Colorado
Department of Public Health & Environment

POLLUTION PREVENTION IDEAS FOR SURFACE COATING

NOVEMBER 2001

The environmental aspects of surface coating operations are regulated by numerous federal and state regulations that address air emissions, hazardous waste management, and in some instances wastewater discharges. The Colorado Department of Public Health and Environment (CDPHE) prepared this bulletin to convey information about source reduction practices for businesses that perform surface coating. Source reduction, or pollution prevention (P2), practices complement emission control measures and waste management procedures required by regulations. CDPHE defines P2 as the reduction or elimination of pollutants or wastes at the source, by using less hazardous raw materials or using more efficient practices or processes. It includes reducing the use of energy, water, and other resources through increased efficiency or through conservation. For more information about regulations that apply to surface coating, contact Joe Schieffelin at (303) 692-3356 or visit the web sites included in the "For More Information" section of this document.

HOTLINE!
Through June 2002, CDPHE is offering focused P2 research and implementation support through a P2 Hotline (303-312-8880). Take advantage of this free and confidential opportunity to obtain assistance investigating process improvements that are on your "wish list" or address waste streams that are expensive to manage or cause compliance problems. Call now!

The objective of this bulletin is to stimulate small quantity generators of hazardous waste to consider implementing various P2 strategies. This document describes commonly applicable P2 opportunities and provides references for further information, and where appropriate, vendor information. However, the P2 opportunities for surface coating are as numerous and diverse as the purpose and configuration of surface coating processes. Therefore, two topics are addressed here: (1) reducing solvent content in coatings and cleaners and (2) improving coating application efficiency. For more detailed information about these and other P2 opportunities than is provided in this bulletin, please consult the information sources included at the end of the document.

After June 2002, contact the CDPHE P2 Program: Kirk Mills at (303) 692-2977 or Margo Griffin at (303) 692-2979. The CDPHE P2 Program (www.coloradoP2.org) provides confidential, non-enforcement, P2 assessments for Colorado businesses and follows up with a report that summarizes P2 opportunities.

Remember, P2 pays – on the "front end" through improved raw material utilization and on the "back end" by decreasing waste management and compliance costs.

REDUCE SOLVENT CONTENT IN COATINGS AND CLEANERS

The primary environmental concern in surface coating is the use of toxic solvent-based coatings and cleaning solutions. As an alternative, surface coaters can consider using products that contain less or no solvent. **Benefits of reducing solvent content include the following:**

1. Operation and maintenance costs for pollution control devices (such as wet scrubbers and filters) are reduced because of decreased loading. Production downtime associated with maintaining these devices can also be reduced.
2. Permitting, monitoring, record keeping, and reporting requirements associated with hazardous constituents and wastes are significantly reduced or eliminated.
3. Worker health and safety is improved because of the reduced exposure to hazardous chemicals and the reduced risk of explosions and fire.

Most surface coatings contain a carrier solvent, which "carries" the coating formulation, evaporates when the coating is applied, and hardens the coating in place. Conventionally, organic solvents have been used as the carrier because they evaporate rapidly allowing the coatings to dry quickly. The major drawback of organic solvents is that VOCs are released into the air and contribute to smog (like Denver's brown cloud). Many VOCs are also hazardous air pollutants due to their toxicity. To reduce the emission of VOCs, solvent-based coatings can be replaced by alternative, low- or no-solvent coatings such as water-based and 100 percent solid (powder) coatings, and radiation-cured (for example, ultraviolet [UV]- and electron beam [EB]) coatings. These alternative coatings often contain less than 0.5 pounds of VOCs per gallon (0 pounds of VOCs per gallon for powder coatings) compared to 5 to 6 pounds of VOCs per gallon in conventional solvent-based coatings.

- **Water-based coatings** primarily use water as the carrier solvent, although a small amount of organic solvent (2 to 15 percent) is also used to facilitate good flow and viscosity characteristics in the coatings. The lower solvent content of water-based coatings contributes to significant emission reductions over conventional solvent-based coatings applications.
- **Powder coatings** have a 100 percent solid content and, therefore, a 0 percent solvent content. The application of 100 percent solid coatings eliminates VOC emissions associated with conventional solvent-based coatings.
- **Radiation-cured coatings** contain no solvent carriers and can be cured using either UV or EB light sources.

Powder Coating

Similarly, alternative, less toxic cleaning solutions – such as water-based detergents or acetone in place of methyl ethyl ketone – should be used to reduce the emission of VOCs

and hazardous waste. Where solvent use cannot be avoided, facilities should recycle spent solvents using distillation equipment to reuse solvents and reduce hazardous waste generation. Equipment cleanup emissions and wastes can also be minimized by the following means:

- Reducing the frequency of coating changes through strategic work scheduling
- Mixing no more coating than necessary to complete the work
- Dedicating mixing and application equipment to commonly used coatings
- Using enclosed wash units when cleaning spray guns to reduce labor time and the amount of cleaners required

IMPROVE APPLICATION EFFICIENCY

Some operations may use equipment that applies more coating than is required to meet product specifications and quality standards. Surface coaters can improve the efficiency of coating applications by using more efficient technology and better application techniques. **Benefits and techniques of improving application efficiency include the following:**

1. Reduced VOC emissions and other hazardous wastes (such as unused solvents) because of efficient coating application
2. Decreased quantity of coating needed to produce a finished product and reduced reject rate of parts
3. Significant savings in operating costs from reduced input material, energy, and rework
4. Reduced pollution associated with power generation and transmission from using energy-efficient equipment

Examples of how to improve application efficiency during spray gun, powder coating, and UV/EB coating operations are described below. In addition, general tips to improve energy efficiency are also presented.

Spray Guns

Spray guns are the most common technology used in surface coating. Therefore, less detail about their general use is provided in this fact sheet. Consult a spray gun manual or vendor for general instructions about proper operation. Spray guns should be selected based on their effectiveness in atomizing a particular coating at a low-pressure setting. The following types of spray guns are listed in order of increasing transfer efficiency (TE), which is a measure of how much coating is deposited on a substrate (part) compared to the total amount sprayed. Recommendations are also presented on how to increase efficiency using each type of spray gun.

HVLP Spray Gun

Type of Spray Gun	Recommendations to Increase Efficiency
Conventional air	▪ Adjust nozzle size to refine the spray gun setup for the particular application ▪ Adjust fluid pressure so that the spray pattern horizontally projects coating from 1- to 6-inches
Airless	▪ Select fluid tip based on manufacturer's recommendations to produce spray pattern that best fits parts to be coated ▪ Adjust orifice size and fluid pressure so that spray gun uses lowest flow rate possible to coat the part ▪ Hold spray gun 12 to 14 inches away from the part (to reduce overspray and running)
Air-assisted airless	▪ (see recommendations for airless spray gun) ▪ Hold spray gun 8 to 10 inches away from the part
High-volume, low-pressure (HVLP)	▪ (see recommendations for conventional air spray gun) ▪ Hold spray gun 6 to 8 inches away from the part
Electrostatic	▪ (see recommendations for airless spray gun) ▪ Hold spray gun 8 to 12 inches away from the part

Total coating efficiency is a function of TE and build efficiency (BE). As stated above, TE measures how much coating is deposited on a substrate compared to the total amount sprayed. It is an indicator of the amount of wasted material in a coating operation. TE affects VOC emissions, coating use rates, and production, waste disposal, and maintenance costs. In general, low TE results in greater waste generation. BE measures how close and consistent the actual film applied to a part is to the desired dry film thickness. The ideal BE is 100 percent. Values greater than 100 percent represent wasted material and, as a result, excessive emissions of VOCs and production costs.

TE and BE can be controlled with the use of good coating technique by well-trained applicators. Surface coaters should train and encourage the following coating techniques:

- Hold the spray gun with a firm but comfortable grip
- While facing the work piece, stand with legs slightly wider than shoulder width
- Position the leg opposite the spray gun back slightly and pivot on the forward foot during spray strokes
- Point the spray gun so that the spray pattern is perpendicular to the part
- Hold the gun at a 30 to 45 degree angle from the part for tubular objects
- Maintain a 50-percent overlap over the previous strip of coating
- Gun triggering (on-off) should occur before and after each pass of the object to provide good edge coverage and to clean out the fluid tip at the end of each stroke
- Move spray gun across the work at the same speed

- Apply a full wet coat whenever possible
- Carryover of the off-spray and rebound should be directed toward unpainted surface
- Clean the inside of the spray gun immediately after use to ensure optimum atomization and spray pattern
- Clean equipment as specified by the manufacturer
- Disassemble and inspect spray guns once a week

POWDER COATING

Powder coating technology has been available in the United States since the middle of the 1950s. Today, it is the fastest growing industrial finishing process in North America and represents about 15 percent of the total industrial finishing market. Powder coating is a good alternative to liquid painting because it significantly reduces or eliminates emissions of HAPs and VOCs.

Powder coating involves using finely ground particles of pigment and resin that are electrostatically charged and sprayed onto electrically grounded parts. Charged particles adhere to the surface of the grounded parts until they are melted and fused to the part by a curing process. Powder coating involves three steps: (1) pretreatment, (2) powder application, and (3) curing. Pretreatment is required to ensure an acceptable coating finish. Surface preparation usually involves alkaline cleaners, iron or zinc conversion coatings, and rinsing. Step 2, powder application, uses four types of equipment:

- **Powder delivery systems**, powder storage or feed hopper and pumping device to transport the powder to the spray gun
- **Electrostatic spray guns**, two types include corona charging (the more common) and tribo charging
- **Powder spray booths**, collect overspray and be easily cleaned for efficient color changeout
- **Powder recovery and recycle systems**, two types include cartridge and cyclone

Powder coating equivalents exist for nearly every liquid coating application. Some of these advancements are significant because they allow powder coating of materials other than

metal. Specifically, low-temperature curing and UV and infrared-curable coatings have allowed for powder coating temperature-sensitive products such as wood and plastic.

The capital investment for powder coating systems can vary dramatically based on factors such as throughput and size. A few examples of cost considerations associated with powder coating include the following:

- **Material costs** of powder coating are the lowest of all coating materials, based on dollars per square foot coated, because the recycle rate for powder overspray can be up to 99 percent. Material costs represent two-thirds or more of the total annual operating costs of most finishing process.
- **Energy use** for powder coating is slightly above average because of the high curing temperature.
- **Rework rate** is significantly less than for liquid coating because powder coating does not drip or sag. In addition, a powder-coated part can be stripped with an air gun and recoated if a flaw is noticed before curing.
- **Maintenance** required for powder coating units is less than for liquid coating units because powder-coating units have fewer moving parts or mechanical pumps to feed the applicators and less frequent filter changes.

ULTRAVIOLET AND ELECTRON BEAM

Surface coating using UV and EB technology often performs as well as or better than conventional solvent-based coatings, with no HAP emissions. The technologies allow for instantaneous curing of coatings that change (polymerize) from a liquid to a solid when irradiated with UV light or accelerated electrons from and EB.

UV Technology

UV technology uses a lamp to emit bright, visible light, invisible UV light, and infrared energy for curing. UV curing is fast and relatively cool if the infrared component of the lamp is shielded, allowing for use on heat-sensitive substrates. UV curing occurs in two stages: (1) photoinitiators included in the coating mixture break down under UV light and (2) free radicals that are generated attack acrylic double bonds and cause polymerization.

EB technology works by exposing an oligomer/monomer mixture to a stream of electrons, causing copolymerization that forms a solid coating. The process produces secondary

radiation in the form of X-rays. EB can cure thick and opaque wet coating films or through opaque coatings because of the ability of the accelerated electrons to penetrate matter.


EB Technology

Examples of UV and EB technology applications include metal cans, metal coils, ready-to-assemble furniture, pressure-sensitive tape, fishing rods, golf club heads, automotive wheels, headlights, windshields, and wide-web-rolled paperboard.

The capital investment for a typical UV curing system is about $100,000, while the capital investment for an EB curing system can be up to five times higher. The higher capital investment in EB is commonly cited as a barrier to this technology. A few examples of cost considerations associated with UV and EB systems include the following:

- **Price range** for UV and EB curable coatings is $25 to $40 per gallon; both technologies can coat 1 pound per thousand square feet.
- **Space** savings can be achieved because UV and EB equipment are about 10 percent of the size of a conventional drying oven.
- **Energy use** for UV and EB technology is lower than for liquid and powder coating units.
- **Maintenance** required for UV and EB units is less than for liquid and powder coating units because the coatings do not "skin over" in the applicator and, as a result, no cleanup is required at the end of shifts.
- **Cure time** is faster in UV and EB operations than in liquid and powder coating operations, which allow fewer particles to contaminate the surface finish and reduces rework and scrap costs.

ENERGY EFFICIENCY TIPS

In addition to the solvent reduction and application efficiency alternatives presented, surface coaters also have opportunities to reduce waste generation and costs by implementing energy efficiency techniques. The following recommendations are presented to conserve energy at surface coating facilities:

- Replace filters regularly to prevent clogs that restrict airflow, increase workload on fans, and reduce energy efficiency.
- Use outside air for compressor intake. Outside air, on the average, is cooler and denser than indoor air and therefore requires less energy to compress.
- Fix air leaks in compressed air lines because air leaks require the compressor to work harder.
- Use radiant heating systems.
- Insulate and reduce air leaks around dock doors.

- Install high-efficiency lighting, for example T-8 lamps and electronic ballasts.
- Upgrade metal halide lighting systems to a lower wattage system.
- For more information about energy efficient lighting alternatives, refer to the following:
  - Grainger www.grainger.com
  - Bulbs.com www.bulbs.com
  - Inter.Light, Inc www.lightsearch.com
  - National Lighting Bureau www.nlb.org
  - Lighting Research Center www.lrc.rpi.edu/index.html
  - GE Lighting www.gelighting.com
  - 1000 Bulbs.com www.1000bulbs.com
- Replace the standard V-belt drives on exhaust fans with synchronous belt and sprocket drives to reduce electrical usage.
- Analyze flue gas from boilers every 2 months to monitor and increase boiler efficiency.
- Insulate piping from the boiler to reduce heat loss.
- Include variable frequency drives on fan motors, and air economizers and thermostat set backs on heating, ventilation, and air conditioning systems.

P2 INFORMATION SOURCES AND LINKS

For additional information about the P2 ideas discussed in this fact sheet, please review the following web sites:

Name and Web Address	Contains Information About…
Surface Coating P2 Reference Guide, www.cdphe.state.co.us/ap/P2/coating.htm	• Substitutes for solvent-based coatings • Spray guns • Powder coating • UV/EB technologies
Coatings Alternatives Guide, http://cage.rti.org	• Substitutes for solvent-based coatings • Alternative application equipment
Home Page of the Finishing Industry, www.finishing.com	• Electroplating • Powder coating • Upcoming events
Industrial Paint & Powder Magazine, www.ippmagazine.com	• Current and past issues of the magazine • Product information • Upcoming events
National Paint and Coatings Association, www.paint.org	• Industry news • Paint Council Network • Upcoming Meetings and Events
Powder Coating Institute, www.powdercoating.org	• Powder coating • Powder Coating Institute
RadTech International North American, www.radtech.org	• Publications on UV/EB technologies • Upcoming events • Web links to vendors
Iowa Waste Reduction Center, www.iwrc.org	• Alternative application equipment • Painting and Coating Compliance Enhancement (PACE) Program
Products Finishing, www.pfonline.com	• Industry news • Powder coating • UV/EB technologies • Web links to vendors
Powder Coating Online, www.1-800-9powder.com	• Powder coating • Job postings • Web links to vendors
PowderNet.com, www.powdernet.com	• Powder coating • Industry news • Classified advertisements • Web links to vendors

P2 SCORECARD FOR SURFACE COATING FACILITIES

This checklist highlights common P2 opportunities at surface coating facilities. While this list of P2 opportunities is not exhaustive, it helps surface coaters assess how well P2 is being implemented at their facility. The goal is to achieve more "Yes" answers by changing coating formulations and workplace practices.

DOES YOUR FACILITY…	Yes	No	NA
1. Use coatings that contain less than 0.5 pounds of VOCs per gallon?			
2. Use (a) water-based cleaners or (b) distillation equipment to recycle solvent-based cleaners *if solvent use cannot be avoided*?			
3. Reduce the frequency of coating changes through strategic work scheduling?			
4. Mix no more coating than necessary to complete the work?			
5. Dedicate mixing and application equipment to commonly used coatings?			
6. Use enclosed wash units when cleaning spray guns (*if spray guns are used)*?			
7. Adjust nozzles to refine spray gun setup for a particular application?			
8. Adjust nozzle size to refine the spray gun setup?			
9. Adjust fluid pressure so that the spray pattern horizontally projects coating from 1- to 6-inches?			
10. Select fluid tip based on manufacturer's recommendations to produce spray pattern that best fits parts to be coated?			
11. Adjust orifice size and fluid pressure so that spray gun uses lowest flow rate possible to coat the part?			
12. Hold spray gun appropriate distance from part depending on spry gun type (see page 4)?			
13. Hold the spray gun with a firm but comfortable grip?			
14. While facing the work piece, stand with legs slightly wider than shoulder width?			
15. Position the leg opposite the spray gun back slightly and pivot on the forward foot during spray strokes?			
16. Point the spray gun so that the spray pattern is perpendicular to the part?			
17. Hold the gun at a 30 to 45 degree angle from the part for tubular objects?			

18. Maintain a 50-percent overlap over the previous strip of coating?			
19. Trigger gun (on-off) before and after each pass of the object?			
20. Move spray gun across the work at the same speed?			
21. Apply a full wet coat whenever possible?			
22. Directed carryover of the off-spray and rebound toward unpainted surface?			
23. Regularly clean the inside of the spray gun immediately after use?			
24. Clean equipment as specified by the manufacturer?			
25. Disassemble and inspect spray guns once a week?			
26. Use powder coating technology?			
27. Use UV- or EB-curing technology?			

Notes:
NA = Not applicable to your facility

Calculate the P2 score for your facility using the following equation:

$$\frac{\text{(Total "Yes" answers)}}{\text{(27-Total "NA" answers)}} \times 100\%$$

> 76 = **Excellent.** Keep up the good work!
51 to 75 = **Good.** But there is still room for improvement.
26 to 50 = **Fair.** Incorporate more P2 opportunities.
< 25 = **Poor.** Many P2 opportunities are available that are easy to implement and can result in immediate cost savings and improved environmental performance at your surface coating facility.