CCME

Canadian Council of Ministers of the Environment

Le Conseil canadien des ministres de l'environnement

Environmental Code of Practice for the Reduction of Volatile Organic Compound Emissions from the Commercial/Industrial Printing Industry

CCME MANAGEMENT PLAN
INITIATIVES V308 AND V613

AUGUST 1999

PN 1301

The Canadian Council of Ministers of the Environment(CCME) is the major intergovernmental forum in Canada for discussion and joint action on environmental issues of national, international and global concern. The 14 member governments work as partners in developing nationally consistent environmental standards, practices and legislation.

Canadian Council of Ministers of the Environment
123 Main St., Suite 360
Winnipeg, Manitoba R3C 1A3
Ph: (204) 948-2090 Fax: (204) 948-2125

For additional copies, please contact:

CCME Documents
200 Vaughan Street
Winnipeg, MB
R3C 1T5
Tel: (204) 945-4664
Fax: (204) 945-7172
E-mail: spccme@chc.gov.mb.ca

ISBN: 1-896997-38-4

Ce document est également publié en français

Abstract

The purpose of this Code is to provide guidance to environmental regulatory agencies, suppliers and operators of commercial and industrial printing facilities concerning the means of reducing emissions containing volatile organic compounds (VOCs) which, in the course of production, are released to the environment. The Code is intended to provide a basis for implementing consistent and uniform control measures and operating standards for commercial and industrial printing facilities across Canada.

The commercial and industrial printing industry is a complex and diverse sector that uses numerous printing processes to produce a wide range of commercial products on a variety of different materials. The printing processes covered by this code are flexography, rotogravure, lithography, letterpress and rotoscreen. The code focuses on the reduction of VOC emissions from the printing process and clean-up operations, the handling and storage of VOC containing materials, and the handling and disposal of wastes. It does not address the control of VOC emissions from the manufacture of the various substrates, i.e., materials upon which ink is applied. VOC emissions requirements from these operations, including the production of plastics, metals, foil, textiles, paper and paperboard, are covered by separate CCME initiatives. Emission limits covering such manufacturing activities in facilities that also operate printing presses will be in addition to any requirements contained in this code.

The Code contains design and operating performance targets for VOC emissions from commercial and industrial printing facilities, recommended operating, record keeping and training practices, and suggested testing protocols. **Examples and interpretation guidelines are included to explain in simple terms the requirements of the Code, and to assist companies in determining what they need to do to meet these requirements**.

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Preface

Ground-level ozone is produced when nitrogen oxides (NO_x) and volatile organic compounds (VOCs) react in the atmosphere in the presence of sunlight. It is a major component of urban smog. At elevated levels, it is known to decrease lung function, cause premature aging of the lung and damage vegetation, including some agricultural crops and forest species.

Ground-level ozone is one of the more serious air-quality problems in Canada today. Concentrations sometimes are twice the Canadian maximum acceptable objective of 82 ppb in the summer months.

Recognizing the problem, the Canadian Council of Ministers of the Environment (CCME) initiated the development of a NO_x/VOC Management Plan for Canada to reduce the formation of ground-level ozone by controlling the emissions of volatile organic compounds and nitrogen oxides.

The plan sets out 58 specific initiatives to reduce NO_x and VOC emissions from existing and new sources. Initiative V308 recommends the development of a CCME environmental code of practice, including new source performance targets for commercial/industrial printing facilities. Initiative V613 refers to retrofitting existing rotogravure and flexographic printers in the Lower Fraser Valley and the Windsor-Quebec Corridor to BACTEA. This Environmental Code of Practice is in response to and in support of these initiatives.

The Code was developed by a multi-stakeholder working group made up of representatives of federal, provincial and regional governments, representatives of the commercial and industrial printing industry and of an environmental non-government organization. Appendix A contains a list of Working Group members. The contributions of all participants and stakeholders who helped develop this Code are gratefully acknowledged.

While this Code establishes minimum broad national emission reduction targets, it is acknowledged that federal, provincial, territorial or regional environmental authorities may impose more stringent limits in response to regional or local problems.

Introduction

The commercial and industrial printing industry is very diverse, involving many types of processes, production techniques, raw materials and products. CCME emission inventory and forecast initiatives, and subsequent studies established that process emissions from the following four printing processes, together with their ancillary in-line press operations and general use of solvents, accounted for over ninety-five (95) percent of the total VOC emissions from the Canadian printing industry:

- Flexography
- Rotogravure
- Lithography
- Letterpress

This environmental Code applies to all persons who own or operate a commercial or industrial printing plant in a facility containing any of the above listed printing processes and that releases emissions containing volatile organic compounds (VOCs) to the atmosphere.

This Code includes VOC emissions from ancillary in-line operations that are associated with printing such as coating, application of adhesives, etc. It does not address the control of small fugitive emissions of VOC's that may occur from the printed product itself, nor VOC emissions associated with the manufacture of the substrate to which the ink is applied, should these take place in the same facility. VOC emissions requirements covering the manufacture of the substrates themselves, are included in separate CCME initiatives. Emission limits will be in addition to any requirements contained in this Code.

In general, VOC process emissions in printing operations increase with the speed and capacity of the press, the concentration of VOCs in the raw materials being processed or used, the processing temperature, and with the surface area of product or raw material exposed to the atmosphere. VOC emissions from solvent handling, storage and cleaning operations may also be significant. Emission control techniques will be site specific. They include raw material reformulation or substitution, process modification, and the use of add-on control equipment, where this is practical.

The cost of conforming with the requirements of this Code may be substantial for those owners and operators of existing printing operations that have not taken any action to reduce VOC emissions. However, in addition to reducing discharges of VOCs to the environment, measures such as product substitution and onsite solvent recovery and distillation can result in reduced raw material and solvent costs and lower waste generation. Emission reduction strategies, if thoughtfully achieved, should also result in an improved workplace environment and better health and safety protection for workers. Odours should be reduced as well. These factors should all contribute to better community relations and an improved long-term competitive position.

This guideline, is written in four parts to assist in implementation and decision making.

PART I defines the application and scope of the Code;

PART II defines design and operating performance targets for printing facilities and the means of demonstrating conformance with them;

PART III identifies record-keeping practices and test methods that will assist owners and authorities to gauge conformance and operating efficiency; and

PART IV recommends equipment, operating and training practices that will contribute to lowering overall VOC emissions from printing facilities.

The information in this Code is intended to be used to minimize emissions containing VOCs to the atmosphere. In implementing this Guideline, however, care must be taken not to compromise the safety or the health of workers or the community. **When making any process changes, the owner/operator must, for safety reasons, ensure that concentrations of combustible materials are maintained well below the Lower Explosive Limit (LEL) in all situations.** It is also recommended that the owner/operator contact the agency responsible for occupational health and safety in his/her area to ensure that any changes contemplated meet their requirements.

It is an individual company's responsibility to determine the appropriate policies, standards and procedures that are require d to conform to <u>all</u> applicable health, safety and environmental laws, regulations, and requirements now and in the future.

Appendices

The appendices include additional background information, explanations of various terms, details of relevant criteria and testing protocols, interpretation guidelines and typical examples of calculations required by this Code, to assist the operator and authorities in the interpretation and implementation of the Code.

Additional background information summarizing the various printing processes, VOC emission sources, VOC control techniques and their effectiveness are included in an accompanying Reference Document entitled *VOC Emissions and Control Techniques for the Commercial and Industrial Printing Industry*, prepared for Environment Canada by William A. (Bill) Neff Consulting Inc. This document is available from Environment Canada on request.

ENVIRONMENTAL CODE OF PRACTICE FOR THE COMMERCIAL AND INDUSTRIAL PRINTING INDUSTRY

PART I Application, Definitions and Scope

1. Applicability

1.1 Except as noted in this section, this Code applies to all persons who own or operate a commercial or industrial printing plant that carries out a printing operation in a facility.

1.2 Except for paragraph 3.1.2 and subsection 6.2, the provisions of this Code do not apply, if it can be demonstrated to the satisfaction of the relevant regulatory authority, by mass balance or other practical means, that a facility's three year rolling average uncontrolled VOC amount is less than 1000 kilograms per year.

1.3 Sections 12 and 14 of this Code do not apply to cleaning materials that have a VOC content of ten percent or less by volume, as used in a facility[1].

1.4 This Code does not apply to manual or non-mechanized screen printing operations.

2. Glossary of Terms and Key Definitions

Adhesive is the material used to bond one or more layers of material to a substrate by the process of lamination.

Alcohol Substitutes are non-alcohol additives that contain VOCs and are used in fountain solutions to reduce the surface tension of water or to prevent ink build-up during the printing process.

Average Facial Velocity is the ratio of total actual volumetric flow rate of a gaseous mixture, to the total cross-sectional area of the opening through which it passes.

Baseline Amounts include baseline VOC component amounts, baseline fractions of the VOC component amount for the cleaning materials related raw material category that is retained in contaminated rags after cleaning, and, if applicable, used in automatic blanket washing systems, baseline printing press VOC amounts, and the baseline uncontrolled VOC amount of a facility.

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[1] This determination should be based on the VOC content of cleaning materials as certified by the supplier or as determined by the test method identified in PART III of this Code.

Baseline Printing Press VOC Amount is the sum of all the baseline VOC component amounts for an individual printing press or printing line in a facility.

Baseline Uncontrolled VOC Amount is, for a given facility:

(a) the uncontrolled VOC amount established pursuant to subsection 3.1.3, or

(b) if applicable, the adjusted uncontrolled VOC amount established pursuant to section 3.3, or

(c) the revised uncontrolled VOC amount established, pursuant to section 3.11 or section 3.12.

Baseline VOC Component Amount is for an individual printing press or printing line in a facility:

(a) the VOC component amount established pursuant to subsection 3.8.2, or

(b) if applicable, the adjusted VOC component amount established pursuant to section 3.3, or

(c) the revised VOC component amount established pursuant to section 3.11 or section 3.12.

Capture Efficiency (CE) is the weight per cent of VOCs in gaseous process emissions that is collected by a containment or capture system and delivered to a control device.

Capture System is equipment for collecting manufacturing or process emissions and transporting them to a control device.

Capture Velocity is the minimum air velocity entering an emission collection device or hood that is necessary to overcome opposing air currents and thereby ensure capture of gaseous process emissions or contaminated air for delivery to a control device.

Cleaning Materials include, but are not limited to, solvents and other materials containing VOCs used to clean hands, tools, printing plates, application equipment, work areas and other process related equipment in a facility.

Coating is a layer of material applied to a substrate in a substantially unbroken film, either before or after it is printed in a facility and includes varnishes.

Coldset is any printing operation where inks are set without the use of heat. For the purposes of this Code, ultraviolet (UV) cured and electron beam cured inks are considered coldset.

Commercial or Industrial Printing Plant includes all manufacturers and enterprises that apply ink directly or indirectly onto a substrate for commercial purposes.

Common Supply System is equipment and operating procedures that formulate and supply a category of raw material to more than one printing press from a single source in a facility.

Control Devices are systems or equipment that destroy VOCs or recover them for subsequent reuse. Control devices include, but are not limited to, combustion, thermal oxidation, biodegradation, adsorption, absorption, condensation, reclamation systems, or any combination of the foregoing technologies.

Control Device Destruction Efficiency (CDE) is the weight percent of the VOCs introduced to a control device that is destroyed or recovered.

Control system is a control device and its capture system.

Cure is the chemical conversion of a coating, ink or varnish from a wet, fluid or viscous state to a solid or semi-solid state.

Dampening System is the equipment used to deliver fountain solution to a lithographic plate.

Design VOC Component Amount is, for any of the raw material categories listed in subsection 3.1.1, the quantity of uncontrolled VOCs, expressed in kilograms per calendar year, that is derived from projected future activity levels and other technical and design considerations, and is deemed to be released by an individual printing press or printing line in a facility, pursuant to paragraph 3.9.2(a).

Existing Printing Press is any printing press in a facility that is not a new printing press.

Facility is a commercial or industrial printing operation carried out at a specific location or site that is under common ownership or control.

Flexographic Printing Process is a letterpress printing process utilizing flexible rubber or other elastomer printing plates and rapid drying liquid inks.

Fountain Solution is a mixture of water, non-volatile printing chemicals and additives that is applied to the image plate of a lithographic printing process to reduce the surface tension of the water so that it spreads easily across the printing plate surface and maintains the hydrophillic properties of the non-image areas, thereby containing the ink within the image areas.

Heatset is any printing operation where heat is delivered by hot air driers to evaporate ink oil and set the ink on a substrate.

High-Volatility Cleaning Material is any cleaning material containing VOCs that is not classified as a low-volatility cleaning material.

Ink is any fluid or viscous composition of materials used in printing operations to transfer an image onto a substrate.

Lamination is a process in a facility of combining two or more layers of material to form a single, multiple-layered sheet.

Letterpress Printing Process is a printing press in which the image area of the printing plate is raised relative to the non-image area and the ink is transferred to the substrate directly from the image surface.

Lithographic Printing Process is a printing press in which the image and non-image areas of the printing plate are on the same plane and chemically differentiated; the image area being oil receptive, and the non-image areas being water receptive.

Lower Explosive Limit (LEL) is the lowest volume per cent of combustible material which, when mixed with air, will burn independently, without the continuous application of heat. LEL's for various hydrocarbons and VOCs are available from standard handbooks such as Handbook of Chemistry and Physics and Chemical Engineer's Handbook.

Low VOC Ink Formulations are inks in which VOC content has been significantly reduced, compared with conventional solvent based inks, or eliminated, and include water-based or water-borne inks, high-solid inks, and reactive ink systems such as ultra-violet (UV), electron beam (EB) and infra-red (IR) cured inks.

Low-Volatility Cleaning Material is any cleaning material containing VOCs that is not applied or heated to within 100 ^{o}C (180 ^{o}F) of its true boiling point during the cleaning cycle and which:

(a) contains less than 300 grams of volatile organic compounds (VOCs) per litre as applied; or

(b) has a VOC composite partial vapour pressure less than 10 mm Hg at 20^{o}C (68^{o}F).

Mixed Facility is a facility in which more than one type of printing process operate.

Net Uncontrolled VOC Amount is the total weight of VOCs entering a facility for any raw material category listed in subsection 3.1.1, minus the total weight of VOCs for that same category, contained in waste materials or byproducts that leave the facility for recovery or approved waste disposal, expressed in kilograms per calendar year, but excludes residual solvent contained in rags used for wipe cleaning.

New Printing Press is a printing press that was manufactured after the date of publication of this Code of Practice, as specified on the press's name plate.

Offset is a printing process that transfers the ink from the printing plate to an intermediary surface (blanket), which in turn, transfers the ink to the substrate.

Overall Control Efficiency (OCE) is the product of the capture efficiency (CE) and the control device destruction efficiency (CDE) divided by 100, i.e., OCE = CE X CDE/100.

Person is any firm, business establishment, association, partnership, corporation or individual, whether acting as principal, agent, employee or in another capacity, including any government entity or charitable organization.

Printing Line is a printing press and associated equipment and driers in a facility that is capable of printing, coating, laminating or varnishing a substrate simultaneously or sequentially in a more or less continuous manner to produce a finished product.

Printing Operation is any production or manufacturing process that places a mark, message or a design on the surface of a finished product with a printing press, and includes coating, laminating and varnishing operations associated with the finished product, if carried out in the same facility, plus every step in the production process, from the delivery of the raw materials and cleaning materials, to the storage and shipment of the printed product and associated byproducts and wastes, except those operations directly associated with the manufacture of the substrate itself.

Printing Plate is a surface or cylinder carrying a design that ultimately is transferred directly or indirectly by ink to the substrate.

Printing Press is a mechanical device and associated equipment, composed of one or more units and related equipment, that applies ink to a surface by means of any of the following printing processes and which ultimately transfers the desired mark, message or design on the printing plate to the material being printed:

Flexographic Printing
Letterpress Printing
Lithographic Printing
Rotogravure Printing
Rotoscreen Printing

Printing Press VOC Amount is the sum of all the VOC component amounts for all of the raw material categories listed in subsection 3.1.1, for an individual printing press or printing line.

Rotogravure Printing Process is a printing press utilizing the intaglio printing concept in which the ink is

carried to the substrate in minute etched or engraved wells on a roll or cylinder, excess ink being removed from the surface of the cylinder by a doctor blade.

Rotoscreen Printing Process is a webfed printing press in which the ink, en route to the substrate, passes through a screen, mesh or fabric to which a refined form of stencil has been applied.

Sheetfed is a printing operation to which individual lengths of substrate are supplied to the printing press sequentially.

Solvent is any non-aqueous organic liquid used as a cleaning material that contains VOCs. Solvents include petroleum distillates, hydrocarbons, chlorinated hydrocarbons, ketones, alcohols, esters, glycol ethers and terpenes. They may be used alone or in blends.

Solvent Recovery System is a covered tank, vessel or equipment designed to separate contaminants from used solvents and solvent containing wastes so that the solvent can be reclaimed and reused. This is usually accomplished by boiling the contaminated solvent, condensing the resultant contaminant-free vapour, and finally passing the distillate through a water separator.

Substrate is the surface of the finished product to which ink is ultimately applied.

Three Year Rolling Average Uncontrolled VOC Amount is, for a given facility, the sum of its actual uncontrolled VOC amounts for the three calendar years immediately preceding the current year, divided by three.

Three Year Rolling Average VOC Emission Rate is, for a given facility, the sum of its actual VOC emission rates for the three calendar years immediately preceding the current year, divided by three.

Total Enclosure is a device or structure that approaches a capture efficiency of 100 percent, in that it completely surrounds VOC emission sources within the enclosed area, thereby maximizing the capture and containment of such emissions for subsequent delivery to a control device.

Uncontrolled VOC Amount is, for a facility, the sum of the net uncontrolled VOC amounts for all of the raw material categories listed in subsection 3.1.1.

Unit is the smallest complete printing element of a printing press.

Varnish is a protective layer of material applied to a substrate in a substantially unbroken film, after it is printed in a facility.

VOC Composite Partial Vapour Pressure is the sum of the partial pressures of the compounds defined as VOCs and calculated as set out in Part III of this Code.

VOC Containing Materials are any materials used in a facility that contain VOCs, including the raw material categories set out in subsection 3.1.1 and solid materials such as rags, cardboard, sawdust, etc., that have been contaminated with solvent-containing substances.

VOC Component Amount is the quantity of uncontrolled VOCs, for any one of the raw material categories listed in subsection 3.1.1, that has been determined to apply to an individual printing press or printing line, pursuant to subsection 3.8.1, expressed in kilograms per calendar year.

VOC Emission Limit is the numerical quantity of VOC emissions to atmosphere, as set out in section 4.1, expressed in tonnes per calendar year, which, if attained by a facility, results in conformance with this Code.

VOC Emission Rate is, at any time, the sum of the individual printing press VOC emission rates in a facility.

Volatile Organic Compound (VOC) is any organic compound which participates in atmospheric photochemical reactions; that is, any such organic compound other than the following which have been excluded because of their negligible photochemical reactivity:

Methane
Ethane
1,1,1 - Trichloroethane (Methyl Chloroform)
Methylene Chloride (Dichloromethane)
Chlorofluorocarbons (CFCs)
Fluorocarbons (FCs)
Hydrochlorofluorocarbons (HCFCs)

Waste Materials are any materials in a facility generated as a byproduct from the printing operation and include leftover inks and coatings, paper or cloth used for cleaning operations, and any spent cleaning materials and sludges.

Webfed is a printing operation which employs an automatic system to supply substrate to a printing press from a roll or from an extrusion process.

Wipe Cleaning is a cleaning method in which a cloth or other material is wetted with a solvent containing VOCs and rubbed on a surface to remove soils.

Abbreviations

ASTM	American Society for the Testing of Materials (U.S.)
BACTEA	Best Available Control Technology Economically Achievable
CCME	Canadian Council of Ministers of the Environment
CDE	Control Device Destruction Efficiency
CE	Capture Efficiency
CFC	Chlorofluorocarbons
EB	Electron Beam
EPA	Environmental Protection Agency (U.S.)
FC	Fluorocarbons
GC/MS	Gas Chromatography/Mass Spectrometry
HCFC	Hydrochlorofluorocarbons
Hg	Mercury
IPA	Isopropyl Alcohol
IR	Infra-red
LEL	Lower Explosive Limit
LFV	Lower Fraser Valley
NO_x	Nitrogen Oxides
OCE	Overall Control Efficiency
SCAQMD	South Coast Air Quality Management District (California)
U.S.	United States of America
UV	Ultra-violet
VOC	Volatile Organic Compounds
WHMIS	Workplace Hazardous Materials Information System
WQC	Windsor-Quebec City Corridor

Units of Measurement

C	Centigrade, temperature scale
F	Fahrenheit, temperature scale
fpm	Feet per minute
g	gram
g/l	grams/litre
g/m^3	grams per cubic metre
kg	kilogram
m	metre, a unit of measure
mg	milligram
ml	millilitre
mm	millimeter
min	minute
m/s	metres/second
ppb	parts per billion
ppm	parts per million

psi	pounds per square inch, a unit of absolute pressure
psig	pounds per square inch gauge, a unit of pressure
tonne	1000 kilograms

PART II Baseline Calculations, VOC Emission Performance Targets and the Demonstration of Conformance

3. Baseline Calculations

3.1 Any person owning or operating a facility should:

3.1.1 determine once a year, at the end of every calendar year, the net uncontrolled VOC amount for each of the following categories of raw materials that entered the facility during the calendar year:

Inks and Ink Related
Dampening System Related
Coatings Related
Varnishes Related
Adhesives Related
Cleaning Materials Related

3.1.2 determine the uncontrolled VOC amount for the facility as a whole.

3.1.3 subject to sections 3.3 and 3.11, establish the baseline uncontrolled VOC amount for the facility as a whole.

3.2 For the purpose of subsection 3.1.3, the baseline uncontrolled VOC amount is the highest uncontrolled VOC amount of the facility during the 1995,1996 and 1997 calendar years.

3.3 If a facility can demonstrate, on the basis of its records, that its highest uncontrolled VOC amount for the 1995, 1996 and 1997 calendar years has been reduced relative to its product output because of actions it has taken to reduce VOC emissions during the period of January 1, 1992 through December 31, 1997, it may adjust its uncontrolled VOC amount according to the following equation, use the adjusted value to establish its baseline uncontrolled VOC amount, and adjust all the other affected baseline amounts accordingly:

Adjusted Baseline Uncontrolled VOC Amount = (UVOCA x PUAPR)/CUAPR

Where:

UVOCA = the highest uncontrolled VOC amount for the 1995, 1996 and 1997

calendar years.

PUAPR = for any of the calendar years from 1992 to 1997, the highest weight to weight ratio of the facility's uncontrolled VOC amount to printed product output for that same calendar year.

CUAPR = the weight to weight ratio of the facility's uncontrolled VOC amount to printed product output, for the same calendar year for which UVOCA was determined.

This is necessary so that when calculating the VOC emission performance targets and determining conformance in sections 4 and 5, a facility is not penalized for taking abatement action to reduce VOC emissions in the recent past.

3.4 Owners and operators of a facility are exempt from the requirements of sections 3.5 through 3.9 if it can be demonstrated, by mass balance or other practical means, that the three year rolling average VOC emission rate of the facility is not greater than:

(a) 25 tonnes per calendar year; or

(b) the product of the facility's baseline uncontrolled VOC amount multiplied by the lowest applicable allowable fraction of baseline uncontrolled VOC amount, specified in column 2 of Table 1, for any type of printing press that operates during the calendar year in that facility.

3.5 Subject to sections 3.4 and 3.7, any person owning or operating a facility should:

3.5.1 allocate and adjust the amounts of the various categories of raw materials listed in subsection 3.1.1 among the various printing presses or printing lines in the facility, based on the facility's records and the following considerations:

(a) the relative capacities of the various printing presses in the facility;

(b) the press utilization rates;

(c) the ink coverage on impression;

(d) the impression area of the web or sheet;

(e) the ink application rates per colour; and

(f) the VOC content of ink, fountain solution, coatings, adhesives, varnishes and cleaning materials (as applied).

(g) the amounts of solvent retained in contaminated rags after cleaning, and, if applicable, used in automatic blanket washing systems; and

3.5.2 establish the baseline printing press VOC amounts for the facility.

3.6 For a given raw material category, in a facility, the individual VOC component values of various printing presses, may be aggregated for the purposes of sections 3.5 and 3.8, where

(a) a raw material category is supplied to various printing presses by a common supply system; or

(b) a common raw material is used in a number of printing presses of the same process type.

3.7 Owners and operators of a facility are exempt from the requirements of Section 3.8 if it can be demonstrated, by mass balance or other practical means, that the three year rolling average VOC emission rate of the facility is not greater than the allowable fraction of the baseline uncontrolled VOC amount for the facility, determined using the equation set out in paragraph 4.2 (b).

3.8 Further to section 3.5, any person owning or operating a facility, that does not qualify for exemption under sections 3.4 and 3.7, should:

3.8.1 determine the individual VOC component amounts and the printing press VOC amounts, noting the fraction of the VOCs in cleaning materials that is retained in contaminated rags after cleaning, and, if applicable, the fraction of VOCs in cleaning materials that is used in automatic blanket washing systems, for each printing press or printing line in the facility, based on the facility's records; and

3.8.2 subject to section 3.3, establish the individual baseline VOC component amounts and the baseline printing press VOC amounts, including the baseline fraction of the VOCs in cleaning materials that is retained in contaminated rags after cleaning, and, if applicable, the baseline fraction of the VOCs in cleaning materials that is used in automatic blanket washing systems, for each printing press or printing line in the facility.

3.9 For the purposes of subsection 3.8.2, the individual baseline VOC component amounts used to determine the baseline printing press VOC amounts are:

3.9.1 for an existing printing press, the actual individual VOC component amounts that correspond, for the same calendar year, to the highest uncontrolled VOC amount for the facility as a whole during the 1995, 1996 and 1997 calendar years; and

3.9.2 for a new printing press

(a) the design VOC component amounts for the first three complete calendar years of operation, and

(b) for subsequent years, the average of the actual individual VOC component amounts during the first three calendar years of operation, as shown in the facility's records.

3.10 Subject to section 3.11, baseline amounts, once established, remain in force until changed in accordance with section 3.12;

3.11 Baseline amounts for a new printing press should be reestablished after three complete calendar years of operation, using the individual VOC component amounts referred to in paragraph 3.9.2(b), and the baseline uncontrolled VOC amount, for the facility as a whole, revised accordingly.

3.12 Owners and operators of a facility may establish revised baseline amounts for the facility at any time. However, the authority having jurisdiction may request that revised baseline amounts for the facility be established at any time when the product output of the facility is reduced significantly.

3.13 For the purposes of Section 3.12, the individual revised baseline VOC component amounts used to determine the revised baseline printing press amounts are: for a printing press, the individual VOC component amounts that correspond, for the same calendar year, to the highest uncontrolled VOC amount for the facility as a whole, during the previous three years.

3.14 For purposes of this section, the test protocols and measurement techniques specified in Part III of this Guideline should be used to determine the VOC levels in raw materials where certified values from the supplier are not available.

4. VOC Emission Performance Targets

4.1 Any person owning or operating a facility should limit VOC emissions from the facility to atmosphere to the greater of the two rates corresponding to the following two options:

4.1.1 a VOC emission limit of no more than 25 tonnes per calendar year; or

4.1.2 the allowable fraction of the baseline uncontrolled VOC amount for the facility, determined pursuant to section 4.2.

Table 1

VOC Emission Performance Targets as a Function of Printing Press Type

Type of Printing Press	Allowable Fraction of Baseline Uncontrolled VOC Amount for a Printing Press or Printing Line	Corresponding Reduction in Uncontrolled VOC Amount %
Flexography	.10	90
Publication Rotogravure	.10	90
Packaging and Product Rotogravure	.10	90
Heatset Web Lithography	.10	90
Coldset Web Lithography	.30	70
Sheet-fed Lithography	.30	70
Webfed Letterpress	.30	70
Sheetfed Letterpress	.30	70
Rotoscreen	.30	70

4.2 For the purposes of subsection 4.1.2, the allowable fraction of the baseline uncontrolled VOC amount, expressed in tonnes per calendar year, is:

(a) for a facility with a single printing process, the fraction of the baseline uncontrolled VOC amount for the facility that is specified in column 2 of Table 1 for the applicable printing process.

(b) for a mixed facility, the amount determined using the following equation:

Allowable Fraction of the Baseline Uncontrolled VOC Amount for a Mixed Facility $= (BPA_1 * F_1 + ... + BPA_y * F_{x)}$

Where:

BPA_y = the Baseline Printing Press VOC Amount of a printing press "y".

F_x = the allowable fraction of printing press "y", corresponding to the printing process "x" used by that press, as set out in column 2 of Table 1.

"x" = one of the 9 printing processes set out in Table 1.

4.3 Once established, VOC emission performance targets remain in force until such time as the facility's baseline amounts are revised pursuant to section 3.8.

4.4 VOC emission targets should be achieved according to the following time schedule:

(a) for facilities with existing printing presses or printing lines, within 5 years after the publication of the Code and no later than 2005. The precise schedule should be negotiated with the authority having jurisdiction.

(b) for facilities with only new printing presses or printing lines, immediately upon start-up.

5. Demonstrating Conformance with VOC Emission Performance Targets

5.1 Any person intending to own or operate a new printing press in a facility should be able to demonstrate, during the design phase, to the relevant authorities that all reasonable efforts are being made to meet the relevant VOC Emission Performance Target for that printing press, as set out in Column 2 of Table 1.

5.2 An owner or operator of an operating facility should demonstrate conformance with the facility's VOC emission performance target, as determined pursuant to section 4, once a year, at the end of every calendar year.

5.3 A facility is deemed to be in conformance with the VOC emission performance targets determined in section 4, if it can be demonstrated, by mass balance or other practical means, that the three year rolling average VOC emission rate of the facility is not greater than the applicable VOC emission performance target for the facility, as determined pursuant to section 4.

5.4 For the purposes of section 5.3, a facility is deemed to be in conformance, if it qualifies for the exemption under either section 3.4 or section 3.7.

5.5 Conformance may be demonstrated by either of the two following approaches:

(a) By the testing and monitoring of selected captured and released streams and other parameters, during periods when operation is considered to be normal and typical for the facility, using sampling and testing methods and protocols that are in accordance with those set out in section 7 that are sufficient to demonstrate conformance when compared with the facility's baseline uncontrolled VOC amount, and that are acceptable to the relevant regulatory authority; or

(b) By calculation.

5.6 For the purposes of Paragraph 5.5 (a), the following equation should be used to demonstrate conformance with the VOC emission performance target determined pursuant to section 4:

$$\text{Actual Fraction of Baseline Uncontrolled VOC Amount Released} = BUA - ((VOC_{c1}*CDE_1)+ \ldots +(VOC_{cx}*CDE_x))$$

Where:

BUA = the Baseline Uncontrolled VOC Amount for the facility as a whole, expressed in tonnes per year;

VOC_{cx} = the weight of VOC contained in process emission stream "x" that are captured and delivered to a control device, as determined by the testing of a representative sample, expressed in tonnes per year;

CDE_x = is the weight fraction of the VOCs introduced to a control device that are destroyed or recovered, as determined by testing during the same sampling period as the determination of VOC_{cx}.

5.7 For the purpose of section 5.6, if a total enclosure, meeting the criteria in Appendix H, is constructed in a facility, VOC_{cx} is deemed to be the baseline VOC component amount established pursuant to subsection 3.8.2, section 3.11, or section 3.12, as the case may be, for each applicable raw material category, provided that emission source is contained within the total enclosure in the facility.

5.8 For the purpose of paragraph 5.5 (b), the fraction of VOCs in a given raw material category that is being released by a given printing press or printing line in a facility may be determined by multiplying the individual baseline VOC component amounts for that press, established pursuant to subsection 3.8.2, section 3.11, or section 3.12, as the case may be, by the

appropriate emission factor set out in column 3 of Table 2 for the corresponding control option set out in column 1 of Table 2, provided the control option has been implemented and the conditions set out in column 2 of Table 2, for applying each control option, are met in all respects.

Table 2

Control Options to Reduce VOC Emissions and their Deemed Effectiveness

Raw Material Categories and Control Options	**Application and Applicable Conditions**	**Emission Factor**
Ink and Ink Related		
Retention of ink oil VOCs in substrates*	All printing processes Select appropriate emission factor from Table 3 depending on type of printing process and substrate.	Emission factor will vary depending on the type of printing process and the specific substrate. See Table 3 for appropriate factor.
Use of Low VOC Ink Formulations*	Ink reformulation and/or process changes that reduce VOC emissions, e.g., reactive inks.	$1 - (VOC_{ib}-VOC_{ir})/VOC_{ib}$
Capture and Control	The CE and CDE will vary depending on the capture system and control system used. For each ink and ink related VOC emission source to which a capture system is applied, select the appropriate CE value from Table 4. For each ink and ink related VOC emission source that is captured and to which a control device is applied, select the appropriate CDE value from Table 5.	For each ink and ink related VOC emission source to which a control system is applied, determine the OCE using the selected CE and CDE values from Tables 4 and 5 and the emission factor for that particular emission source: OCE = CE*CDE/100 Emission Factor = $1 - \frac{OCE}{100}$

Table 2 (Continued)

Control Options to Reduce VOC Emissions and their Deemed Effectiveness

Raw Material Categories and Control Options	**Application and Applicable Conditions**	**Emission Factor**
Dampening System Related		
Reduce IPA in Fountain Solution*	Lithographic printing presses that use IPA fountain solutions (as applied).	$1 - (VOC_{fb}-VOC_{fr})/VOC_{fb}$ (2)
Refrigerate Fountain Solutions containing IPA*	Refrigeration means that the temperature of the fountain solution reservoir is maintained below 15°C (60°F)	$(1 - (VOC_{fb}-VOC_{fr})/VOC_{fb})*0.56$ (2)
Use Alcohol Substitutes*	Use of IPA is eliminated. As applied basis	$1 - (VOC_{fb}-VOC_{fr})/VOC_{fb}$ (2)
Eliminate VOCs Entirely*	As applied basis	0.0 (2)
Capture and Control (Carryover to Drier)	Heatset Lithography where the drier is operated at a vacuum at the web slot of at least 1.3 mm (0.05 inches) of water (10) relative to the press room, or the average facial velocity of the air entering the drier ports is at least 1 m/s, and the CDE of the control device is maintained at 98% or greater.	0.5 for alcohol VOCs (3,5) 0.3 for alcohol substitutes (3,5,13)
Coatings, Varnishes and Adhesives		
Use low VOC coating and adhesive formulations or eliminate them entirely*	Sum of all coatings, adhesive and varnish applications (as applied). Includes process changes that reduce/eliminate VOC emissions, e.g., extrusion laminatio n or UV coatings.	$1 - (VOC_{cb}-VOC_{cr})/VOC_{cb}$
Capture and Control	Sum of all coating and adhesive applications with operating control systems. Select CE and CDE values from Tables 4 and 5.	Determine OCE and emission factor for each controlled coating and adhesive emission source. Same equations as for ink.

Table 2 (Continued)

Control Options to Reduce VOC Emissions and their Deemed Effectiveness

Raw Material Categories and Control Options	**Application and Applicable Conditions**	**Emission Factor**
Cleaning Materials		
Use of Low Volatility Cleaning Material*	Baseline solvent must be high-volatility cleaning material and new solvent (as applied) must meet the definition of low volatility cleaning material	0.3 (3,13)
Use of cleaning material with reduced VOC levels*	Determination on an as applied basis	$1 - (VOC_{sb}-VOC_{sr})/VOC_{sb}$
Containment and Recovery of Solvent Retained in Contaminated Cleaning Rags	Applies to the baseline fraction of the VOC component amount for the cleaning materials related raw material category that is retained in contaminated rags after cleaning for each individual printing press, pursuant to subsection 3.8.2, provided that: the contaminated rags are stored in spring-loaded or self-closing containers until any remaining solvent can be recovered; as much solvent as possible is recovered from the rags as soon as possible after use by use of small centrifuges or other practical means; without delay, the still contaminated rags are stored in self-closing containers prior to laundering or disposal; any recovered solvent is stored in self-closing containers until it can be transferred to drums for final recovery or approved disposal; techniques that minimize VOC emissions during laundering or disposal are employed.	0.7 for a high-volatility cleaning material 0.5 for a low-volatility cleaning material (3,13)

Table 2 (Continued)

Control Options to Reduce VOC Emissions and their Deemed Effectiveness

Raw Material Categories and Control Options	**Application and Applicable Conditions**	**Emission Factor**
Cleaning Materials		
Capture and Control (Carryover of Solvent to Drier from Automatic Blanket Washing Systems)	Applies to the baseline fraction of the VOC component amount for the cleaning materials related raw material category that is used in an automatic blanket washing system for each individual heatset lithography printing press, pursuant to subsection 3.8.2, or the actual fraction of the VOC component amount if the system was implemented after the current baseline amounts were established, provided that the drier is operated at a vacuum at the web slot of at least 1.3 mm (0.05 inches) of water (10) relative to the press room, or the average facial velocity of the air entering the drier ports is at least 1 m/s, and the CDE of the control device is maintained at 98% or greater.	0.85 of the baseline allocated amount for high-volatility cleaning material 0.6 of the baseline allocated amount for low-volatility cleaning material (3,5,13)

* denotes a pollution prevention approach

Where:

VOC_{ib} = the current baseline VOC component amount for the ink and ink related raw material category that was allocated to the individual printing press or printing line in question, and was established pursuant to section 3, expressed in tonnes per year.

VOC_{ir} = the VOC component amount for the ink and ink related raw material category that is currently being used (as applied) by the individual printing press or printing line in question, expressed in tonnes per year.

VOC_{fb} = the current baseline VOC component amount for the dampening system related raw material category that was allocated to the individual printing press or printing line in question, and was established pursuant to section 3, expressed in tonnes per year.

VOC_{fr} = the VOC component amount for the dampening system related raw material category that is currently being used (as applied) by the individual printing press or printing line in question, expressed in tonnes per year.

VOC_{cb} = the sum of the current baseline VOC component amounts for the coatings, adhesives and vanishes related raw material categories that were allocated to the individual printing press or printing line in question, and were established pursuant to section 3, expressed in tonnes per year.

VOC_{cr} = the sum of the current baseline VOC component amounts for the coatings, adhesives and vanishes related raw material categories that are currently being used (as applied) by the individual printing press or printing line in question, expressed in tonnes per year.

VOC_{sb} = the current baseline VOC component amount for the cleaning materials related raw material category that was allocated to the individual printing press or printing line in question, and was established pursuant to section 3, expressed in tonnes per year.

VOC_{sr} = the VOC component amount for the cleaning materials related raw material category that is currently being used (as applied) by the individual printing press or printing line in question, expressed in tonnes per year.

Table 3

Retention Rates of Ink Oil and Coating VOCs in Various Substrates

Printing Process and Ink Type	Substrate Type	Emission Factor
Lithography and Letterpress (3,4)		
Heatset Web	All	0.8 (3,4)
Coldset Web	All	0.05 (3,4)
Sheet-fed	All	0.07 (12)
Flexography		
Water-based Ink	Corrugated	1.0 (3)
Solvent-based Ink	Paper	0.98 (3,7)
Water and solvent Based Ink	Non-porous Substrates	1.0
Rotogravure		
Publication	All	0.97 (4)
Packaging and Product	Paper	0.98 (3,4)
Packaging and Product	Non-porous Substrates	1.0
Rotoscreen	All	1.0

Table 4

Table 4

Capture System Options and Typical Efficiencies (CEs) for the Printing Industry

Application and Capture Technique	Description Applicable Conditions	Typical Capture Efficiency (CE)
Lithographic Process: Heatset Web Driers	Operate drier at a vacuum at the web slot of at least 1.3 mm (0.05 inches) of water (10) relative to the press room; or maintain the average facial velocity of the air entering the drier ports at 1 m/s or more.	99% (2)
Floor Sweeps	Install small pick-up ducts at each station near the source of fugitive emissions.	15% (1)
Balanced Driers	Maintain air flow from driers to avoid discharge into press room.	75% (1)
Additional Drier Air	Exhaust more air from driers than hot air supplied.	80% (1)
Close Capture	Install plexiglass or other rigid curtains over wet web; enclose kits and pumps; cover fountains.	92% (1)
Permanent Total Enclosure	Meet criteria for total enclosures (Appendix H).	100% (1)

Table 5

Control Device Options and Typical Efficiencies (CDEs) for the Printing Industry

Control Device Technology	Description Applicable Conditions	Typical Control Efficiency (CDE)
Destruction Technologies		
Thermal Oxidation	Typical combustion temperatures: 720-1000°C (1) Typical residence time: 0.5-0.75 seconds (9)	98% (2,9,4)
Catalytic Oxidation	Typical combustion temperatures: 320-450°C (1) Typical residence time: 0.5-0.75 seconds (9)	98% (2,9,4)

Table 5 (Continued)

Control Device Options and Typical Efficiencies (CDEs) for the Printing Industry

Control Device Technology	Description Applicable Conditions	Typical Control Efficiency (CDE)
Recovery Technologies		
Biodegradation	Ensure adequate moisture content, nutrients, oxygen, pH, continuous food source	80% (1)
Adsorption	Ensure adequate quantity of high quality activated carbon is available; prior cooling, and filtering of incoming gas stream; carbon beds are regenerated before breakthrough (9).	95% (2,10,4)
Condenser Filters with Carbon	Ensure adequate quantity of high quality activated carbon is available; carbon beds are regenerated before breakthrough (9).	95% (2,10,4)
Condenser Filter	Adequate residence time and adequate cooling	85% (2,10)

5.9 In accordance with section 5.8, the following equation should be used to demonstrate conformance, for the facility as a whole, with the applicable VOC emission performance target, determined pursuant to section 4:

Calculated Fraction of Baseline Uncontrolled VOC Amount = $((SRCA_1) + ... + (SRCA_x)))$

Where: $SRCA_x$ = the sum of the individual baseline component amounts for printing press "x" or printing line in a facility, including those reduced by applying emission factors, pursuant to section 5.7, expressed in tonnes per year; and

5.10 Where more than one of the emission factors set out in Tables 2, 3 and 4, or calculated from

the CE and CDE values set out in Tables 5 and 6, apply to an individual baseline VOC emission component value, they should be applied sequentially, with the factors involving raw material substitution, and marked with an asterisk in the Tables, being applied first and the factors for capture and control options being applied subsequently, to the already reduced value.

5.11 For the purpose of section 5.8, emission factors, CE and CDE values, for additional control options or operating situations not included in Tables 2 through 6, may be developed and applied to an individual baseline VOC emission component value, where the overall control efficiency (OCE) of the control system has been demonstrated to the satisfaction of the responsible regulatory authority, using the following formula:

$$EF_{co} = \frac{100 - (CE_{co} * CDE_{co})}{100}$$

Where:

Ef_{co} = the demonstrated emission factor for the control option in question;

CE_{co} = the demonstrated CE for the control option in question; and

CDE_{co} = the demonstrated CDE for the control option in question.

5.12 In the event of a dispute as to the correctness of an emission factor set out in Tables 2, 3 and 4 or a CE and CDE value set out in Tables 5 and 6 for a particular control option, by either the owner and operator of a facility or the responsible regulatory authority, the overall control efficiency (OCE) of that particular control system may be established by actual testing and the corresponding emission factor calculated using the formula set out in section 5.11 of this Code. In such cases, the demonstrated emission factor should be used for the purposes of section 5.8.

5.13 For the purposes of this section, where testing of emissions is carried out, the test procedures and protocols set out in Part III of this Code, or other generally accepted equivalent testing methods, should be used to generate data for use in the equations specified to demonstrate conformance.

5.14 Once conformance with this code has been demonstrated, the owner or operator of an operating facility should maintain systems and equipment to design and operating standards.

PART III Record Keeping and Test Methods

6. Record Keeping

6.1 Subject to section 6.2, any person owning or operating a facility should retain all data and information necessary to demonstrate that the requirements of this Code are being met for a period of at least three years in a form that will permit review by relevant environmental authorities. Such records may include but are not necessarily limited to following:

6.1.1 Records used to establish a facility's exemption from the application of this Code, or parts of this Code, pursuant to sections 1.2, 3.4 and 3.7;

6.1.2 Records on which the determination and establishment of baseline amounts are based, pursuant to section 3;

6.1.3 Records and calculations used to determine conformance with the VOC emission performance targets set out in section 4, pursuant to paragraph 5.5 (b);

6.1.4 Dates and quantities of solvent reclamation operations that are carried out, including the disposition and estimated solvent content of any sludges.

6.1.5 Records covering the disposal of used solvents, sludges, used rags and contaminated clothing that results from plant operations.

6.1.6 Records and documentation of testing and measurements carried out to demonstrate conformance with the VOC emission performance targets set out in section 4, pursuant to paragraph 5.5 (a) and to establish new or revised emission factors, pursuant to sections 5.12 and 5.13.

6.1.7 Records relating to the maintenance of systems and equipment, pursuant to section 5.14.

6.2 If it can be demonstrated, by mass balance or other practical means, that the three year rolling average uncontrolled VOC amount for a facility, is less than 1000 kilograms per year, only the dates, quantities and types of VOC containing raw materials, cleaning materials and waste materials entering and leaving the facility need be retained.

7. Test Methods

7.1 The test methods referenced in Appendix G, or methods that can be demonstrated to produce equivalent results, should be used for the purposes of this Code. More specifically:

7.1.1 Subject to subsection 7.1.2, EPA Method 24 should be used as a reference method or to determine the VOC content of all VOC containing raw materials, cleaning materials and wastes entering or leaving the facility when certified values from the supplier or agent cannot be obtained;

7.1.2 For the purposes of subsection 7.1.1, EPA Method 24A should be used for VOC containing raw materials associated with a publication rotogravure printing process;

7.1.3 EPA Methods 25 and 25A should be used to determine the VOC content of emitted untreated and treated gaseous streams as modified by the referenced guidance document;

7.1.4 The SCAQMD Method, taken from Rule 1171, should be used for determining the VOC composite partial vapour pressure of a cleaning material.

7.2 Measurement of average facial velocity should be done parallel to the plane of an enclosure or hood opening with a thermistor anemometer with an accuracy of within plus or minus 2 feet per minute and a calibration traceable to The National Institute of Standards and Technology.

PART IV Recommended Equipment, Operating and Training Practices

8. Assessment of Raw Materials and Cleaning Alternatives8. Assessment of Raw Materials and Cleaning Alternatives

Any person owning, operating or designing a facility should:

8.1 Assess the technical and economic feasibility of using raw materials containing low levels of volatile organic compounds (VOCs) for various operations within the facility while meeting applicable product standards and certification requirements.

8.2 Assess the degree of cleaning that is required, and the technical and economic feasibility of using alternate cleaning equipment and techniques to reduce VOC emissions from the various operations within the facility while meeting applicable product and workplace standards.

8.3 Assess the technical and economic feasibility of using aqueous, emulsion and low-volatility cleaning materials in the facility.

9. Management Systems and Operating Procedures

Any person owning or operating a facility should:

9.1 Develop and implement management systems, appropriate to each unique operation, that integrate health, safety and environmental considerations into each aspect of both the design and manufacture of equipment, and the carrying out of manufacturing operations, including the recycling and disposal of VOC containing cleaning materials and wastes. Information on the characteristics of management systems is included in Appendix F.

9.2 Develop and place in an accessible and conspicuous location in the workplace written operating procedures and requirements, encompassing the requirements of this Code and covering all aspects of the facility's operations, including normal operations, start-up, shut-down, solvent conservation, solvent and ink segregation, solvent filtration, solvent reclamation, routine inspections and maintenance, cleaning and maintenance of equipment, containment and recovery of spills, and the disposal of VOC containing wastes.

10. Basic Equipment

Any person owning or operating a facility should:

10.1 In addition to the applicable provisions of sections 8 through 10, ensure, for new facilities, that:

10.1.1 The piping, valves and fittings in contact with VOC containing material are welded or flanged, using gasket material that is compatible with the VOC containing material in question and of the smallest diameter possible, consistent with safe and efficient operating practices.

10.1.2 Except for ball valves, valves in contact with VOC containing material have retained or captive spindles that permit on-line tightening or replacement of gland packing or diaphragms should a leak be detected.

10.1.3 Pumps in contact with VOC containing material are equipped with double mechanical seals or their equivalent.

10.2 For existing facilities that utilize VOC containing materials, substitute or install, whenever the opportunity exists **and where it can be done safely** welded or flanged piping, valves and fittings, of the smallest diameter possible, consistent with safe and efficient operating practices, using gasket material that is compatible with the VOC containing material in question, for threaded joints. If threaded fittings are retained, standard pipe dopes should be avoided and replaced with graphite, glycerine pastes or synthetic materials compatible with the VOC containing material in question. In addition, low emission valves and pumps, as described in subsections 10.1.2, and 10.1.3, should be used in place of existing equipment where this is

feasible.

11. Inspection and Monitoring

11.1 In addition to the applicable provisions of sections 8 through 10, any person owning or operating a facility should:

11.1.1 Ensure that the operating procedures referred to in section 9.2 are being met.

11.1.2 Inspect the equipment and associated piping monthly for leaks and give immediate attention to replacing any defective parts.

11.1.3 Develop and implement a system to detect, recover and minimize emissions from material and solvents containing VOCs that are accidentally spilled in the course of a facility's operations.

12. Solvent Storage and Handling

Subject to section 1.3, to minimize the loss of solvents containing VOCs, any person owning or operating a facility should ensure that:

12.1 Bulk solvent storage tanks with a capacity greater than 1,000 litres are equipped with:

12.1.1 Pressure-vacuum conservation vents that reduce vapour losses due to tank "breathing" caused by temperature changes;

12.1.2 a permanent submerged fill pipe; and

12.1.3 dikes and a drain containment system with sufficient capacity to contain spills or leaks before they evaporate.

12.2 Compressed air is not used to transfer solvent from one vessel to another.

12.3 The use of compressed inert gases to transfer solvent from one vessel to another is restricted to the conditions specified in article 4.4.10.6 of the National Fire Code of Canada.

12.4 Solvent is not transferred by pouring or splashing it into open pails or buckets.

12.5 Solvent transferred from drums is carried out by means of a hand or motor driven pump, connected

to the bung opening of the drum, that discharges through a submerged discharge line in the receiving vessel.

12.6 The bung openings of empty or partially empty drums are replaced after the withdrawal of solvent without delay.

12.7 Solvent transferred from tank cars or tank trucks to storage tanks is accomplished through an outlet that is submerged below the liquid level of the solvent in the receiving vessel.

12.8 Transfer hoses or pipes are completely drained into a covered vessel and are capped immediately after the transfer with positive locking quick connections of the Kamlok type.

12.9 Separate containers, equipped with covers, are provided for storing clean and used solvent.

13. Waste Handling and Disposal

13.1 To minimize VOC emissions to the atmosphere, any person owning or operating a facility should ensure that:

13.1.1 Spent solvent and waste sludge are stored in covered containers until they are removed for recovery or disposal.

13.1.2 Spent solvents of different types are segregated and clearly labelled.

13.1.3 Sludge from a solvent recovery system does not contain more than 20 percent volatile organic solvent.

13.1.4 Spent solvents destined for recovery contain at least 40 percent VOCs.

13.2 Classify spent solvent and solvent containing waste sludges as a hazardous waste, unless specifically required to do otherwise by the relevant authorities, and handle and dispose of them in accordance with all applicable federal, provincial and local requirements.

14. Wipe Cleaning and Clean-up

14.1 Subject to section 1.3, and in addition to the applicable general requirements set out in sections 8 through 13, any person that owns or operates a facility that uses cleaning materials containing VOCs, in aggregate quantities of 1000 litres or more annually, should actively strive to minimize the amount of solvent used by implementing one or more of the following or equally effective techniques:

14.1.1 Using mechanized or automatic methods for cleaning purposes or to remove excess raw materials from equipment and tools prior to final cleaning;

14.1.2 Using the minimum amount of solvent possible. To accomplish this consider such techniques as:

(a) utilizing a closed solvent-dispensing container at work stations, such as the plunger-type can or the so-called safety can with a spring-loaded cover on the pouring spout.
(b) reducing the size of the cloth or rag that is used to apply the cleaning solvent; and
(c) issuing a daily ration of solvent to employees, making each accountable for the amount used;

14.1.3 Placing containers of cleaning solvent with self closing covers near the press area to minimize spills and drippage from tool cleaning and reusing this solvent until contamination prevents effective cleaning.

14.1.4 Using gloves or barrier creams by workers to reduce personal clean-up requirements;

14.1.5 Storing contaminated rags used for wipe cleaning in spring-loaded or self-closing containers until any remaining solvent can be recovered.

14.1.6 Wringing out or centrifuging dirty cloths and rags to recover as much solvent as possible as soon as possible after use, and then, without delay, storing the still contaminated rags, glove liners and clothes in self-closing containers prior to laundering or disposal.

14.1.7 Storing recovered solvent in self-closing containers until it can be transferred to drums for final recovery or disposal.

14.1.8 Employing techniques that minimize VOC emissions during laundering or disposal.

15. Training

15.1 Operating personnel should receive training and instructions related to safety, occupational health and environmental aspects, commensurate with their responsibilities. Items covered should include:

o The theory, characteristics and value of management systems

o Applicable health, safety and environmental laws and regulations including those governing labelling (WHMIS), spills, emergencies and reporting, solvent and waste handling and waste disposal.

o All applicable aspects of this Guideline including:

- recommended equipment and operating practices

- solvent storage and handling
- waste handling and disposal
- record keeping
- test methods

o All applicable operating procedures and practices including:

- normal operations including daily check lists
- routine maintenance
- solvent conservation and maintenance
- cleaning and maintaining process equipment including safety procedures and entry requirements
- containment and recovery of spills
- handling and disposal of wastes
- process equipment and emission control device start-up and shut-down

o Test methods and procedures

o Applicable occupational exposure limits and the use of personal protective and monitoring equipment

o Benefits of following this Guideline

Additional sources of information include:

- provincial and federal environmental regulatory agencies
- provincial occupational health and safety agencies
- raw material suppliers
- national and provincial trade associations
- equipment suppliers and their associations, e.g., ASTM
- information contained in the Appendices of this Guideline
- the bibliography contained as an Appendix to this Guideline

Appendix A List of Commercial and Industrial Printing Industry Working Group Members

Jim Armstrong	Crown Cork and Seal Canada Inc.
Benoît Brasseur	Quebecor Printing Inc.
Regent Brosseau	Montreal Urban Community
Domingo Chan	Flint Ink Corporation of Canada
Jim Farmer	Ontario Printing and Imaging Association
Douglas Groff	Canadian Printing Industries Association
Tim Leah (Chairperson)	Environment Canada, National Office of Pollution Prevention
Martin Lecours	Ministère de l'Environnement et de la Faune, Québec
Paul Murray	AT Plastics
Bill Neff	Consultant
Steve Neville	Ontario Ministry of Environment and Energy
Paul Plotz	Canadian General-Tower Ltd.
Barrie Porteous	Sun Chemical
John Prinsen	Environment Canada, National Office of Pollution Prevention
Desmond Sweeney	Genpak
John Thompson	Sunworthy Wallcoverings
Bob Vandrish	Multipak Ltd.
Paul Van Leeuwen	AT Plastics
Bruce Walker	STOP
Thomas Warlick	Graphic Packaging Corp.

Appendix B Baseline Calculations (section 3)

Appendix B - 1 Examples of Uncontrolled VOC Amount Calculations (section 3.1)

Example 1:

ABC Printing Inc. was operating 3 lithographic printing presses on December 31, 1997. It uses information from the purchasing and shipping divisions to determine the facility's current (1997) net uncontrolled VOC amounts for the various raw material categories and subsequently the uncontrolled VOC amount for the facility as a whole:

Inks and Ink Related	=	180 tonnes per year
Dampening System Related	=	400 tonnes per year
Coatings Related	=	20 tonnes per year
Cleaning Materials Related	=	55 tonnes per year

Uncontrolled VOC Amount		655 tonnes per year

Example 2:

Zebra Packaging Inc. have a rotogravure and a flexographic printing line in their facility. It determines its current (1997) net uncontrolled VOC amounts for the various raw material categories and current uncontrolled VOC amount for the facility as a whole as follows:

Inks and Ink Related	=	800 tonnes per year
Adhesives Related	=	400 tonnes per year
Coatings Related	=	700 tonnes per year
Cleaning Materials Related	=	750 tonnes per year

Uncontrolled VOC Amount		2650 tonnes per year

Example 3:

Lulu Images Inc. is a small custom printer operating a single sheetfed lithographic printing press. It determines its current (1997) net uncontrolled VOC amounts for the various raw material categories and current uncontrolled VOC amount for the facility as a whole as follows:

Inks and Ink Related	=	10 tonnes per year
Dampening System Related	=	12 tonnes per year
Coatings Related	=	10 tonnes per year
Cleaning Materials Related	=	8 tonnes per year

Uncontrolled VOC Amount	40 tonnes per year

Appendix B - 2 Examples of Baseline Uncontrolled Amount Calculations
(sections 3.2 and 3.3)

Example 1:

ABC Printing Inc.'s current (1997) uncontrolled VOC amount of 655 tonnes per year is as high as it has been for the last three years. Normally, the facility's baseline uncontrolled VOC amount would therefore be 655 tonnes per year.

The company, however, modified the dampening system for its coldset press in 1994, by switching from an IPA based fountain solution to an alcohol substitute. The change, which is still in operation, cut the VOC component amount for the dampening system related raw material category in half, from 180 tonnes per year to 90 tonnes per year. As a result, the printing press VOC amount for the coldset press, as well as the uncontrolled VOC amount for the facility as a whole were reduced by 90 tonnes per year. The printed product volume has remained unchanged at a million tons per year.

Further to section 3.3, the baseline uncontrolled VOC amount can be adjusted to take previous abatement actions into account:

UVOCA = 655 tonnes per year
PUAPR = (655+(180-90))/1,000,000 = $.745*10^{-3}$
CUAPR = 655/1,000,000 = $.655*10^{-3}$

Adjusted Baseline Uncontrolled VOC Amount = (655 x .745)/.655 = 745 tonnes per year

Section 3.3 also requires that the baseline printing press VOC amounts and the baseline VOC component amounts of the affected press and other baseline amounts be adjusted accordingly. This is necessary so that when calculating the VOC emission performance targets and determining conformance in sections 4 and 5, a facility is not penalized for taking abatement action to reduce VOC emissions in the recent past. Since, in this case, the total change in the uncontrolled VOC amount of the facility resulted from change made to the dampening system of Litho 2, Litho 2's baseline VOC component amount for the dampening system related raw material category should be increased by the difference between the adjusted baseline uncontrolled VOC amount and the current one, e.g., (745 - 655) or 90 tonnes per year. The adjusted amount is (90 + 90) or 180 tonnes per year, i.e., the amount prior to the change taking place. Similarly, Litho 2's baseline printing press VOC amount should be increased by 90 tonnes per year as well.

Appendix B - 2 Examples of Baseline Uncontrolled Amount Calculations (Continued)

Example 2:

Zebra Packaging Inc. current uncontrolled VOC amount is 2650 tonnes per year. Business has taken a downturn lately, however, and its raw material usage has dropped. The company finds from its records that its uncontrolled VOC amounts for the past three years are as follows:

1995 2750 tonnes per year
1996 2900 tonnes per year
1997 2650 tonnes per year

Further to section 3.2, the company's baseline uncontrolled VOC amount is 2900 tonnes per year. Baseline VOC component amounts and baseline printing press VOC amounts will be those in effect for the 1996 calendar year.

Example 3:

Lulu Images Inc.'s current (1997) uncontrolled VOC amount of 40 tonnes per year is the highest it has been in the last three years. The facility's baseline uncontrolled VOC amount is therefore 40 tonnes per year.

Appendix B - 3 **Example Calculations for Allocating Raw Materials**
(sections 3.5 and 3.8)

Example 1:

On the basis of its company records, ABC Printing Inc. allocated its baseline uncontrolled VOC amount (745 tonnes per year) among its 3 operating printing presses, taking care to break out the amount of VOCs retained in cleaning rags immediately after cleaning from the cleaning materials related raw material category total. The individual baseline VOC component amounts, in tonnes per year, were determined to be as follows:

				Cleaning Material Related		
	Inks	Dampening System	Coatings	General Cleaning	Retained in Rags	Totals
Litho 1 (Heatset)	100	300		20	10	430
Litho 2 (Coldset)	60	(90+90)[2]		5	5	250[2]
Litho 3 (Sheetfed)	20	10	20	8	7	65
Totals	180	490[2]	20	33	22	745[2]

The baseline printing press VOC amounts are as follows:

Litho 1 (Heatset)	430 tonnes per year
Litho 2 (Coldset)	250[2] tonnes per year
Litho 3 (Sheetfed)	65 tonnes per year
Adjusted Baseline Uncontrolled VOC Amount	745[2] tonnes per year

[2] Denotes an adjusted amount (section 3.3).

Appendix B - 3 Example Calculations for Allocating Raw Materials (Continued)

Example 2:

On the basis of its company records Zebra Packaging Inc. allocated its baseline uncontrolled VOC amount (2900 tonnes per year) between its rotogravure and flexographic printing lines taking care to break out the amount of VOCs retained in cleaning rags immediately after cleaning from the cleaning materials related total. The individual baseline VOC component amounts, based on 1996 calendar year operations, in tonnes per year, were determined to be as follows:

					Cleaning Material Related		
	Inks	Adhesives	Coatings	General Cleaning	Retained in Rags	Totals	
Roto 1	650	400	450	350	175	2025	
Flexo 1	250	350	175	100	875		
	----	----	----	----	----	----	
Totals	900	400	800	525	275	2900	

The baseline printing press VOC amounts are as follows:

Roto 1	2025 tonnes per year
Flexo 1	875 tonnes per year

Baseline Uncontrolled VOC Amount	2900 tonnes per year

Example 3:

Lulu Images Inc. determines that its three year rolling average VOC emission rate is 32.5 tonnes per year. It knows its VOC emission limit will be 25 tonnes per year. Lulu Images does not qualify for the exemption from allocating its raw materials (section 3.4). However, since the facility has only one press, the allocation process is straight forward, i.e., the individual baseline VOC component amounts are the same as the net uncontrolled VOC amounts for the various raw material categories, except that the amount of VOCs retained in cleaning rags must be broken out:

				Cleaning Material Related		
	Inks	Dampening System	Coatings	General Cleaning	Retained in Rags	Total
Litho 1 (Sheetfed)	10	12	10	4	4	40

The baseline printing press VOC amount, and the baseline uncontrolled VOC amount for the facility as a

whole, are both 40 tonnes per year.

Appendix C Example Calculations for Determining VOC Emission Performance Targets (section 4)

Example 1:

As a facility with different printing process types, ABC Printing Inc. must limit the actual or calculated VOC emissions from its facility to an amount less than or equal to 25 tonnes per year (Subsection 4.1.1), or the allowable fraction of the weighted average sum of the individual baseline printing press VOC amounts (Paragraph 4.2 (b)), whichever is the greater rate (section 4.1).

Using its baseline printing press VOC amounts established previously (Appendix B-3, Example 1), and the allowable fractions in Column 2 of Table 1, the allowable fraction of the baseline uncontrolled VOC amount for the facility can be calculated:

	Baseline Printing Press VOC Amounts	Component of Allowable Fraction	Component of Performance Target
Litho 1 (Heatset)	430	.10	43
Litho 2 (Coldset)	250[3]	.30	75
Litho 3 (Sheetfed)	65	.30	19.5
Totals: tonnes per year	745[3]		137.5

The facility's two possible VOC emission performance targets are either 25 or 137.5 tonnes per year. In these circumstances, the 137.5 tonnes per year figure is the greater rate and is the applicable VOC emission performance target (section 4.1).

Example 2:

The VOC emission limit for Zebra Packaging Inc. is identical to that for ABC Printing Inc., i.e., 25 tonnes per year. Because the printing processes are different, however, the allowable fractions taken from Column 2 of Table 1 will differ and so will the calculated allowable performance target:

[3] Denotes an adjusted amount (Section 3.3).

Appendix C Example Calculations for Determining VOC Emission Performance Targets (Continued)

	Baseline Printing Press VOC Amounts	Allowable Fraction	Component of Performance Target
Roto 1	2025	.10	202.5
Flexo 1	875	.10	87.5
	----		-----
Totals: tonnes per year	2900		290

The facility's two possible VOC emission performance targets are either 25 or 290 tonnes per year. The 290 tonnes per year value, being the greater rate, is the applicable VOC emission performance target for the facility.

Example 3:

The facility's VOC emission limit is the same as for ABC and Zebra Packaging, i.e., 25 tonnes per year (paragraph 4.2.(a)). Because it has only one printing process (Sheetfed Litho), the allowable fraction of the facility's baseline uncontrolled VOC amount can be read directly from column 2 of Table 1, and the value calculated as follows: 40*0.30 = 12 tonnes per year.

The facility's two possible VOC emission performance targets are either 25 or 12 tonnes per year. In this case, unlike ABC Printing and Zebra Packaging, the 25 tonnes per year VOC emission limit is the greater rate and becomes the applicable VOC emission target for the facility.

Appendix D Examples of Conformance Calculations (section 5)

Example 1:

ABC Printing Inc.'s VOC emission performance target is 137.5 tonnes per year. Although Litho 1 (Heatset) has a drier with an incinerator, the equipment is old and it is currently being operated in a balanced mode. The combustion temperature is also low, typically running at only 1000°F. Fountain solution compositions are as follows: Litho 1 - 20% IPA; Litho 2 - Alcohol Substitute - 10% VOCs (as applied); Litho 3 - 10% IPA. The facility uses only high-volatility cleaning materials and the coatings are solvent based. Using the emission factors and typical efficiencies found in Tables 2 through 5, and the baseline VOC component amounts set out in Appendix
B - 3, the calculated current VOC emission rate is determined as follows:

VOC Emission Rate Calculation

	Raw Material Category	Baseline VOC Component Amounts		Emission Factor	VOC Emission Component
Litho 1	**Ink**				
	Retention in Substrate	100	0.8	{80}[4]	
	Capture and Control			CE = 75% CDE = 95% OCE = 71.3	
			{80}[4]	E Factor=.287	23
	Dampening System				
	Carryover to Driers		300	0.5	150
	Cleaning Material		30	1.0	30
Litho 2	**Ink**				
	Retention in Substrate		60	0.05	3
	Dampening System		180[5]	0.5	90[5]
	Cleaning Material		10	1.0	10
Litho 3	**Ink**				
	Retention in Substrate		20	0.07	1.4
	Dampening System		10	1.0	10
	Coatings				
	Retention in Substrate		20	0.07	1.4

[4] Interim VOC Emission Component value, subject to application of an additional emission factor (Section 5.10), and therefore not included in totals.

[5] Denotes an adjusted amount (Section 3.3).

	Cleaning Materials	15	1.0	15
		---		---
Totals		745[5]		333.8[5]

Appendix D Examples of Conformance Calculations (Continued)

ABC Printing Inc. is currently not in conformance since its calculated VOC emission rate (333.8 t/yr) exceeds its performance target (137.5 t/yr).

To achieve conformance the company plans to upgrade Litho 1's existing drier and thermal oxidizer to achieve a 98 percent OCE. The IPA in the fountain solution will also be reduced to 3 percent and the system refrigerated. The VOCs in the fountain solution of Litho 2 will also be reduced to 5 percent:

	Raw Material Category	Baseline VOC Component Amounts	Emission Factor	VOC Emission Component
Litho 1	**Ink**			
	Retention in Substrate	100	0.8	{80}[6]
	Capture and Control		OCE = 98.0	
		{80}[6]	E Factor=.02 1.6	
	Dampening System			
	Limit IPA/Refrigerate	300	(1-(20-3)/20)*0.56	
	Fountain Solution		E Factor=.084	{25.2}[6]
	Carryover to Driers	{25.2}[6]	0.5	12.6
	Cleaning Material	30	1.0	30
Litho 2	**Ink**			
	Retention in Substrate	60	0.05	3
	Dampening System	180[7]	0.5	{90}[6,7]
	Reduce VOCs in	{90}[6,7]	(1-(10-5)/10)	
	Fountain Solution		E Factor=.5	45[7]
	Cleaning Material	10	1.0	10
Litho 3	**Ink**			
	Retention in Substrate	20	0.07	1.4
	Dampening System	10	1.0	10
	Coatings			
	Retention in Substrate	20	0.07	1.4
	Cleaning Materials	15	1.0	15

[6] Interim VOC Component value, subject to application of an additional emission factor (Section 5.10), and therefore not included in totals.

[7] Denotes an adjusted amount (Section 3.3).

Totals	745[7]	130[7]

These changes bring ABC Printing Inc. into conformance, i.e., its calculated VOC emission rate (130 t/yr) is below its performance target of 137.5 tonnes per year.

Appendix D Examples of Conformance Calculations (Continued)

Example 2:

Zebra Packaging Inc. currently vents all its VOC containing streams to atmosphere. Its VOC emission rate is therefore identical to its uncontrolled VOC amount except for minor quantities of VOCs retained on the substrate. Flexo 1 substrate is paper while Roto 1 substrate is plastic (non-porous). The company is currently out of conformance since its current VOC emission rate (2650 tonnes per year) is well in excess of its VOC emission performance target of 290 tonnes per year.

To improve this situation the company plans to:

- Convert half of its Flexo 1 inks to water-base with 5 percent VOC; current inks contain 70 percent VOC;
- Reduce its VOC emissions from adhesives on Roto 1 by 50 percent by installing an extrusion laminator;
- Reduce its VOCs from coating operations by 50 percent on its Flexo 1 line and 30 percent on its Roto 1 line by switching to water based coatings; and
- Install spring loaded containers for solvent contaminated rags used for cleaning and small centrifuges to recover some of the solvent. Following discussions with their regulatory authority they have identified a third party that can minimize VOC emissions during laundering.

VOC Emission Rate Calculation

Raw Material Category	Baseline VOC Component Amounts	Emission Factor	VOC Emission Component
Roto 1 Ink			
Retention in Substrate	650	1.0	650
Adhesives Related	400	0.5	200
Coatings Related	450	0.7	315
Cleaning Material	350	1.0	350

	Containment from Rags	175	1.0	{175}[8]	
	Recovery from Rags	{175}[8]	0.7		122.5

Appendix D Examples of Conformance Calculations (Continued)

Flexo 1	**Ink**				
	Retention in Substrate	250	0.98		{245}[8]
	Use of Low VOC Inks	{245/2}[8]	1 - (70-5)/70=0.07		8.6
		{245/2}[8]	1.0		122.5
	Coatings Related	350	0.5		175
	Cleaning Material	175	1.0		175
	Containment from Rags	100	1.0	{100}[8]	
	Recovery from Rags	{100}[8]	0.7		70
		-----			-----
Totals		2900			2188.6

Although there has been some improvement, Zebra Printing Inc. is still far from conformance.

To correct this situation, the company considers to collect the drier gases from Roto 1, cover the ink fountains and route all exhaust gases to a new thermal oxidizer. They can also switch the remaining solvent based adhesives (60% VOCs) to water-based (10% VOCs) without impairing product quality. Finally, through tests they find that they can go to a low-volatility cleaning material throughout the facility. These improvements would yield the following results:

Raw Material Category	Baseline VOC Component Amounts	VOC Emission Emission Factor	VOC Emission Component
Roto 1 Ink			
Retention in Substrate	650	1.0	{650}[8]
Capture and Control		CE = 90%	
		CDE = 99%	
		OCE = 89.1	
	{650}[8]	E Factor=.109	70.9

[8] Interim VOC Component value, subject to application of an additional emission factor (Section 5.10), and therefore not included in totals.

	Adhesives Related	400	0.5	{200}[8]
	Water-based adhesives {200}[8]		1 -(60-10)/60	
			E Factor=0.167	33.4
	Coatings Related	450	0.7	315
	Cleaning Material	350	0.3	105.0
	Containment from Rags 175		0.3	{52.5}[8]
	Recovery from Rags	{52.5}[8]	0.5	26.3

Appendix D Examples of Conformance Calculations (Continued)

Flexo 1	**Ink**			
	Retention in Substrate	250	0.98	{245}[9]
	Use of Low VOC Inks	{245/2}[9]	1 - (70-5)/70=0.07	8.6
		{245/2}[9]	1.0	122.5
	Coatings Related	350	0.5	175
	Cleaning Material	175	0.3	52.5
	Containment from Rags 100		0.3	{30}[9]
	Recovery from Rags	{30}[9]	0.5	15
		-----		-----
Totals		2900		924.2

The proposed controls are not sufficient to bring Zebra Packaging Inc. into conformance, i.e., its calculated VOC emission rate (924.2 tonnes per year) exceeds its performance target of 290 tonnes per year. In light of this, and to allow more flexibility in the future, the company decides to construct a total enclosure around all of its presses and route the vent to a new catalytic oxidizer.

The calculation for this control option is straight forward and the calculated VOC emission rate is:

CE = 100%; CDE = 98%; OCE = 98.0
E Factor = .02

Calculated VOC emissions = 2900*.02 or 58 tonnes per year.

This brings the facility comfortably into conformance.

Example 3:

Lulu Images Inc.'s current situation re conformance is as follows:

Litho 1	**Ink**			
	Retention in Substrate	10	0.07	0.7
	Dampening System	12	1.0	12
	Coatings			
	Retention in Substrate	10	0.07	0.7

[9] Interim VOC Component value, subject to application of an additional emission factor (Section 5.10), and therefore not included in totals.

Cleaning Materials	8	1.0	8
	---		---
Totals	40		21.4

Since they are currently conforming with the VOC emission performance target of 25 tonnes per year, no further upgrading would be required.

Appendix E Examples of Modification and Expansion Calculations

Example 1:

ABC Printing Inc. decides to undertake a modest expansion. Litho 3 will be replaced with a new faster sheetfed press, Litho 4 and an automatic blanket washing system will be installed for Litho 1. It is estimated that the automatic system will use 12 tonnes per year of solvent. The company wants to know how these changes will affect its emission requirements. (Refer to Appendix B - 3, Example 1 for the baseline VOC component amounts for Litho 1 and Litho 2). Because Litho 4 is a new piece of equipment, new baseline VOC component amounts and a baseline printing press VOC amount must be established for this press (Subsection 3.9.2). The new amounts are as follows:

		Cleaning Material Related				
	Inks	Dampening System	Coatings	General Cleaning	Retained in Rags	Totals
Litho 1 (Heatset)	100	300		20	10	430
Litho 2 (Coldset)	60	(90+90)[10]		5	5	250[10]
Litho 4 (Sheetfed)	80	80	50	15	12	237
	----	----	----	----	----	----
Totals	240	560[10]	50	40	27	917[10]

Because the total Adjusted Uncontrolled VOC Amount has increased significantly, ABC Printing Inc. elects to revise its baseline printing press VOC amounts and the facility's Adjusted Baseline Uncontrolled Amount:

Litho 1 (Heatset)	430 tonnes per year
Litho 2 (Coldset)	250[10] tonnes per year
Litho 4 (Sheetfed)	237 tonnes per year

Revised Adjusted Baseline Uncontrolled VOC Amount	917[10] tonnes per year

Since the facility's Adjusted Baseline Uncontrolled VOC Amount has changed, the allowable fraction of this amount will change as well and must be recalculated:

[10] Denotes an adjusted amount (section 3.3).

	Baseline Printing Press VOC Amounts	Component of Allowable Fraction	Component of Performance Target
Litho 1 (Heatset)	430	.10	43
Litho 2 (Coldset)	250[11]	.30	75
Litho 3 (Sheetfed)	237	.30	71.1
	----		----
Totals: tonnes per year	917[11]		189.1

The facility's two possible VOC emission performance targets are either 25 or 189.1 tonnes per year. In these circumstances, the 189.1 tonnes per year figure is the greater rate and is the applicable VOC emission performance target (section 4.1).

To determine conformance the following calculation is performed:

VOC Emission Rate Calculation

	Raw Material Category	Baseline VOC Component Amounts	Emission Factor	VOC Emission Component
Litho 1	**Ink**			
	Retention in Substrate	100	0.8	{80}[12]
	Capture and Control		OCE = 98.0	
		{80}[12]	E Factor=.02 1.6	
	Dampening System			
	Limit IPA/Refrigerate 300		(1-(20-3)/20)*0.56	
	Fountain Solution		E Factor=.084	{25.2}[12]
	Carryover to Driers	{25.2}[12]	0.5	12.6
	Cleaning Material	18	1.0	18
	Automatic Blanket Wash	12	0.85	10.2

[11] Denotes an adjusted amount (section 3.3).

[12] Interim VOC Component value, subject to application of an additional emission factor (Section 5.10), and therefore not included in totals.

Litho 2	**Ink**			
	Retention in Substrate	60	0.05	3
	Dampening System	180[13]	0.5	{90}[12,13]
	Reduce VOCs in	{90}[12,13]	(1-(10-5)/10)	
	Fountain Solution		E Factor=.5	45[13]
	Cleaning Material	10	1.0	10
Litho 4	**Ink**			
	Retention in Substrate	80	0.07	5.6
	Dampening System	80	1.0	80
	Coatings			
	Retention in Substrate	50	0.07	3.5
	Cleaning Materials	(15+12)	1.0	27
		-----		-----
Totals		917[13]		216.5[13]

The changes would leave ABC Printing Inc. out of conformance, i.e., its calculated VOC emission rate (216.5 t/yr) exceeds its VOC emission performance target of 189.1 tonnes per year. To correct this situation, and because the company has had good experience with the refrigerated fountain solution system for Litho 1, they decide to install a refrigerated fountain solution system on the new press (Litho 4) as well.

This drops the VOC emission component for the dampening system raw material category of Litho 4 from 80 tonnes per year to 80*0.56 = 44.8 tonnes per year. In turn, the calculated VOC emission rate is reduced from 216.5 to 181.3 tonnes per year, which brings the facility into conformance with its VOC emission performance target of 189.1 tonnes per year.

Example 2:

Business has picked up and Zebra packaging has decided to install a new rotogravure printing line, Roto 2, at its facility. The new press will be installed within the existing total enclosure. The company wants to know how this will affect its emission performance targets. (Refer to Appendix B - 3, Example 2 for the current baseline VOC component amounts for Roto 1 and Flexo 1). Because Roto 2 is a new piece of equipment, new baseline VOC component amounts and a baseline printing press VOC amount must be established for this press (Subsection 3.9.2), viz:

				Cleaning Material Related		
	Inks	Adhesives	Coatings	General Cleaning	Retained in Rags	Totals
Roto 2	900	100	600	200	100	1900

[13] Denotes an adjusted amount (section 3.3).

Using the current baseline printing press VOC amounts for Roto 1 and Flexo 1, the revised baseline amounts are:

Roto 1	2025 tonnes per year
Roto 2	1900 tonnes per year
Flexo 1	875 tonnes per year

Revised Baseline Uncontrolled VOC Amount	4800 tonnes per year

To determine its new performance targets and conformance requirements the following calculations are performed. The facility is a mixed facility and Paragraph 4.2 (b) applies:

	Printing Press VOC Amount	Allowable Fraction	Component of Performance Target
Roto 1	2025	.10	202.5
Roto 2	1900	.10	190.0
Flexo 1	875	.10	87.5
	----		-----
Totals tonnes per year	4800		480.0

The facility's two possible VOC emission performance targets are therefore either 25 or 480.0 tonnes per year. Since the latter figure is the greater rate, it is the applicable value.

To determine conformance, the company performs the following calculation, after confirming that their catalytic oxidizer has sufficient capacity to handle the additional emissions from Roto 2:

CE = 100%; CDE = 98%; OCE = 98.0
E Factor = .02

Calculated VOC emissions = 4800*.02 or 96 tonnes per year. The facility remains comfortably in compliance.

Example 3:

Lulu Images Inc. is planning to add a second shift to its operation. It wants to know what effect this would have on its allowable VOC emissions.

The proposed change would essentially double the facility's current baseline uncontrolled VOC amount of 40 tonnes per year (refer to Appendix B - 3, Example 3). With no process changes contemplated, it would increase to 80 tonnes per year.

Appendix E Examples of Modification and Expansion Calculations (Continued)

The new baseline VOC component amounts and the corresponding new baseline printing press VOC amount and baseline uncontrolled VOC amount calculated in accordance with section 3.10 were determined to be as follows:

				Cleaning Material Related		
	Inks	Dampening System	Coatings	General Cleaning	Retained in Rags	Total
Litho 1 (Sheetfed)	20	24	20	8	8	80

Lulu Images Inc. Elects to revise the facility's baseline uncontrolled VOC amount (Section 3.13). The revised baseline printing press VOC amount, and the revised baseline uncontrolled VOC amount for the facility as a whole, would both be 80 tonnes per year.

The facility's VOC emission limit would remain unchanged at 25 tonnes per year (Paragraph 4.2 (a)), but its allowable fraction of the facility's baseline uncontrolled amount would increase from 12 tonnes per year (refer to Appendix C, Example 3) to 80*0.30 or 24 tonnes per year (the allowable fraction taken from column 2 of Table 1).

The facility's two possible VOC emission performance targets would be either 25 or 24 tonnes per year. Like the case in Appendix C, Example 3, the VOC emission limit (25 tonnes per year) is the greater rate and it stays the applicable VOC emission performance target.

Determining conformance is again straight forward (refer to Appendix D, Example 3):

Litho 1	**Ink**			
	Retention in Substrate	20	0.07	1.4
	Dampening System	24	1.0	24.0
	Coatings			
	Retention in Substrate	20	0.07	1.4
	Cleaning Materials	16	1.0	16
		-----		-----
Totals		80		42.8

Lulu Images Inc. would not be in conformance in these circumstances, i.e., calculated VOC emission rate of 42.8 tonnes per year exceeds its VOC emission performance target of 25 tonnes per year.

The facility currently uses 20 percent IPA in its fountain solution. After talking to its supplier, the facility believes it can reduce the amount of IPA to 5 percent. To check if this would bring the facility into conformance, the following calculation was made:

Appendix E Examples of Modification and Expansion Calculations (Continued)

Litho 1	**Ink**			
	Retention in Substrate	20	0.07	1.4
	Dampening System	24	1 - ((20-5)/20)	6.0
			E Factor = 0.25	
	Coatings			
	Retention in Substrate	20	0.07	1.4
	Cleaning Materials	16	1.0	16
		---		---
Totals		80		24.8

This would bring the facility into conformance and Lulu Images Inc. decides to expand its operation.

Appendix F Characteristics of Management Systems

Management systems are established to enhance the ability of an organization to continuously anticipate, assess and manage risks for the maximum benefit of that organization. They require that clearly stated policies and programs are in place and functioning to continuously evaluate all possible events throughout the entire life-cycle of its processes, that there is accountability and a commitment within the organization to ensure that decisions and necessary actions are actually carried out, and that there is adequate resourcing available to ensure that any identified short-comings are corrected expeditiously.

The Canadian Standards Association has published a document, *Z750 - 94 A Voluntary Environmental Management System*, intended to provide general guidance to business, industry and other organizations on the development and implementation of environmental management systems. It includes environmental management system definitions, principles and other important elements.

The design of environmental management systems should emphasize a systematic approach for:

(a) identifying the significant environmental effects arising from the organization's past, existing or proposed activities, products or services;

(b) identifying the environmental effects arising from incidents, accidents, and potential emergency situations;

(c) identifying the applicable laws, regulations and relevant industrial standards;

(d) rectifying priorities that have been identified through environmental objectives and targets;

(e) facilitating corrective action, process improvement, systems auditing and review activities to ensure both that the policy is complied with and that it remains relevant; and

(f) establishing and updating operational processes and procedures.

It should be based on the following four principles:

- an organization should focus on what needs to be done - it should have a **purpose**;
- people in the organization should have the **commitment** to take the appropriate action;
- the organization should have the **capability** of performing in support of its objectives;
- an organization should be continuously **learning** how to perform better in the pursuit of its objectives, and it should be continuously **learning** how to improve its own management and learning processes.

Appendix F Characteristics of Management Systems (Continued)

Experience has shown that the application of well thought out health, safety and environmental management systems is a good way of meeting both economic and environmental constraints. To be effective, these management systems should have a specified scope and should be capable of demonstrating that:

- the system is understood, effective and implemented;
- the performance criteria satisfy all applicable legal requirements as well as the health and environmental policies of the organization;
- the system is based primarily on prevention rather than correction after an incident; and
- the system is flexible and capable of simple modification and evolutionary change.

There is no "right" or "wrong" way for an individual company to develop management systems or to meet the intent of this Code. Approaches and management system details will vary from one company to another depending on local circumstances, the type of operations being carried out, specific product lines, geography and climate.

There are however certain characteristics of any management system that should be in place to ensure that the program is carried out efficiently and effectively.

The following characteristics are sufficiently generic so as to apply to systems for managing virtually any technical activity[14] :

Planning

Explicit Goals and Objectives
Well-Defined Scope
Clear-Cut Desired Outputs
Consideration of Alternate Achievement Mechanisms
Well-Defined Inputs and Resource Requirements
Identification of Needed Tools and Training

Organization

Strong Sponsorship
Clear Lines of Authority
Variance Procedures

[14] Extract from *Plant Guidelines for Technical Management of Chemical Process Safety*, published by the Centre for Chemical Process Safety of the American Institute of Chemical Engineers, 345 East 47th Street, New York, New York 10017 (1993).

Audit Mechanisms
Corrective Action Mechanisms

Appendix F Characteristics of Management Systems (Continued)

Organization (Continued)

Procedure Renewal and Reauthorization
Explicit Assignment of Roles and Responsibilities
Formal Procedures
Internal Coordination and Communication

Implementation

Detailed Work Plans
Specific Milestones for Accomplishments
Initiating Mechanisms

Control

Performance Standards and Measurement Methods
Checks and Balances
Performance Measurement and Reporting
Internal Reviews

The above list is not necessarily definitive. Not all features or characteristics may be needed in every specific situation. Exceptions and departures based on local circumstances are acceptable. Suggested changes and additions based on actual experience are to be encouraged.

Appendix G Referenced Test Methods

1. The following EPA Reference Methods are found in the U.S. Code of Federal Regulations Title 40, Part 60, Appendix A:

Method 24 -	Determination of Volatile Matter Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coatings
Method 24A -	Determination of Volatile Matter Content and Density of Printing Inks and Related Coatings
Method 25 -	Determination of Total Gaseous Nonmethane organic Emissions as Carbon
Method 25A -	Determination of Total Gaseous Nonmethane organic Emissions as Carbon (Low VOC Concentrations)

Note:

The application of test methods 25 and 25A should be consistent with the October 25, 1993 Guidance Document, issued by the U.S. EPA Office of Air Quality Planning and Standards, as Appendix B to *Alternate Control Techniques Document: Offset Lithographic Printing*, Report No. EPA-453/R-054, June 1994.

2. The SCAQMD Method for determining the VOC composite partial vapour pressure of a cleaning material is set out in Appendix A to *Alternate Control Techniques Document: Offset Lithographic Printing*, Report No. EPA-453/R-054, June 1994.

Appendix H Criteria for Total Enclosures

For an enclosure to be deemed to be a total enclosure, i.e., to have a capture efficiency of 100%, the enclosure should meet the following requirements:

(i) The enclosure should be under negative pressure so that air flow is inward at all openings at an average facial velocity of at least 1.02 m/s (200 fpm),

(ii) Any source of VOC emissions inside the enclosure should be at least one equivalent opening diameter from any opening.

Equivalent opening diameter is defined as the diameter of a circle having an area equal to the actual opening:

$$\text{Equivalent Opening Diameter} = 2\,(\text{Cross-sectional Area})^{1/2} \times (\pi^{-1/2})$$

(iii) All access doors and windows should be closed during routine operations.

(iv) The total area of the openings should be less than 5% of the interior surface area.

(v) All captured VOC should be exhausted to an emission control device.

(vi) For fire and safety reasons the VOC concentration inside the enclosure should be maintained below 25% of the VOC lower explosive limit (LEL).

(vii) If the enclosure is occupied during routine operation, then the VOC concentration inside the enclosure should also conform with relevant occupational health and safety limits.

Appendix I General Capture and Control Guidelines

(i) Local collection systems include floor sweeps, hoods, slotted ducts and partial enclosures.

(ii) Local ventilation systems should be placed (if possible) away from sources of external turbulence which include: thermal air currents, machinery motion, material motion, room air currents and spot cooling and heating of equipment.

(iii) Heavy plastic sheeting may be hung to shroud local sources if it introduces no fire hazard. Turbulence around hoods can also be minimized by using flanged or bell-mouthed hood openings. These also reduce pressure drops at entrances.

(iv) Capture velocity should be selected to overcome the effect of turbulence while maximizing the collection of VOC emissions, minimizing the dilution air and maintaining an adequate ventilation rate in the work space. Recommended design values of capture velocity are available from the American Conference of Government Industrial Hygienists in the Industrial Ventilation manual and are reproduced in the following Table.

Range of Capture Velocities

Condition of Dispersion of Contaminant	**Capture Velocity m/s**	**(fpm)**
Released with little velocity into quiet air	0.25-0.51	(50-100)
Released at low velocity into moderately still air	0.51-1.02	(100-200)
Active generation into zone of rapid air motion	1.02-2.54	(200-500)
Released at high initial velocity into zone of rapid air motion	2.54-10.2	(500-2000)

The distance between the emission source and the capture device should be minimized. The air flow should be over the operator, over the VOC source and into the close capture hood.

Local exhaust collection systems should meet the requirement of the American Conference of Governmental Industrial Hygienists and the Sheet Metal and Air Conditioning Contractors National Association Guidelines.

Appendix J Interpretation Guidelines

I. Purpose

These guidelines explain in plain language the intent and requirements of the Code, and will help companies to determine what they need to do to meet these requirements.

II. How does the Code address my sector?

The Environmental Code of Practice was drafted:

1. to focus attention on the major and most significant VOC emission sources;

2. to ensure full recognition of recent pollution prevention measures;

3. to minimize expensive sampling and testing;

4. to facilitate long range planning through predictable emission limit changes in cases where a facility is modified or expanded;

5. to encourage the most cost-effective measures to be adopted within a facility. Emission limits include emissions from in-line coating and varnishing operations within a facility and are based on the facility as a whole rather than individual printing presses, i.e., the bubble concept. This encourages the use of common abatement equipment, e.g., incinerators, and provides the operator with the maximum flexibility possible.

To accomplish this:

1. Each facility establishes for each year a baseline uncontrolled VOC amount based on potential VOC emissions from raw materials entering the facility. This net uncontrolled VOC amount is then allocated among the different presses in a facility and the various raw material components associated with each press.

2. Two possible emission performance targets are set out in the Code as a function of printing press type:

   (a) a 25 tonnes per year limit for the facility as a whole;

   or

   (b) a limit based on an allowable fraction of the facility's baseline uncontrolled VOC amount.

The VOC emission performance target established for a facility will be the greater of these two options and will depend on the relative size of the facility's operation as well as the type of the printing presses it contains.

This dual approach results in a "sliding scale" with respect to the reductions of potential emissions required for a facility to meet the Code. Large printing operations with high VOC emission potential will be required to reduce their emissions to a greater extent than smaller printers with relatively low emissions. This sliding scale concept is illustrated in Figure 1.

Very small printing shops with annual emissions below the upper tonnes per year limit will meet the Code without any change to their operations. Large operations with high emission levels will be required to reduce their emissions by a percentage based on currently available technology. Medium sized facilities, between these two extremes, should reduce their emissions on a sliding scale by a percentage sufficient to bring them below the upper tonnes per year limit established for the facility.

3. A facility may demonstrate conformance by either of two possible approaches:

(a) the conventional testing and monitoring approach;
or
(b) a calculation method.

For the latter option, emission factors are set out in the Code in Table form for various recognized control options. These are applied at the component level to reduce the uncontrolled baseline amounts. Provisions allow for the use of equivalent control options.

The sum of the reduced amounts is then compared with the VOC emission performance target for the facility to determine conformance.

III Does the CCME Code affect me?

The CCME Code applies to you if you operate a Commercial or Industrial Printing Plant for commercial purposes **unless**:

(a) the plant's three year rolling average uncontrolled VOC amount is less than 1,000 kilograms (1 tonne) per year; or
(b) plant activities involve manual or non-mechanized screen printing operations only.

The applicability of the Code, including its exemptions, is shown schematically in Figure 2 of this Guide. Specific definitions are contained in Section 2 of the Code.

IV How does the system work?

Baseline Calculations (Section 3 of the Code)

If a printer is not exempt he/she should calculate his/her baseline amounts. This is shown schematically in Figure 3 of this Guide.

Facilities that have not taken actions to reduce the VOCs contained in their raw materials during the period 1992 through 1997 should establish their baseline uncontrolled VOC amount according to Section 3.2.

However, if a facility has taken actions to reduce the VOCs contained in its raw materials during the period, it may be able to adjust its baseline amounts (Section 3.3) to take these actions into account.

To determine eligibility:

1. determine the facility's highest uncontrolled VOC amount for the past three years and the weight to weight ratio of this uncontrolled VOC amount to product output for that same year;

2. determine the weight to weight ratio of uncontrolled VOC amount to product output for all the other calendar years between 1992 and 1997;

3. compare the ratio determined in item 1 with those determined in item 2.

   If one or more of the ratios in item 2 is greater than the ratio in item 1, the facility is eligible to adjust its baseline amounts according to Section 3.3. If more than one ratio in item 2 exceeds the ratio in item 1, the highest ratio should be used for calculation purposes.

Once the facility's baseline uncontrolled VOC amount has been established, and before allocating the various categories of raw materials among various printing presses, small printers particularly should determine the applicable VOC emission limit for the facility (Subsection 4.1.1). If it can be demonstrated by mass balance or other practical means that the three year rolling average VOC emission rate is less than the facility's VOC emission limit, the printer is exempt from the requirement to allocate raw materials categories (Section 3.5).

In such a case, the facility is considered to be in conformance and need only retain the documentation and any calculations with the facility's records (Section 6). If not, a facility should proceed to allocate its raw materials according to Section 3.5.

A facility should review its baseline uncontrolled VOC amount annually and adjust the allocations if the baseline amounts have been revised (Section 3.12).

VOC Emission Performance Targets (Section 4 of the Code)

If a printer is not exempt he should calculate his VOC Emission Performance Target for the facility. This is shown schematically in Figure 4.

There are two possible VOC Emission Performance Targets for a facility, i.e., either an absolute VOC emission limit of 25 tonnes/year, not to be exceeded (Subsection 4.1.1), or an allowable fraction of the baseline uncontrolled VOC amount for the facility (Subsection 4.1.2). The applicable target is the greater of the two values.

The two possibilities result in a sliding scale which is illustrated in Figure 1. This dual approach ensures that no facility should release more than the applicable VOC Emission Limit (25 tonne per year) unless, because of its size, the larger limit, which is based on a percent reduction of uncontrolled VOC emissions and limited by available technology, is applicable.

Demonstrating Conformance (Section 5 of the Code)

If a printer is not exempt he should demonstrate conformance with the Code once a year at the end of the calendar year. This is shown schematically in Figure 5 of this Guide.

There are two possible approaches, i.e., either by conventional testing and monitoring or by calculation. If the testing and monitoring option is chosen, sampling and testing methods and protocols should be consistent with those identified in Section 7, and the fraction of the baseline uncontrolled VOC amount that is released should be determined according to Section 5.6.

If the calculation option is chosen, individual baseline VOC component amounts may be reduced according to Section 5.8, i.e., by multiplying them by the appropriate emission factor (Tables 2 through 5) where the applicable conditions contained in the Tables are met. Where more than one emission factor applies to a raw material category on a press they should be applied sequentially, with the emission factors associated with pollution prevention options (marked with an asterisk) being applied

first. The fraction of the baseline uncontrolled VOC amount deemed to be released is the sum of the reduced baseline VOC component values.

In the event that new or additional control options are used to reduce VOC emissions and these are not reflected in Tables 2 through 5, appropriate emission factors may be developed and applied with the consent of the responsible regulatory authority (Section 5.11). Similarly, if there is a dispute concerning the correctness of an emission factor in the Tables or to the application of the factor in a specific situation, by either the printer or the responsible regulatory authority, a new factor may be developed through testing and applied.

Finally, the fraction of the baseline uncontrolled VOC amount that is determined to be released by either the testing and monitoring or calculation approaches should be compared to the facility's VOC emission performance target to determine conformance. Documentation and any relevant calculations should be retained in the facility's records (Section 6).

Recommendations (Sections 8 through 15)

These Sections of the Code do not relate directly with the conformance issue. They simply provide recommendations on various aspects associated with the management of VOC containing materials in a printing operation. If adopted, these recommendations should contribute to cost-effectively reducing VOC emissions while maintaining a healthy workplace.

Figure 1: The Sliding Scale

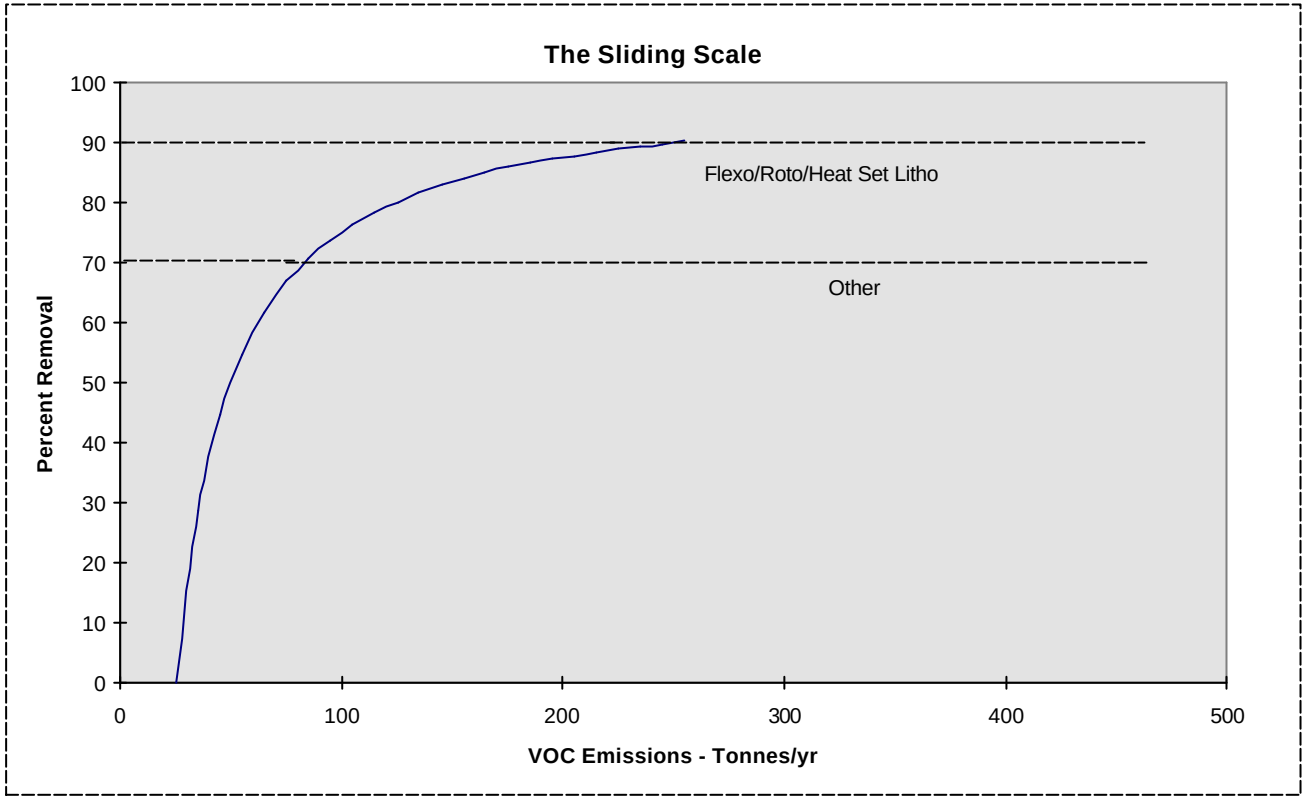


Figure 2: Applicability of Environmental Code of Practice

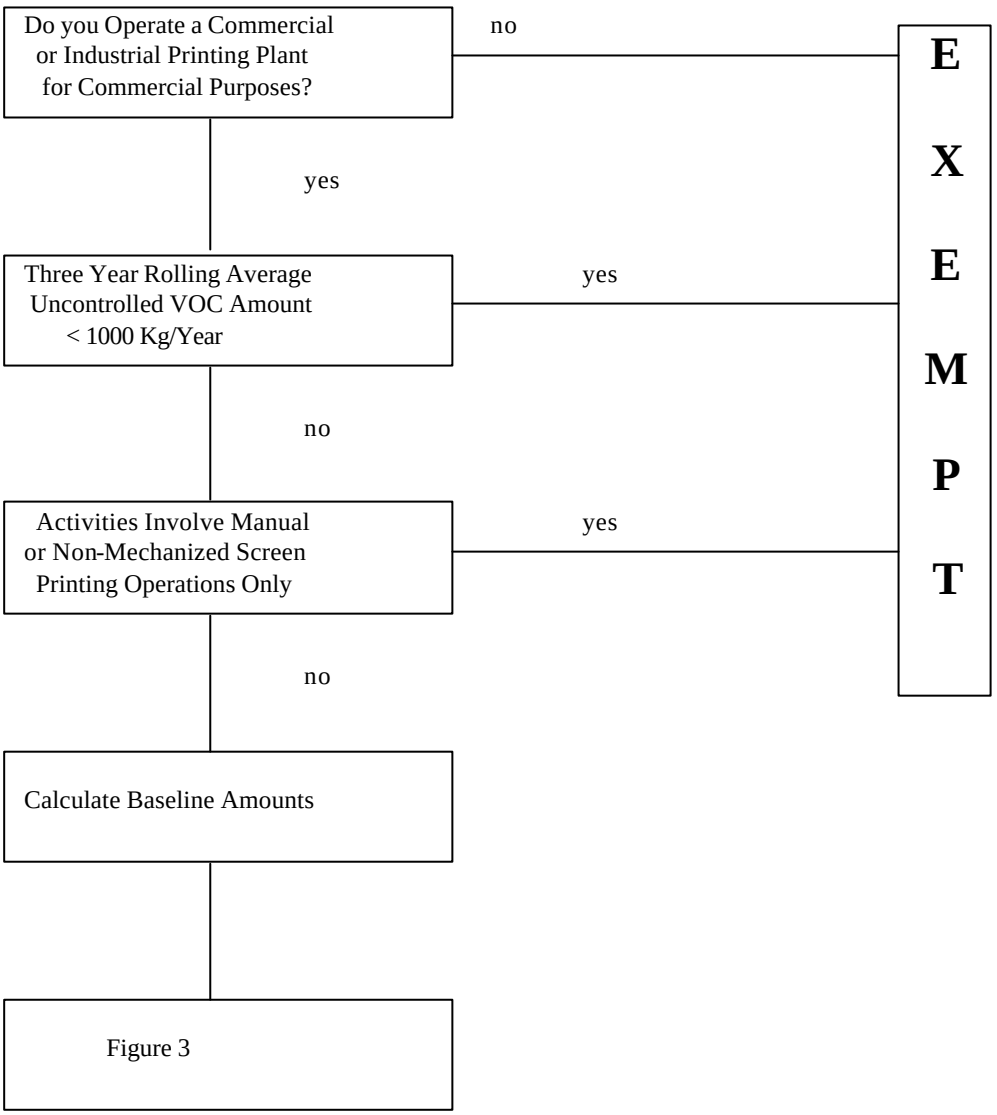


Figure 3: Baseline Calculations

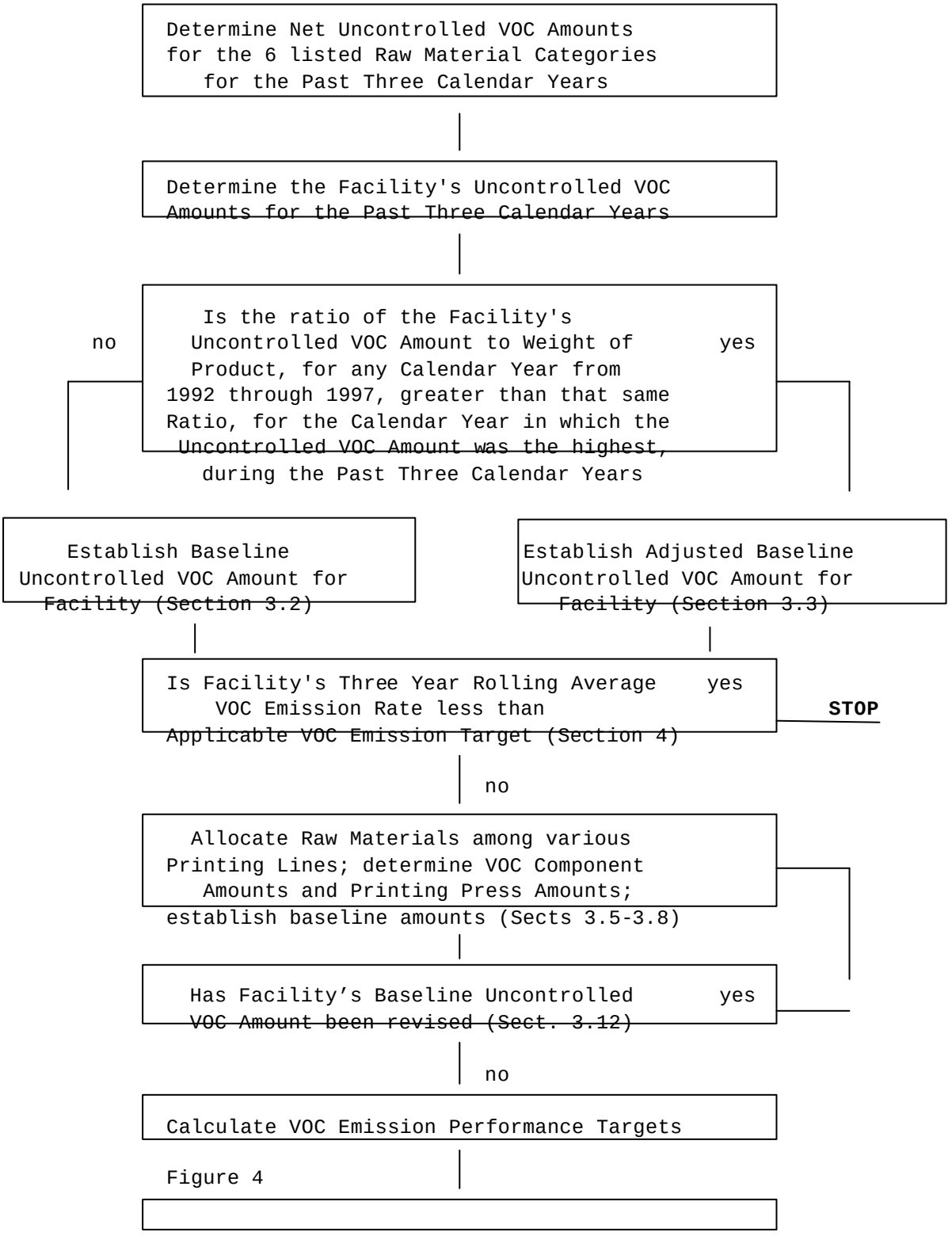


Figure 4

Figure 4: VOC Emission Performance Targets

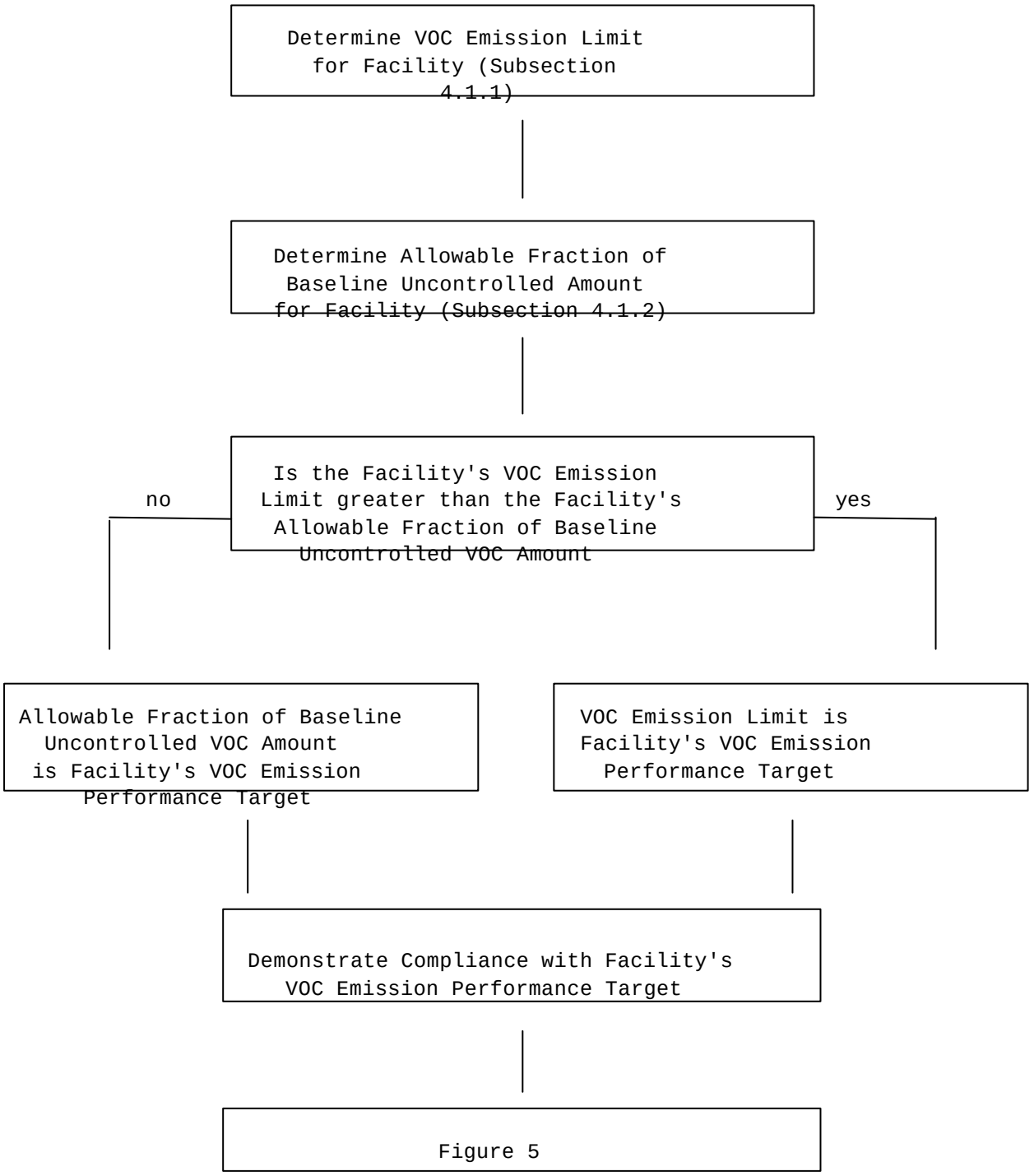
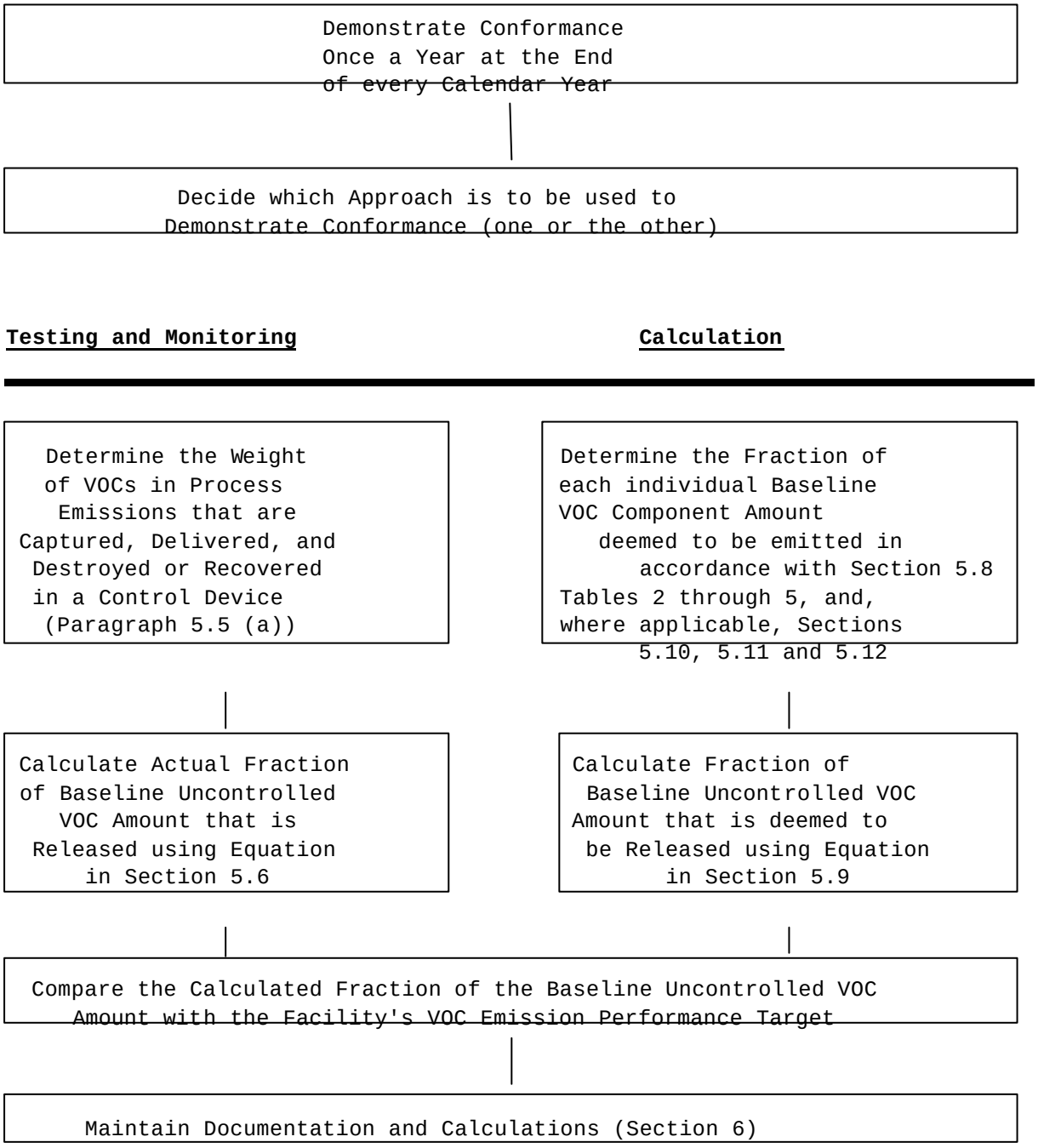


Figure 5: Demonstrating Compliance



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