Bay Area Air Quality Management District

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Workshop Report

BAAQMD Regulation 8, Rule 45: Motor Vehicle and Mobile Equipment Coating Operations

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WORKSHOP REPORT
Regulation 8, Rule 45: Motor Vehicle and Mobile Equipment Coating Operations

TABLE OF CONTENTS

I. INTRODUCTION

The Bay Area Air Quality Management District (District) regulates emissions of volatile organic compounds (VOC) from automotive refinishing operations through Regulation 8, Rule 45: Motor Vehicle and Mobile Equipment Coating Operations (Rule 8-45). Rule 8-45, which was first adopted in 1989, sets VOC limits on various types of paints and surface preparation solvents used in automotive refinishing. The rule also requires the use of spray technology that is transfer efficient, to maximize the amount of paint that adheres to the intended surface and minimize overspray. Currently, VOC emissions from automotive refinishing operations in the Bay Area total 5.8 tons per day (tpd).

This proposal would further reduce VOC emissions from automotive refinishing by incorporating the VOC limits and operational standards contained in the California Air Resources Board (ARB) Suggested Control Measure for Automotive Coatings (SCM). The SCM was developed in 2005 as a guideline to be used by California air districts in amending their automotive refinishing rules.

Staff is also considering including new form of a VOC standard as an alternative to the mass-based standards recommended by the SCM; one based on the reactivity of the coating formulation rather than the weight of VOCs in the coating. Different VOCs vary in their capacity to react in the atmosphere to form ozone. A reactivity standard would account for the ozone-forming ability of each of the compounds used in the coating formulations. A manufacturer could comply through a reduction in the overall reactivity of the coating. This would be an alternative to the traditional mass-based VOC standards expressed in grams VOC per liter of coating in the rule.

Further, the proposal includes new requirements for mobile refinishing operations. Mobile refinishers are typically small, one-person operations that travel from place to place to repair and repaint minor dents and scratches, frequently at auto dealerships. Mobile refinishers would be required to register with the District, and frequent clients, such as auto dealerships, would be required to record mobile refinisher visits.

The proposed amendments would result in a VOC emission reduction of 3.8 tpd, or about 65 percent of the Bay Area automotive refinishing emissions, and cost between $1,648 and $12,484 per facility depending on the size of the operation. [1]

II. BACKGROUND

Regulation 8, Rule 45: Motor Vehicle and Mobile Equipment Coating Operations regulates VOC emissions from automotive refinishing operations. Most VOCs used as solvents in refinishing coatings are precursors to the formation of ozone. Ozone is formed from the photochemical reaction of oxides of nitrogen (NOx) and VOCs. Ozone can result in reduced lung function, increased respiratory symptoms, increased airway hyper-reactivity, and increased airway inflammation. In addition, VOCs can contribute to the secondary formation of particulate matter (PM). Currently, the San Francisco Bay Area is not in attainment of the State air quality standards for ozone and PM, and the ARB has determined that ozone and ozone precursors are sometimes transported from the Bay Area to neighboring air basins. Amendments to Rule 8-45 were included as Control Measure SS 1 in the Bay Area 2005 Ozone Strategy.

A. Automotive Refinishing Operations

Automotive refinishing operations are conducted at auto body repair and paint shops, production auto body paint shops, auto dealership repair and paint shops, fleet operator repair and paint shops, and by mobile refinishers who travel to various sites and do limited body work and repainting at those locations. Many of the facilities do collision repair and some do commercial vehicle refinishing and repair. Mobile refinishing operations are primarily conducted at car dealerships and at facilities that operate fleets of vehicles, like rental car agencies, retail vehicle dealerships, and government agencies.

There are over 1100 automotive refinishing facilities permitted in the District. Overall, the majority of automotive refinishing facilities are small businesses typically having one to five employees. Over 70 percent of the facilities are estimated to have one million dollars or less in annual revenue.[1] Automotive refinishing facilities vary greatly in size and level of sophistication. Some automotive refinishing facilities are medium to large, relatively automated facilities, equipped with spray booths with forced air dryers and filtration, automatic gun cleaners and computerized recordkeeping for coating use; while the remaining facilities are typically family-run shops that may have a few employees. There are probably less than 200 mobile refinishers in the District. Mobile refinishing operations currently do not require a permit from the District.

1. Process Description

Automotive refinishing consists of refinishing done as a result of collision repair, in which the finish coats must blend into the existing color and surface; and complete refinishing and original equipment painting, where a complete topcoat is applied and color match is only necessary insofar as a utility body or truck trailer is expected to match a truck cab or corporate color scheme. Before a surface can be painted, it is critical that the surface is cleaned and degreased to

ensure the undercoatings and topcoatings will bond properly. There are two main categories of automotive coatings: primers or undercoatings and top coats. Primers are applied for fill, corrosion protection and to provide a smooth, uniform surface for the topcoat. Topcoats provide the desired appearance and protection.

2. Surface Cleaning and Preparation:

Prior to the application of any coating, it is critical to prepare and clean the underlying metal or plastic surface of dirt and oils. The first step in the process is sanding the surface to remove old paint and rust. The sanding also roughens the surface for the application of a primer coating. Next, dust is removed usually using compressed air, and then the surface is wiped with solvent to remove grease, oil or road tar. VOCs are released from the evaporation of the solvent from the surface and from the wipe cleaning cloth.

3. Primers

Primers, or undercoatings, include adhesion promoters, pre-coats, pretreatment coatings, primer-surfacers, primer-sealers, and sealers. Primers are used to provide adequate corrosion protection, surface filling properties for dings and scratches, and bond between the substrate and subsequent coats. The primers also provide a smooth surface for the application of the top coat and are sometimes pigmented to reduce the amount of a color coat that would be necessary. Primers are estimated to be responsible for about seven percent of the total VOC emissions (including solvent emissions) from automotive refinishing operations.

Adhesion Promoter

An adhesion promoter is a coating applied directly to uncoated plastic surfaces to facilitate bonding of subsequent coatings.

Precoats

Precoats are applied to bare metal primarily to deactivate the metal surface prior to the application of a subsequent primer surfacer. Developed for use with a water-borne primer-surfacer, they prevent the underlying metal from rusting.

Pretreatment Coatings

Pretreatment coatings are applied directly to bare metal surfaces to provide corrosion resistance and adhesion. Pretreatment coatings contain a minimum of 0.5 weight percent acid to provide surface etching, and not more than 16 weight percent solids.[2]

Primer-Surfacer

Primer-surfacers provide the majority of the fill for a repair. This provides a uniform surface that covers imperfections prior to a sealer or topcoat. Typically, these are applied to slightly above the surrounding painted area and then, when cured, sanded down to obtain a uniform, smooth surface.

Primer-Sealer and Sealers

A primer sealer is a thin-film coating used to isolate the primer-surfacer from the topcoat. The primer-sealer will fill minute sanding scratches, but will not fill voids. It is generally non-sandable, and forms a smooth surface for a topcoat application. An expensive, pigmented topcoat or a color coat will not penetrate through a sealer into underlying primers, which would require the use of more color coat at greater cost.

4. Topcoats

Following the application of the primer or primer system (a combination of primers), a topcoat is used to provide the appearance characteristics of a refinish job. Topcoats can be single-stage solid colors or coats, single-stage metallic finishes, and multistage systems that may include intermediate coats to create the illusion of depth in the finish, overlaid with clear, protective top coats. When a vehicle is partially refinished, the painter's job is to deceive the eye into not seeing a demarcation line between the repaired and the un-repaired portion of the vehicle. The topcoat application is usually applied to a larger area than the primered area, in order to smoothly blend new paint into existing paint. Topcoats are estimated to be responsible for about 60 percent of total VOC emissions from automotive refinishing operations.

Color Coatings

Color coatings are pigmented coatings that require a subsequent clear coating for protection, durability, and gloss. Color coatings include metallic / iridescent coatings.

Most of the major manufacturers offer water-borne color coatings, which have been developed to comply with European Union (EU) emissions standards. The EU standards required all manufacturers to meet a 420 g/l VOC limit for color coats as of January 1, 2007. [1]

Water-borne color coatings greatly reduce VOC emissions and would be a significant change from the more common higher VOC solvent-borne coatings. The use of water-borne coatings usually requires air moving equipment, like fans, in the spray booths to enhance drying. In some cases, heat may be required to speed the drying of the water-borne coatings. [1]

Single-stage Coatings

Single-stage coatings are older technology that is used to refinish vehicles manufactured before the color coat/clear coat finishing systems were developed. Single-stage coatings are often used in production shops where the entire vehicle is painted and can achieve the desired color, protection and durability.

Multi-Color Coatings

Multi-color coatings are also used in automotive refinishing. These coatings are packaged in a single container and result in the appearance of more than one color in a single application. These coatings are also called “splatter” coating due to their appearance and are commonly used on truck beds.

Clear Coatings

Clear coatings contain no or minimal pigments and are applied over a color coating or intermediate translucent coating. The clear coat gives the appearance of depth and shine, and provides protection for the vehicle.

5. Other Coatings

Other coating categories include temporary protective coatings, truck bed liner coatings and underbody coatings. These miscellaneous coating categories account for less than 0.1 percent of the total VOC emissions from automotive refinishing operations.

Temporary Protective Coatings

Temporary protective coatings are used to temporarily protect areas of the vehicle from overspray or mechanical damage. These coating are used instead of masking in the painting process and may be applied to a vehicle prior to shipment. The temporary protective coatings are removed following the application of a primer or top coat, or to prepare a vehicle for sale.

Truck Bed Liner Coatings

Truck bed liner coatings are rubberized coatings used to protect truck beds from abrasion and to provide traction. They help prevent dings and scratches from cargo.

Underbody Coatings

Underbody coatings were formerly called “rubberized asphaltic underbody coatings.” They are applied to the wheel wells, door panels, fenders, undersides of trunks or hoods, and the underside of the vehicle. Underbody coatings are used for sound dampening or protection from road debris.

6. Spray Equipment Cleaning

Following the application of various coatings, the spray equipment must be properly maintained and thoroughly cleaned to ensure the consistent application of a quality finish. There are two primary methods of cleaning spray equipment: the manual cleaning process and mechanical cleaning systems. It is estimated that the solvent used in the equipment cleaning process and surface cleaning and preparation accounts for 30 percent of the total VOC emissions from automotive refinishing operations.

B. Regulatory History

1. The Current Rule

Rule 8-45 was adopted on June 7, 1989, and addressed VOC emissions from automotive refinishing operations. The rule applied to auto body shops, manufacturers and sellers of automotive refinishing coatings, and manufacturers of heavy equipment like passenger buses and heavy duty trucks. (Original equipment manufacturers (OEM) are exempt from Rule 8-45 and are addressed under Regulation 8, Rule 13: Light and Medium Duty Motor Vehicle Assembly Plants.) The rule initially required the use of spray equipment with higher transfer efficiency for primer coats in July 1990 and for all coatings in January 1991. VOC standards for the various affected coating categories[i] were phased in over three increments, with each increment becoming increasingly more stringent. Each increment became effective on January 1, 1990; January 1, 1992; and January 1, 1995.

Rule 8-45 was significantly amended on November 2, 1994 as a result of a technology assessment of technology forcing limits set in 1989. The VOC limits were revised to reflect technological progress and to give manufacturers adequate time to bring reformulated products to market. The revision also included incorporating additional VOC standards, which included a 0.6 lb/gal VOC limit for surface preparation solvent, a 0.5 lb/gal VOC limit for temporary protective coating, and a volume limitation on precoat. A new requirement that topcoats be applied in a spray booth or within a particulate filtration system was also added to the rule.

Rule 8-45 was amended again on January 6, 1999, primarily to allow the use of a precoat under non-water-borne primer-surfacer to prevent corrosion of the metal surface of an auto body.

Currently, Rule 8-45 sets VOC limits for automotive refinishing coatings and solvents used in automotive refinishing operations. Table 1 summarizes the VOC limits for automotive coatings currently contained in the rule.

[i] Affected coating categories were pretreatment wash primer, precoat, primer/primer surfacer, topcoat, and metallic/iridescent topcoat, extreme performance, and camouflage.

Table 1
VOC Limits of Rule 8-45

Rule 8-45 Coating Categories & Solvents	VOC Limits (g/l)	
	Group I[a]	Group II[b]
Pretreatment Wash Primer	780	780
Precoat	580	580
Primer / Primer Surfacer	250	250
Primer Sealer	420	340
Solid Color Topcoat	420	--
Topcoat	--	420
Metallic Iridescent Topcoat	520	420
Multi-Stage Topcoat System	540	--
Camouflage	--	420
Specialty Coatings	840	840
Temporary Protective Coating	60	60
Surface Prep Solvent	72	72
Plastic Surface Prep Solvent	780	780

a. Group I refers to vehicles such as passenger cars, large/heavy duty truck cabs and chassis, light and medium-duty trucks and vans, and motorcycles.
b. Group II refers to public transit buses and mobile equipment.

The rule also sets transfer efficiency requirements. It requires the use of electrostatic application equipment, high-volume, low-pressure (HVLP) spray equipment, or the District-approved equivalent of either technology for applying coatings. In addition, the rule prohibits anyone from specifying the use of coatings that are not compliant with the above limits for any automotive refinishing operation and it prohibits the sale of non-compliant coatings in the District.

2. Regulatory Activity Since the Last Amendments to Rule 8-45

In October 2005, ARB published the Suggested Control Measure for Automotive Coatings (SCM), which is a guideline regulation for California air districts to use in drafting amendments to their automotive refinishing operations rules and regulations. The SCM is based on information provided to ARB by districts and automotive coating manufacturers. The development of the SCM was initiated by ARB staff in cooperation with the districts. The key objectives of the SCM are to:

1. Improve the overall effectiveness and enforceability of district rules;
2. Improve consistency among districts rules; and
3. Achieve VOC emission reductions.

The SCM recommends that California air districts' automotive refinishing rule be amended to:

1. Combine Groups I and Group II vehicle categories and establish VOC limits by coating category only;
2. Eliminate the composite VOC limit for multistage coating systems and establish independent VOC limits for both the color and clear parts of the multistage coating systems;
3. Combine the primer, primer surfacer, and primer sealer categories and establish a single VOC limit for primers; and
4. Eliminate the general specialty coating category and replace it with specific categories, and corresponding VOC limits.

III. TECHNICAL REVIEW

A. Automotive Refinishing Emissions Inventory

District staff has identified over 1100 automotive refinishing facilities in the District, not including mobile automotive refinishers such as Dent Pro or Colors on Parade. Facilities that engage in automotive refinishing include auto body repair shops, automotive paint shops, auto dealerships, public transit agencies like Bay Area Rapid Transit, San Francisco Municipal Transit, and Alameda County and Contra Costa County Transit, airports, public works departments, and educational facilities like high schools and community colleges. Also, mobile equipment manufacturers that produce buses, heavy duty trucks, trailers and trucks are subject to Rule 8-45.

The District 2005 emissions inventory indicates that VOC emissions associated automotive coating totaled approximately 3.99 tons per day (tpd). Also, VOC emissions associated with clean-up and surface preparation solvent use at automotive refinishing operations totaled 1.83 tpd for a total of 5.8 tpd.

The 2001 statewide emission inventory was based on a 2002 survey which asked coating suppliers the amount of coatings sold or supplied to California in 2001. The survey indicated that the 2001 statewide emissions inventory for automotive refinishing operations total 20.7 tons per day.[3] This quantity does not include emissions from solvents used in surface preparation and cleanup because the 2002 survey did not collect these data. ARB estimated the statewide VOC emission inventory using a top down approach. Weighting this value by the ratio of the Bay Area and California population (20 percent)[4] results in an emissions inventory for the Bay Area of 4.14 tpd of VOC exclusive of clean-up and surface preparation solvents, which corresponds well with the District's estimated value of 3.99 tpd.

Table 2 illustrates the relative fraction of the total emissions attributable to each coating category.

Table 2
Estimated VOC Emissions from Automotive Coatings and Solvents

Coating Category	**VOC Emissions** (tpd)	**Fraction of Total VOC Emissions** (percent)
Adhesion Promoter	0.01	0.10
Clear Coating	0.52	8.94
Color Coating	2.48	42.56
Multi-Color Coating	0.00	0.00
Pretreatment Coating	0.07	1.19
Primer	0.34	5.90
Single-Stage Coating	0.55	9.51
Temporary Protective Coating	0.00	0.03
Truck Bed Liner Coating	0.00	0.03
Underbody Coating	0.00	0.03
Uniform Finish Coating	0.02	0.26
Any Other Coating Type	0.00	0.00
Solvents	1.83	31.44
Total	**5.82**	**100.00**

As illustrated in the above table, the coating category with the largest fraction of emissions is due to color coatings; while the second largest source of emissions is due to solvent use in surface preparation and cleanup. These two areas account for over 70 percent of the total emissions from auto refinishing operations by weight, and also from the perspective of reactivity (ozone formed).

IV. Proposed Amendments

The proposed amendments to Rule 8-45 are intended to reduce VOC emissions from automotive refinishing operations. The proposal is based on ARB's 2005 SCM and will incorporate reactivity-based limits as an option to VOC limits of the SCM. The proposal also contains provisions designed to address mobile automotive refinishing operations.

The District is also considering incorporating reactivity-based standards as an alternative to the more traditional mass-based VOC standards contained in the SCM. An automotive refinishing coating manufacturer could comply with these standards in lieu of compliance with the VOC standards. The reactivity-based standards could take one of two forms, an overall percent reduction in the reactivity of the automotive coating, or a reactivity limit.

A. Proposed Coating Categories and VOC Limits and Standards

Table 3 summarizes the proposed coating categories and VOC limits recommended by the SCM.

Table 3
SCM Proposed Coating Categories and VOC Limits[1]

SCM Coating Categories	VOC Limits (g/l)	Effective Dates
Clear Coating	250	January 1, 2009
Color Coating	420	
Multi-Color Coating	680	
Pretreatment Coating	660	
Temporary Protective Coating	60	
Truck Bed Liner Coating	310	
Underbody Coating	430	
Uniform Finish Coating	540	
Any Other Coating Type	250	
All Solvents	25	
Adhesion Promoter	540	January 1, 2010
Primer	250	
Single-Stage Coating	340	

The SCM prohibits anyone from applying, manufacturing, blending, repackaging for sale, supplying, selling, or offering for sale, distributing, or possessing (at an automotive refinishing facility) any coating that does not meet the VOC limits listed in Table 3.

Since the ARB published the SCM, the South Coast Air Quality Management District (SCAQMD) and the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) have adopted amendments to their automotive coating rules that incorporated the recommendations of the SCM.

The proposed amendments to Rule 8-45 incorporate the VOC limits and definitions contained in the SCM. Several categories of coatings are to be combined. Table 4 shows the current coating categories in the rule alongside the new corresponding coating categories from the SCM and the proposed VOC limits for each category.

Table 4
Current and Proposed Coating Categories and VOC Limits for Automotive Refinishing Operations

Rule 8-45 Coating Categories	VOC Limits (g/l)		Proposed Coating Categories	VOC Limits (g/l)
	Group I[a]	Group II[b]		
Anti-glare / Safety Coating	--	--	Color Coating	420
Camouflage	--	420	Color Coating	420
Multi-Stage Topcoat System	540	--	Clear Coating	250
			Color Coating	420
Pretreatment Wash Primer	780	780	Pretreatment Coating	660
Precoat	580	580	Primer	250
Primer & Primer Surfacer	250	250		
Primer Sealer	420	340		
Metallic / Iridescent Topcoat	520	420	Single-Stage Coating	340
Solid Color Topcoat	420	--		
Topcoat	--	420		
Temporary Protective Coating	60	60	Temporary Protective Coating	60
Specialty Coatings (limited by volume)	840	840	Multi-Color Coating	680
			Truck Bed Liner Coating	310
			Underbody Coating	430
			Uniform Finish Coating	540
			Adhesion Promoter	540
			Any Other Coating Type	250
Surface Preparation Solvents	72	72	Solvents	25
Solvents for Plastics Surface Preparation	780	780		

a. Group I refers to vehicles such as passenger cars, large/heavy duty truck cabs and chassis, light and medium-duty trucks and vans, and motorcycles.
b. Group II refers to public transit buses and mobile equipment.

With the incorporation of the new coatings categories, the coating categories currently contained in the rule would be either eliminated or subsumed into the new categories. The affected coating categories include multi-stage topcoat, metallic iridescent topcoat, primer sealer, primer surfacer, precoat, camouflage, specialty coating, and anti-glare safety coating.

The VOC limit for solvents would be reduced from either 780 or 72 g/l to 25 g/l.

B. Reactivity-Based Limits for Automotive Refinishing Coatings

The District is considering the inclusion of reactivity-based limits in the rule as a compliance alternative to the more traditional mass-based VOC limits recommended in the SCM. The use of the reactivity of various organic compounds in the regulatory arena dates back to the 1970s. In 1977, the United States Environmental Protection Agency (EPA) issued the "Recommended Policy on Control of Volatile Organic Compounds," which recommended a limited number of "negligibly reactive" compounds for exemption from VOC-based rules. The EPA deemed organic compounds that form no more ozone than ethane to be negligibly reactive. Since that original listing, EPA has designated about 50 compounds as negligibly reactive and has excluded these compounds from the regulatory definition of VOC.[5]

1. Development of Reactivity Values

Different compounds vary in the extent to which they react in the atmosphere to produce ozone. For example, for every pound of acetone emitted to the atmosphere, a maximum of 0.49 pounds of ozone could potentially be created; whereas, for every pound of xylene emitted, a maximum of 7.49 pounds of ozone could be created. The reactivities (the relative potential to form ozone in the atmosphere) of a vast number of organic compounds (many of which are used in coating formulations) have been determined experimentally. The knowledge that various compounds have various propensities to form ozone is not new.

Although it has been generally known for quite some time that different compounds form differing amounts of ozone, the experimental work to determine relative reactivity values of a large number of compounds is comparatively recent. Beginning in the early 1990s, ARB developed regulations that incorporate the reactivities of various VOCs. In 1991, ARB established a reactivity scale for weighting the emissions of individual VOC species in the Low Emitting Vehicle and Clean Fuels regulations. The scale was designed to account for the differences in the ozone-forming potential of emissions from gasoline engines and alternatively fueled vehicles. ARB adopted the scale as the Maximum Incremental Reactivity or "MIR" scale, which is based on experiments that determined the relative reactivities of various VOCs.

In June 2000, ARB adopted an aerosol coating regulation that incorporates an updated MIR scale. Previously, manufacturers were having difficulty meeting the stringent VOC limits for aerosol coatings. ARB gathered information on the VOC composition and sales information from manufacturers to develop VOC emission profiles for the various aerosol product categories. Using this information, ARB was able to calculate the MIR-weighted emissions limits that would achieve the same ozone reduction as the existing mass-based emissions limits would achieve.

MIR Scale: The reactivity of an organic compound varies depending on environmental conditions – the presence of NOx and a mixture of VOCs, temperature, sunlight, and humidity. This is determined experimentally by adding a minute amount of the VOC into a polluted atmosphere and measuring the incremental change in ozone formation. The maximum of these incremental changes is determined for a variety polluted atmospheres and is called the maximum incremental reactivity or "MIR." This maximum change in ozone formation has been demonstrated to be consistent enough across those atmospheric variations to establish a reactivity scale that can be used for regulatory purposes.[6]

Reactivity values of organic compounds are expressed in grams (or pounds) ozone formed per gram (or pound) of compound emitted to the atmosphere. The value is termed the maximum incremental reactivity or MIR. An MIR value of 1.0 indicates that for every pound of a compound emitted into the atmosphere, one pound of ozone would result. The reactivity-based product limits would limit the estimated ozone-forming potential of coating formulations based on the cumulative reactivity of all of the component VOCs used in the formulation of each coating. Using the reactivity of a compound for regulation is a direct means of accounting for ozone formation because a compound's potential for ozone formation can be taken into account. This type of standard might also allow for greater flexibility in formulating coatings. To date, no local air district has proposed a reactivity-based standard in a district rule, although consumer products and aerosol paints are regulated on a reactivity basis by ARB. Table 5 illustrates how the top 12 compounds used in automotive coating formulations differ in their relative contributions of ozone formation. The top 12 compounds account for almost 80 percent of the total amount of VOCs used in coating formulations.

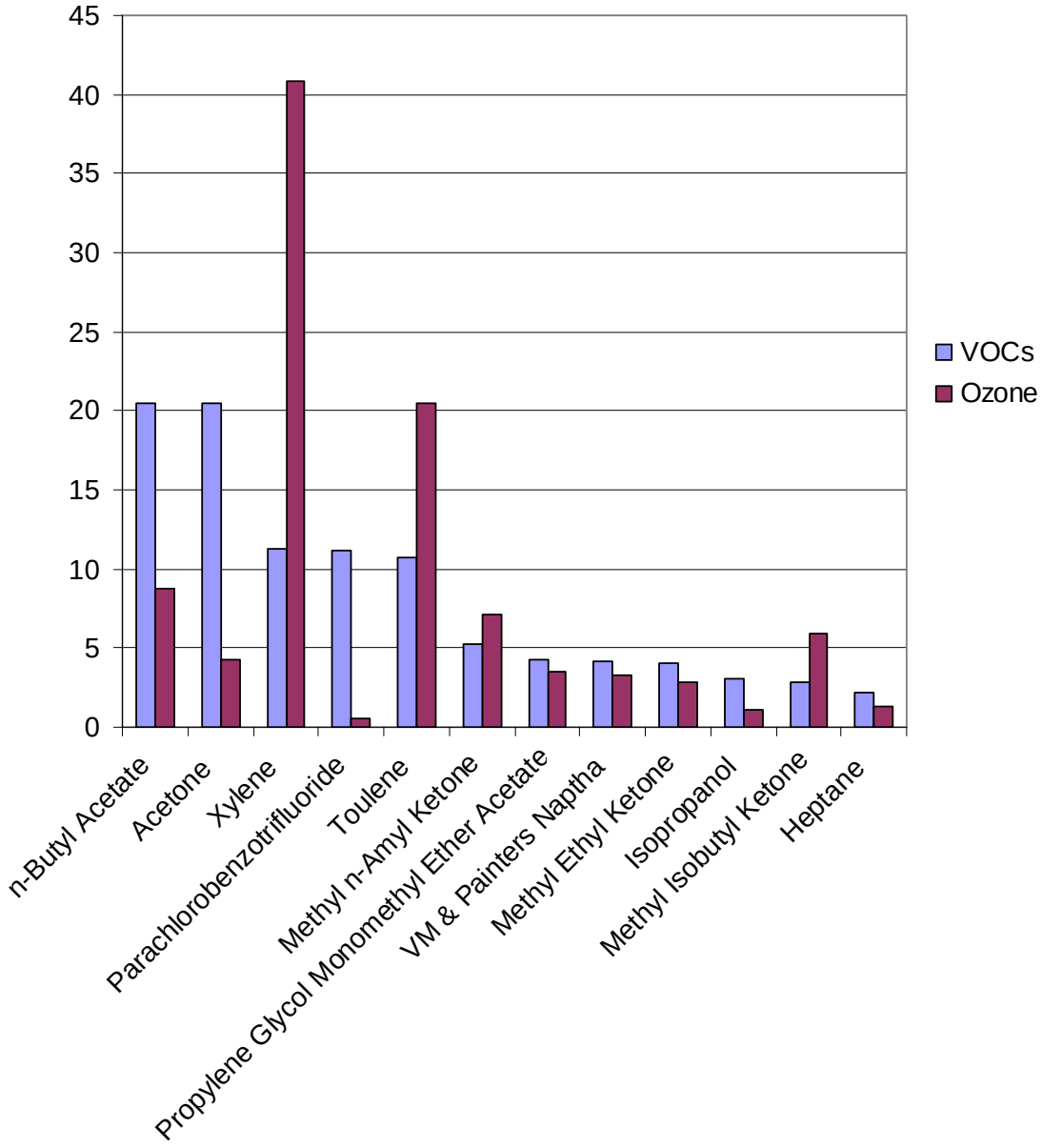
TABLE 5
Top 12 Compounds Used in Automotive Refinishing Coatings in 2001 in California, MIR Values and the Resulting Ozone Formed

Ingredient	Sales Quantity[3] (tons)	Percent of Total VOCs[a]	MIR Index (lbs O_3 per lb VOC)	Ozone Formed[b] (tons)	Percent of Ozone Formed
n-Butyl Acetate	4.26	20.5	0.88	3.75	8.7
Acetone (exempt)	4.25	20.5	0.43	1.83	4.3
Xylene	2.35	11.3	7.48	17.56	40.9
Parachlorobenzotrifluoride (exempt)	2.33	11.2	0.11	0.26	0.6
Toluene	2.22	10.7	3.97	8.81	20.5
Methyl n-Amyl Ketone	1.10	5.3	2.77	3.04	7.1
Propylene Glycol Monomethyl Ether Acetate	0.88	4.2	1.69	1.49	3.5
VM & Painters Naptha	0.87	4.2	1.62	1.41	3.3
Methyl Ethyl Ketone	0.84	4.0	1.48	1.24	2.9
Isopropanol	0.65	3.1	0.71	0.46	1.1
Methyl Isobutyl Ketone	0.59	2.9	4.28	2.55	5.9
Heptane	0.45	2.2	1.26	0.57	1.3
Totals for the Top 12	20.78	100.0		43	100.0

a. Percent the total statewide inventory of VOCs emitted from automotive refinishing operations.
b. The maximum amount of ozone that can be formed.

Table 5 indicates that, although n-butyl acetate and acetone comprise the largest fraction of VOCs used in automotive coating formulations, both at 20.5 percent, they are only responsible for approximately 8.7 and 4.3 percent respectively of the total amount of ozone formed; while xylene, the third largest component at 11.3 percent, is responsible for over 40 percent of the ozone formed, over three times as much as both n-butyl acetate and acetone combined. Figure 1 illustrates this information graphically. This information indicates that changes in the mass of VOCs in a coating formulation may not directly result in equivalent changes in the amounts of ozone formed. The information also shows that the individual reactivities of the compounds used in formulations provide an alternative indicator of the potential of a coating to produce ozone.

Figure 1
Comparison of the VOCs and Ozone Formed Attributable to the Top 12 Compounds Used in Automotive Refinishing in 2001 in California



2. Comparison of Reactivity-Based Limits and Mass-Based VOC Limits

The proposed reactivity-based limits will be as effective as mass-based VOC limits in reducing ozone formation because the limits in the proposed amendments are based on the formulations manufacturers develop to meet the VOC limits of the SCM. These reactivity limits would be used to ensure that manufacturers opting to comply with the reactivity limits would achieve an equivalent, if not greater, ozone reduction as would the formulations used to meet the reduced VOC limits.

Reactivity limits provide a more direct mean of determining the benefits of a regulatory approach. This is because reactivity is a direct indication of the ozone potentially formed from the emissions of various organic compounds. Also, use of reactivity-based limits encourages the use of less reactive compounds in coating formulations, because of the reactivity scale is a sliding scale – some compounds are more photochemically reactive than others. Due to this variation, manufacturers can reduce the overall reactivity of their product by using compounds that are less reactive than others. Further, reactivity limits eliminates the need for classifying organic compounds as "exempt" because the reactivity of all compounds, however slight, is considered. Allowance of the use of reactivity should provide manufacturers greater flexibility in formulating coating. This is because the overall VOC content of a coating can be increased or remain unchanged, thus allowing greater solvency, adhesion, penetration, drying times and an improvement in other characteristics, provided the overall reactivity of the coating is reduced.

3. Reactivity-Based Limits

The reactivity limits being considered are presented in two different forms: a percent reduction in the ozone-forming potential of each coating product or a maximum limit on the overall ozone forming potential of each coating product – termed the compound-weighted MIR limit (CWMIR).

Percent Reduction: Under one proposed compliance option, manufacturers would be required to reduce the overall ozone-forming potential of each coating. The reduction percentage would be equivalent to the percent reduction required by the mass-based VOC reduction required limits (normalized to the solid content of the product). The following table presents the proposed reductions for each of the coating categories.

Table 6
Percent Reduction in Ozone-Forming Potential for Each Coating Category

Current Coating Categories	Proposed Coating Categories	CWMIR Percent Reduction
Camouflage	Color Coating	68
Clear Coating	Clear Coating	60
Multi-Stage Topcoat System	Color Coating	22
Pretreatment Wash Primer	Pretreatment Coating	15
Precoat	Primer	57
Primer / Primer Surfacer	Primer	0
Primer Sealer	Primer	40
Metallic Iridescent Topcoat	Single-Stage Coating	35
Topcoat	Single-Stage Coating	19

It is important to ensure that the reactivity based limits are at least as effective in reducing ozone formation as the proposed mass-based VOC limits. To this end, the values for the percent reductions in ozone-forming potential for each coating category listed in Table 6 are based on the estimated mass-based VOC emission reductions expected from the implementation of the VOC limits of the SCM for each of the coating categories listed. We note that the percent reductions do not directly relate to the change in VOC contents of each of the coating categories. This is because the VOC content as calculated excludes water and exempt compounds.[ii] Many of the formulations developed to meet the limits of the SCM contain greater amounts of solids in place of volatiles (VOCs, exempt compounds and water) and, therefore, it would require less of the product to coat than required by the older formulations. Others rely on the addition of exempt solvents. Further, the use of reactivity-based limits allows manufacturers greater flexibility in formulating automotive coatings.

Compound-Weighted MIR Limit: Automotive coating manufacturers would also be able to comply with reactivity limits by producing coating products that do not exceed a set limit for the CWMIR for each product category. The reactivity limits are based on analyses of anticipated formulations that would comply with the

[ii] The VOC content limits of the rule are defined by the following expression:

$$\text{VOC content} = \frac{Wv - Ww - Wec}{Vm - Vw - Vec},$$

Where:

Wv = combined weight of volatiles (VOCs, water and exempt compounds, in grams;
Ww = weight of water in grams;
Wec = weight of exempt compounds in grams;
Vm = volume of material (volume of coating) in liters;
Vw = volume of water in liters;
Vec = volume of exempt compounds in liters.

coating VOC limits recommended in the SCM. Table 7 presents the proposed CWMIR limits. These limits represent the average CWMIR for each product category listed.

Table 7
Proposed Reactivity Limits for Automotive Coatings

SCM Coating Categories	CWMIR Limit (g O3/ g coating)
Adhesion Promoter	0.60
Color Coating	0.60
Clear Coating	0.35
Multi-Color Coating	0.35
Pretreatment Coating	1.80
Primer	0.60
Single-Stage Coating	0.35
Temporary Protective Coating	n/a*
Truck Bed Liner Coating	n/a*
Underbody Coating	n/a*
Uniform Finish Coating	n/a*
Any Other Coating Type	n/a*
Solvents	n/a*

* There were no data available for these categories at the time of publication.

Staff made a comparison of the formulations of currently compliant coatings with the formulations proposed to meet the VOC limits of the SCM. That comparison indicated that, under some instances, the VOC reductions and the reactivity reductions are not equivalent. In one example, a VOC reduction of over 60 percent was achieved for a clear coat product reformulation; however, the resulting reduction in the reactivity (ozone potentially formed) of the new product amounted to less than 20 percent. While this is only one example, it is indicative of the inherent limitation of mass-based VOC standards. While lower VOC limits have the potential to significantly reduce VOC emissions, these limits may only marginally reduce the potential ozone formed. Consequently, staff believes that limits based on reactivity would provide an alternative method of reducing of ozone than the more traditional use of VOC limits, potentially at less cost.

C. General Requirements

The proposal would also prohibit the application, manufacturing, blending, repackaging for sale, supplying, offering for sale, distributing, or selling any coating that does not meet the proposed VOC limits listed in Table 3 or the

reactivity reductions and limits listed in Tables 6 and 7, unless emissions are controlled by an emission control system.

Staff proposes to eliminate some recordkeeping requirements when the new VOC limits go into effect. These changes are discussed in greater detail in the sections below. Changes in recordkeeping would not, however, pre-empt requirements on limitations contained in a facility's permit to operate.

D. Requirements for Mobile Refinishing Operations

Because mobile refinishers operate in multiple locations, their operations are currently difficult to track and inspect. Therefore, it is difficult to determine the compliance status of these operations. While many established mobile franchises make efforts to comply with Rule 8-45, others may operate in the District for only a short time or illegally (with non-compliant coatings and without proper filtration and recordkeeping). To address this, provisions specific to mobile refinishing operations are being added to the rule.

Mobile refinishers would be required to register their operations with the District and upon request, notify the District of the location of their operations. Mobile refinishers would have to notify the District whenever they were at a single location and working on at least five vehicles. During operations, mobile refinishers have to comply with the same requirements as stationary refinishers, which means that during topcoating operations, the vehicle has to be within an enclosure equipped with proper ventilation and filtration. Mobile refinishers would also be required to meet the recordkeeping requirements of the Rule and ensure that their filtration equipment is in proper working order.

E. Administrative Requirements

1. Compliance Statement Requirement

The proposed amendments would require manufacturers and repackagers of automotive coatings and components to provide additional written information on the following physical properties on the product label, product technical data sheets or the equivalent:

- The VOC content expressed in grams per liter (g/l);
- The weight percentage of volatiles, water, and exempt compounds;
- The volume percentage of water and exempt compounds;
- The density of the material in g/l;
- For products meeting an alternative, reactivity-based limit, the statement: "Meets BAAQMD Regulation 8, Rule 45 Reactivity Standards – Reduces Ozone formed by _____ %" or "Meets BAAQMD Regulation 8, Rule 45 Reactivity Standard of ____ grams of Ozone per gram of product" as appropriate for the product category.

2. VOC Labeling Requirements

Effective, January 1, 2009, the proposed amendments would require manufacturers and repackagers of automotive coatings and components to label all containers with the coating use category and the VOC content. The VOC content would also be required for cleanup and surface preparation solvents.

3. Recordkeeping Requirements

The proposal would simplify recordkeeping requirements for automotive refinishing operations that are subject to Rule 8-45. Once the new VOC limits take effect, weekly records on the mix ratio of components in the coating and amount of coatings use, and daily records of mix ratios and the amount of each specialty coating would no longer be required.

Instead, the operators must keep the following records for a minimum of three years:

- A list of all coatings and solvents used, including:
  1. Name and manufacturer,
  2. Coating type and specified mix ratio,
  3. VOC contents and/or the CWMIR for coatings and solvents,
  4. Whether material is a coating or solvent,
  5. Purchase record identifying the coating type and name and volume of coatings and solvents.
- Key system operating parameters of emission control systems.

The proposal would also require that any person selling coatings that is subject to Rule 8-45 keep the following records:

- Records for the prohibition of sale requirement by maintaining a detailed log of each coating, coating component or solvent showing:
  1. The quantity manufactured, blended, repackaged for sale, supplied, sold, offered for sale, or distributed, including size and number of units;
  2. VOC contents and/or the CWMIR for coatings and solvents; and
  3. To whom they were supplied, sold, offered for sale or distributed including the name, address, phone number, retail tax license number, and valid District permit or registration number.

The clients of mobile refinishing operators who have had at least five automotive refinishing operations conducted in a year or had at least 25 vehicles refinished within a year would be required to maintain records detailing the following:

- The name(s), address(es), phone number(s), retail tax license number(s), and valid District permit or registration number(s);
- The dates each mobile refinishing operation occurred; and
- The number of vehicles refinished on each occasion.

These new requirements would take effect on January 1, 2009.

F. Test Methods

There are several test methods listed that can be used to demonstrate compliance with the rule. These include methods for determining VOC, acid, metallic and exempt compound contents of coatings and solvents. Methods for determining control efficiency, transfer efficiency, and HVLP equivalency are also included. An existing District test method, Method 9, is proposed to be added to the rule to determine the relative amounts of each organic compound. This is only applicable to coatings that comply with the reactivity (CWMIR) limits.

G. Emission Reductions

ARB estimated that implementation of the requirements and VOC limits of the SCM would result in an overall emissions reduction of 65 percent. Table 8 presents VOC emissions in the District stratified over the various coating categories and the expected VOC emissions reduction based on ARB's estimated percent reductions.

Table 8
Estimated VOC Emissions and Reductions from Automotive Refinishing Operations Due to the Proposal

Coating Category	**VOC Emissions** (tpd)	**Emission Reductions** (tpd)	**Percent Reductions** (percent)
Adhesion Promoter	0.01	0.00	78
Clear Coating	0.52	0.31	60
Color Coating	2.48	1.68	68
Multi-Color Coating	0.00	0.00	0
Pretreatment Coating	0.07	0.04	59
Primer	0.34	0.19	56
Single-Stage Coating	0.55	0.32	58
Temporary Protective Coating	0.00	0.00	43
Truck Bed Liner Coating	0.00	0.00	0
Underbody Coating	0.00	0.00	53
Uniform Finish Coating	0.02	0.01	63
Any Other Coating Type	0.00	0.00	0
Solvents	1.83	1.19	65
Total	**5.82**	**3.76**	**65**

Automotive refinishing is a fairly uniform practice throughout California and, consequently, the relative usage of coating is consistent. At the time the SCM was developed, most districts in California had identical VOC limits, with the

exception of the South Coast AQMD. Therefore, the reductions estimated for the Bay Area should be consistent with reductions estimated for the entire state.

H. Costs

The ARB estimated the cost of implementation of the SCM statewide to be $13.9 million annually over the useful life of the filtration, forced air and heating equipment.[1] Weighting this value with the ratio of District and Statewide VOC emissions results in an annual cost of $2.68 million in the District, with an average annual cost per facility of $2,320. However, depending on the size of a facility's operation and number of spray booths operated, the costs can range between $1,648 and $12,484. Table 9 illustrates the range of cost estimates.

Table 9
Summary of Annualized Cost Estimates for Automotive Refinishing Facilities with Varying Equipment and Revenues

Number of Spray Booths	Existing Heating Equipment?	Annual Revenues ($ million)	Annualized Costs
One	no	Less than 1.0	$1,648
Two	no	Less than 1.0	$1,871
Two	no	1.0 to 2.5	$7,966
Two	yes	1.0 to 2.5	$4,327
Two	yes	More than 2.5	$9,685
Three	yes	More than 2.5	$12,484
		Average	**$2,320**

In estimating costs associated with the SCM, the ARB considered two types of costs: non-recurring costs, which includes cost of obtaining air moving and heating equipment which may be necessary to use waterborne coatings and maintain the same level of production; and equipment and training costs associated with switching from solvent-borne to waterborne coatings.

Furthermore, it is estimated that coating formulated to meet the proposed VOC limits would cost up 20 percent more than currently compliant coating on a volumetric basis. However, because the new formulations have greater solid contents and result in the creation of a smaller waste stream, it is expected that the cost of using the new formulation would be about equal to the cost of the currently compliant coating.[7] This does not account for additional equipment cost, however.

The proposal would require mobile refinishing operators to register with the District. It is estimated that the cost of the initial registration would be approximately $100, with an annual recurring fee of $60.

Compliance with the reactivity-based standards has the potential to reduce the cost of the coatings. As an example, one current formulation of clear coat has large amounts of parachlorobenzotrifluoride (PCBTF), an exempt solvent. This is necessary to meet the proposed 250 g/l VOC limit. PCTBF is very expensive, priced from six to ten times as much as conventional solvents. Other solvents could be used to meet the proposed reactivity standards while reducing ozone formation by as much as the SCM mass-based VOC limits.

V. Rule Development / Public Consultation Process

This report and associated Public Workshop comprise the latest step in the District's rule development process for amending Rule 8-45. District staff has:

- Participated in the development of the ARB's Automotive Refinishing SCM;
- Held meetings and conference calls with automotive coatings manufacturers;
- Attended automotive coatings manufacturers demonstrations;
- Hosted meetings with the Bay Area Automotive Refinishing Association;
- Visited automotive refinishing facilities.

District staff also collected information on each of the 1100 automotive refinishing facilities permitted in the Bay Area to help estimate emissions, emission reductions and costs.

The purpose of the Public Workshop is to solicit comments from the public on the proposed amendments to Rule 8-45. During the workshop, staff will also respond to questions about information presented in the Workshop Report. Based on the input received at the workshop and during the associated public comment period, staff will assess whether changes to the proposal are necessary prior to preparing final proposed amendments for consideration at a public hearing before the District's Board of Directors.

References

[1] "Staff Report for the Proposed Suggested Control Measure for Automotive Coatings," Air Resources Board, October 2005.

[2] Auto Body Surface Coating: "A Practical Guide to Reducing Air Emissions," Small Business Pollution Prevention Center, Iowa Waste Reduction Center, University of Northern Iowa, 1998

[3] 2002 Automotive Coatings Survey Data, Air Resources Board, June 2005.

[4] Bay Area Census 2000, Metropolitan Transportation Commission and Association of Bay Area Governments, October 1, 2003. http://www.bayareacensus.ca.gov/

[5] "Interim Guidance on Control of Volatile Organic Compounds in Ozone State Implementation Plans," United State Environmental Protection Agency, 40 CFR Part 51.

[6] "Development of Ozone Reactivity Scales for Volatile Organic Compounds," William P. L. Carter, Published in the *Journal of the Air and Waste Management Association*, Vol. 44, pages 881-899, January 20, 1994.

[7] Tom Laginess, BASF, Phone conversation with Victor Douglas, March 7, 2008.