Environment Canada Environnement Canada

Renewal of the Federal Agenda on the Reduction of Volatile Organic Compound (VOC) Emissions from Consumer and Commercial Products

A Discussion Paper for the 2010 to 2020 Period

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Renewal of the Federal Agenda on the Reduction of Volatile Organic Compound (VOC) Emissions from Consumer and Commercial Products

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1. INTRODUCTION

To further improve air quality throughout Canada, the Government of Canada is preparing to undertake the second and final step in implementing the 2004 Federal Agenda on the Reduction of Emissions of Volatile Organic Compounds from Consumer and Commercial Products (Federal Agenda).[1]

The first step to implement the 2004 Federal Agenda was completed with the commitment to develop three sets of regulations for consumer and commercial products, as announced in the April 26, 2007, Regulatory Framework for Air Emissions.[2] This was followed by the development in 2008 and publication in 2009 of two new regulations to limit the volatile organic compound (VOC) content in automotive refinish products and architectural coatings, and continuing work on the third regulation, which is for certain consumer products in Canada.

For certain consumer and commercial products not yet addressed in Canada, new standards are either already in place or are being developed in the United States. Opportunities for further reductions in these consumer and commercial products are worth exploring, particularly as improved technologies and processes already developed could allow for lower VOC emissions in Canada. Furthermore, maintaining competitiveness and taking advantage of opportunities to align in the North American marketplace are important considerations for Canada.

This discussion paper presents information and supporting rationale for a new series of potential control measures for consumer and commercial products not yet addressed by the Government of Canada. It is intended to provide a starting point for discussions and consultations on risk management options with interested stakeholders and other government departments and agencies. On the basis of the results of the consultations and further research to be undertaken, the Government of Canada intends to publish in the *Canada Gazette*, Part I, a Notice of Intent describing proposed additional control measures to reduce VOC emissions from consumer and commercial products.

2. AIR QUALITY

Smog is an air quality issue that poses serious health and environmental concerns in Canada. Particulate matter (PM) and ground-level ozone[a] are the two principal components that comprise smog. PM and ozone can be transported by prevailing winds

[a] Ozone is a gas that is found in different parts of the atmosphere. Ozone in the upper atmosphere, or more exactly in the stratosphere, is an essential gas that helps protect the Earth from the sun's harmful rays. Near the ground in the troposphere, ozone is harmful to both human health and the environment.

over long distances, making them not only a local urban issue but one that extends regionally in Canada into many smaller communities and rural areas.[3]

Ozone is formed by complex reactions between the precursors, i.e., nitrogen oxides (NO_x) and VOCs, in the presence of sunlight. PM is both released directly into the air by industrial activity and formed in the atmosphere via complex chemical reactions involving the emissions of smog precursors, including sulphur dioxide (SO_2), NO_x, VOC and ammonia (NH_3). In order to reduce smog levels and improve air quality, it is necessary to control and reduce the direct PM and the precursor emissions of SO_2, NO_x, VOC and NH_3.

"Fine" PM or $PM_{2.5}$ and ozone are responsible for causing serious health problems for Canadians, primarily concerning the cardio-respiratory system. This includes thousands of premature deaths, hospital admissions and emergency room visits every year, leading to substantial economic costs. Recent studies have shown that air pollution is also associated with an increased risk of lung cancer and heart disease.

In addition to effects on human health, fine PM is also the main cause of reduced visibility, which occurs when the particulate and other gases scatter and absorb light, creating "regional haze." Regional haze limits the distance one can see as well as degrading the colour, clarity and contrast of scenes. The costs associated with poor visibility have been studied especially as they relate to loss of tourism revenue in areas where vistas are a key tourist attraction, such as in British Columbia's Greater Vancouver Area.[4]

Ozone's environmental effects include decreasing the productivity of some crops such as flowers and shrubs and contributing to overall forest decline. Ozone can also damage synthetic materials, cause cracks in rubber, accelerate fading of dyes, and speed deterioration of some paints and coatings. As well, it damages cotton, acetate, nylon, polyester and other textiles.[5]

Federal and provincial governments in Canada developed, in 2000, the Canada-wide Standards (CWS) for fine particulate matter ($PM_{2.5}$) and ozone, an ambient target that was intended to provide a certain degree of protection from the harmful effects of PM and ozone. The Standards are to be achieved by 2010. The level and form of the standards are:

- **$PM_{2.5}$ CWS – 30 $\mu g/m^3$ (micrograms per cubic metre) as a 24-hour average**
  The **form of the Standard** is the **3-year average** of the annual 98th percentile 24-hour average $PM_{2.5}$ levels.
- **Ozone CWS – 65 ppb (parts per billion) as an 8-hour average**
  The **form of the Standard** is the **3-year average** of the annual 4th highest of the daily maximum 8-hour average ozone levels.

Based on monitoring data for 2003–2005, at least 30% of Canadians lived in communities with $PM_{2.5}$ levels above the CWS and at least 40% of Canadians lived in communities with ozone levels above the CWS.[6]

3. CONSIDERATIONS

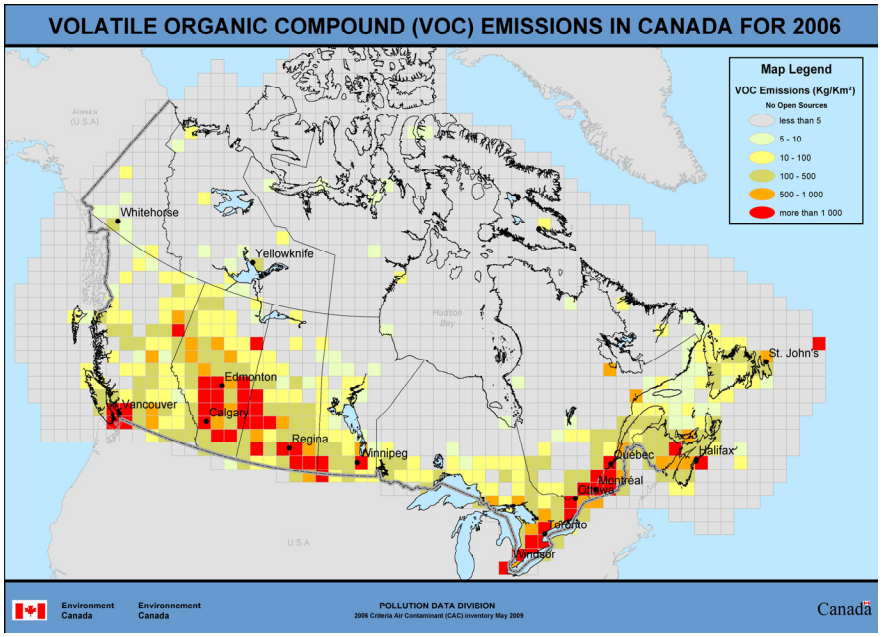
3.1 Characterization of VOCs

VOCs are a class of organic compounds that participate in atmospheric photochemical reactions that contribute to the formation of PM and ozone. By definition, VOCs do not include non-significant photochemically reactive compounds such as methane, ethane and chlorofluorocarbons (CFCs), which are listed in Appendix I.[7,b]

Emissions of VOCs originate from both natural (biogenic) and anthropogenic (human-made) sources. Those of interest with respect to smog, however, are those compounds released by anthropogenic sources.

VOCs that are released by anthropogenic activities tend to be found wherever people live and work. The following map of Canadian VOC emission densities in 2006 shows this overlap clearly, as the highest VOC emission densities tend to occur where there are urban population centres and industrial complexes.

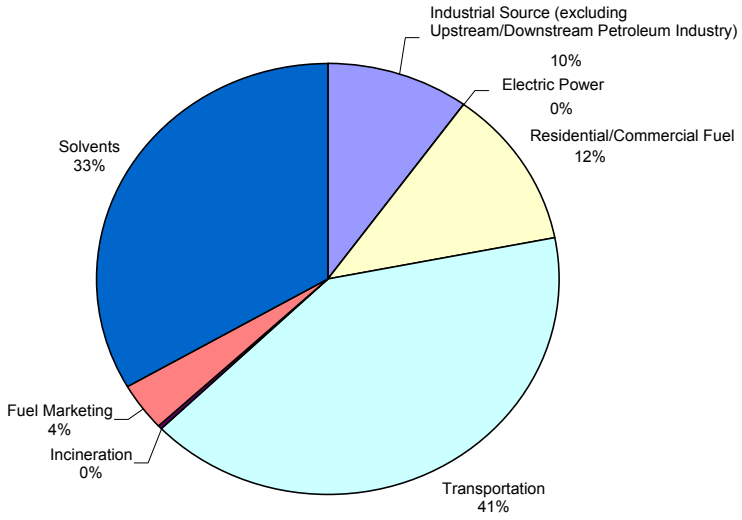
Figure 1: VOC emission densities in Canada in 2006[8]



The following pie chart illustrates the key sources of anthropogenic VOC emissions that affect mainly urban areas, where the use of consumer and commercial products tend to be concentrated.

[b] This definition is consistent with the definition used by the U.S. Environmental Protection Agency for VOC and for the class of substances added to the List of Toxic Substances in Schedule 1 of the *Canadian Environmental Protection Act, 1999* in the *Canada Gazette*, Part II: 2003. 2003-07-02. http://gazette.gc.ca/archives/p2/2003/2003-07-02/html/sor-dors229-eng.html

Figure 2: 2007 Total Anthropogenic VOC Emissions in Canada (1349 kilotonnes)[9]



Solvents, at 33% of this subset of total anthropogenic emissions, are the second largest source of VOC emissions after transportation (41%). Solvents comprise a wide array of individually small sources where solvents are used in processes such as in dry cleaning, printing and degreasing, and where solvents are in industrial and consumer and commercial products themselves. Examples of these products are pesticides, household cleaning products, personal care products, paints and coatings.

3.2 Government of Canada Agenda for VOC Emissions

All of the major sources of VOC emissions that contribute to the formation of smog are being dealt with through actions by the Government of Canada. The National Pollutant Release Inventory (NPRI) began reporting on VOC emissions from facilities that are major users of VOC-containing products in 2003.

To deal with solvents and their VOC emissions, the Ministers of the Environment and of Health published on March 27, 2004, a Notice of Intent entitled Federal Agenda on the Reduction of Emissions of Volatile Organic Compounds from Consumer and Commercial Products,[10] in the *Canada Gazette*, Part I. This document outlined a series of measures to be developed and implemented between 2004 and 2010 to control and reduce emissions of VOCs from consumer and commercial products. (See Appendix II for a brief history of actions on VOCs from consumer and commercial products.)

Further, to provide the Government of Canada with additional tools and the legal authority to develop and propose measures to control VOC emissions, volatile organic compounds were added to Schedule 1 of the *Canadian Environmental Protection Act,*

1999 (CEPA 1999). Section 64(*c*) of CEPA 1999 defines a substance as "toxic" if it is entering or may enter the environment in a quantity or concentration or under conditions that constitute or may constitute a danger in Canada to human life or health. VOCs were found to meet these criteria, and on July 2, 2003, ozone and its precursors and the precursor emissions to respirable PM, including VOCs, were added to Schedule 1 of CEPA 1999.[11]

With respect to industrial sources, in Spring 2007, the Canadian government announced its commitment to develop a regulatory framework for industrial air emissions. Through this initiative, the industrial sources of anthropogenic VOC emissions will be addressed, including those from petroleum refining, oil sands, upstream oil and gas, iron and steel, wood products, and the chemical industry.

Transportation and, in particular, the fossil fuels that power vehicles and engines have been the focus of controls and reductions of VOC emissions through the Federal Agenda on Cleaner Vehicles, Engines and Fuels.[12]

VOC emissions from residential fuel combustion and, in particular, wood heating is being targeted through awareness campaigns[13] at all levels of government.

4. CONSUMER AND COMMERCIAL PRODUCTS

4.1 Characterization of "Consumer and Commercial Products"

"Consumer and commercial products," a subset of the solvent sector, are defined as "any substance, product (including paints, coatings, and solvents) or article (including any containers or packaging) held by any person, the use, consumption, storage, disposal, destruction, or decomposition of which may result in the release of volatile organic compounds." (The term does not include fuels, fuel additives, motor vehicles, non-road vehicles and non-road engines.)[c] (See Appendix III for the 2007 National Emissions Inventory of VOCs for Canada.)

The major consumer and commercial product sources and their respective emission contributions are listed in Table 1.

[c] This definition is consistent with the definition used by the U.S. Environmental Protection Agency.

Table 1: 2007 Source of VOC Emissions from the Consumer and Commercial Products Sector[14]

Source	VOC Emissions (%)
Consumer products	30
Industrial non-process[d]	21
Paints and coatings	20
Portable fuel containers	14
Printing	9
Degreasing	4
Pesticides	2
Dry cleaning	<1

4.2 Government of Canada Action to Date for Consumer and Commercial Products

VOC emissions from dry cleaning and degreasing have been addressed through two regulations under CEPA 1999: the *Tetrachloroethylene (Use in Dry Cleaning and Reporting Requirements) Regulations* (SOR/2003-79), which was promulgated on February 27, 2003, and the *Solvent Degreasing Regulations* (SOR/2003-283), which went into effect on July 24, 2003.[15] These regulations fulfilled one of the Canadian commitments made in the Canada–United States Ozone Annex in 2000.

Action to regulate the two largest sources of consumer and commercial product emissions, namely "paints and coatings" and "consumer products" has recently taken place. The *Volatile Organic Compound (VOC) Concentration Limits for Automotive Refinishing Products Regulations*[16] were published on July 8, 2009, and the *Volatile Organic Compound (VOC) Concentration Limits for Architectural Coatings Regulations* were published on September 30, 2009.[17] The draft regulations are in the process of being finalized to limit VOC concentrations in selected consumer products. The VOC concentration limits in the new draft and final regulations are aligned with a number of current and upcoming regulations in California and other U.S. jurisdictions, and are predicted to result in an average annual reduction in VOC emissions by 28% to 40% in each of the covered sectors. When all three new regulations are published, this will fulfill Canada's second commitment in the Canada–United States Ozone Annex.

The strategy in Canada for establishing a VOC content limit for pesticide products included in the U.S. Consumer Product Rule is being developed in cooperation with Canada's Pest Management Regulatory Agency.

[d] Includes all industrial sources of VOC emissions from commercial and consumer products not included in the other source sectors.

5. RENEWED FEDERAL AGENDA FOR 2010–2020

5.1. Opportunities to Achieve Further Reductions of VOC Emissions in Consumer and Commercial Products

Opportunities exist to further reduce the emissions of VOCs from consumer and commercial products, particularly from sources not yet addressed by government action.

An analysis of the major solvent emission sources in Canada shows the following key points.

- The regulations already in place or being developed for consumer and commercial products in Canada will control about 31% of total solvent emissions.
- Our major trading partner, the United States, has already developed controls for many more product categories currently not addressed in Canada.
- By addressing these outstanding categories in Canada, it is estimated that a further 39% of solvent emissions could be controlled and reduced.
- The initial estimate for reducing emissions by industry in the additional categories indicates that the cost per tonne for reductions would be comparable to those in other sectors, such as transportation.
- About 23% of solvent emissions come from other categories of products where reduction or control would not be feasible or where the product is difficult to limit or define. Included in this group of products is windshield washer fluid and undefined/non-regulated metal working and mining, where control options do not appear available.

By focussing on the product categories that represent a combination of large emissions of VOCs and potential deep reductions of these emissions, the following seven categories of consumer and commercial products have been identified as the preferred next focus for the development of control and reduction measures by the Government of Canada:

- Asphalt cutbacks
- Portable fuel containers
- Cars, vans, light trucks assembly coating/auto parts coatings
- Adhesives and sealants
- Aerosol coatings
- Rubber product manufacturing and plastic parts coatings
- Printing

Table 2 projects emissions from these seven product categories assuming no additional control measures are put in place.

Table 2: Canadian Consumer and Commercial Product Emissions Trends (in kilotonnes)[18]

Consumer and Commercial Product Categories	2005	2010	2015	2020
Asphalt cutbacks	9	11	13	16
Portable fuel containers	64	75	85	99
Cars, vans, light trucks assembly coating/auto parts coatings	10	12	15	17
Adhesives and sealants	12	12	12	13
Aerosol coatings	7	9	10	12
Rubber product manufacturing and plastic parts coatings	13	15	18	21
Printing	41	40	39	38

5.2 Approach

The government is seeking to take action where there is opportunity for significant improvement in a cost-effective way. Approximately seven new sectors have been identified taking this into consideration as well as the following four principles.

1. Build on the best product standards/improvements that have been developed and proven elsewhere.
2. Align with standards within the North American market wherever possible to give Canadian businesses the best opportunities to access the greatest market.
3. Set a level playing field for businesses in Canada.
4. Fulfill the commitments made in April 2007 in the Regulatory Framework for Air Emissions to take further action to further improve air quality by reducing VOC emissions from consumer and commercial products.

6. SECTORS

6.1 Asphalt Cutbacks

General description of the sector

Asphalt cutbacks (liquefied asphalt) are formed when liquefied paving asphalt (asphaltic cement) is mixed with petroleum distillates. Asphalt cutbacks contain a significant amount of light petroleum solvents such as kerosene, diesel or naphtha. These solvents or diluents are added to the asphalt either at the refinery or the asphalt plant. As a result, asphalt cutbacks have been found to be a significant source of VOC emissions.

Asphalt cutbacks fall into three broad categories:

1) Rapid cure
2) Medium cure
3) Slow cure

VOCs are emitted on both the job site and in the mixing plant. However, the main source of emissions is when it is applied to a road surface.

In Canada, estimates are that asphalt cutbacks were the source of almost 9 kilotonnes of VOC emissions in 2005.[19]

Overview of control measures already in place (in Canada, U.S., internationally)

Canada has no regulations to control and reduce VOC emissions from asphalt cutbacks.

The U.S. Environmental Protection Agency (EPA) and California have addressed VOC emissions from this sector through regulations, which are detailed in Appendix IV. In summary, requirements are the following:

- Rapid- or medium-cure asphalt cutback, or slow-cure cutback asphalt material that contains more than 0.5% by volume of VOCs that evaporate at 500°F (260°C) or less, cannot be manufactured, sold, offered for sale, used, or applied for paving, construction, or maintenance of parking lots, driveways, streets, or highways.
- Emulsified asphalt material that contains more than 3.0% by volume VOCs that evaporate at 500°F (260°C) or less cannot be manufactured, sold, offered for sale, used, or applied for paving, construction, or maintenance of parking lots, driveways, streets, or highways.

European Commission regulations exist for bituminous mixtures based on natural and artificial aggregate and bitumen or natural asphalt as a binder.[20] The European Commission published its Construction Products Directive and began to work to harmonize standards in 1989. European specifications for road bitumen were introduced in January 2002. European standards for aggregates were implemented in January 2004 and implementation of European specifications for asphalt occurred in January 2008.[21]

Opportunities for reductions

Opportunities to reduce VOC emissions from asphalt cutbacks are possible using similar methods to those applied in the U.S. where the level of VOCs is limited in rapid- or medium-cure asphalt cutback, or slow-cure asphalt cutback material as well as emulsified asphalt material.

6.2 Portable Fuel Containers

General description of the sector

A portable fuel container (PFC) is a receptacle for holding small amounts of fuel ranging in size from 1 gallon to 5 gallons or more. A study, *Technical and Economical Study on VOC Emissions from Portable Fuel Containers*, prepared for Environment Canada in December 2008, estimates that there are about 70 kilotonnes of VOC emissions leaking each year in Canada from portable fuel containers.[22] Three PFC manufacturers based in the United States currently supply the Canadian market.

Although an individual gas can is a relatively modest emission source, the cumulative VOC emissions from PFCs are quite significant. Gas can emissions are primarily of three types:

1) Evaporative emissions from unsealed or open containers
2) Permeation emissions from gasoline passing through the walls of the plastic containers
3) Evaporative emissions from gasoline spillage during use

For most of these sources, the emission rates also depend upon:

- Composition of the PFC (plastic versus metal)
- Whether the PFC was stored open or closed (i.e., a PFC is considered "open" if its vent and/or spout is uncapped)
- Average size/capacity of the PFC
- Frequency with which the PFC was refilled

Overview of control measures already in place (in Canada, U.S., internationally)

Canadian governments do not have controls for VOC emissions from portable fuel containers at this time.

The U.S. EPA completed regulations for PFCs in January 2009 based on requirements started in California by the California Air Resources Board in 2000 and updated in 2007. Since 2000, individual states have been slowly following suit, but the new EPA regulations will bring all states in line as of January 1, 2009, with all new PFCs produced and sold in the United States having to meet the standards.[23] The regulations that are detailed in Appendix IV require:

- A single, self-venting opening for filling and pouring with no separate vents or openings
- A treated can body for minimal permeation of fuels
- Automatic closure, meaning a nozzle which automatically springs to the closed position when not pouring
- Childproof features as designated by the *Children's Gasoline Burn Prevention Act*

Opportunities for reductions

Opportunities to reduce VOC emissions from PFCs are possible using similar methods to those applied in the U.S. Each of the three PFC manufacturers currently supplying the Canadian market would have to comply with regulations similar to those in the U.S., such as in California, the U.S. Ozone Transport Commission (OTC) states and, as of January 1, 2009, the national PFC rule under the *Clean Air Act*.

Please note that additional authorities to control VOC emissions from this product, under the *Canadian Environmental Protection Act, 1999* are currently being considered by the Government of Canada.

6.3 Cars, Vans, Light Trucks Assembly Coating/Auto Parts Coatings

General description of the sector

This category of consumer and commercial products consists mainly of coating operations conducted on motor vehicle assembly lines and includes coatings to motor vehicle bodies, hoods, fenders, cargo boxes, doors and grill opening panels. It also involves the coating operations in an automobile or light-duty truck assembly plant: prime coat operation, electrodeposition prime coat operation, primer surfacer operation, topcoat operation, spray primer operation and final repair operation.

The primary VOC emissions from automobile and light-duty truck assembly coatings occur during coating application/flash-off and drying/curing of the coatings. The remaining emissions are mainly from mixing and/or thinning. The VOC emissions from mixing and thinning of coatings involve displacement of VOC-laden air in containers used to mix coatings containing solvents (thinners) prior to coating application. The displacement of VOC-laden air also happens during filling of containers and can be caused by changes in temperature, changes in barometric pressure or agitation during mixing. Another potential source of VOC emissions is cleaning materials. The VOCs are emitted when solvents evaporate from the cleaning materials during use.

Emissions of VOCs in Canada for this product category are about 10 kilotonnes per year.[24] The majority of the emissions come from the motor vehicle assembly and parts facilities. Vehicle manufacturing is located in Ontario. The vast majority of parts manufacturing takes place in both Ontario and Quebec.[25]

Overview of control measures already in place (in Canada, U.S., internationally)

The Canadian Council of Ministers of the Environment (CCME) recommended standards and guidelines to reduce VOC emissions from Canadian Automotive Parts Coatings Operations in 2002[26] as part of the NO_x/VOC Phase I Management Plan. Provincial governments can use the CCME recommendations in their own regulations and industry permitting processes.

The standards and guidelines described in the CCME recommendations provide two options for achieving the desired VOC emission reductions from the sector, the first option based on Product and Operations Standards and the second based on Performance Standards. The Standards include VOCs emitted by all of the designated operations used in the coating facilities in the Automotive Parts sector and are comparable to the VOC reduction measures in the United States.

The current U.S. control measures for VOCs from cars, vans and light trucks assembly coating include the California Air Resources Board regulations for motor vehicle assembly-line coating operations and the U.S. EPA guidelines in lieu of regulations for auto and light-duty truck assembly coatings. Details of the U.S. VOC emission limits are available in Appendix IV.

The European Union (EU) finalized a measure that placed VOC limits on coatings, with a first round of limits that took effect on January 1, 2007, including VOC limits for refinish products, with those limits ranging from 250 g/l to 850 g/l for preparatory and cleaning products, bodyfillers/stoppers, primers, topcoats and special finishes.[27] The EU expected the regulation to reduce VOC emissions from paints, varnishes and vehicle-refinish products in EU member states by around 280 000 tons per year by 2010.

Hong Kong's Environmental Protection Department has implemented the *Air Pollution Control Ordinance (Volatile Organic Compounds) Regulation*, effective from April 1, 2007,[28] to control VOC emissions at levels comparable to those in California and will be extending the scope of the controls in the VOC Regulation to vehicle refinishing paints, vessel paints and pleasure craft paints to take effect in phases starting from January 1, 2010.

Opportunities for reductions

Opportunities to reduce VOC emissions from automotive sector are possible using similar methods to those applied in the U.S. Manufacturers in Canada would have to comply with regulations similar to those in the U.S., such as in California and the OTC states.

The government will gather information on the VOC concentration limits for coatings and solvents, their application, cost and feasibility in respect of vehicle assembly-line coating operations and motor vehicle assembly coating products in Canada. The scope of the work will include all commercial, institutional, and industrial or consumer products for coating operations conducted on all passenger cars, vans, light-duty trucks, medium-duty vehicles and heavy-duty vehicles assembly lines and also during parts manufacture.

6.4 Industrial and Commercial Adhesives and Sealants

General description of the sector

Adhesives and sealants are surface-coatings substances allowing the joining or the bonding of two materials together. Commonly, adhesives are referred to as "glues" and sealants as "caulks." Adhesives are produced by chemical curing (changes from liquid to solid), physical hardening or pressure-sensitivity, and fall into two subcategories (aerosol and non-aerosol). As for sealants, they can either be solvent-based or water-based, and the VOCs are emitted as the sealants dry. These are found in both the consumer and industry markets. For the purpose of this agenda, the focus will be primarily on industrial sectors such as, but not limited to, automotive, aeronautics, building and civil engineering, electronics, packaging, wood, furniture, metals, plastics and composites, textiles, and footwear.

The Government of Canada has had research completed to understand this product category more fully. The report *Technical and Economical Study on Volatile Organic Compounds in Industrial and Commercial Adhesives: Final Report*[29] analyzed 58 kinds of adhesives.

The majority of the larger adhesive and sealant manufacturers operating in Canada are owned by U.S. and European multinational firms that operate subsidiary or joint venture operations around the world. Historically, Industry Canada has estimated that foreign-owned subsidiaries represent 70% of Canadian adhesive and sealant shipments and represent about two-thirds of the overall firms in the sector.

The apparent domestic market for adhesives and sealants in Canada in 2007 was $969 million. The Canadian market for adhesives and sealants ranged in value between $900 and $1,050 million in the period between 1999 and 2007. The industrial/commercial segment is estimated to account for about 80% of the Canadian market with consumer products representing 20%. In addition, adhesives have been estimated to represent 70% of the Canadian market while sealants represent 30%.[30]

Adhesives and sealants were the source of an estimated 12 kilotonnes of VOC emissions in 2005.[31] Table 3 provides a distribution of adhesive and sealant manufacturing by province across Canada.

Table 3: Provincial Distribution of Adhesive and Sealant Manufacturing Locations (2006)[32]

Province	Number of Establishments
Ontario	37
Quebec	23
Alberta	5
British Columbia	4
Manitoba	2
Nova Scotia	1
Saskatchewan	1
Total	**73**

Overview of control measures already in place (in Canada, U.S., internationally)

In 1994, the CCME published *A Program to Reduce Volatile Organic Compound Emissions by 40 Percent from Adhesives and Sealants* as guidance for governments in their efforts to reduce VOCs from adhesive and sealants.[33] The CCME publication set no limits for VOC emissions from adhesives and sealants but did call for monitoring of emissions. Canada currently has no regulations in place to control or reduce VOC emissions from adhesives and sealants.

There is currently no nationwide regulations for adhesives and sealants in the United States, although the U.S. EPA has a Control Techniques Guideline (CTG): *Control Techniques Guidelines for Miscellaneous Industrial Adhesives*.[34] The OTC has a model rule,[35] which limits VOC emissions from adhesives, sealants and primers, that individual states are to implement through regulation by 2009. California's South Coast Air Quality Management District (SCAQMD) has a regulation to limit the VOC content of adhesives and sealants.[36] VOC limits for adhesives and sealants and for the application of adhesives

and sealants contained in the U.S. EPA CTG, the OTC model rule and the SCAQMD rule are detailed in Appendix IV.

In the European region, limits on VOC emissions for manufacturing and application of adhesives and sealants are in place through Council Directive 1999/13/EC of March 11, 1999.[37]

Hong Kong's Environmental Protection Department has implemented the *Air Pollution Control Ordinance (Volatile Organic Compounds) Regulation*, effective from April 1, 2007,[38] to control VOC emissions at levels comparable to those in California and has extended the scope of the controls in the VOC Regulations to adhesives and sealants that took effect in phases starting on January 1, 2010.

Opportunities for reductions

According to the report *Technical and Economical Study on Volatile Organic Compounds in Industrial and Commercial Adhesives: Final Report*, approximately 82% of the annual volumes reported supplied to Canada within the OTC product categories were compliant with the OTC VOC content limits. In addition, just under 77% of the annual volumes supplied to Canada within the SCAQMD product categories were compliant with the SCAQMD VOC content limits. Therefore, a high percentage of the industrial/commercial adhesive and sealant product volume currently being supplied to the Canadian market is compliant with the existing OTC and SCAQMD VOC content limits.[39]

The VOC emission reductions that would be realized if the OTC VOC content limits were adopted in Canada range from 3.1–4.1 kilotonnes. If the SCAQMD VOC content limits were adopted in Canada, the VOC emission reductions that would be realized would range from 3.8–5.1 kt.[40]

There could be two approaches for addressing VOC emissions from adhesives and sealants. One approach would be to limit the VOC concentrations in the adhesive and sealant products. The second approach would be to look to control and reduce VOC emissions from the application in facilities of adhesives and sealants. Both approaches are used in the OTC Model Rule for Adhesives and Sealants.

6.5 Aerosol Coatings

General description of the sector

According to the definition provided by the U.S. EPA, aerosol products are made of airborne solid or liquid particles with a size range of 0.01–10 micrometres and can remain in the atmosphere for at least several hours. They are found naturally in the environment but can also be released as a result of human activities.

An "Aerosol Coating Product" is a pressurized coating product containing pigments or resins that dispenses product ingredients by means of a propellant, and is packaged in a

disposable can for hand-held application, or for use in specialized equipment for ground traffic/marking applications.[41]

An estimated 7.5 kilotonnes of VOCs are emitted in Canada from aerosol coating products.[42]

Overview of control measures already in place (in Canada, U.S., internationally)

Canada currently has no regulations in place to control or reduce VOC emissions from aerosols.

In the United States, the California Air Resources Board published the rule for aerosols coatings[43] for both consumer and industrial markets in 2000 using the reactivity-based rule instead of the traditional grams per litre for VOC content limit, which was later adopted by the U.S. EPA in 2007.[44] Details of the U.S. VOC limits are found in Appendix IV.

The European Council Directive 1999/13/EC of March 11, 1999, on the limitation of emissions of VOCs due to the use of organic solvents in certain activities and installations may cover aerosol coatings since the scope of the directive is sufficiently broad with respect to coatings to include their application through pressurized propellants.[45]

Opportunities for reductions

Opportunities to achieve feasible reductions in industrial applications of aerosol coating products will be explored through information to be gathered by the government. Various coatings categories are contained in aerosol packaging, including clear coatings, flat paint products, fluorescent coatings, metallic coatings, non-flat paints, primer coatings, ground traffic/marking paints and specialty coatings including automotive aerosol coatings.

6.6 Rubber Product Manufacturing and Plastic Parts Coatings

General description of the sector

According to the U.S. EPA definition, plastic parts are components composed of synthetic polymers found in parts and accessories for automobiles, trucks, and recreational vehicles, business machines, and laboratory and medical equipment. Coatings are usually applied by a post-mold process. Rubber manufacturing involves a six-step process, which includes mixing, milling, extrusion, calendaring, curing and grinding, starting with the raw material (natural or synthetic) mixed with other chemicals to obtain the desired final product. Rubber is usually used for the production of pneumatic tires for automobile, trucks, airplanes and farm machinery. VOCs are emitted from hazardous materials contained in the coating.

Emissions from this category are estimated to be about 12.5 kilotonnes[46] with over half of the facilities located in Ontario, followed by about a third located in Quebec, one-tenth

in British Columbia with the remaining eight facilities scattered among Alberta, Saskatchewan, Manitoba, Nova Scotia and New Brunswick.

Overview of control measures already in place (in Canada, U.S., internationally)

In 1997, the CCME developed and published an Environmental Guideline for the Reduction of Volatile Organic Compounds from the Plastics Processing Industry.[47] The CCME guideline is available for provincial governments to use within their own regulations and industrial facility permitting.

The CCME guideline covers expanded polystyrene, cellular polyethylene foams, polyvinyl chloride, and reinforced plastics and composite products made from thermoset polyester resins. The guideline focuses on the reduction of VOC emissions from processing and clean-up operations, the handling and storage of VOC-containing materials, and the handling and disposal of wastes. It sets standards for material, equipment, process and operations in plastic processing facilities, record keeping and training standards, and recommended operating practices and testing protocols.

Although the U.S. EPA and the OTC have not regulated this category of products, the California SCAQMD first adopted Rule 1145 – Plastic, Rubber, Leather and Glass Coatings in 1983 and most recently modified it in 2004[48] to reduce VOC emissions from the application of coatings to any plastic, rubber, leather or glass products. (See Appendix IV for details.)

The European Council Directive 1999/13/EC of March 11, 1999, on the limitation of emissions of VOCs due to the use of organic solvents in certain activities and installations covers plastic parts coatings and rubber product manufacturing setting thresholds and emission limits for VOCs.[49]

Opportunities for reductions

There are two possible approaches to VOC reductions in this product category. The SCAQMD is controlling VOC emissions through limits on the VOC content of applications. The second approach, which the CCME guideline intended, is to have the emissions controlled at the manufacturing facilities.

Research is underway to gather technical, economic and socio-economic data on plastic parts and rubber products coatings that are manufactured, imported, exported and sold in Canada. The gathered information could be used to assist in establishing VOC content limits and assessing associated economic impacts for future control measures employed to address VOCs in commercial and industrial products.

6.7 Printing[50]

General description of the sector

Employing over 80 000 people in more than 5000 establishments across the country, the Canadian printing and publications industry plays a major role in the Canadian economy.

There are four basic processes used in the printing industry: web offset lithography, web letterpress, rotogravure and flexography. Printing may be performed on coated or uncoated paper and on other surfaces, as in metal decorating and some fabric coating.

Lithography is the process used mainly for the production of books, pamphlets and newspapers. Letterpress is the oldest form of moveable type printing, and it still dominates in periodical and newspaper publishing, although numerous major newspapers are converting to lithography. Rotogravure, or in gravure printing, is the process where the image area is engraved, or "intaglio" relative to the surface of the image carrier. Rotogravure can produce illustrations with excellent color control, and it may be used on coated or uncoated paper, film, foil and almost every other type of substrate. Its use is concentrated in publications and advertising such as newspaper supplements, magazines and mail order catalogues; folding cartons and other flexible packaging materials; and specialty products such as wall and floor coverings, decorated household paper products, and vinyl upholstery. Lastly, flexography is the major printing industry for flexible packaging and laminates, multiwall bags, milk cartons, gift wrap, folding cartons, corrugated paperboard (which is sheet fed), paper cups and plates, labels, tapes, and envelopes. Almost all milk cartons and multiwall bags and half of all flexible packaging are printed by this process.

Significant emissions from printing operations consist primarily of volatile organic solvents. VOC emissions vary depending on printing process, ink formulation and coverage, press size and speed, and operating time. Most of the solvent contained in the ink and used for dampening and clean-up eventually finds its way into the atmosphere, but some solvent remains with the printed product leaving the plant and is released to the atmosphere later.

Emissions of VOCs from printing are estimated to be 41 kilotonnes annually.[51] Of this total, the vast majority of the emissions come from printing facilities located within Ontario with the next greatest number of facilities in Quebec, followed by British Columbia, Manitoba and Nova Scotia. The remaining provinces and territories have few facilities and therefore few emissions of VOCs from printing facilities.

Overview of control measures already in place (in Canada, U.S., internationally)

In 1999, under the auspices of the CCME, an environmental code of practice was published for VOC emissions from the commercial and industrial printing industry.[52] Provincial governments have the opportunity to use this code of practice in their own regulations for the printing industry. There are currently no federal regulations in place.

In the provinces, the printing industry is regulated in accordance with each provincial government's legislation and regulations. In Ontario, for instance, the operation of printing facilities is governed by the provincial *Environmental Protection Act* and the *Ontario Water Resources Act* and by Certificates of Approval issued to each individual facility by the provincial Ministry of the Environment. The Ontario *Regulation 419/05: Air Pollution – Local Air Quality* sets point of impingement standards for air pollutants and the Ontario *Regulation 127/01: Airborne Contaminant Discharge Monitoring and Reporting* may require some printing facilities to report their emissions.

In the United States, the SCAQMD regulated graphic arts printing and coating operations in June 2008 and the graphics arts and screen printing in 1999. The U.S. EPA has set standards of performance for the graphic arts industry publication rotogravure printing (first adopted 1982 and amended October 2000, for flexible vinyl and urethane coating and printing). In addition, the U.S. EPA has regulations setting standards for hazardous air pollutant emissions from the printing and publishing industry. The VOC emission limits in place in the United States are illustrated in Tables 1, 2 and 3 in Appendix IV.

The European Commission has developed a VOC Solvent Directive 99/13/EC to address sectors of solvent-consuming activities including printing.[53] The European Commission provides guidance on best available techniques for surface treatment of solvents including three printing processes using solvents on a large scale (heatset web offset, flexible packaging and publication gravure).[54]

Hong Kong's Environmental Protection Department has implemented the *Air Pollution Control Ordinance (Volatile Organic Compounds) Regulation*, effective from April 1, 2007, to control the VOC emissions from architectural paints/coatings, printing inks and selected consumer products. The VOC Regulation imposes maximum limits on the VOC content of printing inks at levels that put Hong Kong on par with the internationally most stringent Californian standards.[55]

Opportunities for reductions

The opportunities for printing and publication companies to reduce VOC emissions fall into three main categories:

i. Material substitution: By using low VOC inks, cleaners and fountain solutions, printers deal directly with the source of the problem. Water-based inks, vegetable-oil-based inks and energy-cured inks are all low or no-VOC alternatives that are widely available today. There are also reduced VOC alternatives available for cleaning and fountain solutions.

ii. Good housekeeping: The lowest cost option available to printing facilities encourages the reduced use of solvents and improved containment of used solvents. Simple measures, such as ensuring solvent containers are closed when not in use and placing used solvent rags in closed containers (for future recycling) go a long way to reducing VOC emissions from printing facilities. These techniques will often result in financial savings due to reduced solvent purchases.
iii. Control and capture technology: The first two alternatives are not always available or sufficient in the reduction of VOC emissions. When this situation arises, facilities can use control and capture technologies to reduce VOC emissions. Control and capture uses ventilation systems to direct emissions to devices that will capture or destroy them. Captured emissions can be recycled and re-used.

A combination of the above mentioned approaches could be used to reduce VOC emissions from this sector.

7. DESIGN CONSIDERATIONS

7.1 Improve Air Quality

Action under the federal agenda will be part of the overall effort to improve air quality throughout Canada. Many developed countries throughout the world are now taking actions to reduce VOCs in order to manage ozone. Emission reductions solely focused on nitrogen oxides have proven to be ineffective unless coupled with additional measures targeted towards VOCs.

Consistent with the commitment made on April 26, 2007, in the Regulatory Framework for Air Emissions,[56] the Government of Canada will work with other jurisdictions to develop further measures to address VOC emissions from consumer and commercial products in the 2010–2020 timeframe.

7.2 Alignment with the United States

In considering measures for the Agenda, particular attention has been paid to control actions in the U.S. to identify opportunities for alignment. Actions in the U.S. at the federal level, coupled with initiatives undertaken by states in ozone non-attainment areas, have resulted in a number of control strategies, and the U.S. experience provides detailed insight and perspectives in the areas of priority setting, reduction strategies and the implementation of instruments. The fact that many products that are potential candidates for action are often subject to cross-border trade is a further reason to investigate common approaches. Finally, Canada and the U.S. have a long history of cooperative measures on transboundary air pollution issues, and there are advantages in aligning control measures to provide consistency in approach.

7.3 Types of Measures

In determining the reduction/control measures for inclusion in the Agenda, the full range of management tools will be considered. This includes CEPA instruments (e.g., regulations, codes of practice), voluntary agreements (e.g., environmental performance agreements, memoranda of understanding) and outreach activities on consumer use.

7.3.1 Establishment of National Standards for VOC Content of Products

Actions

CEPA 1999 could be used to develop and establish national standards for priority product categories. Initial actions would build upon product standards that have been developed and proven elsewhere, particularly those that have been developed in the U.S. This alignment could include consideration of content limits used in the federal (U.S. EPA) regulations, as well as those adopted by the OTC and the State of California in instances where such values have significant national influence.

Rationale

In pursuing VOC reductions from consumer and commercial products, the Government of Canada is of the opinion that national standards for VOC content could be established through CEPA 1999 control instruments for priority categories. The federal government has a long tradition of controlling products and would be well positioned to develop new national standards.

A mandatory approach for VOC content in priority product categories could provide an assured VOC reduction effort and definitive, transparent action on VOC emissions from the solvent sector.

Canada lags the U.S. in implementing measures on the VOC content of consumer and commercial products. Consequently, a focus of Environment Canada's actions over the years of the current Agenda has been alignment with controls already in place in the U.S. at the federal level.

The U.S. requirements have been in place for a number of years. As a consequence, reformulation to meet these content limits should not be technology-forcing for Canada. Standards in the U.S. are influencing the composition of products being manufactured in or imported into Canada. Products imported from the U.S. will comply with U.S. EPA requirements. In addition, Canadian manufacturers serving the U.S. market are required to comply with the applicable standards and may have adopted U.S. standards for domestic products for production efficiency.

States in the OTC and the State of California have implemented, or are in the process of implementing, VOC standards which may be more stringent than the federal regulations. In certain instances, OTC and California requirements are identical. Considering the combined economic and population sizes covered by the OTC states and the State of

California, these values may represent levels being achieved by a significant segment of U.S. industry and should be considered in the development of Canadian regulatory requirements, particularly in instances where they have become, or are likely to become, de facto national U.S. standards.

7.3.2 Influencing the Use of Commercial Products by Industrial Sectors

Actions

Environmental Performance Agreements may be negotiated with industrial sectors that are significant users of VOC-containing products. Potential candidate sectors are those identified for control action under the U.S. EPA regulatory schedule for consumer and commercial products, particularly those for which CTGs and VOC-oriented National Emission Standards for Hazardous Air Pollutants have been developed (e.g., auto and light-truck manufacturers). The goal will be alignment with U.S. targets and measures for these sectors.

Voluntary agreements already negotiated by Environment Canada with industry sectors that are potentially significant users of VOC-containing products could be updated to include appropriate commitments, with U.S. targets/measures being the reference criteria.

Targeted outreach programs by Environment Canada could promote adoption of best practices with respect to the use of VOC-containing products detailed in CCME guidelines on printing, automotive refinish coating and industrial maintenance coating. This activity would be ongoing over the course of the Agenda.

Rationale

Environment Canada recognizes that in certain situations, voluntary instruments may be an effective and efficient approach to achieving a desired environmental objective.

Environmental Performance Agreements provide a mechanism by which to address VOC emissions from the use of commercial products in industrial settings where control is most effectively implemented at the point of end use and the population of end users is likely to be readily identifiable.

The U.S. EPA uses CTGs in lieu of regulations where a CTG will be substantially as effective in reducing VOC emissions. A CTG is often the selected option in the U.S. when compliance efforts can most effectively be focused within a State Implementation Plan process, for instance. Environmental Performance Agreements may provide a mechanism for a similar sector-oriented approach in Canada.

In addition, voluntary agreements already in place with industries which are significant users of VOC-containing products provide an opportunity for updating to include appropriate commitments on VOC-containing products.

The National Pollutant Release Inventory could provide a public report on VOC emissions from those facilities that are major users of VOC-containing products and thus a yearly report card on the success of reduction efforts in these areas.

7.3.3 Reducing Federal House Emissions

Measures could be implemented to reduce VOC emissions from the use of consumer and commercial products within the Federal House. Federal departments and agencies are involved in activities that use products addressed under this Agenda and, consequently, there are opportunities for development and implementation of reduction strategies.

7.3.4 Revisiting Existing VOC Regulations

As new standards are developed in the U.S. for consumer and commercial products where regulations already exist and where opportunity for further reductions of VOCs and lower limits could be feasible due to improving technology, existing Canadian VOC regulations could be revisited, where maintaining competitiveness and achieving alignment in the North American marketplace benefits Canadians.

8. PATH FORWARD

Consistent with the process followed in developing the Federal Agenda for Cleaner Vehicles, Engines and Fuels and the Federal Agenda for the Reduction of VOC Emissions from Consumer and Commercial Products, national multi-stakeholder consultations will be undertaken on this Agenda, including a national workshop. Following the consultations and in consideration of stakeholder advice/comments, a formal Notice of Intent (NOI) will be published in Part I of the *Canada Gazette*. The NOI will lay out an agenda of planned measures and future activities to be undertaken by 2020 to deal with VOC emissions from consumer and commercial products, with timeframes for implementation specified.

Following the NOI, the normal process for developing regulations, voluntary agreements and other types of proposed measures will be undertaken in consultation with affected stakeholders through the normal and applicable processes.

Appendix I: Definition of VOCs

Volatile Organic Compounds are defined as volatile organic compounds that participate in atmospheric photochemical reactions, excluding the following[57]

(*a*) methane;
(*b*) ethane;
(*c*) methylene chloride (dichloromethane);
(*d*) 1,1,1-trichloroethane (methyl chloroform);
(*e*) 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113);
(*f*) trichlorofluoromethane (CFC-11);
(*g*) dichlorodifluoromethane (CFC-12);
(*h*) chlorodifluoromethane (HCFC-22);
(*i*) trifluoromethane (HFC-23);
(*j*) 1,2-dichloro-1,1,2,2-tetrafluoroethane (CFC-114);
(*k*) chloropentafluoroethane (CFC-115);
(*l*) 1,1,1-trifluoro-2,2-dichloroethane (HCFC-123);
(*m*) 1,1,1,2-tetrafluoroethane (HFC-134a);
(*n*) 1,1-dichloro-1-fluoroethane (HCFC-141b);
(*o*) 1-chloro-1,1-difluoroethane (HCFC-142b);
(*p*) 2-chloro-1,1,1,2-tetrafluoroethane (HCFC-124);
(*q*) pentafluoroethane (HFC-125);
(*r*) 1,1,2,2-tetrafluoroethane (HFC-134);
(*s*) 1,1,1-trifluoroethane (HFC-143a);
(*t*) 1,1-difluoroethane (HFC-152a);
(*u*)parachlorobenzotrifluoride (PCBTF);
(*v*) cyclic, branched or linear completely methylated siloxanes;
(*w*) acetone;
(*x*) perchloroethylene (tetrachloroethylene);
(*y*) 3,3-dichloro-1,1,1,2,2-pentafluoropropane (HCFC-225ca);
(*z*) 1,3-dichloro-1,1,2,2,3-pentafluoropropane (HCFC-225cb);
(*z*.1) 1,1,1,2,3,4,4,5,5,5-decafluoropentane (HFC 43-10mee);
(*z*.2) difluoromethane (HFC-32);
(*z*.3) ethylfluoride (HFC-161);
(*z*.4) 1,1,1,3,3,3-hexafluoropropane (HFC-236fa);
(*z*.5) 1,1,2,2,3-pentafluoropropane (HFC-245ca);
(*z*.6) 1,1,2,3,3-pentafluoropropane (HFC-245ea);
(*z*.7) 1,1,1,2,3-pentafluoropropane (HFC-245eb);
(*z*.8) 1,1,1,3,3-pentafluoropropane (HFC-245fa);
(*z*.9) 1,1,1,2,3,3-hexafluoropropane (HFC-236ea);
(*z*.10) 1,1,1,3,3-pentafluorobutane (HFC-365mfc);
(*z*.11) chlorofluoromethane (HCFC-31);
(*z*.12) 1-chloro-1-fluoroethane (HCFC-151a);
(*z*.13) 1,2-dichloro-1,1,2-trifluoroethane (HCFC-123a);
(*z*.14) 1,1,1,2,2,3,3,4,4-nonafluoro-4-methoxy-butane ($C_4F_9OCH_3$);
(*z*.15) 2-(difluoromethoxymethyl)-1,1,1,2,3,3,3-heptafluoropropane $[(CF_3)_2CFCF_2OCH_3]$;
(*z*.16) 1-ethoxy-1,1,2,2,3,3,4,4,4-nonafluorobutane ($C_4F_9OC_2H_5$);

(*z*.17) 2-(ethoxydifluoromethyl)-1,1,1,2,3,3,3-heptafluoropropane [$(CF_3)_2CFCF_2OC_2H_5$]; and
(*z*.18) methyl acetate and perfluorocarbon compounds that fall into the following classes:
(i) cyclic, branched or linear completely fluorinated alkanes,
(ii) cyclic, branched, or linear completely fluorinated ethers with no unsaturations,
(iii) cyclic, branched or linear completely fluorinated tertiary amines with no unsaturations, and
(iv) sulphur containing perfluorocarbons with no unsaturations and with sulfur bonds only to carbon and fluorine.

Appendix II: Brief History of Action on VOCs

- Early 1990s to present day: The Canadian Council of Ministers of Environment developed the NO_x/VOC Management Plan to address ground-level ozone. To implement the Management Plan, the following have been developed as guidance for Canadian governments in their efforts to reduce VOC emissions:
  - Environmental Code of Practice for the Reduction of Solvent Emissions from Dry Cleaning Facilities
  - Environmental Code of Practice – Vapour Recovery in Gasoline Distribution Networks
  - A Program to Reduce Volatile Organic Compound Emissions by 40 Percent from Adhesives and Sealants
  - Environmental Code of Practice for the Reduction of Solvent Emissions from Commercial and Industrial Degreasing Facilities
  - Environmental Code of Practice for Vapor Recovery During Vehicle Refueling at Service Stations and Other Gasoline Dispensing Facilities (Stage 2)
  - New Source Performance Standards and Guidelines for the Reduction of Volatile Organic Compound Emissions from Canadian Automotive OEM Coating Facilities
  - Environmental Guideline for the Reduction of Volatile Organic Compound Emissions from the Plastics Processing Industry
  - National Standard and Guidelines for the Reduction of Volatile Organic Compounds from Canadian Commercial/Industrial Surface Coating Operations – Automotive Refinishing
  - National Standards for the Volatile Organic Compound Content of Canadian Commercial/Industrial Surface Coating Operations – Automotive Refinishing
  - Environmental Code of Practice for the Reduction of Volatile Organic Compound Emissions from the Commercial/Industrial Printing Industry
  - Recommended CCME Standards and Guidelines for the Reduction of VOC Emissions From Canadian Automotive Parts Coatings Operations
  - Recommended CCME Standards and Guidelines for the Reduction of VOC Emissions from Canadian Industrial Maintenance Coatings
  - Guidelines for the Reduction of VOC Emissions in the Wood Furniture Manufacturing Sector
  - National Framework for Petroleum Refinery Emission Reductions
- 2000 – Signing of Ozone Annex with U.S.
- 2003 – Final Regulations under the *Canadian Environmental Protection Act, 1999* (CEPA 1999) on Degreasing and Dry Cleaning as per commitments in the Ozone Annex.
- On March 27, 2004, the Ministers of the Environment and of Health published Canada's *Federal Agenda for Reduction of Emissions of Volatile Organic Compounds (VOC) from Consumer and Commercial Products*. The Federal Agenda outlined the Government of Canada's plan to develop regulations under CEPA 1999 to set VOC emission standards for architectural coatings, consumer products and auto-refinishing.
- In October 2006, the Government of Canada published the *Notice of intent to develop and implement regulations and other measures to reduce air emissions* (the notice of intent). The notice of intent outlined the approach that would be taken to reduce the emission of air pollutants, including a commitment to propose regulations under CEPA 1999 to limit the concentration of VOCs in consumer and commercial products.
- In April 2007, the Government of Canada released its Regulatory Framework for Air Emissions (see footnote 9) (the regulatory framework). The regulatory framework identifies the reduction of VOC emissions from consumer and commercial products as part of the national Clean Air Regulatory Agenda. This includes:

- Significant reductions of VOC emissions and other smog precursors from industrial, commercial and consumer products
- Bringing forward regulations between 2007 and 2010 to limit VOC concentration in architectural coatings, automotive refinishing products and certain consumer products
- Aligning the VOC concentration limits, where appropriate, with similar requirements in the U.S.

Appendix III: 2007 National Emission Inventory of VOC for Canada[e]

2007 VOC Emissions for Canada (Version 1, April 2009)	**VOC(t)**
Sectors	
Miscellaneous Sources	
Cigarette smoking	9.1
Dry cleaning	161
General solvent use	253 539
Refined petroleum products retail	50 555
Printing	45 568
Structural fires	261
Surface coatings	77 337
Human	
Other miscellaneous sources	
Total Miscellaneous	**427 431**
Total VOCs Without Open and Natural Sources	**1 962 504**

[e] Environment Canada, Pollution Data Division.

Appendix IV: Measures in Place in the United States

1. Asphalt Cutbacks

The U.S. control measures for VOC from use of cutback asphalts include:

- U.S. EPA: Control of Volatile Organic Compounds from Use of Cutback Asphalt. December 1977. EPA-450/2-77-037
- U.S. EPA: National Emission Standards for Hazardous Air Pollutants: Asphalt Processing and Asphalt Roofing Manufacturing. May 7, 2003 http://www.epa.gov/EPA-AIR/2001/November/Day-21/a28192.htm
- California San Joaquin Valley Air Pollution Control District. Rule 4641: Cutback, Slow Cure, and Emulsified Asphalt, Paving and Maintenance Operations (adopted April 11, 1991, amended September 19, 1991, amended December 17, 1992) http://www.valleyair.org/rules/currntrules/r4641.pdf
- California South Coast Air Quality Management District (SCAQMD). RULE 1108 – CUTBACK ASPHALT (adopted: 05/04/79; last amended: 02/01/85) http://www.arb.ca.gov/DRDB/SC/CURHTML/R1108.HTM and RULE 1108.1 – EMULSIFIED ASPHALT (adopted August 3, 1979) (amended December 4, 1981) (amended November 4, 1983) http://www.arb.ca.gov/DRDB/SC/CURHTML/R1108.HTM
- California Bay Area Air Quality Management District (BAAQMD) – Regulation 8. Organic Compounds Rule 15: Emulsified and Liquid Asphalts (adopted March 21, 1979) (amended September 16, 1987) http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/Rules%20and%20Regs/reg%2008/rg0815.ashx

In summary, the requirements are:

CUTBACK ASPHALT

- A person shall not manufacture, sell, offer for sale, use, or apply for paving, construction, or maintenance of parking lots, driveways, streets, or highways any:
- Rapid- or medium-cure cutback asphalt, or
- Slow-cure cutback asphalt material that contains more than 0.5% by volume VOCs that evaporate at 500°F (260°C) or less.

EMULSIFIED ASPHALT

- A person shall not manufacture, sell, offer for sale, use, or apply for paving, construction, or maintenance of parking lots, driveways, streets, or highways any emulsified asphalt material that contains more than 3.0% by volume VOCs that evaporate at 500°F (260°C) or less.

Table 1 provides a list of asphalt categories and performance standards for both the U.S. national and California Air Resources Board (CARB) regulations.

Table 1: Standards for Use of Asphalt[58]

Asphalt Categories	U.S. National	CARB
Rapid-cure Liquid Asphalt	A person shall not manufacture for sale nor use it for penetrating prime coat, tack coat, dust palliative, or other paving and maintenance operations.	A person shall not use any rapid-cure liquid asphalt in paving material or in paving and maintenance operations.
Medium-cure Liquid Asphalt	A person shall not manufacture for sale nor use it for penetrating prime coat, tack coat, dust palliative, or other paving and maintenance operations.	A person shall not use any medium-cure liquid asphalt in paving material or in paving and maintenance operations. Except exemptions, cool weather (when National Weather Service forecasts that atmospheric temperature for the 24-hour period following application of asphalt will not exceed 10°C (50°F)).
Emulsified Asphalt	A person shall not manufacture for sale nor use emulsified asphalt that contains organic compounds, in excess of 3% by volume, which evaporate at 500°F or lower.	A person shall not use any emulsified asphalt containing petroleum solvents in excess of 3% by volume in paving material or in paving and maintenance operations.
Slow-cure Liquid Asphalt (Road Oil)	A person shall not manufacture for sale nor use if the slow-cure asphalt, which as produced for application contains more than 0.5% of organic compounds that evaporate at 500°F or lower.	A person shall not use any slow-cure liquid asphalt that contains more than 0.5% by volume of petroleum solvents which boil at less than 260ºC (500ºF) as determined by ASTM Distillation Method D402 in paving material or in paving and maintenance operations.
Prohibition of Manufacture and Sale	–	No person shall manufacture, offer for sale or sell liquid asphalt or emulsified asphalt product if such product is prohibited by any of the provisions of this rule. The prohibition of this section shall apply to the manufacture and sale of any liquid asphalt or emulsified asphalt product which will be applied at any physical location within the District.
Prohibition of Specification	–	No person shall require for use or specify the application of a liquid asphalt or emulsified asphalt product if such product is prohibited by any of the provisions of this rule. The prohibition of this Section shall apply to all written or oral contracts under the terms of which any liquid asphalt or emulsified asphalt product is to be applied at any physical location within the District.

2. Portable Fuel Containers

The U.S. control measures for VOC from Portable Fuel Containers include:

- U.S. EPA: Approval and Promulgation of Air Quality Implementation Plans; Maryland; Amendments to the Control of Volatile Organic Compound Emissions from Portable Fuel Containers. July 17, 2008.
- CARB: PORTABLE FUEL CONTAINER REGULATIONS, JULY 29, 2005. http://www.arb.ca.gov/consprod/fuel-containers/pfc/pfcreg2005.pdf
- Ozone Transport Commission (OTC) Model Rule for Portable Fuel Container. 2007. http://www.otcair.org/interest.asp?Fview=stationary# The OTC Model Rule for Portable Fuel Container is based on the Portable Fuel Container Regulations of the CARB.

Table 2 provides a list of identical performance standards in both CARB and OTC rules.

Table 2: Performance Standards for Portable Fuel Containers to Reduce VOC Emissions[59]

Required Features	Details
Automatic shut-off	• Has an automatic shut-off that stops the fuel flow before the target fuel tank overflows.
Automatic closure	• Automatically closes and seals when removed from the target fuel tank and remains completely closed when not dispensing fuel.
No secondary vent	• Has only one opening for both filling and pouring.
Maximum permeation rate	• Does not exceed a permeation rate of 0.4 grams per gallon per day.
Warranty	• Warranted for a period of not less than one year against defects in materials and workmanship.

3. Cars, Vans, Light Trucks Assembly Coating/Auto Parts Coatings

The U.S. control measures for VOC from cars, vans and light trucks assembly coating include:

- CARB: SCAQMD RULE 1115. MOTOR VEHICLE ASSEMBLY LINE COATING OPERATIONS (Adopted March 2, 1979) (last amended May 12, 1995) http://www.arb.ca.gov/DRDB/SC/CURHTML/R1115.HTM
- U.S. EPA: Consumer and Commercial Products, Group IV: Control Techniques Guidelines in Lieu of Regulations for Miscellaneous Metal Products Coatings, Plastic Parts Coatings, Auto and Light-Duty Truck Assembly Coatings. October 7, 2008. http://www.epa.gov/EPA-AIR/2008/October/Day-07/a23750.htm

Table 3: VOC Emission Limits for Automobile and Light-duty Truck Assembly Coatings[60]

Coating	**VOC Limits** **Gram per Litre of Coating, Less Water and Less Exempt Compounds**				
	U.S. National			**CARB**	
	g/L (lb/gal)			**g/L**	**lb/gal**
Electrophoretic primer	When solids turnover ratio (Rt)>0.16:	When 0.040<Rt<0.160:	When Rt<0.040:	145	1.2
	84 (0.7)	84X350^0.I60-Rt (0.084x350^0.160-Rt x 8.34)	No VOC emission limit		
Primer-surfacer operations	1440 (12.0)			1800	15
Topcoat operations	1440 (12.0)			1800	15
Spray primer operations	–			1800	15
Final repair coating	580 (4.8)			580	4.8
Spray primer, primer surfacer and/or topcoat	–			1800	15
Combined primer-surfacer and topcoat operations	1440 (12.0)			–	–

Table 4: VOC Emission Limits for Motor Vehicle, Automobile and Light-duty Truck Coating Materials (U.S. National only)[61]

Coating	VOC Limits Grams per Litre of Coating, Less Water and Less Exempt Compounds	
	g/L	lb/gal
Motor vehicle cavity wax	650	5.4
Motor vehicle sealer	650	5.4
Motor vehicle deadener	650	5.4
Motor vehicle gasket/gasket sealing material	200	1.7
Motor vehicle underbody coating	650	5.4
Motor vehicle lubricating wax/compound	700	5.8
Motor vehicle trunk interior coating	650	5.4
Motor vehicle bedliner	200	1.7
Automobile and light-duty truck glass bonding primer	900	7.5
Automobile and light-duty truck adhesive	250	2.1
Automobile and light-duty truck cavity wax	650	5.4
Automobile and light-duty truck sealer	650	5.4
Automobile and light-duty truck deadener	650	5.4
Automobile and light-duty truck gasket/gasket sealing material	200	1.7
Automobile and light-duty truck underbody coating	650	5.4
Automobile and light-duty truck trunk interior coating	650	5.4
Automobile and light-duty truck bedliner	200	1.7
Automobile and light-duty truck weatherstrip adhesive	750	6.2
Automobile and light-duty truck lubricating wax/compound	700	5.8

4. Adhesives and Sealants

There is currently no nationwide rule or regulation for adhesives and sealants in the United States although a CTG: Control Techniques Guidelines for Miscellaneous Industrial Adhesives. EPA-453/R-08-005, September 2008. http://www.epa.gov/ttncaaa1/t1/ctg/misc_industrial_adhesive_ctg_093008.pdf. The OTC has a model rule that states are intended to implement through regulation and California's SCAQMD has a regulation to limit the VOC content of adhesives and sealants:

- OTC Model Rule For Adhesives and Sealants, January 1, 2009 http://www.otcair.org/interest.asp?Fview=stationary#
- SCAQMD Rule 1168 – Adhesive and Sealant Applications, last amended on January 7, 2005 http://www.arb.ca.gov/DRDB/SC/CURHTML/R1168.PDF

Table 5: VOC Content Limits for Adhesives – US National, OTC and CARB

	VOC Content Limits (g/L of coating)		
Product	**U.S. National**	**OTC**	**CARB**
ABS welding	400	400	**325**
Carpet adhesives (indoor)	150	150	50
Carpet adhesives (outdoor)	250	250	150
Carpet pad adhesives	–	–	50
Ceramic tile adhesives	130	130	65
Computer diskette jacket manufacturing	–	850	350
Contact bond	250	250	80
Cove base installation	150	150	50
CPVC welding	–	490	490
Dry wall and panel adhesives	–	–	50
Metal to urethane/rubber moulding or casting	850	850	–
Motor vehicle adhesive	250	–	–
Motor vehicle weatherstrip adhesive	750	–	–
Multipurpose construction	200	200	70
Non-membrane roof installation/repair	–	300	–
Other plastic cement welding	–	510	–
Perimeter bonded sheet vinyl flooring installation	660	660	–
Plastic solvent welding (excluding ABS)	500	–	–
PVC welding	–	510	510
Rubber floor adhesives	–	–	60
Sheet-applied rubber installation	850	850	850
Single-ply roof membrane adhesives	250	250	250
Special purpose contact adhesives	–	–	250
Structural glazing	100	100	–
Structural wood member adhesives	–	–	140
Subfloor adhesives	–	–	50
Thin metal laminating	780	780	–
Tire retread	100	100	–
Top and trim adhesives	–	–	**250**
VCT and asphalt tile adhesives	–	–	50
Waterproof resorcinol glue	170	170	–
Wood flooring adhesives	–	–	100

The value in **bold red** (ABS welding) has only been in effect since July 1, 2005. The value in **bold blue** (top and trim adhesives) has been effective since January 1, 2007.

Table 6: VOC Content Limits for Adhesives Primers – U.S. National, OTC and CARB

	VOC Content Limits (g/L of coating)		
Product	**U.S. National**	**OTC**	**CARB**
Automotive glass	700	700	–
Plastic	–	–	**550**
Plastic cement welding/plastic solvent welding	650	650	**250**
Single-ply roof membrane	250	250	–
Traffic marking tape	–	150	–
Other	250	250	–

The value in **bold green** (plastic cement welding) has been in effect since January 1, 2005. The value in **bold red** (plastic) has only been in effect since July 1, 2005.

Table 7: VOC Content Limits for Adhesives Applied to Listed Substrate – U.S. National, OTC and CARB

	VOC Content Limits (g/L of coating)		
Product	**U.S. National**	**OTC**	**CARB**
Flexible vinyl	250	250	–
Fiberglass	200	200	80
Metal	30	30	30
Plastic foams	–	–	50
Porous material	120*	120	50*
Reinforced plastic composite	200	–	–
Rubber	250	250	–
Wood	30	–	30
Other substrates	250	250	–

*Wood is excluded from this category.
The data listed under CARB are the current VOC limits since the last amendment unless stated otherwise.

Table 8: VOC Content Limits for Sealants – U.S. National, OTC and CARB

	VOC Content Limits (g/L of coating)		
Product	**U.S. National**	**OTC**	**CARB**
Architectural	–	250	250
Marine deck	–	760	760
Non-membrane roof	–	300	300
Roadway	–	250	250
Single-ply roof membrane	–	450	450
Other	–	420	420

Table 9: VOC Content Limits for Sealants Primers – U.S. National, OTC and CARB

	VOC Content Limits (g/L of coating)		
Product	**U.S. National**	**OTC**	**CARB**
Non-porous architectural	–	250	250
Porous architectural	–	775	775
Marine deck	–	760	760
Modified bituminous	–	–	500
Other	–	750	750

For the VOC limits set by CARB, all adhesives, adhesives bonding primers, adhesive primers or any other primer, the content must not exceed 250g/L of less water and less exempt compounds.

5. Aerosol Coatings

CARB published the rule for aerosols coatings for both consumer and industrial markets in 2000 using the reactivity-based rule instead of the traditional grams per litre for VOC content limit, which was later adopted by the U.S. EPA in 2007.

- Clean Air Act 40 CFR Part 59 Subpart E – National Volatile Organic Compound Emission Standards for Aerosol Coatings http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=d90abcc2092d670d344d6a3c3ce7e857&rgn=div6&view=text&node=40:5.0.1.1.7.5&idno=40
- California Air Resources Board. Consumer Product Regulations. Regulation for Reducing the Ozone formed from Aerosol Coating Product Emissions. http://www.arb.ca.gov/consprod/regs/2008/aptmirtab.pdf

Table 10: VOC Content Limits for Aerosol Coating Products – U.S. National and CARB[62]

	VOC Content Limits (g O_3/g product)	
Coating category	**U.S. National**	**CARB**
Clear coatings	1.50	1.50
Flat paint coatings	1.20	1.20
Fluorescent coatings	1.75	1.75
Metallic coatings	1.90	1.90
Non-flat coatings	1.40	1.40
Primers	1.20	1.20
Art fixatives or sealants	1.80	1.80
Auto body primers	1.55	1.55
Automotive bumper and trim products	1.75	1.75
Aviation or marine primers	2.00	2.00
Aviation propeller coatings	2.50	2.50
Corrosion resistant brass, bronze, or copper coatings	1.80	1.80
Exact match finishes		
Engine enamel	1.70	1.70
Automotive	1.50	1.50
Industrial	2.05	2.05
Floral sprays	1.70	1.70
Glass coatings	1.40	1.40
Ground traffic/marking coatings	1.20	1.20
High temperature coatings	1.85	1.85
Hobby/model/craft coatings		
Enamel	1.45	1.45
Lacquer	2.70	2.70
Clear or metallic	1.60	1.60
Marine spar varnishes	0.90	0.90
Photograph coatings	1.00	1.00
Pleasure craft finish primers, surfacers or undercoaters	1.05	1.05
Pleasure craft topcoats	0.60	0.60
Polyolefin adhesion promoters	2.50	–
Shellac sealers		
Clear	1.00	1.00
Pigmented	0.95	0.95
Slip-resistant coatings	2.45	2.45
Spatter/multicoloured coatings	1.05	1.05
Vinyl/fabric/leather/polycarbonate coatings	1.55	1.55
Webbing/veil coatings	0.85	0.85
Weld-through primers	1.00	1.00
Wood stains	1.40	1.40
Wood touch-up, repair or restoration coatings	1.50	1.50

The VOC content limits established by the U.S. EPA were modeled after CARB. The EPA adopted the same values as CARB. From clear coatings to primers (general coatings), the values are in effect since June

1, 2002. From art fixatives or sealants to wood touch-up, repair or restoration coatings (specialty coatings), the values are in effect since January 1, 2003. Of the recent documented amendments, none of them affected the VOC limit values listed above.

6. Rubber Product Manufacturing amd Plastic Parts Coatings

U.S. EPA and OTC have not published anything regarding this category of products.

The California SCAQMD has developed Rule 1145 – Plastic, Rubber, Leather and Glass Coatings, http://www.arb.ca.gov/DRDB/SC/CURHTML/R1145.PDF to reduce VOC emissions from the application of coatings to any plastic, rubber, leather or glass products. The VOC content was determined by the U.S. EPA Reference Method 24 – Determination of Volatile Matter Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coatings, Code of Federal Regulations Title 40, Part 60, Appendix A) as well as by SCAQMD Method 304 – Determination of Volatile Organic Compounds (VOCs) in Various Materials.

Table 11: VOC Content Limits on Plastic Parts Coating and Rubber Product Manufacturing (CARB only)

Coating Categories	VOC Content Limits (g/L of coating)
Electrical dissipating and shock free	360
Extreme performance two-component	**420**
General one-component	**120**
General two-components	**120**
Leather antique	156
Leather color	60
Leather sealer	60
Leather stain	216
Leather top	**120**
Metallic	420
Military specification one-component	340
Military specification two-component	420
Mirror backing curtain coated	500
Mirror backing rolled coated	**312**
Mold seal	750
Multi-coloured	685
Optical	**50**
Vacuum metalizing	800

All the values in regular font under CARB are the current VOC limits. The one in **bold green** (leather top) is effective since January 1, 2005; the value in **bold orange** (extreme performance two-component) a year after those in bold green. As for the ones in **bold blue** (**g**eneral one-component, mirror backing rolled coated and optical coatings), they have been in effect since January 1, 2007. The most recent modification was made in January 1, 2008, for General two-components, shown in **pink**.

7. Printing

The U.S. control measures for VOC emissions from printing include:

- California Air Resources Board South Coast Air Quality Management District (CARB: SCAQMD) Regulation 8, Rule 20: Graphic Arts Printing and Coating Operations, June 2008. http://www.arb.ca.gov/DRDB/BA/CURHTML/R8-20.HTM
- CARB: SCAQMD Rule 1130. Graphics Arts and Screen Printing (first adopted August 2, 1911; last amended October 8, 1999) http://www.arb.ca.gov/DRDB/SC/CURHTML/R1130.HTM
- U.S. EPA: Rotogravure Printing. Title 40: Protection of Environment, PART 60-Standards of Performance for New Stationary Sources, SubpartQQ – Standards of Performance for the Graphic Arts Industry: Publication Rotogravure Printing (first adopted 1982 and amended October 2000) http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=185bdc165a6c68b9a1df1bc3fa8e658c&rgn=div6&view=text&node=40:6.0.1.1.1.56&idno=40
- U.S. EPA: Flexography Printing. Title 40: Protection of Environment, PART 60-Standards Performance for Flexible Vinyl and Urethane Coating and Printing. (first adopted 1982) of Performance for New Stationary Sources, SubpartFFF – Standards of Performance for Flexible Vinyl and Urethane Coating and Printing (amended October 2000) http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr;sid=7460851454a5527b4dab1830c46a7707;rgn=div6;view=text;node=40%3A6.0.1.1.1.70;idno=40;cc=ecfr
- U.S. EPA: Final Rule of Standards for Hazardous Air Pollutant Emission from the Printing and Publishing Industry http://www.epa.gov/EPA-AIR/2006/May/Day-24/a4821.htm

Table 12: VOC Emission Limits for Printing and Publishing Industry

Graphic Arts Operations	VOC Limits in g/l (lb/gal)
Lithographic ink, blanket and roller washes	300 (2.5)
Lithographic, other cleaners	300 (2.5)
Screen printing, ink removal products	300 (2.5)
Gravure ink	300 (2.5)
Gravure cleaning products	450 (3.7)
Letterpress ink	300 (2.5)
Letterpress cleaning products	500 (4.2)
Ultraviolet inks, ink removal products	300 (2.5)
Adhesive application equipment cleaning products	500 (4.2)
Flexographic ink (porous substrate)	225 (1.9)
Flexographic ink (non-porous substrate)	300 (2.5)
Flexographic printing cleaning products	500 (4.2)
Specialty flexographic cleaning products	500 (4.2)

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