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# Title III Section 313 Release Reporting Guidance

## *Estimating Chemical Releases From Roller, Knife, and Gravure Coating Operations*

# Estimating Chemical Releases From Roller, Knife, and Gravure Coating Operations

Facilities performing coating operations may be required to report annually any releases to the environment of certain chemicals regulated under Section 313, Title III, of the Superfund Amendments and Reauthorization Act (SARA) of 1986. If your facility is classified under SIC codes 20 through 39 and has 10 or more full-time employees, for calendar year 1987 you must report all environmental releases of any Section 313-listed chemical or chemical category manufactured or processed by your facility in an amount exceeding 75,000 pounds per year or otherwise used in an amount exceeding 10,000 pounds per year. For calendar years 1988 and 1989 (and beyond), the threshold reporting quantity for manufactured or processed chemicals drops to 50,000 and 25,000 pounds per year, respectively.

This document has been developed to assist those using roller, knife, and gravure coating equipment in the completion of Part III (Chemical Specific Information) of the Toxic Chemical Release Inventory Reporting Form. Included herein is general information on toxic chemicals used and process wastes generated, along with several examples to demonstrate the types of data needed and various methodologies available for estimating releases. If your facility performs other operations in addition to coating, you must also include any releases of toxic chemicals from these operations.

## Step One

***Determine if your facility processes or uses any of the chemicals subject to reporting under Section 313.***

A suggested approach for determination of the chemicals your facility uses that could be subject to reporting requirements is to make a detailed review of the chemicals and materials you have purchased. If you do not know the specific ingredients of a chemical formulation, consult your suppliers for this information. If they will not provide this information, you must follow the steps outlined to handle this eventuality in the instructions provided with the Toxic Chemical Release Inventory Reporting Form.

The list presented here includes chemicals typically used in coating operations that are subject to reporting under Section 313. This list does not necessarily include all of the chemicals your facility uses that are subject to reporting, and it may include many chemicals that you do not use. You should also determine whether any of the listed chemicals are created during processing at your facility.

**Solvents:** Approximately 50 solvents are on the Section 313 list; these include 1,1,2-trichloroethane, n-butyl alcohol, ethylene glycol, methyl ethyl ketone, 2-ethoxyethanol, xylene, and toluene

**Pigments:** Primarily metal-containing compounds such as titanium dioxide, zinc oxide, white lead, barium sulfate, chromium oxide, nickel titanate, and cobalt chromite

**Additives:** Curing agents, surfactants, defoamers, thickeners, film control agents, and plasticizers such as dibutyl phthalate, dimethyl phthalate, dioctyl phthalate, ammonia, and diethanolamine

**Polymer and resin precursors (residues/impurities):** Ethyl acrylate, formaldehyde, vinyl chloride, vinyl acetate, methyl acrylate, acrylic acid, acrylonitrile, ethylene glycol, melamine, vinylidene chloride, styrene, 1,3-butadiene, and phenol

## Step Two

***Determine if your facility surpassed the threshold quantities established for reporting of listed chemicals last year.***

You must submit a separate Toxic Chemical Release Inventory Reporting Form for each listed chemical that is "manufactured," "processed," or "otherwise used" at your facility in excess of the threshold quantities presented earlier. Manufacture includes materials produced as byproducts or impurities. Toxic compounds that are incorporated into your products (for example, pigments, polymer and resin precursors) would be considered "processed" because they become part of the marketed finished product. Carrier solvents, degreasing solvents, cleaning agents, and other chemicals that do not become part of the finished product would be considered "otherwise used."

The amount of a chemical processed or otherwise used at your facility represents the amount purchased during the year, adjusted for beginning and ending inventories. To ascertain the amount of chemical in a mixed formulation, multiply the amount of the mixture (in pounds) by the concentration of the chemical (weight percent) to obtain the amount of chemical processed.

***Example: Determining whether toluene was used in sufficient quantity last year to require reporting under Section 313.***

*During 1987, a coil coating facility used two different coating formulas, one containing 38 percent toluene (by weight), and the other, 25 percent toluene (by weight). "Pure" (98 percent) toluene was also purchased for use as a coating thinner. Purchasing and inventory records indicate the following:*

- *100,000 pounds of the 38 percent toluene coating was purchased in 1987; 2,000 pounds was in storage at the beginning of the year, and 7,000 pounds was in storage at the end of the year.*
- *50,000 pounds of the 25 percent toluene was purchased in 1987; 5,000 pounds was in storage at the beginning of the year, and none was in storage at the end of the year.*
- *25,000 pounds of the 98 percent toluene was purchased in 1987; none was in storage at either the beginning or the end of the year.*

*The quantity of toluene used can be calculated as follows:*

*[(2,000 lb x 0.38) + (5,000 lb x 0.25)] (beginning inventory) +*

*[(100,000 lb x 0.38) + (50,000 lb x 0.25) + (25,000 lb x 0.98)] (purchased) –*

*(7,000 lb x 0.38) (ending inventory)*

*= 74,350 lb*

*Because this is in excess of the 10,000-pound reporting threshold for "otherwise used" chemicals, a Toxic Release Inventory*

*Reporting Form must be completed for toluene.*

A listed chemical may be a component of several formulations you purchase, so you may need to ask your supplier for information on the concentration (percentage) of the chemical in each. For chemical categories, your reporting obligations are determined by the total amounts of all chemicals in the category. For example, if zinc oxide and zinc sulfate are used as pigments, the quantity of zinc compounds processed is the sum of the amounts of ZnO and $ZnSO_4$ present. For a substance such as cobalt chromite ($CoCr_2O_4$), the amount used must be considered in determining whether the threshold is met for both cobalt-containing and chromium-containing compounds.

You must complete a report for each chemical for which a threshold is exceeded. The thresholds apply separately; therefore, if you both process and use a chemical and either threshold is exceeded, you must report for both activities. If neither threshold is exceeded, no report is needed.

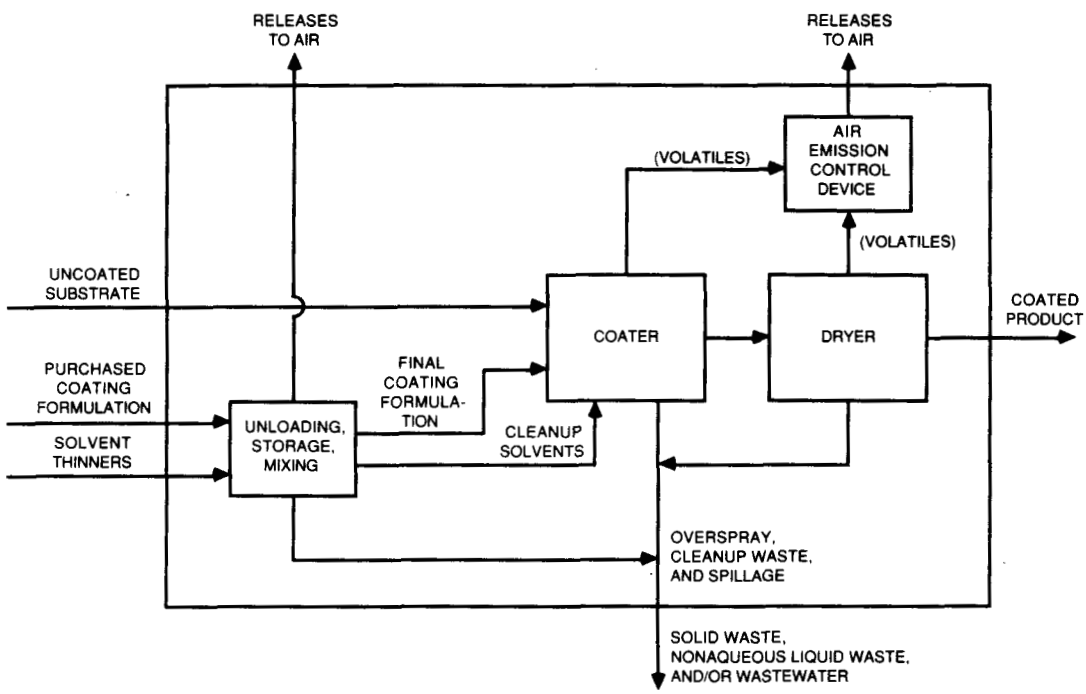
# Step Three

***Identify points of release for the chemical(s) subject to reporting.***

An effective means of evaluating points of release for listed toxic chemicals is to draw a process flow diagram identifying the operations performed at your facility. The figure below is an example flow diagram for coating operations. Because each facility is unique, you are strongly urged to develop a flow diagram for your particular operations that details the input of materials and chemicals and the waste sources resulting from the operation of each unit.

The principal potential sources of chemical release in typical coating operations are:

- Releases of volatile organic compounds from the coating application and dryer areas




**Example Flow Diagram of Roll Coating**

- Excess coating mix and solvent from the cleanup of the coating applicator, coating lines, and empty coating drums
- Transfer from rail cars or tank trucks to storage tanks and subsequent transfer to processing tanks
- Breathing losses from vents on storage tanks
- Agitation of mixing tanks that are vented to the atmosphere
- Evaporation of solvent from the coated substrate after it leaves the coating lines
- Wastes from control equipment used to reduce air emissions from the coating applicator and dryer

## Step Four

***Estimate releases of toxic chemicals.***

After all of the toxic chemicals and waste sources have been identified, you can estimate the releases of the individual chemicals. Section 313 requires that releases to air, water, and land and transfers to offsite facilities be reported for each toxic chemical meeting the threshold reporting values. The usual approach entails first estimating releases from waste sources at your facility (that is, wastewater, air release points, and solid waste) and then, based on the disposal method used, determining whether releases from a particular waste source are to air, water, land, or an offsite disposal facility.

In general, there are four types of release estimation techniques:

- **Direct measurement**
- **Mass balance**
- **Engineering calculations**
- **Emission factors**

Descriptions of these techniques are provided in the EPA general Section 313 guidance document, Estimating Releases and Waste-Treatment Efficiencies for the Toxic Chemical Release Inventory Form.

Provisions of the Clean Air Act, Clean Water Act, Resource Conservation and Recovery Act, and other regulations require monitoring of certain waste streams. If available, data gathered for these purposes can be used to estimate releases. When only a small amount of direct measurement data is available, you must decide if another estimation technique would give a more accurate estimate. Mass balance techniques and engineering assumptions and calculations can be used in a variety of situations to estimate toxic releases. These methods of estimation rely heavily on process operating parameters; thus, the techniques developed are very site-specific. Emission factors are available for some industries in publications referenced in the general Section 313 guidance document. Also, emission factors for your particular facility can be developed in-house by performing detailed measurements of wastes at different production levels.

The mass balance technique for estimating emissions is well suited for coating operations because of the numerous environmental release points involved and the ease with which the ultimate fate of waste chemicals can be determined (that is, process solvents and volatile components of the coatings are released to air, whereas nonvolatile components of the coating that do not become part of the product are released as solid waste or wastewater from clean operations). Direct measurement of waste sources is applicable in any situation; however, such measurements are not routinely performed for many of the coating chemicals subject to reporting.

To estimate toxic chemical releases by mass balance, one must know the quantity of chemical purchased (adjusted for changes in inventory) and the quantity retained in the coated product. The difference in these two

quantities yields the amount of chemical released as waste. An engineering assumption is then used to determine the method of release (air emission, wastewater, solid waste). For coating operations, the following assumptions can be used:

- All volatile organic compounds present in the applied coating formulation, such as solvent coating carriers and unpolymerized resin precursors, can be assumed to be released as air emissions.
- The portion of nonvolatile compounds in the coating formulation that is not retained on the coated substrate can be assumed to be released during cleaning as solid waste (including nonaqueous liquid waste) or wastewater, depending on the cleanup method.
- All solvents used during cleanup of coating equipment can be assumed to end up as solid waste (nonaqueous liquid waste) and/or air emissions, depending on the cleanup method.

## *Toxic Releases to Air*

The mass balance approach is easily applied to solvent carriers of coating solids because they are purposely volatilized during coating and drying. Therefore, the quantity purchased (adjusted for inventory changes) is the quantity released to air. If a control device is used, the quantity of the solvent released should be adjusted for removal efficiency. If solvent is recovered from the control device and reused (as a carrier) in the process, the total quantity of solvent released to the air will still be equal to the quantity of solvent purchased, adjusted for inventory change (because the solvent recovery is an internal reuse, and the benefit of the control device manifests itself in a reduction in the quantity of solvent purchased). If the recovered solvent is shipped offsite instead of being reused, the quantity of solvent released to air would equal the difference between the quantity used (quantity purchased adjusted for inventory change) and the quantity recovered. In this case, the quantity recovered would be reported as "transferred to offsite locations."

In some coating processes, a small amount of solvent may be retained in the product. Although this is usually a negligible amount, if a rough value of the quantity retained is known, it can be subtracted from the quantity released to air.

Unpolymerized resin precursors are usually present in small quantities in organic coating formulations. Typically, these compounds are highly volatile and will be released to air during drying. The entire quantity present in the purchased coating (adjusted for inventory changes) can be assumed to be emitted to air. Amounts of chemicals in purchased formulations in concentrations below the 1% *de minimis* level (0.1% for carcinogens), however, do not have to be considered in threshold calculations. Again, if a control device is used for the dryer and coating area exhaust, its efficiency should be factored into the estimated releases of these compounds.

***Example: Estimating releases of volatile toxic compounds from a coating formulation.***

*A direct roll coater is used to apply an alkyd-urea-formaldehyde resin top coat on plywood paneling. Urea-formaldehyde resin makes up 45 percent of the coating solids, and according to the manufacturer, this urea-formaldehyde resin contains 1.5 percent free formaldehyde. The density of the coating solids is 10 pounds per gallon of solids. As purchased, the coating containing xylene has 8 pounds of solids per gallon of coating. Before it is applied, the coating is thinned with xylene at the coating facility to yield 4 pounds of solids per gallon of coating.*

*According to purchasing and inventory records, 10,000 gallons of the purchased coating formulation was processed during 1987. Assuming complete volatilization of*

*the solvent, air releases of xylene can be calculated as follows:*

*Amount of solids purchased =*

*8 lb solids/1 gal coating x*

*10,000 gal coating*

*= 80,000 lb*

*Volume of coating applied =*

*80,000 lb solids processed x*

*1 gal coating/4 lb solids*

*= 20,000 gal*

*Percentage of volume of solids in applied coating =*

*4 lb solids/1 gal coating x*

*1 gal solids/10 lb solids*

*= 0.4 gal solids/1 gal coating = 40%*

*Amount of xylene used =*

*(1 – 0.4) gal xylene/1 gal coating x*

*20,000 gal coating x*

*7.51 lb xylene/1 gal xylene*

*= 90,120 lb*

*This amount represents the xylene present in the purchased coating plus the amount added as thinner.*

*The quantity of formaldehyde releases is calculated as follows:*

*Amount of formaldehyde released =*

*80,000 lb solids applied x*

*0.45 lb U-F resin/1 lb solids x*

*0.015 lb formaldehyde/1 lb U-F resin*

*= 540 lb*

*This amount represents both the quantity of formaldehyde processed and the quantity released to air. Because 540 pounds is below the threshold limit for processed chemicals, a Toxic Release Inventory Reporting Form would not be required for formaldehyde.*

*If a control device was used to recover xylene and reduce emissions from the coating area and dryer, the emissions of xylene to air would be reduced in accordance with control efficiency. Assuming the control efficiency in this instance is 80 percent, air emissions would be:*

*Amount of xylene released to air =*

*90,120 lb xylene x (1 – 0.80)*

*= 18,024 lb*

*At this plant, the captured xylene is sent off site for disposal. Therefore, the total amount disposed of in this manner would be:*

*Amount of xylene sent off site =*

*90,120 lb (amount used) –*

*18,024 lb (amount released to air)*

*= 72,096 lb*

*Using this approach, the plant in this example could report 72,000 pounds of xylene as "transferred to an offsite facility."*

Your facility is probably required to limit the quantity of VOC emissions from coating and drying areas. Direct measurement data for total VOC emissions can be used if the individual chemical components can be identified. The components will typically be the solvents used as coating carriers. Direct measurement of total VOC is also helpful in determining the efficiency of air emission control devices. If no other data on specific chemicals are available, the efficiency of the device in removing VOC can be assumed to equal its efficiency in removing individual volatile compounds.

Listed toxic compounds may be present in solvents used for cleanup of the coating applicator and surrounding area. Mass balance release estimations are useful for these compounds because they, like solvent coating carriers, are considered "otherwise used." Therefore, the quantity purchased, adjusted for inventory charges, is equal to the

quantity lost as waste. The problem, then, is to determine the media into which waste compounds are released.

Typically, solvent cleaning compounds are volatile, and some portion will be released to air from storage and use. The quantity released to air depends on the compound's relative volatility and method of cleanup. Often, spent solvent cleaning solutions are drummed and shipped offsite for recovery or disposal. In this instance, a mass balance can be performed with the assumption that the concentration of an individual compound in the cleaning solvent is equal to its concentration in the drummed waste.

$$C_i \times (QP) = [C_i \times (QDW)] + AR_i$$

where $C_i$ = concentration of compound "i"

$QP$ = quantity of cleaning solution purchased

$QDW$ = quantity of drummed waste cleaning solution

$AR_i$ = air releases of compound "i"

***Example: Using a mass balance to estimate releases of toxic compounds in solvent cleaning waste.***

*A rotogravure coating applicator is cleaned each time a coating change is made. The solvent solution used contains 80 percent by volume of methylene chloride ($MeCl_2$). Purchasing and inventory records indicate that 1,300 gallons of this solvent solution was used during 1987. Facility operational records show that 17 drums (55 gallons each) of spent cleaning solvent was shipped offsite for recovery during the same period. Assuming that the $MeCl_2$ concentration in the spent solvent is 80 percent, the following mass balance can be made:*

*Volume of $MeCl_2$ released to air =*

*(1,300 gal x 0.80) (used) –*

*(17 drums x 55 gal/drum x 0.80) (recovered)*

*= 292 gal*

*Amount of $MeCl_2$ released to air =*

*292 gal x*

*11.05 lb $MeCl_2$/1 gal $MeCl_2$*

*= 3,227 lb*

*Using this approach, the plant in this example would report 3,200 pounds of $MeCl_2$ as "released to air," whereas 8,300 pounds would be entered as "transferred to an offsite facility." If better information on the concentration of $MeCl_2$ in the spent drummed cleaning solution is available (for example, from direct measurement; see section on toxic releases via solid wastes), such information could be input directly into the mass balance.*

If a different method of cleaning or disposal is used, the preceding mass balance may not apply. The total quantity of waste cleaning chemical would still be equal to the quantity used; however, the portions released to air, nonaqueous liquid waste, and/or wastewater might not be easily determined. Engineering assumptions based on the particular aspects of your cleanup operation would be required to determine the method of release.

## Toxic Releases Via Wastewater

Nonvolatile coating solids that are not transferred to the substrate end up as waste during cleanup operations. This waste will be either nonaqueous liquid waste (if solvent cleanup is used) or wastewater (if water washing is used). The quantity of nonvolatile solids released during cleaning is equal to the quantity used (quantity purchased adjusted for inventory changes) minus the quantity retained on the coated substrate product. The volume of solids retained on the substrate is equal to the area coated multiplied by the coating thickness. The quantity of solids retained can be determined by multiplying the volume of solids retained by the density of the solids.

$$QSP = QSR + QSW$$

$$QSP = (d \times CT \times CA) + QSW$$

where QSP = total quantity of nonvolatile solids in coating processed

QSR = total quantity of nonvolatile solids retained in substrate

QSW = total quantity of nonvolatile solids wastes

d = density of solids

CT = coating thickness

CA = coated area

A relationship can be used to determine an overall coating transfer efficiency for an application/coating combination.

$$(QSR \div QSP) = te$$

$$QSP \times te = QSR$$

$$QSP \times (1 - te) = QSW$$

where te = overall transfer efficiency

For an individual toxic compound present as a nonvolatile solid, the overall transfer efficiency can be used to make a direct estimate of releases from the quantity of the chemical in the purchased coating (adjusted for inventory changes).

$$QCP \times (1 - te) = QCW$$

where QCP = quantity of nonvolatile solid chemical processed

QCW = quantity of nonvolatile solid chemical wasted

***Example: Using a mass balance to estimate releases of nonvolatile toxic compounds from coating formulations.***

*A roll coater applies a water-based polyester resin paint to metal coil. The formulation contains titanium dioxide ($TiO_2$) and white lead ($PbCO_3$) for coloring. According to information provided by the manufacturer, the paint contains 14.5 pounds of nonvolatile solids per gallon of coating, and the density of the solids is 15.3 pounds per gallon. Also, the titanium dioxide and white lead represent 32 and 19 percent by weight of the nonvolatile solids. EPA has proposed to remove $TiO_2$ from the Section 313 list; however, this example is also representative of the use of a mass balance to estimate releases of other similar compounds.*

*Purchasing and inventory records indicate that 39,000 gallons of this formulation was processed during 1987. Production records indicate that 13,200,000 square feet of coil received a 3-mil coat of this formulation. The roll coater is cleaned with a water wash, and the resultant wastewater is discharged to the local sewers. The quantity of $TiO_2$ and Pb released via wastewater can be estimated by the following calculations:*

*Amount of nonvolatile solids processed =*

*39,000 gal coating x*

*10.5 lb solids/1 gal coating*

*= 409,500 lb*

*Volume of solids applied to coil =*

*13,200,000 $ft^2$ coil x*

*0.003 in. thickness ÷*

*12 in./1 ft x*

*7.48 gal/1 $ft^3$*

*= 24,684 gal*

*Amount of solids applied to coil =*

*24,684 gal solids x*

*15.3 lb solids/1 gal solids*

*= 377,665 lb*

*Coating solids transfer efficiency =*

*377,665 lb (applied) ÷*

*409,500 lb (processed)*

*= 0.933*

*Amount of $TiO_2$ processed =*

*409,500 lb (solids processed) x 0.32 ($TiO_2$ wt. percent)*

*= 131,040 lb*

*Amount of $TiO_2$ released =*

*131,040 lb processed x (1 – 0.933)*

*= 8,780 lb*

*Amount of $PbCO_3$ processed =*

*409,500 lb (solids processed) x 0.19 (Pb wt. percent)*

*= 77,805 lb*

*Amount of Pb released =*

*77,805 lb $PbCO_3$ processed x (1 – 0.933) x*

*1 mole $PbCO_3$/267 lb $PbCO_3$ x*

*207 lb Pb/1 mole $PbCO_3$*

*= 4,041 lb*

*Because the wash water leaves the facility through local sewers, 8,800 pounds of $TiO_2$ and 4,000 pounds of Pb would be reported as "discharged to POTW." If the roll coater was cleaned by a "dry" method and the cleanup wastes were drummed for shipment to a waste recovery or disposal facility, the same calculations would apply and the amounts would be reported as "transferred to an offsite location."*

## Toxic Releases Via Solid Waste

As mentioned in the preceding sections, solid and nonaqueous liquid wastes are generated in "dry" coating cleanup operations. These wastes contain cleanup solvents and nonvolatile coating solids that were not transferred to the substrate. The mass balance techniques demonstrated in the example concerning cleanup operations are also applicable to releases via solid and nonaqueous liquid wastes.

Toxic chemical releases via solid and nonaqueous liquid wastes may be measured directly by using data gathered for compliance with RCRA regulations. Many spent solvents are listed as hazardous waste under RCRA Waste Codes F002 through F005. These codes may apply to spent solvents used to clean up the coating applicator and surrounding area. Many spent cleanup solvents may also be considered hazardous under RCRA because of EP toxicity or ignition characteristics.

The RCRA manifesting procedure for hazardous waste shipped offsite requires documentation of quantities shipped. Treatment, storage, and disposal facilities must perform detailed chemical and physical analyses on the wastes. The waste also may be analyzed at your facility. Therefore, estimates of releases for several compounds can be made by direct measurement.

## Other Toxic Releases

Coating operations produce other wastes from which toxic chemicals may be released. These include:

- **Residues from pollution control devices**
- **Product rejects**
- **Used equipment**
- **Empty chemical containers**

Releases from these sources may already have been accounted for, depending on the release estimation methods used. These items (and any other of a similar nature) should be included in your development of a process flow diagram.

The contribution of sources of wastes such as cleaning out vessels or discarding containers should be small compared with process losses. If you do not have data on such sources (or any monitoring data on overall water releases), assume up to 1 percent of vessel content may be lost during each cleaning occurrence. For example, if you discard (to landfill) "empty" drums that have not been cleaned, calculate the release as 1 percent of normal drum content. If the drums are washed before disposal, this may contribute 1 percent of the content to your wastewater loading.

# Step Five

***Complete the Toxic Chemical Release Inventory Reporting Form.***

After estimating the quantity of each chemical released via wastewater, solid waste, and air emissions, you must determine the amount of each chemical released to water, land, or air or transferred to an offsite disposal facility. This determination will be based on the disposal method you use for each of your waste streams. Enter the release estimates for each chemical or chemical category in Part III of the Toxic Chemical Release Inventory Reporting Form. Also enter the code for each treatment method used, the weight percent by which the treatment reduces the chemical in the treated waste stream, and the concentration of the chemical in the influent to treatment (see instructions). Report treatment methods that do not affect the chemical by entering "0" for removal efficiency.

# For More Information

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|---|---|
| **Emergency Planning and Community Right-to-Know Hotline** | (800) 535-0202<br>or<br>(202) 479-2449<br>(in Washington, D.C. and Alaska) |
| **Small Business Ombudsman Hotline** | (800) 368-5888<br>or<br>(703) 557-1938<br>(in Washington, D.C. and Virginia) |

The EPA brochure, Emergency Planning and Community Right-to-Know Act, Section 313 Release Reporting Requirements (EPA 560/4-88-001) presents an overview of the new law. It identifies the types of facilities that come under the provisions of Section 313, the threshold chemical volumes that trigger reporting requirements, and what must be reported. It also contains a complete listing of the chemicals and chemical categories subject to Section 313 reporting. The EPA publication, Estimating Releases and Waste-Treatment Efficiencies for the Toxic Chemical Release Inventory Form (EPA 560/4-88-002), presents more detailed information on general release estimation techniques than is included in this document.

## *Additional Sources of Information on Releases From Roller, Knife, and Gravure Coating Operations*

U.S. Environmental Protection Agency. Calculations of Painting Wasteloads Associated With Metal Finishing. EPA 600/2-80-144. Cincinnati, Ohio. June 1980.

U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, Fourth Edition. AP-42. Research Triangle Park, North Carolina. September 1985.

U.S. Environmental Protection Agency. Procedures for Certifying Quantity of Volatile Organic Compounds Emitted by Paint, Ink, and Other Coatings. EPA 450/3-84-019. PB85-159044. Research Triangle Park, North Carolina. December 1984.