

Massachusetts

2011 Periodic Emissions Inventory of VOC, NO_x, CO, SO₂, PM₁₀, PM_{2.5} and NH₃

February 2018

SECTION 3

STATIONARY AREA SOURCES

(continued)

3.3 STATIONARY SOURCE SOLVENT EVAPORATION

Organic solvent-use results in VOC emissions that evaporate into the atmosphere. Solvents are used in industrial, commercial, and consumer cleaning processes. This section covers the numerous solvent-use categories listed below, all of which fall under the cleaning and application processes discussed in EPA Procedures Guidance Volume I¹ and EIIP Volume III.² Emissions for these categories may be found in the accompanying spreadsheet tables indicated below.

Table: 3.3-1 Degreasing and Solvents

1. Surface Cleaning (Degreasing)
2. Consumer and Commercial Solvent Use
3. Dry Cleaning
4. Graphic Arts
5. Industrial Adhesives and Sealants

3.3-2 Non-Industrial Surface Coating: AIM Coatings & Auto Refinishing

1. Architectural Coatings
2. Traffic Paints
3. High Performance Maintenance Coatings

¹ "Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Volume 1: General Guidance for Stationary Sources". EPA OAQPS RTP, NC 450/4-91-016, May 1991.

² EPA Emissions Inventory Improvement Program (EIIP) Volume III "Area Sources Preferred and Alternative Methods. STAPPA, ALAPCO, EPA OAQPS Planning and Standards MD-14. EPA-454/R-97-004c, July 1997, Current updates Website:
<http://www.epa.gov/ttn/chief/eiip/techreport/volume03/index.html>

4. Other Special Purpose Coatings
5. Auto Refinishing

3.3-3 Industrial Surface Coating

1. Furniture & Fixtures
2. Metal Furniture
3. Metal Containers
4. Motor Vehicles-New
5. Machinery & Equipment
6. Appliances
7. Other Transportation Equipment –Aircraft
8. Other Transportation Equipment –Marine
9. Other Transportation Equipment –Locomotives
10. Sheet, Strip & Metal Coil
11. Factory Finished Wood
12. Electrical & Electronic Coatings
13. Miscellaneous Manufacturing
14. Paper, Film & Foil

3.3-4 Miscellaneous Solvents

1. Cutback Asphalt Paving
2. Emulsified Asphalt Paving
3. Pesticide Application (Agricultural & Non Agricultural)
4. Bakeries
5. Breweries/Wineries/Distilleries)
6. Petroleum and Solvent Spills
7. Asphalt Roofing Kettles & Tankers
8. Leaking Underground Storage Tanks.

Area source emissions were estimated by multiplying an activity factor (e.g., employment) by an emission factor with adjustments made for any controls in a particular category. In order to avoid double counting emissions, point source emissions in similar area/point categories were subtracted from the gross area source emissions estimate. For example, the gross 2011 area source emissions for Graphic Arts (North American Industrial Classification System -NAICS 323* and 511*) were calculated at 1,845.4 TPY VOC (using EPA estimates) and the point source emissions for Graphic Arts were reported at 602.4 TPY. This amounts to a net area source estimate of 1,243 TPY as presented in Section 3.3-1-4 and Table 3.3-1.

EIIP Volume III recommends the development of the per employee emission factors based on reported state point source data and employment. For dry cleaners and bakeries emission factors were developed using point source VOC emissions from the MassDEP Source Registration (SR) program divided by number of employees for a particular NAICS group. The national default per capita emission factors were used where the data were insufficient to develop a per employee factor.

The MassDEP SR database provided the point source emissions. Employment data was obtained from the US Department of Commerce Bureau of Census County Business Patterns³, and the Bureau of Census provided population data.

³ "County Business Patterns 2010 - Massachusetts" CPB 2010 -25 U.S. Department of Commerce, Bureau of Census website: <http://censtats.census.gov/cbpnaic/cbpnaic.shtml>

3.3-1.1 SURFACE CLEANING (DEGREASING)

Surface cleaning or degreasing involves the solvent cleaning or conditioning of metal surfaces and parts, fabricated plastics, electronic and electrical components, and other substrates in a wide range of industries and processes. Degreasing is designed to remove foreign materials such as oil, grease, waxes, and moisture in preparation for further treatment (e.g., painting, electroplating, and galvanizing). The two basic types of degreasing are cold cleaning and vapor cleaning/in-line or conveyorized cleaning. Cold cleaners are typically used in small facilities such as automobile repair/maintenance facilities and industrial maintenance shops. Vapor cleaning is generally used in manufacturing operations. In-line cleaners are large operations and are usually inventoried as point sources, according to EIIP Volume III, Chapter 6.⁴

EIIP Volume III, Chapter 6, Table 6.5-2 provides total degreasing uncontrolled emission factors that are also itemized for sub-categories of cold cleaning and vapor/in-line cleaning. This table provides emission factors for population and employment. MassDEP used the employment factor which is the EIIP preferred method. The SIC codes given in EIIP for degreasing employment were converted to NAICS codes in order to extract degreasing employment data from the latest County Business Patterns. MassDEP used the emission factors for post control cold cleaning emissions because the state degreasing regulation covers cold cleaning operations only.

The Massachusetts Solvent Metal Degreasing regulation, 310 CMR 7.18 (8)(a), was adopted in 1980 requiring Reasonably Available Control Technology (RACT) for cold cleaning solvent degreasers. There were no federal rules controlling VOC emissions from this sector at the time the MA regulation was implemented. According to the EPA Control Technology Guideline (CTG) for this category⁵, implementation of RACT with average compliance would result in a 50% reduction in emissions from cold cleaning.

Massachusetts developed more stringent degreasing regulations effective September 2009.⁶ This regulation is based on the 2001 OTC Model Rule developed by E.H. Pechan, the technical analysis for which estimated a 66% VOC reduction from uncontrolled levels.⁷ MassDEP applied the 80% control effectiveness (CE) and rule effectiveness (RE) recommended by EPA in estimating post 2009 degreasing controlled emissions for 2011.

Point Source Double Counting Adjustment

The discussion in EIIP Volume III, Chapter 6, Section 5.2 regarding the degreasing sector notes that double counting may occur with other area sources, particularly automobile refinishing. In the Background Document of the Massachusetts December 1994 Automotive Refinishing regulation 310 CMR 7.18 (28), MassDEP estimated that 28 % of the emissions from automotive refinishing are from degreasing. Degreasing emissions from auto-body refinishing were therefore deducted from the total uncontrolled degreasing emissions to prevent double counting.

⁴ Emission Inventory Improvement Program Technical Report Series Volume 3 Area Sources, Chapter 6 Solvent Cleaning. September 1997. See: <http://www.epa.gov/ttn/chief/eiip/techreport/volume03/index.html>

⁵ OAQPS GUIDELINES CONTROL OF VOLATILE ORGANIC EMISSIONS FROM SOLVENT METAL CLEANING EPA-450/2-77-022 November 1977 (OAQPS NO. 1.2-079), B.2.3 Projected Emission Reductions. See: <http://www.epa.gov/ozonpollution/SIPToolkit/ctgs.html>

⁶ 310 CMR 7.18 (8)(a) and Background Information and Technical Support Document for Proposed Amendments to 310 CMR 7.00 et seq 310 CMR 7.18 Volatile and Halogenated Organic Compounds – Solvent Metal Degreasing Oct.17 2008.

⁷ E. H. Pechan and Associates estimated a 66 percent reduction in emissions from uncontrolled levels after implementation of the OTC model rule. “*Control Measure Development Support Analysis of Ozone Transport Commission Model Rules.*” pp.19. Prepared for Ozone Transport Commission, March 31, 2001.

In order to prevent further double counting, point source degreasing emissions from other operations were subtracted from the area source degreasing estimate. The following is the degreasing methodology for VOC.

Cold Cleaning

2010 Manufac. employment: NAICS corresponding to SIC 25, 33-39 are: 3371, 3372, 331, 332, 333, 334, 335, 336, and 339
137,343 employees * 24 lb/employee (EIIP Table 6.5-2) = 1,648.1 TPY

Auto Repair: NAICS 811121 corresponding to SIC 417, 423, 551, 552, 554-6, 753
48,288 employees * 270 lb/employee = 6,518.9 TPY
Total Uncontrolled Cold Cleaning emissions: 1,648.1 TPY + 6,518.9 TPY = 8,167.0 TPY

Total Post-control Cold Cleaning emissions –MA RACT-CTG adjustment:
 $8,167.0 \text{ TPY} * [1 - (0.66)(0.8)(0.8)]$
 $= 8,167.0 * [0.58] = 4,736.9 \text{ TPY}$

Vapor/In-Line Cleaning

Electronics & Electrical: NAICS (mainly 335**) corresponding to SIC 36 = 8,823 employees * 29 lb/employee = 127.9 TPY
Other: NAICS corresponding to SIC 25, 33-39, 417, 423, 551, 552, 554-6, 753 = 185,631 employees * 9.8 lb/employee = 909.6 TPY

Total Vapor/Inline Cleaning (electronics/elec & other) = 127.9 + 909.6 = 1,037.5 TPY

Total Uncontrolled Degreasing

Cold Cleaning (8,167.0) + Vapor/Inline (1,037.5) = 9,204.5 TPY

Total Post Control Degreasing

Cold Cleaning (4,736.9 + Vapor/Inline (1,037.5) = 5,774.4 TPY net

Point Source Adjustment

MassDEP SR point source emissions for NAICS: 3371, 3372, 331, 332, 333, 334, 335, 336, and 339, 417, 423, 551, 552, 554-6, 753 and 811121 = 1,344.7 TPY
 $5,774.4 - 1,344.7 = 4,429.7 \text{ TPY} / 312 \text{ days} = 14.2 \text{ TPSD}$

Table 3.3-1 presents the statewide degreasing emissions apportioned to counties based on the top 12 surface cleaning NAICS Codes with the highest number of employees.

3.3-1.2 CONSUMER AND COMMERCIAL SOLVENT USE

The solvent-containing products in this category include personal care products, household products, automotive aftermarket products, adhesives and sealants, household pesticides, some coatings, and other commercial/consumer products that emit VOCs. The commercial and institutional use of these products is included in this category.

Massachusetts regulated consumer products pursuant to 310 CMR 7.25 (12) since 1995 and was superseded in 1998 by EPA's National Volatile Organic Compound Emission Standards for Consumer Products (40 CFR Part 59 Subpart C sections 59.201-59.214). The 1995 Massachusetts regulation covered 11 product categories whereas the 1998 federal rule covered 25 product categories. In effect, the

VOC content of consumer products in Massachusetts has largely been subject to the 1998 federal standards since promulgation of the EPA rule. E.H. Pechan in the OTC 2001 Model Rule⁸ estimated the emissions factor for the 1998 federal rule as 7.06 lb/capita which was used in the Massachusetts 2002, 2005 and 2008 Periodic Emissions Inventories. Pechan used the uncontrolled EPA-EIIP⁹ emissions factor of 7.84 lb/capita, a control efficiency of 20%, rule penetration of 100%, and rule effectiveness of 48.6% to develop the controlled emission factor of 7.06 lb/capita.

Massachusetts did not adopt the 2001 OTC Model Rule until January 2009. In 2007, Massachusetts Technical Support Document (TSD)¹⁰ for this rule established a 16.17% reduction (0.838) from the 1998 federal rule (3,670 ton VOC reduction from a 2002 baseline of 22,690 tons). The final emission factor is 5.92 lb/capita ($7.06 * 0.838$) as shown below.

There is no seasonal adjustment because EPA Procedures Guidance Volume I, Table 5.8-1 indicates that solvent usage is uniform throughout the year and activity is 7 days per week. The following is the calculation for this category.

$$\begin{aligned} \text{Post-control emission factor} &= \text{Pre-control emission factor } [1-(\text{CE})(\text{RP})(\text{RE})] \\ \text{Post-control emission factor} &= 7.84 \text{ lb/capita } [1-(0.2)(1.0)(0.5)] \\ &= 7.84 \text{ lb/capita } [1- 0.1] \\ &= 7.84 \text{ lb/capita } [0.9] = 7.06 \text{ lb/capita} \end{aligned}$$

$$\begin{aligned} \text{Net em. Factor} &= \text{OTC 2001 Model Rule/1998 federal rule emission factor (7.06 lb/cap)} * 0.838 \\ &= 5.92 \text{ lb/capita} \end{aligned}$$

$$\begin{aligned} \text{Controlled Emissions} &= 6,587,536 \text{ pop} * 5.92 \text{ lb VOC/capita/yr} \\ &= 38,998,213 \text{ lb VOC/2,000 lb/ton} \\ &= 19,499.1 \text{ TPY VOC /365 days} \\ &= 53.42 \text{ TPD} \\ &= 53.42 \text{ TPSD} \end{aligned}$$

Table 3.3-1 presents the controlled emissions apportioned to counties.

3.3-1.3 DRY CLEANING

Dry cleaning is a service industry for the cleaning of garments, draperies, leather goods, and other fabrics. Dry cleaning operations generally use solvents instead of water in order to prevent shrinkage and wrinkles. The three basic types of dry cleaning operations are coin-operated, commercial, and industrial. EIIP Volume III, Chapter 4 states that industrial launderers (SIC 7218, NAICS 812332) generally use soap and detergent for cleaning, but may also use large capacity dry cleaning units. EIIP Volume III, Chapter 4, Table 4.5-1 recommends the exclusion of coin-ops (SIC 7215, NAICS 812310) because they exclusively use perchloroethylene (perc) which is no longer counted as a VOC. EIIP Volume III, Chapter 4 Table 4.5-1 provides an employee and per capita emissions factor for SIC code 7216 (NAICS 812320), which represents commercial dry cleaning operations.

⁸ E.H.Pechan & Associates "Control Measure Development Support Analysis of Ozone Transport Commission Model Rules," March 31, 2001, pp 7-8.

⁹ EPA-EIIP Volume III, Chapter 5, Table 5.4-1 See: <http://www.epa.gov/ttn/chief/eiip/techreport/volume03/index.html>

¹⁰ MassDEP "Background Information and Technical Support Document for Proposed Amendments to 310 CMR 7.00 et seq. 310 CMR 7.25 Best Available Controls for Consumer and Commercial Products – Architectural and Industrial Maintenance Coatings, Consumer Products". January 3, 2007.

MassDEP did not use the EIIP employee emissions factor but instead used local emissions per employee factor developed from MassDEP SR inventory of dry cleaners reporting under NAICS 812320.

MassDEP SR emissions (NAICS 812320) = 3.41 tons

MassDEP SR employment

741 employees emit 3.41 tons *2,000 lb = 6,820 lb/741 employees = 9.2 lb/employee

County Business Patterns employment

3,930 employees * 9.2 lb/employee = 36,170 lb /2,000 lb = 18.09 tons

Net emissions = 18.09 tons – 3.41 tons = 14.7 TPY / 312 days = 0.05 TPSD

3.3-1.4 GRAPHIC ARTS

Graphic arts operations involve the printing of newspapers, magazines, books, and other materials. The majority of graphic arts solvent is used in printing-ink formulations and a lesser amount is used in equipment cleaning and fountain solutions. The six basic operations in graphic arts are: lithography, gravure, letterpress, flexography, screen-printing, and metal decorating. EPA Procedures Guidance Volume I, Section 4.3.4 and EIIP Volume III, Chapter 7 does not provide an employee emission factor for printing and publishing (SIC 27 or NAICS 322, 323, and 511). For the 2008 emission inventory, MassDEP used the uncontrolled EPA per capita factor of 1.3 lb per year given in EPA Procedures Guidance Volume I Table 4.3-9 and EIIP Volume III, Chapter 7, Section 5.2.

For this 2011 report MassDEP adopted EPA's latest emission estimates¹¹ based on national controls and a newly developed employee factor of 201.0 lb. EPA Procedures Guidance Volume I, Table 5.8-1 presents a seasonally uniform factor with activity at 5 days per week. The following is the emissions calculation for graphic arts using EPA's new employee emissions factor.

18,362 employees * 201.0 lb VOC per capita = 1,845.4 TPY

1,845.4 TPY- 602.4 TPY (DEP-AQR point) = 1,243.0 TPY/260 days (52 * 5) = 4.78 TPSD

The MassDEP SR point source emissions reported for SIC 27 or NAICS 322, 323 and 511 were subtracted from the total area source emissions. Table 3.3-1 presents the emissions as apportioned to counties.

3.3-1.5 INDUSTRIAL ADHESIVES AND SEALANTS

VOC emissions in this category are primarily from industrial/commercial operations such as product manufacturing, packaging, and construction/installation of metal, wood, rubber, plastic, ceramics, and fiberglass materials. Other operations include upholstery shops, building construction, and roof repair. Household use of adhesives and sealants are covered in the Consumer and Commercial Solvent Use category (Section 3.3-1.2).

There is no EIIP inventory guidance on area source industrial adhesives and sealants, so MassDEP used MANE-VU's emissions estimate¹². MANE-VU used California Air Resources Board's (CARB) per capita emission factors for point and area source adhesives and sealants.¹³ The NAICS document lists three codes that represent this category (322222, 339113, 325520) and the corresponding MassDEP SR point sources

¹¹ <ftp://ftp.epa.gov/EmisInventory/2011nei/doc/>

¹² E-mails from Pat Davis at MARAMA 9/17/2007 and Judy Rand at NJ-DEP 3/1/2006 to adopt CARB per capita emission factors for Adhesives and Sealants.

¹³ Determination of Reasonable Available Technology and Best Retrofit Technology for Adhesives and Sealants, California Air Resources Board, 1988.

were subtracted from the per capita emissions estimate in order to prevent double counting. The following are the per capita emission estimates for Massachusetts from which county emissions are estimated in Table 3.3-1:

Industrial Point Adhesives & Sealants: population 6,587,536 * 0.1081 lb/cap = 712,113 lb VOC / 2,000 lb = 356.1 TPY

Industrial Area Adhesives & Sealants: population 6,587,536 * 1.0974 lb/cap = 7,229,162 lb VOC / 2,000 lb = 3,614.6 TPY

Total emissions (356.1 + 3614.6) = 3,970.7 TPY – 354.4 TPY (point) = 3,616.3 TPY /312 days = 11.59 TPSD

3.3-2 NON-INDUSTRIAL SURFACE COATING

Surface coating includes paints, enamels, varnishes, lacquers, and other product finishes that are either water or solvent based. Solvents are used as carriers for the coating and the clean-up of painting equipment. Surface coating is divided into both non-industrial and industrial applications. Non-industrial applications include the following.

1. automobile refinishing
2. architectural and industrial maintenance coating (AIM)

3.3-2.1 ARCHITECTURAL AND INDUSTRIAL MAINTENANCE COATING (AIM)

The AIM category in this 2011 inventory consists of the following subcategories.

1. architectural coatings
2. traffic paints
3. high performance maintenance coatings
4. other special purpose coatings

These four sub-categories include a wide range of surface coating operations in residential, commercial and industrial settings. The coatings include paints, enamels, varnishes, lacquers, and other product finishes. All these products include either a water-based or solvent based liquid carrier that generally evaporates in the drying or curing process. These solvents are used both as carriers for the coatings and to clean up painting equipment. VOC emissions result from evaporation of the solvents.

Massachusetts regulates architectural and industrial maintenance coatings pursuant to 310 CMR 7.25 (11), which became effective in 1995. EPA also regulates VOC emissions from these coatings pursuant to the federal National Volatile Organic Compound Emission Standards for Architectural Coatings (40 CFR Part 59 Subpart D, Section 59.400 et seq.), which took effect in 1998. The 1995 Massachusetts regulation provided that future EPA emissions standards would supersede the VOC content limits. In effect, therefore, the VOC content of AIM coatings in Massachusetts has largely been subject to the 1998 federal standards since promulgation of the EPA rule.

As part of the development of an OTC Model Rule further regulating AIM coatings, E.H. Pechan and Associates (Pechan) analyzed the emissions from this category.¹⁴

MassDEP incorporated the per capita method developed by Pechan for estimating emissions after adoption of the federal AIM rule. That resulted in an overall 20% reduction in emissions from the AIM category. Massachusetts adopted the 2001 OTC Model Rule for AIM coatings effective January 2009. The following is the equation developed by Pechan.

$$\text{Post-control 1998 emission factor} = \text{Pre-control emission factor} * [1 - (\text{CE})(\text{RP})(\text{RE})]$$

$$\begin{aligned} \text{Post-control 1998 emission factor} = \\ 6.7 \text{ lb/capita} * [1 - (0.2)(1.0)(1.0)] = 6.7 \text{ lb/capita} * [0.8] = 5.36 \text{ lb/capita} \end{aligned}$$

$$\text{Post control 2009 emissions factor (31\% reduction)} = 5.36 \text{ lb} * 0.69 = 3.6984 \text{ lb/capita}$$

The following is the method used for apportioning the pre-and-post-National control AIM emission factors. The four categories take into account the summer adjustment factor of 1.3 provided in Table 4.3-6 of EPA Procedures Guidance Volume I and presented below and in Table 3.3-2.

	PRE 2009 CONTROL			POST 2009 CONTROL		
	Em.fac lb/cap	Emiss TPY	EMISS/365* 1.3	Em.Fac* 0.69 lb/cap	Emiss TPY	EMISS/365* 1.3
Architectural Coat	3.68	11,956.2	42.58	2.5392	8,363.5	29.79
Traffic Paints	0.40	1,299.6	4.63	0.2760	909.1	3.24
High Perfor Maint	0.64	2,079.4	7.41	0.4416	1,454.5	5.18
Other Special Prod	0.64	2,079.4	7.41	0.4416	1,454.5	5.18
TOTAL	5.36	17,654.6	62.88	3.6984	12,181.6	43.39

Pop 2011: 6,587,536

Pre-2009 control emissions

$$6,587,536 * 5.36 \text{ lb/capita} = (17,654.6 \text{ TPY} / 365 \text{ days}) * 1.3 = 62.88 \text{ TPSD}$$

Post-2009 control emissions

$$6,587,536 * 3.6984 \text{ lb/capita} = (12,181.7 \text{ TPY} / 365 \text{ days}) * 1.3 = 43.39 \text{ TPSD}$$

3.3-2.2 AUTO BODY REFINISHING

Auto body refinishing is the repairing of worn or damaged automobiles, motorcycles and light/medium duty trucks; it refers to any surface coating related applications that occur subsequent to those at original equipment manufacturer assembly plants. Coating of new vehicles is not included in this category. The majority of these operations occur at small shops that use solvents in vehicle preparations, primer applications, topcoat operations, and spray equipment cleaning. Auto body refinishing operations are both point and area sources with the majority being area sources.

¹⁴ See E.H. Pechan and Associates, "Control Measure Development Support Analysis of Ozone Transport Commission Model Rules," prepared for Ozone Transport Commission, March 31, 2001.

The preferred EPA-EIIP method is to conduct a survey of solvent usage of auto body refinishing operations in the state. The EIIP alternative method is the top-down apportionment of national emissions to state using employment for this category or population.

The method used by MassDEP for this category is similar to the EIIP preferred method. MassDEP used point source emissions and employment data to develop an area source emissions factor per auto body refinishing employee. This emissions factor was multiplied by the total employment for the auto body refinishing NAICS code 811121

An emissions factor of 549.25 lb/ employee is derived from a total of 55.2 TPY VOC and 201 employees as shown in Table 3.3-2. This emissions factor was multiplied by the County Business Patterns total of 5,593 employees for NAICS 811121 for MA. Point source emissions were subtracted from the area source emissions to prevent double-counting.

Auto body refinishing activity is uniform throughout the year at 5 days per week according to EPA EIIP and Procedures Guidance, Volume I Table 5.8-1. The following is the emissions calculation.

$$\begin{aligned} 55.2 \text{ TPY VOC} / 201 \text{ employees} &= 0.2746 \text{ tons/employee} * 2,000 \text{ lb} = 549.25 \text{ lb/employee} \\ 5,593 \text{ employees} * 549.25 \text{ lb} &= 3,071,976 \text{ lb} / 2,000 \text{ lb} = 1,536.0 \text{ TPY} \\ \text{Point source adjustment: } 1,536.0 \text{ TPY} - 55.2 \text{ TPY} &= 1,480.8 \text{ TPY} / (52 \text{ weeks} * 5 \text{ days/wk}) \\ &= 5.70 \text{ TPSD} \end{aligned}$$

CE/RE/RP factors are not applicable for automobile refinishing because the MassDEP area source emissions factor was derived from net point source emissions after controls. The net point source emissions in Table 3.3-2 reflect both the state and federal controls for Auto Refinishing facilities. The 1995 MA Automotive Refinishing Regulation 310 CMR 7.18 (28) includes limits on VOC coatings, spray booth and equipment housekeeping operational requirements. The 1998 Federal Auto Equipment Refinishing rule (40 CFR Part 59) contains VOC coating limits that are similar to the MA regulations but does not include equipment and operational requirements.

Table 3.3-2 presents the net area VOC emissions apportioned to counties based on the latest County Business Patterns employment data.

3.3-3 INDUSTRIAL SURFACE COATING

Industrial Surface Coating includes several industrial and manufacturing applications outlined in EPA Procedures Guidance Volume I, Table 4.3-6 and EIIP Volume III, Chapter 8. MassDEP estimated VOCs using employment from County Business Patterns multiplied by EPA EIIP emission factors.¹⁵ Several categories were adopted from EPA.¹⁶ As suggested by EPA, MassDEP subtracted the reported state point source emissions in each category as shown in Table 3.3-3.

The following are the Industrial Surface Coating subcategories.

1. wood furniture and fixtures
2. metal furniture
3. metal can containers
4. motor vehicles – new, at assembly plants -

¹⁵ <http://www.epa.gov/ttn/chief/eiip/techreport/volume03/index.html>

¹⁶ <ftp://ftp.epa.gov/EmisInventory/2011nei/doc/>

5. machinery and equipment
6. appliances (*EPA/ERTAC estimates*)
7. other transportation equipment- aircraft (*EPA/ERTAC estimates*)
8. other transportation equipment- marine (*EPA/ERTAC estimates*)
9. other transportation equipment- locomotives (*EPA/ERTAC estimates*)
10. sheet, strip, metal coil
11. factory finished wood
12. electronic & electronic coatings
13. miscellaneous manufacturing
14. paper, film & foil coating

The following is an example of the emission estimation methodology for wood furniture and fixtures (SIC 25, NAICS 337215, 337121, 337129, 337211, 337127) and presented in Table 3.3-3:

County Business Patterns (CBP) employment = 2,101 employees
 EPA/ERTAC emission factor = 244 lb per employee
 CBP employees 2,101 emp * 244 lb/emp = 512.6 lb /2,000 lb = 256.3 TPY
 DEP-AQR point source emissions = 85.9 TPY
 Net emissions 256.3 TPY – 85.9 TPY = 170.4 TPY / (52*5) days = 0.66 TPSD

3.3-4 MISCELLANEOUS SOLVENTS

This section covers the following sub-categories.

1. cutback asphalt and emulsified asphalt (*EPA/ERTAC estimates*)
2. pesticide application: agricultural and non agricultural
3. bioprocesses: bakeries, breweries/wineries/distilleries
4. catastrophic/accidental releases
5. asphalt roofing kettles and tankers
6. leaking underground storage tanks

3.3-4.1 CUTBACK AND EMULSIFIED ASPHALT PAVING

The two types of asphalt paving used for road paving and repair inventoried in this section are cutback asphalt and emulsified asphalt. A third type of asphalt, hot mix, is inventoried in the point source section as recommended in EPA's EIIP, Volume 3, Chapter 17, Section 2.2.¹⁷

Cutback asphalt is used as a diluent, sealant, and bonding agent for paving materials. It consists mainly of petroleum distillates that include: gasoline or naphtha (rapid cure), kerosene (medium cure), and other oil type solvents (slow cure). Evaporation from slow and medium cure, according to AP-42, section 4.5, continues for several months after paving. Cutback asphalt usage is restricted during the ozone season by MassDEP regulation 310 CMR 7.18(9).¹⁸

Emulsified asphalt is a type of liquefied road surfacing material that is used in the same applications as cutback asphalt. Emulsified asphalt uses a blend of water with a soap emulsifier. Similar to cutback asphalt, emulsified asphalt consists of rapid, medium, and slow cure.

¹⁷ See: <http://www.epa.gov/ttn/chief/eiip/techreport/volume03/index.html>

¹⁸ 310 CMR 7.18(9) U Cutback Asphalt. Application of cutback asphalt not permitted from October 1 through April 30.

Cutback Asphalt. The 2011 methodology is the same as the 2002 and 2008 PEI estimates in which MassDEP used Connecticut's 2002 survey results¹⁹ to approximate emissions for MA. Connecticut did not update their 2002 asphalt survey so MassDEP used a growth factor from MA vehicle miles travelled (VMT) to project emissions to 2011.

Prior to the 2002 PEI, MassDEP relied on asphalt usage data from a report of the Asphalt Institute in Lexington, Kentucky.²⁰ In 1992 the Institute reported 707 tons cutback asphalt use in MA, but no monthly breakdown. Since then that source estimated zero cutback asphalt usage in MA (although the report included a caveat that the likelihood of under-reporting of asphalt usage was very high). Subsequent to completion of the June 2006 version of the 2002 inventory, MassDEP participated in discussions with member states of the Ozone Transport Commission (OTC) concerning emissions from this category. Based on these discussions, MassDEP revised its estimate to more accurately reflect emissions from cutback asphalt paving, basing these on Connecticut's (CT) comprehensive survey for 2002. Although CT has cutback asphalt regulations banning summertime use, its survey showed that cutback was being used in the summer. MA Cutback Asphalt regulation that banned summer use is the same as neighboring CT with similar climatic and socio-economic conditions. MassDEP believes that CT's estimates of cutback asphalt usage provide the basis for a more accurate estimate for MA than the Asphalt Institute data on which MassDEP relied on prior to 2002.

The CT 2002 methodology used a comprehensive survey of emulsified and cutback asphalt usage by CT cities and towns. The survey requested cutback and emulsified asphalt usage annually and during the ozone season. The survey also requested the amount used as tack coating and because its VOC is negligible, it was deducted from total asphalt usage. Non-reporting towns' usage was estimated by applying the average use from reporting towns.

The most common cutback asphalt used was MC-3000 for which CT estimated an emission factor of 32 lb VOC/barrel. The CT survey data showed 72% of annual asphalt usage occurred during the ozone season (June through August). The CT survey revealed that cutback asphalt was indeed used during the ozone season despite the restrictions imposed by the CT regulation.

MassDEP has therefore taken CT's 2002 estimate of cutback asphalt VOC emissions and increased that estimate to account for MA higher population, VMT and road network. MassDEP calculated a MA/CT 2002 VMT ratio to estimate the asphalt paving emissions for MA as shown below.

MDVMT = MA daily vehicle miles travelled
CT 2002 cutback asphalt emissions = 176.83 TPY VOC
CT 2002 DVMT = 84.9 Million
CT Ratio: 176.83 TPY VOC / 84.9 DVMT = 2.083 tons VOC per DVMT
MA 2011DVMT = 147.99 MDVMT
MA 2011 cutback emissions annual = 147.99 MDVMT * 2.083 tons VOC/DVMT
= 308.3 tons VOC
MA 2011 cutback emissions summer day (13wks*5 days) = 308.3 tons * 0.72 (fraction used in summer) /65 summer days = 3.41 TPSD

¹⁹ Connecticut's 2002 Periodic Ozone and CO Emissions Inventory, Section 4.3.5 Asphalt Paving. CT Bureau of Air Management, December 2005.

²⁰ Asphalt Institute of America, Lexington KY, Telephone data request: Asphalt Usage Survey, Letter from Ross A. Bentsen March 31, 1992. Subsequent telephone requests for data to Linda Allen to update MA PEIs. <http://www.asphaltinstitute.org/>

Emulsified Asphalt (*EPA/ERTAC estimates*). The Asphalt institute could not provide emulsified asphalt data for 2011 so MassDEP adopted EPA's 2008 estimate of emulsified asphalt emissions²¹ for using the change in VMT between 2008 and 2011²² to adjust for growth in emissions. Pechan obtained a 2008 emulsified asphalt usage of 805 tons from the Asphalt Institute and used the EIIP emission factor of 9.2 lb/barrel.

CY 2008

805 tons emulsified asphalt * 2,000lb = 1,610,000 lbs
/ 8.34 (lb/gallons) = 193,046 gallons /42 gallons/barrel
= 4,596.3 barrels * 9.2lb VOC /barrel = 21.1 TPY

CY 2011

VMT growth from 2008 to 2011 is 0.9963 (that is, VMT declined)
21.1 TPY * 0.9963 = 21.0 TPY

Activity is 72% in summer: 21.0 TPY * 0.72 /65 days = 0.23 TPSD

Total Asphalt

Total MA asphalt emissions = Cutback (308.3TPY or 3.41 TPSD) + Emulsified (21.0 TPY or 0.23 TPSD)
= 329.3 TPY or 3.64 TPSD.

Table 3.3-4 presents the asphalt emissions apportioned to counties based on population.

3.3-4.2 PESTICIDE APPLICATION

Pesticides include a wide variety of chemicals used to kill or retard the growth of insects, rodents, fungi, weeds and other microorganisms. While pesticide use is typically associated with agricultural applications, a significant quantity is used in non-agricultural applications.

The most accurate methodology for calculating VOC emissions from pesticides is to obtain total quantity by type of pesticide used in the state. Several state and federal agencies were contacted, including the State Department of Food and Agriculture for its list of banned pesticides.²³ None of the agencies collect or could provide any data on total quantity used. The only way to obtain the quantity used in Massachusetts would be to contact the manufacturers of the hundreds of different chemicals used. This would be too resource intensive, and data may not be available by state. The most feasible alternative methodology is to use the total agricultural and non-agricultural acreage, and the national estimated quantity of pesticides used per harvested acre, as recommended in EPA Procedures Guidance Volume I and EIIP Volume III, Chapter 9.²⁴

Agricultural Pesticides. MassDEP adopted EPA's estimate of agricultural pesticide emissions; these are presented in Table 3.3-5. Emissions were estimated based on total harvested acres by county, throughput of

²¹ <ftp://ftp.epa.gov/EmisInventory/2011nei/doc>

²² Bob Frey of MassDOT submitted VMT data for 2003 to 2040 by county. Email 5/9/2014. www.mass.gov/massdot

²³ Massachusetts Department of Food and Agriculture - List of banned Chemicals in the State, Farm Bureau.

²⁴ Emission Inventory Improvement Program, Technical Report Series Volume 3 Area Sources, Chapter 9 Pesticides - Agricultural and Nonagricultural. Revised Final, June 2001. <http://www.epa.gov/ttn/chief/eiip/techreport/volume03/index.html>

pesticide active ingredient, and multiplied by a VOC emissions factor. The documentation can be found at EPA's website: <ftp://ftp.epa.gov/EmisInventory/2011nei/doc/>.

Non-Agricultural Pesticides. Total acreage and pesticide applications for non-agricultural land use were obtained from a one-time 1985 report by Harrison Biotech, Inc., presented to the Massachusetts Department of Food and Agriculture.²⁵ The report estimated herbicide use and total acreage for agricultural crops, residential lawns, and municipal and institutional land holdings such as parks/recreation, golf courses, commercial land use, and rail/highway right-of-way use.

The golf course acreage was obtained from the University of Massachusetts and MassDEP had reports with more specific data by county and pesticide application rates. The application rates in the Biotech report were used for this report because they were state specific. The golf course pesticide usage was estimated to grow by 25% using golf course employment data from County Business Patterns NAICS 713910 and presented in Table 3.3-6 of the MassDEP 2002 PEI. Because no further subsequent study has been done MassDEP used the 1985 emission estimates (adjusted) in this 2011 report.

Below is the non-agricultural pesticide usage application using the Biotech study.

residential lawn	210,000 acres * 0.524 lb/acre = 110,040 lb /2,000 lb/ton = 55.02 tons
parks & recreation	52,500 acres * 0.238 lb/acre = 12,495 lb /2,000 lb/ton = 6.25 tons
commercial	50,000 acres * 0.600 lb/acre = 30,000 lb /2,000 lb/ton = 15.00 tons
right of way	14,700 acres * 6.830 lb/acre = 100,401 lb /2,000 lb/ton = 50.20 tons

TOTAL pesticide use = 126.5 Tons

EPA Procedures Guidance Volume 1 and EIIP Volume 3, Chapter 9 recommends that the active ingredient for non-agricultural pesticides should be multiplied by a factor of 2.45 to determine the solvent content. MassDEP apportioned non-agricultural pesticide application to counties based on the distribution of single-family housing units taken from the University of Massachusetts MISER study.²⁶ Non-agricultural pesticides emit a total of 316.1 tons active ingredient (126.5*2.45*1.02 growth factor 2008 -2011). Non-agricultural pesticide application generally occurs during the growing season, April to October (214 days) for a total of 1.48 TPSD as shown in Table 3.3-4.

3.3-4.3 BIOPROCESS EMISSIONS

This category includes emissions from biological processes including bakeries, breweries, wineries, and distilleries. The scale-up methodology was used for estimating VOC emissions. The VOC/employee emission factor was derived from MassDEP SR data as recommended in EIIP Volume I Section 5.6 and EIIP Volume III Chap.8 Sec 3.1-1. County Business Patterns (CBP) provided employment data by NAICS Code.

Bakeries. Bakeries emit VOCs which are primarily ethanol formed by yeast fermentation of bread or dough during the baking process. The SIC Codes for bakeries are 546 (NAICS 311811) and 205 (NAICS 311812). The following is the scale-up methodology for estimating area source VOC emissions from bakeries.

²⁵ Massachusetts Department of Food and Agriculture, "A Generic Environmental Impact Report on the Control of Vegetation on Utility and Railroad Rights-of-Way in the Commonwealth of Massachusetts" - Report prepared by Harrison Biotech, Inc. January 1985 .

²⁶ Massachusetts Institute for Social and Economic Research (MISER) University of Mass, Amherst, 1990, 1996,1999 & 2002 Population.
<http://www.umass.edu/miser/>
<http://eire.census.gov/popest/data/counties/tables/CO-EST2002/CO-EST2002-02-25.php>

$$\begin{aligned}
 & (\text{MassDEP SR point bakery emissions} / \text{MassDEP SR point bakery employment}) * \text{total CBP bakery} \\
 & \quad \text{employment} - \text{MassDEP point emissions} \\
 & 176.8 \text{ TPY VOC} / 2007 \text{ bakery employees} = 0.0881 \text{ ton VOC/employee} * 2,000 \text{ lb} = 176.18 \\
 & \quad \text{lb VOC/employee} \\
 & 176.18 \text{ lb VOC/employee} * 5,709 \text{ total CBP employees} = 502.9 \text{ TPY VOC} - 176.8 \text{ TPY MassDEP} \\
 & \quad \text{bakery VOC} = 326.1 \text{ TPY} \\
 & \text{Net } 326.1 \text{ TPY VOC} / 312 \text{ days} = 1.05 \text{ TPSD}
 \end{aligned}$$

The larger bakeries that are subject to controls operate 5 to 7 days per week and are recorded in the point source section. Numerous smaller bakeries generally operate seven days per week uniformly throughout the year. Bakery emissions are estimated by county in Table 3.3-4.

Breweries/Wineries/Distilleries. County Business Patterns reported 18 breweries (SIC 2082) and 11 wineries (SIC 2084) and 5 distilleries (NAICS 31212, 31213, and 31214) operating in Massachusetts. There were no reported facility emissions in MassDEP SR data, so MassDEP used an alternative emission factor from an EPA Research and Development Report²⁷ in order to estimate emissions. The brewery section of that report presented an emission factor developed by CARB for smaller breweries of 2.8 TPY VOC per facility, which is mainly ethanol. Brewery, winery and distillery production are generally seasonally uniform. Therefore $2.8 \text{ TPY VOC} * 38 \text{ facilities} = 106.4 \text{ TPY VOC} / 365 \text{ days} = 0.29 \text{ TPSD total}$. The emissions are presented in Table 3.3-4.

3.3-4.4 CATASTROPHIC/ACCIDENTAL RELEASES

Sources in this category represent unplanned, unintentional emissions associated with evaporating or combusting of petroleum and solvent spills. Source categories include rail car, tank truck oil spills, and industrial accidents.

Data for catastrophic/accidental releases were obtained from the MassDEP BWSC Division of Response and Remediation.²⁸ The data for VOC spills were provided in gallons, and were converted to pounds and tons using the product density provided in AP-42 Table 4.3-2. This table did not cover all of the VOC chemicals spilled, therefore, the densities of similar chemicals were used. The densities ranged from 6.6 to 12.3 lb/gal.

In response to EPA's Comment #52 on the Draft Massachusetts 1990 Base Year Inventory, MassDEP has assumed 100% evaporation of fuels. There are no data on the amount of chemical VOCs recovered through site cleanup to estimate that an amount less than 100% of VOCs are eventually released to the atmosphere through evaporation. The emissions are generally uniform throughout the year because spills are not seasonal, and vaporization from spills generally continues to occur after spillage.

The total VOC emissions for catastrophic solvent and petroleum spills amounted to 161.6 TPY and 0.44 TPSD and are calculated by county in Table 3.3-6.

²⁷ EPA Research and Development "Identification and Characterization of Missing or Unaccounted for Area Source Categories. For Office of Environmental Engineering and Technology Demonstration by Air and Energy Engineering Research Lab. EPA-600-R-92-006, January 1992.

²⁸ MassDEP Bureau of Waste Site Clean-up, Division of Response and Remediation, Stephanie McCleod, *Listing of Hazardous Spills and Leaking Underground Storage Tanks 2008 in Massachusetts by County*.

3.3-4.5 ASPHALT ROOFING KETTLES AND TANKERS

This category covers the installation and repair of hot applied asphalt roofing. The source of emissions is fuel used for heating the asphalt kettle. EIIP Volume III Area Source Category Method Abstract section²⁹ provided an emission factor of 6.2 lb VOC per ton of asphalt melted. AP-42 Section 11.1 (Hot Mix Asphalt Plants) and 11.2 (Asphalt Roofing) Tables 11.1-1 and 11.1-5 (April 2, 2004) listed emission factors for NO_x, CO, SO₂, and PM₁₀.³⁰

The amount of asphalt was obtained from the Asphalt Institute in Kentucky³¹. The 2002 data is being used for this 2011 report because the Institute no longer provides asphalt usage by state. Emissions were apportioned to counties based on NAICS code 235610 taken from the County Business Patterns (CBP). The summer seasonal adjustment in Table 3.3-4 was assumed to be the same (1.4) as Architectural coating.

$$\begin{aligned} 173,136 \text{ tons roofing asphalt} * 6.2 \text{ lb VOC/ton} &= 1,073,443 \text{ lb VOC /2000 lb} \\ &= 536.7 \text{ TPY VOC} \end{aligned}$$

$$\begin{aligned} \text{Typical summer day emissions} &= 536.7 \text{ TPY /312 days (52*6) * 1.4 (summer adjust)} \\ &= 2.40 \text{ TPSD.} \end{aligned}$$

3.3-4-6 LEAKING UNDERGROUND STORAGE TANKS (LUSTS)

EPA EIIP Volume I Guidance Section 4.8-6³² states that many tanks are over 15 years old and, because they are constructed of steel, they rust over time. LUSTS generally result in contaminated drinking water, subsurface soils and ground/surface water that emit vapors. VOC emissions occur through remediation which includes soil venting, air stripping of VOC in water, soil aeration, product recovery, and carbon adsorption. Although research on emissions from LUSTS is underway, the EIIP methodology used here was taken from a study performed by Radian Corporation for EPA.³³ In a memo to SIP Inventory contacts, Radian provided a VOC emission factor of 28 lb per day per gasoline LUST site undergoing or initiating remediation. EIIP Volume III also provides the same emission factor as an alternative method in the section entitled *Remediation of Leaking Underground Storage Tanks*.

MassDEP Bureau of Waste Site Clean-up Division of Response and Remediation provided gasoline LUST data by county for 2011. A total of 251 LUST sites were identified, and are presented in Table 3.3-4. The following is the VOC emission calculation from LUSTs.

$$\begin{aligned} 251 \text{ LUSTs} * 28 \text{ lb VOC} * 3 \text{ (days)} &= 21,084 \text{ lb VOC /2,000 lb/ton} \\ &= 10.5 \text{ TPY VOC /365 days} \\ &= 0.03 \text{ TPSD VOC} \end{aligned}$$

²⁹ Emission Inventory Improvement Program Technical Report Series Volume 3 Area Sources, Area Source Method Abstracts, Asphalt Roofing Kettles. September 2000. <http://www.epa.gov/ttn/chief/eiip/techreport/volume03/index.html>

³⁰ <http://www.epa.gov/ttn/chief/ap42/index.html>

³¹ Asphalt Institute of America, Lexington KY, Telephone data request: Asphalt Usage Survey, Letter from Ross A. Bentsen March 31, 1992. Subsequent telephone requests for data to Linda Allen to update MA PEIs. <http://www.asphaltinstitute.org/>

³² Emission Inventory Improvement Program Technical Report Series - Volume 1 Introduction, Introduction and Use of EIIP Guidance for Emissions Inventory and Development. <http://www.epa.gov/ttn/chief/eiip/techreport/volume01/index.html>

³³ Radian Corporation, *Memorandum to SIP Inventory Preparers* from Glen Rives and Lauren Elmore, May 6, 1992.