Appendix C

EMISSIONS INVENTORY METHODOLOGY

SUPPORT DOCUMENTATION

FOR THE

FINE PARTICULATE SIP

January 2008

Table of Contents

Page

1. Introduction 2
2. EGU Point Sources 2
3. Non-EGU Point Sources 6
4. Stationary Non-Point Sources 10
5. Non-road Mobile Sources 49
6. On-road Mobile Sources 52
7. Area Source Ammonia and Biogenic Emissions 53

1. Introduction

Emissions inventory documentation support for the PM2.5 Fine Particulate SIP is provided in this appendix. An inventory was prepared for all counties in Michigan. Mobile estimates for the nonattainment counties were prepared by the Southeast Michigan Council of Governments (SEMCOG) and appear in a separate appendix. Mobile emissions for other counties were prepared by the Midwest Regional Planning Organization's (MRPO) contractor using traffic and vehicle information provided by the Michigan Department of Transportation. The Lake Michigan Air Director's Consortium (LADCO) is the MRPO. The focus of the inventory effort was to produce modeling inventories for the base year (2005) and the attainment year (2009). The future year projections take into account existing control measures and measures that are known to be on the way (e.g., CAIR measures). This inventory is referred to as the LADCO Base-M inventory. Procedures used to prepare these inventory products can be found in the "Regional Air Quality Analyses for Ozone, PM2.5, and Regional Haze: Technical Support Document," prepared by LADCO. LADCO has produced numerous summary reports with State and county total emissions and has posted them on their Internet site at:

http://www.ladco.org/tech/emis/basem/baseM_reports.htm

In a related effort, the 2005 Michigan statewide inventory was submitted to the EPA by the Michigan Department of Environmental Quality (MDEQ) pursuant to 40 CFR Part 51, Subpart A – Emissions Inventory Reporting Requirements.

2. EGU Point Sources

2005 EGU Point Source Methodology

The 2005 EGU point source data originated with annual emissions data provided to Michigan DEQ via the Michigan Air Emissions Reporting System (MAERS). Temporal allocation was performed by emission unit, month, day of week and hour using the procedures described in "Temporally Allocating Emissions with CEM Data for Chemical Transport and SIP Modeling," available at:

http://www.epa.gov/ttn/chief/conference/ei15/session4/edick.pdf

In addition to the heat input-based temporal profiles described in the paper, separate temporal profiles were developed based on Continuous Emissions Monitoring (CEM) reported emissions of NOX and SO2 and these profiles were used instead of heat input to temporalize annual emissions of the respective pollutants. The CEM data used as the basis of the profiles was that for 2004 through 2006 obtained from the EPA Clean Air Markets Division (CAMD) website:

http://cfpub.epa.gov/gdm/index.cfm?fuseaction=iss.progressresults

Growing EGU Point Source to 2009

The 2009 data is obtained from Integrated Planning Model (IPM) results obtained by the EPA and converted to a modeling inventory by LADCO. The following is a LADCO Integrated Planning Model discussion, which details the methodologies used to project the EGU emissions to 2009 using results from the IPM model:

Specifically, future year emissions are based on EPA's IPM3.0 modeling. Three CAIR scenarios were addressed:

- Round 5a: EPA's IPM3.0 was assumed as the future year base for EGUs.
- Round 5b: EPA's IPM3.0, with several "will do" adjustments identified by the States. These adjustments should reflect a legally binding commitment (e.g., signed contract, consent decree, or operating permit).
- Round 5c: EPA's IPM3.0, with several "may do" adjustments identified by the States. These adjustments reflect less rigorous criteria, but should still be some type of public reality (e.g., BART determination or press announcement).

Inter-RPO IPM Global Parameter Decisions (May 11, 2005):

The following summarizes the decisions made by VISTAS, MRPO, CENRAP, and MANE-VU for global assumptions to be used in EGU forecasting with IPM. These decisions and changes are made to IPM version 2.1.9 assumptions, which can be referenced via EPA's IPM website at:

http://www.epa.gov/airmarkets/epa-ipm/

A. Market Assumptions

1. National Electricity and Peak Demand
   Decision: Use unadjusted Energy Information Agency (EIA) Annual Energy Output (AEO) 2005 national electricity and peak demand values.
2. Regional Electricity and Demand Breakout
   Decision: Use the existing IPM region breakdown as conducted in earlier modeling.
3. Natural Gas Supply Curve and Price Forecast
   Decision: Take existing supply curves and scale application to EIA AEO 2005 price point. In this approach, the EPA 2.1.9 gas supply curves will be scaled in such a manner that IPM will solve for AEO 2005 gas prices when the power sector gas demand in IPM is consistent with AEO 2005 power sector gas demand projections. In instances where the power sector gas demand in IPM is lower than that of AEO 2005 projections, IPM will project gas prices that are lower than that in AEO 2005 and vice versa.
4. Oil Price Forecast
   Decision: Use EIA AEO 2005 values.

5. Coal Supply and Price Forecast
   Decision: Take existing supply curves and scale application to EIA AEO 2005 price points, coal supply regions, and coal grades. In this approach, the coal supply curves used in EPA 2.1.9 are scaled in such a manner that the average mine mouth coal prices that the IPM is solving in aggregated coal supply regions are comparable to AEO 2005. Due to the fact that the coal grades and supply regions between AEO 2005 and the EPA 2.1.9 are not directly comparable, this is an approximate approach and has to be performed in an iterative fashion. This approach does not involve updating the coal transportation matrix with EIA assumptions due to significant differences between the EPA 2.1.9 and EIA AEO 2005 coal supply and coal demand regions.

B. Technical Assumptions
   1. Firmly Planned Capacity Assumptions
      Decision: Use revisions and new data as provided by RPOs and stakeholders.
      Decision: Allow North Carolina Clean Smokestacks 2009 data as provided to define “must run” units.
   2. Pollution Control Retrofit Cost and Performance [SO2, NOx, and Hg] Decision: Retain pollution control retrofit cost and performance values.
   3. New Conventional Capacity cost and performance assumptions
      Decision: Use EIA AEO 2005 cost and performance assumptions for new conventional capacity.
      Decision: Retain existing 2.1.9 framework cost and performance for new renewable capacity.
      Decision: Exclude constraint on new capacity type builds (i.e., no new coal).
   4. SO2 Title IV Allowance Bank
      Decision: Use existing SO2 allowance bank value (4.99 million tons) for 2007.
   5. Nuclear Re-licensing and Uprate
      Decision: Use existing IPM configuration with updated EIA AEO 2005 (~$27/kW) incurrence cost for continued operation.

C. Strategy Assumptions
   1. Clear Air Mercury Rule (CAMR)
      Decision: Include CAMR in future rounds of IPM modeling.
   2. Renewable Portfolio Standards
      Decision: Model Renewable Portfolio Standards (RPS) based on the most recent Regional Greenhouse Gas Initiative documentation using a single RPS region for MA, RI, NY, NJ, MD and CT. The RPS requirements within these states can be met by renewable generation from New England, New York and PJM. EPA 2.1.9

methodology and hardwired EIA AEO 2004 projected renewable builds for the remainder of the country.

D. Other Assumptions

1. Run Years
   Decision: Revise runs years to 2008 [2007-08], 2009 [2009], 2012 [2010-13], 2015 [2014-17], 2018 [2018], 2020 [2019-22], and 2026 [2023-2030].
2. Canadian Sources
   Decision: Utilize existing v.2.1.9 configuration (no Canadian site specific sources).

3. Non-EGU Point Sources

2005 Non-EGU Point Source Methodologies

The 2005 point source data have as their original sources the 2005 Michigan point source emission inventory. This section of the document describes the compilation and processing of point source emission data submitted to comply with the Consolidated Emission Reporting Rule (CERR) for the EPA NEI 2005 inventory.

The data originates with the entry of data by the reporting facilities into the MAERS. The electronic data received from the reporting facilities is reviewed and compiled by the MDEQ, and exported to the fixed-width text version of the National Inventory Format (NIF). After the exported data is loaded into a PostgreSQL database patterned after the MS Access version of the NIF, the following processing steps and checks are performed.

Both emissions estimated by default calculations in MAERS and any emissions reported by facility operators are maintained in MAERS. For evaluation and quality assurance purposes, both types of records are included in the exports. To avoid double-counting, where a specific process/pollutant has emission records both reported directly by the facility operator, and estimated via MAERS calculations, the latter are excluded.

Portable facilities, such as asphalt plants, report total throughput and emissions, plus operating percentages for each county in which the portable facility was located during the year. From this information, records are generated for each county of operation, and throughput and emissions are apportioned based on the operating percentages reported by county and process. As geographic coordinates for all operating sites are not reported, coordinates corresponding to the centers of the counties of operation are assigned.

As attention has shifted from total particulate to PM10 and PM2.5, total particulate records are excluded from the reporting requirements.

Over 99.8 percent of total criteria emissions are accounted for by emissions reported by operator; therefore, exported criteria emissions estimated via MAERS calculations are excluded.

In the site table, where strFacilityCategory is not set in the export, it is set to “01.”

Mandatory geo-coordinate fields were added to the NIF specifications released in December 2003, well after it would have been possible to collect this information from the reporting facilities for 2002 operations. The following values were deemed most often representative and the exported data are updated accordingly for 2002 data:

“strHorizontalCollectionMethodCode” is set to '027'
“strHorizontalAccuracyMeasure” is set to '2000'
“strHorizontalReferenceDatumCode” is set to '001'
“strReferencePointCode” is set to '106'

For 2005, these geographic data elements were requested of the facilities. The defaults above were applied only where data was not provided by the facility.

MAERS tracks emissions of some pollutants that are of interest to the Great Lakes Commission, but which do not have corresponding pollutant codes in the most recent NIF pollutant code table. Emission records for the following pollutant codes are excluded:

7440508; 8052413; DICDD,TOT; DICDF,TOT; HYDFLUORO; PERFLUORO; TRICDD,TO; TRICDF,TO; CH4; CO2; N20; 117840; 7783064.

Emission records for ammonia are exported with the Chemical Abstract Service (CAS) number 7664417, rather than the pollutant code NH3. These pollutant codes are updated to NH3. Likewise, records exported with pollutant codes PAH and POM are updated to pollutant codes 234 and 246, respectively.

All criteria and HAP emissions are reported at the process level, and the export routines reflect that in the strEmissionDataLevel field of the emission table. This field is set to null for criteria pollutant emission records per EPA guidance.

All emissions are exported as pounds of annual emissions. The EPA guidance suggests that criteria pollutant emission be reported in tons. The field strEmissionUnitNumerator is changed to TON and the filed dblEmissionNumericValue is divided by two000 for criteria pollutant emission records.

Null values in the quarterly throughput fields of process records are set to zero.

Where quarterly throughput fields of process records sum to zero, throughput percentages are set to 25% for each quarter.

MAERS recognizes a control device code of '909' for a “Roll Media Fiberglass Tack Filter (Tacky 1 side),” which is not recognized in the NIF code tables. Where this control device code is exported, the “strPrimaryDeviceTypeCode” field of the control equipment table is updated to a value of 058.

Because of the exclusion of emission records as described above, referential integrity of the exported data can be compromised. At this point, it is re-established by deleting records stepwise, in the following order.

CE records without corresponding EM records
PE records without corresponding EM records
EP records without corresponding EM records
ER records without corresponding EP records
EU records without corresponding EP records
SI records without corresponding EU records

The data are then checked again for referential integrity and mandatory fields and then loaded into the MS Access shell version of the NIF via append queries that connect to the PostgreSQL data tables via ODBC. The Basic Content and Format Checker is run and its output is reviewed. Where corrections are needed, to assure consistency among data sources, the corrections are made in the MAERS and a full iteration of the export and post-processing steps are performed.

The 2005 point source inventory was incorporated into the LADCO Base M inventory and serve as the basis for Michigan’s 2005 CERR submittal.

Growing Stationary Non-EGU Point, Stationary Area, Locomotive, Shipping, and Aircraft Categories to 2009

The 2009 emissions are based on work and a follow-up report (E.H. Pechan & Associates, Inc., Development of Growth and Control Factors for Lake Michigan Air Directors Consortium, Final Report, December 14, 2004) done by E.H. Pechan & Associates, Inc. (Pechan). This work supports LADCO’s efforts to forecast anthropogenic emissions for the purpose of assessing progress for air quality goals, including goals related to regional haze and attainment of the ozone NAAQS. The Pechan growth factors were used to estimate the LADCO base M future year emissions posted by LADCO in 2007. The future year emissions represent both emission controls that already exist and those that are known to be on the way (e.g., CAIR control measures).

To assess progress for attaining air quality goals, LADCO requires emission activity growth and control data to forecast emissions from a 2005 base-year inventory to several future years of interest. These future years include 2009, 2012, and 2018 (e.g., 2018 is the first milestone for regional haze reasonable progress demonstrations). Pechan prepared emission control factors to support forecasting for each of these years. Because the incremental level of effort required to develop emission activity

growth factors for each year over the 2003-2018 period was nominal, Pechan prepared non-EGU point and area and non-road source growth factors for each year over this entire period.

The report describes Pechan efforts to develop emission growth and control data to support future year air quality modeling by LADCO. The report is organized into a background chapter and:

Chapter II, which describes the development of the emission activity growth data;
Chapter III, which discusses how the emission control data were compiled;
Chapter IV, which describes the preparation of the growth and control factor files;
Chapter V, which identifies projection issues for future consideration; and
Chapter VI, which presents the references consulted in preparing this report.

The Pechan Growth and Control Factor report is too lengthy to be included in this document, but it can be provided upon request or downloaded at:

http://www.ladco.org/reports/rpo/MWRPOprojects/Strategies/Growth&ControlDraftReportOct26-04.pdf

For sectors non-EGU point source, stationary area source and MAR source sectors, the future year emissions for the LADCO States were derived by applying growth and control factors to the base year inventory. As stated above, these factors were developed by a contractor (E.H. Pechan). Growth factors were based initially on EGAS (version 5.0), and were subsequently modified (for select, priority categories) by examining emissions activity data.

Additional information on the procedures used to project emissions can be found in the "Regional Air Quality Analyses for Ozone, PM2.5, and Regional Haze: Technical Support Document" prepared by LADCO.

4. Stationary Area Sources

2005 Stationary Area Source Emission Inventory

The following is a description of the various area source categories that were inventoried as part of the year 2005 emissions inventory as required by the EPA under the CERR. It also provides documentation as part of the development of a broader emissions inventory (which encompasses point, area, non-road mobile, on-road mobile, and biogenic sources) that is being developed for State Implementation Plan (SIP) requirements for attainment with the 8-hour ozone and $PM_{2.5}$ NAAQS and the regional haze regulations. For the purpose of developing state SIPs to demonstrate compliance with the ozone NAAQS, PM2.5 NAAQS and regional haze rule, states are currently required to submit base-year inventories, 3-year cycle update inventories, rate of progress inventories, and modeling inventories. In a November 18, 2002 memorandum

– 2002 Base-year Emission Inventory for SIP Planning Process, EPA identified year 2002 as the base-year for the SIP planning process. Within 3 years after designations are determined, states will need to submit SIP attainment demonstrations for the 8-hour ozone and $PM_{2.5}$ NAAQS. The 2002 base-year inventory serves several purposes in supporting air quality modeling and control measure selection to determine the types and amount of emission reductions needed to meet reasonable further progress (RFP) and rate of progress (ROP) emission reduction targets and demonstrate attainment. Many of the emission inventory planning requirements can be found in the EPA document entitled: Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations. Subsequent to the submission of the 2002 inventory, there was considerable discussion by LADCO staff with states and the EPA as to the appropriateness of 2002 base-year inventory with respect to using a 2005 base-year inventory. At the time of the preparation of the year 2005 emissions inventory, these discussions were still ongoing between LADCO and EPA. EPA designated nonattainment areas for the 8-hour ozone NAAQS with an effective date of June 15, 2004, while nonattainment designations for the $PM_{2.5}$ NAAQS were published in the *Federal Register* later on January 5, 2005, with an effective date of April 5, 2005. For those states participating in regional planning organizations, there are additional SIP inventory requirements for regional haze. The cascading effect of subsequent nonattainment designations as well as subsequent attainment demonstrations, existing emission reductions from NOx SIP calls, and the appropriateness of the base-years 2002 and 2005 were discussed by LADCO, EPA, and the states. The 2005 inventory was developed to fulfill both a base-year inventory and three-year cycle update inventories that are required by the existing CERR.

The following chart shows the specific air pollutants that must be provided by the CERR and base-year inventories for the 8-hour ozone and $PM_{2.5}$ NAAQS and regional haze regulations.

Required Air Pollutants Emissions

	CO	NH3	NOX	Pb	PM10-PRI	PM25-PRI	SOX	VOC
Consolidated Emissions Reporting Rule (CERR)	√	√	√	√	√	√	√	√
Ozone NAAQS	√		√					√
PM2.5 NAAQS		√	√		√	√	√	√
Regional haze		√	√		√	√	√	

In producing the 2005 emission inventory, multiple emission estimates must be provided to reflect temporal resolution that is required by the CERR and base-year inventories for the ozone and $PM_{2.5}$ NAAQS. These requirements are summarized as follows:

Temporal Resolution Requirements for Inventories

	Statewide Inventory	Summer Weekday
Consolidated Emissions Reporting Rule (CERR)	**Required**	
Ozone NAAQS	**Required**	**Required**
PM2.5 NAAQS	**Required**	**Optional**
Regional haze	**Required**	**Optional**

Consequently, the statewide year 2005 emission estimates that are being provided reflect the annual and summer weekday for the referenced air pollutants. A list of the 30 area source categories appears on the following page. EPA requires specific data elements to be provided via electronic data transfer using the National Emission Inventory NEI-NIFV3.0 format. A description of data structures can be found in the EPA publication NEI Input Format (NIF) Version 3.0 User's Guide Instructions and Conventions of Use, April 2003.

Summary of Area Sources and Respective Air Pollutants Inventoried for 2005 Inventory

Seq #	Area Source Description	SCCs	SIC	CO	NH3	NOX	PM10-PRI	PM25-PRI	SOX	VOC
1	Crude oil production	2310010000	1311							√
2	Natural gas production	2310020000	1311							√
3	Breweries	2302070001	2082							√
4	Cutback asphalts	2461021000	2951							√
5	Distilleries	2302070010	2085							√
6	Emulsified asphalts	2461022000	2951							√
7	Aircraft refueling	2275900000	4581							√
8	Commercial coal	2103002000	9999	√	√	√	√	√	√	√
9	Commercial distillate oil	2103004000	9999	√	√	√	√	√	√	√
10	Commercial kerosene	2103011005	9999	√	√	√	√	√	√	√
11	Commercial natural gas	2103006000	9999	√	√	√	√	√	√	√
12	Commercial residual oil	2103005000	9999	√	√	√	√	√	√	√
13	Gasoline marketing	2505030120, 2501060100, 2501060051, 2501060052, 2501060053, 2501060200	5541							√
14	Industrial coal	2102002000	3999	√	√	√	√	√	√	√
15	Industrial distillate oil	2102004000	3999	√	√	√	√	√	√	√
16	Industrial kerosene	2102011000	3999	√	√	√	√	√	√	√

17	Industrial natural gas	2102006000	3999	√	√	√	√	√	√	√
18	Industrial residual oil	2102005000	3999	√	√	√	√	√	√	√
19	Residential coal	2104001000	8811	√	√	√	√	√	√	√
20	Residential distillate oil	2104004000	8811	√	√	√	√	√	√	√
21	Residential kerosene	2104011000	8811	√	√	√	√	√	√	√
22	Residential natural gas	2104006000	8811	√	√	√	√	√	√	√
23	Residential propane	2199007000	8811	√		√	√	√	√	√
24	Municipal landfills	2620030000	4953	√		√	√	√		√
25	Vessel ballasting	2505020900	4432							√
26	Vessel loading	2505020120, 2505020030,2505020150, 2505020180, 2505020090, 2505020060	4432							√
27	Remedial action	2660000000	9511	√		√	√		√	√
28	Traffic marking paints	2401008000	1611							√
29	Wineries	2302070005	2084							√
30	Aviation stage I	2501080050	5541							√

Oil and Natural Gas Production

The oil and gas production area source category represents those VOC emissions that result from the exploration, drilling, and the field processing of crude oil and natural gas. Fugitive VOC emissions occur from control valves, relief valves, spills, pipe fittings, pump seals and compressor seals in the production and field processing of crude oil and natural gas. Individual county crude oil and natural gas production data was obtained from the MDEQ, Geological and Land Management Division. VOC emission factors were derived from the EPA publication entitled: Revision of Evaporative Hydrocarbon Emission Factors (EPA – 450/3-76-039). The emission factors are 107 pounds of emitted VOC per thousand barrels of produced crude oil and 175 pounds of emitted VOC per million cubic feet of produced natural gas. For crude oil production, emission controls reflecting NESHAP application of a 45% reduction in VOC were considered. This control level was based on EPA determination of an overall 45% reduction in VOC from oil and natural gas production facilities. This control reduction was obtained from a 5/14/99 EPA fact sheet that was published with the Final Air Toxics Rules for Oil and Natural Gas Production Facilities and Natural Gas Transmission and Storage Facilities. Rule effectiveness of 80% was then applied, and point source deductions were performed to estimate the area source contribution. For natural gas, emission controls from Michigan air pollution control rule R336.1629 of 72% and the federal emission control reduction in VOC of 19% associated with NESHAP application to natural gas transmission and storage were applied. The 19% emission reduction was obtained from the 5/14/99 EPA fact sheet that was published with the Final Air Toxics Rules for Oil and Natural Gas Production Facilities and Natural Gas Transmission and Storage Facilities. The federal NESHAP rule became effective June 17, 1999. Area source emissions were then reported using SCC codes of 2310010000 for crude petroleum oil production and 2310020000 for natural gas production.

Vessel Loading/Ballasting

Evaporative VOC occur from Great Lakes ships when being loaded with gasoline and petrochemicals. Vapors are also displaced when cargo tanks are loaded with water for ballasting. In order to estimate VOC from vessel loading/ballasting activities, a list of marine terminals at Michigan based ports handling petroleum products was obtained from the MDOT. Because of the need to acquire information on gasoline and petrochemical handling at each Michigan port and the time frames during vessel loading/ballasting occurred, a survey form was again sent to the marine terminals that were previously surveyed in the 2002 inventory. This State survey approach went beyond the EPA's prescribed inventory procedures in Volume III, Chapter 12 of the Emission Inventory Improvement Program January 2001 guidance for Marine Vessel Loading, Ballasting and Transit. The survey form requested information on days of operation, seasonal fuel transfer information on gasoline, distillate fuel oil, jet naphtha, jet kerosene, kerosene, residual fuel oil, and crude petroleum loading into ship and barge cargo tanks as well as ballast operations. The survey data was then summed to derive individual county totals. The results of this survey revealed that there were only two fuel types (contaminated gasoline, and residual fuel oil) where loading had

occurred. VOC emission factors (0.00009 lbs/1000 gallons of residual fuel oil and 3.4 lbs/1000 gallons of gasoline) were then applied to their respective fuel volumes to obtain the estimated emission losses. Although the EPA, on September 19, 1995, issued Federal Standards for Marine Tank Vessel Loading Operations and National Emission Standards for Hazardous Air Pollutants for Marine Vessel Loading Operations, the respective facilities transferring fuel were exempt from control requirements. Consequently, emissions estimates were based on the respective emission factors without the application of control measures. Individual county VOC emission estimates from loading and ballasting operations were reported using the following SCC codes:

Vessel Loading/Ballasting Operations	Reported SCC Code
Vessel loading, distillate fuel oil	2505020090
Vessel loading, gasoline	2505020120
Vessel loading, residual fuel oil	2505020060
Vessel loading, crude oil	2505020030
Vessel loading, naphtha	2505020150
Vessel loading, jet kerosene	2505020180
Vessel loading, kerosene	2505020180
Vessel ballasting, gasoline	2505020900
Vessel ballasting, crude oil	2505020900

Service Station Loading (Stage I)

Gasoline vapor loss occurs at service stations when gasoline is unloaded from delivery tank trucks into underground storage tanks. The extent of vapor loss is dependent upon the method of filling (splash, submerge, or vapor balanced). In computing VOC emissions from service station loading, year 2005 gasoline throughput estimates were obtained from Energy Information Administration's Petroleum Marketing Monthly data. The monthly data was then summed to derive an estimated statewide gasoline total. County gasoline total estimates were then determined by apportioning the statewide gasoline by the percent of state gasoline sales occurring within each county. County gasoline sales data was obtained from the U.S. Department of Commerce, Bureau of Census, Michigan 1997 Economic Census, Retail Trade, Geographic Area Series. State gasoline throughput consumption was apportioned on a county basis using the following mathematical equation:

$$Ct = St \times Cs/Ss$$

Where:

Ct = Estimated county gasoline consumption for year 2005
St = Statewide gasoline consumption for year 2005
Cs = County gasoline service station retail sales data
Ss = State gasoline service station retail sales data

VOC emission estimates were developed based upon the guidance provided in the EPA prescribed inventory procedures in Volume III, Chapter 11 of the Emission Inventory Improvement Program January 2001 guidance for Gasoline Marketing (Stage I and Stage II) and subsequent September 2002 Draft Summary of the Analysis of the Emissions Reported in the 1999 NEI for Stage I and Stage II Operations at Gasoline Service Stations. Year 2005 and summer weekday emission factors were developed based upon actual temperature, and RVP fuel volatility information for various regions of the State to reflect the applicable RVP control measures. Monthly temperature data was obtained for the year 2005 from the NOAA, National Climatic Center Local Climatological Data that was utilized in determining year and summer day temperatures for the Michigan Upper Peninsula and Michigan Lower Peninsula regions. RVP data for marketed gasoline during year 2005 was obtained from the Michigan Department of Agriculture, Motor Fuels Quality, Laboratory Division. VOC mission factors were then developed for splash fill, submerge fill, and vapor balanced gasoline dispensing facilities on a county basis which reflected the actual temperature and RVP of marketed gasoline products.

Year 2005 Temperature Summary

Month	Lower Peninsula Month Avg of Day Maximum	Upper Peninsula Month Avg of Day Maximum
December	33.5	24.8
January	28.0	18.9
February	33.8	29.5
March	38.2	33.2
April	59.7	53.8
May	64.8	59.3
June	82.4	77.1
July	83.5	79.4
August	81.8	77.1
September	77.3	72.5
October	62.1	55.7
November	49.4	37.1
Year Avg	57.9	51.5
Ozone Season Avg	74.9	69.9
Summer Weekday Avg	82.6	77.9

Stage I loading emission factors were determined using the methodology specified in September 2002 Draft Summary of the Analysis of the Emissions Reported in the 1999 NEI for Stage I and Stage II Operations at Gasoline Service Stations. The following equation is presented:

$$L = 12.46 \times SPM/T$$

Where:

L = Loading loss (uncontrolled), pounds per 1000 gal of liquid loaded

S= A saturation factor where S= 0.6 for submerged loading with no vapor balance, S = 1.00 for submerge loading with vapor balance, and S = 1.45 = splash

loading no
vapor balance

P = True vapor pressure of liquid loaded, pounds per square inch absolute (psia)

M = Molecular weight of vapors, pounds per pound-mole
T = Temperature of bulk liquid in degrees F + 460

The quantity of county gasoline throughput that is splash filled, submerge filled, and vapor balanced was estimated on basis of past gasoline surveys, and the applicability of state regulations which require the installation of submerge fill or vapor balanced systems. These percentages were obtained from the year 1999 emissions inventory. The same county fractional percentages of splash filled, submerge filled, and vapor balanced were used in the year 2005 inventory for consistency with respect to prior emission inventory.

The respective emission estimates were reported using the following SCC codes:

Michigan Gasoline Marketing Stage I Emission SCC Codes

Stage I Type	SCC
Submerge filled loading	2501060051
Splash filled loading	2501060052
Vapor balanced loading	2501060053

The EPA on December 19, 2003 issued final rule requirements for Stage I gasoline distribution in Standards of Performance for Bulk Gasoline Terminals and National Emission Standards for Gasoline Distribution Facilities (Bulk Gasoline Terminals and Pipeline Breakout Stations. These NESHAP requirements will be applied in point source inventories for bulk terminals.

Calculation of Stage I Emission Factors for Year 2005

Notes: Gasoline stage I temperatures based on available data as of 5/18/06. Reid vapor pressures were derived from Michigan Dept. of Agriculture analytical data which showed higher than expected averages due to the suspension of RVP restrictions during Hurricane Katrina.

Region	Year 2005 Annual Emission Factor lbs/1000 gal	Ozone Season 4/1/05-9/30/05 Emission Factor lbs/1000 gal	Summer Weekday 6/1/05-8/31/05 Emission Factor lbs/1000 gal	Year 2005 Annual Temperature F	Year 2005 Ozone Season 4/1/05-9/30/05 Temperature F	Year 2005 Summer Weekday 6/1/05-8/31/05 Temperature F	Year 2005 Annual RVP	Ozone Season RVP 4/1/05-9/30/05	Summer Weekday RVP 6/1/05-8/31/05	Year 2005 Annual True Vapor Pressure P	Year 2005 Ozone Season 4/1/05-9/30/05 True Vapor Pressure P	Year 2005 Summer Weekday 6/1/05-8/31/05 True Vapor Pressure P	Saturation Factor S	Year 2005 Annual RVP Molecular Weight	Ozone Season 4/1/05-9/30/05 RVP Molecular Weight	Summer Weekday 6/1/02-8/31/02 RVP Molecular Weight
Vapor Balance Gasoline																
Upper Peninsula	0.76	0.91	0.99	**51.1**	**69.9**	**77.9**	11.2	9.6	9.0	4.82	5.82	6.4	1	64.4	66.2	66.67
Lower Peninsula	0.86	1.00	1.07	**57.9**	**74.9**	**82.6**	11.2	9.6	9.0	5.58	6.5	7	1	64.4	66.2	66.67
SE Michigan	0.86	0.96	0.99	**57.9**	**74.9**	**82.6**	11.2	9.3	8.4	5.58	6.23	6.4	1	64.4	66.47	67.07
Submerge Fill Gasoline																
Upper Peninsula	4.54	5.44	5.93	**51.1**	**69.9**	**77.9**	11.2	9.6	9.0	4.82	5.82	6.4	0.6	64.4	66.2	66.67
Lower Peninsula	5.19	6.01	6.43	**57.9**	**74.9**	**82.6**	11.2	9.6	9.0	5.58	6.5	7	0.6	64.4	66.2	66.67
SE Michigan	5.19	5.79	5.91	**57.9**	**74.9**	**82.6**	11.2	9.3	8.4	5.58	6.23	6.4	0.6	64.4	66.47	67.07
Splash Fill Gasoline																
Upper Peninsula	10.97	13.14	14.33	**51.1**	**69.9**	**77.9**	11.2	9.6	9.0	4.82	5.82	6.4	1.45	64.4	66.2	66.67
Lower Peninsula	12.54	14.53	15.54	**57.9**	**74.9**	**82.6**	11.2	9.6	9.0	5.58	6.5	7	1.45	64.4	66.2	66.67
SE Michigan	12.54	13.99	14.29	**57.9**	**74.9**	**82.6**	11.2	9.3	8.4	5.58	6.23	6.4	1.45	64.4	66.47	67.07

Service Station Unloading/Vehicle Fueling (Stage II)

Motor vehicle fueling at service stations results in evaporative loss of gasoline. VOC emissions are produced during displacement of vaporized hydrocarbons and spillage of gasoline during refueling. EPA guidance in Volume III, Chapter 11 of the Emission Inventory Improvement Program January 2001 guidance for Gasoline Marketing (Stage I and Stage II) recommends the MOBILE model be used to generate refueling (Stage II) emission factors for highway emission inventories. Additional procedures were presented in September 2002 Draft Summary of the Analysis of the Emissions Reported in the 1999 NEI for Stage I and Stage II Operations at Gasoline Service Stations. The MOBILE6 model was used to derive the Stage II emission factor by obtaining monthly emission factors in grams/VOC mile as well as fuel economy as miles per gallon and vehicle miles traveled mix for the different gasoline vehicle types (e.g., LDTV, LDGT, and HDGV). For each vehicle type, the monthly emission factor was multiplied by the fuel economy to obtain an emission factor in unit grams of VOC/gallon.

grams VOC/gallon = Grams/mile x miles/gallon

Stage II grams/gallon refueling emission factor rates were initially prepared by SEMCOG using MOBILE6.2 and then later adjusted for year 2005 state specific RVP and temperature data. The VMT mix for each vehicle types was used to calculate a single weighted monthly emission factor. Summer and average annual emission factors were then developed for Southeast Michigan, the rest of the Lower Peninsula, and the Upper Peninsula. SEMCOG's Stage II grams/gallon adjusted emission factors are presented below. It is noted that the Stage II emission rates for year 2005 were greater than year 2002 rates due to the marketing of RVP exempt fuels created by Hurricane Katrina disruption of refinery operations.

Year 2005 Refueling Emission Rates for State of Michigan

Average Type and Geographical Area	**Grams/Gallon**
Summer (Average of monthly refueling emission rates for June, July & August, 2005)	
Southeast Michigan (Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw and Wayne counties)	2.71
Rest of Lower Peninsula (All counties in Lower Peninsula except the 7 Southeast Michigan counties)	3.04
Upper Peninsula (All counties in the Upper Peninsula)	2.85
Average Annual (Average of monthly refueling emission rates)	
Southeast Michigan (Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw and Wayne counties)	2.94
Rest of Lower Peninsula (All counties in Lower Peninsula except the 7 Southeast Michigan counties)	3.05
Upper Peninsula (All counties in the Upper Peninsula)	2.94

All rates were initially calculated using MOBILE6.2 model, and then later adjusted for year 2005 RVP and temperature conditions.

The respective SEMCOG grams VOC/gallon were then converted to lbs/1000 gallons.

Lbs VOC/1000 gallons = Grams VOC/gallon x 1 lb/453 grams x 1000 gallons

Year 2005 gasoline throughput estimates were obtained from Energy Information Administration's Petroleum Marketing Monthly data. The monthly data was then summed to derive an estimated statewide gasoline total. County gasoline total estimates were then determined by apportioning the statewide gasoline by the percent of state gasoline sales occurring within each county. County gasoline sales data was obtained from the U.S. Department of Commerce, Bureau of Census, Michigan 1997 Economic Census, Retail Trade, Geographic Area Series. Total county emissions estimates were based on the county gasoline volume by the corresponding refueling emission factor. Emission rates were reported using the SCC code 2501060100.

Service Station Tank Breathing

Pressure changes occur within underground storage tanks as a result of temperature differences that exist between gasoline vapor and the liquid phases. The exchange of vapor within the storage tank to the atmosphere is commonly described as tank breathing.

Underground gasoline storage tank breathing losses were estimated by applying a 1.0 pound per thousand gallon throughput emission factor using procedures presented in EPA's Volume III, Chapter 11 of the Emission Inventory Improvement Program January 2001 guidance for Gasoline Marketing (Stage I and Stage II) and September 2002 Draft Summary of the Analysis of the Emissions Reported in the 1999 NEI for Stage I and Stage II Operations at Gasoline Service Stations. Year 2005 county gasoline consumption estimates were obtained by apportionment of the statewide gasoline consumption based on the county percentage of state gasoline retail sales. Statewide gasoline consumption data was obtained from Energy Information Administration's Petroleum Marketing Monthly and county retail gasoline sales information was identified in the U.S. Department of Commerce, Bureau of Census, Michigan 1997 Economic Census, Retail Trade, Geographic Area Series. Emission estimates were reported using the SCC of 2501060200.

Gasoline Tank Truck Transit

Breathing losses from gasoline tank trucks occurs as a result of pressure changes within the containment vessel. The pressure change in the containment vessel is caused by temperature differences between the vapor and liquid phases as well as

agitation during transport. Gasoline tank trucks leak VOC vapors and liquids from gaskets, seals, and seams during transport.

Because some gasoline is delivered to bulk plants rather than delivered directly to service stations from terminals, the amount of gasoline transferred in any area may exceed the total gasoline consumption, due to additional trips involved. Therefore, gasoline tank truck transit evaporation emissions were based on the total volume of gasoline transferred rather than county consumption level.

The total gasoline transferred in a given county was obtained by taking the sum of both the service station volume delivery and the bulk plant gasoline transfer. The bulk plant gasoline transfer volume in a county was obtained from point source data. VOC emissions estimates were developed using the gasoline tank truck transit emission factors identified by EPA procedures presented in Volume III, Chapter 11 of the Emission Inventory Improvement Program January 2001 guidance for Gasoline Marketing (Stage I and Stage II) . In this document, VOC loss from gas filled tank truck emission factor was 0.005 lbs/1000 gallons while empty vapor-filled tank trucks were 0.055 lbs/1000 gallons. A single emission factor of 0.06 lbs/1000 gallons was derived by taking the sum of the two respective factors, and then applying this emission factor to the total transported gasoline volume. Further emission adjustments were then made to the respective emission totals to reflect those delivery vessels in those counties that are subject to Michigan Air Pollution Control Rule R 336.1627. A control efficiency of 76% was considered before subsequent application of an 80% rule effectiveness and 100% rule penetration factors for delivery vessels in those counties subject to R336.1627. Emission estimates were reported using the SCC of 2505030120.

Aviation Fuel Stage I Loading

Gasoline vapor loss occurs at airports when gasoline is unloaded from delivery tank trucks into underground storage tanks. Because of the need to temporally adjust aircraft refueling emissions for all respective fuel types within all Michigan counties, it was determined that local aviation fuel sales information could only be acquired by contacting each fuel distributor serving each airport. Because the fleet of the aircraft varies at each airport, the amount of fuel type consumed will likewise be dependent on the types of aircraft being serviced and not just based upon LTOs alone.

A list of those Michigan commercial and private airports where fuels are dispensed was obtained from the MDOT publication 2003 Michigan Airport Directory. A survey form was then mail to each airport operations manager. Total fuels sales information by fuel type(s) and season were obtained from either airport staff or assigned fixed base operators. This information was then summed for each Michigan county to provide an estimate of the total volumes of jet kerosene, jet naphtha, and aviation gasoline handled at each airport facility. Stage I loading VOC emission factors for jet kerosene and jet naphtha were determined using the following equation:

$L = 12.46xSPM/T$

Where:

L = Loading loss (uncontrolled), pounds per 1000 gal of liquid loaded

S= A saturation factor where 1.45 = splash loading

P = True vapor pressure of liquid loaded, pounds per square inch absolute (psia)

M = Molecular weight of vapors, pounds per pound-mole

T = Temperature of bulk liquid in degrees F + 460

For Stage I aviation gasoline VOC emissions, an emission factor was obtained the EPA publication entitled: Documentation for the 2002 Nonpoint Source National Emission Inventory for Criteria and Hazardous Air Pollutants (January 2004 Version). The resultant emission factors were then applied to the total county fuel throughput after considering point source fuel throughput deductions. Because EPA does not have itemized SCC codes by fuel type, VOC emissions were added together and reported using a SCC of 2501080050.

Aircraft Refueling (Stage II)

Aircraft refueling at airports results in the evaporative loss of aviation gasoline, jet kerosene, and jet naphtha. VOC emissions occur when vapor laden air in a partially empty fuel tank is displaced to the atmosphere during refueling. The quantity of the vapor being displaced is dependent upon the fuel temperature, fuel vapor pressure, aircraft fuel tank temperature, and the fuel dispensing rate.

Because of the need to temporally adjust aircraft refueling emissions for each respective fuel type within each Michigan county, it was determined that local aviation fuel sales information could only be acquired by contacting each fuel distributor serving each airport. Because the fleet of the aircraft varies at each airport, the amount of fuel type consumed will likewise be dependent on the types of aircraft being serviced and not just based upon LTOs alone.

A list of those Michigan commercial and private airports where fuels are dispensed was obtained from the MDOT publication 2003 Michigan Airport Directory. A survey form was then mailed to each airport operations manager. Total fuels sales information by fuel type(s) and season were obtained from either airport staff or assigned fixed base operators. This information was then summed for each Michigan county to provide the total dispensed volumes of jet kerosene, jet naphtha, and aviation gasoline. VOC

aviation refueling loss emission factors were obtained from the EPA publication Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, 5th Edition and Supplements (AP-42) were then applied to the respective county total fuel volumes.

Aviation Fuel Type	Emission Factor as lbs of VOC/1000 gallons fuel
Jet kerosene	0.08
Jet naphtha	5.58
Aviation gasoline	12.20

Because there is no provision currently to allow for the reporting of emissions by individual fuel type, emissions were then summed for all fuel types and reported using the SCC code 2275900000.

Traffic Marking Coatings

Traffic marking coatings are paints that are used to mark pavement, including dividing lines for traffic lanes, parking space markings, crosswalks, and arrows to direct traffic flow. VOC emissions result from the evaporation of organic solvents during the application and curing of the marking paint.

VOC emissions were estimated for each county using the methodology identified in the EPA's Volume III, Chapter 14 of the Emission Inventory Improvement Program May 1997 Final Guidance for Traffic Markings. The preferred method was to conduct surveys to determine the volume of water and solvent based coating consumption, coating formulation (in terms of pounds of VOC content per applied gallon), and months of year 2005 when the coatings were applied. Survey forms were mailed to all Michigan county road commissions, major municipality road maintenance departments, and to MDOT. In those situations where a county road commission failed to submit such information, emission estimates were based upon results of those counties that had responded to the survey. An average coating application rate (total gallons of coating applied per road miles in county) was first determined from survey respondents. Road length miles were obtained for the counties that failed to respond to the survey. Total coating gallon consumption estimates were estimated for counties that failed to respond by applying the road length miles to the average coating application rate. Similarly, an average VOC content (as lbs/gallon) was obtained by dividing the total mass of VOC emissions by the total coating volume of survey respondents. The result thereof was then applied to the estimated coating volumes for those counties that did not respond to the survey. This average density was reflective of the proportions of solvent and water based coatings by survey respondents. Seasonal coating application was also based upon county survey results of the months during which the coatings were applied. It

should be recognized that year 2002 was a recession year in which Michigan county and local governments had limited budgets. Consequently, it is likely that projected emissions would be greater during better economic times. Traffic marking paint emissions were reported using a SCC of 2401008000

Cutback Asphalts

Cutback asphalt is a bituminous road coating material that is prepared by blending an asphalt cement tar with a petroleum distillate (such as naphtha, kerosene, or other fuel oils). Cutback asphalt is used as a pavement sealant, tack coat, pothole filler, and a bonding agent between layers of paving material. Evaporative loss of the solvent from bitumen cement occurs as the cutback asphalt cures on the road surface. The rate at which VOC emissions occur is dependent both upon the temperature of the applied road surface, and the type of solvent used in the formulation of the cutback asphalt material. Gasoline or naphtha is used as a diluent in the production of "rapid cure" cutback asphalts. Kerosene and other low volatility fuel oils are also used as diluents in the production of "medium cure" and "slow cure" cutback asphalts.

VOC emissions were estimated for each county using the methodology identified in the EPA's Volume III, Chapter 17 of the Emission Inventory Improvement Program January 2001 Final Guidance for Asphalt Paving. In this document, the preferred method was to conduct surveys to determine locally-specific information on cutback asphalt use on Michigan roads.

In order to estimate VOC emissions from the application of cutback asphalt materials (rapid cure, medium cure, and slow cure), a survey was mailed to all Michigan county road commissions, major municipality road maintenance departments, and to MDOT. The survey requested information on:

1. The quantities of rapid cure, medium cure, and slow cure cutback asphalt materials that were applied during year 2005;

2. The type of petroleum distillate and volume that was used as a diluent in the formulation of each cutback paving material; and

3. The months during which cutback asphalt materials were applied.

The EPA has determined that evaporation occurs on about four months with 75 percent by weight of diluent evaporates in the first day for rapid cure materials while it takes about one week for 50 percent by weight of diluent to evaporate from medium cure cutback asphalt materials. Conservative estimates were made by assuming that all the diluent evaporates within the season during which it is applied.

VOC emission estimates were based on the amount of the petroleum based diluent that comprises the cutback asphalt material and then applying their respective solvent density. Emission estimates were reported using a SCC of 2461021000.

Emulsified Asphalts

Emulsified asphalts are a type of liquefied road surfacing material that is used in the same application as cutback asphalts. Instead of blending the asphalt material with a petroleum distillate like their cutback asphalt counterparts, emulsified asphalts use a blend of water with an emulsifier (soap). Emulsified asphalts either rely on water evaporation to cure (anionic-high float emulsions) or ionic bonding of the emulsion and the aggregate surface (cationic emulsions).

In the EPA's Volume III, Chapter 17 of the Emission Inventory Improvement Program January 2001 Final Guidance for Asphalt Paving., the preferred method is conduct a survey of emulsified asphalt application on Michigan roads. Survey forms were mailed to all Michigan county road commissions, major municipality road maintenance departments, and to MDOT. This form requested information on the quantities of asphalt materials (in pounds and barrels) applied to Michigan roadways and the months during which they were applied. Road length miles were also obtained for all Michigan counties. In those situations where a county road commission failed to submit such information, emission estimates were based upon results of those counties that had responded to the survey. An average application rate (total barrels of emulsified asphalts applied per road miles in county) was first determined from survey respondents. Total barrel consumption estimates were estimated for counties that failed to respond by applying the road length miles to the average emulsified asphalt application rate. VOC emissions were obtained by applying an EPA factor of 9.2 lbs VOC/barrel of applied asphalt. It was further assumed that all emissions occur during the season that the asphalt materials were applied and reported using a SCC of 2461022000.

Breweries

Breweries, microbreweries, brewpubs, and contract brewers emit VOC including ethanol, ethyl acetate, myrcene and other higher alcohols from various brewing processes. For the smaller brewers, VOC are lost by the fermentation, in brew kettles, hot wort, mash and lauter tuns, and through spent grain. Microbreweries and brewpubs typically produce beer for patron on-site consumption, although some may have limited keg distribution. These smaller microbreweries and brewpubs typically combine some processes, and canning/bottling operations typically do not exist since the beer is consumed on-site or stored in kegs.

Various trade organization lists were obtained to identify brewers in the State of Michigan along with their beer production. Although there are some regional breweries, the vast majority are brewpubs and microbreweries. These facilities have very small to

insignificant volatile organic compound emissions. Emission estimates were based on a combined emission factor rate obtained from Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, 5th Edition and Supplements (AP-42) of 3.0465 lbs VOC per 1000 barrels. Consequently, this small emission factor and Michigan beer production rates didn't justify the need for a survey of such establishments. Emissions were estimated by establishment on the basis of trade reported production and applying the respective emission factor. A SCC of 2302070001 was used in reporting brewery emissions.

Distilleries

Distilleries include ethanol production facilities that are used in the production of gasohol motor fuels, grain alcohol for industrial purposes, and distilled spirits for personal consumption. These products are produced from the fermentation of aged mashed grains with distillation for the capture of desired alcohol based products. The fermentation products use yeast to convert grain sugars into ethanol, ethyl acetate, isomyl alcohol, isobutyl alcohol and carbon dioxide. Grains used in the process may include corn, rye, barley, and wheat. A more detailed description of distilleries and their emissions can be found in the EPA publication entitled: Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, 5th Edition and Supplements (AP-42).

During year 2005, there was only one ethanol production facility in operation. The Michigan Ethanol LLC - Caro, Michigan facility was already being reported as a point source. Consequently, the area source contribution from distilleries using SCC 2302070010 had zero emissions for all Michigan counties. A number of new ethanol plants were under construction, but did not operate in the 2005 inventory year.

Wineries

Wineries produce alcohol beverages from the fermentation of fruit juices. The major processes in vinification include fruit harvesting, crushing, pressing, fermentation, clarification, aging, finishing, and bottling. During this fermentation process of both red and white wines, primarily ethanol and smaller quantities of methyl alcohol, n-propyl alcohol, butyl alcohol, isoamyl alcohol, and acetaldehydes are produced along with carbon dioxide. This process involves the reaction of a yeast with glucose and fructose sugars to produce ethanol and carbon dioxide. The EPA emission factors are reflective of VOC evolved during fermentation in vinification.

County estimates of wine production were based upon wine volume information of Michigan Department of Treasury tax receipt information supplied to the Michigan Grape and Wine Industry Council. A VOC emission factor was obtained from Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, 5th Edition and Supplements (AP-42).of 4.6263 lbs VOC/ 1000 gallons This emission factor is a sum of ethyl alcohol, methyl alcohol, n-propyl alcohol, n-butyl

alcohol, sec-butyl alcohol, isobutyl alcohol, isoamyl alcohol and acetaldehyde for red wine from AP-42. Emission estimates were reported using a SCC of 230207005

Stationary Source Fossil Fuel Combustion

The combustion of natural gas, propane-LPG, distillate fuel oil, kerosene, and residual fuel oil in small boilers, furnaces, heaters, and stoves are also a source of VOC, NOx, particulates, sulfur dioxide, and ammonia emissions. Because these sources are so numerous to be identified in point source inventories, this area source category attempts to provide a collective estimate of emissions from these smaller energy consumption sources by subtracting all fuel used by point sources from total fuel consumption. Procedures for the estimation of these smaller sources are presented in the EPA's documents entitled:

1. Volume II, Chapter 2 of the Emission Inventory Improvement Program January 2001 Preferred and Alternate Methods for Estimating Air Emissions from Boilers.

2. Emission Inventory Improvement Program –April 6, 1999, Area Source Category Abstract- Fuel Oil and Kerosene Combustion

3. Emission Inventory Improvement Program –April 6, 1999, Area Source Category Abstract-Natural Gas and LPG Combustion

4. Emission Inventory Improvement Program –April 6, 1999, Area Source Category Abstract-Coal Combustion

5. Documentation for the Draft 1999 National Emissions Inventory (Version 3.0) for Criteria Air Pollutants and Ammonia

6. Hanke, B.H, manuscript prepared for U.S Environmental Protection Agency entitled: A National Methodology and Emission Inventory for Residential Fuel Combustion

This documentation involves determination of total fuel consumption over an area with subsequent fuel deductions made for point source fuel consumption, and then applying emissions factors to estimate fuel emissions.

Total fuel consumption information was based on data supplied from U.S. Department of Energy, EIA documents. This unaccounted fuel consumption was then apportioned to individual counties using U.S. Census Bureau information for the individual end use sector fuel types based upon LADCO states methodology. Area source fuel emissions were reported for the following residential, commercial/institutional, and industrial end use sectors. Since utility boilers are accounted as point sources, area source emissions are not reported for this end use sector.

Residential Boilers & Furnaces

County emission estimates for the residential end use sector was based upon the consumption of natural gas, propane-LPG, distillate fuel oil, kerosene, and coal. This energy consumption information was obtained from U.S. Department of Energy, EIA data. Since the EIA merely provides statewide fuel consumption totals, county fuel consumption estimates were obtained by apportioning the fuel consumption based upon the number of year 2000 occupied household census counts using the given fuel. Emission estimates were calculated using the following mathematical equation:

$$Cf = Ch/Sh \times Sf$$

Where

Cf = Estimated county residential sector consumption of a given fuel type for year 2005

Ch = Number of year 2000 census occupied households in a given county that utilize a given fuel type

Sh = Total number of year 2000 census occupied households statewide that utilize a given fuel type

Sf = Total statewide residential sector consumption of a given fuel type

Michigan Residential Fuel Consumption Information Sources

Residential Fuel Type	U.S. Dept of Energy, EIA Data Sources
Natural gas	Natural Gas Annual 2005, Michigan Table 48
Propane LPG	Petroleum Marketing Annual, 2005, Table 49: Prime Supplier Sales Volumes of Aviation Fuels, Propane and Residual Fuel Oil by PAD District and State
Distillate fuel oil	Fuel Oil and Kerosene Sales 2005 Report, Table 19: Adjusted Sales for Residential Use: Distillate Fuel Oil and Kerosene, 2005
Kerosene	Fuel Oil and Kerosene Sales 2005 Report, Table 18: Adjusted Sales of Kerosene by Energy Use
Coal	EIA Annual Coal Report 2005, Table 26 U.S. Coal Consumption by End Use Sector, by Census Division and State 2005, 2004 (Thousand Short Tons)

Upon obtaining county residential fuel consumption estimates for the various fuel types in all Michigan counties Cf, emission estimates were obtained by applying an emission factor that is specific to that fuel type. These emission factors were obtained from various EPA publications.

Michigan Residential Fuel Emission Factors

Residential Fuel Type	Units	CO	NH_3	NOx	PM10-PRI	PM25-PRI	SO_2	VOC
Natural gas	Lbs/million cubic feet	40	0.49	94	7.6	7.6	0.6	5.5
Propane LPG	Lbs/1000 gal	3.2		13	0.68	0.68	0.1	0.5
Distillate fuel oil	Lbs/1000 gal	5.0	0.8	18	2.38	2.13	42.60	0.7
Kerosene	Lbs/1000 gal	4.8	0.8	17.4	2.38	2.13	41.1	0.7
Coal	Lbs/ton	275	0.000565	3.0	18.63	4.86	37.83	10

Sources of Emission Factors:

1. U.S. Environmental Protection Agency Documentation for the Draft 1999 National Emissions Inventory (Version 3.0) for Criteria Air Pollutants and Ammonia

2. Hanke, B.H, manuscript prepared for U.S Environmental Protection Agency entitled: A National Methodology and Emission Inventory for Residential Fuel Combustion

3. U.S. Environmental Protection Agency. Final Report on Development and Selection of Ammonia Emission Factors

The resulting emission estimates were reported by individual fuel type using the following SCC codes.

Michigan Residential Combustion Emission SCC Codes

Residential Fuel Type	SCC
Natural gas	2104006000
Propane LPG	2199007000
Distillate fuel oil	2104004000
Kerosene	2104011000
Coal	2104001000

Commercial/Institutional Boilers and Furnaces

Estimation of fuel combustion by the commercial/institutional sector was performed using an adaptation of a methodology presented in the U.S. Environmental Protection Agency publications:

1. Emission Inventory Improvement Program –April 6, 1999, Area Source Category Abstract- Fuel Oil and Kerosene Combustion

2. Emission Inventory Improvement Program –April 6, 1999, Area Source Category Abstract-Natural Gas and LPG Combustion

3. Emission Inventory Improvement Program –April 6, 1999, Area Source Category Abstract-Coal Combustion

County emission estimates for the commercial/institutional end use sector were based upon the consumption of natural gas, residual fuel oil, distillate fuel oil, kerosene, and coal. This energy consumption information was obtained from U.S. Department of Energy, EIA data. Fuels were subtracted for point sources, and the net area fuel contribution was apportioned or allocated using procedures instructed by LADCO. This procedure involved statewide commercial/ institutional fuel apportionment to a county level using the commercial/institutional employment data as obtained from U.S. Department of Commerce, Bureau of Census publication entitled: County Business Patterns, Michigan: 2003 (CBP/03-24 issued September, 2005). County fuel estimates of individual fuel types were estimated using the following equation:

$$Cf = Ce/Se \times Sf$$

Cf = Estimated county commercial/institutional sector consumption of a given fuel type
Ce= Total county employment in the commercial/institutional sector
Se= Statewide employment in commercial/institutional sector
Sf= Statewide commercial/institutional sector consumption of a given fuel type

Because the Energy Information data includes diesel fuel totals within the distillate fuel oil total, these motor vehicle fuels were deducted to provide only an estimate of #1, #2, and #4 fuel oils.

Michigan Commercial/Institutional Fuel Consumption Information Sources

Fuel Type	U.S. Dept of Energy, EIA Data Sources
Natural gas	Natural Gas Annual 2005, Michigan Table 48
Residual fuel oil	Fuel Oil and Kerosene Sales 2005 Report, Table 17: Adjusted Sales of Residual Oil by Energy Use, 2004 and 2005
Distillate fuel oil	Fuel Oil and Kerosene Sales 2005 Report, Table 20: Adjusted Sales for Commercial Use: Distillate Fuel Oil, Residual Fuel Oil and Kerosene 2005
Kerosene	Fuel Oil and Kerosene Sales 2005 Report, Table 18: Adjusted Sales of Kerosene by Energy Use
Coal	EIA Annual Coal Report 2005, Table 26 U.S. Coal Consumption by End Use Sector, by Census Division and State 2005, 2004 (Thousand Short Tons)

Upon obtaining county commercial/institutional fuel consumption estimates for the various fuel types in all Michigan counties Cf, emission estimates were obtained by applying an emission factor that is specific to that fuel type. These emission factors were obtained from various EPA publications.

Michigan Commercial/Institutional Fuel Emission Factors

Commercial/Institutional Fuel Type	Units	CO	NH_3	NOx	PM10-PRI	PM25-PRI	SO_2	VOC
Natural gas	Lbs/million cubic feet	84	0.49	100	7.6	7.6	0.6	5.5
Residual fuel oil	Lbs/1000 gal	5	0.80	55	9.07	3.37	194.05	1.13
Distillate fuel oil	Lbs/1000 gal	5	0.80	20	2.38	2.13	53.96	0.34
Kerosene	Lbs/1000 gal	5	0.80	18	2.38	2.13	41.1	0.713
Coal	Lbs/ton	6	0.000565	7.5	6.0	2.2	36.86	0.05

Sources of Emission Factors:

1. LADCO state uniform adopted emission factors for commercial/institutional natural gas combustion

2. U.S. Environmental Protection Agency. FIRES database

3. U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, 5th Edition and Supplements (AP-42)

4. U.S. Environmental Protection Agency. Final Report on Development and Selection of Ammonia Emission Factors

The resulting emission estimates were reported by individual fuel type using the following SCC codes.

Michigan Commercial/Institutional Combustion Emission SCC Codes

Fuel Type	SCC
Natural gas	2103006000
Residual fuel oil	2103005000
Distillate fuel oil	2103004000
Kerosene	2103011005
Coal	2103002000

Industrial Boilers and Furnaces

Estimation of fuel combustion emissions of industrial boilers and furnaces was performed in similar manner as the commercial/institutional sector. Statewide industrial fuel consumption information was obtained from the U.S. Department of Energy, EIA publications. Point source deductions were made for each fuel type to obtain the area contribution which was then apportioned to the county level using LADCO prescribed procedures.

County fuel consumption estimates of natural gas, residual fuel oil, distillate fuel oil, kerosene, and coal were based upon the following mathematical equation:

$$Cf = Ce/Se \times Sf$$

Cf = Estimated county industrial sector consumption of a given fuel type
Ce= Total county employment in the industrial sector
Se= Statewide employment in industrial sector
Sf= Statewide industrial sector consumption of a given fuel type

Michigan Industrial Fuel Consumption Information Sources

Industrial Fuel Type	U.S. Dept of Energy, EIA Data Sources
Natural gas	Natural Gas Annual 2005, Michigan Table 48
Residual fuel oil	Fuel Oil and Kerosene Sales 2005 Report, Table 17: Adjusted Sales of Residual Oil by Energy Use, 2004 and 2005
Distillate fuel oil	Fuel Oil and Kerosene Sales 2005 Report, Table 21 Adjusted Sales for Industrial Use: Distillate Fuel Oil, Residual Fuel Oil, and Kerosene (#1, #2, and #4 fuel oils– excludes diesel oil)
Kerosene	Fuel Oil and Kerosene Sales 2005 Report, , Table 18: Adjusted Sales of Kerosene by Energy Use
Coal	EIA Annual Coal Report 2005, Table 26 U.S. Coal Consumption by End Use Sector, by Census Division and State 2005, 2004 (Thousand Short Tons)

County employment data was obtained from the U.S. Department of Commerce, Bureau of Census publication entitled: County Business Patterns, Michigan: 2003 (CBP/03-24 issued September, 2005). Upon obtaining county industrial fuel consumption estimates for the various fuel types in all Michigan counties Cf, emission estimates were obtained by applying an emission factor that is specific to that fuel type. These emission factors were generally based on the LADCO adopted emissions factors.

Michigan Industrial Fuel Emission Factors

Industrial Fuel Type	Units	CO	NH_3	NOx	PM10-PRI	PM25-PRI	SO_2	VOC
Natural gas	Lbs/million cubic feet	84	3.2	100	7.6	7.6	0.6	5.5
Residual fuel oil	Lbs/1000 gal	5.0	0.8	55	7.17	4.67	157	0.28
Distillate fuel oil	Lbs/1000 gal	5.0	0.8	20	2.3	1.55	53.96	0.2
Kerosene	Lbs/1000 gal	5.0	0.8	18	2.38	2.13	41.1	0.713
Coal	Lbs/ton	6	0.00057	7.5	6.0	2.2	38	0.05

Sources of Emission Factors:

1. LADCO state uniform adopted emission factors for industrial natural gas, residual fuel oil, distillate fuel oil, and coal combustion

2. U.S. Environmental Protection Agency. FIRES database
3. U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, 5th Edition and Supplements (AP-42)

4. U.S. Environmental Protection Agency. Final Report on Development and Selection of Ammonia Emission Factors

Emission estimates were reported using the following SCC codes:

Michigan Industrial Combustion Emission SCC Codes

Industrial Fuel Type	SCC
Natural gas	2102006000
Residual fuel oil	2102005000
Distillate fuel oil	2102004000
Kerosene	2102011000
Coal	2102002000

Remedial Action, Site Clean Up & Leaking Storage Tanks

Evaporative VOC emissions occur during remediation and clean up at those sites of environmental contamination. Such remediation activities may include air stripping or sparging of a VOC from contaminated groundwater or incineration of a spoil material removed from a contaminated site. In some instances carbon adsorption may be required to reduce VOC emitted during air stripping or spraying operations.

Estimation of VOC loss from remedial action activities was determined by summing the allowable emissions from permits to those parties that were engaged in such activities as provided by the MDEQ, Air Quality Division, Permit Section. Although site remediation activities are subject to NESHAPs, these requirements did not apply at the time of the year 2005 emissions inventory. Emissions were reported using a SCC of 2660000000.

Municipal Waste Landfills

A municipal solid waste landfill is defined as any facility that is regulated under Subtitle D of the Resource Conservation and Recovery Act (RCRA) which receives primarily household and/or commercial wastes.

VOC are produced from municipal solid waste by: the volatilization of the waste material itself, the microbiological (anaerobic) putrefaction of organic waste materials that result in the formation of organic acids and alcohols that are vaporized, and the chemical reaction of one or more waste materials or chemical decomposition intermediate. The rate at which VOCs are emitted from a landfill is dependent upon the structural design of cells, the waste composition (physical/chemical properties), the moisture content of the waste, the amount of waste disposed, temperature, age of the landfill, the chemical reactivity of the waste, the microbiological toxicity of the waste, and the effectiveness of landfill gas collection systems. Where landfill gas is collected for use in boilers, internal combustion engines (reciprocating and turbines) or flared at the landfill site, there are additional air pollutants such as NOx, particulates (PM2.5 and PM10), and carbon monoxide produced from incomplete combustion.

Estimation of VOC emissions from municipal landfills were based on the revised technical procedures presented in the EPA publication entitled: Volume III, Chapter 15 of the Emission Inventory Improvement Program January 2001 Revised Final Guidance for Landfills. In this publication, the preferred method for the estimation of area source emissions is to use the LandGem model or the equations from the Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, 5th Edition and Supplements (AP-42) section on landfills. LandGem is a computer based model that uses the same equations as that of AP-42. The emissions calculation for the estimation of landfill gas requires site specific information including: landfill design capacity, accumulated waste totals from operation of the landfill, and existing control requirements from landfill gas collection systems. Landfills may be subject to either

new source performance standards (40 Code of Federal Regulations part 60 Subpart WWW) or emission guidelines (40 Code of Federal Regulations, part 60, Subpart Cc). Landfills are now also subject to NESHAPs which became effective on January 16, 2003. For those landfills that were not being reported in the point source inventory, area emission estimates were reported on the basis on LandGem model simulations using the SCC of 2620030000. These simulations reflected total waste receipts under the prior year 1999 inventory with addition made for waste receipts for years 2000-2005 as obtained from annual reports by the MDEQ, Waste and Hazardous Division Report of Solid Waste Landfilled in Michigan. For those landfills that operated landfill gas collection/combustion systems, emission estimates considered tables 2.4-3 and 2.4-5 of AP-42 with adjustments considered for a landfill gas methane collection efficiency of 75% of LandGem model predicted methane generation at a given landfill site.

Non-Methane Organic Compound Control Efficiencies for Landfill Gas Combustion from AP-42

Combustion Control Device	Typical Control Efficiency (%)
Boilers	98
Flares	99.2
Gas Turbines	94.4
IC Engine	97.2

Emission Rates for Secondary Compounds from Landfill Gas Combustion (Based upon lbs/ Million Cubic Feet of Landfill Gas Combusted)

Combustion Control Device	NOX	PM2.5-PRI	PM10-PRI	CO
Flare	40	17	17	750
IC Engine	250	48	48	470
Boiler	33	8.2	8.2	5.7
Gas Turbines	87	22	22	230

Architectural Surface Coating, 2005

Alternative method one was chosen from the guidance document *Emission Inventory Improvement Program (EIIP), Volume III, Area Sources Preferred and Alternative Methods, Chapter 3: Architectural Surface Coating*. Data was readily available for the use of per capita emission factors.

MDEQ, Air Quality Division staff determined per capita usage factors by dividing the 2004 national total architectural surface quantities for solvent and water based coatings (U.S. Census Bureau MA325F, Paint and Allied Products) by the U.S. population for 2004 (U.S. Census Bureau, http://www.census.gov).

http://www.census.gov/industry/1/ma325f04.pdf

http://www.census.gov/popest/national/files/NST_EST2005_ALLDATA.csv

Solvent-Based Paint

Solvent-based paints produced and shipped in the U.S. in 2004, the most recent available year, were totaled (includes architectural lacquers and architectural coatings, n.s.k.). The resulting number was divided by the 2005 U.S. population to produce a per capita solvent-based paint usage factor of 0.5265 gallons per person.

The resulting solvent paint use, in gallons per county, was multiplied by a VOC emission factor of 3.87 lb/gal, from Table 5-2 of the EIIP guidance, *Volume III, Area Sources Preferred and Alternative Methods, Chapter 3: Architectural Surface Coating.* This produced total VOC emissions from solvent-based paint. The VOC was then speciated for toxics, utilizing speciation factors from Table 5-4 from the EIIP guidance. Acetone, listed in the methodology prepared by the Great Lakes states, was removed because it is not a toxic.

Water-Based Paint

Water-based paints produced and shipped in the U.S. in 2004 were totaled. The resulting number was divided by the 2005 U.S. population to produce a per capita water-based paint usage factor of 2.2473 gallons per person.

The resulting water-based paint use in gallons per county was multiplied by a VOC emission factor of 0.74 lb/gal, from Table 5-2 from the EIIP guidance, *Volume III, Area Sources Preferred and Alternative Methods, Chapter 3: Architectural Surface Coating.* This produced total VOC emissions from water-based paint. The VOC was speciated for toxics, utilizing speciation factors from Table 5-3 from the EIIP guidance.

No point source deductions were performed, as none were needed for this category.

Autobody Refinishing in Michigan, 2005

Alternate method 3 of the EIIP document, *Volume III, Area Sources Preferred and Alternative Methods, Chapter 13: Auto Body Refinishing* was followed by Michigan. National emissions for the category were allocated to the county level based on census data.

79,429.59 tons of VOC were estimated nationally for this category based on 1997, 1998 and 1999 data, as indicated within the GLC methodology. The estimate of national VOC emissions from autobody refinishing was divided by a 2005 national population estimate of 296,410,404 to produce a VOC emission factor of 0.54 lbs/person.

Area source estimations were adjusted by deducting point source VOC emissions.

A seasonal adjustment factor of 1.0 was made for this category for the ozone season. The category of auto refinishing was considered to be uniform throughout the year, per Table 5.8.1 of the EPA document *Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Volume I: General Guidance for Stationary Sources*. Ozone season daily emissions were calculated per the example on page 5-23 of this document. Ozone season throughput was also calculated. 5 activity days per week were selected, per Table 5.8.1. Annually, 260 days of operation were assumed. NOx and CO emissions were not calculated, as this category is not considered a source of NOx or CO.

References

1. Emission Inventory Improvement Program, Volume 3, Chapter 13, *Auto Body Refinishing, January 2000*.
2. Fire 6.23 database
3. U.S. Census Bureau, Population Division. 2006. Population Estimates Program. Washington, DC 20233.
4. Annual County Business Patterns data are available through U.S. census at http://www.census.gov/epcd/cbp/view/cbpview.html
5. Section 3.8 of Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Volume I (1991)

Estimating Emissions from Consumer and Commercial Solvent Use

The GLC methodology, a portion of which is included below, was based on the EIIP guidance document, *Volume III, Area Sources Preferred and Alternative Methods, Chapter 5: Consumer and Commercial Solvent Use.* Michigan used the EIIP and GLC guidance for the estimation of criteria and toxic pollutants for this category for 2005. Michigan chose to use the preferred method with per capita emission factors, adjusted for the federal VOC reduction rule as provided in Table 2 of the EIIP guidance.

SCCs

The following SCCs were utilized by Michigan, per LADCO's recommendations:

2460100000	personal care products
2460200000	household Products
2460400000	automotive aftermarket
2460600000	adhesives and sealants
2460800000	FIFRA-regulated products
2460500000	coatings and related products
2460900000	miscellaneous products

From GLC methodology**:**

Overview

All quotes and information contained within are from the source, Emission Inventory Improvement Program, Volume 3, Chapter 5, *Consumer and Commercial Solvent Use, August 1996*. The consumer and commercial solvent source category includes a wide array of products including personal care products, household cleaning products and household pesticides. However, all VOC emitting products used by businesses, institutions and numerous industrial manufacturing operations are also included. A detailed list of products included in this category can be found on page 5.2-3 of the 1996 EIIP document. The majority of VOCs introduced into the atmosphere from this category is a result of evaporation of the solvent contained in the product or from the propellant released during product use.

Dry cleaning Area Source Emissions for Michigan, 2005

SIC 7215 (coin-operated dry cleaning establishments) was not considered for this inventory. The AQD's dry cleaning staff in the Technical Programs Unit indicated that virtually all coin-operated dry cleaning machines in Michigan have been discontinued due to the large cost of keeping them supplied with perchloroethylene (per Elden Dickinson, AQD). SIC 7216 (dry cleaning establishments, excluding coin-operated facilities) was considered instead. Under the NAICS system, SIC 7216 is known as NAICS 812320.

To calculate 2002 VOC emissions, Michigan utilized alternative method two, per employee emission factor. 2003 county employment data was obtained from the U.S. Census Bureau's document, *2003 Michigan County Business Patterns*. 2005 data was not available, and was not expected for some time.

Dry cleaning has a uniform seasonal adjustment factor (1.0), remaining constant during the ozone season, per EPA's *Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Volume I: General Guidance for Stationary Sources.*

2003 employment data, the latest from the U.S. Census Bureau's County Business Patterns, was obtained for NAICS 812320, for each county where it was available. Where available, employment data for the broader category of NAICS 812 was also obtained.

The next step was to determine a ratio between the number of employees under NAICS 812320, and the number of employees under NAICS 812. For counties that had employment numbers for NAICS 812, this ratio was used to estimate how many of the employees would fall under the code 812320.

The next task was to develop an employment number for those counties where drycleaner employment numbers were not available from the County Business Patterns. Using population numbers for those counties where employment data was available, a per capita number of dry cleaning employees was calculated. As certain counties have no perchloroethylene drycleaners (per lists of perc dry cleaners from Randy Johnson, AQD), values of zero were entered for those counties.

Reports from Michigan's 2005 point source emission inventory (the latest complete inventory) were reviewed to determine if any counties had point source employment for SIC 7216 (NAICS 812320). Berrien, Ingham and Jackson (NAICS 8123) counties did have point sources under SIC 7216, and the number of employees at each source was obtained from the emission inventory. Each source's employment number was subtracted from the appropriate county's employment number.

Once estimates of employment for SIC 7216 were available for each county, an emission factor for VOC of 1,800 lb/yr/employee was obtained from Table 4.5-1 of EIIP Vol. III, Chapter 4.

From EIIP

Subcategory	Reactive VOC (lb/year/employee)	Total Organics (lb/year/employee)
All solvents (total)	1,800	2,300
Halogenated Solvents PERC, TCA and CFC 113 Coin Operated Commercial/Industrial		 980 52 1,200
Mineral Spirits and Other Unspecified Solvents	1,800	1,800

On a per-unit basis: 0.8 tons/facility-year (assumes that average coin-op facility has two dry cleaning units and each emits 0.4 tons of PERC per year).

From AP-42

Commercial: 1.3 lb/year/person (all nonmethane VOC)
Coin Operated: 0.4 lb/year/person (all nonmethane VOC)

A rule for perchloroethylene dry cleaning air emissions became effective late 1996 (58FR49354. National Emission Standards for Hazardous Air Pollutants for Source Categories: Perchloro-ethylene Dry Cleaning Facilities. Final Rule. September 22, 1993.). EPA estimates the rule reduces perchloroethylene emissions from dry cleaning operations by 44%. Depending on the methodology used to estimate air emissions from perchloroethylene dry cleaning operations the effectiveness of this rule may need to be factored into the calculation.

References:

U.S. Census Bureau, *2003 Michigan County Business Patterns*

Emission Inventory Improvement Program Vol. III, *Area Sources: Preferred and Alternative Methods*, Chapter 4, Dry cleaning. May 1996.

Elden Dickinson, Dry Cleaning Unit, Drinking Water and Radiological Protection Division, Michigan DEQ. Personal communication, 5/07/01.

US EPA. Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Volume I: General Guidance for Stationary Sources. May 1991. EPA –450/4-91-016.

Graphic Arts Criteria and Toxics, 2005

The EIIP area source guidance document, dated November 18, 1996, was followed.

The EIIP preferred method was not utilized, as it required a survey of facilities. Alternative Method 1, ink sales emission factor method, was found to be not feasible for Michigan, as (during calculation of the 1999 inventory) point sources used more ink than the state proportion of national ink production was calculated to be.

Per Alternative Method 2, the population of the inventory region was obtained from state data for 2005, and multiplied by the per capita emission factor provided in the EIIP guidance. This produced total uncontrolled emissions from all graphic arts facilities with less than 100 tons per year of VOC emissions, for the entire state. This method used a 1991 EPA emission factor of 0.00065 tons VOC per capita.

Total uncontrolled VOC emissions from area source graphic arts facilities (those with less than 100 tons per year of VOC emissions) was then estimated for each county. This was done by obtaining uncontrolled VOC emissions from point sources with less than 100 tons per year of VOC, from the 2005 EI. SICs 2711, 2721, 2752 and 2754 (NAICS 51111, 511112, 323114, and 323111) were the SIC codes queried. This number was then subtracted from total uncontrolled emissions from graphic arts facilities, on a county by county basis. The remaining number is the area source VOC emissions per year.

Solvent Cleaning 2005 (criteria)

In this category, the use of solvents is broken into two broad classifications. The classifications are solvent cleaning (which is composed of cold cleaning and vapor/in-line cleaning), and solvent cleanup (predominantly wipe cleaning of external surfaces).

EIIP Alternative Method

Solvent Cleaning Equipment (both Cold Cleaners and Vapor/In-line Cleaners):

Emission factors:

EIIP Table 6.5-2 provides per capita and per employee emission factors, as reproduced below.

Recommended Method for Solvent Cleaning Equipment

Michigan chose to use the per employment factors available in Table 6.5-2 from *Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone: Volume I: General Guidance for Stationary Sources* (EPA, 1991), for the 2005 emissions inventory. Employee data was obtained from the U.S. Bureau

of the Census document, *County Business Patterns, Michigan: 2003*, which was the most recent version at the time the category was estimated. Area source emissions were then determined by subtracting point source emissions from total emissions. When the result was a negative number, area source emissions were set to zero.

The following SCCs, per email from Grant Hetherington, WI DNR on 9/19/05, were utilized for reporting the emissions to be consistent with the other LADCO states:

2415360000 - Auto Repair Services (SIC 75): Cold Cleaning

2415345000 - Miscellaneous Manufacturing (SIC 39): Cold Cleaning

2415245000 - Miscellaneous Manufacturing (SIC 39): Conveyerized Degreasing

241523000 - Electronic and Other Elec. (SIC 36): Conveyerized Degreasing

Table 6.5-2: Per Capita and Per Employee Solvent Cleaning Emission Factors (EPA, 1991)

Subcategory	SIC Codes	Per Capita Factor (lb/yr/person)		Per Employee Factor (lb/yr/person)	
		VOCs	Organics	VOCs	Organics
Solvent cleaning (total)	25, 33-39, 417 423, 551, 552, 554-556, 753	4.3	7.2	87	144
Cold Cleaning					
Automobile Repair	417, 423, 551, 552, 554-556, 753	2.5	2.5	270	270
Manufacturing	25, 33-39	1.1	1.1	24	24
Vapor and In-Line Cleaning					
Electronics and Electrical	36	0.21	1.1	29	150
Other	25, 33-39, 417, 423, 551, 552, 554-556, 753	0.49	25	9.8	49

2005 point source employment data was obtained from MAERS. These values were then deducted from the total emissions estimated by using the per capita emission factor and 2005 Michigan county population data.

References

EPA. *Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone: Volume I: General Guidance for Stationary Sources* (May 1991).

EPA. *STAPPA-ALAPCO-EPA Emission Inventory Improvement Program (EIIP).* Volume III - Area Sources Preferred and Alternative Methods. Chapter 6, Solvent Cleaning. September 1997.

US Department of Commerce, Bureau of the Census. *County Business Patterns, Michigan: 2003*. September 2005.

Industrial Surface Coatings, Toxics, 2005

The GLC methodology was followed by Michigan for estimating toxics for 2005. The GLC methodology is based on EIIP, *Volume III, Area Sources Preferred and Alternative Methods, Chapter 8: Industrial Surface Coating*. In most cases alternative method one, default per employee factors, were used, except for SCCs where the per employee-based emission factors yielded unrealistically high values of pollutants. The MDEQ, Air Quality Division staff believe that the point source employee deductions performed for each affected SCC (based on NAICS information from U.S. Census Bureau's *County Business Patterns*, and the Air Quality Division's point source inventory) do not account for all of the point source employees, resulting in the high values.

For the SCCs 2401050000 (miscellaneous finished metal) and 2401070000 (motor vehicles), it was decided that per capita based emission estimates would be utilized instead of the per employment based methods which yielded large values of 486 million lbs VOC (935 tons per summer weekday) and 57 million lbs VOC, respectively. The per capita methods yielded more realistic numbers of 4.6 million and 10.9 million lbs VOC.

For the SCC 2401020000 (furniture and fixtures), the employment based method resulted in an estimate of 31 million lbs (60 tons per summer weekday). The per capita method resulted in an estimate of 20 million lbs. As the estimates for 2401020000 appeared unrealistically large with either method, this category was omitted from the inventory.

Total area source VOC emissions for industrial surface coating for 2005 were approximately 50 million lbs.

From the GLC methodology:

> **Source Identification**
>
> Searching through the Standard Industrial Classification Code List (SIC), the North American Industry Classification System (NAICS), through the Factor Information Retrieval System (FIRE 6.23) and table 8.5-1 of the Volume III Chapter 8 Industrial Surface Coating September 1997 publication of EPA, the following codes were identified for each of the fifteen industrial surface coating category.
>
> **Factory Finished Wood** - **A2401015000**
> **SIC** 2426-2429, 243-245, 2492, 2499
> **NAICS** 321113, 321912, 32192, 321911, 321918, 33711, 321212, 321214, 321213, 321991, 321992, 33999, 333414, 321999, 321211

Wood Furniture - **A2401020000**
SIC 25
NAICS 337122, 337121, 337124, 337214, 33791, 337129, 337125, 337211, 33636, 339942,
337127, 337212, 337215, 33792,

Metal Cans - A2401040000
SIC 3411
NAICS 332431

Misc Finished Metals - **240105000**
SIC 34xx(exclude 341 and 3498)
NAICS 332211, 332212, 332213, 332999, 332722, 332117, 332912, 332611, 332998, 332913, 332439, 33251, 332919, 332312, 322225, 332618, 332321, 332313, 33242, 332612, 332322, 332311, 339911, 333924, 332114, 332721, 332994, 334518, 332111, 332112, 33637, 332115, 332116, 332214, 332813, 339914, 339912, 332812, 332992, 332993, 332995, 332911

Machinery and Equipment - A2401055000
SIC 35
NAICS 333611, 333618, 333111, 332323, 333312, 333112, 33312, 333131, 336311, 333995
333132, 333921, 333922, 333923, 333924, 333513, 332997, 333514, 333511, 333515, 333516, 333992, 333518, 333292, 33321, 333291, 333293, 333294, 33322, 33241, 333295, 333911, 332991, 333912, 333411, 333993, 333612, 333994, 333613, 314999, 334418, 333996, 333997, 33271, 333999, 334119, 334518, 333512, 333991, 333412, 336391, 333415, 333913,

Large Appliances - A240106000
SIC 363
NAICS 335221, 335222, 335224, 335211, 339999, 333414, 335212, 333298, 335228,

Electronic and Other Electrical - 2401065000
SIC 36,123,357
NAICS 334111, 334112, 334113, 33422, 334418, 334613, 333992, 335129, 333311, 333313, 339942, 51222, 335311, 335313, 335312, 335991, 335314, 335999, 33511, 335931, 335932, 335121, 335122, 334613, 336321, 335129, 33431, 334612, 334419, 335911, 335912, 333319,
334411, 334412, 334414, 336322, 334415, 334416, 334417, 333618, 33429, 33421,

Motor Vehicles - 240107000
SIC 3711

NAICS 33611, 336112, 33612, 336211

Other Transportation Coatings - 2401075000
SIC 37(not 3711,373)
NAICS 336213, 336312, 336322, 33633, 33634, 33635, 336399, 336212, 336415, 336411, 336412, 54171, 332912, 336999, 336413, 333911, 333924, 33651, 336991, 336414, 336419, 336214, 336992

Marine Coatings - 240108000
SIC 373
NAICS 48839, 336611, 336612, 81149

Misc. Product Coatings Manufacturing - 240109000
SIC
NAICS 339

Industrial High Performance Maintenance Coatings- 2401100000
SIC
NAICS 811

Other Special Purpose Coatings - 2401200000
SIC
NAICS

VOC factors from Table 8.5-1 of the EIIP guidance were applied to employment estimates based on the U.S. Bureau of the Census document, County Business Patterns: Michigan, 2003, which was the most recent data available at the time the estimates were created.

References

EPA. STAPPA-ALAPCO-EPA Emission Inventory Improvement Program (EIIP). Volume III: Chapter 8 Industrial Surface Coating September 1997.

U. S. Census web site http://www.census.gov/

Open Burning: Municipal Solid Waste, 2005 Criteria Pollutants

For the category of open burning of municipal solid waste (MSW), EPA's methodology from Appendix A of *Documentation for the Final 2002 Nonpoint Sector (Feb 06 Version) National Emission Inventory for Criteria and Hazardous Air Pollutants* was followed. The ratio of urban to rural population was obtained from 2000 U.S. Census data, per the EPA's method, then multiplied by a 2005 U.S. Census Bureau estimate of the county population in Michigan to obtain an estimate of rural population in 2005. Per capita emission factors were used, after first excluding those counties where the population was greater than 80% urban under EPA's presumption that open burning of MSW would not occur there.

Outdoor Wood Boilers, 2005 criteria pollutant estimates

The Wisconsin methodology distributed by Bart Sponseller was followed. Per that methodology, the MARAMA emission factor of 13.82 g/kg wood burned was used.

An estimate of 11.68 cords/yr/unit in Michigan was obtained from Brian Brady, MDEQ Air Quality Division. Brian serves as the MDEQ, Air Quality Division's outdoor wood boiler expert.

Michigan estimated an average weighted density of 1.65 tons/cord of wood, based on information contained within Table 8 of the USDA survey report "Residential Fuelwood Consumption and Production in Michigan, 1992."

Per the Wisconsin methodology, it was assumed that 90% of outdoor wood boilers are used in rural areas and 10% are used in urban areas. To determine which counties were urban and which were rural, staff reviewed the list of counties, which are part of Michigan's Consolidated Statistical Areas (metropolitan areas) and determined that the 22 affected counties should be considered as urban. Ten percent of the 29,568 Michigan outdoor wood boilers were apportioned to the urban counties by population. The remaining 90% of the outdoor wood boilers were apportioned to the 61 rural counties by population.

Residential Wood Burning, 2005

Michigan utilized the EIIP methodology's alternative method for estimating emissions from residential woodburning, by apportioning data from the U.S. Census Bureau and the EIA.

Two options were available to estimate woodburning households per county.

- Housing Units with Wood Heat by County was determined by using 1990 U.S. Census Data, Database C90STF3C1, Summary Level State, for House Heating Fuel for Occupied Housing Units (http://venus.census.gov/cdrom/lookup). Although this data is for the 1990 year, it did provide a value for each county.

- Housing Units with Wood Heat by County was determined by using the U.S. Census Bureau's DP-4, Profile of Selected Housing Characteristics: 2000, Data Set: Census 2000 Summary File 3 (SF 3) for Michigan. This file provided a *total* value of households using wood heating. However, no breakdown was given by county.

The MDEQ, Air Quality Division staff used the 2000 number of total wood burning households in Michigan, and used the 1990 county proportions of the 1990 total to apportion the 2000 value to the county level.

Then, based on county value for number of wood burning households, the value for state wood use in cords was apportioned to each county. The 2003 state wood use in cords data came from the US

MAP States Page, *Table 8, Residential Energy Consumption Estimates, Selected Years 1960-2003, Michigan*, from the U.S. Department of Energy, EIA:

http://www.eia.doe.gov/emeu/states/sep_use/res/use_res_mi.html

Data for 2005 was not yet available.

Once county wood use in cords was produced, the next step was to determine the wood weight in tons for each county. Wood weight was determined by estimating a weighted average wood weight of 1.65 tons per cord, from species and consumption data from Table 8 of the USDA report, "Residential Fuelwood Consumption and Production in Michigan, 1992."

Michigan did not have data available on the number of catalytic and non-catalytic woodstoves in Michigan, but did utilize 1993 survey data which showed the proportions of fireplaces to woodstoves by county in Michigan. This was used to apportion wood weight per county between wood stoves and fireplaces. SCCs and emission factors were selected for fireplaces – cordwood (2104008001), and woodstoves – general (2104008010).

No ozone season activity was estimated, as staff felt it was unlikely that residents would utilize their fireplaces or wood stoves between June 1 and August 31 of each year.

FIRE 6.23 (Factor Information Retrieval System Version 6.23) and Source Summary Database (SSD) list the following Area Mobile Source Codes (AMS):

A2104008000: Total wood stoves and fireplaces
A2104008001: (lb/ton dry wood burned): Fireplaces - general
A2104008010: (mg/Mg dry wood burned): Wood stoves - general
A2104008030: (lb/ton dry wood burned): Catalytic wood stoves - general
A2104008050: (lb/ton dry wood burned): Non-catalytic wood stoves - general
A2104008051: (lb/ton dry wood burned): Non-catalytic wood stoves - conventional
A2104008052: (lb/ton dry wood burned): Non-catalytic wood stoves - low emitting
A2104008053: (lb/ton dry wood burned): Non-catalytic wood stoves - pellet fired

Michigan selected AMS codes A2104008001 and A2104008010. These were the most appropriate codes, as data exists for the proportion of woodstoves to fireplaces per county in Michigan, but data was not available on numbers of catalytic or non-catalytic wood stoves. Emission factors for A2104008010 were converted from mg/Mg to lb/ton by multiplying by the conversion factor of 2.00E-06.

References

1. USEPA, “Factor Information Retrieval System Version 6.23”, U.S. Environmental Protection Agency, 2000.

2. EPA, STAPPA, ALAPCO, Emission Inventory Improvement Program (EIIP), Volume III, July 1997, Chapter 2.

Structure Fires, 2005 Criteria Emissions

The EIIP guidance from EIIP Volume III, Chapter 18: *Structure Fires*, was followed. The preferred method for estimating emissions was used, due to the availability of county level structure fire data for 2002. More recent data was not available; the fire statistics data, which was originally kept by the Michigan State Police Fire Marshall Division, is now kept by the Michigan Department of Labor and Economic Growth. DLEG staff were unable to locate more recent county level data on structure fires. The 2002 data was re-used from the 2002 area source submittal. However, it did not provide any detail on the extent of each structure fire, or indicate if the structure was residential or commercial.

The default fuel loading factor provided in the EIIP guidance (1.15 tons of fuel per structure fire) was used. Emission factors for VOC, CO, and NOx were obtained from Table 18.4-1.

Year 2009 Stationary Area Source Emission Inventory Projections:

See **Growing Stationary Non-EGU Point, Stationary Area, Locomotive, Shipping, and Aircraft Categories for the Years 2009** in the **Non-EGU Point Sources** section for reference and methodology for projecting the Stationary Area Source inventory.

5. Non-Road Mobile

Non-Road Emissions Estimation exclusive of Locomotive, Shipping, and Aircraft Emissions

Non-road emission estimates for 2005 and 2009 were obtained from the EPA’s National Mobile Inventory Model (NMIM). The model uses a database to store the information about individual counties, referred to as the NMIM County Database (NCD); the current version is NCD20051207.

Recent updates to the model were made by the EPA and can be found at: www.epa.gov/omswww/models/nonrdmdl/nonrdmdl2005/readme.htm, (NON-ROAD2005 Update Chronology).

One of the updates included in this modeling was a correction in the NON-ROAD.EXE file that includes modifications for permeation. Changes were also made in the external files (15 files) to incorporate recommendations of SEMCOG and LADCO consultants regarding fuel data. Program files for emissions and population data were modified. These changes were made to improve the accuracy of the model estimates and to produce emission values that will be consistent with those that will be used for future ozone and fine particulate SIP demonstrations.

The Non-road emissions estimates were prepared by Wisconsin for all LADCO States, including Michigan. Additional details on the procedures used to prepare these inventory products can be found in the "Regional Air Quality Analyses for Ozone, PM2.5, and Regional Haze: Technical Support Document" prepared by LADCO.

2005 Aircraft Emissions Estimation

In order to estimate aircraft emissions, aircraft activity was obtained for Michigan airports. Historically this information was obtained from MDOT. However MDOT was unable to provide updated information for year 2005. In the absence of updated MDOT 2005 aircraft activity data, commercial aircraft and commercial air freight departure information by aircraft model type was obtained from FAA airport records. For determining airport LTO cycles, the Air Traffic Activity Data System (ATADS) air traffic count database of larger towered airports, Terminal Area Forecast (TAF) air traffic operations database of towered and non-towered airports, and G.C.R. & Associates airport activity data were used. Since ATADS provides aircraft operations for a limited number of the States' airports, TAF aircraft operations estimates were considered where ATADS information was unavailable. G.C.R. & Associates, Inc. consultant data was used for the smaller airports of which FAA aircraft operations information was unavailable. The following information from the respective sources was considered in the development of emission estimates:

1. Commercial scheduled and non-scheduled aircraft air carrier activity and commercial air freight activity by aircraft model types,

2. General aviation and air taxi annual local and itinerant operations for year 2005,

3. Military annual local and itinerant operations for year 2005. Due to need to have aircraft operations information expressed as LTO cycles, the following assumptions were made:

a. For commercial aircraft and commercial air freight activity, the number of annual aircraft annual LTO cycles was assumed to be equal to the number of departures. The daily LTO cycle frequency was then obtained by dividing the yearly LTO cycles by 365.

b. For general aircraft annual local and itinerant airport operations, each respective operations total was divided by two to obtain the corresponding year local and itinerant LTO cycles. The expected daily local and itinerant LTO cycles then were obtained by dividing these annual totals by 365.

c. For military annual local and itinerant operations, each respective operations total was divided by two to obtain the corresponding year local and itinerant LTO cycles. The expected military daily local and itinerant LTO cycles then were obtained by dividing these annual totals by 365.

Airport LTO cycles were further categorized into commercial aircraft by plane and engine type, general aviation itinerant aircraft of unknown aircraft type, general aviation local aircraft of unknown aircraft type, and military aircraft. This was necessary in order to utilize the U.S. Department of Transportation, FAA EDMS 4.5 Emissions and Dispersion Modeling System. A description of this model can be found in the FAA publication entitled: Emissions and Dispersion Modeling System (EDMS) User Manual (September 2004). Commercial and air freight aircraft emission factors per LTO cycle were determined using EDMS 4.5 for each commercial aircraft type models where possible were used at each towered airport. Default commercial aircraft engine type, and EPA default time in mode values for takeoff, approach, and landing roll times were used in the EDMS 4.5 model simulations.

For those aircraft types that could not be determined using the EDMS 4.5 emissions model, aircraft emission factors based upon EPA alternative fleet average procedures were then used to estimate their emissions. These included general aviation and air taxi itinerant aircraft of unknown aircraft type, general aviation local aircraft of unknown aircraft type, and military aircraft. Conversion from total hydrocarbons to VOC was performed and based upon the EPA guidance.

Aircraft emissions were then obtained by adding emissions contributions from commercial, itinerant general, and local general aircraft, and were reported using the following SCC codes.

Michigan Aircraft Emission SCC Codes

Aircraft Type	SCC
Military	2275001000
Commercial	2275020000
General Aviation	2275050000

2005 Locomotive and Shipping Emissions Estimation

The 2005 non-road shipping and Locomotive emissions were prepared using the same techniques used for the 2002 emissions. These estimates are based on work and a follow-up report (Environ Report for LADCO, April 2004, 2002 Shipping Emissions Sources) completed by Environ to support LADCO's efforts to prepare a 2002 Air Emissions Inventory. The report describes Environ efforts to develop a shipping 2002 air emissions estimates to support air quality modeling. The Environ report is too long to be included in this document, but it can be provided upon request or downloaded at:

http://ladco.org/reports/rpo/MWRPOprojects/Emissions/Environ_Final_Report_non-road.pdf

The estimate of 2005 locomotive and shipping emissions was made by LADCO in the same manner as the 2002 inventory described above. The 2005 estimates are part of LADCO's base M inventory.

Non-Road Mobile Source Emission Inventory Projections to 2009

The non-road source categories exclusive of locomotive, shipping, and aircraft were grown in the EPA Mobile source model NMIM. The locomotive, shipping, and aircraft non-NMIM source categories were grown using growth factors provided in the report (E.H. Pechan & Associates, Inc., Development of Growth and Control Factors for Lake Michigan Air Directors Consortium, Final Report, December 14, 2004) done by E.H. Pechan & Associates, Inc. for LADCO and available upon request.

See **Growing Stationary Non-EGU Point, Stationary Area, Locomotive, Shipping, and Aircraft Categories for the Years 2009** in the **Non-EGU Point Sources** section for references and methodology for projecting the Locomotive, Shipping and Aircraft emissions inventory.

6. On-Road Mobile

For the 2005 base year, the emissions model CONCEPT was run by a LADCO contractor (Environ) using transportation data (e.g., VMT and vehicle speeds) supplied by the state (MDOT) and local planning agencies (SEMCOG) in the LADCO States and Minnesota for 24 networks. These data were first processed with T3 (Travel Demand Modeling [TDM] Transformation Tool) to provide input files for CONCEPT to calculate link specific, hourly emission estimates. CONCEPT was run with meteorological data for a July and January weekday, Saturday, and Sunday (July 15 – 17 and January 16 – 18). The mobile emissions derived from the SEMCOG network, which include all the Michigan nonattainment counties, are detailed in Appendix D.

Similar to the base year modeling, CONCEPT was run using transportation data (e.g., VMT and vehicle speeds) supplied by the state and local planning agencies for 2009 and 2018. CONCEPT was only run with meteorological data for a weekday. The emissions for Saturday and Sunday were derived by using scaling factors based on the 2005 emissions.

Additional details on the procedures used to prepare these inventory products can be found in the “Regional Air Quality Analyses for Ozone, PM2.5, and Regional Haze: Technical Support Document” prepared by LADCO.

7. Area Source Ammonia and Biogenic Emissions

Ammonia Emissions

LADCO estimated area source ammonia emissions for all member states, including Michigan. The CMU-based 2002 (Base K) ammonia emissions were projected to 2005 using growth factors from the Round 4 emissions modeling. These emissions were then adjusted by applying temporal factors by month based on the process-based ammonia emissions model.

Biogenic Emissions

A LADCO contractor (Alpine) provided an updated version of the CONCEPT/MEGAN4 (Model of Emissions of Gases and Aerosols from Nature) biogenics model, which was used to produce 2005 base year biogenic emission estimates. Model improvements included: (a) reduced model run times, (b) improved ability to run successive days, and (c) enhanced meteorological input processing5.

Compared to the previous (EMS/BIOME) emissions, there is more regional isoprene using MEGAN compared to the BIOME estimates used for Base K. Also, with the

secondary organic aerosol updates to the CAMx air quality model, Base M includes emissions for monoterpenes and sesquiterpenes, which are pre-cursors of secondary PM2.5 organic carbon mass.

Additional details on the procedures used to prepare these inventory products can be found in the “Regional Air Quality Analyses for Ozone, PM2.5, and Regional Haze: Technical Support Document” prepared by LADCO.