Light-Duty Vehicle Greenhouse Gas Emissions Inventory for Air Quality Modeling Technical Support Document

United States
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Agency

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Assessment and Standards Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

EPA United States Environmental Protection Agency

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ACRONYMS

AEO	Annual Energy Outlook
BEIS	Biogenic Emission Inventory System
btp	Bulk plant terminal-to-pump
C3	Category 3 (commercial marine vessels)
CAMD	EPA's Clean Air Markets Division
CAP	Criteria Air Pollutant
CARB	California Air Resources Board
CEM	Continuous Emissions Monitoring
CMAQ	Community Multiscale Air Quality
DOE	Department of Energy
E0	0% Ethanol gasoline
E10	10% Ethanol gasoline
E85	85% Ethanol gasoline
EISA	Energy Independence and Security Act of 2007
EGU	Electric Generating Utility
FAA	Federal Aviation Administration
FIPS	Federal Information Processing Standard
HAP	Hazardous Air Pollutant
HDGV	Heavy-duty Gasoline Vehicles
IPM	Integrated Planning Model
LDGHG	Light Duty Greenhouse Gas
LDGT1	Light-duty Gasoline Trucks, 0-6000 pounds gross vehicle weight
LDGT2	Light-duty Gasoline Trucks, 6000-8500 pounds gross vehicle weight
LDGV	Light-duty Gasoline Vehicles
MOBILE6	Mobile Source Emission Factor Model, version 6
MOVES	Motor Vehicle Emissions Simulator
NEEDS	National Electric Energy Database System
NEI	National Emission Inventory
NMIM	National Mobile Inventory Model
OAQPS	EPA's Office of Air Quality Planning and Standards
ORL	One Record per Line (a SMOKE input format)
ORNL	Oak Ridge National Laboratory
MP	Multipollutant
PFC	Portable Fuel Container
rtb	Refinery-to-bulk terminal
RFS1	Renewable Fuel Standard program
RFS2	Revised annual renewable fuel standard
SMOKE	Sparse Matrix Operator Kernel Emissions
SCC	Source Category Code
TAF	Terminal Area Forecast
VOC	Volatile Organic Compound
WRAP	Western Regional Air Partnership

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1 Introduction

This document provides the details of emissions data processing done in support of the Environmental Protection Agency (EPA) and National Highway Traffic Safety Administration (NHTSA) joint rulemaking effort to establish Light Duty Vehicle Greenhouse Gas (LDGHG) Emissions Standards and Corporate Average Fuel Economy (CAFÉ) Standards. The emissions and modeling effort is hereafter referred to as LDGHG and consists of three emissions cases. Table 1 provides of list of the emissions cases created for this modeling effort.

Table 1. List of cases run in support of the LDGHG air quality modeling

Case Name	**Internal EPA Abbreviation**	**Description**
2005 basecase	2005cp_tox	2005 case done with average year fires data and an average year temporal allocation approach for Electrical Generating Units (EGUs), to use for computing relative response factors with 2030 scenarios
2030 Reference case	2030cp_tox	2030 "baseline" scenario representing the best estimate for the future year without implementation of national CO_2 emissions standards.
2030 Control case	2030cp_tox_ldghg	2030 "control" case scenario representing implementation of national CO_2 emissions standards for light-duty vehicles. These standards will require these vehicles to meet an estimated combined average emissions level of 250 grams/mile of CO_2 in model year 2016.

The data used in the 2005 emissions cases are often the same as those described in the 2005-based, v4 platform document (http://www.epa.gov/ttn/chief/emch/index.html#2005). The LDGHG cases use some different emissions data than the official v4 platform for two reasons. First, the LDGHG Standard was evaluated in comparison to the modeling performed for the Revised annual Renewable Fuel Standard (RFS2); therefore, RFS2-specific inputs were retained for LDGHG. The 2005 RFS2 modeling was performed from December 2008 through March of 2009, prior to the completion of the 2005 v4 platform. Second, the LDGHG modeling used data intended only for the rule development and not for general use. All of the documentation provided here describes what was done differently and specifically for the LDGHG effort in contrast to what is used in the v4 platform.

In LDGHG, we used a 2005 base case approach for the year 2005 emissions scenario. While there is not documentation on the approach specific to 2005, this approach is similar to that in OAQPS's 2002-based v3 platform (http://www.epa.gov/ttn/chief/emch/index.html#2002). A base case approach uses average year fires and EGU temporal profiles from 3 years of EGU data. We use a base case approach because we want to reduce year-specific variability in these components of the inventory: for example large fires vary in location and day of the year each year, and EGU shutdowns and high use on high energy demand days also vary by year. By using a base case approach, these two aspects of the inventory are maintained in future year modeling and therefore do not introduce potentially spurious year-specific artifacts in air quality modeling estimates. In addition, the same biogenic emissions data as the v4 platform was used not only in the 2005 case for LDGHG, but also in both future-year cases run for LDGHG. For LDGHG, the only significant data changes between the 2005 and future-year cases are emission inventories and speciation approaches.

For this effort, we have created and provided state, county, and source category code (SCC) emission summaries for the nonpoint and mobile sectors. For point sources, we have posted the actual inventory datasets that we used for emissions modeling. These data have been provided to the EPA docket for this rule. In addition, the data can be found associated with the "LDGHG 2005 and 2030 emissions data" link on the Clearinghouse for Inventories and Emissions Factors (CHIEF) website at http://www.epa.gov/ttn/chief/emch/index.html#2005.

In the remainder of this document, we provide a description of the approaches taken for the emissions in support of air quality modeling for LDGHG. In Section 2, we describe the ancillary data and 2005 inventory differences from the v4 platform. In Section 3, we describe the speciation differences among each of the cases run for LDGHG. In Section 4, we describe the 2030 Reference case as compared to the 2005 base case, and in Section 5, we describe the 2030 Control Case in comparison to the 2030 Reference case.

2 2005 Emission inventories and their preparation

As mentioned previously, the 2005 emissions modeling approach for LDGHG used much of the same data and approaches as the 2005 v4 platform. In this section, we identify the differences between the data used for LDGHG and that used for the 2005 v4 platform. Section 2.1 provides ancillary data differences that impact multiple sectors and Sections 2.2 through 2.4 provides differences for the point, area, and mobile sectors.

Table 2 below lists the platform sectors used for the LDGHG modeling platform. It also indicates which platform sectors include HAP emissions and the associated sectors from the National Emission Inventory (NEI). Subsequent sections refer to these platform sectors for identifying the emissions differences between the v4 platform and the LDGHG platform.

Table 2. Sectors Used in Emissions Modeling for the LDGHG Platform

Platform Sector	2005 NEI Sector	Description	Contains HAP emissions?
IPM sector: *ptipm*	Point	NEI EGU units at facilities mapped to the IPM model using the National Electric Energy Database System (NEEDS) database.	Yes
Non-IPM sector: *ptnonipm*	Point+	All NEI point source units not matched to the ptipm sector.	Yes
Average-fire sector: *avefire*	N/A	Average-year wildfire and prescribed fire emissions derived from the 2001 Platform avefire sector, county and annual resolution.	Yes
Agricultural sector: *ag*	Nonpoint	NH3 emissions from NEI nonpoint livestock and fertilizer application.	No
Area fugitive dust sector: *afdust*	Nonpoint	PM_{10} and $PM_{2.5}$ emissions from fugitive dust sources in the NEI nonpoint inventory.	No
Remaining nonpoint sector: *nonpt*	Nonpoint+	All nonpoint sources not otherwise included in other emissions modeling sectors.	Yes
Nonroad sector: *nonroad*	Mobile: Nonroad	Nonroad emissions from National Mobile Inventory Model (NMIM) using NONROAD2005, other than for California, for which emissions submitted by the California Air Resources Board (CARB) were used. CARB data used for HAPs are annual, allocated to monthly using NMIM, while other data are monthly.	Yes
Aircraft, locomotive, marine: *alm_no_c3*	Mobile: Nonroad	Aircraft, locomotive, commercial marine except for category 3 (C3) commercial marine vessels	Yes
C3 commercial marine: *seca_c3*	Mobile: nonroad	C3 commercial marine vessels	Yes

Platform Sector	2005 NEI Sector	Description	Contains HAP emissions?
Onroad, except gasoline PM: ***on_noadj***	Mobile: onroad+	A combination of onroad mobile sources from MOBILE6, MOVES, and 2005 NEI v2 data from California. MOVES-based data used for: 1) onroad diesel exhaust PM, CO, NOx, VOC, some VOC HAPs 2) onroad gasoline exhaust CO and NOx 3) onroad gasoline evaporative and exhaust VOC, and some VOC HAPs. More details are provided in the 2005 v4 platform documentation.	Yes
Onroad starting exhaust PM: ***on_moves_startpm***	Mobile: onroad+	MOVES-based onroad mobile start gasoline exhaust PM data. More details provided in the 2005 v4 platform documentation.	No
Onroad running exhaust PM ***on_moves_runpm***	Mobile: onroad+	MOVES-based onroad mobile running gasoline exhaust PM data. More details provided in the 2005 v4 platform documentation.	No
Biogenic: ***biog***	N/A	Hour-specific emissions generated from the Biogenic Emission Inventory System (BEIS), version 3.14 model (includes emissions in Canada and Mexico) run with the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system.	No
Other point sources not from the NEI: ***othpt***	N/A	Point sources from Canada's 2000 inventory, Mexico's 1999 inventory, and off-shore point sources from the 2001 platform	No
Other nonpoint and nonroad not from the NEI: ***othar***	N/A	Canada 2000 and Mexico 1999 nonpoint and nonroad mobile inventories	No
Other onroad sources not from the NEI: ***othon***	N/A	Canada 2000 and Mexico 1999 onroad mobile inventories	No

+ Some data included in modeling sector has been revised beyond what is included in the 2005 NEI v1 or v2.

As with the 2005 v4 platform, we processed all emissions data with a custom version of the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system, version 2.5. Users seeking to replicate modeling done for this effort can use version 2.6 of SMOKE. More details about SMOKE including user documentation are available at its website (http://www.smoke-model.org).

2.1 Custom configuration for emissions modeling for LDGHG

Unlike the 2005 v4 platform, the configuration for LDGHG modeling included additional hazardous air pollutants (HAPs) and used slightly older ancillary data. Both of these differences are described in this section.

Table 3 lists the additional HAP pollutants processed for the LDGHG platform, which were not included in the 2005 v4 platform. However, since using the full multipollutant HAP version of the Community Multiscale Air Quality (CMAQ) model would have taken longer than the time available for our project, we used a "lite" version of the multipollutant CMAQ that required emissions only for the species flagged in the third column of Table 3. Additional model species that appear in model-ready data files are listed in the right two columns of the table, but we did not run these additional HAPs through CMAQ for this effort.

Table 3. Comparison of model species in the 2005 v4 platform and the LDGHG platform

Description	2005 v4 platform species	LDGHG platform Species in CMAQ MP lite	Additional LDGHG platform HAP Species*	Description
Carbon Monoxide	CO	CO	ACRYLONITRILE	Acrylonitrile
Nitrogen Oxide	NO	NO	BR2_C2_12	1,2 Dibromoethane
Nitrogen Dioxide	NO2	NO2	CARBONTET	Carbontet
Nitrous acid	HONO	HONO	CHCL3	Chloroform
Ammonia	NH3	NH3	CL_ETHE	Vinyl Chloride
Sulfur dioxide	SO2	SO2	CL2_C2_12	1,2 Dichloroethane
Sulfuric acid vapor	SULF	SULF	CL2_ME	Methylene Chloride
$PM_{2.5}$ Elemental carbon	PEC	PEC	CL3_ETHE	Trichloroethylene
$PM_{2.5}$ Organic carbon	POC	POC	CL4_ETHANE1122	1,1,2,2 Tetrachloroethane
$PM_{2.5}$ primary nitrate	PNO3	PNO3	CL4_ETHE	Perchloroethylene
$PM_{2.5}$ primary sulfate	PSO4	PSO4	DICHLOROBENZE NE	Dichlorobenzene
$PM_{2.5}$ other	PMFINE	PMFINE	DICHLOROPROPE NE	Dichloropropene
PM Coarse (PM_{10} – $PM_{2.5}$)	PMC	PMC	ETOX	Ethylene Oxide
Acetaldehyde	ALD2	ALD2	HEXAMETHY_DIIS	Hexamethylene 1,6-Diisocyanate
Higher aldehydes	ALDX	ALDX	HYDRAZINE	Hydrazine
Ethene	ETH	ETH	MAL_ANHYDRIDE	Maleic Anhydride
Ethane	ETHA	ETHA	PROPDICHLORIDE	Propdichloride
Ethanol	ETOH	ETOH	QUINOLINE	Quinoline
Formaldehyde	FORM	FORM	TOL_DIIS	2,4-Toluene Diisocyanate
Internal olefin carbon bond	IOLE	IOLE	TRIETHYLAMINE	Triethylamine
Isoprene	ISOP	ISOP	DIESEL_PEC	Diesel $PM_{2.5}$ elemental carbon
Methanol	MEOH	MEOH	DIESEL_POC	Diesel $PM_{2.5}$ organic carbon
Nonreactive VOC	NR	NR	DIESEL_PMFINE	Diesel $PM_{2.5}$ primary nitrate
Nonvolatile (from VOC mass)	NVOL	NVOL	DIESEL_PNO3	Diesel $PM_{2.5}$ primary sulfate
Terminal olefin carbon bond	OLE	OLE	DIESEL_PMC	Diesel $PM_{2.5}$ other
Parrafin carbon bond	PAR	PAR	DIESEL_PSO4	Diesel coarse PM
Toluene and other monoalkyl aromatics	TOL	TOL	BERYLLIUM_C	Coarse Beryllium
Unknown VOC	UNK	UNK	BERYLLIUM_F	Fine Beryllium
Unreactive VOC	UNR	UNR	CADMIUM_C	Coarse Cadmium
Xylene and other polyalkyl aromatics	XYL	XYL	CADMIUM_F	Fine Cadmium
Sequiterpenes	SESQ	SESQ	CHROMHEX_C	Coarse Hexavalent Chromium
Terpene	TERP	TERP	CHROMHEX_F	Fine Hexavalent Chromium
Benzene	BENZENE	BENZENE	CHROMTRI_C	Coarse Trivalent Chromium
Chlorine	CL2	CL2	CHROMTRI_F	Fine Trivalent Chromium
Hydrochloric acid	HCL	HCL	LEAD_C	Coarse Lead
Divalent gaseous mercury	HGIIGAS	HGIIGAS	LEAD_F	Fine Lead
Elemental mercury	HGNRVA	HGNRVA	MANGANESE_C	Coarse Manganese
Particulate mercury	PHGI	PHGI	MANGANESE_F	Fine Manganese
Naphthalene from the HAP inventory		NAPHTHALENE	NICKEL_C	Coarse Nickel
Acrolein from the HAP inventory		ACROLEIN	NICKEL_F	Fine Nickel
Acetaldehyde from the HAP inventory		ALD2_PRIMARY		
1,3 Butadiene from the HAP inventory		BUTADIENE13		

Description	2005 v4 platform species	LDGHG platform Species in CMAQ MP lite	Additional LDGHG platform HAP Species*	Description
Methane from the HAP inventory		CH4		
Formaldehyde from the HAP inventory		FORM_PRIMARY		
M-isomer of Xylene from the HAP inventory	MXYL			
O-isomer of Xylene from the HAP inventory	OXYL			
P-isomer of Xylene from the HAP inventory	PXYL			
Toluene from the HAP inventory	TOLU			

* These species are created by the emissions configuration, but were not modeled.

In addition to the model species differences, the LDGHG platform had a few additional custom aspects in the 2005 cases. Table 4 lists the datasets used by the LDGHG platform that are different from the v4 platform, including a description of the impact of the differences. These differences stem from the 2005 v4 platform having been done after the RFS2 platform, which was used as the basis for the LDGHG platform, resulting in newer inventory data used for the v4 platform. These inventory differences are described more in later sections of this document. In addition, Appendix B provides a more detailed comparison of the ancillary datasets for the 2005 v4 platform versus the LDGHG platform.

Another consideration is the speciation across the LDGHG future-year cases as compared to 2005. Section 3 provides a detailed account of these differences. Otherwise, the future-year ancillary data were largely the same as those in 2005, with no substantial differences. All ancillary data files can be found at the 2005-based platform website (http://www.epa.gov/ttn/chief/emch/index.html#2005).

Table 4. Description of differences in ancillary data between the LDGHG 2005 case and the 2005 v4 platform

Ancillary Data Type	**Difference between 2005 v4 platform and LDGHG platform**
Spatial cross references	The 2005 v4 platform data are updated to support the newer (2006) Canadian inventories. The LDGHG files contain references to diesel exhaust start emissions from MOVES, that were not available for the v4 platform.
Temporal cross-references	The 2005 v4 platform data are updated to support the 2006 Canadian data, additional source category codes (SCCs) found in the 2005 v2 NEI point inventory, and a revised oil and gas inventory. The LDGHG files contain references to diesel exhaust start emissions from MOVES.
Temporal profiles	The 2005 v4 platform dataset adds additional profiles from Environment Canada to support processing of the 2006 Canadian inventory.
Speciation cross-references and Speciation profiles	The LDGHG data files are configured to support the multi-pollutant (MP) version of CMAQ, whereas the 2005 v4 platform data file is configured to support only the non-MP version. Therefore, the LDGHG data files include profiles for additional HAP species, including HAP VOCs, HAP metals, chromium, and diesel PM. The 2005 v4 platform data files include profiles for passing through the pre-speciated VOCs for the 2006 Canadian inventory. Furthermore, new headspace vapor VOC speciation profiles were used based on new test data for E0 and E10 fuels for LD GHG.
Inventory tables	The LDGHG data file is configured to support the MP version of CMAQ, whereas the 2005 v4 platform data file is configured to support only the non-MP version.
NonHAP exclusions data	The 2005 v4 platform data has been updated with new oil and gas SCCs not used for the LDGHG platform.

2.2 Point sources

The 2005 emissions from the U.S. point source sectors (ptipm and ptnonipm) used for LDGHG differ from the v4 platform primarily because the emissions are based on the 2005 NEI version 1, rather than the 2005 NEI version 2. While the NEI version 2 was available in time for this work, we intentionally remained consistent with the RFS2 modeling approach that had just been completed. The original emissions were created from the NEI database on June 10, 2008. These emissions were further modified, further changing the 2005 NEI version 1, as follows:

1) Inventory split into ptipm and ptnonipm sectors using the IPM column of the SMOKE-ready datasets
2) Applied fugitive dust transport fractions to the appropriate SCCs (SCC list available at http://www.epa.gov/ttn/chief/emch/dustfractions**)**
3) Further analyzed HCl emissions for missing ptipm sector HCl sources and moved emissions originally labeled as ptnonipm to correctly be placed with their associated criteria air pollutants (CAP) emissions in the ptipm sector
4) Removed emissions of benzene, acetaldehyde, formaldehyde, methanol, to support the "no hap use" approach for the ptipm and ptnonipm sectors. This approach creates emissions of these HAPs from VOC speciation profiles rather than the HAP emissions inventory, because the CAP and HAP emissions were not consistent enough to be able to use the HAP inventory for VOC speciation.
5) Added an additional 47 ethanol plants. Unless otherwise noted in Table 5 (a list of ethanol facilities and their emissions), we adjusted the original VOC emissions provided by a factor of 0.65 (a reduction) to offset the ethanol-heavy speciation profile (99.6% ethanol) that we had available for speciation of ethanol plants. This prevented the overstating of ethanol emissions. In addition, we multiplied all

emissions by 1/(453.6 × 2000) × 1,000,000 = 1.1023113109 (converting from grams/yr per million gallons to tons/yr) to correct the units of the emissions (from grams per million gallon per year to tons/year). These changes resulted in roughly a 10.23% increase in the emissions values initially provided by OTAQ. The list of these facilities and their emissions is available in Table 5.

6) Removed facilities that closed between 2002 and 2005, since much of the ptnonipm portion of the 2005 v1 NEI was carried forward from the 2002 v3 NEI. This change was also made in creating the v4 platform. The list of removed sources is available in the Excel® file "Closures_applied_to_2002v3_point_for_2005af.xls" provided with the 2005 v4 platform documentation.
7) Removed Minnesota airport ground support equipment (SCCs 2265008005 and 2270008005), to prevent double counting with the nonroad sector.
8) Other minor adjustments:
    - Removed exclamation marks, asterisks, and embedded double quotes in facility names, and other key text fields, changed "PM25" and "PM25-PRI" to "PM2_5", and changed the state/county Federal Information Processing Standard (FIPS) code field for tribal records from 00000 to 88TTT, where TTT is the tribal code.
    - Removed two SCC=201002 records because this is an invalid SCC; both records had zero emissions

To implement the inventory processing, we split the 2005 ptnonipm CAP and HAP inventories into five separate datasets to facilitate replacement and projection for the 2030 reference and control scenarios. These datasets are:

1) A dataset with one ethanol plant (Chippewa) CAP and HAP emissions for which the emissions are held at 2005 values for the 2030 LDGHG reference and control scenarios;
2) A dataset with three ethanol plants' CAP and HAP emissions that are replaced in both the 2030 LDGHG reference and control scenarios;
3) A dataset with CAP and HAP emissions for 43 additional ethanol plants not available in the 2005 v1 NEI, which also have different emissions in the 2030 reference and control scenarios;
4) A dataset with CAP emissions from the all other nonEGU sources from the 2005 NEI v1
5) A dataset with HAP emissions from the all other nonEGU sources from the 2005 NEI v1

In addition to differences in the U.S. point sources, further differences exist from the v4 platform for the Canadian point emissions. The Mexico point emissions are identical to those documented for the 2002 v3 platform and the 2005 v4 platform. The LD GHG modeling inventories included year 2000 Canadian emissions from the 2002 v3 platform and did not include the updated 2006 Canadian emissions, to be consistent with the modeling done for RFS2. We did not model mercury and therefore did not use Canadian mercury emissions data. The offshore sources were different from what was used in the 2005 v4 platform because they were not updated with the new offshore inventory available in the 2005 v2 NEI. For more information on the Canadian and Mexican emissions used for this effort, please refer to the 2002 v3 platform documentation at http://www.epa.gov/ttn/chief/emch/index.html#2002.

In addition, we processed emissions for LDGHG using the 3-d emissions option for all point source sectors rather than the "inline" point source option that we used for the 2005 v4 platform. This approach has essentially no effect on the modeling results. Using the inline approach makes the CMAQ emissions data files smaller, but that option was not available for multi-pollutant CMAQ in time for use on this effort.

Table 5. Emissions from ethanol plants added to 2005 v1 point inventory (tons/year)

County Name	State Name	St/Co FIPS	PLANT	CO	NO_X	VOC	SO_2	$PM_{2.5}$	PM_{10}	ACROLEIN
Swift Co	Minnesota	27151	Chippewa Valley Ethanol Co LLLP (*)	29.7	40.4	155.1	0.6	19.7	28.4	0.0001
Chippewa Co	Minnesota	27023	Granite Falls WWTP (+)	0.0	0.0	0.7	0.0	0.0	0.0	0.0000
Dodge Co	Minnesota	27039	Al-Corn Clean Fuel (+)	28.5	45.0	207.6	0.5	0.0	24.0	0.0618
Sibley Co	Minnesota	27143	Heartland Corn Products (+)	51.4	62.9	378.3	0.4	36.7	61.6	0.0000
Dawson Co	Nebraska	31047	Cornhusker Energy Lexington (CEL)	10.5	30.3	14.3	38.6	1.1	12.1	0.0557
Stevens Co	Minnesota	27149	Diversified Energy Company (DENCO), LLC	52.4	151.6	71.6	192.9	6.5	60.6	0.2783
Wichita Co	Kansas	20203	ESE Alcohol Inc.	3.1	9.1	4.3	11.6	0.4	3.6	0.0166
Sedgwick Co	Kansas	20173	Abengoa Bioenergy Corporation	52.4	151.6	71.6	192.9	5.5	60.6	0.2783
Roosevelt Co	New Mexico	35041	Abengoa Bioenergy Corporation	62.8	181.9	86.0	231.5	6.6	72.8	0.3339
Linn Co	Iowa	19113	Archer Daniels Midland (ADM)	964.7	1,338.4	418.1	1,266.3	546.7	1,248.9	2.7827
Clinton Co	Iowa	19045	Archer Daniels Midland (ADM)	733.2	1,017.2	317.7	962.4	415.5	949.2	2.1148
Platte Co	Nebraska	31141	Archer Daniels Midland (ADM)	366.6	508.6	158.9	481.2	207.8	474.6	1.0574
Lyon Co	Minnesota	27083	Archer Daniels Midland (ADM)	154.4	214.1	66.9	202.6	87.5	199.8	0.4452
Peoria Co	Illinois	17143	Archer Daniels Midland (ADM)	439.8	1,273.1	601.9	1,620.4	365.5	509.3	2.3375
Pembina Co	North Dakota	38067	Archer Daniels Midland (ADM)	52.4	151.6	71.6	192.9	43.5	60.6	0.2783
Tazewell Co	Illinois	17179	Aventine Renewable Energy, Inc. (formerl	385.9	535.4	167.2	506.5	218.7	499.6	1.1131
Monroe Co	Wisconsin	55081	Badger State Ethanol, LLC	108.9	315.3	149.0	401.2	13.4	126.1	0.5788
Des Moines Co	Iowa	19057	Big River Resources, LLC	108.9	315.3	149.0	401.2	13.4	126.1	0.5788
Washington Co	Nebraska	31177	Cargill (was PGLA-1CO)	328.0	455.1	142.1	430.5	185.9	424.6	0.9458
Christian Co	Kentucky	21047	Commonwealth Agri-Energy, LLC	41.9	121.3	57.3	154.3	5.2	48.5	0.2226
Codington Co	South Dakota	46029	Glacial Lakes Energy, LLC (GLE)	104.7	303.1	143.3	385.8	12.9	121.3	0.5567
Kossuth Co	Iowa	19109	Global Ethanol	209.4	606.3	286.6	771.6	25.8	242.5	1.1131
Riverside Co	California	06065	Golden Cheese Company of CA	10.5	30.3	14.3	38.6	1.3	12.1	0.0557
Cerro Gordo Co	Iowa	19033	Golden Grain Energy LLC	146.6	424.4	200.6	540.1	15.3	169.8	0.7793
Hardin Co	Iowa	19083	Hawkeye Renewables, LLC	115.2	333.4	157.6	424.4	14.2	133.4	0.6122
Brown Co	South Dakota	46013	Heartland Grain Fuels, LP	20.9	60.6	28.7	77.2	2.2	24.3	0.1113
Beadle Co	South Dakota	46005	Heartland Grain Fuels, LP	29.3	84.9	40.1	108.0	3.1	34.0	0.1558
Pierce Co	Nebraska	31139	Husker Ag, LLC	54.5	157.6	74.5	200.6	5.7	63.1	0.2894
Kearney Co	Nebraska	31099	KAAPA Ethanol, LLC	125.7	363.8	172.0	463.0	15.5	145.5	0.6678
Stearns Co	Minnesota	27145	Land O' Lakes / Melrose Dairy Proteins	5.4	15.8	7.5	20.1	0.7	6.3	0.0290
Crawford Co	Illinois	17033	Lincolnland Agri-Energy	58.6	169.8	80.2	216.0	7.2	67.9	0.3119

County Name	State Name	St/Co FIPS	PLANT	CO	NO_X	VOC	SO_2	$PM_{2.5}$	PM_{10}	ACROLEIN
Cherokee Co	Iowa	19035	Little Sioux Corn Processors	184.3	533.5	252.2	679.0	19.3	213.4	0.9795
Jefferson Co	Colorado	08059	Merrick & Company (Coors Brewery)	4.2	12.1	5.7	15.4	0.5	4.9	0.0223
Tazewell Co	Illinois	17179	MGP Ingredients, Inc.	188.5	545.6	257.9	694.4	23.2	218.3	1.0020
Lincoln Co	Nebraska	31111	Midwest Renewable Energy, LLC (MRE)	41.9	121.3	57.3	154.3	5.2	48.5	0.2226
Hamilton Co	Nebraska	31081	Nebraska Energy	104.7	303.1	143.3	385.8	10.9	121.3	0.5565
Roberts Co	South Dakota	46109	North Country Ethanol (NCE)	52.4	151.6	71.6	192.9	6.5	60.6	0.2783
Delaware Co	Iowa	19055	Permeate Refining	3.1	9.1	4.3	11.6	0.4	3.6	0.0166
Ida Co	Iowa	19093	Quad-County Corn Processors	56.5	163.7	77.4	208.3	7.0	65.5	0.3005
Finney Co	Kansas	20055	Reeve Agri-Energy	25.1	72.8	34.4	92.6	3.1	29.1	0.1336
Sioux Co	Iowa	19167	Siouxland Energy & Livestock Coop (SELC)	46.1	133.4	63.1	169.8	4.8	53.4	0.2449
Red Willow Co	Nebraska	31145	SW Energy, LLC.	0.2	0.6	0.3	0.8	0.0	0.2	0.0011
Loudon Co	Tennessee	47105	Tate & Lyle	254.7	353.3	110.4	334.3	144.3	329.7	0.7346
Hitchcock Co	Nebraska	31087	Trenton Agri-Products, LLC. (TAP)	83.8	242.5	114.6	308.6	10.3	97.0	0.4452
Winnebago Co	Wisconsin	55139	Utica Energy, LLC	108.9	315.3	149.0	401.2	11.4	126.1	0.5788
Gove Co	Kansas	20063	Western Plains Energy, LLC	62.8	181.9	86.0	231.5	6.6	72.8	0.3339
Mitchell Co	Georgia	13205	Wind Gap Farms (Anheuser/Miller Brewery)	0.8	2.4	1.1	3.1	0.1	1.0	0.0045
			Total	**6,074.3**	**12,610.4**	**5,923.2**	**14,417.5**	**2,537.1**	**7,456.6**	**24.0**

(*) Data taken from the 2002 NEI rather than provided by OTAQ for 2005. Units conversion not performed on this facility and no adjustment of the emissions by 0.65.

(+) Data taken from the 2005 NEI v1, rather than provided by OTAQ for 2005. Units conversion not performance on these facilities and no adjustments of the emissions data by 0.65.

2.3 2005 Nonpoint sources

The emissions from the agricultural ammonia (ag) and nonpoint fugitive dust (afdust) sectors are the same as the v4 platform. For the “other” nonpoint (nonpt) sector, the only difference from the v4 platform is that these emissions do *not* include the oil and gas extraction emissions (SCCs matching 23100XXXXX) provided by the Western Regional Air Partnership (WRAP) for the western states. These updated oil and gas extraction emissions were provided after the modeling platform development for RFS2 and LDGHG.

For the Canadian and Mexican nonpoint sector (othar), we used the same inventories as the 2002 v3 platform, and did not yet have the updated 2006 Canadian inventory used in the v4 platform.

The avefire emissions are the same as those in the 2005ci_tox_05b case mentioned above, with the exception that we added 1-3-butadiene, acrolein, and xylenes, and toluene using ratios to $PM_{2.5}$ available in the 2005 platform documentation. These factors were also used to create emissions for benzene, acetaldehyde, and formaldehyde in the 2005 v4 platform and were unchanged for LDGHG; however, this sector was processed as “no-integrate”; therefore, emissions for benzene, acetaldehyde, and formaldehyde were obtained from speciated VOC.

2.4 2005 Mobile sources

Mobile sources include three US onroad sectors (on_noadj, on_moves_startpm, on_moves_runpm) and three US nonroad sectors (nonroad, alm_no_c3, and seca_c3). In addition, it includes Canadian and Mexican emissions in a separate onroad sector (othon) and nonroad/nonpoint sector (othar).

For onroad mobile, the on_moves_startpm and on_moves_runpm emissions inventory data are from an updated draft version of the Motor Vehicle Emission Simulator (MOVES) compared to the 2005 v4 platform. The LDGHG emissions also keep additional pollutants as described in Section 2.1. In addition for these MOVES sectors, the temperature adjustment calculations applied to $PM_{2.5}$ species were the same as the v4 platform, since these adjustments had not changed between draft MOVES versions.

The on_noadj sector for LDGHG also uses an updated version of MOVES, and this updated version also provides onroad diesel exhaust emissions for CO, NOx, PM, and VOC HAPs. Note that PM emissions from these diesel sources are not subject to temperature adjustments like the on_moves_startpm and on_moves_runpm sectors. These MOVES-based onroad diesel emissions replace the MOBILE6-based NMIM emissions in the 2005v4 platform.

For onroad gasoline exhaust PM emissions, the allocation of MOVES PM2.5 emissions to SMOKE-ready format PM species is documented in Appendix B of the 2005v4 Platform Documentation. However, LDGHG MOVES data also provides diesel exhaust PM2.5 emissions, and these equations are provided in this document in Appendix A of this document.

A small processing error impacted the MOVES diesel PM exhaust emissions used for this modeling. The fraction of metals in the speciation profile (F_{metal}) in equation 4 in Appendix A was inadvertently squared, resulting in an underestimate in metals, which caused a very small underestimate in inventory organic carbon (POC) and a corresponding equal overestimate in inventory PMFINE (other PM species not already classified). Total PM2.5 was not impacted. This error impacts all LDGHG scenarios, and the small impact of this error is shown in the national totals provided in Table 6.

Table 6. National summary of MOVES Diesel Exhaust PM Error for 2005 Base Case

Pollutant	HDDV	LDDV/LDDT	HDDV Error	LDDV/LDDT Error
PEC (Elemental Carbon)	90,734	3,107		
PSO4 (PM Sulfate)	6,812	154		
PNO3 (PM Nitrate)	134	6		
metal_bad (Eq 4 in Appendix A)	1	0		
metal (Eq 4 in Appendix A)	313	14		
POC_bad (Organic Carbon)	45,315	1,300	260	12
POC (Organic Carbon)	45,054	1,288		
PMFINE_bad (Other PM)	11,661	319	-260	-12
PMFINE (Other PM)	11,921	331		
PMC (PM-Coarse, or PM10 minus PM2.5)	13,300	420		
PM2_5_total_bad	154,656	4,886		
PM2_5_total	154,656	4,886		

The nonroad emissions inventory data are the same as the v4 platform, with additional HAPs being kept for LDGHG as well. The alm_no_c3 emission sector does use different data from that of the v4 platform. Specifically, the aircraft emissions remain in this sector and are older data from that of the v4 platform. In the v4 platform, the aircraft emissions had been revised to be consistent with the 2005 NEI v2 and included in the ptnonipm sector. The airport emissions used in LDGHG were from the 2002 NEI, version 3, acquired March 27, 2007 and used in the 2002 v3.1 platform.

Additionally, the onroad emissions for Canada and Mexico for LDGHG (othon sector) differ from the v4 platform because we used the older Canadian data. The data we used reflect 2000 emissions and are the same data used in the v3 and v3.1 2002-based platforms. The 2005 v4 platform uses 2006 Canadian inventory data.

3 VOC speciation changes that represent fuel changes

A significant detail that changes for each of the LDGHG modeling cases is the VOC speciation profiles used to split total VOC emissions into the various VOC model species needed for CMAQ. In this section, we summarize the various speciation profile information used in configuring the various cases, and we include Table 7 to provide a summary of the VOC speciation approach for each of the future-year cases.

The approaches taken in the LD GHG 2005 case below are not the same as the 2005 v4 platform, and so the first 2005 column shown represents the 2005 v4 platform and the second 2005 column shown is for LD GHG. Two new headspace vapor profiles were created for LD GHG modeling that were not available for the 2005 v4 platform development. The approaches used for each of the future-year cases are customized for those cases, and they include the impact of fuel changes for each of the future-year cases on emissions from the on_noadj sector, the nonroad sector, and parts of the nonpt and ptnonipm sectors. The speciation changes from fuels in the nonpt sector include changes for portable fuel containers (PFCs) and some parts of the bulk-plant-to-pump (btp) and refinery-to-bulk terminal (rbt) emissions. The speciation changes from fuels in the ptnonipm sector include the remainder of the emissions for the btp and rbt emissions. Mapping of fuel distribution SCCs to btp and rbt emissions categories can be found in Appendix A of the RFS2 Emissions Inventory for Air Quality Modeling Technical Support Document (EPA Report No. 420-R-10-005, January 2010, http://www.epa.gov/otaq/renewablefuels/420r10005.pdf).

A general indication of the VOC speciation approach is provided in Table 7.

Table 7. Summary of VOC speciation profile approaches by sector across cases

Inventory type and mode	VOC speciation approach for fuels	VOC Profile Codes	2005 v4 platform	2005 LD GHG case	2030 Reference Case	2030 Control Case
Mobile Exhaust	Tier 1 E0 **and** E10 combinations	8750 8751	on_noadj nonroad	on_noadj nonroad		
	Tier 1 E0 **or** E10 by county	8750 8751			nonroad	
	Tier 2 E0 **or** E10 by county	8756 8767			on_noadj	
	Tier 1 E10	8751				nonroad
	Tier 2 E10	8757				on_noadj
Mobile Evaporative	E0 **and** E10 combinations	8753 8754	on_noadj nonroad	on_noadj nonroad		
	E0 **or** E10 by county	8753 8754			on_noadj nonroad	
	E10	8754				on_no_adj nonroad
Other <u>sources:</u> nonroad refueling, PFCs, btp, rbt	E0 headspace (old)	8737	All listed			
	E0 headspace (new)	8762		All listed		
	E0 headspace (new) **or** E10 headspace (new) by county	8762 8763			All listed	
	E10 headspace (new)	8763				All listed

Table 8 provides the purpose of the VOC speciation profile codes used in the table:

Table 8. Explanation of VOC profile codes listed in Table 7

Exhaust		Evaporative		Refueling	
8750	Tier1 E0	8753	E0	8737	E0 headspace vapor (old)
8751	Tier1 E10	8754	E10	8762	E0 headspace vapor
8756	Tier2 E0			8763	E10 headspace vapor
8757	Tier2 E10				

Appendix C summarizes the data file names used for all of the data files that are updated from the v4 platform. All ancillary data files are available on the 2005-based platform website previously referenced.

4 2030 Reference Case

The 2030 Reference case is intended to represent the emissions associated with use of the most likely volume of ethanol in the absence of the LDGHG CO_2 reductions and RFS2 rule and Energy Independence and Security Act of 2007 (EISA) renewable fuel requirements. For this case, the ethanol volume was projected for 2030 using the Department of Energy, Energy Information Administration in the 2007 Annual Energy Outlook (AEO) report. That year's AEO projections were used because Department of Energy (DOE) started accounting for EISA in their 2008 AEO projections. Therefore, the 2030 LDGHG Reference scenario shares several of the same emissions (especially for stationary sources) as the 2022 RFS-2 AEO case (please see the RFS-2 TSD, available at http://www.epa.gov/otaq/renewablefuels/420r10005.pdf). A list of inventory datasets used for this and all cases is provided in Appendix C. A list of all growth and control assumptions for this Case is provided in Appendix D. Section 5 describes the projection differences between the 2030 Reference and 2030 Control cases.

4.1 2030 Reference Case Point sources

The point sources for the 2030 Reference case included US EGU point sources (ptipm), US nonEGU point sources (ptnonipm) and sources from Mexico, Canada, and the Gulf of Mexico (othpt). The US EGU point sources for both the reference and control 2030 cases use an Integrated Planning Model (IPM) run for criteria pollutants, HCl, and mercury in 2020 (though Hg was not modeled). We used 2020 because it was the closest readily available year to the 2030 year used for LD GHG modeling. With very few exceptions, we have used year 2020 as the furthest "out year" for stationary source projections. Also, by using many of the same emissions inputs as RFS-2 that are not impacted by the LDGHG control strategy, we could better isolate the impacts of LDGHG-related controls versus RFS-2 controls and obtain a more 'apples to apples' comparisons of air quality and emissions-related impacts between RFS-2 and LDGHG.

The code number used by EPA's Clean Air Markets Division (CAMD) to denote the run is EPA30Draft_BC_42l. While these IPM emissions are different from those used in the v4 platform, they are consistent with the 2020 emissions used in the v3 platform. OAQPS post-processed these data in the same way as described in the 2005 v4 platform documentation for the "base case" to create daily emissions that include temporal allocation information from three years of Continuous Emissions Monitoring (CEM) data. The temporal allocation approach is the same as for the LDGHG 2005 base case (2005cp_tox_05b), to eliminate artificial differences in temporal allocation between the base and future years.

For the Mexican and offshore point source emissions, we held the data constant with the 2005 base case. This means that the Mexican emissions were based on year 1999, since Mexico has not provided emissions projections to date. We used 2020 emissions projections for Canadian emissions, provided by Environment Canada, which are consistent with the base year Canadian data. The Canadian data are the same as those used for the 2002-based v3 platform. The data used for LDGHG future year reference and control cases are different from our v4 platform.

For the US nonEGU emissions (sector ptnonipm), there were two main pieces for the 2030 LDGHG ptnonipm inventories: data projected from 2005 values and data that were replaced by OTAQ-generated data that are intended to represent emissions estimates for any year beyond 2016. Referring to the five parts listed in Section 2.2, datasets (4) and (5) were projected from 2005 to 2030 values, datasets (2) and (3) were replaced, and dataset (1) was unchanged.

4.1.1 Part 1: Projecting 2005 to 2030 Reference for ptnonipm

We applied both control and growth factors to a subset of the 2005 ptnonipm to create the 2030 Reference data. We started with 2020 projection factors from the 2002 v3.1 platform for most of the LDGHG year 2030 projections. Given the uncertainty of emissions projections and the lack of any additional controls coming into effect between 2020 and 2030, we decided that using 2020 as the year for most of our non-EGU point and nonpoint projections would be sufficient; exceptions to this are described below. This approach matched the year used for the ptipm sector. Furthermore, we did not have to adjust the factors for a 2005-base year in most cases, because most of the 2005 v1 nonEGU point emissions data were populated with 2002 emissions values.

The 2002 v3.1 platform growth and control factors had been revised from the 2002v3.0 platform projection factors that are documented in the 2002 v3 emissions modeling platform documentation (see http://www.epa.gov/ttn/chief/emch/index.html#2002)**.** These updates included Hazardous Waste Incineration adjustments and Small and Large Municipal Waste Combustor closures and adjustments. The following describes how we further modified the 2002v3.1 projection factors for the 2030 Reference case.

We intended to use a SMOKE "control" packet (data file) to apply control factors that implement known emissions reductions from point sources for national rules. For the Reference case, the control packet was intended to be the same as the revised control packet from the 2002 v3.1 factors to give key VOC HAPs the same control factors as those for VOC. The VOC HAPs (and CAS numbers) of interest for this effort were: 1,3-butadiene (CAS=106990), acrolein (CAS=107028), formaldehyde (CAS=50000), methanol (CAS=67561), benzene (CAS=71432), acetaldehyde (CAS=75070), and naphthalene (CAS=91203). However, the "control" packet inadvertently was not applied for either the 2030 Reference or 2030 Control cases. This emissions processing error results in the same amount of missed reductions from both the 2030 Reference and Control Cases. These "missed" reductions, and the percent of the ptnonipm inventory that is under-controlled are provided in Table 9a. Appendix D documents which control and projection programs were erroneously not included in the 2030 Reference and Control cases. No other sectors were impacted by this error.

Table 9a. Impact on the ptnonipm Sector of Not Applying Base Case Controls to the LDGHG 2030 Reference Case

Pollutant	2030 Reference Case: Corrected	2030 Reference Case: Modeled	Missing Reductions	Percent of ptnonipm Inventory Erroneously Not Reduced
CO	3,194,382	3,206,284	11,902	0.4%
NH3	153,039	157,947	4,907	3.1%
NOX	2,205,555	2,408,024	202,469	8.4%
PM10	586,770	613,850	27,080	4.4%
PM2_5	356,113	372,081	15,969	4.3%
SO2	2,102,054	2,290,193	188,139	8.2%
VOC	1,165,031	1,414,238	249,208	17.6%

While these fractions are somewhat large for only the ptnonipm sector, the fractions when compared to the entire anthropogenic inventory are much smaller. Table 9b shows the impact across all anthropogenic sectors, which is closer to what the air quality model uses. The VOC impact is further lessened in the air quality model because of the biogenic VOC emissions, which are much larger than the anthropogenic in most cases. In addition, since the discrepancy occurred consistently in both the 2030 Reference and Control cases, the impact on the affect of the control strategy is further limited.

Table 9b. Impact on Total Anthropogenic Emissions of Not Applying Base Case Controls to the LDGHG 2030 Reference Case

Pollutant	2030 Reference Case: Corrected	2030 Reference Case: Modeled	Missing Reductions	Percent of Total Anthropogenic Inventory Erroneously Not Reduced
CO	53,960,990	53,972,892	11,902	0.0%
NH3	4,258,901	4,263,808	4,907	0.1%
NOX	11,516,138	11,718,607	202,469	1.7%
PM10	12,720,907	12,747,988	27,080	0.2%
PM2_5	4,031,794	4,047,763	15,969	0.4%
SO2	9,170,404	9,358,543	188,139	2.0%
VOC	12,093,860	12,343,067	249,208	2.0%

We also used SMOKE with a "projection" packet to apply growth adjustments, some control adjustments, and plant closures. For LDGHG, the projection packet for ptnonipm consisted of several components. First, we modified the data from the 2002v3.1 platform packet to remove entries for which we had new factors for this effort, such as onroad refueling and aircraft. In addition, we added the same list of VOC HAPs to the projection factors as we had added to the control packet for the VOC-specific entries already present (e.g., landfills in nonpt sector). Next, we added the LDGHG Reference case-specific projection factors from several OTAQ sources, as follows:

1. Onroad refueling: We retained the same list of refueling ptnonipm and nonpt state/county FIPS codes and SCCs from the 2002 v3 emissions modeling platform. For California, we used the 2005v2 California-submitted data and 2005 NMIM and 2030 NMIM reference case VOC and VOC-HAP refueling emissions to obtain annual adjustment ratios by pollutant and county. The formula for the projection factors was Factor 2030 = NMIM $Emis_{2030}$ /NMIM $Emis_{2005}$ (note: we applied different refueling adjustment factors to the Reference and Control cases because of different onroad gasoline refueling inventories in the 2 cases. These factors were applied to the refueling SCCs from the 2005 base case.

2. Year 2025 aircraft Federal Aviation Administration (FAA) takeoff and landing data from the Terminal Area Forecast (TAF) data: This is the furthest out-year of FAA TAF data activity and replaces the 2020 factors for both LDGHG 2030 scenarios.

3. We applied adjustments to refinery emissions by state and SCC, using the same factor for all pollutants to represent activity adjustments (note: different adjustments were made to the control case). The state-level adjustments and the list of SCCs affected were provided by Rich Cook on 11/25/2008 in the Excel® workbook "RFS2_Refinery_Adjust.xls"; this is the same set of factors used in the RFS-2 AEO (baseline) scenario. The LDGHG control scenario applies an adjustment on top of these LDGHG reference case emissions.

4. For gasoline distribution SCCs (both ptnonipm and nonpt SCCs), we additionally applied VOC and VOC HAP adjustments to SCCs representing emissions from bulk-plant-to-pump (btp) and refinery-to-bulk terminal (rtb) processes. These SCC-level adjustments impact VOC and VOC HAPs in both the ptnonipm and nonpt sectors. The adjustments were provided by OTAQ on 12/16/2008 in the Excel® workbook "2005ai_tox_SCC_50state_CAPHAP-20081216.xls". Different adjustments were applied to the LDGHG control scenario, based on assumed changes in the ratios of E0 to E10. The LDGHG control scenario applies an adjustment on top of these LDGHG reference case emissions.

We applied the control and projection factors to the ptnonipm 2005 inventory described in Section 2.2, resulting in a "2030" ptnonipm inventory. To this inventory, we added additional OTAQ-supplied inventory data as described in Step 2 below. The configuration of the processing was designed specifically to prevent inadvertent double counting of emissions.

4.1.2 Part 2: Additional OTAQ-supplied emissions data for ptnonipm

In addition to the data preparation described above, we added the following data supplied by OTAQ:

1. Ethanol plant additions: These emissions data completely replace all of the ethanol plants listed in Table 5 except the first one. OTAQ provided the emissions, stack parameters, locations and the same SCC assignments were made as described for 2005: $PM_{2.5}$ (30299999) and VOC and all other pollutants (30125010). The original VOC emissions were supplied by OTAQ in Excel® and OAQPS further adjusted the data to correct for units conversions and to adjust VOC downward to account for too much ethanol in the speciation profile. These were the same adjustments made to the 2005 data and are described in Section 2.2. Further, we changed the original data to use the same Stack IDs for both $PM_{2.5}$ and PM_{10}, to ensure SMOKE could properly calculate PMC as PM_{10}-$PM_{2.5}$ after matching emissions sources. Lastly, we removed the benzene, formaldehyde, acetaldehyde, and methanol inventory emissions from these sources because they are "no integrate" sources for VOC HAPs (we do not use the VOC HAPs to augment speciation information for this sector), and so these model species were to be calculated from VOC speciation.

2. In addition, we retained the Chippewa plant from 2005 (the emissions at this plant were only changed for an emissions scenario not related to LDGHG modeling).

4.2 2030 Reference Case Nonpoint sources

The nonpoint sources are sources aggregated to the county (or Canadian Province) and process level and included US fugitive dust sources (afdust sector), US agricultural NH3 (ag sector), US average fires (avefire sector), other US nonpoint sources (nonpt sector), and emissions for Canada and Mexico (othar and othar_hg). Of these, the nonpt sector contained the most detailed changes for the RFS2 modeling, as explained further below.

The emissions used for this case for the afdust and ag sectors are the same as those used in 2020 in the 2002-based v3 platform, previously referenced. Additionally, the avefire emissions are the same as those in the 2005cp_tox_05b case mentioned above, and were intentionally held constant between the 2005 base case and the 2030 Reference and Control cases.

The emissions for Canada and Mexico were the same as the 2002 v3 platform referenced earlier, with one minor exception: we modified the Canada nonroad sources to remove C3 commercial marine SCC (2280003010), which was just one record in British Columbia and which prevented double-counting with the seca_c3 sector. This means that the LDGHG platform differs from the v4 platform in that older estimates of 2020 emissions were used for nonpoint sources in Canada, rather than 2006 estimates retained between the base and future years in the v4 platform. This sector includes both nonroad mobile and nonpoint sources.

The nonpt sector is comprised of several different pieces. Like the ptnonipm sector, the nonpt sector required two steps to compile the 2030 Reference case inventories: data projected from 2005 values and data that are replaced by OTAQ-generated data in 2030.

We discovered a very minor error in our creation of 2030 Reference and Control case nonpt emissions. We inadvertently dropped NEI nonpoint inventory oil and gasoline production emissions in WRAP states (excluding California) from both the 2030 Reference and Control cases. This error resulted in 1 ton of CO and 31 tons of NOx dropped in New Mexico, and a cumulative 2,184 tons of VOC dropped in Arizona, Montana, Nevada, New Mexico, North Dakota, South Dakota, and Wyoming.

4.2.1 Part 1: Projecting 2005 to 2030 Reference case for nonpt

The same steps taken and described for the ptnonipm sector (Section 4.1.1) were also taken for the nonpt sector. In fact, all of the information that we added to the SMOKE projection and control packets has already been described in that section and the parts that also applied to the nonpt sector have already been identified in that section. Unlike the ptnonipm sector, we did not miss applying controls to this sector because all of the nonpoint sector reductions are done using a different packet than the missed control packet described for ptnonipm.

In addition to the documentation provided previously for ptnonipm, the 2020 projection factors for Residential Wood Combustion SCCs in this nonpt sector were not updated for 2030 because the difference would have been very small and these emissions are highly uncertain.

The refueling and gasoline distribution projection approaches described in the point source section also apply to the nonpoint sector, since those approaches affect SCCs in both sectors.

4.2.2 Part 2: Additional OTAQ-supplied emissions data for nonpt

In addition to the nonpt emissions projected from 2005 to 2030, several additional OTAQ-provided emission inventories were created to complete the emissions needed for the 2030 Reference case nonpt sector:

1. Ethanol plant additions: These are conceptually the same as the ptnonipm plant additions but are for plants with unknown coordinates, and are therefore aggregated to the county-SCC level. SCC assignments determine spatial allocation using spatial surrogate ancillary data. The nonpoint ethanol plants were created from an Excel® spreadsheet provided by OTAQ on 11/17/2008: Corn_EtOH_Plant_Inv_2022-aeo.xls. The same VOC adjustments and SCC assignments detailed for ptnonipm were made here as well. These additional emissions are expected to be implemented by year 2022 and are held at the same level for year 2030 LDGHG modeling.

2. Ethanol transfer additions: These new VOC emissions account for vapor loss during transport and loading by truck and rail are assigned three SCCs (30205031, 30205052, and 30205053). Ethanol transfer emissions were provided for an RFS-2 AEO scenario on 12/11/2008 by OTAQ in an Excel® workbook called “EtOH_transport_vapor_AEO.xls”. These additional emissions are expected to be implemented by year 2022 and are held at the same level for year 2030 LDGHG modeling.

3. Biodiesel plant additions: These new emissions are assigned SCC 2102006001 and also contain an units correction (grams/year to tons/year) of 1.102311309E-06, applied by OAQPS after receiving the data from OTAQ. These data were created from an Excel® spreadsheet provided by OTAQ on 11/21/2008**:** Biodsl_Plant_Inv_2022-aeo-prelim.xls. We selected the SCC 2102006001 (Stationary Source Fuel Combustion;Industrial;Natural

Gas;All Boiler Types) to represent these sources in consultation with Ron Ryan. The VOC was not adjusted by 65% like it was for ethanol and cellulosic plants. OAQPS converted emissions from grams to tons. These additional emissions are expected to be implemented by year 2022 and are held at the same level for year 2030 LDGHG modeling.

4. Portable Fuel Containers: These MSAT-based emissions were provided by OTAQ for the year 2030 for the 2002v3 platform and are unchanged for the 2030 LDGHG Reference case. We applied adjustment factors (provided by OTAQ) to the LDGHG control case.

4.3 Mobile sources

The mobile sources included many different approaches, depending on the modeling sector. Each of these is described in a separate subsection below.

4.3.1 US Aircraft, locomotive, and non-c3 commercial marine (alm_no_c3)

This sector was projected from the base year (2005) to the LDGHG future year (2030); the base year emissions are actually year 2002 and the same as those used in the 2002v3 platform. There are two components for projecting these emissions to year 2030:

1. <u>FAA TAF data for year 2025.</u> This data was updated in December 2007 and, as discussed in Section 4.1.1, the furthest out year of 2025 is used to approximate year 2030 emissions.
2. <u>Updated locomotives and C1/C2 CMV factors.</u> OTAQ provided updated loco-marine Final Rulemaking (FRM) national-based adjustment factors for locomotive-marine emissions on 12/17/2009: "alm_no_c3_2030LDGHG_vs_2005_pcQA_locofix.xls".

We applied HAP factors to VOC to obtain 1,3-butadiene, acetaldehyde, acrolein, benzene, and formaldehyde. The remaining HAPs -metals and other non-VOC HAPs not already provided- are held at base year levels (the 2002 emissions estimates used in the 2005 basecase).

The alm_no_c3 emissions are the same for the 2030 Reference and Control cases.

4.3.2 Canada and Mexico onroad mobile sources (othon)

The data in this sector are the same as 2020 data released in 2002-based v3 platform, previously referenced. These are different from 2005 v4 platform because the 2006 Canadian data were not available for use in this project.

4.3.3 C3 commercial marine sources from all waters (seca_c3)

The seca_c3 sector emissions data were provided by OTAQ in an ASCII raster format used since the ECA-IMO project began in 2005. The (S)ECA C3 year 2030 base case from the ECA/IMO project was unchanged and used for both the 2030 LDGHG Reference and 2030 LDGHG

Control cases. The 2030 base seca_c3 inventory was provided by OTAQ 03/27/2008: task11_2030base.zip. OTAQ also provided factors to compute HAP emission (based on emissions ratios) on 2/28/2008, which OAQPS applied to either VOC or $PM_{2.5}$ to obtain HAP emissions values. Table 10 below shows these factors and whether they were applied to VOC or $PM_{2.5}$. As with the 2005 case, this sector uses CAP-HAP VOC integration.

Table 10. HAP emission ratios for generation of HAP emissions from criteria emissions for C3 commercial marine vessels

Pollutant	Apply to	Pollutant Code	Factor
Acetaldehyde	VOC	75070	0.0002286
Benzene	VOC	71432	9.795E-06
Formaldehyde	VOC	50000	0.0015672
Benz[a]Anthracene	PM2_5	56553	5.674E-07
Benzo[a]Pyrene	PM2_5	50328	1.844E-07
Benzo[b]Fluoranthene	PM2_5	205992	1.56E-07
Benzo[k]Fluoranthene	PM2_5	207089	1.56E-07
Chrysene	PM2_5	218019	9.929E-08
Indeno[1,2,3-c,d]Pyrene	PM2_5	193395	1.418E-08
Acenaphthene	PM2_5	83329	3.404E-07
Acenaphthylene	PM2_5	208968	5.248E-07
Anthracene	PM2_5	120127	5.248E-07
Benzo[g,h,i,]Perylene	PM2_5	191242	1.277E-07
Fluoranthene	PM2_5	206440	3.12E-07
Fluorene	PM2_5	86737	6.95E-07
Naphthalene	PM2_5	91203	1.987E-05
Phenanthrene	PM2_5	85018	7.943E-07
Pyrene	PM2_5	129000	5.532E-07
Beryllium	PM10	7440417	5.459E-07
Cadmium	PM10	7440439	7.642E-06
Chromium VI	PM10	18540299	2.948E-06
Chromium III	PM10	16065831	1.343E-05
Lead	PM10	7439921	3.002E-05
Manganese	PM10	7439965	5.732E-05
Nickel	PM10	7440020	0.0016377
Selenium	PM10	7782492	1.337E-05

OAQPS converted emissions to SMOKE point source ORL format allowing for emissions to be allocated to modeling layers above the surface layer. OAQPS corrected emissions for one state/county FIPS code fix in Rhode Island. All non-US emissions (i.e., in waters considered outside of US territory) are simply assigned a dummy state/county FIPS code=98001. Due the huge size of these data, the CAP emissions are in one ORL file and the HAP emissions for benzene, acetaldehyde, and formaldehyde are in a separate ORL file; all other HAPs are not provided for LDGHG as they are uninvolved in air quality model chemistry and are not of interest for this rulemaking. The emissions spatial extent includes waters off of the coasts of the US, Canada, and Mexico, as well as emissions in major waterways and the Great Lakes. The

SMOKE-ready data have also been cropped from the original data provided by OTAQ to cover only the 36km CMAQ domain, which is the largest domain used for this effort.

4.3.4 US nonroad mobile sources (nonroad)

<u>All states except California:</u>

OTAQ provided several runs of NMIM emissions that were blended together to create the 2030 Reference and Control case nonroad sector emissions. Table 11 shows how the various NMIM runs were combined to create the reference and control case non-California nonroad mobile inventories. The first component "2002v3-based 2030 Base Case" is from the 2030 Base case in our 2002v3 platform for the SCCs listed in Table 11, and these emissions are the same in the reference and control cases. OTAQ also provided diesel recreational marine (pleasure craft) emissions in November 2009 that are used in both the reference and control cases. An NMIM run specific to the Reference case "LdGhgN2030Aeo.txt" was provided in November 2009 for the remainder of the nonroad mobile sector: gasoline engine and recreational marine sources.

The only difference in the control case is a substitution of the gasoline engine and recreational marine emissions with the "E10" NMIM run: "LdGhgN2030e10.txt".

Table 11. Components of 2030 Nonroad Sector for Reference and Control Cases

NMIM file	**SCCs**	**Description of Nonroad SCCs**	**Use**
2002v3-based 2030 Base Case	2267x	LPG equipment	Both Reference and Control Cases
	2268x	CNG equipment	
	2270x	Diesel engines	
	2285002015, 2285006015	Railway maintenance	
LdGhgN2030e0_nponzseg11dies.txt	22820200x	Diesel recreational-marine	Both Reference and Control Cases
LdGhgN2030Aeo.txt	2260x	2-stroke gasoline engines	Reference Case only
	2265x	4-stroke gasoline engines	
	228200x, 228201x	Gasoline recreational marine	
LdGhgN2030e10.txt	2260x	2-stroke gasoline engines	Control Case only
	2265x	4-stroke gasoline engines	
	228200x, 228201x	Gasoline recreational marine	

All NMIM data are based on AEO2007 fuels and NMIM county database NCD20080727. We also reassigned NMIM evaporative and refueling xylene (compound XYL or CAS=EVP__1330207, RFL__1330207) into MXYL (CAS=EVP__108383, RFL__108383) and OXYL (CAS=EVP__95476, RFL__95476) using a 68% and 32% ratio to both evaporative and refueling XYL, respectively. We also split NMIM exhaust xylene (CAS=EXH__1330207) into MXYL (CAS=EXH__108383) and OXYL (CAS=EXH__95476) using a 74% and 26% ratio to XYL, respectively. We converted emissions from monthly totals to monthly average-day values based the on number of days in each month. CO_2 and all of California emissions were removed prior to creating SMOKE ORL files.

California nonroad:

California monthly nonroad emissions are year 2030 and are based on March 2007 California Air Resources Board (CARB) data (Martin Johnson: mjohnson@arb.ca.gov). NH3 emissions are from NMIM runs for California (same data as were used in 2030 from the 2002 v3 platform). We allocated refueling emissions to the gasoline equipment types based on evaporative mode VOC emissions from the 2002 v3 platform 2030 NMIM data, and the refueling emissions were computed by multiplying SCC 2505000120 emissions by 0.61, to adjust to remove double counting with Portable Fuel Container inventory for California. We estimated HAP emissions by applying HAP-to-CAP ratios computed from the California data provided for the 2005 NEI v2, collected by EPA on 12/2007. This was done because the CARB submittal from March 2007 did not include estimates for HAPs. We retained only those HAPs that are also estimated by NMIM for nonroad mobile sources; all other HAPs were dropped.

4.3.5 Onroad mobile sources (on_moves_runpm, on_moves_startpm, and on_noadj)

As in 2005, the on_moves_runpm and on_moves_startpm sectors include emissions from onroad gasoline sources for PM, which need temperature adjustment factors. The temperature adjustment factors were specific to 2030 (different from those used in 2005) and we used the same adjustment factors in both of the 2030 cases. The temperature adjustments have the limitation that they were based on the use of MOVES default inputs rather than county-specific inputs, because a county-specific database for input to MOVES was not available at the time this approach was needed. Further, the version of MOVES used for all runs was a draft version and has since changed.

Also like 2005, the on_noadj sector includes non-PM MOVES data for gasoline and diesel vehicles for some pollutants, NMIM-based data for motorcycles and the remaining pollutants for onroad gasoline and diesel, as well as all California onroad mobile emissions. The detailed approaches described here are the same as those for 2005 (except for the NMIM and MOVES data used), but are included here for convenience.

Table 12 shows the various pieces of onroad mobile NMIM and MOVES-based emissions inventories that were used to create the 2030 Reference and Control case onroad mobile sectors: on_moves_startpm, on_moves_runpm, and on_noadj. Unless otherwise noted, the emissions are part of the “no-adjust” on_noadj sector. As Table 12 shows, several pieces of NMIM and the state-level MOVES data used in this project were different between the 2030 Reference and Control cases; the only exceptions are the NMIM onroad diesel vehicles and the adjustment factors (used in the on_moves_startpm and on_moves_runpm) that were the same for each case.

Table 12. MOVES and NMIM Inventory Components of 2030 Onroad Sectors for Reference and Control Cases

MOVES and NMIM files	**SCCs**	**Description of Onroad SCCs**	**Use**
LdGhgO2030e10.txt (NMIM)	223x	All diesel vehicles	Reference Case: Used only to 1) apportion diesel vehicle emissions to county-level for MOVES pollutants, 2) as-is for all non-MOVES pollutants
	ALL	All Onroad Emissions	Control Case: Used to 1) apportion emissions to county-level for all MOVES pollutants, 2) as-is for all non-MOVES pollutants
LdGhgO2030Aeo.txt (NMIM)	220x	All gasoline vehicles and trucks	Reference Case only: Used for 1) all motorcycle emissions, 2) as-is for all non-MOVES pollutants, 3) apportioning MOVES gasoline vehicle emissions to county-level
LgrDiesExh2030_812_Ref.txt (MOVES exhaust)	223007x	Diesel vehicles classes 8-12 (HDDV)	Both Reference and Control Cases: PM, CO, NOx, VOC, acetaldehyde, benzene, formaldehyde, acrolein, 1,3-butadiene
LgrDiesExh2030_67_Ref.txt (MOVES exhaust)	2230001x	Diesel vehicles class 6 (LDDV)	Reference Case only: PM, CO, NOx, VOC, acetaldehyde, benzene, formaldehyde, acrolein, 1,3-butadiene
	223006x	Diesel vehicles class 7 (LDDT)	
LgrDiesExh2030_67_Ctltxt (MOVES exhaust)	2230001x	Diesel vehicles class 6 (LDDV)	Control Case only: PM, CO, NOx, VOC, acetaldehyde, benzene, formaldehyde, acrolein, 1,3-butadiene
	223006x	Diesel vehicles class 7 (LDDT)	
LgrGasExh2030aeoR2_Ref.txt (MOVES exhaust)	22010x except 220108x	Non-motorcycle gasoline vehicles and trucks	Reference Case only: CO, NOx, VOC, acetaldehyde, benzene, formaldehyde, acrolein, 1,3-butadiene
LgrGasExh2030e10R2_Ctl.txt (MOVES exhaust)	22010x except 220108x	Non-motorcycle gasoline vehicles and trucks	Control Case only: CO, NOx, VOC, acetaldehyde, benzene, formaldehyde, acrolein, 1,3-butadiene
LgrGasPm2030aeo_Ref.txt (MOVES exhaust)	22010x except 220108x	Non-motorcycle gasoline vehicles and trucks	Reference Case only: PM-only, subject to temperature adjustments (on_moves_startpm and on_moves_runpm sectors)
LgrGasPm2030e10_Ctl.txt (MOVES exhaust)	22010x except 220108x	Non-motorcycle gasoline vehicles and trucks	Control Case only: PM–only, subject to temperature adjustments (on_moves_startpm and on_moves_runpm sectors)
LgrEvapAeoR2_Ref.txt (MOVES evaporative)	22010x except 220108x	Non-motorcycle gasoline vehicles and trucks	Reference Case only: VOC and benzene
LgrEvapE10R3_Ctl.txt (MOVES evaporative)	22010x except 220108x	Non-motorcycle gasoline vehicles and trucks	Control Case only: VOC and benzene

<u>on_moves_startpm and on_moves_runpm</u>
For the on_moves_runpm and on_moves_startpm sectors, the same preprocessing as was done in 2005 was done here, but using a 2030 Reference case NMIM runs to create the monthly county-to-state ratios by state and SCC and using the 2030 PM adjustment factors.

OTAQ supplied four input files for the reference and control cases that contain state-level MOVES-based onroad gasoline and diesel emissions by month for the following pollutants (NEI pollutant IDs are provided in parentheses):

1. Onroad Gasoline Exhaust: VOC, NOX, CO, 1,3-butadiene (106990), acetaldehyde (75070), acrolein (107028), benzene (71432), and formaldehyde (50000);
2. Onroad Diesel Exhaust: VOC, NOX, CO, 1,3-butadiene (106990), acetaldehyde (75070), acrolein (107028), benzene (71432), formaldehyde (50000), and MOVES-defined PM species OC, EC, and SO4, components of PM2.5 –PM25OC, PM25EC, and PM25SO4 respectively;
3. Evaporative: Non-refueling VOC and benzene (71432) –gasoline vehicles only;
4. Onroad Gasoline MOVES-speciated PM at 72ºF: MOVES-defined PM species OC, EC, and SO4, components of PM2.5 –PM25OC, PM25EC, and PM25SO4 respectively. Emissions are computed at 72ºF and we used SAS® to convert the MOVES-based $PM_{2.5}$ species into the following SMOKE-ready pollutants:

    - PEC_72: unchanged from MOVES-based PM25EC, subject to temperature adjustment below 72ºF.
    - POC_72: modified MOVES-based PM25OC to remove metals, PNO3 (computed from MOVES-based PM25EC), NH4 (computed from MOVES-based PM25SO4 and PNO3), and MOVES-based PM25SO4. Subject to temperature adjustment below 72ºF.
    - PSO4: unchanged from MOVES-based PM25SO4, not subject to temperature adjustment.
    - PNO3: computed from MOVES-based PM25EC, not subject to temperature adjustment.
    - OTHER: sum of computed metals (fraction of MOVES-based PM25EC) and NH4 (computed from PNO3 and PSO4), not subject to temperature adjustment.
    - PMFINE_72: Computed from OTHER and fraction of POC_72. Subject to temperature adjustment below 72ºF.
    - PMC_72: Computed as fraction of sum of PMFINE_72, PEC_72, POC_72, PSO4, and PNO3. Subject to temperature adjustment below 72ºF.

The first three inputs listed above are processed in the on_noadj sector because temperature adjustments are not needed for these inventories. The fourth input listed above is further broken into the on_moves_runpm and on_moves_startpm sectors; these emissions require separate temperature adjustments after some intermediate emissions processing.

MOVES gasoline emissions were used for light-duty gasoline vehicles (LGDV), light-duty gasoline trucks 0-6000 pounds gross vehicle weight (LDGT1), light-duty gasoline trucks 6000-8500 pounds gross vehicle weight (LDGT2), and heavy-duty gasoline trucks (HDGV). Motorcycle emissions were not available from MOVES at the time of this project and so emissions from that vehicle class came from the case-specific NMIM runs.

MOVES-based, monthly state-level emissions were first allocated to counties using county-SCC specific state-to-county ratios that we created from the 2030 Reference case NMIM run. California MOVES-based emissions are discarded; they do not replace the existing California inventories (discussed in on_noadj sector). MOVES data were provided by OTAQ in October 2009.

In each MOVES file, "start" emissions are represented by SCCs with the SCC characters 8-9 equal to "00": 2201001**00**0 (LDGV), 2201020**00**0 (LDGT1), 2201040**00**0 (LDGT2), 2201070**00**0 (HDGV), 2230001**00**0 (LDDV), 2230060**100**0 (LDDT), and 223007X**00**0 (HDDV). These start emissions are assigned to urban and rural SCCs based on the county-level ratio of NMIM emissions from urban versus local roads. For example, LDGV start emissions (2201001000) were split into urban (2201001370) and rural (2201001350) based on the ratio of LDGV emissions from urban (2201001330) and rural (2201001210) local roads.

Finally, the set of emissions are broken into 3 sets that are processed in 3 separate sectors for LDGHG:

1. <u>on_moves_startpm</u>: monthly MOVES-based onroad gasoline "start" PM emissions subject to temperature adjustments, and onroad gasoline PM species not subject to temperature adjustments (e.g., PNO3 and PSO4). These are limited to 8 SCCs (urban/rural and 4 vehicle types) representing parking areas for the following pollutants: PEC_72, POC_72, PNO3, PSO4, OTHER, PMFINE_72, and PMC_72.
2. <u>on_moves_runpm</u>: monthly MOVES-based onroad gasoline "running" PM emissions subject to a different set of temperature adjustments compared to "start" emissions; similar to the on_moves_startpm sector, this sector includes all onroad gasoline PM species, not just those subject to temperature adjustments. The same pollutants are provided as on_moves_startpm.
3. <u>on_noadj</u> MOVES-based emissions: The remaining monthly diesel exhaust and non-PM gasoline MOVES-based emissions that are also not subject to temperature adjustments - see inputs (1) and (2) above. These emissions are modeled in the on_noadj sector discussed below and include both start and running emissions for all diesel (MOVES_based) pollutants and gasoline non-PM pollutants.

<u>on_noadj</u>
The on_noadj sector contains all US onroad mobile emissions that do not get a PM temperature adjustment. There are three sources of data that are pre-processed to create three sets of monthly inventories for this sector.

1. MOVES-based diesel exhaust and non-PM gasoline: These are the monthly non-PM MOVES-based emissions discussed in item #3 in "Outputs" in the on_moves_runpm and on_moves_startpm sector discussion. In short, these are non-California, select pollutants exhaust and evaporative (non-refueling) onroad gasoline LDGV, LDGT1, LDGT2, HDGV, and onroad diesel (HDDV –all classes) emissions.
2. California onroad inventory: California year 2030 complete CAP/HAP onroad inventory. California monthly onroad emissions are year 2030 and are based on March 2007 California Air Resources Board (CARB) data (Martin Johnson: mjohnson@arb.ca.gov).

NH3 emissions are from NMIM runs for California (same data as were used in 2030v3). We estimated HAP emissions by applying HAP-to-CAP ratios computed from California 2005 NEI submittal provided by EPA in 12/2007. This was done because the CARB submittal from March 2007 did not include estimates for HAPs. We retained only those HAPs that were also estimated by NMIM for nonroad mobile sources; all other HAPs were dropped.

3. Remaining onroad NMIM-based onroad inventory: The remainder of the non-California onroad inventory not replaced by MOVES. This includes monthly emissions for all onroad diesel, all motorcycles, all refueling, and onroad LDGV, LDGT1, LDGT2, HDGV, and HDDV emissions for pollutants not covered by MOVES (e.g., SO2, NH3). All NMIM onroad data are based on a composite Reference case inventory from Table 10, which uses AEO2007 fuels and NMIM county database NCD20080727.

The remainder of this section discusses the pre-processing required to create monthly ORL files for the remainder of the on_noadj sector (#3 above).

Table 10 shows how two NMIM inventories were combined to create the Reference case NMIM emissions. OTAQ provided a "reference and control" set (LdGhgO2030e10.txt) in October 2009 of NMIM E10-penetration emissions to be used for both the Reference and Control case. This is the complete NMIM scenario for the control case, but is used only for diesel vehicle emissions in the Reference case scenario. This reference and control set of monthly emissions includes all 50 states plus DC and all CAPs and HAPs of interest. A Reference case-specific (LdGhgO2030Aeo.txt) set of NMIM monthly emissions was also provided in October 2009 by OTAQ for onroad gasoline emissions. Onroad gasoline emissions in the control case use the "reference and control" case E10-based inventory.

Similar to nonroad pre-processing, we also reassigned NMIM evaporative and refueling xylene (compound XYL or CAS=EVP__1330207, RFL__1330207) into MXYL (CAS=EVP__108383, RFL__108383) and OXYL (CAS=EVP__95476, RFL__95476) using a 68% and32% ratio to both evaporative and refueling XYL, respectively. We also split NMIM exhaust xylene (CAS=EXH__1330207) into MXYL (CAS=EXH__108383) and OXYL (CAS=EXH__95476) using a 74% and 26% ratio to XYL, respectively.

Emissions were converted from monthly to average-day based the on number of days in each month. CO_2 and all of California emissions were removed prior to creating the NMIM-only parts of the final inventory files.

We also removed refueling emissions from the raw NMIM data prior to creating the SMOKE inputs, since these emissions were included in the nonpt and ptnonipm sectors. The NMIM refueling data were used with existing 2005 refueling emissions to create projection ratios for ptnonipm and nonpt refueling, as previously described in Section 4.1.1.

5 2030 Control Case

The 2030 LDGHG Control Case was intended to represent the implementation of national CO_2 emissions standards for light-duty vehicles. A list of inventory datasets used for this and the 2030 reference and 2005 cases is provided in Appendix A.

5.1 2030 Control Case Point sources

The point sources for the 2030 Control Case include the same emissions as the 2030 Reference Case for the following point source sectors: US EGU point source (ptipm), sources from Mexico, Canada, and the Gulf of Mexico (othpt).

As described in Section 4.1.1, the base case controls were erroneously not applied to both the 2030 Reference, and by extension, the 2030 Control case ptnonipm inventories. No other sectors are impacted by this error.

For the nonEGU point sources (ptnonipm), some of the 2030 Reference case emissions were adjusted to reflect the 2030 Control case. These differences from the 2030 Reference case are:

- Gasoline Distribution: These SCC- adjustments were supplied by OTAQ on 11/09/2009 in the Excel® workbook "LDGHG_SCC_GasDistrib_Adjust2.xls". These adjustments reduce all pollutant emissions from the Reference to the Control case for Refinery-To-Bulk-Terminal (rbt) and Bulk-Terminal-To-Pump (btp) by approximately 18.3% to 18.8%, respectively. On 12/28/2009, OTAQ also provided an additional 25 rbt-related SCCs that were subject to the same projection factors. These adjustments impact both the ptnonipm and nonpt sectors.
- Oil Refining, Crude Oil Transport, and Crude Oil Production: These SCC-level adjustments were supplied by OTAQ on 11/09/2009 in the Excel® workbook "Oil_Prod_Transp_Refine_2030_adjust.xls". These adjustments reduce all pollutant emissions from the Reference to the Control case for refinery-related SCCs by approximately 6.1% and for transport and production-related SCCs by approximately 0.6%. These adjustments impact both the ptnonipm and nonpt sectors.
- Onroad refueling: We used the same overall projection approach for onroad refueling as was used in the 2030 Reference case for the ptnonipm and nonpt sectors. Instead of using the 2030 Reference case NMIM run, we used the Control case-specific NMIM run for the 2030 refueling ratio calculation. We applied these factors to the refueling SCCs from the 2030 Reference case using this formula: $Factor_{2030control} = NMIM\ Emis_{2030Control} / NMIM\ Emis_{2030Refernce}$. These adjustments impact both the ptnonipm and nonpt sectors.
- The headspace vapor VOC speciation profile changed to reflect the assumption of 100% E10 in the 2030 control case fpr rbt and btp emissions, the specifics of which are provided in Section 3.

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5.2 2030 Control Case Nonpoint sources

The nonpoint sources for the 2030 Control Case include the same emissions as the 2030 Reference Case for the following sectors: US fugitive dust sources (afdust sector), US agricultural NH3 (ag sector), the US average fires (avefire sector), and the nonpoint emissions for Canada and Mexico (othar).

The 2030 Control Case emissions for the "other nonpoint" sector (nonpt) emissions differed from the 2030 Reference case in the following ways:

- Created revised PFC emissions by applying adjustment factors by county and pollutant, based on an Excel® spreadsheet provided by OTAQ on 1/14/2009: "aeo_to_eisa.xls". These adjustments reduced PFC emissions as compared to the 2030 Reference case.
- As previously mentioned for the point sources, we changed refueling, rbt/btp, and oil refining, transport, and production emissions projections, which also affected the nonpt sector.
- The headspace vapor VOC speciation profile changed to reflect the assumption of 100% E10 in the 2030 control case fpr rbt and btp emissions, the specifics of which are provided in Section 3.

5.3 2030 Control Case Mobile sources

Compared to the 2030 Reference case, the mobile source emissions included changes for all onroad mobile (on_noadj, on_moves_startpm, and on_moves_runpm), and non-California nonroad mobile sources (nonroad). The aircraft, locomotive, and non-C3 commercial marine (alm_no_c3), C3 commercial marine (seca_c3) and the Canada and Mexico emissions (othon) were unchanged.

For the nonroad sector, as discussed in Section 4.3.4, OAQPS substituted 2030 Control case emissions for nonroad gasoline 2-stroke and 4-stroke equipment and gasoline recreational marine sources. California emissions were not changed, but emissions in all other states were updated. Otherwise the steps taken were the same as described for the 2030 Reference case.

For the US onroad mobile sectors, as discussed in Section 4.3.5, OAQPS substituted NMIM 2030 Control case emissions for onroad gasoline vehicles and motorcycles. In addition, the MOVES-based emissions for the control case completely replaced the reference case MOVES data with the exception of MOVES-based vehicle class 8-12 diesel (HDDV) that are shared by both the reference and control cases.

We allocated the state-SCC MOVES data to county-SCC using ratios developed from the Control case-specific NMIM county-SCC data. Other than the different data used for creating the monthly county-SCC SMOKE-ready inventories, we used the same processing steps as described for the 2005 base and 2030 Control cases.

Lastly, VOC speciation profile changes affected this sector, as described in Section 3.

APPENDIX A

Equations to adapt pre-speciated diesel emissions from MOVES to air quality modeling species needed for CMAQ

As shown in equation (1) below, MOVES provides total $PM_{2.5}$, PEC and PSO4. A remainder term, *R*, makes up the difference between the two species and the total $PM_{2.5}$.

$$\text{MOVES total } PM_{2.5} = PEC + PSO4 + R \qquad (1)$$

The *R* term includes POM, which consists of POC and the hydrogen and oxygen atoms attached to the carbon as part of the organic matter, PNO3, soil oxides and metals (also known as “crustal” and called METAL here), ammonium, and water, and thus can be also written as:

$$R = POM + PNO3 + METAL + NH4 + H_20 \qquad (2)$$

To correctly calculate the five $PM_{2.5}$ species needed for CMAQ, we first needed to break out the POC, PNO3, and PMFINE from *R*. Different calculations are used for light-duty diesel vehicles and heavy-duty diesel vehicles, since the speciation profiles for these are different. The speciation profiles used for these calculations are:

For both light duty diesel vehicles and heavy duty diesel vehicles, the SPECIATE 4.0 PM2.5 speciation profiles “3914” (HHDV) and “92042” (LDDV) will be used to help calculate the other species. At the time, OTAQ did not provide a justification for choosing this profile, but the fractions of metals and PNO3 are small and so presumably the choice does not matter too much as long as the smallest of those fractions is representative.

We computed the primary nitrate based on speciation profile 92011 from the SPECIATE4.1 database (Hsu et al., 2006) using equation (3) shown below.

$$PNO3 = PEC \times F_{NO3} / F_{EC} \qquad (3)$$

where,

F_{EC} = Fraction of elemental carbon in speciation profile:

- LDDV: 57.4805% (based on profile 92042)[1]
- HDDV: 77.1241% (based on profile 3914)

F_{NO3} = Fraction of nitrate in speciation profile

- LDDV: 0.1141% (based on profile 3914, intentionally inconsistent)
- HDDV: 0.1141% (based on profile 3914)

To identify which sources should get the LDDV and which should get the HDDV approach, see Table 1, below.

Since CMAQ’s PMFINE species is the sum of soil oxides, metals, ammonium, and water, we needed to calculate all of its components. First, the metals and ammonium are computed using equations (4) and (5). Equation (5) is based on stoichiometric calculations.

$$METAL = PEC \times F_{metal} / F_{EC} \qquad (4)$$

[1] All profile fractions provided in email from Catherine Yanca on 11/6/2009, 1:49pm in attachment “Equations for diesel MOVES speciation use in CMAQ 110609.doc”

$$NH4 = (PNO3/MW_{NO3} + 2 \times PSO4/MW_{SO4}) \times MW_{NH4} \quad (5)$$

where,

F_{metal} = Fraction of metals in speciation profile (0.002663[2])
MW_{SO4} = Molecular weight of sulfate (96.0576)
MW_{NO3} = Molecular weight of nitrate (62.0049)
MW_{NH4} = Molecular weight of ammonium (18.0383)

The final component of PMFINE is the non-carbon mass of organic carbon. To calculate the non-carbon mass, we first needed to compute organic carbon from the remainder term, *R*.

A key assumption is that POM is a factor of 1.2 greater than the mass of primary organic carbon, which is also used in the CMAQ postprocessing software at EPA.

$$POM = 1.2 \times POC \quad (6)$$

Using this assumption and assuming that the H_20 is negligible, the equation needed for the calculation of POC is shown in equation (7) below.

$$POC = 5/6 \times (R - METAL - NH4 - PNO3) \quad (7)$$

From equation (6), the non-carbon portion of the organic carbon matter is 20%, of the POC. By definition, PMFINE is the sum of the non-carbon portion of the mass, METAL and NH4. Thus, we computed PMFINE_72 using equation (8) shown below.

$$PMFINE\_72 = METAL + NH4 + 0.2 \times POC\_72 \quad (8)$$

For mobile sources, we assumed that PMC is 8.6% of the $PM_{2.5}$ mass. Equation (9) shows how we calculated it.

$$PMC = 0.086 \times (PMFINE + PEC + POC + PSO4 + PNO3)$$

Table A-1. List of SCC groups for application of LDDV or HDDV approach

Approach	**SCC list**
LDDV	2230001000 through 2230060334
HDDV	2230071110 through 2230075330

[2] Value provided by Catherine Yanca and Joe Somers to OAQPS in email provided 11/5/2009

APPENDIX B

Inventory Data Files Used for Each LDGHG Modeling Case – SMOKE Input Inventory Datasets

In any of the following dataset names where the placeholder <mon> has been provided, this is intended to mean 12 separate files with the <mon> placeholder replaced with either jan, feb, mar, apr, may, jun, jul, aug, sep, oct, nov, or dec, each associated with a particular month of the year.

Table B-1. List of inventory data associated with LDGHG modeling cases.

Case	**Sector**	**SMOKE Input Files**
2005 Base (2005cp_tox_05b)	ptipm	Annual: ptinv_ptipm_cap2005nei_26aug2008_v2_orl.txt
		Annual: ptinv_ptipm_hap2005agtox_v1_noBAFM_28aug2008_v0_orl.txt
		Daily: ptday_ptipm_caphap_noncem_2005ag_<mon>_ida.txt
		Daily: ptday_ptipm_caphap_cem_2005ci_<mon>_ida.txt
	ptnonipm	ptinv_ptnonipm_xportfrac_2005cap_remainder_24nov2008_v0_orl.txt
		ptinv_ptnonipm_2005hap_noBAFM_remainder_24nov2008_v0_orl.txt
		ptinv_ptnonipm_2005caphap_chippewa_delete_for_2022EISA_19nov2008_v0_orl.txt
		ptinv_ptnonipm_caphap_ethanol_plant_additions_2005_17dec2008_v1_orl.txt
		ptinv_ptnonipm_2005caphap_3ethanol_plants_delete_for_all2022_19nov2008_v0_orl.txt
	afdust	arinv_afdust_2002ad_xportfrac_26sep2007_v0_orl.txt
	ag	arinv_ag_cap2002nei_06nov2006_v0_orl.txt
	alm_no_c3	arinv_alm_no_c3_cap2002v3_30jul2008_v1_orl.txt
		arinv_alm_no_c3_hap2002v4_12sep2008_v0_orl.txt
	nonpt	arinv_nonpt_caphap_ethanol_plant_additions_2005_17dec2008_v0_orl.txt
		arinv_nonpt_pf4_cap_nopfc_08sep2008_v0_orl.txt
		arinv_nonpt_pf4_hap_nopfc_11sep2008_v0_orl.txt
		arinv_pfc_2002_caphap_27dec2007_v0_orl.txt
	nonroad	arinv_nonroad_caps_2005v2_<mon>_revised_08sep2008_v0_orl.txt
		arinv_nonroad_calif_caphap_2005v2_<mon>_02apr2008_v0_orl.txt
		arinv_nonroad_haps_2005v2_<mon>_revised_05sep2008_v0_orl.txt
	on_noadj	mbinv_onroad_calif_caphap_2005v2_<mon>_02apr2008_v0_orl.txt
		mbinv_noadj_capshaps_2005v2_nmim_not2moves4LDGHG_<mon>_12NOV09_12nov2009_v0_orl.txt
		mbinv_on_noadj_MOVES_LDGHG_2005_<mon>_17NOV09_17nov2009_v0_orl.txt
	on_moves_runpm	mbinv_on_moves_runpm_LDGHG_2005_<mon>_12NOV09_12nov2009_v0_orl.txt
	on_moves_startpm	mbinv_on_moves_startpm_LDGHG_2005_<mon>_12NOV09_12nov2009_v0_orl.txt
	seca_c3	ptinv_seca_c3_caps2005pf4_31jul2008_v0_orl.txt
		ptinv_seca_c3_haps_east2005pf4_31jul2008_v0_orl.txt
		ptinv_seca_c3_haps_central2005pf4_31jul2008_v0_orl.txt
		ptinv_seca_c3_haps_west2005pf4_31jul2008_v0_orl.txt
		ptinv_seca_c3_haps_NonUS_east2005pf4_09sep2008_v0_orl.txt
		ptinv_seca_c3_haps_NonUS_central2005pf4_09sep2008_v0_orl.txt
		ptinv_seca_c3_haps_NonUS_west2005pf4_09sep2008_v0_orl.txt
All Cases	avefire	arinv_avefire_2002ce_21dec2007_v0_ida.txt
		arinv_avefire_2002_hap_18nov2008_v0_orl.txt
	othar	arinv_nonroad_mexico_interior1999_21dec2006_v0_ida.txt
		arinv_nonroad_mexico_border1999_21dec2006_v0_ida.txt
		arinv_nonroad_Canada_2000_inventory_11feb2008_v2_ida.txt
		arinv_nonpoint_Canada2000_21dec2006_v0_ida.txt
		arinv_nonpt_mexico_interior1999_21dec2006_v0_ida.txt
		arinv_nonpt_mexico_border1999_21dec2006_v0_ida.txt
	othon	mbinv_onroad_Canada2000_07nov2006_v0_ida.txt
		mbinv_onroad_mexico_border1999_21dec2006_v0_ida.txt
		mbinv_onroad_mexico_interior1999_21dec2006_v0_ida.txt
	othpt	ptinv_2000_canada_egu_07nov2006_v0_ida.txt
		ptinv_2000_canada_nonegu_05dec2006_v0_ida.txt
		ptinv_mexico_border99_03mar2008_v1_ida.txt
		ptinv_mexico_interior99_05feb2007_v0_ida.txt
		ptinv_offshore_point_from_2001_platform_07nov2006_v0_ida.txt
2030 Reference and Control	ptipm	Annual: ptinv_egu_summer_2020_pf31capsHgHCl_19feb2008_v0_orl.txt
		Annual: ptinv_ptipm_hap2005agtox_v1_noBAFM_noHgHCL_07jan2009_v2_orl.txt
		Daily: ptday_ptipm_caphap_cem_2022ci_<mon>_ida.txt
		Daily: ptday_ptipm_caphap_noncem_2022ci_<mon>_ida.txt
		Daily: ptday_ptipm_hap_cem_2005ci_<mon>_ida.txt

Case	Sector	SMOKE Input Files
		Daily: ptday_ptipm_hap_noncem_2005ag_<mon>_ida.txt
	afdust	arinv_afdust_2020ce_02b_BASE_07apr2008_v0_orl.txt
	ag	arinv_ag_2020ce_02b_BASE_08apr2008_v0_orl.txt
	alm_no_c3	arinv_alm_no_c3_cap2030cp_21dec2009_v0_orl.txt
		arinv_alm_no_c3_hap2030cp_21dec2009_v0_orl.txt
	seca_c3	ptinv_seca_c3_BAF_HAPs2030pf31_17dec2009_v0_orl.txt
		ptinv_seca_c3_caps2030pf31_10jun2008_v0_orl.txt
2030 Reference Only (2030cp_tox_05b)	ptnonipm	ptinv_ptnonipm_xportfrac_2030cp_tox_cap_remainder_17dec2009_v0_orl.txt
		ptinv_ptnonipm_2005caphap_chippewa_delete_for_2022EISA_19nov2008_v0_orl.txt
		ptinv_ptnonipm_2030cp_tox_hap_noBAFM_remainder_17dec2009_v0_orl.txt
		ptinv_ptnonipm_caphap_ethanol_plant_additions_2022AEO_05jan2009_v1_orl.txt
	nonpt	arinv_nonpt_caphap_biodiesel_plant_additions_2022AEO_18dec2008_v0_orl.txt
		arinv_nonpt_caphap_ethanol_plant_additions_2022AEO_15dec2008_v0_orl.txt
		arinv_nonpt_pf4_2030cp_tox_cap_nopfc_17dec2009_v0_orl.txt
		arinv_nonpt_pf4_2030cp_tox_hap_nopfc_fixed_with_wrap_oilgas_17dec2009_v0_orl.txt
		arinv_nonpt_voc_ethanol_transfer_additions_2022AEO_15dec2008_v0_orl.txt
		arinv_pfc_reference_caphap2030LDGHG_14dec2009_v0_orl.txt
	nonroad	arinv_nonroad_capshaps_LDGHG_2030_REFERENCE_<mon>_15DEC09_15dec2009_v0_orl.txt
		arinv_nonroad_calif_caphap_2030v31_<mon>_17apr2008_v0_orl.txt
	on_noadj	mbinv_onroad_calif_caphap_2030v31_<mon>_30apr2008_v0_orl.txt
		mbinv_on_noadj_nmim_not2moves_2030LDGHG_REFERENCE_<mon>_10DEC09_10dec2009_v0_orl.txt
		mbinv_on_noadj_MOVES_LDGHG_2030_REFERENCE_<mon>_11DEC09_11dec2009_v0_orl.txt
	on_moves_runpm	mbinv_on_moves_runpm_LDGHG_2030_REFERENCE_<mon>_11DEC09_11dec2009_v0_orl.txt
	on_moves_startpm	mbinv_on_moves_startpm_LDGHG_2030_REFERENCE_<mon>_11DEC09_11dec2009_v0_orl.txt
	ptnonipm	ptinv_ptnonipm_2005caphap_chippewa_delete_for_2022EISA_19nov2008_v0_orl.txt
		ptinv_ptnonipm_2030cp_tox_ldghg_hap_noBAFM_remainder_28dec2009_v0_orl.txt
		ptinv_ptnonipm_caphap_ethanol_plant_additions_2022AEO_05jan2009_v1_orl.txt
		ptinv_ptnonipm_xportfrac_2030cp_tox_ldghg_cap_remainder_28dec2009_v0_orl.txt
		arinv_nonpt_caphap_biodiesel_plant_additions_2022AEO_18dec2008_v0_orl.txt
		arinv_nonpt_caphap_ethanol_plant_additions_2022AEO_15dec2008_v0_orl.txt
		arinv_nonpt_pf4_2030cp_tox_ldghg_cap_nopfc_28dec2009_v0_orl.txt
		arinv_nonpt_pf4_2030cp_tox_ldghg_hap_nopfc_fixed_with_wrap_oilgas_28dec2009_v0_orl.txt
		arinv_nonpt_voc_ethanol_transfer_additions_2022AEO_15dec2008_v0_orl.txt
		arinv_pfc_control_caphap2030LDGHG_14dec2009_v0_orl.txt
	nonroad	arinv_nonroad_calif_caphap_2030v31_<mon>_17apr2008_v0_orl.txt
		arinv_nonroad_capshaps_LDGHG_2030_CONTROL_<mon>_15DEC09_15dec2009_v0_orl.txt
	on_noadj	mbinv_onroad_calif_caphap_2030v31_<mon>_30apr2008_v0_orl.txt
		mbinv_on_noadj_nmim_not2moves_2030LDGHG_CONTROL_<mon>_10DEC09_10dec2009_v0_orl.txt
		mbinv_on_noadj_MOVES_LDGHG_2030_CONTROL_<mon>_11DEC09_11dec2009_v0_orl.txt
	on_moves_runpm	mbinv_on_moves_runpm_LDGHG_2030_CONTROL_feb_11DEC09_11dec2009_v0_orl.txt
	on_moves_startpm	mbinv_on_moves_startpm_LDGHG_2030_CONTROL_<mon>_11DEC09_11dec2009_v0_orl.txt

APPENDIX C

Ancillary Data Files Used for LDGHG 2005 Case Compared to 2005 v4 Platform Data Files

To match the Datasets and Versions listed in this table to actual data files, combine the Dataset name and the version number in the following pattern: <Dataset Name>_<Date>_<Version number>.txt, where <Date> is the last date of change for that version and will have a unique value for the combination of Dataset Name and Version number.

Table C-1. Detailed list of ancillary data differences between the LDGHG 2005 and the 2005 v4 platform

Description	Environment Variable	Sectors	2005 v4 platform		2005 LDGHG platform		Comment and Impact	Impact?
			Dataset	Vsn	Dataset	Vsn		
Area-source spatial cross-reference	AGREF	All sectors	amgref_us_can_mex_revised	5	amgref_us_can_allmex3	12	For v4 platform, revised for new Canadian inventory and spatial surrogates. LDGHG includes MOVES SCCs for diesel parking areas	Yes
Onroad spatial cross-reference	MGREF	All sectors	amgref_us_can_mex_revised	7	amgref_us_can_allmex3	12	For v4 platform, revised for new Canadian inventory and spatial surrogates. LDGHG includes MOVES SCCs for diesel parking areas	Yes
Area and onroad temporal profiles	ATPRO, MTPRO, PTPRO	All sectors	amptpro_2005_us_can_revised	0	amptpro_2005_us_can	3	For v4 platform, revised for new Canadian inventory and temporal profile. LDGHG includes HDD idling profiles	Yes
Area temporal cross-reference	ATREF, PTREF	All sectors	amptref_v3_3_revised	1	amptref_v3_3	9	For v4 platform, added SCCs needed for 2005 v2 point inventory and for WRAP oil and gas inventory. LDGHG includes MOVES-based diesel parking SCCs	Yes
Onroad temporal cross-reference	MTREF	All sectors	amptref_v3_3_revised	0	amptref_v3_3	9	For v4 platform, added SCCs needed for 2005 v2 point inventory (but not for WRAP oil and gas inventory). Superceeded by v1 of the same dataset.	Yes
Grid descriptions	GRIDDESC	All sectors	griddesc_lambertonly	24	griddesc_lambertonly	23	An older file used for LDGHG with an unrelated grid not defined.	No
Inventory table	INVTABLE	All sectors	invtable_hapcapintegate_cb05soa_nomp	4	invtable_hapcap_cb05soa	9	LDGHG used a full toxics approach for processing the emissions and 2005 v4 platform used an approach without most toxics. Impacts only the species included in the air quality modeling. LDGHG also includes speciated PM from MOVES diesel sources.	No
Inventory table	INVTABLE	avefire, ptnonipm, ptipm	invtable_hapcapnohapuse_cb05soa_nomp	4	n/a		Approach for implementing "no HAP use" approach for these sectors was different in LDGHG, but the result was the same.	No
Non-HAP Exclusions for nonpt sector	NHAP EXCLUDE	nonpt	nhapexclude_nonpt_pf4	3	nhapexclude_nonpt_pf4	2	v3 includes WRAP oil and gas SCCs since these do not have HAP VOCs either. v3 needed for the v4 platform but not LDGHG as LDGHG does not include WRAP oil and gas SCCs.	Yes
Elevated configuration file for seca_c3 sector	PELV CONFIG	seca_c3	pelvconfig_seca_c3	0	n/a		v4 platform used inline point sources, and so PELVCONFIG file needed only in v4 platform.	Yes
Speciation profiles for TOG	GSPRO	All sectors	gspro_tog_cb05_soa_pf4_pretier2	1	gspro_tog_nohapuse_cb05_tx_pf4_pretier2	1	Excluded ald2_primary and form_primary from v4 platform since not needed	No
Speciation profiles speciated VOC	GSPRO	othpt	gspro_speciated_voc	0	n/a		For the v4 platform, this speciation profile dataset passes through the pre-speciated VOC point source species provided by Environment Canada 2006 data.	Yes

Description	Environment Variable	Sectors	2005 v4 platform		2005 LDGHG platform		Comment and Impact	Impact?
			Dataset	Vsn	Dataset	Vsn		
Speciation profiles Canada PM	GSPRO	othpt	gspro_pm25_canada_2006_point	0	n/a		For the v4 platform, this speciation profile dataset provides the Canadia-specific $PM_{2.5}$ speciation profile recommended by Environment Canada for point sources (1% POC, 2% PEC, 12% PSO4, 85% PMFINE)	Yes
Speciation profiles for biogenic emissions	GSPRO	biog	gspro_biogenics	0	n/a		For the v4 platform, this dataset contains the biogenic VOC speciation profiles previously included in gspro_static_cmaq v7 for the RFS2 effort	No
Speciation profiles Other VOC HAP	GSPRO	All sectors	n/a		gspro_other_hapvoc_nobenz-benz	0	For LDGHG, this dataset has the HAP VOC species that get passed through from inventory to the multipollutant inputs created for LDGHG.	Yes
Speciation profiles CHROMIUM	GSPRO	All sectors	n/a		gspro_chromium	0	Chromium speciation profiles needed only for multi-polltutant approach used in LDGHG	Yes
Speciation profiles METALS	GSPRO	All sectors	n/a		gspro_hapmetals	0	HAP metal pass-through profiles needed only for multi-pollutant approach used in LDGHG.	Yes
Speciation profiles MOVES PM	GSPRO	All sectors	n/a		gspro_speciated _pm	3	Speicated PM (non-72 degrees) added for MOVES diesel exhaust in LDGHG.	Yes
Speciation profile 8762/8763 for TOG to BAF	GSPRO	All sectors	n/a		gspro_cmaq_cb05_hspace_BAF	1	For LDGHG, benzene from TOG for headspace profiles 8762 and 8763	Yes
Speciation profile 8762/8763 for nontoxics	GSPRO	All sectors	n/a		gspro_cmaq_cb05_hspace_nontoxic	0	For LDGHG, toxics from TOG for headspace profiles 8762 and 8763	Yes
Speciation profile 8762/8763 for toxics	GSPRO	All sectors	n/a		gspro_cmaq_cb05_hspace_toxic	0	For LDGHG, toxics from NONHAPTOG for headspace profiles 8762 and 8763	Yes
Speciation xref for PM2.5 diesel SCCs but do not produce diesel	GSREF	All sectors	gsref_no_dieselpm	1	n/a		Both the LDGHG and v4 platform did not create the DIESEL_PM species needed for the multipollutant version of CMAQ, the data set used for the v4 platform contains the SCC cross-references for diesel SCCs without the DIESEL_PM species.	No
Speciation xref NO DIESEL PM, othar	GSREF	othar	gsref_no_dieselpm	1	gsref_no_dieselpm	2	Prevents creation of diesel PM species in Canada for LDGHG	No
Speciation xref for non-diesel PM2.5	GSREF	All sectors	gsref_pm25_pf4_nondiesel	8	gsref_pm25_pf4_nondiesel	1	For the v4 platform, this dataset includes updates for 2005 v2 point sources as well as WRAP oil and gas inventory. Note that future years of LDGHG used more current version than "v1" of this dataset, and the v8 dataset could be used for replicating LDGHG runs.	No

Description	Environment Variable	Sectors	2005 v4 platform		2005 LDGHG platform		Comment and Impact	Impact?
			Dataset	Vsn	Dataset	Vsn		
Speciation xref for VOC, not year-specific	GSREF	All sectors	gsref_voc_general	19	gsref_voc_general_ldghg	0	LDGHG copied V20 file from v4 platform and replaced headspace profile 8737 with 8762. For v4 platform, includes updates for 2005 v2 point inventory, WRAP oil and gas SCCs, changes to gasoline distribution SCCs and all SCCs from HAP inventory.	Yes
Speciation xref for NONHAPVOC, not year-specific	GSREF	All sectors	gsref_nonhapvoc_general_update	3	gsref_nonhapvoc_general	1	For the v4 platform, includes WRAP oil and gas SCCs and removed duplicates. LDGHG replaces profile 8737 with headspace profile 8762.	Yes
Speciation xref for VOC, year-specific	GSREF	All sectors	gsref_voc_2005	2	gsref_voc_2005_ldghg	0	The LDGHG file is the v4 file updated to include new headspace profiles 8762.	
Speciation xref for NONHAPVOC, year-specific	GSREF	All sectors	gsref_nonhapvoc_2005	1	gsref_nonhapvoc_2005_ldghg	0	LDGHG replaces headspace profile 8737 with 8762	Yes
Speciation xref static NOX -- HONO for mobile sources	GSREF	All sectors	gsref_static_nox_hono_pf4	3	gsref_static_nox_hono_pf4	2	The v4 platform dataset adds four Canadian SCCs that are needed for processing the 2006 Canadian inventory.	
Speciation xref for Integrate-HAPs static	GSREF	All sectors	gsref_static_integratehap_emv4	2	n/a		For the v4 platform, this speciation cross-reference dataset passes through the pre-speciated VOC point source species provided by Environment Canada 2006 data.	Yes
Speciation xref for Canada PM	GSREF	othpt	gsref_pm25_canada_2006_point	2	n/a		For the v4 platform, this speciation cross-reference dataset assigns the single Canadia-specific $PM_{2.5}$ speciation profile recommended by Environment Canada for all point sources.	Yes
Speciation xref HAP chromium nonroad sectors	GSREF	alm_no_c3 nonroad seca_c3	n/a		gsref_chromium_nonroad	1	Enables creation of chromium species	Yes
Speciation xref HAP chromium on_noadj sector	GSREF	on_noadj	n/a		gsref_chromium_onroad	1	Enables creation of chromium species	Yes
Speciation xref HAP chromium stationary sectors	GSREF	nonpt ptipm ptnonipm	n/a		gsref_chromium_stationary	0	Enables creation of chromium species	Yes
Speciation xref HAP metals nonroad sectors	GSREF	alm_no_c3 nonroad seca_c3	n/a		gsref_metals_nonroad	0	Enables creation of HAP metal species	Yes

Description	Environment Variable	Sectors	2005 v4 platform		2005 LDGHG platform		Comment and Impact	Impact?
			Dataset	Vsn	Dataset	Vsn		
Speciation xref HAP metals stationary sector	GSREF	nonpt ptipm ptnonipm	n/a		gsref_metals_stationary	1	Enables creation of HAP metal species	Yes
Speciation xref HAP metals nonroad sectors	GSREF	nonroad	n/a		gsref_metals_nonroad	0	Enables creation of HAP metal species	Yes
Speciation xref HAP metals on_noadj sector	GSREF	on_noadj	n/a		gsref_metals_onroad	0	Enables creation of HAP metal species	Yes
SCC Descriptions	SCCDESC	All sectors	sccdesc_pf31	5	sccdesc_pf31	8	LDGHG updated to include MOVES diesel start SCCs and Canada 2006 added (late for v4)	Yes

APPENDIX D

Growth and Control Assumptions and Affected Pollutants for the 2030 LDGHG Reference Case

For nonEGU point and stationary area sources, the "2005" inventory data used 2002 emissions. As a result, we used our 2002-based approaches for these sectors to project to 2030. Many of these controls have effective dates between 2002 and 2005, and therefore would not be applied to a true 2005 inventory value. As mentioned in Section 4.1.1, these controls were inadvertently not applied to the 2030 reference and control cases.

Table D-1. Control Strategies and Projection Assumptions in the 2030 LDGHG Reference Case Emissions Inventories

Control Strategies **(Grouped by Affected Pollutants or Standard and Approach Used to Apply to the Inventory)**	**Pollutants Affected**	**Approach or Reference:**	**Applied?**
Non-EGU Point Controls			
NO_X SIP Call (Phase II): Cement Manufacturing Large Boiler/Turbine Units Large IC Engines	NOx	1	No
DOJ Settlements: plant SCC controls Alcoa, TX MOTIVA, DE	NOx, SO2	2	No
Refinery Consent Decrees: plant/SCC controls	NOx, PM, SO2	3	No
Closures, pre-2007: plant control of 100% Auto plants Pulp and Paper Large Municipal Waste Combustors Small Municipal Waste Combustors Plants closed in preparation for 2005 inventory	all	4	No
Industrial Boiler/Process Heater plant/SCC controls for PM	PM	5	No
Large Municipal Waste Combustors (LMWC)	PM, Hg, and metals	6	Partially
Small Municipal Waste Combustors (SMWC)	PM, Hg, metals, NOx, SO2	6	Partially
MACT rules, national, VOC: national applied by SCC, MACT Boat Manufacturing Polymers and Resins III (Phenolic Resins) Polymers and Resins IV (Phenolic Resins) Wood Building Products Surface Coating Generic MACT II: Spandex Production, Ethylene manufacture Large Appliances Miscellaneous Organic NESHAP (MON): Alkyd Resins, Chelating Agents, Explosives, Phthalate Plasicizers, Polyester Resins, Polymerized Vinylidene Chloride Manufacturing Nutritional Yeast Oil and Natural Gas Petroleum Refineries -Catalytic Cracking, Catalytic Reforming, & Sulfur Plant Units Pesticide Active Ingredient Production Publicly Owned Treatment Works Reinforced Plastics Rubber Tire Manufacturing Asphalt Processing & Roofing Combustion Sources at Kraft, Soda, and Sulfite Paper Mills Fabric Printing, Coating and Dyeing	VOC	EPA, 2007	Only Municipal Solid Waste Landfills were applied

Control Strategies (Grouped by Affected Pollutants or Standard and Approach Used to Apply to the Inventory)	Pollutants Affected	Approach or Reference:	Applied?
Iron & Steel Foundries Metal: Can, Coil Metal Furniture Miscellaneous Metal Parts & Products Municipal Solid Waste Landfills Paper and Other Web Plastic Parts Plywood and Composite Wood Products Wet Formed Fiberglass Production Wood Building Products Surface Coating Carbon Black Production Cellulose Products Manufacturing Cyanide Chemical Manufacturing Friction Products Manufacturing Leather Finishing Operations Miscellaneous Coating Manufacturing Organic Liquids Distribution (Non-Gasoline) Refractory Products Manufacturing Sites Remediation			
Solid Waste Rules (Section 129d/111d) Hospital/Medical/Infectious Waste Incinerator Regulations	NOx, PM, SO2	EPA, 2005	Partially
MACT rules, national, PM: **Portland Cement Manufacturing** **Secondary Aluminum**	PM	7	No
MACT rules, plant-level, VOC: **Auto Plants**	VOC	8	No
MACT rules, plant-level, PM & SO_2: **Lime Manufacturing**	PM, SO2	9	No
MACT rules, plant-level, PM: **Taconite Ore**	PM	10	No
Stationary Area Assumptions			
Municipal Waste Landfills: project factor of 0.25 applied,	VOC	EPA, 2007	Yes
Livestock Emissions Growth to year 2020	NH3	11	Yes
Residential Wood Combustion Growth and Changeouts to year 2020	all	12	Yes
Gasoline Stage II growth and control to 2030 Reference	VOC	13	Yes
Portable Fuel Container growth and control to year 2030	VOC	14	Yes
EGU Point Controls			
CAIR/CAMR/CAVR IPM Model 3.0	NOx, SO2, PM	15	Yes
Onroad Mobile and Nonroad Mobile Controls (list includes all key mobile control strategies but is not exhaustive)			
National Onroad Rules: Tier 2 Rule 2007 Onroad Heavy-Duty Rule Final Mobile Source Air Toxics Rule (MSAT2) Renewable Fuel Standard	all		Yes

Control Strategies (Grouped by Affected Pollutants or Standard and Approach Used to Apply to the Inventory)	**Pollutants Affected**	**Approach or Reference:**	**Applied?**
Local Onroad Programs: National Low Emission Vehicle Program (NLEV) Ozone Transport Commission (OTC) LEV Program	VOC	16	Yes
National Nonroad Controls: Clean Air Nonroad Diesel Final Rule – Tier 4 Control of Emissions from Nonroad Large-Spark Ignition Engines and Recreational Engines (Marine and Land Based): "Pentathalon Rule" Clean Bus USA Program Control of Emissions of Air Pollution from Locomotives and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder Exhaust emission standards for marine spark-ignition engines and small land-based nonroad engines	all	17, 18, 19	Yes
Aircraft, Locomotives, and Commercial Marine Assumptions			
Aircraft: Itinerant (ITN) operations at airports to year 2022	all	20	Yes
Locomotives: Energy Information Administration (EIA) fuel consumption projections for freight rail Clean Air Nonroad Diesel Final Rule – Tier 4 Locomotive Emissions Final Rulemaking, December 17, 1997 Control of Emissions of Air Pollution from Locomotives and Marine	all	18, 21, (EPA, 2009)	Yes
Commercial Marine: EIA fuel consumption projections for diesel-fueled vessels OTAQ ECA C3 Base 2022 inventory for residual-fueled vessels Clean Air Nonroad Diesel Final Rule – Tier 4 Emissions Standards for Commercial Marine Diesel Engines, December 29, 1999 Tier 1 Marine Diesel Engines, February 28, 2003	all	21, (EPA, 2009)	Yes
Reference Case-specific inventory adjustments			
Nonpt and ptnonipm: Gasoline distribution by SCC: bulk-plant-to-pump (btp) and refinery-to-bulk terminal (rtb) processes Ethanol plant additions	VOC all	EPA, 2010	Yes
ptnonipm: Refinery adjustments by state and SCC Ethanol plant additions	all all	EPA, 2010	Yes
nonpt: Ethanol transfer additions Biodiesel Plant additions	VOC all	EPA, 2010	Yes
Nonroad (not including California): AEO-specific gasoline equipment and gasoline rec-marine E0-based emissions for diesel rec-marine	all	EPA, 2010	Yes
Onroad (not including California): NMIM and MOVES AEO-specific emissions for onroad gasoline and diesel	all	EPA, 2010	Yes

APPROACHES:

1. Used *Emission Budget Inventories* report (EPA, 1999) for list of SCCs for application of controls, and for percent reductions (except IC Engines). Used Federal Register on Response to Court decisions (Federal Register, 2004) for IC Engine percent reductions and geographic applicability
2. For ALCOA consent decree, used http:// cfpub.epa.gov/compliance/cases/index.cfm; for MOTIVA: used information sent by State of Delaware
3. Used data provided by Brenda Shine, EPA, OAQPS
4. Closures obtained from EPA sector leads; most verified using the world wide web.
5. Used data list of plants provided by project lead from 2001-based platform; required mapping the 2001 plants to 2002 NEI

plants due to plant id changes across inventory years

6. Used data provided by Walt Stevenson, EPA, OAQPS
7. Same as used in CAIR, except added SCCs appeared to be covered by the rule: both reductions based on preamble to final rule. (Portland Cement used a weighted average across two processes)
8. Percent reductions recommended and plants to apply to reduction to were based on recommendations by rule lead engineer, and are consistent with the reference: EPA, 2007e
9. Percent reductions recommended are determined from the existing plant estimated baselines and estimated reductions as shown in the Federal Register Notice for the rule. SO2 % reduction will therefore be 6147/30,783 = 20% and PM10 and PM2.5 reductions will both be 3786/13588 = 28%
10. Same approach used in CAIR: FR notice estimates reductions of "PM emissions by 10,538 tpy, a reduction of about 62%." Used same list of plants as were identified based on tonnage and SCC from CAIR.
11. Except for dairy cows and turkeys (no growth), based in animal population growth estimates from USDA and Food and Agriculture Policy and Research Institute.
12. Expected benefits of woodstoves change-out program: http://www.epa.gov/woodstoves/index.html
13. VOC emission ratios of year 2022 AEO-specific from year 2005 from the National Mobile Inventory Model (NMIM) results for onroad refueling including activity growth from VMT, Stage II control programs at gasoline stations, and phase in of newer vehicles with onboard Stage II vehicle controls.
14. VOC and benzene emissions for year 2020 from year 2002 from MSAT rule (EPA, 2007c, EPA, 2007d)
15. http://www.epa.gov/airmarkets/progsregs/epa-ipm/docs/summary2006.pdf
16. Only for states submitting these inputs: http://www.epa.gov/otaq/lev-nlev.htm
17. http://www.epa.gov/nonroad-diesel/2004fr.htm
18. http://www.epa.gov/cleanschoolbus/
19. http://www.epa.gov/otaq/marinesi.htm
20. Federal Aviation Administration (FAA) Terminal Area Forecast (TAF) System, December 2007: http://www.apo.data.faa.gov/main/taf.asp
21. http://www.epa.gov/nonroad-diesel/2004fr.htm

Appendix D References

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