Printers' National Environmental Assistance Center

Fact Sheet

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Determining VOC/HAP Emissions From Nonheatset Web Offset Lithographic Printing Operations

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Background

The two most important aspects involved in air pollution control regulations for the printer is knowing how much air pollution is being released from their operation and what specific air pollution permit and possible control regulations need to be met. The first step in determining what permit or possible control requirements apply is to determine both the actual and potential emissions of air pollutants from each press and from the entire facility as some state/local permitting authorities require permits for individual presses and many operating permits are required for the entire facility.

The two principal pollutants of concern are volatile organic compounds (VOC) and hazardous air pollutants (HAPs). VOCs are those chemicals that will readily evaporate and lead to the formation of ozone in the lower atmosphere. There is a small list of chemicals that are considered exempt from the definition of VOC and the ones possibly found in offset printing include acetone, methyl acetate, and methylene chloride. (For more information see the PNEAC fact sheet "What are VOCs and Do Printing Materials Contain Them?" There is a list of 188 Hazardous Air Pollutants that are subject to regulation. A list of common HAPs found in offset lithographic printing operations is included in this fact sheet.

The principal reason why a printer needs to know their VOC and HAP emissions is because of construction and/or operating permits and emission inventory reporting requirements. Many state and local air pollution control agencies have instituted a system of permitting that requires a source of air pollution to obtain either a permit to construct and/or operate. Permits can be viewed as a contract between the printer and the permitting authority allowing the printer to operate as long as specified emission limits are not exceeded. If permits are required, they are required to be in hand prior to accepting delivery of a new press, significantly modifying an existing press such as adding a coating unit, or actually running the press.

The need to obtain an air pollution control permit depends on the threshold that has been set by the state and/or local air pollution control agency responsible for your area. The thresholds can be based on several different parameters. Some state and local agencies use an *actua*l emission rate or amount emitted while others use a *potential* emission rate or amount threshold. Some agencies use actual material consumption rates to determine if permits are required. Permits can be required for a single piece of equipment or for an entire facility. The permitting thresholds can vary quite dramatically and it is important to know what the permit threshold is for your particular location. Even if a printer is not required to obtain an air pollution control permit, good environmental management practice dictates that emission calculations should be performed at lease annually or when significant changes occur. Examples of significant changes are when a new piece of equipment that emits air pollution such as a press is purchased or when an existing piece of equipment emitting air pollution is modified, such as adding a coating unit on a press. In order to verify that a permit is not required, some state and local air permitting authorities require printers to calculate the emissions. For more information see PNEAC fact sheet "Understanding Air Pollution Permits".

VOC and HAP Emissions From Nonheatset Web Offset Lithography

The majority of VOCs and HAPs emitted from the nonheatset web process are emitted through general pressroom ventilation air rather than through process stacks or vents. As a result of the lack of a definitive point of emissions from the nonheatset web press, the direct measurement of emissions (or emission rates) is difficult, if not impractical. Therefore, emissions have to be calculated from material use and material content information. This approach is quite acceptable to permitting authorities. In fact, this same approach is used for printing and coating operations (e.g., flexographic printing or rotogravure printing) where most or all of the VOCs and HAPs are emitted through process stacks or vents. The materials utilized in the nonheatset web offset lithographic printing process that contain VOCs and HAPs are the fountain solution with isopropyl alcohol or isopropyl alcohol substitutes/extenders, cleaning solvents used to clean ink and other press components, ink oils, coatings, and adhesives.

Other sources of emissions in a nonheatset web offset lithographic printing operation include parts washers, binding and finishing equipment, and some prepress equipment. While these sources are generally not significant, their emissions need to be included in a total facility emission inventory. In some instances, such as an ink jetting operation using solvent-based inks, some of the sources, other than presses, of VOC/HAP emissions may have to be permitted as the emissions could exceed the specified threshold.

VOC and HAP emissions from materials used in nonheatset web printing operations are a function of consumption multiplied by the VOC or HAP content and any applicable release factor. There are two extremely important retention factors that should be used in determining emissions from input materials. These retention factors allow for a reduction in VOC or HAP emissions because it has been established with USEPA that due to their physical characteristics and how certain materials are used and handled, they are not released into the air. In using the retention factors, it is important to check with the state/local air permitting authority to make sure their use is acceptable.

For determining VOC emissions from nonheatset web inks printed on paper, a retention factor of 95% has been accepted by USEPA. The 95% retention factor equates into a 5% release factor and was established as a result of ink oil retention studies conducted by the printing industry). The 95% retention factor was included in a document entitled Control Techniques Guideline for Offset Lithography, the PrintSTEP workbooks, the Potential to Emit (PTE) Guidance for Specific Source Categories memo and attached technical support document, and the Emission Inventory Improvement Program (EIIP) documents. The links to these references are provided at the end of this fact sheet. This retention factor is also to be used for any varnishes that would be applied as an overprint coating as they are essentially printing inks without pigments.

The other important retention factor for determining VOC and HAP emissions is the one for low vapor pressure cleaning solutions used in conjunction with shop towels. USEPA has established a 50% shop towel retention factor for cleaning solutions with VOC composite vapor pressures less than 10 mm Hg at 20^{o}C (68^{o}F). The shop towels need to be kept in a closed container when not being used. This retention factor was included in the Alternative Control Techniques Guideline for Offset Lithography, the PrintSTEP workbooks, the Potential to Emit (PTE) Guidance for Specific Source Categories memo and attached technical support document, and the Emission Inventory Improvement Program (EIIP) documents. The links to these references are provided at the end of this fact sheet.. The ACT guideline was released to supplement the draft Control Techniques Guideline (CTG) and provides significant revisions to some of the elements contained in the CTG.

No retention or release factors have been established for VOCs or HAPs used in fountain solutions, coatings, adhesives, or other materials used in nonheatset web lithographic printing operations. Therefore, all of the VOCs and HAPs in these materials would all be considered or assumed to be released into the atmosphere. The emissions from automatic blanket washers would all be considered

released into the atmosphere. The only “credit” for VOC or HAP not released to the air would be for that contained in discarded wastes.

VOC Emission Calculation Worksheet For Nonheatset Web Offset Lithographic Printing

The following worksheet presents both the formulas and assumptions that can be used to determine both actual and potential VOC emissions from nonheatset web offset lithographic printing operations. The assumptions on retention and release factors are taken directly from the EPA documents described earlier.

Material	**Usage[1]**	**Units**	**VOC Content[2]**	**Units**	**Release Factor[3]**	**VOC Emissions[4]**
Ink		Pounds/Yr		% by Weight		
Fountain Solution (FS) Concentrate		Gallons/Yr		Lbs VOC/Gal		
FS Additive		Gallons/Yr		Lbs VOC/Gal		
Cleaning Solution		Gallons/Yr		Lbs VOC/Gal		
		Gallons/Yr		Lbs VOC/Gal		
		Gallons/Yr		Lbs VOC/Gal		
Coatings and Conventional Varnishes		Pounds/Yr		% by Weight		
		Gallons/Yr		Lbs VOC/Gal		
Misc.		Gallons/Yr		Lbs VOC/Gal		
Total VOC Emissions						

1. Usage is defined as purchase amount minus change in standing inventory, minus the amount that is discarded.

2. List either percent VOC content (by weight) or pounds of VOC per gallon for the product.

    a. The VOC content information may be provided by the supplier via the MSDS, USEPA Method 24 analysis (http://www.epa.gov/ttn/emc/promgate/m-24.pdf), or summing % content of all VOCs and multiplying it by the density to calculate VOC. If density is unknown, multiply specific gravity from MSDS by 8.33 lbs/gal.

    b. Do not include exempt VOCs such as Methylene Chloride, 1,1,1-Trichloroethane, Acetone, T-Butyl Acetate or Methyl Acetate. These exempt VOCs and their concentration should be identified in the Hazardous Ingredients section of the MSDS.

    c. For Ink VOC content, the amount can be determined by using the VOC content for each ink used or use the highest VOC containing ink in each category (e.g., black, blue, red, or yellow process inks and PMS inks).

3. Use the following for the appropriate VOC release factor:

Ink	0.05
Fountain Solution Concentrate	1.0
Fountain Solution Additive	1.0
Cleaning Solution*	0.5
Coating	1.0
UV	1.0
Water-based	1.0
Conventional	0.05

* The VOC composite vapor pressure of the cleaning solution cannot exceed 10 mm Hg at 20^{o}C (68^{o}F). Alternatively, the VOC content of the cleaning solution cannot exceed 30% by weight.

4. The actual VOC emissions are determined by multiplying the Usage, VOC Content, and Release Factors together. The total VOC emissions are the result of adding all of the individual VOC emission determinations together. To convert the total pounds per year into tons per year, divide the total pounds by 2,000 because there are 2,000 pounds in one ton.

Annual Potential Emissions (APE)

Unfortunately, there is no one universal formula that can be used that would allow for the easy determination of potential emissions. The challenge lies in how EPA and various state agencies interpret the term “potential to emit.” Under the current set off interpretations, emissions are to be calculated with the assumption that all equipment in a facility is run at its maximum hourly design or production capacity 24 hours a day, 365 days per year, or 8,760 hours per year. The interpretation does not recognize any downtime required for maintenance, equipment set up, or in process production problems such as paper jams. The interpretation also does not allow for time spent cleaning the press either during the run or when inks or other input materials must be changed. In other words, calculations require the assumption that the press is both printing and being cleaned at the same time with no reduction in emissions allowed for the time required to change plates, inks, and other materials or settings during new job set ups.

However, the definition does allow for some flexibility in that any inherent physical limitations shown too negatively limit the maximum material consumption rate can be used to reduce the emissions. For example, it is difficult to run a press at its maximum rated speed due to product quality issues, substrate, and other production related factors. Also, any equipment that reduces emissions of pollutants and is an integral component of a production line can also be used to reduce potential emissions. For example, the emissions reduced via a combination dryer/control device in a heatset web offset lithographic press can be used in the potential emission calculations. Lastly, any applicable regulation requiring a specific reduction in emissions or limits on input materials, such as inks, fountain solutions, or cleaning solvents or any other limit imposed through a federally enforceable permit can be used to reduce the potential emission calculations.

Since there is no specific guidance from EPA on how to determine potential emissions from the printing industry, this has caused confusion on the part of both printers and state/local permitting authorities with respect to the proper approach to be used. The printing industry is currently working with EPA on this issue, and some guidance on the subject was released in April 1998. This guidance is significant because it establishes that printers who emit less than 50% of the major source threshold in their area are not capable of emitting enough pollution to be considered a "major" source. Being considered a major source would require them to obtain either a Title V or federally enforceable state operating permit (FESOP). FESOPs are also known as synthetic minor or "cap" permits.

For small printers, a "cap" approach set at a 50% threshold of the major source definition based on actual emissions without control devices was established. To further simplify determinations for small

printers, the emission caps were translated into a consumption level for one or more "environmental indicators." Indicators were established for each printing process category and for key input materials. For nonheatset web presses, the key input materials are fountain solution additives and cleaning solvents. For a copy of the policy and technical support document see the links at the end of the fact sheet.

In order for a printer to take advantage of EPA's policy, they need to have a provision in their state regulations or air permit recognizing the less than 50% actual emission approach. Printers that want to take advantage of EPA's policy need to contact their state regulatory agency to confirm the acceptability of this approach. If the state does not have a provision, then the approach outlined in the policy cannot be utilized.

In addition, if the actual emissions are greater than 50% of the major source threshold in your area, this also prohibits using EPA's new policy. For this situation, potential emissions will have to be determined by using the approach described above. In an effort to provide additional clarification on this issue, a position paper advancing a more realistic approach to determining potential emissions was submitted to EPA by the printing industry trade associations. The paper reviewed the problems associated with the current interpretation and supported using the following approach:

$$Annual\ Potential\ Emmisions = \frac{Total\ Actual\ VOC\ Emissions}{Actual\ Operating\ Hours\ *} \times \frac{8{,}760\ Hours}{Year}\ **$$

*or Annual Operating Limit Per An Existing Permit

**Actual hours of operation includes all hours that the presses ran including that portion of makeready that involves either solvent use and ink/fountain solution consumption.

Some state agencies have already accepted this approach for printers. If this approach is to be used, it is imperative that its acceptability be confirmed. Otherwise, there is a risk of possible enforcement action, especially if the proper documentation or permits have not been obtained.

Example of VOC Emission Calculation Using Above Approach and Worksheet

Material	Annual Usage	VOC Content
Nonheatset Web Ink, Process	25,200 pounds	35% by weight
Fountain Solution Concentrate	420 pounds	0.717 pounds/gallon
Fountain Solution Additive	120 gallons	6.7 pounds/gallon
Cleaning Solution - Blanket Wash	1,200 gallons	6.24 pounds/gallon
Cleaning Solution - Roller Wash	300 gallons	5.9 pounds/gallon
Coating - UV	180 gallons	8.5 pounds/gallon
Coating - Conventional	6,000 pounds	35% by weight

Material[1]	Usage[2]	Units	VOC Content[3]	Units	Release Factor[4]	VOC Emissions[5]
Ink	25,200	Pounds/Yr	0.35	% by Weight	0.05	441
Fountain Solution (FS) Concentrate	420	Gallons/Yr	0.717	Lbs VOC/Gal	1.0	301.14
FS Additive	120	Gallons/Yr	6.7	Lbs VOC/Gal	1.0	804
Cleaning Solution	1,200	Gallons/Yr	6.24	Lbs VOC/Gal	0.5	3,744
	300	Gallons/Yr	5.9	Lbs VOC/Gal	0.5	885
		Gallons/Yr		Lbs VOC/Gal		
Coatings – UV	180	Pounds/Yr	8.5	% by Weight	0.0	0.0
Coating – Conventional	6,000	Gallons/Yr	0.35	Lbs VOC/Gal	0.05	105
		Gallons/Yr		Lbs VOC/Gal		
Misc.		Gallons/Yr		Lbs VOC/Gal		
Total VOC Emissions						6,280 lbs/yr 3.14 tons/yr

Potential Emissions

For this example, it is assumed that the facility operated 250 days (5 days/week for 50 weeks) with two shifts or 16 hours per day. Of the 16 hours, 4 are spent in makeready activities where cleaning solvent or ink is not being used resulting in actual crewed hours of 3,000 hours/year.

$$Total\,VOC\ Annual\ Potential\ Emmisions = \frac{31.4\,Tons/Year}{3000\,Hours/Year} \times \frac{8{,}760\,Hours}{Year}$$

$$Total\,VOC\ Annual\ Potential\ Emmisions = 9.17\,Tons/Year$$

HAP Emission Calculation Worksheet For Nonheatset Web Offset Lithographic Printing

The following worksheet presents both the formulas and assumptions that can be used to determine both actual and potential HAP emissions from nonheatset web offset lithographic printing operations. The assumptions on retention and release factors are taken directly from the EPA documents described earlier.

Material	Usage[1]	Units	HAP Content[2]	Units	Release Factor[3]	HAP Emissions[4]
Ink		Pounds/Yr		% by Weight		
Fountain Solution (FS) Concentrate		Gallons/Yr		Lbs HAP/Gal		
FS Additive		Gallons/Yr		Lbs HAP/Gal		
Cleaning Solution		Gallons/Yr		Lbs HAP/Gal		
		Gallons/Yr		Lbs HAP/Gal		
		Gallons/Yr		Lbs HAP/Gal		
Coating		Pounds/Yr		% by Weight		
		Gallons/Yr		Lbs HAP/Gal		
		Gallons/Yr		Lbs HAP/Gal		
Misc.		Gallons/Yr		Lbs HAP/Gal		
Total HAP Emissions						

1. Usage is defined as purchase amount minus change in standing inventory, minus the amount that is discarded.

2. List either percent HAP content (by weight) or pounds of HAP per gallon for the product.

    a. The HAP content information may be provided by the supplier via the Material Safety Data Sheet or USEPA Method 311 analysis. Total HAP content may have to be estimated by summing individual HAP concentrations and/or multiplying it by the density.

    b. For total HAP content determination indicate total HAP content for the material.

    c. For individual HAPs content determination, indicate the individual HAP under the material heading and its respective concentration in the HAP concentration column.

    d. For ink HAP content, use the highest HAP containing ink in each category. **Note: There should not be any HAPs in offset lithographic inks. Confirm with supplier.**

3. Use the following for the appropriate HAP release factor*:

Ink	0.05
Fountain Solution Concentrate	1.0
Fountain Solution Additive	1.0
Cleaning Solution**	0.5
Coating	
UV	1.0
Water-based	1.0
Conventional	0.05

* Since all the HAPs used in offset lithography are VOCs, the same release factors will apply.

** The VOC composite vapor pressure of the cleaning solution cannot exceed 10 mm Hg at 20^{o}C (68^{o}F). Alternatively, the VOC content of the cleaning solution cannot exceed 30% by weight.

4. The HAP emissions are determined by multiplying the Usage, HAP Content, and Release Factors together. The total HAP emissions are the result of adding all of the individual HAP emission determinations together. To convert the total pounds per year into tons per year, divide the total pounds by 2,000 because there are 2,000 pounds in one ton.

<u>Annual Potential Emissions (APE)</u>

To determine potential HAP emissions using the following formula:

$$Annual\ Potential\ Emmisions = \frac{Total\ Actual\ VOC\ Emissions}{Actual\ Operating\ Hours\ *} \times \frac{8{,}760\ Hours}{Year} **$$

*or Annual Operating Limit Per An Existing Permit

**Actual hours of operation includes all hours that the presses ran including that portion of makeready that involves either solvent use and ink/fountain solution consumption.

Some state agencies have already accepted this approach for printers. If this approach is to be used, it is imperative that its acceptability be confirmed. Otherwise, there is a risk of possible enforcement action, especially if the proper documentation or permits have not been obtained.

List of HAPs Most Common to the Lithographic Printing Industry

The following list of HAPs can be found in materials used in nonheatset web offset printing and is provided to assist in the identification of HAPs. A complete list of HAPs is included in this fact sheet and the applicant needs to compare it with materials actually or possibly used on press.

HAP	CAS Number	Material
Cumene	98828	Blanket Conditioner Blanket/Roller Wash
Ethyl Benzene	100414	Metering Roller Cleaner Blanket/Roller Wash
Ethylene Glycol	107211	Fountain Solution
n-Hexane	110543	Spray Adhesive
Naphthalene	91203	Blanket/Roller Wash
Methanol	67561	Stay Open
Methyl Chloroform (1,1,1-Trichloroethane)	71556	Blanket/Roller Wash
Methylene Chloride (Dichloromethane)	75092	Metering Roller Cleaner Blanket/Roller Wash
Methyl Ethyl Ketone	79345	UV Cleaning Solution
Toluene	108883	Metering Roller Cleaner Blanket Wash
Xylene	1330207	Blanket Conditioner Blanket/Roller Wash

Glycol Ethers	CAS Number	Material
Ethylene Glycol Monomethyl Ether (2-Methoxyethanol**)**	109864	Fountain Solution Blanket/Roller Wash
Ethylene Glycol Monoethyl Ether (2-Ethoxyethanol)	110805	Fountain Solution Blanket/Roller Wash
Ethylene Glycol Dimethyl Ether (1, 2-Dimethoxyethane)	110714	Fountain Solution Blanket/Roller Wash
Diethylene Glycol Mono-n-Butyl Ether (Butyl Carbitol**)**	112345	Fountain Solution Blanket/Roller Wash
Diethylene Glycol Monomethyl Ether (2-(Methoxyethoxy) Ethanol)	111773	Fountain Solution Blanket/Roller Wash
Diethylene Glycol Monoethyl Ether (2-(Ethoxyethoxy) Ethanol)	110900	Fountain Solution Blanket/Roller Wash
Diethylene Glycol Dimethyl Ether (2-Methoxyethyl Ether)	111966	Fountain Solution Blanket/Roller Wash
Diethylene Glycol Diethyl Ether (2-Ethoxyethyl Ether)	112367	Fountain Solution Blanket/Roller Wash

The following chemicals are **not** to be included in the Glycol Ethers Category:

Chemical	CAS Number
Diethylene Glycol	111466
Propylene Glycol Methyl Ether	107982
Dipropylene Monomethyl Ether	34590948
All Other Propylene Glycol Ethers	
Propylene Glycol Methyl Ether Acetate	108656

The category of regulated “glycol ethers” is larger than those identified on this page. Further information may be obtained by contacting the RCRA/Superfund hotline at 800-424-9346 to request a copy of EPA’s document entitled “Toxic Release Inventory – List of Toxic Chemicals within the Glycol Ethers Category”. The publication number is EPA – 745-R-95-0006.

Example of HAP Emission Calculation Using Above Approach and Worksheet

Material	Annual Usage	HAP Content
Nonheatset Web Ink, Process	25,200 pounds	0% by weight
Fountain Solution Concentrate (Ethylene Glycol)	420 gallons	0.717 pounds/gallon
Fountain Solution Additive (2-Butoxyethanol) (Ethylene Glycol)	120 gallons	6.7 pounds/gallon 5.5 pounds/gallon 1.2 pounds/gallon
Cleaning Solution - Blanket Wash (Naphthalene) (2-Butoxyethanol)	1,200 gallons	6.24 pounds/gallon 2.3 pounds/gallon 1.1 pounds/gallon
Cleaning Solution - Roller Wash (Naphthalene)	300 gallons	5.9 pounds/gallon 1.2 pounds/gallon
Coating - UV	180 gallons	0.0 pounds/gallon
Coating - Conventional	6,000 pounds	0% by weight

Material[1]	Usage[2]	Units	HAP Content[3]	Units	Release Factor[4]	HAP Emissions[5]
Ink	25,200	Pounds/Yr	0.0	% by Weight		0.0
Fountain Solution (FS) Concentrate						
Ethylene Glycol	420	Gallons/Yr	0.717	lbs HAP/Gal		301.14
FS Additive						
2-Butoxyethanol	120	Gallons/Yr	5.5	lbs HAP/Gal		660
Ethylene Glycol	120	Gallons/Yr	1.2	lbs HAP/Gal		144
Cleaning Solution BW						
Naphthalene	1200	Gallons/Yr	2.3	lbs HAP/Gal	0.5	1,380
2-Butoxyethanol	1200	Gallons/Yr	1.1	lbs HAP/Gal	0.5	660
Cleaning Solution RW						
Naphthalene	300		1.2		0.5	180
Coating Conventional	6,000	Pounds/Yr	0.0	% by Weight		0
Coating UV	180	Gallons/Yr	0.0	lbs HAP/Gal		0
Total HAP Emissions						3,325 lbs/yr 1.66 tons/yr

Individual HAP Emissions

	CAS Number	Lbs/Yr	Tons/Yr
2-Butoxyethanol	111762	1,320	0.66
Ethylene Glycol	107211	445	0.22
Naphthalene	91203	1,560	0.78

Potential Emissions

For this example, it is assumed that the facility operated 250 days (5 days/week for 50 weeks) with two shifts or 16 hours per day. Of the 16 hours, 4 are spent in makeready activities where cleaning solvent or ink is not being used resulting in actual crewed hours of 3,000 hours/year.

$$\text{Total Hazardous Air Pollutants Annual Potential Emmisions} = \frac{1.66\,Tons/Year}{3000\,Hours/Year} \times \frac{8{,}760\,Hours}{Year}$$

Total HAP APE = 4.85 Tons/Year
2-Butoxyethanol APE = 1.93 Tons/Year
Ethylene Glycol APE = 0.64 Tons/Year
Naphthalene APE = 2.28 Tons/Year

References

1. Draft CTG - Control of Volatile Organic Compound Emissions from Offset Lithographic Printing, September 1993 is available at www.epa.gov/ttn/atw/print/printpg.html under Closely Related Rules, Policies or Program Guidance

2. Alternative Control Techniques Document: Offset Lithographic Printing (EPA-453/R-94-054), June 1994 is available at www.epa.gov/ttn/atw/print/printpg.html under Closely Related Rules, Policies or Program Guidance

3. PrintSTEP workbooks are available through www.epa.gov/compliance/assistance/sectors/printstep.html under PrintSTEP Products.

4. Potential to Emit (PTE) Guidance for Specific Source Categories -Memo and Attached Technical Support Document are available at www.epa.gov/ttn/oarpg/t5pgm.html - scroll down to item dated 4-14-98.

5. EIIP Volume III, Chapter 7 on Graphic Arts is available at www.epa.gov/ttn/chief/eiip/techreport/volume03/iii07.pdf

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