	0.187604	5
06001	2265001010	75070	0.034401	5
06021	2260002006	106990	0.00028	5
06021	2260002006	107028	3.84E-05	5
06021	2260002006	50000	0.000398	5
06021	2260002006	71432	0.003259	5
06021	2260002006	75070	0.000457	5
06021	2265001020	106990	0.319786	5
06021	2265001020	107028	0.066658	5
06021	2265001020	50000	1.220082	5
06021	2265001020	71432	1.522297	5
06021	2265001020	75070	0.608339	5
48001	2260001000	106990	0.032812	5
48001	2260001000	107028	0.006512	5
48001	2260001000	50000	0.058605	5
48001	2260001000	71432	0.70733	5
48001	2260001000	75070	0.035782	5
48001	2260002000	106990	0.001097	5
48001	2260002000	107028	0.000219	5
48001	2260002000	50000	0.001857	5
48001	2260002000	71432	0.018899	5
48001	2260002000	75070	0.001217	5
48001	2265001000	106990	0.034624	5

Table G-28. Continued.

FIPS	SCC	CAS	emis	grp
48001	2265001000	107028	0.003068	5
48001	2265001000	50000	0.075164	5
48001	2265001000	71432	0.397382	5
48001	2265001000	75070	0.017972	5
48001	2265007015	106990	5.26E-05	5
48001	2265007015	107028	3.86E-06	5
48001	2265001000	106990	0.034624	5
48001	2265001000	107028	0.003068	5
48001	2265001000	50000	0.075164	5
48001	2265001000	71432	0.397382	5
48001	2265001000	75070	0.017972	5
48001	2265007015	106990	5.26E-05	5
48001	2265007015	107028	3.86E-06	5

Table G-29. Partial listing of non-gasoline emissions.

FIPS	SCC	CAS	emis	grp
06001	2270005045	107028	0.000112	3
06021	2270005045	107028	0.001556	3
48001	2270001000	106990	0.000114	3
48001	2270001000	107028	0.000843	3
48001	2270001000	50000	0.010962	3
48001	2270001000	71432	0.00152	3
48001	2270001000	75070	0.005444	3

22. From the gasoline dataset created in step 21, merged the emissions with the fractions created in step 18 by FIPS/SCC/CAS. Output all observations from the dataset created in step 21 to the dataset.

23. Multiplied the emissions by fractions. If the CAS = 71432 (benzene) multiplied the emissions by the exhaust fraction to get exhaust emissions and multiply the emissions by the evaporative fraction to get evaporative emissions. If not benzene, these calculations were not done.

Table G-30. Partial listing of gasoline emissions with projection factors and exhaust and evaporative emissions for benzene (Steps 22 and 23).

FIPS	SCC	CAS	emis	exh_frac	eva_frac	emis_exh	emis_eva
06001	2260001010	106990	0.219016	.	.	.	.
06001	2260001010	107028	0.065565	.	.		.
06001	2260001010	50000	0.438031	.	.	.	.
06001	2260001010	71432	3.291336	0.987316341543	0.012683658457	3.249589818309	0.041746181691
06001	2260001010	75070	0.131409	.	.	.	.
06021	2260002006	106990	0.00028	.	.	.	.
06021	2260002006	107028	3.84E-05	.	.	.	.
06021	2260002006	50000	0.000398	.	.	.	.
06021	2260002006	71432	0.003259	0.990589732427	0.00941027	0.003228331938	0.00003067
06021	2260002006	75070	0.000457	.	.	.	.
48001	2260001000	106990	0.032812	.	.	.	.
48001	2260001000	107028	0.006512	.	.	.	.
48001	2260001000	50000	0.058605	.	.	.	.
48001	2260001000	71432	0.70733	0.7166970164271	0.2833029835729	0.5069413006294	0.2003886993706
48001	2260001000	75070	0.035782	.	.	.	.

Steps 19 through 23 were performed in the SAS® MACRO read_msat.

24. Merged the output of step 23 with the projection factors calculated in calc_factors.sas by FIPS/CAS using PROC SQL. Retain all observations from step 23 output.

Table G-31. Partial listing of gasoline emissions with projection factors.

FIPS	SCC	CAS	emis	emis_exh	emis_eva	pf_exh	pf_evap
06001	2260001010	106990	0.219016	.	.	1.0012384215	.
06001	2260001010	107028	0.065565	.	.		.
06001	2260001010	50000	0.438031	.	.	1.0018241077	.
06001	2260001010	71432	3.291336	3.249589818309	0.041746181691	0.944296577	0.5999749383
06001	2260001010	75070	0.131409	.	.	1.0015537589	.
06021	2260002006	106990	0.00028	.	.	1.0012845671	.
06021	2260002006	107028	3.84E-05	.	.	1	.
06021	2260002006	50000	0.000398	.	.	1.0018887224	.
06021	2260002006	71432	0.003259	0.003228331938	0.00003067	0.9424016216	0.5999925419
06021	2260002006	75070	0.000457	.	.	1.0016036635	.
48001	2260001000	106990	0.032812	.	.	1.0028720014	.
48001	2260001000	107028	0.006512	.	.	1	.
48001	2260001000	50000	0.058605	.	.	1.0038495361	.
48001	2260001000	71432	0.70733	0.5069413006294	0.2003886993706	0.9104735847	0.570001502
48001	2260001000	75070	0.035782	.	.	1.0033413338	.

25. Calculated projected or controlled emissions for step 24 output. For benzene, the projected emissions were the sum of the exhaust emissions multiplied by the exhaust projection factor (calculated in calc_factors.sas) and the evaporative emissions multiplied by the evaporative projection factor (calculated in calc_factors.sas) (Equation 23). Otherwise the emissions were multiplied by the exhaust projection factor (Equation 24).

Table G-32. Partial listing of gasoline emissions after calculating controlled emissions. The variable emis is the controlled emissions and emis_orig is the reference projected emissions for MSAT.

FIPS	SCC	CAS	emis	emis_exh	emis_eva	pf_exh	pf_evap	emis_orig
06001	2260001010	106990	0.2192872341	.	.	1.0012384215	.	0.219016
06001	2260001010	107028	0.065565	.	.	1	.	0.065565
06001	2260001010	50000	0.438031	.	.	1.0018241077	.	0.438031
06001	2260001010	71432	0.4388300157	3.249589818309	0.041746181691	0.944296577	0.5999749383	3.291336
06001	2260001010	75070	3.093623204868	.	.	1.0015537589	.	0.131409
06021	2260002006	106990	0.1316131779	.	.	1.0012845671	.	0.00028
06021	2260002006	107028	0.0002803597	.	.	1	.	3.84E-05
06021	2260002006	50000	0.0003987517	.	.	1.0018887224	.	0.000398
06021	2260002006	71432	0.003060787025	0.003228331938	0.00003067	0.9424016216	0.5999925419	0.003259
06021	2260002006	75070	0.0004577329	.	.	1.0016036635	.	0.000457
48001	2260001000	106990	0.0329062361	.	.	1.0028720014	.	0.032812
48001	2260001000	107028	0.006512	.	.	1	.	0.006512
48001	2260001000	50000	0.0588306021	.	.	1.0038495361	.	0.058605
48001	2260001000	71432	0.5757785228416	0.5069413006294	0.2003886993706	0.9104735847	0.570001502	0.70733
48001	2260001000	75070	0.0359015596	.	.	1.0033413338	.	0.035782

26. Concatenated the output of step 25 with the non-gasoline emissions created in step 21.

27. Sorted step 27 output by FIPS/SCC/CAS and output to a permanent dataset.

Table G-33. Partial listing of nonroad emissions after concatenating controlled nonroad gasoline emissions with non-gasoline nonroad emissions, sorting by FIPS, SCC, and CAS and output to a permanent dataset with only needed variables (Steps 26 and 27).

FIPS	CAS	SCC	emis	emis_exh	emis_eva	flag	emis_orig
06001	106990	2260001010	0.2192872341	.	.		0.219016
06001	107028	2260001010	0.065565	.	.		0.065565
06001	50000	2260001010	0.438031	.	.		0.438031
06001	71432	2260001010	0.4388300157	3.249589818309	0.041746181691		3.291336
06001	75070	2260001010	3.093623204868	.	.		0.131409
06001	107028	2270005045	0.000112	.	.		.
06021	106990	2260002006	0.1316131779	.	.		0.00028
06021	107028	2260002006	0.0002803597	.	.		3.84E-05
06021	50000	2260002006	0.0003987517	.	.		0.000398
06021	71432	2260002006	0.003060787025	0.003228331938	0.00003067		0.003259
06021	75070	2260002006	0.0004577329	.	.		0.000457
06001	107028	2270005045	0.001556	.	.		.
48001	106990	2260001000	0.0329062361	.	.		0.032812
48001	107028	2260001000	0.006512	.	.		0.006512
48001	50000	2260001000	0.0588306021	.	.		0.058605
48001	71432	2260001000	0.5757785228416	0.5069413006294	0.2003886993706	C	0.70733
48001	75070	2260001000	0.0359015596	.	.		0.035782
48001	106990	2270001000	0.000114	.	.		.
48001	107028	2270001000	0.000843	.	.		.
48001	50000	2270001000	0.010962	.	.		.
48001	71432	2270001000	0.00152	.	.		.

Steps 24 through 27 were performed in the SAS® MACRO apply_pf.

All steps were performed in the SAS® MACRO control with the four digit year, 2015, 2020, or 2030 as the argument.

Figure G-2 shows the steps to calculate the exhaust and evaporative fractions and Figure G-3 shows the steps of the application of the exhaust and evaporative fractions and projection factors.

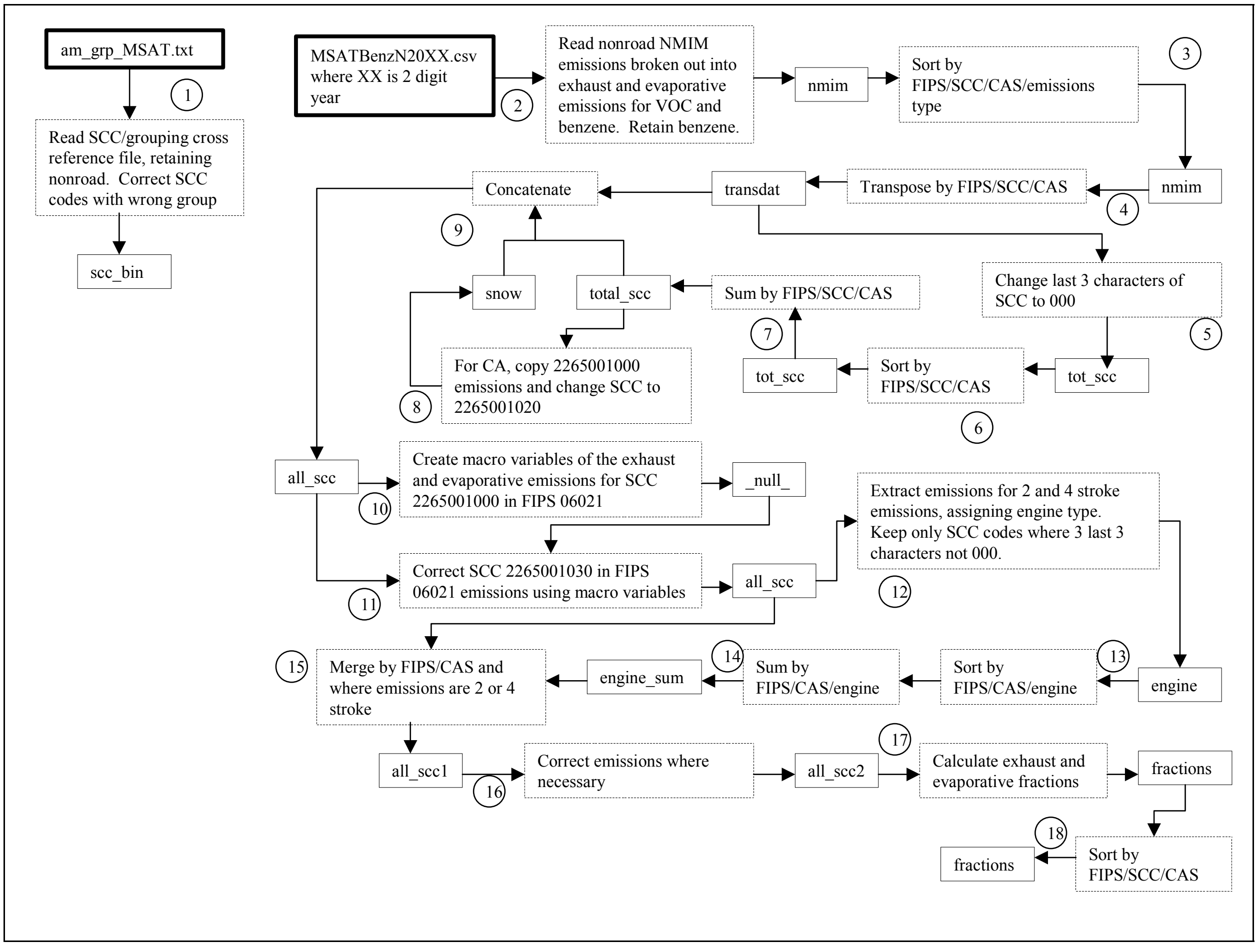

Figure G-2. Steps in the calculation of the exhaust and evaporative emissions fractions (steps 2-18 in control_nonroad.sas (found in the MSAT rule docket EPA-HQ-OAR-2005-0036).

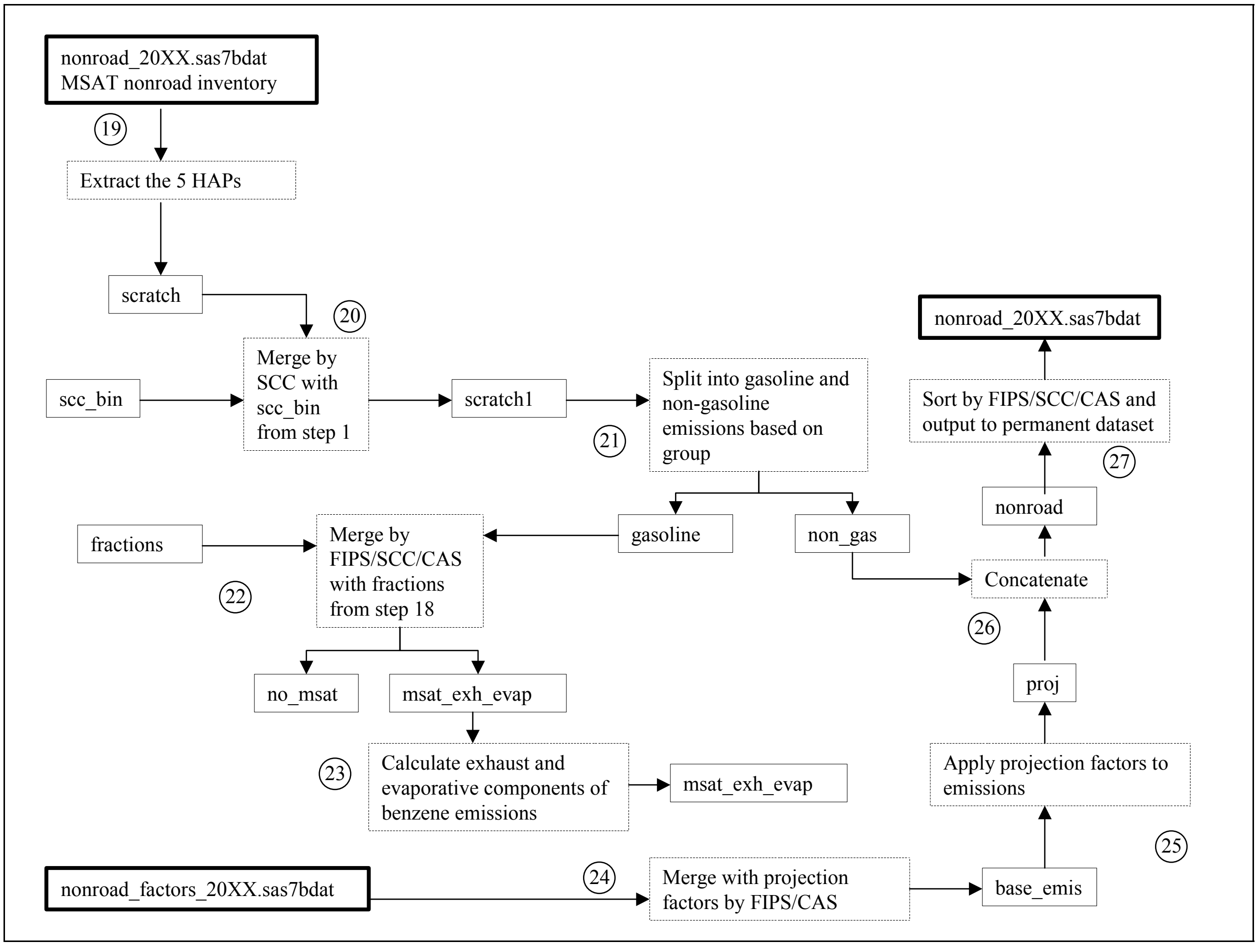

Figure G-3. Steps in calculating controlled nonroad emissions (steps 19-27 of control_nonroad.sas).