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Final Report

Waterborne Coatings And the Autobody Shop: A Status Report

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This report was prepared by the Local Hazardous Waste Management Program in King County, Washington. The program seeks to reduce hazardous waste from households and small quantity generator businesses in King County by providing information and technical assistance to protect human health and the environment.

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CONTENTS

Tables

What is the purpose of this report?

This report presents a summary of the status of waterborne coating systems development. The findings provide current technical feasibility information to autobody shops and regulatory decision-makers. The information in this report was collected from a variety of sources including manufacturers' representatives, jobbers, trade journals and regulatory agencies. The report was reviewed by manufacturers' representatives, jobbers and regulatory agency representatives who commented that it was comprehensive and accurate. Consult the same sources for more details.

In this report, information is presented in a question answer format. Waterborne coating system issues are described.

What is meant by the term "coating system", as used in this report?

Modern coating systems consist of a primer, base coat and clear coat. The primer provides adhesion between the following coats and vehicle surface and may also provide some additional corrosion protection. The primer is also used to fill in surface sanding scratches and other minor surface defects. The base coat, put down over the primer, provides the color and may also contain metal flakes or pearlescent material to give the coating a special look. The clear coat is put down over the base coat to protect it from weathering and provide a high gloss, transparent finish. Depending on the nature of the job, other types of coatings may be applied between the basic coatings described in this paragraph.

What methods are available to reduce the VOC content of autobody coatings?

Autobody shops refinish automobiles that have been damaged and repaired or require a new coating job. All autobody shops use solvent-borne coatings. The Puget Sound Air Pollution Control Agency (PSAPCA) has established regulations that require the shops to improve coating transfer efficiency and to use coatings with lower VOC (Volatile Organic Compounds, as defined by PSAPCA regulations) content to reduce VOC emissions (see Appendix I).

Autobody shops have reduced solvent emissions by changing practices. The use of HVLP (high volume, low pressure) paint spray guns has dramatically improved coating transfer efficiency. Less coating must be sprayed and therefore less solvent is emitted. Improved shop practices may also result in lower solvent emissions. If the substrate is prepared well, less primer surfacer is needed to fill scratches. If the job is done well the first time, rework and subsequent solvent emissions are reduced.

Solvent emissions can also be reduced by using coatings with lower VOC content. Lacquers have a relatively low solids content as compared to other types of coatings such as polyurethanes and epoxies. Lacquers typically do not meet PSAPCA VOC content regulations and are not commonly used in the Puget Sound region. The VOC content of the polyurethane and epoxy coatings can be reduced by reformulating them. One method is to increase the solids content of the coating and alter the organic solvents used to keep the coating sprayable. The other is to use water as a co-solvent that substitutes for some of the organic solvent.

Are waterborne solvents available to local shops?

Waterborne autobody shop primers are available form a number of suppliers. However, they must be applied over a solvent-borne precoat when applied to ferrous substrates. The precoat would not be required if a solvent-borne precoat were used. There are high solids solvent-borne primers available with VOC contents similar to waterborne primers.

In the United States, there are no commercially available waterborne base coats or clear coats that can produce finishes of a quality acceptable to the autobody industry. Coating manufacturers and OEMs (original equipment manufacturers) are developing and testing waterborne systems. The systems will not be available for the refinishing market until they are field tested and proven. Formulation research must be done by the coating manufacturers. Until those systems are available and proven, an autobody shop should use best management practices to reduce the amount of solvent used and discarded.

At least one manufacturer, who has been marketing waterborne base coats in Europe, plans to make them available in the United States within a year. However, no waterborne clear coats will be offered. Individual autobody shops do not have the resources necessary to conduct the extensive testing needed to performance test the coatings.

A waterborne clear coat probably will not be developed within the next several years. A clear coat must resist weathering and maintain a high gloss, transparent finish. It is difficult to get a waterborne resin to resist deterioration by the ultraviolet radiation of the sun.

Are waterborne coatings used by local autobody shops?

Shops tend to use waterborne primers for special applications. No shops reportedly use them routinely. They are used when a solvent-borne primer is not suitable for the application. For example, they may be used when the substrate, such as plastic, is sensitive to solvents and a barrier coating must be applied before a solvent-borne coating is applied.

No body shops are reported to be using waterborne coating systems, based on discussions with several vendors. There are fleet operations that are using waterborne coatings. However, their finishing requirements are not as stringent, appearance wise, as autobody shops. Some fleet operations can use single stage coatings that do not require a clear

coat. The appearance quality of the finish may not have to be as good as that of a personally owned automobile. Some orange peel and rough finish may be tolerable. Fleet operators may use a single stage system because its application time is significantly less than a two-stage system.

How does the application of waterborne primers compare with organic solvent based coatings?

A typical waterborne primer surfacer costs about $50/gallon as sprayed. A typical acrylic lacquer costs about $50/gallon. However, few shops use lacquer in the Puget Sound region because lacquer does not typically comply with PSAPCA VOC content rules. A typical solvent-borne catalyzed primer costs $100 to $150/gallon as sprayed. Most autobody shops are using catalyzed coatings.

Waterborne primers cannot be applied directly to a bare steel surface. The water will cause flash rusting. A solvent-borne precoat must be applied first. A solvent-borne color coat and clear coat must be applied because no waterborne color and clear coatings are available. This tends to minimize any advantages of the waterborne primer because only a fraction of the paint systems applied is waterborne.

Application costs of the waterborne primers are higher than that of solvent-borne primers. Application conditions are more critical for waterborne coatings than for solvent-borne coatings. Ambient, vehicle and coating temperatures must be controlled better. Water is a one speed solvent. Therefore, flash off times cannot be adjusted as easily as those of solvent-borne coatings. As with solvent-borne paints, the waterborne coating must be thoroughly dried to avoid trapping vapor under following coats. However, moisture contamination of a following solvent-borne coating is more serious than solvent contamination.

Most shops use convection heating systems in their paint booths. Some shops also have a curing booth. Waterborne primers require a heated curing booth to accelerate the drying process. An infrared curing system may be required for waterborne coating application to meet production deadlines, however, few shops have one. Shops may have to invest in an infrared system to stay competitive.

Waterborne primers require a longer time to dry than solvent-borne systems. Time between coats may be increased from 15 minutes to 30 minutes. Therefore, work flow is impacted reducing productivity and increasing costs.

Paint guns used with waterborne primers reportedly require more thorough cleaning than solvent-borne paint guns. Again this cuts into production time.

Painters may find it desirable to have two sets of guns, one for the waterborne coatings and one for the solvent-borne coatings. Water is not compatible with the solvent-borne coatings. If the guns are used for waterborne coatings application they must be thoroughly dried before spraying solvent-borne coating. Purchasing two sets of guns would increase the cost of tools used by the painter.

How does the VOC content of waterborne coatings compare with solvent-based coatings?

Waterborne coatings contain VOCs. A typical waterborne primer contains 1.9 lbs/gallon VOC.

A typical high solids solvent-borne primer has a VOC content of 2.1 lbs/gallon. A low VOC solvent-borne primer contains 3.5 lbs/gallon VOC. A standard solvent-borne primer has a VOC content of 4.5 to 5.5 lbs/gallon (Table 1).

Table 1. VOC Content of available autobody primers

Primer Description	VOC Content (lbs/gallon)
Typical waterborne primer	1.9
Typical high solids solvent-borne primer	2.1
Low VOC solvent-borne primer	3.5
Standard solvent-borne primer	4.5 to 5.5

Is hazardous waste generation or recycling affected?

Solvent-borne coating equipment can be cleaned up in a closed system minimizing solvent emissions. Spent cleaning solvent can be reclaimed through distillation on or off site and reused. Waterborne coating equipment is cleaned with water. This introduces a waste that is not compatible with solvent waste into a shop using solvent-borne coating systems. If waste waterborne primer is combined with solvent waste then contaminated solvent is produced.

Water used to clean the painting equipment would have to be characterized and properly disposed of. We do not have data at this time to offer an example wastewater characterization. However, it is likely to contain metals and organic solvents above sewer discharge limitations and therefore could not be released to the sewer.

Spent cleaning solvent can be distilled either on or off site and reused. It may be uneconomical for a shop to distill and reuse equipment cleaning wastewater, based on the cost and problems associated with distillation of paint contaminated water.

Are the waterborne coatings safer to use than solvent-borne coatings?

We did not look into the industrial hygiene and safety aspects of waterborne coating systems.

What are the conclusions drawn from the information presented in this report?

No waterborne coating systems are available for the refinishing market. Waterborne primers are available. Coating manufacturers are working to develop feasible waterborne base and clear coats. Waterborne base coats may be marketed in the United States within a year. No waterborne clear coats are out of the developmental stage and probably will not be for years.

Until waterborne coatings have been adequately performance tested they can not be used commercially. As waterborne coatings become commercially available autobody shops should evaluate them as potential pollution prevention alternatives. However, waterborne coating systems have their own peculiar waste management problems. The coatings do contain organic solvents, resins, pigments, and other potentially hazardous materials.

The impact of waterborne coatings on the autobody shop waste stream requires further evaluation. If waterborne coatings are mixed with solvent-borne coatings then waste management and recycling problems can result. At least two disposal containers bust be used to segregate the water and solvent waste streams. Water used to clean the waterborne painting equipment must be disposed of. We have not characterized this wastewater and therefore can make no statements at this time regarding its disposition.

For now, autobody shops should continue to work to reduce solvent emissions by using low VOC coatings and HVLP guns. Reducing the need for redos by producing an acceptable finish the first time reduces the time spent on the job, the amount of solvent emitted and hazardous waste produced. Focusing on doing quality work is perhaps the most effective way to reduce hazardous waste and at the same time increase the productivity of a shop.

APPENDIX I

PSAPCA REGULATION EXCERPTS

Regulation II, Section 1.05, Special Definitions Adopted 03/13/80 (462)
Revised/Renumbered 12/11/80 (482), 02/11/82 (510), 06/13/91 *[effective 07/15/91]* (700)

(t) **GROUP I VEHICLES** means passenger cars, large/heavy-duty truck cabs and chassis (≥10,000 pounds gross vehicle weight), light- and medium-duty trucks and vans (<10,000 pounds gross vehicle weight), and motorcycles.

(u) **GROUP II VEHICLES AND EQUIPMENT** means public transit buses and mobile equipment.

(aaa) **VOLATILE ORGANIC COMPOUND** or **VOC** means any organic compound that participates in atmospheric photochemical reactions. This excludes all compounds determined to have negligible photochemical reactivity by the US EPA and listed in 40 CFR Part 51.165.

(-) See Regulation II for other definitions you may be interested in.

Regulation II, Section 3.04, Motor Vehicle and Mobile Equipment Coating Operations
Adopted 06/13/91 *[effective 07/15/91]* (700)

(a) It shall be unlawful for any person to cause or allow the application of any coating with a VOC content in excess of the following limits to Group I vehicles and their parts and components, or Group II vehicles and mobile equipment where color match is required:

	VOC Content (excluding water but including negligibly reactive compounds)	
Type of Coating	(grams/liter)	(pounds/gallon)
Pretreatment	780	6.5
Precoat	780	6.5
Primer/Primer Surfacer	720	6.0
Primer Sealer	720	6.0
Topcoat	720	6.0
Metallic/Iridescent	720	6.0

(b) It shall be unlawful for any person to cause or allow the application of any coating with a VOC content in excess of the following limits to Group II vehicles and mobile equipment where color match is not required:

	VOC Content (excluding water but including negligibly reactive compounds)	
Type of Coating	(grams/liter)	(pounds/gallon)
Pretreatment Wash Primer	780	(6.5)
Precoat	780	(6.5)
Primer	340	(2.8)
Topcoat	420	(3.5)
Metallic/Iridescent Topcoat	650	(5.4)
Extreme Performance	720	(6.2)
Camouflage	420	(3.5)

(c) through (i) were omitted here

PSAPCA Compliance Guidance for Spray Coating Operations
October 25,1991

VOC CONTENT LIMITS: (page 5)

Coatings consist of solids (resins, pigments, extenders, additives) and solvents (including thinners). Solvents lower the viscosity (reduce or thin), act as the carrier for the solids, and dissolve the solid resin. Solvents evaporate from the coating before, during and after application. Solvents include VOC, water, and negligibly reactive compounds. To protect air quality, these regulations exist limiting the amount of VOC which can be contained in a gallon of coating. The VOC content of a coating is measured in pounds of VOC per gallon of coating or a gram of VOC per liter of coating. Since water does not take part in the reaction to form ozone, the VOC content is listed as "pounds per gallon of coating excluding water but including negligibly reactive compounds." The intent of these sections is to promote the use of low VOC content coatings. **Water-based, high-solids, or powder coatings and water-based cleaning materials are the preferred means for compliance with this Regulation.** (emphasis added)