CCME

Canadian Council of Ministers of the Environment

Le Conseil canadien des ministres de l'environnement

Guidelines for the reduction of VOC emissions in the wood furniture manufacturing sector

CCME MANAGEMENT PLAN
INITIATIVES V307 AND V612

PN 1336

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
Toll free (800) 805-3025
www.ccme.ca

ISBN : 1-896997-52-X

Ce document est aussi disponible en français.

Table of Contents

		Page
1.0	Introduction……	1
2.0	Definitions……..	2
3.0	Guidelines……...	10
3.1	Goals……...	10
3.2	Applicability……	10
3.3	Implementation……...	10
3.4	Standards…….	11
3.4.1	Coating Product Standard……...	11
3.4.2	Operating Standards…….	11
3.4.2.1	Application Equipment…….	11
3.4.2.2	Codes of Good Practices and Record Keeping…….	12
3.4.2.3	Operating Standard for New and Expanded Facilities……	12
Schedule 1 - Coating Product Standard……..		13
Schedule 2 - Application Equipment……		16
Schedule 3 - Record Keeping and Codes of Good Practice……..		17
Part 1: Record Keeping and Reporting……...		17
Part 2: Codes of Good Practice……..……		18
Solvent Management……		18
Training…….		19
Materials Handling…….		20
Equipment Operation, Maintenance and Cleaning……..		23
Check Lists for the Codes of Good Practices…...		26
Schedule 4 - List of Stakeholders…….		35

1.0 INTRODUCTION

Under initiative V307 of the 1990 Management Plan for NOx and VOCs (Phase 1 Plan) the Canadian Council of Ministers of the Environment (CCME) required new source performance standards and codes of practice or guidelines for the reduction of volatile organic compound (VOC) emissions from new commercial and industrial surface coating operations in Canada. Initiative V612 of the Phase 1 plan also indicated a requirement for similar guidance to support regional development and implementation of retrofit emission reductions for existing Canadian surface coating operations.

The overall goal of these Guidelines is to achieve a maximum reduction of VOC emissions from the wood furniture manufacturing sector in Canada while conforming to the principle of Best Available Technologies Economically Achievable (BATEA). The wood furniture manufacturing sector is comprised of wood furniture, kitchen cabinets and caskets. These Guidelines are meant to provide a basis for provincial and regional governments in developing management instruments – either regulatory or non-regulatory – to achieve their own specific VOC emission reduction objectives.

These Guidelines are a model set of requirements and only come into effect if adopted, in whole or in part, by an authority having jurisdiction. Where these guidelines have been adopted, in whole or in part, by an authority having jurisdiction, it shall be subject to any restrictions or conditions added by the regulatory authority. Readers of these Guidelines are therefore advised to check with federal, provincial, or territorial authority having jurisdiction to determine whether these Guidelines apply in their area of interest.

Two standards are proposed: a Product Standard and an Operating Standard. The Product Standard describes VOC content limits for coatings products. The Operating Standard has three components:

a) an Application Equipment Standard;
b) a Code of Good Practices, including record keeping and reporting requirements; and,
c) an Operating Standard for New and Expanded Facilities.

A large number of stakeholders from industry, governments and public interest groups were involved in the consultations that accompanied the development of these Guidelines. Participating stakeholders have given very generously of their time to attend workshops and to provide detailed feedback on draft guidelines. Their contribution is gratefully acknowledged.

2.0 DEFINITIONS

Air dried coatings	Coatings used at ordinary room conditions - a temperature of 60 to 80ºF with 40 to 60% relative humidity.
Applied solids	Coating solids that remain on the substrate being coated or painted after curing.
As applied	The condition of a coating after any dilution by the user just prior to application to the substrate. Refers to the VOC and solids content of the finishing material that is actually used for coating the substrate, and includes materials used for in-house dilution of the finishing material.
As supplied	The condition of a coating before dilution, as sold and delivered by the coating manufacturer to the user.
Capture device	A hood, enclosed room, floor sweep, or other means of collecting solvent emissions or other pollutants into a duct so that the pollutant can be directed to an emission control device such as an incinerator.
Cleaning operations	Operations in which organic solvent is used to remove coating materials from equipment used in wood furniture manufacturing operations.
Coating	A protective, decorative, or functional material applied in a thin layer to a surface. Such materials include, but are not limited to, paints, topcoats, varnishes, sealers, stains, wash coats, basecoats, inks, and temporary protective coatings.
Coating solids (or solids)	The part of the coating that remains after the coating is dried or cured; solids content is determined using data from EPA Method 24, or an alternative or equivalent method.
Control device	Any equipment that reduces the quantity of a pollutant that is emitted to the air. The device may destroy or secure the pollutant for subsequent recovery. Includes, but is not limited to, incinerators, carbon adsorbers, and condensers.
Control device efficiency	The ratio of the pollution released by a control device and the pollution introduced to the control device, expressed as a fraction.
Control efficiency	The efficiency of a control system, calculated as the product of the capture and control device efficiencies, expressed as a percentage.
Control system	The combination of capture and control devices used to reduce emissions to the atmosphere.

Conventional air spray	A spray coating method in which the coating is atomized by mixing it with compressed air at an air pressure greater than 10 pounds per square inch (gauge) at the point of atomization. Airless and air assisted airless spray technologies are not conventional air spray because the coating is not atomized by mixing it with compressed air. Electrostatic spray technology is also not considered conventional air spray because an electrostatic charge is employed to attract the coating to the work piece.
Curtain coating	A method of continuous coating in which the objects being coated pass through a falling sheet or «curtain» of coating material as produced by a curtain coating machine.
Dip coating	Application method in which an object is dipped into a container of coating and withdrawn. Excess coating that drains off can be collected and recycled. This method is used in factories to coat small, difficult to paint, or fabricated assemblies.
Drying	Process by which coatings change from a liquid to solid state due to evaporation of the solvent, physicochemical reactions of the binding medium, or a combination of these causes.
Electrostatic spray	A method of applying a spray coating in which an electrical charge is applied to the coating. The atomized coating is attracted to the object by the electrostatic potential between it and the object being coated.
Emission	The release or discharge, whether directly or indirectly, of VOC into the ambient air.
Equipment leak	Emissions of volatile organic compounds from pumps, valves, flanges, or other equipment used to transfer or apply finishing materials or organic solvents.
Expanded facility	An «expansion» means adding new capacity to a production line by some physical modification requiring capital investment. It does not refer to an increase in emissions resulting from taking advantage of existing capacity on a previously under-utilized line (i.e., it does not apply if an extra shift is added to an existing line). See also «Facility» and «New facility.»

Facility	A «facility» is defined as a wood manufacturing or Wood Finishing operation located in one building, or in a series of buildings located on one property, or in a series of buildings located on contiguous (adjacent) properties. See also «Expanded facility» and «New facility.»
Filler	A heavily pigmented product used to fill pores in wood. When applied, the solvent is usually allowed to evaporate, and the filler is wiped off, providing a smooth level surface.
Filling	Application of a highly pigmented coating (by brush or spray) from which the solvents are then allowed to evaporate following which the excess coating is then removed, usually by wiping off, leaving the product in the wood pores and providing a smooth, level surface.
Finish coats	See topcoats.
Finish coating	Application of one or more clear final coats, usually by spraying.
Finishing application station	The part of a finishing operation where the finishing material is applied, *e.g.* a spray booth.
Finishing material	A coating used in the wood furniture industry. For the wood furniture manufacturing industry, such materials include, but are not limited to, basecoats, stains, wash coats, sealers, and topcoats.
Finishing operation	Those activities in which a finishing material is applied to a substrate and is subsequently air-dried, cured in an oven, or cured by radiation.
Flash-off area	A structure on a finishing line between the coating application area (*e.g.* spray booth) and the curing area. Used to provide a degree of control of the evaporation rate of solvents from the applied, uncured film.
Flow coating	A method of coating in which the object passes through a series of nozzles which flood the object with the coating, the excess draining off and returned to the reservoir for re-use.
Forced drying	Accelerated drying achieved by increasing the temperature above ambient, and circulating the heated air onto or near the coated surface.

Glaze	A pigmented, coloured coating applied after the sealer, for specific color effects. Often partly wiped off to provide an antiquing effect.
Glazing	Application of a coloured coating, usually by spraying. Often wiped off from some areas, to achieve specific colour effects.
Ground coat	A coat of coloured material, usually opaque, that is applied before graining inks, glazing coats, or other opaque finishing materials, and which is usually top coated for protection.
High solids coating	A coating with more solids than volatile content. Sixty percent solids sometimes is used as a benchmark measurement, at or beyond which a coating is said to be high solids.
Incinerator	For the purposes of this industry, an enclosed combustion device that thermally oxidizes volatile organic compounds. This term does not include devices that burn municipal or hazardous waste material.
Ink	A fluid containing dyes and/or coloring that is used to make markings (such as imitation wood grain) but not to protect surfaces.
Lacquer topcoat	Defined as a clear coating which dries solely by evaporation of solvent, with no subsequent polymerization occurring by oxidation or other chemical reaction. This therefore excludes catalyzed lacquers.
New facility	A facility manufacturing wood products and/or involved in the coating of wood products that begins operations after January 1, 2004. See also «Facility» and «Expanded facility.»
Non-volatile content	The portion of a coating that does not evaporate during drying or curing under specified conditions, comprising the binder and, if present, the pigment.
Permanent total enclosure	A permanently installed enclosure that completely surrounds a source of emissions such that all emissions are captured and contained for discharge through a control device.

Prime coat operation	The prime coat spray booth or dip tank, drain/flash-off area and bake oven(s) used to apply and cure the prime coat.
Primer	The first organic coating applied to the cleaned and pre-treated surface of the part.
Pigmented Primer	Opaque coatings which contain coloured pigments formulated to hide the wood surface, and are applied prior to the topcoat to provide a firm bond, and to level or seal the wood product surface.
Purge	The coating and associated purging material expelled from the spray system when clearing it. Done when changing colour or to maintain the cleanliness of the spray system.
Purge capture	The capture of purge immediately after use in purging the system (to prevent the release of VOCs). Includes the disposal of the captured purge material.
Radiation cured coating	A coating formulated so that the curing reaction is produced by projecting electromagnetic radiation (ultraviolet, visible, or infrared light) onto the uncured coating after application.
Repairs	Operations where coatings are applied to rectify defects in the finish. May be cured in the same way as the original finish, or cured at a lower temperature. May use different or modified versions of the original coating. Activities where coatings are applied to rectify defects in the finish. See «Touch-up.»
Roll Coating	A method of continuous coating in which objects being coated pass in contact with a roll which transfers a layer of coating to it. Analogous to certain sheet metal and printing processes such as coil coating and flexography respectively.
Sealer	A thin coating applied to the substrate to prevent penetration of subsequent coats. May be applied over stains and fillers and be modified to improve sanding. Wash coats, which are used in some finishing systems to optimize aesthetics, are not sealers.
Sealing	Application of a clear coating to seal the substrate, usually by spraying to permit sanding and/or the application of additional coloured coatings such as glazes and toners.
Solids	Nonvolatile matter in a coating composition; the ingredients of a coating composition that, after drying, are left behind and form the dry film.

Solvent	A liquid used in a coating for dissolving or dispersing constituents in a coating, adjusting the viscosity of a coating, cleaning, or wash off. When used in a coating, it evaporates during drying and does not become a part of the dried film.
Solvent cleaning operation	Operations used to remove uncured coating or contaminants such as soil, grease or lubricants from parts, products, tools, machinery, equipment and general work areas.
Solvent-borne coating	One which contains 5% or less water as the volatile constituent, the remainder being organic solvent.
Spray application	A method of applying coatings by atomizing the coating material and directing the atomized particles toward the part to be coated. Can be used for all coating operations. Atomization can be caused by air jets (conventional spray or HVLP), high pressure (airless spray) or by centrifugal force (bells or disks). Electrostatic charges can be used to improve transfer efficiency with all methods but is an integral and essential element for application with centrifugal atomization.
Spray booth	A structure housing automatic or manual spray application equipment for coating operations by this method. Includes facilities for the capture and entrapment of particulate overspray.
Stain	Any color coat having a solids content by weight of no more than 8.0 percent that is applied in single or multiple coats directly to the substrate. Includes, but is not limited to, non-grain-raising stains, equalizer stains, sap stains, body stains, no-wipe stains, penetrating stains, and toners.
Staining	Application of a dye solution or pigment-containing solution, usually by spraying, to achieve certain colour effects. The solutions may or may not have film-forming properties.
Storage containers	Vessels or tanks, including mix equipment, used to hold finishing, cleaning, or wash off materials.
Substrate	The surface onto which coatings are applied.
Substrate pre-cleaning	Removal of oils and greases by means of solvents, usually by a manual wiping operation.

Surface coating operation	Any operation involving the application of a coating application product *e.g.,* stains, fillers, sealers, finish coats.
Thinner	A volatile liquid that is used to dilute coatings. Used to reduce viscosity, color strength, and solids, or to modify drying conditions.
Toners	Coloured coatings applied prior to the finish coats to provide specific colour effects such as shading or uniformity of colour desired to offset natural variations in the colour of the wood.
Toning	Application of a coloured coating, usually by spraying, to achieve specific colour effects.
Topcoat	The final coatings applied to provide the final colour, sheen and/or protective surface. Same as finish coat. See also «lacquer topcoat.»
Total Potential Emissions	The total weight of VOCs that are purchased by the establishment in one year based on the VOC content of coatings, diluents, and cleaners.
Touch-up	The application of finishing materials to cover minor finishing imperfections. See «Repairs.»
Transfer efficiency	The ratio of the amount of coatings solids transferred to the surface of the body or part to the total amount of coating solids used in the operation.
Volatile Organic Compound (VOC)	Volatile organic compounds as defined in the *Order Adding Toxic Substances to Schedule I to the Canadian Environmental Protection Act (1999),* published in the *Canada Gazette, Part I,* Vol. 136 (Ottawa, Saturday, July 27, 2002). *(When under press, the VOC definition was as follows: VOCs that participate in atmospheric photochemical reactions, excluding, for example, acetone, methane, ethane, methyl chloroform, methylene chloride, parachlorobenzotrifluoride (PCTBF), chlorofluorocarbons (CFCs), fluorocarbons (FCs), hydrochlorofluorocarbons (HCFCs)).*
Volatile Organic Compound content (standard)	For the purposes of this Standard, «VOC content (standard)» is defined as «the mass of VOC (in grams) per litre of coating as applied, less water and exempt solvents.» (Calculated as described in Schedule 1, Equation 1.)

Volatile Organic Compound content (actual)	For the purposes of this Standard, «VOC content (actual)» is defined as «the mass of VOC (in grams) per litre of coating as applied.» (Calculated as described in Schedule 3, Equation 2.)
Volume Solids	The proportion of a volume of coating which is not volatile and constitutes the actual final coating remaining on the surface after application and curing.
Wash coat	A thin clear coating, often a thinned version of the finish coat, usually applied as a first film forming coating to prevent subsequent coatings from affecting the surface or to protect prior staining of the wood.
Wash coating	Application of a very thin or dilute coating, usually by spraying, and which acts as a barrier coating for performance or aesthetic reasons.
Water reducible coating	A coating that, as applied, contains more than 5% of its volatile fraction as water. May contain less than 5% water as supplied.
Water-borne coating	One which, as supplied and applied, contains more than 5% of its volatile fraction as water.
Wood finishing	Any one or a combination of the following operations: staining, wash coating, filling, sealing, toning, glazing, finish coating, purging, repairs and facility/equipment cleaning.
Wood furniture	Any furniture product made of wood, rattan or wicker, including kitchen cabinets and caskets, but excluding flat stock, flooring, panelling, windows and doors. Non-wooden (*e.g.,* metal or plastic) furniture parts are excluded from the definition for the purposes of this Standard.
Wood furniture component	Any part that is used in the manufacture of wood furniture. Examples include, but are not limited to, drawer sides, cabinet doors, seat cushions, and laminated tops.

3.0 GUIDELINES

3.1 GOALS

The overall goal of these Guidelines is to achieve a maximum reduction of VOC emissions from the wood furniture manufacturing sector in Canada while conforming to the principle of Best Available Technologies Economically Achievable (BATEA). These Guidelines are meant to provide a basis for provincial and regional governments in developing management instruments – either regulatory or non-regulatory – to achieve their own specific VOC emission reduction objectives.[1]

3.2 APPLICABILITY

These Guidelines are intended to apply both to new and existing facilities and are intended to apply to all facilities where coatings are applied to wood furniture products. The Guidelines apply to the following operations:

- Substrate pre-cleaning
- Staining
- Wash coating
- Filling
- Sealing
- Toning
- Glazing
- Finish coating
- Purge
- Repairs
- Facility/equipment cleaning

3.3 IMPLEMENTATION

These Guidelines will come into effect when adopted by an authority having jurisdiction.

[1] For example, Ontario's stated VOC reduction objective of 45% based on 1990 levels by the year 2010.

3.4 STANDARDS

In order to meet the goals outlined in Section 3.1, two standards are proposed:

1. a Product Standard; and,
2. an Operating Standard.

The Product Standard describes VOC content limits for coatings products. The Operating Standard has three components:

a) an Application Equipment Standard;
b) a Code of Good Practices (including record keeping and reporting requirements); and,
c) an Operating Standard for New and Expanded Facilities.

Alternatively, rather than complying with the Product and Operating Standards, wood furniture manufacturing facilities may achieve VOC emission reductions using pollution control (abatement) technologies. Although this approach is not typical in this industry, it should be clear that this remains an option available at the facility's discretion. Facilities choosing this method of reducing VOC emissions must demonstrate to the appropriate government authorities that the level of capture and control meets or exceeds the level of VOC emission reduction that would be achieved by complying with the Product and Operating Standards.

3.4.1 COATING PRODUCT STANDARD

Users of coatings for wood furniture shall limit the VOC content, as applied, of each coating for use in Canada as stated in Schedule 1. The VOC content shall be calculated as described in Schedule 1.

3.4.2 OPERATING STANDARDS

3.4.2.1 APPLICATION EQUIPMENT STANDARD

All facilities applying coatings to wood furniture in Canada shall adhere to the Application Equipment Standard specification described in Schedule 2.

3.4.2.2 CODES OF GOOD PRACTICES AND RECORD KEEPING

All facilities applying coatings to wood furniture in Canada shall adhere to the Codes of Good Practices and record keeping/reporting provisions specified in Schedule 3.

3.4.2.3 OPERATING STANDARD FOR NEW AND EXPANDED FACILITIES

All new and expanded facilities (as defined in Section A-1.0) must demonstrate to provincial and/or municipal authorities that they have fully considered and exploited pollution prevention opportunities, that is, opportunities for technological options and process efficiencies that would lead to further VOC reductions. These options could include, but are not limited to, one or a combination of:

- water-based coatings;
- UV-based coatings
- high-solids coatings;
- high-efficiency application technologies (*e.g.,* electrostatic spray coating);
- taking advantage of opportunities to use higher efficiency coating techniques for pre-treating two-dimensional wood furniture parts prior to assembly (knock-down furniture);
- process efficiencies to reduce the use of solvents and/or coatings;[2] or,
- solvent recovery practices.

The procedure for demonstrating whether such pollution prevention opportunities have been adequately considered and/or implemented will be established by the respective jurisdictions. In the case of provincial governments, this could be made a part of Certificate of Approval requirements for the new or expanded facilities.

[2] Facilities could conceivably include as part of their demonstration to government representatives, details of the development and implementation of an Environmental Management System (EMS), such as under ISO 14000 certification, or participation in a pollution prevention program such as Enviroclub^{OM} (available in Quebec).

SCHEDULE 1 - COATING PRODUCT STANDARD

Table 1 provides maximum VOC contents for categories of coating products, as applied.[3] The limits are calculated using the methods described below, which adjust for the amount of volatiles that are not considered VOCs (*i.e.,* exempted solvents and water). See definitions in Section 2.0.

Table 1: VOC Product Content Limits

Wood furniture, kitchen cabinets and caskets

Coating type	**VOC Content (g/L as applied)**
Wash coat	730
Semi-transparent stains	760
Non-Grain-Raising (NGR) stains	780
Glazes	760
Fillers	480
Clear sealers	670
Pigmented coatings	600
Clear topcoats	670
Lacquer topcoats[4]	780
All other coatings	780

Calculation of VOC Content

The coating products subject to VOC content limits are defined «as applied». In many instances this is not «as supplied». The primary product may be adjusted for:

1. viscosity, by the addition of VOC-containing reducers to render it suitable for application,
2. cure or performance, by the addition of a second component or cross-linker, or
3. both.

[3] Not to be calculated as a weighted average, but rather, applicable to all coatings.

[4] Defined as a clear coating which dries solely by evaporation of solvent, with no subsequent polymerization occuring by oxidation or other chemical reaction. This therefore excludes catalyzed lacquers.

To determine compliance, the VOC content of the product is calculated after all reducers and components are incorporated into the product according to the coating product manufacturer's specifications.

For the purposes of this Standard, «VOC content» is defined as «the mass of VOC (in grams) per litre of coating as applied, less water and exempt solvents.». To determine whether the content limits in Table 1 are met, the VOC content of the coating product as applied must be calculated using Equation 1.

Equation 1

$$VOC_{STANDARD} = \frac{W_{VOL} - W_{EX} - W_W}{1 - V_{EX} - V_W}$$

where,

$VOC_{STANDARD}$	is the mass of VOC (in grams) per unit volume of coating product as applied, less water and exempt solvents.
W_{VOL}	is the total weight of volatile material per litre of coating product as applied, in grams.
W_{EX}	is the weight of exempt volatile material per litre of coating product as applied, in grams.
W_W	is the weight of water per litre of coating product as applied, in grams.
V_{EX}	is the volume of exempt volatile material per litre of coating product as applied, in litres.
V_W	is the volume of water per litre of coating product as applied, in litres.

Note that the Equation 1 does not apply to coatings that contain reactive diluents, as is the case in UV-curable coatings. In these cases the VOC content of the coating is determined after curing (*i.e.,* after reaction) as described in U.S. EPA Reference Method 24[5].

[5] Code of Federal Regulations Title 40, Part 60, Appendix A

The VOC content of the coatings may be determined by the user based upon the product formulation information for the product as supplied, as provided by the supplier. The values to be used in Equation 1 must take into account the addition of thinners and other (VOC and/or exempt) additives to make up the coating product as applied.

The VOC content may also be determined using U.S. EPA Reference Method 24 to obtain the input values for Equation 1.

ASTM Standard D-3690-92[6] may be used to determine the VOC content less water and exempt solvents. This Standard uses the same approach described above, *i.e.,* it uses an equation that is essentially the same as Equation 1 (*i.e.,* expressed in different terms, but mathematically equivalent).

[6] ASTM D3960, *Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings*.

SCHEDULE 2 - APPLICATION EQUIPMENT

This standard prohibits the use of conventional air spray equipment in industrial finishing of newly manufactured wood products, with the following exception. Conventional air atomized application equipment is permitted for repair work, touch-up or other special uses provided the total annual quantity of coating applied in this manner does not exceed more than 5% of the total coatings used in the facility in the 12 month period. Wood finishing operations primarily involved in the repair and restoration of wood products are exempt from this Schedule.

SCHEDULE 3 - RECORD KEEPING AND CODES OF GOOD PRACTICE

This Schedule is divided into two parts, the first dealing with specific record keeping and reporting requirements, and the second dealing with best practices in general.

PART 1: RECORD KEEPING AND REPORTING

Canadian wood finishing facilities must keep the records described below on a monthly basis, using information from wood finishing product purchases and in-house inventories. This information shall be provided to federal, provincial or municipal government authorities upon request. Records for a particular year shall be maintained for at least three years after the end of that year.

Facilities shall maintain the following records on a monthly basis:

- volumes of each wood finishing product used;
- the VOC content of each wood finishing product used;
- volumes of added solvent; and,
- any other relevant information on solvent use, such as for cleaning operations.

For record keeping purposes, the VOC content of the coating product as applied must be calculated using Equation 2.

Equation 2

$$VOC_{ACTUAL} = \frac{W_{VOL} - W_{EX} - W_W}{V_T}$$

where,

VOC_{ACTUAL}	is the mass of VOC (in grams) per total unit volume of coating product as applied.
W_{VOL}	is the total weight of volatile material (VOC + water + exempt volatile material) of coating product as applied, in grams.
W_{EX}	is the weight of exempt volatile material of coating product as applied, in grams.
W_W	is the weight of water of coating product as applied, in grams.
V_T	is the total volume of coating product as applied, in litres.

PART 2: CODES OF GOOD PRACTICE

Previous studies have shown that good operating practices can provide significant reductions in VOC emissions. In addition to the reduction of VOC emissions, the practices can also result in material and waste disposal cost savings.

Wood manufacturing facilities must not only develop appropriate Codes of Good Practice, they must also develop and document procedures for implementing them as part of standard work practice. The Work Practice Implementation Plan is a document that describes a number of tasks specific to the storage, handling and application of materials. The plan must be onsite for review and include the following:

- Operator training course
- Material storage and handling plan
- Equipment operation, maintenance and cleaning plan

The Codes of Good Practice is comprised of four distinct elements:

1. Solvent Management;
2. Training;
3. Materials Handling; and
4. Equipment Operation, Maintenance and Cleaning.

Each of these four elements is an important and integral part of the Code of Good Practice and an effective program to minimize fugitive VOC emissions cannot be achieved if any one is ignored.

SOLVENT MANAGEMENT

The application of well thought-out health, safety and environmental management systems is an integral part of a program to achieve VOC reduction objectives in an effective and efficient way. These management systems shall have a specified scope and be capable of demonstrating the following:

- 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 modification and evolutionary change.

Certain characteristics of any management system must 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 and in particular to solvent management systems:

1. Planning
    a) Explicit goals and objectives
    b) Well-defined scope
    c) Well defined inputs and resource requirements
    d) Identification of needed tools and training

2. Organization
    a) Clear lines of authority and explicit assignment of roles, responsibilities
    b) Variance procedures and audit mechanisms
    c) Corrective action mechanisms
    d) Formal procedures

3. Implementation
    a) Detailed work plans
    b) Specific milestones for accomplishments
    c) Initiating mechanisms

4. Control
    a) Performance standards and measurement methods
    b) Performance measurement and reporting
    c) Checks and balances
    d) Internal reviews

Not all features or characteristics may be needed in every specific situation. Exceptions and departures based on local circumstances are acceptable and suggested changes and additions based on actual experience are to be encouraged.

TRAINING

The VOC emissions generated outside of the primary coating operations are comparatively small. Further, they arise from a variety of sources and operations, some of which may not be recognized for their contribution to the VOC emission pool. All personnel involved in these operations shall be made aware of this contribution and the need to reduce or eliminate it wherever possible. This can

best be accomplished by a comprehensive and effective training of supervisory and operating personnel.

Training must therefore be provided to personnel in the following areas commensurate with their specific responsibilities:

1. The theory, characteristics and value of solvent management systems;
2. Applicable health, safety and environmental laws and regulations including those governing labeling, spills, emergencies and reporting and waste handling and disposal;
3. All applicable aspects of this Code of Good Practice including:
    a) Equipment and operating standards,
    b) Solvent storage and handling,
    c) Waste handling and disposal,
    d) Record keeping,
    e) Test methods; and,
4. All applicable operating procedures and standards including:
    a) Normal operations including daily check lists,
    b) Routine maintenance,
    c) Solvent conservation and maintenance,
    d) Cleaning and maintaining equipment including safety,
    e) Procedures and entry requirements,
    f) Containment and recovery of spills,
    g) Handling and disposal of wastes,
    h) Equipment start-up, shut down and emergency responses,
    i) Test methods and procedures,
    j) Use of personal protective and monitoring equipment, and
    k) Intent and benefits of following this Code of Good Practice.

MATERIALS HANDLING

Returnable Containers

Totes

- Totes, during transportation and while in storage, shall be completely sealed to avoid the possibility of fugitive emissions of Volatile Organic Compounds (VOCs) into the atmosphere.

- During the transfer of the materials in totes to the circulation system tanks or into later storage vessels, a small ventilation opening must be utilized to prevent the creation of a vacuum in the container. Failure to do so could result in only partial emptying of the container and result in unexpected large spillage when the transferring operation is thought to be complete and the tote is disconnected. As a precaution against this eventuality and to avoid even small losses in this way, the tote valve shall be secured in the closed position before disconnection. Immediately after this has been done, the lids and vents on the tote shall be tightly closed to prevent any subsequent escape of VOCs from the container.
- Lids, vents and other openings shall be designed to eliminate the possibility of leaking during the return transportation.
- Totes shall be shipped back to the materials supplier or a qualified processor of such empty containers for cleaning and re-use.
- By prior agreement a small amount of solvent (or de-ionized water as appropriate) must be added to the totes before their return for cleaning. This step will ensure that only a minimum quantity of cleaner (probably also a VOC) is required for the cleaning operation by preventing the drying of paint to the inside walls, valves and other fittings. Care must be taken to control the amount of solvent added for this purpose to ensure that the classification of the container as "Empty" is not affected.

Drums

- All paint drums arriving at the plant shall be returnable and re-usable where feasible and appropriate to the manufacturer's handling requirements.
- During transfer operations analogous to those described above for totes, the ventilation bung may be removed but should be securely replaced immediately thereafter.
- If it is necessary, because of system design, to remove the lid for access to the material, *e.g.* for viscosity adjustment or pumping, the open drum shall be covered with a flexible covering in such a way as to minimize VOC losses to the atmosphere. The lids shall be carefully stored in the interim to ensure that they are not inadvertently damaged during this period and that they are used to reseal the container when empty.
- Steps shall be taken to make certain that the empty drums are tightly closed, and all bungs replaced to avoid possible fugitive emissions during the return to the supplier or drum cleaner.

Non-Returnable Containers

- All full and part full non-returnable containers shall be shipped and stored with lids and other openings sealed air tight.
- Handling during transfer operations to mixing or circulating tanks shall be done, as closely as possible, in the same way as returnable containers.
- If any thinning is required, at least a portion of the required solvent shall be added to the just emptied container to assist in minimizing any residual material. The solvent/paint mixture shall then be added to the material just removed.
- After emptying, the non-returnable container shall immediately be processed by approved methods as waste or hazardous waste as appropriate to the residues, if any, remaining in the container.
- The use of non-returnable containers shall be reduced or, if possible, be discontinued, to the extent feasible and appropriate to the materials handling procedures in use at the coating facility.

Mix Tanks

- In paint mix rooms, all mixing tanks shall be kept tightly closed except when required for additions or sampling. Sampling tubes should be fitted if possible to minimize the need to open the vessel.
- All tank lid gaskets shall be on a regular inspection schedule to ensure proper sealing. Defective or damaged seals shall be replaced promptly.
- Tanks shall be vented through a flame arrestor/conservation vent combination. At installations where vent pipes are interconnected between mix tanks, tanks not in use shall be kept with lids and other openings securely closed.

Bulk-Storage Tanks

- Bulk-storage tanks containing paint, solvents, purge materials and holding tanks for wastes shall be totally enclosed systems.
- Ventilation should be through flame arrestor/conservation vents. Vent pipes from each tank shall be independent of those from other tanks. Interconnection between tanks is not recommended.
- Fill lines shall enter tanks from the top only to prevent accidental leakage and spills.
- Transfer pumps, filters, metering devices, valves, *etc.* shall be periodically inspected under regularly scheduled maintenance. Any devices found to be defective or suspect shall be repaired immediately.

Application Equipment, Baking Equipments and Abatement Equipment
The operation of application equipment, baking and force dry equipment and of abatement equipment such as booth controls, ovens afterburners must include:

- Written procedures for the proper operation of the equipment,
- Training of employees in the operation and monitoring of the equipment used,
- All necessary test equipment required for setting and monitoring the proper operation of the equipment,
- Record keeping procedures,
- Monitoring of the operation of the equipment and of the records kept, and
- Periodic retraining and review of procedures.

EQUIPMENT OPERATION, MAINTENANCE AND CLEANING

Paint System Flushing
Paint circulating systems must, of necessity, be cleaned periodically. The frequency of cleaning, a costly operation which can generate significant quantities of solvent to be recycled, can be reduced by keeping the system well balanced. A well balanced system keeps paint settling to a minimum and thus reduces the creation of dirt, a major quality problem for paint finishes. When system flushing does become necessary, cleaning agents shall be carefully selected for minimum VOC content, lowest photochemical reactivity while still remaining effective. The coatings supplier should recommend the cleaning solution composition keeping all of the above three factors in mind.

- As an initial step, as much old paint as possible from the circulating lines shall be blown back using compressed air and if necessary solvent. The returned paint shall be blown back into totes, tankers or waste storage tanks.
- Transfer of flushing solvents into mix tanks, and paint circulating systems shall be done through completely sealed piping and/or hose arrangements to avoid fugitive VOC emissions.
- All tank lids and other openings in the system except flame arrestor/conservation vents shall be closed during the circulation of solvents.
- Used flushed paint and paint/flushing solvent mixtures shall be pumped into transportable sealable containers and sent for reclamation and reuse.
- Although the circulating system itself is a totally enclosed system, VOCs can be released during the blowback operation. As a preventative measure, therefore, the mix tanks or paint lines shall be emptied at the same rate as paint or solvents are returned from the circulating system.

Mix Tanks

Paint deposits can build up on the insides of mix tanks above the usual liquid level.

- Heavy paint deposits on inside tank walls shall be manually removed by scraping with non-sparking tools. Alternatively, they may be removed by blasting with high pressure water streams.
- Collected waste material shall be transferred to transportable containers having sealable lids.
- Wherever possible, VOC generating solvent washes shall be avoided and VOC-free cleaning agents used if available.
- When necessary to use solvents for tank cleaning, managed amounts of strippers shall be applied with brushes or wipers.
- Used brushes, wipers and other equipment used for this purpose shall be stored for disposal, in approved, sealable containers. If subject to spontaneous combustion, the storage container shall contain sufficient water to cover the waste.
- As far as possible, residual solvents in tanks shall be removed by pumping or draining into sealed containers and sent for recycling.
- Air supply breathing apparatus shall be supplied along with good ventilation.

Paint Transfer and Spray Equipment

- Paint transfer and application equipment such as pumps, filters, regulators, valves, metering devices, spray guns, bells, *etc.* shall be cleaned using measured amounts of VOC-creating solvents.
- Parts shall be manually scrubbed, applying small amounts of strippers.
- When soaking is required, containers with air tight lids shall be used.
- Used solvents shall be returned to sealed containers of a waste collection system for recycling and reuse.

Filters

- Filter vessels shall be emptied before cleaning or changing filter media by blowing out with compressed air.
- Used filter bags shall be immediately transferred into containers equipped with sealable lids for storage and transportation.

Spray Booths

The cleaning of spray booths is a difficult job, costly in both labour materials and potential interruption of production. Effective spray booth cleaning procedures can therefore prove both cost and VOC reduction effective. This can best be accomplished with plant-specific written procedures for the cleaning crews.

- In down draft spray booths, air supply and exhaust volumes shall be maintained at optimum design parameters.
- Overspray, the main element requiring removal, shall be kept at minimum levels for conventional or electrostatic air atomized spray guns by fine tuning spray patterns and reducing paint fluid and air atomizing pressures.
- Carefully planned cleaning schedules will also contribute to fewer cleaning cycles without sacrificing quality.
- Wherever possible grates shall be cleaned with high pressure hot water.
- Spray booth walls must be coated with strippable compounds, preferably low VOC types which can be readily removed by hot, high pressure water streams. Flat surfaces must be cleaned by scraping.
- Windows and walls not suitable for coating with strippable compounds must be cleaned with measured amounts of VOC-containing strippers applied manually by brush. Complex equipment shapes must be cleaned with wipers moistened with small amounts of solvents.
- Cleaning of automatic application zones must be limited and disposable shrouds used where possible.
- Booth cleaning equipment, including solvents must be stored in closed cabinets, preferably with limited access.
- Solvents used in cleaning operations must be closely monitored with volumes and access controlled. The use of non-VOC strippers and/or hot high pressure water shall be used as the preferred option wherever feasible.
- Used cleaning equipment shall be stored and sent for disposal in tightly sealed containers.

CHECK LISTS FOR THE CODES OF GOOD PRACTICE

Table 1: Check List for Codes of Good Practices

Solvent Management

No	Practice	Currently Done? Y/N	Comments, Plans, Actions, Timing
1	Effective solvent management plan in place		
2	Plan assessed for safety, health, legal, and environmental policy requirements		
3	Emphasis of plan on prevention rather than correction		
4	Plan designed for modification and change		
5	Audit mechanism in place		
6	Formal procedures in place		
7	Corrective action mechanisms		
8	Roles and responsibilities clearly assigned		

Table 2: Check List for Codes of Good Practices

Solvent Management Training

No	Practice	Currently Done? Y/N	Comments, Plans, Actions, Timing
1	Solvent management plan principles and objectives		
2	Applicable health, safety and environmental regulations		
3	Solvent conservation		
4	Solvent recovery and recycling.		
5	Equipment and operating standards and procedures		
6	Use of personal protective and monitoring equipment		
7	Solvent storage and handling		
8	Spill prevention		
9	Containment and recovery of spills and leaks		
10	Cleaning and maintenance of equipment		
11	Waste handling and disposal		
12	Record keeping		
13	Test methods		

Table 3: Materials Handling

Returnable Containers

No	Practice	Currently Done? Y/N	Comments, Plans, Actions, Timing
1	Totes and drums completely sealed during transportation and storage		
2	Small ventilation opening during transfer to circulating system		
3	Tote valves secured in closed position after emptying and before disconnecting		
4	Ensure lids and vents are tightly closed after emptying container		
5	Lids, vents and other openings designed to prevent leaking during return transportation		
6	Any solvent/water added after emptying is by prior agreement with supplier		
7	Above additions controlled to avoid excessive use and reclassification of container as empty		
8	All drums arriving at the facility are returnable and reusable		
9	Drums covered with flexible covering if lids removed for pumping, viscosity adjustment, *etc.*		
10	Removed lids safely stored to prevent damage to seal		
11	Lids removed during use promptly replaced and container tightly resealed		

Table 3: Materials Handling

Non-Returnable Containers

No	Practice	Currently Done? Y/N	Comments, Plans, Actions, Timing
1	Use of non-returnable containers reduced to minimum possible		
2	Containers shipped with lids and openings tightly sealed		
3	Handling as for returnable containers to minimize losses		
4	Portion of thinner, if any added to emptied container to minimize residual material		
5	Empty containers to be promptly processed as hazardous waste		

Table 3: Materials Handling

Mix Tanks

No	Practice	Currently Done? Y/N	Comments, Plans, Actions, Timing
1	All mix tanks are kept tightly closed except for additions		
2	Procedures for additions designed to minimize fugitive emissions		
3	Sampling tubes fitted		
4	Lid gaskets regularly inspected and replaced if defective		
5	Tanks vented through flame arrestor/conservation vent		
6	Tanks not in use have vents and lids sealed		
7	Pumps, filters, valves, metering devices and vents inspected under regularly scheduled maintenance		
8	Repairs promptly made.		

Table 3: Materials Handling

Bulk storage tanks

No	Practice	Currently Done? Y/N	Comments, Plans, Actions, Timing
1	All bulk storage tanks are totally enclosed systems		
2	Ventilation of tanks is through flame arrestor/conservation vents		
3	Each tank has independent vent system. Tank vents are not inter-connected		
4	Fill lines enter tank from the top to prevent spills		
5	Pumps, filters, valves, metering devices and vents inspected under regularly scheduled maintenance		
6	Repairs promptly made		

Table 4: Equipment Operations

Application Equipment

No	Practice	Currently Done? Y/N	Comments, Plans, Actions, Timing
1	Written procedures provided		
2	Operators trained in the operation of the equipment		
3	Monitoring procedures for equipment operations in place		
4	Scheduled maintenance program		
5	Record keeping procedures defined		
6	Operation and record keeping monitored		
7	Scheduled periodic retraining program		

Table 4: Equipment Operations

Curing Equipment

No	Practice	Currently Done? Y/N	Comments, Plans, Actions, Timing
1	Written procedures provided		
2	Operators trained in the operation of the equipment		
3	Monitoring procedures for equipment operations in place		
4	Scheduled maintenance program		
5	Record keeping procedures defined		
6	Operation and record keeping monitored		
7	Scheduled periodic retraining program		

Table 4: Equipment Operations

Abatement Equipment

No	Practice	Currently Done? Y/N	Comments, Plans, Actions, Timing
1	Written procedures provided		
2	Operators trained in the operation of the equipment		
3	Monitoring procedures for equipment operations in place		
4	Scheduled maintenance program		
5	Record keeping procedures defined		
6	Operation and record keeping monitored		
7	Scheduled periodic retraining program		

Table 5: Equipment Cleaning

Paint System Flushing

1	Paint system kept well balanced to minimize need for cleaning		
2	Cleaning solutions selected for minimum possible VOC content		
3	Paint in system blown back before cleaning solution added		
4	Recovered paint kept in sealed containers for reclamation, if possible or disposal		
5	Transfer of cleaning solution into system done through sealed piping		
6	All lids and openings except flame arrestor/conservation vents kept sealed during cleaning		
7	Spent paint/cleaning solution pumped into transportable sealable containers		
8	Recovered paint, paint/cleaning solution sent for reclamation if possible		
9	Paint mix tanks and lines emptied at same rate as returned from circulating system		

Table 5: Equipment Cleaning

Mix Tanks

No	Practice	Currently Done? Y/N	Comments, Plans, Actions, Timing
1	Initial cleaning done by non-VOC methods		
2	Collected waste stored in transportable, sealed containers		
3	Use non-VOC cleaners.		
4	Tanks cleaned using brushes or wipers where possible		
5	Cleaning brushes, wipers stored in approved, sealable containers		
6	Residual solvents removed by pumping where possible		
7	Safety equipment includes air breathing apparatus		

Table 5: Equipment Cleaning

Filters

No	Practice	Currently Done? Y/N	Comments, Plans, Actions, Timing
1	Filter vessels emptied before cleaning or changing by blowing out with compressed air		
2	Used filters immediately transferred to transportable, sealed containers		

Table 5: Equipment Cleaning

Spray booth cleaning

No	Practice	Currently Done? Y/N	Comments, Plans, Actions, Timing
1	Specific written cleaning procedures		
2	Regular inspection and maintenance of air supply and exhaust performance		
3	Application equipment maintained for minimum overspray		
4	Planned cleaning schedules to minimize cleaning cycles		
5	Grates cleaned by high pressure water where possible		
6	Spray booth walls coated with film or low VOC compounds compatible with high pressure water cleaning		
7	Other areas cleaned by low VOC methods (brushes, wipers, *etc.*)		
8	Automated application zones protected with disposable shrouds		
9	VOC-containing cleaning equipment and materials in controlled access cabinets		
10	Solvents used for cleaning have controlled access with closely monitored usage		
11	Non-VOC strippers and cleaners used where feasible		
12	Used cleaning equipment and fluids stored and sent for disposal in sealed containers		

SCHEDULE 4 - LIST OF STAKEHOLDERS

The following persons participated in the consultations to support the development of the CCME Guidelines for VOC Reduction in the Wood Finishing sector, either as participants (P) in the consultative workshops or by providing information or as corresponding (C) stakeholders.

	Name	Organization
C	Robert Ablamowicz	Sherwin Williams Canada
C	Derek Ashton	Durham Furniture
C	Ilse Bacchus	PPG Canada
P	Jean-François Banville	Environment Canada, Quebec Region
C	Bob Beaty	BC Ministry of Water, Land and Air Protection
C	Ziane Bensalah	La Cie Cormier & Gaudet Ltée
C	Dave Bezak	Manitoba Conservation
C	Ralph Bock	Saskatchewan Environment and Resource Management
P	Jacques Blanchard	Ville de Montréal
C	Fiona Bragdon	NB Department of the Environment and Local Government
P	Ainsley Brooks	Willow Rock
C	John Brothers	Tamarack Wood Products
C	Mark Buller	Kitchen Craft Cabinetry
P	Alain Carrière	Cantox Environmental Inc. (Consultants)
P	Anne-Marie Carter	Environment Canada, Quebec Region
C	Julie Carter	Meubles Idéal Ltée
C	Terry Clark	Canadian Council of Furniture Manufacturers
C	Dianna Colnett	Greater Vancouver Regional District
P	Roger Couture	AKZO Nobel Peintures ltée
P	John Crawley	Chemcraft International
C	Leslie Creek	Krug Furniture Inc.
P	Jacques Crochetière	CanLak Inc.
C	Graham Currie	Greater Vancouver Regional District
C	Jack Currie	John E. Goudey Mfg. Ltd
C	Diane Dawiskiba	Palliser Furniture Ltd
C	Tom Donoghue	The Global Group
P	André Dumouchel	Cantox Environmental Inc. (Consultants)

C	Richard Dutchak	Loewen Windows
C	Abe Dyck	Decor Cabinets
P	Barrie Edwards	Becker Acroma Inc.
C	Jim Eisenhauer	Unison Windows Inc.
C	James Esworthy	Red Star Furniture Design
C	Jim Flux	Pacific Rim Cabinets
P	Jean Gagnon	Shermag Inc.
P	Roberto Gagnon	CanLak Inc.
C	Mary Gallant	McAskill Woodworking Ltd.
P	Suzanne Goldacker	Cantox Environmental Inc. (Consultants)
C	Pascoal Gomes	Canadian Environmental Network
C	Madelyn Harding	The Sherwin-Williams Company
C	Bill Hutton	Schwartz Chemical
P	Philippe Jossinet	Chemcraft International inc.
P	Charles Kaufmann	Cantox Environmental Inc. (Consultants)
P	Carroll Kelly	Chemcraft International
C	William Kravetz	RKR Coating Ltd
C	Claude Lacasse	Revêtement Polyval Robar
C	Benoit Laplante	Meubles Canadel Inc
C	Bill Laurysen	Laurysen Kitchens Ltd.
P	Lise-Anne Lavoie	AQIP (Quebec Paint Industry Association) and CPCA (Canadian Paint and Coatings Assoc.)
P	Brent Lawson	Valspar Composites
P	Brian Leclair	Ontario Ministry of the Environment
P	Martin Lecours	Ministère de l'environnement du Québec
C	Liz Lilly	BC Ministry of Water, Land and Air Protection
P	Mike Livermore	Valspar Composites
P	Lloyd Love	Durham Furniture
C	René Lupien	Antoni Coatings
C	Iain MacDonald	Centre for Advanced Wood Processing
C	Kathryn MacGregor	OFMA (Ontario Furniture Manufacturers Association)
C	Grant Mackay	Acorn Kitchens Ltd.
P	Sean Maguire	Cognis Corp. Canada (also RadTech Canada Focus Group)
P	Pat Martin	Becker-Acroma Inc.
C	Joe McAskill	McAskill Woodworking Ltd.

P	Grant McCulloch	Environment Canada, Prairie and Northern Reg.
P	Bruce McPherson Jr.	The Gibbard Furniture Shops (on OFMA Board of Directors)
C	Jean-Francois Mercier	Meubles Laurier Ltée
P	Jean-François Michaud	AFMQ (Association de fabricants de meuble du Québec)
P	Richard Morris	Gibbard Furniture
C	George Murphy	Alberta Environment
C	Richard Murry	CPCA (Canadian Paint and Coatings Association)
P	Mario Pelletier	Société Laurentide Inc.
P	Tony Piccirillo	Valley City Manufacturing
P	S.T. Rajan	Kremlin Spray Equipment
C	Robert Rivard	Canadian Kitchen Cabinet Association
C	Veto Rus	BC Door
C	Jean Sarto	Meubles Morigeau Lepine Ltée
P	Roy Selinger	Dufferin Games Ltd
P	Jacob Shapiro	Cantox Environmental Inc. (Consultants)
C	George Sinclair	OFMA (Ontario Furniture Manufacturers Association)
C	Patricia Skopelianos	Global Group
P	Andy Steele	The Valley City Manufacturing Company Ltd.
P	Art Stelzig	Environment Canada
C	Jeffery Taylor	Environment Canada, Pacific and Yukon Region
C	Gerry Ternan	Environment Canada, Atlantic Region
P	Raymond Thériault	AFMQ (Association de fabricants de meuble du Québec)
P	Claude Toupin	Fournitures Funéraires Victoriaville inc.
P	Phil Trory	Palliser Furniture Ltd.
P	Arthur Verlaan	Descor
P	Bruce Walker	STOP
C	Anita Wong	Environment Canada, Ontario Region

P: Participant in the consultative workshops or contributed information
C: Corresponding member