

# Integrating P2 Into the Inspection Process

## Painting and Coatings Industry

### *Background*

The painting and coatings industry uses chemical compounds to protect product workpieces or distinguish them from other products or workpieces. This industry is a subsector of the organic chemical industry as material ingredients used can be organic or non-organic, and waterborne or solvent borne. Painting and coatings are carried to the workpiece through an application process. Workpieces can be made of metals or other substrates, such as wood or plastic. A major trend in the industry is towards substitution of solvent-based with water-based coatings, especially in areas with strong environment, health, and safety regulations.

A wealth of information is available on this sector, ranging from best practices to alternative technologies to waste recycling. Toxic materials substitution is highly driven by local market conditions, including waste disposal costs and local or regional environmental regulations. This document focuses on pollution prevention techniques for reducing emissions of volatile organic compounds (VOCs) from paint and coating processes, including reducing the amount of solvents used in coating formulations as well as in surface preparation and equipment cleaning. Most of the information contained in this document relates to the coating of metal substrates used to manufacture metal containers, automobiles, machinery (including computers), metal furniture, appliances, and other consumer goods. The Kansas SBEAP published a detailed manual for this industry sector in 1996, with a revised manual proposed for publication in 2002. Advanced education for painting and coating technicians is also widely available, with some programs offering scholarships.

The painting and coating process can be broken down into three major categories: cleaning and surface preparation, application of the coatings, and equipment cleaning.

### **Surface Preparation**

Although each of these steps can affect the performance of the final finish, proper surface preparation is essential in ensuring the success of a particular coating. In fact, as high as 80% or more of all coating adhesion failures can be directly attributed to improper surface preparation (NCDPPEA, 1998).

In surface preparation, a variety of methods are used to remove soils or other imperfections from substrates, creating a surface that bonds well with the coating. The most common form of debris is oils and/or greases that originate from mechanical processing, or oils and greases that are deliberately applied for purposes of preventing corrosion during temporary storage or shipping. Other surface contaminants commonly include oxidation, rust, corrosion, heat scale, tarnish, and in some cases, old paint, all of which must also be removed prior to the application of

a new paint coat. Traditionally, halogenated solvents have been used as cleaning and stripping agents to remove these substances.

Surface preparation may include the application of a conversion coating to improve adhesion, corrosion resistance, and thermal compatibility. Conversion coatings chemically react with the metal surface to enhance the bonding of the coating and to act as a buffer between the coating and substrate, reducing the effects of sudden temperature changes. Iron or zinc phosphate conversion coatings are usually used for steel workpieces. Iron, zinc, and chromium phosphates are all used for aluminum workpieces. In the phosphating process, acid attacks the metal surface, forming a microcrystalline layer that improves the surface for paint application.

### **Coatings Application**

Following surface preparation, paints and coatings are applied to substrates using a variety of methods, including:

- dip coating, in which parts are dipped into tanks of paint and the excess paint is allowed to drain off
- tumbling or barreling in which the part is rotated while it is coated
- curtain coating, flow coating
- various spray technologies.

A number of coats, starting with a primer coat followed by subsequent coats (basecoats and topcoats) and a finishing coat (clear coats), are usually applied. Given the different types of coatings necessary to ensure adequate protection, performance, and aesthetic characteristics, coatings should always be considered as a system. Once paint has been applied, a curing process takes place that converts the coating into a hard, tough, and adherent film. Coatings cure either by chemical reaction or polymerization of the resins (i.e., cross linking). The curing process includes ambient temperature oxidation, chemical reaction with another component (two-component coating systems), or baking in an oven.

### **Equipment Cleaning**

The final stage of any coating operation is the cleaning of equipment, such as spray guns and hoses, which generally involves flushing solvent through the coating system.

Traditionally, each step in the coating process generates waste and emissions, including everything from spent solvents to excess or obsolete paints. However, inefficient paint transfer can be the largest source of waste and VOC emissions from paint and coating processes. Overspray or paint used but not applied to the surface being coated generally becomes waste and is lost raw materials.

### ***Regulatory Issues***

Significant amounts of pollutants are generated from paint and coatings processes. The exact amount for the nation is difficult to calculate because use is spread across numerous industry groups, and companies do not report emissions by manufacturing process to EPA. Wastes from paint application include leftover paints, dirty thinner from the cleaning of spray guns and paint cups, air emissions of VOCs and HAPs, spray booth filters, contaminated rags, debris from area wash

downs, and outdated supplies. Applicable regulations depend on the environmental medium to which the waste is released (e.g., air, land, or water) and the regulatory status of the generator. The major federal statutes that affect coating processes include the Clean Air Act (CAA) and the Clean Air Act Amendments of 1990 (CAAA), which regulate air releases; the Resource and Conservation Recovery Act (RCRA), which regulates hazardous wastes; and the Clean Water Act (CWA), which regulates wastewaters and may include pretreatment regulations.

Air pollution is a major issue for this industry as surface-coating operations of all kinds are major users of 189 hazardous air pollutants (HAPs) of which 149 are also VOCs. Commonly used compounds include toluene, xylene, and MEK. Even small businesses in Kansas may be classified as *major sources* if their potential to emit is at a major level, even if actual emissions are well below those levels. Emissions from gas fired curing or baking ovens also need to be addressed.

Hazardous wastes regulated under the Resource Conservation and Recovery Act Subtitle C can also be a significant source of pollution. Generally, wastes generated during the application of paints and coatings might be considered hazardous because of the presence of solvents or toxic metals. These wastes include waste thinners, waste paints, waste filters, and solvent-contaminated rags.

Under the CWA, most point sources of wastewater (e.g., discharge pipes or sewers) discharging to waterways require a National Pollutant Discharge Elimination System (NPDES) permit. Businesses must specify levels of toxicity and other characteristics that must be achieved prior to discharge. Some businesses discharge wastewaters from phosphating processes or waterfall paint booth units via their NPDES permit. Pretreatment of the wastewater is generally necessary. Wastewater generated from coating applications might be regulated because of the presence of organic solvents or heavy metals (NCDPPEA, 1998).

Another type of discharge regulated by the CWA is one that goes to a publicly owned treatment works (POTWs). The national pretreatment program controls the indirect discharge of pollutants to POTWs by industrial users. Facilities regulated under this program must meet certain pretreatment standards. Recent rules require facilities that utilize the phosphating process and discharge to a POTW be permitted due specifically to this type of discharge.

### ***Where Is the P2 Potential?***

There is a significant P2 potential within this industry related to all environmental medias but especially air and hazardous waste.

The following are examples of ways to reduce toxicity and quantities of solution needed for surface preparation, application of coatings, and equipment cleaning.

## Change the Process

### **Surface Preparation**

Start with a clean substrate by buying clean raw materials, storing raw materials so they are protected from contamination, using just-in-time ordering, and avoiding “dirty” manufacturing processes that use oily cutting fluids. Then, utilize mechanical cleaning processes such as wiping loose dirt and dust from the part, or removing rust and metal scales by sanding and brushing.

### **Coating Application**

Developing guidelines for paint mixing can help reduce raw materials, hazardous wastes, and toxic air emissions. In many cases, facilities will mix a fixed amount of paint for each job (e.g., one pint or one quart). For small jobs especially, the amount of paint prepared often exceeds the amount of paint actually applied. Facilities can encourage mixing only the amount of paint needed for the project. Providing various sizes of paint-mixing and sprayer cups can help limit over mixing. The disadvantage to this technique is that if too little paint is mixed for the job and more needs to be made, color matching can be difficult.

Operators may be skilled in producing high quality finishes but lack the knowledge to minimize paint use. Technical assistance programs, such as those programs available through vocational schools and the Iowa Waste Reduction Center can help operators by teaching them the following:

- Avoid arcing the spray gun and blowing paint into the air.
- Maintain a fixed distance from the painted surface while triggering the gun.
- Keep air pressure (which is often set too high) low; this can increase transfer efficiency by 30 to 60%.
- Keep the gun perpendicular to the surface being painted.
- Use proper on/off trigger technique.
- Use high transfer efficiency equipment.
- Less overspray means reduced emissions. Transfer efficiency is a measure of how much paint actually goes on the product, compared to how much paint is sprayed. Typical transfer efficiency from conventional guns ranges from 20 to 40%, making average overspray rates 60 to 80% (NCDPPEA, 1998).



Use of dedicated delivery systems can also reduce raw material use, as well as hazardous waste generation and air emissions. This process change utilizes a separate delivery system for paint colors and/or types that are used the most or on a constant basis. This process change avoids the wastes generated as a result of paint and coating changes.

## **Equipment Cleaning**

- Reducing solvent use in equipment cleaning can significantly reduce pollution. This can include the following:
- scraping paint cups or tanks before rinsing with solvent
- making use of Teflon-lined metal paint containers that are easier to clean
- using an enclosed gun-cleaning station
- spraying solvent through the gun into the cleaning station where it is condensed for recovery and reuse
- scheduling jobs so that large batches of similar items are painted in order to reduce the amount of solvent and waste paint generated.
- scheduling jobs from light to dark colors will minimize cleaning between colors
- implementing a rigid inventory control and document the dispensing of paints and solvents to prevent overuse
- improving over all material handling to avoid spills
- always segregate waste stream to avoid the disposal of non-hazardous waste or creating excess hazardous waste

## **Change the Material**

### **Surface Preparation**

Use an aqueous cleaner or a mild alkaline solution to clean the workpiece instead of a solvent or strong acid solution that has to be handled as hazardous waste and can contribute to HAP and or VOC emissions. Use of aqueous cleaners in ultrasonic cleaning units can be very efficient when cleaning parts that have small crevices.

Non-caustic paint removers are a good alternative to replace phenolic strippers, which are known to release acid fumes and VOCs to the environment.

### **Coating Application**

High solids coatings are similar to solvent coatings, but a change in the resin system provides a greater concentration of solids, about 25 to 60 percent. These coatings also have lower VOC concentrations as compared to traditional solvent paints but require a specialized spray gun. They have the same applications as conventional coatings and result in less overspray.

Water-based coatings eliminate or greatly reduce the use of solvents and allow for water cleanup. They have obvious waste reduction and VOC reduction benefits and can be used with most conventional spray equipment. These coatings have a wide range of applications but can cause rusting of metal tanks and substrates.

Powder coatings eliminate solvent in the coating and greatly reduce solvent needed for cleaning. They do not require mixing or stirring and have nearly 100 percent transfer efficiency. Hazardous solvents and air emissions are virtually eliminated with this material change, but they do require the handling of heated parts and are difficult to apply in thin coats.

For more information on alternative coatings, refer to the SBEAP *Environmentally Conscientious Painting Manual*.

## **Equipment Cleaning**

Substitute a solvent with a low or no-solvent alternative and ensure that paints used do not contain regulated metals that may create a need for costly testing and disposal as a hazardous waste.

## **Change the Technology**

### **Surface Preparation**

Use countercurrent cleaning process that begins with a “dirty” cleaner and is followed by a “clean” cleaner. Consider reducing solvent evaporation by installing tank lids, increasing freeboard space, and installing freeboard chillers in conventional solvent-vapor degreasing units.

Units that recycle cleaning and conversion coating solutions are available. Some units also utilize an evaporation system for non-hazardous solutions to prevent the need to discharge to a POTW. Initial costs of these units may be high, however.

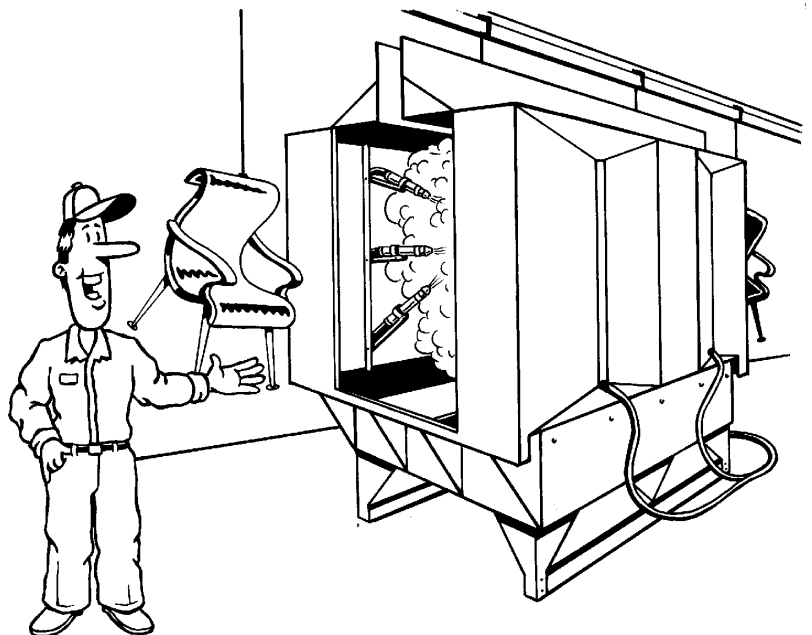
Cryogenic coating removal is the technology that treats a product with liquid nitrogen to make the coating brittle, then propels plastic beads at it. The stripped paint and beads are then collected and disposed of accordingly.

### **Coating Application**

Technology changes related to application of paint or coating generally involves changing or modifying the type of spray gun used to apply the paint or coating. Traditionally air-atomized (AA) guns have been used to apply solvent-based coatings with a transfer efficiency of about 30-60 % creating pollution problems and wastes associated with overspray.

High volume low pressure or HVLP, is a principle that can be applied to conventional AA guns. Such guns have a larger diameter nozzle and deliver paint at low pressures of less than 10 pounds per square inch. HVLP technology can increase transfer efficiency up to 90 %, reducing overspray, VOC, and HAP emissions while providing good coverage for intricate parts. Delivery rates are lower than with conventional sprayers.

Curtain coatings produce a curtain of spray at a 90-degree angle as parts pass underneath on a conveyor belt. This technology has a transfer efficiency rate of 90 – 98 % and is ideal for flat or flexible surfaces.



Tumbling, barreling, and centrifuge technologies all use barrels to rotate parts as they are coated. This technology works well for painting large volumes of small parts, but does require a higher level of operator experience.

### **Equipment Cleaning**

Several alternatives are available for recycling solvents on site. Gravity separation is inexpensive and relatively easy to implement. This technique enables a solvent/sludge mixture to separate under quiescent conditions. The clear solvent can be decanted with a drum pump and used for equipment cleaning. This reduces the amount of wash solvent purchased. Reclaimed solvent can also be used for formulating primers and base coats, but might create problems if it is not sufficiently pure.

For those facilities that generate large quantities of waste solvent, on-site distillation may provide a more cost-effective solution. Batch distillation of all high-grade solvent wastes can virtually eliminate the need to purchase lower quality solvents used in priming and cleaning operations. An operator can reclaim 4.5 gallons of thinner with 0.5 gallons left as sludge. This ratio will vary depending on the specific operation (NCDPPEA, 1998).

Reducing the amount of filters used in painting can reduce hazardous waste generation volumes. Use of reusable metal filters or cleanable Styrofoam filters is one method of reducing filter volume waste. When the filter is too clogged for use, it can be cleaned by blowing compressed air over until it is clean enough for reuse. The paint removed in this process needs to be collected and evaluated as it may still be classified as a hazardous waste.

## Opportunities for Improved Housekeeping in Coating Operations

Waste	Method
General	<ul style="list-style-type: none"> <li>• Improve material handling and storage to avoid spills</li> <li>• Segregate waste streams</li> <li>• Perform preventative maintenance</li> <li>• Practice emergency preparedness</li> <li>• Charge departments generating waste for costs associated with management and disposal</li> </ul>
Paint Waste	<ul style="list-style-type: none"> <li>• Maintain rigid inventory control to reduce thinner use</li> <li>Initiate routine maintenance and training to reduce leaks and spills</li> <li>• Mix paint according to need; document use</li> <li>• Provide operator training to improve transfer efficiency</li> <li>• Schedule jobs to maximize color runs</li> </ul>
Solvent Waste	<ul style="list-style-type: none"> <li>• Control inventory to reduce use</li> <li>• Substitute coating material for one with low or no solvents</li> <li>• Substitute cleaning solution for one with low or no solvents</li> <li>• Practice proper equipment cleaning methods</li> <li>• Recycle solvents onsite</li> </ul>

**P2 Options Overview** (NCDPPEA, 1998)

<b>P2 Options</b>	<b>Description</b>	<b>Benefits</b>
Use Low-VOC Paint	<ul style="list-style-type: none"> <li>• Substitute waterborne, powder, UV curable or high-solids paints for solvent-borne paint</li> <li>• Use paints that have less toxic pigments</li> </ul>	<ul style="list-style-type: none"> <li>• Reduces VOC Emissions</li> <li>• Reduces toxicity of paint sludge</li> </ul>
Increase Transfer Efficiency	<ul style="list-style-type: none"> <li>• Use electrostatic spraying</li> <li>• Use flow coating, roller coating, or electrodeposition</li> <li>• Improve operating practices</li> <li>• Provide operator training</li> </ul>	<ul style="list-style-type: none"> <li>• Reduces paint loss due to overspray</li> </ul>
Reduce Quantity and Toxicity of Solutions Used for Surface Preparation	<ul style="list-style-type: none"> <li>• Reduce solvent evaporation by installing tank lids, increasing freeboard space, and installing freeboard chillers in conventional solvent vapor degreasing units</li> <li>• Use aqueous solutions or mechanical methods</li> <li>• Maximize mechanical or aqueous cleaning processes</li> </ul>	<ul style="list-style-type: none"> <li>• Reduces spent solvents, aqueous solutions and rinsewater from surface preparation</li> <li>• Reduces VOC emissions</li> </ul>
Reduce Equipment Cleaning Waste	<ul style="list-style-type: none"> <li>• Use less toxic solvents</li> <li>• Install gun washer</li> <li>• Adopt distillation/recycling practices</li> <li>• Use enclosed cleaning devices</li> </ul>	<ul style="list-style-type: none"> <li>• Reduces VOC emissions</li> <li>• Reduces toxicity of cleaning wastes</li> </ul>
Adopt Better Housekeeping Practices	<ul style="list-style-type: none"> <li>• Segregate waste streams</li> <li>• Implement rigid inventory control</li> <li>• Improve material handling and storage</li> <li>• Mix paint according to need; document use</li> <li>• Schedule jobs to maximize color runs</li> <li>• Perform preventative maintenance</li> <li>• Practice emergency preparedness</li> </ul>	<ul style="list-style-type: none"> <li>• Reduces paint waste</li> <li>• Reduces solvent use</li> <li>• Reduces leaks and spills</li> </ul>

**Notes Page**

## **Painting and Coatings Industry P2 checklist:**

### ***Surface Preparation***

- Utilize “just-in-time” ordering practices to minimize need to use oils on parts while in storage.
- Reduce solvent evaporation by installing tank lids, increasing freeboard space, and installing freeboard chillers in conventional solvent vapor degreasing units.
- Use aqueous solutions or mechanical methods.
- Maximize mechanical or aqueous cleaning processes.
- Use less toxic solvents.
- Use countercurrent washes.
- Use non-caustic paint removers.

### ***Coating Application***

- Substitute waterborne, powder, or high-solids paints for solvent-borne paint .
- Use paints that have less toxic or regulated pigments.
- Modify equipment to use HVLP spray technology.
- Use flow coating, roller coating, or dip type coating processes.
- Provide operator training to increase transfer efficiency.
- Use a dedicated delivery system.

### ***Equipment Cleaning***

- Adopt distillation/recycling practices.
- Use enclosed cleaning devices.
- Mix paint according to need; document its use.
- Schedule jobs to maximize color runs.
- Perform preventative maintenance.
- Use pop-up level indicators on drums and other bulk receptacles to prevent overfilling.
- Control your inventory to prevent overuse or underuse of materials at your shop.
- Don't allow your raw materials to become too old and unusable, creating hazardous wastes. Use a first-in, first-out policy.
- Keep waste streams separate for reuse, recycling, or treatment. Keep non-hazardous materials from becoming contaminated. If you put hazardous waste into oil, the entire mixture can become hazardous.
- Label all materials and wastes. Keep tight-fitting lids on containers except when adding or removing material or waste.
- Keep a spill kit onsite, and train employees yearly in spill prevention and response.
- Use “dry cleanup” methods. Scrape and scoop instead of washing the area down.
- Inventory your chemical storage and ensure storage in a manner to prevent spills and leaks and use secondary containment.
- Contact the Kansas Small Business Environmental Assistance Program for individual on-site pollution prevention and compliance assistance at 800-578-8898.

### ***Case study/Cost benefit*** (NCDPPEA, 1998)

Navistar International Transportation Corporation's assembly plant in Springfield, Ohio, is the site of painting and final assembly of Navistar's medium- and heavy-duty trucks and school bus chassis. Many of the pollution prevention activities have taken place in Navistar's painting operations.

In the prime coating operation, conventional air-atomized, low-solids paint was replaced with waterborne paint, resulting in a 50% reduction in VOC emissions.

Electrostatic robotic application of paint has increased transfer efficiency of equipment in topcoat operations. For almost all colors of topcoat, Navistar was able to change from applying two coats of paint to only one coat of paint without lowering product quality, reducing the amount of paint wasted by 65,000 gallons and the amount of solvent used by 138,000 gallons annually.

Other raw material, process and equipment changes have resulted in annual reductions exceeding 65 tons of VOC emissions, 82 tons of HAPs and 27,600 gallons of hazardous waste. Savings were reported in excess of \$3.5 million.

#### ***Additional resources:***

The Small Business Environmental Assistance Program, SBEAP, is a confidential non-regulatory program to assist small business with environmental concerns. Contact the SBEAP at 800-578-8898 or [www.sbeap.org](http://www.sbeap.org).

Guide to Cleaner Technologies for Organic Coating Replacements is an important guide that emphasizes the need to consider very different ways to achieve desired results from coatings, and provides many technical solutions.

<http://es.epa.gov/program/epaorgs/ord/org-coat.html>

Pollution Prevention in Painting and Coating Operations is a relatively short and clear guide. <http://www.epa.state.oh.us/opp/paints/fact23.html>

Waste Reduction in Metal Coating has direct links to many "how to" manuals and fact sheets for cleaner production for painting in general, and metal coating in particular. <http://wrrc.p2pays.org/metalcoat.htm>

North Carolina Division of Pollution Prevention and Environmental Assistance, April 1998, *Pollution Prevention in Metal Painting and Coating Operations*, <http://www.p2pays.org/ref/01/00777.htm/>

Source: North Carolina Division of Pollution Prevention and Environmental Assistance, April 1998, *Pollution Prevention in Metal Painting and Coating Operations*, <http://www.p2pays.org/ref/01/00777.htm/>