



2007 Area Source Emissions Inventory Methodology

540 – ASPHALT ROOFING

I. Purpose

This document describes the Area Source Methodology used to estimate emissions of volatile organic compounds (VOC) from asphalt roofing operations in the San Joaquin Valley Air Basin. An area source category is a collection of similar emission units within a geographic area (i.e., a County). An area source category collectively represents individual sources that are small and numerous, and that may not have been inventoried as specific point, mobile, or biogenic sources. The California Air Resources Board (CARB) has grouped these individual sources with other like sources into area source categories. These source categories are grouped in such a way that they can be estimated collectively using one methodology.

II. Applicability

The emission calculations from this Area Source Methodology apply to facilities that are identified by the following Category of Emission Source (CES) code and Reconciliation Emission Inventory Code (REIC):

Table 1. Emission inventory codes.

CES	REIC	Description
66720	540-590-0400-0000	Asphalt Roofing

III. Point Source Reconciliation

Emissions from the area source inventory and point source inventory are reconciled against each other to prevent double counting. This is done using relationships created by the California Air Resources Board (CARB) between the area source REIC and the point sources' Standard Industry Classification (SIC) code and emissions process Source Category Code (SCC) combinations. The area source in this methodology is not represented within our point source inventory so reconciliation is not necessary.

IV. Methodology Description

This methodology estimates VOC emissions from the application of hot-applied (hot-mopped) asphalt in roofing operations. Hot-applied asphalt is asphalt that is typically melted in kettles and used in the construction of built-up roofing (BUR) and low slope commercial/industrial roofing operations. The only significant source of emissions during the application of hot-applied asphalt is from the heating of the asphalt within the kettle.

From the total amount of asphalt used for roofing operations within the state, we estimated the amount used for hot-applied roofing operations within the District. An emission factor was then applied to calculate the emissions from this source category.

This methodology does not include emissions from the application of cold-applied roofing asphalt because CARB already estimates these emissions in the architectural coating categories. Other emissions not estimated by this methodology include those from the fuel combustion processes (i.e., for heating the kettle) and the manufacturing of asphalt felts or shingles. These processes are covered in their own respective categories.

V. Activity Data

The total amount of asphalt used for roofing operations in California was obtained from the Asphalt Institute (personal communication from Linda Allen, Asphalt Institute, December 8, 2008). This amount was then disaggregated to the county level using county population (CARB, 2009) as a surrogate (see Table 2). Please note that the Kern county population in the table reflects only the District's portion as estimated by CARB.

Table 2. SJVAPCD roofing asphalt consumption, 2007.

County	Population (number)	Population (% of State)	Roofing asphalt consumed (tons)
Fresno	923,052	2.44%	10,102
Kern ⁽¹⁾	672,624	1.78%	7,361
Kings	153,268	0.41%	1,677
Madera	149,916	0.40%	1,641
Merced	252,544	0.67%	2,764
San Joaquin	680,183	1.80%	7,444
Stanislaus	523,095	1.38%	5,725
Tulare	430,974	1.14%	4,716
District Total	3,785,656	10.02%	41,429
State Total	37,771,431	100.00%	413,362

⁽¹⁾ Reflects only the Valley portion of Kern County.

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The National Roofing Contractors Association (NRCA) publishes an annual report of United States regional roofing work patterns in their Annual Market Survey (NRCA, 2008). Using the total amount of asphalt consumed in each county (Table 2), these patterns were used to estimate the amount of roofing asphalt that is hot-applied within the District. A summary of the patterns expected for the District (Pacific Region) is shown below:

- 33.48% of roofing jobs are steep slope work
- 66.52% of roofing jobs are low-slope work
 - 28% of low-slope work is new construction
 - 40.08% of low-slope new construction work uses hot-applied asphalt
 - 72% of low-slope work is reroofing/repair & maintenance
 - 39.17% of low-slope reroofing/repair & maintenance work uses hot applied asphalt

Assuming that hot-applied asphalt is only used in low-slope roofing operations, the amount of hot-applied asphalt used within the District is calculated as follows:

$$M_{hot-applied} = \sum (M_{total} \times PCT_{low-slope} \times PCT_{construct} \times PCT_{hot-applied})$$

Where:

$M_{hot-applied}$ = tons of hot-applied roofing asphalt

M_{total} = tons of roofing asphalt used within a county, total

$PCT_{low-slope}$ = percentage of low slope roofing work

$PCT_{construct}$ = percentage of low-slope work by construction type (i.e., new or reroof)

$PCT_{hot-applied}$ = percentage of low slope roofing work that uses hot applied asphalt

The results of these calculations are presented in the following table:

Table 3. SJVAPCD hot-applied asphalt consumption, 2007.

County	Hot-applied asphalt (tons)		
	New Construction	Reroofing	Total
Fresno	751.66	1,888.95	2,640.61
Kern ⁽¹⁾	546.33	1,372.96	1,919.30
Kings	124.56	313.02	437.57
Madera	121.55	305.45	427.00
Merced	205.71	516.95	722.66
San Joaquin	554.95	1,394.61	1,949.55
Stanislaus	425.91	1,070.32	1,496.22
Tulare	350.65	881.20	1,231.84
Total	3,081.30	7,743.45	10,824.75

⁽¹⁾ Reflects only the Valley portion of Kern County.

VI. Emission Factors

Emission factors for asphalt roofing operations were obtained from a research report by V.P. Puzinauskas in 1979 titled "Emissions from Asphalt Roofing Kettles" (Puzinauskas, 1979). In the report, it was determined that there are 6.2 pounds of VOC emitted for every ton of roofing asphalt melted within the kettles.

VII. Emissions Calculations

A. Assumptions

1. Hot asphalt roofing kettles emit 6.2 pounds of VOC per ton of roofing asphalt melted
2. VOCs are the only emissions from roofing kettles

B. Sample Calculations

VOC Emissions from Hot-Applied Roofing in Fresno County

Multiply the annual amount of hot-applied roofing asphalt consumed in Fresno county by the kettle emission factor:

$$E_{hot-applied, voc} = M_{hot-applied} \times EF_{hot-applied, voc} \times \frac{1 \text{ ton}}{2,000 \text{ lbs}}$$

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Where:

$E_{hot-applied}$ = VOC emissions from hot-applied roofing asphalt

$M_{hot-applied}$ = tons of hot-applied roofing asphalt

$EF_{hot-applied,voc}$ = VOC emission factor for hot-applied roofing kettles

Example:

Given that 2,641 tons of hot-applied asphalt were consumed in Fresno County in 2007:

$$E_{hot-applied,voc} = 2,641 \text{ tons hot-applied asphalt} \times \frac{6.2 \text{ lbs VOC}}{\text{ton asphalt}} \times \frac{1 \text{ ton}}{2,000 \text{ lbs}}$$

$$E_{hot-applied,voc} = 8.2 \text{ tons of VOC}$$

VIII. Temporal Variation

A. Daily

ARB Code 8. 8 hours per day - uniform activity from 8 a.m. to 4 p.m. (normal working shift).

B. Weekly

ARB Code 5. 5 days per week - uniform activity on weekdays; none on Saturday and Sunday.

C. Monthly

Monthly activity within the District is assumed to be uniform throughout the year (EIIP, 2008).

IX. Spatial Variation

Activity within each county may be distributed uniformly across areas zoned for residential, commercial, and industrial land uses.

X. Growth Factor

Growth factors are developed by either the District's Planning Department or CARB for each EIC. These factors are used to estimate emissions in future years. The growth factors associated with this emissions category may be obtained from the Air Quality Analysis Section of the District's Planning Department.

XI. Control Level

Control levels are developed by either the District’s Planning Department or CARB for each EIC. Control levels are used to estimate emissions reductions in future years due to implementation of District rules. These control levels take into account the effect of control technology, compliance and exemptions at full implementation of the rules. Asphalt roofing operations are not subject to District rules. Control levels associated with this emissions category may be obtained from the Air Quality Analysis Section of the District’s Planning Department.

XII. ARB Chemical Speciation

CARB has developed organic gas profiles in order to calculate reactive organic gasses (ROG), volatile organic compounds (VOC) or total organic gas (TOG) given any one of the three values. For each speciation profile, the fraction of TOG that is ROG and VOC is given. The organic gas profile codes can also be used to lookup associated toxics. CARB’s speciation profiles for asphalt roofing operations are presented in Table 4. Organic gas profile #24 is applied to REICs 540-590-0400-0000 (Asphalt Roofing).

Table 4. CARB chemical speciation profiles for gasoline dispensing processes.

Profile Description	ARB Organic Gas Profile#	Fractions	
		ROG	VOC
Asphalt Roofing - Tar Kettle	24	0.733	0.733

XIII. Assessment Of Methodology

This methodology uses a top-down approach to estimate VOC emissions from the use of heating kettles in hot-applied asphalt roofing operations. This approach is expected to produce a conservatively high estimate. The population of roofing workers (NAICS 23561 or SIC 1761) would allow us to more accurately disaggregate the consumption of roofing asphalt to the county level. However, the U.S. Census does not make public that level of data for this economic sector, therefore, the total county population was used as a surrogate instead.

The amount of roofing asphalt estimated to have been consumed in California by the Asphalt Institute was not categorized by roofing type (i.e. shingles, hot-applied, cold applied, etc.). In order to estimate how much asphalt was used for hot-applied roofing operations, an NRCA survey (NRCA, 2008) of roofing contractors was used. The survey broke down roofing patterns based on geographic regions, of which the District fell into the Pacific region (California, Oregon, and Washington). Regional differences, along with an overall 13% response rate, will lead to a certain degree of inaccuracy when attempting to describe such a large and diverse area. However, lacking any local data, the survey was the best source of information that could be obtained to characterize roofing patterns. This estimate could be improved by surveying roofing contractors within the District.

This methodology utilizes a different approach than the one used to estimate previous years' emissions for the District. The previous methodology was created in 1991 and estimated asphalt roofing emissions through a similar process, however, it also included emissions due to the usage of cold-applied asphalt (as stated before, these emissions are not included within this methodology because they are captured in a separate category by CARB). The absence of emissions from cold-applied asphalt usage possibly explains the difference in emissions between the two methodologies as those emissions account for much of the total in the previous estimate.

XIV. Emissions

Following is the 2007 total unreconciled emissions inventory for REIC 540-590-0400-0000. This REIC does not have a point source component and consists of only area sources. Emissions are reported for each county in the District.

Table 6. Total emissions for REIC 540-590-0400-0000 (2007).

County	Emissions (tons/year)					
	NO _x	CO	SO _x	VOC ⁽¹⁾	PM ₁₀	PM _{2.5} ⁽²⁾
Fresno	N/A	N/A	N/A	8.21	N/A	N/A
Kern ⁽³⁾	N/A	N/A	N/A	5.98	N/A	N/A
Kings	N/A	N/A	N/A	1.36	N/A	N/A
Madera	N/A	N/A	N/A	1.33	N/A	N/A
Merced	N/A	N/A	N/A	2.25	N/A	N/A
San Joaquin	N/A	N/A	N/A	6.05	N/A	N/A
Stanislaus	N/A	N/A	N/A	4.65	N/A	N/A
Tulare	N/A	N/A	N/A	3.83	N/A	N/A
TOTAL	N/A	N/A	N/A	33.68	N/A	N/A

- (1) The District only reports ROG to ARB. As noted in Section XII, ROG is the same as VOC.
- (2) At this time, the District does not calculate PM_{2.5} emissions. PM_{2.5} emissions can be estimated using the speciation profiles found in Section XII.
- (3) Reflects only the Valley portion of Kern County.

Following is the net change in total unreconciled emissions between this update (2007 inventory year) and the previous update (2006 inventory year) for REIC 540-590-0400-0000. The change in emissions are reported for each county in the District.

Table 7. Net emissions change for REIC 540-590-0400-0000 (2007-2006).

County	Emissions (tons/year)					
	NO _x	CO	SO _x	VOC ⁽¹⁾	PM ₁₀	PM _{2.5} ⁽²⁾
Fresno	N/A	N/A	N/A	-27.82	N/A	N/A
Kern ⁽³⁾	N/A	N/A	N/A	-82.08	N/A	N/A
Kings	N/A	N/A	N/A	-8.75	N/A	N/A
Madera	N/A	N/A	N/A	1.33	N/A	N/A
Merced	N/A	N/A	N/A	2.25	N/A	N/A
San Joaquin	N/A	N/A	N/A	-38.18	N/A	N/A
Stanislaus	N/A	N/A	N/A	4.58	N/A	N/A
Tulare	N/A	N/A	N/A	-213.90	N/A	N/A
TOTAL	N/A	N/A	N/A	-362.56	N/A	N/A

- (1) The District only reports ROG to ARB. As noted in Section XII, ROG is the same as VOC.
- (2) At this time, the District does not calculate PM_{2.5} emissions. PM_{2.5} emissions can be estimated using the speciation profiles found in Section XII.
- (3) Reflects only the Valley portion of Kern County.

XV. Revision History

2007. This is a new District methodology.

XVI. Update Schedule

In an effort to provide inventory information to CARB and other District programs and maximize limited resources, the District has developed an update cycle based on emissions within the source category as shown in Table 8.

Table 8. Area source update frequency criteria.

Total Emissions (tons/day)	Update Cycle (years)
<=1	4
>1 and <= 2.5	3
>2.5 and <=5	2
>5	1

Since the VOC emissions from this category are less than one (1) ton per day, it is recommended that this methodology be updated and revised every four years.

Table 9. Asphalt roofing methodology update frequency

EIC	Frequency (In years)	Source of Emissions (Point Source Inventory / Data Gathering)
540-590-0400-0000	4	Data Gathering

XVII. References

- 1) California Air Resources Board - CEIDARS (CARB) (2009). Population and Vehicle Trends Report - Kern County. (Accessed July 10, 2009).
<http://www.arb.ca.gov/app/emsinv/trends/ems_trends.php>
- 2) National Roofing Contractors Association (NRCA) (2008). 2006-2007 Annual Market Survey.
- 3) Puzinauskas, V.P. (1979). Emissions from Asphalt Roofing Kettles. Research Report No. 79-2, The Asphalt Institute, College Park, MD, November, 1979.
- 4) U.S. EPA Emission Inventory Improvement Program (EIIP) (2000). Asphalt Roofing Kettles. (November 22, 2006).
<<http://www.epa.gov/ttn/chief/eiip/techreport/volume03/asphalt.pdf>>