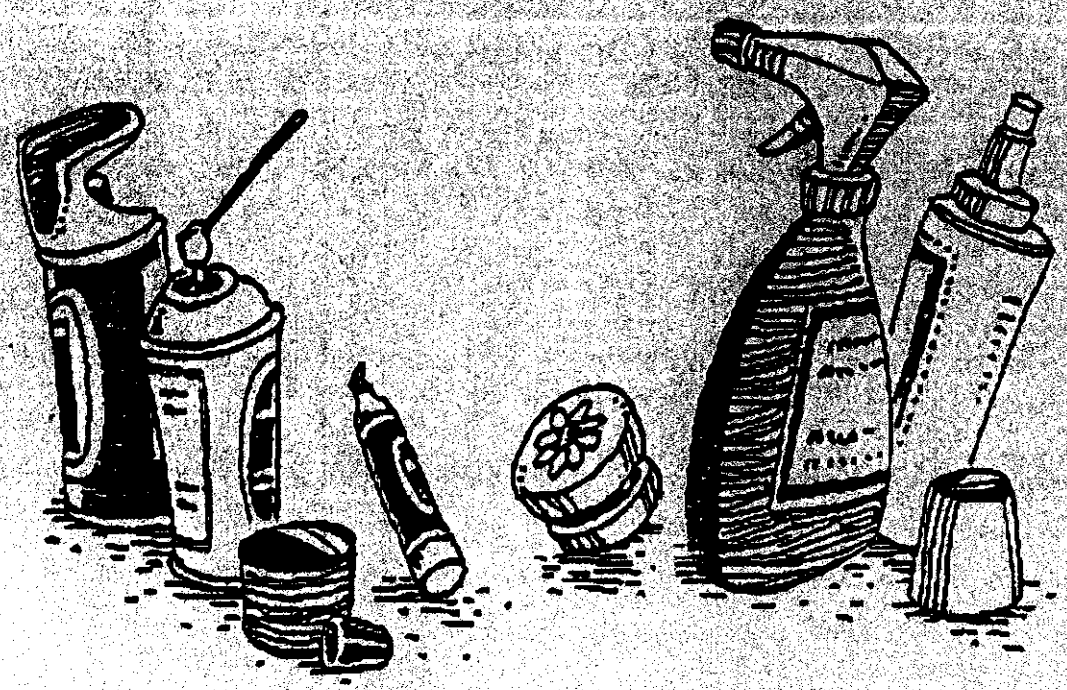
PROPOSED AMENDMENTS TO THE STATEWIDE REGULATION TO REDUCE VOLATILE ORGANIC COMPOUND EMISSIONS FROM CONSUMER PRODUCTS
- PHASE II -

TECHINCAL SUPPORT DOCUMENT

STATE OF CALIFORNIA
AIR RESOURCES BOARD
STATIONARY SOURCE DIVISION
OCTOBER 1991



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FOR
PROPOSED AMENDMENTS TO THE
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FROM CONSUMER PRODUCTS
- PHASE II -

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October 1991

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Technical Support Document

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I.

INTRODUCTION

A. OVERVIEW

In 1988, the Legislature enacted the California Clean Air Act of 1988 (the "Act", Stats. 1988, Chapter 1568) to address the air pollution problems of California. In the Act, the Legislature declared that attainment of the California State health-based air quality standards is necessary to protect public health, particularly of children, older people, and those with respiratory diseases. The Legislature also directed that these standards be attained by the earliest practicable date.

The Act added section 41712 (Appendix A) to the California Health and Safety Code, which requires the Air Resources Board (ARB/Board) to adopt regulations to achieve the maximum feasible reduction in reactive organic compounds emitted by consumer products, if the Board determines that adequate data exists for it to adopt the regulations, and if the regulations are technologically and commercially feasible and necessary. In enacting section 41712, the Legislature gave the Board clear new authority to control emissions from consumer products, an area that had previously been subject to very few air pollution control regulations.

As defined in section 41712, a consumer product means any chemically formulated product used by household and institutional consumers, including but not limited to, detergents; cleaning compound; polishes; floor finishes; cosmetics; personal care products; home, lawn, and garden products; disinfectants; sanitizers; and automotive specialty products. The definition of consumer products specifically does not include paint, furniture coatings, or architectural coatings.

Consumer products comprise an important source of volatile organic compound (VOC) emissions in California. Consumer products are widely distributed goods that contain varying quantities of VOC. While the emissions from any one product may appear to be small, when combined in the aggregate, the emissions contribute significantly to California's air quality problems. Based on the ARB 1987 Emission Inventory, consumer

products account for approximately 10 percent of the non-vehicular VOC emissions in the state, or about 200 tons per day.

B. BACKGROUND

Several actions have been taken by the Board to fulfill the requirements of the "Act" as it pertains to consumer products. In July 1989, the ARB approved a Consumer Products Control Plan which outlined a regulatory strategy for the regulation of consumer products. The control plan outlined a schedule for regulation development and established priorities for implementation. The schedule included the development of a regulation for deodorants and antiperspirants considered by the Board in the fall of 1989 followed by four regulations at six month intervals for personal care products, household products, automotive and industrial products and pesticide products. As new information became available, however, the staff concluded that it would be more effective in terms of emission reductions and resources to develop a more comprehensive regulation that would address products in each of the major categories as opposed to developing individual regulations for each category.

On November 8, 1989, the Board approved Resolution 89-76, in which the Board approved a regulation to reduce VOC emissions from antiperspirants and deodorants. The approved regulation became legally effective on February 28, 1991, and is contained in Title 17, California Code of Regulations (CCR), sections 94500-94506 (CARB, 1990)

On October 11, 1990, the Board conducted a public hearing to consider the adoption of a regulation to reduce the VOC emissions from 16 different consumer products and to amend the antiperspirants and deodorants regulation approved in November 1989 (Phase I). At the hearing, the Board approved Resolution 90-60, in which the Board approved the consumer products regulation and the amendments to the antiperspirant regulation. The approved regulations became legally effective on October 21, 1991, and are contained in Title 17, California Code of Regulations, sections 94500-94517 (ARB, 1991).

The regulation approved by the Board in October 1990 addressed only 16 of the hundreds of consumer products potentially subject to regulation. To achieve the maximum feasible reduction in VOCs from consumer products it is necessary to look at additional consumer products and determine if there are additional emission reductions that can be achieved. In the year subsequent to the Board action in October 1990, the ARB staff conducted a survey of consumer products and technical investigations to determine if there were additional product categories that could be incorporated into the statewide comprehensive regulation. Based on the findings, the staff is proposing to amend the regulation to add 12 more categories (Phase II). Additionally, the staff is proposing to amend the regulatory language in several sections to clarify and improve the regulation.

This technical support document (TSD) provides the technical information the staff used in developing the proposed amendments to the

consumer products regulation. Much of the information contained in this TSD was obtained from members of the consumer product industry through three public workshops, VOC product surveys, individual meetings with representatives from consumer product companies and comments on distributed drafts of the proposed amendments. In addition, the staff relied on technical information available in the scientific literature. This document presents an overview of the proposed amendments, a discussion of the ambient air quality and the need for emission reductions, VOC emissions for the categories proposed for amendment, descriptions of the regulated categories, and a discussion of the economic, environmental and lifestyle impacts resulting from the proposed amendments.

References:

California Air Resources Board, "Final Statement of Reasons for Rulemaking, Public Hearing to Consider the Adoption of a Regulation to Reduce Volatile Organic Compound Emissions from Antiperspirants and Deodorants," December 1990.

California Air Resources Board, "Final Statement of Reasons for Rulemaking, Public Hearing to Consider the Adoption of a Statewide Regulation to Reduce Volatile Organic Compound Emissions from Consumer Products," August 1991.

II.

PROPOSED AMENDMENTS TO THE CONSUMER PRODUCT REGULATION

A. SECTION 94508 - DEFINITIONS

The proposed amendments include 72 new or revised definitions and the deletion of 14 definitions. Staff proposes to add forty-three new definitions to Section 94508. These new definitions are listed in Table II-1. Of these, 17 are definitions for the new product categories being proposed for amendment and 26 are definitions added to clarify terminology referenced in the regulation.

TABLE II-1
Definitions Proposed for Addition

Aerosol Cooking Spray	Aftershave
Agricultural Use	All Other Carbon-Containing Compounds
All Other Forms	Automotive Brake Cleaner
ASTM	California Sales
Body Splash	Cologne
Charcoal Lighter Material	Container/Packaging
Consumer	Device
Crawling Bug Insecticide	Flea and Tick Insecticide
Existing Product	Hand Dishwashing Detergent
Flying Bug Insecticide	Insecticide
Household Product	Label
Insecticide Foggers	LVP Compound
Lawn and Garden Insecticide	Perfume
Non-Carbon Containing Compound	Personal Fragrance Product
Person	Product Brand Name
Principal Display Panel(s)	Product Form
Product Category	Restricted Materials
Responsible Party	Table B Compound
Spray Buff Product	Type A Propellent
Toilet Water	Type C Propellent
Type B Propellent	Wasp and Hornet Insecticide
Usage Instructions	

Table II-2 identifies the definitions which are proposed to be modified in the regulation.

TABLE II-2

Definitions Proposed for Modification

Aerosol Product	Air Freshener
Automotive Windshield Washer Fluid	Bathroom and Tile Cleaner
Carburetor - Choke Cleaner	Disinfectant
Distributor	Dusting Aid
Fabric Protectant	Floor Polish or Wax
Furniture Maintenance Product	General Purpose Cleaner
Household Adhesive and Sealant	Insect Repellent
Institutional Product or "Industrial and Institutional (I&I) Product"	Laundry Starch Product
	Liquid
	Manufacturer
Nonresilient Flooring	Paint
Pesticide	Propellant
Pump Spray	Retailer
Retail Outlet	Solid
Volatile Organic Compound	Wax
Wood Floor Wax	

Table II-3 identifies those categories proposed for deletion. The categories are proposed for deletion because they are no longer applicable to the regulation, were combined with another category, or are being postponed for consideration.

TABLE II-3

Definitions Proposed for Deletion

Aerosol Food Product	Automotive Bug and Tar Remover
Automotive Chrome Polish	Automotive Leather/Vinyl Cleaner
Automotive Tire Dressing	
Automotive Wheel Cleaner	Brake Cleaner
Food	Household Consumer
Household Pesticide	Industrial Spray Buff
Lubricant	Rug Deodorizer
Water Proofing Products	

B. SECTION 94509 - STANDARDS

The proposed Phase II Consumer Products Regulation amendments would establish VOC content standards for 12 different consumer product categories. The effective date of the standards for the Phase II product categories is proposed for January 1, 1995, with the exception of three categories. The effective date would be one year later for disinfectants and insecticides, which are products that must be registered according to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). To ensure consistency with the South Coast Air Quality Management District's (SCAQMD) Rule 1174, the proposed standard for charcoal lighter materials becomes effective in the SCAQMD on the date the amendments to the consumer products regulation become effective. In all other areas of California, the proposed charcoal lighter standard becomes effective on January 1, 1993. In addition, future effective standards are proposed for carburetor-choke cleaners, aerosol dusting aids, fabric protectants, and aerosol household adhesives on January, 1, 1997. A future effective standard for "crawling bug" insecticides is proposed for January 1, 1998.

The regulation prohibits the sale, supply, offer for sale, or manufacture for sale in California of any consumer product which at the time of sale or manufacture contains volatile organic compounds in excess of the limits specified. Also, the proposed standards are set on the basis of percent VOC by weight except for charcoal lighter materials which are set on pounds of VOC emissions per start. The percent by weight limits apply to products only after the "minimum recommended dilution" has taken place. Spot or incidental use of products with "minimum recommended dilution" in concentrated forms is allowed so products such as general purpose cleaners can be used occasionally in small amounts to treat hard-to-remove soils. Standards for hand dishwashing detergents apply only to the as-supplied product. This is because these products are all diluted for use. Therefore, it is not required to account for differences between dilutable and ready-to-use products. A summary of the proposed standards is shown on the following table, Table II-4.

TABLE II-4

Percent Volatile Organic Compounds by Weight

Proposed Table of Standards
(Phase II)

Product Category	1/1/95	Future Effective (Date)
Aerosol Cooking Sprays	18	
Automotive Brake Cleaners	50	
Carburetor-Choke Cleaners	75	50 (1/1/97)
Charcoal Lighter Materials *		
Disinfectants		
Aerosols	60	
Dusting Aids		
Aerosol	35	25
All Other Forms	7	(1/1/97)
Fabric Protectants	75	60 (1/1/97)
Hand Dishwashing Detergents	2	
Household Adhesives		
Aerosol	75	25
All Other Forms	10	(1/1/97)
Insecticides		
Crawling Bug	40	20
Flea and Tick	20	(1/1/98)
Flying Bug	30	
Foggers	40	
Lawn and Garden	20	
Wasp and Hornet	40	
All Other Insecticides	20	
Laundry Starch Products	5	

TABLE II-4, Continued

Percent Volatile Organic Compounds by Weight

Proposed Table of Standards
(Phase II)

Product Category	1/1/95	Future Effective (Date)
Personal Fragrance Products		
Aftershave/Body Splashes	60	
Colognes, Toilet Waters, & Perfumes**	70	
All Other Personal Fragrance Products	50	

* Effective January 1, 1993, and on the date the amendments to the consumer products regulation become effective in the SCAQMD, no person shall sell, supply, or offer for sale, or manufacture for sale in California any charcoal lighter material without the written approval from the Executive Officer and without a demonstration to the satisfaction of the Executive Officer that the VOC emissions resulting from the ignition of charcoal with the charcoal lighter material are less than or equal to 0.02 pound of VOC per start.

** The standard for colognes, toilet waters, and perfumes does not apply to existing products provided that any such product is registered within 90 days of the effective date of this regulation as required under Section 94513.

A one year period is provided for retailers and suppliers to "sell through" products manufactured prior to the earliest effective date of the standard. In order to ensure that the sell through provision can be effectively enforced, the sell through provision is not available for products that do not display the manufacture date of the product, or a code indicating such a date.

The effective date for products that are registered under FIFRA is one year after the date listed in the table of standards. FIFRA and State law requires that pesticide products be registered with the EPA and the California Department of Pesticides Regulation (DPR). The registration process requires companies to provide test results that demonstrate the safety and efficacy of new or reformulated products. This provision allows additional time for companies to register products reformulated for compliance. With this additional year for compliance, products subject to FIFRA requirements will have 5 years to come into compliance.

If adopted, effective January 1, 1993, any consumer product listed in the table of standards that is sold, supplied, or offered for sale in California cannot contain any ozone depleting compounds regulated by the EPA. This provision does not apply to any existing products sold, supplied, or offered for sale prior to the effective date of the regulation amendments. The requirements of the regulation also do not apply to ozone depleting compounds appearing as impurities in amounts less than or equal to 0.01 percent by weight.

C. SECTION 94510 - EXEMPTIONS

The following discussion describes the amendments proposed to Section 94510 - Exemptions.

1. **Fragrance:** The VOC standards, as adopted in 1990, do not apply to fragrances and colorants up to a combined level of 2 percent by weight contained in any consumer product. This exemption was established to allow manufacturers a de minimus level of these substances in various products such that the products may be marketed in an appealing manner to consumers. The staff proposes that this exemption for fragrances and colorants be modified by deleting colorants from the exemption and amending the exempted level to 1 percent.

The staff determined that it should not be necessary to provide a 2 percent exemption. Based on conversations with colorant manufacturers (BASF; Seltzer), it was revealed that colorants are solid compounds with low vapor pressures and are therefore already exempt from the standards in the regulation under Section 94510(c). Further review of formulations found in industry trade journals (Household & Personal Products Industry) and a report prepared for the New York State Department of Environmental Conservation (Pacific Environmental Services) revealed that most consumer products contain less than 1 percent fragrance. In addition to the referenced sources above, the staff also received information (Fragrance Materials Association) which indicates that the level of fragrance used in hair sprays, shaving cream, general purpose cleaners, dishwashing liquid, and spray furniture polish is less than 1 percent.

For products with a fragrance content greater than 1 percent, such as some air fresheners and perfumes, the fragrance content can be considered an active ingredient of the product and is often present in the formulation at higher percentages, approximately 1 to 25 percent for personal fragrances, and 1 to 6 percent for air fresheners. Since for these products the fragrance is a significant part of the total VOC, the fragrance VOCs were taken into consideration during the development of the standard.

2. **Cologne, Perfume, and Toilet Water:** Section 94510(h), as proposed, provides an exemption from the VOC standards for colognes, perfumes, or toilet water formulations registered within 90 days of the effective date of the consumer products regulation as required under Section 94513(a). This would exclude existing perfume, cologne, and toilet water formulations from the 70 percent VOC standard specified in Section 94509(a). While the

technology exists to produce these products at 70 percent VOC, as evidenced by the 84 complying products currently available, the staff recognizes the difficulties that would be encountered in reformulating existing products to the proposed 70 percent standard while retaining the identical scent. New products, in contrast, should be able to be developed within the constraints of the proposed 70 percent standard. This is further discussed in Chapter V. While the staff recognizes the difficulties in reformulating existing products, the staff intends to continue evaluating technologies available to the perfume industry and will reevaluate the need for this provision in the future.

3. **Paradichlorobenzene:** An exemption is proposed for flying bug insecticides comprised of at least 98 percent paradichlorobenzene. Paradichlorobenzene (PDCB) moth preventatives are composed almost entirely of PDCB, the active ingredient. These products, typically sold as "moth balls", are used in enclosed spaces such as closets and drawers. Low-VOC aerosol spray products have been identified in the 1991 Consumer Products Survey which are intended to protect clothing from moths. However, the spray products must be applied on individual articles of clothing for moth protection, unlike PDCB products which protect all clothing stored in the enclosure in which they are placed. Therefore it is uncertain whether the aerosol products are suitable replacements for PDCB products. Cedar blocks have also been marketed for moth repellancy. However, these products do not kill or prevent moth larvae that can hatch on clothing and eat the fibers. Staff will continue to evaluate the appropriateness of this exemption and recommend amendments if necessary.

4. **Cyanoacrylate adhesives:** Household adhesives containing at least 80 percent cyanoacrylate monomer and packaged in containers not greater than one ounce are proposed to be exempt from the requirements of Section 94509(a). These products are often referred to as super glues, adhesives that dry quickly to form an adhesive bond. The exemption is proposed due to the fact that most of the VOC content in these products becomes nonvolatile after taking part in a rapid polymerization reaction upon exposure to moisture on the bonding substrates.

D. SECTION 94511 - INNOVATIVE PRODUCT PROVISION

Background:

The innovative products provision is a section of the regulation which provides an alternative to complying with the VOC standards in Section 94509(a). An innovative product is a product that does not meet the VOC content standards in the consumer products regulation, yet results in less VOC emissions than a "representative" product that meets the VOC standard due to some characteristic of the product formulation, design, delivery system or other factors. This provision was included in the Consumer Products Regulation approved by the Board on October 11, 1990. The staff is proposing to amend the language to improve the clarity of the provision.

Proposed Changes:

The primary change proposed for the innovative product provision is to clarify the procedure by which emissions from an innovative product are compared to the emissions from a noncomplying product "had it been reformulated" to comply. The present provision allows a manufacturer to demonstrate that a product is innovative by one of two ways. A product can be "innovative" by (1) demonstrating that its VOC emissions are less than the emissions from a complying representative product or, (2) "if the innovative product is a modification to an existing product", by showing that the use of the product will result in less VOC emissions as compared to the reductions in emissions that would have occurred from the existing product had it been reformulated to meet the standards.

The problem with this version is that the language "if the innovative product is a modification to an existing product" limits the innovative product to modifications of existing products, if a manufacturer chooses to compare the emissions of the innovative product emissions to the emissions from a noncomplying product. This limitation is unnecessary since it is difficult to distinguish between a modification to an existing product and a completely new product. Language is proposed to remove this restriction. In addition, an equation is proposed to clarify how the emissions from a "noncomplying product had it been reformulated" are to be determined.

Other proposed changes to the Innovative Products Provision include clarification of the term "representative product", correction of inconsistent usage of the terms "emissions" and "emission reductions", and adding language to section (f), now proposed section (e), which allows the Executive officer to specify terms and conditions necessary to verify that the requirements of the provision are met.

Example of How the Provision Could Be Utilized:

Since this is a new approach to regulating consumer products and there has been much discussion on how the provision would be implemented, staff has provided an illustration of how the provision could be utilized.

To use the provision, the manufacturer must demonstrate by clear and convincing evidence that the use of the innovative product will result in less VOC emissions than a "representative" product that complies with the VOC standards or a noncomplying representative product "had it been reformulated". A representative product is a product that is subject to the same VOC standard as the innovative product, is of the same product form, and is efficacious compared to other products in the category.

For example, take the case of a hairspray manufacturer with a 95 percent VOC hairspray and the conditions set out in Table II-5.

TABLE II-5

Innovative Hairspray Example

Product	VOC content (weight percent)	VOC Emissions (g/use)
Current Product	95%	2.0
Innovative Product	Greater than 80%	1.0
Representative Compliant Product	Less than 80%	1.5
Noncomplying Representative Product ("had it been reformulated")	95% / 80% *	1.68

* Actual VOC content is 95%. Emissions per use "had it been reformulated" assume a 80% VOC level.

The VOC standard for hairspray is 80 percent in 1993. To meet the requirements of the regulation, the manufacturer may choose to reformulate the current 95 percent VOC noncomplying product to meet the 80 percent standard or modify it to comply under the Innovative Products Provision. If the manufacturer chooses to comply under the Innovative Products Provision, the manufacturer does not have to meet the 80 percent standard. However, the manufacturer must modify the product such that it will result in less VOC emissions (per use, for example) than a product that meets the 80 percent standard. For instance, the hairspray manufacturer in our example may decide to add more resin to the hairspray and decrease the spray rate. Since the resin is the ingredient that holds the hair together, the manufacturer may reason that a product which contains more "hair holding" resin will achieve an equivalent "hold" level with less product and therefore less emissions. The manufacturer may also assume that consumers will spray their hair for the same duration of time with the new innovative product, out of habit, requiring a reduction in spray rate.

Now that the manufacturer has a hairspray that is believed to meet the requirements of the Innovative Products Provision, the manufacturer must demonstrate it by showing that the innovative hairspray results in less emissions per use than a hairspray that meets the 80 percent standard. To show this, the manufacture can compare the emissions per use from the innovative hairspray to (1) the emissions per use from a representative hairspray that complies with the 80 percent standard; or (2) the emissions per use from a representative noncomplying hairspray "had it been reformulated" to meet the 80 percent standard.

The first step in this process is to determine the emissions from the "innovative" hairspray and the product that it will be compared to. This will require consumer testing along with additional laboratory testing. As shown in Table II-5, the emissions of VOC per use are determined to be 1.0 grams. The manufacturer must now compare the emissions from the innovative hairspray, 1.0 grams, to either (1) the emissions per use from a representative product that complies with the 80 percent standard, or (2) the emissions per use from a representative noncomplying product had it been reformulated to meet the 80 percent standard.

Approach 1

If the manufacturer decides to compare to a hairspray that meets the 80 percent standard, consumer testing of the complying hairspray would be required to determine the emissions per use from the complying hairspray. Table II-5 shows the emissions per use from the complying hairspray to be 1.5 grams. In this case, the innovative product results in less emissions per use than a complying product and would be a candidate for the Innovative Product Provision as long as the testing was performed properly.

Approach 2

Lets suppose, now, that the manufacturer would rather compare to a noncomplying hairspray had it been reformulated to the 80 percent VOC standard. This approach may be preferred in cases where the manufacturer is more familiar with noncomplying products (in some cases the manufacturer's own products) that have been on the market for a long period of time. The noncomplying hairspray "had it been reformulated" is a hypothetical hairspray that is identical to the original noncomplying hairspray except that it is assumed to meet the given VOC standard, in this case 80 percent. The manufacturer can compare the innovative product to any noncomplying representative product. However, in this example, the manufacturer has a noncomplying hairspray at 95 percent, the original product before it was modified. Lets assume the original, 95 percent VOC, product is used. Table II-5 shows the emissions from the noncomplying product to be 2 grams VOC per use. The emissions from the noncomplying hairspray had it been reformulated are calculated as follows, per Section (a)(2) of the Innovative Products Provision: (1) the emissions from the noncomplying hairspray are determined; (2) the emission value determined in (1) is multiplied by the percent VOC standard (80 percent in this case) and divided by the percent VOC of the noncomplying product (95 percent in this case). The emissions from the noncomplying hairspray "had it been reformulated" are therefore calculated as follows:

$$2 \text{ grams} \times (80\% / 95\%) = \underline{1.68 \text{ grams}}$$

Since the emissions from the innovative product, 1.0 grams, are less than the emissions from the noncomplying product had it been reformulated, 1.68 grams, the innovative product is a candidate for the Innovative Products Provision.

Issue raised by industry

Several industry representatives have commented on the requirement that the "representative product" be efficacious compared to other products in the same product category according to test methods generally accepted by the industry. Industry has commented that efficacy is often a function of many performance aspects and that industry accepted test methods are not always available. Industry has also commented that consumer acceptance is the best indicator of efficacy.

Response

To determine whether an innovative product will result in "less" emissions, one must compare the emissions of the innovative product to the emissions of some other product selected as a standard of comparison. To insure that the comparison is a fair one, the regulation provides that the comparison must be made to a "representative consumer product", which is defined in section 94511 as a product which is subject to the same VOC standard, is of the same product form as the innovative product, and has "at last similar efficacy as other complying consumer products in the same product category based on tests generally accepted for that product category by the consumer products industry." It is absolutely critical that the "comparison" product have at least similar efficacy to other complying products (e.g., the comparison product must be "representative" of the other products in the same category). Without this provision, manufacturers could select as a "comparison" product a poor performance product on the market. By showing that consumers would need to use less of an "innovative product" compared to a product with very poor efficacy, use of the "innovative" product may actually result in more VOC emissions than the majority of currently marketed products in the same product category. By not including an efficiency requirement, the innovative product exemption would be circumvented, thereby seriously undercutting the emission reductions that would otherwise have been achieved by the regulation.

To avoid this problem, the regulation clearly specifies that comparison must be made to a "representative consumer product" with similar efficacy to other complying products, and that efficacy determinations must be based on tests generally accepted by the consumer products industry. It is further specified that emission reductions must be demonstrated by "clear and convincing" evidence. These provisions will insure that emission reductions from innovative products can be convincingly demonstrated to be actual, verifiable reductions.

There may be some situations where this type of demonstration is burdensome or impossible. In such situations, manufacturers have the option of complying with the VOC limits specified in the Table of Standards. The innovative products provision is not designed to allow applications to be made in every case, but only in those cases in which it can be clearly demonstrated that verifiable emission reductions will be achieved.

Finally, in response to industry's comment that consumer acceptance is the best indicator of product efficacy, other factors such as advertising, brand loyalty, packaging, etc. also affect consumer acceptance. Therefore, consumer acceptance alone is not a sufficient indicator of product efficacy.

E. SECTION 94512 - ADMINISTRATIVE REQUIREMENTS

Modifications are proposed to the code-dating provision under Section 94512 (b), "Administrative Requirements". The code-dating provision requires manufacturers of consumer products to display the date on which the product was manufactured, or a code indicating such date. The day, month, and year is now proposed in order to clarify that the term "date" refers to this specific information and not more general information such as the month and year only. If a violation is found, this clarification will assist enforcement staff in determining the extent of the violation.

In addition, a change in the effective date of the code-dating requirement is proposed in order to allow manufacturers more time to comply. Currently, the code-dating requirement becomes effective three months after the the effective date of the regulation. The staff proposes to change this date to twelve months before the effective date of the VOC standards specified in Section 94509.

F. SECTION 94513 - REGISTRATION

The staff proposes to include modifications and additions to Section 94513, Registration. This section was modified to reflect changes made to ARB's 1991 consumer products survey and to clarify the information required to be registered. Amendments proposed include adding registration definitions to Section 94508, "Definitions," requests for additional product information, and clarification of terms.

New definitions were added to Section 94508 to clarify the information required under the registration section. The definitions added include the following:

All Other Carbon-Containing Compounds
California Sales
Product Brand
LVP Compound
Non-Carbon Containing Compound
Product Brand Name
Product Category
Product Form
Responsible Party
Table B Compound
Type A Propellant
Type B Propellant
Type C Propellant

It is also being proposed that the requirements for registration only apply to those product categories that are identified in the Table of Standards. In the Phase I version of the regulation, registration was required of both products listed in the Table of Standards and several additional products of interest to the staff. Since this type of information can be obtained under ARB's general authority in sections 39607, 39701 and 41511 of the California Health and Safety Code, and section 91100 of Title 17, California Code of Regulations, it is not necessary at this time to incorporate additional registration requirements for products not in the Table of Standards.

In addition, the staff are proposing to modify Section 94513 (b). With the proposed modifications, "responsible parties" of household and industrial and institutional (I&I) products will be required to report to the Executive Officer the net weight percent, to the nearest one-tenth percent (0.1 percent), of each Table B compound and low vapor pressure (LVP) compound. The ARB staff has determined that in order to monitor and ensure that no increase in ozone depleting compounds occurs, it is necessary to have usage information on each Table B compound. Also, to evaluate the exemption for compounds with less than 0.1 mm Hg and to accurately determine the accuracy of compounds being reported as LVP compounds, the staff believes it is necessary to obtain information on each individual LVP compound.

G. SECTION 94515 - TEST METHODS

Section 94515 is proposed for amendment to incorporate new test methods for determining whether a material is a liquid or a solid, the certification of charcoal lighter materials, and the distillation points of petroleum distillate-based charcoal lighter materials. American Society for Testing and Materials (ASTM) Method D-4359-90, "Determining Whether a Material Is a Liquid or a Solid", is proposed to differentiate solid and liquid product forms, which may have different VOC standards. This test method may be necessary for viscous liquids, gels, or other materials which are not clearly a liquid or a solid. South Coast Air Quality Management District Rule 1174, Ignition Method Compliance Certification Protocol, dated February 28, 1991, is included for the determination of emissions from charcoal lighter material during "start up". ASTM D86-90 (Sept. 28, 1990) was included for the determination of distillation temperatures of petroleum distillate-based lighter fluids.

Section 94515(b) is proposed for amendment to require that manufacturers maintain records for only those days in which production occurred. Under existing language, manufacturers are required to keep records even for days on which they did not produce any products. This amendment is designed to reduce the amount of records required by a manufacturer and to simplify the reporting process. Language is also proposed stating that in cases where physical test methods indicate a violation of the VOC content standards while company records do not, the physical test methods may be used to establish a violation.

References:

BASF, telephone conversation between BASF representative and Tom Evashenk, September 13, 1991.

Fragrance Materials Association of the United States, personal communication to Paul Milkey, July 10, 1990.

Household & Personal Products Industry, Formulary, Volume 3, 1988.

Pacific Environmental Services, "Analysis of Regulatory Alternatives For Controlling Volatile Organic Compound (VOC) Emissions From Consumer and Commercial Products in the New York City Metropolitan Area", January 17, 1990, Appendix E.

Seltzer, telephone conversation between Seltzer representative and Tom Evashenk, September 13 1991.

III.

AMBIENT AIR QUALITY AND THE NEED FOR EMISSION REDUCTIONS

A. AIR QUALITY

To protect California's population from the harmful effects of ozone and PM-10 (particulate matter less than 10 microns equivalent aerodynamic diameter), federal and state air quality standards for these contaminants have been established. These standards are shown in Table III-1. The state hourly ozone standard is 0.09 parts per million (ppm) and the national hourly ozone standard is 0.12 ppm. The state PM-10 standard for a 24 hour period is 50 micrograms per cubic meter (ug/m^3) and the national standard is 150 ug/m^3 determined over a 24-hour period.

TABLE III-1

Ambient Air Quality Standards for Ozone and PM-10

Pollutant	Averaging Time	State Standard	National Standard
Ozone	1 hour	0.09 ppm (180 ug/m^3)	0.12 ppm (235 ug/m^3)
PM-10	Annual Geometric Mean	30 ug/m^3	- - -
	24 hour	50 ug/m^3	150 ug/m^3
	Annual Arithmetic Mean	- - -	50 ug/m^3

Ozone: VOCs and nitrogen oxides (NOx) react in the presence of sunlight to form ozone, a major ingredient of smog. At low ambient concentrations, ozone is a colorless, odorless gas and the chief component of urban smog. It is by far the state's most persistent and widespread air quality problem. The rate of ozone generation is related closely to the rate of VOC (in the form of reactive organic gases - ROG) production as well as the availability of NOx in the atmosphere (CARB, 9/87;Seinfeld, 1989). To reduce the formation of ozone it is necessary to both reduce the emissions of NOx and VOCs.

Short-term exposure to ozone affects the respiratory system. Ozone is a strong irritant that can cause constriction of the airways, forcing the respiratory system to work harder in order to provide oxygen to the body. Besides shortness of breath, it can aggravate or worsen existing respiratory diseases, such as emphysema, bronchitis and asthma.

Chronic exposure to ozone can damage deep portions of the lung. ARB research has documented permanent lung damage in young adults, aged 14-25, most of whom were life-long residents of the highly polluted South Coast Air Basin. The research, which provides some of the most definitive research to date of the potential life-long health threat from poor air quality, found early signs of permanent lung disease in 104 out of 107 accident victims that were studied (CARB, 9/87).

This recent research is the most comprehensive to date to dispel the belief that the respiratory system fully restores itself from exposures to ozone. Instead, the study suggests that lung tissue reacts somewhat like sunburned skin, which loses some of its restorative ability with each exposure, eventually leading to permanent or premature damage (CARB, 9/87).

Ozone also affects vegetation throughout most of California including reduced yield and quality in agricultural crops and disfiguration or unsatisfactory growth in ornamental vegetation. Recent ARB studies indicate that ozone pollution damage to crops is estimated to cost agriculture over 300 million dollars annually (CARB, 3/87).

PM-10: Particulate matter (PM-10) is a solid or liquid substance less than (<) 10 microns determined as equivalent aerodynamic diameter. PM-10 can be directly emitted to the atmosphere as the result of anthropogenic actions such as fuel combustion or natural causes such as wind erosion. Indirect PM-10 is formed via a complex reaction involving a gas-to-particulate matter conversion process in which VOCs can participate. The focus of this section will be on the indirect aerosol formation of PM-10.

Airborne particulate matter (PM-10) is composed of up to 35 percent aerosols which may be the result of atmospheric chemical reactions of sulfates, nitrates, ammonium, trace metals, carbonaceous material (VOCs) and water. The products of gas-phase reactions may themselves combine to form new particles (either single or two or more vapor phase species) or increase existing particle growth by condensation of VOC's. Furthermore, although the contribution from VOCs is not known, carbonaceous aerosols generally account for a significant fraction of the fine (<2 micron equivalent aerodynamic diameter) urban particulate matter. In Los Angeles, for example, aerosol carbon alone accounts for about 40 percent of the total fine particulate mass (Seinfeld, 1989).

Particulate matter with diameters smaller than or equal to 10 microns equivalent aerodynamic diameter (PM-10) have the greatest impact on the respiratory system because they can reach deep into the lungs. The elderly, persons suffering from lung or cardiovascular disease, infants and children, and asthma sufferers have been identified as being at greater risk from exposure to particulate matter. PM-10 causes irritation of the respiratory tract and may contain toxic compounds which adhere to the particle surfaces and can enter the lungs. Because it is visible in the atmosphere, PM-10 also contributes to reduced visibility.

Over the past twenty years, air pollution agencies in California have been working diligently to improve air quality. Much of the effort was directed to the more traditional sources of air pollution - the automobile and smokestacks. However, even though there have been dramatic gains, California still has serious air pollution problems. As the level of potential emissions reduction from these traditional sources are reduced, new sources of previously unregulated emissions must be evaluated for possible reductions.

Today, over 90 percent of California's population lives in areas that are non-attainment for both the state ozone and PM-10 standard. Figure III-1 is a map showing the attainment status of California's air basins and counties with regard to the ambient air quality standards for ozone. Figure III-2 is a map showing the attainment status for California air basins and counties with regard to the state ambient air quality standard for PM-10. As shown in the map, 13 air basins or portions thereof, covering 50 counties have been designated non-attainment for PM-10.

Consumer products contain VOCs which contribute to the air pollution problem in California. Although each consumer product may seem to be a small source of emissions, when multiplied by the total number of users in California, the total VOC emissions become significant. As the California population continues to grow, so too will VOC emissions from consumer products grow. Current consumer product emissions are at least 200 tons per day.

To protect public health and to respond to the inability of current air pollution programs to achieve the state air quality standards, the California legislature adopted the California Clean Air Act of 1988 ("Act"). The Act requires each air pollution district to develop plans to achieve and maintain state ambient air quality standards and also requires all non-attainment areas to achieve a 5 percent per year emission reduction for each criteria pollutant. In addition, the Act requires the ARB to adopt regulations to achieve the maximum feasible reduction in reactive organic compound (i.e. VOCs) emissions from consumer products by January 1, 1992. To achieve the goals of the "Act" and to help California meet the federal and state ambient air quality standards, it will be necessary to obtain emission reductions from all sources, both large and small.

Figure III-1

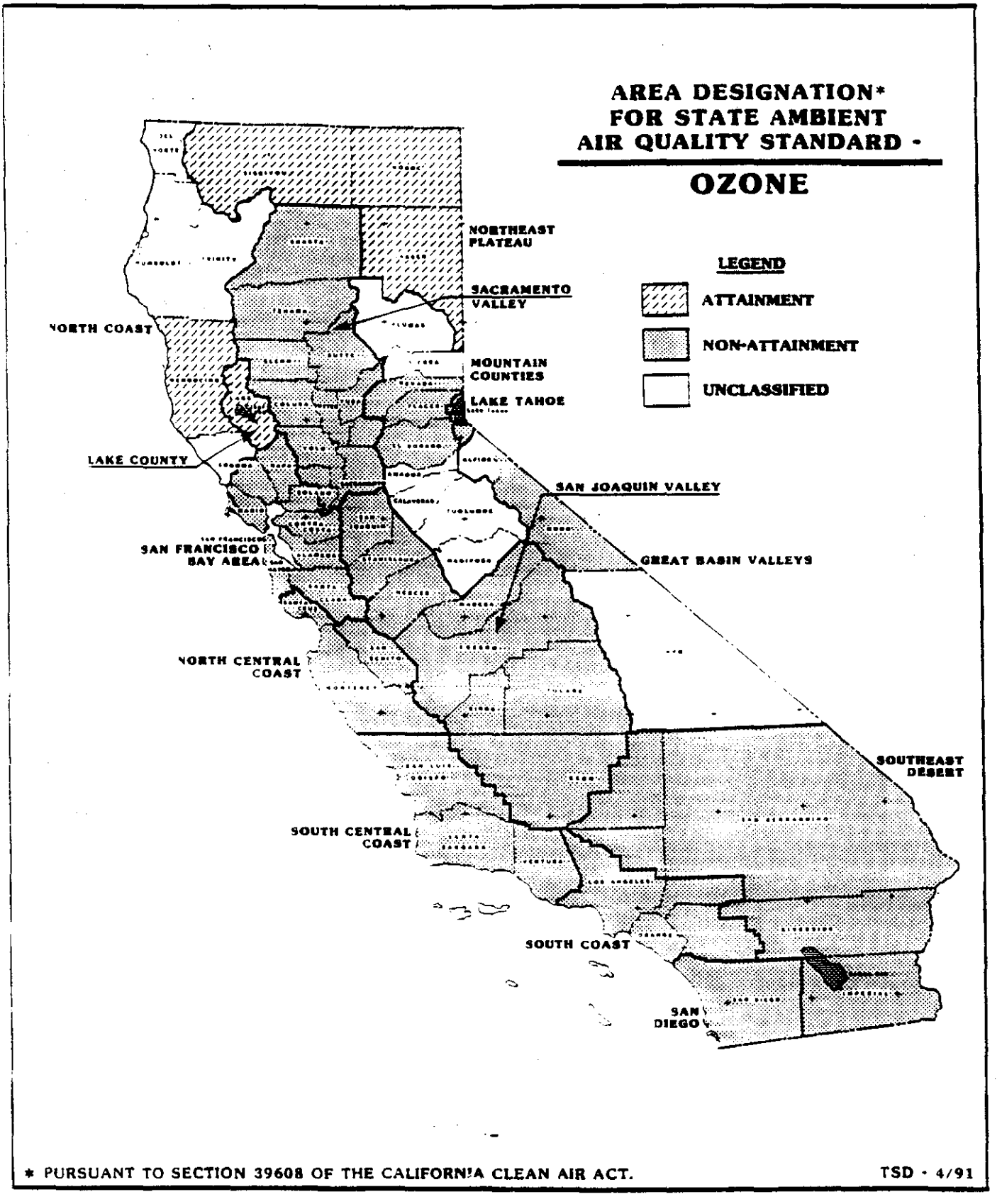
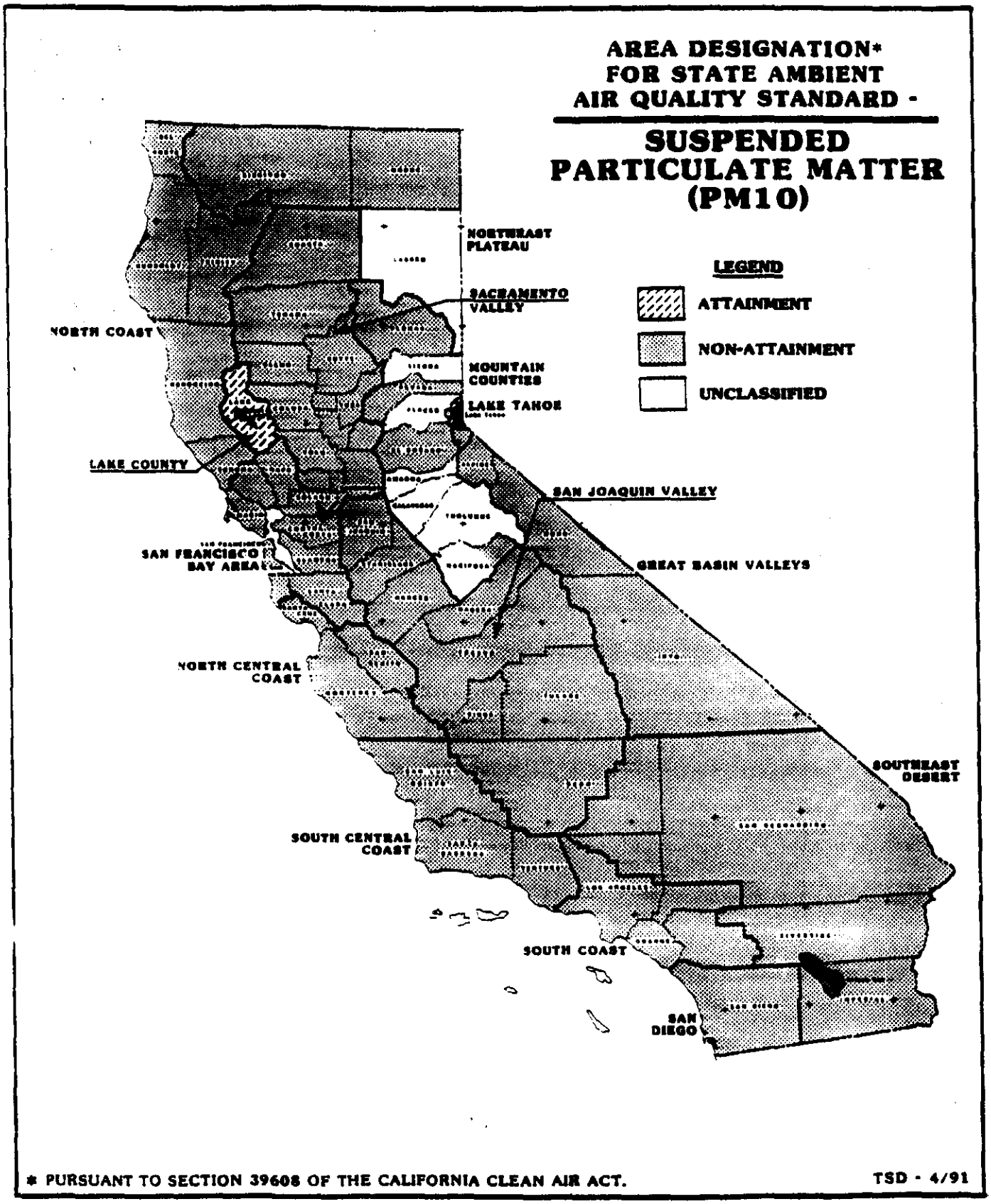

AREA DESIGNATION*
FOR STATE AMBIENT
AIR QUALITY STANDARD -
OZONE
LEGEND
ATTAINMENT
NON-ATTAINMENT
UNCLASSIFIED
NORTHEAST PLATEAU
SACRAMENTO VALLEY
NORTH COAST
MOUNTAIN COUNTIES
LAKE TAHOE
LAKE COUNTY
SAN JOAQUIN VALLEY
SAN FRANCISCO BAY AREA
GREAT BASIN VALLEYS
NORTH CENTRAL COAST
SOUTHEAST DESERT
SOUTH CENTRAL COAST
SOUTH COAST
SAN DIEGO
* PURSUANT TO SECTION 39608 OF THE CALIFORNIA CLEAN AIR ACT.
TSD - 4/91

Figure III-2


AREA DESIGNATION*
FOR STATE AMBIENT
AIR QUALITY STANDARD -
SUSPENDED
PARTICULATE MATTER
(PM10)
LEGEND
ATTAINMENT
NON-ATTAINMENT
UNCLASSIFIED
NORTHEAST PLATEAU
SACRAMENTO VALLEY
NORTH COAST
MOUNTAIN COUNTIES
LAKE TAHOE
LAKE COUNTY
SAN JOAQUIN VALLEY
SAN FRANCISCO BAY AREA
GREAT BASIN VALLEYS
NORTH CENTRAL COAST
SOUTHEAST DESERT
SOUTH CENTRAL COAST
SOUTH COAST
SAN DIEGO
* PURSUANT TO SECTION 39608 OF THE CALIFORNIA CLEAN AIR ACT.
TSD - 4/91

B. ENVIRONMENTAL PATHS OF VOC EMISSIONS TO THE ATMOSPHERE

1. Indoor vs. Outdoor Emissions:

VOC emissions from consumer products must reach the outdoor environment (ambient air) before they are available for participation in the reactions that lead to ozone formation. The VOCs in consumer products may reach the atmosphere by a number of routes, depending on a variety of factors such as the chemical composition of the product, product usage, the location of usage, and the ambient conditions (e.g. temperature, air flow, humidity).

When consumer products such as a charcoal lighter fluids, automotive brake cleaners, carburetor-choke cleaners, and personal fragrance products are used outdoors or in well ventilated areas such as a garage, or bathroom with an exhaust fan, VOCs have a relatively direct route to ambient air after they have vaporized. There are some opportunities in these cases for interaction with surfaces ("sinks"), which will be described in more detail below. However, in general, these effects are less pronounced than in enclosed indoor environments where vapors have a less direct path to ambient air.

Indoor emissions of VOCs from consumer products such as fabric protectants, dusting aids, and laundry starch products escape to ambient air through the infiltration/diffusion of indoor air with outdoor air in what will be referred to as air exchange. Prior to removal to the ambient air, however, other processes may occur. These can be simplified into the three processes described under "Indoor Emissions".

Except in the limited number of cases where a product undergoes a chemical reaction, which will be discussed later, the VOCs emitted from consumer products in both indoor and outdoor environments do eventually reach the ambient air and are available to participate in the photochemical reactions that produce ozone. As described below, VOCs may attach to surfaces temporarily, but will eventually be re-emitted. An expert in this area of research has communicated to ARB that virtually all VOCs from consumer products will eventually reach the atmosphere (Sparks).

2. Indoor Emissions:

Indoor emissions of VOCs from consumer products can reach ambient air by a variety of mechanisms. The following cases represent the primary routes to ambient air: (a) gaseous or vapor phase compounds are removed with air exchange; (b) liquid VOCs evaporate over time and exit with air exchange; and (c) gaseous VOCs are adsorbed on surfaces and subsequently desorbed and removed through air exchange. These cases are not meant to be mutually exclusive. For instance, an aerosol propellant, which is a gas at room temperature, may be partially removed with air exchange and partially adsorbed on a surface with subsequent desorption and transport to the ambient air via diffusion.

(a) Vapor Phase Organics Are Removed with Air Exchange:

The propellants used in aerosol products such as isobutane, propane, dimethyl ether, and partially halogenated chlorofluorocarbons such as HCFC-142b, HCFC-22, and HFC-152a are gases at room temperature. These gases are emitted when an aerosol product is sprayed and are immediately available for removal as a building's indoor air is exchanged with outdoor air. Highly volatile liquids and products delivered in a fine mist may also be immediately available for transport to the atmosphere through air exchange. In these cases, transport to ambient air will be a function of the exchange rate.

The air exchange rate, commonly expressed in air changes per hour (ACH), is a measure of the rate at which indoor and outdoor air are exchanged and will be a function of the heating and ventilation system in the house or building, as well as openings such as window and doors. According to an analysis of the literature (Wilson et al.; Wilcox et al.) by ARB's Research Division, most single family homes will have ACH values from 0.2 to 1.5 averaged over the year. VOC emissions will be transported to the ambient air more quickly with high infiltration rates. However, VOCs will eventually reach the ambient air with even the lowest ACH values.

(b) Liquid VOCs Evaporate Over Time and Exit with Air Exchange:

Liquid VOCs such as the solvents in consumer products must evaporate before they can be removed by air exchange. Liquids will continue to evaporate until an equilibrium is reached between the liquid and vapor phases. Since the amounts of liquid will be small compared to the volume of virtually any indoor area and since vapor is continually removed due to air exchange, the liquid will continue to evaporate until it is gone. The rate of evaporation will be a function of many factors such as the vapor pressure of the individual chemical components and their interaction with each other, the temperature, and the air exchange rate. Increases in temperature and exchange rate will increase the rate at which a liquid will evaporate. After evaporation occurs, the vapors will be transported to the ambient air via the air exchange as discussed above in part (a).

(c) VOCs are Adsorbed on Surfaces and Subsequently Desorbed and Removed through Air Exchange:

Before exiting to the atmosphere, VOCs may be adsorbed onto surfaces such as walls, carpets, and furniture. These surfaces are known as "sinks". Studies have shown that organic vapors adsorbed by sinks are re-emitted. In a study by Tichenor et al., samples of glass, ceiling tile, carpet, painted wallboard, and upholstery were exposed to vapor phase concentrations of organic compounds in a test chamber. The chamber was supplied with clean air at the rate of 1 air change per hour (ACH) until the start of the test when part of the clean air flow was replaced by a flow containing the test organic vapor, during which adsorption occurred. After 48 hours, the flow containing the test

organic vapor was replaced with clean air, starting the desorption phase of the test. The study showed that "common indoor materials were found to adsorb and subsequently re-emit vapor phase organic compounds" (Tichenor et. al.). After desorption has occurred, volatile organics are available for removal to the outside air via air exchange.

3. Chemical Reactions Transform VOCs:

The VOCs emitted from the consumer products proposed for regulation will eventually reach ambient air, except in the case of cyanoacrylate "super glue" adhesives and hand dishwashing detergents. In these special cases, the VOCs may be involved in chemical reactions which alter their composition. Cyanoacrylate adhesives rapidly polymerize on exposure to moisture on the surface of substrates, transforming most of the VOCs in these products to the nonvolatile material that forms the bond. The other example is hand dishwashing detergents. Depending on the use, some of the VOCs in hand dishwashing detergents may be biodegraded by microorganisms in the sewer system and wastewater treatment facility. Some emissions may also be emitted to the atmosphere. A more detailed discussion of this subject may be found in Chapter VII, "Issues".

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IV.

EMISSIONS ESTIMATES FOR NEW CONSUMER PRODUCT CATEGORIES

A. CONSUMER PRODUCT VOLATILE ORGANIC COMPOUND SURVEY

The ARB staff conducted a consumer product survey in the spring of 1991 to gather information on consumer product emissions and California sales data. Information on product composition, form, applicable product category (e.g., automotive brake cleaners, dusting sprays, etc.), usage and California sales was requested for 49 different consumer product categories. Sixteen of which were previously identified for regulation in October 1990. A discussion of the survey development and handling is presented below.

Survey Form and Distribution

The ARB staff worked with the Chemical Specialties Manufacturers Association (CSMA) and other industry representatives to develop the survey form so that the language and information requested in the survey was easily understandable and relatively simple to complete. The final survey form contained detailed instructions on completing the form, definitions for the information requested and each product category being surveyed, a confidentiality form and the names of the ARB staff to phone for assistance. A copy of the form and accompanying letter is included in Appendix B.

The survey form was mailed to each person or company on the ARB's consumer products mailing list on March 12, 1991. At that time, there were over 3000 names on the mailing list, which included companies involved in the sales, manufacturing, raw material supply, or distribution of household, personal, industrial and institutional products. Respondents were requested to return the survey by May 10, 1991, giving them approximately 60 days to complete the survey.

Survey Handling and Data Verification

The staff took several steps to ensure survey confidentiality and data security. Part I of the 1991 consumer products survey, "the confidential information submittal form," was provided in the survey package to allow the

respondent to indicate whether or not the information contained in the survey should be kept confidential. Each page of the survey form also allowed the respondent to indicate whether information contained on that page should be kept confidential. Data received by the staff that was indicated to be confidential was stamped confidential and placed in a pre-arranged folder. Data security was maintained by storing the confidential survey submittals, which were not actively being processed, under lock and key at all times. Only members of the ARB staff actively involved with development of the consumer products regulation were permitted to examine the contents of surveys received and the computer data files containing such information.

The staff processed each survey following a protocol developed by the staff. The staff examined each survey submittal to determine if the respondent manufactured or distributed any of the products for which information was requested. If the respondent indicated that they did not manufacture any of the consumer product categories being surveyed, the survey submittal was identified as non-applicable. Each survey submittal, both applicable and non-applicable, was then entered into a master log book and assigned a facility number. Applicable surveys were placed in their own folder with a tracking sheet that allowed the ARB staff to determine the submittal status of the survey as it was being processed.

The staff took several steps to verify the accuracy of data that was provided by each survey respondent. Survey submittals received at least three levels of extensive review. First, each survey was reviewed by two different ARB staff members of the Solvents Control Section. If information contained on the survey form was suspected of being inaccurate or unusual, the contact person identified on the survey form was contacted to determine if errors had occurred. Any erroneous survey data identified in this manner were corrected as necessary. After each survey was reviewed and any errors corrected, the survey data was entered into a data base designed by the ARB staff. Entered survey data within each category then underwent a third review by the staff person assigned to that category. In addition, summaries of the data were made available to industry (Summaries 1, 2, and 3) for review. Errors that were identified by industry representative were also corrected by the staff.

Results and Summaries

The ARB staff received 750 survey submittals. Of these, 536 submittals contained data for the applicable consumer product categories. A list of companies which supplied survey submittals is included in Appendix B.

Most respondents to the survey requested confidentiality protection for part or all of the information supplied to the ARB on the survey form. To address industry's concerns about maintaining the confidentiality of the data submittals, the ARB staff solicited public input on the data summaries proposed for publication. In a letter dated June 18, 1991, the ARB staff outlined the summaries and listings of the information from the 1991 consumer products survey proposed for release and invited any comments regarding the ARB staff's proposed policy. In a subsequent letter, dated July 30, 1991, the ARB staff identified the final decision to disclose the data as described in the June 18 letter, with several modifications. The data to be released included Summaries 1, 2, and 3 and List 1 and 2. This

decision represented the ARB staff's efforts to balance the public's right to know with a manufacturer's interest in protecting the confidentiality of product information.

Summaries 1, 2 and 3, and Lists 1 and 2 were compiled using VOC survey data received by the ARB staff (see Appendix B). Summary 1 includes the following information for each product: (1) identification of the product category and code, (2) an ARB assigned product number, (3) identification of the product form, and (4) total VOC content. Summary 2 includes the following information from each aerosol product: (1) identification of the product category and code, (2) an ARB assigned product number; this number and other numbers assigned in summaries 1 and 3 or in List 1 and 2 do not correspond with each other, (3) the percent propellant contained in the product and (4) the type of propellant used. Summary 3 is a summary of the potential VOC emissions in 1990 for the Phase II product categories proposed for regulation. List 1 is a list of products and the names of the associated manufacturers, grouped by product categories, that have been reported in the survey, as having a VOC content at or below the proposed VOC standard. The staff emphasizes that List 1 is not an endorsement of complying products as "environmentally friendly" nor is it all-inclusive. List 2 is a list of all products grouped by product categories, that have been reported in the survey. Finally, to ensure data confidentiality, each summary and list discussed above was scrambled to prevent identification of product VOC content and other formulation data for a individual product.

In addition to the summaries and lists mentioned above, aggregate data summaries have also been compiled for each product category. These summaries include the following information for each product category: (1) total number of products reported in the survey, (2) number of different available product forms reported, (3) number of I&I and household products, (4) total poundage (lbs/day) of Table B compounds, LVP compounds, All Other Carbon-Containing compounds (VOC content), Non-Carbon-Containing compounds and Propellant Types.

B. METHODOLOGY OF ESTIMATING EMISSIONS

Health and Safety Code section 41712 requires the Board to achieve the maximum feasible reduction in reactive organic compounds emitted by consumer products. As defined in the regulation, VOCs are reactive organic compounds. VOCs are defined as any compound containing at least one atom of carbon, except methane, carbon dioxide, and certain other organic compounds determined by the Environmental Protection Agency (EPA) and the ARB to be negligibly photochemically reactive. These compounds, that are determined to be negligibly photochemically reactive, are referred to as "Table B" compounds in this report.

While all VOCs are potential contributors to air pollution, the staff are also aware that some VOCs used in consumer products have very low vapor pressures, and due to the product formulation characteristics and product use, do not contribute to as great an extent as the more volatile VOCs. Based on staff's evaluation of the consumer products being proposed for control, the regulation provides that only those compounds that exert a vapor pressure greater than 0.1 mm Hg when measured at 20 degress Centigrade will be counted toward the emission estimates.

To determine the VOC emissions for each consumer product category and to quantify emission reductions, the staff used data provided in the 1991 consumer product VOC survey. The 1991 survey provided the staff with comprehensive data on product composition and 1990 production figures, in pounds per year, for products sold in California. Using data that had undergone the extensive levels of review discussed previously, the staff determined the emissions for 12 additional categories that are being proposed as amendments to the existing consumer product regulation. The emissions from each product reported in the survey responses were calculated using the following equation:

$$VOC_e = VOC_c * Prod / 2000 / 365 / 100$$

where,

VOC_e = VOC emissions (per product) [=] ton VOC/day
VOC_c = VOC content of product [=] wt%
Prod = 1990 California production (except otherwise specified) [=] lb product sold in California/year
2000 = conversion factor for lb to tons [=] 2000 lb/ton
365 = conversion factor for year to day [=] 365 day/year
100 = conversion factor for wt% to fractional weight, no units

Because charcoal lighter fluids, hand dishwashing detergents and certain household adhesives may have alternative environmental fates, the estimated emissions for these categories were adjusted accordingly. For charcoal lighter fluids, the staff conservatively estimated that approximately 20 percent of the fluid used either evaporates or is otherwise not combusted during use. The emission estimates for hand dishwashing detergents were determined using results obtained from a study sponsored by the Soap & Detergent Association (SDA). Results from the SDA experiments and studies that evaluated ethanol release during hand dishwashing show that up to 5 percent of the ethanol in the detergent is emitted during use (Wooley). In determining emissions for cyanoacrylate based household adhesives, staff estimated that approximately 5 percent of the total VOC content in these products is emitted into the atmosphere since most of the VOC content is involved in the polymerization process and is not emitted into the atmosphere (Adhesive and Sealant Council). These emission estimates represent conservative estimates of the overall emissions from these categories. Further discussions on how these emission estimates were determined for these categories can be found in Chapter V.

C. EMISSION ESTIMATES

The emissions from all consumer products are estimated to be about 200 tons per day in 1987 (excluding aerosol paints) and account for approximately 10 percent of all the non-vehicular VOC emissions in California. This is a significant source of VOC emissions and, if not regulated, the percentage contribution to the total smog-forming emissions

will increase as California's population continues to grow and the emissions from automobiles and factories are increasingly regulated.

The estimated emissions of VOCs from the 12 consumer products being proposed for regulation were over 57,000 lbs/day (28.5 T/D) statewide in 1990. The emissions from these products are summarized in Table IV-1. The emissions from these products account for approximately 15 percent of the total consumer product emissions. Insecticides are the largest category with 18,500 lbs/day, followed by personal fragrance products at 10,900 lbs/day.

TABLE IV-1

VOC Emissions by Product Category
(Phase II - 1990)

Product Category	VOC Emissions lbs/Day
Aerosol Cooking Sprays	1,480
Automotive Brake Cleaners	1,600
Charcoal Lighter Fluid	5,600
Carburetor Choke Cleaners	3,300
Disinfectants (Aerosol)	7,600
Dusting Aids -	
Aerosol	980
All Other Forms	20
Fabric Protectants	440
Hand Dishwashing Detergents	800
Household Adhesives -	
Aerosol	840
All Other Forms	1,520
Insecticides -	
Crawling Bug	7,640
Flea and Tick	800
Flying Insect	2,000
Foggers	2,900
Wasp and Hornet	720
Lawn and Garden	3,080
All Others	1,400
Laundry Starch Products	3,400
Personal Fragrance Products	
Aftershave and Body Splashes	2,820
Colognes, Toilet Water and Perfumes	8,000
All Other	80
Total:	~ 57,000 lbs/Day (28.5 Tons/Day)

Source: ARB 1991 Consumer Product Survey

References:

Adhesive and Sealant Council, Inc., Industry presentation to the ARB staff, September 27, 1991.

Wooley, J., Nazaroff, W., "Release of Ethanol to the Atmosphere During Use of Consumer Cleaning Products," Journal of Air Waste Management Association, 40: 1114-1120(1990).

V.

DESCRIPTIONS OF NEW CATEGORIES AND THE TECHNOLOGICAL AND COMMERCIAL FEASIBILITY OF THE PROPOSED STANDARDS

A. GENERAL DISCUSSION OF METHODS OF COMPLYING WITH THE STANDARDS

Several methods are available to reformulate products that do not comply with the standards in the proposed regulation. The VOC solvents may be replaced in part or in whole with water or another non-VOC material. The percentage of active ingredients, which in many cases are low vapor pressure materials exempt from the VOC standards, may be increased. The VOC propellants may be replaced with a non-VOC alternative. The product form may be changed. Finally, the innovative product provision may be an option for products that do not meet the VOC standards, but result in lower emissions than would be achieved through compliance with the standard, due to some feature of the product.

One method of complying with the proposed VOC standards is to replace the VOC solvents with water. This may be achieved by the creation of an emulsion system or by changing to water-compatible active ingredients. In an emulsion system, two separate liquid phases are present with one phase dispersed in small droplets through the other "continuous phase". In many consumer products, a water and solvent/oil phase are present, with the active ingredients dissolved in the solvent/oil phase. Often, emulsifying agents, such as surfactants, are added to the formulation to facilitate the mixing of the two phases. As an example, aerosol air fresheners may be classified as single phase or dual phase systems. The single phase air fresheners are solvent based while the dual phase air fresheners are typically emulsion systems with a water phase and a solvent phase which contains the fragrance. The 1990 and 1991 consumer product surveys revealed that the solvent based, nonemulsion, aerosol air fresheners are nearly 100 percent VOC, while the dual phase emulsion systems are typically in the range of 30-35 percent VOC, since water makes up one phase. Water emulsion complying products have been identified in many categories including dusting aids, insecticides, aerosol cooking sprays, carburetor-choke cleaners, brake cleaners, and personal fragrance products. Manufacturers with non-complying products can very likely utilize emulsion technology to comply with the regulation.

Another way to allow the replacement of VOC solvents with water is to use water compatible active ingredients. Some manufacturers may utilize existing water compatible actives to develop complying products. For instance, some insecticides with active ingredients sensitive to water may switch to certain pyrethroids which are stable in water emulsion systems. Other manufacturers may have to develop water compatible active ingredients. As an example, Kodak is in the process of developing a hairspray resin that is soluble in demineralized water, in contrast to current products which are soluble in ethanol (Eastman Kodak).

For products with active ingredients that are non-VOC or low vapor pressure exempt compounds, compliance may be achieved by increasing the concentration of these "actives". As an example, an adhesive may increase the content of nonvolatile polymers that form the bond after the solvents have evaporated.

Aerosol products with hydrocarbon (VOC) propellants may be able to reduce their VOC content by replacing the hydrocarbon propellant with a non-VOC alternative. For instance, if a product utilizes a propellant only to dispense the product ingredients, and not for its solvent properties, compressed gas propellants may be an alternative. Aerosol valve technology utilizing special nozzles or "micro-tap" technology to maintain consistent spray characteristics is currently available for products using compressed gases or compressed gas/hydrocarbon propellant blends (Aerosol Age, Dec. 1989 and Dec. 1990)(Summit). In addition, research and development efforts are currently underway to expand the application of this technology (Summit). Another option that has recently been utilized in a commercially available hairspray product (Proctor & Gamble) is the "Airspray" system which is manually pumped by the operator. Yet another unique option is the "Exxel" system which uses a rubber bladder to force out the product ingredients.

If the propellant must also function as a solvent, hydrofluorocarbon (HFC) propellants may be an alternative to hydrocarbon propellants. HFC-152a is one possible alternative to hydrocarbon propellants. HFC-152a has a moderately high vapor pressure of 62 psig at 70°F and is a fair solvent with a Kauri-Butanol (KB) value of 11. The KB value is a measure of a solvent's strength, with higher KB values representing "stronger" solvents. HFC-152a is relatively expensive at about $1.75/lb., compared with less than $0.30/lb. for hydrocarbon propellants (DuPont). HFC-152a is currently used alone or blended with hydrocarbon propellants in hair mousse products and is described as easy to work with from a formulation point of view (Johnsen). While production of HFC-152a is currently limited, capacity and consumption are increasing (DuPont). It is expected that the cost of HFC-152a will be reduced as production increases due to the marketplace economics.

If the amount of propellant used is due to the need to fully evacuate the product contents, then other non-propellant technologies may allow a reduction in the amount of propellant used. For instance, there are some aerosol products, such as laundry starch products, which may be used in a horizontal position by the consumer. Such a position may cause premature propellant loss because the dip tube becomes raised into the can's headspace

above the product content level. In these cases, manufacturers have traditionally used more than the minimum amount of propellant needed to compensate for such propellant losses and to ensure that the can is satisfactorily evacuated as intended (CSMA Task Force). However, new technologies, such as ceramic weighted dip tubes, may provide a means to reduce the propellant content while still allowing satisfactory product evacuation. This technology allows the weighted dip tube to "chase" the product in the can, thereby preventing or reducing propellant loss, even in horizontal positions (Rogers). Moreover, weighted dip tubes can also be used in aerosol products which use compressed gas as the propellant, where propellant loss is an even more critical concern. Such a system employing weighted dip tubes is currently in use in European consumer products and may be adaptable to U.S. products.

Although the proposed regulation is generally not designed to require a change in product form, this option is available to manufacturers to meet the VOC limits. Since some of the product standards include different VOC limits for different product forms, changing the form of the product may provide a more favorable means of approaching the VOC limits for an individual product.

Finally, the innovative product provision is available to products that do not meet the VOC standards, yet result in less emissions due to some feature of the product. Potential candidates for this provision include: (1) products that deliver the active ingredients more efficiently, allowing less product to be used; (2) products that contain more active ingredients or more effective active ingredients; and (3) products that emit VOC ingredients that are transformed to non-VOCs.

References:

Aerosol Age, "Micro-vapor Tap Improves CO2 Performance," Aerosol Age, Decembe, 1989.

Aerosol Age, "Actuator Button Regulates Container Pressure," Aerosol Age, December, 1990.

CSMA Household Products, Task Force, presentation to ARB staff on September 10, 1991.

DuPont, telephone conversation with Paul Milkey, circa 10/1/91.

Eastman Kodak Co., "Eastman AQ Polymers For Water-based Hair Spray," Publication No. CB-14A, December, 1990.

Johnson, Montfort, A., "The Fluorocarbons-Old Problems and New Opportunities," Aerosol Age, January, 1991.

Proctor and Gamble, print advertisement for Vidal Sassoon "Airspray", 1991.

Rogers, Sue, "CMB's New System", Aerosol Age, July 1990.

Summit Packaging Systems, Inc., telephone conversation with Paul Milkey, 10/1/91.

B. COMMERCIALLY AND TECHNOLOGICALLY FEASIBLE VOC STANDARDS

Health and Safety Code section 41712 requires that all consumer product regulations adopted by the Board must be technologically and commercially feasible. Last year, during the development of Phase I consumer product standards, the staff established criteria that were used to develop VOC limits that would meet these statutory standards. The staff has used the same criteria during the development of the Phase II proposal.

In general, the staff took the view that within a given product category, products that perform similar functions should not have large differences in VOC content. The underlying question is, "If other products have a low VOC content, while performing similarly, why is this manufacturer not able to do the same or better?" For all of the product categories proposed for regulation, there exist complying products currently on the market. This fact creates a strong presumption that the proposed standards are technologically and commercially feasible. Further discussion of these concepts is presented below.

1. Commercially Feasible

The term "commercially feasible" is not defined in the Health and Safety Code. In interpreting this term, the staff has utilized the reasoning employed by the United States Court of Appeals for the District of Columbia in interpreting the federal Clean Air Act. In the leading case of International Harvester Company V. Ruckelshaus, (D.C. Cir. 1973) 478 F.2d 615, the Court held that the Environmental Protection Agency could promulgate technology-forcing motor vehicle emission standards which might result in fewer models and a more limited choice of engine types for consumers, as long as the basic market demand for new passenger automobiles could be generally met.

Following this reasoning, the staff has concluded that a regulation is "commercially feasible" as long as the "basic market demand" for a particular consumer product can be met. While the proposed standards are not expected to eliminate any product forms or types, the staff does not believe that the Legislature intended that manufacturers be guaranteed the right to sell consumer products in all the same variety of forms and types that presently exist. To adopt such a narrow interpretation would be inconsistent with the clearly expressed legislative intent that "...the state board shall adopt regulations to achieve the maximum feasible reduction in reactive organic compounds emitted by consumer products..." (Health and Safety Code section 41712(a)).

Some commenters have expressed the view that consumers do not have a "basic market demand" for a general class of products, but that consumers instead have a number of a separate and distinct "basic market demands" for many specialty products with differing characteristics. In the category of "glass cleaners", for example, some glass cleaners are ammonia-based and some are vinegar-based. Under the views of some commenters, it might be inappropriate for the ARB to establish a single standard for glass cleaners

(based on the "basic market demand" for "a product that will clean glass"), because such a standard may not take into account the separate market demand of some consumers for "ammonia-based glass cleaners" and the demand of other consumers for "vinegar-based glass cleaners". Similarly, it has been argued that separate "basic market demands" must be recognized for all forms of a product (i.e., aerosols, pumps, solids, gels, etc.), and that the ARB does not have the authority to set a VOC standard that would have the effect of eliminating any of the existing product forms.

The ARB staff does not agree with this view. Every currently marketed product or product form has some unique features that differentiate it from other products. Consumers who purchase a particular product or product form have demonstrated a preference over competing products that they do not buy. However, a preference for a particular product form is not the same as the basic market demand for the function that the product performs. The International Harvester case, supra, clearly makes this distinction. In International Harvester, the court stated that the proposed emissions standards would be feasible even though they might result in the unavailability of certain kinds of vehicles and engine types which some consumers preferred (e.g., fast "muscle" cars), as long as the basic market demand for passenger cars could be generally met. Applying this principle to the area of consumer products, the proposed amendments allow the basic market demand to be met for products in each consumer product category, even though for some categories it may no longer be possible to manufacture certain product types or formulations. The ARB staff believes that this is a common sense approach which is in full accord with the requirements of section 41712.

Although the ARB is not legally compelled to do so, for many product categories an attempt has in fact been made to accommodate differing consumer preferences. This is reflected in those product categories for which separate VOC limits have been set for different product forms. The ARB will continue to use this approach in cases where it is both feasible and appropriate to do so, in light of all the data and comments presented during the regulatory process.

2. Technologically Feasible

The Health and Safety Code section 41712(b) provides that the Board shall not adopt consumer product regulations unless the regulations are also "technologically feasible". Technological feasibility is a different concept than "commercially feasible", and does not take into account the cost of the product to be produced. The staff believes that a proposed standard is technologically feasible if it meets at least one of the following criteria: (1) the standard is already being met by at least one product within the same category, or (2) the standard can reasonably be expected to be met in the time frame provided through additional development efforts. For all of the categories being proposed for control, both the initial standards and the future effective standards, products are currently marketed that comply with the regulation. Tables V-1 and V-2 lists the number of complying products for each Phase II product category.

TABLE V-1

Summary of Products Which Comply with the Proposed Standards (1/1/95)

Product Category	Product Form	Proposed Standard Wt % VOC (1/1/95)	Total # Products in Survey	Number of Complying Products Available in Calif.
Aerosol Cooking Sprays	All Forms	18	45	31
Automotive Brake Cleaners	All Forms	50	60	45
Charcoal Lighter Material	All Forms	0.02 lb/start	23	*
Carburator Choke Cleaners	All Forms	75	69	24
Disinfectants	Aerosols	60	84	41
Dusting Aids	Aerosols	35	28	15
	All Others	7	19	12
Fabric Protectants	All Forms	75	66	59
Hand Dishwashing Detergents	All Forms	2	157	106
Household Adhesives	Aerosol	75	58	45
	All Others	10	250	166
Insecticides -				
Crawling Bug	All Forms	40	210	134
Flea and Tick	All Forms	20	39	23
Flying Insect	All Forms	30	64	15
Foggers	All Forms	40	62	53
Wasp & Hornet	All Forms	40	37	22
Lawn & Garden	All Forms	20	164	89
All Others	All Forms	20	129	51
Laundry Starch Products	All Forms	5	42	26
Personal Fragrance Products -				
Aftershave & Body Splashes	All Forms	60	198	58
Colognes, Toilet Water & Perfumes	All Forms	70	669	93
All Other	All Forms	50	45	16

* UTQ - Unable to quantify

Note: Kingsford has recently qualified a charcoal lighter fluid to meet South Coast Air Quality Management District requirements and the staff believes that this product will meet the proposed standards.

TABLE V-2
Summary of Products Which Comply with the
Proposed Standards (1/1/97)

Product Category	Product Form	Proposed Standard Wt % VOC	Total # Products in Survey	Number of Complying Products Available in Calif.
Carburetor Choke Cleaners	All Forms	50	69	15
Dusting Aids	Aerosol	25	28	9
Fabric Protectants	All Forms	60	66	59
Household Adhesives	Aerosol	25	58	22
Insecticides - Crawling Bug (1/1/98)	All Forms	20	210	99

C. AEROSOL COOKING SPRAYS

Product Description:

An aerosol cooking spray is defined as any aerosol product designed either to reduce sticking on cooking and baking surfaces or is applied on food, or both. They are generally identified by their labels as pan coating, pan release, food release, no-stick, or flavored cooking sprays that are used in the professional and home settings.

The major use for aerosol cooking sprays is for non-stick cooking on utensils and all cooking surfaces such as grills, frying and baking pans, and broilers. They can be used on food preparation surfaces such as iron, steel, aluminum, copper, glass, or pottery. Aerosol cooking sprays can also be used as flavoring or seasoning to saute or flavor foods. Additionally, some aerosol cooking sprays can be used as both a non-stick and flavoring spray. Alternatives for these products that are available for use by consumers, include the use of teflon coated non-stick cookware (e.g. "Silverstone"), non-stick bakeware, or greasing the cookware by hand.

The product is applied by holding the aerosol can in an upright position 12 to 15 inches from the surface or food and spraying in a sweeping motion from side to side. Usually, a re-application of the product is needed for each new use. Some water emulsion products require shaking before being applied.

In general, aerosol cooking sprays help to reduce sticking of foods on cooking surfaces and aid in the clean-up of food residues on cookware, bakeware and utensils. In some cases, they are used as flavoring sprays. Moreover, manufacturers claim that cooking sprays benefit people who are on low-fat or restrictive diets because the cooking sprays contain little fat, are low in calories and have no cholesterol.

Based on the 1991 ARB VOC survey, 45 aerosol cooking sprays were reported. Although one product was reported as a pump spray, this product was excluded, by definition, from the emissions inventory for this category. Table V-3 is a summary of the proposed standard and emissions estimate for aerosol cooking sprays.

TABLE V-3

Aerosol Cooking Spray Emissions Summary
(Total Emissions 1480 lbs/day)

Product Form	Percent of Market	Emissions (lbs/day)	Percent of Emissions
Aerosol	100	1480	100

Product Formulation:

The "birth" of aerosol cooking sprays can be linked to the "discovery" of lecithin in 1953 (Johnsen, 1991). At the time, lecithin was already known for its mold release properties for such operations as the making of rubber tires and certain sugar candies. It was reasoned that if lecithin worked well as a good release agent for molded goods, then maybe it could also work well for baked and cooked foods. This was confirmed when eggs and cheese were cooked on a lecithin coated frying pan and the food did not stick to the pan. During the discussion on how the new "discovery" could be marketed, it was decided that lecithin could be applied as an aerosol spray. Thus the production of aerosol cooking sprays began in 1954 using CFC (chlorofluorocarbon) propellants.

Because of CFC/ozone depletion concerns during the mid-1970's, manufacturers began to look at alternative propellants. During this time, it was discovered that hydrocarbon propellants could loosen the thick lecithin which allowed the full efficacy of the surfactant properties to be developed. This also allowed a weak emulsion of lecithin, water, and

hydrocarbon propellant to be developed. A U.S. Patent was given in 1975 for the emulsion formula and this led the way for more water emulsion aerosol cooking sprays.

By 1980, a few trace additives were included in the aerosol cooking sprays. Because butter has a highly regarded taste and was itself an established main release agent, other ingredients were added to imitate its characteristics. Beta-carotene was added at 2-3 ppm (parts per million) to achieve the yellow color and flavoring agents were added at about 0.025 to 0.60 percent to achieve the butter aroma and taste (Johnsen, 1991). Methyl silicone, a spreading agent, was also added in some products at levels not exceeding 10 ppm. Aerosol cooking sprays may contain various combinations of vegetable oil, lecithin, propellant, water, flour, alcohol, flavoring, colorants, emulsifiers, anti-oxidants, and other trace additives.

Different formulations exist for this category, but the products are still used primarily for pan release. Some examples of the different formulations found in the patent literature are described below.

One example is the patent held by Harold W. Hanson, Sr. (U.S. Patent 4,192,898, 1980) and is titled "Stable Clear Liquid Release Agent and Method for Preparation". This patent describes a formula which may be comprised of palm oil (15-41 percent), olive oil (58-84 percent), polysorbate 80 (0.25-2 percent), and carbon dioxide propellant (3-5 percent). Instead of compressed gas, hydrocarbon propellants may be used in amounts up to 30 percent. Polysorbate 80 is used as an emulsifying agent and de-foamer. Additional ingredients may include flavoring, colorant, an amount of lecithin to act as an anti-spattering, anti-bleeding and emulsifying agent, anti-oxidants, and aluminum stearate (1-10 percent).

Another example is the patent held by Dan W. Follmer (U.S. Patent 3,896,975, 1975) and is titled "Non-Foaming Lecithin Emulsion Cookware Lubricant." This formula may contain lecithin (Phosphatidylinositol, 1-5 percent; Phosphatidylcholine, 0.1-1 percent; Phosphatidylcephalin, 1-2.5 percent), mono and diglycerol oleates (0.5-2 percent), soybean oil (1-10 percent), aliphatic organic liquid solvent (0-10 percent), water (15-75 percent), and propellant (10-50 percent). Additional ingredients such as ascorbic acid (up to 5 percent) and calcium ascorbate (up to 1 percent) can be included. Various hydrocarbon propellents can be used such as propane, butane, isobutane and pentane. In addition, inorganic propellants such as nitrogen, nitrous oxide and carbon dioxide can be used with the latter being particularly useful with the water emulsion system described in the patent. The water-oil-lecithin combination produces an opaque layer on the cooking surface, which is useful for showing if the degree of coverage is adequate. Water is used in the formulation to prevent scorching of the lecithin in a preheated pan. As the water evaporates, local cooling of the pan surface occurs. The oleates and aliphatic solvents are used as emulsifiers.

A third example is the patent held by Vasant Sejpal (U.S. Patent 4,188,412, 1980) and is titled "Non-Foaming, Clear, Aerosol Vegetable Oil Compositions Containing Lecithin, Ethyl Alcohol and Hydrocarbon Propellants." This formula can contain a vegetable oil (5-65 percent),

lecithin (3-15 percent), ethanol (7.5-25 percent), and a 60/40 isobutane/propane blend (10-75 percent). The lecithin-oil-alcohol combination is intended to provide a clear, non-foaming, composition and a uniform, one phase system. Also, the formula is intended to provide an anti-stick composition which has higher anti-sticking properties per unit weight than previous formulations. The vegetable oil may contain Food and Drug Administration (FDA) approved anti-oxidants such as butylated hydroxyanisole (BHA), propyl gallate, and tertiary-butylhydroxyquinone (TBHQ), a crystal inhibitor such as oxystearin and an anti-foam agent such as methyl silicone.

Aerosol cooking sprays that contain flour as a suspended solid necessitate the use of vapor-tap valves. Without a vapor-tap valve, agglomeration of the flour can occur, causing permanent clogging of the valve which renders the product inoperable. The vapor-tap valves require extra propellant because it is bled off during spraying and it also reduces the pressure of the product as it is used (Clapp, 1991a, 1991b).

The key ingredient in aerosol cooking sprays is lecithin, a naturally occurring mixture of phospholipids. Lecithin is present in egg yolks and most oil seeds, but the most common commercial source is from soy oil refining. Lecithin is used commercially because it has excellent emulsification properties and light color. In addition, this ingredient is a useful foam stabilizer and suspending agent, has anti-spattering properties, and is a good release agent. It can be blended with specialty oils to provide fluidity. Structurally, lecithin is very similar to the triglyceride molecule and contains unsaturated oxygen. A typical composition of soybean lecithin is comprised of 16 percent phosphatidylcholine, 14 percent phosphatidylethanolamine; 10 percent inositol phosphatides; 25 percent other phosphatides, sugar, sterols, and moisture; and 35 percent soybean oil (McCormick, 1986). Lecithin is one of two common phosphatides, present at levels of 1 to 2 percent in the vegetable oils, and at higher levels in animal fats (McCormick, 1986). Because of its reputation as a health food supplement, lecithin is used in fat-sparing formulations. The claimed benefits of using lecithin are the reductions in fat, calories, and cholesterol in cooked foods.

There is no industry standard for testing the efficacy of aerosol cooking sprays because companies have their own protocols or test methods for comparing performance characteristics. Since different formulations exist in the marketplace that can achieve food release, it is difficult to recognize one formulation as being more "efficacious" than all others. For example, U.S. Patent 4,188,412 (1980) held by Vasant Sejpal, shows a variety of alcohol-based formulas that are claimed to have good food release characteristics. On the other hand, the water emulsion system described in U.S. Patent 3,896,975 (1975) and held by Dan W. Follmer, is a different formula, yet it is also claimed to have good food release characteristics.

Since aerosol cooking sprays are used as a processing aid in the cooking and baking of foods or as flavoring on foods, all listed ingredients must be "generally recognized as safe (GRAS)" for use by the FDA. Based on

the 1991 ARB VOC survey, the VOC content ranges from 13 percent to 36 percent by weight.

Recommended VOC Standard:

The proposed standard for aerosol cooking sprays is 18 percent. This standard is technologically and commercially feasible and will achieve emission reductions. Based on the ARB VOC survey, at least 31 products can meet this standard. These products are identified in Appendix B. Of the 31 complying products, 11 are sold for household use, 15 are sold for industrial and institutional use and 5 are sold for both markets. The estimated emission reductions, based on the proposed standard, is 400 lbs/day. Table V-4 is a summary of the proposed standard and emission reductions.

TABLE V-4

Aerosol Cooking Spray Standard Summary

Product Form	Proposed Standard (% VOC)	Number of Complying Products	Percent of Market Complying	Emission Reduction (lbs/day)
Aerosols	18	31	47	400

As shown in the above table, almost 50 percent of the market already complies with the recommended VOC standard. The recommended VOC standard will allow for a wide variety of formulation types including anhydrous and water emulsion forms.

Compliance with the Standard:

Manufacturers may achieve compliance with the standard by reformulation, or the use of other alternative forms for cooking, baking or flavoring. Since the VOC content of anhydrous sprays is mainly hydrocarbon propellant, the concentration of the propellant may be changed. Also, the various operable ranges of formulations given in the alcohol-based (U.S Patent 4,188,412, 1980) and water emulsion (U.S patent 3,896,975, 1975) patents offer some choices for reformulation.

The replacement of hydrocarbon propellants with inorganic propellants such as carbon dioxide, nitrous oxide, nitrogen (U.S Patent 3,896,975, 1975; Johnsen, 1991), and perhaps argon (Johnsen, 1991) may be feasible. The substitution of hydrocarbon propellants with the exempt compound, HFC-152a (1,1-difluoroethane) may also be possible. This propellant is currently commercially available (DuPont, 1991); however, it has not yet undergone a GRAS determination. Although much of the toxicological testing has been

done, the impetus for applying to FDA for approval as a GRAS compound has not yet been realized.

In addition, manufacturers may wish to consider other alternatives such as those listed below:

	U.S Patent	Inventor	Date	Title
1)	4,023,912	Darrell Mahler	May 17, 1977	Solid Stick Pan Lubricant
2)	4,142,003	Vasant D. Sejpal	Feb. 27, 1979	Non-Aerosol Vegetable Oil Compositions Containing Lecithin and Pure Ethyl Alcohol
3)	4,155,770	Charles Doumani	May 22, 1979	Mineral Oil Modified Lecithin Cookware Spray Composition
4)	4,163,676	Kurt S. Konigs-bacher	Aug. 7, 1979	Ethanol-Modified Lecithin Cookware Spray Composition
5)	4,339,465	Oran L. Strouss	Jul. 13, 1982	Method of De-Panning Baked Goods
6)	4,547,388	Oran L. Strouss	Oct. 15, 1985	Pan Release Agent and Its Preparation
7)	4,849,019	Takuji Yasukawa et al.	Jul. 18, 1989	Pan-Releasing Type Oil Composition
8)	4,888,186	Judith Cooley et al.	Dec. 19, 1989	Method for Producing Flavored Popcorn
9)	4,906,490	Abraham I. Bakal	Mar. 6, 1990	Method of Producing Butter Flavored Granules

Issues:

1. Issue: The CSMA Aerosol Cooking Spray Task Force initially requested that five separate subcategories be developed for aerosol cooking sprays. Now the Task Force requests that three separate subcategories be developed. The subcategories and their proposed VOC standards would be: (1) aerosol alcohol cooking spray (36 percent, 30 percent beginning in 1997), (2) aerosol baking spray (25 percent), and (3) aerosol alcohol-free cooking sprays (20 percent). These levels would allow for on-going, low emission, quality cooking sprays and a low-fat, low calorie, no cholesterol way to cook. Furthermore, it is contended the patents covering the use of alcohol restrict the levels of alcohol/propellant that can be used in existing formulations. The Task Force claims that reducing the propellant levels may encroach on patent claims and the efficacy of the release characteristics would be reduced by reducing lecithin levels requiring application of more product. (CSMA Task Force, 9-18-91).

   Response: The subcategories are not necessary. The proposed VOC standard of 18 percent represents 31 complying products and a complying

market share of almost 50 percent as reported in the 1991 ARB VOC survey. The complying products represent different formulations and have demonstrated consumer acceptance. Examples of both pan release and flavoring sprays are included in the products that comply. There is no difference in health benefits between the complying and non-complying products since the complying products also provide a low-fat, low calorie, no cholesterol way to cook. With regard to the need for alcohol, there are products that are currently on the market that do not contain alcohol that have similar release characteristics as the alcohol-based products indicating that alcohol is not essential in aerosol cooking sprays. For baking sprays, there are complying products that can be used for baking purposes. There are also alternative methods for releasing food from bakeware. One method is described in U.S. Patent 4,339,465, held by Oran L. Stouss, and is titled "Method of De-Panning Baked Goods" (1982).

2. Issue: The CSMA Aerosol Cooking Spray Task Force stated that there is a lack of alternative food-approved, liquified or compressed gas propellants. It is claimed that there is also the inability to use compressed gas propellants because of the viscosity of the systems and the inability to develop suitable sprays without the addition of alcohol. Also, testing new propellants is claimed to be extremely costly, highly speculative and take a great deal of time. (CSMA Task Force, 8-29-91)

   Response: According to Johnsen (1991), there are food-approved compressed gases such as carbon dioxide, nitrous oxide, nitrogen, and perhaps argon. A few of the formulas described in the "Product Content Formulation" section called for the possible use of carbon dioxide as a propellant. Since there are complying products on the market that contain no alcohol, formulations without alcohol are technologically and commercially feasible. In addition, discussion with a DuPont representative (1991) indicates that HFC-152a has been exempted as a VOC by the U.S. Environmental Protection Agency. This propellant is commercially available and much of the toxicological testing has been done. The impetus for applying to FDA for approval as a food-grade propellant has not yet been realized, but it appears feasible. Furthermore, all 31 complying products currently use hydrocarbon propellants; therefore, these products do not need HFC-152a to comply with the standard. However, HFC-152a can be an optional ingredient in the future, particularly for those manufacturers who want to continue using various ranges of alcohol in their formulations or have greater flexibility in developing different formulations.

References:

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Cooley, Judith, and Douglas, Diane. "Method for Producing Flavored Popcorn," December 19, 1989, U.S Patent 4,888,186.

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DuPont Representative, Telephone Conversation, September 19, 1991.

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Hanson, Sr., Harold W. "Stable Clear Liquid Release Agent and Method for Preparation," March 11, 1980, U.S. Patent 4,192,898.

Johnsen, Montfort A. "Cookware Release Sprays," Spray Technology & Marketing, May 1991, pp. 40-47.

Konigsbacher, Kurt S. "Ethanol-Modified Lecithin Cookware Spray Composition," August 7, 1979, U.S. Patent 4,163,676.

Mahler, Darrell, and Doumani, Charles. "Solid Stick Pan Lubricant," May 17, 1977, U.S. Patent 4,023,912.

McCormick, Richard D. "Breaking the Fat/Calorie Barrier Naturally with Lecithin," Prepared Foods, February 1986, pp. 87-88.

SanGiovanni, Michael L., "American/National's Precitube Offers Pocket Convenience," Spray Technology and Marketing, April 1991, p. 44.

Sejpal, Vasant D. "Non-Aerosol Vegetable Oil Compositions containing Lecithin and Pure Ethyl Alcohol," February 27, 1979, U.S Patent 4,142,003.

Sejpal, Vasant D. "Non-Foaming, Clear, Aerosol Vegetable Oil Compositions Containing Lecithin, Ethyl Alcohol and Hydrocarbon Propellants," February 12, 1980, U.S. Patent 4,188,412.

Strouss, Oran L. "Method of De-Panning Baked Goods," July 13, 1982, U.S. Patent 4,339,465.

Strouss, Oran L. "Pan Release Agent and Its Preparation," October 15, 1985, U.S. Patent 4,547,388.

Yasukawa, Takuji, Nishide, Tsutomu, and Yasumura, Daisuke. "Pan-Releasing Type Oil Composition," July 18, 1989, U.S. Patent 4,849,019.

D. AUTOMOTIVE BRAKE CLEANERS

Product Description:

Automotive brake cleaners are products designed to remove oil, grease, brake fluid, brake pad material or dirt from motor vehicle brake mechanisms. In addition to removing contaminants from brake components, brake cleaners are also used to ease disassembly or to provide final cleaning during assembly of the brake components. Most brake cleaner formulations are based on VOC or exempt solvents.

As shown in Table V-5, brake cleaning products are packaged in aerosol and liquid form with market shares of 95 percent and 5 percent, respectively. The propellant used in the aerosol form is either compressed gas (carbon dioxide) or liquified hydrocarbon blends (isobutane/propane). Based on the 1991 consumer products survey, aerosol brake cleaners with carbon dioxide propellant dominate the market today and usually comprise 3 to 5 percent of the product content. The 1991 consumer product survey also revealed that emissions from Table B compounds (exempt solvents) are 5300 lbs/day. Total VOC emissions for this category are 1,600 lbs/day.

TABLE V-5

Automotive Brake Cleaners Emissions Summary
(Total Emissions 1,600 lbs/day)

Product Form	Percent of Market	Emissions (lbs/day)	Percent of Emissions
Aerosol	95	1,520	95
Liquid	5	80	5

Product Formulation:

Information compiled from ARB's 1991 consumer products survey show that most brake cleaners consist of either VOC's or Table B (exempt solvents) or both. A typical brake cleaning formulation will consist primarily of solvents and propellant (if aerosol). As mentioned earlier, the solvents contained in brake cleaners are used to remove contaminants from brake components such as soils, brake fluid, oils and greases. Most of the chlorinated brake cleaning solvents used to accomplish this cleaning task consist of 1,1,1-trichloroethane (TCA) and tetrachloroethylene (perchloroethylene) blends. Non-chlorinated brake cleaners may consist of toluene, acetone, xylene, terpenes, petroleum distillates, d-limonene, methyl ethyl ketone, methanol and ethanol. Manufacturers view chlorinated solvents as essential for cleaning/degreasing operations that are currently performed during brake maintenance and are preferred for their quick cleaning/degreasing ability and drying time. The use of TCA in brake

cleaning products has served as the mainstay for a number of years, but recent environmental, economic and regulatory developments are prompting industry to re-evaluate the use of chlorinated solvents. The provisions of the Montreal Protocol and the Federal Clean Air Act mandate a phase-out of ozone depleting compounds, including chlorinated solvents such as TCA, over the next fifteen years. TCA is scheduled to be phased out in the year 2002. Further discussion of possible TCA replacements are discussed later in this section and in Chapter VII of this document.

Recommended VOC Standard:

The standard being recommended for this category is 50 percent VOC content by weight for aerosols and liquids. Based on information submitted in the 1991 Consumer Products Survey, there are 45 products available that currently meet the proposed standard (Appendix B). As shown in Table V-6, the total estimated emissions reductions for aerosol and pump forms with a 50 percent VOC content by weight are 280 lbs/day.

TABLE V-6

Automotive Brake Cleaner Standards Summary

Product Form	Proposed Standard (% VOC)	Number of Complying Products	Percent of Market Complying	Emission Reduction (lbs/day)
Aerosol	50	38	89	260
Liquid	50	7	90	20

Compliance with the Standard:

Compliance with the proposed standard can be achieved in different ways. For those products that currently use TCA, the regulation would allow the continued use of TCA as a solvent since it is an exempt VOC. However, manufacturers considering reformulation of their products to replace TCA or other chlorinated solvents will have to use another solvent to develop a complying formulation due to the scheduled phase-out of chlorinated solvents under the Federal Clean Air Act. Also, when considering product formulation, manufacturers need to be aware that perchloroethylene has been identified as a Toxic Air Contaminant (TAC) by the ARB and there is an economic risk as well as potential liabilities associated with replacing VOC's with compounds that have been identified as TAC's or are scheduled for review in the future. One method of compliance could be achieved by replacing the VOC solvents currently contained in these products with water and exempt VOC's. Other methods involve the replacement of chlorinated solvent-based brake cleaners with water-based technology. The ARB staff is aware of products with water-based formulations that are currently available on the market that rely on water-based technology which

are reported to have equal cleaning abilities as products that currently used chlorinated solvents. For example, one manufacturer currently employs a water-based formulation which uses detergents, emulsifiers and grease dissolvers as active ingredients (Mirachem Corp.). Another manufacturer markets a patented cleaner which contains fatty acids and surface active agents that penetrate oil, grease and embedded dirt and cause the contaminants to disperse into a colloidal suspension which can then be washed or wiped away (Delta-Omega Technologies, Ltd.). Also, recent developments in aerospace and metal working industries have allowed several alternatives for the replacement of chlorinated and CFC solvents as cleaning agents that may be transferable to brake cleaning products (SAMPE Environmental Conference). These alternatives include aqueous and semi-aqueous formulations. The aqueous formulations consist of alkaline, acidic and water/alcohol solutions, while the semi-aqueous formulations consist of terpenes or hydrocarbon compounds, surfactants and a corrosion inhibitor.

Issues:

1. Issue: Manufacturers claim that water emulsions or other brake cleaners using water do not provide sufficient cleaning effect and causes rust on brake parts which can become a hazard. They have emphasized that in order to remove glaze from brake linings a strong solvent is needed. Also, considering the inevitable phase-out of chlorinated solvents under the Federal Clean Air Act, manufacturers have indicated that chlorinated solvents currently used in brake cleaners will require a one to one replacement with hydrocarbon based solvents in order to provide an effective brake cleaning product.

   Response: The ARB staff does not agree that brake cleaning products which contain water could cause rust on brake components found on automobiles today. Automotive brakes can encounter water in much larger quantities during normal daily operation and are designed to be operated in environments that may involve continuous contact with water or sustained periods of high humidity. Automobile manufacturers design brake systems to operate in wet conditions such as a rain storm. In fact, a certain degree of rust that can be found on brake components such as the drum, rotor or caliper is considered normal (Midas). Thus, the staff does not expect any adverse impacts from the use of water-based brake cleaners on brake parts that were designed to be exposed to water.

   The staff recognizes that the occurrence of glazing can impede and compromise the safe operation of an automobile, but current brake maintenance practice does not involve the use of brake cleaners to remove what is commonly known as glazing on brake pads, shoes, rotors or drums. To properly remove glazing, most professional automobile brake mechanics will resurface the rotor or drum and replace the pads or shoes to ensure safe operation of the vehicle (Midas).

When considering the eventual phase-out of chlorinated solvents and their use in brake cleaners, it is not the staff's intention to encourage a one to one replacement of chlorinated solvents with hydrocarbon solvents nor is it necessary. The two water-based products mentioned previously are examples of product formulations that can clean brake assemblies without using large amount of solvents. The staff acknowledges that professionals engaged in brake maintenance and repair are primarily concerned with the time required to complete a brake job and alterations of operational procedures may be required to adjust to new brake cleaning formulations which do not contain chlorinated solvents. These changes in operational procedures primarily involve the time required for the formulation to dry. A typical professional may have to change established habits and sequences of performing a brake job to adjust to an aqueous or semi-aqueous formulation.

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E. CARBURETOR-CHOKE CLEANER

Product Description:

Carburetor-choke cleaner is defined as a product designed to remove dirt and other contaminants from a carburetor, but does not include products designed to be introduced directly into the fuel lines or fuel storage tank prior to introduction into the carburetor. Carburetor-choke cleaners also remove dirt and other contaminants from such parts as butterfly valves and choke linkages.

Carburetor-choke cleaners are sold in both aerosol and liquid forms. The most commonly used form is the aerosol because it allows carburetors to be cleaned while they are still attached to the engine. All aerosols are sold with a thin straw-like plastic tube which inserts into the valve button orifice to allow for localized cleaning of the carburetor and its components. The liquids are usually used by professionals and home mechanics who clean, repair or rebuild disassembled engine components. Since carburetor-choke cleaners contain flammable compounds, they are intended to be used in well-ventilated areas and not near heat, sparks, or open flame.

Before an aerosol product is used, the air engine air filter and canister are removed. The spray is then applied to the internal and external surfaces of the carburetor to remove varnish, carbon, grease, and gum deposits. The instructions on some aerosols require the product to be applied to the carburetor intake, throat, and lower throttle plate area while the engine is on and occasionally revved. Some product instructions also require the engine to be run for at least 5 minutes subsequent to cleaning. Some aerosol products claim that they are not harmful to catalytic converters or oxygen sensors.

Liquid products may be sold in 2 gallon or 5 gallon containers and usually contain a dip basket. The containers are not filled completely with solution to allow head space for the dip basket. The carburetor parts are placed in the basket and immersed in the solution. The solvents in the solution help to remove the carbon, gum, varnish, and other contaminants. Depending on the degree of contamination, hand brushing or other mechanical means of cleaning may be necessary. After the carburetor parts are removed from the solution, they are rinsed with another solvent or high pressure water and allowed to dry. In general, liquid carburetor part cleaners are also used to clean other metal parts, whether they are engine components or not.

Based on the 1991 ARB VOC survey, 69 carburetor-choke cleaners were reported. Of these, 53 are aerosols and 16 are liquids. The aerosols account for 82 percent of the market and 95 percent of the emissions. Table V-7 below summarizes the emissions for carburetor-choke cleaners.

TABLE V-7

Carburetor-Choke Cleaner Emissions Summary
(Total Emissions 3,300 lbs/day)

Product Form	Percent of Market	Emissions (lbs/day)	Percent of Emissions
Aerosols	82	3,140	95
Liquids	18	160	5

Product Formulation:

Carburetor-choke cleaners contain solvents and propellants, many of which are VOCs. Typical aerosol formulations may include solvents such as aromatic petroleum distillates, methylene chloride, toluene, xylene, acetone, alcohol, ethyl acetate, butyl acetate and propellant (USEPA, 1988). Other aerosol formulations may contain the following ingredients in various combinations - diacetone alcohol, methyl ethyl ketone, 2-butoxyethanol, isopropyl alcohol, 1,1,1-trichloroethane, methanol, morpholine and cyclohexanol. Propane, isobutane, a combination of both, carbon dioxide, or dimethyl ether (DME) may be used as propellants. There are also aerosol carburetor-choke cleaners that utilize water-based emulsions.

Liquid carburetor-choke cleaners are used to clean whole carburetor assemblies and other metal parts. They may contain such ingredients as phenol, cresol, tall oil, potassium hydroxide, methylene chloride, water, and aromatic petroleum distillates.

Because of similarities in the function and type of use, many carburetor-choke cleaners use ingredients that are the same as or similar to those described for engine degreasers in the Technical Support Document titled "Proposed Regulation to Reduce Volatile Organic Compound Emissions from Consumer Products (CARB, 1990)."

Based on the 1991 ARB VOC survey, the VOC content for aerosols and liquids ranges from 1 percent to 100 percent and 0 percent to 100 percent by weight, respectively. Some of the low-VOC products contain exempt chlorinated compounds such as 1,1,1-Trichloroethane (TCA) and methylene chloride. However, regulatory developments and health and safety concerns are prompting companies to develop formulations that exclude these solvents. The Montreal Protocol and Federal Clean Air Act (FCAA) mandate an eventual phase-out of TCA by early next century. EPA lists methylene chloride as a hazardous air pollutant and the ARB lists it as a toxic air contaminant. Therefore, the challenge is to reformulate products without adding other VOCs that would increase emissions. Some companies have developed water-based formulations that contain lower levels of solvents and some surfactants. The surfactants are used to enhance cleaning.

Recommended VOC Standard:

The proposed standard for carburetor-choke cleaners is 75 percent beginning in 1995 and 50 percent in 1997. This standard applies to both aerosols and liquids. Based on the ARB VOC survey, there are 24 complying products. Of these, at least 12 aerosols and 12 liquids can meet the standard. These products are identified in Appendix B. Of the 24 complying products, 8 aerosols and 7 liquids are sold for the industrial and institutional market, 2 aerosols and 2 liquids are sold for the household market, and 2 aerosols and 3 liquids are sold for both markets. The estimated emission reductions for both forms, based on the proposed standard, are 660 lbs/day beginning in 1995 and 740 lbs/day beginning in 1997. The future effective standard was based on data obtained in the VOC survey which indicated that further emission reductions were possible.

Currently, a total of 15 aerosol and liquid products can meet the future effective standard.

Because of the nature and use of carburetor-choke cleaners, the approach for developing the proposed standards for these products is consistent with the approach described for engine degreasers (CARB, 1990). Currently, low-VOC products do exist; however, the effective dates will allow for a timely transition from high-VOC products to low-VOC products.

Table V-8 below is a summary of the proposed standards and emission reductions.

TABLE V-8

Carburetor-Choke Cleaner Standard Summary

Product Form	Proposed Standard (% VOC)	Number of Complying Products	Percent of Market Complying	Emission Reduction lbs/day
All Forms	75	24	36	660
All Forms(1997)	50	15	20	740

Compliance with the Standard:

Compliance with the standard may be achieved by reformulation or the use of other product forms. Reformulation will involve finding suitable replacements for methylene chloride and TCA, both of which are common ingredients in carburetor-choke cleaners. The trend is to remove these solvents due to concerns about toxicity and requirements under the FCAA. Because of the FCAA requirements and the proposed VOC standards, manufacturers will need to reformulate these products without increasing VOC emissions.

Water-based systems can replace solvent-based systems to meet the proposed standard. Currently, there are 5 complying products which are water emulsions. Another possibility is the development of a water-DME or water-ethanol-DME system. DME is soluble up to 35 percent in water and if 6 to 7 percent ethanol or isopropanol is added to any ratio of water and DME, complete solubility will occur (Johnsen, 1982; Aerosol Age, 1982a, 1982b). The use of DME has been recommended for most product areas including the industrial and automotive areas (Daly, Jr. and Osterman, 1982). Other solvents and surfactants may be added to this system to provide a complying and effective product.

Another possibility may be to substitute compressed gases such as carbon dioxide and nitrous oxide for hydrocarbon propellants. Approximately

20 percent of the products reported in the VOC survey already contain compressed gasses. New low-spray rate valves may be designed specifically for compressed gas systems to produce far better aerosols than was possible with the old standard valves (Sanders, 1987). The substitution of hydrocarbon propellants with the exempt compound HFC-152a may also be possible. DME and HFC-152a have been commercially available for many years (Daly, Jr. and Osterman, 1982; Sterling, 1982; Daly, Jr., 1986). A recent conversation with a DuPont representative, a supplier of HFC-152a, indicates that it is commercially available; however, an impetus may be needed for researching alternative formulations using this compound (DuPont, 1991). Furthermore, the use of hand pump sprays or squeeze bottles would eliminate the need for propellants.

Issues:

1. Issue: CSMA automotive representatives stated that the 100 percent VOC formulas provide the most efficient product with the best results. (Cyclo Automotive Products, 9-18-91)

   Response: The existence of 12 currently complying aerosol products at 75 percent VOC demonstrates that it is not necessary to formulate products with 100 percent VOC. Carburetor-choke cleaners may have detergents and different solvents which aid in removing the grease, dirt and other contaminants, while allowing a low-VOC formulation. Since these products are being purchased and used by consumers, they are commercially and technologically feasible.

References:

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F. CHARCOAL LIGHTER MATERIAL

Product Description:

The staff has defined charcoal lighter material as any combustible material designed to be applied on, incorporated in, added to, or used with charcoal to enhance ignition. This does not include electrical starters and probes; metallic cylinders (chimneys) using paper tinder; natural gas; and propane. All other products used to enhance ignition of barbecue charcoal are included in this definition, such as lighter fluids, paraffin cubes and wood chips, gels, "fire-rings" (metallic rings filled with fluid to light charcoal from underneath), pre-soaked or "ready-start" charcoal (essentially charcoal with lighter fluid already incorporated into it), and "bag-light" charcoal (small bags of charcoal which are lit with the charcoal still in the bags). According to the ARB VOC survey, non-petroleum-based lighter materials do not have significant market shares in California. Since the market is dominated by petroleum-based lighter fluids, the following discussion will focus on these products.

Product Formulation:

By definition, charcoal lighter materials are intended to be combusted, either in part or whole, during charcoal barbecuing. Petroleum distillate-based lighter fluids are comprised of 100 percent VOC, with properties similar to those of kerosene. None of the charcoal lighter fluids have been found to contain water or exempt solvents. As discussed previously, other charcoal lighter materials are comprised of an alcohol/gel mixture (charcoal lighter gels); waxy, long-chain hydrocarbons (paraffin cubes and paraffin-coated wood chips); flavored wood chips for kindling (e.g., mesquite chips); and charcoal briquets, either impregnated with lighter fluid (e.g., "ready-start", "instant light") or contained in a combustible bag which is intended as the starter material ("bag-light").

The staff calculated emissions only for petroleum distillate-based charcoal lighter fluids because of their dominance in California. Emissions for the other types of charcoal lighter materials were not calculated. The amount of VOC emissions from charcoal lighter fluids is the amount of fluid sold in California (assuming all fluid sold is used) multiplied by the emission factor for lighter fluids (i.e., the percentage of lighter fluid

used that is actually emitted). Although this relationship is simple, estimates of the sales and emission factor components can be complicated. The following is a discussion on the various estimates for these two components which are available in the literature or in studies provided to the ARB staff.

Total California sales of charcoal lighter fluids have been reported to the ARB staff to be between 26,000 and 30,000 lbs/day in California. The range is due to two estimates: (1) ARB's estimate of 26,000 pounds lbs/day based on its 1991 consumer products survey, and (2) an industry estimate of 30,000 pounds per day based on the Nielsen Marketing Research studies submitted to ARB staff by the Clorox Company (Kennedy). Since these estimates are in good agreement and at least one minor lighter fluid manufacturer has not submitted survey data at the time of writing, ARB staff will use a conservative lighter fluid sales estimate of 28,000 lbs/day for estimating average daily emissions.

Before the emission estimates are discussed, it should be noted that other Nielsen Marketing Research Sales data provided to the South Coast AQMD (SCAQMD) during the development of their Rule 1174 (Control of Volatile Organic Compound Emissions from the Ignition of Barbecue Charcoal) in September, 1990 showed that California sales of charcoal lighter fluids may actually be closer to 42,000 lbs/day. Staff calculated this amount of sales based on the following: (1) national lighter fluid sales of $114 million dollars per year (Lieu), (2) a California population factor of 11.7 percent of the national population (Brewer; Lieu), (3) an assumed average cost of $1.50 per quart of lighter fluid (Lieu), and (4) an assumed density for lighter fluid equal to that of kerosene at 6.9 lbs/gal (Lieu). It is reasonable to expect that California usage of charcoal lighter fluid is at least proportional to, and probably even proportionally higher, than the national average, given California's abundant fair weather and penchant for encouraging outdoor activities such as barbecuing. With this in mind, it is reasonable to expect that actual sales of lighter fluids in California may be significantly higher than indicated by either the 1991 ARB VOC Survey or the Nielsen Marketing Research Sales data provided to the ARB staff by the Clorox Company.

Charcoal lighter fluid is unique in this regulation in that a significant fraction of the lighter fluid is combusted during its use. Because of this, both the SCAQMD and the Clorox Company (makers of Kingsford lighter fluid) conducted tests to determine the VOC emissions per start from the use of charcoal lighter fluids under standardized conditions. These conditions were standardized to put the testing of all fluids on an equal and reproducible basis. Such standardized testing is designed to provide data on the relative emissions of different lighter fluids when tested under the same conditions; the testing is not designed to be an absolute measurement of actual emissions under the conditions used by all or even "worst-case" consumers.

Actual emissions from charcoal lighter fluids used by consumers are highly dependent on a variety of realistic conditions (e.g., amount of charcoal and lighter fluid used, type of grill used, the selected visual

endpoint, ambient temperature, etc.), any or all of which may not be accurately represented in the testing protocol (Welsh). For instance, the standardized test conditions call for 1.75 fluid ounces of lighter fluid to be used for every pound of charcoal used for testing. This means that only 3.5 fluid ounces of lighter fluid were used for each test, since each test required approximately 2 pounds of charcoal. Household lighter fluids are usually packaged in 1 quart containers. Since each quart contains 32 fluid ounces, the test conditions would imply that approximately 9 barbecue uses are obtained from each quart of fluid by the average consumer. The staff believes that initial testing conditions which result in 9 barbecue uses per quart of fluid may be unrealistic. Based on past experience, the staff believes that many consumers unwittingly use more charcoal lighter fluid than is necessary. For instance, many consumers continue to squirt lighter fluid onto lighted charcoal in the mistaken belief that it will enhance ignition. Others may simply squirt on more fluid if flames are not immediately detectable. In any case, since the actual emissions are highly dependent on the amount of lighter fluid used in the testing, any possible consumer misuse not accounted for in the testing protocol can result in significantly higher lighter fluid emissions than that conservatively estimated by the staff.

Keeping these uncertainties in mind, staff estimated the emissions from this category by determining the appropriate emission factors (i.e., percentage of lighter fluid used that is actually emitted) for charcoal lighter fluids. Conservatively, the SCAQMD first estimated that approximately 10 to 25 percent of all lighter fluid is emitted (Perryman). After their intial testing of lighter fluids, the SCAQMD measured lighter fluid emissions at approximately 0.09 lb VOC/start (Haimov). At this level, nearly 50 percent of the product is estimated to be emitted during use (Appendix C). Finally, the recent testing data of charcoal lighter fluids under standardized conditions indicated that approximately 20 percent of the charcoal lighter fluid was emitted during that particular set of testing (Anderson; Marinoff). Thus, the available data on charcoal lighter fluid emissions vary widely, indicating that between 10 and 50 percent of all charcoal lighter fluid used in California, estimated to be between 26,000 lbs/day and 42,000 lbs/day, is emitted to the atmosphere.

Table V-9 shows the staff's estimates of charcoal lighter fluid emissions using the various emission factors and California sales discussed above. These differing factors and sales are combined in different combinations to enable a more comprehensive estimate of actual emissions. In addition to yearly average daily emissions, staff also calculated summer average daily emissions. Because of the lighter fluids' seasonal use (i.e., most usage is assumed to occur between May and October), the summer average daily emissions are likely to be more representative of the VOC emissions from this category which can impact local districts' efforts to attain ambient air quality standards during peak ozone days in the summer.

As shown in Table V-9, the staff's most conservative estimates for statewide yearly and summer average daily VOC emissions are 2600 lbs/day and 5400 lbs/day, respectively (emission factor = 10%, California sales = 26,000 lbs/day). On the other hand, the staff's least conservative estimates for

TABLE V-9

Charcoal Lighter Material Emissions Summary (Lighter Fluid Only)

METHOD	CALIF SALES LBS/DAY	EMISSION FACTOR	CALIF EMISSIONS YEARLY AVG LBS/DAY	CALIF EMISSIONS SUMMER AVG LBS/DAY	SCAQMD EMISSIONS YEARLY AVG LBS/DAY	SCAQMD EMISSIONS SUMMER AVG LBS/DAY
		0.10	4,200	8,400	1,890	3,780
1	42,000	0.20	8,400	16,800	3,780	7,560
		0.25	10,500	21,000	4,730	9,460
		0.50	21,000	42,000	9,450	18,900
		0.10	2,660	5,320	1,200	2,400
2	26,600	0.20	5,320	10,640	2,390	4,780
		0.25	6,650	13,300	2,990	5,980
		0.50	13,300	26,600	5,990	11,980
		0.10	3,060	6,120	1,380	2,760
3	30,600	0.20	6,120	12,240	2,750	5,500
		0.25	7,650	15,300	3,440	6,880
		0.50	15,300	30,600	6,890	13,780

yearly and summer average daily VOC emissions are 21,000 lbs/day and 42,000 lbs/day, respectively (emission factor = 50%, California sales = 42,000 lbs/day). Note that the staff's conservative estimates, as reported in the Staff Report, for yearly and summer average daily VOC emissions of 5600 lbs/day and 10,200 lbs/day, respectively (emission factor = 20%, California sales = 26,000 lbs/day), fall within the least conservative and most conservative estimates.

Recommended VOC Standard:

Because of the previous studies already conducted on this category, staff's proposed standard 0.02 lb VOC/start and other regulatory requirements were based on the SCAQMD Rule 1174, "Control of Volatile Organic Compound Emissions from the Ignition of Barbecue Charcoal" (Perryman, 1990). This standard was chosen to minimize the impacts on industry and the SCAQMD through the use of one standard for both the SCAQMD and statewide.

Using the various estimated sales figures and emission factors available, staff estimated the potential emission reductions from compliance with the standard. These estimates are shown in Table V-10 and have been calculated for both yearly and summer average daily emissions. As shown in Table V-10, the staff conservatively estimates that compliance with the standard will result in VOC reductions of approximately 2000 lbs/day and 3600 lbs/day from yearly average and summer average daily emissions, respectively (assuming California sales = 26,000 lbs/day and emission factor = 20 percent). The least conservative estimate for emission reductions is 0 lbs/day reduction from an emission factor of 10 percent. With this emission factor, the unregulated emissions from charcoal lighter fluids (approximately 0.019 lb VOC/start) would be less than the allowable regulatory standard (0.025 lb VOC/start), thereby resulting in no emission reductions. The most conservative estimates for VOC emission reductions are 15,400 lbs/day and 30,800 lbs/day for yearly average and summer average daily emissions (assuming California sales = 42,000 lbs/day and emission factor = 50 percent).

TABLE V-10

Charcoal Lighter Material Standard Summary (Lighter Fluid Only)

METHOD	CALIF SALES LBS/DAY	EMISSION FACTOR	FLUID USAGE EMISSIONS LBS/START	PERCENT EMISSION REDUCTION TO 0.025 LB/START	CALIFORNIA EMISSION REDUCTIONS		SOUTH COAST AQMD EMISSION REDUCTIONS	
					YEARLY AVG LBS/DAY	SUMMER AVG LBS/DAY	YEARLY AVG LBS/DAY	SUMMER AVG LBS/DAY
		0.10	0.019	0	0	0	0	0
1	42,000	0.20	0.038	34	2,870	5,740	1,290	2,580
		0.25	0.047	47	4,910	9,820	2,210	4,420
		0.50	0.094	73	15,410	30,820	6,930	13,860
		0.10	0.019	0	0	0	0	0
2	26,600	0.20	0.038	34	1,820	3,640	820	1,640
		0.25	0.047	47	3,110	6,220	1,400	2,800
		0.50	0.094	73	9,760	19,520	4,390	8,780
		0.10	0.019	0	0	0	0	0
3	30,600	0.20	0.038	34	2,090	4,180	940	1,880
		0.25	0.047	47	3,580	7,160	1,610	3,220
		0.50	0.094	73	11,230	22,460	5,050	10,100

Compliance with the Standard:

Data from the SCAQMD indicates that nearly all lighter materials not based on petroleum distillates are expected to easily comply with the standard (Haimov, Sept. 1990). Thus, staff expects that only petroleum distillate-based lighter fluids will need to be reformulated. This reformulation should not be very difficult, since data from the Clorox Company indicates that, by properly varying the physical properties of lighter fluids such as distillation points, a lighter fluid can be formulated to meet the standard (Kennedy, 1991). To illustrate this, the announcement earlier this year that the Kingsford lighter fluid was successfully reformulated to meet the SCAQMD standard amply demonstrates the feasibility of complying with the standard, despite previous statements by both the Clorox Company and the Barbecue Industry Association (BIA) that reformulation of this product to reduce VOC emissions was impossible (Clorox).

Since the ARB standard and test protocol are the same as their Rule 1174 counterparts, any charcoal lighter material which is registered as a complying product with the SCAQMD under the requirements of Rule 1174 will be accepted as complying with the ARB standard. However, any ARB administrative requirements which differ from those of Rule 1174, such as registration of usage instructions, code-dating, and continual compliance verifications must still be fulfilled.

Compliance with the standard will first be determined by either the SCAQMD or ARB using the SCAQMD Rule 1174 "Ignition Method Compliance Certification Protocol" for all charcoal lighter materials, including those based on petroleum distillate fluids. In addition, the Clorox company has provided data that suggests a direct correlation between particular properties of a charcoal lighter fluid, such as distillation temperatures, and the fluid's emissions. Thus, in conjunction with the testing conducted under the SCAQMD testing protocol, petroleum distillate-based lighter fluids will also be tested for their distillation points at 5 percent and 95 percent recovery points. If the lighter fluid passes the SCAQMD testing protocol, then subsequent compliance verifications would involve merely testing the product to determine if its distillation points at 5 percent and 95 percent recovery remain the same as they were during the intial certification testing, within the limits described in ASTM D86-90 (Standard Test Method for Distillation of Petroleum Products). Since the non-petroleum distillate-based lighter materials vary widely in composition and form, staff proposes that any subsequent compliance testing of these products to be conducted by using the SCAQMD Rule 1174 testing protocol.

To ensure consistency with the SCAQMD Rule 1174 and the ARB Consumer Products VOC regulation requirements, the staff is proposing that all charcoal lighter materials sold outside of the SCAQMD jurisdiction comply with the ARB VOC regulation requirements by January 1, 1993 (with a one year sell-thorugh period). Because of the equivalence of the two regulations, the staff is also proposing that products sold within the SCAQMD jurisdiction be subject to the ARB requirements by January 1, 1992 (with no sell-through period). The compliance date of January 1, 1992, is the same

as the one specified in Rule 1174. The staff expects no obstacles for products sold within the SCAQMD to comply with both the SCAQMD Rule 1174 and ARB VOC regulation requirements by January 1, 1992, since ARB will accept products complying with Rule 1174 and these products will have had to comply with the SCAQMD requirements by that time anyway.

Because of the cost and complexity of the SCAQMD testing protocol (approximately $15,000 per product), both the SCAQMD and the ARB are investigating other potential methods for standardized emissions testing, including the determination of a possible correlation between the physical properties of lighter fluids and their emissions. To date, the studies conducted by the Clorox Company on the relationship of distillation and flash point temperatures with emissions only suggests, but does not conclusively show, a reproducible or accurate correlation between these two factors and the emissions. Further studies are needed to verify any possible correlation that can be used in lieu of using the SCAQMD Rule 1174 testing protocol. Until these studies are completed and independently verified, the staff is proposing the use of the established SCAQMD Rule 1174 testing protocol for all initial certifications and, to the extent necessary, continual certifications of charcoal lighter materials.

References:

1991 ARB Consumer Products VOC Survey.

Anderson, Paul, et al., Clorox Company, "Emissions of Volatile Organic Compounds from Charcoal Lighter Fluids", March 1991.

Brewer, Susan, California Department of Finance, Letter to Maryann McDonald (ARB) on California Air Basin Population Estimates, June 6, 1990.

Clorox, comment letter to the SCAQMD, March 13, 1989.

Haimov, Mitch, et al., SCAQMD Source Testing and Monitoring Branch, "Emissions of Volatile Organic Compounds from Various Charcoal Ignition Methods", September 1990.

Kennedy, Tim, Clorox Company, Presentation to ARB staff, March 19, 1991.

Lieu, Sue, SCAQMD Planning Division, "Addendum to Staff Report: Socioeconomic Impact Assessment, Proposed Rule 1174, Control of Volatile Organic Compound Emissions from the Ignition of Barbecue Charcoal", September 1990.

Marinoff, Steven, South Coast AQMD Source Testing and Monitoring Branch, Personal communication with Floyd Vergara, October 2, 1991.

Perryman, Pamela, SCAQMD Office of Planning and Rules, "Staff Report: Proposed Rule 1174, Control of Volatile Organic Compound Emissions from the Ignition of Barbecue Charcoal", September 1990.

Welsh, Bill, SCAQMD Source Testing and Monitoring Branch, Personal communication with Floyd Vergara, October 15, 1991.

G. AEROSOL DISINFECTANTS

Product Description:

With exceptions specified in the regulation, disinfectants are defined as any product intended to destroy or irreversibly inactivate infectious or other undesirable bacteria, pathogenic fungi, or viruses on surfaces or inanimate objects. Since these products are intended to kill organisms, they are registered with the Environmental Protection Agency as pesticides under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and the California Department of Pesticide Regulation (DPR).

In addition to products that are primarily disinfectants, there are numerous products that are primarily designed as cleaning agents with secondary, limited disinfectant claims. Since the intent of this standard is to regulate those products that are primarily disinfectants, products that are primarily intended to be general purpose cleaners, toilet bowl cleaners, metal polishes, glass cleaners, and bath and tile cleaners are excluded from the standard. For the sake of clarity and to further focus the intent of the regulation, the regulation also excludes from this definition topical products that are intended for use on humans or animals and products for use on pools, therapeutic tubs and saunas.

Disinfectants are formulated in the following forms: aerosols, liquids, powders and granules, pumps, foams, and towelettes (1991 ARB VOC Survey). For this regulation, the staff proposes that the standard apply only to aerosol disinfectants. There are several reasons for this proposal:

(1) Aerosols, while comprising less than 1 percent of the total market (retail and industrial/institutional markets combined), are responsible for approximately 40 percent of the emissions from the entire disinfectant category (1991 ARB VOC Survey).

(2) Current technology and literature shows that compliance with a 60 percent VOC by weight standard is being achieved by products on the market and reformulation of non-complying products is possible while maintaining product efficacy.

(3) Although emissions from the non-aerosol products comprise approximately 60 percent of the emissions from this category, there is very little potential for emission reductions from nonaerosol dilutable disinfectants, since these products are normally intended to be diluted to very low VOC content levels.

Product Formulation:

The major VOC ingredients in aerosol disinfectants are ethanol, isopropanol, and hydrocarbon propellants (propane, n-butane and isobutane).

The alcohols, along with other highly-effective ingredients such as quaternary ammonium compounds (quats) and phenolics (e.g. o-phenylphenol), comprise the active ingredients in the aerosol formulations. Other VOC or LVP (low vapor pressure) ingredients may include small amounts of fragrances, glycols, and corrosion inhibitors. The 1991 ARB VOC Survey shows that the total VOC content (active ingredients and propellants) of aerosol disinfectants ranges from 5 percent to 90 percent by weight.

Disinfectants are used in household, I&I (industrial and institutional) and health-care settings. Aerosol disinfectants have a significant share of the household market, while liquids dominate in the I&I and health-care markets (Binenstock). Liquids dominate in the I&I and health-care markets because they provide sufficient disinfection for the I&I market (CAAHS; 1991 ARB VOC Survey) and because of their superior cost-effectiveness over aerosols (CAAHS; CDA; ARB 1991 Hard-Surface Disinfectant Usage Survey). Most aerosol disinfectants available to household and I&I consumers are based on alcohol and phenol or quaternary ammonium compounds or a combination of both (1991 ARB VOC Survey). Most nonaerosol disinfectants are based on alcohol, chlorine, iodine, peroxide, glutaraldehyde, or pine oil.

Although alcohol comprises most of the VOCs in aerosol disinfectants, it is important to note that alcohol is not the only active ingredient in disinfectants. In fact, the volume of alcohol-based disinfectants in the total combined household and I&I markets, both aerosol and nonaerosols, is relatively small compared to disinfectants based on other active ingredients. For example, the majority of I&I products used for hard-surface disinfection is based on non-VOC components such as iodine (e.g., iodophors), chlorine (e.g., hypochlorite or chlorhexidine) and peroxide (e.g., hydrogen peroxide) or potent non-alcohol VOCs such as glutraldehyde.

Depending on the type and quantity of VOC and non-VOC active ingredients used, antimicrobial agents can be formulated to meet a variety of germ killing requirements. Because of the variety of active ingredients available and the varying amounts used in disinfectant formulations, disinfectants can be categorized in terms of varying potency. The following classifications of anticmicrobial agents in Table V-11 are copied directly or paraphrased from the sources indicated. Please refer to the "References" section for a full listing of all the sources noted.

TABLE V-11

Classes of Antimicrobial Agents

Sanitizer	-	an agent, usually chemical (may be physical) and possessing disinfecting qualities when applied separately following a cleaning process. When used in combination with a cleaner or detergent, it reduces the microbial content to an acceptable level under Public Health requirements (American Public Health Association)
Disinfectant		
Limited	-	kills *Staphylococcus aureus* (gram-positive bacteria) (FIFRA).
Broad -Spectrum	-	kills *Staphylococcus aureus* and *Salmonella choleraesuis* (prototype gram-negative bacteria) (FIFRA).
Hospital	-	kills *Staphylococcus aureus*, *Salmonella choleraesuis*, and *Pseudonomas aeruginosa* (prototype aerobic bacillus) (FIFRA).
Fungicidal	-	kills *Tricophyton mentagrophytes* ("athlete's foot fungus", prototype filamentous fungus) (FIFRA).
Tuberculocidal	-	kills *Mycobacterium tuberculosis* var. *bovis*, an indicator of effective disinfection because mycobacteria represents one of the most resistant groups of organisms (U.S. EPA).
Virucidal	-	no prototype target organisms to show borad-spectrum virucidal activity. Activity must be shown against specific virus to make claim against that virus (FIFRA).
Low-level	-	hospital disinfectant without tuberculocidal claim (Centers for Disease Control).
Intermediate -level	-	hospital disinfectant with tuberculocidal claim. Necessary for surfaces that come into contact only with intact skin and have been visibly contaminated with blood or bloody body fluids. Surfaces must be precleaned prior to disinfection (Centers for Disease Control).
High-level	-	kills all forms of microbial life except *high* numbers of spores. Necessary only for invasive items that come into contact with mucous membranes such as laryngoscopes, endotracheal tubes, etc. Not necessary for environmental surfaces and objects (fomites) (Centers for Disease Control).

Sterilant - kills all forms of microbial life including high numbers of spores. Necessary only for invasive items that penetrate skin or contact normally sterile areas of the body such as scalpels needles, etc. (Centers for Disease Control).

The above definitions reflect the widely-held opinion that environmental-level (use of detergent/water), low-level (hospital disinfectant) and intermediate-level (hospital disinfectant with tuberculocidal activity) disinfection are the appropriate levels for routine disinfection of surfaces and items in household and I&I settings. These surfaces and items include common environmental surfaces such as walls, doorknobs, faucet handles, light switches and countertops, which are not normally expected to pierce intact skin or come into contact with mucous membranes in typical daily situations. Because of their potency and toxicity, high-level disinfectants and chemosterilants are neither necessary nor desirable for routine environmental disinfection; indeed, the staff is unaware of any high-level disinfectant or chemosterilant which is currently available to the general public.

Disinfectants using different amounts of the same active ingredient or different combinations of the same active ingredients can be formulated to achieve different levels of disinfection below high-level disinfection. For example, different levels of alcohol in combination with other active ingredients can yield either low- and intermediate-level disinfection. To illustrate this point, a review of the products registered as disinfectants under FIFRA reveals the following examples of intermediate-level (tuberculocidal, hospital) aerosol disinfectants with their corresponding levels of alcohol, by weight (NPIRS):

(1) 19 percent ethanol (Lysol Disinfectant Trigger Spray, L&F)
(2) 37 percent ethanol (Enviro-sep aerosol, Grow Group)
(3) 43 percent isopropanol (Safari aerosol, Omnitech Intl).
(4) 53 percent ethanol (Concept aerosol, Hysan)
(5) 52 percent isopropanol (CSA Staf aerosol, CSA Limited)
(6) 67 percent ethanol (Citrace aerosol, Dow)
(7) 80 percent ethanol (Lysol Disinfectant Spray, L&F)

It is apparent from the above list of products that a variety of disinfectants use widely varying amounts of alcohol and other active ingredients to achieve intermediate-level disinfection. Aerosol disinfectants can achieve effective, intermediate-level disinfection without the use of high levels of alcohol.

As shown in Table V-12, the staff estimates that the current emissions from disinfectants are approximately 19,200 lbs/day of VOC, of which aerosols comprise approximately 7,600 lbs/day of VOC. For proper disinfection, all hard-surface disinfectants are applied in a thin film and left on the surface for at least 10 minutes (most applications) (AOAC; FIFRA). Thus, it is reasonable to expect all of the VOC and some, if not all, of the LVP content to be emitted to the atmosphere. This assumption is

especially applicable to aerosol disinfectants, which are comprised mostly of relatively high-volatility components such as alcohols and hydrocarbon propellants.

TABLE V-12

Disinfectants Emission Summary
(Total Emissions 19,200 lbs/day)

Product Form	Percent of Market	Emissions (lbs/day)	Percent of Emissions
Aerosol	1	7,600	40
Liquid and All Other Forms	99	19,200	60

Recommended VOC Standard:

Based on current literature regarding disinfectant efficacy; the results of the 1991 ARB VOC and Hard-Surface Disinfectant Usage surveys; and consultation with the Department of Health Services and other health and medical experts, the staff is proposing a 60 percent by weight VOC limit for aerosol disinfectants. This standard will ensure that products, based on the different active ingredients available, will continue to provide the different levels of disinfection currently being achieved. Thus, low- and intermediate-level (tuberculocidal hospital) disinfectants will continue to be available for household and I&I consumers.

With adequate product formulation and the proper selection of product components, compliance with the standard should result in products which will deliver to the surface being disinfected a level of alcohol at or above 70 percent by volume. The staff calculated this level of delivered alcohol for products based on pure alcohol without other active ingredients; lower alcohol levels may be possible with judicious use of other active ingredients such as the phenolics and quats. This possibility is amply demonstrated by the previously-discussed examples of low-alcohol formulations (19 percent to 57 percent by weight) which achieve intermediate-level disinfection.

According to the studies of Klein and Deforest and other studies conducted recently, levels of alcohol (ethanol) delivered to test surfaces with at least 70 percent ethanol by volume will be effective against classes of hydrophilic viruses with increasing resistance to disinfectants up to and including poliovirus, type 1 (Klein and Deforest; Block S.S.; Christensen,

R.P., et al.). Since the market-leading aerosol disinfectant has demonstrated efficacy against the polio virus, these studies demonstrate that antimicrobial activity at 70 percent ethanol by volume is predicted to be equivalent to the level of efficacy found in the market-leading aerosol disinfectant (See discussion on disinfectants in Chapter VII "Technical Issues"). These studies also demonstrate that significant emission reductions are possible from this category, since the current market-leading product, with approximately 95 percent of the aerosol disinfectant market (L&F Products, Administrative Record), currently delivers a spray calculated to contain 88 percent ethanol by volume.

As shown in Table V-13, there are 41 aerosol products currently available which would meet a 60 percent by weight VOC standard. These aerosol disinfectants are listed in Appendix B. It is important to note that there are approximately five hundred nonaerosol disinfectants which already contain less than 60 percent VOC by weight. These non-aerosol disinfectants achieve the low- and intermediate-level disinfection required by I&I and health-care consumers, as evidenced by the available data on these markets (1991 CARB VOC and Hard-Surface Disinfectant Usage surveys).

TABLE V-13

Disinfectants Standard Summary

Product Form	Proposed Standard (% VOC)	Number of Complying Products	Percent of Market Complying	Emission Reduction (lbs/day)
Aerosols	60	41	1	2000
Liquids and all others	N/A	~500 (if 60% were std)	99	N/A

Compliance with the Standard:

Compliance with the standard can be and is currently being achieved through one or a combination of the following steps:

(1) Reduction of alcohol (ethanol or isopropanol) level
(2) Reduction of VOC propellant level
(3) Substitution of part or all of VOC propellant with non-VOC propellant (e.g. HFC-152a, carbon dioxide, nitrogen, nitrous oxide)
(4) Changing the level of phenolics and other non-alcohol active ingredients to help offset a reduction in alcohol, if a reduction in alcohol is necessary.

Although our analysis shows that efficacious products can be and are already being achieved at levels below 60 percent by weight VOC, there are

still several issues raised by industry representatives. In general, questions raised by L&F Products, makers of Lysol Disinfectant Spray, revolve around what the efficacy of a high-alcohol (greater than 70 percent by weight) aerosol disinfectant will be after reformulation to comply with the standard (60 percent by weight). Because of its length, the discussion of these and other issues related to disinfectants is included in Chapter VII, "Technical Issues".

The staff concludes from the information presented in the discussion on disinfectants that the 60 percent by weight VOC standard can result in a product that, when properly formulated and packaged, delivers to the surface to be disinfected a liquid film that contains at least 76 percent by volume alcohol. This is above the level demonstrated in current literature to be effective against nearly all non-spore-forming bacteria, fungi, and viruses.

References:

1991 ARB Consumer Products VOC Survey, conducted for sales in calender year 1990.

1991 ARB Hard-Surface Disinfectant Usage Survey, sent to 7247 health-care facilities including hospitals, dental offices, day care centers, nursing homes, convalescent homes, veterinary clinics, planned parenthood centers, and other facilities involved in the care of humans or animals, circa March 1991.

American Public Health Association, Control of Communicable Diseases in California, compiled by the California Department of Health Services, 1983.

Binenstock, Alan, "Disinfectants: Regulations and Consolidations Restrict Industry Growth", Soap/Cosmetic/Chemical Specialties, December 1988.

CAHHS, California Association of Hospitals and Health Systems, Personal communication from Floyd Vergara to Robert Heilig, August 21, 1990.

CDA, California Dental Association, Personal communication from Floyd Vergara to Terry Fong, circa July 1990.

CDC, Centers for Disease Control, U.S. Department of Health and Human Services, Guidelines for Prevention of Transmission of Human Immunodeficiency Virus and Hepatitis B Virus to Health-Care and Public-Safety Workers, February 1989.

Favero, M.S., et

FIFRA, The Federal Insecticide, Fungicide, and Rodenticide Act, As Amended, 7 U.S.C. 136-136y.

NPIRS, National Pesticide Information Retrieval System, computer database for all FIFRA-registered pesticides operated by Purdue University for the U.S. Environmental Protection Agency, disinfectant databses search conducted for Floyd Vergara, circa June 1990.

Prince, Herbert N., "Disinfectant Activity Against Bacteria and Viruses: A Hospital Guide", Particulate and Microbial Control, March/April 1983.

MMWR, Morbidity and Mortality Weekly Report, Centers for Disease Control, No. 34:681-86, November 15, 1985.

L&F Products (formerly Lehn and Fink Products), 19% w/w ethanol Lysol Disinfectant Trigger Spray, EPA Reg. 777-73.

Grow Group, 37% w/w ethanol Enviro-sep aerosol disinfectant.

H. DUSTING AIDS

Product Description:

Dusting aids are products applied to dust cloths or dust mops to increase their ability to attract and hold dust particles. Some dusting aids are also labeled for use on furnace or air conditioning filters to improve their collection efficiency. According to information provided by industry, the oils in these products act as a "magnet", attracting dust to the cloth or mop head (Drackett Products Company). Product labels have been identified claiming an increase of six to eight times the dust holding capacity of a dust cloth or mop when the product is used (Drackett Institutional Endust and Amway Buff-Up product labels). Some dusting aids may also be used to fingerprints, oil-based stains and other soils from clean surfaces such as wood paneling and stainless steel.

For dusting, these products are sprayed, sprinkled, or poured on the cloth or dust mop, not the surface to be dusted. For floor dusting, many products must be allowed a period of time after the product is applied to the dust mop head to allow the product to penetrate and diffuse throughout the dust mop strands. This "cure" time allows the entire mop head to absorb the product and prevents excess product from leaving a slippery residue on floors. The cure time varies with the product from no cure time at all to overnight. When these products are used as cleaners, the product is sprayed directly on the surface to be cleaned or poured onto a cleaning cloth before wiping.

While there is some overlap in the functions provided by "furniture maintenance products" and "dusting aids", the categories can be distinguished. Dusting aids are primarily used for dusting, including dusting of floors, without leaving a wax or silicone based coating. Most furniture maintenance products are used primarily to clean and polish furniture, leaving a wax or silicone based protective coating. Although some furniture maintenance products may be used to dust furniture, they are not used for dusting floors, since they would leave a slippery residue.

Dusting aids are available in aerosol, pump spray and liquid forms. As shown in Table V-14 below, the aerosol form represents the majority of the market share and emissions from the category, having 96 percent of the market and responsible for 97 percent of the emissions.

TABLE V-14

Dusting Aid Products Emissions Summary
(Total Emissions 1000 lbs/day)

Product Form	Percent of Market	Emissions (lbs/day)	Percent of Emissions
Aerosol	96	980	97
All Other	4	20	3

Product Formulation:

Dusting aids typically contain oil, solvent and/or water, hydrocarbon propellants (in aerosols), and small amounts of other agents such as emulsifiers, dust attractants and fragrances. The oil is the primary dust attracting active ingredient in these products and is typically a light hydrocarbon oil.

The solvents or "carriers" used in dusting aids include hydrocarbon solvents, methyl chloroform and water. With the exception of water, these carriers may act as cleaning agents for oil-based stains and may decrease the time required for the product to permeate into the fibers of a dust mop (Drackett Products Company). Aerosol products typically contain hydrocarbon propellants such as propane and isobutane which also function as carriers, but do not act as cleaning agents since they evaporate upon use.

Other agents such as emulsifiers, dust attractants, and fragrances may also be included in the formulation in small amounts. Emulsifiers increase the ability for dissimilar liquids such as oil and water to mix. Special dust attracting agents may also be included such as cationic quaternary ammonium compounds which attract dust particles which tend to be negatively charged (Amway Corporation). A small amount of fragrance may also be included in the formula.

Recommended VOC Standards:

The VOC standards for dusting aids are as follows: 7 percent for nonaerosol forms, primarily liquids and pumps, and 35 percent for aerosol forms with a future effective standard of 25 percent in 1997. As shown in Table V-15 below, which is based on the 1991 Consumer Products Survey, 15 products in the aerosol category comply with the 35 percent standard. In addition, the 35 percent standard has been supported for household products

by the industry (CSMA). Nine products comply with the 25 percent future effective standard. The complying market share for aerosols is small due to the dominance of two non-complying aerosol products in the market place. In the "all other" category, 12 products comply with the 7 percent standard. These complying products are identified in Appendix B.

An analysis of the survey results for household and industrial and institutional (I&I) dusting aids revealed that I&I dusting aids do not appear to require a higher VOC content. For both the aerosol and other forms, the majority of complying products identified were I&I products.

In addition, nonaerosol products which meet the 7 percent standard have been identified in the literature (Ash). Finally, technologies have been identified under "Compliance with the Standard" that may be used in reformulating non-complying products, including aerosols, to meet the standards in the regulation.

TABLE V-15

Dusting Aid Products Standards Summary

Product Form	Proposed Standard (% VOC)	Number of Complying Products	Percent of Market Complying	Emission Reduction (lbs/day)
Aerosol	35	15	3.8	180
	25	9	2.2	220
All Other	7	12	52.5	20

The standards for dusting aids are identical to those for furniture maintenance products. Due to the similarity in formulation and function between dusting aids and some furniture maintenance products, maintaining a permanent higher VOC standard for dusting aids may result in a shift in the marketplace from furniture maintenance products to dusting spray products. A minor change in the formulation and labeling of some existing furniture maintenance products may qualify them as dusting sprays. For this reason, maintaining a permanent higher standard for dusting sprays would penalize some furniture maintenance products which must meet the 25 percent standard, yet perform many of the same functions as a dusting aid product.

Compliance with the Standard:

Many reformulation options are possible for non-complying dusting aids. The hydrocarbon oils in these products are VOCs, but are generally exempt due to low vapor pressure. Therefore only the VOC solvents and propellants need to be considered. Other VOC ingredients such as fragrances are generally present in low quantities and are not significant.

An option for non-complying aerosol products is to replace some of the solvent in their products with water, adding emulsifying agents if necessary. Another option would be a substitute for the VOC hydrocarbon propellants, which are used in most dusting aids. Aerosol systems using compressed air or other non-VOC propellants may be an alternative. Using dimethyl ether (DME) as the propellant is another alternative. Although DME is a VOC, it is soluble in water, allowing a reduction in the solvent content of the product.

Issues:

1. Issue: One manufacturer indicated that replacing some of the solvent in their dusting aid product with water decreased the ability of the product to "wick" into the fibers of a dust mop which would increase the "cure time".

   Response: Complying products have been identified with a short one hour cure time and no cure time at all (Amway Buff-Up and S.C. Johnson Conq-R-Dust labels). In addition, a non-complying product has been identified with a recommended overnight cure time for dust mopping. There appears to be no clear relationship between VOC solvent levels and the cure time of dusting aids based on these claims.

2. Issue: One manufacturer has asked for a higher VOC standard for their institutional dusting aid product. According to the manufacturer, this is due to the heavier soils encountered in institutions.

   Response: The ARB staff has not received any information that indicates that heavier soils are encountered in institutions. In fact, telephone conversations with janitorial services personnel indicated that the dust load in institutional settings is often about the same or lower than in households due to daily maintenance (Thomas and John Building Maintenance, Sacramento Janitorial Service, O'Connor-Brekke Specialty Cleaning Services, and Camellia Services). In addition, complying products are available in both household and institutional formulations as mentioned above under "VOC Standards".

References:

Amway Corporation, August 5, 1991, telephone conversation.

Amway Corp., "Buff Up" Dust Control Spray label, and S.C. Johnson Wax & Son, Inc., "Conq-R-Dust" one hour dust mop treatment label.

Ash, Michael and Irene, Formulary of Detergents and other Cleaning Agents, Chemical Publishing Co., Inc., New York, N.Y., 1980, p. 300-301.

Chemical Specialties Manufacturers Association (CSMA), written correspondence to the Air Resources Board, September 19, 1991.

Drackett Products Company, March 4, 1991, meeting in Sacramento.

Drackett Products Company, "Endust" institutional formula label, and Amway Corporation, "Buff Up" Dust Control Spray Label.

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I. FABRIC PROTECTANTS

Product Description:

Fabric protectants are defined in the regulation to include products designed to be applied to fabric substrates to protect the surface from soil, dirt, and other impurities. This does not include silicone based products marketed to provide water repellency. In addition, products marketed for use only on fine fabrics which display a "dry clean only" label are not included in the category.

Fabric protectants are available for a variety of applications. Separate products exist for clothing, for fine fabrics such as silk and wool, for outdoor equipment such as tents, and for furniture and carpeting. Fabric protectants are applied to the fabric to be protected and allowed to dry. Upon drying, a resin film is left behind which forms a barrier between the fabric and soil. Occasional reapplication is necessary to ensure that adequate protection is maintained (Chemical Specialties Manufacturers Association, July 15, 1991).

The results of the 1991 ARB survey show that fabric protectants are available in aerosol, liquid and pump forms. Aerosol products represent 62% of the total market and 24% of the emissions, while liquids and pumps account for about 37% of the market and approximately 76% of the emissions from the category. The entire category accounts for an estimated 440 lbs/day of VOC emissions. However, emissions of exempt compounds, as reported in the 1991 ARB survey, are estimated to be 2,400 lbs/day. The staff is aware that 3M, the primary marketer of fabric protectants, has made

a committment to phase-out all use of TCA by the end of 1992. Since VOC solvents will be used as replacements for TCA, the VOC emissions from this category potentially will increase to approximately 2,840 lbs/day by 1993. Table V-16 is a summary of the emissions from fabric protectants by product form.

TABLE V-16

Fabric Protectants Emissions Summary
(Total Emissions 440 lbs/day)

Product Form	Percent of Market	Emissions (lbs/day)	Percent of Emissions
Aerosol	62	100	24
Liquid	33	280	61
Pumps	5	60	15

Product Formulation:

Products designed to protect fabric can be classified into two categories: products based on fluoropolymers and products based on siloxanes. Products containing fluoropolymer resin are designed primarily to prevent solid soils from adhering to the fabric. Although siloxane products will provide some protection from soil and dirt, their primary purpose is to repel water (Chemical Specialties Manufacturers Association, September 10, 1991). As stated earlier, products designed and advertised solely as water repellents are not included in this category and have been postponed for future consideration.

While product formulations vary to some degree, fabric protectants generally use fluoropolymer resin dissolved in TCA. Due to their low surface energy values and polarity, fluoropolymer resins are able to thoroughly wet and surround fabric fibers, thereby providing protection for a wide variety of fabrics (Chemical Specialties Manufacturers Association, July 15, 1991). The low surface energy of these compounds is ideal for limiting the rate and ability of water and oil-based media to wet and stain the fabric. As a solvent, TCA is used to carry the resin deep into the fabric before evaporating. The resin which is left behind polymerizes to form a protective coating. Other protectants such as carpet protectants may differ slightly and contain other compounds to dissolve and carry the resin. Aerosol products typically use carbon dioxide, propane, or isobutane as a propellant. VOC content is relatively low for products in this category since TCA is classified as an exempt solvent. However, under the terms of the Federal Clean Air Act, TCA is scheduled to be phased out by the year 2002.

Recommended VOC Standard:

The proposed standards, which are supported by data supplied by the 3M Corporation, are 75 percent VOC by 1/1/95 and 60 percent VOC by 1/1/97 for all product forms (Chemical Specialties Manufacturers Association, July 15, 1991). These limits will prevent a direct 1:1 replacement of TCA with VOC solvents as the use of TCA is phased out under the terms of the Federal Clean Air Act. Based on the information supplied by the 3M Corporation, the staff expects that waterborne fabric protectants will be available for certain application by 1995. Table V-17 summarizes the proposed standard for the product category and the number of complying products and their market shares. If manufacturers replace VOC solvents on a 1:1 mass basis, total emissions would be approximately 2,840 pounds per day. The standards will reduce the VOC solvents use in these products by 25 percent in 1995, and 40 percent in 1997. The staff estimates that compliance with the standard will achieve approximately 1,000 pounds by 1997.

TABLE V-17

Fabric Protectants Standard Summary

Product Form	Proposed Standard (% VOC)	Number of Complying Products	Percent of Market Complying	Emission Reduction * (lbs/day)
Aerosol	75	25	100	500
Liquid	75	26	81	80
Pumps	75	7	42	40
Aerosol(1997)	60	25	100	300
Liquid(1997)	60	26	81	60
Pumps(1997)	60	7	42	40

* Most products are in the process of being reformulated with VOC solvents as a replacement for TCA. The emission reduction estimates assume TCA is replaced with VOC solvents.

Compliance with the Standard:

Most products currently available meet the proposed standard. This is due to the fact that many products use TCA, an exempt compound with negligible photochemical reactivity, as the principal solvent. However, VOC solvents will replace TCA use for most products by 1993. The standard is designed to reduce the amount of VOCs used in these products.

The standards proposed are expected to result in the increased use of waterborne formulations (Chemical Specialties Manufacturers Association, July 15, 1991). Research is underway to reduce the VOC solvent content of certain fabric protectants by replacing a portion of the product with water.

However, for some fabrics such as silk and wool, the use of fabric protectants containing water may not be possible. These fabrics do not tolerate water with respect to dimensional stability and dye bleeding (Chemical Specialties Manufacturers Association, July 15, 1991). Therefore, staff proposes that products which are labeled as "dry clean only" are not subject to the regulation at this time.

Products designed to repel water and based on siloxanes are also not included in this category. The reformulation of these products with water is not possible since water is a catalyst to the polymerization of the siloxanes and, at this time, no alternative technology has been identified (Chemical Specialties Manufacturers Association, September 10, 1991).

References:

Chemical Specialties Manufacturing Association, Household Products Task Force Presentation to the CARB staff, July 15, 1991.

Chemical Specialties Manufacturing Association, Household Products Task Force Presentation to the CARB staff, September 10, 1991.

1991 Air Resources Board Consumer Products Survey.

J. HAND DISHWASHING DETERGENTS

Hand dishwashing detergent is a surfactant-based washing product designed for hand dishwashing or other light cleaning tasks. The products are designed to be able to handle food soils, be mild on hands, create high and long lasting suds, and rinse free of films and spots.

Almost all hand dishwashing detergents are liquids with the exception of some powder products for the I&I market. Liquid products are mostly aqueous blends of surfactants. Results from the survey show that emissions of the VOC content from hand dishwashing detergents in 1990 were 14,000 lbs/day. The Soap and Detergent Association (SDA) however, has suggested that the emissions of VOCs from hand dishwashing detergent is less than its VOC content.

SDA suggests that only a fraction of the VOC content from hand dishwashing detergents is released into the air because they are most often used in water diluted wash solutions and are disposed of "down the drain". The SDA has contracted studies to evaluate the emissions of VOCs from hand dishwashing detergents during use and after they are disposed of down the drain.

The studies that evaluated emissions during use were based on experiments that monitored the release of ethanol, one of the main VOCs in hand dishwashing detergents. The experiments, conducted by UC Berkeley researchers, measured ethanol released into the air of an environmental

chamber during simulated dishwashing procedures. The results show that 4 percent of the ethanol in the detergent was emitted from a 10 minute wash procedure using 15 ml of detergent in 8 L of water (1 to 500 dilution). The results also show that 5 percent of ethanol is released in a second procedure with an one hour soak in still wash solution before a 10 minute wash. The amount of detergent used in the second procedure was 40 ml in 8 L of water (1 to 200 dilution). The detergent usage level of 15 ml for the first procedure is based on results from a Proctor and Gamble Company survey of detergent use habits (15 ml per household twice a day). (Wooley, Nazaroff) However, the actual use and dilution pattern can be highly variable. Most hand dishwashing detergents do not come with recommended dilution instructions, therefore consumers usually choose the amounts they use by "a typical squeeze" of the bottle, or by the desired level of the suds (SDA, 1991). In spot dishwashing, many consumers do not dilute the product, but rather apply the product on a sponge and then wash the dishes with the sponge without a full sink of water. As noted by professor William Nazaroff, one of the UC Berkeley researchers, the degree of dilution is a key factor affecting the emission mechanisms (Nazaroff). Lower dilutions results in higher use concentration and hence emissions. Since many uses of dishwashing detergents do not include dilution in a sink-full (8 liters in the experiments) of water, staff believe that the results from the high release experimental procedure better reflect emissions from actual consumer uses. For this reason, staff has chosen to estimate the emissions from hand dishwashing detergents during use at 5 percent of the VOC content.

The dishwashing experiments involved procedures that were at most on the order of an hour. It should be noted however, that the residence time of dishwashing detergents disposed of down the drain to highly turbulent wastewater systems can be days (County of Sacramento). Therefore, the emissions of hand dishwashing detergent VOCs from wastewater systems could significantly contribute to higher overall emissions. The SDA has conducted modeling to determine VOC emissions from wastewater systems. These modeling studies simplified the wastewater system into theoretical mass transfer points, from which emissions can then be estimated using steady state mass transfer or equilibrium partition equations (Engineering Science). In comparison with related studies recently performed for the ARB by experts from academia, the Engineering Science studies did not account for many of the mechanisms affecting emissions from municipal sewers and publicly owned treatment works (Corsi, Chang et. al). After discussion with the ARB staff, the SDA conducted a follow-up study by CH2M Hill, Inc.. This study again focused on ethanol, the major VOC component in detergents. This study concluded that due to the low volatility/solubility ratio, or Henry's Law constant, of ethanol, the impact of many of the emission mechanisms will be negligible. Therefore, emissions of ethanol from wastewater systems will be minimal. Based on these results, the staff has chosen at this time not to include emissions from wastewater into the emissions estimate for hand dishwashing detergents. However, the staff will continue to review pertinent data to investigate potential emissions systems. The South Coast AQMD has adopted a rule, Rule 1179, that requires wastewater treatment facilities to quantify their overall emissions. The staff believe that data gathered from Rule 1179, and our continued consultations with staff from

several regional water quality districts and academia experts will enhance our ability to ascertain the relative VOC emissions of hand diswashing detergents from wastewater.

While emissions of hand dishwashing detergents from wastewater systems need to be quantified, the SDA studies clearly show that there are emissions from use. Table V-18 summarizes the VOC emissions from hand dishwashing detergents.

TABLE V-18

Hand Dishwashing Detergent Emissions Summary
(Total Emissions 14,000 lbs/day)

Product Form	Percent of Market	Emissions (lbs/day)	Percent of Emissions
All	100	14,000* 800**	100

* Total VOC content released into wastewater and into air.

** Adjusted emissions into the air. Assuming that 5% of VOC content is released into the air during use.

Product Formulation:

Surfactants are the basic or the main active ingredient in hand dishwashing detergents. Surfactants lower the water's surface tension, remove grease and food soils, and create high suds (SDA, 1987). Mixtures of linear alkylbenzene sulfonate (LAS), lauryl ether sulfate (LES), lauryl monoethanolamide (LEA) are common. Surfactant systems that contain substantial portions of LES can give liquid hand dishwashing detergents a soft feel. End product formulators either blend liquid products from individual ingredients or dilute concentrates and add other minor ingredients. Aside from perfume and colorants, some commonly used minor ingredients are preservatives and hydrotropes. Preservatives prevent bacterial decay of the surfactants. Hydrotropes, such as aromatic sulfonates, urea or ethanol lowers the cloud point of products, the temperature at which the organic and aqueous phases separate upon cooling. Selection of surfactants affect cloud points, the more soluble surfactant blends will have lower cloud points. The linearity of LAS allows it to be more soluble as well as biodegradable. Smaller molecular mass surfactants are also more soluble. The electrolyte content of the product also aid in lowering the cloud point. (Woollatt)

The VOCs most often found in hand dishwashing detergent is ethanol. Ethanol is used as a hydrotrope, and a viscosity modifier. It may also be

occurring as a residual processing aid. Ethanol is used to modify the viscosity of surfactant concentrates and can be a reactant used in the surfactant formulation (Amway).

Recommended VOC Standard:

The recommended VOC standard proposed for hand dishwashing detergents is 2 percent. The staff estimates that the emission reduction estimate from this category is 480 lbs/day. The staff believes that this is conservative because only emissions from use, as determined in the SDA studies, were accounted for in the emissions estimate. In addition, different consumer use patterns and alternative applications may contribute to higher emissions. Emissions may be greater if the detergent concentration, water temperature, degree of agitation is higher than those used in the experiments. Emissions may also be greater if hand dishwashing detergents are used in applications such as washing cars and cleaning surfaces. Table V-19 summarizes the proposed standard and the emissions reduction.

TABLE V-19

Hand Dishwashing Detergent Standard Summary

Product Form	Proposed Standard (% VOC)	Number of Complying Products	Percent of Market Complying	Emission Reduction lbs/day
All	2	106	16	480*

* This represents the reduction from assuming that 5 percent of the VOC content is emitted from use.

The proposed standard for hand dishwashing detergent products apply to the formulation as sold. All hand dishwashing detergents sold are designed to be diluted into a wash solution. This is unlike other products that are sold both in ready to use forms, and in concentrates with "recommended" dilutions. Since there are no "undiluted" forms of hand dishwashing detergents, there is no need to apply a dilution factor into the VOC content determination. Because of this, the staff has proposed to exclude hand dishwashing detergents from the "minimum recommended dilution" provision in section 94509 (b) of the proposed regulation.

The staff believes that the proposed standard is technologically and commercially feasible. The results form the survey, presented in Appendix B, show that 106 products sold in California meet this standard. These products span both the household and institutional and industrial markets.

Compliance with the Standard:

The primary method of complying with the standard is expected to be the reduction of ethanol use in products. Formulators can achieve the phase stability and cloud point required by using other hydrotropes such as urea and aromatic sulfonates, and selecting appropriate surfactant blends. The selection of appropriate surfactants can also contribute to achieving the desired viscosity. There are currently many companies that market low VOC products nationally. This includes regions where products are stored transported in low temperatures. Since surfactants are the major cleaning active ingredients in hand dishwashing detergents, reducing ethanol or other VOCs for compliance will not reduce efficacy.

References:

Amway, Conversation between Amway Corporation representatives and ARB staff Peter Liu, July 31, 1991

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County of Sacramento, Personal conversation between County of Sacramento Water Quality Division, Department of Public Works staff, September 18, 1991.

Nazaroff, William, Personal conversation between Professor William Nazaroff and the ARB staff Peter Liu, May 2, 1991.

SDA, A Handbook of Industry Terms, The Soap and Detergent Association, 1987.

SDA, Meeting between SDA, Proctor Gamble Co., and CH2M Hill representatives and ARB staff October 3, 1991.

Woolatt, Edgar, The Manufacture of Soaps, Other Detergents and Glycerine, Halsted Press, 1985, pp 82-99.

Wooley, J., Nazaroff, W., Release of Ethanol to the Atmosphere During Use of Consumer Cleaning Products, Journal of Air Waste Management Association, 40:1114-1120 (1990).

K. HOUSEHOLD ADHESIVE

Product Description:

Household adhesives are defined as products used to bond one surface to another by attachment. The category does not include products used on humans and animals, adhesive tape, contact paper, wallpaper, shelf liners, or any other product where the adhesive has been incorporated onto or in an inert substrate. Products containing at least 80 percent cyanoacrylate monomer and packaged in containers 1 ounce and less are not subject to the standards. Cyanoacrylate-based glues are better known as "super" glues. In

addition, adhesives sold in sizes weighing more than one pound or containing more than 16 fluid ounces are not subject to the standards.

Adhesion is the joining together of two dissimilar materials, the adhesive and the objects to be joined. This is accomplished by a wide variety of adhesives such as glue, mucilage, paste, and rubber cement. Household adhesives are used to repair and maintain a wide variety of household items which are typically used to bind materials such as glass, plastic, rubber, wood, and metal together. Household adhesives are derived and developed from naturally occurring materials as well as being syntheszed in laboratories (Wake).

This category is represented by a very diverse group of products available to the consumer. The thousands of different glues available for consumer use today are represented by more than 100 distinct chemical types (Consumer Reports). Many of these product can be used for a variety of applications and substrates. For the purposes of the proposed amendments, the staff has categorized household adhesives into three groups: aerosol adhesives, cyanoacrylate based adhesives, and general purpose adhesives. The general purpose adhesive category represents all household adhesives which are neither aerosol nor cyanoacrylate based adhesives. Therefore, the expression "general purpose adhesive" is synonymous with "all other" adhesives. These three groups represent the range of household adhesives which are available to meet both specific needs and which can be used for general household adhesive applications.

Important performance properties of adhesives are tensile strength, peel, shear, and tack. Tensile strength represents the adhesive's ability to prevent material separation. Peel refers to the ability of an adhesive to stick to a surface after curing, while shear is the ability of an adhesive to resist material tearing. Tack refers to the adhesive's ability to stick to the substrate immediately after contact, which allows substrates to be held together until a permanent bond can be formed by the curing of the adhesive (SCAQMD).

Household adhesives are sold in aerosol, gel, liquid, and other forms. However, as mentioned above, household adhesives have been divided into aerosols adhesives, cyanoacrylates, and general purpose or "all other" adhesives. General purpose adhesives account for approximately 69 percent of household adhesives used, with an estimated 59 percent of the emissions resulting from this category. Aerosol adhesives represent approximately 8 percent of the market and 32 percent of the VOC emissions. The estimated emissions from aerosol adhesives are somewhat misleading since there are many aerosol adhesives which use 1,1,1-trichloroethane (TCA) as a solvent. As discussed in Chapter VII ("Technical Issues"), the Federal Clean Air Act's mandated phase-out of TCA may cause an increase in VOC emissions from aerosol adhesives if TCA is replaced with VOC solvents.

Cyanoacrylates are comprised of essentially 100 percent VOC. Approximately 5,000 lbs/day of these so-called "super" glues were reported in the ARB consumer products survey. However, for these products, most of the VOC content is involved in the polymerization process and is not emitted

to the atmosphere. The staff estimates that less than 5 percent of the VOC content is emitted to the atmosphere from these products (Adhesive and Sealant Council). Thus, staff estimates that the VOC emissions from these products are approximately 240 lbs/day.

While total VOC emissions from household adhesives are estimated at 2,400 lbs/day, the inventory for both VOC and low vapor pressure organic compounds is estimated to be over 10,000 pounds per day. Table V-20 summarizes the emissions from household adhesives.

TABLE V-20

Household Adhesives Emissions Summary
(Total Emissions 2,360 lbs/day)

Product Form	Percent of Market	Emissions (lbs/day)	Percent of Emissions
Aerosol	8	840	35
All others (General purpose)	92	1520	65

Product Formulation:

Adhesives work to bond materials by different chemical methods. For some adhesives, the surfaces of the materials adhere to the adhesive utilizing the strength of the surface adhesion and the material strength of the adhesive to hold the two components together. Other types of adhesives, such as cements, dissolve the surfaces of the substrates and, with the aid of solid ingredients, fuse and chemically bond the substrates together. Some adhesives are formulated with water, VOC solvents, or exempt VOC solvents. Other adhesives, such as hot-melt glues, are comprised entirely of adhesive solids and contain no solvents (Parker and Taylor).

Household adhesives are composed of several components such as resins, solvents, and fillers which are designed to perform a distinct function. The function of the primary ingredient, or resin, is to adhere well to various substrates such as glass, wood, metal, plastic, rubber and bind them together. The solvents are the media for transferring the adhesive materials to the substrate. The solvent must be capable of dissolving all of the various adhesive components, since the solubility of each component varies for the individual solvents. The solvents also have the ability to wet the substrate, which promotes adhesion, and the ability to allow the adhesive to flow, which allows a uniform application of the adhesive (Parker and Taylor). Fillers in adhesives frequently improve the shear strength of the bond by reducing the shrinkage during curing, and by reducing thermal expansion on exposure to elevated temperature during use.

As mentioned previously, the proposed amendments provide standards for aerosol adhesives and "general purpose" (i.e., all other forms) adhesives. In addition, products based on cyanoacrylate ester monomers have been exempted from the regulation. The following is a discussion of these three types of adhesives.

General Purpose Adhesives

General purpose adhesives are composed of a variety of different chemical types. These products can be simplified into epoxy and other polymerizing glues, contact cements, and wood glues.

Epoxies cure by means of a chemical reaction as opposed to evaporation. Consequently, these adhesives maintain their volume while curing making them useful for filling gaps. These adhesives are usually based on liquid epoxides and are two component systems; the epoxide with filler and non-reactive agent and the catalyst hardener. Epoxide systems cure without release of water or other by-products of the condensation reaction and can therefore be used to form bonds without application of pressure. In general, epoxies are strong, hard glues useful for a variety of household applications (Wake).

Other polymerizing glues include catalyzed acrylic glues and silicone rubber. Catalyzed acrylic glues are relatively new adhesives which work well on a variety of materials. Silicone rubber cements release acetic acid as they cure, which can cause irritation to the skin and eyes. These glues are adaptable to a wide range of temperatures and can be used on a wide variety of materials.

Contact cements are typically composed of either natural or synthetic rubber dissolved in organic solvent with resin. Contact cements harden quickly by evaporation of the volatile solvent. The VOC content of these products is therefore very high. These products are useful on materials such as wood products, countertops, and tiles. While these products are not very strong, their big advantage is that they bond on contact (Adhesive and Sealants Council).

Wood glues are comprised of the white and aliphatic or "yellow" glues. White glues are water-based adhesives commonly used for paper, wood, and porous substrates. These glues form strong bonds and can be cleaned up easily before cure. Aliphatic glues are similar to white glues in chemistry and are used mostly for wood products. These products also form strong bonds and are cleanable with water before curing (Consumer Reports).

Aerosol Adhesives

Aerosol adhesives are used in the consumer market for a variety of household applications such as arts and crafts, photo mounting, and paper goods. These products contain adhesive resins, usually rubber based, dissolved in exempt compounds and VOC solvents. The VOC content ranges from a low of 0 percent, due to the use of exempt solvents (e.g., 1,1,1-TCA) and propellant, to a high of 100 percent. Aerosol adhesives typically contain

20 to 25 percent propane as the propellant to expel the adhesive. In many cases, the liquefied propellant also acts as a cosolvent for these products.

Cyanoacrylates

Cyanoacrylates, commonly known as "super glues", are single component adhesives capable of bonding most substrates in seconds rather than the usual minutes or hours and are recognized for their high tensile strength. These adhesives, based on alkyl-2-cyanoacrylate ester monomers, cure rapidly as the result of anionic polymerization initiated by moisture on the surface of the substrate. Cyanoacrylates are sold in small quantities for consumer use, typically less than one ounce, due to small amount needed for each application.

Since most of the product is polymerized during the curing process, very little VOC is emitted to the atmosphere. While total VOC usage for these products is estimated to be 5,000 lbs/day, the staff estimates that less than 5 percent of this amount, or 240 lbs/day, are emitted to the atmosphere. Because there are no alternative technologies that have been identified for this product and because of their small estimated emissions, household adhesives based on cyanoacrylates have been exempted from the proposed amendments.

Recommended VOC Standard:

The proposed VOC standards for household adhesives are 75 percent for aerosol products and 10 percent for all other or general purpose adhesives beginning in 1/1/95. In addition, a future-effective standard of 25 percent is proposed for aerosol adhesives in 1/1/97. As shown in Table V-21, which is based on the Consumer Products Survey, products in each form are available which can meet the proposed standards for 1/1/95. In addition, a wide variety of different resin types are available within the general purpose category which can meet the proposed standards at this time. A list of the complying products is provided in Appendix B.

The total reduction of VOC emissions from household adhesives is estimated to be approximately 960 pounds per day for 1995 and 1360 pounds per day in 1997. Of this total, general purpose adhesives account for 900 pounds per day or 66 percent percent of the expected reduction. A future effective standard for aerosol adhesives is expected to provide an additional 460 pounds reduction beginning in 1997.

TABLE V-21

Household Adhesives Standard Summary

Product Form	Proposed Standard (% VOC)	Number of Complying Products	Percent of Market Complying	Emission Reduction lbs/day
Aerosol(1995)	75	45	65	60
Aerosol(1997)	25	22	29	400
All others (General purpose)	10	166	87	900

Compliance with the Standard:

Aerosol and general purpose products are available which meet the proposed standards. In addition, complying products have been identified which can be applied to a wide variety of household materials. Products that comply with the proposed standards are identified in Appendix B.

Manufacturers have five years to reformulate general purpose adhesives which do not meet the proposed standards. Since there are complying products already available for use as general purpose adhesives, the staff expects that the proposed compliance date will be sufficient for reformulating non-complying products. One subcategory of general purpose adhesives which does not meet the proposed standard is contact adhesives. water-based contact adhesives have been developed for the industrial market (Adhesives and Sealants Council). The staff is aware of industry efforts which are underway to reformulate contact adhesives for the consumer market and which will meet the standard by using this technology (Adhesives and Sealants Council).

For aerosol adhesives, an additional two years have been provided to allow industry needed time to meet the 25 percent future-effective standard. In the interim, the staff proposes a standard of 75 percent which can be met by 65 percent of the market. The staff expects industry to comply with the standard and reduce VOC emissions by reformulating with water or by developing innovative adhesives with improved transfer efficiency and reduced spray rate.

References:

Adhesives and Sealants Council, Industry presentation to the ARB staff, September 27, 1991.

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South Coast Air Quality Management District, Staff Report for Rule 1168, Control of Volatile Organic Compound Emissions From Adhesive Applications, March 29, 1989.

Wake, W.C., Synthetic Adhesives and Sealants, John Wiley & Sons, 1986, pp. 89-111.

L. INSECTICIDES

Product Description:

Insecticides are pesticide products that are designed for use against pests such as insects and other arthropods. Insecticides include products that can act to kill, destroy, control, prevent or repel the target pests. All insecticides that are sold in California must be registered both with the U.S. EPA according to the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), and the California Department of Pesticide Regulation (DPR).

Insecticide products rely on active ingredients that are toxic to the pests to provide the insecticidal actions. Active ingredients work by a variety of mechanisms. Some active ingredients cause acute disruptions to the function of the nervous system, others induce physiological reactions such as dehydration or enzyme inhibition, and still others inhibit the growth and development of the pest. The balance of the formulation after the active ingredients are the inert ingredients, which make up the majority of the formulation. The inert ingredients usually serve one or more of the following functions: dilute the insecticide to a ready-to-use concentration; spread the formulation evenly over the area or space to be treated; propel the formulation from aerosol cans; or attract the pests. (Bohmont)

Consumer product insecticides are formulated and sold in a multitude of product forms. The survey results show that aerosol, liquid, pump, solid, and gel forms of insecticides are all sold in California. Furthermore, the survey results show that there are several distinct "primary uses" for insecticides. As confirmed by members of the CSMA pesticide task force, identical "product forms" with different "primary uses" can have dissimilar product formulation technologies (CSMA Task Force, June 25). For example, aerosols for "flying bug", and aerosols for "crawling bug" differ not only in active ingredients, but also in spray patterns. This is the reason why the staff has chosen to subcategorize the insecticide category into several primary use categories. Presented below are the descriptions of the insecticide categories proposed for the Phase II amendments. The insecticide products reported in the survey have all been divided into the these categories with the assistance of the CSMA pesticides task force.

Subcategory Descriptions

"Crawling bug insecticides" are products that kill ants, roaches and other crawling arthropods. These products are sold in aerosol and pump sprays, liquid, powder or granular baits, and bait or trap stations. Most spray products contain active ingredients that can kill on contact and/or kill residually. Residual kill is where the insecticide is applied as a residue on surfaces, and insects are killed later when they contact the residue.

"Flea and tick insecticides" are products that kill adult and pre-adult fleas and ticks or prevent the hatching of their eggs. These products are sold in aerosol or pump sprays, liquids and powders. The spray products are sold as both residual and contact sprays. The contact sprays do not contain persistent active ingredients that will work for weeks, but rather only those that will work for a short time after spraying.

"Flying bug insecticides" are products that kill flying pests such as flies, mosquitoes and moths by contact. These products are sold as aerosol and pump contact space sprays. Space sprays are products that can be sprayed in fine mists or droplets to suspend the insecticide active ingredient in air for some time to allow contact with flying pests.

"Insecticide foggers" are products that are designed to kill or control specific or several types of pests by releasing insecticides in a fine mist or fog that is distributed into an indoor space. These products can be effective in treating heavy infestations of pests throughout a house. An insecticide fogger is a single use product, meaning that it releases all or most of its content during use. Aerosol fogger products have locking valves, which when activated releases the pressurized content.

"Lawn and garden insecticides" are products that are designed for use against pests found in lawns and gardens. Lawn and garden products are sold in aerosol and pump sprays, ready-to-use and emulsifiable concentrate liquids, dissolvable and ready-to-apply granules and powders. These products are designed not to harm plants. Some products are systemic, where the insecticides are taken through the roots of a plant to provide defense against pests.

"Wasp and hornet insecticides" are products that are designed for a user to kill biting or stinging flying insects such as wasps, hornets, yellow jackets or bees from some distance by spraying high volume bursts or streams of insecticide at the insect or its hiding place. Wasp and hornet insecticides reported in the survey are all sold as directed aerosols sprays with the exception of one product.

"All other insecticides" are any products not described in the above categories but are designed for use against insects or other arthropods. These products include, but are not limited to multi-purpose ready-to-use or concentrated insecticides, and insecticides used on human body and clothing but excluding insect repellants.

Emissions

The VOC emissions calculated from the survey data of the above categories totaled 18,540 lbs/day. In addition, insecticides formulations often contain Table B compounds, primarily 1,1,1-trichloroethane (TCA). The majority of foggers, wasp and hornet products, and some crawling bug and flea and tick products utilize TCA. The staff estimated the TCA emissions from these categories by summing the total Table B compounds the reported minus Table B (Type A + Type B) propellants. This estimate shows that insecticides contributed approximately 6,800 lbs/day TCA emissions. The Federal Clean Air Act (FCAA) requires that the production of TCA be phased-out in 2002. If manufacturers choose to replace TAC with VOCs in these insecticide products, the VOC emissions will increase dramatically. Table V-22 below summarizes the breakdown of the sales and emissions from insecticides.

Table V-22

Insecticides Products Emissions Summary
(Total Emissions 18,540 lbs/day)

Product Category	Percent of Market	Emissions (lbs/day)	Percent of Emissions
Crawling Bug	34	7,640 400*	41
Flea and Tick	7	800 200*	4
Flying Insect	11	2,000	11
Foggers	17	2,900 5,400*	16
Lawn and Garden	22	3,080	17
Wasp and Hornet	4	720 800*	4
All Others	5	1,400	8

* Emission of 1,1,1 Trichloroethane

Crawling bug insecticides account for the largest source of emissions from the category. Insecticide foggers, despite accounting for only 16 percent or 2,900 lbs/day of VOC emissions, contributed to 5,400 lbs/day or 79 percent of the TCA emissions. Similarly, wasp and hornet insecticdes contributed greater TCA emissions than VOC emissions.

Product Formulation:

As mentioned above, active ingredients are the substances that provide the insecticidal actions. Pests acquire the "lethal doses" of active ingredients by ingestion or by contact. Ingestion poisoning is ususally accomplished when pests eat the baits or plants treated with insecticides. Contact poisoning is accomplished when insecticides penetrate into the pests' internal body through inhalation or through their exoskeleton or outerbody. Contact poisons can be delivered by directly contacting the pest or by suspending the insecticide in air breathed by the pest. Contact poisons can also be laid down as surface residues that are contacted by the pest after application. Insecticide active ingredients used today have a wide range of "activity" and "persistence." Activity is the measure of the "speed" and the "extent" of the toxic effects. The speed of an active ingredient in causing effects that immobilize an insect is often referred to as its "knockdown" ability. The extent, or whether the toxic effect will lead to death does not always correspond to good knockdown. For example, natural pyrethrins are very good knockdown agents; however, insects can often recover from the effects of pyrethrin if no other active ingredient is used. The persistence of an active ingredient is a measure of its stability in the environment. Following the ecological problems caused by persistent insecticides such as DDT, almost all active ingredients used today are biodegradable. However, many actives still have stability of several weeks or months to provide residual actions.

There are numerous active ingredients used in insecticides today. The following are examples from the six major classes of compounds used in consumer products today.

Botanicals	Synthetic Pyrethroids	Organic Phosphates	Carbamates
Pyrethrin	Allethrin	Diazinon	Carbryl (Sevin)
Rotenone	Permethrin	Chlorpyrifos	Propoxur (Baygon)
	Cyfluthrin	Malathion	1-naphthyl n-methyl carbamate
	Halomethrin	Dichlorvos	

Inorganics	Synergists
Boric Acid	Piperonyl Butoxide
Arsenates	Sesamin
Sulfur	MGK 264

The active ingredients listed above are discussed in more detail below.

Pyrethroids

One of the most widely used class of active ingredient compounds are pyrethrins or pyrethroids. Pyrethroids are contact poisons that penetrate rapidly into the nervous system to cause paralysis or death. The initial effect is of such rapid onset that within a few minutes the insect is

incapable of moving or flying away. Because of its fast knockdown and low mammalian toxicity, pyrethroids are popular active ingredients for household insecticide sprays, particularly in aerosols and aerosol foggers. (Ware) Pyrethroids are found in most spray products in all of the proposed insecticide categories. Natural pyrethrins are expensive and breakdown very quickly. Synthetic pyrethroids have been produced that possess a wide range of activity, toxicity and stablility. For example, tetramethrin has a knockdown effect greater than natural pyrethrins, while resmethrin and permethrin in comparison, have a weaker knockdown effect but a much higher toxicity towards a variety of insects (Buchel). The latest generation of sythetic pyrethrins such as tralomethrin, and halomethrin show activities and stability many times higher than earlier generation synthetics. These new compounds can provide both excellent knockdown and residual kill, and may do so at much lower concentrations (United Technologies).

Synergists

Although pyrethroids are very effective in the knockdown of insects, the dose for knockdown is often insufficient to be lethal because pyrethroids are rapidly detoxified in the insect by enzymatic action. Synergists are usually added to extend the knockdown dose to kill the insects. Synergists or synergist combinations such as piperonyl butoxide and N-octyl bicycloheptane dicarboximide, help deactivate enzymes that are used by insects for detoxification of the pyrethroid in its body. Synergists with pyrethrins are found in practically all of the aerosol fogger insecticides and space sprays. In addition to synergists, a second insecticidal ingredient is also often added with pyrethroids to provide the lethal dose.

Organo-Phosphates

Another important class of active ingredients used in consumer insecticide products is organo-phosphates. Organo-phosphates are phosphoric acid derivatives that generally act against the insects by inhibition of the enzyme acetylcholinesterase. This disturbs the function of the nervous system to cause paralysis and death. Organo-phosphates are a wide variety of compounds with a tremendous range of activity, persistence, and function. Compounds that have longer persistance can provide residual insecticidal activities. Organo-phosphates as a class present higher mammalian toxicity than pyrethroids and carbamates, but compounds with relative low human and toxicity have been widely used in consumer insecticide products. Chlorpyrifos or Dursban is often used in bait stations, and in household sprays with pyrethroids. Diazinon is widely used for home lawn and garden products. (U.S. EPA)

Carbamates

Carbamates or carbamic acid derivatives are another major class of active ingredients used in insecticides. Carbamates are effective against a broad spectrum of insects, and similar to organo-phosphates they act to inhibit the enzyme acetylcholinesterase. Carbaryl, or Sevin, is a carbamate

that exhibit a wide spectrum of insect control and is widely used in lawn and garden products. Propoxur, or Baygon, is effective against roaches and is often used in bottled sprays such as aerosols (Ware). However, propoxur has been listed by the EPA as a hazardous air pollutant.

Other Active Ingredients

Aside from pyrethrins, organo-phosphates and carbamates, there are numerous other types of active ingredients used in consumer insecticide products. Inorganic insecticide chemicals such as heavy metals are used often as stomach poisons in baits against chewing insects. Arsenic trioxide in ant and roach baits is an example. More recently, growth regulators have been incorporated into products such as foggers and aerosol sprays to prevent the development of insects to maturity and to induce morphological changes that sterilize insects. Hydroprene and methoprene are two growth regulators which are shown to be effective against fleas and roaches (Zoecon).

Inert Ingredients

The active ingredient discussed above are formulated with inert ingredients into a variety of end-use products. In the case of aerosols, pump sprays and bait products, the active ingredient is usually no more than a few percent. Higher levels of active ingredient are usually present in concentrated products that are available in liquid and solid forms.

For aerosols, pumps and liquids, a carrier system is needed to dispense the active ingredients. Traditional formulations have relied on petroleum distillates, aromatic distillates and TCA as the carrier for active ingredients. However, advances in emulsion technology have enabled water-based carrier products to be formulated and marketed in all of the insecticide categories proposed for regulation. Since very few active ingredients used today are actually water soluble, emulsion and dispersal agents are used to create a dispensible water/oil mixture where the active ingredient is still dissolved in the oil phase. Today water-based emulsions have been demonstrated to be compatible with active ingredients from the major classes of active ingredients including pyrethroids, carbamates, organo-phosphates and insect growth regulators (Albanese)(Zoecon). Pyrethroids as a class of compounds, are especially compatible with water-based systems (MGK, September 28). A few pyrethroids such as fenvalerate, and some organo-phosphates and carbamates, such as Diazinon and Baygon degrade in the presence of water and cannot be formulated into water-based products with long shelf life. Diazinon, for example, is traditionally sold as an emulsifiable concentrate, which is diluted with water just before use to minimize degradation. However, recent developments in micro-emulsion technology has allowed diazinon to remain stable in ready-to-use water-based aerosols and pump sprays (Ortho, September 4).

The inert ingredients in aerosol insecticides include the propellants and the solvent or water-based emulsion carrier systems. The propellants used are predominantly hydrocarbon blends with compressed carbon dioxide

being the next prevalent choice. Inert ingredients in aerosols play a major role in the spray characteristics of the products. The tailoring of valve design, propellant blends and carrier mixture properties such as viscosity and surface tension allow formulators to produce products with desired spray patterns.

The inert ingredients in pump sprays are similar to those in aerosols except for the absence of the propellants. Water-based carrier systems are used in the vast majority of the products.

As mentioned above, liquid and solid products are sold in a wider range of active ingredient concentrations. Inerts in liquids are again solvents or water-based emulsions at various solvent concentrations. A large portion of the liquid products are emulsifiable concentrates, which are high solvent phase emulsions that must be diluted with water before use. Soluble powders or granules contain relatively high concentrations of actives, with most of the inerts being dissolution aids or fillers. Ready-to-use dusts usually have a low concentration of actives, with a high amount of inerts such as talc, clay or ash. The inert ingredients in baits are usually foodstuff or other attractants (Bohmont).

Recommended VOC standard:

Table V-23 summarizes the proposed standards and the estimated emission reductions for insecticides. The proposed standards for insecticides are effective one year after the date listed in the Table of Standards. The additional year is proposed to give companies additional time to complete their FIFRA and DPR registrations for reformulated products. Companies must register new products or product formulation changes with the EPA and DPR. The registration requires companies to submit results of efficacy and toxicological studies to demonstrate that the product can meet its label claims and that the product will not present harmful effects to human health.

TABLE V-23

Insecticide Products Standard Summary
Effective Date 1/1/95

Product Category	Proposed Standard (% VOC)	Number of Complying Products	Percent of Market Complying	Emission Reduction (lbs/day)
Crawling Bug	40	134	63	4,100
	20 (1/1/98)	99	59	1,540
Flea and Tick	20	23	53	280
Flying Insect	30	15	38	260
Foggers	40	53	87	220
				5,600*
Wasp and Hornet	40	22	90	120
				900*
Lawn and Garden	20	89	72	2,200
All Others	20	51	40	900

* If unregulated, manufacturers can choose to replace TCA with VOCs at a 1 to 1 ratio. Under this scenario, the VOC emissions will increase dramatically. The noted reductions here represent the VOC emission reductions that the proposed standards may provide assuming a 1 to 1 TCA/VOC replacement scenarios.

The standard for flying bug insecticides does not apply to products comprised of at least 98 percent paradichlorobenzene. Paradichlorobenzene (PDCB) insecticides are moth preventative products that are typically sold as "moth balls." They are used in clothing storage enclosures such as closets, drawers and boxes. PDCB "moth balls" are composed almost entirely of PDCB, the active ingredient. PDCB acts to kill and repel moths and their larvae. Low VOC aerosol products that are intended to protect clothing from moths have been identified in the ARB survey. However, the spray products must be applied on individual articles of clothing for moth protection, unlike PDCB products which protect all clothing stored in the enclosure in which they are placed. Therefore it is uncertain whether the aerosol products are suitable replacements for PDCB products. Cedar blocks have also been marketed for moth repellancy. However these products do not kill moths, especially moth larvae that can hatch on clothing and eat the fibers.

Compliance with the Standard:

There are products that can meet the proposed standards in each of the seven categories, these products are listed in Appendix B. Almost all of the bait products already meet the proposed standards because they usually contain over 90 percent foodstuff (Clorox). Most of the emulsifiable concentrates and dissolvable solids found in the crawling bug and lawn and garden categories meet the proposed standard after the recommended minimum dilution is made. The majority of ready-to-use pump products are water-based products with VOC contents lower than the proposed standards. Therefore, the bulk of the products that may have to be reformulated for compliance are the high VOC aerosol and other high VOC liquid or pump spray products.

Compliance with the proposed standards is expected to be accomplished mostly by reformulating solvent-based products with water-based systems. As discussed earlier, water-based technologies have already been utilized in all of the proposed categories. Companies have reformulated their products to water-based systems because of advantages in non-flammability, reduced health risks, long term cost savings, and compatibility with household applications. In addition, advances in emulsion and active ingredient technology allow water-based formulations to maintain similar insect control efficacy to the solvent-based products.

<u>Lowering VOC Reduces Flammability of Products</u>

Flammability concern with consumer insectide products is a major driving force for water-based reformulation that has preceded the development of ARB's Consumer Products Regulation. Non-flammability is especially important in household products, where the consequence of safety liability can be tremendous and marketing of products with "high flammability" labels undesirable (ICF). For example, manufacturers have minimum flame extension requirements for indoor use products such as foggers (MGK). Industrial users also often require their workers to use non-flammable or low-flammable products (SMUD). In addition to safety concerns, the flammability of products places economic burdens on retailers and distributors that warehouse insecticides. The National Fire Protection Association (NFPA) model codes, NFPA 30 and NFPA 30B, classifies liquid and aerosol products in levels of flammability from I to III, I being least flammable. Warehouses that store products in the higher flammability levels are required to install expensive fire protection equipment or risk not being covered by fire insurance (Ortho, September 4).

Concern about the flammability of insecticides is compounded by the phase-out of TCA required by Title VI in the Federal Clean Air Act (FCAA). TCA has been heavily relied upon as a non-flammable cosolvent in foggers and wasp and hornet products. If TCA is replaced with VOC solvents, many products would again be elavated to a high flammability classification. Water-based systems became the logical choice of substitution for many companies. In both the fogger and the wasp and hornet categories, companies have substituted TCA directly with water-based systems without losing the desired biological activity and spray pattern (United Industries,

September 30). The ARB survey results show that 10 percent of the foggers and 33 percent of the wasp and hornet products sold in the state in 1990 are water-based products. In addition, S.C. Johnson Wax, the major marketer of household insecticides has introduced a water-based fogger product to the market in 1991 (S.C. Johnson Wax).

Low Toxicity of Water-based Systems

In addition to non-flammability, reformulation with water-based systems allows companies to substitute inert ingredients that may have potential toxic effects with one that is inherently safe - water. Many compounds in petroleum distillates such as hexane and xylene are identified in the FCAA as hazardous air pollutants. In addition, these compounds are considered by the EPA as inert ingredients of toxicological concern for FIFRA registration. The EPA's list of inerts of toxicological concern is included in Appendix C.

Compatibility of Water-based Systems with Household Applications

Water-based formulations offer advantages in many household applications. For indoor applications, water-based formulations do not leave odorous, staining and oily residues that will damage furniture, carpeting and flooring (MacLaughlin Gormley King, 1987). For outdoor applications, water-based formulations have the advantage of being less harmful to plants than petroleum distillates.

Effectiveness of Water-based Products

The factors that affect the effectiveness of insecticides are the product delivery characteristics and the biological activity. Current water-based products can satisfactorily achieve both qualities in aerosol and liquid products. Advances in active ingredient and emulsion technology will further improve the performance of water-based products and allow further VOC emission reductions.

Spray Patterns

Fine sprays are needed for flying bug insecticide products. Water-based emulsion products can deliver the desired fine sprays. In fact, the ARB survey results show that water-based products dominate the sales in this category. Manufacturers stated that the proposed VOC content limit of 30 percent should allow them to formulate products with adequate propellant level and emulsion viscosity to deliver fine sprays (United Industries, September 30) (S.C. Johnson Wax, October 3).

Fine spray, particle suspension and low droplet fall-out are desired qualities in foggers. In addition, fogger products must avoid can freezing. Can freezing results from the refrigeration effects of aerosol expansion upon release of the contents. If evacuation is slow, the can's temperature may drop to a point that causes sputtering. The level of VOC required is limited by the amount of hydrocarbon propellants that is needed to produce good particle breakup and allow fast evacuation. S.C. Johnson Wax and

United Industries, the major maunfacturers of insecticide foggers, have presented data that show good particle suspension, low fall-out, and fast evacuation for water-based foggers at the 40 percent VOC level.

Biological Activity

The activities of insecticides are determined by the active ingredient utilized. As mentioned earlier, water-based emulsion systems have been demonstrated to be compatible with most major active ingredients. Therefore, formulators will have a wide range of active ingredients available for reformulation. Pyrethroids, the "workhorse" active ingredient in spray products, are predominatly stable in water-emulsions. Many of the highly active new generation pyrethroids can also be carried in water-based emulsions (MGK). As mentioned earlier, even compounds that degrade in the presence of water can be formulated in water-based products, through new technolgies in microemulsion and microencapsulation, without losing biological activity (Ortho, September 4).

Issues:

1. Issue: Companies have stressed the importance of having fast knockdown, especially for spray products in the crawling bug and wasp and hornet categories. Questions have been raised about whether the proposed standards allow for the formulation of fast knockdown products. Questions have also been raised about whether the lack of fast knockdown may decrease the effectiveness of the product to control the overall pest population and to provide user safety.

   Response: As discussed earlier, insecticide activities can vary in extent and in speed. The important factors in insect population control are whether the insecticide can "kill" the insects with the applied dose, and the number of pests that can acquire such dose. Such qualities can often be achieved by products that do not visually exhibit killing actions. Products such as bait stations contain "slow kill" insecticides that kill pest when they return to their hiding place after eating the bait. Consumers, therefore, do not see immediate effects. Consumers are sometimes skeptical of slow kill products. However, home testing done by American Cyanamid on their roach bait stations show that when properly used, consumers obtained excellent results in "getting rid of roaches" (Becker et. al.). Insect growth regulator products are another class of "slow kill" products that have demonstrated success in population control. Insect growth regulators can either stop the development of nymphal or pupil pests, or cause morphological changes on pests that block their ability to reproduce. The onsets of these effects take days or weeks to develop, however the net result is that a generation or several generations of pests are controlled. Insect growth regulators have been effectively used by pest control operators to extensively destroy pest populations. The same chemicals used by the pest control operators have now been formulated into consumer products (Zoecon).

While fast knockdown may not be a necessary quality in controlling pest population, companies have emphasized that it is still a very important quality to the consumers. For wasp and hornet sprays, fast knockdown is needed to prevent the pests from attacking the user. In addition, consumers generally attribute fast knockdown as directly related to the overall effectiveness of most aerosol products. S.C. Johnson Wax and Reckitt and Coleman, manufacturers of the leading brands of crawling bug aerosols, stated to staff that results from their market research show that consumers buy these products primarily for their knockdown ability. Consumer perception, shaped from traditional use patterns and marketing, is that if a pest is not killed quickly and within their sight the product does not work. Slower knockdown products, despite being able to deliver the "lethal dose" that eventually kills the pest, are perceived by consumers as less effective. Such misconception may lead to misuse, where a consumer literally "chases the pest around the house while spraying at it" (CSMA Task Force, June 25).

Fast knockdown is a quality of certain active ingredients, particularly of pyrethroids. Pyrethroids have shown excellent knockdown against a large variety of pests. However, inert carriers in some products can aid and enhance the the effect of the active ingredients. For example the chlorinated solvents in wasp and hornet aerosols, first CFCs and now TCA, help to stun the pests by what is believed to be a freezing effect from rapid evaporation (S.C. Johnson Wax, October 16). With the phase-out of TCA, the role of the active ingredient in fast knockdown becomes more important. Selected synthetic pyrethroids that have excellent knowdown abilities allow effective water-based products to be formulated (MGK). The survey results show that many water-based products are currently available.

Inert ingredients can also aid the speed of penetration of active ingredients into pests that have well protected bodies. Cockroaches, one of the primary pests for most crawling bug insecticides, have hard, oily and waxy outerbodies, or exoskeletons. In addition, their breathing openings (spiracles) are located mostly on the abdomen. When spraying cockroaches directly, their spiracles are usually protected from contact, therefore penetration of the actives through the exoskeleton is needed for reliable fast knockdown (S.C. Johnson Wax, October 16). Solvents can dissolve some of the waxy protective layers of the exoskeleton, thus allowing faster penetration through the exoskeleton (Reckitt and Coleman). Current water/solvent emulsion technologies enable the delivery of droplets that behave similarly to solvent droplets in aiding active ingredient penetration. The proposed limit of 40 percent VOC content for crawling bug insecticides reflects these technologies (S.C. Johnson Wax, October 8).

Improvements in emulsion technologies will allow products to achieve fast knockdown of roaches and other crawling bugs at even lower levels of VOC content. Data submitted by United Industries show that their water-based products, at VOC levels significantly lower than 40 percent, can achieve fast knockdown even with current "workhorse" pyrethroids such as d-trans allethrin. Results from tests using CSMA

aerosol test methods show that average time for 100 percent knockdown can be as fast as 35 to 40 seconds (United Industries, October 4). Such knockdown speed is close to what other industry representatives have stated as acceptable by the consumers. S.C. Johnson Wax representatives have stated that average knowdown times of 30 seconds should be acceptable to the consumers. Many companies have stated that they are currently conducting research to improve emulsion systems that can deliver adequate knockdown at lower VOC levels lower than 40 percent (S.C. Johnson Wax, October 3) (MGK).

With the commercialization of higher activity active ingredients, the reliance on solvent penetration for knockdown will be lessened. These new actives have insect toxicological activities many times higher than current "workhorse" pyrethroids. The higher activities allow these compounds to achieve equivalent knockdown at lower dosage levels (United Industries, September 30). Therefore, even if smaller doses penetrate in a given amount of time, the knockdown will be just as fast. The proposed future effective standard of 20 percent VOC content for crawling bug insecticides reflects a level which developing and some existing technologies can achieve. The survey results show that many products sold in the state can already achieve this level.

2. Issue: Industry representatives have expressed concerns about their ability to market reformulated products by the proposed effective dates. They stated that the registration of reformulated products with the EPA and the DPR places additional burdens beyond their control on their ability to comply in time. They also stated that companies' inability to comply by the effective date may lead to the inability of the industry to satisfy the demands from consumers of products that affect public health. The CSMA has proposed that the effective dates of the standards for insecticides should be five years after the effective date of the regulation. The CSMA further proposed that insecticide products should be allowed a three year sell through period. In addition, the CSMA proposed that an "open" provision equivalent to an administrative variance be allowed for companies that will not be able to comply because of "events beyond control". (CSMA)

Response: Staff has proposed standards for insecticides effective at January 1, 1996 and January 1, 1998. In addition staff has proposed to continue the extension of an additional year for compliance to insecticides and other FIFRA registered products. This additional time extends the actual proposed effective dates to 1996 and 1999. In our discussion with individual companies, the DPR and EPA, the staff has determined that these timeframes are adequate for companies to market complying products. The staff believes that the introduction of reformulated products plus existing products that already meet the standards will allow industry to meet the public's demand for insecticide products. The staff also believes that the existing variance procedure provides a mechanism to resolve any unforseeable events. The following presents the key considerations in the staff's determination.

Leading companies in the insecticide industry have indicated to staff that the standards will be achievable. As discussed previously, due to other driving forces for reformulation such as flammability, health concerns and TCA phase-out, companies have already reformulated products to low VOC levels or have begun development of low VOC products. For example, United Industries, one of the top national marketers of insecticides, currently sells products that meet the proposed standards and the proposed future effective standard. S.C. Johnson Wax has been developing low VOC reformulation to achieve their corporate policy to reduce overall VOC use by 1995. S.C. Johnson Wax representatives agree that products can be developed and marketed by 1996 to meet the proposed standards (S.C. Johnson Wax, October 8). Representatives from MacLaughlin, Gormley and King and Zoecon, supplier of product intermediates to formulators and end-formulations for private labelers, have also stated that their companies currently market or are developing products that meets the proposed standards.

With developmental efforts for low VOC products in progress, the timeframe provided by the proposed effective dates should be adequate for companies to register new products. Comments provided by the EPA and the DPR indicate that typical timeframes required for registration of reformulated products with both agencies shoud be within 1 to 2 years. This is consistent with data provided industry.

EPA staff stated that the timing of individual FIFRA registrations is dependent on the data requirements, the completeness and the correctness of the submitted applications, and the review process conditions of the specific applications. EPA has further commented that representative registration reviews should be 6 to 12 months for scenarios that companies are expected to encounter in reformulations to reduce VOC contents (U.S. EPA Letter). This is consistent with many of the registration timing summaries provided by the member companies of the CSMA Pesticide Task Force. Many formula changes presented by CSMA were registered within one year and most are under two years. In a product development timeline presented by the Chevron Chemical Company, the typical FIFRA registration for products using a new active ingredients is shown to be 12 to 18 months, and at times can take up to 2 years. The registration timeframe summaries the timeline from the Chevron Chemical Company, and a comment letter from the EPA Office of Pesticides and Toxic Substance to the ARB staff are included in Appendix C.

The timeframe provided by the proposed effective dates will also be adequate for registration of new products with the DPR. DPR registration timing summaries presented by industry included a formula change registration that took only 19 days for review. However, most registrations were completed in 60 days. DPR has commented that the registration reviews should be approximately 60 days for new products and 120 days for new active ingredients (DPR Memo). Timeframe summaries submitted by industry and a comment memo from DPR to ARB staff are in Appendix C.

The staff believes that the standards can be achieved by the effective date. However, the staff also believes that the variance procedure will allow companies additional time to comply should they need such allowance because of "events beyond their control". Industry representatives have presented product registration cases in which the review process took up to four years (Reckitt and Coleman). They indicate that these delays are often caused by factors beyond their control, such as backlog of applications, or mishandling of applications at the EPA. The variance provision is designed to handle cases such as this.

3. Issue: Industry representatives have expressed concerns that active ingredients that they rely on may be "lost" from EPA's FIFRA re-registration and from suspension by provisions in the California Birth Defect Prevention Act of 1984 (SB950). They expressed concerns that losing the availibility of active ingredients can disrupt their reformulation efforts and hinder their ability tc comply with the standards in time.

FIFRA re-registration is a five phase process conducted by the EPA to review the environmental fate, health and toxicological risks, and efficacy data of pesticides registered before 1984. To re-register pesticide products, registrants must generate a database of test results that are equivalent to those required for registration after the FIFRA amendments of 1988. Some of the test data may have already been generated, but others have not been performed. These "data gaps" of test results must be fulfilled for re-registration to be approved. Active ingredient or basic formulation registrants must fulfill "data gaps" for each type of end-formulation that utilizes their materials. Since the testing required to generate the data are often very expensive, registrants will choose only to "support" end-formulation types that have high sales. For example, the consortium of the supplier and major customers of malathion in the U.S. will fund only those tests required to support high sales applications such as home garden apple tree products, while tests needed for low sales malathion uses such as for agricutural crops will not be supported (Ortho, October 18, 1991).

Similar to the FIFRA re-registration process, SB950 requires registrants of active ingredients, identified by the DPR as having significant data gaps in mandatory health effects test data, to fulfill those gaps. SB950 further requires the DPR to suspend the registration of any pesticides on January 1, 1992 for which there remains a data gap. The suspension will be revoked if satisfactory health effect test results are submitted to fufill the data gap. The DPR notified registrants of fourteen active ingredients in August 1991 that their materials have been identified for suspension due to failures to fufill data gaps by the legislative time frame (DPR Letter, August 2, 1991). In October 1991, two legislative bills, SB550 and AB1742, were passed and signed to amend procedures for the suspension. These bills required the commencement of the suspension; however, they also outlined conditions for which deferral of suspension and extension of

time for data submission can be granted. Active ingredients suspended will be "lost" if the registrant decline to perform the required test, or if the registrant voluntarily withdraws the active ingredient (DPR, October 17, 1991).

Response: The staff has discussed the concerns about losing active ingredients with representatives from industry, and EPA and DPR staffs. From these discussions, the staff has determined that while some actives will certainly be "lost" from the FIFRA re-registration and the SB950 processes, the manufacturers' ability to reformulate products for compliance will not be restricted. Most of the compounds or uses "lost" will be those that are economically unpractical for the registrant to support. These compounds will predominantly be uncompetitive products that do not represent the mainstay of the marketplace, or compounds that are old and will be superseded by new, more effective, compounds. Formulators will have available these new compounds along with re-registered traditional "workhorse" compounds to formulate low VOC products.

The insecticides industry is progressing towards newer and more effective active ingredients in their reformulation. Already mentioned earlier are new generation pyrethroids and biological regulators. Ingredients registered in California after 1984 are required to generate the database of health effect tests equivalent to current registration requirements. Therefore, they already satisfy SB950 and FIFRA re-registration requirements. These compounds will not be affected by either process and their availability will be strictly governed by the demand in the marketplace.

Older, or pre-1984 active ingredients, are required to fulfill data gaps with current data requirements. These ingredient have been through the trials of the marketplace. Those that are effective and economical remain today as popular or highly utilized ingredients. Registrants will choose to fund the testing required for these products because the sales of these compounds warrant that investment. For example, the data gaps of current "workhorse" pyrethroids such as allethrin and permethrin for SB950 are already filled. Test results to fill data gaps for dursban, a traditional "workhorse" residual active ingredient have all been submitted, and all except one has been reviewed (DPR letter, September 12). Registrants will not only support products that traditionally have the highest sales but also compounds that exhibit a strong potential for niche markets. Insect growth regulators such hydroprene and methoprene are examples of such compounds. These two compounds will be among the first group of compounds to complete their re-registration.

The overlap of insecticides active ingredient selectivity and activity can simplify reformulations for companies. Insecticide active ingredients are usually effective against a range of target pests. Therefore companies generally use an active ingredient in several products. For example, resmethrin is used in flea and tick, and flying bug insecticides. A compound that has similar selectivity as

resmethrin can be substituted into the products in all three categories. Therefore, if resmethrin is lost, companies can use only one substuitute, such as sumithrin, in all the products.

Companies will be able to ascertain more clearly which actives may be lost from the SB950 and the FIFRA re-registration processes as they progress in implementation. The signing of SB550 and AB1427 requires the DPR to commence suspension of compounds according to SB950 in 1992. Actives registrants must demonstrate the initiation of testing, or show commitment inorder to defer the suspension. Similarly, formulators are asking for commitments from their active suppliers to support their products in both the SB950 and the re-registration process. Formulators who are uncertain of the actives supplier's commitment are seeking backup products. Others are entering into business agreements with suppliers to support the testing efforts to fufill the data gap (Ortho, October 18).

4. Issues: Some industry representatives have pointed out that water-based wasp and hornet products may be incompatible for use by utilities workers around exposed or un-insulated high power electrical sources. Many utility and telecommunication companies require wasp and hornet sprays used by their workers to have dielectric strengths of 20,000 Volts or greater (SMUD). In addition, they require the product must be low-flammable and have low flame extensions and no flame flash back (Bell Communications Research, Inc.).

Response: Major insecticides manufacturers have indicated that current and future water-based products with VOC content at the level of the proposed standard will be safe and effective for the general consumers. However, water-based products must be evaluated to determine if the special needs of the utility and telecommunication industries can be met. These special needs have traditionally been satisfied by products that utilize 1,1,1-Trichloroethane (TCA), and VOC-based products have not been demonstrated to be viable alternatives. The staff will continue to evaluate pertinent data regarding the safety of wasp and hornet products for industrial users.

The electrical lines and junctions in residential areas are well insulated. This is required for the safety of the public. Sources that can present electrical hazards to a household wasp and hornet insecticide user can present similar hazards in rain. When "live" wires or junctions are caused by damages from storms or accidents, they are treated as urgent repairs by the utility companies (SMUD). The survey results show that 33 percent of the wasp and hornet products sold in California are water-based products. These products are sold in retail stores, large builders outlets such as Home Depot, and hardware chains such as Ace Hardware (United Industries, September 30). S.C. Johnson Wax representatives have also stated that a water-based product can be developed (S.C. Johnson Wax, October 3).

The electrical safety and flammability requirements by utilities and telecommunication companies can be satisfied by products that utilize

TCA. Bell Communications' specifications for wasp and hornet sprays calls for products containing TCA (Bell Communications). The low flammability required for industrial products would not be preserved if the TCA in the products are replaced with VOC. Water-based systems have the low flammability quality, but whether their dielectric strength is sufficient is currently being determined by industry. Many current water-based wasp and hornet products have VOC levels significantly less than the 40 percent proposed limit. United Industries representatives have stated to the staff that they believe the 20,000 Volts dielectric strength is achievable even at these lower VOC levels (United Industries, September 30).

The flammability of VOC-based products make them unsuitable for industrial applications. If water-based products are also demonstrated to be unacceptable for the utilities and telecommunication industries, the only current alternative is the continual use of TCA-based products. The Federal Clean Air Act (FCAA) give EPA the authority to allow the "essential use" of TCA. The lack of safe alternatives for utilities workers to protect themselves from potentially dangerous pests can make TCA use in wasp and hornet products an "essential use". If such a scenario is reached, the proposed standard and the current exemption of TCA in the Regulation will allow these "essential" TCA products to be available. The time allowed for TCA phase-out by the FCAA gives the staff opportunities to revisit the standards to consider any new developments in the area of wasp and hornet insectcides for the utilities and telecommunication industries.

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M. LAUNDRY STARCH PRODUCTS

Product Description:

Laundry starch products are designed for application to fabric, either during or after laundering, to impart and prolong a crisp, fresh look and may also act to help ease ironing of the fabric.

The principle function of starch in finishing textile fabrics is to impart or accentuate the desired physical characteristics in the cloth. In laundry work in homes or in commercial laundries, and in finishing clothing and other textiles, starch is used as a stiffening agent to form a smooth surface which does not become soiled readily making laundering easier. Starching washed clothes is a means of replacing the original finish of the cloth which was partly or completely removed by laundering. This finish, whether applied at the factory or in the home or laundry, leaves the textile material smoother, brighter, more pliable and holds down surface fibers; too much starch; however, will stiffen the textile goods. Finally, laundry starch products can also extend the life of fabrics. Other commercial uses of starch include its use in the food industry as a thickener, filler, binder and stabilizer.

Laundry starch products may be divided into several closely-related categories: ironing aids; fabric finishes and sizings; light starch; regular starch; and heavy starch. The primary difference is the amount of starch solids and ironing assistant (silicone) contained in these products. Ironing aids and sizing fabric finish have relatively low starch solid content and a somewhat higher ironing assistant content while the products called starches tend to have a higher starch solid content. (Faultless Starch/Bon Ami Company)

Laundry starch products are packaged in aerosol, pump, liquid and solid (dry) form. As shown in Table V-24, market shares for aerosol, pump, liquid and solid (dry) forms are 86 percent, 3 percent, 9 percent and 2 percent respectively. The total emissions from this category are 3,400 lbs/day. Although dry starch is the most economical form available to consumers,

aerosol spray starch is preferred due to the difficulty of using liquid and dry forms. (Faultless Starch/Bon Ami Company and CARB contract # A5-156-32)

TABLE V-24

Laundry Starch Products Emissions Summary
(Total Emissions 3,400 lbs/day)

Product Form	Percent of Market	Emissions (lbs/day)	Percent of Emissions
Aerosol	86	3,000	89
Liquid	9	380	11
Pump	3	<1	<1
Solid (dry)	2	<1	<1

Product Formulation:

Laundry starch products consist of starch, propellant (if aerosol), surfactant (wetting agent) and silicone (ironing aid). Starch is one of the most abundant plant materials in the world. It's formed in all green plants and is stored as microscopic granules in all grains and tubers as a future food supply for the germinating seed. The starch can be obtained from cereal grains such as corn, wheat and rice; from tubers such as the potato; from roots such as the sweet potato, manioc and arrowroot; and from the pith of certain palms such as the sago palm.

Laundry starch works by sizing the fabric (closing the pores by completely covering the surface). In addition to starch, silicone, bluing, perfume, optical enhancers and hydrocarbon propellant (if aerosol) can also be found as ingredients of modern laundry starches. The silicone or ironing aid is used to make the ironing easier while the bluing, optical enhancers and perfume are added to provide cosmetic appeal. The hydrocarbon propellant used to expel product contents is isobutane or a blend of isobutane and propane.

Recommended VOC Standard:

The standard being recommended for this category is 5 percent VOC content by weight for all forms. Based on information submitted in the 1991 Consumer Products Survey, there are 26 products currently available that meet the recommended standard. The total estimated emission reductions for all forms in this category are 480 lbs/day. This is summarized in Table V-25.

TABLE V-25

Laundry Starch Products Summary

Product Form	Proposed Standard (% VOC)	Number of Complying Products	Percent of Market Complying	Emission Reduction (lbs/day)
Aerosol	5	9	36	360
Liquid	5	3	13	120
Pump	5	1	100	0
Solid	5	13	100	0

Compliance with the Standard:

Compliance with the standard would primarily be achieved through reducing the propellant levels currently contained in laundry starch products or in varying the blends of propellants used. Other formulation adjustments may be necessary, along with possible changes in valve design.

Issues:

1. Issue: Manufacturers of laundry starch products and CSMA have contended that current propellant contents have been maximized and a 6 percent propellant content is the minimum amount of propellant that can be used while assuring complete evacuation of the contents of the can. Manufacturers have also emphasized that current propellant contents are based on their particular formulas and "failure to empty" complaint histories.

   Response: Based on results received in the 1991 consumer products survey, the staff identified a propellant content range from 4 percent to 6 percent. Approximately 36 percent of the aerosol laundry starch market can comply with the standard being proposed. Regarding the "failure to empty" issue, the staff is aware of an anti-abuse system developed by CMB Aerosols (Aerosol Age) that may be a useful modification to current aerosol laundry products in reducing "failure to empty" complaints received from consumers. Coupling this anti-abuse system by CMB Aerosol and varying currently used propellant blends may provide a solution when dealing with "failure to empty" complaints.

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N. PERSONAL FRAGRANCE PRODUCTS

Category Description:

The personal fragrance category consists of products designed primarily to add a scent to the human body or clothing. The category covers a wide range of products including perfumes, colognes, toilet waters, body splashes and aftershaves. The personal fragrance category does not include antiperspirants, deodorants, "athlete's foot" sprays, mouthwashes, breath fresheners, skin care products, feminine deodorant sprays, soaps, or products designed for pets.

Subcategory Descriptions

Products in the personal fragrance category have been categorized differently than other consumer products. Since they perform similar functions, they could not be defined based on their intended use. Personal fragrance products have been categorized by the concentration of fragrance oil in each. However, the fragrance oil concentrations are generally given as approximate ranges with the understanding that there are many products that fall outside the typical ranges. For this reason, the definitions for each of the personal fragrance products are based, at least in part, on the product label. For instance, products labeled as "perfume", "parfum" or "eau de parfum" are considered to be perfumes. Products which do not fall under any of the defined categories are covered under the "other" category.

Aftershave products include aftershave lotions, balms, creams and gels and are applied, usually by hand, after shaving. These products are generally lightly fragranced and provide a cool, refreshing sensation to the skin. Some products also contain moisturizers to soothe the skin after shaving.

Body splashes are products designed to be applied all over the body. These products are typically liquids that are splashed on by hand, although some spray and "mousse" products were identified in the consumer products survey. Body splashes are used to refresh the skin and provide a light scent.

Perfumes, colognes and toilet waters are used exclusively for their scent. These products are generally more concentrated in fragrance than the aftershaves or body splashes and are used in smaller quantities. In general, perfumes are the most concentrated, followed by toilet waters (or eau de toilettes), and colognes (or eau de colognes) (Muller). Perfumes are typically dabbed on in small quantities behind the ear, on the wrist, or on other warm areas of the skin. Colognes and toilet waters are used in somewhat larger amounts since they are less concentrated.

The "All Other" category consists of miscellaneous personal fragrance products that are not labeled such that they fall under any of the other personal fragrance categories. Examples are scented powders and oils.

Emissions

As shown in Table V-26, emissions from the entire personal fragrance category total approximately 11,000 lbs/day. Products in the perfume, cologne, and toilet water category make up the largest segment of the personal fragrance market at about 66 percent, with emissions of about 8,100 lbs/day of VOC emissions. The aftershave and body splash category accounts for about 32 percent of the market with emissions of about 2800 lbs/day VOC emissions. The "other" category accounts for about 1.5 percent of the market, contributing less than 1 percent of the emissions from the personal fragrance category.

TABLE V-26

Personal Fragrance Products Emissions Summary
(Total Emissions 11,000 lbs/day)

Product Form	Percent of Market	Emissions (lbs/day)	Percent of Emissions
Aftershaves and Body Splashes	32	2,820	25
Perfumes, Colognes, & Toilet Waters	66	8,120	74
Other	2	80	1

Product Formulation:

Ethanol-Based Products

The majority of personal fragrance products contain fragrance oil dissolved in ethanol and, to a lesser degree, water. Small amounts of other ingredients may also be included such as colorants and agents to prevent photodegradation or oxidation of fragrance ingredients. Aerosol products,

of course, also contain propellants. Typically, hydrocarbon propellant blends such as isobutane and propane or hydrochlorofluorocarbon (HCFC) blends such as HCFC-22 and HCFC-142b are used.

Fragrance Oils

Typical concentrations of fragrance oil in various personal fragrance products are shown in Table V-27 below.

TABLE V-27

FRAGRANCE OIL CONCENTRATIONS

Product	Percent
Perfume	15-25
Eau de Toilette	5-15
Eau de Cologne	2-10
After Shave Lotion	1.5-5.0
After Shave Balm	0.75-2.0

Source: Fragrance Materials Association

The remainder of the formulation is typically ethanol and water in the approximate ratio of 85 percent ethanol to 15 percent water (Firmenich).

The fragrance oil is generally a complex combination of ingredients, "rarely less than ten and frequently as many as several hundred" (FMA). Fragrance oil constituents may be derived from natural sources (isolates), they may be produced from isolates through chemical reactions (semi-synthetic aroma chemicals), or synthesized from basic organic chemicals such as coal or petroleum (syntheic aroma chemicals) (Hall, et. al.). Fragrance oil constituents typically have molecular structures with between 9 and 15 carbon atoms (FMA) and may or may not have vapor pressures below the 0.1 mm Hg exemption level. While most of the ingredients in fragrance oils contribute to the scent, fragrance oils may also contain "materials which are present to solubilize, homogenize, emulsify or fix fragrance constituents" (FMA).

Fragrance Creation

The creation of a fragrance is primarily an artistic process although technical aspects must be considered as well. In general, the fragrance consists of a "top-note", "middle-note", and "base-note". The top-note consists of the most volatile components of the fragrance and is the scent that is first noticed from a fragrance. The middle-note, "heart", or "bouquet" consist of less volatile components and becomes more evident after the initial impact of the top note decreases. Finally, the base-note or

"back-note" consists of the heavier notes that persist the longest. To balance out the evaporation of these notes, "fixatives" may be added. Fixatives are low vapor pressure components that blend the evaporative stages of a perfume so that each note contains some of the other notes.

Fragrance "Families"

Although fragrances contain many components, many of the predominant creations have been classified into "families" such as the following: green, floral, citrus, lavender, spicy, aldehydic, chypre, oriental, woody, tobacco-leather, musk and fougere. The families range in character from the light floral creations to heavy tobacco or leather scented products.

Aftershave Formulations

Aftershave formulations are more diverse than the other personal fragrance products. Some formulations are ethanol based and similar in formulation to a cologne with reduced fragrance content. However, there are also many alcohol-free or low alcohol emulsions with high water content and moisturizing ingredients included.

Recommended VOC Standard:

The VOC standards for personal fragrance products are as follows: (1) existing perfumes, colognes, and toilet waters are exempt from any standard; (2) new perfume, cologne, and toilet water formulations must meet a 70 percent VOC standard; (3) both new and existing aftershaves and body splashes must meet a 60 percent standard; and (4) miscellaneous personal fragrance products must meet a 50 percent VOC standard.

Existing perfume, cologne, and toilet water formulations are exempt from the 70 percent standard which applies to new products, if they register within 90 days of the effective date of the consumer products regulation, as required under section 94513(a). Registration is necessary to determine which products are "existing" and which are new. Although technology under "Complying with the Standard" has been identified to reformulate perfumes, colognes, and toilet waters to a 70 percent standard, the staff is unaware of a means of reformulating existing products while retaining the identical scent. New products, however, could be designed within the constraints of the 70 percent standard. If information becomes available indicating that existing products can be reformulated while retaining their identical scent, the staff will reevaluate the need for this provision.

New perfumes, colognes, and toilet waters are to be subject to a 70 percent standard. As shown in Table V-28 below, 93 existing products in the perfume, cologne, and toilet water categories comply with the 70 percent standard, indicating new products should be able to comply with the standard. The 93 complying products account for about 10 percent of the market and are listed in Appendix B.

A 60 percent VOC standard is to apply to aftershaves and body splashes. From Table V-28 below, 58 products under the aftershave and body splash

categories comply with the 60 percent standard. These products represent about 63 percent of the market. The standard applies to all aftershaves and body splash formulations both existing and new products. The staff does not believe it is necessary to provide an exemption for existing products since these products, unlike perfumes and colognes, are not designed primarily to provide a scent but to provide a cooling sensation, sooth the skin in addition to providing a light scent. Because of this, there is a larger latitude in reformulation as is shown in the VOC survey data. In addition, these products are often used in large quantities per application e.g. splashes on, whereas perfume and colognes are used in relatively small quantities.

Miscellaneous products that do not fall under any of the personal fragrance categories must comply with a 50 percent standard. This standard is necessary to prevent products from relabeling to prevent a VOC standard. As shown in Table V-28, there are 16 complying products in the category representing nearly 60 percent of the market.

TABLE V-28

Personal Fragrance Products Standards Summary

Product Form	Proposed Standard (% VOC)	Number of Complying Products	Percent of Market Complying	Emission Reduction lbs/day
Aftershaves & Body Splashes	60	58	62.8	360
New Perfumes, Colognes & Toilet Waters	70	93	9.9	*
Other	50	16	58.8	20

* The 70 percent standard for colognes, perfumes and toilet waters will only apply to new products introduced into the market. Therefore the emissions prevented will depend on the "turnover rate", the percentage of existing products replaced by new ones that will comply with the 70 percent standard. Data supplied by the Cosmetic, Toiletry, and Fragrance Association indicates a turnover rate of approximately 5 percent (CTFA). In addition, some products are considered "classics" and are not likely to be replaced for many years. The percentage of "classics" has been estimated by one industry source at 15 percent of the personal fragrance market (FMA, 10/3/91). Based on these assumptions, emissions prevented will total over 1300 lbs/day after twenty years, the time required for complete turnover of the "nonclassic" fragrance products.

Source: 1991 Consumer Products Survey

Compliance with the Standard:

Existing Products

Both new and existing aftershaves, body splashes and miscellaneous personal fragrance products are subject to a VOC standard. Existing products have several reformulation options available to them. However, the primary reformulation options are expected to be (1) a reduction in alcohol content using emulsion technology, or (2) adjustment of the fragrance composition.

The most straightforward method of reformulating aftershaves and body splashes is to replace some of the alcohol with water or some other non-VOC. Simple replacement, as industry has pointed out, may lead to an altered fragrance due to some of the fragrance oil ingredients "coming out of solution". However, emulsion technology can be utilized to prevent this. Emulsion technology using emulsifying agents such as surfactants has been utilized in various fragranced household products. One text suggests avoiding fragrance precipitation by "mixing the fragrance with a suitable surface-active agent which acts as a solubilizer" (Jellinek). Currently, emulsion technology has been applied primarily to aftershaves, especially aftershave balms, which tend to contain moisturizing agents. One source reports, "reduced alcohol emulsions, billed as aftershave soothers, combine reduced sting associated with low alcohol formulations with the presence of water, moisturizers, and oils in elegant, yet masculine formulations..." (Brooks and Burmeister). One such formulation has been identified with less than 10 percent VOC (Brooks and Burmeister). Another formulation with at least 66 percent water is described as clear, non-oily, non-greasy, and low-sting (Kenney). Many other complying formulations are to be found in a recent issue of Cosmetics and Toiletries (C & T Formulary).

While reducing the alcohol in aftershaves as well as body splashes may reduce the cooling sensation which is provided by the alcohol as it evaporates from the skin, other materials are available that can be used to produce a cooling effect. "As an alternative to the use of alcohol, cooling ingredients such as menthol, witch hazel or mint compositions may be substituted" (Brooks and Burmeister). In addition, a 1985 patent review has identified several other "cold-receptor stimulating compounds" suitable for aftershaves (Kenney).

Another option would be to adjust the fragrance oil components to allow a higher water content. To increase fragrance solubility in aerosol products, a recent article advises lowering the quantities of crystalline materials such as vanillin, coumarin and heliotropin and using resins such as oak moss and Mousse de Chene sparingly (Carrubba). Although the above refers to aerosol products, the concept that some fragrance constituents are less soluble in water than others is well known.

New Products

All new personal fragrance products will be subject to a VOC standard. New products could be developed based on a variety of technologies

including: (1) emulsion technology; (2) alternative (non-VOC) propellant systems; (3) microencapsulation, and (4) water soluble fragrances.

Emulsion technology may allow the development of many new products meeting the proposed VOC standards. As stated previously, many aftershave products currently use this technology. It is expected that this technology could also be used for newly developed personal fragrance products in other categories. Several complying formulations utilizing emulsion technology have been identified in the literature. A "cream cologne" in the range of 3-6 percent VOC has been identified (deNavarre). Other complying cologne formulations in clear gel form have been identified (deNavarre). Cream and "roll-on" perfume formulations have also been identified (deNavarre) (Torrey). While many of the complying emulsion formulations available in the literature are viscous products, microemulsion technology may allow less viscous, clear formulations. U.S. Patents numbered 4,184,985, 4,186,207 and 4,299,737 describe a solubilizer for clear aqueous or aqueous-alcoholic solutions of fat soluble perfume oils. Although the perfume concentrations recommended are below the levels necessary for most personal fragrance products, this kind of technology may be available for some products.

An option to reduce the VOC content of aerosol personal fragrance products is to replace the VOC propellants with a non-VOC system. Although hydrocarbon propellants function also as solvents in aerosol formulations, they are poor solvents for some fragrance constituents. According to a recent article in "Cosmetics and Toiletries", hydrocarbon propellants are poor solvents for many of the polar constituents of perfume oils (Carrubba). One possible non-VOC propellant alternative identified by the literature is a compressed air system which, according to company literature, is suitable for fragrance products (Novospray). The use of hydrochlorofluorocarbons (HFC's) may also be an option as stated in Section V.A. However, the use of hydrochlorofluorocarbons (HCFC's) is not an option for new products due to the ozone depleting potential of these compounds.

Microencapsulation is another technology that may be utilized in new products. Microencapsulation is the "enveloping [of] microscopic amounts of matter in a thin film of polymer" (Magill). This technology has been used to "create microencapsulated fragrances, most of which are used in scratch and sniff formats or the high-line perfume pull-apart type samplers" (Magill). U.S. Patent No. 4,428,869 describes a cologne consisting of a combination of non-confined fragrance oils with encapsulated or physically entrapped fragrance oils. Microencapsulation of fragrance oils that are not soluble at low alcohol concentrations, may allow lower VOC formulations.

Another option would be to adjust the fragrance oil components to allow a higher water content. As discussed in the formulation options for existing products, the quantities of crystalline and resinous materials could be reduced. A recent article also states that "fractional distillation of the polar compounds [in some essential oils] would yield water soluble extracts retaining the same fragrance as their essential oil even though they may differ greatly in chemical nature. Examples would include the distilled aromatic waters from rose, witch hazel, yarrow, orange flowers, chamomile, balm mint and linden " (Dorato).

While none of the technologies listed above is in wide use at this time, the wide variety of technologies, individually or in combination, will provide industry with a means of reformulating their products to the proposed standards. It should also be noted that many of the complying products listed in the 1991 consumer products survey are conventional alcohol based liquid products.

Issues:

1. Issue: Industry has pointed out that reducing the alcohol content of personal fragrance products will result in some fragrance components precipitating out of solution, resulting in an altered fragrance.

   Response: While simple replacement of alcohol with water may result in some fragrance components precipitating out, emulsifying agents may be used to prevent this. Several formulations were cited in the section "Compliance with the Standard" using emulsion technology to allow high water content. In addition, certain fragrance oil components are more compatible with water. By properly selecting the components from these fragrance oils, a formulator can create a scent that can tolerate high levels of water. According to the 1991 ASRB Consumer Products Survey, many aftershave products with greater than 40 percent water have been identified. Colognes in excess of 30 percent water and perfumes in excess of 10 percent water have also been identified.

2. Issue: Industry has commented that the proposed VOC restrictions will hinder the creative process of developing a fragrance by limiting their choice of fragrance oils.

   Response: The ARB staff has identified complying colognes and perfumes from a number of the fragrance families, including, but not limited to the following: musk, floral, chypre, aldehydic, tobacco and leather, spicy, and oriental. This indicates that manufacturers will not be limited to a narrow range of scent types. In addition, the staff have identified a number of technologies that can be used to comply to with the VOC standards in the regulation without necessarily limiting manufacturers to fewer fragrance oils. Manufacturers are encouraged to use some of their creative abilities to develop products that meet consumers needs and reduce VOC emissions.

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VI.

IMPACTS

A. ECONOMIC IMPACTS

1. Economic Impact on Industry

Manufacturers of non-complying consumer products have several options available to them to meet the requirements of the proposed regulation. These options include reformulation of existing products, changing product forms, and development of new technology that allows the products to qualify for the innovative products exemption. Reformulation is the most likely means of meeting the VOC standards in the regulation since in most cases there are already a significant number of complying products available.

To develop a product-specific cost analysis, the staff requested cost information from industry in a letter, dated June 13, 1991 (See Appendix D). Of the nearly 3,000 letters sent to industry, the staff received cost information from six companies. The limited response did not allow the staff to conduct the more detailed per product cost analysis. Therefore, the analysis in this report is similar to the economic analysis conducted last year for Phase I. The staff's approach and assumptions for the cost analyses are fully outlined below.

The staff performed an analysis to determine the economic impact of the regulation. In conducting this analysis, the staff assumed that the regulation would impact both consumer product manufacturers and consumers. It is recognized that there can be impact on "upstream" suppliers of containers, solvents, propellants and other chemicals; however, the impact should be minimal. The effect on upstream suppliers would primarily be a shift in the demand from one chemical to another chemical or from one type of container to another type. The total demand for consumer products should not change. The impact on product distributors would also be a change in the type of individual products being handled, and not a change in overall demand.

The first part of the analysis is a "before tax" study. The cost of reformulation certainly is a cost of doing business; however, since there are many factors which affect a company's tax status, taxes are not considered in the cost calculations to put all comparisons on an equal plane. The analysis presents the cost to reformulate per product, an annual cost to reformulate per product, the total annual cost per product, cost increase per unit, and the cost effectiveness of the regulation.

There are many variables in producing a product for market, and assumptions about those variables will greatly affect the outcome of any cost analysis. For each assumption, a test of "reasonableness" was applied to determine if this was a likely approach to take or if the event had a high probability of occurring. Results were also compared to data provided by other agencies and industry to verify that the numbers are "reasonable." In all cases, only new or additional costs were considered, and not costs that would have been expected in the normal course of business if the regulation had not been in effect.

To bracket the cost numbers, the staff conducted two analyses, one for low (optimistic) cost, and one for high cost, with a different set of assumptions for each bracket. To further refine the analyses, the products were divided into six categories to better reflect the impact on each category. The five categories are household care, automotive care, personal care, pesticides and disinfectants, and adhesives.

Approach

For a systematic approach to the cost analysis, the entire time from initial statement of development goals to final delivery of the new product to the marketplace shelves was divided into eight phases. The phases are: product development, including reformulation and development of a new delivery system if necessary; stability testing; efficacy testing; safety testing; labeling modification; registration with regulatory agencies if necessary; manufacturing change; and marketing. The length of time in each phase was estimated based on an industry analysis of 80 new product innovations (Souder). Most of the phases occur in sequence; however, there is some time overlap in each phase.

Next, estimated personnel resources were allocated against each phase considering the most probable types of skills needed including general engineering, technician, drafting, packaging engineering, specification engineering, model making, chemical engineering, technical publication, production support, quality assurance, marketing, warehousing, word processing, and clerical (Karger). For the high cost approach, additional personnel were allocated to each phase.

After the personnel costs were determined, additional cost elements were considered at each phase and added as appropriate. These cost elements are facility cost, equipment cost, tool, jig, fixture and miscellaneous materials handling equipment, purchased material, packaging costs, distribution costs, warehousing, technical data, research studies and tests, promotional literature, residual inventory and disposal, consumer tests,

general and administrative expense, patent cost, registration fees, and computer support (Karger, Midco). The result of these considerations is a per-product cost for developing a reformulated product and putting it on the market.

Assumptions

The staff used different assumptions for the low and the high cost analyses, and considered each product category separately. In reviewing the ARB Consumer Products Survey, the staff found that many of the products which would technically be non-complying are within a couple of percentage points of VOC weight from being in compliance with the standard. These products may require only minor modification to their current formulation to come into compliance, and would most likely retain their current product form. For the low cost analysis then, it was assumed that the product form would not change, e.g. an aerosol would remain an aerosol and a pump spray would remain a pump spray. Therefore, no major costs were added for changing delivery systems.

Since the product form in the low cost analysis did not change, these products would not require any major retooling of manufacturing equipment, and technical data changes would be minor. Also, since the product would not change substantially, it was assumed that the change in marketing costs would be small. It was also assumed that these reformulated products would be marketed nationally. Industry estimates of the material cost increases ranged from no cost increase to a cost increase of $.07 per unit (Aerosol). For the low cost analysis it was assumed that there was no per unit material cost increase.

For the high cost approach, it was assumed that reformulation would result in a different product form and/or a different propellant, either of which may require a new delivery system. If a new delivery system is required, the new product form and delivery system would require additional personnel resources at each phase, especially in product development and manufacturing change. Also, the new delivery system would require investment for prototypes, new filling machines training, and tech data, so these costs were added (Terco). Additional costs were also added for packaging, distribution and warehousing.

It was assumed for the high cost approach that, because of the new product form, there would be additional marketing costs, including research studies and tests, promotional literature, and consumer tests. These costs vary by the type of product, with household products typically having a larger expense in this area. The cost analysis did not include the costs for an extensive advertising campaign. New products are regularly brought onto the market, and the advertising for a new product, whether reformulated or not, would replace the advertising for the existing product, and would be a normal cost. It was assumed that the new product would be marketed nationally. Based on industry estimates of material cost increases which ranged from a low of no cost increase to a high of $.07 increase per unit, a material cost increase of $.07 per unit was assumed for the high cost analysis.

The staff also recognized that development of a new product does not occur in isolation. Few companies have only one product line; for those that have more than one product line, the product lines can be very similar. Development and production tasks, from the initial concept through marketing, would be proceeding simultaneously on more than one product line, with a transfer of information and work-sharing between the products. For these companies, this "technology transfer" would substantially reduce the cost of developing and marketing a new product on a per product basis.

Annual Cost

For all of the cost analysis calculations, costs were determined for each of the six product categories and for a low cost and high cost approach in each of these six categories. For calculations involving amortization, both a 5 year and 10 year period were used for each of the categories as well. The results of each part of the analysis are summarized in tables in Appendix D.

The first step in the economic analysis was the determination of the total cost to reformulate a typical consumer product in each of the product categories. To determine annual cost to reformulate, the total cost was amortized over both 5 years and 10 years. An interest rate of 10 percent was assumed. The basis for these numbers was discussed previously under Approach and Assumptions. The average annual costs ranged from a low of $15,600 to a high of $270,000 per product.

Total Annual Cost

The total annual cost per product category is estimated by multiplying the annual cost to reformulate a product in a category (from the previous step) by the number of non-complying products in that category. The number of non-complying products in each category was taken from the ARB survey (ARB). The total estimated annual cost to industry is obtained by summing the five product categories. The total estimated annual cost ranges from a low of 13 million dollars to a high of 205 million dollars. The wide range in cost estimates is due to the wide range in annual costs to reformulate.

2. Economic Impact on Consumer

Assumptions

The staff believes that the majority of the reformulation costs incurred by manufacturers will be passed on to the consumer. Manufacturers could pass the reformulation cost by raising the price of only reformulated products, by raising the price of products not covered by the regulation, or by changing product container size. To determine the maximum effect this regulation would have on the consumer, it was assumed that the entire reformulation cost would be passed on in the form of a price increase for only the particular products covered by the regulation.

Cost Increase

The cost increase per unit is made up of two factors, the cost increase of reformulation and the increase in the cost of the material in the product. The material increase cost was not included in the annual cost calculations because it is an operations cost and not an investment cost.

The reformulation cost per unit is obtained by dividing the total annual cost per product by the total annual number of non-complying units sold in that product category. The total annual number of units sold was based on the ARB survey which was for sales in California only. Since it was assumed that the products are marketed nationally, the total annual cost per product was scaled down for California by population. California has approximately 11.5 percent of the nation's population.

After the reformulation cost per unit was calculated, the material cost increase per unit was added. For the low cost approach, no material cost increase was added, and for the high cost approach $.07 per unit was added. The total cost increase per unit ranged from less than $0.01 to $0.60.

3. Cost Effectiveness

Cost effectiveness ratios are used to compare the cost of the regulation to the benefits in terms of reduced emissions. The cost effectiveness ratios used for this regulation are expressed in dollars required per pound of VOC reduced. These ratios were determined by dividing the total annual cost of the regulation, including total annual reformulation cost and total annual material cost increase. It was assumed that the reformulated products would be marketed nationally, resulting in emission reduction benefits throughout the nation.

The cost effectiveness ratios ranged from less than $0.01 to slightly over $1.00 per pound of VOC reduced. The large range in these ratios reflects the large range of estimated reformulation costs per product. The staff believes that the large majority of the cost to reformulate will be passed on to the consumer by increases in unit cost.

The range in the cost-effectiveness estimates reflects the uncertainty in the cost to reformulate the wide variety of products covered under the regulation. Table VI-1 shows a comparison of the cost-effectiveness of the proposed amendments to other measures that have been adopted in recent years. As shown in Table VI-1 the cost effectiveness of the proposed regulation is within the range of other control measures adopted by the Board.

TABLE VI-1

Comparison of Cost-Effectiveness of the Proposed Amendments to the Consumer Products Regulation with Cost-Effectiveness of Other Control Measures for Criteria Pollutants

Source	Pollutants(s)	Cost Effectiveness ($/Ton of Pollutant Reduction)
Architectural Coatings (1989)	VOC	Net savings-12,800
Low Emission Vehicles/Clean Fuels (1990)	NOx, VOC, CO	10,000-32,000
Light Duty Diesel Exhaust Standards> (1987)	PM10	5,400-21,400
Heavy Duty Diesel Exhaust Standards (1985)	PM10	6,400
Deodorants & Anti-perspirants (1989)	VOC	1,000-2,400
Phase I Consumer Products (1990)	VOC	Net Savings-2,100
Phase II Consumer Products (1991)	VOC	8-2,100

4. Economic Impact on Small Business

The staff evaluated the impact of the proposed amendments on small business to determine if small businesses would experience significant adverse economic impact. Based on a comparison of the return on owner's equity (ROE) before and after costs associated with the proposed amendments, the staff concluded that both small businesses engaged in retailing and wholesaling of consumer products and small manufacturers will be able to absorb the costs of the proposed amendments without a significant adverse impact on their profitability. For a full explanation of this analysis, see Appendix D.

B. ENVIRONMENTAL IMPACTS

The purpose of the proposed amendments is to reduce VOC emissions from the use of consumer products. The use of consumer products identified in

this TSD results in statewide VOC emissions of approximately 29 tons per day. The proposed specifications should result in reducing these emissions by about 30 percent.

The California Clean Air Act of 1988 (Stats 1988, ch 1568) requires in part (Health and Safety Code section 41712) that on or before January 1, 1992, the ARB adopt regulations to achieve the maximum feasible reduction of VOC emissions from consumer products. The ARB shall not adopt regulations unless the regulations are technologically and commercially feasible and are necessary. As discussed in this report, we have determined that reducing VOC emissions from consumer products, as contained in the staff-proposed regulation, is feasible, cost-effective, and necessary. Total emissions and emission reductions are shown in Table VI-2.

TABLE VI-2

Summary of Emissions and Emission Reductions from the Proposed Standards

Product Category	VOC Emissions lbs/day	Proposed Standard Wt % VOC (1/1/95)	Emission Reductions lbs/day	Proposed Standard Wt % VOC (1/1/97)	Additional Emission Reductions lbs/day
Aerosol Cooking Sprays	1,480	18	400		
Automotive Brake Cleaners	1,600	50	280		
Charcoal Lighter Material* (Yearly Average)	5,600	0.02 lb/start	1,680		
Carburator Choke Cleaners	3,300	75	660	50	740
Disinfectants - Aerosols	7,600	60	1,840		
Dusting Aids -					
Aerosol	980	35	180	25	220
All Other Forms	20	7	20		
Fabric Protectants	440	75	600	60	400
Hand Dishwashing Detergents	800	2	480		
Household Adhesives -					
Aerosol	840	75	60	25	400
All Other Forms	1,520	10	900		
Insecticides -					
Crawling Bug	7,640	40	4,100	20(1/1/98)	1540
Flea and Tick	800	20	280		
Flying Insect	2,000	30	260		
Foggers	2,900	40	220		
Wasp & Hornet	720	40	120		
Lawn & Garden	3,080	20	2,200		
All Others	1,400	20	900		
Laundry Starch Products	3,400	5	480		
Personal Fragrance Products -					
Aftershave & Body Splashes	2,820	60	360		
Colognes, Toilet Water & Perfumes	8,000	70	-		
All Other	80	50	18		
TOTAL	57,000		16,000		3,300

*Includes emissions only from petroleum distillate-based fluids.
Note: Totals Have Been rounded to the nearest 100 pounds.
Total Reductions (1995 & 1997) 16,000 + 3,300 = 19,300 lbs/day

As can be seen from the Table VI-2, emission reductions are estimated to be 19,300 pounds per day by 1998. There are additional future effective limits for 4 product categories starting 1/1/97 and 1 product category starting 1/1/98. The total reduction of 10 tons per day for all consumer products in this proposal represents approximately 5 percent reduction of emissions from the current level of emissions at over 200 tons per day. As shown in Table VI-3, the emissions reductions from Phase I, Phase II, and the antiperspirant and deodorants regulation combined are approximately 60 T/D, representing approximately a 30 percent reduction of the total daily consumer product VOC emissions.

TABLE VI-3

Total VOC Emissions Reduction from All Consumer Product Regulations

Year	Emission Reduction lbs/day
1993	53,000
1994	12,000
1995	16,000
1996	9,000
1997	3,300
1998	25,000
	Total: 118,300 lbs/day (60 T/D)

In the development of this regulation, the Air Resources Board staff considered the following possible environmental impacts of the proposed amendments:

- stratospheric ozone depletion
- greenhouse warming
- water pollution
- landfill impacts
- toxic air contaminants

As described below, the ARB staff has concluded that this regulatory action will not have any significant adverse impacts on the environment.

Stratospheric ozone depletion.

Stratospheric ozone shields the earth from harmful ultraviolet radiation. Its depletion causes higher ultraviolet (UV) radiation levels at the earth's surface. The EPA has estimated that for every 1 percent decrease in stratospheric ozone, there would be approximately 20,000 additional skin cancer cases. In addition to the increase in skin cancer incidences, an increase in eye cataracts and suppression of human and animal immune systems may also occur because of the increase in UV radiation. (40CFR Part 82, 8/12/88) Since the reactions which form tropospheric ozone are driven by UV radiation, it is conceivable that a reduction in

stratospheric ozone may also result in an increase in photochemical smog formation because of the increased UV radiation.

Compounds, such as chlorofluorocarbons (CFCs) and other halocarbons (e.g. halons, 1,1,1-TCA, carbon tetrachloride), are generally very stable and do not degrade appreciably in the troposphere. Instead, they gradually diffuse into the stratosphere where they release chlorine or bromine atoms. It has been estimated that each chlorine atom released can remain in the stratosphere long enough to react with 10,000 molecules of ozone. Bromine atoms released from halons are even more reactive than chlorine atoms.

Title VI, of the Federal Clean Air Act amendments (FCAA) of 1990 have codified and expanded upon the revised Montreal Protocol to address the depletion of the stratospheric ozone layer. The law requires a complete phase-out of CFCs and halons with interim reductions. Ozone-depleting substances have been grouped into two classes. Class I compounds (CFCs, halons, carbon tetrachloride, and methyl chloroform) are scheduled to be phased out by 2000, with the exception of methyl chloroform which is scheduled to be phased out by 2002. All Class II compounds (hydrochlorofluorocarbons (HCFCs)) will be phased out by 2030. Table VI-4 lists the two classes and the associated ranges of ozone depletion potential.

Regulations are required to reduce the use and emissions of Class I and Class II substances to the lowest achievable level and to maximize the recapture and recycling of these chemicals. The EPA's current approach to reduce emissions of ozone depleting substances is to combine production freezes and reductions with an increasing usage fee. These measures are intended to maximize recapture and recycling of these chemicals by providing a disincentive to wasteful practices.

TABLE VI-4

FCAA Class I and Class II Substances

CLASS	CHEMICAL TYPE	RANGE ODP
CLASS I		
Group I	CFCs	0.6 - 1.0
Group II	Halons	3 - 6
Group III	CFCs	0.8 - 1.0
Group IV	CC14	1.1
Group V	1,1,1-TCE	0.1
CLASS II	HCFCs	0.02 - 0.1

The consumer product regulation compliments the FCAA requirements by prohibiting any new uses of ozone-depleting compounds which have been identified in section 94509(e). While the regulation allows the continued use of 1,1,1-trichloroethane and other ozone depleting compounds in existing products, the regulation prohibits any new uses of these compounds. Because of the requirements under the FCAA and market incentives, it is expected that even existing uses of ozone depleting compounds will be phased out over the next several years.

The staff has concluded that the consumer product regulation supports the goals and intent of the Federal Clean Air Act by identifying such ozone depleting compounds and prohibiting their use in new consumer products. As a result, the staff expects to see a continuing decline in the use of ozone depleting compounds in consumer products.

Global warming.

Global warming is the name given to the phenomenon of average global temperature increases caused by heat trapped in the atmosphere by certain gases and vapors. There has been recent speculation that global average temperature will increase as a result of elevated concentrations of so-called "greenhouse gases", such as carbon dioxide (CO2), methane and other gases. The increase in concentrations of these gases is due to emissions from both natural and manmade activities. This phenomenon has not been conclusively verified; however, there is enough preliminary data to warrant investigation of possible effects of the consumer product regulation on global warming.

In consumer products, the ingredients which have received the most attention as possible greenhouse gases are certain halocarbons (HFCs and HCFCs) and CO2. While the use of HCFCs would be prohibited due to their ozone-depleting characteristics, the regulation does not specifically prohibit the use of HFCs and CO2 as substitute propellants for the currently used hydrocarbon propellants. Indeed, these propellants are becoming increasingly important in helping to reduce the VOC content and flammability of aerosol products. The CO2 used in current products is not generated exclusively for use in aerosol products; instead, it is obtained as a by-product from other CO2-generating industries such as petrochemical refining processes. In normal practice, this CO2 would be emitted as an unregulated gas. Thus, no impact on global warming from any increased use of CO2 as a propellant is expected, since this CO2 would have been emitted anyway. Replacement of hydrocarbon propellants with HFC propellants is expected to be limited due to cost of the new propellants. Thus, the impact on global warming from use of HFCs as replacement propellants is expected to be minimal.

The staff estimates that any increase in emissions of global warming gases as a result of the proposed amendments would be insignificant in comparison with existing emissions. At most, HFC emissions would be a few tons a day compared to the nearly 100 million tons of carbon dioxide which are emitted to the atmosphere each day.

Water pollution.

To reduce VOC content, manufacturers are expected to replace some or most of the VOC in many non-complying products with water, organic compounds with low vapor pressure, or non-VOC compounds. The net effect of compliance with the regulation is expected to be an overall reduction in the mass of VOC emitted to the environment. Thus, the staff believes that the reduced VOC content will result in a decrease in the amount of VOC loading to the water treatment system.

Because of existing regulations, many household and institutional and industrial products which are intended for ultimate disposal into the sewage system are designed to be biodegradable in wastewater treatment systems (Soap and Detergent Association). The staff expects that many of these products will be reformulated with compounds which are also biodegradable; there is no data available to indicate that reformulated products will be any less biodegradable than their predecessors. Thus, no adverse impact to the water treatment systems or publicly owned treatment works (POTWs) is expected.

Landfills.

The staff expects minimal or even a small positive impact on landfill loading because of the proposed amendments. Reformulated products are expected to be packaged in containers identical or similar to current non-complying products. For instance, a switch from a VOC to a non-VOC propellant may require only minor modifications to an aerosol can's internals (e.g. lining, valving, actuator, etc.), but the basic aerosol package should remain the same or nearly the same. If an aerosol product is repackaged into a pump, recyclability should not be adversely impacted because both aerosol cans and pump sprays can be recycled if properly packaged and handled. Indeed, the pump spray has the unique advantage over aerosol cans in that it can be reused and refilled many times as amply exemplified by current pump spray glass cleaners, insecticides, and hairsprays.

Aerosol cans, because of their closed-system design, are inherently "one-use" products which cannot be refilled by the consumer. Furthermore, the staff expects some non-complying products to be reformulated to be more concentrated, thereby delivering more product per use and using less packaging. Products reformulated in this way should provide a positive impact on landfill loading. Thus, the staff expects any impact from the proposed amendments on solid waste management to be minimal or even positive.

Toxic air contaminants.

California Health and Safety Code section 39655 defines a toxic air contaminant (TAC) as an air pollutant which may cause or contribute to an increase in mortality or an increase in serious illness or which may pose a present or potential hazard to human health. In addition, substances which have been identified as Hazardous Air Pollutants pursuant to section 7412 of

Title 42 of the United States Code shall be identified by the ARB as a TAC. Once a substance is identified as a TAC, the ARB staff in consultation with affected sources, evaluates the need for an appropriate degree of regulation for each contaminant. Appropriate control measures are then developed as necessary.

The staff believes that manufacturers will not reformulate non-complying products to include or increase any TAC in the product. Responsible consumer product manufacturers are acutely aware of the process of identifying TACs and of the specific compounds listed or being investigated as TACs. Because of the potential liabilities involved with formulating a product with a TAC, especially with foreknowledge of a compound's status as a TAC, the staff does not expect significant reformulation of non-complying products with known or potential TACs.

C. CONSUMER IMPACTS

An important consideration regarding the proposed amendments is the impact on the consumer. While manufacturers may change formulations, product forms, and product costs, consumers may need to change their preferences, purchases, and uses for some products. The staff believes, however, that any impact to the consumer will be minimal since for each product category there are products currently available in the market place which meet the proposed standards.

In a July 1990, report commissioned by S.C. Johnson & Son, Inc., americans supported environmental regulations, despite more inconvenience or extra cost to them. The study showed many consumers strongly favored safe propellants in aerosols, mandatory recycling, refillable packaging, spray pumps instead of aerosols, and a ban on toxic ingredients. The proposed amendments will encourage the marketing of such products.

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VII.

TECHNICAL ISSUES

A. 1,1,1 - TRICHLOROETHANE

Title VI of the Federal Clean Air Act (FCAA) requires the phase-out of the production of class I and class II stratospheric ozone depleting compounds (ODC). Class I compounds are substances that have the highest ozone-depletion potential (ODP), a measure of the relative ability of a compound to deplete the stratospheric ozone layer. Class II ODCs are any other substances that the EPA determines or anticipates to contribute to the depletion of the stratospheric ozone layer. 1,1,1-Trichloroethane (TCA) is a class I compound, its production is required to be terminated by January 1, 2002. However, limited production of TCA for essential uses can be allowed to continue until January 1, 2005, if the EPA determines that such allowance is necessary and is consistent with the Montreal Protocol. The phase-out of TCA begins in 1993, and gradually progressive cuts in production levels will be implemented until production is terminated. In addition to the phase-out, Congress has implemented an excise tax for TCA. The excise tax became effective in 1991 and will increase periodically until the phase-out is complete (HSIA Newsletter). This increased taxation plus the dwindling supply will make TCA increasingly impractical for many applications and will impact many consumer products that currently use TCA in their formulations. Manufacturers will need to substitute TCA with replacements that can still provide safe, effective, and economical formulations. In our analysis of this issue, the staff has determined that:

- The phase-out schedule under the FCAA is gradual, giving companies time to find safe and effective alternatives.

- Replacement of TCA may significantly increase VOC emissions from consumer products, if VOC replacements are chosen.

- Aside from increased smog precursor emissions, replacment of TCA with VOCs may present other health and safety problems.

- In most cases, current technology shows that a 1 to 1 replacement with VOCs is unecessary. Low VOC water-based technologies are already used in many products today and new technologies on the horizon show promise for others.

Based on these findings, the staff has proposed standards at levels that reflect current or developing low VOC technologies. These standards stipulate the continual exemption of TCA, thus allowing time for companies to substitute TCA with low VOC replacements.

Background

EPA and the ARB consider TCA to be negligibly photochemically reactive and is therefore a solvent that is exempt from the definition of VOC in the Consumer Product Regulation and many other VOC regulations. It has been used extensively in formulations for automotive, institutional and industrial, and household products. An estimate of the domestic consumption of TCA in aerosol products alone shows that approximately 24.6 million pounds is used in automotive and industrial products and approximately 13.6 million pounds are used in household products (ICF). TCA has been used in aerosol products because of advantages such as non-flammability, high stability, adequate solvency, low surface tension and viscosity for forming small droplets, and high eveporation rate (ICF). TCA is ususally used in product formulations as a blend with VOC solvents or other exempt solvents. Based on the ARB 1991 Consumer Product Survey, 5 of the 12 products being considered in Phase II accounted for approximately 4 million pounds per year of TCA emissions. Table VII-1 below summarizes the emissions for these products.

TABLE VII-1
Summary of Emissions from 1,1,1-Trichloroethane Containing Products*

Product Category	Total 1990 TCA (lbs/day)	Total 1990 VOC (lbs/day)
Phase II Amendment Categories		
Automotive Brake Cleaner	4,000	1,600
Carburetor-Choke Cleaner	400	3,400
Fabric Protectant	2,200	440
Insecticide Fogger	5,600	3,000
Wasp and Hornet Insecticide	800	800
Total:	13,000 lbs/day	9,240 lbs/day

* Staff estimated the emissions of TCA by summing the amount of exempt compounds reported in the survey for the products listed, minus exempt propellants. Exempt compounds in some products, such as brake cleaners may also include methylene chloride. Staff made adjustments by assuming a representative TCA/methylene chloride ratio found in aerosol industry market reports (ICF).

FCAA Allows for Time to Implement Technology

As mentioned above, Title VI of the FCAA requires the phase-out of class I and class II ODCs. In addition, sections 606, 608 and 610 of Title VI also give the EPA authority to accelerate the phase-out schedules. The Chemical Specialties Manufacturers Association has expressed concerns that such authority may be excercised to ban TCA early, thus not allowing companies to reformulate products to meet VOC standards. (CSMA) The staff discussed with EPA's Division of Global Change the legislative intent and the regulatory plans for these sections.

According to EPA's current interpretation of the FCAA, section 606 gives EPA broad authority to accelerate the phase-out schedule of any class I and class II ODCs. However, EPA is to implement such actions only if significant scientific evidence shows that schedule acceleration is needed to protect human health and the environment, or if the Montreal Protocol phase-out schedule is modified to be more stringent than the FCAA. Currently, the EPA staff does not anticipate that TCA will be shown to have greater ozone depleting potential or toxicity than what is currently accepted. The current date for TCA phase-out in the Montreal Protocol is 2005, with stepwise production cuts implemented at later dates than in the FCAA. The EPA staff believe that the less stringent schedule in the Montreal Protocol will also not be accelerated unless significantly greater health and environmental risks of TCA are found. EPA recognizes that there are substitutes today for TCA in many applications such as water-based systems, hydrocarbon solvents and perchloroethylene. However, an early TCA ban would unlikely be pursued on the account of the latter two, because of the other health and environmental risks involved with these substances. (EPA)

Section 608 requires EPA to issue regulations establishing standards for the use and disposal of class I and II substances in the service of appliances and industrial refrigeration equipment. In addition, the EPA must adopt regulations that reduce the use of class I and II substances in these applications to the "lowest achievable level". The EPA staff indicated that regulatory plans for Section 608 include adoption of standards on disposal and recycling in 1992 and 1994. They also stated that this section should not impact TCA phase-out. (EPA)

Section 610 requires EPA to ban the "non-essential use" of class I substances by 1992. A federal regulation scheduled for adoption in November 1991, will ban class I substances use in products such as party streamers, noise horns, "silly strings" and CFC containing cleaning fluids for non-commercial photographic equipment. This section has no impact on the TCA phase-out. (EPA)

As discussed above, an accelerated phase-out of TCA is unlikely. Barring an early phase-out, the schedule provided by the FCAA, shown in Table VII-2, will be gradual, allowing companies time to reformulate products to comply with VOC standards.

TABLE VII-2

1,1,1-Trichloroethane Phase-out and Tax Schedule

Year	% of Baseline Production	Excise Tax, cents per pound
1991	100	13.7
1992	100	13.7
1993	90	16.7
1994	85	30.0
1995	70	31.0
1996	50	35.5
1997	50	40.0
1998	50	44.5
1999	50	49.0
2000	20	53.5
2001	20	58.0
2002	--	----

VOC Emissions from TCA Replacement

In proposing standards for those product categories where TCA was used in many formulations, the staff took into consideration that TCA will become unavailable for use in most consumer products. However, the staff also recognized that if TCA is replaced with VOCs, the VOC emissions from the Phase II categories listed in Table VII-3 will increase dramatically. In fact, results from the ARB survey show that a 1 to 1 replacement of TCA by VOCs will contribute to an 120 percent increase in VOC emissions from these categories. Therefore the staff believes that the proposed standard must reduce emissions from current high VOC products, and at the same time limit the emissions increase that could result from reformulations to phase-out TCA.

The ARB survey results show that, for those product categories where TCA can be used in the product formulation, there is a wide range of TCA usage. For some product categories there exists within the category, products that use exclusively TCA as a solvent, products that use high levels of VOC solvents and no TCA, products that use both TCA and VOC solvents and also products that do not use any TCA and are low VOC. These latter products are often water based emulsion systems. The staff has proposed VOC standards that will encourage the use of low VOC or water based formulations to comply with the regulation and discourage a 1 to 1 replacement of TCA with VOC solvents. The proposed standards will reduce emissions from products having VOC contents above the limit and will limit the amount of VOCs that can be used to replace TCA. This approach will prevent significant increases in VOC emissions that may result from reformulations required by the TCA phase-out.

As mentioned above, the survey results show that there are low VOC products that do not require the use of TCA currently available for each product category where TCA usage was significantly reported. The specific

technology for these products will be discussed in the individual product category sections in Chapter V. However, the fabric protectants category stands out as having no low VOC alternatives to TCA based products reported in the survey. For this category, the standards are proposed at levels that the industry leader, 3M, has stated will be achievable in the future. 3M has taken the initiative to commit to developing new technology that will allow them to reduce the VOCs in a product that has traditionally shown incompatibility with low VOC- waterborne systems. As the staff shall discuss later, 3M and other company's motivation for developing low VOC products are driven by health, safety and cost considerations, in addition to compliance with VOC regulations.

The staff believe that the proposed VOC standards, and the continual exemption of TCA for existing products are not in conflict with the TCA phase-out under the FCAA. The "no new use" provision for ODC in this regulation precludes any increase in TCA use in new product formulations. The phase-out schdule, as mentioned earlier, will be gradual, giving companies time to incorporate low VOC technologies.

Additional Issues Pertaining to TCA Substitution

While the first phase-out of TCA production and the first proposed Phase II VOC standards will not take effect, respectively, until 1993 and 1995, some companies have already introduced water-based products to replace TCA-based products. This is because the drive for companies to seek low VOC water-based alternatives preceded the development of the ARB Consumer Products Regulation. (United Industries) In the past, companies have replaced TCA with other solvent systems, often to reduce ingredient cost. (ICF) While some VOC replacements such as hydrocarbon solvents and perchloroethylene offer similar advantages in solvency, surface tension, and evaporation, they present problems in health and safety risks.

One of the most important qualities that TCA provides for aerosol formulations is non-flammability. This quality is especially crucial in household products, where consequences from safety liabilities could be tremendous and marketing of products labeled "extremely flammable" undesirable. (Johnsen) In addition to being a safety hazard to the users, flammability also impacts warehouse safety and warehousing costs. With strict "flammability" classifications defined in the National Fire Protection Association Code 30B, warehouses storing flammable products, such as high VOC aerosols, are required to install expensive fire protection equipment or risk being not covered by insurance. (Ortho) The non-flammability of water based alternatives is a major reason why companies have begun research on or have developed low VOC water based systems well in advance of ARB's Consumer Production Regulation.

Lower toxicity is an additional advantage of water-based systems when compared to VOC as replacements for TCA. Compounds like perchloroethylene and many compounds found in aliphatic and aromatic solvents, such as hexane, toluene, and xylene, are all hazardous air pollutants identified in the FCAA. Furthermore, perchloroethylene is also listed by the ARB as a toxic air contaminant.

In addition to flammability, toxicity and environmental concerns, the efficacy and cost of TCA replacements are also important. Low VOC water-based systems can be formulated to provide the desired function of TCA systems with the aid of emulsifying agents and surfactants. In applications where the solvent systems act as carriers, new emulsion technology enables non-water soluble active ingredients to be incorporated into stable water/oil emulsions. Emulsion technology allows formulators to tailor the spray and active ingredient delivery pattern of water-based products to be similar to those provided by the TCA and VOC systems. The many water-based insecticide products found in the market today are examples of the successful utilization of water-based carrier systems. In cleaning applications, water based surfactant and solvent emulsions are formulated to provide cleaning action for many applications. Water-based engine degreasers and carburetor choke cleaners are all sold in the market today. Utilization of water-based systems can also lower long term formulation cost. This is because water provides substantial ingredient cost savings versus petroleum distillates. It also alleviates industy's dependence on the fluctuating price and supply of petroleum products. In addition, since water has a similar density to TCA, the use of water in place of TCA can provide similar fill weight (ICF).

Justification for Standards on TCA Products

As discussed previously, companies such as 3M have stated that the health, safety and environmental problems with high VOC products provide the incentive for the development of low VOC substitutes for TCA based products, even if the technology needs to be created. Similar statements are echoed by other companies. SC Johnson Wax representatives, for example, have stated to staff that their company has adopted a corporate policy to reduce VOCs in their products. (Johnson Wax) The staff believe that standards proposed for the "TCA" products in phase II are consistent with industry goals. The staff believes that the standards proposed in Phase II will reduce VOC emissions that cause smog in addition to encouraging the technology that will produce safer products for consumers.

B. DOWN THE DRAIN PRODUCTS

This section addresses the issue of emissions from "down the drain" products. "Down the drain" products, as commented by the Soap and Detergent Association (SDA) and the Chemical Specialties Manufacturing Association (CSMA), are products that are used inside laundry machines, sinks and bathtubs. They contend that down the drain products emit negligible VOC emissions during use and after being disposed of down the drain (SDA). In support of these comments, the two associations cited the results from studies contracted by the SDA that examined the environmental fate of VOCs from liquid detergents and dilutable general purpose cleaners. One set of studies experimentally determined the fractional release of VOCs from hand dishwashing and laundry detergents during use. The second set of studies used modeling to provide estimates of the overall VOC emissions from

detergents, including emissions from wastewater systems. The staff reviewed the studies and have the following comments:

- It is inappropriate to apply results from the experiments conducted on hand dishwashing and laundry detergents to other down the drain products that are used differently.

- The SDA modeling study shows that ethanol emissions from degergents disposed to wastewater systems are low. The staff will continue to study this issue and to confirm these results with experimental data that may become available as regional sanitation districts and the South Coast Air Quality Management District study VOC emissions from wastewater systems.

- Due to the large volume of down the drain products used each day, the emissions that are released to the atmosphere from their use are significant and VOC emissions reductions will be achieved by establishing VOC limits for down the drain products.

Extrapolation of Measurement Studies

In the measurement studies, researchers from UC Berkeley (UCB) measured, in an environmental chamber, the airborne release of ethanol from hand dishwashing and machine laundering. The study showed that 4 to 5 percent of the ethanol in the hand dishwashing detergent actually was emitted to the atmosphere. For laundry detergents, the percent was lower, 0.2 to 1 percent. The staff believes that the results from these studies are accurate to the extent of detection accuracy. However, the staff believes that the results from the dishwashing and machine laundering experiments can not be extrapolated to other down the drain products that are used differently. Bathroom cleaners, for example, can have significantly higher emissions before they are disposed down the drain. This is because they are applied in thin films over large surface areas, and the mass transfer mechanisms would be very different than dishwashing, and especially with laundering, where products are used in a covered wash basin. This was a point emphasized by professor Nazaroff of UCB, one of the principal investigators, in a conversation with the staff regarding the experiments. (Nazaroff)

The UCB studies focused only on ethanol, 1,2-propanediol and 2-aminoethanol. Compounds that have physical characteristics significantly different than these compounds may have very different emissions from use. The studies focused on one compound at a time, and not the total VOC release from use. Compounds such as fragrances and perfume commonly found in detergents can add to overall emissions and these were not examined.

Review of Modeling Study

The results from the SDA modeling studies, submitted in 1990, show that less than 1 percent of the ethanol content from detergents is emitted from the wastewater systems after it is disposed of down the drain. The input parameters for the model simplified the wastewater system into theoretical

emission points, where mass transfer or partition equations can be used to estimate emissions. The staff expressed concerns to the SDA about using simplified models to estimate emissions, especially from the very complex sewer systems. In response to these concerns, the SDA submitted results from a new study by CH2M Hill that used conservative assumptions to try to offset emission underestimation that can result from simplifying the sewer system. The new study also concluded that emissions of ethanol in detergents from wastewater systems is low. However, due to the large volume of hand dishwashing and laundry detergents sold, over 2 million pounds per day in California based on the ARB survey, it is important that these emission results be confirmed.

The SDA studies are currently the only studies available that examine the relative emissions of ethanol from wastewater systems. Comprehensive studies by experts in academia have shown that significant fractions of compounds like chloroform can be emitted from wastewater. This is not in total disagreement with the SDA studies. (Corsi, Chang, et al) Potentially toxic compounds found in wastewater such as chloroform and perchloroethylene have higher volatility and lower solubility than ethanol, therefore their emissions can be higher. The results from studies of potentially toxic VOC emissions has generated interest in the overall VOC emissions from wastewater and additional data on VOC emissions will soon be available. The South Coast Air Quality Management District has recently adopted a rule that requires publicly owned treatment works to inventory their overall VOC emissions. (SCAQMD) Some of the major facilities have indicated that they may perform speciation analysis to better characterize the emissions. (Los Angeles City) The staff believe that results from such analysis will provide additional data that can be used to confirm the SDA study results.

Using the data from the UCB study, the staff has determined that the emissions from hand dishwashing detergents is, at a minimum, estimated at 800 lbs/day. The standard proposed for hand dishwashing detergents will result in an emissions reduction of at least 480 lbs/day.

C. AEROSOL DISINFECTANTS

Since aerosol disinfectants are predominantly used in the household setting, the staff conducted literature searches to find widely-accepted, government-approved guidelines for the use of hard-surface disinfectants as part of regular housekeeping in the household. To staff's knowledge, no such federal or state government-approved guidelines exist. To be conservative, the staff relied, in part, on widely-accepted government guidelines for the prevention of infections in public-safety and health-care workers. Such guidelines include the following publications: (1) Guidelines for Prevention of Human Immunodeficiency Virus and Hepatitis-B Virus to Health-Care and Public-Safety Workers, 1989, published by the Centers for Disease Control (CDC) in Atlanta, Georgia, (2) Practical Infection Control in the Dental Office, 1989, also published by the CDC, and (3) Control of Communicable Diseases in California, jointly written by the American Public Health Association (APHA) and the California Department of Health Services (DHS). The staff reasons that using these documents as guidelines in

establishing a VOC standard for aerosol disinfectants is appropriate because:

a. the guidelines represent impartial and unbiased guidelines written by leading health and infection control experts and compiled from current literature and studies in the field of infection control,

b. the use of these guidelines is supported by state and federal public health agencies,

c. the guidelines are widely used in health-care and public-safety facilities,

d. the guidelines were designed for preventing life-threatening infections in health-care and public-safety workers. These workers are constantly exposed to high levels of infectious agents, such as Human Immunodeficiency Virus (causes AIDS), and thereby represent "worst cases."

Other sources of information used in developing the standard for aerosol disinfectants included consultations with infection control staff from DHS; the market information provided by the 1991 ARB Consumer Products VOC and Hard-Surface Disinfectant Usage surveys; product disinfection and label information from various disinfectant manufacturers; and computer database searches of the National Pesticide Information Retrieval System (operated by Purdue University for the U.S. EPA), the pesticide registration database of the California Department of Pesticide Regulation (DPR), and the University of California's MedLine (medical and infection control literature).

The staff proposes to limit the VOC content of aerosol disinfectants to 60 percent by weight. This proposed standard is based on the staff's analysis of the information described above. The following will discuss the need for and the feasibility of reducing the VOC emissions from aerosol disinfectants.

1. <u>Why regulate the VOC content in aerosol disinfectants?</u>

The proposed standard will affect only aerosol disinfectants. This means that no adverse impacts due to the regulation should be felt by liquid, pump spray, solid and other nonaerosol disinfectants.

On a mass basis, nonaerosol disinfectants comprise approximately 99 percent of the total combined consumer and industrial/institutional (I&I) market, with aerosol disinfectants comprising the remaining 1 percent. However, aerosol disinfectants emit approximately 7600 lbs/day, a disproportionately large 40 percent of the total emissions for the entire disinfectant category (1991 ARB VOC Survey).

Most aerosol disinfectants are based on a combination of alcohol (either ethanol or isopropanol) with a secondary active ingredient, such as

a phenolic (e.g., o-phenylphenol) or quaternary ammonium compounds (quats). The VOC emissions from aerosol disinfectants result from either the alcohol or the combination of alcohol and VOC propellant. The alcohol content ranges from 10 to 80 percent by weight, while the VOC propellant content ranges from 0 to approximately 35 percent by weight. The total VOC content in aerosol disinfectants ranges from 10 percent to 90 percent by weight.

While reformulation of aerosol disinfectants is possible and can result in emission reductions, there are few, if any, emission reductions available from the nonaerosol products. Few reductions are possible from nonaerosol disinfectants because the vast majority of these products are dilutable concentrates. From the 1991 ARB VOC survey, staff estimates that over 95 percent of the nonaerosol disinfectants would result in a VOC level below 5 percent by weight, and many below 1 percent by weight, after the recommended dilution. Thus, there are very little, if any, potential emission reductions in nonaerosol forms that can be achieved by establishing a VOC standard. Although ready-to-use pump disinfectants are generally comprised of approximately 70 percent by volume ethanol or isopropanol, they are relatively minor in terms of their sales volume and emissions. The technology to make ready-to-use pump disinfectants is straightforward and involves simply packaging premixed liquid disinfectants in a pump package.

Information obtained from health experts, two surveys of manufacturers and health-care facilities, and current literature on infection control indicates that current aerosol disinfectants can be reformulated to meet the 60 percent VOC by weight standard and still achieve stringent hospital-level disinfection required by both I&I and household consumers. ARB staff estimates that aerosol disinfectants emit approximately 7600 lbs/day with one product comprising approximately 95 percent of the total emissions (1991 ARB VOC Survey). Based on survey data, the proposed standard of 60 percent VOC by weight is expected to achieve a 25 percent reduction in these emissions (approximately 2000 lbs/day). Along with the other consumer product categories, ARB staff evaluated the current levels of VOCs found in disinfectants reported in the 1991 ARB Consumer Product VOC survey. This survey, along with other technical information obtained by staff, indicates that significant emission reductions from this category are possible without adversely affecting existing products' performance.

Manufacturers have raised a number of health-related issues regarding this category and the applicable VOC standard. Because of the complexity of these issues, it was felt that a comprehensive discussion for this product category is necessary. In addressing these complex issues, we will address the following questions:

a. Are there existing formulas or formulas used in past studies that can reasonably be predicted to achieve the same level of disinfection being achieved by current high-VOC products but at a lower level of VOC?

b. Are the high-levels of VOC found in current household aerosol disinfectants necessary to achieve the level of disinfection that is necessary in households?

c. Does the available literature show that current household aerosol disinfectants contain levels of VOC in excess of what is required to provide effective disinfection?

2. What is a disinfectant?

With certain exceptions listed in the regulation, disinfectants are defined as products intended to destroy or irreversibly inactivate infectious or other undesirable bacteria, pathogenic fungi, or viruses on surfaces or inanimate objects. Because the standard is intended to apply only to products that are primarily disinfectants, the definition excludes products that make secondary disinfectant claims. These secondary disinfectants include some general purpose cleaners, bathroom and tile cleaners, metal polishes and glass cleaners. It is important to note that the standard will also not apply to topical agents to be used on animals or humans, such as rubbing alcohol, unless such a product is packaged primarily as a hard-surface disinfectant.

3. What is the purpose of disinfection?

The following is a list of terms and their definitions which will be used frequently in subsequent discussions. These definitions are taken verbatim or within the context of use (e.g., disinfection is the process of using a disinfectant) from the following sources, as indicated: (1) Disinfection, Sterilization and Preservation, Block, S.S., 3rd Ed., (2) Control of Communicable Diseases in California, American Public Health Association (APHA) and California Department of Health Services (DHS), 1983, (3) Guidelines for Prevention of Transmission of Human Immunodeficiency Virus and Hepatitis-B Virus to Health-Care and Public Safety Workers, Centers for Disease Control (CDC), 1989, and (4) Practical Infection Control in the Dental Office, Centers for Disease Control (CDC), 1989. Please consult the "References" section for a full listing of each source used.

TABLE VII-3

Disinfection Terms and Definitions

o Sterilization	- the use of a physical or chemical procedure to destroy all microbial life, including highly resistant bacterial endospores (Block).
o Disinfection	- use of an agent, usually chemical, applied to inanimate objects for the purpose of destroying disease-causing microorganisms, but not necessarily spores unless specified on the label (American Public Health Association).

TABLE VII-3 (continued)

- o Environmental disinfection - the cleaning and disinfection of soiled environmental surfaces using any cleaner or disinfectant agent which is intended for environmental use. Such surfaces include floors, woodwork, ambulance seats, countertops, etc. (Centers for Disease Control).

- o Low-level disinfection - disinfection which kills most bacteria, some fungi, but not Mycobacterium tuberculosis or bacterial spores. Low-level disinfection can be achieved by using an EPA-registered "hospital disinfectant (no label claim for tuberculocidal activity). These agents are excellent cleaners and can be used for routine housekeeping or removal of soiling in the absence of visible blood contamination (Centers for Disease Control).

- o Intermediate-level disinfection - disinfection which kills Mycobacterium tuberculosis, vegetative bacteria, most viruses and most fungi, but does not kill bacterial spores. Intermediate-level disinfection can be achieved by using: (1) an EPA-registered "hospital disinfectant" that has a label claim for tuberculocidal activity, or (2) commercially available hard-surface germicides or solutions containing at least 500 ppm free available chlorine (a 1:100 dilution of EPA-registered household bleach - approximately 1/4 cup bleach per gallon of tap water). Intermediate-level disinfection is for those surfaces that come into contact only with intact skin (e.g., stethoscopes, blood pressure cuffs, splints, etc.) and have been visibly contaminated with blood or bloody body fluids. Surfaces must be precleaned before the germicidal chemical is applied for disinfection (Centers for Disease Control).

- o High-level disinfection - disinfection that kills all forms of microbial life except high numbers of bacterial spores. Can be achieved by hot water pateurization (80-100 C, 30 min) or exposure to an EPA-registered "sterilant" chemical (10-45 min or as directed by manufacturer). For resuable instruments or devices that come into with mucous membranes (e.g., laryngoscope blades, endotracheal tubes, etc.) (Centers for Disease Control).

TABLE VII-3 (continued)

o Critical items	- Instruments that will touch bone or penetrate issue. Forceps, scalpels and scalers are examples of critical items. To prevent transmission of infectious germs, critical items must be sterilized (Centers for Disease Control - Dental Guidelines).
o Semicritical items	- Instruments that will touch mucous membranes but will not touch bone or penetrate tissue. Dental mirrors and amalgam (i.e., filling) condensers are examples of semicritical items. To prevent transmission of infectious germs, semicritical items should either undergo heat sterilization (if tolerable) or high-level disinfection. (Centers for Disease Control - Dental Guidelines).
o Noncritical Items	- Equipment and environmental surfaces that will come into contact only with intact skin. Chairs and countertops are examples of noncritical items (emphasis added). Noncritical items should undergo either intermediate-level or low-level disinfection, depending on whether or not the items are visibly contaminated with blood or other soils. Cleaning alone will be sufficient for most noncritical items that are not visibly contaminated with blood (Centers for Disease Control - Dental Guidelines).

As stated above, disinfection is the process of killing or inactivating some, but not all, microorganisms on surfaces and inanimate objects. The process of killing all microbes including high numbers of spores is called "sterilization." Since chemical sterilization usually involves the exposure of the surface to be treated with a chemosterilizer for long periods of time, the federal and state guidelines previously discussed recommend that sterilization and high-level disinfection be used only for critical and semicritical items (CDC)(APHA). Since most environmental surfaces (e.g., walls, table tops, floors) and fomites (e.g., doorknobs, light switches, faucet handles) in the household and health-care facilities are not expected to penetrate skin or tissue or contact mucous membranes during normal contact, they are generally considered to be noncritical items. For these items, general cleaning with a detergent and water or a disinfectant/ detergent will be sufficient (i.e., environmental or low-level disinfection, respectively) (CDC)(APHA). Of course, these items should be exposed to an intermediate-level disinfectant after precleaning if the items have been visibly soiled with blood or other body fluids possibly containing infectious agents (CDC).

Disinfection can range from the relatively simple removal of germs that cause mold, mildew and odors in the household, to the more difficult

procedure of killing disease-causing microbes which can result in cross-infection in hospital settings. For the sake of brevity, this discussion will emphasize preventing the transmission of disease-causing germs as it relates to effective disinfection.

Most infectious diseases are contracted through one or more of the following ways: (1) inhalation of airborne germs (e.g. tuberculosis), (2) ingestion of fecal-oral organisms (e.g. polio and hepatitis-A viruses), (3) self-inocculation into the bloodstream or mucous membranes of blood-borne or mucous-borne agents (e.g., HIV, hepatitis-B, common cold), or (4) infection with vector-transmitted diseases (e.g. malaria by mosquitos and Lyme's disease by ticks). Since disinfectants are designed strictly for use on hard-surfaces, this discussion will focus on the non-inhaled, non-vector transmitted diseases (i.e., fecal-oral and blood- or mucous-borne).

4. Does effective disinfection depend solely on the use of chemical disinfectants?

Although the term "disinfectant" usually refers to chemical products, it should be noted that the term "disinfection" does not refer strictly to the use of chemical products to kill infectious agents; the actual physical removal of microorganisms by scrubbing and adequate precleaning prior to use of the chemical disinfectant is the most important step in any disinfecting protocol (MWWR; Bond, et al.). Precleaning helps to ensure that the amount of organic soil which can reduce a disinfectant's ability to kill germs is minimized. The label and print advertisement for the market leading aerosol disinfectants state that the products are to be used on precleaned surfaces. The value and necessity of precleaning are very important points to remember.

5. To what extent are aerosol disinfectants used in households and in I&I settings?

From the 1991 ARB Consumer Products VOC Survey, it is clear that aerosol disinfectants are the dominant form in the household market; however, aerosol disinfectants are relatively insignificant in the I&I market (e.g., hospitals, convalescent homes, dental offices, food processing plants, etc.). This finding is confirmed by the 1991 ARB Hard-Surface Disinfectant Usage Survey and other articles written on the subject (Binenstock). The results of the 1991 ARB Hard-Surface Disinfectant Usage Survey are presented in Table VII-4.

TABLE VII-4

Results from the 1991 ARB Hard-Surface Disinfectant Usage Survey

Health Care Facility Type	Annual Disinfectant Usage (lbs/year) Aerosols	Liquids
Convalescent and Nursing Homes	4,000	257,000
Day-Care Centers	250	25,300
Hospitals and Clinics	25,500	1,610,000
Veterinary Hospitals	1,700	100,000
Miscellaneous	1,200	1,580,000
Total =	32,700	3,570,000
% of Total Mass =	1%	99%

To obtain usage data representative of health care facilities in California, staff sent approximately 7250 hard-surface disinfectant usage surveys to small, medium and large health-care facilities covering the types shown in Table VII-4 throughout California (See Appendix C). Over 1250 applicable health care facilities completed and returned the survey. Approximately 400 surveys were returned either because the survey recepient was not a health care facility or because the address was incorrect. The compiled results from the completed surveys are presented in Table VII-4.

From the results shown in Table VII-4, it is apparent that aerosol disinfectants comprise approximately 1 percent of the disinfectant market represented by health-care facilities. The staff also found from the 1991 ARB Consumer Products VOC Survey of manufacturers that approximately 99 percent of the I&I market for disinfectants is comprised of nonaerosol disinfectants.

In addition to the information presented in Table VII-4, a survey conducted in 1990 by the California Dental Association of its members and product suppliers concluded that aerosol disinfectant usage in dental offices is not significant and any change in the availability of aerosol disinfectants would not adversely affect its members (CDA). Again, this supports the findings of both ARB surveys, which show that health-care use of aerosol disinfectants is not significant when compared to the total mass of nonaerosol disinfectants used.

From Table VII-4 and the information provided by the CDA, it is apparent that health care facilities overwhelmingly favor the use of liquids, pumps, powders and other nonaerosol products over aerosol disinfectants. Since these health-care facilities have very stringent disinfection requirements, it is reasonable to conclude that the current nonaerosol products being used in the market by the majority of health-care facilities are meeting or exceeding their stringent disinfection requirements.

6. Is it necessary to use an aerosol disinfectant rather than a nonaerosol in the home or health care setting?

As stated previously, it is apparent that hospitals and other health-care facilities with stringent disinfection requirements overwhelmingly use nonaerosol disinfectants. The majority of these nonaerosol products used in health-care and other I&I facilities contain significantly less VOC than aerosol disinfectants. It is also apparent that the major market for aerosol disinfectants is the household market. While it can be argued that household aerosol disinfectants are convenient to use, it is not correct to state that they are the only effective disinfectants available to and being used by household consumers. To illustrate this, it is important to note that many of the nonaerosol products reported by health-care facilities in the disinfectant usage survey are readily available to household consumers through normal retail outlets.

Although not the only disinfectant available, alcohol-based aerosol disinfectants (ethanol or isopropanol) are the most prevalent in the household market. The majority of aerosol disinfectants rely on ethanol with some other active ingredient, such as o-phenylphenol, for their germicidal activity. Ethanol- and isopropanol-based disinfectants are also widely available in liquid (rubbing alcohol or liquid ethanol), pump and even towlette form.

Staff recognizes that alcohol is a good disinfectant; there is a vast amount of literature to support this. However, it should be noted that the majority of the literature confirming the efficacy of alcohol disinfectants is based on studies with liquid disinfectants. The literature does not state that effective disinfection necessarily has to be achieved through the use of an aerosol disinfectant. Given that the transfer efficiencies of pumps and liquids are inherently better than aerosols (American Research and Testing Incorporated), the desirability of using an aerosol disinfectant where a liquid, pump or towlette would do equivalent disinfection is questionable.

From the information contained in this discussion, the staff has determined that low-VOC alternatives are available for effective disinfection. These low-VOC disinfectants are currently being used in such quantities by health care facilities that aerosol disinfectants play a relatively insignificant role at these facilities. Since these health care facilities are meeting their stringent disinfection requirements with low-VOC alternatives and these alternatives are widely available, we believe

that the public health can be safeguarded with effective low-VOC alternative disinfectants.

7. What types of disinfectants are currently available to household and I&I consumers and how is the effectiveness of these products judged?

Although alcohol comprises most of the VOCs in aerosol disinfectants, it is important to note that alcohol is not the only active ingredient in disinfectants. The total sales volume of all alcohol-based hard-surface disinfectants for the I&I market, is relatively minor when compared to disinfectants based on other active ingredients. For example, the majority of I&I products used for hard-surface disinfection is based on LVP components such as quaternary ammonium compounds (quats); non-VOC components such as iodine (e.g., iodophors), chlorine (e.g., hypochlorite or chlorhexidine) and peroxide (e.g., hydrogen peroxide); or potent non-alcohol VOCs such as gluteraldehyde.

Depending on the type and quantity of VOC, LVP and non-VOC active ingredients used, antimicrobial agents can be formulated to meet a variety of germ killing requirements. Because of the variety of active ingredients available and the varying amounts used in disinfectant formulations, disinfectants can be categorized by increasing order of potency. The following list of antimicrobial potency classifications has been adapted or taken verbatim from the following sources: (1) Control of Communicable Diseases in California, American Public Health Association and California Department of Health Services, (2) Federal Insecticide, Fungicide, and Rodenticide Act, (FIFRA, 7 U.S.C. Sec. 136-136y), (3) "Tuberculocidal Activity Test Method", U.S. EPA, and (4) Guidelines for Prevention of Transmission of Human Immunodeficiency Virus and Hepatitis B Virus to Health-Care and Public-Safety Workers, Centers for Disease Control (CDC). Please refer to the "References" section for a full listing of all these sources.

TABLE VII-5

Classes of Antimicrobial Agents
(in increasing order, top to bottom)

Sanitizer	- an agent, usually chemical (may be physical) and possessing disinfecting qualities when applied separately following a cleaning process. When used in combination with a cleaner or detergent, it reduces the microbial content to an acceptable level under Public Health requirements (American Public Health Association).
Disinfectant	
Limited	- kills *Staphylococcus aureus* (gram-positive bacteria) (FIFRA).

TABLE VII-5 (continued)

Broad -Spectrum	-	kills Staphylococcus aureus and Salmonella choleraesuis (prototype gram-negative bacteria) (FIFRA).
Hospital	-	kills Staphylococcus aureus, Salmonella choleraesuis, and Pseudonomas aeruginosa (prototype aerobic bacillus) (FIFRA).
Fungicidal	-	kills Tricophyton mentagrophytes ("athlete's foot fungus", prototype filamentous fungus) (FIFRA).
Tuberculocidal	-	kills Mycobacterium tuberculosis var. bovis, an indicator of effective disinfection because mycobacteria represents one of the most resistant groups of organisms (US EPA).
Virucidal	-	no prototype target organisms to show broad-spectrum virucidal activity. Activity must be shown against specific virus to make claim against that virus (FIFRA).
Low-level	-	hospital disinfectant without tuberculocidal claim (CDC).
Intermediate -level	-	hospital disinfectant with tuberculocidal claim. Necessary for surfaces that come into contact only with intact skin and have been visibly contaminated with blood or bloody body fluids. Surfaces must be precleaned prior to disinfection (CDC).
High-level	-	kills all forms of microbial life except high numbers of spores. Necessary only for invasive items that come into contact with mucous membranes such as laryngoscopes, endotracheal tubes, etc. Not necessary for environmental surfaces and objects (fomites) (CDC).
Sterilant	-	kills all forms of microbial life including high numbers of spores (CDC). Necessary only for invasive items that penetrate skin or contact normally sterile areas of the body such as scalpels needles, etc. (CDC).

The above definitions reflect the widely-held opinion that environmental-level (use of detergent/water), low-level (hospital disinfectant) and, at times, intermediate-level (hospital disinfectant with tuberculocidal activity) disinfection are the appropriate levels for routine disinfection of surfaces and items in household and I&I settings. These

surfaces and items include common environmental surfaces such as walls, doorknobs, faucet handles, light switches and countertops, which are not normally expected to pierce intact skin or come into contact with mucous membranes in typical daily situations. Because of their potency and toxicity, high-level disinfectants and chemosterilants are neither necessary nor desirable for routine environmental disinfection. The staff is unaware of any high-level disinfectant or chemosterilant which is currently available to the general public.

Disinfectants using different amounts of the same active ingredient or different combinations of the same active ingredients can be formulated to achieve different levels of disinfection below high-level disinfection. For example, different levels of alcohol in combination with other active ingredients can yield either low- and intermediate-level disinfection. To illustrate this point, a small sampling of the products registered as disinfectants under FIFRA reveals the following examples of intermediate-level (tuberculocidal, hospital) aerosol and pump spray disinfectants with their corresponding levels of alcohol, by weight (NPIRS):

- 19 percent ethanol (Lysol Disinfectant Trigger Spray, L&F)
- 37 percent ethanol (Enviro-sep aerosol, Grow Group)
- 43 percent isopropanol (Safari aerosol, Omnitech Intl)
- 53 percent ethanol (Concept aerosol, Hysan)
- 52 percent isopropanol (CSA Staf aerosol, CSA Limited)
- 67 percent ethanol (Citrace aerosol, Dow)
- 80 percent ethanol (Lysol Disinfectant Spray, L&F).

It is apparent from the above list of products that a variety of alcohol-based disinfectants use widely varying amounts of alcohol and other active ingredients to achieve intermediate-level disinfection. Clearly, aerosol and nonaerosol disinfectants can achieve effective, intermediate-level disinfection without the use of high levels of alcohol.

Disinfectant effectiveness must be demonstrated to the EPA prior to registration of such products under the requirements of FIFRA. Moreover, the California Department of Pesticide Regulation may require additional testing to show disinfectant effectiveness prior to registering a product for use and sale in California. Since the effectiveness of disinfectants cannot be seen under the naked eye, the efficacy of disinfectants is determined by the use of a set of rigidly controlled in vitro tests that are described in the Federal Register, the manual of the Association of Official Analytical Chemists (AOAC) and various EPA guidelines.

Testing is conducted against various prototype microorganisms to achieve different disinfection designations. As previously shown in Tables VII-3 and VII-5, disinfectants must demonstrate complete kill of 10,000 microorganisms in ten minutes at room temperature against *Staphylococcus aureus* (*S. aureus*), *Salmonella choleraesuis* (*S. choleraesuis*), and *Pseudonomas aeruginosa* (*P. aeruginosa*) to be registered as a "hospital/medical" disinfectant. "Tuberculocidal" and "fungicidal" activity claims are achieved by demonstrating effectiveness against *Mycobacterium tuberculosis* var. *bovis* (tubercule bacilli) and *Tricophyton mentagrophytes*

("athlete's foot fungus"), respectively. Since the tubercule bacillus is among the most difficult bacteria to kill and the three previous bacteria are considered representative of gram-negative, gram-positive and aerobic bacteria, hospital disinfectants with tuberculocidal and fungicidal claims are implictly considered to be effective against virtually all non-spore-forming bacteria and fungi (Prince).

Unlike the target organisms for bacteria and fungi, there are no such target organisms to indicate broad-spectrum virucidal activity. EPA allows no generalized virucidal claims on the label; instead it requires all claims for virucidal activity to be demonstrated against the specific viruses being tested. Since there are no standardized target viruses, virucidal claims on disinfectant labels vary widely among the available disinfectants.

In other words, the lack of standardized viruses to show virucidal activity often results in products with different virucidal label claims, even though they are essentially identical in formulation. To take advantage of current public concerns, one product may claim activity against influenza, while another may claim activity against herpes, while the third may claim activity against HIV. Since the process of registering against individual viruses is time- and resource-consuming, most disinfectant manufacturers carefully select which viruses to register their products against such that maximum marketability is achieved for the least cost. A disinfectant product with numerous label claims may, on face value, appear superior to another product with fewer label claims, when in fact they may be very similar or even equivalent in effectiveness.

8. <u>What types of disinfectants are available to the public which can kill the AIDS virus? Is 80% by weight ethanol necessary to kill the AIDS virus?</u>

It is generally recognized in the infection control community that the Human Immunodeficiency Virus (HIV), which causes AIDS, is a relatively fragile organism outside of the body and is easily killed. There are two types of HIV identified to date; HIV-1, the most common strain, and HIV-2, a relatively rare strain found mostly in small populations from foreign countries. Most disinfectants available in the market and registered against the AIDS virus is registered against HIV-1. The sheer number of available disinfectants with widely varying amounts of ethanol and other active ingredients attest to the fact that high levels of ethanol are not needed to kill HIV on environmental surfaces and fomites (NPRIS computer printout List C, 1988). As of 1988, there were 101 disinfectants registered with the EPA as being virucidal against HIV-1. There are numerous disinfectants available to the public for disinfecting against HIV; many of these products contain low levels of VOC.

9. How would the regulation affect the use of disinfectants in preventing the spread of fecal-oral and mucous-borne diseases?

Fecal-oral diseases are those which are spread by ingestion of or contact with feces-containing material which harbor infectious agents onto mucous membranes. Typical examples of such diseases are polio and hepatitis-A (infectious hepatitis). A good example of a mucous-borne disease is the common cold.

Representatives from L&F Products claim that the incidence of infectious disease can be shown through the following relationship (Popek):

$$\text{Disease} = \frac{\text{Number of Organisms} \times \text{Virulence}}{\text{Susceptibility of Host}}$$

L&F proposes that disinfectants, as used in household and other settings, would reduce the number of organisms and would therefore reduce the incidence of disease. This contention may have merit in an ideal situation far removed from the realities of household disinfection. However, for organisms which are transmitted either by ingestion or self-inocculation into the bloodstream or mucous membranes, current literature on effective disinfection and common sense show that there are at least two relatively simple non-disinfection steps not shown in this relationship which can effectively reduce the number of organisms "available" for infection - regular handwashing and avoiding contact of the fingers with the nose or eyes.

Handwashing is the single most important procedure for preventing nosocomial infections. Handwashing with plain soaps or detergents suspends microorganisms and allows them to be rinsed off; this process is often referred to as mechanical removal of microorganisms. Generally, superficial contact with a source not suspected of being contaminated, such as touching an object not visibly soiled, does not require handwashing. When handwashing is necessary, such as when touching objects that are likely to be contaminated, washing times of 15 seconds or less have been reported as effective in removing most transient contaminates from the skin. Therefore, for most activities, a vigorous, brief (at least 10 seconds) rubbing together of all surfaces of lathered hands followed by rinsing under a stream of water is recommended. (Garner, J.S. and Favero, M.S.)

There is no doubt that effective disinfection is important in helping to prevent nosocomial diseases. However, the term "effective disinfection" depends on what surfaces are being treated. For control of the spread of infection in hospitals, there is general agreement that the infectious hazard from walls, floors or similar surfaces to hospital patients or staff is insignificant. As cleaning plays a major part in disinfection, the use of a chemical disinfectant is justified only in high-risk areas such as isolation rooms occupied by infected patients. The use of a detergent is normally sufficient for cleaning floors and walls in hospitals. (Walder)

10. How would the proposed standard affect the efficacy of aerosol disinfectants, especially in regard to transmission of infectious diseases such as AIDS and infectious diarrhea?

As discussed previously, a disinfectant that kills Staphylococcus aureus, Salmonella choleraesuis, Pseudonomas aeruginosa, Mycobacterium tuberculosis var. bovis, and Trycophyton mentagrophytes is rated as a fungicidal and tuberculocidal hospital disinfectant (FIFRA). Disinfectants with this rating are also known as "intermediate-level" disinfectants by the infection control community (CDC). Nearly all currently-available, alcohol-based aerosol disinfectants have this rating, regardless of alcohol content. Intermediate- and low-level disinfectants (i.e., hospital disinfectants without tuberculocidal claims) are recommended by federal public health agencies for preventing the spread of HIV and hepatitis-B virus (causes serum hepatitis) in health care workers (CDC). Since low-VOC, intermediate- and low-level disinfectants already exist, staff expects no adverse impacts on the ability of these products to kill HIV due to the regulation.

Current literature demonstrates that most existing aerosol and liquid disinfectants formulated with 60 percent by weight ethanol will provide hospital-level disinfection with tuberculocidal and fungicidal activity. Such disinfectants are implicitly considered to be effective against virtually all vegetative bacteria and fungi and nearly all lipophilic and hydrophilic viruses. However, for ethanol-based disinfectants, the question has been raised of whether a 60 percent ethanol by weight disinfectant can inactivate the group of hydrophilic viruses known as picornaviruses. Picornaviruses are a group of small (20-30 nanometers) viruses which contain no lipids and which do not react with lipids (Block). Such viruses include Polioviruses, Coxsackieviruses and Echoviruses.

Unfortunately, EPA has not selected a target organism for demonstrating broad-spectrum virucidal activity. L&F Products, makers of Lysol Disinfectant Spray, claim that polio virus (type 1), because of its high resistance to germicides, should be considered as a virucidal standard (L&F). This is supported somewhat by recent (Rutala) and past studies (Klein and Deforest; Christensen, R.P.). Since there is no existing standard using polio virus, predictions of what level of VOC will be effective against polio virus are, of necessity, predicated on well-documented past studies.

For this regulation, ARB staff assumed that polio virus is a reasonable standard to show efficacy against hydrophilic viruses. With this in mind, staff reviewed current literature to determine what levels of VOC are necessary to inactivate this virus. To date, studies conducted to determine germicidal effectiveness against this virus have been conflicting. For example, both Klein and Christensen, in testing ethanol-based disinfectants (with and without o-phenylphenol), show that the minimum ethanol content required to inactivate the polio virus is 70 percent by volume (62 percent by weight). Other studies provided by L&F Products indicate that 80 percent ethanol by weight will definitely inactivate polio virus, while 53 percent ethanol will definitely not work against polio virus. Although the L&F data shows that 80 percent ethanol by weight will work against polio virus, it does not conclusively show that 80 percent ethanol by weight is the minimum level required. Since 70 percent ethanol by volume (62 percent by weight, as delivered) has been shown by studies to inactivate polio virus, the

standard of 60 percent VOC by weight in the can was chosen by staff to enable complying products to deliver a spray onto the surface with 70 percent ethanol by volume, at a minimum.

According to the U.S. Bureau of Standards, 70 percent by volume ethanol is equivalent to 62 percent ethanol by weight for the liquid film on the sprayed surface (USBS). Staff performed a propellant-loss analysis to show that a 50 percent to 60 percent ethanol by weight aerosol disinfectant in the can, when sprayed, would concentrate to over 70 percent by volume after the propellant fraction has flashed off and evaporated (Appendix C). Thus, a complying product with 60 percent VOC in the can should be able to deliver a spray with an effective level of ethanol.

Triangular diagrams are diagrams for three-component solutions which can be used to predict selected physical properties of aerosol disinfectants formulated to meet the standard. For example, according to readily available triangular diagrams (Sanders), a single-phase aerosol disinfectant at approximately 40 psig pressure could be formulated with 60%-10%-30% (ethanol:water:HFC-152a) weight ratios (Figure 5, Point 5). HFC-152a is used in this example because it is a non-VOC propellant which, when used in this suggested formulation, will result in aerosol disinfectants with moderate pressure (40 psig) and medium spray charateristics that are within industry norms for this product. A product formulated in such a way is expected to deliver, after propellant flashoff and evaporation, a disinfectant liquid film to the sprayed surface with an estimated 85 percent ethanol by weight (90 percent by volume). From the earlier discussion, it is clear that this level of delivered ethanol is significantly higher than the 62 percent ethanol by weight (70 percent by volume) that has been shown by past and current studies to inactivate the polio virus.

Manufacturers have raised the point that ethanol would evaporate at a faster rate when aerosolized; thus, a level of ethanol greater than 62 percent by weight (70 percent by volume) is needed to account for additional evaporation of ethanol. While staff agree that sufficient "extra" ethanol is needed to allow for a margin of error, staff's analysis shows that sufficient allowance for error can be achieved while still compl$ng with the standard. To illustrate this, it must be noted that, given the same set set of product and ambient conditions (e.g. droplet size distribution, ambient temperature), the evaporation rate of ethanol in aerosolized disinfectant droplets is at a maximum when only ethanol, water and propellants are contained in the aerosol product. However, existing aerosol disinfectants employ several methods to reduce ethanol evaporation. Current aerosol disinfectants such as Lysol Disinfectant Spray and Citrace Hospital Disinfectant are required to provide germ-killing action for at least ten minutes on the surface as stipulated by the EPA (AOAC). To stay viable on the sprayed surface for ten minutes, existing aerosol disinfectants employ both a combination of a "wet" (medium to coarse droplets) spray along with evaporation inhibitors to reduce the rate of evaporation of the ethanol (Christensen). Since this technology is currently being used, staff expects manufacturers to use the same technology to reduce the evaporation of ethanol in complying aerosol disinfectants.

Vapor Pressures of HFC-152a/Ethanol/Water Solutions at 70°F*

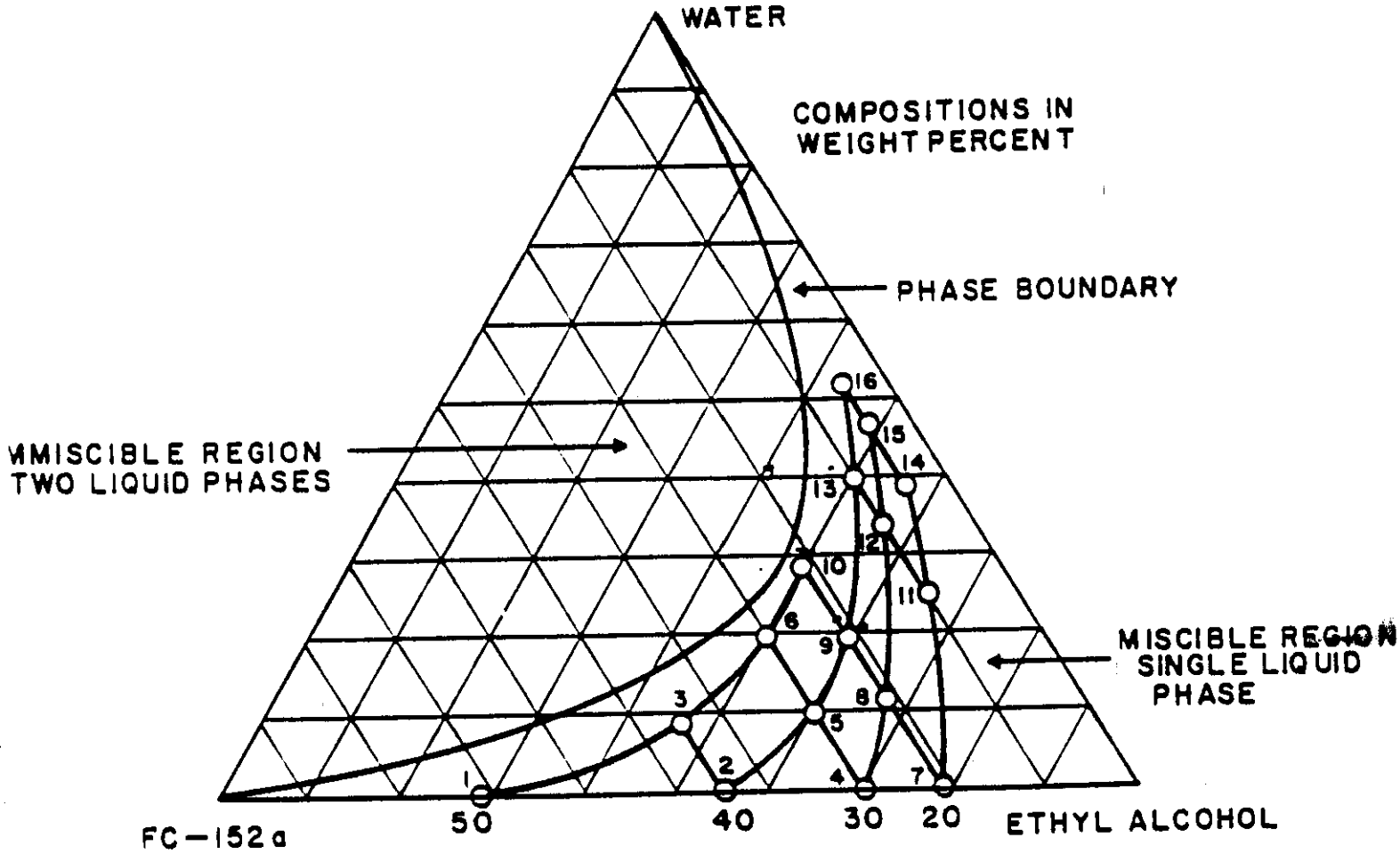

Figure VII-1

* Reprinted from Sanders, Paul A., Handbook of Aerosol Technology, 2nd Ed., p. 155.

In addition, the complying formulation based on HFC-152a described previously contains a significantly greater ethanol/water concentration (85 percent ethanol by weight) than the 62 percent by weight shown to be effective against polio virus. Because of this, it is reasonable to expect that the high ethanol/water ratio (85 percent ethanol by weight) in the disinfectant concentrate, in combination with the evaporation-reducing techniques described above, should result in a complying aerosol disinfectant that will deliver a spray with sufficient allowance to account for any droplet evaporation of ethanol that may occur.

It should be noted that the suggested formulation discussed above is not intended to be the only possible formulation for compliance with a 60 percent VOC by weight standard; it is intended to demonstrate that a reformulation is possible. Depending on the choice of propellant blends, desired spray characteristics, and ethanol/water ratio, a manufacturer can develop other formulations which can also meet the VOC standard while providing an ethanol product with over 70 percent ethanol by volume. From this information, it appears that an aerosol disinfectant can be formulated to have 60 percent by weight total VOC in the can and still result in a 70 percent by volume ethanol product on the sprayed surface. Disinfectants which deliver a product with 70 percent ethanol by volume have been shown to inactivate polio virus and nearly all vegetative microorganisms.

Based on the available information presented above, the staff expects no adverse impacts on the effectiveness of aerosol disinfectants. For example, it is well documented that HIV is a very fragile virus outside of the human host. Levels of ethanol much lower than those found in current aerosol disinfectants are effective in killing this virus. Similarly, the staff expects no adverse impacts on aerosol disinfectants' ability to inactivate fecal-oral viruses such as rotavirus. Currently, there are aerosol and liquid disinfectants with levels of ethanol below 60 percent by weight which are registered with FIFRA for rotavirus activity. Rotavirus is believed to be a major cause of infectious diarrhea in young children (L&F).

11. <u>Why was 60 percent by weight chosen as the standard for aerosol disinfectants?</u>

As explained previously, 60 percent by weight VOC represents a level, in staff's opinion, where emission reductions can be achieved without compromising the product's effectiveness. At 60 percent by weight VOC, the ARB VOC survey shows that 41 aerosol disinfectants would comply. If the standard were to apply to nonaerosol disinfectants, virtually all of the over 500 nonaerosol disinfectants in the survey would also comply after the recommended dilution.

12. <u>How can an aerosol disinfectant manufacturer comply with this standard?</u>

As discussed previously, there are several ways a manufacturer can comply with the standard such that the total VOC content is at or below 60% by weight: (1) formulate a proper balance of alcohol/water/propellant ratio such that compliance is achieved while maintaining product integrity, (2) change propellant to non-VOC propellant such as HFC-152a, (4) increase the

amount of other active ingredients, such as the phenols and/or quaternary ammonium compounds, to achieve greater disinfection while allowing a reduction in VOC content.

13. How does staff provide assurance that there will not be a health problem from compliance with the standard?

In effect, the staff's proposed standard challenges the industry to maintain the current disease control benefits of aerosol disinfectants, while reducing the contribution these products now make to California's serious air quality problems. The staff intends to recommend to the Board that ARB and DHS staff jointly evaluate the progress and reasonable efforts made by manufacturers in developing viable and complying aerosol disinfectants. In determining what possible impacts the standard may have on the health benefits of these products, both ARB and DHS staff will evaluate the effectiveness of products formulated to comply with the standard and achieve intermediate-level, hospital disinfection according to the products' ability to kill or inactivate *Staphylococcus aureus*, *Salmonella choleraesuis*, *Pseudonomas aeruginosa*, *Mycobacterium tuberculosis var. bovis*, *Trycophyton mentagrophytes*, and any target organism or organisms which the EPA determines by notice in the Federal Register as a general-purpose virucidal indicator(s) for showing activity against most hydrophilic and/or lipophilic viruses. ARB and DHS staff will jointly report to the Board on the progress of manufacturers in developing complying products which meet this criteria.

D. CONSUMER PRODUCT SELL-THROUGH

This section addresses whether a one-year sell-through period for non-complying products is sufficient for the consumer products subject to this regulation and whether special or additional sell-through provisions are needed for small businesses. Various industry groups have expressed concerns that a one-year sell-through period is not sufficient and that other alternatives are needed. However, based on information obtained about the channels of trade and on data collected in a retail store survey in 1991, the staff believes a one-year sell-through period is sufficient and that no special or additional sell-through provisions are needed for small businesses.

Summary of October 1990 Board Hearing

At the October 1990 Board hearing, industry representatives testified that a one-year sell-through period is not sufficient. The industry representatives requested that the date a product was manufactured be used in determining compliance. They presented data which were obtained from a sampling of aerosol products purchased randomly from small and large retail stores throughout California. However, they also requested that a three-

year sell-through period be allowed if using the date of manufacture is not possible.

In response to the information presented by the staff and to the industry's testimony, the Board adopted the one-year sell-through period. However, the Board requested the staff to further investigate whether special or additional provisions are necessary for small retail businesses ("mom and pop" stores) and to report back to the Board when amendments to the regulation are submitted for the Board's consideration in 1991.

Industry Concerns

Industry has continued to request either the date of manufacture be used to determine compliance or that the regulation provide for a three-year sell-through period. They contend that:

(1) Products move faster through large stores as opposed to small, neighborhood stores ("mom and pop" stores), but some products stay on the shelf longer because of a special function or season. Also, the one-year sell-through period may be adequate for major companies and brand-name products, but small companies without major brand names would be most adversely affected because they lack the resources for engaging in product recalls and redistribution of noncomplying products.

(2) A one-year sell-through period is not sufficient to avoid the potential extensive recall of non-complying products from wholesale warehouses and retail store shelves for shipment outside the state. If recalls are necessary, the extra VOC emissions from the increased transportation of the goods would likely offset the emission reductions gained from the removal of the non-complying products from the shelf.

ARB Response

The staff re-evaluated the information gathered in 1990 and obtained new data from a retail business survey conducted in 1991. Based on the information and data obtained, the staff believes the one-year sell-through period is sufficient and in most situations, product recalls will not be necessary. The staff's reasoning is presented below.

Lead Time: Because of the future effective dates for compliance and the one-year sell-through period, manufacturers will have a minimum lead time of 4 years to phase-out existing inventories, prepare reformulated complying products, and prepare for the recall of non-complying products, if necessary. For Phase I categories, the effective compliance dates are 1993 and 1994 (1995 for FIFRA registered products). For Phase II categories, the effective compliance dates are 1995 (1996 for FIFRA registered products). The consumer products industry has been involved in the development of these regulations since 1989 and are aware of the regulatory requirements. Even as the performance standards were being developed, various associations and organizations were involved in the regulatory process, including the Chemical Specialties Manufacturers Association, Cosmetic, Toiletry and

Fragrance Association, Soap and Detergent Association, Fragrance Materials Association, Adhesives and Sealants Council, California Grocers Association, California Retailers Association, Northern and Southern California Grocers Association, and Liquor Dealers Association. The staff assumes the associations have kept their members apprised of the regulatory developments. With this knowledge already on hand, the consumer products industry, including manufacturers, distributors and retailers have a reasonable amount of time to direct resources to conduct reformulation research and development and to properly plan for any changes in inventory to minimize any disruptions to their distribution systems.

Manufacturers: Manufacturers must keep abreast of the current progress and future outlook of the market to remain competitive. The staff believes that by being aware of the compliance dates, lead time, and sell-through period, the manufacturers can make a fair assessment of product development and sales, and plan for an eventual phase-out of non-complying products, thereby minimizing the need for a large recall or redistribution. By coordinating the phase-out with distributors, disruptions due to the recall or redistributions of products are further minimized.

In addition, compliance with the regulation is not expected to present major obstacles for reformulation because the industry is not being asked to develop completely new technology or products in order to replace or change their existing inventories. The standards have been set such that there are existing complying products in every product category. With the ample lead time and sell-through period, it should be possible for industry to utilize technology transfer from these existing products to minimize any difficulties during the transition period. Some companies have already begun reformulation efforts in response to the initiation of regulation development in Fall 1989. For those manufacturers that cannot comply with the reguirements of the regulations due to extraordinary reasons beyond the manufacturer's control the manufacturer may apply for a variance. A variance, if issued, will allow the manufacturer additional time to comply with the standards provided that certain increments of progress are being achieved. However, the staff believes that most manufacturers can avoid this process by keeping informed in the business market and keeping abreast of the regulatory developments and directing their resources as necessary.

Distributors: Since 1990, the staff has also kept wholesale and retail associations and wholesale distributors informed of the regulatory developments. The staff knows that distributors are important links to retailers and that delivery routes and lines of communications already exist. Delivery personnel know their customers and place of business and should have few difficulties receiving recalled products while at the same time delivering other normally stocked products, provided that arrangements are made in advance. Distributors and retailers have had previous experience in recalling specific products. This situation is not expected to be any different, except that distributors and retailers will know what will occur much further in advance and any potential product recall will be greatly minimized. Additionally, the staff believes that industry's concerns that VOC emissions would increase due to the transportation of goods is unlikely because of the low probability of product recall.

Retail Businesses: The staff believes that the one-year sell-through period will not be a hinderance to retail businesses since they also have various associations which can keep them informed of the various regulatory developments. As discussed earlier, these retail businesses have a minimum of four years lead time to clear their shelves of non-complying products. For large businesses, products move very quickly since they deal in very high sales volume and have turnover rates of several weeks to several months. They often receive special incentives or deals from manufacturers that allow products to be sold more rapidly than normal. In addition, large businesses provide special promotions such as prizes or vacations with manufacturer incentives to further increase sales. Weekly advertisements and specials on TV, radio, and newspapers also keep consumers informed of "good deals" that can keep sales volume up. Large chains and franchises also have large storage and transportation facilities to move merchandise quickly and efficiently. The ample lead time and short sales time thus gives large businesses a long notice to plan for any future changes in their inventory.

Although small businesses ("mom and pop" stores) lack the capabilities that large businesses possess, they also have an ample lead time to prepare for changes in their inventory and use other marketing strategies to clear their shelves of non-complying products. In many cases, a change in strategy will not even be necessary since small stores must select products that have high turnover rates to enable them to make a quick profit in order to remain viable. They also select products that are popular with customers to ensure product sales and periodically check their shelves to determine which products are selling or not selling and change their orders with their distributors according to their needs.

In addition, since a direct relationship exists between the distributor's profit and the small business's profits, the distributor often checks the inventory and stocks the shelves directly for small stores. It is the distributor's responsibility to determine which products are more profitable and where they may be placed in the store for the greatest exposure. Some distributor's also have a guarantee on almost 100 percent of their products such that if the products are not sold in a period of time, the distributor will buy back the products or give credit to the store.

Consumer Product Retail Store Survey

To respond to the Board's concern about the one-year sell-through provision on small retail businesses and to implement the Board's directive regarding whether consideration of special or additional provisions are necessary for small retail businesses, the staff conducted a retail store survey to determine the typical time it takes for products to be sold from a retail store. A discussion of the survey development, implementation, and results is presented below.

Definition of a Small Business: The staff relied upon the definition for small business used by the U.S. Small Business Administration (SBA) to provide the general parameters for the consumer product retail store survey. According to the SBA, a "small" business can be defined as one that is

independently owned and operated, not dominant in its field and meets employment or sales standards developed by the agency (13 CFR, section 121, 1976). For the retail trade industry, the sales standard is given as the average annual sales that do not exceed 3.5 million dollars for the preceding three fiscal years (up to 13.5 million dollars under some circumstances).

Survey: The survey form developed by the staff included questions that related to employees, annual gross sales, ownership and sell-through period for products representative of those being regulated (a copy of the survey form is included in Appendix E). For the purposes of the survey, the sell-through period is recognized as the time it takes a product to be sold to the consumer after being placed on the retail store shelf.

The survey was sent to only those retail businesses that would be most likely to sell the products represented. From the Standard Industrial Classification (SIC) Manual (1987), 8 retail trade SIC codes were selected. They are:

SIC Code	Description
5251	Hardware Stores
5261	Retail Nurseries, Lawn and Garden Supply Stores
5331	Variety Stores
5399	Miscellaneous General Merchandise Stores
5411	Grocery Stores
5531	Auto and Home Supply Stores
5912	Drug Stores and Proprietary Stores
5921	Liquor Stores

From the County Business Patterns 1988 (U.S. Department of Commence, 1990), these 8 retail codes total a little over 28,000 establishments. Based on the binomial distribution theory, for a population of 28,000, a confidence level of 95% and an expected defect rate of 50 percent, a sample size of at least 1,460 stores would need to be surveyed to provide a representative response for the population. To provide an ample buffer, the staff sent the survey to 4,000 different retail businesses in California.

The survey was mailed on August 16, 1991, to retail business addresses purchased from Hugo Dunhill Mailing Lists, Inc. The business addresses represented a random selection of the 8 SIC codes listed above and of retail stores located in California.

Survey Results and Discussion

As mentioned previously, 4,000 surveys were mailed to retail businesses in California. The ARB staff recieved 531 completed surveys representing 13 percent of the businesses surveyed or approximately 2 percent of the total population of retail businesses in the SIC codes selected.

The staff conducted an analysis using the responses from those retail businesses meeting the SBA small retail business sales requirement, that of

having annual sales less than 3.5 million dollars per year. Although the SBA definition of small retail businesses includes retail grocery stores with annual sales up to 13.5 million dollars, the survey design did not allow staff to identify which respondents met this requirement; therefore, only grocery stores with sales of 3.5 million dollars per year or less were included in the analyses. Of the survey respondents, 475 indicated that their estimated annual sales were less than 3.5 million dollars. Of these, 49 percent had sales less than 0.5 million per year, 29 percent had sales between 0.5 and 1 million dollars per year, 15 percent had sales between 1 and 2 million dollars per year and 7 percent had sales between 2 and 3.5 million dollars per year.

The majority of these businesses responded that, for the product categories indicated on the survey form, most products sold within one year. For all stores with annual sales less than 3.5 million dollars, the survey results show that 89 percent of the products within the product categories surveyed sold within one year. As shown in Figure VII-2, 8 percent of the stores products took 1 to 2 years to be sold and 1 percent responded it took 2 - 3 years. For about 2 percent of the products it takes more than 3 years to clear the shelves.

Typical Sell-Through Period for Stores Having Annual Sales of Less than $3,500,000

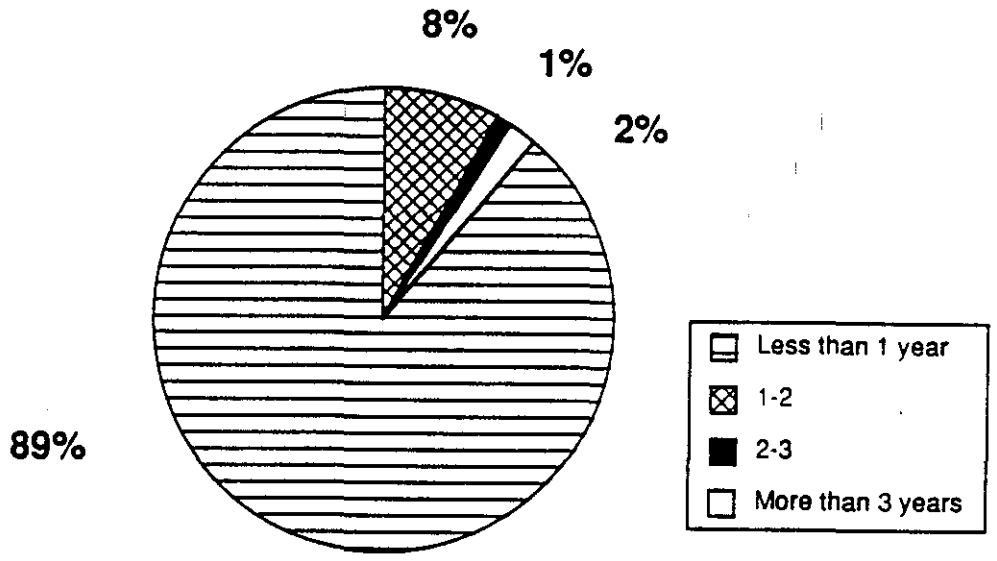

Figure VII-2

A further breakdown of sell through time as a function of yearly sales is presented in Table VII-6

TABLE VII-6

Percent of Survey Responses with Less Than 1 Year Sell Through
(All Product Categories)

Annual Sales, Millions of Dollars	Number of Businesses (Percent)	Percent Indicating Sell-Through < 1 Year
0.0 - 0.5	49	87
0.5 - 1	29	89
1 - 2	15	97
2 - 3.5	7	95

As a comparison between Figures VII-1 and VII-2 indicates, there is not a significant difference in the sell-through period for stores having annual sales less than 0.5 million dollars and those with annual sales between 0.5 and 3.5 million dollars. For the stores with annual sales less than 0.5 million dollars, 87 percent of the products were sold within one year, 10 percent between 1 and 2 years and 1 percent between 2 and 3 years. This is depicted in Figure VII-3.

Typical Sell-Through Period for Stores Having Annual Sales of Less than $500,000

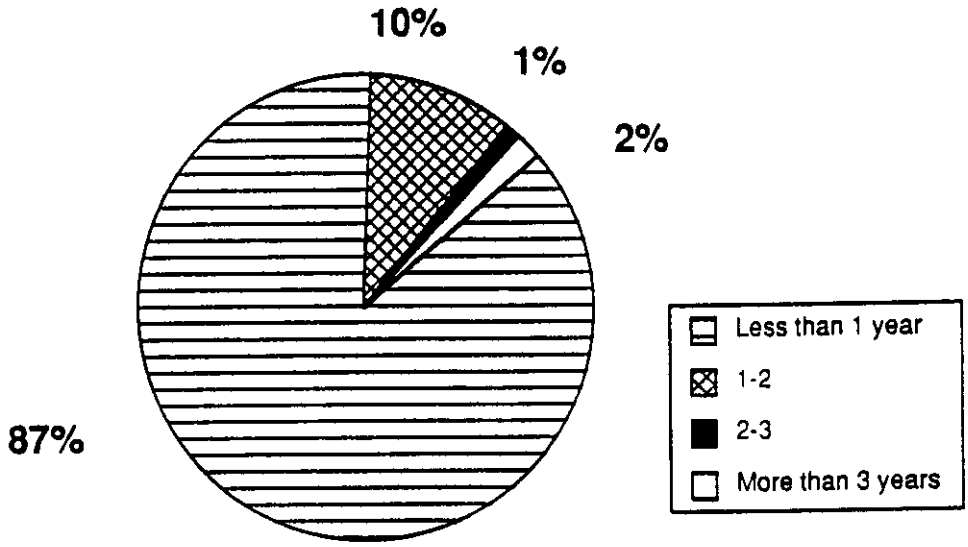

Figure VII-3

Another concern that has been raised by industry is that for certain product categories, such as pesticides, the sales are seasonal, and therefore may require a longer sell through period than other products that do not have seasonal sales patterns. The survey data indicates that such a pattern may exist, since for the pesticide products the percent of respondents indicating that these products sell within one year is lower than the other categories. This is shown in Tables VII-7 and VII-8.

TABLE VII-7

Typical Sell-Through Period By Product Categories For Stores Having Annual Sales Less Than $3,500,000

	Percent Products Sold (Years)			
Product Category	Less Than 1	1-2	2-3	More Than 3
Automotive	94	5	1	0
Household	88	9	1	2
Pesticide	83	13	2	2
Personal Care	88	9	1	2
Miscellaneous	91	5	1	3

TABLE VII-8

Typical Sell-Through Period By Product Category For Stores Having Annual Sales Less Than $500,000

	Percent Products Sold (Years)			
Product Category	Less Than 1	1-2	2-3	More Than 3
Automotive	93	7	0	0
Household	86	11	1	2
Pesticide	78	17	2	3
Personal Care	86	10	1	3
Miscellaneous	90	5	1	4

To be conservative, the staff also looked at the sell-through period for products sold in businesses having less than 0.5 million dollars in annual sales and were a sole ownership. Even for these stores, most of the respondents indicated that products were sold within 1 year. This is shown in Figures VII-4 and Table VII-9.

Typical Sell-Through Period for Solely Owned Stores Having Annual Sales of Less Than $500,000

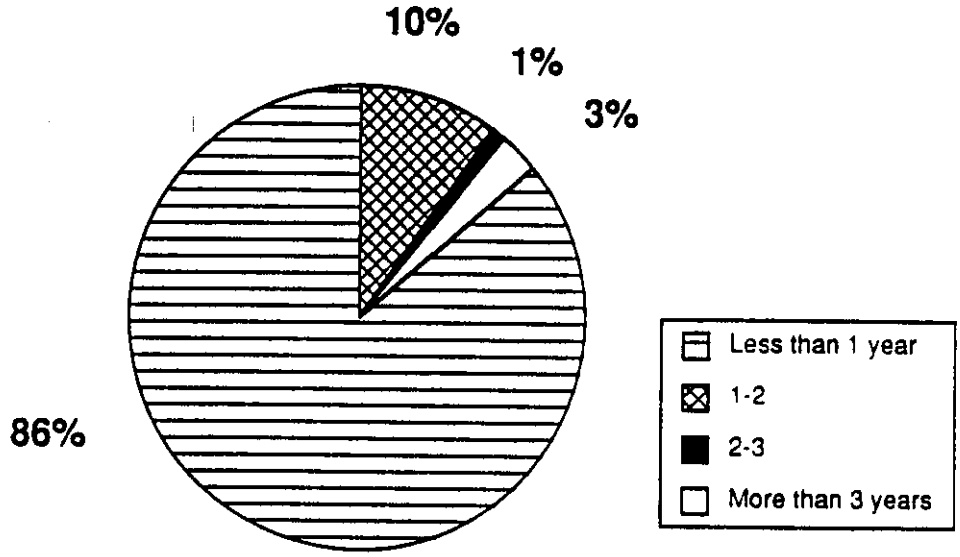

Figure VII-4

TABLE VII-9

Typical Sell-Through Period By Product Category
For Solely Owned Stores
Annual Sales of Less Than $500,000

	Percent Products Sold (Years)			
Product Category	Less Than 1	1-2	2-3	More Than 3
Automotive	94	6	0	0
Household	85	11	1	3
Pesticide	75	17	3	5
Personal Care	83	11	1	5
Miscellaneous	91	4	1	4

The results from the retail survey indicate that, for those stores with annual sales less than 3.5 million dollars, 89 percent of the products were sold within one year. For certain product categories, such as pesticide products, a smaller percentage of the products were sold within one year,

approximately 83 percent. This indicates that, even though there may be a seasonal pattern to sales of pesticide products, a large percentage of the pesticide products are still sold within one year. Based on this data, the staff believes that a one year sell-through is sufficient, even for pesticide products. Because of the lead time available and the large percentage of products that are sold within one year, prudent retailers have ample time to carefully manage inventories to ensure that all non-complying products are sold or removed from the store shelves prior to the enforcement date of the standards.

E. CONSUMER PRODUCT EFFICACY

Throughout the development of the consumer product regulation and the proposed amendments there have been numerous discussions on product efficacy. The issue has been raised that the efficacy of reformulated products will be less than that of the existing "non-complying" products and therefore consumers will use more of the reformulated products and VOC emissions may actually increase.

What is efficacy and how is it determined? To define efficacy is not a simple task. According to CSMA, "The 'efficacy' of most consumer products consists not just of a single measurable factor, but of a number of factors, some but not all of which can be quantitatively and linearly measured and compared....For some products, there are standard quantitative industry methods for evaluating some of these factors, but in most cases there are none, only proprietary methodologies developed and employed by individual manufacturers" (CSMA, 1991). Another manufacturer states "...for most product categories, there are no efficacy 'tests generally accepted for that product category by the consumer products industry'. Most manufacturers consider their test methods proprietary information and part of their competitive advantage over other companies" (Procter & Gamble, 1991). Other manufacturers believe that the product with the highest market share determines the efficacy for a particular product category.

Since there are no generally-accepted industry standards with which to evaluate the efficacy of a reformulated product, the staff must rely upon the information provided in the survey and in discussions with consumer product manufacturers. The staff believes that the reformulated products will be at least as efficacious as existing products. This is a reasonable assumption since there are a number of existing products that already meet the proposed standards and that, combined, have sufficient commercial presence to demonstrate consumer acceptance. This is strong evidence that it is possible to reformulate non-complying products without sacrificing efficacy. In addition, an inefficacious reformulated product will likely fail in the marketplace and therefore not result in a significant increase in VOC emissions due to increased usage.

Consumer acceptance or market share may be one indication that a product is efficacious; however, there is danger in relying too heavily on this assumption since consumers often purchase a product due to such factors as product marketing, advertising, promotions, fragrance, ease of use, etc.

Therefore, consumer acceptance alone would not demonstrate product efficacy. A market leader is not the market leader only because of product performance testing that is conducted in the company laboratory; a market leader's position in the marketplace is a function of many of the above factors, some of which are briefly described here.

Product Marketing

Marketing is a term used to cover all aspects of the effort to bring the product to the consumer (Audits and Surveys, Inc., 1974). The "market" may have to do with such factors as geographical area, gender, ethnicity, age, income, household, or education and can encompass some or all of these. Product marketing includes strategies that encourage "new" consumers to buy an existing product as well as strategies to determine what type of consumers are likely to buy a product that is still going through research and development.

Through demographic analysis, marketing research, and consumer behavior research, companies are able to develop a profile of the type of consumer most likely to buy a certain product.

Once the target market is identified, creative strategies are developed to appeal to the target market's "personality", exploit the products image, and use advertising campaigns that are believable and persuasive. To communicate the ideas or perceptions developed by creative strategies, guidelines are set for an appropriate media mix such as radio, television, or print. The guidelines are set by knowing the target market and the kinds of media images that the target market may most be influenced by. To add to the appeal to target markets, promotions and themes are developed. Finally, since market conditions constantly change, companies perform periodic evaluations of their products to determine whether further strategies are needed. Therefore, product efficacy is not emphasized so much as being able to bring the product to the "right" type of consumers.

Advertising

Companies use advertising to expose the product and to create an image of that product to the consumer in some way, shape, or form. Using target marketing, companies already have a preconceived notion of what the consumer may be inclined to purchase and why. The advertisements attempt to touch upon some of those values, emotions, or way of thinking to try to persuade or convince consumers that purchasing the product will be of "benefit" to them. For consumers who want to believe they can have everything, advertising can reinforce the fantasy and the daydream that "upward mobility can be ensured by a clean shave" or that "academic failure can be averted by use of a personal computer" (O'Shaughnessy, 1987). For those products that are shown with popular celebrities, consumers purchase the products because they wish to identify with the image or lifestyle of the celebrity that is promoted by the advertising (O'Shaughnessy, 1987).

In many cases, just by sheer volume of exposure of a product through all forms of media such as radio, television, newspaper, billboards, and

magazines is enough to influence consumers into purchasing the product. From the constant bombardment of the advertisements, consumers may purchase the product on a whim, out of curiosity, or because they're confused about the other "unknown" brands. The consumer thus purchased the product due to recognition and not product efficacy.

Promotions

Promotions are offered by companies to influence consumers into purchasing or using the product with little financial risk to the consumer. Free gifts, free trials, or free samples is a common practice for companies to introduce a new product and to establish brand recognition. Another form of promotion is to offer the product through a sale, discount, or use of coupons. If different brands of products appear to perform similarly, then consumers will opt for the brand that can be purchased at a reduced price. If the product is normally sold at a similar price as the other brands then the consumer will perceive that he/she purchased it at a "bargain" price. Still other forms of promotions are special incentives such as contests, prize give-aways, and vacations. The emphasis is given to the chances of winning these incentives rather than to the product characteristics themselves. All of these forms of promotions are therefore used as vehicles to get consumers to purchase the products immediately or at least at a later date with little or no meaning to product efficacy.

Store Image

Products may be purchased not because of their own merits, but because they are associated with a particular store (O'Shaughnessy, 1987). Often, consumers like to shop at a certain store because of its own attributes and the consumer purchases a brand because it is associated with the stores attributes. According to the definition in Sirgy (1983), "store image" is "the way the store is defined in the shopper's mind, partly by its functional qualities and partly by an aura of psychological attributes." With respect to these attributes, the 9 that are identified are merchandise, service, clientele, physical facilities, convenience, promotion, store atmosphere, institutional factors, and post-transactional satisfaction. If the consumer views most attributes of the store positively then they may also apply similar attributes to the products being sold in the store.

Product Image

According to Sirgy (1983), "Products are assumed to have a personality or image, just like people. This image is not determined by the physical characteristics of a product alone, but by a host of other factors such as packaging, advertising, price, and channels of distribution." The product image would then influence the consumer to purchase the product not just on the functional characteristics themselves, but on the total "personality" of that product. Using product image, companies thus try to market the objective and subjective attributes of a product that may best fit the desired perceptions of the consumer based on his/her own personality characteristics.

To summarize, product efficacy is only one of many other important factors which determine whether a product becomes a market leader.

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