Executive Summary

A. Introduction

To reduce excess ozone concentrations in non-attainment areas, control of ozone precursors such as volatile organic compounds (VOCs) and oxides of nitrogen (NO_x) is needed. As part of California's abatement strategy, we have been successfully implementing mass-based VOC emission controls for aerosol coating products. To further refine the current regulatory approach, in this rulemaking the Air Resources Board (ARB) staff is recommending using photochemical reactivity as the basis for regulating emissions from aerosol coatings.

The proposed amendments presented here recognize that each VOC has a different ability to induce ambient ozone in the air once emitted. This concept is known as photochemical reactivity. By understanding the differences in VOCs' potentials to form ozone, and by using that knowledge in regulatory applications, a more effective and cost efficient control strategy can be established that, rather than limiting the total mass of VOCs, limits the amount of ozone produced by the VOCs. We believe this control approach has the potential to provide more flexibility to manufacturers, at less cost than traditional mass-based VOC controls, while achieving equivalent or greater air quality benefits.

Therefore, in this rulemaking staff is proposing to amend the Aerosol Coatings Regulation (section 94520-94528, Title 17, California Code of Regulations) by replacing the January 1, 2002, VOC limits for aerosol coatings with reactivity limits that achieve an equivalent air quality result. At its November 19, 1998, hearing the ARB adopted VOC content limits that are more stringent than the existing limits which became effective January 8, 1996. These more stringent limits become effective on January 1, 2002. At that hearing, recognizing that some of the limits were technologically challenging, the Board directed staff to return to them with an alternative reactivity-based compliance option for aerosol coatings. To that end, staff has been working with the affected industry on voluntary reactivity provisions for this regulation.

However, during development of the voluntary reactivity regulation proposal, staff and several representatives of the aerosol coating industry came to the conclusion that it was preferable to pursue replacing the VOC content limits with mandatory reactivity-based VOC limits. In making the request, the industry representatives indicated that reactivity-based VOC limits may provide more flexibility, while efficiently reducing the ozone formed from aerosol coatings. With agreement from the majority of the aerosol coating industry, staff began working on a proposal for mandatory reactivity-based VOC limits. These proposed amendments are described here and in greater detail in the Technical Support Document.

We also note that a commitment was included to consider incorporating reactivity into our consumer products regulations (including aerosol coatings) when the ARB adopted the 1994 State Implementation Plan (SIP) for Ozone. Since 1995, ARB staff has been working with the affected consumer products stakeholders on approaches to include reactivity within our regulations. This proposal for aerosol coatings is the result of that work. This proposal is intended to be a "pilot project" which provides a model for additional reactivity-based control measures.

In accordance with Government Code section 11346.2(a)(1), this Executive Summary, contains an overview, in plain language, of the staff's proposal to amend the Aerosol Coatings Regulation. The overview is provided in a question and answer format. We also explain the rationale for this proposal. A more detailed description of all the proposed regulatory changes, in plain English, is included in Chapter VI of the Technical Support Document.

B. Summary of Proposed Rulemaking

What amendments are being proposed to the Aerosol Coatings Regulation?

We are proposing to amend the Aerosol Coatings Regulation by replacing the January 1, 2002, VOC limits with reactivity-based limits that achieve equivalent air quality benefits. By restricting the reactivity of the VOCs, rather than the total mass of the VOCs, staff believes these reactivity-based limits will provide more reformulation options at potentially less cost. In developing the proposed reactivity limits, our goal was to propose limits that ensure that the ozone reduction commitment from the existing mass-based VOC limits would not be compromised. The limits are based on the maximum incremental reactivity (MIR) scale developed by Dr. William Carter of the University of California, Riverside. To implement the reactivity provisions we are also proposing to add a new Subchapter 8.6 that would contain the MIR values. The proposed reactivity limits are shown in Table 1. Other amendments to the Aerosol Coatings Regulation are proposed to implement the reactivity limits.

What specific amendments to Method 310 are proposed?

We are proposing revisions to ARB Method 310 so that it can be used to verify and provide discreet results for aerosol coating product ingredients. These proposed amendments will aid in enforcing the proposed amendments to the Aerosol Coatings Regulation.

Although analytical procedures exist for identifying individual chemical species, currently, ARB applies Method 310 for determining the overall VOC content of aerosol coating products. In this reactivity-based regulation, chemical ingredient information (in percent by weight) is needed for determining the ozone formation potential of aerosol coating products. Hence, amendments to the regulatory language are proposed to allow Method 310 to be used in this application.

TABLE 1
PROPOSED LIMITS FOR AEROSOL COATING PRODUCTS

	Reactivity Limit g O_3 / g product
General Coatings	**Effective Date : 06/01/02**
Clear Coatings	1.54
Flat Paint Products	1.21
Fluorescent Coatings	1.77
Metallic Coatings	1.93
Nonflat Paint Products	1.40
Primers	1.11
Specialty Coatings	**Effective Date : 01/01/03**
Art Fixatives or Sealants	1.80
Auto Body Primers	1.57
Automotive Bumper and Trim Products	1.75
Aviation or Marine Primers	1.98
Aviation Propeller Coatings	2.47
Corrosion Resistant Brass, Bronze or Copper Coatings	1.78
Exact Match Finishes	
Engine Enamel	1.72
Automotive	1.77
Industrial	2.07
Floral Sprays	1.68
Glass Coatings	1.42
Ground Traffic/Marking Coatings	1.18
High Temperature Coatings	1.83
Hobby/Model/Craft Coatings	
Enamel	1.47
Lacquer	2.70
Clear or Metallic	1.60
Marine Spar Varnishes	0.87
Photograph Coatings	0.99
Pleasure Craft Finish Primers, Surfacers or Undercoaters	1.05
Pleasure Craft Topcoats	0.59
Shellac Sealers	
Clear	0.98
Pigmented	0.94
Slip-Resistant Coatings	2.41
Spatter/Multicolor Coatings	1.07
Vinyl/Fabric/Leather/Polycarbonate Coatings	1.54
Webbing/Veil Coatings	0.83
Weld-Through Primers	0.98
Wood Stains	1.38
Wood Touch-Up, Repair or Restoration Coatings	1.49

When will the reactivity limits become effective?

The current mass-based VOC limits became effective on January 8, 1996, with more stringent limits scheduled to become effective on January 1, 2002. The reactivity limits are intended to replace the January 1, 2002, VOC limits. However, to allow adequate time to reformulate aerosol coatings, staff is proposing to extend the date that the reactivity limits would become effective. We are proposing to bifurcate the effective dates for the reactivity limits, with the general coating category limits becoming effective on June 1, 2002, and the specialty coating category limits becoming effective on January 1, 2003. By providing the additional seven months to comply with the specialty coating category limits manufacturers will be able to focus first on reformulation efforts for the general coating categories, which will provide the greatest air quality benefit.

Extending the effective dates would result in a delay of the reductions of ozone precursors for up to one year. However, the general coatings categories constitute about 78 percent of the total ozone formation potential of the aerosol coatings category, and, by requiring compliance by June 1, 2002, most of the planned ozone reductions will be achieved concurrent with the 2002 ozone season. For an additional seven months there will be an ozone shortfall of 1.7 tpd from the specialty coating categories. We believe the extension of the effective date is necessary to prevent disruptions in the aerosol coating market place and to minimize the possibility of an economic hardship for aerosol coating manufacturers. This proposal also ensures that efficacious products will continue to be available to the consumer in all 35 categories. We believe that these considerations override the relatively small short-term air quality disbenefit.

C. Background and Staff Proposal

What is reactivity?

The photochemical reactivity (or reactivity) of a VOC is a measure of its potential to enhance ozone formation in the air once emitted. In the presence of sunlight, VOCs in the air react with oxides of nitrogen (NO_x) to form ozone. Of the many different VOCs released into the atmosphere, each reacts at a different rate and through a different chemical reaction mechanism. The VOCs with high reactivity have a greater potential to form ozone, while other VOCs react slowly in the atmosphere, and are less likely to form ozone.

In the current Aerosol Coatings Regulation and virtually all other VOC regulations, total VOC content is limited on a percent-by-weight basis, without consideration of the differences in VOC reactivity. In this type of control strategy all VOCs are treated similarly, or in some cases (exemptions), form very low amounts of ozone such that their contribution to ambient ozone concentrations is not considered. Therefore, a reactivity-based control strategy could be viewed as a “refinement” of mass-based control strategies, because each VOC is considered with its respective ozone formation potential. This type of control has the potential to lead to more efficient ozone reductions by targeting substitutions of highly reactive compounds with lower reactive compounds. For example, the ozone formed from one gram of toluene is over seven times more than that formed from one gram of propane (Carter, 2000). The reactivity-based approach proposed here relies primarily on VOC substitution rather than VOC reduction. A reduction in the total VOC content may not always be necessary.

How can we compare the reactivities of VOCs?

Research on VOC reactivities over the last several decades has led to the development of scales to serve as tools to compare one VOC's reactivity to another. One such scale is the MIR scale developed by Dr. William P. L. Carter at the University of California at Riverside. This scale provides a numerical value to each VOC's potential to form ozone based on modeling analyses and other data derived from smog chamber studies. The higher the MIR value, the more ozone likely to be formed by a compound. We are proposing to use the MIR scale as the basis for setting reactivity limits.

Why has the MIR scale been selected as the most appropriate scale?

For ozone control strategies, the reactivity scale selected should be designed for the best overall air quality benefit. At the request of ARB, Dr. Carter studied 18 different methods of ranking the reactivity of individual VOCs in the atmosphere using a single-cell trajectory model with the SAPRC90 chemical mechanism (Carter, 1994). Dr. Carter concluded that if only one scale is to be used for regulatory purposes in California, the MIR scale is the most appropriate.

Based on this recommendation, the ARB is proposing to use the MIR scale for the Aerosol Coatings Regulation. The MIR scale appears to be most accurate for VOC-limited conditions, such as in the South Coast Air Basin, in which VOC controls would be most effective. We also note that the MIR scale is currently used to derive reactivity adjustment factors in the Low Emission Vehicle/Clean Fuels Regulations.

Will the MIR scale change?

Although we expect the MIR scale to gradually change as more data become available, we do not expect the qualitative ranking of VOC reactivities to change appreciably. As discussed below over 80 percent of compounds used in aerosol coatings are well-characterized, and another 17 percent are fairly well-characterized, such that their MIR values are expected to remain stable. However, if significant changes in MIRs occur the ARB is committed to reevaluate the reactivity limits to ensure that they continue to achieve the required ozone reduction. Should the limits change, manufacturers would be given adequate reformulation time to comply. Staff is continuing to evaluate an appropriate process to update MIR values and limits, and may propose additional changes at the Board hearing.

How is MIR value uncertainty addressed?

In providing MIR values for VOCs, Dr. Carter, based on his technical expertise, indicates the degree of uncertainty associated with each value. To describe the reliability of reactivity estimates Dr. Carter developed six bins. Bins one and two include compounds with reaction mechanisms that are well-characterized. Bins three and four include compounds with limited data, and bins five and six contain compounds for which very little data exist. We are proposing to use these bins as a mechanism to account for MIR value uncertainty.

Staff acknowledges that MIR values may decrease as well as increase. However, to ensure the air quality benefits, in designing this proposal staff has only considered that MIR values may increase. We are proposing that compounds in bins one and two be multiplied by an uncertainty factor of "1.0," in other words, no adjustment. For compounds contained in bin three we are proposing to adjust their MIR values by a factor of "1.25;" compounds in bin four would be adjusted by a factor of "1.5;" compounds in bins five and six by a factor of "2.0." We are also proposing to adjust hydrocarbon solvent MIR values by a factor of "1.15." These adjustment factors are assigned based on Dr. Carter's evaluations on the amount of experimental data available and MIR mechanistic uncertainty (see also Chapter II). These factors are proposed such that, if MIR values change due to new or improved data becoming available, the ozone reduction commitment would not be compromised. The uncertainty factors, under this proposal, would be applied to the MIR values prior to calculating the target ozone reduction. By addressing uncertainty within development of the proposed limit, manufacturers selecting solvents for reformulation would be able to use the MIR values without adjustment.

We have reviewed the VOCs currently used in aerosol coatings, and the uncertainty bins in which they fall. This analysis showed that over 80 percent on a by-weight basis of the VOCs used in aerosol coatings fall into bins one and two, and no MIR value adjustment would be necessary. Only two percent of compounds used fall into bin three, and less than one percent of compounds in bin four are currently used. About 17 percent of compounds used are hydrocarbon solvents and MIR values would be adjusted by 1.15. The remaining compounds used, less than one percent, fall into bins five and six. Because over 95 percent of compounds are fairly well-characterized we are able to propose reactivity limits for aerosol coating products at this time.

How do you convert a mass-based VOC reduction commitment into an equivalent ozone reduction?

In developing the proposed reactivity limits, our goal was to propose limits that ensure that the ozone reductions that would result from the mass limits would be preserved. Each proposed reactivity limit for a coating category is therefore based on the ozone reduction that would have been realized with the mass limits for each category of aerosol coatings. This required fairly extensive calculations based on product formulation data obtained from an industry survey. As mentioned above, uncertainty factors were incorporated into the reactivity limits.

How was a hydrocarbon solvent reactivity classification scheme developed?

Typical hydrocarbon solvents include VOC solvents such as mineral spirits, and naphtha. These solvents are not composed of a single chemical component, but rather many hydrocarbon constituents. Because of this, we developed a method to assign MIR values to hydrocarbon solvents based on average boiling points, alkane, and aromatic contents. Solvents with similar average boiling point and alkane and aromatic content are assigned to a group, and an MIR value is assigned to each group. Our approach for assigning MIR values to hydrocarbon solvents is included in Chapter IV and Appendix C of the Technical Support Document.

What information is needed to establish a reactivity program?

To establish reactivity-based limits, product sales and VOC speciation data are needed. These data are available from the 1997 survey of aerosol coatings.

How were the reactivity limits set?

Typically, when VOC limits are proposed, the available technologies, cost, total VOC content, and complying marketshares are used as guiding factors to determine technologically and commercially feasible VOC limits. This was the case when the staff proposed, and the Board adopted the January 1, 2002, revised VOC limits for aerosol coatings. These mass-based VOC limits are designed to achieve a reduction in VOC emissions of about 3.1 tons per day (tpd). In developing the proposed reactivity limits, our goal was to propose limits that ensure that the ozone reduction associated with the mass limits would be preserved. Therefore, each proposed reactivity limit is based on the VOC emission reduction commitment for each category of aerosol coatings. The VOC reduction is converted into an ozone reduction using the MIR scale. The ozone reduction target is adjusted for uncertainty, and this becomes the target reduction that the reactivity limits must achieve. Through an iterative process, reactivity limits are derived that achieve the necessary ozone reduction. A complete description of how the limits are calculated is included in Chapter IV of this report.

Is there any ongoing or planned research on reactivity?

Research on reactivity is ongoing. The ARB continues to fund research to improve analytical techniques to estimate VOC reactivities.

What is the role of the Reactivity Scientific Advisory Committee (RSAC)?

In April 1996, the ARB established the RSAC. The committee is made up of independent, respected scientists who have the responsibility to provide advice on the use of hydrocarbon reactivity in ARB programs. At their August 26, 1998, meeting the RSAC approved of our regulatory approach for a reactivity-based regulation for aerosol coatings, but suggested that the basis for the regulation, the MIR scale, should undergo peer review before using it in regulatory applications.

Based on this advice, the ARB contracted with Dr. William Stockwell of the Desert Research Institute to conduct the review of Dr. Carter's MIR scale. The result of that review was shared with the RSAC at their October 8, 1999, meeting. They expressed overwhelming support for the review and commented that the MIR scale, and the mechanism from which it is derived, represented the "state-of-the-science."

Are there other reactivity-based programs at the ARB and/or in the United States?

The proposed amendments would be the first reactivity-based ARB regulation proposed for non-mobile sources. However, the ARB has taken the lead in considering reactivity principles as a means to control ozone formation. In 1990, the ARB adopted the Low Emissions Vehicle and Clean Fuels Regulations. These regulations first used the MIR scale developed by Dr. Carter to determine the ozone-forming potential of vehicle exhaust by utilizing reactivity adjustment factors (RAF). A RAF is the ratio of the reactivity of exhaust emissions, from an alternatively fueled vehicle, to the reactivity of exhaust emissions from a conventional gasoline fueled vehicle. The ozone reactivity for the exhaust emissions is calculated using the MIRs for the individual VOCs found in the emissions. By making a reactivity adjustment to the emissions, an alternatively fueled vehicle is able to emit more mass emissions, as long as they are less reactive than those from a gasoline fueled vehicle.

Does the SIP require use of reactivity?

When the ARB adopted the 1994 State Implementation Plan for Ozone we included a commitment to consider reactivity when developing control strategies for consumer products (including aerosol coatings). We included reactivity as a potential control strategy in recognition that the 85 percent overall VOC emission reduction may be difficult to achieve on a mass-based approach alone. Since 1995 the ARB staff has been working with the affected consumer products stakeholders on approaches to include reactivity within our regulations, and this proposal was designed to meet the commitments made when the 1994 SIP was adopted.

Why are we proposing reactivity as a control strategy for aerosol coatings products?

As mentioned above, the ARB committed to investigate the use of reactivity in consumer products control strategies. Also, at its November 19, 1998, hearing the ARB adopted VOC content limits that are more stringent than the existing limits which became effective January 8, 1996. These more stringent limits become effective on January 1, 2002. At that hearing, recognizing that some of the limits were technologically challenging, the Board directed staff to return to them with an alternative reactivity-based compliance option for aerosol coatings. To that end, staff has been working with the affected industry on a voluntary reactivity regulation. However, during development of the voluntary proposal, staff and several representatives of the aerosol coating industry came to the conclusion that it was preferable to pursue replacing the VOC content limits with mandatory reactivity-based VOC limits. With agreement from the majority of the aerosol coating industry, the proposal that is the subject of this rulemaking would replace the January 1, 2002, VOC content limits with mandatory reactivity limits.

The aerosol coating category was selected for the first reactivity-based regulation because it is a well-defined, discreet consumer product category. We also have detailed speciation data from a recent survey. These data indicate that the VOCs used are well-characterized. We also note that aerosol coating manufacturers agreed to work with us early on to see if reactivity could be a viable control strategy. As such the regulation will act as a pilot for other potential reactivity-based regulations.

Will VOCs that are currently considered exempt continue to be exempt if the proposed amendments to the Aerosol Coatings Regulation are adopted?

In these amendments staff is proposing to eliminate the exemptions for low and negligibly reactive compounds. Currently, the Aerosol Coatings Regulation contains exemptions for negligibly reactive VOCs such as methane, and low reactive VOCs, such as acetone. This approach assumes these compounds do not contribute to ozone formation. However, under a reactivity-based strategy the potential ozone formation of all VOCs is considered. Using the MIR scale we are able to distinguish individual VOCs including acetone, by their characteristic reactivity values. The negligibly reactive and low reactive VOCs do make small contributions to ozone formation once they are emitted, they are just much less potent in forming ozone. However, staff believes that because these compounds have comparatively very low reactivity values, industry will still have strong incentives to use these compounds, where they are otherwise a desirable component in aerosol coatings.

What are the potential benefits of the proposed amendments to the Aerosol Coatings Regulation?

We believe there are several benefits to adopting the proposed amendments. First of all, we believe the proposed amendments will ensure that ozone reduction benefits are achieved from aerosol coatings. At present, total VOC content is limited on a percent-by-weight basis, without consideration of the differences in VOC reactivity. To comply with these more stringent VOC content limits, manufacturers would reduce the total VOC content. However in some instances manufacturers may choose to use more reactive VOC solvents, thus reducing the air quality benefit. Limiting the reactivity of the VOCs in a product helps ensure that ozone reductions are achieved as products are reformulated.

Secondly, we believe the proposed amendments may provide manufacturers more reformulation options. Manufacturers may be able to maintain the same overall VOC content as in their current formulations, however they will have to use VOC solvents that have lower ozone formation potentials. This approach should allow manufacturers more reformulation options and, as our economic impact analysis shows, may be a more cost effective compliance mechanism.

Another benefit that may result from the proposed amendments is a reduction in the use of toxic compounds such as toluene and xylenes due to their higher photochemical reactivity compared to other solvents.

Finally, the ARB will also benefit through this pilot project by using it as an example for future reactivity-based control strategies.

D. Effects of the Proposed Rulemaking

What products will be affected by the proposed rulemaking?

Thirty-five categories of aerosol coating products will be affected. These products are primarily aerosol paints, but also include aerosol clear coatings and aerosol stains.

Who would be affected by the proposed rulemaking?

The proposed rulemaking would affect any person who sells, supplies, offers for sale, applies, or manufactures for use in California any aerosol coating product subject to the regulation. This includes manufacturers, distributors, wholesalers, retailers, and aerosol paint users. The regulation is intended to apply to both household and industrial uses of aerosol paints. However, it should be noted that the regulation contains a specific exemption for noncommercial application of aerosol coatings. This exemption was provided to avoid enforcement actions against home use of noncomplying aerosol coatings.

The primary impact would be on manufacturers and marketers of aerosol coatings, which will have to reformulate some of their products. There would also be an impact on distributors and retailers, who must ensure that they are selling or supplying complying products. In addition, because some products will have to be reformulated, suppliers of chemicals, propellants, containers, valves, and other components may be impacted, depending on whether there is an increased or decreased demand for their products. Finally, consumers may have to pay more for some aerosol coating products, or may have to make some adjustments in their use of the reformulated products.

Will the performance of aerosol coatings products be affected?

There may be some changes in the characteristics of the reformulated aerosol coating products because their formulations will change. However, we do not expect significant impacts on product performance.

The regulation specifies different limits for each of the 35 categories of products to ensure that each type of product can be successfully reformulated and continue to be available to consumers. There are already complying products in nearly all of the 35 categories (in most cases representing a significant marketshare).

We expect the performance of water-based aerosol coatings to be unchanged. This is because these products currently are formulated with lower reactive solvents that have less ozone formation potential. Therefore, these products, formulated with water and dimethyl ether, already comply with the proposed limits.

How will the proposed changes to ARB Method 310 affect aerosol coating manufacturers?

We do not expect that the proposed amendments to ARB Method 310 will have an impact on aerosol coating manufacturers. Analytical data and other necessary information may be required from aerosol coating manufacturers to assist with the determination of chemical ingredients by Method 310, but this information should be readily available.

E. Regulatory Development Process and Evaluation of Alternatives

How did ARB staff develop the proposed amendments?

This rulemaking was developed in cooperation with the aerosol coating industry, solvent manufacturers, and other interested stakeholders. We began the process of determining if reactivity could be a useful control strategy for consumer products by establishing the Reactivity Subgroup within our Consumer Products Working Group in 1995. This group has met nine times. Findings from meetings of the Reactivity Subgroup, showing reactivity to be a viable control strategy, led us to begin developing a concept for a reactivity-based control regulation for aerosol coatings. Development of the regulation began in early 1998 and was originally proposed as an optional compliance strategy to the mass-based limits for aerosol coatings.

In developing the proposal, we have conducted eight public workshops, with the first held in November of 1997. At the first workshop we presented general regulatory concepts. Our most recent public workshop was held on April 11, 2000, at which time we presented the mandatory reactivity limit proposal. During the workshops, ARB staff discussed the proposed amendments, the limits, and other elements of the proposal necessary to establish the limits. Also, in the fall of 1999 we formed the Aerosol Coating Workgroup that is comprised of aerosol coatings manufacturers. Through this group we have exchanged information on the elements of the proposal. This workgroup has met or held teleconferences five times. In addition to these more formal meetings, ARB staff has held meetings with individual aerosol coatings manufacturers.

Who has been most active in the process?

Aerosol coating manufacturers and marketers, and trade associations have been most active in the process. The trade associations include the National Paint and Coatings Association (NPCA), the National Aerosol Association (NAA), and the Chemical Manufacturers Association (CMA). ARB staff maintains a comprehensive mailing list of companies and interested parties, which received information throughout the development of the proposed rulemakings. Information has also been made available on the ARB's Internet site.

Did ARB staff evaluate any alternatives?

As originally proposed, the reactivity regulation would have been an alternative means to comply with the Aerosol Coatings Regulation. However, with this mandatory proposal manufacturers would no longer have an option. Staff does believe that this proposal provides more flexibility and more reformulation options than the mass-based VOC limits by requiring manufacturers to focus on ozone reductions rather than mass reductions. We also note again, that aerosol coatings industry representatives made the request of ARB staff to consider establishing mandatory reactivity limits.

It should also be noted that the option of complying through use of the Alternative Control Plan will no longer be available. This regulation is not currently designed to average reactivity adjusted emissions. However, in the future we will be considering updating the Alternative Control Plan to include reactivity considerations.

F. Compliance with the Proposed Amendments

How will manufacturers comply with the proposed reactivity limits?

Manufacturers of noncomplying products will need to replace higher reactive VOC solvents or propellants in their formulations with lower reactive VOC ingredients and/or fewer VOCs. To comply with the proposed reactivity limits the most effective way to lower the reactivity would be to find comparable lower reactive substitutes for the highest reactive solvents in their products.

Are the proposed reactivity limits technologically and commercially feasible?

As explained in Chapter VII and VIII of the Technical Support Document, we believe the proposed reactivity limits are technologically and commercially feasible. The proposed amendments specify limits for 35 individual categories of coating products to ensure that each type of product can be successfully reformulated and continue to be available for consumer use. For all but two of the proposed VOC limits, there are currently complying products being sold.

The two categories that do not currently have complying products are “glass coating” and “corrosion resistant brass, bronze, or copper coatings.” We believe, that given the availability of a variety of lower reactive solvents, there are numerous reformulation options that can be used by manufacturers to reformulate their products. Products in these categories may also be successfully reformulated by using technologies employed in other product categories with significant complying marketshares.

TABLE 2
PROPOSED REACTIVITY LIMITS AND COMPLYING MARKETSHARES

Product Category	Proposed Reactivity Limit (g O_3/g product)	Number Complying Products	Percent Complying Products	Complying Marketshare (Percent)
Clear Coatings	1.54	45	38	45
Flat Paint Products	1.21	26	22	11
Fluorescent Coatings	1.77	44	86	64
Metallic Coatings	1.93	54	33	27
Nonflat Paint Products	1.40	302	38	36
Primers	1.11	31	20	29
Art Fixatives or Sealants	1.80	7	47	47
Auto Body Primers	1.57	12	63	64
Automotive Bumper and Trim Products	1.75	34	49	73
Aviation or Marine Products	1.98	<10	100	100
Aviation Propeller Coatings	2.47	<10	100	100
Corrosion Resistant Brass, Bronze, or Copper Coatings	1.78	0	0	0
Exact Match Finishes: Engine Enamel	1.72	8	28	72
Exact Match Finishes: Automotive	1.77	276	87	62
Exact Match Finishes: Industrial	2.07	30	94	99
Floral Sprays	1.68	13	81	87
Glass Coatings	1.42	0	0	0
Ground Traffic/Marking Coatings	1.18	64	58	24
High Temperature Coatings	1.83	28	43	42
Hobby/Model/Craft Coatings: Enamel	1.47	32	94	94
Hobby/Model/Craft Coatings: Lacquer	2.70	<10	40	60
Hobby /Model Craft Coatings: Clear or Metallic	1.60	13	76	34

(continued on next page)

TABLE 2 (Continued)
PROPOSED REACTIVITY LIMITS AND COMPLYING MARKETSHARES

Product Category	Proposed Reactivity Limit (g O_3/g product)	Number Complying Products	Percent Complying Products	Complying Marketshare (Percent)
Marine Spar Varnishes	0.87	<10	100	100
Photograph Coatings	0.99	<10	50	39
Pleasure Craft Finish Primers, Surfacers or Undercoaters	1.05	<10	100	100
Pleasure Craft Topcoats	0.59	<10	100	100
Shellac Sealers: Clear	0.98	<10	100	100
Shellac Sealers: Pigmented	0.94	<10	100	100
Slip-Resistant Coatings	2.41	7	100	100
Spatter/Multicolor Coatings	1.07	12	55	89
Vinyl/Fabric/Leather/ Polycarbonate	1.54	16	80	31
Webbing/Veil Coatings	0.83	<10	100	100
Weld-Through Primers	0.98	<10	38	67
Wood Stains	1.38	<10	100	100
Wood Touch-Up, Repair or Restoration Coatings	1.49	<10	> 60	> 90

What is the ozone reduction from the proposed amendments?

The proposed limits are expected to reduce the ozone formation potential of aerosol coatings by about 9.6 tpd. This is the equivalent ozone reduction that would be expected from the mass-based VOC reduction commitment of about 3.1 tpd. The six general coating categories and the ground traffic/marking coating category account for about 80 percent of the ozone formation potential, while the other 28 categories account for the remaining 20 percent of the ozone formation potential from aerosol coatings.

G. Economic Impacts

What are the expected economic impacts of the proposed amendments to the Aerosol Coatings Regulation on businesses?

Overall, we believe the proposed amendments to establish reactivity-based limits would result in cost savings for aerosol coatings manufacturers compared to the estimated cost to comply with the mass-based VOC limits. We conducted an analysis of the costs manufacturers would incur to reformulate their existing products to meet the proposed reactivity limits. We compared this cost with the costs estimated for compliance with the mass-based VOC limits adopted on November 19, 1998. Our analysis showed that reformulating to meet the reactivity limits will result in cost savings compared to compliance with the mass-based VOC limits.

We conducted an economic impacts analysis when we proposed the amendments to the mass-based VOC limits that were adopted by the Board on November 19, 1998 (ARB, 1998a). For this complete analysis the reader is referred to "Initial Statement of Reasons for the Proposed Amendments to Regulations for Reducing Volatile Organic Compound Emissions from Aerosol Coatings, Antiperspirants and Deodorants, and Consumer Products" (ARB, 1998a).

Because our cost analysis for these proposed reactivity limits is less than was predicted for the mass limits we believe that the conclusions of that economic impacts analysis would still apply for this rulemaking. We previously evaluated the potential impacts on profitability and other aspects of businesses subject to the proposed limits (with particular attention to California businesses), the cost-effectiveness of the limits, and the estimated cost impacts to consumers. To conduct our analysis, prior to adopting the mass-based VOC limits, we relied on a combination of publicly available financial databases (Dun and Bradstreet, *Ward's Business Directory of U.S. Manufacturing Industries*), the 1997 ARB Aerosol Coatings Survey (ARB, 1998b), industry journals/literature, and discussions with industry representatives.

Based on our earlier analysis, we expect most manufacturers to be able to absorb the added costs of the proposed rulemaking without an adverse impact on their profitability. We also found that the proposed rulemaking is cost-effective relative to similar ARB regulations or measures, and the impacts to consumers based on changes to raw materials cost are consistent with existing ARB regulations.

In the analysis conducted for the mass-based VOC limits, we estimated the change in "return on owner's equity" (ROE) as an indicator of the standards' potential impacts on business profitability. The cost to comply with the proposed regulation, due to increased research and development, materials costs, equipment purchases and other investment costs, is presumed to impact a business' ROE and therefore its profitability. The cost to reformulate noncomplying products for a typical small, medium and large company was used to determine the total annual reformulation costs. At that time, our analysis indicated that the estimated change in ROE can vary from essentially no change to slightly over an eight percent change. The average change in ROE was about two percent, relative to the pre-regulatory ROE. This estimated change in ROE is well within the change in ROE estimated for ARB's existing consumer products regulations. Given that the costs estimated from our analysis of costs to comply with the reactivity limits are lower, we expect the change in ROE to be no more, and likely less, than was estimated for the mass-based VOC limits.

Our ROE analysis for the mass-based VOC limits may have overestimated the impact on businesses because it assumes that manufacturers will absorb all of the compliance costs. In reality, we expect at least some of the investment costs to be passed on to consumers. The analysis also did not quantify the extent of cost mitigation from "technology-transfer" among product lines and from third-party manufacturers (i.e., contract fillers) who fill essentially equivalent products for a number of competing businesses.

In our earlier analysis, we also determined that most businesses would be able to absorb the costs to comply without significant adverse impacts on their profitability. This same conclusion can be drawn for manufacturers reformulating to meet the reactivity limits because the costs to reformulate products are less than those calculated to meet the mass-based VOC limits.

However, we also conclude that there is the possibility that some individual businesses may be adversely affected by this regulatory action. It is possible that some aerosol coatings manufacturers had begun to incur costs as they worked toward meeting the mass-based limits. Our analysis did not consider these costs, so in some instances the costs estimated here to comply with the reactivity limits may be underestimated. Therefore, it is possible that these proposed amendments may have a significant adverse impact on some businesses that are not in a market position to invest monies to develop new lower reactive products as well as other manufacturers, or to absorb the increased cost resulting from their compliance with the proposed rulemaking.

Again, based on our earlier analysis, we do not expect these proposed amendments to have a significant impact on employment, or business creation, elimination, or expansion. We also do not expect the proposed amendments to have a significant impact on the competitiveness of California businesses compared with those outside of California. This is because all companies that sell aerosol coating products in California would have to meet the proposed requirements, whether located in or outside of California.

The proposed reactivity limits will primarily impact aerosol coating manufacturers and marketers (companies which contract out the manufacturing of their products). However, we recognize that other industries could also be impacted to a lesser amount, which is difficult to quantify. These industries include distributors, retailers, and "upstream" suppliers who supply containers, valves, solvents, propellants, and other chemicals used in aerosol coatings.

Distributors and retailers could be impacted if some manufacturers decide to carry a dual inventory of products (one for California and one for the rest of the nation). Another potential cost to distributors or retailers would be the implementation of procedures to ensure that noncomplying products are not sold past the three year "sell-through period." However, based on retail sell-through data obtained during the development of ARB's existing consumer product regulations, we believe the existing three year sell-through period should provide ample time to allow for the sale of noncomplying aerosol coating products.

Upstream suppliers could be impacted because manufacturers will be purchasing some different solvents, propellants, and other materials for their reformulated products. They may also purchase different containers, valves, or other components for their reformulated products. However, we do not expect these changes to result in a major impact on the affected industries because chemical companies generally supply many different industries, and because many of the upstream suppliers also provide the alternative products which will be used in the reformulated products. In fact, we expect some upstream suppliers will benefit since the proposed reactivity limits are likely to create new or increased demand for materials to be used in compliant formulations.

Will the proposed rulemaking be cost-effective?

Cost-effectiveness is one measure of a regulation's efficiency in reducing a given amount of pollutant (often reported in "dollars (to be) spent per pound of VOC reduced"). The determination of cost-effectiveness is well-established and often used to compare a proposed regulation's cost-efficiency with those of other regulations. To conduct our analyses, we relied on specific formulation data from the 1997 ARB Aerosol Coatings Survey, industry journals/literature, and discussions with industry representatives. Our analyses considered separately the impacts on the cost-effectiveness from nonrecurring, investment costs (as an annualized cost) and the impacts from recurring costs (primarily changes in raw material ingredients).

It is important to keep in mind that in these amendments we are proposing limits that will reduce the amount of ozone formed rather than reduce the total amount of VOC emissions. However, because traditionally cost-effectiveness is based on cost per pound of VOC reduced, we are presenting our analysis in the same units. We estimate the cost-effectiveness of the proposed amendments to the aerosol coatings regulation to range from no cost to about $1.67 per pound of VOC reduced, with a sales-weighted average of about $0.74. When the mass-based VOC limits were adopted by the Board on November 19, 1998, we estimated the cost-effectiveness of those amendments to range from $0.93 to $3.19, with an overall average cost-effectiveness of $1.57 per pound of VOC reduced. These data for the proposed reactivity limits support our conclusion that reformulating to meet reactivity limits is a more cost-effective compliance alternative and are consistent or lower than other existing ARB regulations and control measures.

Will consumers have to pay more for aerosol coatings subject to the rulemaking?

We estimate the cost per unit to range by category from no cost to an increase of about $0.11 per unit. The average cost per unit increase is expected to be about $0.05. These values compare favorably to the cost increase predicted from compliance with the mass-based VOC limits (about $0.10). To the extent manufacturers pass these costs along to the consumer, the actual retail price changes may be higher or lower than indicated by this analysis. Chapter XI and Appendix I of the Technical Support Document contain the detailed analyses of our estimated range in unit cost increases.

What are the expected economic impacts of the proposed modifications to Method 310?

We do not expect that the proposed amendments to Method 310 will result in any costs to manufacturers. Even though we would require manufacturers to supply formulation data if their products are selected for testing, this is information that is readily available and should not pose any cost burden.

H. Environmental Impacts

What are the expected environmental benefits of the proposed amendments?

The proposed amendments are designed to provide an equivalent air quality benefit as would be achieved upon implementation of the January 1, 2002, VOC content limits. The primary intent of this rulemaking is to reduce the total amount of ozone formed from aerosol coating product emissions, rather than reduce the total mass of VOC emissions. The mass-based VOC reductions, upon implementation in 2002, would achieve a VOC reduction of 3.1 tpd. In this rulemaking, we are converting the commitment of 3.1 tpd of VOC emissions reductions into 9.6 tpd of ozone reductions.

Another benefit that may result from the proposed amendments is a reduction in the use of toxic compounds such as toluene and xylenes due to their higher photochemical reactivity compared to other solvents.

In addition, VOCs have also been found to contribute to the formation of $PM_{2.5}$ (minute particulate matter of 2.5 micrometers or less equivalent aerodynamic diameter). Results of aerosol formation studies suggest that reactive aromatic compounds and aromatic-containing hydrocarbon solvents used in aerosol coatings, such as toluene, xylenes, and naphthas, may have high $PM_{2.5}$ formation potentials. To comply with the reactivity limits the most efficient ozone reductions would be achieved by reducing the amounts of these highly reactive compounds**.** Because of this we believe the proposed rulemaking may have an additional positive impact on $PM_{2.5}$ formation (see below also).

How would the proposed rulemaking reduce the risk to public health?

It has long been known that exposure to ground level ozone and $PM_{2.5}$ have adverse impacts on public health. These potential health impacts include respiratory problems, aggravated asthma, and impairment of the immune system. Therefore, by reducing the ozone and, potentially, $PM_{2.5}$ concentrations, this regulation would reduce the health risks posed by exposure to these pollutants.

Another benefit that may result from the proposed amendments is a reduction in the amounts of toxic compounds such as toluene and xylenes due to their higher photochemical reactivity compared to other solvents.

Are there any potential negative environmental impacts from the proposed reactivity limits?

We are proposing to delay the effective date of the reactivity limits from January 1, 2002, to June 1, 2002, and January 1, 2003, for general coatings and specialty coatings, respectively. Because of this a short-term shortfall of 9.6 tpd of ozone will occur for five months. However, the general coatings categories constitute 78 percent of the total ozone formation potential. By requiring compliance by June 1, 2002, 7.9 tpd, or 82 percent of the ozone reductions will be achieved concurrent with the 2002 ozone season. For an additional seven months there will be an ozone shortfall of 1.7 tpd. We believe the extension of the effective date is necessary to prevent disruptions in the aerosol coating market place and to minimize the possibility of an economic hardship for aerosol coating manufacturers. This proposal also ensures that efficacious products will continue to be available to the consumer in all 35 categories. We believe that these considerations override the short-term air quality disbenefit.

Both high molecular weight VOCs (or solvent) and aromatics are expected to contribute to the formation of aerosols. While the heavier organic compounds are less reactive, they may have higher potentials to form $PM_{2.5}$ than their light weight counterparts. A similar situation is also found for aromatic compounds and solvents used in aerosol coating products. However, the extent that manufacturers would reformulate using these high aerosol forming VOC or aromatic species is difficult to predict. Hence, we will continue to monitor implementation of the regulation to ensure that there is no adverse impact as a result of the proposed rulemaking.

We did identify one other potential adverse impact from implementation of the proposed amendments. Methylene chloride has been identified as a toxic air contaminant by the ARB. Because methylene chloride is a negligibly reactive VOC and also has desirable solvent qualities, its use could potentially increase as products are reformulated to meet the reactivity limits. Because of this, we are proposing a “no new use” provision for methylene chloride to prohibit increased uses. As proposed, if an existing product already uses methylene chloride, no additional methylene chloride could be added when the product is reformulated. Any product that does not currently contain methylene chloride, could not reformulate using methylene chloride. Our complete analysis is contained in Chapter X and Appendix G.

As explained further in Chapter X of the Technical Support Document, we do not expect any other adverse environmental impacts to result from the proposed amendments. We examined the potential effect of the proposed regulation on global warming, stratospheric ozone depletion, the use of Toxic Air Contaminants, and the impacts on water quality and solid waste disposal.

REFERENCES

Carter, W.P.L. (1994) Development of Ozone Reactivity Scales for Volatile Organic Compounds. Journal of the Air and Waste Management Association 44:881-899.

Air Resources Board. (1998a), Initial Statement of Reasons for the Proposed Amendments to the Regulations for Reducing Volatile Organic Compound Emission from Aerosol Coatings, Antiperspirants and Deodorants, and Consumer Products. October 2, 1998.

ARB (1998b) 1997 Air Resources Board Aerosol Coatings Survey. November 25, 1997.

Carter, W.P.L. (2000). The SAPRC-99 Chemical Mechanism and Updated VOC Reactivity Scales, Draft Version. Revised April, 11, 2000. Prepared for the California Air Resources Board Contracts Nos. 92-329 and 95-308. Appendix D, pp. D-1 to D-33. http://www.cert.ucr.edu/~carter/reactdat.htm

Recommendation

We recommend that the Board adopt the proposed amendments to the Aerosol Coatings Regulation, the proposed Tables of MIR values, and the proposed amendments to ARB Method 310. Adoption of the proposed amendments would put in place the first reactivity-based regulation for consumer products. These amendments, if adopted, could be used as a model for additional reactivity-based regulations.

State of California
AIR RESOURCES BOARD

Technical Support Document

Initial Statement of Reasons for the

Proposed Amendments to the Regulation for Reducing Volatile Organic Compound Emissions from Aerosol Coating Products,
and
Proposed Tables of Maximum Incremental Reactivity (MIR)Values,
and
Proposed Amendments to Method 310, "Determination of Volatile Organic Compounds in Consumer Products"