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Auto Body Surface Coating: A Practical Guide to Reducing Air Emissions

University of Northern Iowa. Small Business Pollution Prevention Center.

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Auto Body Surface Coating:

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1. Introduction

The federal Clean Air Act Amendments (CAAA) of 1990 are having a significant impact on small businesses. New regulations are being proposed and implemented that require air emission permits, and in many cases, expensive air emission control devices.

These new requirements have had a tremendous effect on how automobile surface coating processes are performed. Specific chemicals and materials used by the auto body industry are targeted for regulation and control. The lists include chemicals known as Volatile Organic Compounds (VOCs) and Hazardous Air Pollutants (HAPs). Both Volatile Organic Compounds and Hazardous Air Pollutants are not only harmful to the environment, but can also cause severe health problems for technicians exposed to these materials.

- **Volatile Organic Compounds (VOCs)** are considered air pollutants because they create unwanted ozone smog in the lower atmosphere. Many VOCs are also toxic to humans. Most organic solvents used in the automotive painting industry are VOCs and emissions of these materials have fallen under new federal air regulations.

- **Hazardous Air Pollutants (HAPs)** are 189 materials listed by the Environmental Protection Agency (EPA), many of which are solvents used in surface coating operations. HAPs include toluene, xylene, and methyl ethyl ketone. Eventually, all HAP emissions will be subject to rigid standards and strict controls.

The Clean Air Act Amendments of 1990 are significantly impacting small businesses

The EPA has estimated that the automobile refinishing industry alone is responsible for over 287,000 tons of VOCs released in the U.S. every year. As much as 20 lbs of organic solvents may be emitted during the surface coating of just one medium-sized automobile.

Control systems have been developed to help combat VOC emissions from surface coating operations. Many manufacturing firms are currently using these systems in their paint booths to reduce VOC emissions by as much as 95 percent. These add-on controls include: Carbon Adsorption, Thermal Incineration, Catalytic Incineration, and Condensers.

VOCs and HAPs

Although proven effective in the manufacturing industry, emission control systems are extremely expensive, ranging from $20,000 to $70,000. For this reason, they are considered impractical for use in controlling VOCs from small- to medium-sized auto body repair shops. Currently the only practical means of reducing the VOCs emitted from automobile refinishing operations is to reduce the volume of VOCs and HAPs being used. This requires changes in products, equipment and application techniques for auto refinishers.

This practical pollution prevention guide was developed to help automotive refinishers:

- **Reduce the amount of VOCs and HAPs emitted during painting operations**
- **Avoid the need for expensive ($20,000 - $70,000) emission control devices**
- **Decrease the amount of paint-related wastes generated**
- **Maintain a high quality finish**

In essence, "how to do more with less" in surface coating processes.

This Guide provides:

- An overview of the auto refinishing process (Section 2)
- A review of the spray equipment currently used for auto refinishing operations (Section 3)
- An outline of proper spray application processes (Section 4)
- A look at spray equipment cleaning (purging) processes (Section 5)
- Information on determining products' VOC content (Section 6)
- A review of surface prep cleaners (Section 7)
- An overview of undercoats (Section 8)
- A look at automotive topcoat systems (Section 9)
- Recommended approach to practical air emission reduction (Section 10)
- A projection of what to expect in the future (Section 11)

2. Auto Refinishing Process Overview

The basic steps in automotive refinishing include:

1. Prepaint surface cleaning:

Solvents are used for the removal of contaminants such as grease, tar, wax, and silicone, all of which can have an adverse effect on the bond between the coating and the substrate. Poorly cleaned surfaces result in finish imperfections or even the peeling of the topcoat from the substrate. Although these solvents are not typically atomized for application purposes, VOCs are released through the simple evaporation of the liquid solvents. Many of the solvents used for prepaint surface cleaning contain toluene and xylene. Each is listed as a VOC and HAP. In fact, most of these cleaners contain 75 to 100 percent VOCs. EPA studies indicate the evaporation of these solvents accounts for approximately 8 percent of the total VOC emissions released during the refinishing process (see Figure 2).

2. Undercoat application:

The application of undercoats (prep coats, primer-surfacers, primer-sealers, and sealers) contributes significantly to the volume of VOCs released during surface coating operations. Undercoats generally contain less than 50 percent solvents by volume. However, because of the poor transfer efficiency of the equipment and the number of coats typically applied, solvent based undercoats are responsible for about 17 percent of all VOCs released during surface coating applications.

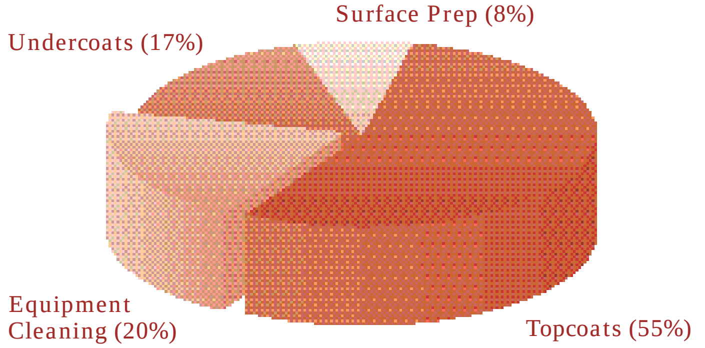

Figure 2: EPA Estimates of VOC Emissions

3. Application of the topcoat:

More than half of the VOCs released during the refinishing process occur during the top coat application, with metallics and lacquer finishes releasing the highest volume. As with undercoats, the primary reason for the high release of VOCs in topcoat application is the poor transfer efficiency of traditional spray equipment. Less than one-half of the topcoat material will be applied to the desired surface using conventional spray equipment. The rest is expelled as overspray.

Over half the VOCs released during the refinishing process are from top coat application

4. Spray equipment cleaning operations:

Approximately 20 percent of VOCs released from auto refinishing occurs during equipment cleaning operations. This figure reflects the volume of organic solvents emitted to the atmosphere during conventional equipment cleaning (purging) procedures. The majority of commercial spray equipment cleaners found on the market today are made entirely of organic solvents.

A. Recommended Steps for Practical Reduction of Air Emissions:

To reduce VOCs released during refinishing operations, facilities should use the following recommended steps for practical air emission reduction:

SPRAY EQUIPMENT

See Section 3 for Spray Equipment

- Determine the price range you are willing to spend for spray equipment.
- Determine the types of coatings that will be sprayed through the equipment, and the atomization properties required for proper application of these coatings.
- Prior to purchasing any paint gun, consult your paint representative to determine what type of gun works best for the application of the product you will be using.
- Contact your paint representative and/or spray gun representative to determine the fluid tip/air cap combination and gun settings recommended for the materials being sprayed.
- Choose spray equipment that will achieve the highest transfer efficiency while providing the required atomization properties within your price range.

SPRAY APPLICATION PRACTICES

See Section 4 for Spray Application Practices

- Select the suggested air pressure and tip sizes for the specific product and equipment being used.
- Always hold the gun perpendicular to the surface being sprayed, using parallel strokes. Never arc the gun.
- Feather the trigger at the beginning and end of each pass.
- Use a 50 percent overlap for each pass. (Note: This technique may need to be altered slightly when applying high metallic, high solids basecoats, and some three stage systems.)
- When painting small and medium sized panels, make each pass the full length of the panel.
- With larger panels, use a comfortable stroke, with a 4 - 5 " overlap of the strokes.
- If blending is necessary, keep the blend area as small as possible without jeopardizing the appearance of the blend.
- Spray the border edges of the substrate first (banding). This will assure all edges are covered without extending the spray pattern well beyond the borders of the object.
- Use color hiding power labels to determine the thickness of the applied paint film. These markers will also indicate when adequate coverage has been achieved.

Recommended Steps, con't

EQUIPMENT CLEANING

- Use an air powered mechanical gun cleaning system.
- Use low VOC cleaning solvents.
- If the guns are to be cleaned manually, spray into an enclosed backdrop to capture atomized solvents.
- Use a broom straw, cleaning broach, or a soft wood toothpick to clear passageways.

See Section 5 for Equipment Cleaning

SURFACE PREP

- Always wash dirt and grime from the vehicle using water or a soap and water mixture.
- Use waterborne cleaners when possible.
- If, due to heavy contamination, waterborne cleaners prove unsatisfactory, use solvent based cleaners for the initial cleaning. For secondary cleaning operations, use the waterborne products.
- If waterborne cleaners prove unsatisfactory due to substrate make-up, use solvent based cleaners sparingly.
- Keep solvent laden dirty rags in a closed container.
- Keep solvent containers closed when not in use.
- Avoid operations that require multiple prepaint surface cleanings.

See Section 7 for Surface Prep

PREP COATS

- Use versatile products such as epoxy primers or self-etching primers. The use of these products may alleviate the need for additional surface coating operations such as primer-surfacing or primer-sealing.
- If a self-etching primer or epoxy primer is not desirable, use a wash-primer, or metal conditioner, conversion coating system.
- Avoid zinc-phosphate primers with high VOC content.

See Section 8.A for Prep Coat

PRIMER-SURFACERS

- Use a properly operating primer gun with the correct fluid tip/air cap combination for your particular type of primer-surfacer.
- Use low VOC waterborne primer-surfacer products.
- If the curing time of waterborne products proves unsatisfactory, consider the use of versatile urethane primers.
- To reduce VOC emissions, limit material costs, and achieve a better quality product, perform body work using a minimal amount of primer-surfacer.
- If a colored sealer is not used, make sure the primer-surfacer is a color that can easily be covered with the desired topcoat.

See Section 8.B for Primer-Surfacers

Recommended Steps, con't

PRIMER-SEALERS

See Section 8.C for Primer-Sealers

- Use low VOC primer-sealers such as single component waterborne primers or waterborne epoxy primers.
- Use low VOC urethane primer-sealers as an alternative when possible.
- Always choose a color of primer-sealer that can be easily covered with the topcoat to be sprayed, or choose a tintable primer-sealer and tint it to an easily covered shade.

SEALERS

See Section 8.D for Sealers

- Choose the proper sealer for each specific job.
- If filling capabilities are required, use a primer-sealer in place of a sealer.
- Always choose a primer-sealer of a color that can be easily covered with the coating to be sprayed, or choose a tintable primer-sealer.

TOPCOATS

See Section 9 for Topcoats

- Mix color coats in-house, making certain the formula for the proper shade of the specific color code is used. This will help avoid the need for blending the finish to achieve a satisfactory color match.
- Keep good records of paint match information, including spray-out cards and detailed notes.
- Avoid the use of lacquer-based topcoats.
- Choose low VOC topcoats that require fewer than three coats to achieve adequate coverage (polyurethane or urethane).
- Apply only the number of coats needed to achieve a quality finish.
- Use high solids / low VOC clears to topcoat color coats.
- Keep the use of paint additives to a minimum.
- When available, use waterborne basecoats.

3. Spray Equipment

Prior to the Clean Air Act, most technicians chose spray equipment based solely on its ability to apply a quality finish. As the focus on VOC emissions within the refinishing industry continues to grow, transfer efficiency has become a major factor in spray equipment selection.

Simply put, transfer efficiency is the percentage of material atomized through the gun that actually ends up as a coating on the desired surface. However, the transfer efficiency of any type of spray equipment is subject to change under a variety of conditions. Variables affecting transfer efficiency include:

- Technician's spraying technique
- Size and configuration of the object to be sprayed
- Distance of the gun from the object to be sprayed
- Size of air cap and nozzle used
- Air pressure at the tip
- Volume of material exiting the gun at the tip
- Volume of air leaving the gun at the tip
- Viscosity of the material being sprayed
- Atmospheric conditions (temperature, humidity and barometric pressure)

Spray gun manufacturers have developed several new spray technologies in an attempt to achieve optimum efficiency. While achieving excellent transfer efficiency, many of these new technologies were found to be unacceptable for use in the application of automobile topcoats. Excess orange peel, pinholing, solvent popping, and mottling were common with many of these systems. Fortunately, a few of these new technologies proved capable of producing a high quality finish and thus are able to compete with conventional spray equipment in the refinishing industry. These new systems include gravity fed conventional, high-volume/low-pressure turbine, high-volume/low-pressure non-turbine, and low-pressure/low-volume spray guns.

Transfer efficiency is a major factor in spray equipment selection

A. Conventional Air Atomization Spray Equipment

For decades, the conventional suction feed spray gun has been the overwhelming favorite of automotive refinishers worldwide. These systems provide excellent atomization of the coating while giving the operator the control needed to achieve an even, high gloss finish. Conventional air guns rely on high pressure air (35 - 80 psi) to atomize the coating for application. This atomization of coatings takes place in three separate stages.

The conventional suction feed spray gun has been the overwhelming favorite of auto refinishers

1. The paint is surrounded by a highly pressurized column of air. This air column causes turbulence to occur in the paint, which begins to separate the paint into small droplets.
2. The paint is then forced through the fluid nozzle of the gun. Air is released through containment holes in the air cap, enhancing the atomization of the fluid.

3. Finally, air is released from the horns of the air cap and comes in contact with the atomized paint. This not only helps in the atomization process, but also shapes the paint pattern.

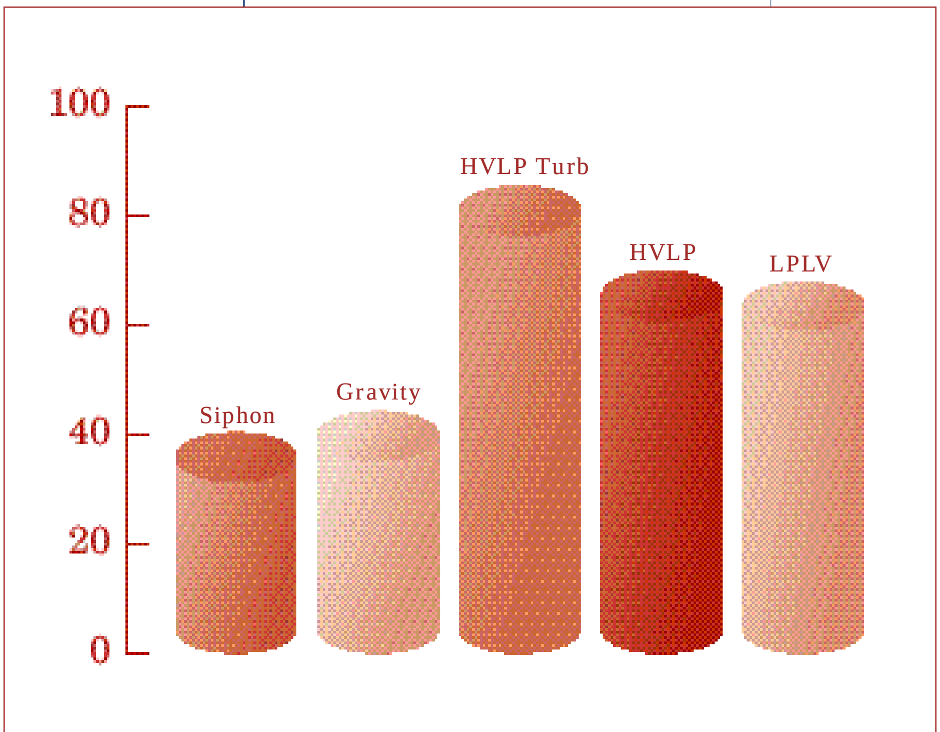

Figure 3: Transfer Efficiency of Spray Equipment

The sudden release of this high pressure air through the small openings of the nozzle breaks up the paint and propels the spray away from the gun. The atomized material is transferred to the substrate at a high velocity causing violent air turbulence to occur at the surface of the substrate. This turbulence forces much of the atomized material away from the surface to be coated, resulting in more than half of the atomized paint particulates and solvents being lost as waste overspray.

Siphon Tube Feed Conventional Spray Guns

The siphon tube spray gun has been by far the favorite of auto body refinishing technicians for both undercoat and topcoat applications. This equipment produces a fully atomized paint pattern for even surface coverage and gives the control needed for the application of metallic finishes. The spray pattern allows even distribution of metallic flakes throughout the substrate resulting in a finish free of metallic mottling flaws. The simple design of these guns makes them very economical to purchase and maintain. A good quality siphon tube spray gun costs from $120 - $300.

Depending on the material sprayed and the pressure used, the transfer efficiency of a siphon tube spray gun may be as low as 35 percent. Sprayable material is lost through the exhaust system or as overspray on the booth floor. Because air pressure is used to pull the fluid from the cup to gun, only low viscosity coatings may be used effectively in these systems. The higher the material's viscosity, the greater the air pressure required to draw the material up the siphon tube. The higher the pressure, the greater the amount of material wasted as overspray. The siphon design makes it impossible to retrieve all the paint from the cup, so there will always be some unused material.

Gravity Fed Conventional Spray Guns

Gravity fed technology first became popular with European auto refinishers for its ability to apply higher viscosity coatings such as epoxy primers and high solids paints and clears. As the use of these coatings has increased in the U.S., so has the acceptance of gravity fed guns within the automobile repair industry.

The major design difference between the gravity and siphon fed designs is the location of the paint cup. The cup is located on top of the gravity fed guns, as opposed to the siphon tube spray guns, which have the cup located below the body of the gun. This cup location gives the gravity fed guns a distinct advantage in clearance over siphon fed equipment. This advantage becomes evident when spraying the lower panels of today's smaller automobiles. Gravity fed spray guns rely on gravity, not air pressure, to feed the fluid to the gun. Higher viscosity solutions can be sprayed and atomized more effectively than in siphon fed equipment.

Because of cup placement, virtually all the paint in the cup can be used with little or no waste. The majority of these cups are made of a semi-clear solvent-resistant plastic which gives the painter the added advantage of being able to see the amount of material left in the reservoir while spraying. The transfer efficiency of the gravity fed guns is slightly better due to the higher viscosity material used, averaging approximately 40 percent.

Many painters adjust well to the gravity fed technology and can apply quality finishes with the first or second use. Others find adapting to this type of equipment difficult. There are four specific obstacles that must be overcome to use gravity fed spray guns effectively. First, because of the gravity fed design of these guns, as the paint level decreases, so does the rate of material feed. Although minor, the operator must still adjust technique throughout the coating process to compensate for the change in fluid flow. Second, some painters find that the high positioning of the cup interferes with the visibility of the surface during coating applications. Modifications to a painter's spray technique may be required to compensate for this obstruction. Third, difficulties occur when spraying the underside of body panels. If the gun is pointed upwards, the material will not flow to the gun from the cup. Finally, the physical design of the equipment does not allow the operator to set the gun down without the aid of a stand or spray gun hanger.

B. High-Volume/Low - Pressure (HVLP) Turbine

HVLP Turbine Guns

The HVLP turbine spray guns have reportedly achieved transfer efficiencies of 80 to 90 percent, exceeding all other automotive refinishing spray equipment on the market today (see Figure 3, pg 8). These systems use columns of low pressure air to cause turbulence within the paint as the first stage of atomization. The air used for the final step of atomization originates from high-volume turbine driven blowers. This air is heated to assist

in the atomization process and is transferred to the gun using large diameter air lines. The air is used to atomize the paint in basically the same manner as a conventional gun, but is much more efficient. The turbine supplies all the air needed for the system to operate. No outside air source is required.

HVLP turbine spray guns have some distinct disadvantages.

- The cost of these systems is high, with price tags commonly exceeding $3,000.
- The large air lines are often cumbersome for the operator.
- Blending metallic finishes is very difficult using the HVLP system due to the heavy application coats.
- The atomization of the turbine HVLP spray guns may not give the quality finish required to match automotive factory finishes.

C. High-Volume/Low-Pressure (HVLP) (non-turbine)

HVLP Non-Turbine Guns

The problems of the HVLP turbine in automotive refinishing were quickly realized by the spray gun manufacturers. To help alleviate some of these downfalls, manufacturers developed more versatile, less expensive HVLP spray equipment. Depending on the make of gun, these systems have a transfer efficiency ranging from 55 - 75 percent, and report a savings in material of 20 - 30 percent over conventional spray guns. The non-turbine HVLP guns use only conventional shop air for their operations. No expensive auxiliary air supply sources or turbines are needed. These spray guns do require high volumes of air (13 - 30 cfm at 10 psi), so at least a five horsepower compressor, with adequate piping (i.e. 3/4") is usually required to supply the needed volume of air. As with all non-turbine low pressure spray equipment, incoming air must be dry to prevent water condensation within the gun.

The non-turbine HVLP technology has proved to be a vast improvement over the turbine models, but it still has obstacles that must be overcome. The application rates of the HVLP systems are much slower than that of conventional spray equipment. Also, non-turbine HVLP spray guns do not offer the metallic control of conventional style guns, making the spraying of metallic topcoats difficult to master. As with all HVLP spray equipment, non-turbine models clog easily. For this reason, coating material filtration and proper gun cleaning practices are essential. Finally, blending topcoats using the HVLP technology has been a challenge for painters. The thick coats applied using the HVLP guns do not produce the gradual tapering effect needed for blending of high solid and metallic topcoats.

HVLP Spray Guns With Pressure Assist Cup

One attempt to improve the HVLP technology to better suit the auto repair industry was the addition of a pressure cup to the system. These systems use a paint cup mounted under the gun, similar to a conventional spray gun design. With this style, the cup is pressurized, using a separate regulated air line, to feed the paint to the gun. The pressurized cup improves the transfer efficiency of the gun.

As with any pressurized paint gun, care must be taken not to over-pressurize the paint cup or remove a pressurized cup. Equipment damage or operator injury may result. Some atomization problems may also be experienced when spraying epoxy primers and high solids coatings due to their high viscosity.

HVLP Gravity Fed Spray Guns

The gravity fed HVLP guns (see Figure 4) combine the finest qualities of the HVLP and conventional gravity fed spray guns into one design. Like its conventional counterpart, these guns work especially well on high solids and water-based paints, clears, and primers due to their top mounting, gravity fed material cup.

This design also shares the disadvantages of its conventional counterpart; as the paint level decreases, so does the feed rate. Therefore, the operator must adjust technique to compensate for the change in fluid flow.

HVLP Siphon Fed Spray Guns

To gain acceptance in the auto refinishing industry, some spray gun manufacturers are producing siphon fed HVLP spray equipment. The siphon fed spray guns come as close as any of the HVLP equipment to looking and feeling like a conventional siphon spray gun. Some companies are even producing conversion kits to make a conventional siphon fed into an HVLP siphon feed gun. This makes the price of this HVLP technology extremely affordable. These guns produce basically the same soft spray pattern as all HVLP guns with atomizing pressures as low as 5 psi. The siphon design has a lower transfer efficiency than other HVLP technologies.

Figure 4: HVLP Gravity Fed Spray Gun

D. Low-Pressure/Low- Volume (LPLV)

Another spray technology developed to improve transfer efficiency is the Low-Pressure/Low-Volume (LPLV) spray equipment.

LPLV Guns

Like the HVLP equipment, LPLV guns use conventional shop air and do not require expensive turbine units. The LPLV spray guns require only 7 - 8 cfm of compressed air at 10 psi (as opposed to the 13 - 30 cfm required for HVLP equipment). Unlike HVLP equipment, the first stage of atomization occurs within the LPLV spray gun. Air and paint are mixed inside an internal chamber of the air cap to further assist in the paint atomization. The LPLV systems boast a transfer efficiency ranging from 55 - 75 percent.

As with all the new spray technologies, the LPLV systems have obstacles that the painter must overcome. Among these is a pressurized cup, used in some LPLV systems, which is only pressurized when the gun trigger is pulled. Some changes in spray technique may be required to accommodate this delay in material delivery. LPLV spray equipment has gained only minimal acceptance in the automobile refinishing industry.

Prior to purchasing any paint gun, consult your paint representative to determine which type of gun will work best for the application of the product you will use. Your paint and/or spray gun representative can also help you determine the proper fluid tip/air cap combination and proper gun settings.

E. Recommended Practices for Spray Equipment

- Determine the price range you are willing to spend for spray equipment.
- Determine the types of coatings that will be sprayed through the equipment and the atomization properties required for their proper application.
- Choose spray equipment that will achieve the highest transfer efficiency while providing the required atomization properties within your price range.
- Prior to purchasing any paint gun, consult your paint representative to determine what type of gun will work best for the application of the product you will be using.
- Contact your paint representative and/or spray gun representative to determine the fluid tip/air cap combination and gun settings that should be used with the material being sprayed.

4. Spray Application Techniques

Both the quality of the finish and transfer efficiency greatly depend on the technician's skill and spraying techniques. Cost and sophistication of paint application equipment do not ensure a quality finish. In order to achieve a quality finish, the painter must focus on the proper combination of the following variables:

- Type of material to be sprayed
- Viscosity of material
- Thinner/reducer speed used
- Type of hardener or reactor used
- Addition of additives
- Booth air temperature
- Booth air flow
- Paint gun orifice size
- Paint gun air cap style
- Paint gun adjustments (air, fluid, fan size)
- Distance of the spray gun from surface
- Operator's spray gun speed

According to a study done by the Pacific Northwest Pollution Prevention Research Center, "Transfer Efficiency and VOC Emissions of Spray Gun Coating Technologies in Wood Finishing", the VOC emissions released during a surface coating process are directly related to the skill of the spray gun operator. The study concluded that "the difference in transfer efficiency due to painter skill level with a single gun type were often larger than the differences between gun types." In other words, proper painting technique is often more important than high transfer efficient spray equipment when it comes to reducing emissions. A skilled technician will adjust spraying style with each specific job to compensate for the type of coating being sprayed, the atmospheric conditions, the size and shape of the object being coated and the spray equipment used. Due to all the variables involved, it is impossible to specify the one best spray technique for all situations.

The quality of the finish and transfer efficiency depend on t skill and technique of the technician

Painting technique is often more important than transfer efficient spray equipment in reducing emissions

In general, technicians should follow these basic rules.

A. Always have the correct gun setup for the coating to be sprayed and the size of the area to be covered. These variables include the size of fluid tip and air cap used. Fluid tip size is determined by the viscosity of the coating as well as the flow rate setting of the gun. The viscosity is determined using a Zahn cup measuring system (see figure 5, pg 14).

The flow rate can be determined through the following process:

For pressure fed spray equipment:

1. Turn off the atomizing air.
2. Aim spray gun tip towards a container (preferably a graduated container).
3. Pull the trigger of the gun, spraying the unatomized coating into the container for 60 seconds.
4. Measure the amount of material expelled from the gun into the container to determine the flow rate in ounces/minute.

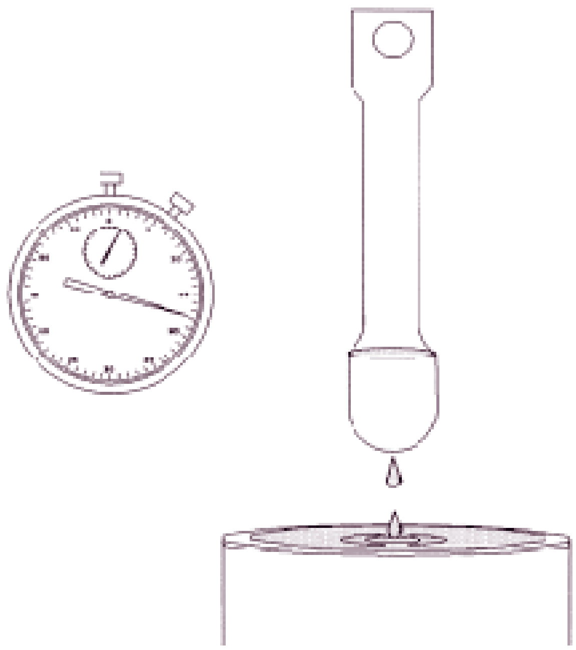

Figure 5: Zahn Cup

For siphon fed spray equipment:

1. Measure the amount of material in the spray cup
2. Pull the trigger of the gun, spraying the gun at normal operating settings for 60 seconds.
3. Measure the amount of material left in the spray cup to determine the volume of material sprayed per minute.

B. Once the proper fluid tip size has been determined, an air cap can be chosen. The choice of an air cap depends on fluid tip size and the desired air consumption of the gun. Many paint gun manufacturers have fluid tip/air cap combinations preset to help determine the proper pairing. Because fluid tips and air nozzles are precision machined to very stringent tolerances, it is important that their orifices remain free from obstructions to assure proper atomization and spray pattern uniformity.

C. Set the air pressure at the lowest possible setting that will provide the required degree of atomization. Too low of a setting may result in a heavy centered spray pattern. Too high of a pressure setting will cause a dry spray pattern, resulting in a dry rough finish. Never exceed the coating manufacturer's recommended air pressure settings.

Always hold the gun perpendicular to the substrate

D. The size of the fan pattern will vary with the size and configuration of the surface to be coated. For small spot repair operations, a small pattern is usually preferable. For large panels, a full pattern is generally the most desirable setting.

E. When spraying, always hold the gun perpendicular to the surface being sprayed, using parallel strokes. Never arc the spray gun (Figure 6), with two notable exceptions:

- spraying extremely large panels that exceed the length of the painters reach. In these cases, the painter will arc the gun at the end of the pass to help blend the overlap areas, and
- performing panel spotting or blending operations.

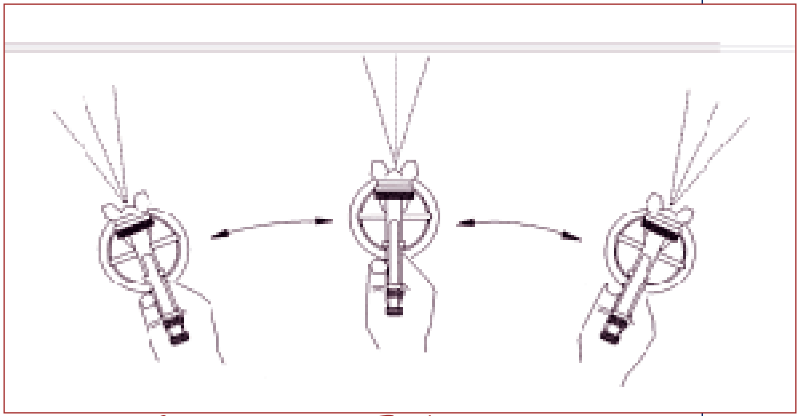

Figure 6: Improper Spray Technique

F. The spray gun should be held at a distance of 6 - 8" from the substrate, and this distance should be maintained with each stroke (Figure 7). In general, the painter should use a 50 percent overlap for each pass, feathering the trigger at the beginning and end of each stroke (Figure 8). This technique may need to be altered slightly when applying high-metallic, high-solids basecoats and for some three stage systems to avoid striping. The speed of each pass should be a comfortable pace for the technician while maintaining a full wet coat, free of sags or runs.

The spray gun should be held 6-8" from the substrate

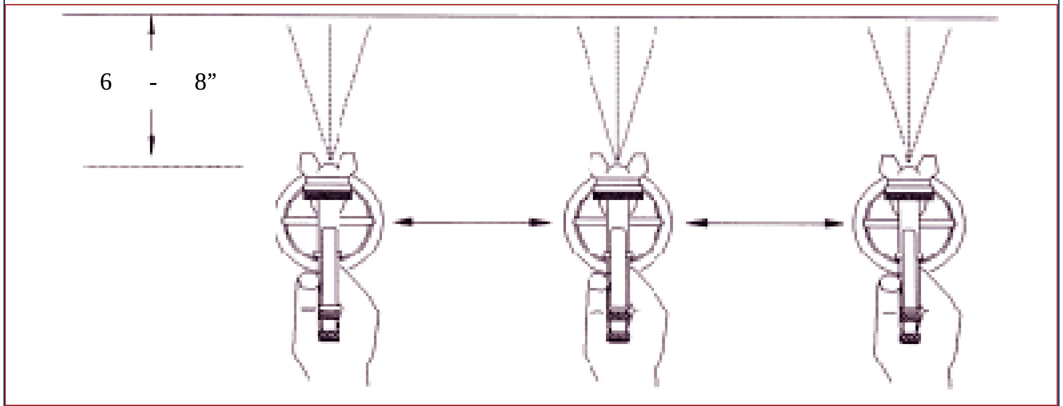

Figure 7: Proper Spray Distance and Technique

The painter should use a 50% overlap for each pass

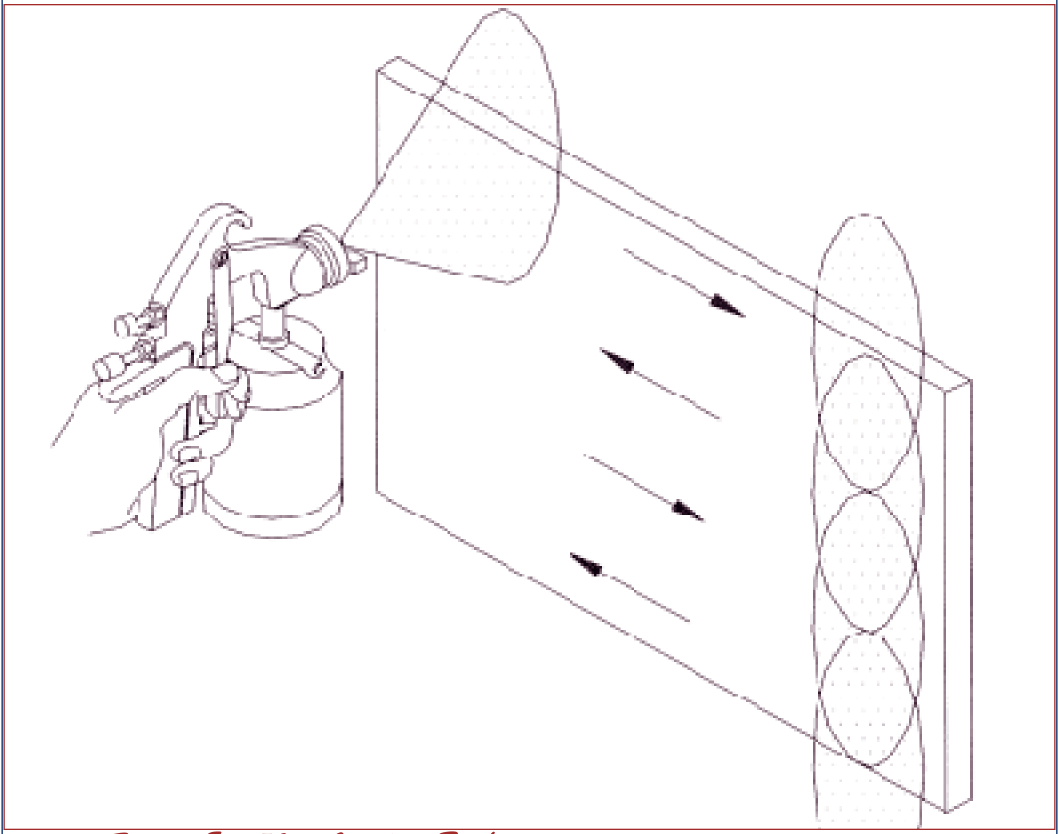

Figure 8: 50% Overlap Technique

G. Always paint small and medium size panels without breaking the stroke. With larger panels, use a 4 - 5" overlap of the strokes, arcing the gun at the end of each pass. When spotting or blending a panel, keep the blend as small as possible without jeopardizing the appearance of the blend. To help insure proper coverage of edges while reducing overspray, spray the outer boundaries of the panel first. This technique, called banding, allows the painter to maintain adequate coverage at the edges of the panel without extending the spray stroke well beyond the end of the panel surface (Figure 9).

When applying a topcoat, use hiding power labels to determine when the surface has been adequately covered. Through the use of these labels, the technician can be assured of achieving proper coverage without the application of excess material (Figure 10).

Always paint small and medium size panels without breaking the stroke

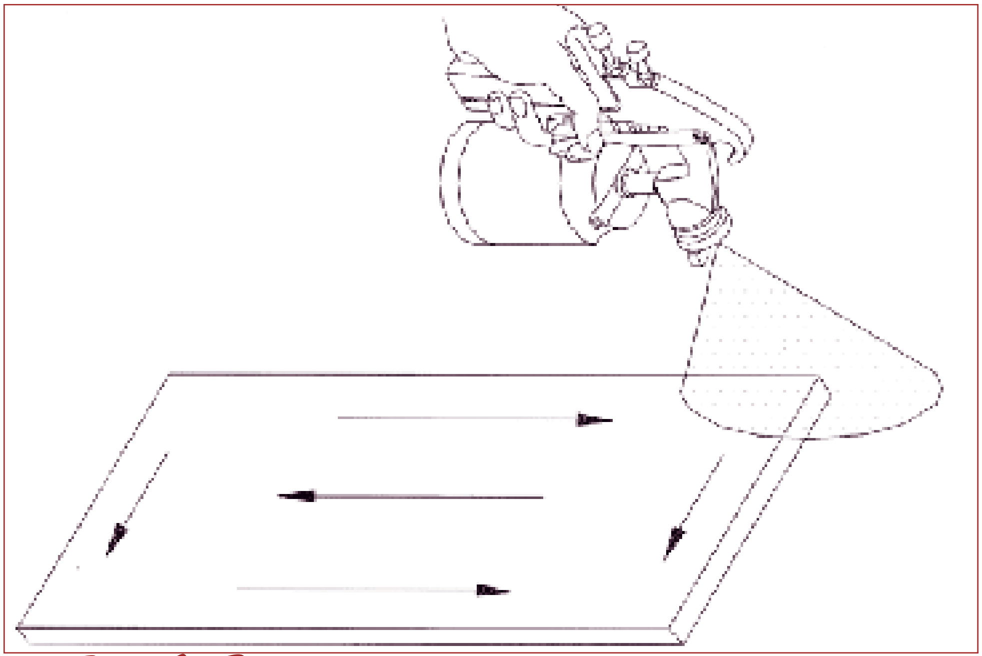

Figure 9: Banding

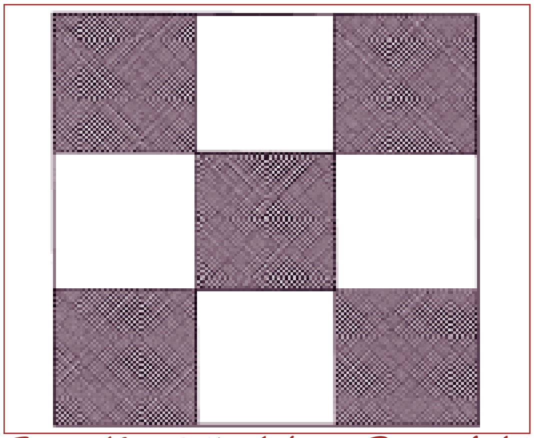

Figure 10: Self-Adhering Power Label

A. Recommended Practices for Spray Application Techniques

- Use the suggested air pressure and tip sizes for the specific product and equipment being used.
- Always hold gun perpendicular to the surface being sprayed, using parallel strokes. Never arc the gun.
- Feather the trigger at the beginning and end of each pass.
- Use a 50 percent overlap for each pass. This technique may need to be altered slightly when applying high-metallic, high-solids basecoats and some three stage systems.
- When painting small- and medium-sized panels, make each pass the full length of the panel.
- With larger panels, use a comfortable stroke, with a 4 - 5 " overlap of the strokes.
- If blending is necessary, keep the blend area as small as possible without jeopardizing the appearance of the blend.
- Spray the border edges of the substrate first (banding). This will assure all edges are covered without extending the spray pattern well beyond the borders of the object.
- Use color hiding power labels to determine the thickness of the applied paint film. These markers will also indicate when adequate coverage has been achieved.

5. Spray Equipment Cleaning

The proper cleaning and maintenance of spray equipment has always been an essential part of achieving a quality finish. This is especially true with newer high transfer efficiency spray technologies. These new spray guns are machined to very close tolerances and are highly susceptible to dried paint or other obstructions that can affect the performance of the gun. The EPA has estimated that 20 percent of all VOC emissions released by automobile refinishers occur during cleanup operations (Figure 11).

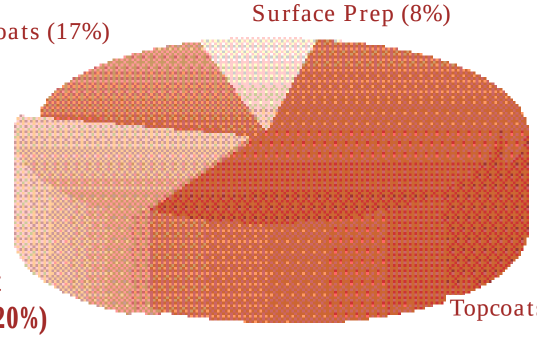

Figure 11: EPA Estimates of VOC

A. Manual Cleaning Processes

Prior to the introduction of paint gun cleaning systems, all spray equipment was cleaned by hand using the following basic steps:

- Remove all remaining paint from the cup.
- With the air hose and cup removed, pull the gun trigger to remove all remaining paint from the siphon tube.
- Rinse the cup with a small amount of thinner.
- Pour clean thinner into the cup and reattach it to the gun.
- With the air supply reattached, spray the thinner through the gun to remove any paint remaining in the interior orifices.
- Remove the cup and pour thinner out of the cup.
- Wipe off the outside of the gun, and inside and outside of the cup using a rag or paper towel.
- Remove the air cap and clean with a cleaning brush. A cleaning brush is also used to clean other external moving parts and behind the trigger.
- Reassemble the gun and return it to its storage area. Many painters remove the air cap from the gun and place it in the cup. A small amount of thinner is left in the cup so the cap can soak during storage.

20% of VOC emissions are released during gun cleaning operations

Using metal objects to clean the small passageways can result in severe damage which greatly reduces the efficiency of the spray gun. If needed, use a soft wooden toothpick to remove obstructions from the orifices.

These manual cleaning techniques, still commonly used in many small shops, release an excessive amount of VOCs to the atmosphere. They

also expose the operator to solvents for an extended amount of time.

Mechanical cleaning systems reduce the amount of thinner used during the cleaning process by more than one half

B. Pneumatically Powered Mechanical Cleaning Systems

Within the last few years the mechanical gun wash system has gained popularity in the refinishing industry. Mechanical gun washers (Figure 12) provide a safe, quick way to effectively clean paint equipment, including HVLP and LPLV spray guns. The initial cleaning steps used with mechanical gun cleaners are the same as cleaning a gun using manual techniques.

- Remove all the remaining paint from the cup.
- With the air hose removed, pull the trigger of the gun to remove all remaining paint from the siphon tube.
- Rinse the cup with a small amount of thinner.

Following these initial cleaning steps, the disassembled gun is then placed in the gun washer. The gun's siphon tube is placed in the siphon tube holder, and the gun trigger is locked open using a locking plate. The cup is simply inverted and placed over a cleaning jet. The lid of the washer is then closed and the washer turned on. The operator can leave the cleaning station and remain away from paint, thinner, and isocyanate fumes. After 1 - 3 minutes, the painter can remove the cleaned spray gun from the washer. The washer lid must then be closed to prevent the thinner from evaporating and to keep the VOC emissions to a minimum.

With proper use and maintenance, these units reduce the amount of thinner used during the cleaning process by more than one-half (some manufacturers boast a 75 - 90 percent reduction). Mechanical systems also reduce the labor time needed for equipment cleaning by over 60 percent.

Although VOC emissions from gun washing systems (Figure 13) have yet to be accurately measured, the reduction should be substantial. In addition, some solvent manufacturers offer a low VOC gun wash solvent to further reduce emissions from cleaning operations.

Figure 12: Enclosed Air Powered Mechanical Cleaning System

Figure 13: A Two Gun Capacity Gun Wash System

C. Recommended Practices for Spray Equipment Cleaning

- Use an air powered mechanical gun cleaning system.
- Use low VOC cleaning solvents.
- If cleaning guns manually, spray into an enclosed backdrop to capture atomized solvents.
- Never use metal objects to remove dried paint or other obstructions from the small orifices of spray equipment. If necessary, use a soft wooden toothpick.

6. Determining Product VOC Content

The VOC content of paints or related products may be found on the Material Safety Data Sheet (MSDS) provided by the manufacturer. The MSDS lists the VOC content of the product as shipped in pounds per gallon, minus water and non-VOC solvents (Figure 14).

The listed VOC content gives the user a means of comparing different products. Use caution when comparing these values because the listed VOC content is of the product as packaged, not necessarily its sprayable form. Most products require the addition of reducers, thinners, hardeners or reactors prior to application. These additives contain up to 100 percent VOCs by volume and will change the VOC content of the coating. For example, if a topcoat is to be mixed with a hardener and reducer at a ratio of 2:1:1 respectively, then the VOC content should be calculated as follows.

Paint VOC content	-	4.50 lbs/gal	x	50%	=	2.25	
Hardener VOC content	-	6.44 lbs/gal	x	25%	=	1.61	
Reducer VOC content	-	7.55 lbs/gal	x	25%	=	1.89	
				100%	=	5.75 lbs/gal	

This sprayable product has a VOC content of 5.75 lbs/gal, not 4.50 lbs/gal as listed on its MSDS.

When comparing product VOC content, the amount of the product needed should also be considered. If a product has a low VOC content but requires 3 - 4 applications, it may actually release a greater volume of VOCs during the operation than a high VOC product that will perform equally well using two light coats.

MSDS sheets list the VOC content as packaged

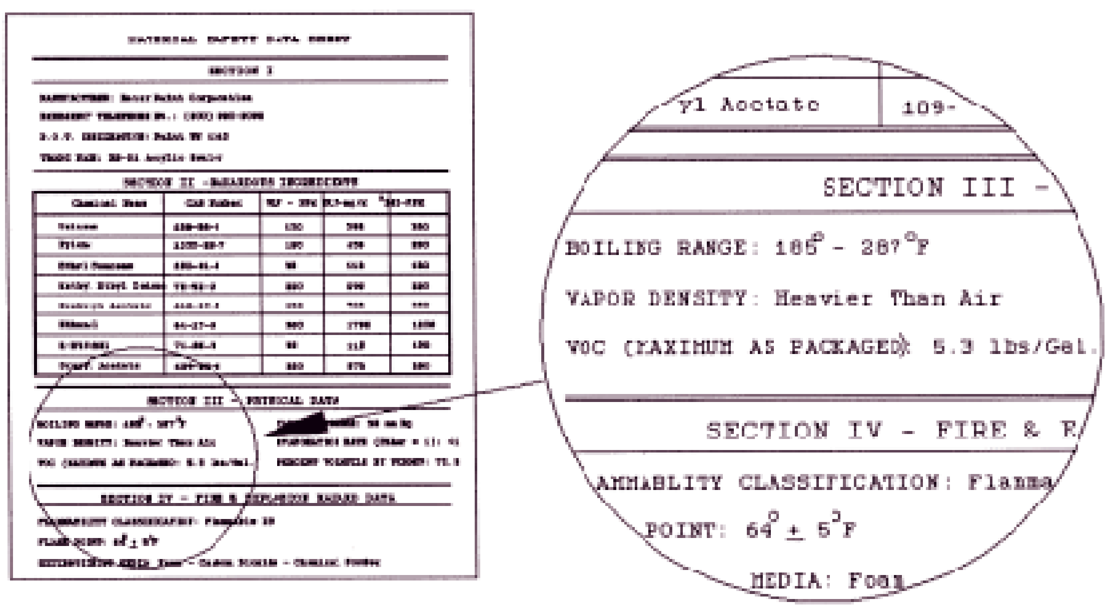

Figure 14: Determining VOC Content from the Material Safety Data Sheet

7. Surface Prep

To achieve maximum adhesion between the surface to be refinished (the substrate) and the undercoat, the surface must first be cleansed of all contamination. Cleaners are used to remove dirt, grease, wax, silicon, mold release agents (used in plastic and rubber production) and any other contaminants that could compromise the undercoat's adhesion to the substrate. Many of these cleaners contain toluene, which is listed as both a VOC and a HAP. The EPA has estimated that 8 percent of all VOCs released during the refinishing process result from surface prep operations (Figure 15).

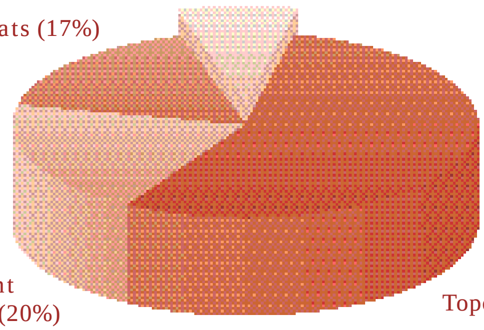

Figure 15: EPA Estimates of VOC Emissions

A. Soap and Water

Prior to working on an automobile, all dirt should be removed from the surface. To limit the amount of solvent used for surface prep, use a mild detergent or car wash soap to clean off road grime and dirt. Then rinse the surface with water to remove any remaining soap. This is one of the simplest and least expensive means of reducing both VOC emissions and material costs. This process also flushes the dirt and dust from body seams, reducing the risk of dirt blowback during refinishing. Biodegradable detergents do not generate any VOC emissions.

To limit the amount of solvents used, a mild detergent should be used to remove roa grime and dirt.

B. Synthetic Reducers

In the past, some painters have used reducers as a pre-paint cleaner. Reducers were popular mainly because they eliminated the need for the purchase of a second, less versatile product. But reducers have proved to be unsatisfactory pre-paint cleaners for several reasons. Reducers do not remove silicone from surfaces as efficiently as commercially produced cleaners and they have a tendency to soften existing paints and primers, causing them to swell and blister. In addition, synthetic reducers are 100 percent VOCs.

C. Solvent-Based Cleaners

After all the road dirt and grime have been removed, a solvent-based cleaner can be used to effectively remove all grease, wax and silicone from the surface. Solvent-based cleaners typically have a VOC content of 6.0 lbs/gal and may contain up to 100 percent solvent.

Most prep cleaners come in two formulas and strengths. One type is used for the initial surface cleaning prior to sanding. They are designed to remove heavy silicone, wax and grease contamination. Many of these cleaners contain harsh solvents such

as xylene and mineral spirits. These highly concentrated solvents, if used as a final wash, can cause poor adhesion and/or "solvent popping" of the topcoat.

The second formula is designed for the removal of light contamination and is used primarily for final cleaning prior to painting. These final cleaners will not soften the painted or primed surface like some of the harsher solvents, nor do they leave harmful residues on the substrate.

Waterborne cleaners have been developed to replace high VOC cleaners

D. Waterborne Cleaners

Recently, waterborne cleaners have been developed to replace the high VOC solvent-based cleaners. Like their solvent-based counterparts, waterborne cleaners generally come in two concentrations. One for the general cleaning of surfaces, and another for the final preparation of surfaces prior to painting.

Waterborne cleaners remove wax, grease and silicone like their solvent-based counterparts, but with less than one-sixth the VOC content. However, waterborne cleaners do have three distinct disadvantages. First, they may not remove heavy silicon and grease contamination as well as traditional solvent-based cleaners. Second, they do not evaporate as quickly as solvent-based cleaners, thus increasing the time needed for surface prep. Finally, many of these cleaners are not recommended for specific substrates, such as water-based or acrylic lacquer finishes.

E. Recommended Practices for Surface Prep

To reduce the VOCs emitted during surface prep operations, the following practices should be implemented:

- Always wash dirt and grime from the vehicle using water or a soap and water mixture.
- Use waterborne cleaners when possible.
- If, due to heavy contamination, waterborne cleaners prove unsatisfactory, use solvent-based cleaners for the initial cleaning of the surface. For secondary cleaning operations, use the waterborne products.
- If waterborne cleaners prove unsatisfactory due to substrate make-up, use solvent-based cleaners sparingly.
- Keep solvent-laden dirty rags in a closed container.
- Keep solvent containers closed when not in use.
- If possible, avoid operations that would necessitate multiple prepaint cleaning operations (e.g., post surface prep repair operations which could contaminate the substrate with grease or oil).

8. Undercoats

Undercoats are defined as all material applied over the substrate prior to the application of a topcoat. These primers fall into four separate categories:

- Prep Coats
- Primer-surfacers
- Primer-sealers
- Sealers

The EPA has estimated that undercoating processes account for 17 percent of all VOCs released during refinishing operations (Figure 16).

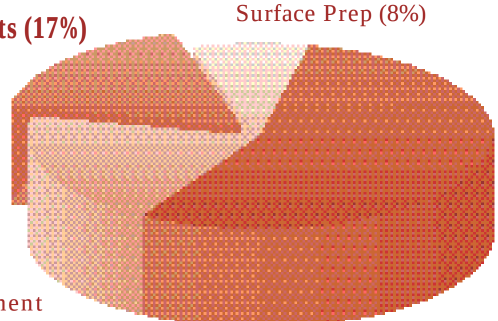

Figure 16: EPA Estimates of VOC

A. Prep Coats

The prep coat is applied directly over bare metal or metal alloy, galvanized or plated metal, plastic or rubber substrates. The type of prep coat used will vary depending on the substrate and the type of coating to be applied over the prep coat. It is important to read and follow all directions for these products very carefully and contact your factory representative with any questions prior to application. It is also advisable to use one brand of product throughout the surface coating operation while following all factory recommendations. This will help take the guess-work out of determining which products are compatible. It will also cut down product inventory and product waste within the shop.

Use one brand of product, following all factory recommendations

The prep coat has two major functions:

1. Provide a corrosion resistant coating.

2. Provide maximum adhesion between the substrate and the next coating to be applied.

Metal Conditioners/ Conversion Coatings

Metal conditioners are acidic solutions that clean the surface of the substrate, removing contaminants that would otherwise compromise the bond between the substrate and the undercoat. The metal conditioner is generally wiped on with a rag, and after 2-4 minutes neutralized with water. Metal conditioners work well only if the surface has been wiped completely dry after the neutralization process has been completed. If moisture remains on the metal surface and is allowed to air dry, the integrity of the bond between the substrate and the primer-surfacer will be compromised. The remaining moisture may also cause oxidation to form on the bare metal surface.

Conversion coating leaves a phosphate coating on the substrate

Following the metal conditioner, a conversion coating is applied to the substrate. This conversion coating, usually phosphoric acid, etches the metal to improve bonding with the primer-surfacer. The conversion coating also leaves a phosphate coating on the surface of the substrate, forming a more corrosion-resistant surface.

Although this system contains low amounts of VOCs (approximately 1.0 lbs/gal) it has some distinct disadvantages. First, the primer-surfacer must be sprayed on shortly after the metal conditioning process has been completed to avoid corrosion of the metal. Second, the employee performing the metal conditioning operation is exposed to an acidic solution which may cause skin irritation. Finally, the metal conditioner-conversion coating system is time consuming, especially when large areas require treatment.

Wash-Primers/Vinyl Wash-Primers

Some water based wash-primers contain no VOCs

Wash-primers were developed to eliminate one of the steps associated with metal conditioner and conversion coating systems. Wash-primers contain either phosphoric acid or nickel dihydrogen phosphate, which forms an adherent phosphate coating when applied to steel and aluminum. The acid also removes rust, welding scale, and oil from the bare metal while etching the surface to insure the good adhesion of the primer-surfacer.

Wash-primers are usually sprayed on the metal surface using a hand held plastic sprayer. Many wash primers must be neutralized with water and dried prior to surface coating. Most of these conditioners are low in VOCs, with average contents of approximately 1.0 lb/gal. Some of the newer water based wash-primers do not contain VOCs.

Application of these products requires caution. Some are designed for use on steel surfaces only, and should not be used on aluminum substrates. Application to any surface other then a bare metal surface must also be avoided, as lifting of the surface coat may result.

Some wash-primers are designed for use on most metal surfaces as well as plastic and rubber substrates. These wash-primers form a good bond between the topcoat and the hard-to-adhere-to, plastic and rubber surfaces.

Since wash-primers react with metal surfaces, the use of a paint gun for application should be avoided. Wash-primers can react with the metal spray gun, resulting in an adhesive coating formed inside the cup and on the interior components of the gun. For this reason, the solution should be applied by hand or with a non-metallic spray bottle. Check with your paint supplier for specific recommendations.

Zinc Phosphate Primers

Many automobile manufacturers use zinc phosphate coatings as a primer during surface coating operations. In the factory, the application of the zinc phosphate coating is a multi-step, time consuming process. But zinc phosphate systems used as a primer in the refinishing industry are a simple, one step, process. A light coat of zinc phosphate is sprayed on the metal surface and allowed to dry for 30 to 60 minutes. The zinc phosphate etches the substrate and deposits a phosphate coating on the surface to provide protection from moisture. The result is a non-reactive roughened surface that is perfect for the application of a primer coat and needs no sanding prior to surface coating. These primers can be used on both steel and aluminum surfaces. Zinc phosphate does not have a pot-life, but must be stirred before each use due to excessive settling.

Zinc phosphate has a VOC concentration of 4.5 - 5.0 lbs/gal as packaged. The VOC content of the sprayable solution, reduced 1:1 with enamel reducer, is as high as 6.0 lbs/gal.

In addition to the high VOC level, zinc phosphate has four other distinct disadvantages.

1. It is not recommended for use as a primer under many waterborne primer-surfacers.
2. Zinc phosphate does not adhere as well as the wash-primers or self-etching primers.
3. The primer has no filling capabilities.
4. The 30 - 60 minute curing time of the zinc phosphate may be unsatisfactory for production surface coating operations.

Self-Etching Primers

Self-etching primers are usually two component primers that provide good corrosion resistance and good adhesion to bare metal substrates. These primers also have some filling properties to hide minor surface imperfections. The primed surface may be sanded and recoated usually after 45 - 60 minutes.

The VOC content of self etching primers ranges from 5.0 - 6.5 lbs/gal as packaged. With the addition of the activator and reducer, the total VOC content of the sprayable product may be as high as 6.0 - 7.0 lbs/gal. In addition to the high VOC content, these coatings also have the disadvantage of a pot-life ranging from several hours to several days depending on the product.

Epoxy Primers

Epoxy primers are one of the most versatile automotive paint products on the market today. These two component primers can be used as a primer, primer-surfacer, primer-sealer, and adhesion promoter. Epoxy primers provide excellent corrosion resistance and adhesion to bare metal and coated surfaces. The epoxy resins in the primer produce a strong chip resistant surface over the substrate.

Epoxy primers are one of the most versatile products on the market

Solvent-based self-etching epoxy primers have a VOC content of approximately 3.5 - 4.0 lbs/gal. With the addition of the activator and reducer, the sprayable primers have VOC contents of approximately 5.0 lbs/gal.

These products also have a pot-life, some as little as 6-8 hours, which may increase the amount of waste material generated. The curing time for these primers ranges from 1 to 2 hours for the solvent-based, to as much as 10 hours for the waterborne

Minimizing the number of coats applied limits the amount of VOCs emitted during the primer-surfacer stage

epoxy primers. It should also be noted that some of these primers contain lead and chrome, and their activators may contain isocyanates.

Adhesion Promoters

Adhesion promoters do not provide the corrosion protection supplied by other prep coats and should not be used over bare metal substrates. However, these products do provide improved adhesion to plastic and rubber components, as well as painted surfaces.

The application of adhesion promoters has become an important step in the refinishing process with the growing popularity of the harder, more durable high tech surface coatings. When sprayed over OEM urethane, water-based, or high solids paints and clears, adhesion promoters provide improved adhesion between the substrate and the topcoat. Adhesion promoters come ready to spray with a VOC content of 6.5 - 7.0 lbs/gal. They generally require a curing time of approximately 15 - 30 minutes prior to topcoating.

Primer-surfacers should be used to fill small imperfections only

Recommended Practices for Prep Coats

- Use versatile products such as epoxy primers or self-etching primers. These products may alleviate the need for additional surface coating operations such as primer-surfacing or primer sealing.
- If a self-etching primer or epoxy primer is not desirable, use a wash-primer, or metal conditioner, conversion coating system.
- Avoid high VOC content zinc phosphate primers.

B. Primer-Surfacers

The best way to limit VOC emissions during the primer-surfacer stage of the refinishing process is to minimize the number of coats applied. By ensuring that all major body imperfections are removed prior to priming operations, the technician not only reduces the amount of expensive material used during the repair process, but also reduces the amount of VOCs released. Primer-surfacers should only be used to remove small imperfections such as sanding scratches; they are not meant to fill dents.

Primer-surfacers are sprayed over primers and have the following functions:

1. Provide adhesion between the primer and the material to be applied over the primer-surfacer. This includes the primer-sealers, sealers, and topcoats.
2. Provide corrosion protection to the metallic substrate.
3. Act as a filling material to cover minor surface flaws.
4. Provide a coating that can be ` easily sanded to a smooth surface.

If a primer-sealer or sealer will not be used over the primer-surfacer, or if the sealer to be used is transparent, the color of the primer-surfacer must be considered. To reduce VOC emissions and the amount of paint required, choose a primer which is a color that can easily be covered by the topcoat. Some primers on the market today are tintable, allowing for easy coverage of the surface-primer by the topcoat. Many primer-surfacers still contain lead and chromium. Most two component primer-surfacers contain isocyanates.

When applying primer-surfacers, as with all coatings, it is important to use a gun specially designed for use with that type of product. Using a properly operating primer gun with the correct fluid tip/air cap combination will help reduce overspray and reduce the waste of time and material due to a dry or uneven coating.

Acrylic Lacquer Primer-Surfacer

Acrylic lacquer primer-surfacers have been very popular in auto body shops over the years. These primer-surfacers provide an easy sanding surface that drys quickly (usually within 30 minutes) and has good filling capabilities. Acrylic lacquer primer-surfacers also provide good corrosion resistance and excellent holdout characteristics. Lacquer based primer-surfacers are good for spot repair and small panel jobs. However, using lacquer-based primers over deteriorating or sensitive surfaces may result in lifting or accelerated deterioration of the old painted substrate. These primers are not generally recommended for large jobs due to their poor durability and lack of compatibility with the majority of today's topcoat systems.

Acrylic lacquer primers usually have a VOC content ranging from 4.5 - 5.0 lbs/gal. When thinned (usually 100 - 125 percent) and ready to spray, VOC content is approximately 5.5 - 6.0 lbs/gal.

Alkyd Synthetic Enamel Primer-Surfacer

Alkyd enamel primer-surfacers have good filling and holdout properties as well as excellent corrosion resistant qualities. They produce a flexible, tough, chip-resistant base that is excellent for the application of a topcoat. Because of their enamel base, these primer-surfacers are less likely than their lacquer-based counterparts to adversely affect sensitive substrates.

Alkyd enamel primer-surfacers contain 4.0 - 4.5 lbs/gal VOCs as packaged. When thinned to a sprayable concentration, the amount of VOCs increases to 4.5 - 5.0 lbs gal. The one distinct drawback of alkyd enamel primer-surfacers is their slow curing time. These primer-surfacers must dry for at least four hours before sanding operations can be performed. For this reason, alkyd enamel primer-surfacers are not typically used for spot repair operations, but rather large panel surfaces and complete paint jobs.

Self-Etching Primers (as a Primer-Surfacer)

Self-etching primers are usually two-component primers that provide good corrosion resistance with fair filling qualities. The primed surface may be sanded and recoated after 45 - 60 minutes of drying time.

The VOC content of self etching primers ranges from 5.0 - 6.5 lbs/gal as packaged. With the addition of the activator and reducer, the total VOC content of the sprayable product may be as high as 6.0 - 7.0 lbs/gal. In addition to high VOC content, this product also has the disadvantage of a pot-life ranging from several hours to several days depending on the product.

A properly operating primer gun with correct fluid tip/air cap combination will help reduce overspray

One-Component Waterborne Primer-Surfacer

When waterborne primers were introduced to the collision repair market in the mid-to-late 1980's, they were met with controversy and resistance. Waterborne primers have been reported to cause rusting of untreated metallic substrates and non-coated ferrous spray equipment components. Some painters feel these products have a curing time too slow for production work, especially in regions with high humidity. While many of these reported problems are due to improper use of the product, long curing times remain the primers' greatest adversary.

These primers do have some very beneficial qualities. They possess excellent high building properties with tremendous hold-out capabilities. Many can be used on flexible parts as a primer without the need for the addition of a flex agent. Single component waterborne primers come ready to spray with a 4.5 - 5.0 lbs/gal VOC content, resulting in a 20 percent reduction in VOC emissions as compared to conventional solvent- based primers.

Single component waterborne primers come ready to spray with a 4.5 - 5.0 lbs/gal VOC content

Epoxy Primer (as a Primer-Surfacer)

As a primer-surfacer, epoxy primers provide excellent filling qualities and possess excellent hold-out capabilities. The tough surface produced by the epoxies makes a good durable base for the application of any topcoat.

Solvent-based self-etching epoxy primers have a VOC content of approximately 3.5 - 4.0 lbs/gal. With the addition of the activator and reducer, the sprayable primer-surfacer formula has a VOC content of up to 4.5 lbs/gal. Waterborne epoxy primers, which are also available, have a VOC content of less then 2.1 lbs/gal for the sprayable product.

Polyester Primer-Surfacer

Polyester primer-surfacers contain polyester resins which, when cured, form a durable surface with excellent high building qualities and minimal shrinkage. Because of their high viscosity, polyester primer-surfacers are best sprayed using gravity feed spray equipment.

Polyester primer-surfacers have a relatively long curing time, ranging from 2 - 3 hours. These primer-surfacers generally do not sand as easily as other primer-surfacers, and some loss in productivity may result. The topcoats that can be applied to these primer-surfacers are usually limited to the newer polyurethanes. The VOC content of polyester primer-surfacers ranges from 4.6 to 5.0 lbs/gal thinned and ready to spray.

Acrylic Urethane Enamel Primer-Surfacer

Acrylic urethane was developed for the newer high tech topcoats. These primer-surfacers provide high build characteristics with little or no shrinkage. Urethane primer-surfacers have a VOC content ranging from 4.3 - 5.0 lbs/gal after the addition of the activator and reducer. Urethane primer-surfacers have a relatively slow curing time, some requiring up to two hours to cure under ideal conditions.

Recommended Practices for Primer-Surfacers

- Use low VOC waterborne primer-surfacer products.
- If the curing time of waterborne products is unsatisfactory, consider the use of versatile urethane or epoxy primers.
- To reduce VOC emissions, limit material costs, and achieve a better quality product, make sure body work is done in such a manner as to require only a minimal amount of primer-surfacer.
- If a colored sealer will not be used, make sure the primer-surfacer used is a color that can easily be covered with the desired topcoat.
- Use a properly operating primer gun with the correct fluid tip/air cap combination for your particular type of primer-surfacer.

C. Primer-Sealers

Primer-sealers differ from primer-surfacers in two basic areas. First, primer sealers fill only very minor imperfections. Second, they should not be sanded prior to the application of a topcoat.

Primer-sealers must meet the following performance criteria:

1. Provide corrosion resistance.
2. Provide adhesion to bare metal substrate.
3. Fill minor surface imperfections.
4. Seal sanded surfaces to prevent solvent penetration and bleed-through.
5. Provide a single, neutral-colored base for easy topcoat coverage.

The choice of sealer color affects not only the coverage of the topcoats, but may also affect the final color shade of the finish, especially when using topcoats containing transparent pigments. The primer-sealer should be as close to the color of the factory sealer as possible.

The choice of sealer color affects not only the coverage of the topcoats but may also affect the final color shade of the finish

Lacquer Primer-Sealers

Lacquer primer-sealers produce fair filling qualities with good adhesion properties. These primers are designed to be topcoated with lacquer topcoats. One coat is generally recommended prior to painting with a 30 minute drying time.

Figure 17: Application of the Primer-Sealer

Lacquer primer-sealers are commonly used for spot repair and small paint jobs, but not generally for large surface coating operations. VOC content is approximately 6.0 lbs/gal as packaged in sprayable form.

Enamel Type Primer-Sealers

Enamel type primer-sealers also have fair filling qualities with good adhesion and holdout properties. Usually used for large panel or complete paint jobs, only one coat of primer-sealer is generally needed prior to topcoating. VOC content averages 4.5 - 5.0 lbs/gal.

Single Component Waterborne Primer-Surfacer (as a Primer-Sealer)

Single component water-based primers possess excellent high building qualities and work well as barrier coats with tremendous hold-out properties. Many can be used on flexible parts as a primer without the addition of a flex agent.

These primers come ready-to-spray with a 4.5 - 5.0 lbs/gal VOC content. Because water is used as the primary solvent, the flash and cure times of these products are relatively long, especially in regions of high humidity. The water may also cause the corrosion of non-coated ferrous application equipment if not cleaned properly.

Epoxy Primer (as a Primer-Sealer)

As a primer-sealer, epoxy primers provide excellent hold out capabilities. The tough surface produced by the epoxies makes a good durable base for the application of all topcoats.

Solvent-based self-etching epoxy primers have a VOC content of approximately 3.5 - 4.0 lbs/gal. With the addition of the activator and reducer, the sprayable primer-surfacer formula has a VOC content of 4.5 lbs/gal. Waterborne epoxy primers have a VOC content of less then 2.1 lbs/gal for the sprayable product.

Acrylic Urethane Primer-Sealers

Urethane primer-sealers provide high build characteristics with little or no shrinkage. They also have superior holdout properties which make them an excellent primer-sealer.

Urethane primer-sealers have a VOC content ranging from 4.3 - 5.0 lbs/gal after the addition of the activator and reducers. Urethanes must usually be topcoated within 24 hours to avoid the need for sanding and recoating.

D. Sealers

Recommended Practices for Primer-Sealers

- Use low VOC primer-sealers such as single component waterborne, or waterborne epoxy primers.
- The use of low VOC urethane primer-sealers would also be an acceptable choice.
- Always choose primer-sealer color that can be easily covered by the topcoat to be sprayed, or choose a tintable primer-sealer and tint it to an easily covered shade.

Sealers are applied prior to the topcoat if needed. They should have the following qualities:

1. Provide adhesion between the topcoat and the surface.
2. Provide a single, neutral-colored base for easy coverage.
3. Seal sanded surfaces to prevent solvent penetration.
4. Fill minor imperfections.

In general, sealer types include lacquer sealers, enamel sealers, and urethane sealers. These sealers are developed to be coated by lacquer, enamel and urethane topcoats respectively, and generally require only one coat prior to painting. These sealers come ready to spray with VOC contents of approximately 6.5, 6.0, 6.0 lbs/gal respectively.

As with primer-sealers, the choice of sealer color affects coverage and the final shade of your topcoat, especially topcoats containing transparent pigments. Therefore, when choosing a sealer, always take into account the sealer color as well as the topcoating.

Along with these basic sealers, there are also specialty sealers available for use on specific problem surfaces.

Tie Coat Sealers

Tie coat sealers are used to achieve extra adhesion between lacquer topcoats and factory enamel finishes.

Barrier Coat Sealers

Barrier coat sealers are applied over very sensitive and or checked surfaces. These sealers supply superb holdout, preventing the lifting or checking of the new topcoat.

Recommended Practices for Sealers

- Chose the proper sealer for each specific job.
- If filling capabilities are required, use primer-sealer in place of a sealer.
- Always choose a primer-sealer color that can be easily covered with the next coating, or choose a tintable primer-sealer.

When choosing a sealer, take into account the color of the sealer as well as the topcoating to be applied

9. Topcoats

Application of the topcoat is the next phase of the surface coating operation. Topcoats are applied directly over the undercoats, which may be a prep coat, primer-surfacer, primer-sealer or sealer. Topcoats include paints and clears that give the surface the color, gloss and durability demanded by today's consumers. The EPA estimates indicate that topcoats are responsible for 55 percent of all VOCs released during surface coating operations (Figure 18).

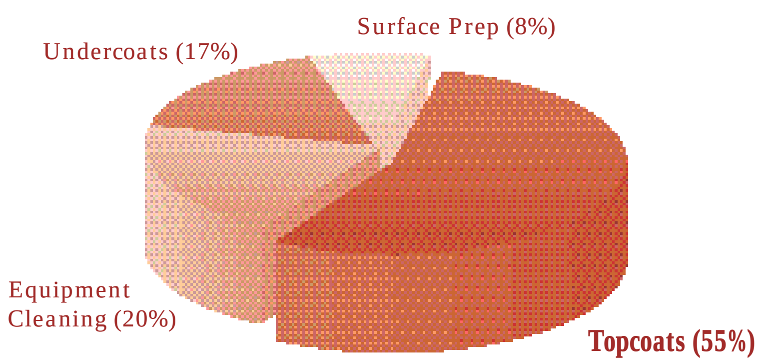

Figure 18: EPA Estimates of VOC Emissions

Paints are considered to be either solid or metallic-type topcoat. The solid color paints are made up of solvents, binders and opaque pigments that produce the color of the finish. Metallic colors are made up of solvents, binders and opaque pigments like the solid colors, but also include small light-refracting flakes. These small metallic, polychrome or mica flakes refract some of the light that enters the finish, resulting in a surface that appears richer and deeper in color. The orientation of the refracting flakes, as well as their location within the finish layer, affect the perceived color and richness of the painted surface. The positioning of these flakes within the finish is dictated by the type of paint, the speed of the thinner and hardener, the type and settings of the spray equipment, along with the spraying techniques used.

Topcoats are responsible for 55% of the VOCs released during surface coating operations

Topcoats are categorized as either single stage or two stage systems. Three stage systems are used by some automobile manufacturers, but will not be addressed in this manual.

Many paint companies offer the option of high-solids paints or clears which contain 60 percent or more solids by volume. Solvents such as glycol esters, esters and ketones, which keep more of the solids in suspension with less solvent, are generally used in high-solid paints, primers and clears. These systems reduce the amount of VOCs released by up to 75 percent, while reducing the amount of paint material needed by almost one-half as compared to conventional systems. Generally, only one to three coats are needed to achieve adequate coverage using high solids paints.

High solids paints have a high viscosity in their sprayable form. High viscosity materials are more difficult to atomize into the fine droplets needed to achieve a quality

To help reduce the amount of paint waste and VOCs released, color coats should be mixed in-house

automotive finish. The high solids coatings, due to their high viscosity, also have poor metallic flake orientation capabilities compared to low solids coatings.

Whichever paint system is used, it is important to mix material as specified by the manufacturer. Today's high-tech finishes, especially when used in the newer HVLP spray equipment, must be mixed accurately to produce a high quality finish. Consequently, painters must have the means to accurately measure the volumes of paint, reducers, and additives during mixing. To achieve the proper viscosity of a paint mixture for specific conditions, a viscosity cup (Figure 5, pg 14) should be used when mixing all paints and clears. This will help to ensure viscosity of the material is adequate to achieve a good quality finish while keeping overspray and VOCs to a minimum.

To help reduce the amount of paint waste and VOCs released, color coats should be mixed in-house. Mixing paints in-house allows the facility to make any tint changes needed to achieve a color match. It also gives the technician the freedom to mix only the amount of paint required for that specific job. Paint jobbers will generally only mix paint in quantities of one pint or greater. This amount is often more than needed, resulting in waste paint.

Spray-out cards with appropriate information on the product used and color match should be made and catalogued. This will decrease the time and money wasted matching a color, especially considering the number of colors and variations of paint formulas for each type of vehicle on the road today.

A. Single Stage Topcoats

Acrylic Lacquer

Lacquer finishes are most commonly used for small spot repair operations due to their fast cure time and minimal overspray concerns. Lacquer coatings cure solely due to solvent evaporation, producing a hard, brittle finish.

Because quick evaporating solvents are used to thin lacquer coatings, the finish does not have a chance to flow adequately prior to drying, resulting in a dull, relatively rough finish. The fully cured lacquer finish must be polished to achieve a smooth, high-gloss finish. Usually four to five coats of lacquer are applied to insure proper paint thickness is maintained after polishing.

The hard, brittle coating of the lacquer products is not designed to withstand the flexing of nonrigid surfaces. For this reason, a flex additive is used when coating rubber and flexible plastic components with lacquer paints.

To achieve the correct viscosity for conventional spray gun application, lacquer paints are thinned 125 - 150 percent. This high solvent concentration results in a VOC content of 6.0 - 6.5 lbs/gal, 70 - 90 percent by volume. The EPA estimates that the use of lacquer paints increases the amount of VOC emissions by 45 percent compared to enamel topcoats.

Alkyd Enamel

Alkyd enamels are the least durable of all the automotive paints. Alkyd enamels dry in a two stage curing process. First, the finish dries by solvent evaporation similar to lacquer type coatings. This stage takes from seven to nine hours, depending on drying conditions. In the following six hours to 30 days, the enamel cures due to the oxidation of the binder as it reacts with air.

The drying time, the gloss and the durability of the finish can all be improved with the addition of a chemical hardener. However, these hardeners not only reduce the pot-life of the paint, they also release isocyanates during spraying and curing operations.

Alkyd enamels are thinned 15 - 33 percent depending on the brand. Only two to three coats usually are required to provide adequate coverage. Alkyd enamels contain approximately 5.0 - 5.5 lbs/gal VOCs in sprayable form, approximately 55 - 75 percent VOCs by volume.

Acrylic Enamel

Acrylic enamels are used for both spot repairs as well as overall painting operations. These enamels offer more durable finishes and faster drying times than the alkyd enamels. Acrylic enamels dry in five to seven hours, with the second curing period taking an additional six to 72 hours at 72°F.

Drying time, gloss and durability of acrylic enamels can all be improved with the addition of a chemical hardener. These hardeners increased the durability of the surface by almost 50 percent compared to acrylic enamels without hardeners.

Acrylic enamels, on average, contain 5.0 - 5.5 lbs/gal VOCs in their sprayable form. With acrylic enamels requiring only two to three coats to provide adequate coverage, the VOCs are reduced by 45 percent over lacquer type paints.

Enamel products usually do not need the addition of a flex agent on fairly rigid parts. If used on very flexible parts, the addition of a flex agent may be required, increasing the VOC content.

Polyurethane Enamel Single Stage Topcoats

Polyurethane topcoats are a two-part painting system requiring the addition of a hardener or reactor (the second component) to assure proper curing of the finish. Polyurethane top coats have great spraying characteristics along with good metallic flow properties. They produce a high gloss, chemically resistant finish that will withstand the effects of ultraviolet radiation for many years.

Polyurethane enamels have a VOC concentration of 5.0 - 5.5 lbs/gal in their sprayable form. The high VOC content of these coatings is offset by their excellent coverage. Normally, only two to three coats are needed to provide a good quality finish. Polyurethane finishes have good flexibility and can be used over flexible parts without the addition of flex additives.

Acrylic Urethane Enamel

Acrylic urethanes produce one of the most durable automotive finishes available today. They have twice the durability of polyurethanes, with less curing time needed to achieve a tack free finish.

Acrylic urethanes have a relatively high VOC content (ranging from 5.0 - 5.5 lbs/gal) in their sprayable form. Generally, only two coats of these topcoats are required to produce a quality finish, reducing the amount of material needed for the top coating process.

With acrylic enamels requiring only two-three coats to provide adequate coverage, the VOCs are reduced by 45% over lacquer.

B. Two Stage Basecoat/ Clearcoat Topcoats

It has been estimated that nearly half of the automobiles on the road today have a basecoat / clearcoat finish. The first stage of the finish, the basecoat, contains the pigments that give the finish the desired color. In the case of metallic finishes, the basecoat also contains the "metallic" flakes.

When basecoat / clearcoat systems first came out, the basecoats were primarily lacquer based. Today, paint companies are producing acrylic enamel, polyester, and urethane basecoats; all of which have better metallic control then their lacquer counterparts. The basecoat is designed to be easy spraying and quick drying with excellent metal control. The quick-drying effect is designed to keep the base free of dirt and other contaminants. It also locks the metallic flakes in position to achieve a mottle-free finish.

VOC content of waterborne base coats is relatively low, ranging from 2.5 - 3.5 lbs/gal

The sole purpose of the basecoat is to achieve the desired color tint and metallic appearance. Only two coats of the base are normally needed to achieve adequate surface coverage. Basecoats do not contain the additives needed to withstand chemical and ultraviolet deterioration or the chemicals needed to achieve a high gloss surface.

To protect the basecoat, a durable clear finish is applied. This clear coating can often be applied over the base after only 15 to 30 minutes of cure time. Commonly the VOC content of the basecoats range from 6.0 - 7.0 lbs/gal.

Clearcoats are typically acrylic urethane or polyurethane coatings, although acrylic enamel and lacquer clears are also available. These clears are designed to flow upon application resulting in a smooth, glass-like finish in as few as two coats.

VOC content of the clears ranges from 5.0 - 5.5 lbs/gal in their sprayable form. Many of the major paint companies are producing low VOC clears (3.5 lbs/gal or less) for use with basecoat / clearcoat systems. These low VOC, high-solid clears create a high-gloss finish with half the materials of a low solids clear.

Waterborne Basecoat Systems

Waterborne basecoats are currently being used by a small number of automobile manufacturing plants in North America. But with the implementation of stricter VOC regulations, these coatings are expected to gain popularity within the industry. VOC content of these waterborne basecoats is relatively low, ranging from 2.5 - 3.5 lbs/gal in their sprayable form.

The waterborne technology uses water as the main solvent, giving these basecoats low VOC emissions while retaining low solids content. The low solids level means greater metallic control, resulting in a uniform finish free of mottling. Some experts note that to achieve the optimal metallic flake orientation, the volume of solids in a coating must be less than 20 percent by weight. Yet to achieve compliance within the regulated areas of the U.S., the solids volume in solvent based basecoats must be in excess of 45 percent. Currently, the only way to achieve low solids and low VOC content is through the use waterborne technology.

Early versions of waterborne basecoats were very sensitive to atmospheric conditions in the booth. Waterborne paints generally contain less than 10 percent solvents (excluding water and exempt solvents) by weight. To achieve proper crosslinking of the coating, both the water and the other solvents must evaporate at the same time and rate. This will not occur if the humidity is above the acceptable range of that coating (generally 65 - 80 percent). High humidity and/or low temperatures also increase the curing time of the finish, and increase the possibility of runs and sags.

In order to achieve a good quality finish, humidity and temperature of the booth must be closely regulated. In an industrial setting, painting conditions can be closely monitored to provide an ideal painting environment. In the repair industry, such control can not be adequately achieved without expensive control devices. Modern paint booths can effectively control application temperature as well as curing conditions, but booth humidity remains relatively unchecked.

To help combat the difficulties associated with the early waterborne systems, new waterborne technologies were developed. Currently, there are two types of waterborne basecoats being produced, acrylic latex and urethane polymer. Both use melamine formaldehyde polymers as the basic film former. The addition of these polymers and glycol ethers has been instrumental in controlling the flow of waterborne basecoat finishes during topcoating operations. Since the initial stage of curing is no longer dependent on the rate of water evaporation, the need for expensive humidity control devices are no longer necessary. Adequate air movement within the spray booth is necessary to assist in the curing of the waterborne coating. This has made waterborne basecoat technology accessible to the auto repair industry. These systems are now being utilized in the regulated areas of the west coast with some success. However, waterborne coatings are still susceptible to cold weather and must be protected from freezing during transportation and storage.

Currently, the only way to achieve the low solids and VOC content is through the use of waterborne technology

Advantages of Waterborne Basecoat Systems

- Low VOC content of the sprayable product (2.5 - 3.5).
- Good metallic flake orientation properties.
- Good atomization properties.
- No catalyst is needed for the latex basecoat, only the clear will require the addition of a catalyst.
- No flash time is required between color coats.

Advantages, con't

- Waterborne basecoats have superb hiding properties and generally require only two coats for complete coverage.
- Equipment can be cleaned with water instead of solvents.
- At least one waterborne paint manufacturer offers a coagulating agent that will separate the solids from the cleanup water, allowing the water to be reused while reducing the volume of waste generated.

Disadvantages of Waterborne Basecoat Systems

- Current mixing systems need to be modified or replaced to accommodate waterborne basecoats.
- All waterborne products must be transported and stored in such a manner as to protect them from freezing.
- All spray equipment used to apply waterborne coatings will need to be of a material such as stainless steel to protect against corrosion.
- Booth temperature and adequate air movement is essential for achieving a finish free of runs and sags.
- To hasten curing, infrared drying systems or forced air curing systems may be needed.
- Waterborne products are more susceptible to substrate contamination than are solvent-borne products.
- The waste water/paint mixture resulting from equipment cleanup operations may require more expensive disposal fees than solvent/paint wastes.

C. Paint Additives

The use of any additives can increase VOC content

Along with the chemical hardeners and flex additives previously mentioned, there are many other paint additives available. These include flatting compounds, accelerators, retarders, color blenders and fisheye eliminators. The addition of any one of these additives not only affects the sprayability of the product and the quality of the finish, it also increases the VOC content of that system. To keep VOC emissions low and material costs down, the use of additives should be kept to a minimum.

D. Recommended Practices for Topcoats

- Mix color coats in-house, making certain the formula for the proper shade of the specific color code is used. This will help avoid the need for blending of the finish to achieve a satisfactory color match.
- Keep good records of paint match information, including spray-out cards and detailed notes.
- Avoid the use of lacquer-based topcoats.
- Choose low VOC topcoats that require fewer than three coats to achieve adequate coverage (polyurethane or urethane).
- Only apply the number of coats needed to achieve an adequate finish.
- Use high solids, low VOC clears to topcoat color coats.
- The addition of paint additives should be kept to a minimum.
- When available, use waterborne basecoats.

10. Recommended Approach to Practical Air Emission Reduction

Spray Equipment

- Determine how much you are willing to spend for spray equipment.
- Determine the types of coatings that will be sprayed through the equipment and the atomization properties required for their proper application.
- Prior to purchasing any paint gun, consult your paint representative to determine what type of gun will work best for the products you will be using.
- Contact your paint representative and/or paint gun representative to determine the fluid tip/air cap combination and gun settings that should be used with the material being sprayed.
- Choose spray equipment that has the highest transfer efficiency while providing the required atomization properties within your price range.

Spray Application Techniques

- Use the recommended air pressure and tip sizes for the specific product and equipment being used.
- Always hold the gun perpendicular to the surface being sprayed, using parallel strokes. Never arc the gun.
- Feather the trigger at the beginning and end of each pass.
- Use a 50 percent overlap for each pass. This technique may need to be altered slightly when applying high-metallic, high-solids basecoats, and for some three stage systems.
- When painting small and medium sized panels, make each pass the full length of the panel.
- With larger panels, use a comfortable stroke, with a 4 - 5 " overlap of the strokes.
- If blending is necessary, keep the blend area as small as possible without jeopardizing the appearance of the blend.
- Spray the border edges of the substrate first (banding). This will assure all edges are covered without extending the spray pattern well beyond the borders of the object.
- Use color hiding power labels to determine the thickness of the applied paint film. These markers will also indicate when adequate coverage has been achieved.

Equipment Cleaning

- Use an air powered mechanical gun cleaning system.
- Use low VOC cleaning solvents.
- If cleaning guns manually, spray into an enclosed backdrop to retain atomized solvents.
- If necessary, use a broom straw, cleaning broach or a soft wood toothpick to clear passageways. Never use metal objects.

Surface Prep

- Always wash dirt and grime from the vehicle using water or a soap and water mixture.
- Use waterborne cleaners when possible.
- If, due to heavy contamination, waterborne cleaners prove unsatisfactory, use solvent-based cleaners for the initial cleaning. For secondary cleaning operations, use the waterborne products.
- If waterborne cleaners prove unsatisfactory due to substrate make-up, use solvent-based cleaners sparingly.
- Keep solvent laden dirty rags in a closed container.
- Keep solvent containers closed when not in use.
- If possible, avoid operations that would necessitate multiple prepaint cleaning operations.

Prep Coats

- Use versatile products such as epoxy primers or self-etching primers. The use of these products may alleviate the need for additional surface coating operations such as primer-surfacing or primer-sealing.
- If a self-etching primer or epoxy primer is not desirable, use a wash-primer or metal conditioner, conversion coating system.
- Avoid high VOC content zinc phosphate primers.

Primer-Surfacers

- Use a properly operating primer gun with the correct fluid tip/air cap combination for your particular type of primer-surfacer.
- Use low VOC, waterborne primer-surfacer products.
- If the curing time of waterborne products proves unsatisfactory, consider the use of versatile urethane primers.
- To reduce VOC emissions, limit material costs, and achieve a better quality product, make sure body work is done in such a manner as to require only a minimal amount of primer-surfacer.

Primer-surfacers con't

- If a colored sealer is not used, make sure the primer-surfacer is a color that can easily be covered with the desired topcoat.

Primer Sealers

- Use low VOC primer-sealers such as single component waterborne or waterborne epoxy primers.
- The use of low VOC urethane primer-sealers would also be an acceptable choice.
- Always choose a color of primer-sealer that can be easily covered by the topcoat to be sprayed or choose a tintable primer-sealer and tint it to an easily covered shade.

Sealers

- Chose the proper sealer for each specific job.
- If filling capabilities are required, use a primer-sealer in place of a sealer.
- Always choose a primer-sealer of a color that can be easily covered with the coating to be sprayed, or choose a tintable primer-sealer.

Topcoats

- Mix color coats in-house, making certain the formula for the proper shade of the specific color code is used. This will help avoid the need for the blending of the finish to achieve a satisfactory color match.
- Keep good records of paint match information, including spray-out cards and detailed notes.
- Avoid the use of lacquer-based topcoats.
- Choose low VOC topcoats that require fewer than three coats to achieve adequate coverage (polyurethane or urethane).
- Apply only the number of coats needed to achieve an adequate finish.
- Use high solids, low VOC clears to topcoat color coats.
- Keep addition of paint additives to a minimum.
- When available, use waterborne basecoats.

11. What to Expect in the Future

The automotive refinishing industry has undergone many significant changes in the last ten years, with even greater changes anticipated within the next decade. The Clean Air Act Amendments require implementation of new stringent emission control and permitting requirements within the next ten years. Although it is not yet clear what specific regulations are in store for the automotive refinishing industry, it is clear that some form of emission regulations will be imposed. Impending regulations are already causing many changes within the paint manufacturing and application equipment industries.

Paint manufacturers are focusing their efforts on the development of paints and primers that will meet the rigid standards of the future. VOC contents of topcoats will probably be limited to 5.0 lbs/gal or less, while undercoats may be limited to as low as 3.5 lbs/gal. Paint manufacturers will continue emphasizing development of waterborne and high-solids paints and primers.

Waterborne paints will probably be limited to basecoats which will require the application of a urethane clearcoat. The use of glycol ethers, esters, ester alcohols and water as solvents for paint products will continue to increase. Other high solvency products such as propylene glycol and methyl butyl ethers will also gain popularity with paint manufacturers.

High viscosity, high solids paints and primers may require modification of current paint practices within the refinishing industry. Paint-heaters may be essential in every paint shop to lower the viscosity of the high-solids solvent-based paints and primers prior to spraying. Heaters are not effective with waterborne paints due to their lack of effect on these products' viscosity.

The spray equipment used by the typical paint shop will be of the HVLP variety. High transfer-efficient spray equipment will continue to improve, providing the technician with better atomization and metallic control.

The spray equipment used by th typical paint shop will be of the HVLP variety.

Recently, a new paint system has been developed using super-critical carbon dioxide (CO^{2}) in place of solvents to lower the viscosity of the coating. These systems reduce VOC emissions from 25 percent to as much as 80 percent, depending on the coating used. Currently, the use of these systems is limited to industrial painting; the finish quality needed for the application of automotive finishes has yet to be achieved. As the technology improves and investment costs lower, CO^{2} systems may be used on a limited scale for auto refinishing operations.

Automobile refinishers will be unable to rely solely on low VOC products and high transfer efficient spray equipment to reduce VOC emissions. Employers will also need to train their painters and prep technicians in the proper use of all existing and new equipment and products entering the market place. Spray paint techniques must also be

improved to reduce overspray to reduce material waste and VOC emissions. This will require painters to have additional training in proper spraying techniques using the new high transfer spray equipment.

It will take the efforts of all paint related industries to provide adequate reduction of VOCs and HAPs. Changes in coating products, spray equipment and application techniques will all be met with some resistance. But with continued cooperation and education, harmful VOC and HAP emissions from refinishing operations will be dramatically reduced, creating a cleaner and healthier environment for all.

Laser Touch ™

The Iowa Waste Reduction Center has developed and patented the **Laser Touch** ™ targeting system to help improve transfer efficiency, and reduce overspray and material consumption. The **Laser Touch** ™ is designed to provide spray technicians with a “real-time” means of assessing their spray technique and improving their spray performance. It uses a split laser beam image to provide the spray gun operator with a visual indication of gun-to-part distance, gun angle and targeting.

The **Laser Touch** ™ has proved to be the most well received and productive training tool used in the Spray Technique Analysis and Research program. STAR trainees using the **Laser Touch** ™ have shown dramatic improvements in maintaining a consistent spray distance, proper gun angle, uniform coating thickness and improved transfer efficiency. The following comments are representative of statements made by **Laser Touch** ™ users:

- “I cannot believe my spray distance varied that much, this device helps me immediately in keeping me consistent.”
- “Quite frankly, it’s perhaps one of the biggest money saving devices that we have ever seen come about it this industry.”
- “This is great for both experienced painters as well as the beginners.”

For more information on the **Laser Touch** ™ call the IWRC at 319-273-8905.