

Organic Gas Speciation Profiles for Architectural Coatings (2014 Survey)

—OG3903 & OG3904

May 6, 2022

California Air Resources Board
1001 I Street
Sacramento, California 95814

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I. Introduction

In Title 17 of the California Code of Regulations, architectural coating is defined as “any product which is used as, or usable as, a coating applied to the interior or exterior surfaces of stationary structures and their appurtenances, to portable buildings, to pavements, or to curbs, such as house and trim paints, varnishes, stains, lacquers, industrial maintenance coatings, primers, undercoaters, and traffic coatings” [1].

The California Air Resources Board (CARB) conducts regular surveys on architectural coatings. The most recent survey was conducted in 2014 to gather information on volatile organic compound (VOC) contents of architectural coatings that were sold or supplied for use in California during calendar year 2013 [2]. The following two new organic gas (OG) speciation profiles were developed based on the 2014 Survey data:

- OG3903: 2013 Architectural Coatings – Solvent-Based (2014 Survey)
- OG3904: 2013 Architectural Coatings – Water-Based (2014 Survey)

Profile OG3903 will be used to replace the existing OG3901 for solvent-based architectural coating categories, and profile OG3904 will be used to replace the existing OG3902 for water-based architectural coating categories, for 2013 and later years. The two profiles currently in-use, OG3901 and OG3902, were developed based on the 2005 CARB Architectural Coatings Survey [3].

II. Methodology

The 2014 Survey showed that about 89 million gallons of architectural coatings were sold in California during 2013, with 6% of that volume coming from solvent-based products and 94% from water-based products [2]. There are also about 2 million gallons of colorants which were sold in California during the same time. To account for incomplete survey market coverage, the reported sales were adjusted by dividing by a market adjustment factor of 0.9. The 2014 Survey also gathered chemical speciation data for all volatile ingredients, including reactive organic gas (ROG) and exempt compounds. The product sales and chemical composition data obtained from the survey were used to develop the composite speciation profiles for solvent-based coatings (OG3903) and water-based coatings (OG3904).

III. Results and Discussion

Speciation profile consists of chemical compound/group name, weight percentage of total organic gas (TOG), and CARB SAROAD code defined in CARB’s CEIDARS pollutant table. For the six chemical compounds/groups reported in the survey but don’t currently have CARB SAROAD, the new codes are assigned to them as shown in Table 1.

Table 1: New CARB SAROAD codes to be added to CEIDARS pollutant table

CARB SAROAD	CAS	Chemical Name	Formula	Molecular Weight
43546	75-91-2	tert-butyl hydroperoxide	C4H10O2	90.12
43547	140-31-8	n-aminoethylpiperazine	C6H15N3	129.20
43548	1477-55-0	m-xylene-a,a-diamine	C8H12N2	136.19
43553	4169-04-4	propylene glycol phenyl ether	C9H12O2	152.19
99163		aggregated VOCs < 0.1%		
99764		aggregated exempt compounds < 0.1%		

The details of the new profiles OG3903 and OG3904 are summarized in the Appendix (Table 3 and Table 4). In the solvent-based profile OG3903, 37.6% of the TOG is from architectural coatings/consumer products (or hydrocarbon solvent) bin 11, followed by 13.6% parachlorobenzotrifluoride (PCBTF), 12.6% acetone and 5.4% ethanol. The ROG/TOG ratio is 0.6999. In the water-based profile OG3904, the most abundant species is 2,2,4-trimethyl-1,3-pentanediol isobutyrate (27.6%), followed by ethylene glycol (15.3%), propylene glycol (14.4%) and 2-ethylhexyl benzoate (6.6%). The ROG/TOG ratio is 0.9962.

IV. Estimated Impacts of Profile Update

CARB has 61 Emission Inventory Codes (EICs) for architectural coating categories (including 3 EICs for colorant). OG3903 will be assigned to the solvent-based coating categories and OG3904 will be assigned to the water-based coating categories (Table 5). Implementation of the new profiles for their related EICs will affect the estimation of their ROG emissions and ozone forming potential (OFP).

Using the emissions for year 2020 as an example, the statewide annual average TOG emissions for architectural coating categories (520-520-9###-0000) are 33.6 tons/day based on CEPAM: California 2022 Ozone SIP Baseline Emission Projection Planning Inventory (version 1.01) [4], which is about 0.6% of the statewide total anthropogenic TOG emissions. With the new profiles, the estimated ROG emissions for these categories are 27.86 tons/day, which is 9.9% less than the ROG emissions calculated by using the current profiles for year 2020 (Table 2). This is mainly because the ROG/TOG ratio of the solvent-based coating profile reduces from 0.8701 (OG3901) to 0.6999 (OG3903). The increased use of the exempt compound PCBTF in the new survey (13.6%) compared to the previous survey (2.1%) is the largest contributor to this change.

The impact of the profile update on OFP is also evaluated for year 2020. If the new profiles are applied, the calculated OFP will be approximately 9.7% less than that estimated with the current profiles (Table 2).

Table 2: Impacts on architectural coating categories (520-520-9###-0000) using updated profiles OG3903 and OG3904 (2020)

Statewide annual average emissions	Using current profiles OG3901 & OG3902 (tons/day)	Using new profiles OG3903 & OG3904 (tons/day)	Change of Emissions (tons/day)	Percentage of Change
ROG	31.3	28.2	-3.1	-9.9%
OFP (tons O ₃)	60.1	54.3	-5.8	-9.7%

Disclaimer

Because the composite speciation profiles are an average of all coating categories, the chemical compositions and ratios of ROG/TOG provided herein may not be applicable for certain individual EICs in all situations and consultation is suggested for specific applications.

References:

1. *California Code of Regulations, Public Health, Title 17, Sections 33002.*
2. *Architectural Coatings Survey.* [cited 2022 January 4]; Available from: <https://ww2.arb.ca.gov/our-work/programs/coatings/architectural-coatings/architectural-coatings-survey>.
3. *California Air Resources Board Main Speciation Profiles, 2021,* California Air Resources Board, Accessed: January 28, 2022.
4. *CEPAM, 2022,* California Air Resources Board, Accessed: May 5, 2022.

V. Appendix

Table 3: Profile OG3903: 2013 Architectural Coatings – Solvent-Based (2014 Survey)

Species Name	CARB-SAROAD	Weight Percentage (%)
1,2,4-trimethylbenzene	45208	0.622406
1,3,5-trimethylbenzene	45207	0.061593
1-butoxy-2-propanol	99233	0.032370
1-methyl-2-pyrrolidinone	98129	0.032841
1-phenoxy-2-propanol	44211	0.007509
2,2,4-trimethyl-1,3-pentanediol diisobutyrate	44255	0.114978
2,2,4-trimethyl-1,3-pentanediol isobutyrate	99247	0.013258
2,4-pentanedione	99443	0.009257
2,6-dimethyl-4-heptanone	99194	0.008124
2-butanone	43552	0.201412
2-butoxyethanol	98074	0.703110
2-butoxyethyl acetate	99148	0.008533
2-ethylhexyl acetate	99189	0.053874
2-pentanone	98160	0.080332
3-aminopropyltriethoxysilane	43957	0.021072
acetone	43551	12.558270
aggregated VOCs < 0.1%	99163	1.905953
architectural coatings/consumer products bin 2	44002	0.314490
architectural coatings/consumer products bin 6	44006	0.541378
architectural coatings/consumer products bin 7	44007	0.044005
architectural coatings/consumer products bin 11	44011	37.596773
architectural coatings/consumer products bin 12	44012	0.716857
architectural coatings/consumer products bin 16	44016	4.033202
architectural coatings/consumer products bin 21	44021	3.240127
architectural coatings/consumer products bin 22	44022	2.811995
architectural coatings/consumer products bin 23	44023	0.353707
architectural coatings/consumer products bin 24	44024	0.146049
benzoyl peroxide	99437	0.013743
benzyl alcohol	99187	0.805843
butyl propionate	99457	0.018336
cyclohexanone	43264	0.008203
decamethylcyclopentasiloxane	43355	0.166475
diacetone alcohol	43320	0.018789
diethylbenzene	43473	0.017513
diethylene glycol monobutyl ether acetate	99210	0.016084
diethylenetriamine	99204	0.629208
dimethyl sulfoxide	99172	0.011078
dipentene	99214	0.061211

Species Name	CARB-SAROAD	Weight Percentage (%)
dipropylene glycol	43374	0.013539
dipropylene glycol monomethyl ether	43366	0.020775
distillates (petroleum), hydrotreated heavy naphthenic	44234	0.789667
distillates (petroleum), hydrotreated heavy paraffinic	43493	0.009370
distillates (petroleum), hydrotreated light naphthenic	44235	0.531196
distillates (petroleum), hydrotreated light paraffinic	43494	0.009808
distillates (petroleum), straight-run middle	44259	0.137697
d-limonene	98027	0.027688
ethanol	43302	5.388888
ethyl 3-ethoxypropionate	99222	0.074245
ethyl acetate	43433	0.026366
ethyl silicate	44229	0.052794
ethylbenzene	45203	0.567935
ethylene glycol	43370	0.006736
ethylene glycol propyl ether	99232	0.061849
fuels, diesel, No. 2	99475	0.007868
furfuryl alcohol	99026	0.047259
heavy paraffinic distillate solvent extract	99466	0.017360
hexylene glycol	43371	0.048770
isobutyl acetate	43446	0.019369
isobutyl alcohol	43306	0.097412
isobutyl isobutyrate	43451	0.053006
isopropanol	43304	0.613128
isopropylbenzene	98043	0.009722
kerosene	60006	0.047651
methanol	43301	0.068100
methyl acetate	43432	0.101538
methyl amyl ketone	43561	0.709965
methyl carbitol	98123	0.013337
methyl ethyl ketoxime	99183	0.173616
methyl isobutyl ketone	43560	0.319189
methyltrimethoxysilane	99224	0.007104
m-xylene-a,a-diamine	43548	0.019418
n-aminoethylpiperazine	43547	0.108403
n-butyl acetate	43435	0.753332
n-butyl alcohol	43305	0.490561
n-nonane	43235	0.074999
octamethylcyclotetrasiloxane	99396	2.865186
other misc. VOC compounds aggregated in profile	99146	0.697405
parachlorobenzotrifluoride	99185	13.635893
pentyl propanoate	43868	0.008246
perchloroethylene	43817	0.131657

Species Name	CARB-SAROAD	Weight Percentage (%)
polydimethylsiloxane	43461	0.555605
propyl acetate	43434	0.006314
propylene carbonate	99193	0.247082
propylene glycol	43369	0.155029
propylene glycol methyl ether	43365	0.169482
propylene glycol monomethyl ether acetate	43431	0.254805
sec-butyl alcohol	43314	0.010391
solvent-refined heavy paraffinic distillates (petroleum)	99492	0.194909
styrene	45220	0.015153
t-butyl acetate	99218	0.445752
toluene	45202	0.557800
trimethoxymethane	99476	0.021056
trimethylbenzene	45107	0.023638
tripropylene glycol methyl ether	44266	0.028504
vinyl toluene	99306	0.120672
white mineral oil (petroleum)	44269	0.335803
Total		100.000000

Table 4: Profile OG3904: 2013 Architectural Coatings – Water-Based (2014 Survey)

Species Name	CARB-SAROAD	Weight Percentage (%)
1,2,4-trimethylbenzene	45208	0.018074
1-butoxy-2-propanol	99233	0.266034
1-methyl-2-pyrrolidinone	98129	0.931295
1-nitropropane	44204	0.036175
1-phenoxy-2-propanol	44211	0.449867
2-(2-butoxyethoxy)ethanol	98110	3.614225
2-(2-ethylhexyloxy)ethanol	99228	0.033068
2-(methylamino)ethanol	43333	0.484038
2,2,4-trimethyl-1,3-pentanediol diisobutyrate	44255	0.968584
2,2,4-trimethyl-1,3-pentanediol isobutyrate	99247	27.605680
2-amino-2-methyl-1-propanol	99211	1.410183
2-butoxyethanol	98074	1.398735
2-butoxyethyl acetate	99148	0.005190
2-ethyl-1-hexanol	98112	0.022328
2-ethylhexyl acetate	99189	0.032401
2-ethylhexyl benzoate	44208	6.568521
2-(hydroxymethylamino)ethanol	44267	0.106967
4,4-dimethyloxazolidine	44212	1.459009
acetic acid	43404	0.161075
acetic acid, alkyl (C9 to C11) esters mixture	43952	0.012286

Species Name	CARB-SAROAD	Weight Percentage (%)
acetone	43551	0.046482
aggregated exempt compounds < 0.1%	99164	0.146265
aggregated VOCs < 0.1%	99163	3.665144
architectural coatings/consumer products bin 6	44006	0.027400
architectural coatings/consumer products bin 11	44011	2.369423
architectural coatings/consumer products bin 12	44012	0.006823
architectural coatings/consumer products bin 16	44016	0.047216
architectural coatings/consumer products bin 21	44021	0.194598
architectural coatings/consumer products bin 22	44022	3.910042
benzyl alcohol	99187	0.169291
carbitol	98096	0.110856
diethylene glycol	43373	0.005942
diethylene glycol ethyl ether acetate	43931	0.017091
diethylene glycol monobutyl ether acetate	99210	0.006053
dipropylene glycol	43374	0.367324
dipropylene glycol dimethyl ether (mixed isomers)	99276	0.240825
dipropylene glycol monomethyl ether	43366	1.057133
dipropylene glycol monopropyl ether	44206	0.022681
dipropylene glycol n-butyl ether	99252	1.957975
distillates (petroleum), hydrotreated heavy naphthenic	44234	0.065289
distillates (petroleum), hydrotreated heavy paraffinic	43493	0.196642
distillates (petroleum), hydrotreated light naphthenic	44235	0.024597
distillates (petroleum), solvent-dewaxed heavy paraffinic	43358	0.359591
distillates/naphtha/mineral spirits	99151	1.490986
ethanol	43302	1.298190
ethanolamine	43723	0.462466
ethylbenzene	45203	0.008046
ethylene glycol	43370	15.309269
ethylene glycol propyl ether	99232	0.442510
gamma-butyrolactone	99184	0.163277
hexylene glycol	43371	0.057141
isopropanol	43304	0.189510
methanol	43301	2.260045
methyl carbitol	98123	0.636332
methyl ethyl ketoxime	99183	0.067054
methyltrimethoxysilane	99224	0.260493
m-xylene-a,a-diamine	43548	0.007932
n,n-dimethylethanolamine	99440	0.103633
naphtha (petroleum), hydrotreated heavy	44233	0.057093
n-butyl acetate	43435	0.016662
n-butyl alcohol	43305	0.130657
octamethylcyclotetrasiloxane	99396	0.010692

Species Name	CARB-SAROAD	Weight Percentage (%)
other misc. VOC compounds aggregated in profile	99146	0.263975
parachlorobenzotrifluoride	99185	0.158371
phenoxyethanol	99209	0.067789
polydimethylsiloxane	43461	0.016993
propylene carbonate	99193	0.014329
propylene glycol	43369	14.370560
propylene glycol methyl ether	43365	0.051794
propylene glycol n-propyl ether	99229	0.085404
propylene glycol phenyl ether	43553	0.006152
sec-butyl alcohol	43314	0.178778
solvent-refined heavy paraffinic distillates (petroleum)	99492	0.232598
tert-butyl hydroperoxide	43546	0.011344
tributyl phosphate	50275	0.131908
triethylamine	99207	0.136492
triethylene glycol	43376	0.045579
triethylene glycol monobutyl ether	44265	0.008059
tripropylene glycol methyl ether	44266	0.037204
tripropylene glycol n-butyl ether	43881	0.009835
vinyl acetate	98119	0.032053
white mineral oil (petroleum)	44269	0.570377
Total		100.000000

Table 5: Mapping of new OG profiles to architectural coating categories

EIC	EIC Name	OG Profile No.
52052091000000	Architectural Coatings: Solvent-Based Coatings (Unspecified)	OG3903
52052091050000	Architectural Coatings: Solvent-Based Primers, Sealers, and Undercoaters	OG3903
52052091060000	Architectural Coatings: Solvent-Based Quick Dry Primers, Sealers, and Undercoaters	OG3903
52052091080000	Architectural Coatings: Solvent-Based Specialty Primer, Sealer, and Undercoaters	OG3903
52052091090000	Architectural Coatings: Solvent-Based Bituminous Roof Primer	OG3903
52052091120000	Architectural Coatings: Solvent-Based Sanding Sealers	OG3903
52052091130000	Architectural Coatings: Solvent-Based Waterproofing Sealers	OG3903
52052091180000	Architectural Coatings: Solvent-Based Waterproofing Concrete/Masonry Sealers	OG3903
52052091220000	Architectural Coatings: Solvent-Based Faux Finishing	OG3903
52052091240000	Architectural Coatings: Solvent-Based Mastic Texture	OG3903
52052091260000	Architectural Coatings: Solvent-Based Rust Preventative	OG3903

EIC	EIC Name	OG Profile No.
52052091310000	Architectural Coatings: Solvent-Based Stains - Clear/Semitransparent	OG3903
52052091360000	Architectural Coatings: Solvent-Based Stains - Opaque	OG3903
52052091410000	Architectural Coatings: Solvent-Based Varnish - Clear/Semitransparent	OG3903
52052091530000	Architectural Coatings: Solvent-Based Quick Dry Enamel Coatings	OG3903
52052091570000	Architectural Coatings: Solvent-Based Lacquers (Unspecified)	OG3903
52052091590000	Architectural Coatings: Solvent-Based Flat Coatings	OG3903
52052091600000	Architectural Coatings: Solvent-Based Nonflat - Low Gloss/Medium Gloss	OG3903
52052091610000	Architectural Coatings: Solvent-Based High Gloss Nonflat Coatings	OG3903
52052091640000	Architectural Coatings: Solvent-Based Bituminous Roof Coatings	OG3903
52052091650000	Architectural Coatings: Solvent-Based Concrete Curing Compounds	OG3903
52052091660000	Architectural Coatings: Solvent-Based Dry Fog Coatings	OG3903
52052091690000	Architectural Coatings: Solvent-Based Floor Coatings	OG3903
52052091700000	Architectural Coatings: Solvent-Based Form Release Coatings	OG3903
52052091710000	Architectural Coatings: Solvent-Based High Temperature Coatings	OG3903
52052091720000	Architectural Coatings: Solvent-Based Industrial Maintenance Coatings	OG3903
52052091730000	Architectural Coatings: Solvent-Based Metallic Pigmented Coatings	OG3903
52052091740000	Architectural Coatings: Solvent-Based Roof Coatings	OG3903
52052091760000	Architectural Coatings: Solvent-Based Traffic Coatings	OG3903
52052091770000	Architectural Coatings: Solvent-Based Wood Preservatives	OG3903
52052092000000	Architectural Coatings: Water-Based Coatings (Unspecified)	OG3904
52052092050000	Architectural Coatings: Water-Based Primers, Sealers, and Undercoaters	OG3904
52052092060000	Architectural Coatings: Water-Based Quick Dry Primers, Sealers, and Undercoaters	OG3904
52052092080000	Architectural Coatings: Water-Based Specialty Primer, Sealer, and Undercoaters	OG3904
52052092090000	Architectural Coatings: Water-Based Bituminous Roof Primer	OG3904
52052092120000	Architectural Coatings: Water-Based Sanding Sealers	OG3904
52052092130000	Architectural Coatings: Water-Based Waterproofing Sealers	OG3904
52052092180000	Architectural Coatings: Water-Based Waterproofing Concrete/Masonry Sealers	OG3904
52052092220000	Architectural Coatings: Water-Based Faux Finishing	OG3904
52052092230000	Architectural Coatings: Water-Based Form Release Compounds	OG3904
52052092240000	Architectural Coatings: Water-Based Mastic Texture	OG3904
52052092260000	Architectural Coatings: Water-Based Rust Preventative	OG3904
52052092310000	Architectural Coatings: Water-Based Stains - Clear/Semitransparent	OG3904

EIC	EIC Name	OG Profile No.
52052092360000	Architectural Coatings: Water-Based Stains - Opaque	OG3904
52052092410000	Architectural Coatings: Water-Based Varnishes - Clear/Semitransparent	OG3904
52052092570000	Architectural Coatings: Water-Based Lacquers (Unspecified)	OG3904
52052092590000	Architectural Coatings: Water-Based Flat Coatings	OG3904
52052092600000	Architectural Coatings: Water-Based Nonflat - Low Gloss/Medium Gloss	OG3904
52052092610000	Architectural Coatings: Water-Based High Gloss Nonflat Coatings	OG3904
52052092640000	Architectural Coatings: Water-Based Bituminous Roof Coatings	OG3904
52052092650000	Architectural Coatings: Water-Based Concrete Curing Compounds	OG3904
52052092660000	Architectural Coatings: Water-Based Dry Fog Coatings	OG3904
52052092690000	Architectural Coatings: Water-Based Floor Coatings	OG3904
52052092720000	Architectural Coatings: Water-Based Industrial Maintenance Coatings	OG3904
52052092730000	Architectural Coatings: Water-Based Metallic Pigmented Coatings	OG3904
52052092740000	Architectural Coatings: Water-Based Roof Coatings	OG3904
52052092760000	Architectural Coatings: Water-Based Traffic Coatings	OG3904
52052092770000	Architectural Coatings: Water-Based Wood Preservatives	OG3904
52052092810000	Colorant - Excluding IM Coatings (50 G/L)	OG3904
52052092820000	Colorant – Solvent-Based IM Coatings	OG3903
52052092830000	Colorant - Waterborne IM Coatings (50 G/L)	OG3904