CALIFORNIA
AIR RESOURCES BOARD

SURVEY

Data Summary and Findings

April 10, 2019

2013 - 2015 Survey of Consumer & Commercial Products

Table of Contents

Consumer and Commercial Product Survey Summary and Findings

Executive Summary

This document provides an overview and discussion of the 2013, 2014, and 2015 Consumer and Commercial Product Survey Data summaries (Survey Data) published on April 2, 2019. These surveys were part of a larger, systematic effort by the California Air Resources Board (CARB) to update emission estimates for all major emission sources to support attainment of federal ambient air quality standards, and ensure clean, healthful air for all Californians. The sales and formulation information for products sold in California was required to be reported by manufacturers and formulators.

The 2013, 2014, and 2015 surveys were structured to include all consumer and commercial product categories, including 71 new categories of products. In total, more than 1,500 product manufacturers and formulators provided CARB with California sales and chemical formulations for over one million products. The resulting survey data summaries provide a rich dataset of consumer product sales, chemical speciation, air emissions, reactivity, and other summary information for almost 500 specific consumer product categories.

Highlights of the Survey Data includes the following:

- The Survey Data indicate that consumer product reactive organic gas (ROG) emissions are over 20 percent higher than found in CARB's existing consumer product emission inventory, predominantly due to the Personal Care Product sector. This is likely due to the following factors: faster than anticipated sales growth for the sector, different compliance pathways for regulated categories than those assumed in the existing inventory, or underrepresentation of sales in previous CARB surveys.

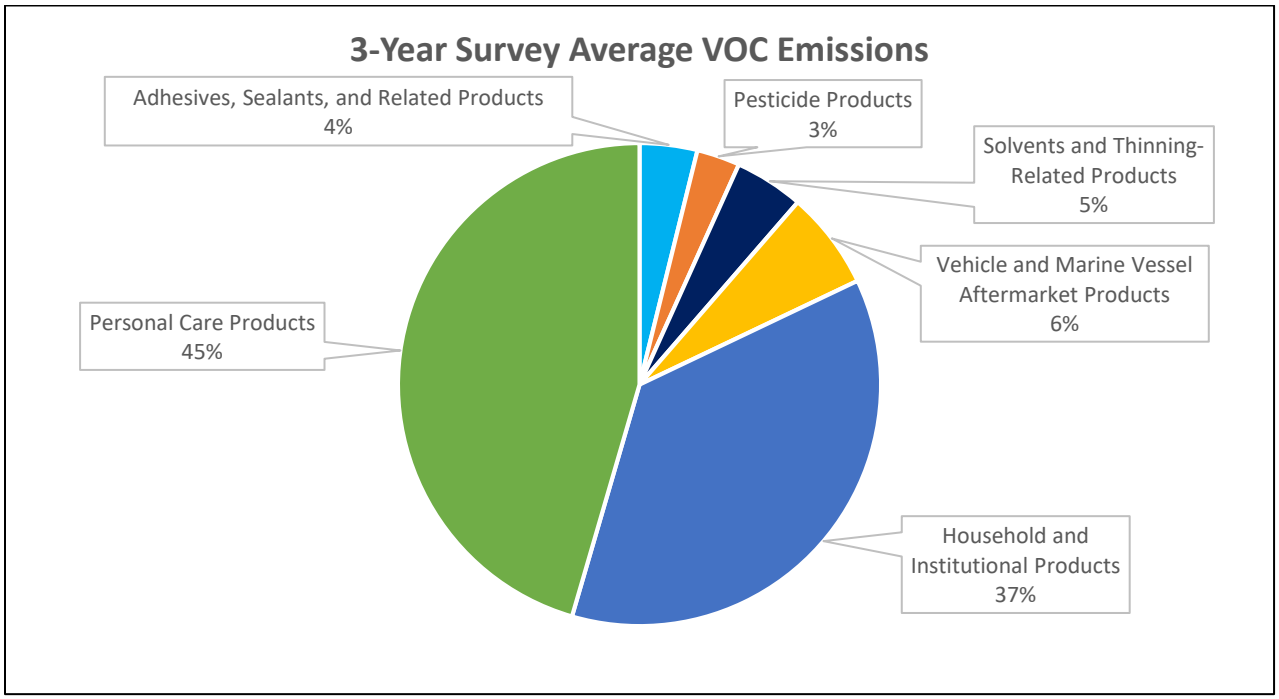
- The Personal Care Products sector and the Household and Industrial Product sector contribute 45 percent and 37 percent, respectively, of the total volatile organic compound (VOC) emissions from all six major sectors in the three year survey, as seen in Figure ES-1. The top five sources of consumer product VOC emissions for each of the three years surveyed – Hand Sanitizer, Personal Fragrance Product (with 20 Percent of Less Fragrance), Hair Finishing Spray, Rubbing Alcohol, and Aerosol Disinfectant – derive from these two sectors.

- Mass and chemical speciation remain relatively constant across all six major product sectors for the three survey reporting years. One notable exception is the VOC content and emissions decrease for the Solvents and Thinning-Related Products sector, likely due to two consumer product regulations to limit allowable VOC content that began implementation during the survey reporting period.

- Fragrance ranks as the second or third highest of all reported total organic gas (TOG) ingredients in all three survey years, representing nearly eight percent by weight of the total TOG. Consistent with CARB's Aerosol Coatings Regulation, unspeciated fragrance ingredients are assigned as a default the ozone-forming reduction value for terpinolene. Fragrance therefore contributes up to 25 percent to the total ozone forming potential and is the greatest ozone forming potential contributor among all TOG constituents of the six major sectors in the three year consumer product survey. The greatest presence of fragrance is within the TOG ingredients of the Personal Care Products and the Household and Institutional Products sectors.

These three years of consumer product survey data provide us the scientific foundation to identify the most cost-effective and health-protective new measures needed from consumer products to meet California's air quality and community health goals.

Figure ES-1. The VOC Emissions Contributions of the Six Major Sectors Surveyed



Overview of CARB's Consumer Products Program

In 1988, the Legislature enacted the California Clean Air Act, which declared that attainment of the California state ambient air quality standards is necessary to promote and protect public health, particularly of children, older people, and those with respiratory diseases. This landmark legislation added section 41712 to the California Health and Safety Code (HSC), directing CARB to achieve the maximum feasible VOC reductions from consumer products needed to meet state and federal air quality standards. Such regulations must be commercially and technologically feasible and may not require elimination of a product form (HSC, Section 41712(b)).

"Consumer Product" for CARB regulatory purposes, means a chemically formulated product used by household and institutional consumers, including, but not limited to, detergents; cleaning compounds; polishes; floor finishes; cosmetics; personal care products; home, lawn, and garden products; disinfectants; sanitizers; aerosol paints; and automotive specialty products; but does not include other paint products, furniture coatings, or architectural coatings (CCR, Section 94508(a)(29)).

VOC emissions from consumer products and other sources (motor vehicles, stationary sources, etc.) react with other pollutants under sunlight to form ground-level ozone and particulate matter (PM2.5). Consumer products are the largest emission inventory category for ROG emissions Statewide. Reducing emissions from consumer products therefore plays an integral part in CARB's effort to reduce smog in California.

CARB's Consumer Products Regulatory Program is an important part of the agency's overall effort to reduce the amount of ozone forming compounds, toxic air contaminants (TACs), and greenhouse gases (GHGs) emitted from the use of chemically formulated consumer products. California leads the nation with 145 VOC limits for consumer product categories adopted to date, with 13 states (including the District of Columbia) and the United States Environmental Protection Agency (U.S. EPA) typically adopting CARB's VOC limits for certain categories. The most recent amendments to CARB's Consumer Product Regulations were approved for adoption in May 2018. CARB's Consumer Products Regulations cumulatively reduce in-use VOC emissions by about 50 percent from uncontrolled levels.

Overview of the Scope of 2013 – 2015 Survey

Since the inception of CARB's consumer products program, CARB staff has conducted several surveys to generate updated emission inventories and to inform regulatory actions that reduce the air quality impacts from the use of chemically formulated consumer products.

In 2014 CARB launched its most extensive survey conducted to date. The purpose of this three-year survey was to gather updated information on the sales and contents of consumer and commercial products sold or supplied for use in California. The result of the 3-year survey allows for an updated and more detailed understanding of the sales volume, chemical content, and reactivity of consumer and commercial products sold or

supplied for use in California. In addition to updating the consumer products emissions inventory, the survey also assists CARB staff in evaluating emissions trends for consumer products and determining the feasibility of further reducing consumer product emissions.

CARB staff classified reported survey ingredients according to their regulatory definition. TOG emissions encompass all organic compounds found in the atmosphere that contribute to ozone formation. For regulatory purposes, TOG is comprised of several distinct classes of compounds:

- VOCs that evaporate most readily. CARB staff identified reported compounds as VOC as per the definition in section 94508(a)(138) of the Consumer Products Regulation.

- Low vapor pressure VOCs (LVP-VOCs) that evaporate at a relatively lower rate. CARB staff identified reported compounds as speciated LVP-VOC as per the definition in section 94508(a)(83) of the Consumer Products Regulation. VOC + LVP-VOC = ROG.

- Exempt VOCs that have been determined to have negligible photochemical reactivity. CARB staff identified reported compounds as exempt (i.e. excluded) from the definition of VOC, as defined in section 94508(a)(138) of the Consumer Products Regulation. ROG + Exempt VOC = TOG.

CARB staff applied fate and transport adjustments to the emissions of a total of 63 survey categories. The majority of the fate and transport adjusted emissions were made to 38 categories of Household and Institutional Products, followed by 24 categories of Personal Care Products and one Vehicle and Marine Vessel Aftermarket Product Category. Fate and transport adjustments reduced the emissions when applied to reported survey ingredient formulation data, because a portion of adjusted category ingredients was assumed to go down the drain, or get combusted, and therefore not emitted into the air. More information can be found in the document entitled Survey Category Fate and Transport Adjustments at: https://www.arb.ca.gov/consprod/survey/survey.htm .

The three-year collection of survey data for Consumer and Commercial Products started in September 2014 with data for the year 2013, followed in July 2015 with data for the year 2014, and continued in July 2016 with data for the year 2015. The three-year mandatory survey included 491 consumer product categories.[1] Nearly 70 of these were categories that had never been surveyed before. Approximately 1400 companies reported over one million products. By comparison, the most extensive

[1] For Aerosol Adhesives and Coatings, only product sales data was required to be reported for 2013 and no data reporting was required for 2014 or 2015, since many of these products would be subject to new VOC limits in 2017 and therefore 2013 through 2015 product formulation data would soon be outdated.

survey previously conducted was in 2003 and gathered information from approximately 250 product categories, 915 companies, and almost 26,000 products.

In order to ensure the validity of the data, CARB staff undertook an extensive quality assurance and quality control (QA/QC) effort to review and correct the data submitted by responsible parties and formulators. Some of the types of QA/QC performed included checks of formulation data and product categorization. Significant QA/QC was also performed as part of fee assessment work that involved data reported by companies emitting 250 tons per year of VOC or more. As part of CARB's data review, staff contacted responsible parties and formulators with follow up information requests as needed.

Contents of Survey Data Summary

In June 2018 and December 2018 CARB staff posted draft survey documents. The current data release follows a similar format as the prior data releases. The 'Read Me' tab in each of these documents provides additional information regarding how the draft data were generated and are displayed. The current data release includes the following:

- Data Summary – All Categories (2013, 2014 and 2015)
- TOG Speciation Summary Report (2013, 2014 and 2015)
- Survey Chemical List and Assignments
- Survey Fate and Transport Adjustments

These summary documents were posted on April 2, 2019 and are available at: https://www.CARB.ca.gov/consprod/survey/survey.htm .

Survey Data Summary and Observations

The Survey Data shows similar year to year emissions for each of the six major sectors of consumer product categories over the three year survey period. An exception is the nearly 24 percent decrease in Solvents and Thinning-Related Products VOC emissions from 2014 and 2015 that reflects the effect of implementation of two regulations within this sector that became effective on December 31, 2013. The three-year sell through period for the regulations for Multipurpose Solvent non-aerosol and Paint Thinner non-aerosol ended on December 31, 2016. The two regulations within this sector reduced the VOC content in these products and effected a concurrent increase in exempt-VOC emissions.

As shown in Figure 1, Personal Care Products, followed by Household and Institutional Products, are the two sectors that dominate consumer product VOC, ROG and TOG emissions. These two sectors represent about 80 percent of the total VOC and ROG emissions and nearly 70 percent of the total TOG emissions from all surveyed consumer product categories.

Figure 1. Survey Three-Year Average Emissions by Major Sector

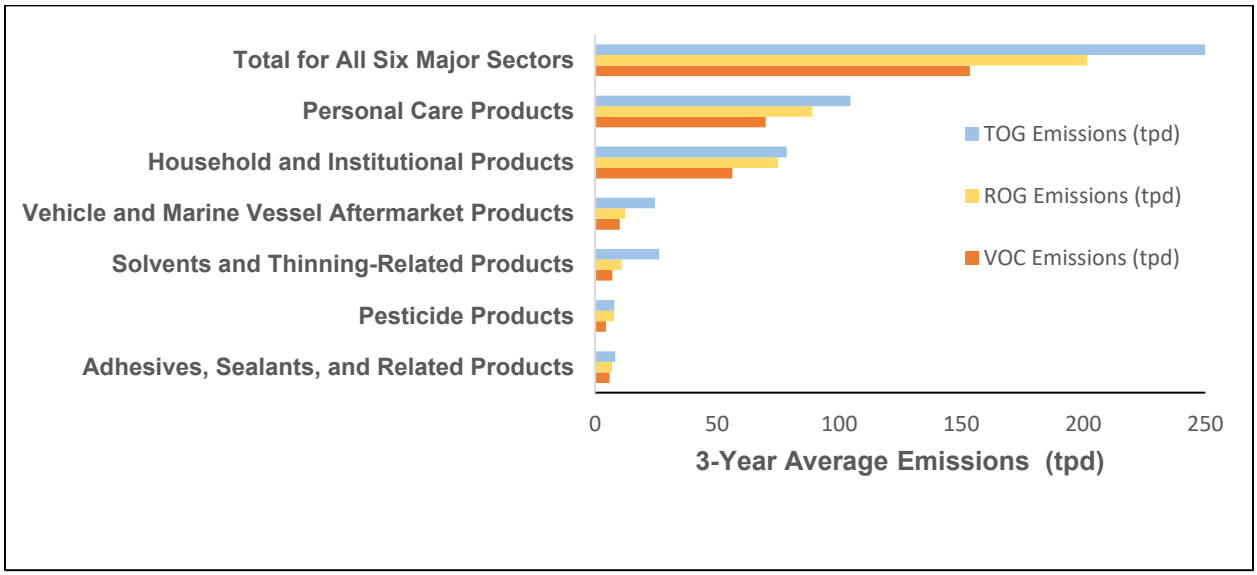


Table 1, below, illustrates that many product categories that are the top contributors to VOC emissions are from the Personal Care Product and Household and Industrial Product Sectors. 21 survey categories are found in the top 25 VOC emission categories for all three years. The same consumer product categories are the top five VOC emitters each year, with minor shifts in their ranking. Of the top five VOC categories each year, four are Personal Care Products and one is a Household and Institutional Product.

The VOC dominance of the Personal Care Products and Household and Institutional Products sectors for each of the three years of the survey is manifested as follows:

- In all three years, at least seven of the top product categories in the Personal Care Products sector were ranked among the top 25 categories for VOC. Combined, these categories contributed approximately 50 percent of the VOC emissions of the top 25 categories.

- In all three years, at least 13 of the top product categories in the Household and Institutional Products sector were ranked among the top 25 categories for VOC. Combined, these categories contributed 40 percent of the VOC emissions of the top 25 categories.

Table 1. Top 25 VOC Emissions Survey Categories

2013		2014		2015	
Category Name	**VOC (tpd)**	**Category Name**	**VOC (tpd)**	**Category Name**	**VOC (tpd)**
Hair Finishing Spray	11.2	Anti-microbial Dry Hand Wash (Hand Sanitizer)	11.3	Anti-microbial Dry Hand Wash (Hand Sanitizer)	11.8
Anti-microbial Dry Hand Wash (Hand Sanitizer)	10.8	Hair Finishing Spray	10.7	Personal Fragrance Product with 20% or less fragrance	10.7
Personal Fragrance Product with 20% or less fragrance	10.5	Personal Fragrance Product with 20% or less fragrance	10.5	Hair Finishing Spray	10.4
Rubbing Alcohol	10.1	Rubbing Alcohol	8.1	Rubbing Alcohol	9.2
Disinfectant (aerosol)	5.9	Disinfectant (aerosol)	6.9	Disinfectant (aerosol)	6.3
General Purpose Cleaner (nonaerosol)	5.2	General Purpose Cleaner (nonaerosol)	6.5	General Purpose Cleaner (nonaerosol)	5.5
Automotive Windshield Washer Fluid (Type "A" Areas)	4.5	Detergent	4.1	Air Freshener, liquid/pump spray	4.6
Air Freshener, liquid/pump spray	4.1	Air Freshener, liquid/pump spray	3.8	Detergent	4.6
Detergent	3.7	Plastic Pipe Cement and Primer	3.4	Automotive Windshield Washer Fluid (Type "A" Areas)	4.0
Multi-purpose Lubricant (including solid and semisolid products)	3.2	Sunscreen (hair or body) (aerosol)	3.1	Sunscreen (hair or body) (aerosol)	3.5
Air Freshener, Single Phase Aerosol	3.0	Automotive Windshield Washer Fluid (Type "A" Areas)	2.9	Dual Purpose Air Freshener/Disinfectant (aerosol)	2.7
Dual Purpose Air Freshener/Disinfectant (aerosol)	2.6	Air Freshener, Single Phase Aerosol	2.4	Liquid Fabric Softener	2.2
Sunscreen (hair or body) (aerosol)	2.4	Dual Purpose Air Freshener/Disinfectant (aerosol)	2.4	Air Freshener, Single Phase Aerosol	2.1
Liquid Fabric Softener	2.2	Multi-purpose Lubricant (including solid and semisolid products)	2.3	Charcoal Lighter Material	2.0
Deodorant Body Spray	2.1	Liquid Fabric Softener	2.2	Multi-purpose Lubricant (including solid and semisolid products)	2.0
Paint Thinner (nonaerosol)	1.9	Deodorant Body Spray	1.9	Air Freshener, Double Phase Aerosol	1.8
Crawling Bug Insecticide (aerosol)	1.8	Charcoal Lighter Material	1.8	Deodorant Body Spray	1.8
Charcoal Lighter Material	1.8	Scented Candle	1.7	General Purpose Degreaser (nonaerosol)	1.8
Floor Wax Stripper	1.7	Denatured Alcohol	1.7	Antiperspirant	1.7
External Analgesic Product	1.7	Air Freshener, Double Phase Aerosol	1.6	Crawling Bug Insecticide (aerosol)	1.7
Air Freshener, Double Phase Aerosol	1.7	Aerosol Cooking Spray	1.6	Denatured Alcohol	1.7
Body Repair Products (other than coatings)	1.6	General Purpose Degreaser (nonaerosol)	1.6	Scented Candle	1.7
Denatured Alcohol	1.5	Antiperspirant	1.6	Aerosol Cooking Spray	1.6
Scented Candle	1.5	Crawling Bug Insecticide (aerosol)	1.5	Mouthwash/Rinse	1.4
Aerosol Cooking Spray	1.5	External Analgesic Product	1.5	Floor Wax Stripper	1.3

Fragrance

“Fragrance” is defined as a substance or complex mixture of aroma chemicals, natural essential oils, and other functional components with a combined vapor pressure not in excess of 2 millimeters of mercury at 20° C, the sole purpose of which is to impart an odor or scent, or to counteract a malodor. (CCR, section 94508(a)(54)) The Consumer Products Regulation has provided an exemption for fragrances: VOC limits do not apply to fragrances up to a combined level of 2 percent by weight contained in any consumer product. This exemption applies to the entire fragrance mixture provided it meets the regulatory definition of “Fragrance”.

In 2016, CARB staff conducted a survey of fragrance formulations in order to learn more about the VOC and LVP-VOC constituents of fragrances in consumer products. The resulting reported TOG ingredients were split nearly evenly between VOC and LVP-VOC chemical species, with most of the LVP-VOC represented by dipropylene glycol. The VOC species consisted largely of benzyl acetate, citrus and non-citrus terpenes, and hexyl acetate, and included over 130 different VOC compounds that each made up less than 0.1 percent of the total fragrance mass reported. However, the fragrance survey provided limited and inconclusive insight into the profile of fragrance across different survey categories. Responsive fragrance formulations represented only 8.1 percent of the mass reported as “fragrance” in product formulations in the 2013 survey. Further, only 39 percent of the fragrance survey mass was speciated to the chemical compound level.

In the absence of reliably representative profiles from the fragrance survey and consistent with best practice, in processing survey data CARB staff assumed that all reported fragrance is a VOC. Due to the lack of a reliable fragrance profile, CARB staff followed the Aerosol Coatings Regulation’s fragrance convention and assigned a maximum incremental reactivity (MIR) to Fragrance using the MIR value for terpinolene. This MIR value of 6.36 was used to calculate the product weighted MIR (PWMIR) for products containing fragrance. The use of the terpinolene MIR as a surrogate for fragrance is an "upper limit" estimate of the ozone impacts of fragrance compounds, based on worst-case considerations.

Fragrance features as a key TOG ingredient in the three-year survey. Ingredients reported in the survey as "Fragrance" represent approximately eight percent of the survey's TOG content and rank as the second or third most prominent TOG ingredient in each of the three survey years. This high weight percent of fragrance coupled with the high surrogate MIR for terpinolene assigned to it results in fragrance contributing approximately 25 percent to the total ozone forming potential from all TOG constituents and fragrance being the greatest ozone forming potential contributor of any ingredient in the consumer product survey.[2]

[2] CARB’s Aerosol Coatings Regulation assumes unspeciated fragrances in a product at a weight percent greater than 0.25 be assigned the default MIR for terpinolene of 6.36. (CCR, Section 94542(i)(2)(F))

LVP-VOCs

CARB's Consumer Products Regulatory Program provides for an exemption for LVP-VOCs, specifying that regulatory VOC limits do not apply to LVP-VOCs. According to the definition in section 94508(a)(83) of the Consumer Products Regulation, an LVP-VOC is a chemical "compound" or "mixture" that contains at least one carbon atom and meets one of the following:

- has a vapor pressure less than 0.1 millimeter of mercury at 20^{o} C; or
- is a chemical compound with more than 12 carbon atoms, or a chemical mixture comprised solely of compounds with more than 12 carbon atoms, as verified by formulation data, and the vapor pressure and boiling point are unknown; or
- is a chemical compound with a boiling point greater than 216^{o} C; or
- is the weight percent of a chemical "mixture" that boils above 216^{o} C.

The LVP-VOC emissions from the Personal Care Products and Household and Institutional Products sectors are nearly equal and represent approximately 40 percent and 39 percent, respectively, of the total LVP-VOC emissions from the six major sectors surveyed. As a percent of TOG, the Pesticide Products sector has the highest LVP-VOC content at 42 percent, followed by the Household and Institutional Products sector at 24 percent and the Personal Care Products sector at 18 percent. The two most prevalent LVP-VOC ingredients are glycerol and propylene glycol, each with nearly seven percent of the total TOG ingredients from the six major sectors surveyed. Each of these qualify for treatment as LVP-VOCs on the basis of their vapor pressure.

Reactivity

Many different types of ROG compounds are emitted into the atmosphere, where they can affect photochemical ozone formation and other measures of air quality. However, because ROG compounds can react in the atmosphere at different rates and with different mechanisms, the different types of ROG compounds can differ significantly in their effects on air quality.

"Reactivity" describes the ozone-forming potential of a particular ROG compound. The ozone impact of a ROG compound depends on the environment where it is emitted as well as the nature of the ROG compound. The effect of a ROG compound on ozone formation in a particular environment can be determined from its "incremental reactivity", which is defined as the amount of additional ozone formed when a small amount of the ROG compound is added to the environment, divided by the amount added. The incremental reactivity of a compound is determined through predictive photochemical models that are calibrated using environmental chamber experiments and other experimental measurements. The reactivity of a compound can be expressed using different metrics. Product weighted maximum incremental reactivity (PWMIR) is typically expressed in units of mass of ozone to mass of product. Using these units, the PWMIR of a product reflects the presence of non-reactive components in the formulation that are included in the product mass. This is the metric used by CARB for the Aerosol Coatings regulation and the Multipurpose Lubricant regulation and is also

used to calculate the sales weighted average PWMIR of each of the categories in the three-year survey. Another useful metric, often used in comparisons of the reactivity of widely different inventory sources, is TOG reactivity. TOG reactivity has units of mass of ozone to mass of TOG and does not take into consideration non-reactive components.

Since 1988, the primary approach of the Consumer Products Regulatory has been the achievement of mass-based reductions VOC. However, reactivity-based control strategies that take the "reactivity" differences of ROG compounds into account have also been implemented in CARB regulations. Such reactivity-based control strategies are reflected in the 1993 Clean Fuel/Low Emissions Vehicle regulation, the 2000 Aerosol Coatings regulation and most recently the 2018 Multi-Purpose Lubricant regulation.

Each of the six major sectors of surveyed categories has comparable year to year emissions of TOG and ozone forming potential (OFP). Table 2 shows the TOG emissions, the corresponding ozone forming potential and the reactivity of the TOG profile for each of the six major sectors of surveyed categories.

Table 2.
Survey Three-Year Average TOG, Ozone Forming Potential and TOG Reactivity

Major Sector Name	TOG (tpd)	Ozone Forming Potential (Ozone tpd)	Reactivity of TOG (Ozone tpd / TOG tpd)
Adhesives, Sealants, and Related Products	8.2	18.0	2.2
Pesticide Products	7.8	8.7	1.1
Solvents and Thinning-Related Products	26.2	19.5	0.7
Vehicle and Marine Vessel Aftermarket Products	24.5	17.7	0.7
Household and Institutional Products	78.5	211.9	2.7
Personal Care Products	104.6	189.7	1.8
Total for All Six Major Sectors	**249.8**	**465.4**	**1.9**

Table 2 shows that Personal Care Products and Household and Institutional Products are responsible for the majority of TOG emissions and OFP from consumer products. The ranking of these two sectors is reversed when it comes to their ozone formation potential: Table 2 shows that ozone formation from Household and Institutional Products is the highest amongst six sectors and is closely followed by Personal Care Products. Together, these two sectors represent a three year average of 73 percent of the total TOG emissions and 86 percent of the total ozone formed by all six major sectors of surveyed categories.

The reactivity of the TOG profile for each sector is the ratio of the rate of ozone forming potential divided by the corresponding TOG emission rate. The reactivity of the TOG profile for each of the six major sectors of surveyed categories remains relatively unchanged from year to year, indicating an equivalent similarity in the year to year sector TOG speciation profile. While the TOG reactivity of the Personal Care Sector is

lower than that of the Adhesives, Sealants, and Related Products Sector, the contribution of the two sectors to ozone formation is primarily determined by TOG emissions that are over an order of magnitude higher for the Personal Care Sector.

The OFP dominance of the Household and Institutional and the Products Personal Care Products and sectors seen in Table 2 is also reflected in Table 3, which shows the top 25 individual surveyed categories in terms of OFP emissions. There is consistency in categories appearing in each year's top 25 OFP categories: 19 individual survey categories are found in the top 25 OFP emission categories for all three years. The same set of three Household and Institutional Products sector categories, in alternate order, rank as the top OFP emissions categories in each of the three years:

- General Purpose Cleaner (nonaerosol)
- Air Freshener, liquid/pump spray, and
- Detergent

These are followed at the top of OFP emissions by the same set of four Personal Care sector categories, in alternate ranking order, in each of the three years:

- Personal Fragrance Product with 20 percent or less fragrance
- Hand and Body Conditioner, Cream, Lotion, and Moisturizer
- Anti-microbial Dry Hand Wash (Hand Sanitizer), and
- Hair Finishing Spray

The impact of the Household and Institutional Products and the Personal Care Products sectors on OFP emissions in more detail is shown by the following observations:

- In all three years, 10 of the top 25 product categories in the Household and Institutional Products sector were ranked among the top 25 categories for OFP. Combined, these 10 categories contributed about half of the OFP emissions of the top 25 categories.
- In all three years, eight of the top 25 product categories in the Personal Care Products sector were ranked among the top 25 categories for OFP. Combined, these 8 categories contributed 27 percent of the OFP emissions of the top 25 categories.

There is also a noticeable shared presence of categories in the top OFP and top TOG lists in each survey year: a comparison of the top 25 OFP and TOG individual categories for each survey year (listed in Table 3 and Table 2 respectively) shows 16 shared categories in 2013 and 2014, and 17 shared categories in 2015.

Table 3. Top 25 Ozone Forming Potential Survey Categories

2013		2014		2015	
Category Name	**Ozone Forming Potential (tpd)**	**Category Name**	**Ozone Forming Potential (tpd)**	**Category Name**	**Ozone Forming Potential (tpd)**
General Purpose Cleaner (nonaerosol)	26.2	General Purpose Cleaner (nonaerosol)	33.0	Detergent	32.5
Air Freshener, liquid/pump spray	26.1	Detergent	29.4	Air Freshener, liquid/pump spray	29.3
Detergent	24.5	Air Freshener, liquid/pump spray	24.5	General Purpose Cleaner (nonaerosol)	28.5
Personal Fragrance Product with 20% or less fragrance	20.2	Personal Fragrance Product with 20% or less fragrance	19.7	Personal Fragrance Product with 20% or less fragrance	20.2
Hand and Body Conditioner, Cream, Lotion, and Moisturizer	19.3	Anti-microbial Dry Hand Wash (Hand Sanitizer)	17.3	Anti-microbial Dry Hand Wash (Hand Sanitizer)	18.1
Anti-microbial Dry Hand Wash (Hand Sanitizer)	16.5	Hand and Body Conditioner, Cream, Lotion, and Moisturizer	16.7	Hand and Body Conditioner, Cream, Lotion, and Moisturizer	17.0
Hair Finishing Spray	15.8	Hair Finishing Spray	15.5	Hair Finishing Spray	15.2
Other nail care products	13.0	Liquid Fabric Softener	11.6	Scented Candle	13.3
Floor Wax Stripper	11.8	Scented Candle	11.5	Liquid Fabric Softener	11.5
Liquid Fabric Softener	11.7	Plastic Pipe Cement and Primer	10.8	Disinfectant (aerosol)	9.8
Deodorant	10.5	Disinfectant (aerosol)	10.7	General Purpose Degreaser (nonaerosol)	9.6
Rubbing Alcohol	10.1	General Purpose Degreaser (nonaerosol)	9.6	Body Wash/ Mousse/Gel/Soap/ Foam/Scrub	9.5
Scented Candle	10.0	Conditioner without styling claims	9.4	Conditioner without styling claims	9.1
General Purpose Degreaser (nonaerosol)	9.4	Floor Wax Stripper	9.1	Deodorant	8.8
Disinfectant (aerosol)	9.1	Body Wash/ Mousse/Gel/Soap/Foam/Scrub	8.8	Floor Wax Stripper	7.9
Body Wash/ Mousse/Gel/Soap/Foam/Scrub	8.8	Deodorant	8.1	Dye, permanent	7.3
Conditioner without styling claims	7.5	Pet Care Products (pet litter, etc.)	7.8	Shampoo	6.3
Air Freshener, Single Phase Aerosol	7.0	Shampoo	6.5	Rubbing Alcohol	5.8
Shampoo	5.6	Dye, permanent	5.4	Sunscreen (hair or body) (aerosol)	5.5
External Analgesic Product	4.9	General Use Hand or Body Cleaner or Soap	5.4	Pet Care Products (pet litter, etc.)	5.3
Multi-purpose Solvent (nonaerosol)	4.9	Multi-purpose Solvent (nonaerosol)	5.1	General Use Hand or Body Cleaner or Soap	5.1
Paint Thinner (nonaerosol)	4.8	Rubbing Alcohol	5.0	Antiperspirant	4.4
Dryer Sheets/Fabric Softener - Single Use Dryer Product	4.3	Sunscreen (hair or body) (aerosol)	4.8	Dish Detergent/Soap (manual)	4.2
Pet Care Products (pet litter, etc.)	4.3	Air Freshener, Single Phase Aerosol	4.7	Dual Purpose Air Freshener/Disinfectant (aerosol)	4.1
General Use Hand or Body Cleaner or Soap	4.3	Oven or Grill Cleaner (nonaerosol)	4.5	Brake Cleaner	4.1

Survey Data TOG Speciation

The Survey Data provides a comprehensive and detailed dataset of TOG ingredients found in consumer products sold in California. This updated TOG speciation data for hundreds of consumer product categories will facilitate an improved understanding of consumer product contribution to ozone formation and other atmospheric processes. Table 4, below, describes the Survey Data top ten TOG ingredients across all

categories, as well as a nonexhaustive list of their functions. These ten substances represent over 60 percent of all TOG in the 2015 survey. TOG speciation summary reports detailing the top 95 percent of TOG ingredients by consumer product sector for 2013, 2014, and 2015 can be found at: https://www.arb.ca.gov/consprod/survey/survey.htm .

Table 4. Description of Top Ten TOG Ingredients

Substance and Classification	Percent of TOG	MIR	Select Functions
Ethanol: VOC	22.90%	1.53	Used as a solvent in personal care and household cleaning products, including: as an astringent in skin care products, in lotions as a preservative and to ensure that lotion ingredients do not separate, and in hairsprays to help the spray adhere to hair. Used to kill microorganisms like bacteria, fungi and viruses, in many hand sanitizers.
Fragrance: VOC	7.52%	6.36	Provides a pleasant odor, or counteracts a malodor. Found in many personal care products, air fresheners, and other household products.
Hydrocarbon Solvent, Bin#11 VOC Portion	7.24%	0.70	Solvent found in charcoal lighter material, lubricants, and other household products.
Propylene Glycol: LVP-VOC	7.22%	2.58	Solvent, humectant, preserves consistency, moisture and softness of personal care products; stabilizer of laundry detergents.
Acetone: Exempt	7.07%	0.36	Solvent widely used to dissolve other substrates such as paints or varnishes, or for cleaning purposes. Ingredient in nail polish removers, also found in cleaning products, fragrance products, and hair care products.
Glycerol: LVP-VOC	7.01%	3.15	Used in many personal care products, such as moisturizers, hair conditioners, and toothpaste. May be used to enhance product moisture and lubrication.
Isopropyl Alcohol: VOC	3.95%	0.61	Used as antifoaming agent, cosmetic astringent, solvent, and viscosity decreasing agent.
Hydrocarbon Solvent, Bin#11 LVP-VOC Portion	3.56%	0.70	Solvent used in paint thinner, lubricants, and other household and industrial products.
Isobutane: VOC	2.33%	1.23	Propellant used in air fresheners, cooking spray, spray on dry shampoo, and other aerosol products.
Decamethylcyclopentasiloxane: Exempt	2.04%	0.00	Used as an emollient, lubricant, or solvent in personal care products.

Comparison of Survey to the SIP Inventory

A total of 71 survey categories in the current survey were never surveyed before and thus their emissions are not included in the State Implementation Plan (SIP) inventory. In 2015, the total ROG emissions from these first time ever surveyed categories were approximately 14 tpd and represent approximately 7 percent of the total ROG emissions from all 491 surveyed categories.

Of the 71 first time ever surveyed categories:

- 42 are Personal Care Products sector categories contributing 73 percent of the total ROG emissions from first time ever surveyed categories
- 25 are Household and Institutional Products sector categories contributing 27 percent of the total ROG emissions from first time ever surveyed categories

The top ROG emission contributors among these categories are Scented Candles, External Analgesic Products, Mouthwash, Pet Care Products (pet litter, etc.) and No Rinse Shampoo.

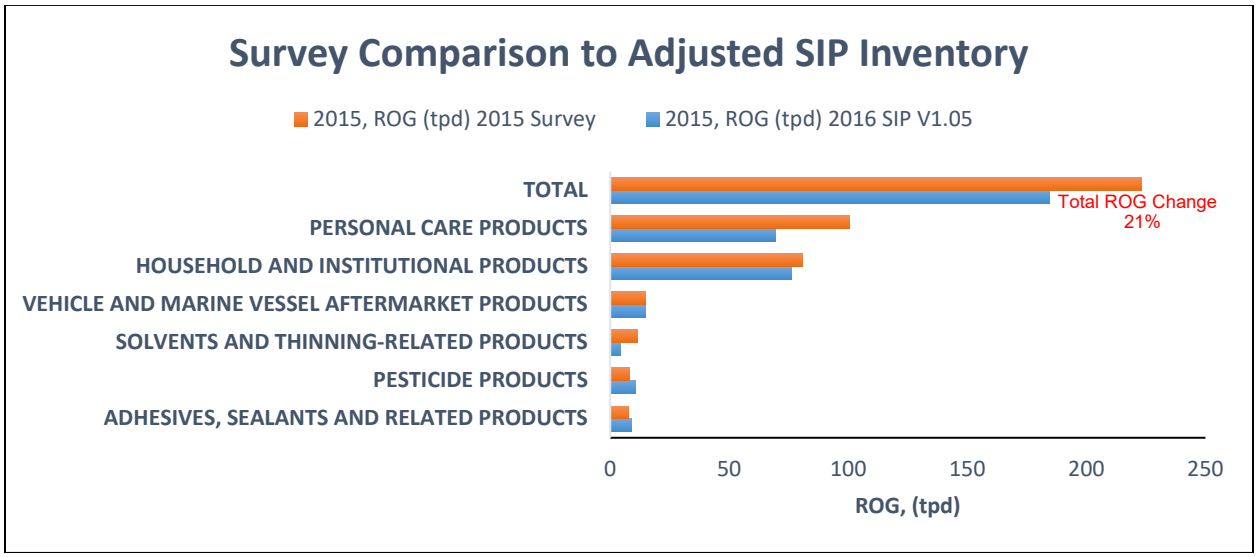
The comparison of the current survey data to the consumer products emission inventory used in the 2016 ozone State Implementation Plans (SIPs) is a valuable indicator of how the different sectors of consumer products individually and as a whole have changed. In order to bring parity to the comparison between the SIP inventory and the current survey shown in Figure 2, the following adjustments were made:

- The fate and transport adjustments were applied to the SIP inventory data consistent to their application to the survey data. A total of 63 survey categories in the current survey were adjusted for fate and transport. The category-specific and ingredient-specific fate and transport adjustments used for the survey were applied to the SIP emission data to allow for a more appropriate comparison to the survey emission data.
- The same market adjustment factor was applied to the survey data as done for the SIP inventory data. A market adjustment factor was applied to all prior surveys conducted by the Consumer Products Regulatory Program and is reflected in the SIP inventory emissions. The same factor was applied to the current survey data to allow for a more appropriate comparison to the SIP inventory emission data.
- The emissions of 71 newly surveyed categories were added to the SIP inventory data. Emissions from categories surveyed for the first time in 2013 – 2015 were added to the SIP inventory.
- Emissions from the aerosol coatings sector were excluded from the SIP inventory. Aerosol Coatings Sector formulation data and consequent emissions were not part of the three-year survey and were also not included in the SIP inventory emissions comparison.

Figure 2 shows the change in the year 2015 ROG emissions for each of the six major sectors of consumer products categories surveyed compared to the corresponding sector in the adjusted SIP inventory. As shown in Figure 2, the total ROG emissions

from all six sectors of consumer products surveyed indicate an increase of 21 percent compared to the adjusted SIP inventory.

Figure 2. Consumer Products ROG Emissions in SIP Inventory and the 2015 Survey



The largest change in ROG emissions relative to the adjusted SIP inventory derives from the Personal Care Products sector. ROG emissions from the Personal Care Products sector and the Household and Institutional Products sector represent 45 percent and 36 percent, respectively, of the total ROG emissions from all six sectors in the 2015 Survey. The current three-year survey shows that these two sectors have swapped first and second ranking in ROG emissions compared to the SIP inventory. In the current SIP inventory for the year 2015 the Household and Institutional Products sector and the Personal Care Products sector represent 41 percent and 38 percent, respectively, of the total ROG emissions from the six major sectors.

The Personal Care Products Sector is the largest contributor to the increase in ROG emissions compared to the SIP inventory. The increased ROG emissions from the Personal Care Products Sector represent 17 percent out of the total 21 percent increase for all sectors compared to the adjusted SIP inventory. Approximately 27 percent of the total ROG increase from all six surveyed sectors compared to the SIP comes from newly surveyed categories in the Personal Care Products sector. Potential reasons for increases in the Personal Care Products sector include faster than anticipated growth in sales for the sector, different compliance pathways for regulated categories than those assumed in the existing inventory, or underrepresentation of sales in previous CARB surveys.

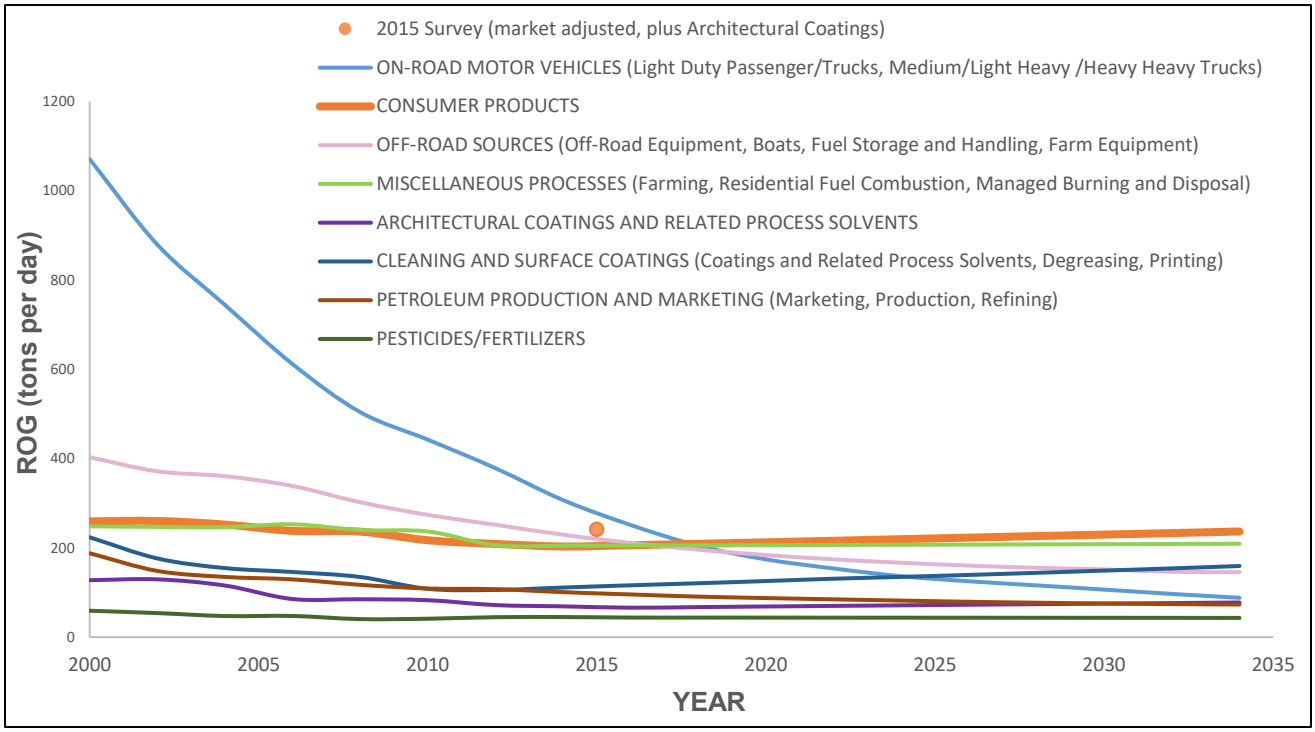
The greatest percentage change in ROG emissions shown in Figure 2 is for the Solvents and Thinning-Related Products Sector. Despite the large increase compared to the SIP, the ROG emissions for this sector are only a 5.1 percent of the total ROG emissions from all six sectors in the 2015 Survey. The Solvents and Thinning-Related

Products Sector ROG emission increases contribute 3.8 percent out of the total 21.8 percent increase between the 2015 Survey and the adjusted SIP Inventory.

The Contribution of Consumer Products to ROG Emissions

The trajectory of ROG emissions for Consumer Products in the official (i.e. unadjusted) SIP Inventory is shown in Figure 3. While emissions for consumer products and other top ROG sources have steadily decreased in the past, reductions from light-duty vehicles have outpaced those from other categories. Emissions from consumer products have now become the top ROG emission source and are increasing as California's population continues to grow. The Survey Data further underscores the prominence of ROG emissions from Consumer Products. In Figure 3, the single point used to indicate the comparative magnitude of 2015 Survey ROG emissions includes the market adjusted emissions from the six major sectors surveyed plus the additional emissions included in the SIP inventory for the Aerosol Coatings Sector.

Figure 3. Emission Trends of Top ROG Emission Sources in the SIP Inventory



Next Steps

The magnitude of ROG emissions from Consumer Products shown in Figure 3 indicates that additional approaches to reduce its emission impacts are important. In 2017, CARB committed to additional measures to reduce emissions as part of the 2016 State

Strategy for the State Implementation Plan (2016 SIP). The 2016 SIP commitments for Consumer Products are shown in Table 4.

Table 4. 2016 SIP Commitments for Consumer Products VOC Emission Reductions

	2023	2031
South Coast	1 to 2 tons per day	4 to 5 tons per day
Statewide	--	8 to 10 tons per day

CARB staff will use the Survey Data to assess future regulatory directions for the Consumer Products Program. In April 2019, CARB will initiate a rule development process designed to achieve the reductions shown in Table 4 with the intention of bringing a proposed regulatory amendment to the Board for its consideration by the end of 2020. The comprehensive product sales and formulation data provided by the 2013, 2014 and 2015 survey provide the technical foundation to develop innovative and effective new strategies to meet California's emission reduction commitments.

Appendix A provides histograms of all survey categories with at least 0.5 tpd VOC emissions, which collectively are responsible for about 80 percent of the survey's total VOC emissions. CARB staff will work with stakeholders in the summer of 2019 to evaluate these categories with the intent of identifying the most promising emission reduction strategies. To meet our emission reduction commitments, the consumer products program regulatory amendments should build upon the existing regulatory approach, but also consider innovative new strategies to achieve additional cost-effective emission reductions and air quality benefits.