4.2.2.1 General Industrial Surface Coating[1-4]

4.2.2.1.1 Process Description

Surface coating is the application of decorative or protective materials in liquid or powder form to substrates. These coatings normally include general solvent type paints, varnishes, lacquers, and water thinned paints. After application of coating by 1 of a variety of methods such as brushing, rolling, spraying, dipping and flow coating, the surface is air and/or heat dried to remove the volatile solvents from the coated surface. Powder type coatings can be applied to a hot surface or can be melted after application and caused to flow together. Other coatings can be polymerized after application by thermal curing with infrared or electron beam systems.

Coating Operations -

There are both "toll" ("independent") and "captive" surface coating operations. Toll operations fill orders to various manufacturer specifications, and thus change coating and solvent conditions more frequently than do captive companies, which fabricate and coat products within a single facility and which may operate continuously with the same solvents. Toll and captive operations differ in emission control systems applicable to coating lines, because not all controls are technically feasible in toll situations.

Coating Formulations -

Conventional coatings contain at least 30 volume percent solvents to permit easy handling and application. They typically contain 70 to 85 percent solvents by volume. These solvents may be of 1 component or of a mixture of volatile ethers, acetates, aromatics, cellosolves, aliphatic hydrocarbons, and/or water. Coatings with 30 volume percent of solvent or less are called low solvent or "high solids" coatings.

Waterborne coatings, which have recently gained substantial use, are of several types: water emulsion, water soluble and colloidal dispersion, and electrocoat. Common ratios of water to solvent organics in emulsion and dispersion coatings are 80:20 and 70:30.

Two-part catalyzed coatings to be dried, powder coatings, hot melts, and radiation cured (ultraviolet and electron beam) coatings contain essentially no volatile organic compounds (VOC), although some monomers and other lower molecular weight organics may volatilize.

Depending on the product requirements and the material being coated, a surface may have 1 or more layers of coating applied. The first coat may be applied to cover surface imperfections or to assure adhesion of the coating. The intermediate coats usually provide the required color, texture or print, and a clear protective topcoat is often added. General coating types do not differ from those described, although the intended use and the material to be coated determine the composition and resins used in the coatings.

Coating Application Procedures -

Conventional spray, which is air atomized and usually hand operated, is 1 of the most versatile coating methods. Colors can be changed easily, and a variety of sizes and shapes can be painted under many operating conditions. Conventional, catalyzed, or waterborne coatings can be applied with little modification. The disadvantages are low efficiency from overspray and high energy requirements for the air compressor.

In hot airless spray, the paint is forced through an atomizing nozzle. Since volumetric flow is less, overspray is reduced. Less solvent is also required, thus reducing VOC emissions. Care must be taken for proper flow of the coating, to avoid plugging and abrading of the nozzle orifice. Electrostatic spray is most efficient for low viscosity paints. Charged paint particles are attracted to an oppositely charged surface. Spray guns, spinning discs, or bell shaped atomizers can be used to atomize the paint. Application efficiencies of 90 to 95 percent are possible, with good "wraparound" and edge coating. Interiors and recessed surfaces are difficult to coat, however.

Roller coating is used to apply coatings and inks to flat surfaces. If the cylindrical rollers move in the same direction as the surface to be coated, the system is called a direct roll coater. If they rotate in the opposite direction, the system is a reverse roll coater. Coatings can be applied to any flat surface efficiently and uniformly and at high speeds. Printing and decorative graining are applied with direct rollers. Reverse rollers are used to apply fillers to porous or imperfect substrates, including papers and fabrics, to give a smooth uniform surface.

Knife coating is relatively inexpensive, but it is not appropriate for coating unstable materials, such as some knit goods, or when a high degree of accuracy in the coating thickness is required.

Rotogravure printing is widely used in coating vinyl imitation leathers and wallpaper, and in the application of a transparent protective layer over the printed pattern. In rotogravure printing, the image area is recessed, or "intaglio", relative to the copper plated cylinder on which the image is engraved. The ink is picked up on the engraved area, and excess ink is scraped off the nonimage area with a "doctor blade". The image is transferred directly to the paper or other substrate, which is web fed, and the product is then dried.

Dip coating requires that the surface of the subject be immersed in a bath of paint. Dipping is effective for coating irregularly shaped or bulky items and for priming. All surfaces are covered, but coating thickness varies, edge blistering can occur, and a good appearance is not always achieved.

In flow coating, materials to be coated are conveyed through a flow of paint. Paint flow is directed, without atomization, toward the surface through multiple nozzles, then is caught in a trough and recycled. For flat surfaces, close control of film thickness can be maintained by passing the surface through a constantly flowing curtain of paint at a controlled rate.

4.2.2.1.2 Emissions And Controls

Essentially all of the VOC emitted from the surface coating industry is from the solvents which are used in the paint formulations, used to thin paints at the coating facility, or used for cleanup. All unrecovered solvent can be considered potential emissions. Monomers and low molecular weight organics can be emitted from those coatings that do not include solvents, but such emissions are essentially negligible.

Emissions from surface coating for an uncontrolled facility can be estimated by assuming that all VOC in the coatings is emitted. Usually, coating consumption volume will be known, and some information about the types of coatings and solvents will be available. The choice of a particular emission factor will depend on the coating data available. If no specific information is given for the coating, it may be estimated from the data in Table 4.2.2.1-1.

All solvents separately purchased as solvent that are used in surface coating operations and are not recovered subsequently can be considered potential emissions. Such VOC emissions at a facility can result from onsite dilution of coatings with solvent, from "makeup solvents" required in flow

Table 4.2.2.1-1 (Metric And English Units). VOC EMISSION FACTORS FOR UNCONTROLLED SURFACE COATING[a]

EMISSION FACTOR RATING: B

Available Information On Coating	Emissions Of VOC[b] kg/liter Of Coating Or lb/gal Of Coating[c]
Conventional or waterborne paints:	
VOC, wt % (d)	d • (coating density)/100
or	
VOC, vol % (V)	V • (solvent density)/100
Waterborne paint:	
X = VOC as wt % of total volatiles including water; and d = total volatiles as wt % of coating	d • X • (coating density)/100
or	
Y = VOC as vol % of total volatiles including water; and V = total volatiles as vol % of coating	V • Y • (solvent density)/100

[a] Based on material balance, assuming entire VOC content is emitted.

[b] For special purposes, factors expressed in kg per liter of coating less water may be desired. These can be computed as follows:

$$\frac{\text{kg per liter of coating}}{1 - (\text{vol \% water}/100)} = \text{kg per liter of coating less water}$$

[c] If coating density is not known, typical densities are given in Table 4.2.2.1-2. If solvent density is not known, the average density of solvent in coatings is 0.88 kg/L (7.36 lb/gal).

coating and, in some instances, dip coating, and from the solvents used for cleanup. Makeup solvents are added to coatings to compensate for standing losses, concentration or amount, and thus to bring the coating back to working specifications. Solvent emissions should be added to VOC emissions from coatings to get total emissions from a coating facility.

Typical ranges of control efficiencies are given in Table 4.2.2.1-3. Emission controls normally fall under 1 of 3 categories: modification in paint formula, process changes, or add-on controls. These are discussed further in the specific subsections that follow.

Table 4.2.2.1-2 (Metric And English Units). TYPICAL DENSITIES AND SOLIDS CONTENTS OF COATINGS[a]

Type Of Coating	Density		Solids (Volume %)
	kg/L	lb/gal	
Enamel, air dry	0.91	7.6	39.6
Enamel, baking	1.09	9.1	42.8
Acrylic enamel	1.07	8.9	30.3
Alkyd enamel	0.96	8.0	47.2
Primer surfacer	1.13	9.4	49.0
Primer, epoxy	1.26	10.5	57.2
Varnish, baking	0.79	6.6	35.3
Lacquer, spraying	0.95	7.9	26.1
Vinyl, roller coat	0.92	7.7	12.0
Polyurethane	1.10	9.2	31.7
Stain	0.88	7.3	21.6
Sealer	0.84	7.0	11.7
Magnet wire enamel	0.94	7.8	25.0
Paper coating	0.92	7.7	22.0
Fabric coating	0.92	7.7	22.0

[a] Reference 1.

Table 4.2.2.1-3. CONTROL EFFICIENCIES FOR SURFACE COATING OPERATIONS[a]

Control Option	Reduction[b] (%)
Substitute waterborne coatings	60 - 95
Substitute low solvent coatings	40 - 80
Substitute powder coatings	92 - 98
Add afterburners/incinerators	95

[a] References 2-4.
[b] Expressed as % of total uncontrolled emission load.

References For Section 4.2.2.1

1. *Controlling Pollution From the Manufacturing And Coating Of Metal Products: Metal Coating Air Pollution Control*, EPA-625/3-77-009, U. S. Environmental Protection Agency, Cincinnati, OH, May 1977.

2. H. R. Powers, "Economic And Energy Savings Through Coating Selection", The Sherwin-Williams Company, Chicago, IL, February 8, 1978.

3. *Air Pollution Engineering Manual*, Second Edition, AP-40, U. S. Environmental Protection Agency, Research Triangle Park, NC, May 1973. Out of Print.

4. *Products Finishing*, *41*(6A):4-54, March 1977.