

SECTION 3.7

ADHESIVES AND SEALANTS

(Updated September 1990; Reissued October 1997)

EMISSION INVENTORY SOURCE CATEGORY

Cleaning and Surface Coatings / Other

EMISSION INVENTORY CODES AND DESCRIPTION

299-292-8202-0000 (83030) Adhesive and Sealant - Solvent-Based

299-292-8250-0000 (83063) Adhesive and Sealant - Water-Based

METHODS AND SOURCES

This category is an inventory of the total organic gas (TOG) emissions from solvents contained in adhesives and sealants used for construction, transportation and other industries. Two industries, packaging and wood converting (forest products), are assumed to be accounted for in the point source inventory and are not included in these estimates. The emissions from adhesives and sealants are broken into two subcategories; **Solvent-Based** (CES 83030) and **Water-Based** (CES 83063). Emission estimates for 1983 were updated to 1987 by using growth factors which are assumed to be representative of increases in emissions associated with the use of adhesives and sealants. ¹

Data for the emission estimates were taken from the Decision Resources article titled "Outlook for the U.S. Adhesives and Sealants Industry" ² and from the SAIC report titled "Development and Improvement of Organic Compound Emissions Inventory for California." ³

The Decision Resources article provided information on the 1983 national production of adhesives and sealants in construction, transportation, and all other industries. It was assumed that production equals usage. According to Henry J. Buccigross of Decision Resources, of the total amount of adhesives and sealants produced nationally in 1983, about 10 percent is solvent-based and 45 percent is water-based. The remainder of adhesives and sealants includes hot melts (25 percent) and other adhesives and sealants (20 percent) which have negligible emissions into the ambient air. ⁴ Based on the SAIC report, California's use of national production of adhesives and sealants was 12.3 percent.

The emission factors for TOG emissions from solvent-based adhesives and sealants for the transportation and other industries categories were based on 1980 data from the SAIC Report. The emission factors for TOG emissions from solvent-based adhesives and sealants used for the construction industry were based on the 1976 data from the EPA report.⁵ The emission factors for TOG emissions from all water-based adhesives and sealants were based on data from Decision Resources.^{2,4} The information from Decision Resources is the most recent and the most reliable data.

Table I shows the 1983 emission estimates for solvent-based adhesives. Table II shows emission estimates for water-based adhesives. Statewide emission estimates were distributed to counties based on construction trends of new non-residential and residential buildings in California⁶ and are summarized in Table III and Table IV.

ASSUMPTIONS

1. Production of adhesives and sealants equals usage.
2. Data from Decision Resources and the SAIC report are reasonable bases for estimating usage of adhesives and sealants.
3. Two categories are accounted for in the point source inventory: packaging and wood converting (forest products).
4. Statewide emission estimates can be distributed to counties based on new non-residential and residential construction trend data for each county in California.
5. Emission factors derived from the SAIC report, the EPA report, the Decision Resources article, and a conversation with Henry J. Buccigross of Decision Resources are the most accurate and reliable data available at this time.

SAMPLE CALCULATIONS

1. Calculate national usage of solvent-based adhesives and sealants (assuming production equals usage):

$$(\text{National production of solvent-based adhesive} \times 10^6 \text{ lbs}) \times \% \text{ solvent-based adhesive} \times \frac{1}{2,000 \text{ lbs/ton}}$$

= amount of solvent-based adhesives and sealants used in the U.S.

$$(1,320 \times 10^6 \text{ lbs}) \times 10\% \times \frac{1}{2,000 \text{ lbs/ton}} = 66,000 \text{ tons}$$

2. Calculate usage of solvent-based adhesives and sealants in California. According to the SAIC report, ³ California's fraction of the U.S. usage of solvent-based adhesives and sealants is 12.3 percent.

$$66,000 \text{ tons} \times 12.3\% = 8,118 \text{ tons}$$

3. The emission factor for solvent-based adhesives and sealants was obtained by using a weighted average.

$$950 \text{ lbs/ton} \times \frac{25,000 \text{ tons}}{66,000 \text{ tons}} + 1,400 \text{ lbs/ton} \times \frac{41,000 \text{ tons}}{66,000 \text{ tons}}$$

$$= 1,230 \text{ lbs/ton}$$

4. Calculate emissions from solvent-based adhesives and sealants in California.

$$\text{Emissions} = \text{usage} \times \text{emission factor} \times \frac{1}{2,000 \text{ lbs/ton}}$$

$$= \frac{8,118 \text{ tons} \times 1,230 \text{ lbs/ton}}{2,000 \text{ lbs/ton}}$$

$$= 4,991 \text{ tons/year}$$

The statewide emissions are distributed based on California construction trends published by Security Pacific Bank in December 1983. ⁶ From this reference, the percent of new building construction value for each county relative to the state was estimated. If a county lies in two air basins, the split is made using population distribution. For example, to estimate emissions for Alameda County the calculation is as follows:

$$\text{Total CA TOG Emissions from Solvent-based emissions} \times \text{\% of New Building Valuation in Alameda County}$$

$$= \text{TOG emissions in Alameda for solvent based adhesive}$$

$$= 4,991 \text{ tons/yr} \times 4.43\% = 221.06 \text{ tons/yr}$$

The total emissions from solvent-based adhesives and sealants correspond to CES 83030. The same procedure of calculation is followed in estimating emissions from water-based adhesives and sealants corresponding to CES 83063.

REFERENCES

1. Air Resources Board, Technical Support Division, Emission Inventory Branch, Projections and Gridding Section. Growth Scenario TND85, Control Scenario CS1985 (February 23, 1990).
2. Barber, E. E., et al., Outlook for the U.S. Adhesives and Sealants Industry, Decision Resources (Feb. 1981).
3. Rogozen, M. B., et al., Development and Improvement of Organic Compound Emission Inventories for California, Draft Final Report, Systems Applications, Inc. for CARB Sacramento, CA contract no. A0-101-32 (1982).
4. Personal Communication with Henry L. Buccigross, Decision Resources (April 22, 1985) (617) 864-5770.
5. Johnson, W. L., Preliminary Draft of Industry Classification, Estimates of Adhesives Consumed, and Solvent Emissions. EPA Preliminary Draft, Research Triangle Park (1976).
6. Security Pacific Bank, 1983 "California Construction Trends" (Dec. 1983).

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TABLE I

1983 CA Emission Estimates (tons TOG/yr) From
Solvent-Based Adhesives and Sealants

Industry	1983 U.S. Production <u>(x 10⁶)</u>	% Solvent Based ⁴	Amount of U.S. Solvent-Based <u>(tons)</u>	CA Use of National Production <u>(tons)³</u>	Emission Factors <u>(lb/ton)</u>	1983 CA Emissions <u>(tons /yr)</u>
Construction	500	10	25,000	12.3	950 ⁴	1461
Transportation	410	10	20,500	12.3	1400 ^{3,5}	1765
All Others	<u>410</u>	10	<u>20,500</u>	12.3	1400 ^{3,5}	<u>1765</u>
Total	1,320		66,000			4991

TABLE II

1983 CA Emission Estimates (tons TOG/yr) From
Water-Based Adhesives and Sealants

<u>Industry</u>	<u>1983 U.S. Production (x 10⁶)</u>	<u>% Solvent Based ⁴</u>	<u>Amount of U.S. Solvent-Based (tons)</u>	<u>CA Use of National Production (tons)³</u>	<u>Emission Factors (lb/ton)</u>	<u>1983 CA Emissions (tons /yr)</u>
Construction	500	45	112,500	12.3	90	622.7
Transportation	410	45	92,500	12.3	90	512.0
All Others	<u>410</u>	45	<u>92,500</u>	12.3	90	<u>512.0</u>
Total	1,320		297,000			1,646.7

Table III
 1987 Area Source Emissions
 Activity: Manufacturing and Industrial
 Process: Surface Coating
 Entrainment: Adhesives Evap
 Dimm: Adhesive
 CES: 83030
 Process Rate Unit: 1000 Gallons/Year

AB	County	Process Rate	TOG Emis. (Tons / Year)	CO Emis. (Tons / Year)	NOX Emis. (Tons / Year)	SOX Emis. (Tons / Year)	PM Emis. (Tons / Year)
GBV	ALPINE	0	0.00	0.00	0.00	0.00	0.00
	INYO	3	2.14	0.00	0.00	0.00	0.00
	MONO	0	0.00	0.00	0.00	0.00	0.00
LC	LAKE	39	24.72	0.00	0.00	0.00	0.00
LT	EL DORADO	11	7.15	0.00	0.00	0.00	0.00
	PLACER	6	4.51	0.00	0.00	0.00	0.00
MC	AMADOR	8	5.56	0.00	0.00	0.00	0.00
	CALAVERAS	19	12.05	0.00	0.00	0.00	0.00
	EL DORADO	26	16.50	0.00	0.00	0.00	0.00
	MARIPOSA	4	2.73	0.00	0.00	0.00	0.00
	NEVADA	21	13.67	0.00	0.00	0.00	0.00
	PLACER	10	6.94	0.00	0.00	0.00	0.00
	PLUMAS	10	6.26	0.00	0.00	0.00	0.00
	SIERRA	0	0.00	0.00	0.00	0.00	0.00
	TUOLUMNE	15	9.44	0.00	0.00	0.00	0.00
NC	DEL NORTE	4	2.95	0.00	0.00	0.00	0.00
	HUMBOLDT	17	10.66	0.00	0.00	0.00	0.00
	MENDOCINO	14	9.23	0.00	0.00	0.00	0.00
	SONOMA	26	16.24	0.00	0.00	0.00	0.00
	TRINITY	2	1.29	0.00	0.00	0.00	0.00
NCC	MONTEREY	90	55.33	0.00	0.00	0.00	0.00
	SAN BENITO	7	4.98	0.00	0.00	0.00	0.00
	SANTA CRUZ	83	51.02	0.00	0.00	0.00	0.00
NEP	LASSEN	4	2.94	0.00	0.00	0.00	0.00
	MODOC	2	1.22	0.00	0.00	0.00	0.00
	SISKIYOU	7	4.33	0.00	0.00	0.00	0.00
SC	LOS ANGELES	5304	3262.00	0.00	0.00	0.00	0.00
	ORANGE	4120	2533.80	0.00	0.00	0.00	0.00
	RIVERSIDE	1278	786.50	0.00	0.00	0.00	0.00
	SAN BERNARDINO	2118	1302.80	0.00	0.00	0.00	0.00
SCC	SAN LUIS OBISPO	130	80.20	0.00	0.00	0.00	0.00
	SANTA BARBARA	99	61.36	0.00	0.00	0.00	0.00
	VENTURA	246	151.38	0.00	0.00	0.00	0.00
SD	SAN DIEGO	1084	667.39	0.00	0.00	0.00	0.00
SED	IMPERIAL	22	13.78	0.00	0.00	0.00	0.00
	KERN	25	15.65	0.00	0.00	0.00	0.00
	LOS ANGELES	31	18.86	0.00	0.00	0.00	0.00
	RIVERSIDE	148	91.42	0.00	0.00	0.00	0.00
	SAN BERNARDINO	96	59.05	0.00	0.00	0.00	0.00
SF	ALAMEDA	58	142.71	0.00	0.00	0.00	0.00
	CONTRA COSTA	49	119.72	0.00	0.00	0.00	0.00
	MARIN	10	24.82	0.00	0.00	0.00	0.00
	NAPA	6	15.69	0.00	0.00	0.00	0.00
	SAN FRANCISCO	61	150.74	0.00	0.00	0.00	0.00
	SAN MATEO	21	52.56	0.00	0.00	0.00	0.00
	SANTA CLARA	91	223.01	0.00	0.00	0.00	0.00
	SOLANO	8	20.07	0.00	0.00	0.00	0.00
	SONOMA	4	8.76	0.00	0.00	0.00	0.00
SJV	FRESNO	147	90.55	0.00	0.00	0.00	0.00
	KERN	158	97.23	0.00	0.00	0.00	0.00
	KINGS	25	15.34	0.00	0.00	0.00	0.00
	MADERA	19	11.97	0.00	0.00	0.00	0.00
	MERCED	39	24.73	0.00	0.00	0.00	0.00
	SAN JOAQUIN	126	77.36	0.00	0.00	0.00	0.00
	STANISLAUS	64	39.86	0.00	0.00	0.00	0.00
	TULARE	66	40.80	0.00	0.00	0.00	0.00
SV	BUTTE	43	26.40	0.00	0.00	0.00	0.00
	COLUSA	2	1.99	0.00	0.00	0.00	0.00
	GLENN	3	2.21	0.00	0.00	0.00	0.00
	PLACER	84	51.85	0.00	0.00	0.00	0.00
	SACRAMENTO	340	209.74	0.00	0.00	0.00	0.00
	SHASTA	29	18.49	0.00	0.00	0.00	0.00
	SOLANO	18	11.20	0.00	0.00	0.00	0.00
	SUTTER	11	6.52	0.00	0.00	0.00	0.00
	TEHAMA	10	6.12	0.00	0.00	0.00	0.00
	YOLO	34	21.05	0.00	0.00	0.00	0.00
	YUBA	7	4.82	0.00	0.00	0.00	0.00
TOTAL		16665	10832.36	0.00	0.00	0.00	0.00

Fraction of Reactive Organic Gases (FROG): . 8676
 (Reactive Organic Gases (ROG) Emissions = TOG X FROG)
 Fraction of PM10 (FRPM10):
 (PM10 Emissions = PM X FRPM10)

Table IV
 1987 Area Source Emissions
 Activity: Manufacturing and Industrial
 Process: Surface Coating
 Entrainment: Water Based-Evap
 Dimn: Adhesive
 CES: 83063
 Process Rate Unit: 1000 Gallons Per Year

AB	County	Process Rate	TOG Emis. (Tons / Year)	CO Emis. (Tons / Year)	NOX Emis. (Tons / Year)	SOX Emis. (Tons / Year)	PM Emis. (Tons / Year)
GBV	ALPINE	0	0.00	0.00	0.00	0.00	0.00
	INYO	16	0.75	0.00	0.00	0.00	0.00
	MONO	0	0.00	0.00	0.00	0.00	0.00
LC	LAKE	180	8.20	0.00	0.00	0.00	0.00
LT	EL DORADO	51	2.31	0.00	0.00	0.00	0.00
	PLACER	32	1.39	0.00	0.00	0.00	0.00
MC	AMADOR	40	1.85	0.00	0.00	0.00	0.00
	CALAVERAS	88	3.93	0.00	0.00	0.00	0.00
	EL DORADO	121	5.42	0.00	0.00	0.00	0.00
	MARIPOSA	19	0.87	0.00	0.00	0.00	0.00
	NEVADA	99	4.51	0.00	0.00	0.00	0.00
	PLACER	50	2.25	0.00	0.00	0.00	0.00
	PLUMAS	46	2.00	0.00	0.00	0.00	0.00
	SIERRA	0	0.00	0.00	0.00	0.00	0.00
	TUOLUMNE	69	3.15	0.00	0.00	0.00	0.00
NC	DEL NORTE	21	0.94	0.00	0.00	0.00	0.00
	HUMBOLDT	78	3.55	0.00	0.00	0.00	0.00
	MENDOCINO	67	3.08	0.00	0.00	0.00	0.00
	SONOMA	119	5.37	0.00	0.00	0.00	0.00
	TRINITY	9	0.39	0.00	0.00	0.00	0.00
NCC	MONTEREY	405	18.26	0.00	0.00	0.00	0.00
	SAN BENITO	36	1.66	0.00	0.00	0.00	0.00
	SANTA CRUZ	374	16.81	0.00	0.00	0.00	0.00
NEP	LASSEN	21	0.94	0.00	0.00	0.00	0.00
	MODOC	8	0.36	0.00	0.00	0.00	0.00
	SISKIYOU	32	1.36	0.00	0.00	0.00	0.00
SC	LOS ANGELES	4310	194.03	0.00	0.00	0.00	0.00
	ORANGE	3342	150.30	0.00	0.00	0.00	0.00
	RIVERSIDE	1040	46.88	0.00	0.00	0.00	0.00
	SAN BERNARDINO	1723	77.48	0.00	0.00	0.00	0.00
SCC	SAN LUIS OBISPO	587	26.41	0.00	0.00	0.00	0.00
	SANTA BARBARA	450	20.19	0.00	0.00	0.00	0.00
	VENTURA	1109	50.00	0.00	0.00	0.00	0.00
SD	SAN DIEGO	3143	141.45	0.00	0.00	0.00	0.00
SED	IMPERIAL	100	4.52	0.00	0.00	0.00	0.00
	KERN	114	5.15	0.00	0.00	0.00	0.00
	LOS ANGELES	138	6.25	0.00	0.00	0.00	0.00
	RIVERSIDE	670	30.12	0.00	0.00	0.00	0.00
	SAN BERNARDINO	433	19.49	0.00	0.00	0.00	0.00
SF	ALAMEDA	502	90.52	0.00	0.00	0.00	0.00
	CONTRA COSTA	421	75.92	0.00	0.00	0.00	0.00
	MARIN	87	15.69	0.00	0.00	0.00	0.00
	NAPA	55	9.85	0.00	0.00	0.00	0.00
	SAN FRANCISCO	530	95.26	0.00	0.00	0.00	0.00
	SAN MATEO	185	33.21	0.00	0.00	0.00	0.00
	SANTA CLARA	785	141.25	0.00	0.00	0.00	0.00
	SOLANO	70	12.77	0.00	0.00	0.00	0.00
	SONOMA	30	5.47	0.00	0.00	0.00	0.00
SJV	FRESNO	664	29.89	0.00	0.00	0.00	0.00
	KERN	712	32.05	0.00	0.00	0.00	0.00
	KINGS	111	5.04	0.00	0.00	0.00	0.00
	MADERA	87	3.95	0.00	0.00	0.00	0.00
	MERCED	181	8.21	0.00	0.00	0.00	0.00
	SAN JOAQUIN	568	25.59	0.00	0.00	0.00	0.00
	STANISLAUS	292	13.14	0.00	0.00	0.00	0.00
	TULARE	298	13.52	0.00	0.00	0.00	0.00
SV	BUTTE	193	8.76	0.00	0.00	0.00	0.00
	COLUSA	14	0.70	0.00	0.00	0.00	0.00
	GLENN	16	0.77	0.00	0.00	0.00	0.00
	PLACER	379	17.17	0.00	0.00	0.00	0.00
	SACRAMENTO	1537	69.26	0.00	0.00	0.00	0.00
	SHASTA	135	6.04	0.00	0.00	0.00	0.00
	SOLANO	82	3.70	0.00	0.00	0.00	0.00
	SUTTER	48	2.11	0.00	0.00	0.00	0.00
	TEHAMA	44	2.00	0.00	0.00	0.00	0.00
	YOLO	153	6.94	0.00	0.00	0.00	0.00
	YUBA	35	1.54	0.00	0.00	0.00	0.00
TOTAL		27354	1591.79	0.00	0.00	0.00	0.00

Fraction of Reactive Organic Gases (FROG): . 9444
 (Reactive Organic Gases (ROG) Emissions = TOG X FROG)
 Fraction of PM10 (FRPM10):
 (PM10 Emissions = PM X FRPM10)